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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE WOLF MOUNTAIN QUADRANGLE, ROUTT COUNTY, COLORADO

(Report includes 11 plates)

Prepared for:

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GEOLOGICAL SURVEY

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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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INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Wolf Mountain quadrangle, Routt County, Colorado. This report was compiled to support the land-planning work of the Bureau of Land Management and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the United States Geological Survey under contract number 14-08-0001-15789. Published and unpublished public information was used as the data base for this study. No new drilling or field mapping was done as part of this study, nor was any confidential data used.

Location

The Wolf Mountain 7½-minute quadrangle is located in central Routt County in northwestern Colorado, approximately 8 mi (13 km) northwest of Steamboat Springs and 20 mi (32 km) northeast of Craig, Colorado. With the exception of a few ranches, the area within the quadrangle is unpopulated.

Accessibility

U.S. Highway 40 passes approximately 2 mi (3.2 km) south of the Wolf Mountain quadrangle. The southern half of the quadrangle is accessible along unimproved roads which head northward from U.S. Highway 40. An improved road leaves U.S. Highway 40 at Mount Harris and runs diagonally southwest to northeast across the quadrangle along the valley of Wolf Creek.

Railway service for the Wolf Mountain quadrangle is provided by the Denver and Rio Grande Western Railroad from Denver to the railhead at Craig. The route passes 2 mi (3.2 km) south of the quadrangle and serves as the major transportation route for coal shipped east from northwestern Colorado.

Physiography

The Wolf Mountain quadrangle lies on the eastern edge of the Colorado Plateau in the rugged Elkhead Mountains. This area extends northeastward from the Yampa River Valley to the edge of the Park Range, which forms the Continental Divide in northwest Colorado.

Approximately 2300 ft (700 m) of relief is present in the Wolf Mountain quadrangle, from a high elevation of 9145 ft (2787 m) on Wolf Mountain in the northwest, to below 6800 ft (2073 m) in the creek valleys in the southern edge of the quadrangle. The landscape of the quadrangle is characterized by ridge and valley topography. The high ridges and steep slopes of the central portion of the quadrangle are dissected by narrow canyons along stream valleys; whereas in the northeast quarter of the quadrangle, more gentle slopes and wider stream valleys are dominant. The resistant remnants of volcanic dikes and sills form the prominent topographic highs of Wolf Mountain, Sand Mountain, Slippery Sides Mountain, and Rattlesnake Butte.

Two drainage systems are present in the Wolf Mountain quadrangle. The southern portion of the quadrangle is drained by Tow Creek and Wolf Creek which flow directly into the Yampa River. The northern half of the quadrangle is drained by Deep Creek, Chimney Creek, Salt Creek, Farnsworth Creek and other small tributaries of the Elk River, which flows southeastward into the Yampa River.

Climate and Vegetation

The climate of northwest Colorado is semi-arid. The Sierra Nevada Mountains block much of the Pacific moisture, and moist air from the Gulf of Mexico is blocked by the Rocky Mountains. Clear, sunny days prevail in the Wolf Mountain area, with daily temperatures varying from 0° to 35° F (-18°

to 2° C) in January to 42° to 80° F (6° to 27° C) in July. Annual precipitation in the area averages approximately 20 in (51 cm), most of which occurs as snowfall during the winter months.

Open to very-dense stands of deciduous trees, often relatively small in size, occur at higher elevations in the Wolf Mountain quadrangle where moisture and soil depth are adequate. At lower elevations and in the northeastern quarter of the quadrangle, the typical mountain shrubbery ranges from 2 to 8 ft (0.6 to 2.4 m) in height.

Land Status

The Wolf Mountain quadrangle lies in the eastern edge of the Yampa Known Recoverable Coal Resource Area. Most of the western edge and a small area in the south-central part of the quadrangle lie within the KRCRA. The coal ownership status is shown on plate 2 of the Coal Resource Occurrence maps. No outstanding Federal coal leases, prospecting permits, or licenses are located within the quadrangle.

GENERAL GEOLOGY

Previous Work

The first geologic description of the general area of the Wolf Mountain quadrangle was published by Emmons (1877) as part of the Survey of the Fortieth Parallel. The decision to build a railroad into the region stimulated several investigations of coal between 1886-1905, including papers by Chisholm (1887), Storrs (1902), Hewett (1889), Hills (1893), and Parsons and Liddell (1903). Fenneman and Gale (1906) published a geologic report on the Yampa Coal Field including a description of the geology and occurrence of coal in the Wolf Mountain quadrangle. In 1955, Bass, Eby and Campbell expanded Fenneman and Gale's work in their report on the geology and mineral fuels of parts of Routt and Moffat Counties. This report by Bass, Eby and Campbell remains the most comprehensive work on the area and forms the basis from which this study is taken.

Stratigraphy

The majority of the rocks which crop out in the Wolf Mountain quadrangle are Upper Cretaceous in age, and include the coal-bearing Iles and Williams Fork Formations of the Mesaverde Group.

Approximately 4000+ ft (1200+ m) of Upper Cretaceous Mancos Shale is exposed in the central and eastern portions of the quadrangle. The Mancos Shale consists of dark-gray marine shale with interbedded sandy shale and thin-bedded, tan, silty sandstone. The number and thickness of these beds of sandy shale and sandstone increase toward the top of the formation (Bass, Eby, and Campbell, 1955). No coal is present in the Mancos Shale.

The Upper Cretaceous Mesaverde Group conformably overlies the Mancos Shale in the Wolf Mountain area. The Mesaverde Group contains two formations, the Iles and the overlying Williams Fork. The 1500-ft-(457-m) thick Iles Formation crops out in a north-south trending line along the western edge and in the southeast quarter of the quadrangle. It consists of ledge-forming sandstone beds interbedded with gray, sandy shales. The major sandstones, in ascending order, are the Tow Creek Sandstone Member, the base of which forms the boundary between the Iles and the Mancos Shale; a recognizable double-ledge-forming sandstone about 400 ft (122 m) above the base of the Iles; and the Trout Creek Sandstone Member, which forms the contact between the Iles Formation and the overlying Williams Fork Formation. Coal beds are found beginning approximately 400 ft (122 m) above the base of the Iles and extending up to the Trout Creek Sandstone Member. These coal beds make up the Lower Coal Group of the Mesaverde Group.

The Williams Fork Formation, which is exposed in the northwest corner of the quadrangle, conformably overlies the Iles Formation. The Williams Fork Formation, which is approximately 1300 ft (400 m) thick in the Wolf Mountain area, is divided generally into four sequences: a lower coal-bearing sequence; a marine shale sequence; the Twentymile Sandstone Member; and an upper marine shaly sandstone sequence (Ryer, 1977). Only the lower coal-bearing sequence and the marine shale sequence are exposed in the Wolf Mountain quadrangle.

The lower coal-bearing sequence is designated as the Middle Coal Group of the Mesaverde Group, and contains approximately 300 ft (91 m) of interbedded siltstone, silty sandstone, very fine grained sandstone, and coal. Two major coal beds, the Wolf Creek and the Wadge, are found in the Middle Group. They are stratigraphically located approximately 30 to 40 ft (9 to 12 m) and 200 ft (60 m), respectively, above the top of the Trout Creek Sandstone Member. The marine shale sequence, approximately 600 ft (183 m) thick in the Wolf Mountain area, is composed of dark-gray to brown shale and siltstone. The marine shale sequence becomes more sandy toward the top of the unit and eventually grades into the overlying Twentymile Sandstone Member to the west of the Wolf Mountain quadrangle.

A thin layer of Tertiary-age Browns Park Formation rests unconformably on the Mancos Shale on top of Sand Mountain in sections 13 and 24, T. 7 N., R. 87 W., and section 19, T. 7 N., R. 86 W. The Browns Park Formation consists of semi-consolidated, white, tuffaceous sand, claystone and conglomerate.

The rocks exposed in the Wolf Mountain quadrangle accumulated close to the western edge of a Late Cretaceous epeirogenic seaway which covered part of the Western Interior of North America. Several regressive-transgressive cycles caused the deposition of a series of marine, near-shore marine, and non-marine sediments in the Wolf Mountain area. The Mancos Shale was deposited in an offshore marine environment which existed east of the shifting strand line. Deposition of the Mancos Shale in the quadrangle area ended with the eastward movement of the shoreline, and the subsequent deposition of the littoral marine Tow Creek Sandstone Member of the Iles Formation. The interbedded sandstones, shales, and coals of the Iles and Williams Fork Formations were deposited as a result of minor changes in position of the shoreline. The major environments present during deposition of the Iles and Williams Fork were near-shore marine, littoral, brackish and fresh water, and fluvial systems.

The coals with wide areal extent were deposited near the seaward margins of non-marine environments, probably in large brackish water lagoons or swamps. The slow migration of this depositional environment is responsible for the wide areal extent of the Wadge and Wolf Creek coal beds in the Yampa study area. Coals of limited areal extent were generally deposited in environments associated with fluvial systems, such as back-levee and coastal plain swamps, interchannel basin areas, and abandoned channels. The major sandstones of the Iles and Williams Fork Formations, such as the Trout Creek Sandstone Member, were deposited in shallow marine and near-shore environments. Subsequent deposition of the marine Lewis Shale marked a large landward movement of the sea, and the end of near-shore and continental sedimentation of the Mesaverde Group in the Wolf Mountain area.

Intrusive Rocks

Several areas in the Wolf Mountain quadrangle have been intruded by Upper Tertiary plugs, sills, and dikes of intermediate and basaltic composition. Wolf Mountain (sections 2 and 11, T. 7 N., R. 87 W.) and Slippery Sides Mountain (sections 17, 20, and 21, T. 7 N., R. 86 W.) contain part of a series of northwest-trending dikes of olivine basalt that have intruded the Mesaverde Group. Sand Mountain (T. 7 N., R. 86 and 87 W.) is part of a large mass of intrusive rocks located on the south flank of the Wolf Creek dome. The intrusion trends toward the northwest and covers almost 2 square miles. Several dikes and sills which consist of olivine-free basalt are associated with the Chimney Creek dome. Rattlesnake Butte (section 10, T. 7 N., R. 86 W.) is the remnant of a small plug.

Structure

The Yampa KRCRA lies in the southern extension of the Washakie/Sand Wash structural basin of south-central Wyoming. The basin is bordered on the east by the Park Range, some 7 mi (11 km) east of the Wolf Mountain quadrangle, and on the southwest by the Axial Basin anticline which is centered approximately 25 mi (40 km) southwest of the quadrangle.

The axis of a synclinal extension of the basin trends southeastward and passes approximately 7 mi (11 km) to the west of the quadrangle. This syncline is modified in the Wolf Mountain area by three major structural features -- the Tow Creek anticline, the Wolf Creek dome, and the Chimney Creek dome. The Tow Creek anticline, the largest structural feature in the eastern Yampa coal area, generally trends north-south and has a northeastward bend at the northern end. The Tow Creek anticline contains three crests; the Yampa crest, the Wolf Creek dome, and the Chimney Creek dome, which are separated from each other by a series of small synclines. The Wolf Creek dome lies 3 mi (4.9 km) slightly northwest of the Yampa crest, which forms the southern end of the anticline. Chimney Creek dome, the third crest of the anticline, lies approximately 3 mi (4.9 km) northeast of the Wolf Creek dome. Chimney Creek dome is probably related to an igneous intrusive, since numerous dikes and sills crop out around the dome. Several northwest-trending faults cut the Tow Creek anticline in the southern part of the quadrangle.

The coal-bearing rocks of the Iles and Williams Fork Formations lie to the west and south of the major structural features in the quadrangle. In the southeast corner of the quadrangle, rocks of the Iles Formation dip 7^{o} to 8^{o} to the south; while in the southwest corner of the quadrangle, the strata dip 14^{o} to 20^{o} to the southwest. In the northwest corner of the quadrangle, the strata dip 12^{o} to 14^{o} to the west.

COAL GEOLOGY

Several coal beds of the Middle and Lower Coal Groups of the Mesaverde Group have been identified in the quadrangle (CRO plate 1). The Lower Coal Group includes all coal beds beginning approximately 400 ft (122 m) above the base of the Iles Formation and extending to the Trout Creek Sandstone Member. The Middle Coal Group includes the coal beds between the Trout Creek and Twentymile Sandstone Members in the lower coal-bearing zone of the Williams Fork Formation. Coals of the Lower Group are characteristically lenticular and of limited areal extent, while the coal beds in the Middle Group, in the Wolf Mountain area, persist over a large area.

Lower Group Coals

The coals in the Lower Group have not been formally named, but for this report, the coal beds have been numbered with bracketed numbers for identification purposes in this quadrangle only (CRO plates 1 and 3).

Coal Beds {1}, {2}, {3}, and {4}. Lower Group Coals {1}, {2}, {3}, and {4} are exposed at the Franz Mine in section 36, T. 8 N., R. 87 W. Coal Bed {1} is 7 ft (2.1 m) thick and is found approximately 710 ft (216 m) below the top of the Trout Creek Sandstone Member. Bed {2} is also 7 ft (2.1 m) thick and lies 28 ft (8.5 m) above Bed {1}. Coal Bed {3} is 6 ft (1.8 m) thick and is separated from Bed {2} by 37 ft (11.3 m) of rock. Coal Bed {4} is 8.5 ft (2.6 m) thick and is located approximately 37 ft (11.3 m) above Bed {3}.

No information is available on the variation in thickness or the areal extent of these beds, but they are inferred to extend at least 1/2 mile from outcrop. A chemical analysis of the coal beds found at the Franz Mine is given in Table 1.

Beds {1}, {2}, {3}, and {4} are noncoking, high-volatile bituminous C in rank, on an as-received basis.

Coal Bed {5}. Lower Group Coal Bed {5} crops out in section 1, T. 6 N., R. 87 W. This 5.2-ft-(1.6-m) thick coal is found approximately 525 ft (160 m) stratigraphically below the top of the Trout Creek Sandstone Member (Bass, Eby, and Campbell, 1955). Because Bed {5} is known from a single outcrop, no information is available on variations in thickness or on the areal extent of this bed, but it is inferred to extend at least 1/2 mi from the point of measurement. No known chemical analysis of Coal Bed {5} has been made, but the quality of the coal is assumed to be similar to other coal beds of the Lower Coal Group of the Mesaverde Group, and thus is probably low sulfur, noncoking, high-volatile bituminous C in rank.

Coal Bed {6}. Bed {6} is exposed in the Butcher Knife Mine in section 1, T. 6 N., R. 87 W. This bed lies approximately 510 ft (155.5 m) above the Trout Creek Sandstone Member. Bed {6} is 5.8 ft (1.8 m) thick and contains a 0.1 ft (3 cm) parting of rock in the middle of the bed. Bed {6} is known only from this mine and cannot be correlated with other beds in the area. Its inferred extent is at least 1/2 mi along the strike of the beds and down dip. A chemical analysis of Coal Bed {6} is given in Table 1. The quality of the coal is similar to other Lower Group coal beds and is low sulfur, noncoking, high-volatile bituminous C in rank. Although Bed {6} has only been identified outside the KRCRA, a Reserve Base calculation is included in this report for the portions of this coal bed that are projected to lie on Federal coal land within the KRCRA boundary (CRO plate 2).

Coal Bed {7}. Bed {7} is exposed just southwest of Bed {6} in the Rice Mine in section 1, T. 6 N., R. 87 W. (CRO plate 1). Bed {7} lies stratigraphically approximately 60 ft (18 m) above Bed {6} and 450 ft (137 m) below the top of the Trout Creek Sandstone Member. The coal bed has a total thickness of 5.7 ft (1.7 m), including a 0.3 ft (9 cm) parting of rock in the upper third of the bed. The bed's areal extent is unknown, although it is assumed to extend at least 1/2 mile from the mine. A chemical analysis of Coal Bed {7} from samples taken at the Rice Mine is shown in Table 1. Bed {7} is low sulfur, noncoking, high-volatile bituminous C in rank, on an as-received basis.

Coal Bed {8}. Bed {8} has been mined at the Grey Mine in section 28, T. 7 N., R. 86 W. (CRO plate 1). The 5.7-ft-(1.7-m) thick bed lies on the axis of a small synclinal fold that plunges 7° to 8° to the south. No information regarding variations in coal thickness or of the areal extent of the bed is available, but the bed is inferred to extend at least 1/2 mile from the mine. A chemical analysis of Bed {8} from samples taken at the Grey Mine is given in Table 1. Ranked on an as-received basis, the coal is low sulfur, non-coking, high-volatile bituminous C.

Other Lower Group Coal Beds. Several other unnamed Lower Group coal beds are also exposed in the Wolf Mountain quadrangle. Three unnamed abandoned mines in the southwest corner of the quadrangle (sections 1 and 2, T. 6 N., R. 87 W.) were opened in coal beds of slightly less than the Reserve Base minimum thickness of 5 ft (1.5 m) (CRO plate 1). Three other coals, stratigraphically located 450 to 550 ft (137 to 167 m) below the Trout Creek, are exposed in section 4, T. 6 N., R. 86 W. (CRO plate 1). These coals vary from 4.8 to 3.4 ft (1.4 to 1.0 m) in thickness. These other Lower Group coals are lenticular in nature and often contain thin partings of rock.

No resource calculations were made for these coals because of their limited extent and because of the thinness of the beds. Also, no known chemical analyses have been made; the quality is assumed to be similar to other Lower Group coal beds, probably high-volatile bituminous C in rank.

Middle Group Coals

Wolf Creek Coal Bed. The Wolf Creek coal bed has been identified in a drill hole and in two outcrops in the northwest corner of the quadrangle (CRO plate 1). The Wolf Creek bed is situated approximately 50 ft (15 m) stratigraphically above the Trout Creek Sandstone Member. In the northwest corner of the quadrangle, the Wolf Creek bed thickens in a southwestwardly direction from less than 6 ft (1.8 m) to more than 11 ft (3.3 m). In the southwest corner of the quadrangle, the Wolf Creek bed is inferred to be present on the basis of data from adjoining quadrangles. Here the bed is inferred to be 7 to 8 ft (2.1 to 2.4 m) thick.

No chemical analyses have been made of the Wolf Creek bed in the Wolf Mountain quadrangle, but an analysis of the bed from a sample taken in the adjoining Quaker Mountain quadrangle was included in the report by Bass, Eby and Campbell (1955) and is shown in Table 1. The Wolf Creek coal bed is noncoking, high-volatile bituminous C coal, on an as-received basis.

Wadge Coal Bed. The Wadge coal bed, which lies approximately 160 ft (49 m) above the Wolf Creek bed, is identified from two outcrops and a drill hole in the northwestern part of the quadrangle, and is the bed which was mined at the Seneca No. 2 Mine in the southwestern part of the quadrangle.

In the Wolf Mountain quadrangle, the Wadge bed thins from 7 ft (2.1 m) in section 26, T. 8 N., R. 87 W., to 5.5 ft (1.7 m), less than 1.5 mi (2.4 km) to the south.

A chemical analysis of the Wadge coal bed from the Seneca No. 2 Mine (section 2, T. 6 N., R. 87 W.) has been reported by Boreck and others (1977) and is shown in Table 1. The Wadge coal bed is noncoking, high-volatile bituminous C coal, on an as-received basis.

COAL RESOURCES

Data from coal test holes, mine measured sections and outcrop measurements (CRO plate 1) was used to construct outcrop, isopach, and structure contour maps of the Wadge and Wolf Creek coal beds. Sources of information are listed in Table 4. In general, the Wolf Mountain quadrangle structure contour maps are based on contours of the top of the Trout Creek Sandstone Member by Bass, Eby, and Campbell (1955). An Areal Distribution and Identified Resource (ADIR) map (CRO plate 9) of the isolated coal beds of 5.0 ft (1.5 m) thickness or greater was also constructed for this report.

Coal resources of the Wolf Creek coal bed and of the isolated data points greater than 5.0 ft (1.5 m) thick were calculated using data obtained from the coal isopach map (CRO plate 4) and the ADIR map (CRO plate 9). No resource calculations were made for the Wadge bed because it apparently attains Reserve Base thickness only at locations on non-Federal land. The coal-bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed, times a conversion factor of 1800 short tons of coal per acre-foot for bituminous coal, yields the coal resources in short tons of coal for each coal bed. Reserve Base and Reserve values for the Wolf Creek bed are shown on CRO plate 7, and are rounded to the nearest 10,000 short tons. Total coal Reserve Base data for the Wolf Creek coal bed where it is thicker than 5.0 ft (1.5 m) and lies less than 3000 ft (914 m) below the ground surface is shown on CRO plate 7 and totals approximately 2,960,000 short tons. Total coal Reserve Base data for the isolated data points thicker than 5.0 ft (1.5 m) are included on CRO plate 2 and total approximately 6,730,000 short tons. The criteria used in calculating Reserve Base and Reserve data in this report differ from those stated in U.S. Geological Survey Bulletin 1450-B, which calls for a minimum thickness of 28 in (70 cm) for bituminous coal and a maximum depth of 1000 ft (300 m).

Reserve Base (in short tons) in the various development potential categories for surface and underground mining methods are shown in Tables 2 and 3. In this study, coal lying between the ground surface and a depth of 200 ft (61 m) (200 ft of overburden) is considered strippable; coal lying between 200 ft (61 m) and 3000 ft (914 m) (3000 ft of overburden) below ground level, and having bed dips of less than 15° is considered to be amenable to underground mining. Coal lying between 200 ft (61 m) and 3000 ft (914 m) below ground level and having bed dips greater than 15° is considered to be amenable to in-situ mining methods.

Dames & Moore has not made any determination of economic recovery for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Development Potential for Surface Mining Methods

Areas where the coal beds are overlain by 200 ft (61 m) or less of overburden are considered to have potential for strip mining and were assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios is as follows:

$$MR = \frac{t_o\ (0.911)}{t_c\ (rf)}$$

where MR = mining ratio

t_o = thickness of overburden

t_c = thickness of coal

rf = recovery factor.

Areas of high, moderate, and low development potential are here defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15, as shown on CRO plates 6, 8, and 9. These mining-ratio values for each development-potential category are applicable only to this quadrangle, and were derived in consultation with the U.S. Geological Survey.

The coal development potential for surface mining methods (<200 ft or 61 m of overburden) is shown on plate 10, the CDP map. Mining ratio contours could not be shown for the Wolf Creek coal bed in the southwest corner of the quadrangle because of insufficient coal isopach data. Mining-ratio values for the Wolf Creek in the northwest corner of the quadrangle place the coal bed in all three development-potential categories, with the greatest quantity of coal having a high development potential. An additional development-potential category, unknown potential, has been used to categorize the coal resources contained in isolated, non-isopached beds which are identified in isolated outcrops and which may be amenable to surface mining methods.

Development Potential for Subsurface Mining Methods

The coal development potential for subsurface mining of coal is shown on plate 11, the CDP map. In the Wolf Mountain quadrangle, the Wolf Creek coal bed is classified as having a high development potential for underground mining where it is found between 200 ft (61 m) and 1000 ft (305 m) (1000 ft of overburden) below the ground surface, except in section 11, T. 7 N., R. 87 W., where the dip is greater than 15°.

Areas are considered to have a low development potential for in-situ recovery methods where the coal beds dip between 15° and 35°, exceed 5 ft (1.5 m) in thickness, and occur between 200 ft (61 m) and 3000 ft (914 m) below the ground surface. Areas are considered to have moderate development potential where the coal beds dip greater than 35° and meet the thickness and depth criteria listed above.

The development potential by in-situ underground coal gasification methods for the coal Reserve Base of the Wolf Mountain quadrangle is considered low, based on the coal bed dip of less than 35°.

An unknown development potential category for underground mining has been used to categorize the Reserve Base developed from isolated, non-isopached coal beds.

TABLE 1

CHEMICAL ANALYSES OF COALS ON AN AS-RECEIVED BASIS

WOLF MOUNTAIN QUADRANGLE, ROUTT COUNTY, COLORADO

LOCATION	COAL BED NAME	Source	Proximate				Ultimate					Heating value	
			Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu **
T. 6 N., R. 87 W., sec. 1, NW 1/4 (Rice Mine)	Bed {7}	A	11.8	38.0	57.3	4.7	.5	...	...	...	....	....	11,660
T. 6 N., R. 87 W., sec. 1, NW 1/4 (Butcher Knife Mine)	Bed {6}	B	11.6	36.1	48.0	4.3	.6	...	...	...	....	6360	11,450
T. 6 N., R. 87 W., sec. 35 (Seneca No. 2 Mine)	Wadge	C	10.9	36.7	45.2	7.2	.5	5.6	61.9	1.5	23.3	....	10,820
T. 7 N., R. 86 W., sec. 28, SE 1/4 (Gray Mine)	Bed {8}	B	10.8	35.6	49.0	4.6	.6	...	...	...	....	6480	11,660
T. 8 N., R. 87 W., sec. 36, SW 1/4 (Franz Mine)	Bed {1}, {2}, {3}, {4}	B	11.7	35.4	49.1	3.8	.7	...	...	...	....	6440	11,590
T. 8 N., R. 87 W., sec. 27, SE 1/4 *	Wolf Creek	B	6.1	27.4	55.7	10.8	.6	...	...	...	....	6720	12,100

* Chemical analysis from Quaker Mountain
** To convert Btu/lb to kJ/kg, multiply by 2.326
A Aresco and Haller (1953)

B Bass, Eby, and Campbell (1955)

C Boreck, Jones, Murray, Schultz, and Suek (1977)

TABLE 2

STRIPPABLE COAL RESERVE BASE DATA

FOR FEDERAL COAL LANDS (IN SHORT TONS)

WOLF MOUNTAIN QUADRANGLE, ROUTT COUNTY, COLORADO

Coal Bed Name	High Development Potential (0-10 mining ratio)	Moderate Development Potential (10-15 mining ratio)	Low Development Potential (>15 mining ratio)	Unknown Development Potential	Total
Wolf Creek	670,000	470,000	540,000	0	1,680,000
Non-isopached coal beds	0	0	0	2,320,000	2,320,000
Total	670,000	470,000	540,000	2,320,000	4,000,000

Notes: Development potentials are based on mining ratios.

To convert short tons to metric tons, multiply by 0.9072.

TABLE 3

COAL RESERVE BASE DATA FOR SUBSURFACE MINING METHODS FOR FEDERAL COAL LANDS (IN SHORT TONS) WOLF MOUNTAIN QUADRANGLE, ROUTT COUNTY, COLORADO

	Conventional Underground			In-Situ		
Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Low Development Potential	Unknown Development Potential	Total
Wolf Creek	150,000	0	0	1,130,000	0	1,280,000
Non-isopached coal beds	0	0	0	0	4,410,000	4,410,000
Total	150,000	0	0	1,130,000	4,410,000	5,690,000

Note: To convert short tons to metric tons, multiply by 0.9072

TABLE 4

SOURCES OF DATA USED ON PLATE 1 (CRO MAP)

Plate 1 Index No.	Source	Data Base
1	Bass, et al, 1955	U.S. Geological Survey Bulletin 1027D, plate 25, section 114
2	↓	Same as above, section 113
3	↓	Same as above, section 115
4	↓	Same as above, section 164
5	↓	Same as above, section 163
6	↓	Same as above, section 161
7	↓	Same as above, section 162
8	U.S. Geological Survey	Inactive Coal Prospecting Permit No. Denver 033822-A, R. C. Jones
9	Bass, et al, 1955	U.S. Geological Survey Bulletin 1027D, plate 25, section 165
10	↓	Same as above, plate 24, section 141
11	↓	Same as above, section 208
12	↓	Same as above, section 209
13	↓	Same as above, section 217
14	↓	Same as above, section 218
15	↓	Same as above, section 219
16	↓	Same as above, section 194

REFERENCES

American Society for Testing and Materials, 1974, Standard specifications for classification of coals by rank, in Gaseous fuels, coal, and coke; atmospheric analysis: ASTM Publication D 388-66, pt. 26, p. 54-58.

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