Text to Accompany:

Open-File Report 79-1388

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE ELKOL QUADRANGLE, LINCOLN COUNTY, WYOMING

[Report includes 18 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

By

DAMES & MOORE

DENVER, COLORADO

CONTENTS

ILLUSTRATIONS

Illustrations--Continued

TABLES

INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Elkol quadrangle, Lincoln County, Wyoming. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) 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 U.S. Geological Survey under contract number 14-08-0001-17104. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Published and unpublished public information available through March, 1979, was used as the data base for this study. No new drilling or field mapping was performed, nor was any confidential data used.

Location

The Elkol quadrangle is located in south-central Lincoln County, Wyoming, approximately 3 airline miles (4.8 km) south of the town of Kemmerer, Wyoming. The town of Elkol is located in the northwestern part of the quadrangle.

Accessibility

U.S. Highway 30N, a paved heavy-duty road connecting the town of Kemmerer to the north of the quadrangle with the town of Granger to the southwest, crosses the northeast corner of the Elkol quadrangle. U.S. Highway 189, a paved medium-duty road, crosses north-south through the central part of the quadrangle connecting Kemmerer with Interstate Highway 80, approximately 22 miles (35 km) to the south, and with the town of Evanston to the southwest. A paved medium-duty road joins Elkol in the northwestern corner of the quadrangle with U.S. Highway 189 near the northern edge of the quadrangle. Numerous unimproved dirt roads and trails provide access for the remainder of the quadrangle (U.S. Bureau of Land Management, 1971; Wyoming State Highway Commission, 1978).

The Oregon Short Line Railroad, a branch of the Union Pacific Railroad, crosses the northeastern corner of the quadrangle along the Hams Fork valley and passes through the town of Kemmerer north of the quadrangle. It is a major shipping route connecting Pocatello, Idaho, with the Union Pacific Railroad main east-west line at Granger. A spur from the railroad extends south through the central part of the quadrangle. Branches serve the Kemmerer Coal Company's Elkol and Sorensen strip mines near Elkol and the FMC Corporation's Skull Point strip mine on the west-central edge of the quadrangle (U.S. Bureau of Land Management, 1971 and 1978; Bozzuto, 1977; Mining Information Services, 1978; Wyoming State Highway Commission, 1978).

Physiography

The Elkol quadrangle lies on the eastern edge of the Wyoming Overthrust Belt. The landscape within the quadrangle is characterized by long north-south-trending ridges and valleys. Oyster Ridge, located in the eastern third of the quadrangle, rises approximately 600 feet (183 m) above the valley of Cumberland Flats. A second unnamed ridge, which includes Skull Point, lies along the western border of the quadrangle. Altitudes in the quadrangle range from approximately 7,560 feet (2,304 m) on a ridge in the northwestern corner of the quadrangle to less than 6,640 feet (2,024 m) on the North Fork of Little Muddy Creek on the south-central edge of the quadrangle.

Hams Fork, a tributary of the Green River to the east of the quadrangle boundary, flows easterly across the northeastern corner of the quadrangle. The North Fork of Little Muddy Creek, providing the principal drainage for the quadrangle, flows southerly through the center of the quadrangle. It is a tributary of Blacks Fork and the Green River east of the quadrangle. The Skull Point Reservoir lies on the west-central edge of the quadrangle, and a second unnamed reservoir is located about 1 mile (0.3 m) east of Elkol. Numerous small lakes and ponds occur throughout the quadrangle. A large playa is located in the southwestern corner of the quadrangle. Streams in the quadrangle, with the exception of Hams Fork which flows year-round, are intermittent and flow mainly in response to snowmelt in the spring (U.S. Bureau of Land Management, 1971).

Climate and Vegetation

The climate of southwestern Wyoming is semiarid, characterized by low precipitation, rapid evaporation, and large daily temperature variations. Summers are usually dry and mild, and winters are cold. The annual precipitation averages approximately 10 inches (25 cm) and is fairly evenly distributed throughout the year (Wyoming Natural Resources Board, 1966).

The average annual temperature of the area is 39° F (4° C). The temperature during January averages 17° F (-8° C) and typically ranges from 4° F (-16° C) to 30° F (-1° C). During July, the average temperature is 62° F (17° C), and the temperature typically ranges from 43° F (6° C) to 82° F (28° C) (Wyoming Natural Resources Board, 1966; U.S. Bureau of Land Management, 1978).

Winds are usually from the west and west-southwest with an average annual velocity of 15 miles per hour (24 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the quadrangle include grasses, sagebrush, mountain mahogany, saltbush, greasewood, rabbitbrush, serviceberry, willow, and cottonwood (U.S. Bureau of Land Management, 1978).

Land Status

The Elkol quadrangle lies in the eastern part of the Kemmerer Known Recoverable Coal Resources Area (KRCRA). Approximately 85 percent of the quadrangle lies within the KRCRA boundary and the Federal government owns the coal rights for about one third of this land. Two active coal leases occur within the KRCRA boundary as shown on plate 2.

GENERAL GEOLOGY

Previous Work

Veatch (1907) mapped the geology and economic resources of a large part of Lincoln and Uinta counties in southwestern Wyoming, including this quadrangle. Cobban and Reeside described the stratigraphy of the coal-bearing Frontier Formation in the Kemmerer area in 1952. Hale (1960) described the stratigraphy of the Frontier Formation in southwestern Wyoming and Utah. Lawrence (1963) described the Wasatch and Green River Formations in the Cumberland Gap area. Oriel and Tracey (1970) described the stratigraphy of the Evanston and Wasatch Formations present in the Kemmerer area. Glass (1975) reported coal analyses and measured sections of Adaville Formation coals from the Elkol and Sorensen mines located in this quadrangle and in the southeast and southwest quarters of the Kemmerer 15-minute quadrangle. The geology of the Kemmerer 15-minute quadrangle, north of the Elkol quadrangle, was mapped by Rubey and others (1975), and Schroeder and Lunceford (1976) mapped the goelogy and coal resources of the Cumberland Cap quadrangle. Roehler and others (1977) described the geology and coal resources of the Hams Fork coal region including the Kemmerer coal field. Myers (1977) made a detailed study of the stratigraphy of the Frontier Formation in the Kemmerer area. Glass (1977) described the coal-bearing formations and coal beds present in the Hams Fork coal region. M'Gonigle mapped the surface geology of the Elkol (1979a) and Warfield Creek (1979b) quadrangles. Unpublished data from Rocky Mountain Energy Company (RMEC) also provided coal thickness information.

Stratigraphy

The formations exposed in the Elkol quadrangle range in age from Early Cretaceous to Eocene. The Frontier and Adaville Formations, trending north-south through the quadrangle, are coal-bearing.

The Bear River Formation of Early Cretaceous age is exposed along the eastern edge of the quadrangle. It consists of interbedded claystone, fine-grained sandstone, and fossiliferous limestone (Rubey and others, 1975).

The Aspen Shale of latest Early Cretaceous age conformably overlies the Bear River Formation and is composed of dark gray shale containing a few beds of gray sandstone and white to light-gray porcelanite. The upper formational contact is placed at the top of the highest prominent porcelanite bed. The formation is exposed in the eastern half of the Elkol quadrangle and is approximately 825 feet (251 m) thick in the adjacent quadrangle to the north (Rubey and others, 1975; M'Gonigle, 1979a).

The sandstones and shales of the Frontier Formation of early Late Cretaceous age crop out in the east-central part of the quadrangle, where they conformably overlie the Aspen Shale. M'Gonigle (1979a) has divided the Frontier Formation into mappable units which are, in ascending order, the Chalk Creek Member, Coalville Member, Allan Hollow Member, Oyster Ridge Member, and the Dry Hollow Member.

The Chalk Creek Member generally consists of mudstone, sandstone, and siltstone, with some coal, bentonite, procelanite, and limestone (Cobban and Reeside, 1952). The League of Nations (Lower Carter Group), Spring Valley, and Willow Creek coal zones are contained within this member (Veatch, 1906, and Townsend, 1960) in the Kemmerer area. This member is approximately 970 feet (296 m) thick where measured at Cumberland Gap and 1,400 feet (427 m) thick in the Kemmerer area (Myers, 1977).

The Coalville Member is composed of resistant brown to tan sandstone interbedded with softer shale units approximately 100 to 150 feet (70 to 46 m) thick (Myers, 1977).

The Allen Hollow Member consists primarily of dark-gray calcareous shale and is approximately 300 feet (91 m) thick (Cobban and Reeside, 1955).

A ridge-forming sandstone unit, the Oyster Ridge Member, overlies the Allan Hollow Member and is characterized by the presence of Ostrea soleniscus, a long, slender oyster (Bozzuto, 1977). This member is approximately 135 feet (41 m) thick (Cobban and Reeside, 1952).

The Dry Hollow Member caps the formation and consists of approximately 300 feet (91 m) of sandstone, mudstone, siltstone and coal. The Kemmerer coal zone is located approximately 250 feet (76 m) above the Oyster Ridge Member (Cobban and Reeside, 1952).

The Frontier Formation is overlain by the Hilliard Shale of early Late Cretaceous age and consists of a very thick sequence of dark-gray shale containing minor glauconitic sandstone beds (Cobban and Reeside, 1952). The formation is exposed in the western half of the quadrangle (M'Gonigle, 1979a) and ranges from 5,500 to 6,600 feet (1,676 to 2,012 m) in thickness (Rubey and others, 1975; Bozzuto, 1977).

The Adaville Formation of Late Cretaceous age conformably overlies the Hilliard Shale and is exposed along the western edge of the quadrangle. It consists of yellow, gray, and black carbonaceous claystone, siltstone, thin-bedded to massive brown and yellow sandstone, and numerous coal seams (Cobban and Reeside, 1952; Rubey and others, 1975). A regressive sand sequence, the Lazeart Sandstone Member, comprises the lower 200 to 400 feet (61 to 122 m) of the formation. This prominent ledge- and cliff-forming unit is composed of light-gray to white sandstone directly overlain by the thickest coal beds of the formation (Rubey and others, 1975). The Adaville Formation is approximately 2,900 feet (884 m) thick in the adjacent quadrangle to the north (Rubey and others, 1975).

The main body of the Wasatch Formation (Eocene) unconformably overlies Cretaceous and older rocks along the eastern edge of the quadrangle (Rubey and others, 1975; M'Gonigle, 1979a). The main body is composed of green and brown-red variegated mudstone, light-red and tan conglomerate, and cross-bedded channel sandstone and ranges up to 400 feet (122 m) thick (Lawrence, 1963).

The main body of the Wasatch Formation is conformably overlain by the Fontenelle tongue of the Green River Formation of early Eocene age. The tan-white gastropodal and ostracodal marlstone and limestone, shale and sandstone of the Fontenelle tongue are exposed along the extreme eastern border of the quadrangle (Lawrence, 1963; M'Gonigle, 1979a). The Fontenelle tongue attains a maximum thickness of 135 feet (41 m) in the area (Lawrence, 1963).

Holocene deposits of alluvium cover the stream valleys and tributaries of the North Fork of Muddy Creek and Hams Fork.

The Upper Cretaceous formations in the Elkol quadrangle indicate the transgressons and regressions of a broad, shallow north-south seaway that extended across central North America. These formations accumulated near the western edge of the Cretaceous sea and reflect the location of the shoreline (Weimer, 1960 and 1961).

The interbedded claystones, sandstones, and limestones of the Bear River Formation were deposited in a predominantly marine environment. According to Roehler and others (1977), the formation thickens to the north, where it was deposited in mixed fluvial, paludal, and marine environments.

Deposition of the Aspen Shale marked a westward or landward movement of the sea. According to Hale (1960), the marine shales and sandstones of the Aspen Shale were deposited in water depths up to 120 feet (37 m).

The Frontier Formation sediments were deposited during two major transgressions and regressions of the sea. The coal beds in the upper and lower parts of the formation were deposited in coastal swamps during periods when the sea retreated eastward. The Oyster Ridge Sandstone Member is a littoral or beach deposit marking the retreat of the Cretaceous sea from the area (Hale, 1960; Myers, 1977; Roehler and others, 1977).

The marine sequence of shales, claystones and sandstones of the Hilliard Shale were deposited during a transgression of the Cretaceous sea and indicate the fluctuations of the shoreline (Roehler and others, 1977).

The Lazeart Sandstone Member at the base of the Adaville Formation is a beach deposit marking a transition from the marine deposition of the Hilliard Shale to the continental coastal plain deposition of the Adaville Formation. The sediments of the Adaville Formation were deposited in flood plains and swamps along the coastal plain (Roehler and others, 1977).

The main body of the Wasatch Formation is composed of continental sediments. The bright-colored mudstones were probably deposited on a flood plain and then cut by stream channels now filled with well-sorted conglomerate (Oriel and Tracey, 1970).

Lacustrine deposits derived from Gosiute Lake are represented in the Fontenelle tongue of the Green River Formation (Lawrence, 1963).

Structure

The Elkol quadrangle is located on the southeastern edge of the structurally complex Wyoming Overthrust Belt. Folded Paleozoic and Mesozoic rocks are thrust eastward over folded older-Cretaceous rocks with younger Cretaceous and Tertiary rocks resting unconformably on top of the older rocks. Coal-bearing strata crop out in eroded limbs of folds as long north-south trending belts bounded on the west by major thrust faults (Roehler and others, 1977).

The coal-bearing formations in the Elkol quadrangle crop out on the eastern limb of the Lazeart syncline, an asymmetrical fold whose axis lies a few miles west of the quadrangle. Coal-bearing strata generally dip 15° to 24° to the west (M'Gonigle, 1979a).

Several faults have been mapped by M'Gonigle (1979a) in the eastern part of the quadrangle (plate 1), only two of which affect coal-bearing formations.

COAL GEOLOGY

Coal-bearing formations in the Elkol quadrangle include both the Frontier and Adaville. The Frontier Formation contains two major coal zones, the Spring Valley, located approximately 400 feet (122 m) above the base of the formation, and the Kemmerer coal zone near the top of the formation. Two minor coal zones, the League of Nations (or Lower Carter Group) (Veatch, 1906; Townsend, 1960) and the Willow Creek are believed not to contain coal of Reserve Base thickness (5 feet or 1.5 meters) in the Elkol quadrangle.

Numerous coal beds of the Adaville Formation are also present, cropping out along a ridge trending north-south along the western edge of the quadrangle. The thicker coal beds are located in a stratigraphic interval approximately 1,000 feet (305 m) thick, immediately overlying and intertonguing with the Lazeart Sandstone.

<u>Chemical analyses of coal</u>.--An analysis of coal from the Spring Valley zone (Frontier Formation) in the Elkol quadrangle is included in table 1. Representative analyses of coal from both the Adaville Formation and Kemmerer zone (Frontier Formation) in the Kemmerer 15-minute quadrangle are also included.

In general, coals in the Spring Valley and Kemmerer coal zones are high-volatile B bituminous in rank, and coal from the Adaville No. 1 coal bed ranks as subbituminous A. Coals from other Adaville coal beds are either subbituminous B or C (Glass, 1977). These coals have been ranked on a moist, mineral-mater-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Frontier Formation Coal Zones

The Frontier Formation coal zones occupy a belt approximately one mile (1.6 km) wide trending north-south through the east-central part of the quadrangle. Dips average 22° to the west (M'Gonigle, 1979a).

Spring Valley Coal Zone

Four coal beds of the Spring Valley coal zone have been isopached in the Elkol quadrangle. These coal beds have been informally named with bracketed numbers for identification purposes in this quadrangle only, and may have different designations in other quadrangles.

The Spring Valley [1] coal bed is, stratigraphically, the lowest coal bed isopached in the quadrangle. The coal bed is 12.4 feet (3.8 m) thick where measured in sec. 9, T. 20 N., R. 116 W., thinning southward (plate 4).

The Spring Valley [2] coal bed lies above the Spring Valley [1] coal bed and has a maximum measured thickness of 7.0 feet (2.1 m) in sec. 21, T. 20 N., R. 116 W. This coal bed also thins to the south (plate 7).

The Spring Valley [3] coal bed has been isopached in the southern part of the quadrangle (plate 9) where it locally attains a thickness of 5.8 feet (1.8 m). The coal bed averages 4.0 feet (1.2 m) in thickness in this quadrangle and 3 feet (0.9 m) in the Cumberland Gap quadrangle to the south, where the coal bed is designated as the Spring Valley [1] coal bed.

The Spring Valley [4] coal bed locally attains a maximum measured thickness of 6.9 feet (2.1 m) in sec. 4, T. 19 N., R. 116 W. (plate 11). Coal from the Spring Valley [4] bed was mined in the subsurface at the Blazon and Service mines. This coal bed thins to the south, but has been traced into the Cumberland Gap quadrangle (Schroeder and Lunceford, 1976) where it is designated the Spring Valley [2] coal bed.

Kemmerer Coal Zone

The Kemmerer coal zone overlies and is separated from the Oyster Ridge Member by approximately 220 to 250 feet (67 to 76 m) of mudstone, sandstone, and siltstone. The Kemmerer coal zone is laterally extensive and can be traced for many miles north and south of this quadrangle.

The Cumberland (RMEC, no date) or Main Kemmerer (Veatch, 1907) seam is the major coal bed located within the Kemmerer coal zone. This coal bed (seam) crops out along the western side of Oyster Ridge, attaining a maximum thickness of 20.3 feet (6.2 m), excluding 1.3 feet (0.4 m) of partings, where measured near the southern boundary of the quadrangle (plate 4). It has been mined in the past a minimum of five different locations within the quadrangle.

In the adjacent southeast quarter of the Kemmerer 15-minute quadrangle to the north, the Cumberland seam averages 9 feet (2.7 m) in thickness. In the Cumberland Gap quadrangle, the Cumberland seam has a maximum measured thickness of 21 feet (6.4 m), excluding a rock parting 1 foot (0.3 m) thick.

The Upper Kemmerer, or Radio coal bed (Hunter, 1950), has been encountered in sec. 5, T. 19 N., R. 116 W., where it is situated approximately 20 to 50 feet (6 to 15 m) above the Cumberland seam. This coal bed thickens locally to 6 feet (1.8 m), but is usually less than Reserve Base thickness in most parts of the Kemmerer coal field. Minable thicknesses have been reported for this coal bed near the town of Frontier, Wyoming (Hunter, 1950; Glass, 1977).

Adaville Formation Coal Zone

The Adaville Formation is the most prolific coal-bearing formation in the Hams Fork coal region (Glass, 1977) and, probably, in the country (Hunter, 1950). The Adaville coals are numbered consecutively from the lowermost bed upward, but because these coal beds thicken, thin, split, and coalesce over very short distances (Glass, 1977), the numerical designations have little meaning. Informal bracketed numbers, used to designate some of the Adaville coal beds, are for identification purposes in this quadrangle only.

In the Elkol quadrangle, as many as 21 Adaville coal beds are currently strip-mined in the Kemmerer Coal Company's Sorenson mine (plate 1). FMC Corporation's Skull Point mine in sec. 27, T. 20 N., R. 117 W. is also presently producing Adaville coal (Bozzuto, 1977; Mining Information Services, 1978).

The Adaville No. 1, generally the thickest of the Adaville coal beds, overlies or intertongues with the Lazeart Sandstone Member. Although this coal bed exhibits depositional discontinuities, especially along strike (Buzzoto, 1977), it maintains a thickness of at least 10 feet (3.0 m) in the quadrangle and thickens to over 40 feet (12.2 m) at some locations (plate 4). This coal bed occasionally contains claystone and coaly shale, but is generally quite clean and requires no mechanical cleaning (Engstrom, 1977).

To the north, in the southeast quarter of the Kemmerer 15-minute quadrangle, the Adaville No. 1 coal bed attains a maximum measured thickness of 88.1 feet (26.9 m), with no partings, in sec. 20, T. 21 N., R. 116 W. In the adjacent quadrangle to the south, most of the Adaville Formation is covered by gravel (Schroeder and Lunceford, 1976), but the Adaville No. 1 coal bed is believed to be present in a single coal test hole with a thickness of 13 feet (4.0 m). In the the Cumberland Gap quadrangle and the southern part of the Elkol quadrangle, thick Adaville Formation coal beds (Adaville No. 1?) are probably contained within the Lazeart Sandstone Member.

Because the land areas containing Adaville coal in the Elkol quadrangle are either non-Federal or have already been leased, detailed descriptions of other Adaville coal beds are not discussed in this report. Isopach maps of Adaville coal beds are shown on plates 7, 9, 11, 14, and 16, and in figures 1, 3, and 5. (All figures are included at the end of this report.)

COAL RESOURCES

Information from an oil and gas well, coal test holes drilled by Rocky Mountain Energy Company (RMEC), and coal bed measurements by

Veatch (1907), Hunter (1950), Glass (1975), and M'Gonigle (1979a), were used to construct maps of the coal beds in the Elkol quadrangle. At the request of RMEC, coal-rock data for some of their drill holes have not been shown on plate 1 or on the derivative maps. However, data from these drill holes may have been used to construct the derivative maps. These data may be obtained by contacting RMEC. The source of each indexed data point shown on plate 1 is listed in table 3.

Coal resources were calculated using data obtained from coal isopach maps (plates 4, 7, and 11). The coal bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed, and by a conversion factor of 1,700 short tons of coal per acre-foot (13,018 metric tons per hectare-meter) for subbituminous coal, or 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, yields the coal resources in short tons for each isopached coal bed. Coal beds of Reserve Base thickness (5 feet or 1.5 meters) or greater that lie less than 3,000 feet (914 m) below the ground surface are included. These criteria differ somewhat from those used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a minimum thickness of 28 inches (70 cm) for bituminous coal and a maximum depth of 1,000 feet (305 m) for both subbituminous and bituminous coal.

Reserve Base and Reserve tonnages for the Spring Valley [2] and [4] coal beds and the Cumberland seam are shown on plate 13, and are rounded to the nearest 10,000 short tons (9,072 metric tons). Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 1.02 million short tons (0.93 million metric tons) for the entire quadrangle.

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

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn so as to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest development potential affecting any part of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential, 25 acres (10 ha) a moderate development potential, and 10 acres (4 ha) a low development potential, then the entire 40 acres (16 ha) are assigned a high development potential.

Development Potential for Surface Mining Methods

Areas where the coal beds of Reserve Base thickness are overlain by 200 feet (61 m) or less of overburden are considered to have potential for surface mining and are 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 for surface mining of coal is shown below:

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

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal:

0.911 for subbituminous coal

0.896 for bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential for surfce mining methods are defined as areas underlain by coal beds having respective mining ratio values of 0 to 10, 10 to 15, and greater than 15. These mining ratio values for each development potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey.

Areas where the coal data is absent or extremely limited between the 200-foot (61-m) overburden line and the outcrop are assigned unknown development potentials for surface mining methods. Areas where coal-bearing units are not present within 200 feet (61 m) of the surface are considered to have no coal development potential.

The coal development potential for surface mining methods (less than 200 feet or 61 meters of overburden) is shown on plate 18. Of the Federal land areas within the KRCRA boundary, 3 percent are rated high, 11 percent are rated unknown, and 86 percent are rated as having no development potential for surface mining methods. Reserve Base tonnages in the various development potential categories for surface mining methods are listed in table 2.

Development Potential for Subsurface and In-Situ Mining Methods

Areas ordinarily considered to have a development potential for conventional subsurface mining methods include those areas where the coal beds of Reserve Base thickness are between 200 feet (61 m) and 3,000 feet (914 m) below the ground surface and have dips less than 15°. Areas of high, moderate, and low development potential for conventional subsurface mining are defined by the U.S. Geological Survey as areas underlain by coal beds of Reserve Base thickness at depths ranging from 200 to 1,000 feet (61 to 305 m), 1,000 to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m), respectively. Unknown development potentials are assigned to those areas where coal data is absent or extremely limited.

All Federal lands within the KRCRA boundary in this quadrangle have been classified as having an unknown development potential for conventional subsurface mining methods because the coal beds have dips greater than 15°.

Unfaulted coal beds lying between 200 and 3,000 feet (61 and 914 m) below the ground surface, dipping greater than 15°, are considered to have a development potential for in-situ mining methods. Based on criteria provided by the U.S. Geological Survey, coal beds of Reserve Base thickness dipping between 35° and 90° with a minimum Reserve Base of 50 million short tons (45.4 million metric tons) for bituminous coal and 70 million short tons (63.5 million metric tons) for subbituminous coal have a moderate potential for in-situ development; coal beds dipping from 15° to 35°, regardless of tonnage, and coal beds dipping from 35° to 90° with less than 50 million short tons (45.4 million metric tons) of coal have a low development potential for in-situ mining methods. Coal lying between the 200-foot (61-m) overburden line and the outcrop is not included in the total coal tonnages available as it is needed for cover and containment in the in-situ process.

Because the dips of the coal-bearing strata range from 15° to 24° and the total Reserve Base tonnage available for in-situ mining is less than 50 million short tons (only 90,000 short tons or 81,650 metric tons as shown on plate 13), all Federal land areas within the KRCRA boundary having known development potential for in-situ mining methods have been rated low. The remaining Federal lands are classified as having unknown development potential for in-situ mining methods.

Table 1. Chemical analyses of coals in the Elkol quadrangle, Lincoln County, Wyoming.

Location	COAL BED NAME	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/Lb
SE¼, NW¼, sec. 20, T. 21 N., Elkol Mine (Glass, 1975)	Adaville No. 1	A	16.7	36.5	42.8	4.0	1.3	-	-	-	-	-	10,530
		C	0.0	43.8	51.4	4.8	1.5	-	-	-	-	-	12,640
SW¼, NE¼, sec. 12, T. 22 N., R. 116 W., No. 6 Mine (U.S. Bureau of Mines, 1931)	Kemmerer	A	3.9	40.1	49.0	7.0	0.6	-	-	-	-	-	12,890
		C	0.0	41.7	51.0	7.3	0.6	-	-	-	-	-	13,420
Sec. 4, T. 20 N., R. 116 W., Fitzpatrick Mine (U.S. Bureau of Mines, 1931)	Spring Valley	A	7.1	35.2	50.8	6.9	0.4	-	-	-	-	-	12,470
		C	0.0	37.9	54.7	7.4	0.5	-	-	-	-	-	13,420

Form of Analysis: A, as received
B, air dried
C, moisture free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2. -- Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the Elkol quadrangle, Lincoln County, Wyoming.

Coal Bed	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Spring Valley [4]	147,000	41,000	326,000	-	514,000
Spring Valley [2]	264,000	123,000	26,000	-	413,000
Totals	411,000	164,000	352,000	-	927,000

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

Table 3. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1, Line B
2		Measured Section
3		Measured Section
4	Rocky Mountain Energy Co., (no date), unpublished data; and Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 123, No. 43	Drill hole No. 3 (Diamond Coal & Coke Mine No. 3)
5	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3, Line A
6		Drill hole No. 2, Line A
7		Drill hole No. 1, Line A
8		Measured Section
9		Measured Section
10		Measured Section
11		Measured Section
12		Measured Section
13		Drill hole No. 2, Line A
14		Drill hole No. 1, Line A
15		Measured Section

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
16	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
17	↓	Measured Section
18	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 123	Measured Section No. 49
19	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1, Line A
20	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 123	Measured Section No. 50
21	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1, Line A
22	↓	Drill hole No. 2, Line A
23		Drill hole No. H, Line A
24		Drill hole No. I, Line A
25		Drill hole No. J Line A
26		Drill hole No. K North
27		Drill hole No. L, Line A
28		Drill hole No. M, Line A
29		Drill hole No. N, Line A

Page 2 of 5

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
30	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 0, Line A
31		Measured Section (Pacific Coal Mine)
32		Measured Section
33		Measured Section
34		Measured Section (Diamondville Mine)
35	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 121-122	Measured Section No. 21
36		Drill hole No. 22 (Diamond Coal & Coke Mine No. 4)
37	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
38		Measured Section
39		Drill hole No. 3, Line A
40		Measured Section
41		Drill hole No. 2, Line A
42		Drill hole No. 1, Line A
43		Measured Section

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
44	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
45		Measured Section (Diamond Coal & Coke Mine No. 4)
46		Measured Section
47		Measured Section
48		Measured Section
49		Measured Section
50		Drill hole No. 2
51		Drill hole No. 1
52	William G. Helis Estate	Oil/gas well No. 27-1 Kemmerer
53	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
54		Measured Section
55		Drill hole No. 2
56		Measured Section
57		Drill hole No. 1
58	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 123	Measured Section No. 33 (Diamond Coal & Coke Mine No. 2)
59	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
60	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
61		Drill hole No. 2, Line A
62		Drill hole No. 1, Line A
63	Glass, 1975, Geological Survey of Wyoming Report of Investigations No. 11, p. 72-78	Measured Section No. 74-7, 74-8, and 74-9
64	Glass, 1975, Geological Survey of Wyoming Report of Investigations No. 11, p. 65-68	Measured Section No. 74-4 and 74-5
65	Hunter, 1950, Wyoming Geological Association Guidebook, p. 123-132	Measured Section

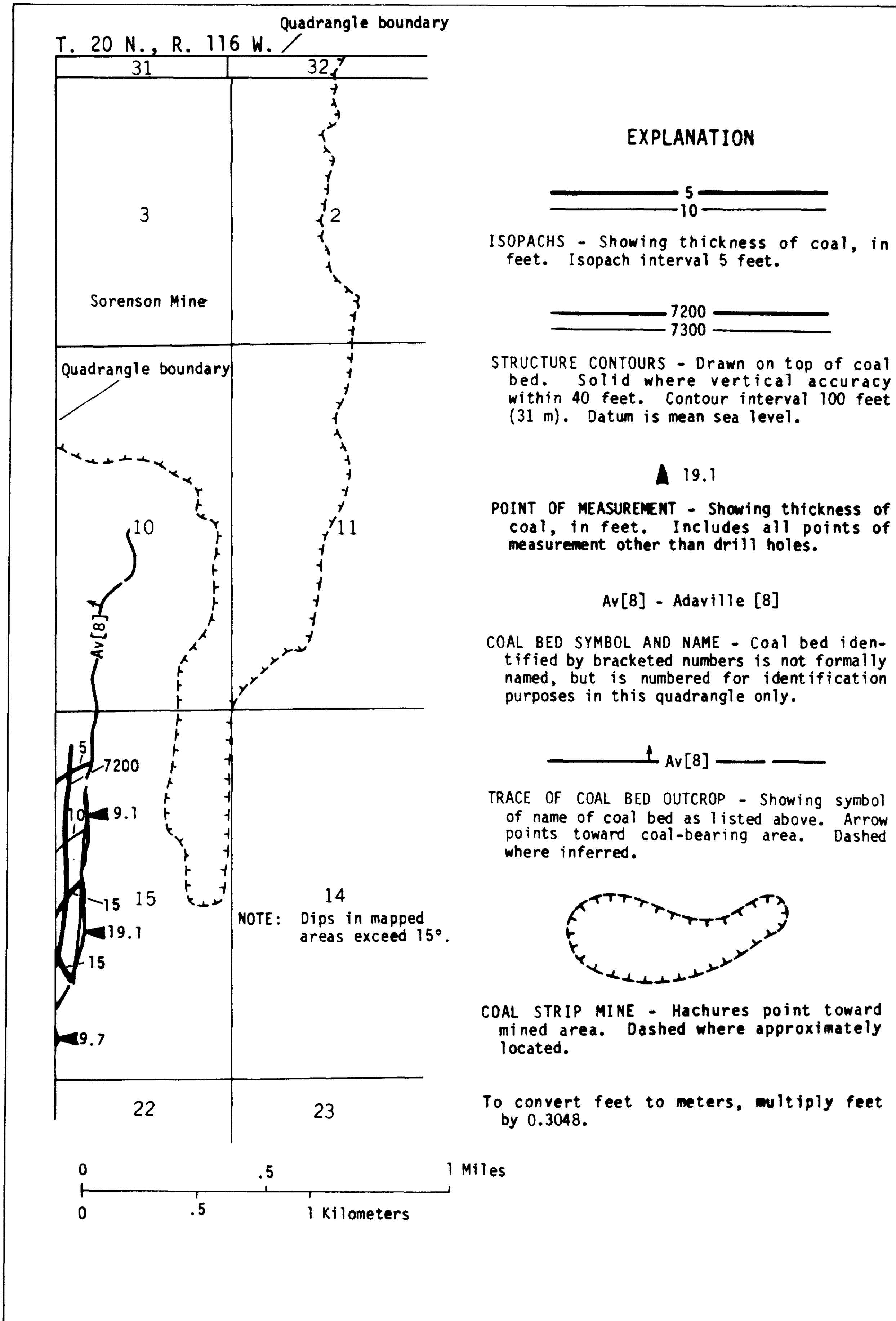
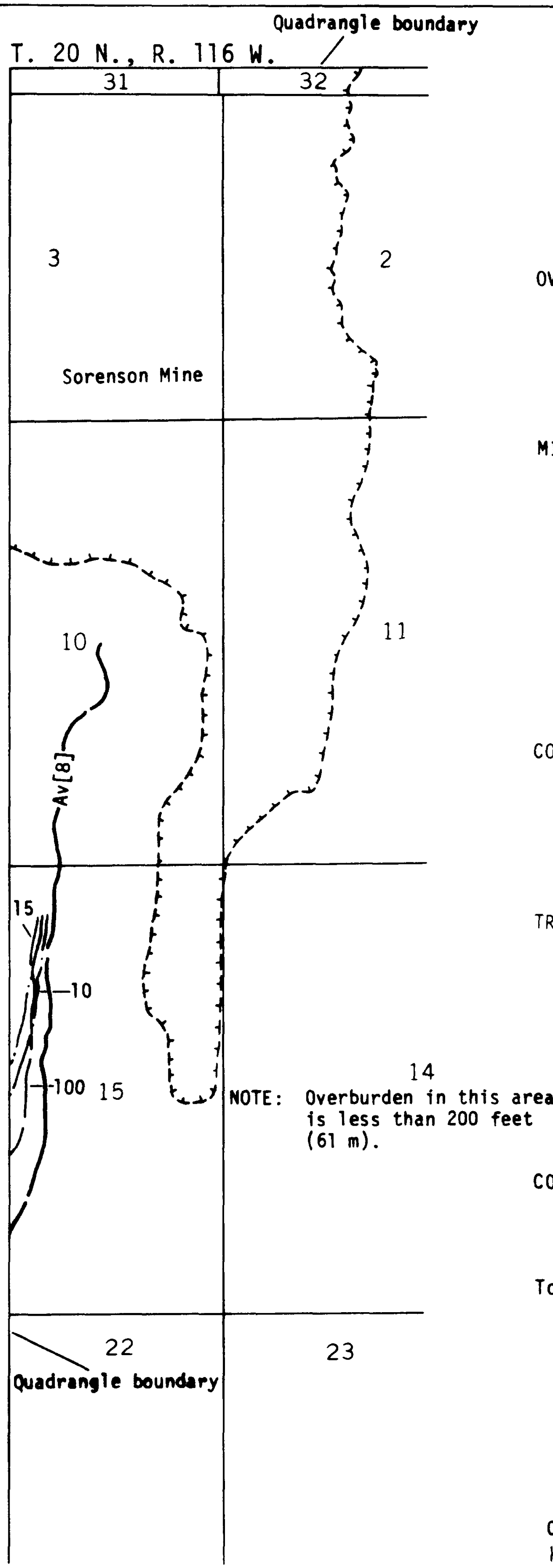


FIGURE 1. — Isopach and structure contour map of the Adaville [8] coal bed.



EXPLANATION

100

OVERBURDEN ISOPACHS - Showing thickness of overburden, in feet, from surface to top of coal bed. Dashed where vertical accuracy possibly not within 40 feet.

10

MINING-RATIO CONTOUR - Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in areas underlain by coal of Reserve Base thickness within the stripping-limit (in this quadrangle, the 200-foot-overburden isopach). To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply mining ratio by 0.8428.

Av[8] - Adaville [8]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

Av[8]

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Dashed where inferred.

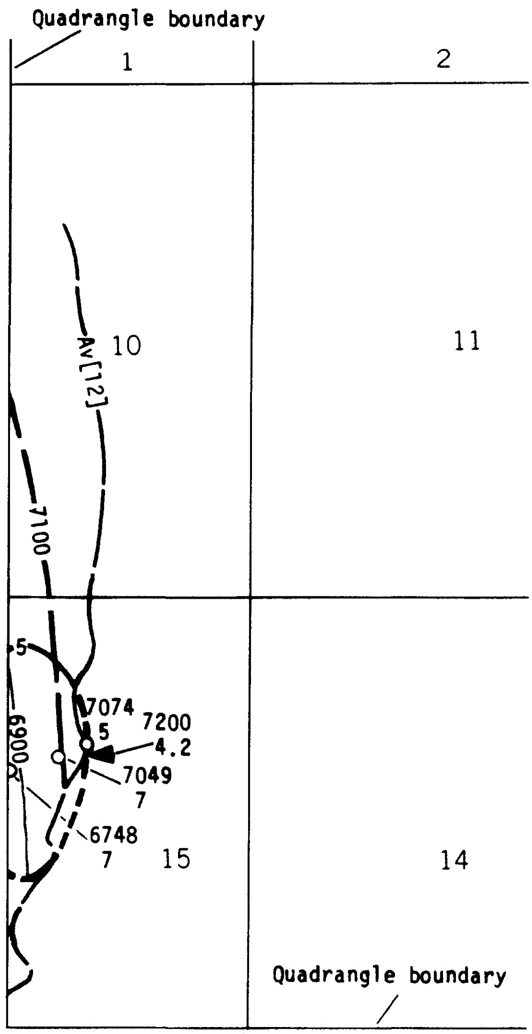
COAL STRIP MINE - Hachures point toward mined area. Dashed where approximately located.

To convert feet to meters, multiply feet by 0.3048.

0 Miles .5 1

0 .5 1 Kilometers

FIGURE 2. — Overburden isopach and mining ratio map of the Adaville [8] coal bed.



T. 19 N., R. 116 W.

NOTE: Dips in mapped areas exceed 15°.

EXPLANATION

5

ISOPACHS - Showing thickness of coal, in feet. Long dashed where inferred; short dashed where projected beyond coal-bearing area. Isopach interval 5 feet.

7100
6900

STRUCTURE CONTOURS - Drawn on top of coal bed. Long dashed where vertical accuracy possibly not within 40 feet. Contour interval 200 feet (61 m). Datum is mean sea level.

7074
5

DRILL HOLE - Showing altitude of top of coal bed, and thickness of coal, in feet.

7200
4.2

POINT OF MEASUREMENT - Showing altitude of top of coal bed, and thickness of coal, in feet. Includes all points of measurement other than drill holes.

Av[12] - Adaville [12]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

Av[12]

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Dashed where inferred.

To convert feet to meters, multiply feet by 0.3048.

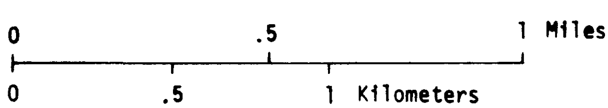
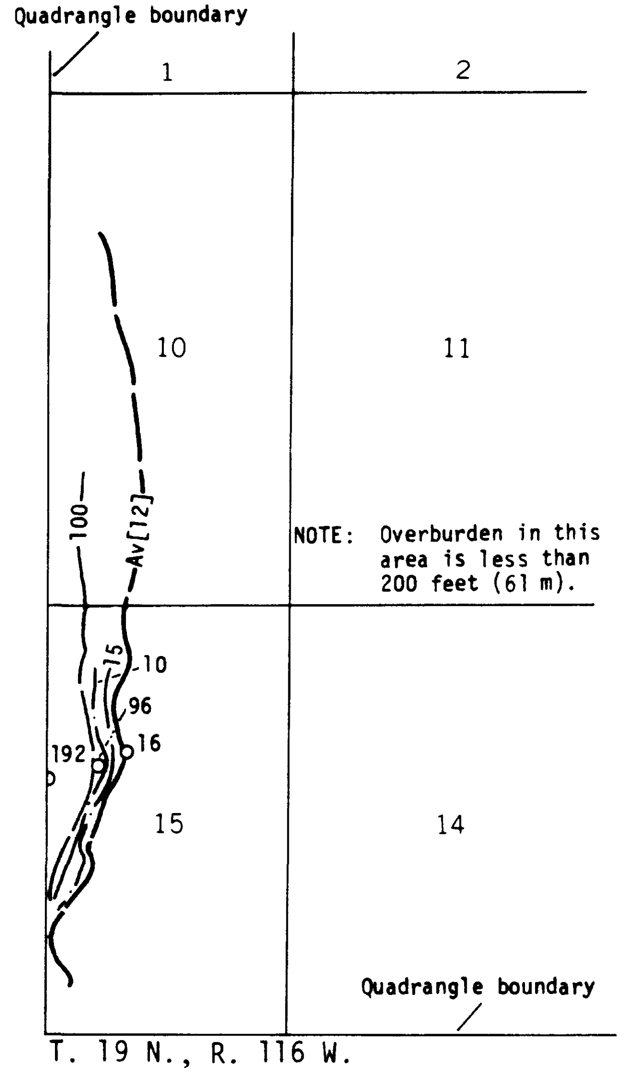


FIGURE 3. — Isopach and structure contour map of the Adaville [12] coal bed.



EXPLANATION

100

OVERBURDEN ISOPACHS - Showing thickness of overburden, in feet, from surface to top of coal bed. Dashed where vertical accuracy possibly not within 40 feet.

○ 192

DRILL HOLE - Showing thickness of overburden, in feet, from surface to top of coal bed.

10

MINING-RATIO CONTOUR - Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in areas underlain by coal of Reserve Base thickness within the stripping-limit (in this quadrangle, the 200-foot-overburden isopach). To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply mining ratio by 0.8428.

Av[12] - Adaville [12]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

Av[12]

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Dashed where inferred.

To convert feet to meters, multiply feet by 0.3048.

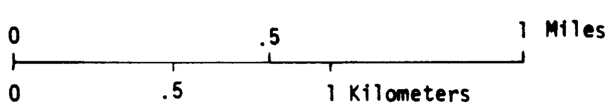
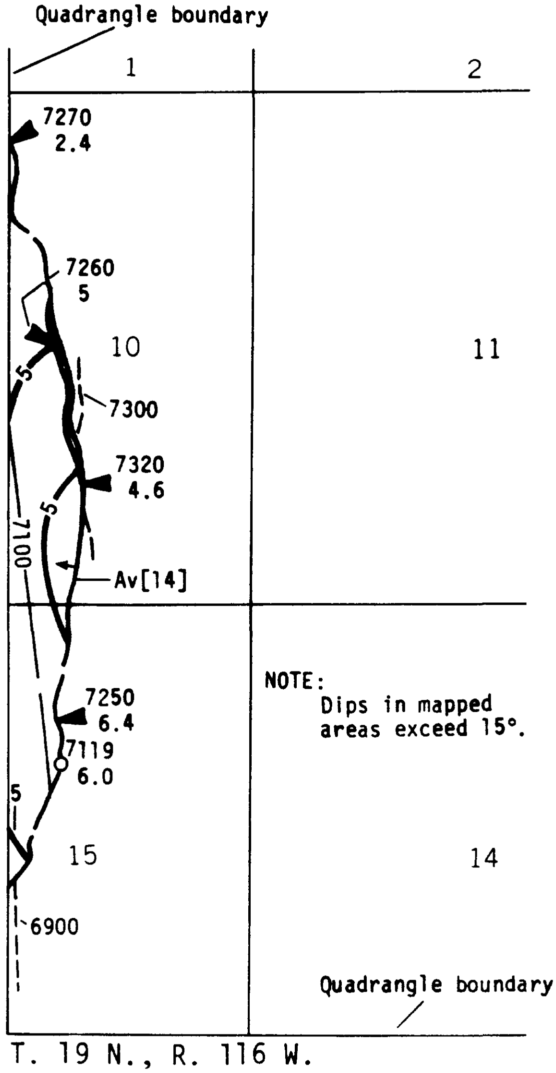


FIGURE 4. — Overburden isopach and mining ratio map of the Adaville [12] coal bed.



EXPLANATION

5

ISOPACHS - Showing thickness of coal, in feet. Long dashed where inferred. Isopach interval 5 feet.

7100

STRUCTURE CONTOURS - Drawn on top of coal bed. Long dashed where vertical accuracy possibly not within 40 feet; short dashed where projected above ground surface. Contour interval 200 feet (61 m). Datum is mean sea level.

7119
6.0

DRILL HOLE - Showing altitude of top of coal bed, and thickness of coal, in feet.

7250
6.4

POINT OF MEASUREMENT - Showing altitude of top of coal bed, and thickness of coal, in feet. Includes all points of measurement other than drill holes.

Av[14] - Adaville [14]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

Av[14]

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Dashed where inferred.

To convert feet to meters, multiply feet by 0.3048.

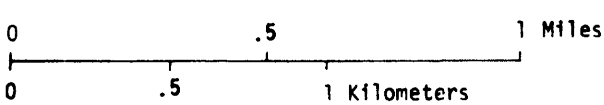
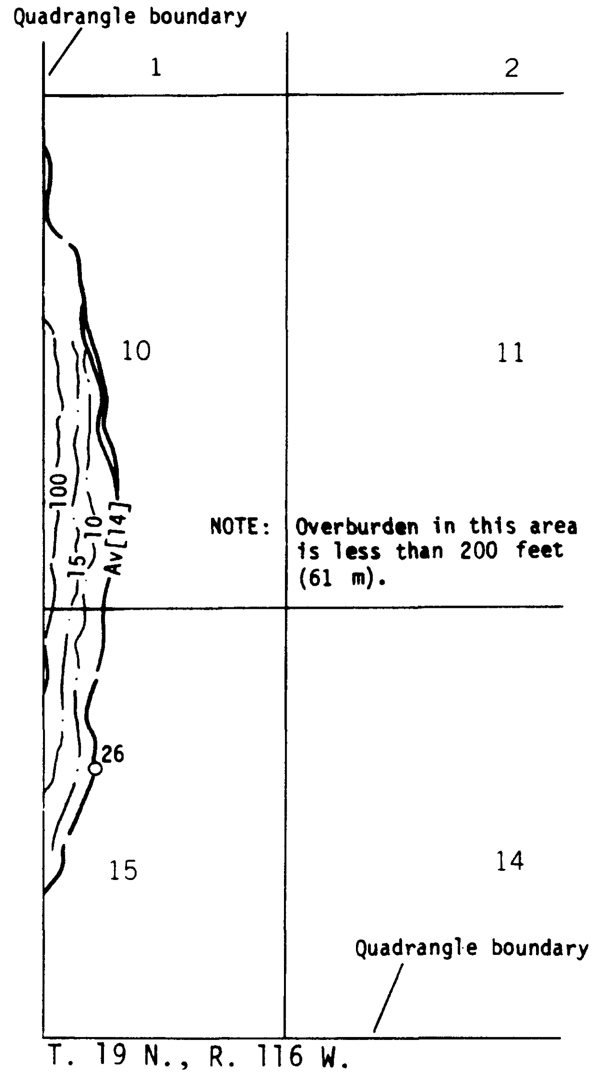


FIGURE 5. — Isopach and structure contour map of the Adaville [14] coal bed.



EXPLANATION

——— ——— 100 ——— ———

OVERBURDEN ISOPACHS - Showing thickness of overburden, in feet, from surface to top of coal bed. Dashed where vertical accuracy possibly not within 40 feet.

○26

DRILL HOLE - Showing thickness of overburden, in feet, from surface to top of coal bed.

———·———10———·———

MINING-RATIO CONTOUR - Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in areas underlain by coal of Reserve Base thickness within the stripping-limit (in this quadrangle, the 200-foot-overburden isopach). To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply mining ratio by 0.8428.

Av[14] - Adaville [14]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

——————— Av[14] ——— ———

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Dashed where inferred.

To convert feet to meters, multiply feet by 0.3048.

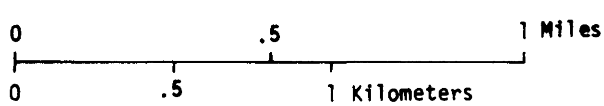


FIGURE 6. — Overburden isopach and mining ratio map of the Adaville [14] coal bed.

REFERENCES

American Society for Testing and Materials, 1977, Standard specification for classification of coals by rank, in Gaseous fuels; coal and coke; atmospheric analysis: ASTM Standard Specification D 388-77, pt. 26, p. 214-218.

Bozzuto, R. T., 1977, Geology of the Skull Point mine area, Lincoln County, Wyoming, in Rocky Mountain and thrust belt geology and resources, Joint Wyoming, Montana and Utah Geological Association Guidebook, 29th Annual Field Conference, 1977: p. 673-678.

Cobban, W. A., and Reeside, J. B., Jr., 1952, Frontier Formation, Wyoming and adjacent areas: American Association of Petroleum Geologists Bulletin, v. 36, no. 10, p. 1913-1961.

Engstrom, L. A., 1977, The Kemmerer coal field update, in Rocky Mountain and thrust belt geology and resources, Joint Wyoming, Montana and Utah Geological Association Guidebook, 29th Annual Field Conference, 1977: p. 679-687.

Glass, G. B., 1975, Analyses and measured sections of 54 Wyoming coal samples (collected in 1974): Wyoming Geological Survey, Report of Investigations No. 11, 219 p.

______ 1977, Update on the Hams Fork coal region, in Rocky Mountain and thrust belt geology and resources, Joint Wyoming, Montana, and Utah Geological Association Guidebook, 29th Annual Field Conference, 1977: p. 689-706.

Hale, L. A., 1960, Frontier formation, Coalville, Utah, and nearby areas of Wyoming and Colorado, in Overthrust belt of southwestern Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 15th Annual Field Conference, 1960: p. 136-146.

Hunter, W. S., Jr., 1950, The Kemmerer coal field, in Southwestern Wyoming, Wyoming Geological Association Guidebook, 5th Annual Field Conference, 1950: p. 123-132.

Lawrence, J. C., 1963, Origin of the Wasatch Formation, Cumberland Gap area, Wyoming: University of Wyoming, Contributions to Geology, v. 2, no. 2, p. 151-158.

M'Gonigle, John, 1979a, Preliminary geologic map and coal resources of the Elkol quadrangle, Lincoln County, Wyoming: U.S. Geological Survey, unpublished map, scale 1:24,000.

______ 1979b, Preliminary geologic map and coal resources of the Warfield Creek quadrangle, Lincoln County, Wyoming: U.S. Geological Survey, unpublished map, scale 1:24,000.

Mining Informational Services, 1978, Wyoming Directory of Mines, in 1978 Keystone Coal Industry Manual: New York, McGraw-Hill, p. 1190-1191.

References--Continued

Myers, R. C., 1977, Stratigraphy of the Frontier Formation (Upper Cretaceous), Kemmerer area, Lincoln County, Wyoming, in Rocky Mountain and thrust belt geology and resources, Joint Wyoming, Montana and Utah Geological Association Guidebook, 29th Annual Field Conference, 1977: p. 271-311.

Oriel, S. S., and Tracey, J. I., Jr., 1970, Uppermost Cretaceous and Tertiary stratigraphy of Fossil Basin, southwestern Wyoming: U.S. Geological Survey Professional Paper 635, 53 p.

Rocky Mountain Energy Company, (no date), Unpublished data from township maps T. 20 N., R. 116 W., and T. 19 N., R. 116 W., and from the Union Pacific coal inventory of 1969.

Roehler, H. W., Swanson, V. E., and Sanchez, J. D., 1977, Summary report of the geology, mineral resources, engineering geology and environmental geochemistry of the Sweetwater-Kemmerer area, Wyoming, part A, geology and mineral resources: U.S. Geological Survey Open-File Report 77-360, 80 p.

Rubey, W. W., Oriel, S. S., and Tracey, J. I., Jr., 1975, Geology of the Sage and Kemmerer 15-minute quadrangles, Lincoln County, Wyoming: U.S. Geological Survey Professional Paper 855, 18 p.

Schroeder, M. L., and Lunceford, R. L., 1976, Preliminary geologic map and coal resources of the Cumberland Gap quadrangle, Lincoln and Uinta Counties, Wyoming: U.S. Geological Survey, unpublished map, scale 1:24,000.

Townsend, D. H., 1960, Economic report on the Kemmerer coal field, in Overthrust belt of southwestern Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 15th Annual Field Conference, 1960: p. 252-255.

U.S. Bureau of Land Management, 1971, BLM public lands guide, Rock Springs district, Wyoming: Ogden, Utah, scale 1:337,920.

______ 1978, Draft environmental statement, proposed development of coal resources in southwestern Wyoming: U.S. Department of the Interior, v. 1 to 3.

U.S. Bureau of Mines, 1931, Analyses of Wyoming coals: U.S. Bureau of Mines Technical Paper 484, pp. 54-57, 115-121.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

Veatch, A. C., 1906, Coal and oil in southern Uinta County, Wyoming: U.S. Geological Survey Bulletin 285-F, p. 331-353.

References--Continued

______ 1907, Geography and geology of a portion of southwestern Wyoming with special reference to coal and oil: U.S. Geological Survey Professional Paper 56, 178 p.

Weimer, R. J., 1960, Upper Cretaceous stratigraphy, Rocky Mountain area: American Association of Petroleum Geologists Bulletin, v. 44, no. 1, p. 1-20.

______ 1961, Uppermost Cretaceous rocks in central and southern Wyoming, and northwest Colorado, in Symposium on the Late Cretaceous rocks in Wyoming and adjacent areas: Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 17-28.

Wyoming Natural Resources Board, 1966, Wyoming weather facts: Cheyenne, p. 30-31.

Wyoming State Highway Commission, 1978, Wyoming official highway map: Cheyenne, Wyoming, approximate scale 1:140,000.