Text to Accompany:

Open-File Report 79-1389

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE CUMBERLAND GAP QUADRANGLE, UINTA AND LINCOLN COUNTIES, WYOMING

[Report includes 9 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

By

DAMES & MOORE

DENVER, COLORADO

CONTENTS

	Page
Introduction	1
Purpose	1
Location	1
Accessibility	1
Physiography	2
Climate and vegetation	3
Land status	3
General geology	3
Previous work	3
Stratigraphy	4
Structure	8
Coal geology	8
Frontier Formation coal zones	9
Spring Valley coal zone	9
Kemmerer coal zone	10
Coal beds of the Adaville Formation	11
Coal resources	12
Coal development potential	13
Development potential for surface mining methods	13
Development potential for subsurface and in-situ mining methods	14
References	27

ILLUSTRATIONS

Plates 1-9. Coal resource occurrence and coal development potential maps:

1. Coal data map

2. Boundary and coal data map

3. Coal data sheet

4. Isopach and structure contour map of the Spring Valley [1] coal bed, Cumberland seam, and Adaville No. 1 coal bed

5. Overburden isopach and mining ratio map of the Spring Valley [1] coal bed, Cumberland seam, and Adaville No. 1 coal bed

6. Isopach and structure contour map of the Spring Valley [2] and Adaville No. 3A coal beds

7. Overburden isopach and mining ratio map of the Spring Valley [2] and Adaville No. 3A coal beds

8. Areal distribution and identified resources map of the Spring Valley [1] and [2] coal beds and the Cumberland seam

9. Coal development potential map for surface mining methods

Page

Figure 1. Isopach and structure contour map of the Adaville No. 2 coal bed.................................. 23

2. Overburden isopach and mining ratio map of the Adaville No. 2 coal bed.......................... 24

3. Isopach and structure contour map of the Adaville No. 4C coal bed................................ 25

4. Overburden isopach and mining ratio map of the Adaville No. 4C coal bed....................... 26

TABLES

		Page
Table 1.	Chemical analyses of coals in the Cumberland Gap quadrangle, Uinta and Lincoln Counties, Wyoming	16
2.	Coal Reserve Base data for surface mining methods in Federal coal lands (in short tons) in the Cumberland Gap quadrangle, Uinta and Lincoln Counties, Wyoming	17
3.	Sources of data used on plate 1	18

INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Cumberland Gap quadrangle, Uinta and Lincoln Counties, 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 Cumberland Gap quadrangle is located in north-central Uinta County and south-central Lincoln County, Wyoming, approximately 12 airline miles (19 km) south of the town of Kemmerer and 24 airline miles (39 km) northeast of the town of Evanston, Wyoming. Several ranches are located within the quadrangle.

Accessibility

Wyoming Highway 189, a paved medium-duty road crossing north-south through the western third of the quadrangle, connects the town of Kemmerer to the north of the quadrangle boundary with Interstate Highway 80 approximately 15 miles (24 km) to the southwest. An improved light-duty road, the Carter Cutoff road, crosses eastward through Cumberland Gap, then turns south through the central part of the quadrangle, connecting Wyoming Highway 189 with the town of Carter to the southeast of the quadrangle. A second light-duty road follows the Little Muddy Creek valley easterly from Wyoming Highway 189. The remainder of the quadrangle is served by numerous unimproved dirt roads and trails (U.S.

Bureau of Land Management, 1971; Wyoming State Highway Commission, 1978).

The Union Pacific Railroad passes through Carter approximately 7 miles (11 km) to the southeast of the quadrangle. This main east-west line provides railway service across southern Wyoming connecting Ogden, Utah, to the west with Omaha, Nebraska, to the east.

The Oregon Short Line Railroad, a branch of the Union Pacific Railroad, passes through Kemmerer north of the quadrangle. It is a major shipping route connecting Pocatello, Idaho, with the Union Pacific Railroad main line at Granger, Wyoming (U.S. Bureau of Land Management, 1971 and 1978; Wyoming State Highway Commission, 1978).

Physiography

The Cumberland Gap quadrangle lies on the eastern edge of the Wyoming Overthrust Belt. The landscape within the quadrangle is characterized by north-south-trending ridges and valleys. Oyster Ridge, crossing through the west-central part of the quadrangle, rises approximately 600 feet (183 m) above Cumberland Flats in the western third of the quadrangle. Altitudes range from 7,297 feet (2,224 m) on the south-central edge of the quadrangle to less than 6,500 feet (1,981 m) on Little Muddy Creek along the east-central edge of the quadrangle.

Little Muddy Creek and its tributaries drain the quadrangle eastward into the Green River east of the quadrangle boundary. Albert Creek flows northerly along the western side of Oyster Ridge to join Little Muddy Creek in the west-central part of the quadrangle. Little Muddy Creek flows easterly across the central part of the quadrangle crossing the Oyster Ridge through Cumberland Gap. Several small unnamed lakes and ponds are scattered throughout the quadrangle. Streams in the quadrangle, with the exception of Little Muddy Creek which flows year-round, are intermittent and flow mainly in response to snowmelt in the spring (U.S. Bureau of Land Management, 1971 and 1978; Wyoming State Highway Commission, 1978).

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 approximately 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, and juniper (U.S. Bureau of Land Management, 1978).

Land Status

The Cumberland Gap quadrangle lies in the east-central part of the Kemmerer Known Recoverable Coal Resources Area (KRCRA). Approximately half of the quadrangle lies within the KRCRA boundary and the Federal government owns the coal rights for approximately a third of this land. One active coal lease occurs 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. 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 described the Wasatch and Green River Formations in the Cumberland Gap area in 1963. Oriel and Tracey (1970) described the stratigraphy of the Evanston and Wasatch Formations present in the Kemmerer area. Glass (1975) described measured sections of Adaville Formation coals from the Elkol and Sorensen mines located near the town of Elkol and included coal analyses for the Adaville Formation coals. The geology of the Kemmerer and Sage 15-minute quadrangles was mapped by Rubey and others (1975). 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. Schroeder and Lunceford mapped the geology and coal resources of the Cumberland Gap quadrangle (1976) and the Bridger quadrangle (1977). M'Gonigle (1979) mapped the surface geology of the adjacent Elkol quadrangle. Unpublished data from Rocky Mountain Energy Company (RMEC) also provided coal thickness information.

Stratigraphy

The formations exposed in the Cumberland Gap quadrangle range in age from Late Jurassic to Eocene. The Frontier and Adaville Formations, trending north-northeast through the quadrangle, are coal-bearing.

The oldest formations exposed within the quadrangle have been mapped as a single unit (Schroeder and Lunceford, 1976) and include the Late Jurassic Preuss Red Beds and Stump Sandstone along with the Early Cretaceous Gannett Group. An unknown thickness of the rocks in this unit is exposed in isolated areas in the southeastern part of the quadrangle. The Preuss Red Beds consist of dull-reddish to purplish-gray sandstone, sandy siltstone, and claystone. The Stump Sandstone consists of gray to greenish-gray fine-grained sandstone, limestone, siltstone, and claystone. The Gannett Group contains a basal unit of red mudstone, siltstone, claystone, sandstone, and conglomerate, overlain by a sequence of alternating limestone, mudstone, siltstone and claystone beds (Rubey and others, 1975).

The Bear River Formation of Early Cretaceous age is exposed along the southern 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 approximately 825 feet (251 m) thick in the Kemmerer 15-minute quadrangle to the north (Rubey and others, 1975; Schroeder and Lunceford, 1976).

The Frontier Formation of early Late Cretaceous age crops out in the central part of the quadrangle where it conformably overlies the Aspen Shale. Schroeder and Lunceford (1976) have divided the formation into two mappable units. The lower half consists of approximately 970 feet (296 m) of non-marine sandstone, mudstone, and water-laid volcanics, and the League of Nations (Lower Carter Group), Spring Valley, and Willow Creek coal zones. The upper half of the formation is chiefly marine sandstone, siltstone, and shale. This unit is approximately 990 feet (302 m) thick and contains, near the top, a non-marine unit approximately 260 feet (79 m) thick consisting of sandstone, mudstone, and the Kemmerer coal zone. This non-marine unit is underlain by the prominent Oyster Ridge Sandstone Member, a white sandstone unit containing Ostrea soleniscus, a long slender oyster (Cobban and Reeside, 1952; Bozzuto, 1977).

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 (Schroeder and Lunceford, 1976) 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 northwestern edge of the quadrangle (Schroeder and Lunceford, 1976). 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. The Adaville Formation is approximately 2,900 feet (884 m) thick in the Kemmerer 15-minute 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; Schroeder and Lunceford, 1976). The main body is composed of green and brown-red variegated mudstone, light-red and tan conglomerate, and cross-bedded channel sandstone ranging 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; Schroeder and Lunceford, 1976). 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 Little Muddy Creek and Albert Creek.

The Preuss Red Beds and Stump Sandstone are shallow marine in origin. The Gannett Group sediments accumulated in fluviatile and lacustrine environments (Eyer, 1969; Furer, 1970).

The Upper Cretaceous formations in the Cumberland Gap 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 Cumberland Gap 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 Cumberland Gap 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 19° to 25° to the west (Schroeder and Lunceford, 1976).

A minor anticline and syncline have been mapped in the Wasatch Formation in the east-central part of the quadrangle.

COAL GEOLOGY

Coal-bearing formations in the Cumberland Gap 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. Several coal beds of the Adaville Formation crop out in the extreme northwestern corner of the quadrangle. The thicker coal beds overlie and intertongue with the Lazeart Sandstone at the base of the formation.

Chemical analyses of coal.--Representative analyses of coal from the Spring Valley and Kemmerer coal zones and the Adaville No. 1 coal bed from the Kemmerer area are included in table 1.

In general, coals in the Spring Valley and Kemmerer coal zones rank as high-volatile B bituminous, and coal from the Adaville No. 1 coal bed ranks as subbituminous A. Coal from other Adaville coal beds is either subbituminous B or C (Glass, 1975). These coals are ranked on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Frontier Formation Coal Zones

Frontier Formation coal zones crop out on the eastern and western sides of Oyster Ridge, trending northeast-southwest through the central part of the quadrangle. Dips generally range from 18° to 25° to the west-northwest.

Spring Valley Coal Zone

Two coal beds in the Spring Valley coal zone, lying approximately 400 to 500 feet (122 to 152 m) stratigraphically above the base of the Frontier Formation, have been isopached in the Cumberland Gap quadrangle. These coal beds have been given informal 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 isopached bed within the quadrangle. The coal bed is 6 feet (1.8 m) thick locally where measured in sec. 20, T. 19 N., R. 116 W. (plate 4).

It has been traced into the Elkol quadrangle to the north where it averages 4.0 feet (1.2 m) in thickness (M'Gonigle, 1979) and has been designated the Spring Valley [3] coal bed.

The Spring Valley [2] coal bed is located approximately 70 feet (21 m) above the Spring Valley [1] coal bed and has a maximum measured thickness of 6 feet (1.8 m) where isopached in sec. 20, T. 19 N., R. 116 W (plate 6). This coal bed is also present in the Elkol quadrangle, where it is designated the Spring Valley [4], thickening locally to 6.9 feet (2.1 m) in sec. 4, T. 19 N., R. 116 W.

Kemmerer Coal Zone

The Kemmerer coal zone overlies and is separated from the Oyster Ridge Sandstone Member by approximately 220 to 280 feet (67 to 85 m) of mudstone, sandstone, and siltstone. This group of coal beds crops out on the western side of Oyster Ridge and has been traced for more than 60 miles (97 km) in the Kemmerer coal field (Glass, 1977).

The thickest and most persistent coal bed in the Kemmerer zone is the Cumberland seam (RMEC, no date). This coal bed is also known as the Kemmerer No. 1 or Frontier No. 1 (Glass, 1977), or Main Kemmerer (Veatch, 1907), and has been mined extensively in the northern part of the quadrangle at Cumberland Mine Nos. 1 and 2 (plate 4). Measured coal thicknesses at these abandoned mines range from approximately 5 to 20 feet (1.5 to 6.1 m) with minor rock partings. In the southern part of the quadrangle, the Cumberland seam is considerably thinner. In much of this area it is less than 5 feet (1.5 m) thick. The seam thickens locally to 8.1 and 9.8 feet (2.5 and 3.0 m) where measured in secs. 26 and 13, (T. 18 N., R. 117 W.), respectively.

In the Elkol quadrangle, the Cumberland seam remains thick, attaining a maximum measured 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. In the adjacent Bridger quadrangle to the south, the Cumberland seam thins markedly, averaging 4 feet (1.2 m) in thickness.

Coal Beds of the Adaville Formation

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.

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

The Adaville No. 1, generally the thickest of the Adaville coal beds, classically overlies the Lazeart Sandstone Member. However, recent work in this area suggests that, in many cases, the Adaville No. 1 probably intertongues with the sandstone.

Using scattered coal test hole information provided by RMEC, the inferred trace of the Adaville No. 1 coal bed has been projected in both the southern part of the Elkol quadrangle and in the northwestern part of this quadrangle (plate 4). Because most of this area is covered by gravel, more drilling is required to confirm the presence, thickness and extent of the Adaville No. 1 coal bed.

Several other Adaville Formation coal beds, lying stratigraphically above the Adaville No. 1, either crop out or have been inferred to occur in the northwestern corner of the quadrangle (Schroeder and Lunceford, 1976; RMEC, no date). Because the land areas containing Adaville coal in the Cumberland Gap 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 plate 6 and in figures 1 and 3. (All figures are included at the end of this report.)

COAL RESOURCES

Information from coal test holes drilled by RMEC, as well as coal bed measurements by Veatch (1907) and Schroeder and Lunceford (1976), were used to construct maps of the coal beds in the Cumberland Gap 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 the coal isopach maps (plates 4 and 6). 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), 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 Cumberland seam and the Spring Valley [1] and [2] coal beds are shown on plate 8, 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 650,000 short tons (590,000 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 surface 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 is shown on plate 9. Of the Federal land areas within the KRCRA boundary, 6 percent are rated high, 46 percent are rated unknown, and 48 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 19° to 25° and the total Reserve Base tonnage available for in-situ mining is less than 50 million short tons (only 83,000 short tons or 75,000 metric tons as shown on plate 8), 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 Cumberland Gap quadrangle, Uinta and Lincoln Counties, 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., R. 116 W., 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 Cumberland Gap quadrangle, Uinta and Lincoln Counties, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Cumberland Seam	94,500	26,700	135,200	-	256,400
Spring Valley {2}	83,500	65,700	105,500	-	254,700
Spring Valley {1}	38,400	17,000	-	-	55,400
Totals	216,400	109,400	240,700	-	566,500

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. 2, Line A
2	↓	Drill hole No. 1, Line A
3	Schroeder and Lunceford, 1976, U.S. Geological Survey, unpublished map	Measured Section No. 11
4	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3, Line A
5	↓	Drill hole No. 2, Line A
6	↓	Drill hole No. 1, Line A
7	Amoco Production Corp.	Oil/gas well No. 1 Champlin-407-Amoco-A
8	Schroeder and Lunceford, 1976, U.S. Geological Survey, unpublished map	Measured Section No. 10
9	↓	Measured Section No. 9
10	↓	Measured Section No. 8
11	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3, Line A
12	↓	Drill hole No. 2, Line A
13	↓	Drill hole No. 1 (Union Pacific Coal)
14	↓	Drill hole No. 1, Line A

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
15	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 125	Drill hole No. 68
16	↓	Drill hole No. 69
17	↓	Drill hole No. 70
18	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1, Line A
19	↓	Drill hole No. 3, Line A
20	↓	Drill hole No. 2, Line A
21	↓	Drill hole No. 1, Line A
22	↓	Drill hole No. 131, Line A
23	Schroeder and Lunceford, 1976, U.S. Geological Survey, unpublished map	Measured Section No. 4
24	↓	Measured Section No. 3
25	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3, Line A
26	↓	Drill hole No. 2, Line A
27	↓	Drill hole No. 1, Line A
28	Schroeder and Lunceford, 1976, U.S. Geological Survey, unpublished map	Measured Section No. 2
29	↓	Measured Section No. 1

Page 2 of 5

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
30	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 127	Mine Section No. 93
31	↓	Drill hole No. 4 (No. 95)
32	Schroeder and Lunceford, 1976, U.S. Geological Survey, unpublished map	Measured Section No 7
33	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 124	Mine Section No. 52 (Cumberland Mine No. 2)
34	↓	Drill hole No. 53
35	↓	Drill hole No. 54
36	↓	Drill hole No. 55
37	↓	Measured Section No. 56
38	↓	Measured Section No. 57
39	↓	Measured Section No. 58
40	↓	Measured Section No. 59
41	Schroeder and Lunceford, 1976, U.S. Geological Survey, unpublished map	Measured Section No. 13
42	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2, Line A
43	↓	Drill hole No. 1, Line A
44	↓	Drill hole No. 4, Line A
45	↓	Drill hole No. 2, Line A

Page 3 of 5

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
46	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1, Line A
47	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 125	Measured Section No. 66
48	↓	Measured Section No. 65
49	Schroeder and Lunceford, 1976, U.S. Geological Survey, unpublished map	Mine Section No. 6
50	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 124	Measured Section No. 60
51	↓	Measured Section No. 61
52	↓	Measured Section No. 63
53	Schroeder and Lunceford, 1976, U.S. Geological Survey, unpublished map	Measured Section No. 5
54	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 124	Mine Section No. 62 (Cumberland Mine No. 1)
55	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2, Line A
56	↓	Drill hole No. 1, Line A
57	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 125	Measured Section No. 64
58	Schroeder and Lunceford, 1976, U.S. Geological Survey, unpublished map	Measured Section No. 12
59	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 4, Line B

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
60	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3, Line B
61	↓	Drill hole No. 2, Line B
62	↓	Drill hole No. 1, Line B
63	↓	Drill hole No. 5, Line A

Page 5 of 5

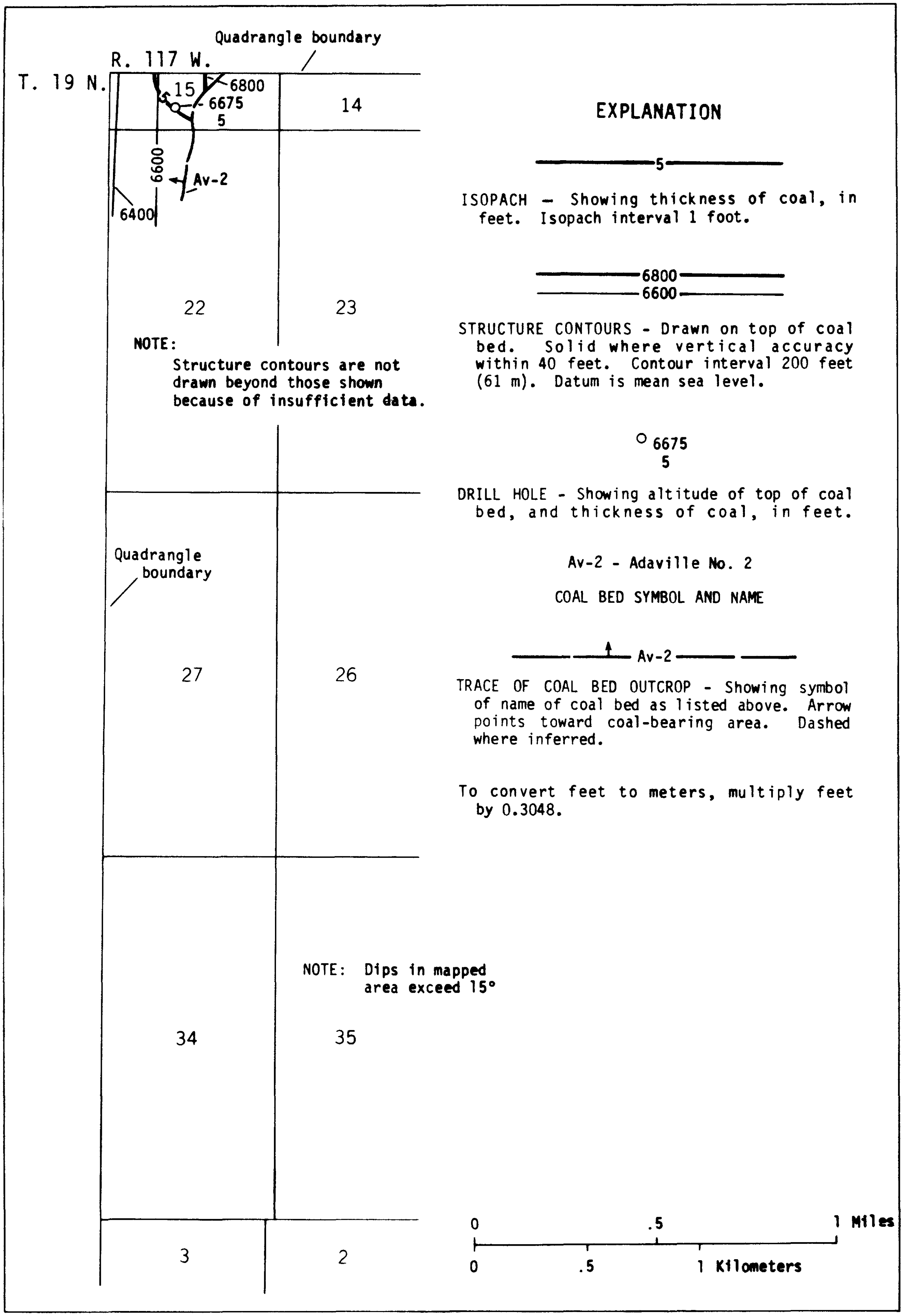
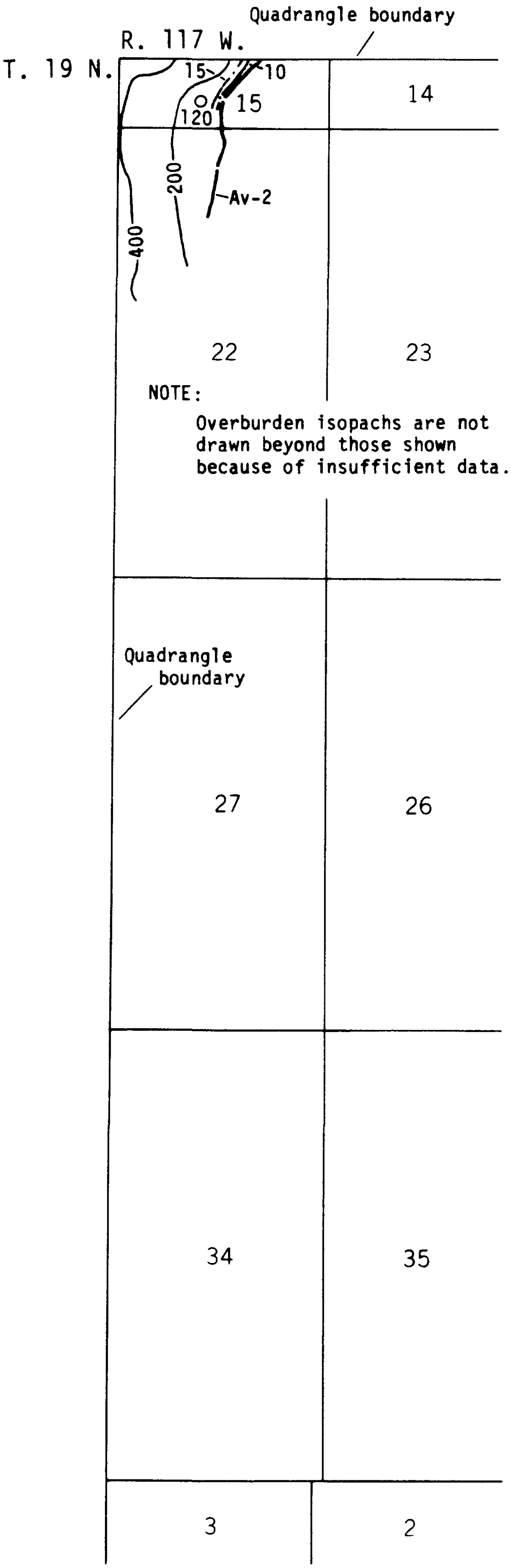


FIGURE 1. — Isopach and structure contour map of the Adaville No. 2 coal bed.



EXPLANATION

——— 200 ———

OVERBURDEN ISOPACH - Showing thickness of overburden, in feet, from surface to top of coal bed. Isopach interval 200 feet (61 m).

○ 120

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

——·—— 15 ——·——

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-2 - Adaville No. 2

COAL BED SYMBOL AND NAME

—— —— Av-2 —— ——

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.

0 .5 1 Miles

0 .5 1 Kilometers

FIGURE 2. — Overburden isopach and mining ratio map of the Adaville No. 2 coal bed.

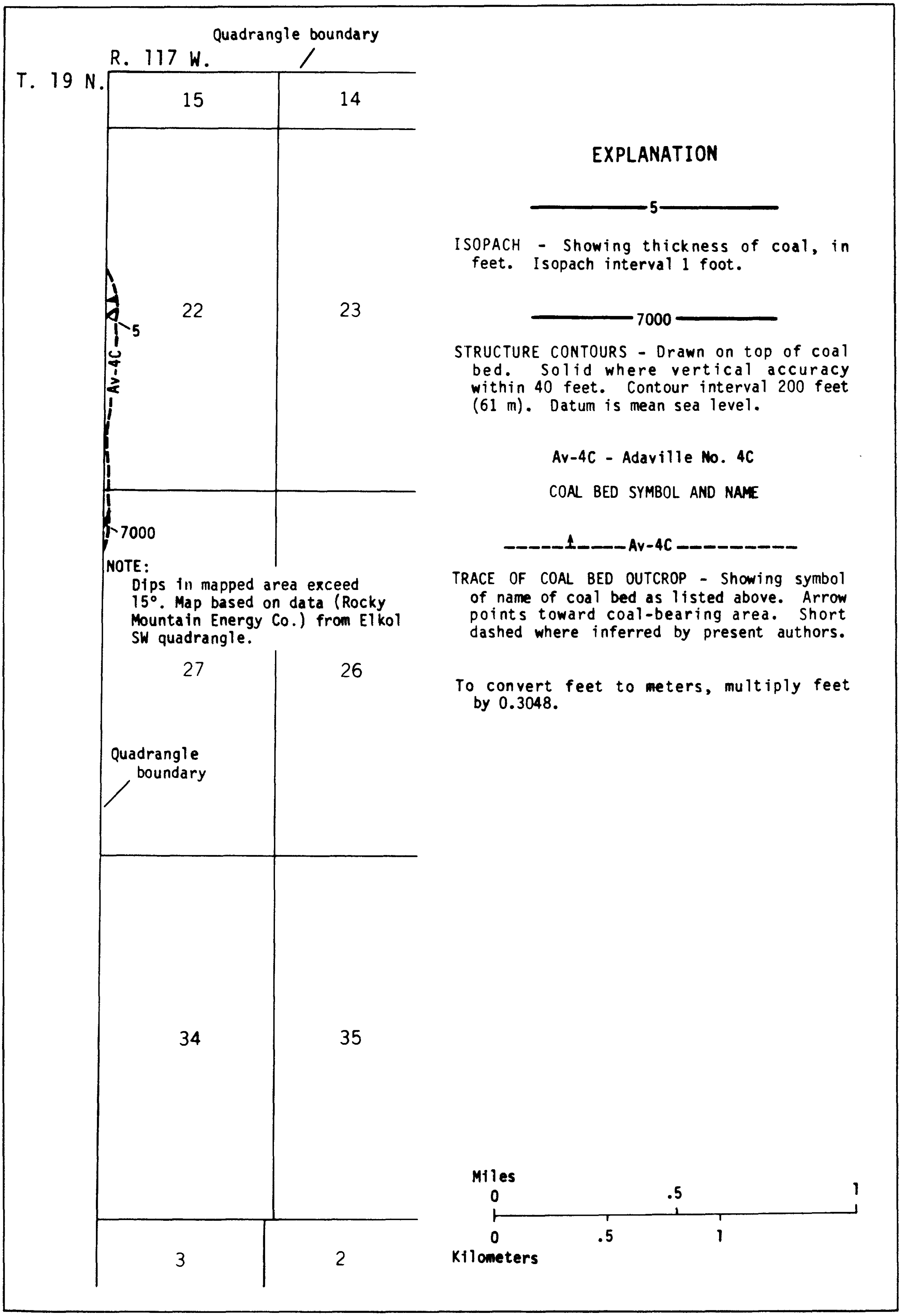


FIGURE 3. — Isopach and structure contour map of the Adaville No. 4C coal bed.

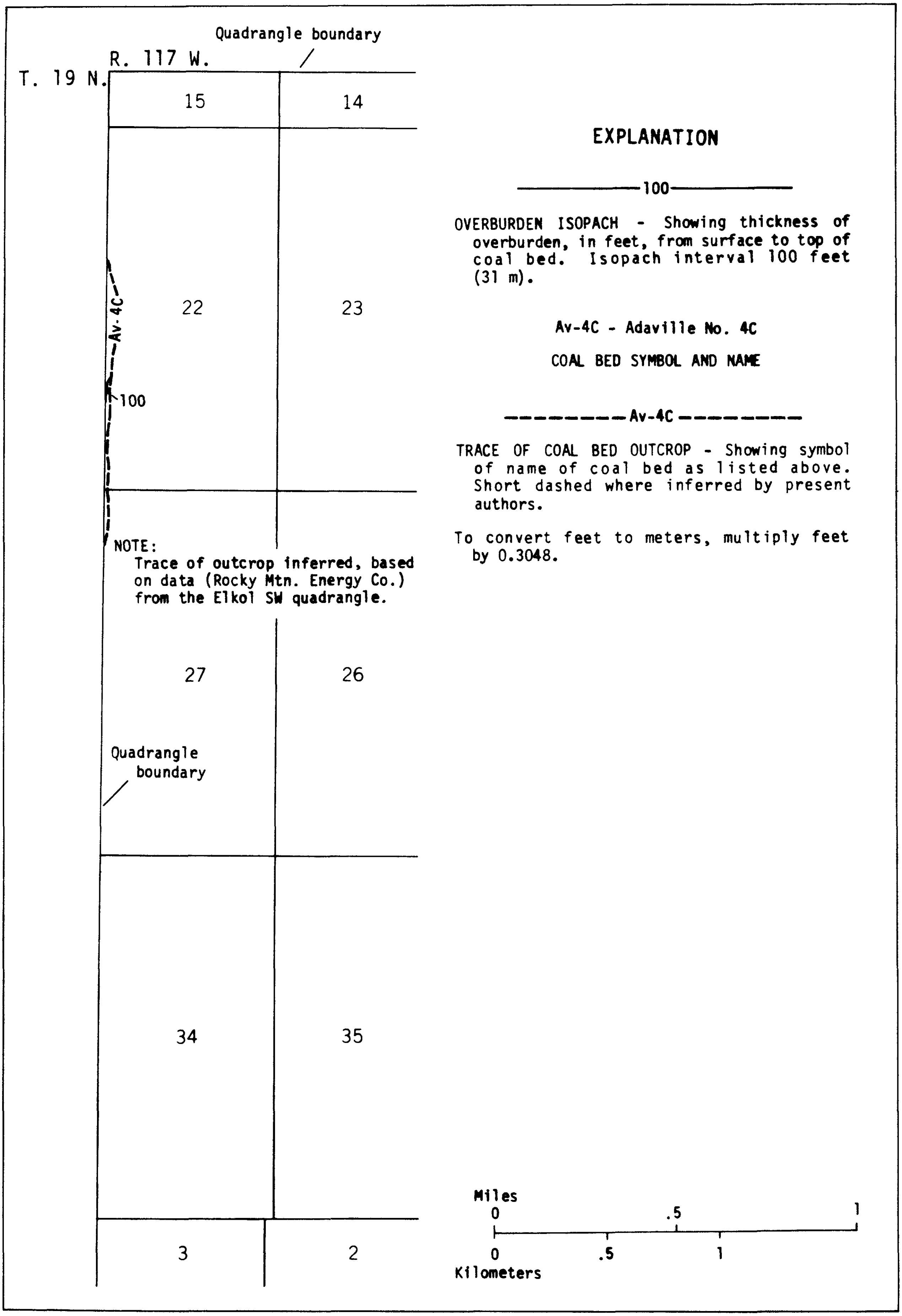


FIGURE 4. — Overburden isopach map of the Adaville No. 4C coal bed.

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.

Eyer, J. A., 1969, Gannett Group of western Wyoming and southeastern Idaho: American Association of Petroleum Geologists Bulletin, v. 53, No. 7, p. 1368-1390, 8 figs.

Furer, L. C., 1970, Petrology and stratigraphy of non-marine Upper Jurassic-Lower Cretaceous rocks of western Wyoming and southeastern Idaho: American Association of Petroleum Geologists Bulletin, v. 54, No. 12, p. 2282-2302, 22 figs.

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

References--Continued

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

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 drill-hole data 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.

______ 1977, Preliminary geologic map and coal resources of the western half of the Bridger quadrangle, Uinta County, Wyoming: U.S. Geological Survey, unpublished report and map, scale 1:24,000.

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.

References--Continued

Veatch, A. C., 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.