Geology and Mineral Resources of the Mud Springs Ranch Quadrangle, Sweetwater County, Wyoming

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1065-C

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By HENRY W. ROEHLER

GEOLOGY OF THE SOUTHEAST PART OF THE ROCK SPRINGS UPLIFT, WYOMING

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Stratigraphy, structure, and mineral resources of rocks of Late Cretaceous and Early Tertiary age

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CONTENTS

ILLUSTRATIONS

[Plates are in pocket]

TABLES

ENGLISH-METRIC CONVERSION

[The metric system is not currently used to compute coal, oil, and gas resources in the United States]

English unit			Metric unit
Short ton	=	0.907	Metric tonne
Mile	=	1.609	Kilometers
Square mile	=	2.59	Square kilometers
Acre	=	.4047	Hectare
Foot	=	.3048	Meter
Cubic foot	=	.0283	Cubic meter
Btu	=	.252	Kilogram calorie

GEOLOGY AND MINERAL RESOURCES OF THE MUD SPRINGS RANCH QUADRANGLE, SWEETWATER COUNTY, WYOMING

By HENRY W. ROEHLER

ABSTRACT

The Mud Springs Ranch quadrangle occupies an area of 56 mi² (square miles) on the southeast flank of the Rock Springs uplift in southwestern Wyoming. The climate is arid and windy. The landscape is mostly poorly vegetated and consists of north-trending ridges and valleys that are dissected by dry drainages. Sedimentary rocks exposed in the quadrangle are 5,400 ft (feet) thick and are mostly gray sandstone, siltstone, and shale, gray and brown carbonaceous shale, and thin beds of coal. They compose the Blair, Rock Springs, Ericson, Almond, and Lewis Formations of Cretaceous age and the Fort Union Formation of Paleocene age. The structure is mostly homoclinal, having southeast dips of 5°-12° in the northern part of the quadrangle, but minor plunging folds and one small fault are present in the southern part of the quadrangle. Three coal beds in the Fort Union Formation and 15 coal beds in the Almond Formation exceed 2.5 ft in thickness, are under less than 3,000 ft of overburden, and are potentially minable. Geographic stratigraphic, and resource data are present for each bed of minable coal. The total minable coal resources are estimated to be about 283 million short tons. Nine coal and rock samples from outcrops were analyzed to determine their quality and chemical composition. Four dry oil and gas test wells have been drilled within the quadrangle area, but structurally controlled stratigraphic-trap prospects remain untested.

INTRODUCTION

LOCATION AND ACCESSIBILITY

The Mud Springs Ranch 7½-minute quadrangle occupies 56 mi² on the southeast flank of the Rock Springs uplift in southwestern Wyoming. It is 18 mi (miles) northeast of the common boundary of Wyoming, Colorado, and Utah. The quadrangle area is accessible by Wyoming Highway 430, which crosses the northeast part part of the quadrangle 23 mi southeast of the city of Rock Springs (fig. 1). Many improved and unimproved roads and trails branch from Wyoming Highway 430 within the quadrangle area (pl. 1).

SUMMARY OF WORK

The author's geologic investigations in the Rock Springs uplift area are part of a project undertaken by the U.S. Geological Survey to locate and evaluate coal and other mineral resources on federally owned lands. The Rock Springs project encompasses an area of more than 1,100 mi² amd includes 20 7½-minute quadrangles.

Field work in the Mud Springs Ranch quadrangle began in June 1975 and ended in September 1975. The geology of the quadrangle was mapped using plane table and alidade and aerial photographs. A geologic map was later compiled from the field data using a Kern PG-2 stereoscopic plotter (Roehler, 1978). Eighty-six stratigraphic sections were measured by Jacob's staff and Abney level to correlate rock units and coal beds. More than 300 coal outcrops were excavated by pick and shovel to obtain accurate thicknesses of coal beds and partings. Nine coal and rock outcrops were sampled and analyzed to determine their chemical composition. Invertebrate fossils were collected at several localities and were used to interpret environments of deposition and to determine the ages of rock units.

PREVIOUS INVESTIGATIONS

The area of the Mud Spring quadrangle was included on a geologic map of the southern part of the Rock Springs coal field that was compiled by Schultz (1910. pl. 14) This uncolored map was published on a planimetric base at a scale of 1:250,000. Outcrops of coal are shown on the map, but none of the beds was identified by name, sampled, or located stratigraphically.

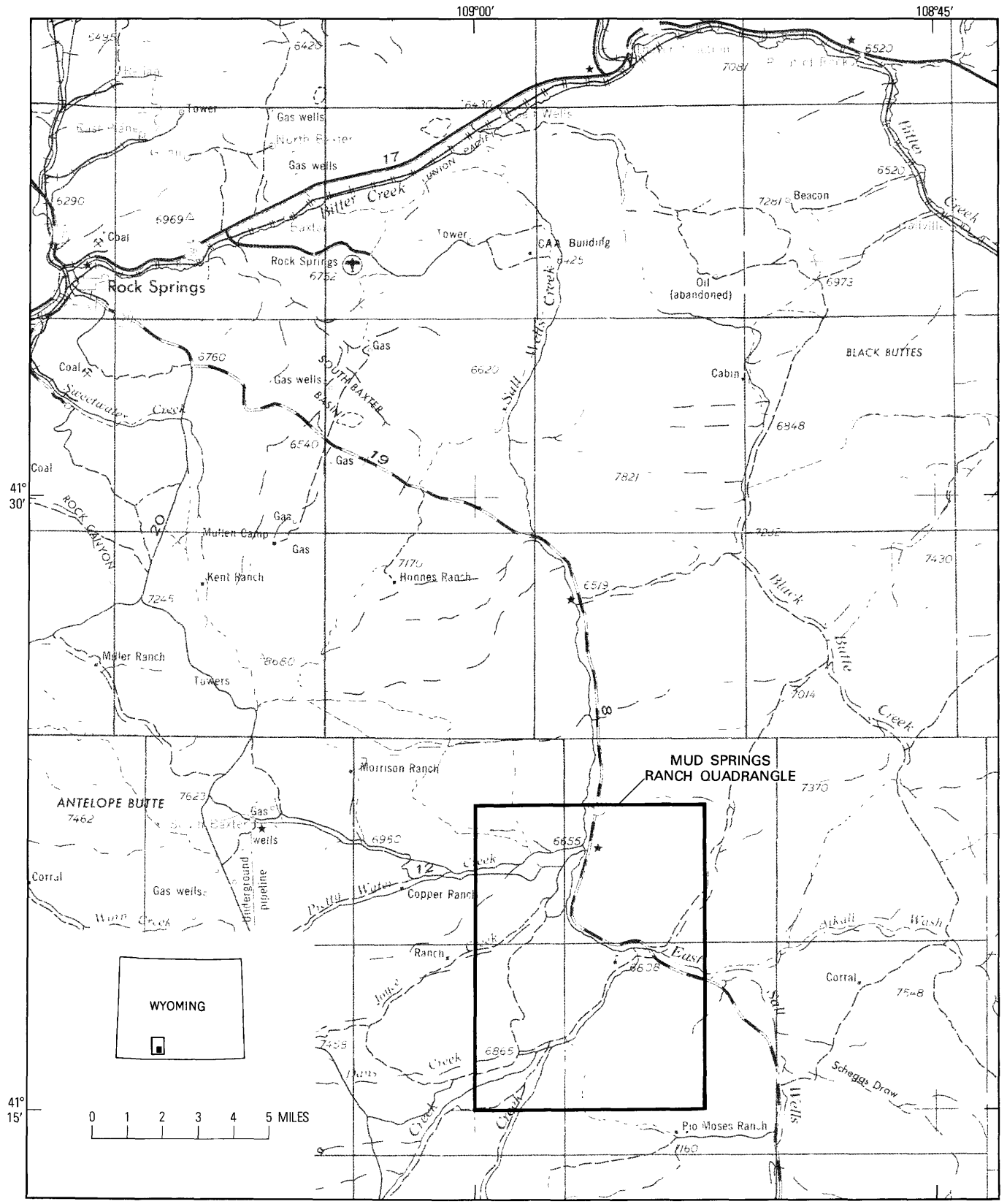

FIGURE 1.—Index map showing the location of the Mud Springs Ranch quadrangle in southwest Wyoming. Base from AMS 1:250,000 Rock Springs, Wyoming, Colorado, 1954 (revised 1962).

Appraisals of coal resources in the Rock Springs coal field have been made by Schultz (1910). Berryhill, Brown, and Taylor (1050), and Root, Glass, and Lane (1973).

ACKNOWLEDGMENTS

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PHYSIOGRAPHY

The Mud Springs Ranch quadrangle is in an area of ridges and valleys that trend irregularly northward. Cooper Ridge, which is covered by cedar trees, is a large west-facing escarpment near the center of the quadrangle (pl. 1). The steep western slopes of Cooper Ridge are formed by a series of light-gray sandstone benches that rise precipitously for a few hundred feet to the crest of the ridge. The eastern slopes of Cooper Ridge are more gentle by comparison and are formed by a number of minor escarpments having long dip slopes that decrease in overall elevation from the crest of the ridge eastward to Big Flat Draw and its contiguous strike-valley equivalents. Mean-sea-level elevations in the quadrangle range between 7,682 ft (feet) on Cooper Ridge in sec. 2, T. 15 N., R. 103 W., and 6,675 ft on Salt Wells Creek in sec. 18, T. 16 N., R. 102 W.

The major drainage is Salt Wells Creek and its tributaries. Salt Wells Creek flows intermittently during the spring runoff and after heavy rains but is normally dry during hot summer months. Salt Wells Creek flows northward from the quadrangle area for about 20 mi and joins Bitter Creek about 10 mi east of Rock Springs, Wyo. (fig. 1).

The climate is arid and windy. Mean annual precipitation is about 7.5 in. (inches) (Root and others, 1973). Diurnal temperatures during summer months (June–August) usually range from 70°–95°F during the day to 40°–50°F at night. Temperatures exceeding 95°F are rare. Winter temperatures are more variable, but usually range from 30°–50°F during the day to 0°–20°F at night. The coldest winter temperatures may reach −30°F. Most precipitation is in the form of snow, which normally occurs from September to May.

Vegetation is sparse. Cedar trees (*Juniperus* sp.), a few pine trees, sagebrush, and grass grow at higher elevations. The vegetation at lower elevations is characterized by clumps of sagebrush and desert grasses. Wildlife includes deer, antelope, coyotes, bobcats, badgers, prairie dogs, ground squirrels, and a variety of birds.

The only industry is cattle and sheep ranching. The quadrangle is unoccupied except for residents at the Mud Springs Ranch in sec. 32, T. 16 N., R. 102 W., and occasional sheep herders.

STRATIGRAPHY

GENERAL

Sedimentary rocks that crop out in the Mud Springs Ranch quadrangle are of Late Cretaceous and Paleocene age and are about 5,400 ft thick. Figure 2 summarizes the geology of the stratigraphic succession. Details of the stratigraphy of the coal-bearing formations are shown on plate 2.

CRETACEOUS ROCKS

BLAIR FORMATION

The Blair Formation weathers to low rounded gray hills and tan ridges separated by alluvial valleys. It normally has a total thickness of about 1,500 ft, but only the upper 1,000 ft are exposed in the Mud Springs Ranch quadrangle. The Blair Formation is composed of soft gray shale and sparse, very thin, interbeded, gray, very fine grained, calcareous sandstone and gray calcareous siltstone. The formation was deposited in a shallow marine environment. No fossils were collected from the formation in the quadrangle area.

ROCK SPRINGS FORMATION

The Rock Springs Formation weathers mostly to an undulating drab-gray shale valley between tan and brown sandstone ridges that are present near the top of the formation. The formation is 1,500 to 1,625 ft thick. It has been subdivided into tongues by Hale (1950) and Smith (1961; 1965). In ascending order these are: the Chimney Rock Tongue, 111 ft thick, composed of gray very fine grained sandstone and some interbedded gray shale and siltstone; the Black Butte Tongue, 708 ft thick, composed of gray shale and very sparse thin interbedded gray very fine grained sand-

System	Age	Stratigraphic unit		Thickness (ft)	Description
Tertiary	Paleocene	Fort Union Formation (part)		1,275	Gray shale and interbedded variegated mudstone, gray siltstone, gray very fine to coarse-grained sandstone, gray and brown carbonaceous shale, and coal. Intraformational unconformities are indicated by fossil soils. The upper part is not present in the Mud Springs Ranch quadrangle. The formation is 1,375–1,400 ft thick in sections measured east of the quadrangle.
		Unconformity			
		Lewis Shale		200–350	Dark-gray soft shale. The upper 1–15 ft are usually light gray limy siltstone composing a fossil soil marking the Tertiary-Cretaceous Laramide unconformity.
		Almond Formation		750–825	Gray very fine grained sandstone and interbedded gray shale, gray siltstone, gray, black, and brown carbonaceous shale and coal.
		Ericson Sandstone	Canyon Creek zone[1]	325–375	Gray very fine grained to very coarse grained salt-and-pepper subangular crossbedded sandstone and sparse thin gray siltstone and gray shale.
			Rusty zone[1]	225–250	Gray very fine to medium-grained partly hematitic siltstone and gray occasionally carbonaceous shale. The upper and lower contacts are poorly defined; it appears to intertongue in places with the Canyon Creek zone and the Trail zone.
			Trail zone[1]	250–375	Gray very fine to coarse-grained salt-and-pepper, partly hematitic crossbedded sandstone.
Cretaceous	Late Cretaceous	Rock Springs Formation	Gottsche Tongue[2]	73–125	Gray very fine-grained crossbedded sandstone, gray carbonaceous hematitic siltstone, gray soft shale, dark-gray and brown carbonaceous shale, and sparse thin beds of coal.
			McCourt Tongue[1]	60–85	Gray very fine grained partly calcareous sandstone.
			Coulson Tongue[1]	75–80	Gray soft shale and sparse thin beds and laminae of gray siltstone.
			Brooks Tongue[1]	40–65	Gray very fine grained partly calcareous sandstone interbedded with gray sandy soft shale in the lower part.
			Black Butte Tongue[3]	700–725	Gray soft shale and sparse thin beds and laminae of gray very fine grained calcareous sandstone and gray siltstone.
			Chimney Rock Tongue[3]	110–150	Gray very fine grained calcareous sandstone and interbedded gray calcareous siltstone and gray sandy shale.
		Blair Formation (part)		1,000	Gray soft shale and sparse thin interbedded gray very fine grained calcareous sandstone and gray calcareous siltstone. The lower part is not exposed in the Mud Springs Ranch quadrangle. The Blair Formation is 1,350–1,550 ft thick on geophysical logs of drill holes in the quadrangle.

[1]Smith (1961).
[2]Smith (1965).
[3]Hale (1950).

FIGURE 2.—Geologic formations exposed in the Mud Springs Ranch quadrangle, Sweetwater County, Wyo.

stone and gray siltstone; the Brooks Tongue, 65 ft thick, composed of gray very fine grained sandstone and interbedded gray shale; the Coulson Tongue, 75 ft thick, composed of gray shale; the McCourt Tongue, 85 ft thick, composed of light-gray very fine grained calcareous partly crossbedded sandstone; and the Gottsche Tongue, 73 ft thick, composed of interbedded light-gray very fine grained crossbedded sandstone, gray siltstone, gray and brown carbonaceous shale and coal. The Black Butte Tongue was deposited in a prodelta environment, the Chimney Rock, Brooks, and McCourt Tongues were deposited in delta-front environments, the Coulson Tongue was deposited in an offshore marine environment, and the Gottsche Tongue was deposited in a delta plain environment.

Fossils collected from the Chimney Rock Tongue at USGS locality D2214 in NE¼NE¼ sec. 26, T. 16 N., R. 103 W., indicate that the lower part of the Rock Springs Formation is of Campanian Age (Smith, 1965, p. 20). The assemblage of marine fossils from locality D2214 is:

PELECYPODS
- *Nuculana* sp.
- *Pinna* sp.
- *Inoceramus subcompressus* Meek and Hayden
- *Pteria* cf. *P. linguaeformis* (Evans and Shumard)
- *Ostrea russelli* Landes
- *Pecten (Syncyclonema) halli* Gabb
- *Anomia* sp.
- *Cymella montanensis* (Henderson)
- *Legumen ellipticum* Conrad
- *Cymbophora* sp.

CEPHALOPODS
- *Scaphites hippocrepis* (DeKay)
- *Baculites* sp.

The upper part of the Rock Springs Formation is probably of late Campanian age, because of the presence of *Baculites asperiformis* (Smith, 1965, p. 17).

ERICSON SANDSTONE

Light-gray sandstone outcrops of the Ericson Sandstone are present along Cooper Ridge (pl. 1). The Ericson has an overall thickness of 850 to 950 ft. It has been divided by Smith (1961) into three informal zones, a lower gray dominantly sandstone unit 270 to 360 ft thick named the Trail zone, a middle rust-colored sandstone, siltstone, and shale unit 225 to 250 ft thick named the Rusty zone, and an upper gray predominantly sandstone unit 330 to 365 ft thick named the Canyon Creek zone. The Canyon Creek and Trail zones weather to cliffs and ledges, whereas the Rusty zone is less resistant and weathers to low slopes and in a few places to a valley.

The Canyon Creek and Trail zones have similar lithologies consisting of light-gray very fine to very coarse grained poorly sorted subangular crossbedded sandstone containing abundant dark chert grains and minor very thin gray shale, gray carbonaceous shale, and lenses of gray pebble conglomerate. The Rusty zone is composed of interbedded gray very fine to medium-grained subangular poorly sorted hematitic crossbedded sandstone, and gray silty shale, gray siltstone, and, locally, very thin beds of gray carbonaceous shale and coal. The Ericson is remarkably well exposed in a wide trench that was dug by the Mountain Fuel Supply Co. while laying a pipeline down the west slopes of Cooper Ridge in the north center of sec. 20, T. 16 N., R. 102 W. The fluvial origin of the formation there is clearly demonstrated by the sedimentary structures visible in the walls of the trench. The formation shows large-scale trough crossbedding in a succession of scour-and-fill channel deposits that contain small slump blocks and lenses of flattened gray shale pebbles interbedded with small-scale crossbedded sandstone and lenses of sandy mudstone. The formation appears to have been deposited on a flat, sparsely vegetated plain transected by braided streams.

Fossils are rare in the Ericson, but a few poorly preserved leaves were found in a gray shale near the top of the Rusty zone in measured section 7975 in sec. 18, T. 15 N., R. 102 W. (Roehler, 1978), and two very weathered caudal vertebra of an unidentified dinosaur were collected from the basal part of the Trail zone in sec. 30, T. 16 N., R. 102 W.

ALMOND FORMATION

The Almond Formation weathers to a series of tan and brown sandstone ridges and intervening drab-gray valleys composed mostly of shale and coal. The formation is 750 to 825 ft thick. It is divided into three parts on the basis of lithologies that reflect environments of deposition. The upper 300 to 400 ft are mostly light gray very fine grained sandstone and thin interbedded gray shale, gray and brown carbonaceous shale, and coal. An interval 125 to 250 ft thick near the center of the formation is mostly dark gray and brown carbonaceous shale and coal, and some thin interbedded gray shale and gray very fine grained crossbedded sandstone. The lower 150 to 300 ft of the formation are mostly interbedded gray very fine grained crossbedded sandstone, dark-gray and brown carbonaceous shale, and very sparse thin beds of coal. The environments of deposition of the upper, middle, and lower parts are, respectively: (1) mixed shallow marine, barrier bar, and lagoonal; (2) lagoonal; and (3) coastal swamp (pl. 2). Analysis of sedimentary structures permits the further subdivision of the barrier bar sand-

stones *AA*, *A*, *B*, *D*, *E*, *F*, and *G*, shown on plate 2, into units of lower shoreface middle shoreface, upper shoreface, beach sand dune, washover, and flood-delta origin.

Fossil mollusks were collected from the Almond Formation at two localities in the Mud Springs Ranch quadrangle. *Anomia gryphorhynchus* Meek and *Leptesthes* sp. were identified among specimens collected at USGS locality D9398, in SE¼ sec. 33, T. 16 N., R. 102 W., and *Glycymeris holmesiana* (White) was identified among specimens collected at USGS locality D9402 in NW¼ sec. 17, T. 15 N., R. 102 W. Beds containing fossils of the oyster *Crassostrea* sp. are very abundant in parts of the formation that were deposited in lagoonal environments. One such bed, called the oyster marker, is 250 to 325 ft below the top of the formation and is an excellent stratigraphic datum in measured sections (pl. 2). The oyster marker bed appears to have been deposited as a persistent north-trending reef. None of the fossil mollusks collected is age diagnostic, but regional stratigraphic correlations in the Rock Springs uplift area suggest that the formation is probably of late Campanian age.

LEWIS SHALE

The Lewis Shale weathers to a flat drab-gray valley between brown-weathering sandstone ridges that compose the upper part of the Almond Formation and the lower part of the Fort Union Formation. The Lewis Shale thickens from 200 to 350 ft in a northeastward direction across the quadrangle because of Late Cretaceous erosion of the top of the formation. It is composed of soft dark-gray shale deposited in a marine environment.

LARAMIDE UNCONFORMITY

The quadrangle area is on the east flank of the ancestral Rock Springs uplift, a Late Cretaceous anticline that nearly conforms geographically to the Holocene Rock Springs uplift. In the quadrangle area the Lance Formation, Fox Hills Sandstone, and part of the Lewis Shale, consisting of as much as 2,500 ft of Upper Cretaceous rocks, were eroded from the ancestral Rock Springs uplift before the end of the Cretaceous Period. The resulting hiatus at the boundary of Cretaceous and overlying Tertiary rocks is called the Laramide unconformity. The unconformity is easily identified in outcrops by a fossil soil, as much as 10 ft thick, which consists of a bench-forming light-gray limy siltstone containing root impressions. There are 1° to 3° of angular discordance between the dips of Tertiary and Cretaceous rocks above and below the unconformity.

PALEOCENE ROCKS

FORT UNION FORMATION

The Fort Union Formation crops out in drab-brown and gray ridges and valleys in the southeast part of the quadrangle. The upper 150 to 300 ft of the formation are not present in the quadrangle. The lower 1,275 ft are present and were measured in stratigraphic section 8275 (pl. 3) in secs. 15, 16 and 17, T. 15 N., R. 102 W. The formation is everywhere underlain by the Lewis Shale.

Two intraformational unconformities were mapped within the Fort Union Formation. Each is recognized in outcrops by a fossil soil consisting of light-gray-weathering calcareous siltstone that is locally siliceous and contains root impressions. The fossil soils within the Fort Union Formation are very similar in appearance to the fossil soil at the Laramide unconformity. The upper unconformity and fossil soil in the Fort Union Formation, labeled *FSA* on plate 2, has been identified in outcrops nearly everywhere on the east flank of the Rock Springs uplift. The lowermost unconformity and fossil soil, labeled *FSB* on plate 2, was identified only in the southern part of the quadrangle.

The Fort Union Formation is of Paleocene age, as indicated by plant and animal fossils collected in the Sand Butte Rim NW quadrangle, which is several miles northeast of the Mud Springs Ranch quadrangle (Roehler, 1978). The paleontologic evidence in the Sand Butte Rim NW quadrangle indicates that the part of the formation overlying unconformity *FSA* is of late Paleocene age, and that the part underlying unconformity *FSA* is of early Paleocene age. Plant fossils are rare in the Mud Springs Ranch quadrangle, except for poorly preserved wood in the lower parts of a few sandstones of fluvial origin. A few turtle and crocodile bones were collected in the northwest part of sec. 15, T. 15 N., R. 102 W.

The Fort Union Formation was deposited in the intermontane Green River basin area at elevations probably less than 1,000 ft above sea level. The lower part of the formation, from the base to unconformity *FSB*, was deposited mostly in swamps. The interval between unconformities *FSA* and *FSB* was deposited in alternating swamps and floodplains in an area intersected by large dominantly eastward flowing streams. More than half of the rocks in this interval are composed of fluvial sandstones. The stratigraphic interval above unconformity *FSA* was deposited in swamps, except for a thin sequence of gray, green and red floodplain

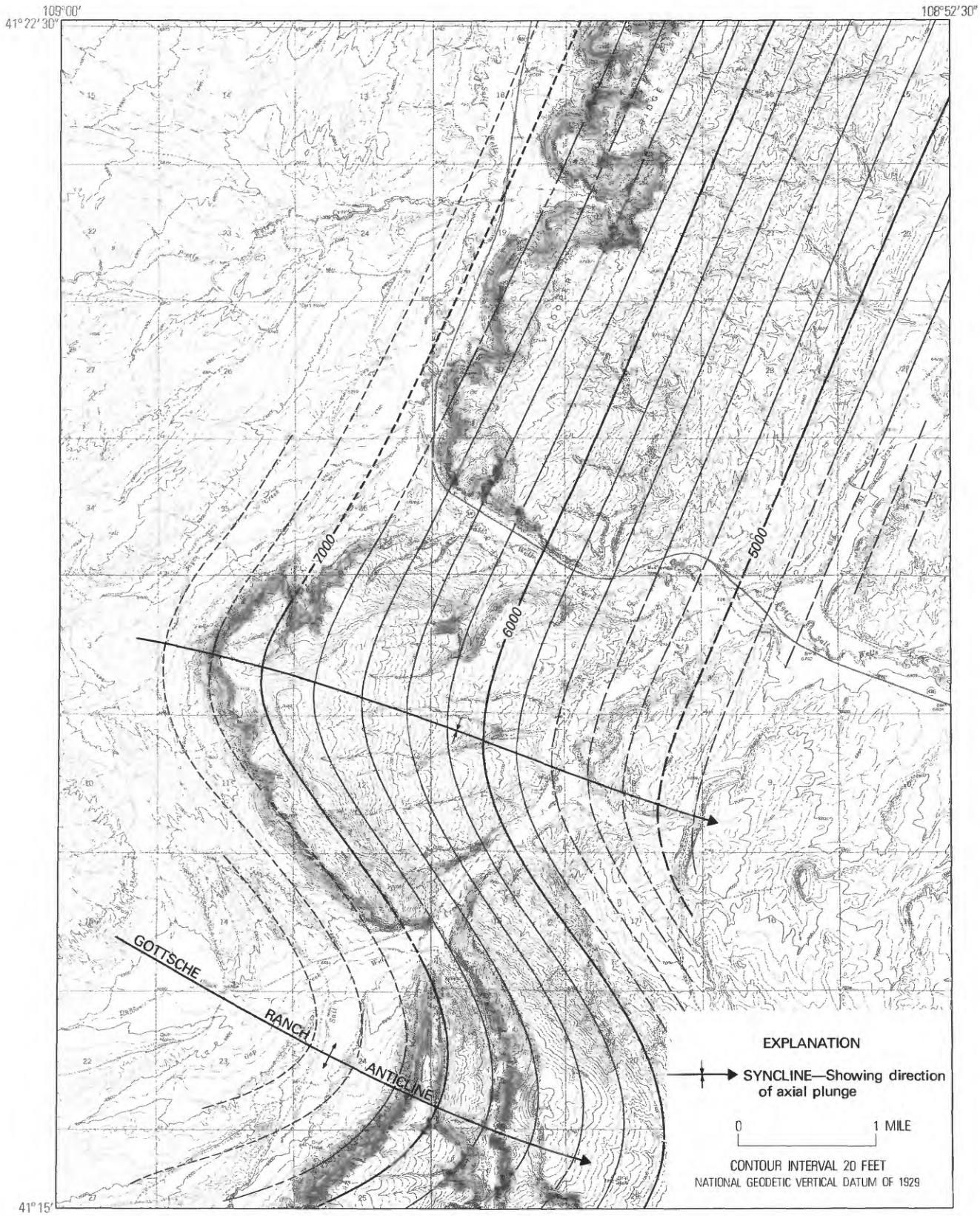


FIGURE 3.—Structure contours on the Brooks Tongue of the Rock Springs Formation in the Mud Springs Ranch quadrangle, Sweetwater County, Wyo. Contours dashed where approximately located; short dashed where datum is eroded. Contour interval 200 ft. Base from U.S. Geological Survey 1:24,000 Mud Springs Ranch, 1967.

deposits (pl. 2). The red parts of these deposits were probably deposited as lateritic soils in a local southeast-trending well-drained area of moderate topographic and structural relief.

STRUCTURE

FOLDS

Rocks exposed in the northern part of the Mud Springs Ranch quadrangle dip 5° to 12° to the southeast on the southeast flank of the Rock Springs uplift. The southeast dips in the southern part of the quadrangle are interrupted by the minor plunging folds of the Gottsche Ranch anticline and an adjacent unnamed syncline (fig. 3).

GOTTSCHE RANCH ANTICLINE

Gottsche Ranch anticline takes its name from the abandoned Gottsche Home Ranch in sec. 18, T. 15 N., R. 103 W., several miles west of the Mud Springs Ranch quadrangle. Only a segment of the anticline is present in the quadrangle area, but the fold has been mapped in surface rocks for more than 10 mi in T. 15 N., Rs. 102 and 103 W. The axis of the anticline plunges southeastward at about 5°. The steep northeast limb has dips of more than 12°. There is no surface structural closure along the axis. A pronounced reversal of dips from northeast to southeast across the eroded crest of the Gottsche Ranch anticline is visible in northwest-facing escarpments in the Rock Springs and Ericson Formations in secs. 24 and 25, T. 15 N., R. 103 W.

UNNAMED SYNCLINE

An unnamed syncline, north of the Gottsche Ranch anticline, plunges southeastward at 5° to 7° (fig. 3). Dips on the steep southwest limb are 5° to 12° to the northeast; dips on the northeast limb are 4° to 6° to the southeast.

FAULTS

A minor high-angle fault caused visible displacement of sandstones at the top of the Almond Formation in sec. 28, T. 15 N., R. 102 W. (pl. 1). The fault trace trends east; the fault plane dips 65° north, and maximum measured vertical displacement of the fault is 25

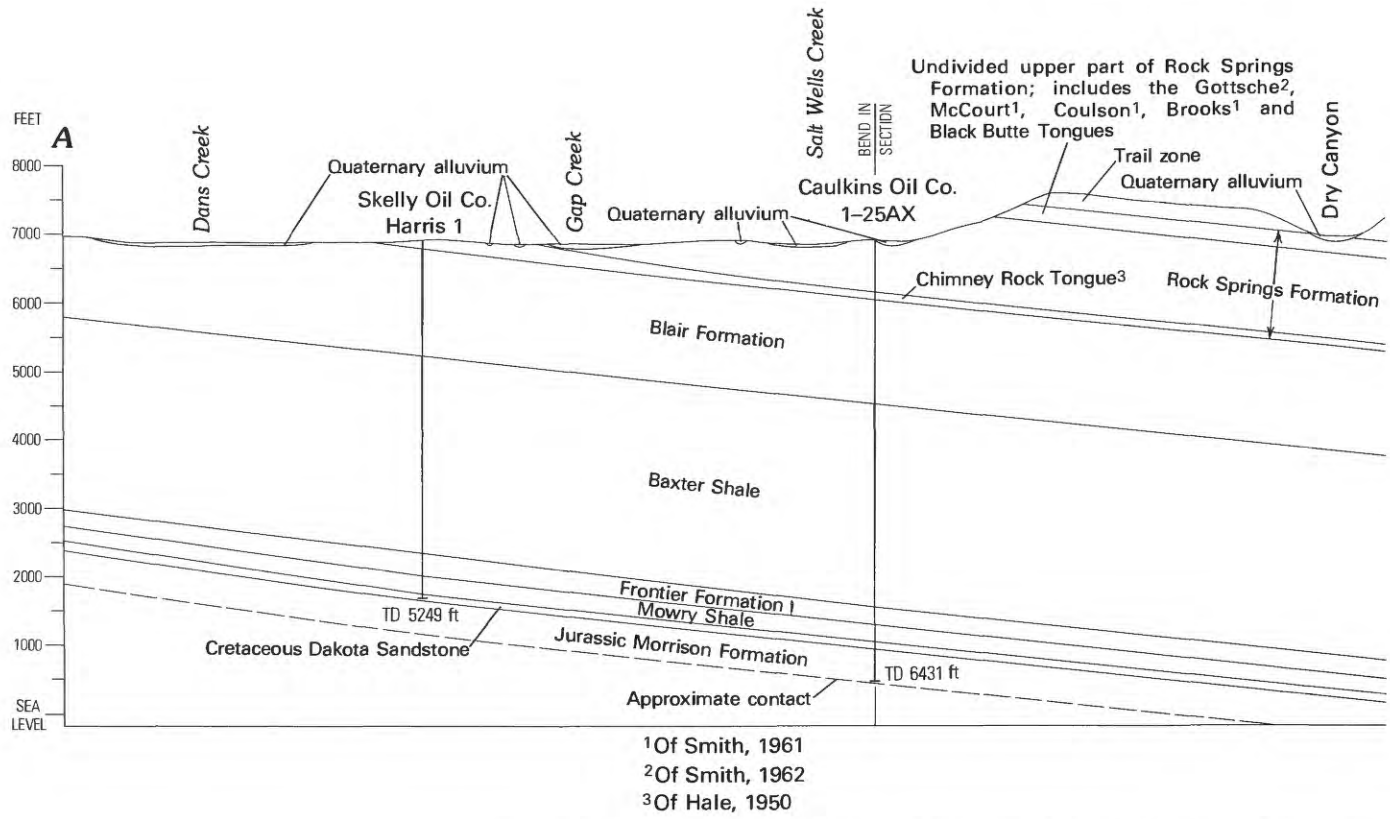


FIGURE 4.—Cross section of rocks penetrated in three dry holes in the Mud Springs Ranch

ft. The fault is mappable in surface rocks for only a few hundred feet. It dies out westward in exposures of the middle part of the Almond Formation and eastward in exposures of the Lewis Shale.

ECONOMIC GEOLOGY

OIL AND GAS

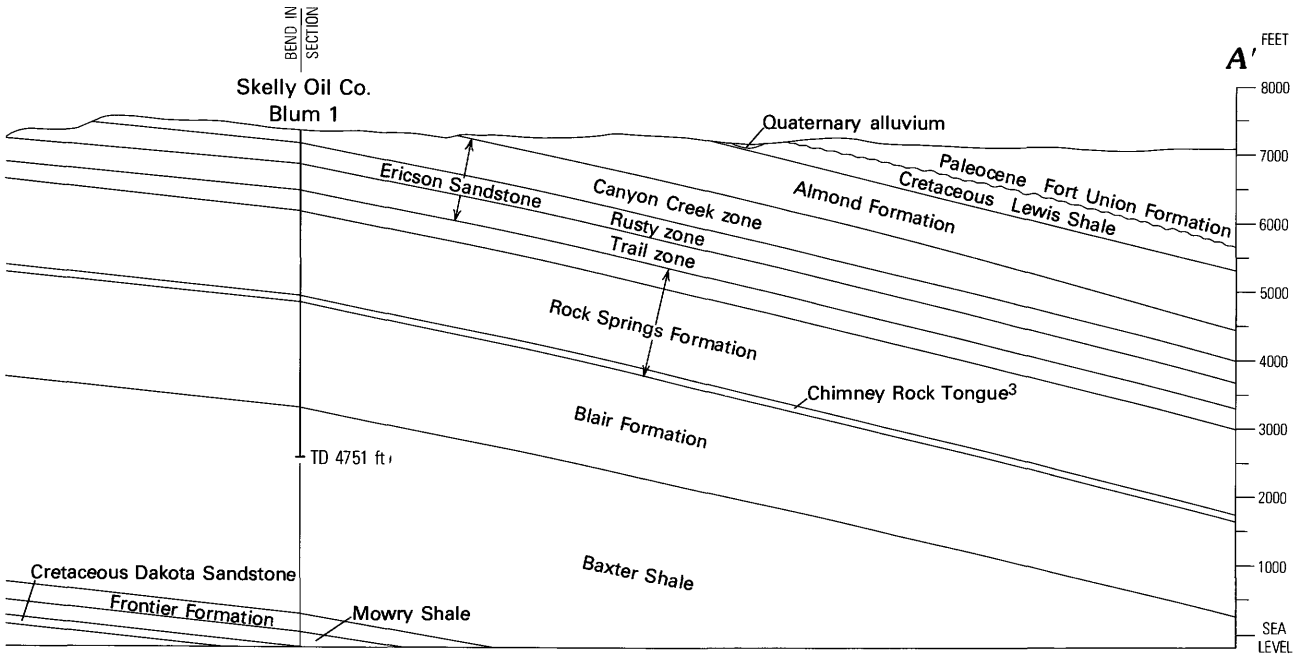
Four dry holes have been drilled in the Mud Springs Ranch quadrangle. The True Oil Co. Federal 14–20 Well, which was drilled in sec. 20, T. 16 N., R. 102 W., bottomed in the Entrada Sandstone of drillers at 8,202 ft. Formation tops in the well are at the following depths (in feet): Rock Springs Formation, 865; Blair, 2,364; Baxter Shale, 3,819; Frontier Formation, 6,945; Aspen Shale, 7,225; Dakota Sandstone, 7,456; Morrison Formation, 7,596; Curtis Formation of drillers, 8,034; Entrada Sandstone of drillers, 8,152. Data on three other dry holes, the Skelly Oil Co. Harris No. 1, the Caulkins Oil Co. No. 1-25 AX, and the Skelly Oil Co. Blum No. 1, are shown in figure 4. Although no shows of oil or gas were reported in any of the holes drilled in the quadrangle, good possibilities remain for the discovery of gas and (or) oil in stratigraphic traps formed by the updip wedge out of sandstones in the Frontier, Dakota, and Morrison Formations on the Gottsche Ranch anticline.

COAL

NOMENCLATURE

Coal-bearing rocks in the Rock Springs coal field were divided by Schultz (1909) into four coal groups. In descending order these are the Black Rock coal group of the Fort Union Formation, the Black Buttes coal group of the Lance Formation, the Almond coal group of the Almond Formation, and the Rock Springs coal group of the Rock Springs Formation. Only the Black Rock and Almond Coal groups have coal beds of economic importance in the Mud Springs Ranch quadrangle (pl. 2). The Black Buttes coal group is not represented, and the Rock Springs coal group is composed mostly of a noncoal-bearing marine shale and sandstone facies.

The names of coal beds in the southeast part of the Rock Springs uplift were assigned by the author during field investigations undertaken between 1972 and 1975. The names applied in the Mud Springs Ranch quadrangle in descending order are as follows: Black Rock coal group (Fort Union Formation); Big Burn bed, upper Little Valley bed, and lower Little Valley bed; Almond coal group (Almond Formation); Falcon bed, Golden Eye bed, Teal bed, Waxwing bed, Pintail bed, Finch bed, Gull bed, Sparrow bed, Coot bed, Mallard bed, Robin bed, Magpie bed, upper Mourning



quadrangle, Sweetwater County, Wyo. The location of the cross section is shown on plate 1.

Dove bed, lower Mourning Dove bed, and Starling bed. Coal beds were named only if they were more than 2.5 ft thick, mappable and potentially minable. None of the beds named by the author had been named prior to the time he began his field investigations in 1972, but several beds have been subsequently named. The Little Valley bed of this report is equivalent to the Deadman seam recently named at the Jim Bridger strip mine 25 mi north of the Mud Springs Ranch quadrangle. Several new names have also been proposed for coal beds in the Black Rock and Almond coal groups in the vicinity of the planned Black Butte Coal Co. strip mine near the Union Pacific Railroad, about 15 mi northeast of the Mud Springs Ranch quadrangle. There is no direct evidence that any of the names proposed by the Black Butte Coal Co. duplicate those used in this report, but it appears likely that the Big Burn and Mourning Dove beds of this report are equivalent to the Nuttal and Lebar beds of the Black Butte Coal Co., respectively.

OUTCROPS

Coal beds in the Mud Springs Ranch quadrangle usually crop out as weathered smooth dark-gray or black bands in drab-gray predominantly shale valleys, or on slopes below sandstone escarpments. The coal is usually covered by a veneer of alluvium at least 1 ft thick. The best exposures are in drainage cuts and on the crests of ridges between drainages.

ENVIRONMENTS OF DEPOSITION

The Almond coal beds were deposited in a tropical climate in brackish-water lagoons that formed behind barrier bars that developed along the western coastlines of the Late Cretaceous epicontinental Lewis sea. The lagoons were choked with vegetation, but areas of open water were interspersed with small brackish-water lakes and embayments. Short-headed streams crossed salt marshes at landward edges of the lagoons, where the lagoons merged laterally into freshwater coastal swamps. Parts of the Falcon, Golden Eye, Teal, and Pintail coal beds were deposited on back barrier bar flats (sandstone beds *A*, *D*, *F*, and *G*, pl. 2). The Finch, Gull, Sparrow, Coot, Mallard, Robin, Magpie, upper Mourning Dove, lower Mourning Dove and Starling coal beds were deposited in more centrally located parts of large lagoons.

Coal beds in the Fort Union Formation were deposited in a subtropical climate in extensive freshwater swamps. The Big Burn and Little Valley beds are present nearly everywhere on the east flank of the Rock Springs uplift, which suggests that some of the swamps occupied hundreds of square miles.

PROXIMATE, ULTIMATE, AND BTU ANALYSES

No proximate, ultimate, and Btu analyses were made of outcrop samples collected in the quadrangle area, because of alteration effects caused by weathering. The quality of the coals, however, is expected to be similar to that mined in other parts of the Rock Springs uplift. The Little Valley coal bed (Deadman bed) of the Fort Union Formation at the Jim Bridger strip mine in sec. 20, T. 21 N., R. 100 W., has 43–46 percent volatile matter, 54–57 percent fixed carbon, 7–14 percent ash, and 0.6–0.8 percent sulfur on a moisture and ash-free basis; the heating value ranges from 11,920 Btu/lb (Btu/pound) to 12,440 Btu/lb. Coal from the lower part of the Almond Formation at the abandoned Point of Rocks mine in sec. 26, T. 20 N., R. 101 W., has 37–42 percent volatile matter, 58–62 percent fixed carbon, 4–11 percent ash, and 0.6–1.0 percent sulfur on a moisture and ash-free basis; the heating value ranges between 10,380 Btu/lb and 13,070 Btu/lb (Schultz, 1910).

GEOCHEMICAL ANALYSES

Nine channel samples were collected from coal outcrops and were analyzed to determine their chemical composition. Four analytical methods were used: (1) neutron activation of uranium and thorium on the coal as received; (2) X-ray fluorescence on the coal ash; (3) semiquantitative spectrographic analysis on the coal ash; and (4) quantitative chemical analyses of coal both as received and on the ash. The coal beds sampled are listed in table 1, and data from geochemical analyses are presented in tables 2, 3, and 4.

The results of geochemical analyses of individual coal beds are so variable that the data cannot be used for identification correlation purposes. None of the geochemical analyses suggests that trace or minor elements are present in the coal in quantities large enough to be potentially hazardous to the environment, if the coals are mined within the quadrangle.

RESOURCES

The method used to compute coal resources was outlined by Averitt (1975). Resources were computed only for beds that are more than 2.5 ft thick. Reporting categories are reliability of data (measured and indicated) and overburden (1 to 1,000 ft; 1,000 to 2,000 ft). An inferred category was not used because of the absence of drill and core-hole data.

TABLE 1.—*Coal and rock samples analyzed for trace elements in the Mud Springs Ranch quadrangle, Wyoming*

Lab. No.	Field No.	Location	(Sec.)	(T., N.)	(R., W.)	Bed name	Bed thickness (ft)
		Fort Union Formation					
D178103--	6754-	SW¼NW¼SW¼	9	15	102	Little Valley------	5.3
D178104--	67512-	SW¼NW¼SW¼	9	15	102	Little Valley------	5.8
		Almond Formation					
D178099--	40752-	SE¼SE¼NE¼	32	16	102	Mourning Dove------	16.6
D178100--	61754-	SE¼NW¼SW¼	21	16	102	Lower Starling-----	2.8
D178094--	61755-	SE¼NW¼SW¼	21	16	102	Shale parting in--- middle Starling.	2.9
D178095--	61756-	SE¼NW¼SW¼	21	16	102	Upper Starling-----	2.9
D178096--	617514-	SE¼NW¼SW¼	21	16	102	Lower Mourning----- Dove.	3.3
D178097--	617515-	SE¼NW¼SW¼	21	16	102	Shale parting in--- Mourning Dove.	3.5
D178098--	617516-	SE¼NW¼SW¼	21	16	102	Unnamed bed 3.5 ft- above Mourning Dove.	1.5

A six-step procedure was followed to compute coal resources: (1) structure contours were drawn on the top of each coal bed; (2) 1,000-foot overburden line was drawn (where applicable) by subtracting structural elevations from topographic elevations; (3) measured and indicated categories were determined by plotting a line 1.5 miles from measurements of coal thicknesses measured at outcrops and by projecting the thickness data into the subsurface; (5) a compensating polar planimeter was used to find the area underlain by coal in each cadastral section, or part thereof, in each of the reporting categories. An average weight of 1,1770 short tons per acre-foot was used for subbituminous coal. A weighted average bed thickness was visually determined for each reporting category in each township section by averaging maximum and minimum thicknesses, taking into account the geographic configuration of isopachs; and (6) tonnage corrections were applied to compensate for dips of beds. Each calculation was rounded to the closest 1,000 tons. Resources are recorded in millions of tons on tables for the beds. Coal resources are also reported by geographic location and by thickness categories.

Calculated total minable resources of coal in the Mud Springs Ranch quadrangle are 283,338,000 short tons (table 5). It is estimated that only about 5 percent of the coal can be recovered by surface mining because the beds are generally thin, widely spaced in vertical section, and have dips greater than 5°.

BIG BURN BED

The Big Burn bed is poorly exposed in a small area in sec. 15, T. 15 N., R. 102 W. (fig. 5). The net thickness of coal is more than 2.5 ft in only one measured section near the center of sec. 15. Coal resources are less than 200,000 short tons (table 6).

UPPER LITTLE VALLEY BED

The bed is present in the lower part of the Fort Union Formation everywhere in the quadrangle except in secs. 4 and 9, T. 15 N., R. 102 W., and sec. 27, T. 16 N., R. 102 W., where it is locally burned on outcrops (pl. 2). The net thickness of coal in the bed varies between 3 and 6 ft near the southeast corner of the quadrangle, but it thickens irregularly northward and is slightly more than 9 ft thick in sec. 27, T. 16 N., R. 102 W. (fig. 6). The bed has many shale, bone, and siltstone partings (pl. 3). Calculated coal resources are about 43.7 million short tons (table 7).

TABLE 2.—*Major and minor oxide and trace-element composition of the laboratory ash of nine coal samples from the Mud Springs Ranch quadrangle, Wyoming*

[Values are in either percent or parts per million. The coals were ashed at 525° C. L after a value means less than the value shown, and N, names not detected. S after the element title means that the values listed were determined by semiquantitative spectrographic analysis. The spectrographic results are to be identified with geometric brackets whose boundaries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, etc., but are reported arbitrarily as mid-points of those brackets, 1.0, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, etc. The precision of the spectrographic data is approximately one bracket at 68 percent, or two brackets at 95 percent confidence.]

Sample number	Ash (percent)	SiO2 (percent)	Al2O3 (percent)	CaO (percent)	MgO (percent)	Na2O (percent)	K2O (percent)	Fe2O3 (percent)	TiO2 (percent)	P2O5 (percent)	Sample number
D178094	84.1	72	17	0.26	0.51	0.23	1.5	1.2	0.63	1.0L	D178094
D178095	10.0	45	24	5.6	1.48	.14	.54	2.5	.91	2.6	D178095
D178096	12.7	53	14	8.4	1.71	.18	.95	3.1	.67	1.0L	D178096
D178097	90.8	79	12	.25	.73	.15	2.3	1.5	.70	1.0L	D178097
D178098	35.6	51	29	2.1	2.22	.24	.38	.97	1.4	1.0L	D178098
D178099	41.0	70	16	.29	.76	.14	1.7	1.6	.64	1.0L	D178099
D178100	13.5	59	20	1.2	.56	.12	.80	3.0	1.3	1.0L	D178100
D178103	17.8	61	16	2.5	1.58	.19	1.1	3.4	.77	1.0L	D178103
D178104	12.4	66	8.0	3.5	2.16	.15	.12	3.2	.87	1.0L	D178104

Sample number	SO3 (percent)	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Cd (ppm)	Ce-S (ppm)	Co-S (ppm)	Cr-S (ppm)	Cu (ppm)	Ga-S (ppm)	Sample number
D178094	0.20L	150	300	N	1.0L	N	10L	70	26	30	D178094
D178095	4.3	1,000	5,000	15	1.0L	500L	20	70	53	50	D178095
D178096	5.3	300	5,000	7	1.0	N	15	100	78	30	D178096
D178097	.20L	150	2,000	N	1.0	N	10	100	38	30	D178097
D178098	2.5	500	3,000	10	3.0	N	20	30	26	50	D178098
D178099	.45	300	700	3	1.0	N	15	100	47	30	D178099
D178100	2.7	300	15,000	20	3.0	N	30	70	70	30	D178100
D178103	5.0	700	500	7	1.0L	N	10L	70	78	30	D178103
D178104	5.9	700	700	15	1.0L	N	10L	70	121	20	D178104

Sample number	La-S (ppm)	Li (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	Pb (ppm)	Sc-S (ppm)	Sr-S (ppm)	V-S (ppm)	Sample number
D178094	N	44	390L	N	20	15	25L	10	70	70	D178094
D178095	100	44	410	15	30	50	40	30	3,000	150	D178095
D178096	N	21	450	10	20	50	25L	15	300	150	D178096
D178097	N	33	390L	N	20	20	30	15	100	100	D178097
D178098	N	160	410	50	30	50	35	15	700	100	D178098
D178099	100L	58	390L	N	30	30	40	15	500	150	D178099
D178100	100L	66	390L	15	30	70	35	30	700	150	D178100
D178103	N	72	390L	20	30	20	30	15	300	100	D178103
D178104	N	25	390L	15	30	20	25L	20	150	70	D178104

Sample number	Y-S (ppm)	Yb-S (ppm)	Zn (ppm)	Sample number
D178094	30	3	104	D178094
D178095	70	7	145	D178095
D178096	70	7	489	D178096
D178097	70	5	63	D178097
D178098	70	5	356	D178098
D178099	70	5	120	D178099
D178100	150	10	107	D178100
D178103	70	5	41	D178103
D178104	70	7	26	D178104

TABLE 3.—*Amounts of seven trace elements in nine coal samples from the Mud Springs Ranch quadrangle, Wyoming*

[Analyses on air-dried (32°C) coal. All values are in parts per million. L after a value means less than the value shown]

Sample number	As (ppm)	F (ppm)	Hg (ppm)	Sb (ppm)	Se (ppm)	Th (ppm)	U (ppm)	Sample number
D178094	2	470	0.05	0.8	0.4	15.8	5.1	D178094
D178095	1	200	.06	.5	.9	3.0L	1.7	D178095
D178096	1	225	.03	.5	1.5	3.0L	2.2	D178096
D178097	4	850	.10	.9	1.0	13.5	4.7	D178097
D178098	1	545	.04	.3	1.2	10.7	1.9	D178098
D178099	2	625	.07	.2	1.3	12.3	3.2	D178099
D178100	1	85	.06	.5	1.4	4.8	1.2	D178100
D178103	4	60	.17	.9	1.7	6.0	2.3	D178103
D178104	1	20L	.02	.9	1.5	3.0L	1.3	D178104

TABLE 4.—*Major, minor, and trace-element composition of nine coal samples, reported on a whole-coal basis, Mud Springs Ranch quadrangle, Wyoming*

[Values are in either percent or parts per million, Si, Al, Ca, Mg, Na, K, Fe, Mn, Ti, P, Cl, Cd, Cu, Li, Pb, and Zn values were calculated from analysis of ash. As, F, Hg, Sb, Se, Th, and U values are from direct determinations on air-dried (32°C) coal, the remaining analyses were calculated from spectrographic determinations on ash. L after a value means less than the value shown, and N means not detected]

Sample number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	As (ppm)	B-S (ppm)	Sample number
D178094	28	7.5	0.15	0.26	0.14	1.0	0.70	0.32	2	150	D178094
D178095	2.1	1.3	.40	.089	.010	.045	.17	.054	1	100	D178095
D178096	3.1	.96	.76	.13	.017	.10	.27	.051	1	30	D178096
D178097	34	6.0	.16	.40	.10	1.7	.97	.38	4	150	D178097
D178098	8.5	5.5	.54	.48	.064	.11	.24	.30	1	200	D178098
D178099	13	3.5	.086	.19	.041	.59	.45	.16	2	150	D178099
D178100	3.7	1.4	.12	.046	.012	.090	.28	.11	1	50	D178100
D178103	5.1	1.5	.32	.17	.025	.16	.43	.082	4	150	D178103
D178104	3.8	.52	.31	.16	.014	.013	.28	.064	1	100	D178104

Sample number	Ba-S (ppm)	Be-S (ppm)	Cd (ppm)	Ce-S (ppm)	Co-S (ppm)	Cr-S (ppm)	Cu (ppm)	F (ppm)	Ga-S (ppm)	Hg (ppm)	Sample number
D178094	200	N	0.84L	N	10L	70	22	470	20	0.05	D178094
D178095	500	1.5	.10L	50L	2	7	5.3	200	5	.06	D178095
D178096	700	1	.13	N	2	15	9.9	225	3	.03	D178096
D178097	2,000	N	.91	N	10	100	35	850	30	.10	D178097
D178098	1,000	3	1.1	N	7	10	9.3	545	20	.04	D178098
D178099	300	1.5	.41	N	7	50	19	625	15	.07	D178099
D178100	2,000	3	.41	N	5	10	9.4	85	5	.06	D178100
D178103	100	1.5	.18L	N	2L	15	14	60	5	.17	D178103
D178104	100	2	.12L	N	1.5L	10	15	20L	2	.02	D178104

Sample number	La-S (ppm)	Li (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Sb (ppm)	Sc-S (ppm)	Sample number
D178094	N	37	330L	N	15	15	3,700L	21L	0.8	10	D178094
D178095	10	4.4	41	1.5	3	5	1,200	4.0	.5	3	D178095
D178096	N	2.7	57	1.5	2	7	550L	3.2L	.5	2	D178096
D178097	N	30	350L	N	20	20	4,000L	27	.9	15	D178097
D178098	N	57	150	20	10	20	1,600L	12	.3	5	D178098
D178099	50L	24	160L	N	15	15	1,800L	16	.2	7	D178099
D178100	15L	8.9	52L	2	5	10	590L	4.7	.5	5	D178100
D178103	N	13	69L	3	5	3	780L	5.3	.9	3	D178103
D178104	N	3.1	48L	2	3	2	540L	3.1L	.9	2	D178104

Sample number	Se (ppm)	Sr-S (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	Y-S (ppm)	Yb-S (ppm)	Zn (ppm)	Zr-S (ppm)	Sample number
D178094	0.4	70	15.8	5.1	70	20	2	87	150	D178094
D178095	.9	300	3.0L	1.7	15	7	.7	14	20	D178095
D178096	1.5	30	3.0L	2.2	20	10	1	62	20	D178096
D178097	1.0	100	13.5	4.7	100	70	5	57	150	D178097
D178098	1.2	200	10.7	1.9	30	20	2	130	70	D178098
D178099	1.3	200	12.3	3.2	70	30	2	49	70	D178099
D178100	1.4	100	4.8	1.2	20	20	1.5	14	30	D178100
D178103	1.7	50	6.0	2.3	20	15	1	7.3	30	D178103
D178104	1.5	20	3.0L	1.3	10	10	1	3.2	30	D178104

LOWER LITTLE VALLEY BED

The bed is present everywhere in the lower 50 ft of the Fort Union Formation, except for a small area in sec. 34, T. 16 N., R. 102 W. where it is burned (pl. 2). The net coal thicknesses range from less than 2.5 ft to more than 6 ft (fig. 7). The bed has many shale, bone, and siltstone partings; it thins and splits in outcrops between measured sections 2075 and 2175 in sec. 27, T. 16 N., R. 102 W. (pl. 3). Calculated coal resources are approximately 33.1 million short tons (table 8).

UNNAMED COAL BED AT THE BASE OF THE FORT UNION FORMATION

An unnamed coal bed is present in the lower 10 ft of the Fort Union Formation in measured sections 1575 and 1875 near the southeast corner of the quadrangle (fig. 8, pl. 2). The bed is slightly less than 3 ft thick, has a small areal extent, and the resources are about 250,000 short tons (table 9).

FALCON BED

The Falcon bed is the uppermost coal bed in the Almond coal group. It is present only in the northeast part of the quadrangle (fig. 9). The bed has net coal thicknesses in outcrops ranging from 2.9 to 5.9 ft. The coal is clean in outcrops in secs. 22 and 27, T. 16 N., R. 102 W., but it contains carbonaceous shale and siltstone partings north and south of that area (pl. 3). The Falcon bed rests directly upon the weathered upper surface of sandstone bed *A* (pl. 2). Calculated

TABLE 5.—*Cumulative coal resources, in millions of short tons, by thickness categories and geographic location, in the Mud Springs Ranch quadrangle, Wyoming*

[Leaders (---), no data]

Overburden thickness (ft)--		0-1,000			1,000-2,000		
Bed thickness (ft)-----		2.5-5.0	5.0-10.0	More than 10.0	2.5-5.0	5.0-10.0	Total for Township
T. 16 N., R. 102 W.							
Sec.	9	0.022	0.053	---	---	---	
	10	.180	.178	0.651	---	---	
	15	6.506	4.367	1.177	---	---	
	16	1.451	.473	---	---	---	
	20	.687	.064	---	---	---	
	21	6.441	1.895	---	---	---	
	22	4.081	.304	---	---	---	
	27	5.915	.224	---	---	---	
	28	12.693	1.626	---	---	---	
	29	.316	.053	---	---	---	
	32	.126	.039	.052	---	---	
	33	15.339	1.836	1.049	---	---	
	34	7.065	3.656	---	---	---	78.519
T. 15 N., R. 102 W.							
Sec.	3	8.415	6.249	---	1.531	---	
	4	17.591	1.628	---	.151	---	
	5	2.624	.173	---	---	---	
	8	13.957	3.988	---	6.295	---	
	9	11.198	9.853	---	2.048	---	
	10	3.540	6.644	---	1.292	---	
	15	.749	5.212	---	5.369	0.816	
	16	7.248	13.298	---	2.807	---	
	17	14.341	11.754	---	---	---	
	18	.024	---	---	---	---	
	20	5.822	2.152	---	---	---	
	21	13.944	2.438	---	.814	---	
	22	5.365	.168	---	3.965	---	
	27	3.718	.877	---	.510	---	
	28	5.434	.809	---	---	---	
	29	---	.008	---	---	---	204.819
Total---		174.792	80.019	2.929	24.782	0.816	
Grand total----------							283.338

resources are nearly 7.4 million short tons, mostly in beds 2.5 ft thick (table 10).

GOLDEN EYE BED

The Golden Eye bed crops out for nearly 6 mi between sec. 22, T. 16 N., R. 102 W., in the northeast part of the quadrangle, and sec. 21, T. 15 N., R. 102 W., in the southeast part of the quadrangle (fig. 10). The bed is absent north of the center of SW¼ sec. 22, T. 16 N., R. 102 W., where it is eroded and replaced by marine shale. It splits into four thin beds before wedging out southward in sec. 21, T. 15 N., R. 102 W. The Golden Eye bed is mostly bright clean coal as much as 6.1 ft thick (pl. 3). Calculated coal resources are about 20.1 million short tons (table 11).

TEAL BED

The Teal bed crops out in secs. 5, 8, and 17, T. 15 N., R. 102 W., and in secs. 20, 21, and 28, T. 15 N., R. 102 W., but is missing in outcrops for more than 1.5 mi between the two areas (fig. 11). The coal is clean, but the net thickness in outcrops is everywhere less than 3 ft. The elongated northwest-trending configuration of the thicker parts of the bed, shown in figure 11, is interpreted from the geographic location of sandstone bed F. Calculated coal resources are approximately 3.4 million short tons (table 12).

WAXWING BED

The Waxwing bed is identified and correlated on plate 2. It crops out for several miles, but exceeds 2.5 ft in thickness in only one local area in the northwest part of sec. 17, T. 15 N., R. 102 W. No isopach map was prepared for the bed; its resources are too small to calculate. Two detailed sections of the bed, 3775 and 3075, are shown on plate 3.

PINTAIL BED

The Pintail bed is present in most of the eastern and southeastern parts of the quadrangle, but it wedges out in a northward direction in the northeast part of sec. 21, T. 16 N., R. 102 W. (fig. 12). The coal is mostly between 3 and 6 feet thick and is generally clean, but locally it has carbonaceous shale partings (pl. 3). The bed is burned in a small area in the southwest part of sec. 33, T. 16 N., R. 102 W. and the northwest part of sec. 4, T. 15 N., R. 102 W. The burned area is visible in slopes on the north side of Wyoming Highway 430. Calculated coal resources are slightly more than 40.9 million short tons (table 13).

FINCH BED

The Finch bed is present in T. 15 N., R. 102 W. in the southeast part of the quadrangle (fig. 13). It consists of 8.7 ft of clean coal in the vicinity of measured section 3775 in the southwest part of sec. 8, T. 15 N., R. 102 W., but it splits into two benches north and south of that area (pl. 3). The upper bench is thinner than the lower bench, has less areal extent, and is locally missing by intraformational erosion. Calculated coal resources are 22.5 million short tons (table 14).

UPPER AND LOWER GULL BEDS

The Gull beds crop out for several miles in T. 14 N., R. 102 W. The beds have a net coal thickness of 7.1 ft in a small area in sec. 28, T. 15 N., R. 102 W., near the southeast corner of the quadrangle (fig. 14), but areas where the coals are more than 2.5 ft thick are very small. Calculated coal resources are about 4.6 million short tons (table 15).

SPARROW BED

Outcrops of the Sparrow bed are present near the center of the Almond Formation nearly everywhere in the Mud Springs Ranch quadrangle. The bed splits and wedges out in outcrops in the southern part of sec. 21, T. 16 N., R. 102 W., and the northern part of sec. 28, T. 16 N., R. 102 W. It is burned in outcrops in sec. 33, T. 16 N., R. 102 W. (fig. 15). It is thickest in outcrops near the center of sec. 20, T. 15 N., R. 102 W., but it splits south of there into two benches in the southeast part of sec. 20, T. 15 N., R. 102 W. (pl. 3). The bed locally has thin carbonaceous shale and siltstone partings. Calculated coal resources are more than 10.7 million short tons (table 16).

COOT BED

The Coot bed is present only in secs. 10, 15, and 16, T. 16 N., R. 102 W. in the northeast corner of the quadrangle (fig. 16). It is burned along outcrops near the boundary of sec. 15 and 16, T. 16 N., R. 102 W., where it is approximately 4 ft thick. The coal is clean and bright with no partings (pl. 3). Calculated coal resources are less than 600,000 short tons (table 17).

MALLARD BED

The Mallard bed is present in secs. 9, 10, 15, 16, 21, and 22, T. 16 N., R. 102 W., in the northeast corner of the quadrangle (fig. 17). It is burned in the vicinity of measured section 4375 near the common corner of secs. 9, 10, 15, and 16, T. 16 N., R. 102 W. (pl. 2). The bed is 11.5 ft thick in the northwest part of sec. 15, T. 16 N., R. 102 W., where it crops out in two benches, but it thins rapidly to one bench in outcrops south of there (pl. 3). In places the bed has carbonaceous shale and siltstone partings. Calculated coal resources are roughly 8 million short tons (table 18).

ROBIN BED

The Robin bed is present in secs. 9, 10, 15, 16, 21, and 22, T. 16 N., R. 102 W., in the northeast corner of the quadrangle (fig. 18). It is burned in outcrops where it exceeds 5 ft in thickness, near the northeast corner of sec. 16, T. 16 N., R. 102 W. The bed is 15.8 thick and has carbonaceous shale and siltstone partings in an area 700 ft north of the quadrangle boundary in the southwest part of sec. 10, T. 16 N., R. 102 W. Calculated coal resources are 6 million short tons (table 19).

MAGPIE BED

The Magpie bed is present in secs. 9, 10, 15, and 16, T. 16 N., R. 102 W., in the northeast corner of the quadrangle (fig. 19). It thickens and thins irregularly along outcrops, but consists of 9.3 ft of clean coal in the SE¼NE¼ sec. 16, T. 16 N., R. 102 W. (pls. 2 and 3). The bed has one carbonaceous shale and siltstone parting near its center. Calculated coal resources are 1.5 million short tons (table 20).

UPPER MOURNING DOVE BED

The upper Mourning Dove bed is present in most of the eastern part of the Mourning Dove bed, in outcrops near the boundary of secs. 32 and 33, T. 16 N., R. 102 W., the combined thickness of the two beds is 16.6 ft. Where the beds merge, the lower Mourning Dove bed was included in the upper Mourning Dove bed for resource calculations (fig. 20). The upper Mourning Dove bed thickens and thins irregularly along outcrops; it has net coal thicknesses exceeding 4 ft in only local areas (pl. 3). It is easily recognized in outcrops where it has distinctive tonstein partings (volcanic ash layers altered to kaolinite). The tonstein partings are medium brown in fresh exposures but usually weather light gray to white. They have a clay texture and small mineral clusters of kaolinite that can be mistaken for sericite in hand specimens. Calculated coal resources exceed 37.3 million short tons (table 21).

LOWER MOURNING DOVE BED

The lower Mourning Dove bed is present in the east-central part of the quadrangle. It wedges out in outcrops near the north edge of the quadrangle in the southern part of sec. 16, T. 16 N., R. 102 W., and near the south edge of the quadrangle in the southeast part of sec. 20, T. 15 N., R. 102 W., (pl. 2; fig. 21). The lower Mourning Dove bed has persistent shale partings, and in the vicinity of measured section 5275 in the southeast part of sec. 29, T. 16 N., R. 102 W., it locally splits into two benches (pl. 3). The bed is easily recognized in sec. 21, T. 16 N., R. 102 W., by the presence of a tonstein parting in the lower 1 ft of the bed. Calculated coal resources are slightly larger than 34.4 million short tons (table 22).

STARLING BED

The Starling bed crops out in two places in the quadrangle (fig. 22). It has thicknesses of more than 2.5 ft in approximately a 2-mi² area in and adjacent to secs. 21 and 28, T. 16 N., R. 102 W. The bed splits in a northward direction in outcrops in the southwest part of sec. 21, T. 16 N., R. 102 W. The upper bench has a tonstein parting in its lower part and is more persistent than the lower bench (pl. 3). Calculated coal resources are more than 8.7 million short tons (table 23).

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FIGURES 5-22

TABLES 6-23

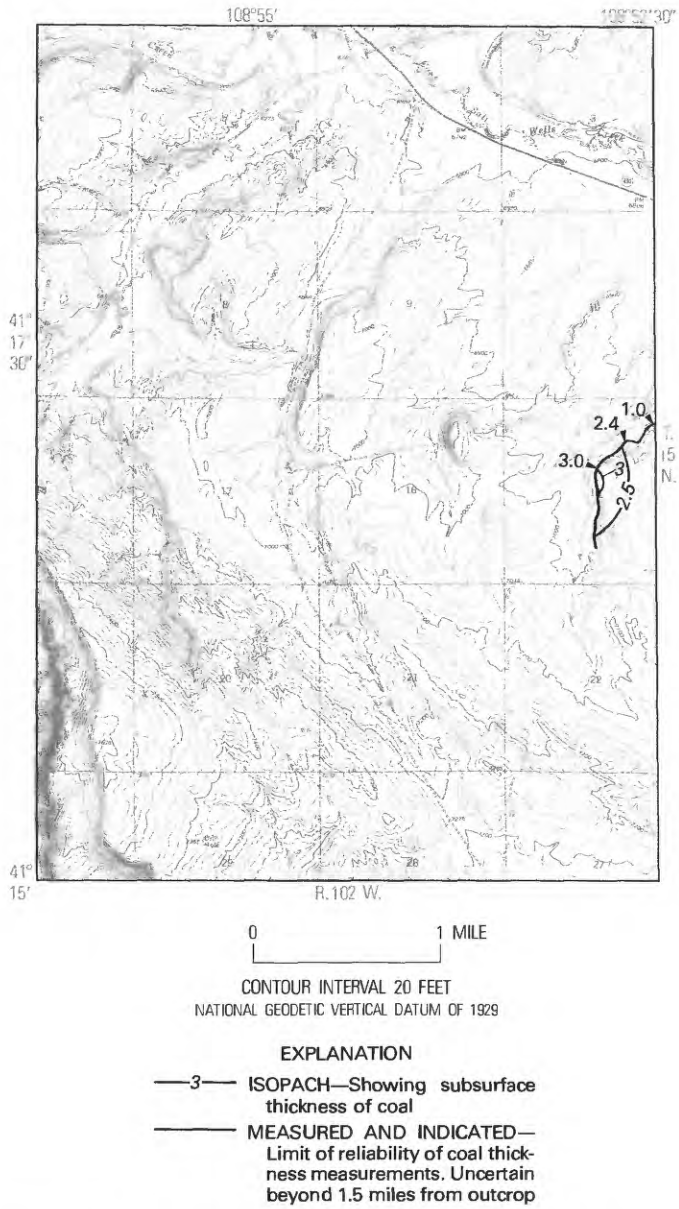

FIGURE 5.—Isopach map of the Big Burn coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal outcrop dashed where covered; coal measured in feet.

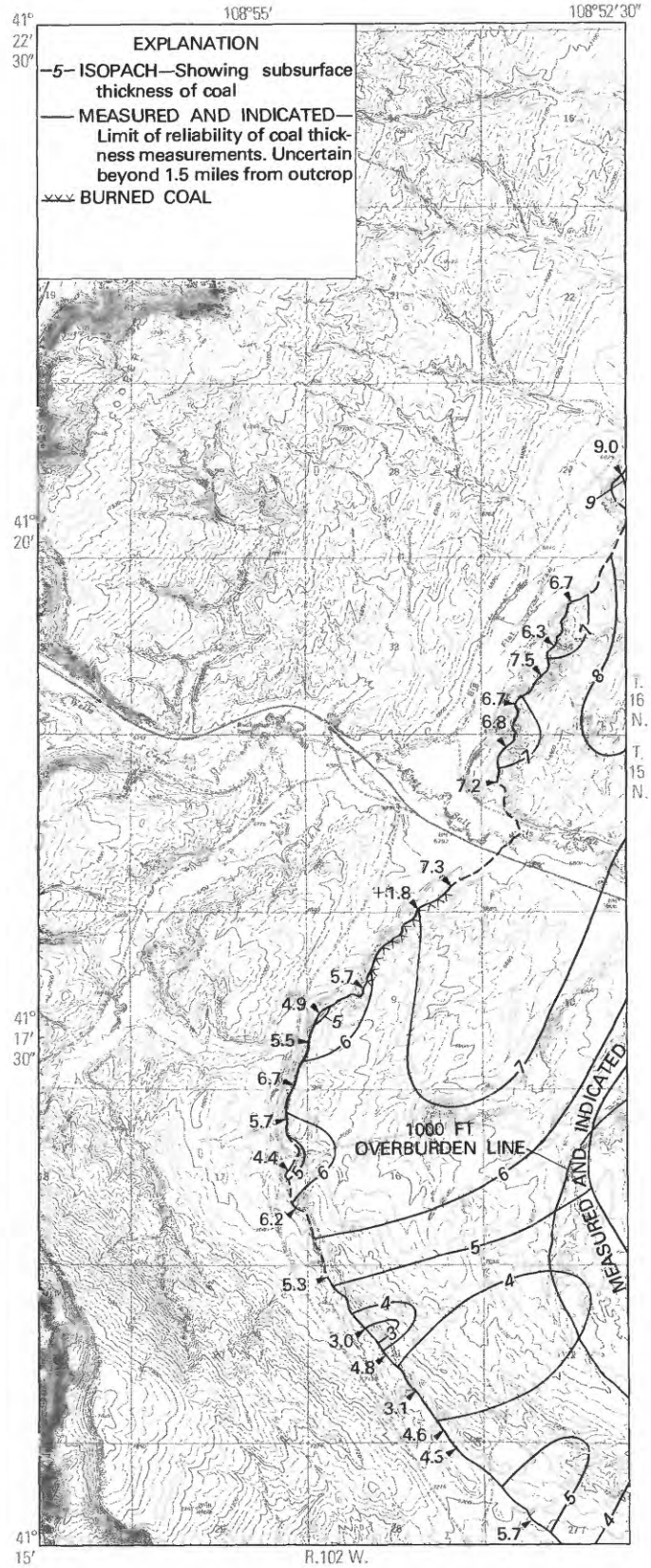

FIGURE 6.—Isopach map of the upper Little Valley coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal outcrop dashed where covered; coal measured in feet.

TABLE 6.—*Measured and indicated coal resources in the category 2.0–5.0 ft thick of the Big Burn coal bed under 0–1,000 ft of overburden, sec. 15, T. 15 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming*

Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons)	
		for section	for township
2.7	0.181	0.181	0.181

TABLE 7.—*Measured and indicated coal resources in the upper Little Valley coal bed, Mud Springs Ranch quadrangle, Wyoming*

[Leaders (---), no data]

Overburden thickness (ft)--		0-1,000		1,000-2,000		Total coal resources (million tons)	
		Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Bed thickness (weighted avg. in ft)	Coal resources (million tons	For section	For township
Bed 2.5-5.0 ft thick, T. 15 N., R. 102 W.							
Sec.	9	4.9	0.016	4.5	0.695	0.711	
	15	4.6	.401	---	---	.401	
	16	4.7	.154	---	---	.154	
	17	4.6	.045	---	---	.045	
	21	4.5	2.841	---	---	2.841	
	22	3.9	2.713	4.2	1.052	3.765	
	27	4.3	1.252	---	---	1.252	
	28	3.9	.097	---	---	.097	9.266
Bed 5.0-10.0 ft thick, T. 15 N., R. 102 W.							
Sec.	3	7.4	6.269	---	---	6.269	
	4	7.3	.382	---	---	.382	
	8	6.5	.096	---	---	.096	
	9	6.9	6.094	---	---	6.094	
	10	6.9	6.444	---	---	6.444	
	15	6.0	2.889	5.3	0.261	3.150	
	16	6.3	6.853	---	---	6.853	
	17	5.8	.334	---	---	.334	
	21	5.2	.163	---	---	.163	
	27	5.3	.877	---	---	.877	30.662
Bed 5.0-10.0 ft thick, T. 16 N., R. 102 W.							
Sec.	27	8.6	0.224	---	---	0.224	
	34	7.6	3.581	---	---	3.581	3.805
Grand total----------							43.733

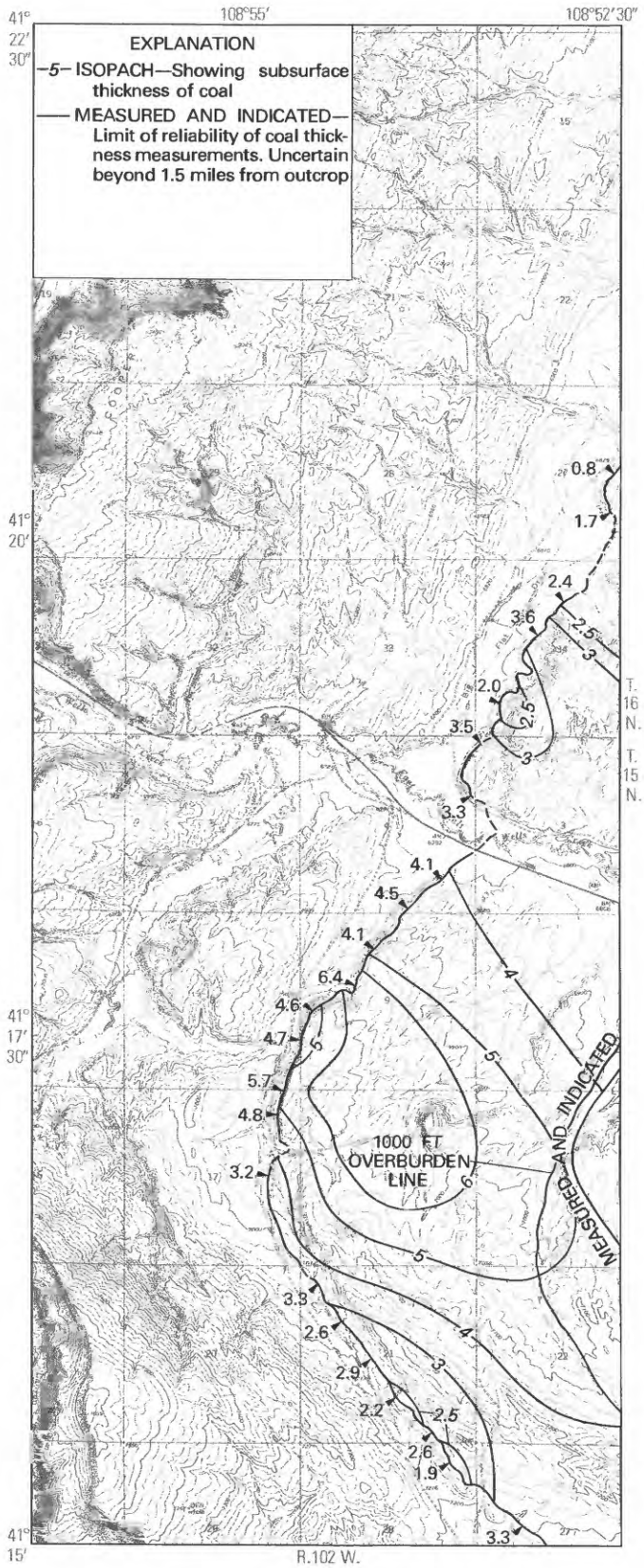

FIGURE 7.—Isopach map of the lower Little Valley coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal outcrop dashed where covered; coal measured in feet.

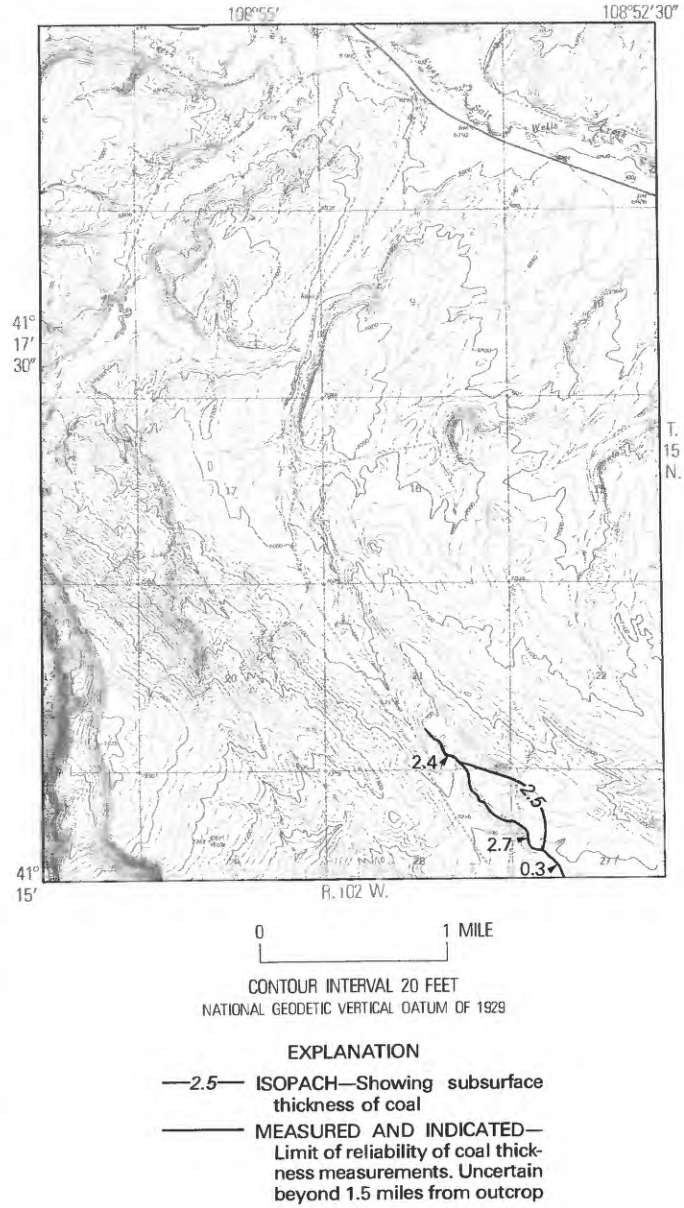

FIGURE 8.—Isopach map of the unnamed coal bed at the base of the Fort Union Formation showing measured net coal thicknesses (at triangles), along outcrops. Coal measured in feet.

TABLE 8.—*Measured and indicated coal resources of the lower Little Valley coal bed, Mud Springs Ranch quadrangle, Wyoming*

[Leaders (---), no data]

	Overburden thickness (ft)				Total coal resources (million tons)	
	0-1,000		1,000-2,000			
	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	For section	For township
Bed 2.5-5.0 ft thick, T. 15 N., R. 102 W.						
Sec. 3	3.5	3.184	---	---	3.184	
4	3.9	.395	---	---	.395	
8	4.8	.016	---	---	.016	
9	4.7	1.502	---	---	1.502	
10	3.9	3.387	3.8	0.093	3.480	
15	4.6	.348	4.6	.597	.945	
16	4.7	.857	---	---	.857	
17	4.0	.414	---	---	.414	
21	3.8	2.581	---	---	2.581	
22	4.1	2.589	4.5	1.209	3.798	
27	3.5	1.645	---	---	1.645	
28	2.7	.076	---	---	.076	18.893
Bed 2.5-5.0 ft thick, T. 16 N., R. 102 W.						
Sec. 34	3.2	1.195	---	---	1.195	1.195
Bed 5.0-10.0 ft thick, T. 15 N., R. 102 W.						
Sec. 8	5.4	0.062	---	---	0.062	
9	6.2	3.759	---	---	3.759	
10	5.3	.200	---	---	.200	
15	5.5	2.323	5.2	0.555	2.878	
16	6.1	5.834	---	---	5.834	
17	5.4	.133	---	---	.133	
21	5.1	.050	---	---	.050	
22	5.1	.168	5.1	.025	.193	13.109
Grand total						33.197

TABLE 9.—*Measured and indicated coal resources in the category 2.5 to 5.0 ft thick of an unnamed coal bed at the base of the Fort Union Formation (section 1775, pl. 2), under 0-1,000 ft of overburden, in T. 15 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons) for section	for township
21	2.5	0.012	0.012	
27	2.6	.112	.112	
28	2.7	.134	.134	0.258

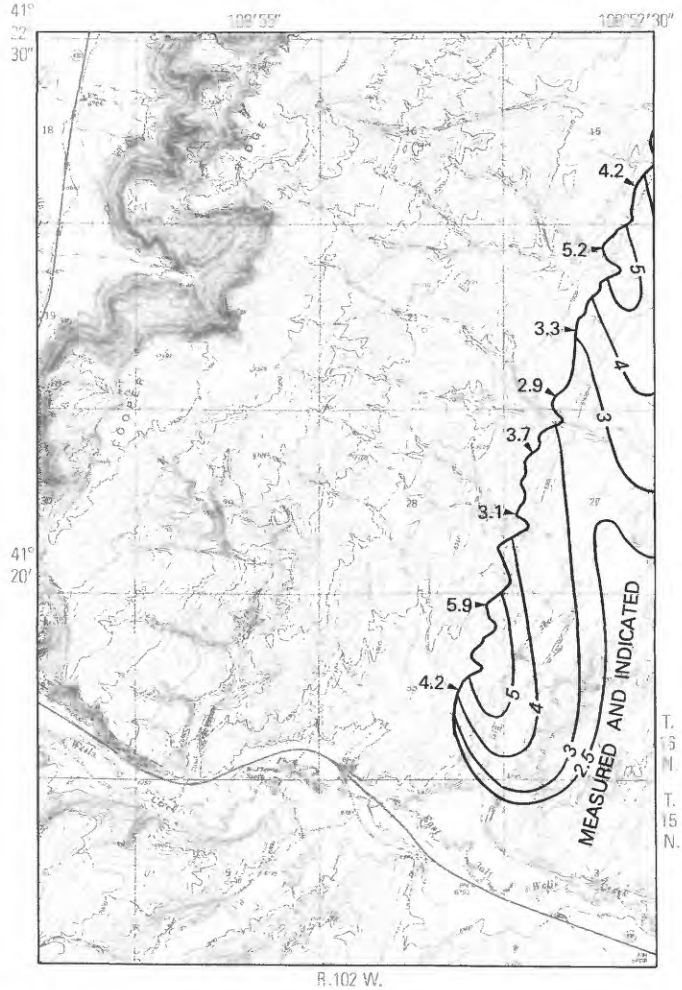

FIGURE 9.—Isopach map of the Falcon coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal measured in feet.

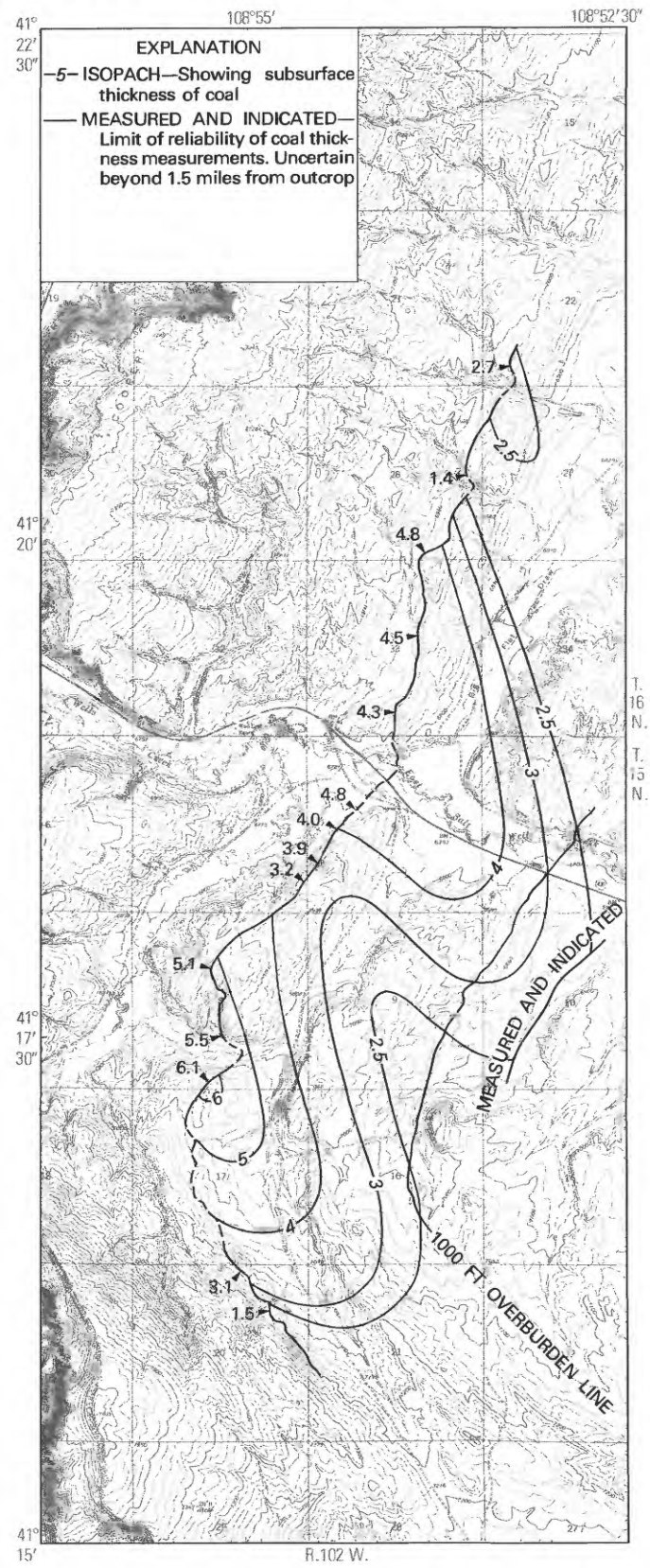

FIGURE 10.—Isopach map of the Golden Eye coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal outcrops dashed where covered; coal measured in feet.

TABLE 10.—*Measured and indicated coal resources of the Falcon coal bed under 0-1,000 ft of overburden, Mud Springs Ranch quadrangle, Wyoming*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons) For section	For township
	Bed 2.5-5.0 ft thick, T. 15 N., R. 102 W.			
3	2.7	0.105	0.105	
4	2.7	.035	.035	0.140
	Bed 2.5-5.0 ft thick, T. 16 N., R. 102 W.			
15	4.1	0.200	0.200	
22	3.9	1.466	1.466	
27	3.3	2.347	2.347	
28	3.3	.021	.021	
33	4.0	.476	.476	
34	3.5	1.912	1.912	6.422
	Bed 5.0-10.0 ft thick, T. 16 N., R. 102 W.			
22	5.2	0.304	0.304	
33	5.5	.493	.493	
34	5.1	.075	.075	0.872
	Grand total			7.434

TABLE 11.—*Measured and indicated coal resources of the Golden Eye coal bed, Mud Springs Ranch quadrangle, Wyoming*

[Leaders (---), no data]

Overburden thickness (ft)--		0-1,000 Bed thickness (weighted avg. in ft)	0-1,000 Coal resources (million tons)	1,000-2,000 Bed thickness (weighted avg. in ft)	1,000-2,000 Coal resources (million tons)	Total coal resources (million tons) For section	For township
		Bed 2.5-5.0 ft thick, T. 15 N., R. 102 W.					
Sec.	3	3.2	1.506	2.8	0.329	1.835	
	4	4.5	3.883	---	-----	3.883	
	5	3.2	.058	---	-----	.058	
	8	4.1	1.780	---	-----	1.780	
	9	2.8	2.271	2.7	.195	2.466	
	10	3.6	.136	2.8	.982	1.118	
	16	3.2	2.272	2.5	.032	2.304	
	17	4.3	2.141	---	-----	2.141	
	20	3.2	.334	---	-----	.334	
	21	2.9	.167	---	-----	.167	16.086
		Bed 2.5-5.0 ft thick, T. 16 N., R. 102 W.					
Sec.	22	2.6	0.030	---	-----	0.030	
	27	2.7	.268	---	-----	.268	
	28	3.3	.209	---	-----	.209	
	33	4.3	1.851	---	-----	1.851	
	34	2.9	.265	---	-----	.265	2.623
		Bed 5.0-10.0 ft thick, T. 15 N., R. 102 W.					
	8	5.3	0.495	---	-----	0.495	
	17	5.5	.922	---	-----	.922	1.417
	Grand Total						20.126

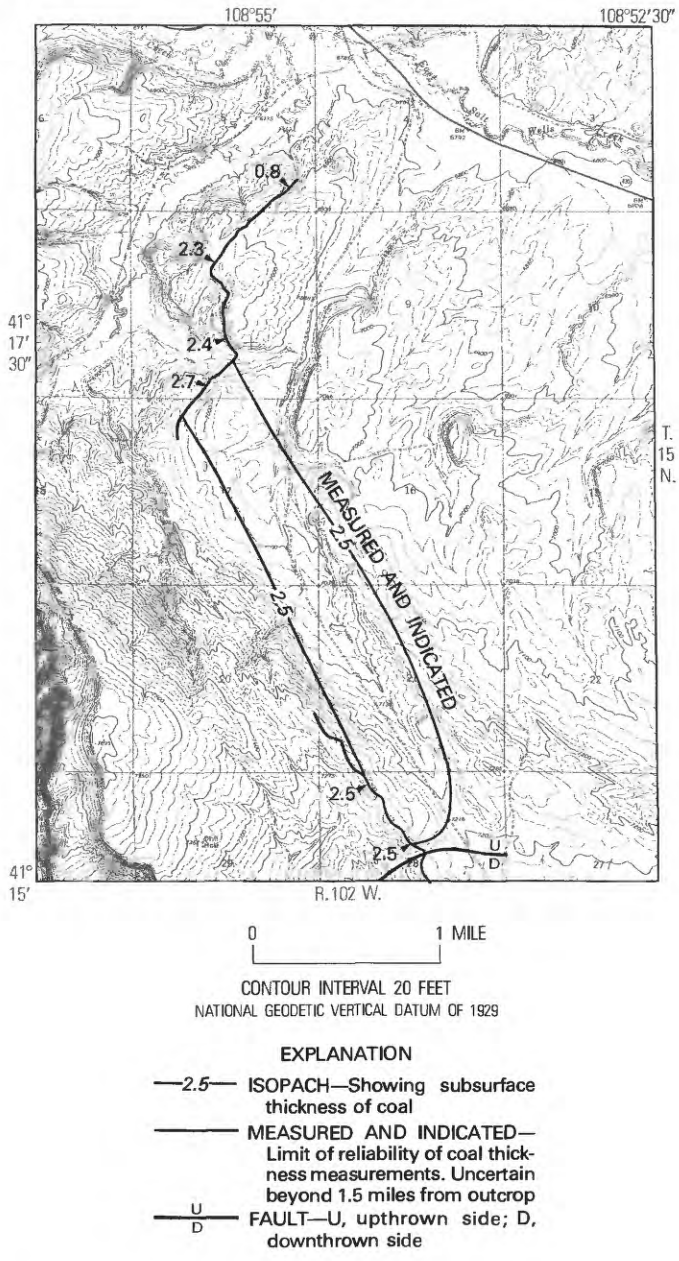

FIGURE 11.—Isopach map of the Teal coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal outcrops dashed where covered; coal measured in feet.

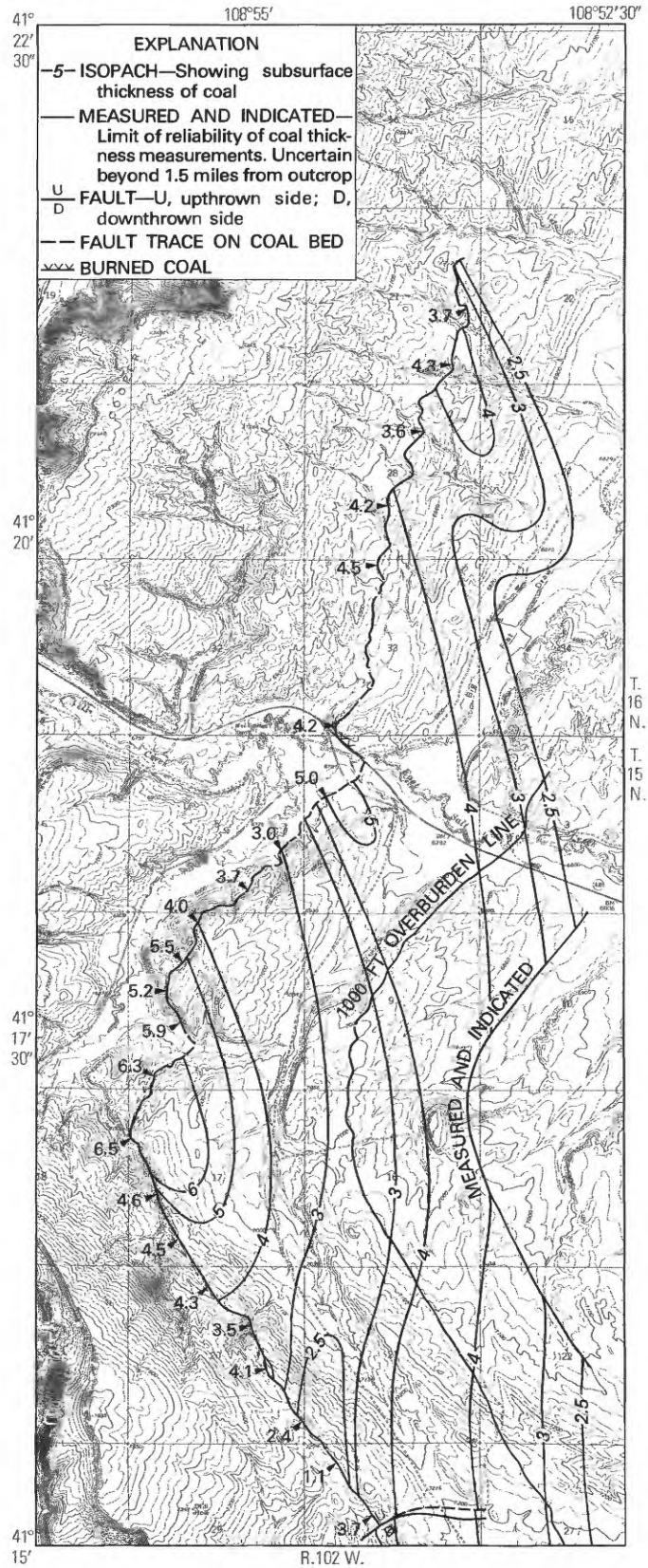

FIGURE 12.—Isopach map of the Pintail coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal outcrop dashed where covered; coal measured in feet.

TABLE 12.—*Measured and indicated coal resources in the category 2.5–5.0 ft thick of the Teal coal bed, under 0–1,000 ft of overburden, T. 15 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons)	
			For section	For township
8	2.6	0.106	0.106	
16	2.6	.179	.179	
17	2.6	1.179	1.179	
20	2.6	.219	.219	
21	2.6	1.346	1.346	
28	2.6	.379	.379	3.408

TABLE 13.—*Measured and indicated coal resources of the Pintail coal bed, Mud Springs Ranch quadrangle, Wyoming*

[Leaders (—), no data]

Overburden thickness (ft)—	0–1,000 ft		1,000–2,0000		Total coal resources (million tons)	
	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	For section	For township
Bed 2.5–5.0 ft thick, T. 15 N., R. 102 W.						
Sec. 3	3.1	.674	2.9	0.706	1.380	
4	4.3	3.998	4.2	.151	4.149	
5	3.4	.389	---	---	.389	
8	3.7	2.292	---	---	2.292	
9	3.8	1.887	4.1	2.687	4.574	
10	---	---	3.4	.318	.318	
15	---	---	3.8	.293	.293	
16	3.3	1.372	4.0	2.807	4.179	
17	4.4	2.451	---	---	2.451	
20	3.5	.969	---	---	.969	
21	3.7	3.111	4.2	.741	3.852	
22	3.8	.063	3.2	1.704	1.767	
27	3.6	.709	2.8	.510	1.219	
28	4.1	1.920	---	---	1.920	29.752
Bed 2.5–5.0 ft thick, T. 16 N., R. 102 W.						
21	3.9	0.362	---	---	0.362	
22	2.9	.189	---	---	.189	
27	3.0	1.421	---	---	1.421	
28	3.8	1.855	---	---	1.855	
33	4.1	3.082	---	---	3.082	
34	2.7	.550	---	---	.550	7.459
Bed 5.0–10.0 ft thick, T. 15 N., R. 102 W.						
4	5.1	0.392	---	---	0.392	
8	5.6	.963	---	---	.963	
17	6.0	2.337	---	---	2.337	3.692
Grand total						40.903

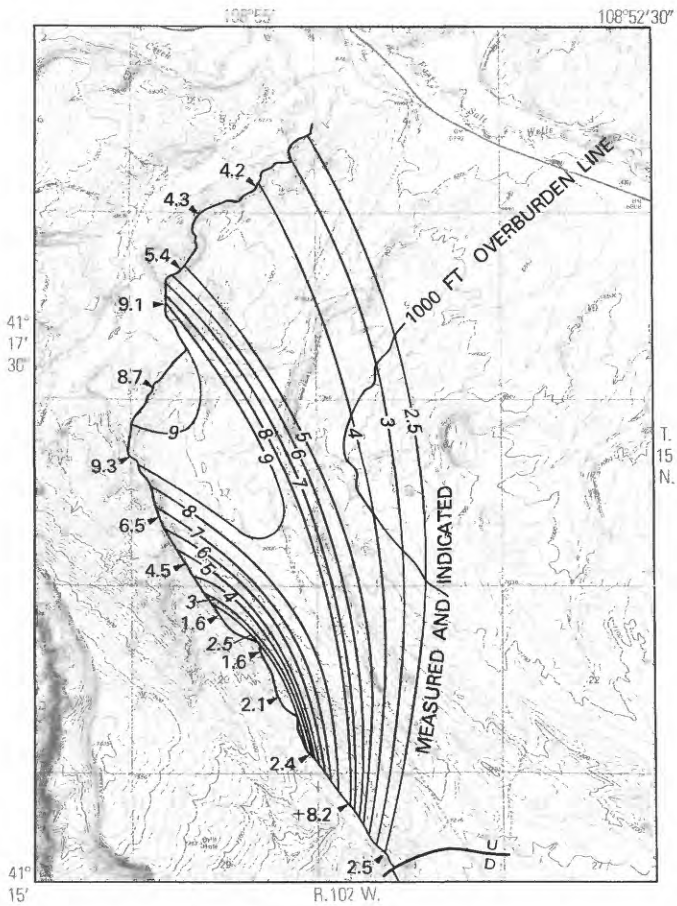

FIGURE 13.—Isopach map of the Finch coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal outcrop dashed where covered; coal measured in feet.

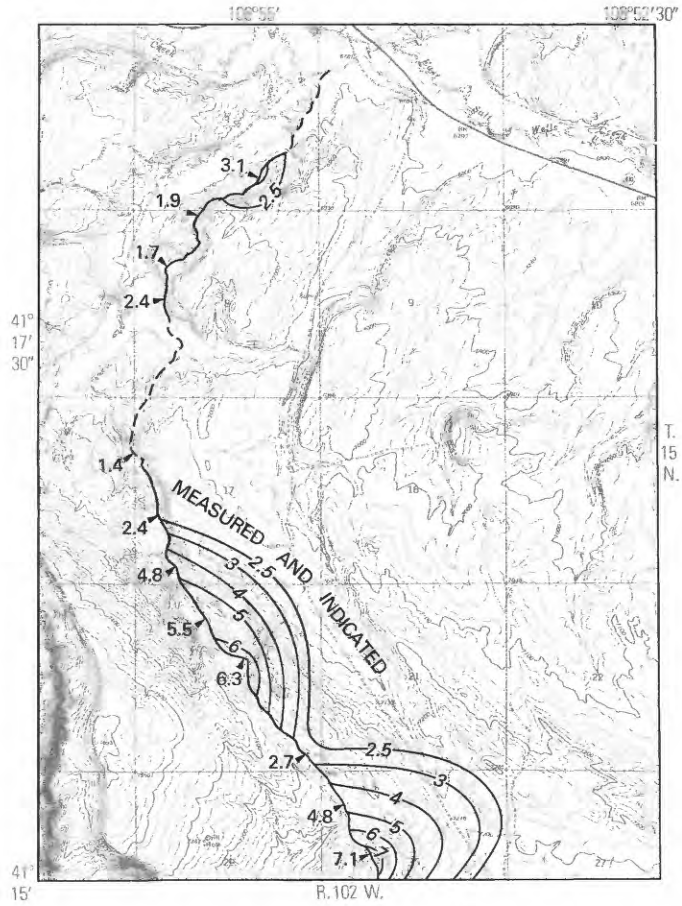

FIGURE 14.—Isopach map of the Gull coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal outcrop dashed where covered; coal measured in feet.

TABLE 14.—*Measured and indicated coal resources of the Finch coal bed, T. 15 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming*

[Leaders (---), no data]

Overburden thickness (ft)--		0-1,000		1,000-2,000		Total coal resources (million tons)	
		Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	For section	For township
Bed 2.5-5.0 ft thick							
Sec.	4	2.7	0.093	---	-----	0.093	
	5	3.6	.459	---	-----	.459	
	8	4.3	2.276	---	-----	2.276	
	9	3.3	1.200	2.8	0.151	1.351	
	16	4.2	1.008	3.0	.922	1.930	
	17	4.6	.168	---	-----	.168	
	20	3.5	.358	---	-----	.358	
	21	3.2	.955	---	-----	.955	
	28	3.2	.222	---	-----	.222	7.812
Bed 5.0-10.0 ft thick							
Sec.	8	7.7	2.372	---	-----	2.372	
	16	6.0	.611	---	-----	.611	
	17	8.8	8.011	---	-----	8.011	
	20	7.2	1.246	---	-----	1.246	
	21	7.1	2.200	---	-----	2.200	
	28	7.0	.255	---	-----	.255	14.695
Grand Total----------							22.507

TABLE 15.—*Measured and indicated coal resources of the Gull coal bed, under 0-1,000 ft of overburden, T. 15 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons) For section	Total coal resources (million tons) For township
Bed 2.5-5.0 ft thick				
5	2.7	0.115	0.115	
17	3.4	.458	.458	
20	3.5	.871	.871	
21	2.7	.245	.245	
28	3.4	1.367	1.367	3.056
Bed 5.0-10.0 ft thick				
17	5.0	0.017	0.017	
20	5.3	.603	.603	
28	5.9	.537	.537	1.570
Grand total----------				4.626

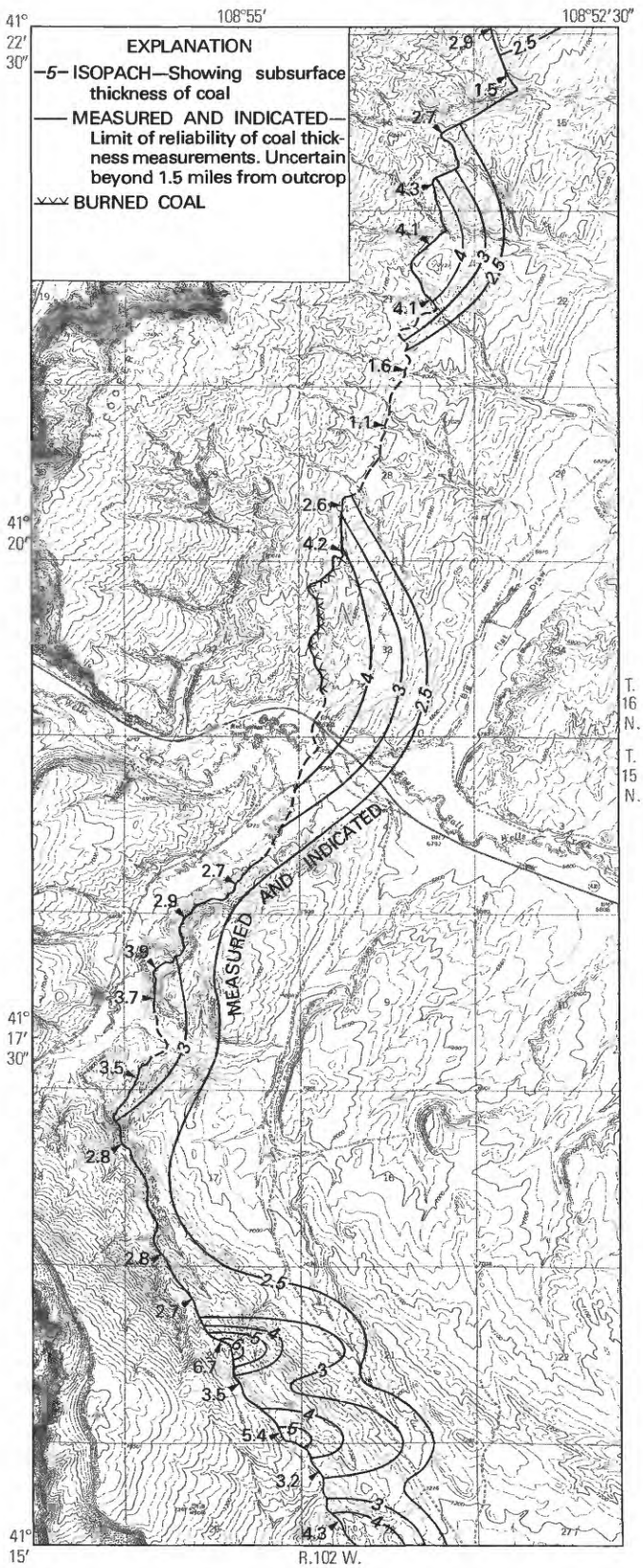

FIGURE 15.—Isopach map of the Sparrow coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal bed dashed where covered or approximately located; coal measured in feet.

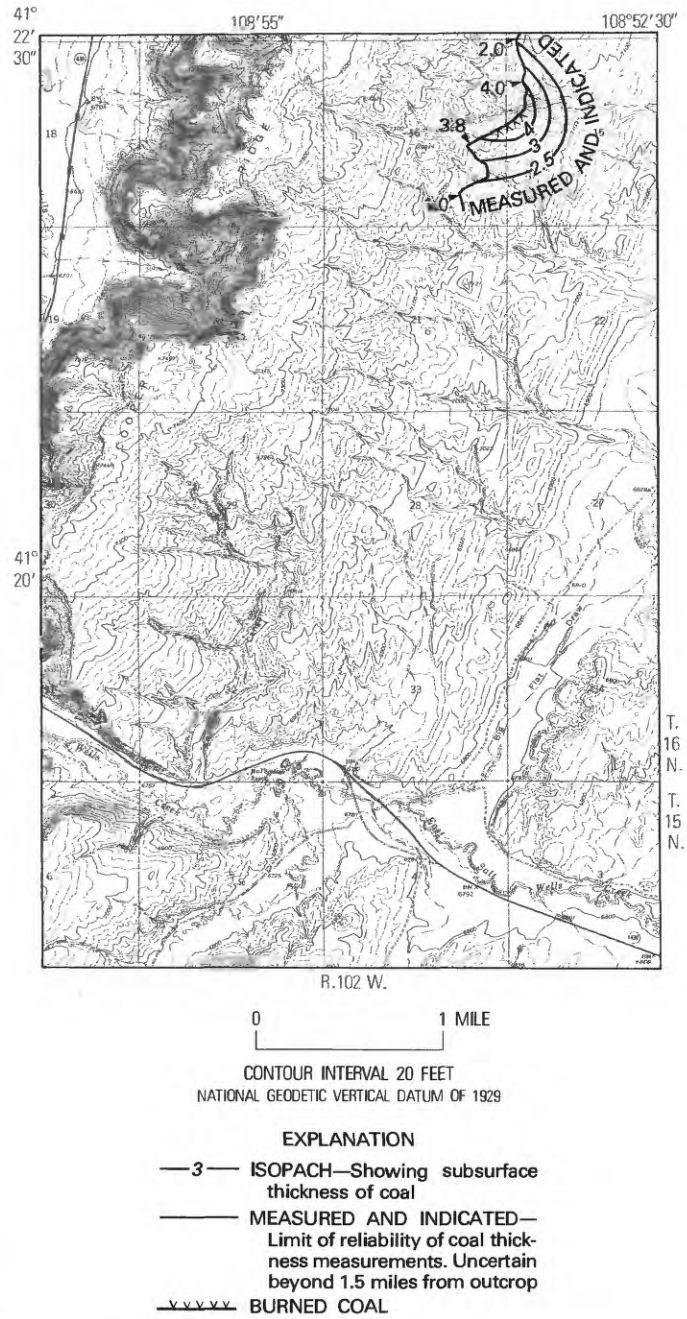

FIGURE 16.—Isopach map of the Coot coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal measured in feet.

TABLE 16.—*Measured and indicated coal resources of the Sparrow coal bed, under 0–1,000 ft of overburden, Mud Springs Ranch quadrangle, Wyoming*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons) For section	Total coal resources (million tons) For township
	Bed 2.5 to 5.0 ft thick, T. 15 N., R. 102 W.			
4	3.1	0.790	0.790	
5	2.7	.243	.243	
8	2.8	1.092	1.092	
17	2.7	.754	.754	
18	3.1	.020	.020	
20	2.9	1.176	1.176	
21	2.9	1.253	2.253	
28	3.3	1.239	1.239	6.567
	Bed 2.5 to 5.0 ft thick, T. 16 N., R. 102 W.			
10	2.6	0.046	0.046	
15	2.7	.167	.167	
16	3.1	.250	.250	
21	3.3	.687	.687	
22	2.8	.228	.228	
28	2.9	.198	.198	
33	3.5	2.237	2.237	3.813
	Bed 5.0 to 10.0 ft thick, T. 15 N., R. 102 W.			
20	5.4	0.303	0.303	
21	5.1	.025	.025	
28	5.1	.017	.017	
29	5.2	.008	.008	0.353
Grand total				10.733

TABLE 17.—*Measured and indicated coal resources in the category 2.5 to 5.0 ft thick of the Coot coal bed, under 0–1,000 ft of overburden, T. 16 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons) For section	Total coal resources (million tons) For township
15	2.9	0.444	0.444	
16	3.1	.131	.131	0.575

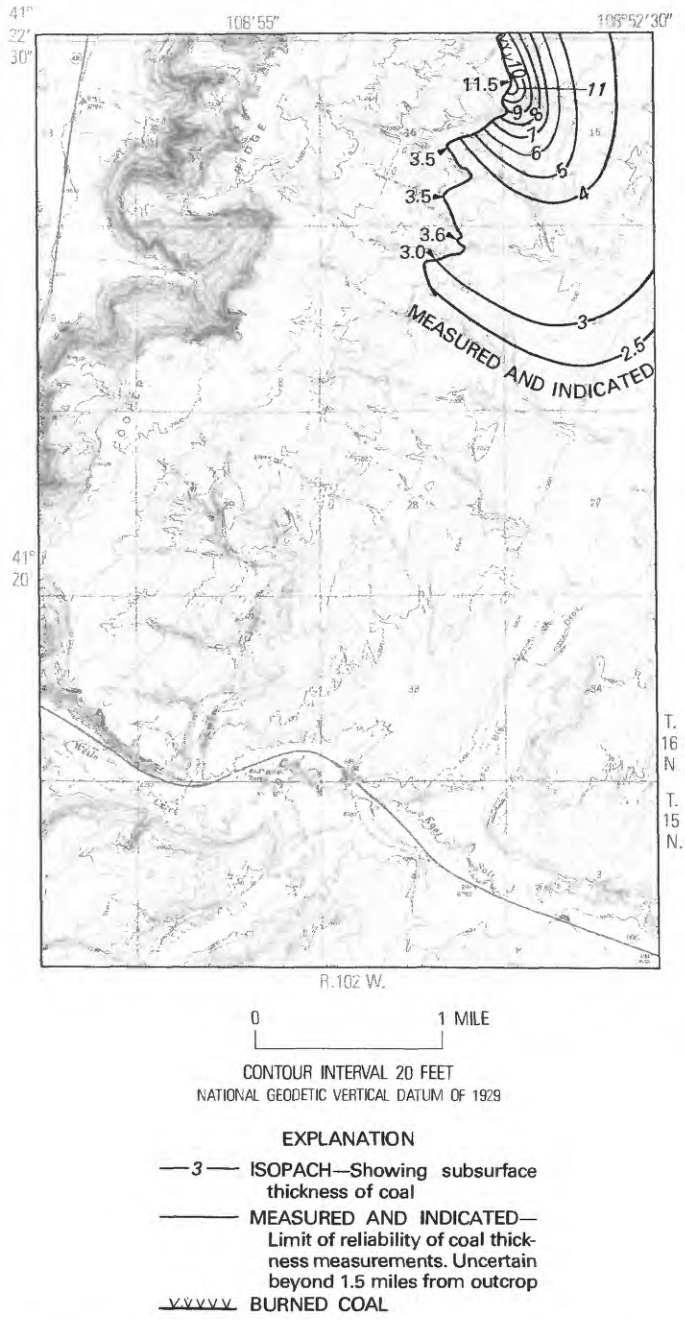

FIGURE 17.—Isopach map of the Mallard coal bed showing measured net coal thicknesses, in feet (at triangles), along outcrops. Coal measured in feet.

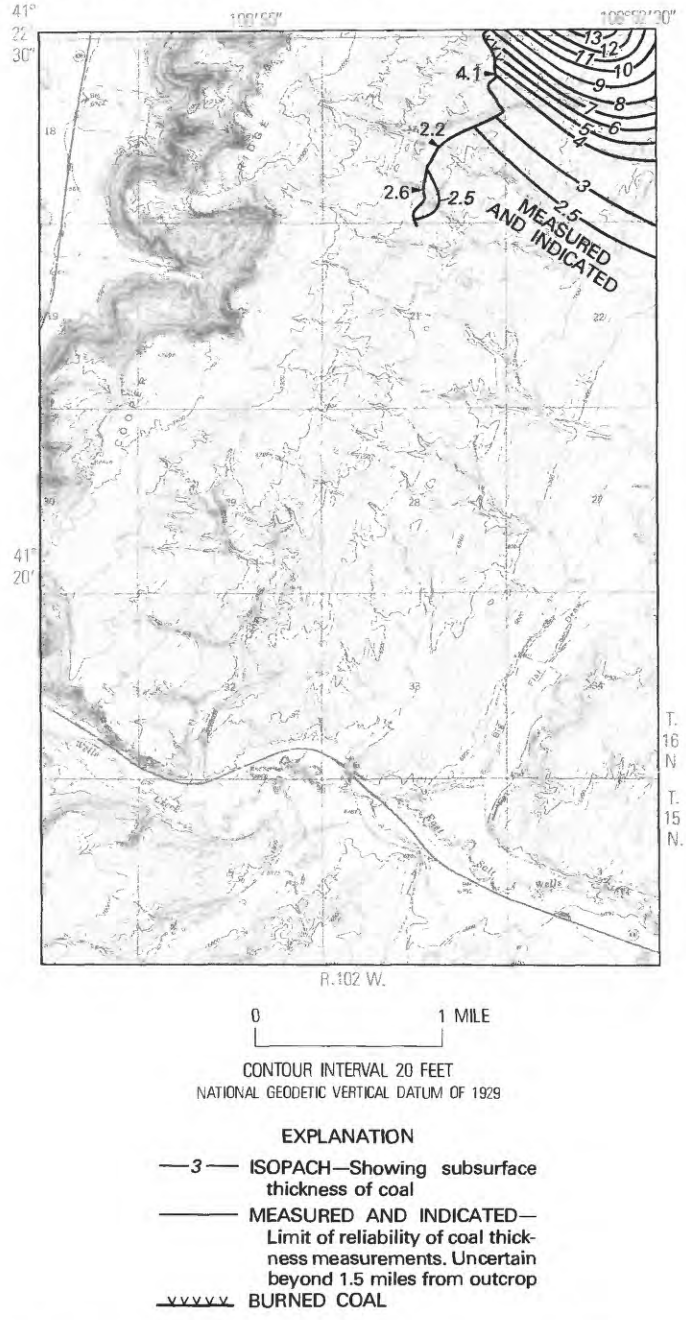

FIGURE 18.—Isopach map of the Robin coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal measured in feet.

TABLE 18.—*Measured and indicated coal resources of the Mallard coal bed, under 0–1,000 ft of overburden, T. 16 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons) For section	For township
		Bed 2.5 to 5.0 ft thick		
10	4.0	0.098	0.098	
15	3.8	2.381	2.381	
16	3.5	.484	.484	
21	3.2	.614	.614	
22	3.2	2.161	2.161	5.738
		Bed 5.0 to 10.0 ft thick		
9	9.5	0.015	0.015	
10	7.0	.102	.102	
15	6.2	1.755	1.755	
16	6.0	.166	.166	2.038
		Bed more than 10.0 ft thick		
15	10.6	0.241	0.241	0.241
	Grand Total			8.017

TABLE 19.—*Measured and indicated coal resources of the Robin coal bed, under 0–1,000 ft of overburden, T. 16 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons) For section	For township
		Bed 2.5 to 5.0 ft thick		
15	3.4	1.444	1.444	
16	3.2	.198	.198	
22	2.7	.145	.145	1.787
		Bed 5.0 to 10.0 ft thick		
9	7.8	0.038	0.038	
10	9.3	.076	.076	
15	7.6	2.461	2.461	
16	6.5	.106	.106	2.681
		Bed more than 10.0 ft thick		
10	12.0	0.410	0.410	
15	11.3	1.177	1.177	1.587
	Grand total			6.055

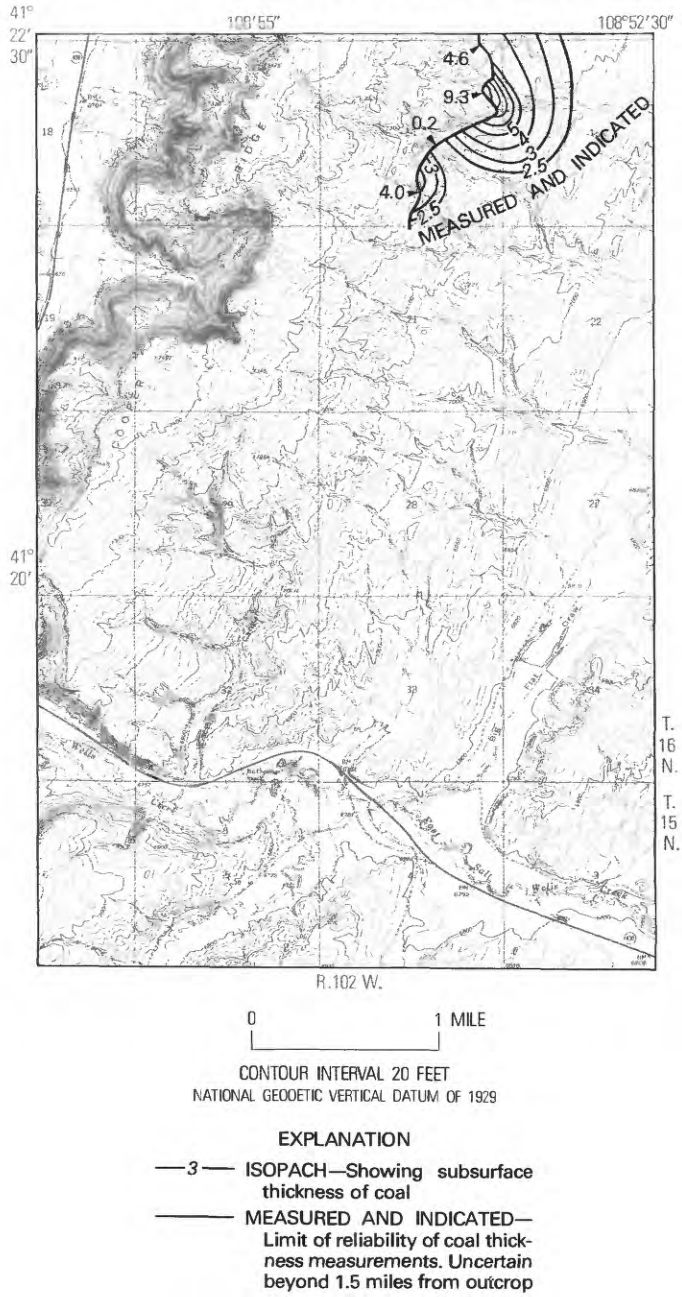

FIGURE 19.—Isopach map of the Magpie coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal measured in feet.

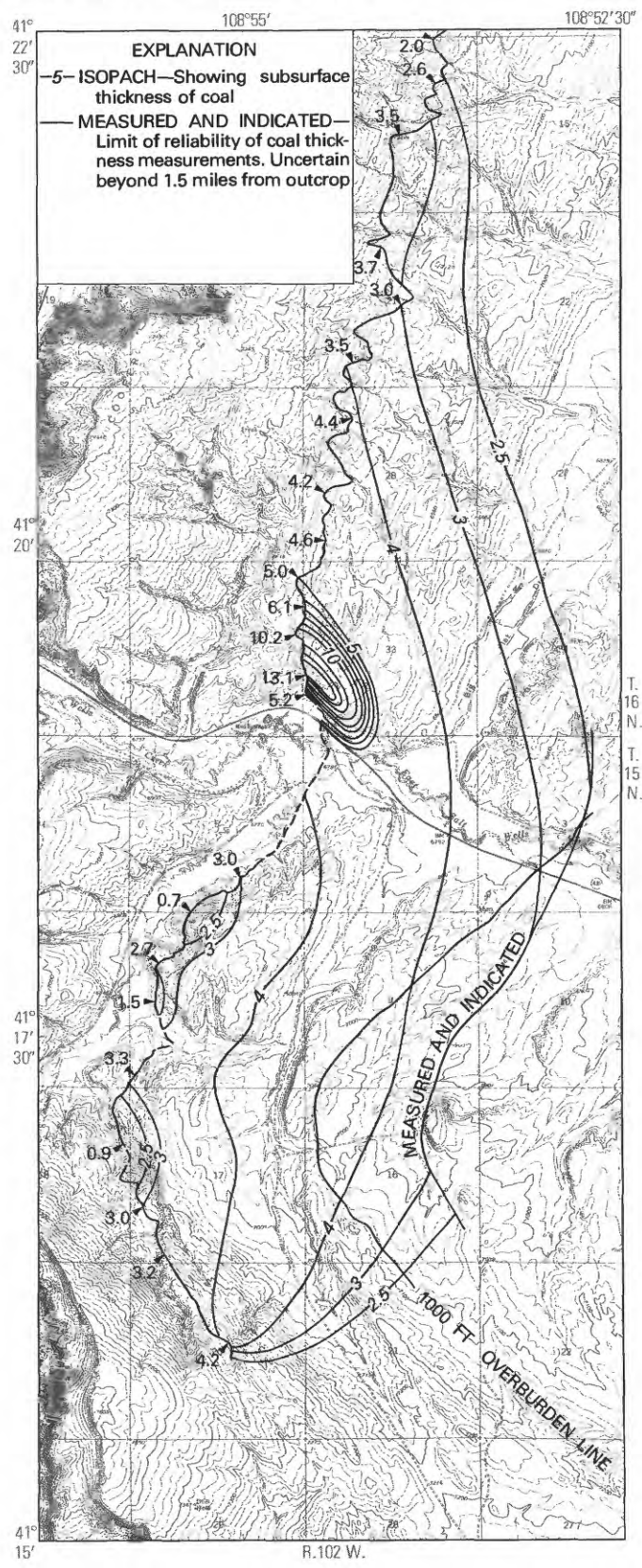

FIGURE 20.—Isopach map of the upper Mourning Dove coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal outcrop dashed where covered; coal measured in feet.

TABLE 20.—*Measured and indicated coal resources of the Magpie coal bed, under 0–1,000 ft of overburden, T. 16 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons) For section	Total coal resources (million tons) For township
Bed 2.5 to 5.0 ft thick				
9	4.5	0.022	0.022	
10	3.2	.036	.036	
15	3.2	.791	.791	
16	3.2	.354	.354	1.203
Bed 5.0 to 10.0 ft thick				
15	5.8	0.151	0.151	
16	6.5	.201	.201	.3520
Grand total				1.555

TABLE 21.—*Measured and indicated coal resources of the upper Mourning Dove coal bed, Mud Springs Ranch quadrangle, Wyoming*

[Leaders (---), no data]

Overburden thickness (ft)--		0–1,000 Bed thickness (weighted avg. in ft)	0–1,000 Coal resources (million tons)	1,000–2,000 Bed thickness (weighted avg. in ft)	1,000–2,000 Coal resources (million tons)	Total coal resources (million tons) For section	Total coal resources (million tons) For township
Bed 2.5–5.0 ft thick, T. 15 N., R. 102 W.							
Sec.	3	3.0	1.564	3.0	0.235	1.799	
	4	4.2	4.715	---	-----	4.715	
	5	3.4	.611	---	-----	.611	
	8	3.6	3.232	---	-----	3.232	
	9	4.2	2.484	3.8	1.787	4.271	
	10	3.5	.011	3.2	.352	.363	
	16	4.0	.854	3.6	2.224	3.078	
	17	4.0	4.082	---	-----	4.082	
	18	2.6	.004	---	-----	.004	
	20	3.7	.750	---	-----	.750	
	21	3.0	.618	2.6	.017	.635	23.540
Bed 2.5–5.0 ft thick, T. 16 N., R. 102 W.							
Sec.	16	3.1	0.898	---	-----	0.898	
	21	2.8	1.627	---	-----	1.627	
	27	2.6	.495	---	-----	.495	
	28	3.5	3.303	---	-----	3.303	
	32	4.9	.008	---	-----	.008	
	33	4.1	3.536	---	-----	3.536	
	34	2.8	1.538	---	-----	1.538	11.405
Bed 5.0–10.0 ft thick, T. 15 N., R. 102 W.							
Sec.	4	5.8	0.066	---	-----	0.066	0.066
Bed 5.0–10.0 ft thick, T. 16 N., R. 102 W.							
Sec.	32	6.0	0.039	---	-----	0.039	
	33	7.0	1.153	---	---	1.153	1.192
More than 10.0 ft thick, T. 16 N., R. 102 W.							
Sec.	32	10.6	0.052	---	-----	0.052	
	33	10.9	1.049	---	-----	1.049	1.101
Grand total							37.304

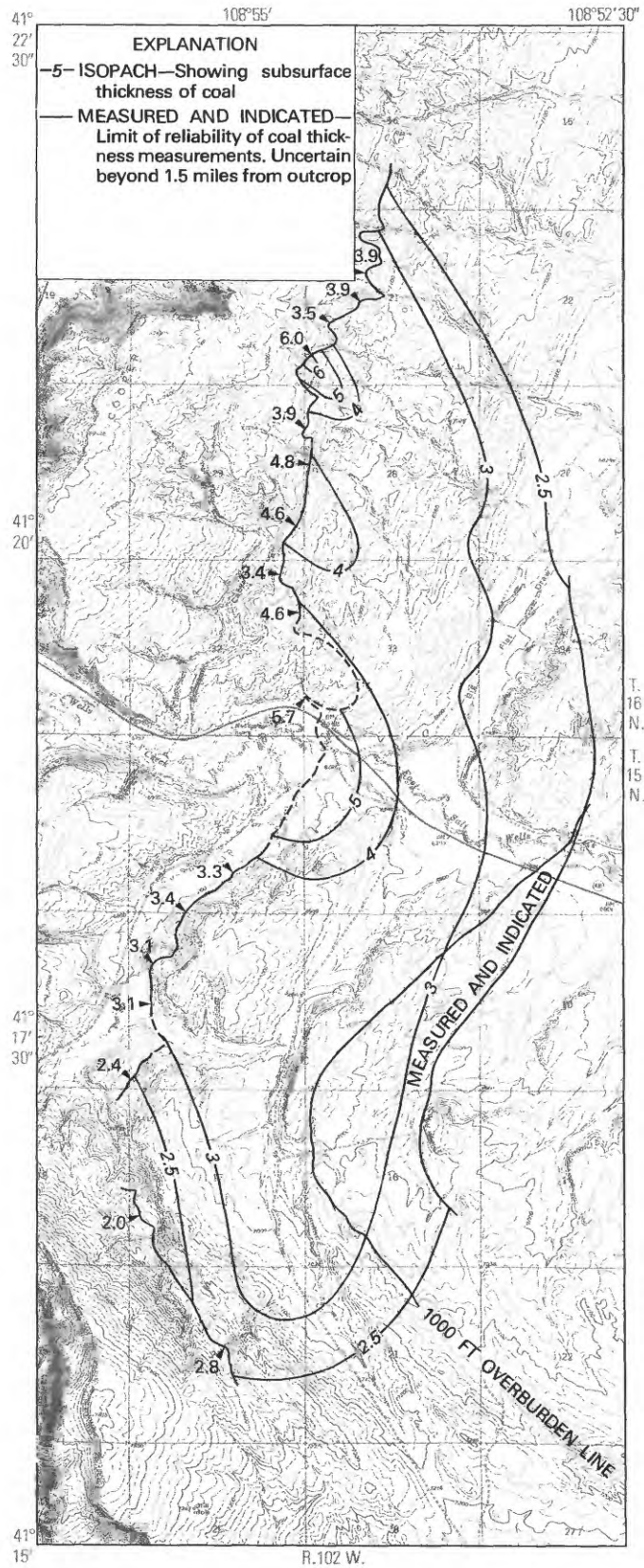

FIGURE 21.—Isopach map of the lower Mourning Dove coal bed showing measured net coal thicknesses, in feet (at triangles), along outcrops. Coal measured in feet; coal outcrop short dashed where covered. Long dashes indicate area where the upper and lower Mourning Dove beds coalesce. Resources for this area are included in upper Mourning Dove bed.

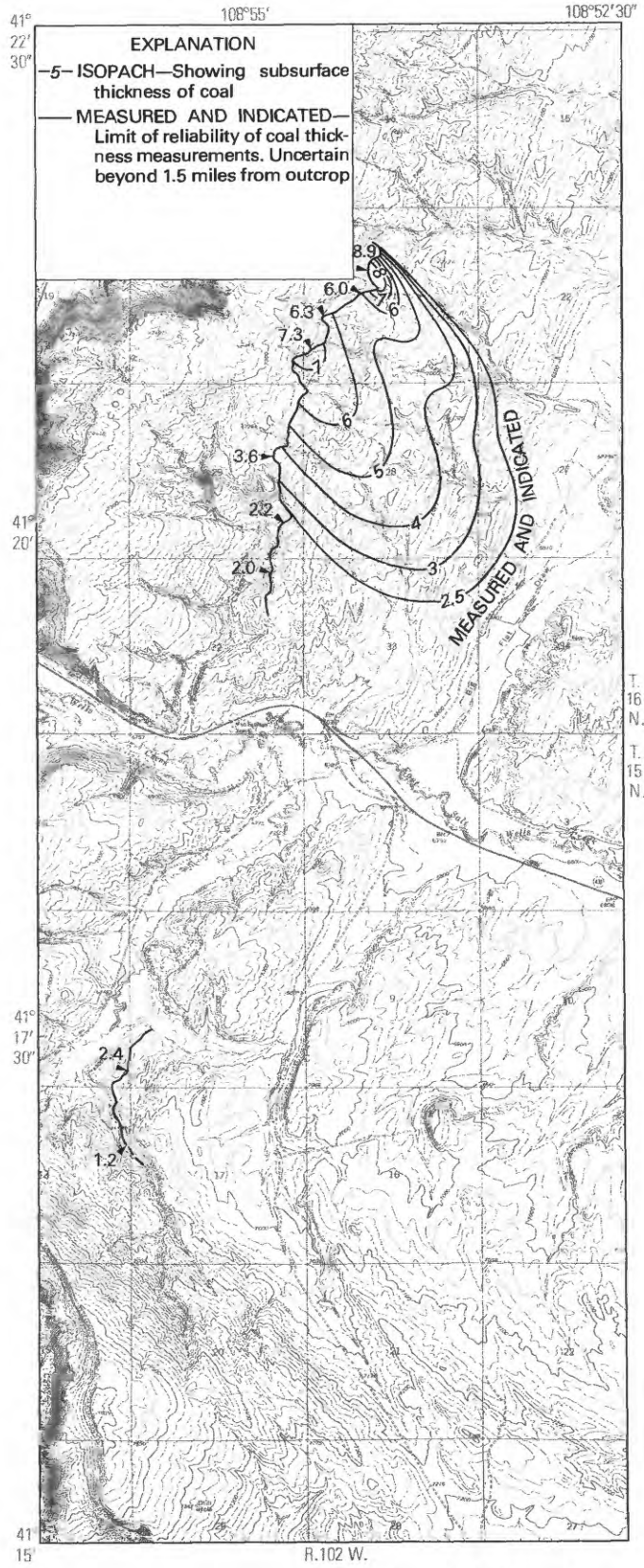

FIGURE 22.—Isopach map of the Starling coal bed showing measured net coal thicknesses (at triangles), along outcrops. Coal measured in feet.

TABLE 22.—*Measured and indicated coal resources of the lower Mourning Dove coal bed, Mud Springs Ranch quadrangle, Wyoming*

[Leaders (---), no data]

Overburden thickness (ft)--	0-1,000		1,000-2,000		Total coal resources (million tons)	
	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	For section	For township
Bed 2.5-5.0 ft thick, T. 15 N., R. 102 W.						
Sec. 3	2.8	1.382	2.8	.261	1.643	
4	3.7	3.682	---	---	3.682	
5	3.5	.749	---	---	.749	
8	3.3	3.163	---	---	3.163	
9	3.4	1.838	3.0	1.475	3.313	
10	3.8	.006	3.7	.303	.309	
16	3.2	.552	3.0	1.898	2.450	
17	3.1	2.649	---	---	2.649	
20	2.8	1.145	---	---	1.145	
21	2.7	.815	2.6	.056	.871	19.974
Bed 2.5-5.0 ft thick, T. 16 N., R. 102 W.						
16	2.6	0.034	---	---	0.034	
21	3.3	2.637	---	---	2.637	
22	2.6	.072	---	---	.072	
27	2.7	.936	---	---	.936	
28	3.5	3.867	---	---	3.867	
29	4.1	.093	---	---	.093	
32	3.8	.118	---	---	.118	
33	3.7	3.668	---	---	3.668	
34	2.7	1.580	---	---	1.580	13.005
Bed 5.0-10.0 ft thick, T. 15 N., R. 102 W.						
4	5.3	.788	---	---	.788	
5	5.3	.173	---	---	.173	.961
Bed 5.0-10.0 ft thick, T. 16 N., R. 102 W.						
20	5.5	0.018	---	---	0.018	
21	5.5	.206	---	---	.206	
28	5.2	.068	---	---	.068	
33	5.3	.190	---	---	.190	.482
Grand total						34.422

TABLE 23.—*Measured and indicated coal resources of the Starling coal bed, under 0-1,000 ft of overburden, T. 16 N., R. 102 W., Mud Springs Ranch quadrangle, Wyoming.*

Sec.	Bed thickness (weighted avg. in ft)	Coal resources (million tons)	Total coal resources (million tons) For section	Total coal resources (million tons) For township
Bed 2.5-5.0 ft thick				
21	4.3	0.973	0.973	
22	2.7	.018	.018	
27	2.7	.448	.448	
28	3.8	3.240	3.240	
29	3.6	.223	.223	
33	2.7	.489	.489	
34	2.6	.025	.025	5.416
Bed 5.0-10.0 ft thick				
20	7.0	0.046	0.046	
21	6.0	1.689	1.689	
28	5.7	1.558	1.558	
29	5.4	.053	.053	3.346
Grand total				8.762

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