Text to accompany:

Open-File Report 78-058

1978

COAL RESOURCE OCCURRENCE MAPS OF THE WALCOTT QUADRANGLE, CARBON COUNTY, WYOMING

(Report incudes 3 plates)

Prepared for:

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Prepared by:

TEXAS INSTRUMENTS INCORPORATED
DALLAS, TEXAS

CONTENTS

ILLUSTRATIONS

[Plates are in pocket]

APPENDICES

INTRODUCTION

Purpose

This text is to be used along with the accompanying Coal Resource Occurrence (CRO) Maps of the Walcott quadrangle, Carbon County, Wyoming (3 plates; U.S. Geol. Survey Open-File Report 78-058), prepared by Texas Instruments Incorporated under contract to the U.S. Geological Survey. This report was prepared to support the land planning work of the U.S. Bureau of Land Management's Energy Minerals Activities Recommendation System (EMARS) program, and to contribute to a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. The Coal Resource Occurrence maps for this quadrangle cover part of the southwestern portion of the KRCRA of the Hanna coal field. The lack of correlatable coal of Reserve Base thickness in this quadrangle, as indicated on the CRO maps, precluded the construction of Coal Development Potential (CDP) maps which normally accompany this type of report.

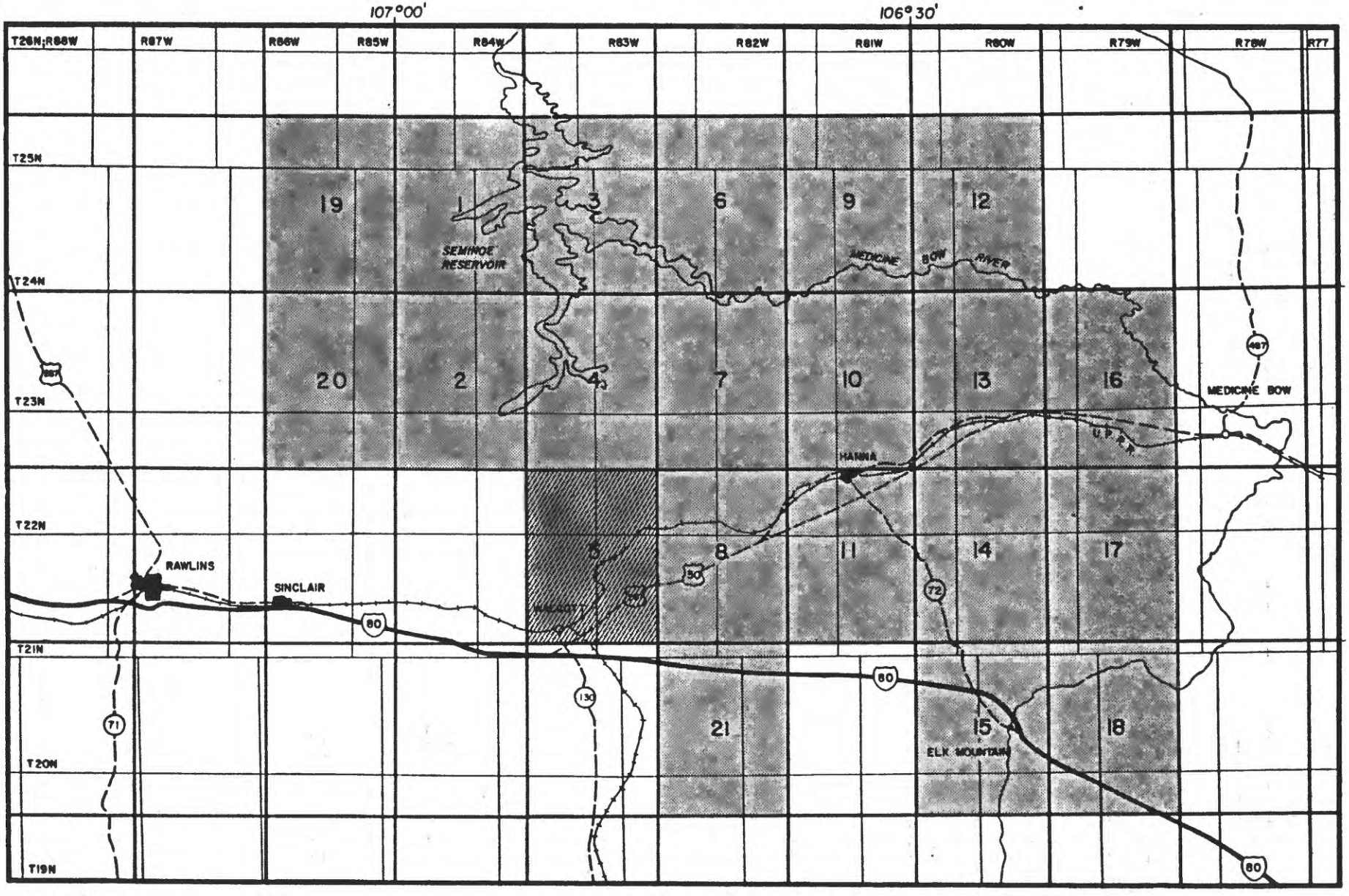
Acknowledgment

Texas Instruments Incorporated acknowledges the cooperation of the Rocky Mountain Energy Company, a wholly owned subsidiary of the Union Pacific Railroad Company, in supplying copies of survey sheets, drillers reports, electric logs, and coal analyses from the Union Pacific coal inventory program.

The Hanna and Carbon coal basins were studied as part of the Union Pacific coal inventory program and test drilling was conducted in 1970-1971. More than 650 Union Pacific coal drill holes have been evaluated as part of this contract study of 21 quadrangles in Carbon County, Wyoming, and the results of 230 coal analyses have been incorporated into these reports.

Location

The Walcott 7½-minute quadrangle is in the northeastern part of Carbon County, Wyoming. The center of the quadrangle is approximately 22 miles (35 km) east-northeast of Rawlins and 14 miles (22 km) southwest of Hanna, Wyoming. The town of Walcott is located in the southwestern part of the quadrangle (Figure 1).



Walcott quadrangle (5)

Scale 1:446,000

Figure 1. — Map of Hanna and Carbon Basins study area

Accessibility

U.S. Highway 30/287 passes through the southern part of the quadrangle, connecting U.S. Interstate Highway 80, one mile (1.6 km) south of the town of Walcott, to the towns of Hanna and Medicine Bow to the east of the quadrangle.

Five local light-duty roads provide general access within the quadrangle. One road runs due north from Walcott, providing access to the eastern arm of Seminoe Reservoir immediately north of the quadrangle. A second road runs north from Walcott Junction, on U.S. Highway 30/287, to the town of Walcott and then continues in a northwesterly direction up the broad valley between Cedar Ridge and Saint Marys Ridge. A third road leaves U.S. Highway 30/287, in sec. 25, T.21N., R.84W., and provides access to the southeast and south as it parallels the single-track railroad from Walcott to Saratoga and Encampment. A fourth local road provides access from U.S. Highway 30/287 to the railroad maintenance camp of Edson in sec. 6, T.21N., R.83W. The fifth local road in the northeast corner of the quadrangle is the mine access road from U.S. Highway 30/287 to the Seminoe open-pit mine of Arch Mineral Corporation. Numerous local unimproved dirt roads provide ready access to most parts of the quadrangle from U.S. Highway 30/287 and the five light-duty roads.

The main east-west track of the Union Pacific Railroad crosses the quadrangle from northeast to southwest and connects Medicine Bow and Hanna to the east with Fort Steele, Sinclair, and Rawlins to the west. A single-track branch railroad extends southward from Walcott to Saratoga and Encampment. The Seminoe open-pit mine is serviced by a single-track branch railroad that connects the mine tipple in the northeast corner of the quadrangle to the main line of the Union Pacific Railroad.

Physiography

The quadrangle is located on the southwestern edge of the Hanna structural basin. The topography is typical of the high plains grasslands of southern Wyoming. Several northwest-trending rocky ridges break the general monotony of the rolling grasslands but their local relief is generally less than 500 feet (152 m). The southeast end of Cedar Ridge, Saint Marys Ridge, Dana (or Pass Creek) Ridge, Edson (or St. Marys) Ridge, and Monument Ridge

are the most conspicuous named topographic features. Names of topographic features are taken from the 1:24,000 topographic map (1971 edition). If different names were used on the geologic map of Dobbin, Bowen, and Hoots (1929) the earlier names are shown in parentheses throughout this report. Elevations within the quadrangle range from 7,495 feet (2,284 m) at Saint Marys Hill to 6,570 feet (2,003 m) in Taylor Draw in the northwest part of the quadrangle. Elevations of the upland plains are between 6,600 (2,012 m) and 6,900 feet (2,103 m). Saint Marys Creek and Taylor Draw are the two principal drainage courses in the quadrangle. Because of the low rainfall many of their tributary streams are intermittent.

Climate

Climate data for the Walcott quadrangle were obtained by evaluating and averaging the data recorded at two nearby weather stations. The Elk Mountain station is located 23 miles (37 km) east-southeast of the center of the quadrangle at an elevation of 7,270 feet (2,216 m). Precipitation records are available for 65 years to 1970; temperature records are available for 22 years to 1970. The Seminoe Dam station is located 24 miles (39 km) north of the center of the quadrangle at an elevation of 6,838 feet (2,084 m); precipitation and temperature records are available for 33 years to 1970.

The climate is semiarid with a mean annual temperature of 42°F (6°C) and extremes ranging from 98° to -42°F (37° to 41°C). July is the warmest month with a mean monthly temperature of 66°F (19°C), and January is the coldest month with 22°F (-6°C). For seven months of the year, April to October, the mean monthly temperature exceeds 32°F (0°C). Average annual precipitation is 14 inches (36 cm); 53 percent of this total falls in the five months of March to July. Part of the precipitation in March, April, and May is in the form of snow. Average annual snowfall is 102 inches (259 cm); 63 percent falls in the four months of January to April. Snow rarely falls in July and August but an inch or more of snow may fall in any other month. March is the month of maximum snowfall (18 inches, or 46 cm).

High winds are common throughout most of the year. The prevailing wind direction, as recorded at four weather stations around the perimeter of the Hanna and Carbon Basins, is westerly for all twelve months of the year. The

growing season is restricted to less than 100 days between the last killing frost in late May and the first killing frost in early September.

Land Status

The quadrangle is in the southwest part of the Hanna and Carbon Basins KRCRA. The Federal Government owns approximately 45 percent of the coal rights in the quadrangle; the remaining 55 percent is non federally owned. Approximately 12 percent of the area of the quadrangle is included in the KRCRA, and within this region about 40 percent of the land is federally owned and 1 percent is currently leased for coal.

Two mines are shown on Plate 1: the abandoned Buckley and Ryan underground mine in sec. 14, T.21N., R.84W., owned by Messrs. Buckley and Ryan; and the active Seminoe No. 1 strip mine in secs. 16 and 17, T.22N., R.83W., owned by Arch Mineral Corporation. A third mine, the abandoned J.P. Ryan underground mine, is located within the quadrangle but is not shown on Plate 1 because its precise location is not known. The analysis of a coal sample taken at the J.P. Ryan mine is shown in Appendix 3; the reference source (U.S. Bureau of Mines, 1931, p. 94-95) clearly differentiates the J.P. Ryan mine and the Buckley and Ryan mine. Dobbin, Bowen, and Hoots (1929, p. 43) also note the presence of two mines and infer that at the time of their field work (1925?) the Buckley and Ryan mine was abandoned, but the J.P. Ryan mine was producing coal for local consumption in Walcott.

GENERAL GEOLOGY

Previous Work

Dobbin, Bowen, and Hoots (1929) mapped the Walcott quadrangle as part of their study of the geology and coal and oil resources of the Hanna and Carbon Basins. Weitz and Love (1952) compiled a geologic map of Carbon County which incorporates available data, published and unpublished, to that date. Gill, Merewether, and Cobban (1970) provide a detailed description and discussion of the more important sedimentary rock formations of the area. Blanchard and Comstock (1976) recently mapped the geology and coal occurrences of the Pats Bottom quadrangle immediately to the north of this quadrangle.

Stratigraphy

Rocks exposed in the Walcott quadrangle range in age from Late Cretaceous to Quaternary. Coal occurrences mapped in the quadrangle include one short segment of a coal bed outcrop in the Mesaverde Group, 11 coal beds in the Medicine Bow Formation, and 4 coal beds in the Ferris Formation.

The oldest formation exposed in the quadrangle is the Steele Shale, with a very limited outcrop in the extreme southwest. The Steele Shale is a marine formation of Late Cretaceous age, first named for Fort Steele which is located 4.5 miles (7.2 km) west of the southwestern boundary of the quadrangle. In its type area the reported thickness for the formation is 3,000 feet (914 m). The unit consists of dark-gray shales that contain sparse layers of gray-weathering limestone concretions and thin beds of gray very fine grained sandstone and siltstone.

Conformably overlying the Steele Shale is the Upper Cretaceous Mesaverde Formation of Dobbin, Bowen, and Hoots (1929). Later studies in south-central Wyoming by Gill, Merewether, and Cobban (1970) have resulted in elevating the Meseverde to group status and in measuring and defining four separate formations within the group. Surface mapping delineating the formations of the Mesaverde Group has not been extended into the Walcott quadrangle, however, and the group is here treated as a single unit. Dobbin, Bowen, and Hoots (1929) describe the Mesaverde Formation from a stratigraphic section located 1.5 miles (2.4 km) west of the Walcott quadrangle, just north of Fort Steele, and give a total thickness of 2,279 feet (695 m) for the unit. The same outcrops extend into the southwestern corner of the Walcott quadrangle. In addition, the Mesaverde is exposed in the cores of the Saint Marys and Dana (or Pass Creek) Ridge anticlines in the south half of the Walcott quadrangle. The Mesaverde Formation contains a lower unit of indurated white to gray massive to thin-bedded and cross-bedded sandstones alternating with thinner beds of gray shales. This lower unit is of marine origin. A middle member of the formation consists of gray to brown thin-bedded to massive sandstones alternating with beds of gray carbonaceous shales and thin irregular beds of coal. The depositional environment for this unit was fresh to brackish water. The top member of the formation consists of white to gray sandstones alternating with beds of gray shales

and thin beds of carbonaceous shale and coal. The unit is primarily non-marine but grades into shallow marine at the very top.

The Upper Cretaceous Lewis Shale conformably overlies the Mesaverde Formation; the contact between the two units is gradational. Lewis Shale is exposed in two broad bands, one across the southwestern corner and the other across the central part of the Walcott quadrangle. The thickness for the unit in this area is approximately 3,300 feet (1,006 m). The formation consists for the most part of dark-gray marine shales with numerous intercalated beds of sandy shale and gray ripple-marked and cross-bedded to massive sandstone. Dobbin, Bowen, and Hoots (1929) state that the Fox Hills Sandstone is represented in the upper part of the Lewis Shale but they did not differentiate it in their mapping of the Walcott quadrangle.

The Upper Cretaceous Medicine Bow Formation conformably overlies the Lewis Shale in the Walcott quadrangle. It is exposed in a broad band across the north half of the quadrangle and in the core of the Walcott syncline in the south part of the quadrangle. Dobbin, Bowen, and Hoots (1929) give a thickness of 6,200 feet (1,890 m) for the Medicine Bow Formation in this area. They describe the formation as consisting of yellow, gray and carbonaceous shales, beds of coal, and gray and brown sandstones. The lower part of the formation is made up of brown massive to cross-bedded sandstones that contain numerous beds of coal. These sandstones are overlain by an intermediate group of gray shales and brown fine-grained thin-bedded sandstones with some beds of massive white sandstone. The sandstones at the top of the formation are coarse grained, massive, and friable and are interbedded with thick beds of dark-gray shale. The depositional environment of the formation is dominantly fresh-water with occasional brackish-water elements, except in the lower part where there are sandstone beds with a marine fauna of Fox Hills type.

Conformably overlying the Medicine Bow Formation is the Ferris Formation. This latter formation is exposed across the northeastern portion of the quadrangle. The Ferris Formation is about 6,500 feet (1,981 m) thick at its type locality near the old Ferris Ranch on the North Platte River, 8 miles (13 km) northwest of the center of the Walcott quadrangle. The formation consists of a thick sequence of continental rocks that can be divided into two parts: a lower unit of Late Cretaceous age which is about 1,100

feet (335 m) thick and an upper unit of Paleocene age which is about 5,400 feet (1,646 m) thick. The basal 300 feet (91 m) of the lower unit consists of dark-gray shales and buff to yellow coarse-grained friable massive sandstones with irregular thin beds of conglomerate. The overlying 800 feet (244 m) portion of the lower unit is made up largely of conglomerate which occurs as pockets, lenses, and thin beds irregularly distributed throughout the sandstone. The upper unit of the Ferris Formation consists of gray brown and yellow sandstones interbedded with numerous thick beds of coal.

The North Park Formation is irregularly distributed across the southern portion of the quadrangle. The formation lies unconformably on all the older rock units in this area. Dobbin, Bowen, and Hoots (1929) state that the formation in this area does not exceed a few hundred feet in thickness and they tentatively assign it a Miocene (?) age. McGrew (1951), on the basis of mammalian fauna, assigns an early Pliocene age to the formation. The North Park Formation consists chiefly of white fine-grained unconsolidated sand, sandy clay, and marl with occasional intercalated thin beds of gray limestone.

Quaternary alluvium occurs as scattered deposits along most of the major drainage channels.

Structure

The Walcott quadrangle is on the southwest edge of the intermontane Hanna Basin. This structural basin is comparatively small in areal extent, 40 miles (64 km) east-west and 25 miles (40 km) north-south, but very deep. In its central portion, the southeast part of T.24N., R.82W., about 19 miles (31 km) northeast of the center of this quadrangle, there are 30,000 to 35,000 feet (9,140 to 10,670 m) of sediments overlying crystalline basement. The confines of the present basin were defined during the Laramide Orogeny when the bordering highlands of the basin were raised and deformed while sedimentary fill accumulated rapidly in the basin. Today, the borderlands are characterized by complex folding and faulting, while within the basin only mild deformation is expressed by a few broad folds and normal faults. The Late Cretaceous sea retreated temporarily from southern Wyoming in Mesaverde time and made its final withdrawal in Fox Hills time, when the depositional environment changed from marine to continental.

The south half of the quadrangle is characterized by a series of large folds and faults trending southeasterly and generally parallel to the adjacent margin of the Hanna Basin. The northeast flank of the Fort Steele anticline extends through the extreme southwest corner of the quadrangle; the axial trace of the structure is immediately south of the quadrangle. This large generally symmetrical fold plunges to the southeast; it represents the southeasterly limit of the Rawlins Uplift, the structural feature that defines the west boundary of the Hanna Basin. Parallel to the Fort Steele anticline is the Walcott syncline that extends across the south-central part of the quadrangle. This structure plunges southeasterly and is covered by the unconformable overlap of the North Park Formation in the southeast part of the quadrangle. The syncline is asymmetric with moderate dips on its southern flank and steep to overturned dips on its northern flank.

Walcott syncline and Saint Marys anticline are en echelon structures in the west-central part of the quadrangle. Saint Marys anticline also plunges southeasterly and finally cannot be identified in the Lewis Shale Formation in sec. 13, T.21N., R.84W. Dips of the beds on both flanks are moderate. To the southwest, the south flank of Saint Marys anticline has been thrust over the north flank of the Walcott syncline by the Saint Marys fault with the result that Mesaverde beds rest directly on Medicine Bow beds. The surface trace of Saint Marys fault indicates the fault dips gently to the north at the west-central boundary of the quadrangle but steepens to the southeast as it becomes a strike fault in the Lewis Shale Formation in sec. 13, T.21N., R.84W. This fault may have a horizontal movement of over half a mile (0.8 km) according to Dobbin, Bowen, and Hoots (1929, p. 31). The north flank of Saint Marys anticline has been cut off by an unnamed thrust fault that is parallel to and north of Saint Marys fault. This unnamed fault thrusts Mesaverde and Lewis Shale beds south over Mesaverde beds, dips steeply to the north, and, to the southeast, becomes a strike fault in the Lewis Shale Formation in sec. 18, T.21N., R.83W.

North of the unnamed fault at this last location is the Dana (or Pass Creek) Ridge anticline, a major structure more than 8 miles (13 km) in length that is also en echelon to the Walcott syncline and Saint Marys anticline. The structure is asymmetrical, with moderate dips on the northern flank and steep to overturned dips on the southern flank.

As Dobbin, Bowen, and Hoots (1929, p. 43) point out, the structure in this area is more varied than in any other part of the Hanna and Carbon Basins. The Saint Marys anticline and the Dana (or Pass Creek) Ridge anticline bring beds of the upper part of the Mesaverde Formation to the surface and effectively separate the Lewis Shale and Medicine Bow Formations of the subsidiary Walcott Basin from the major and deeper Hanna Basin to the north.

The northern part of the Walcott quadrangle exhibits the simple structure of the main Hanna Basin. The strike of the beds is uniformly east-southeast and the dip of the beds decreases from 40^{o} to 25^{o} to the northeast, toward the center of the basin.

COAL GEOLOGY

Previous Work

The coal deposits of the Hanna and Carbon Basins have been studied by Veatch (1907), Dobbin, Bowen, and Hoots (1929), Berryhill and others (1950), and Glass (1972 and 1975).

Twenty-six coal analyses have been published since 1913 for coal beds of the Mesaverde Group and the Medicine Bow, Ferris, and Hanna Formations within the Hanna and Carbon Basins (Appendices 1 and 2). Samples collected and analyzed prior to 1913 have not been considered in this report (American Society for Testing and Materials, 1977, p. 218). An average analysis of coal beds in each of these four stratigraphic units has also been calculated for the 230 analyses from the Union Pacific coal inventory program (Appendices 1 and 2). An apparent rank has been calculated from the average analysis for coal in each of the four stratigraphic units. A standard rank determination (ASTM, 1977, p. 216, sec. 6.2.2) cannot be made because: (a) some of the published analyses are from weathered coal samples; and (b) the procedure and quality of sampling for the Union Pacific coal evaluation program are not known.

Glass (1975) and U.S. Department of Interior (1975) published not only proximate coal analyses for 17 samples collected in the Hanna Basin, but also assays for 10 major and minor oxides, 12 major and minor elements, and up to 32 trace elements. Glass (1975, p. 1) stresses that his assay data are insufficient to characterize the chemical and physical properties of any

individual coal bed, but that this will be possible at a later date as the study continues. Assay results of the 17 Hanna Basin samples show that these coals contain no significantly greater amounts of trace elements of environmental concern than are found in the 42 samples collected in six other Wyoming coal fields.

General Features

In the Walcott quadrangle, 17 coal beds and 15 local coal lenses either have been mapped by Dobbin, Bowen, and Hoots (1929) or have been identified in the subsurface (Plates 1 and 3). In the Mesaverde Formation only one coal bed was mapped; two coal beds and a local coal lens occur in the subsurface in drill hole 2. Four local coal lenses also occur in the subsurface in drill hole 1; if the interpretation is correct that the base of the Lewis Shale was intersected at about 900 feet (274 m) in this drill hole, then these four local coal lenses all occur within the underlying 2,300 feet (701 m) or more of Mesaverde sediments. Eleven coal beds were mapped in the Medicine Bow Formation; seven of these coal beds and seven local coal lenses were intersected in the subsurface by drill holes. Four coal beds were mapped in the Ferris Formation and all of these coal beds, together with three local coal lenses, occur in the subsurface.

A published analysis for a coal sample from an unnamed Medicine Bow coal bed is shown in Appendix 3. The sample was taken at the abandoned J.P. Ryan underground mine (see the preceding section, Land Status). Analyses of three samples from the Medicine Bow coal bed 4 are also shown in Appendix 3. These samples were taken during the Union Pacific coal inventory program.

Mesaverde Coal Beds

A short segment of coal bed 2 crops out in sec. 28, T.21N., R.84W. Dip of the bed is toward the northeast at approximately 24°. This bed and two local lenses were penetrated in drill hole 2 (Plate 3). Maximum measured thickness for these coal beds is 3 feet (0.9 m). Three of the lenses penetrated in drill hole 1 (Plate 3) are 7 feet (2 m) thick and the fourth is 12 feet (4 m) thick. There are no analyses available for samples from the Mesaverde coal beds identified in this quadrangle.

Medicine Bow Coal Beds

In the southwest part of the quadrangle, the Buckley and Ryan coal bed and the coal beds designated WL1, WL2, WL3, WL4, WL6, and WL8 crop out on the flanks of the Walcott syncline. Dips on the southwest limb of the fold are from 20° to 24° to the northeast; the strata are overturned on the northeast limb and dip to the northeast at 45° to 70°. With the exception of one 5.1 foot (1.6 m) measurement taken of the Buckley and Ryan coal bed, all measured thicknesses of these beds, including subsurface intersections, are less than 5 feet (1.5 m).

Coal beds 3, 4, and WL5, in the lower part of the Medicine Bow Formation, crop out in the north half of the quadrangle. Dips of these beds are toward the northeast and vary from 33° to 51°. The many measured points along the outcrops indicate the coal beds are consistently less than 5 feet (1.5 m) thick. Coal bed 4 attains a subsurface thickness of 5 feet (1.5 m), as measured in drill holes 8 and 9, but all other measurements of the three coal beds are below Reserve Base thickness. Analyses of samples from Medicine Bow coal beds are shown in Appendix 3.

Ferris Coal Beds

Coal beds 21, 28A, 29, and 31 crop out in the extreme northeast corner of the quadrangle. In addition to these four coal beds, three local lenses were penetrated in drill hole 21. Dip of the beds is toward the northeast at approximately 25°. With the exception of coal bed 31, coal bed thicknesses are less than 5 feet (1.5 m). Coal bed 31 has an aggregate thickness of 25.7 feet (7.8 m) at a measured point in sec. 16, T.22N., R.83W. where it has been strip mined in the Seminoe Mine.

COAL RESOURCES

Previous Work

Coal reserves of the Hanna and Carbon Basins have been estimated or calculated by Dobbin, Bowen, and Hoots (1929), Berryhill and others (1950), and Glass (1972).

Method of Calculating Resources

Data from Dobbin, Bowen, and Hoots (1929), oil and gas well logs, and coal drill holes (written communication, Rocky Mountain Energy Company, 1977) were used to construct the Coal Data Map (Plate 1) and the Coal Data Sheet (Plate 3) for the Walcott quadrangle. U.S. Geological Survey reviewed these two plates and concluded that no individual coal bed or coal zone on unleased Federal land within the KRCRA was thick enough and extensive enough to be selected for coal reserve evaluation. However, the calculation of coal Reserve Base was requested for the isolated or noncorrelatable data points in the quadrangle.

The information on Plates 1 and 3 served as the basis for estimating coal resources in areas of sparse, isolated coal data, insufficient to construct isopach and structure contour maps. The estimates of coal resources within the KRCRA boundary were made in accordance with the classification system given in U.S. Geological Survey Bulletin 1450-B and by following methods suggested by the U.S. Geological Survey:

- All outcrop measurements and subsurface measurements are considered as one planar unit.
- All coal deeper than 3,000 feet (914 m) is excluded.
- Coal bed thicknesses from surface mapping are true thicknesses; thicknesses from subsurface data are apparent thicknesses. No corrections were made for coal bed thicknesses to compensate for the dip of the containing rocks.
- Coal resources are calculated for a single coal bed at least 5 feet (1.5 m) thick or for an aggregate thickness of multiple coal beds, each at least 5 feet (1.5 m) thick.
- Areal subsurface distribution of coal from outcrop data points is determined by constructing an arc with a radius equal to one-half the length of the outcrop within a five-foot or greater thickness limit, and centered on a point midway on the outcrop.
- Areal subsurface distribution for a subsurface data point with a five-foot or greater thickness of coal is defined by a circle with a radius of 0.5 mile (805 m).
- Coal resources at depths of less than 200 feet (61 m) are tabulated separately from coal resources at depths between 200 and 3,000 feet (61 and 914 m).

When estimating coal resources in areas of sparse, isolated data some data require a unique solution. For example:

- Where a coal bed outcrop has data points with a coal thickness less than 5 feet (1.5 m), a 5-foot (1.5 m) cut-off point is interpolated, and the resulting segments with values greater than 5 feet (1.5 m) are used to generate arcs (radii equal to half the partial outcrop length).

- Where areas within outcrop segment arcs and areas within 0.5 mile (805 m) of a drill hole coincide, the areas are combined, and drill hole coal thickness values are averaged with outcrop coal thickness values.

- When evaluating multiple coal beds of an isolated or noncorrelatable data point, the interburden between subsurface coal beds may be too great to allow the aggregate thickness of coal to be considered as one planar unit. In such instances, a conservative judgment is made and the resources for each bed are calculated separately and then totaled.

Results

The coal resource acreage from isolated or noncorrelatable data points was determined by planimetering the areas which occurred in unleased Federal land within the KRCRA boundary. Coal Reserve Base values were obtained by multiplying the coal resource acreage for each section of Federal land by the average thickness of the coal bed, or the average aggregate thickness of multiple coal beds, times a conversion factor of 1,770 short tons (1,606 t) of coal per acre-foot for subbituminous coal. Reserve Base values are shown on Plate 2 and are considered to be in the inferred reliability category of identified coal resources.

The total coal Reserve Base of unleased Federal lands within the KRCRA in the Walcott quadrangle is 0.1 million short tons (0.09 million t) of inferred resources with 0-200 feet (0-61 m) overburden. Coal resources are not considered to occur below the 200-foot level. Coal reserves were not calculated and therefore the coal development potential could not be assessed. The coal Reserve Base data are for rough inventory estimates only.

REFERENCES CITED

American Society for Testing and Materials, 1977, Standard specification for classification of coals by rank, ANSI/ASTM D388-77, in 1977 Annual Book of ASTM Standards, pt. 26, Am Soc. for Testing and Materials, Philadelphia, Pa., 840 p., p. 214-218.

Berryhill, H.L., Jr., Brown, D.M., Brown, A., and Taylor, D.A., 1950, Coal resources of Wyoming: U.S. Geol. Survey Circ. 81, 78 p., 4 figs.

Blanchard, L.F., and Comstock, M.C., 1976, Geologic map of the Pats Bottom quadrangle, Carbon County, Wyoming: U.S. Geol. Survey Geol. Quad. Map (in progress).

Dobbin, C.E., Bowen, C.F., and Hoots, H.W., 1929, Geology and coal and oil resources of the Hanna and Carbon Basins, Carbon County, Wyoming: U.S. Geol. Survey Bull. 804, 88 p., 27 pls., 3 figs.

Gill, J.R., Merewether, E.A., and Cobban, W.A., 1970, Stratigraphy and nomenclature of some Upper Cretaceous and Lower Tertiary rocks in south-central Wyoming: U.S. Geol. Survey Prof. Paper 667, 53 p., 15 figs.

Glass, G.B., 1972, Mining in the Hanna coalfield: Wyoming Geol. Survey Misc. Rept., 45 p., 13 figs.

_____, 1975, Analyses and measured sections of 54 Wyoming coal samples (collected in 1974): Wyoming Geol. Survey Rept. Inv. no. 11, 219 p., 130 figs.

McGrew, P.O., 1951, Tertiary stratigraphy and paleontology of south-central Wyoming, in Wyoming Geol. Assoc. Guidebook, 6th Ann. Field Conf., south central Wyoming, p. 54-57, 1 fig.

Rocky Mountain Energy Company, 1977, Survey sheets, coal drill hole data, and coal analyses from the Union Pacific coal evaluation program: unpublished publicly available data from company files.

U.S. Bureau of Mines, 1931, Analyses of Wyoming coals: U.S. Bur. Mines. Tech. Paper 484, 159 p.

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. Geol. Survey Bull. 1450-B, 7 p., 1 fig.

U.S. Department of Interior, 1975, Hanna Basin study site, Hanna coal field, Wyoming: Bur. Land Management EMRIA rept. no. 2, 193 p., 10 pls., 10 figs.

Veatch, A.C., 1907, Coal fields of east-central Carbon County, Wyoming: U.S. Geol. Survey Bull. 316-D, p. 244-260, 1 pl.

Weitz, J.L., and Love, J.D., 1952, Geologic map of Carbon County, Wyoming: U.S. Geol. Survey, prepared in cooperation with Wyoming Geol. Survey and Wyoming Univ. Dept. Geology, scale 1:159,400.

Appendix 1. — Average analyses of coal samples from the Hanna and Carbon Basins

Source of Data	Number of samples (1)	Total footage Ft	in	Average analyses — as-received basis, Percent: Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb	Calorific Value, Btu/lb. Moist, mineral-matter-free basis (2)	Apparent rank of coal (3)
Published analyses	26	318	6	12.5	7.1	36.2	44.2	0.6	10,553	11,438	sub A or hvCb
Union Pacific coal inventory program	230	1,605	10	12.48	8.74	35.12	43.68	0.82	10,398	11,494	sub A or hvCb

Notes:

(1) Published data from USBM (1931, p. 40-45, sample nos. 2623, 2624, 22800, 22972, 93486, 93488, 93541, A14123, A14124); Glass (1975, p. 16-19, sample nos. 74-23 to 74-34, inclusive); Dept. of Interior (1975, p. 38, sample nos. D169597-99, D169607-08). Union Pacific coal inventory program data from company files, Rocky Mountain Energy Company (1977).

(2) Moist, mineral-matter-free Btu/lb calculated from average analyses, as-received basis, using Parr formula (ASTM, 1977, p. 216, sec. 8.2).

(3) Sub A — subbituminous A; hvCb — high volatile C bituminous (ASTM, 1977, p. 215, sec 4.2, and p. 217).

[To convert feet and inches to meters, multiply feet by 0.3048 and inches by 0.0254. To convert Btu/lb to kilojoule/kilogram, multiply by 2.326].

Appendix 2. — Average analyses of coal grouped by coal-bearing formations in the Hanna and Carbon Basins

Source of data	Formation or Group	Number of samples (1)	Total footage Ft	Total footage in	Average analyses — as-received basis: Percent: Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb	Calorific Value, Btu/lb: Moist, mineral-matter-free basis (2)	Apparent rank of coal (3)
Published analyses	Mesaverde	1	4	0	14.1	7.8	36.5	41.6	1.1	10,290	11,251	sub A or hvCb
	Medicine Bow	2	10	1	12.8	3.8	33.3	50.2	0.8	11,050	11,534	hvCb
	Ferris	10	93	1	.13.0	8.3	34.3	44.3	0.4	9,970	10,956	sub A or hvCb
	Hanna	13	211	4	12.0	6.6	38.1	43.3	0.7	11,946	11,797	hvCb
Union Pacific coal inventory program	Mesaverde	13	70	5	9.45	8.41	35.42	46.72	0.77	11,112	12,237	hvCb
	Medicine Bow	16	93	4	13.09	4.03	35.46	47.42	0.80	10,927	11,446	sub A or hvCb
	Ferris	114	863	1	12.69	7.96	34.39	44.97	0.44	10,331	11,309	sub A or hvCb
	Hanna	87	579	0	12.51	10.67	35.96	40.85	1.33	10,280	11,640	hvCb

Notes:

(1) Published data from USBM (1931, p. 40-45, sample nos. 2623, 2624, 22800, 22972, 93486, 93488, 93541, A14123, A14124); Glass (1975, p. 16-19, sample nos. 74-23 to 74-34, inclusive); Dept. of Interior (1975, p. 38, sample nos. D169597-99, D169607-08). Union Pacific coal inventory program data from company files, Rocky Mountain Energy Company (1977).

(2) Moist, mineral-matter-free Btu/lb calculated from average analyses, as-received basis, using Parr formula (ASTM, 1977, p. 216, sec. 8.2).

(3) Sub A — subbituminous A; hvCb — high volatile C bituminous (ASTM, 1977, p. 215, sec. 4.2, and p. 217).

[To convert feet and inches to meters, multiply feet by 0.3048 and inches by 0.0254. To convert Btu/lb to kilojoule/kilogram, multiply by 2.326].

Appendix 3. - Coal analyses, Walcott quadrangle

Drill hole	Location			Coal bed	Sample interval				Sample width		Analyses - as-received basis					
					From		To				Percent					
	Sec.	Twp.	Rge.		Ft	in	Ft	in	Ft	in	Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb
8	27	22N	84W	4	325	8	328	2	2	6	10.86	2.91	35.91	50.32	0.19	11,495
9	27	22N	84W	4	114	0	115	6	1	6	10.43	3.62	36.00	49.95	0.80	11,559
11	35	22N	84W	4	106	6	111	1	4	7	10.38	3.87	35.55	50.20	0.77	11,374
Sample 93541	14	21N	84W	Unnamed	-	-	-	-	3	9	11.4	3.1	33.8	51.7	0.6	11,430

Drill hole data from Rocky Mountain Energy Company (1977)
Data for sample 93541 from U.S. Bureau of Mines, 1931, p. 44-45 and 94-95
[To convert feet and inches to meters, multiply feet by 0.3048 and inches by 0.0254.
To convert Btu/lb to kilojoules per kilogram, multiply by 2.326].