Text to accompany:

Open-File Report 78-052

1978

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

(Report includes 15 plates)

Prepared for:

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Prepared by:

TEXAS INSTRUMENTS INCORPORATED
DALLAS, TEXAS

This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

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 Dana quadrangle, Carbon County, Wyoming (15 plates; U.S. Geol. Survey Open-File Report 78-052), 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 an area in the southwest part of the KRCRA of the Hanna coal field. The lack of correlatable coal of Reserve Base thickness on unleased Federal land 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 and 230 coal analyses have been incorporated into these reports.

Location

The Dana 7½-minute quadrangle is in the northeastern part of Carbon County, Wyoming. The center of the quadrangle is approximately 8 miles (13 km) northeast of Walcott and 8 miles (13 km) southwest of Hanna, Wyoming (Figure 1).

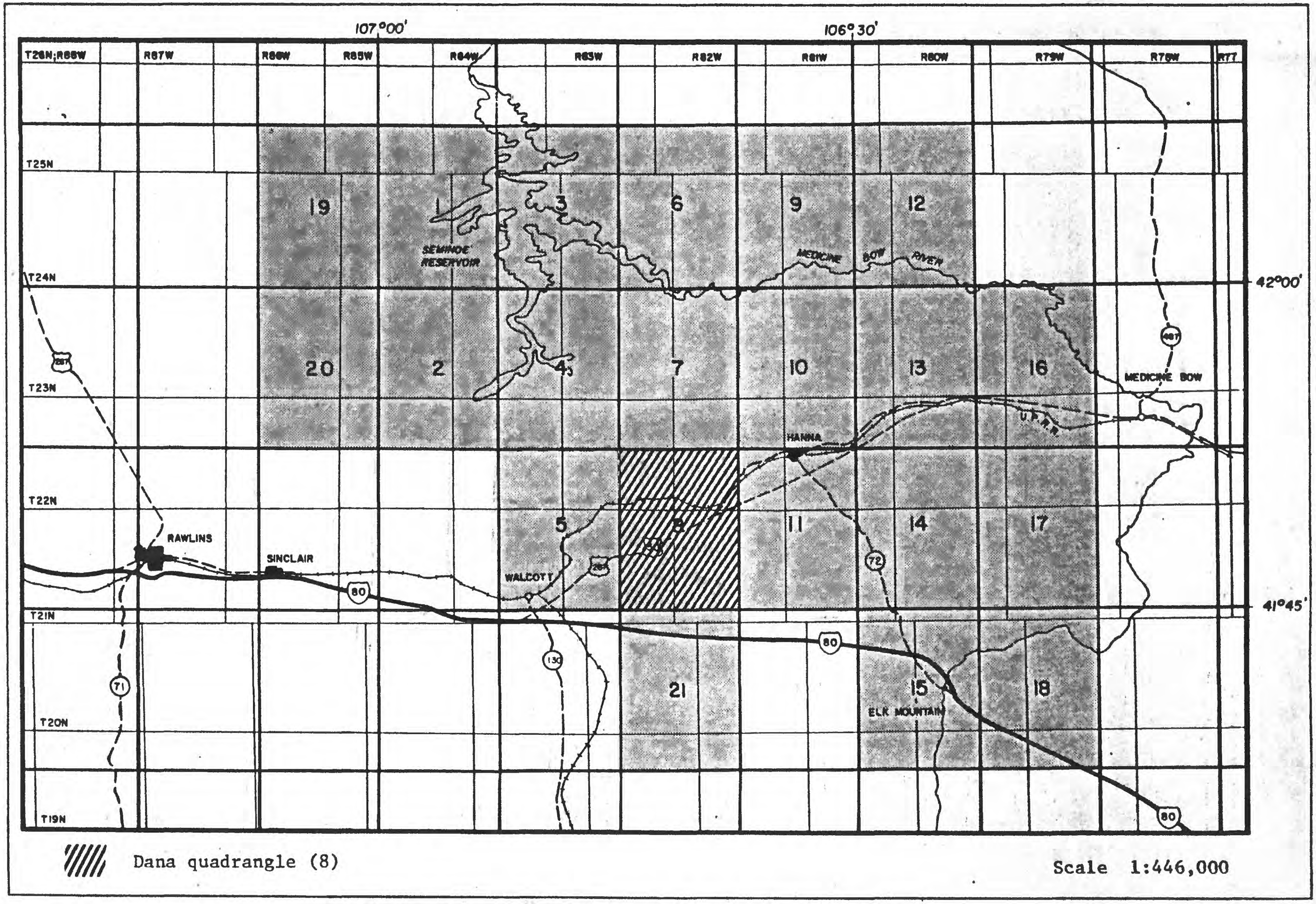

Figure 1. — Map of Hanna and Carbon Basins Study Area

Accessibility

U.S. Highway 30/287 crosses the central part of the quadrangle from east to west, connecting the towns of Hanna, 5 miles (8 km) east of the quadrangle, and Walcott, 5 miles (8 km) to the west.

Six local light-duty roads provide general access within the quadrangle as follows:

- A road leaves U.S. Highway 30/287 at the center of the quadrangle and runs south to the northeastern slopes of Dana (or Pass Creek) Ridge. The road continues southeasterly beyond this quadrangle and gives access to the mountainous country west of the town of Elk Mountain.

- A road leaves U.S. Highway 30/287 in the east-central part of the quadrangle, runs north and crosses the Union Pacific railroad tracks, then continues in a north-northwest direction to the open pit coal mines of Arch Mineral Corporation, located immediately west of the northwest corner of this quadrangle.

- A road leaves the western outskirts of the town of Hanna, runs parallel to the Union Pacific railroad tracks on the north side, to enter this quadrangle at the northeast border. The road continues southwesterly for a short distance and then turns westward to join the local road described in the preceding paragraph.

- The road from the town of Hanna that services the coal mines of Energy Development Company enters this quadrangle near the northeast corner and continues westerly to the Section 18 strip mine.

- A branch road leaves the above-mentioned road at the railroad coal tipple of Energy Development Company and runs northerly, providing access to the Vanguard and Rimrock coal mines to the north of this quadrangle.

- A road leaves U.S. Highway 30/287 at the west section line of sec. 4, T.21N., R.82W. and runs northwest to near the Union Pacific railroad tracks, east of the abandoned settlement of Dana. This road location follows closely the location of the service road which, in the latter years of the last century, connected the town of Dana with the now-abandoned Dana 1 mine (see Plate 1); it also follows closely the abandoned railroad route between Dana and Carbon, a historic relic from about 1902 when the Union Pacific Railroad rerouted its tracks between Dana and Medicine Bow further north through the town of Hanna.

Numerous local unimproved dirt roads provide ready access to most parts of the quadrangle from U.S. Highway 30/287 and the six light-duty roads.

However, the extreme southwestern corner of the quadrangle is relatively isolated from the other areas by Dana (or Pass Creek) Ridge. Within the quadrangle only a single jeep trail crosses this prominent topographic barrier. In this report, 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 the report.

The main east-west track of the Union Pacific railroad crosses the northern half of the quadrangle and connects Medicine Bow and Hanna to the east with Walcott, Fort Steele, Sinclair, and Rawlins to the west. A single-track branch railroad, the Dana spur of the Arch Mineral Corporation Railroad, leaves the main track east of the abandoned settlement of Dana and runs west-northwest to service the coal mines of Arch Mineral Corporation. In the northeast corner of the quadrangle is the western terminal loop of the Energy Development Company's single-track branch railroad. This rail spur is the transportation link between the company's coal tipple in sec. 22, T. 22 N., R. 82 W., and the main Union Pacific track at the southern outskirts of Hanna, 3 miles (5 km) to the east.

Physiography

The quadrangle is located at the southern limit of the Hanna structural basin. The topography is typical of the high plains grasslands of southern Wyoming, except in the southwestern part of the quadrangle where the north-west trending Dana (or Pass Creek) Ridge is a prominent topographic feature, with a maximum relief of about 700 feet (213 m). In the northwestern part of the quadrangle, Edson (or St. Marys) Ridge is a named feature, but with a local relief of less than 250 feet (76 m), it is not so prominent a topographic feature as Dana (or Pass Creek) Ridge. Elevations within the quadrangle range from 7,906 feet (2,410 m) at the crest of Dana (or Pass Creek) Ridge to 6,600 feet (2,012 m) in the valley of Big Ditch where that creek flows northwest from the quadrangle at the north-central border.

The land area of the quadrangle lies in the drainage basin of the North Platte River, which is 13 miles (21 km) and more west of the center of this quadrangle. The majority of streams in the quadrangle are tributary to Saint Marys Creek and Big Ditch. St. Marys Creek flows westerly across the center of the quadrangle to join the North Platte River near Fort Fred Steele, 14 miles (23 km) west-southwest of the center of this quadrangle. Big Ditch drains westerly, near the northeast boundary of the quadrangle; it leaves the quadrangle at the north-central boundary, drains northwesterly, and enters Seminoe Reservoir 11 miles (18 km) northwest of the center of this quadrangle. The tributary streams draining the southwestern slopes of Dana (or Pass Creek) Ridge drain to Pass Creek beyond the southwestern limits of the quadrangle. Pass Creek drains southwest and enters the North Platte River about 8 miles (13 km) up river from Fort Steele.

Climate

Climate data for the Dana quadrangle were obtained by evaluating and averaging the data recorded at two nearby weather stations. The Elk Mountain station is located 18 miles (29 km) 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 27 miles (43 km) northwest 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 $42^{o}F$ ($6^{o}C$) and extremes ranging from 98^{o} to $-42^{o}F$ (37^{o} to $-41^{o}C$). July is the warmest month with a mean monthly temperature of $66^{o}F$ ($19^{o}C$), and January is the coldest month with $22^{o}F$ ($-6^{o}C$). For seven months of the year, April to October, the mean monthly temperature exceeds $32^{o}F$ ($0^{o}C$). Average annual precipitation is 14 inches (36 cm); 53 percent of this total falls in the five months of March through 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 through 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 southern 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 privately owned. Approximately 35 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. Of this federally owned land, 80 percent is currently leased for coal. Plate 2 of the CRO maps illustrates the ownership status of the land in the quadrangle and the boundary of the KRCRA.

Four coal mines are located within the quadrangle (Plate 1). These are:

- The abandoned Dana 1 underground mine in sec. 5, T21N., R.82W. This mine was opened in 1888 by the Union Pacific Railway Company (shortly thereafter, the Union Pacific Coal Company) but it closed in 1892, producing a total of less than 63,000 short tons (57,000 t). Glass (1972) notes that the mine worked the lower Dana bed that was 11.2 feet (3.4 m) thick in this vicinity; Dobbin, Bowen, and Hoots (1929) state the lower Dana bed occurred about 50 feet (15 m) below the Dana bed at the mine. The mine closed because the coal that was mined proved unsatisfactory for use in railroad locomotives (Veatch, 1907, p. 259).

- The abandoned Dana 2 underground mine in sec. 4, T.21N., R.82W. This small local mine, worked only in 1940 by Messrs. Treat and James, produced just over 300 short tons (272 t) from coal bed 25, according to Glass (1972). Dobbin, Bowen, and Hoots (1929) mapped coal bed 25-A at this location, and they note that coal bed 25-A is about 500 feet (152 m) above the Dana coal bed.

- The Vanguard No. 2 underground mine, owned by the Energy Development Company, was operating at the close of 1977. Located in sec. 18, T.22N., R.82W., this deep-level mine has been producing coal from bed 50 for a few years only.

- The Section 18 strip mine of the Energy Development Company is also located in sec. 18, T.22N., R.82W. Coal bed 50 has been mined in this open pit from 1970 and the mine was producing at the close of 1977. Glass (1972) notes that coal bed 50 averages 15 feet (4.6 m) thick at this locality.

GENERAL GEOLOGY

Previous Work

Dobbin, Bowen, and Hoots (1929) mapped the Dana 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 to the northwest of this quadrangle.

Stratigraphy

Rocks exposed in the Dana quadrangle range in age from Late Cretaceous to Quaternary. Coal beds are found in the Medicine Bow Formation of Late Cretaceous age and in the Ferris Formation of Late Cretaceous/Paleocene age.

The oldest stratigraphic unit exposed is the Mesaverde Formation of Late Cretaceous age. It crops out along the crest of Dana (or Pass Creek) Ridge in the southwest part of the quadrangle. The crestline of the ridge is also the axial trace of the Dana (or Pass Creek) anticline. Dobbin, Bowen, and Hoots (1929) originally mapped these rocks as the Mesaverde Formation but Gill, Merewether, and Cobban (1970) elevated the formation to group status, and they defined and measured four formations in the Mesaverde Group. These formations have not as yet been mapped in the Dana quadrangle so the Mesaverde rocks are regarded as a single formation in this report. Dobbin, Bowen, and Hoots (1929) give a thickness of 2,700 feet (823 m) in this area. They describe the formation as consisting of three units, as follows:

- A lower unit of marine origin; white to gray indurated massive to thin-bedded and cross-bedded sandstones, alternating with thinner beds of gray shale.

- A middle unit from a fresh to brackish water environment; gray to brown thin-bedded to massive sandstones, alternating with beds of gray carbonaceous shale and thin irregular beds of coal. No Mesaverde coal beds crop out in the Dana quadrangle.

- An upper unit, primarily of nonmarine origin but grading into shallow-water marine at the top; white to gray sandstones alternating with beds of gray shale and thin beds of carbonaceous shale and coal.

The Lewis Shale of Late Cretaceous age overlies the Mesaverde with a conformable and gradational contact. In the Dana quadrangle the formation is exposed in the southwest area, on the south flank of the Dana (or Pass Creek) anticline. On the north flank of this anticline the Lewis Shale has been limited to small exposures on the west margin of the quadrangle, by the overlap of the younger North Park Formation.

Dobbin, Bowen, and Hoots (1929) report a thickness of 3,300 feet (1,006 m) for the Lewis Shale in this area. The formation consists for the most part of dark gray marine shales with numerous intercalated beds of sandy shales and gray ripple-marked and cross-bedded to massive sandstones. 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 Dana quadrangle.

The Medicine Bow Formation of Late Cretaceous age conformably overlies the Lewis Shale. The formation is exposed in the extreme southwestern corner of the Dana quadrangle, on the southern flank of the Dana (or Pass Creek) anticline; the outcrops are limited by the overlap of the younger North Park Formation. Medicine Bow rocks are also exposed in the west-central part of the quadrangle, where again there is overlap by the North Park Formation. The thickness given by Dobbin, Bowen, and Hoots (1929) for the Medicine Bow Formation in this area is 6,200 feet (1,890 m). They describe the formation as consisting of yellow, gray and carbonaceous shales, gray and brown sandstones, and beds of coal. The lower part of the formation comprises 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. However, in the lower part, there are sandstone beds with a marine fauna of Fox Hills type (Dobbin and others, 1929, p. 24).

Conformably overlying the Medicine Bow Formation is the Ferris Formation. The Ferris is exposed across the northern third of the Dana quadrangle. In the east-central part of the quadrangle it is overlapped by the North Park Formation. 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, approximately 13 miles (21 km) northwest of the center of this 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; about 1,100 feet (335 m) thick; consists of dark-gray shales, buff to yellow coarse-grained friable massive sandstones, irregular thin beds of conglomerate; in the upper part, conglomerates are irregularly distributed as pockets, lenses, and thin beds.

- An upper unit of Paleocene age; about 5,400 feet (1,646 m) thick; consists of gray, brown and yellow sandstones, numerous thick beds of coal; plant microfossils collected from about the middle of the unit indicate an early rather than late Paleocene age.

The North Park Formation unconformably overlies all of the older rock units in the Dana quadrangle. It is exposed in the extreme southwestern corner of the quadrangle, and as a broad band from the southeastern quarter to the west-central part of the quadrangle. 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 sands, sandy clays, and marls, with occasional intercalated thin beds of gray limestone.

Quaternary alluvium has been mapped along the Big Ditch drainage channel in the northeast corner of the quadrangle.

Structure

The Dana quadrangle is on the south-central 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 16 miles (26 km) north 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.

In the Dana quadrangle the southern edge of the Hanna Basin is defined by the Dana (or Pass Creek) anticline. The large southeast-trending structure crosses the southwestern part of the quadrangle. Dips of the beds on the north flank of the structure are moderately steep but they decrease to the northeast, toward the center of the basin; dips of the beds on the south flank are steep to overturned. In the extreme southwest corner of the quadrangle, beds of the North Park Formation have moderate dips, 30°, to the southwest as they rest unconformably on the steeply dipping (75° and overturned) older rocks.

Rocks of the North Park Formation overlap older rocks in the stratigraphic succession, from the Mesaverde Formation to the Ferris Formation. Dobbin, Bowen, and Hoots (1929) state that the large exposure of the North Park Formation in the central and southeast parts of this quadrangle, forms part of a broad syncline. Consequently, in the east-central part of the quadrangle the angular discordance between North Park rocks and rocks of the older formations is very marked. In sec. 3, T.21N., R.82W., North Park beds dip 45° to the south-southwest; Ferris beds dip 35° east-northeast.

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 Dana quadrangle, 38 coal beds and 36 local coal lenses have either been mapped by Dobbin, Bowen, and Hoots (1929) or identified in the subsurface (Plates 1 and 3). Of these, 2 coal beds and 3 local coal lenses occur in the Mesaverde Formation, 2 coal beds and 1 local coal lens in the Medicine Bow Formation, and 34 coal beds and 32 coal lenses in the Ferris Formation. Four of the Ferris coal beds were selected by U.S. Geological Survey for resource evaluation.

Analyses of fourteen coal samples collected in the Dana quadrangle are shown in Appendix 3. A published analysis of the Ferris coal bed 50 is shown; the other 13 analyses are from the Union Pacific coal inventory program. The analysis of a local coal lens in the Medicine Bow Formation, in drill hole 21, includes a calorific value of 11,647 Btu/pound (27,091 kJ/kg), which is slightly higher than the average calorific value of 10,941 Btu/pound (25,449 kJ/kg) for 18 Medicine Bow coal samples collected throughout the Hanna and Carbon Basins (Appendix 2). Analyses of 13 Ferris coal samples show an average calorific value of 9,987 Btu/pound (23,230 kJ/kg), which is only three percent less than the average calorific value for 124 Ferris coal samples collected in the project area (Appendix 2). In summary, the coal beds within the Dana quadrangle are similar in quality to coal beds of like age throughout the Hanna coal field.

Mesaverde Coal Beds

The Mesaverde coal beds 91 and 112, and three local coal lenses, do not crop out in the quadrangle but they were mapped in the subsurface in drill hole 22 (Plate 3). Four of the five intersections are less than Reserve Base thickness; a coal lens above coal bed 112 is 5 feet (1.5 m) thick. Coal bed 91 was intersected in this drill hole about 2,400 feet (732 m) below the surface and about 420 feet (128 m) above coal bed 112. Three local coal lenses and coal bed 112 occur in an 82-foot (25-m) stratigraphic interval. The coal beds are assigned to the Mesaverde Formation following projection of surface mapping data into the subsurface, and correlation of these data with the stratigraphic well log of drill hole 22.

Medicine Bow Coal Beds

Two Medicine Bow coal beds crop out on the flanks of Dana (or Pass Creek) Ridge anticline. Coal bed DL1 is located near the south boundary of the quadrangle, on the south flank of the anticline; it dips to the southwest at approximately 80°; it has a maximum measured thickness of 3.2 feet (1 m); and it is mapped by Dobbin, Bowen, and Hoots (1929) for a short distance to the southeast, into the adjoining quadrangle to the south. Coal bed 3 crops out at the west-central border of the quadrangle, on the north flank of the Dana (or Pass Creek) Ridge anticline; it dips to the northeast at approximately 40°; it has a maximum measured thickness of 2 feet (0.6 m), in drill hole 21; and, as it is traced to the southeast, the coal bed passes beneath the overlapping North Park Formation.

A local Medicine Bow coal lens was intersected by drill hole 21, 73 feet (22 m) above coal bed 3. This coal lens is 5 feet (1.5 m) thick in the drill core but the lens does not crop out at surface. The coal lens was sampled and analysed as part of the Union Pacific coal inventory program (Appendix 3).

Ferris Coal Beds

Ferris coal beds crop out in the northern half of the quadrangle; they dip to the north, northeast, and east toward the center of the Hanna Basin. Thirty-four coal beds were mapped by Dobbin, Bowen, and Hoots (1929). Twenty-three of these coal beds and 32 local coal lenses have been mapped in the subsurface (Plates 1 and 3). The dips of the Ferris coal beds range from 8° to 35°; thicknesses range from 0.3 to 22.6 feet (9 cm to 7 m), but the coal beds are lenticular and the majority of measured thicknesses are less than Reserve Base thickness.

U.S. Geological Survey selected the Ferris coal beds 26, 31, 50, and 65 for coal resource evaluation. The oldest coal bed selected, 26, dips to the northeast and east at angles ranging from 18° to 26°; measured thicknesses range from 6 to 11 feet (2 to 3.4 m); and analyses of three samples taken from drill hole intersections of this coal bed are shown in Appendix 3.

Coal bed 31 occurs about 430 feet (131 m) above coal bed 26; two thin coal beds and four minor local coal lenses were mapped in this intervening stratigraphic section. Coal bed 31 crops out in the northwest and north-central parts of the quadrangle with dips to the north of about 17°. Measured thicknesses range from 1.3 to 11.2 feet (0.4 to 3.4 m). Analyses of two samples of coal bed 31 are shown in Appendix 3.

Coal bed 50 occurs about 945 feet (288 m) above coal bed 31 in the stratigraphic section; crops out in the north-central and northeast parts of the quadrangle; dips to the north, northeast, and east at 17° to 30°; and varies in thickness in this quadrangle from 10 to 22.6 feet (3.0 to 6.9 m). This coal bed is currently being mined in the Section 18 surface mine and the Vanguard No. 2 underground mine of the Energy Development Company. Analyses of three samples from coal bed 50 are shown in Appendix 3.

Coal bed 65, the youngest coal bed selected for evaluation, is about 2,000 feet (610 m) higher in the stratigraphic section than coal bed 50. The outcrops of coal bed 65 are confined to near the northeast border of the quadrangle; the coal bed dips east at 8^{o} to 35^{o}; and thicknesses vary from 1.6 to 12.5 feet (0.5 to 3.8 m). Analyses of two samples from this coal bed are shown in Appendix 3.

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 Dana quadrangle. U.S. Geological Survey reviewed these two plates and on the basis of Reserve Base criteria, selected four Ferris coal beds for the evaluation of coal resources. In addition, calculation of coal resources was requested for isolated or noncorrelatable data points.

The coal data map and coal data sheet were used to construct structure contour, coal isopach, and overburden isopach maps for the four correlatable coal beds (Plates 4-15). For single coal beds, the maps were drawn using, as control points, thicknesses measured at outcrop and subsurface data from drill hole information. Where coal beds are split, cumulative coal thicknesses were used, excluding non-coal partings. Control points were generated from surface data and from drill holes by combining outcrop and subsurface thicknesses of individual beds to produce a single, cumulative thickness of the entire zone. Plates 4-15 were then evaluated with respect to the land status of the quadrangle (Plate 2) and it was found that not only did no selected coal bed crop out on unleased Federal land within the KRCRA boundary of the quadrangle, but that insufficiency of data precludes projecting the beds into unleased Federal land. Therefore, no Reserve Base values or coal reserves can be calculated for the four selected beds.

For evaluating the coal resources of isolated or noncorrelatable data points, 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 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 required 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. 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 of the Dana quadrangle is 0.3 million short tons (0.27 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, J.C., 1976, Geologic map of the Pats Bottom quadrangle, Carbon County, Wyoming: U.S. Geol. Survey Geol. Quad. Map (in progress).

Dobbin, D.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.

Wyoming Geological Survey, 1977, Plats of surface and underground mines: Wyoming Geol. Survey, unpublished data.

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

Source of Data	Number of samples (1)	Total footage		Average analyses — as-received basis						Calorific Value, Btu/lb	Apparent rank of coal (3)
				Percent						Moist, mineral-matter-free basis (2)	
		Ft	in	Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb		
Published analyses	26	318	6	12.5	7.1	36.2	44.2	0.6	10,553	11,438	sub A <u>or</u> 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 <u>or</u> 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, Dana 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
21	11	21N	83W	L	69	6	74	4	4	10	9.00	4.08	35.97	50.95	0.52	11,647
19	27	22N	82W	65	423	0	431	0	8	0	15.55	6.79	35.97	41.69	0.52	9,874
19	27	22N	82W	65	435	0	441	4	6	4	14.50	8.34	35.69	41.47	0.26	9,695
11	29	22N	82W	26	96	6	108	1	11	7	13.58	9.26	34.30	42.86	0.65	9,842
11	29	22N	82W	L	294	0	300	5	6	5	14.10	7.97	34.39	43.54	0.74	9,984
18	33	22N	82W	26	65	0	69	3	4	3	15.28	10.57	33.30	40.85	0.24	9,249
8	13	22N	83W	50	35	0	53	8	18	8	11.97	10.85	34.16	43.02	0.48	10,025
7	13	22N	83W	50	123	2	132	6	9	4	13.63	8.65	35.75	41.97	0.40	10,059
5	23	22N	83W	31	272	0	278	6	6	6	13.27	3.95	35.19	47.59	0.25	10,578
5	23	22N	83W	30	337	0	341	3	4	3	14.41	6.71	33.27	45.61	0.58	9,937
5	23	22N	83W	26	728	11	737	6	8	7	11.57	8.70	35.58	44.15	0.29	10,266
2	23	22N	83W	31	224	10	234	10	10	0	13.93	7.73	37.69	40.65	0.20	9,985
2	23	22N	83W	30	275	5	281	0	5	7	13.83	6.14	35.62	44.41	0.24	10,271
Sample																
74-29	18	22N	82W	50	-	-	-	-	9	5	11.3	10.9	34.1	43.7	0.4	10,070

Drill hole data from Rocky Mountain Energy Company (1977).

Data for sample 74-29 from Glass (1975, p. 16-17 and 141-144).

[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.]