



MAP SHOWING ISOPACHS OF COAL AND OVERBURDEN OF THE CANYON COAL BED, BIRNEY 30' x 60' QUADRANGLE, BIG HORN, ROSEBUD, AND POWDER RIVER COUNTIES, MONTANA

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INTRODUCTION

As part of its Regional Coal Resource Assessment Program, the U.S. Geological Survey is preparing maps of potentially minable coal beds in the Birney 30' x 60' quadrangle, exclusive of the Northern Cheyenne Indian Reservation, at a scale of 1:100,000. The Birney quadrangle is located in southeastern Montana in the northwestern part of the Powder River coal region. It is 12 miles north of Sheridan, Wyo., and 33 miles southeast of Hardy, Mont. The maps in this series present coal bed data from a large area on moderate-scale base and show trends of thickening, thinning, and splitting of the coal bed, areas of this moderate overburden, areas of coal resources, and structure of the coal bed. This report shows the variations in thickness of coal in the Canyon bed and the 200-, 400-, 500-, and 1,000-foot thicknesses of overburden contours. The Canyon coal bed occurs in the Tongue River Member of the Paleocene Fort Union Formation. It is one of about 20 coal beds in this member in the Birney quadrangle and is 500 to 700 feet below the top of the member. The Canyon coal bed is one of the most extensive coal beds in the Powder River coal region, extending across the Powder River basin both in Wyoming and Montana. It joins the thick Wyodak coal bed in the east side of the basin (Kent and others, 1980) and is equivalent to the Monarch coal bed on the west side (Culbertson and others, 1979). In the Birney 30' x 60' quadrangle, the Canyon coal bed has not been mined, except at a few localities for local use.

This map showing thickness of coal and thickness of overburden was constructed using data from 315 drill holes and 100 surface measurements within the Birney quadrangle; these data were supplemented by additional data points from the areas immediately adjacent to the quadrangle. The 315 drill holes include coal exploration holes drilled by the Montana Bureau of Mines and Geology, the U.S. Geological Survey, the U.S. Bureau of Reclamation, and private individuals and companies. Data points also include oil and gas exploration holes that have adequate geophysical logs available for interpretation of the thickness and depth of the Canyon coal bed. The 100 surface measurements and the edge-of-coal-bed line are taken from published and unpublished maps resulting from several coal mapping programs of the U.S. Geological Survey, as well as from maps of the Montana Bureau of Mines and Geology.

The line shown for the edge of the coal bed represents either the outcrop trace of the Canyon coal bed or the inferred contact between burned and unburned coal. In many places where the Canyon coal bed is thick, it has burned back from the outcrop for distances up to half a mile. The resulting heat has baked and fused the overlying rocks into a brittle resistant reddish rock called clinker (shown on the map). The contact between the clinker and unaltered rocks on the surface ("edge of clinker") is assumed to be vertically above the contact between burned and unburned coal, and so it is used here to define the "edge of coal bed." The location of the edge-of-coal-bed line is subject to error locally, both because of the difficulty of locating the edge of clinker on the surface and because in places a coal bed is known to have burned for a short distance beyond the edge of clinker without altering the appearance of the surface rocks. Although the amount of coal burned but not recognized as burned is unknown, it is probably negligible.

Recent studies of the Canyon coal bed in this quadrangle include isopach, structure, and thickness-of-overburden maps prepared by the Montana Bureau of Mines and Geology on a planimetric base (Cole and Fine, 1979, 1980; Fine and others, 1980; Matson and Blumer, 1973). In Wyoming, Kent and Munson (1975a, b) have published isopach, structure, and thickness-of-overburden maps on the Canyon coal bed for the Reclus 30' x 60' quadrangle, which adjoins the Birney quadrangle on the southeast corner. The Canyon coal bed, in general, dips gently less than 1 degree southward on the west side of the Birney quadrangle and southward on the east side. In the southern and western parts of the quadrangle, the Canyon is offset by numerous normal faults that generally trend northward or eastward. Only 200-, 400-, 500-, and 1,000-foot contours are shown.

The fault pattern shown in the northwestern part of the quadrangle in T. 6 and 7 S., R. 39 and 40 E. has been modified by the mapping and photointerpretation of W. C. Culbertson (unpubl. data, 1980) from that shown on the maps of Matson and Blumer (1973). Many of the faults shown elsewhere have been discovered since 1975 by field investigations of the U.S. Geological Survey aided by abundant new drilling. It is probable that new field investigations supplemented by drilling will result in locating additional faults in areas that have not been mapped in detail.

Coal in the Canyon bed is subbituminous B in rank in the southwestern part of the quadrangle, but decreases in rank eastward so that the eastern margin is subbituminous C or lignite. The Canyon coal is generally free of partings and has an average ash content of about 5 percent; a sulfur content of 0.5 percent or less, and a heat-of-combustion that ranges, on an as-received basis, from 9,500 Btu/lb in the west to 8,000 Btu/lb in the east.

ISOPACHS OF THE CANYON COAL BED

In the Birney 30' x 60' quadrangle, the Canyon coal ranges in thickness from 3 to 33 feet. It is thickest in T. 7 and 8 S., R. 44 E., where it ranges from 26 to 33 feet in thickness in an area of about 50 square miles, and in T. 6 S., R. 39 and 40 E., where it is 25 to 31 feet thick in an area of about 30 square miles. In the southern part of the Birney quadrangle, the Canyon bed is remarkably consistent, ranging in thickness from 16 to 22 feet across several townships. In the northern and northeastern parts of the quadrangle, however, the Canyon is split into two beds. The thickness of coal shown by the isopachs is the thickness of coal exclusive of partings in the Canyon bed or the thickness of the Lower or Upper Canyon where the Canyon is split. In most areas the Canyon coal or its splits are free of identifiable partings, but locally a bench of coal is separated from the main body of coal by a few feet of shale. If the thickness of the parting is less than the thickness of the bench of coal, then the bench is included in the thickness of the main bed. It is also included if the bench is more than 2½ feet thick and lies above the main bench in an area where it could be recovered by surface mining (0-200 feet of overburden).

Coal thicknesses based only on measurements of surface exposures should be treated with caution, because it is difficult to find an exposure of thick coal (5 feet plus) whose exposed thickness is not significantly less than the thickness of the coal in a nearby drill hole. It is not clear how much this decrease in thickness on the outcrop results from slow oxidation during weathering, but this factor may be significant. When subbituminous coal is exposed to air, it "scales," or breaks down into small fragments that are readily subject to oxidation. Another factor is the slumping of overlying strata down across the top of the coal bed, which may result in the observer mistaking the slumped top of the coal bed for the true top. In much of the area where the Canyon bed is more than 15 feet thick, most outcrop measurements are reported as incomplete thicknesses, which means that either the top or base of the bed could not be seen. In areas in the Birney quadrangle where drill-hole data were available, the drill-hole data were used to determine the placement of the isopachs, and surface data were used mostly as indicators of the minimum thickness of the coal bed. But where drill-hole data were absent or scarce, as in much of the northern part of the quadrangle, the surface data were used to determine the position of the isopachs. Consequently, the true thickness of the coal in these areas is probably underestimated by an unknown amount, perhaps 10 or 20 percent.

In much of the northern part of the Birney quadrangle, the Canyon is split into two benches of coal separated by as much as 100 feet of rock. On the map, the line of splitting marks either the known or the inferred place where the separation becomes so great that the two benches are considered to be separate beds. In most of this area, only the thickness of the bed believed to be the lower bench is shown by isopachs, because it is generally the thicker of the two benches. However, in the shaded area in and near T. 6 S., R. 41 E., only the thickness of the upper bench is shown. Here the upper bench is 5 to 16 feet thick and is separated by as much as 30 feet

from a lower bench that is 2 to 6 feet thick. At two places within the zone of splitting, the bed identified as one of the splits may represent a coalescence of the two splits. These places are in sec. 4, T. 6 S., R. 42 E. and vicinity, where the Upper Canyon is 15 feet thick, and in sec. 36, T. 6 S., R. 42 E. and vicinity, where the Lower Canyon is 12 to 13 feet thick and contains a parting as much as 3.4 feet thick.

In an area of about 70 square miles in the southeast corner of the Birney quadrangle, a bench of coal 2½ to 7 feet thick that lies 1 to 14 feet above the main bed is included as part of the Canyon at most localities. The interval between coal splits generally increases northward in this area.

The Canyon coal bed was deposited as peat in a swamp on a flood plain in Paleocene time. The rock parting that splits the Canyon is probably the result of deposition of sediment on the peat bog from a beached levee during the flooding of a large river somewhere to the north. After deposition of these clastic sediments ("creasease splits"), the swamp reestablished itself and continued the deposition of peat to form the Upper Canyon bed.

In a zone that trends northward from T. 7 S., R. 39 E. to the valley of the Tongue River, the Canyon coal is only 4 to 8 feet thick. In crossing this zone from north to south, the Canyon starts in the west part of T. 7 S., R. 39 E. as a single bed 20 to 25 feet thick, splits southward into two beds totaling about 15 feet, becomes a single bed 4 to 5 feet thick and then abruptly increases to 13 to 15 feet thick. This zone of thinning is probably the result of a slightly higher topographic surface during peat deposition. The thinning may represent a slight tectonic uplift, or it may be the result of differential compaction of sediments prior to deposition of the Canyon coal bed. Differential compaction assumes that this was the site of deposition of a thick body of sand along the channel of a preexisting river. The sand would not compact as much as the adjacent clayey or carbonaceous sediments, so it would become a linear topographic high.

ISOPACHS OF OVERBURDEN ON THE CANYON COAL BED

The thickness of overburden on the Canyon coal bed is shown by isopach contours of 200, 400, 500, and 1,000 feet. The 200-, 400-, and 500-foot contours outline areas where the coal is potentially recoverable by surface mining methods. The 1,000-foot overburden contour outlines the area underlain by coal classified as reserve base. For subbituminous coal, reserve base is defined as coal in beds more than 5 feet thick and at depths of less than 1,000 feet. The overburden on the Canyon coal bed consists principally of shale, siltstone, sandstone, coal, clinker, and lenses of limestone. The composition of the overburden varies from place to place. In general the overburden is poorly consolidated, but locally some of the sandstone beds are cemented with calcium carbonate and weather to ledges or benches on the outcrop. As shown by the representative sections in figure 1, coal beds can be an important part of the overburden. In many places the thick coal in the overburden has burned, baking and fusing the overlying rocks to form clinker.

EXPLANATION

- EDGE OF COAL BED—Outcrop, or contact between burned and unburned coal.
- FALL—Dashed where approximately located, U. upthrown side; D, downthrown side.
- ISOPACH OF COAL BED—Showing coal thickness in feet. Dashed where coal is absent. Contour interval is 2 feet, and a 5-foot contour is added.
- ISOPACH OF OVERBURDEN—Showing thickness of overburden in feet. Only 200-, 400-, 500-, and 1,000-foot contours are shown.
- APPROXIMATE LINE OF SPLITTING—Arrow points to area where Canyon is split into two separate beds. In this area, thickness is shown only for the Lower Canyon coal, except in shaded area where thickness is shown only for the Upper Canyon coal.
- DRILL HOLE
- LOCATION OF COAL-BED THICKNESS MEASURED ON OUTCROP

To convert to	multiply by
feet	0.3048
meters	3.2808
miles	1.609
kg./kg	0.566

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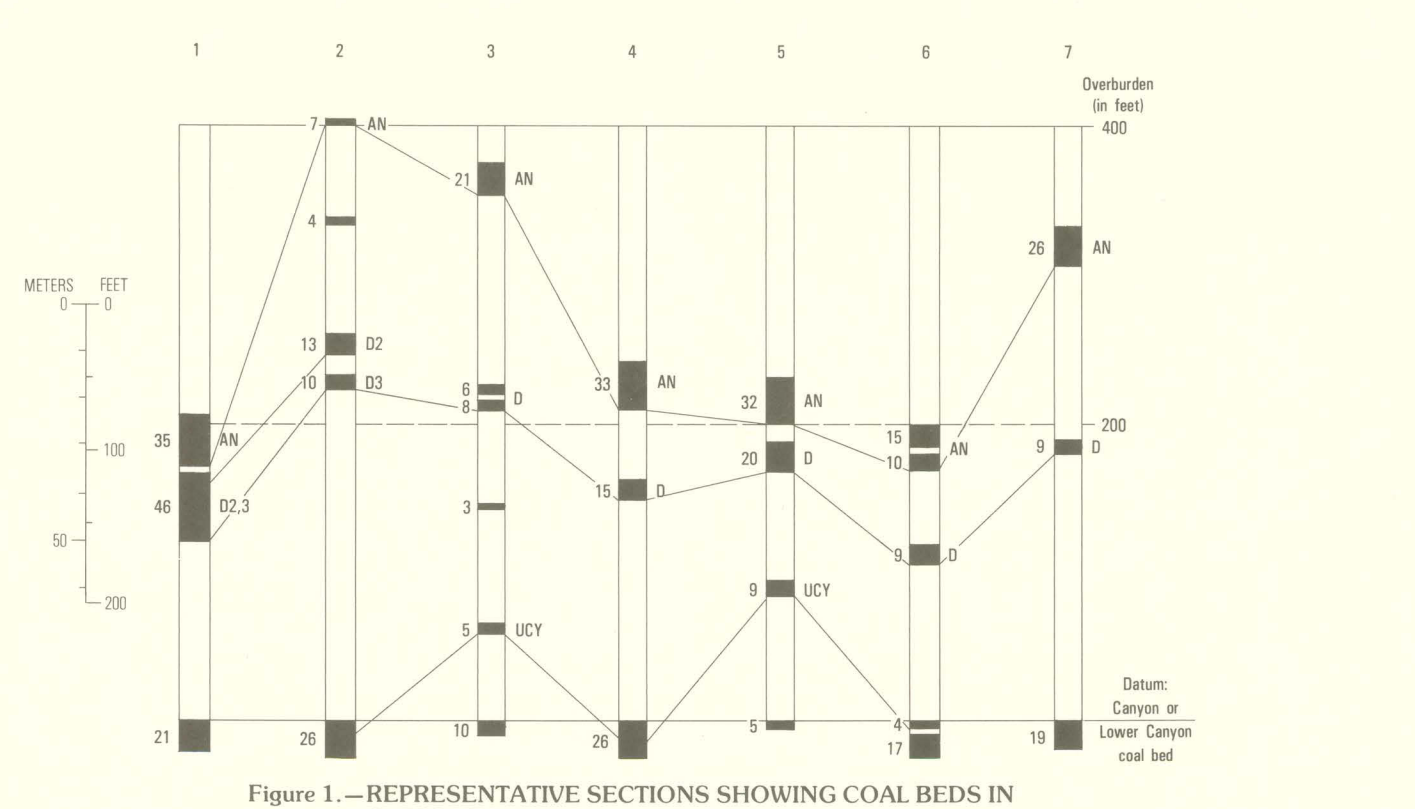
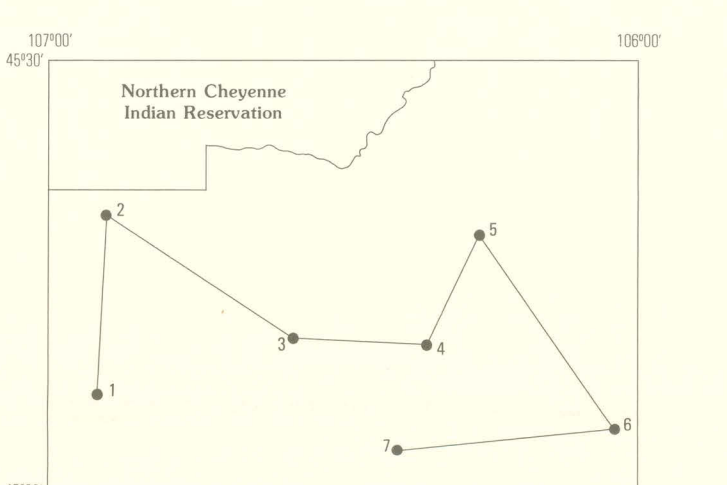


Figure 1.—REPRESENTATIVE SECTIONS SHOWING COAL BEDS IN OVERBURDEN OF THE CANYON COAL BED. Number indicates thickness of coal bed in feet. Abbreviations of coal bed names: UCV, Upper Canyon; D, Dietz; AN, Anderson.

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