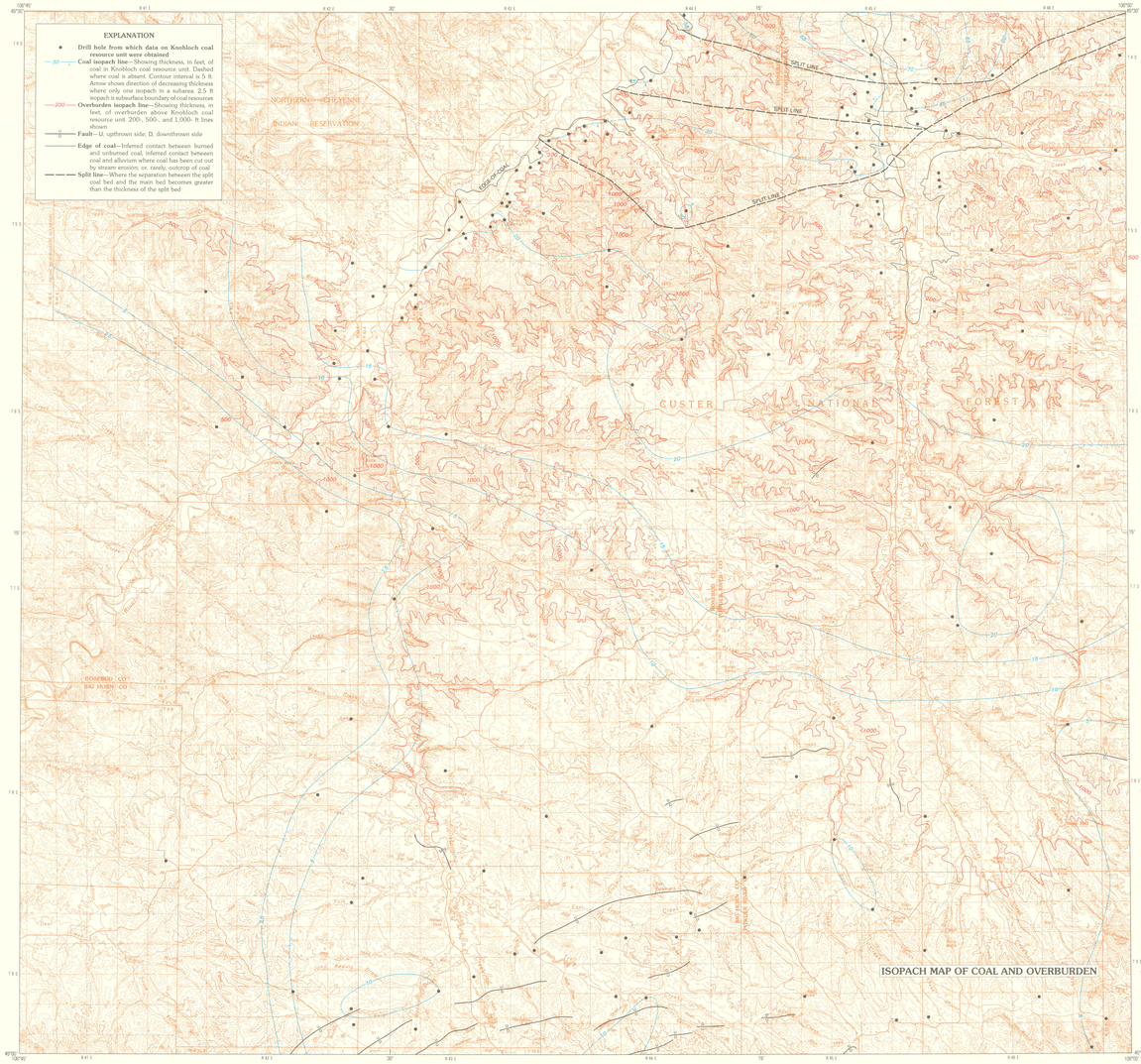
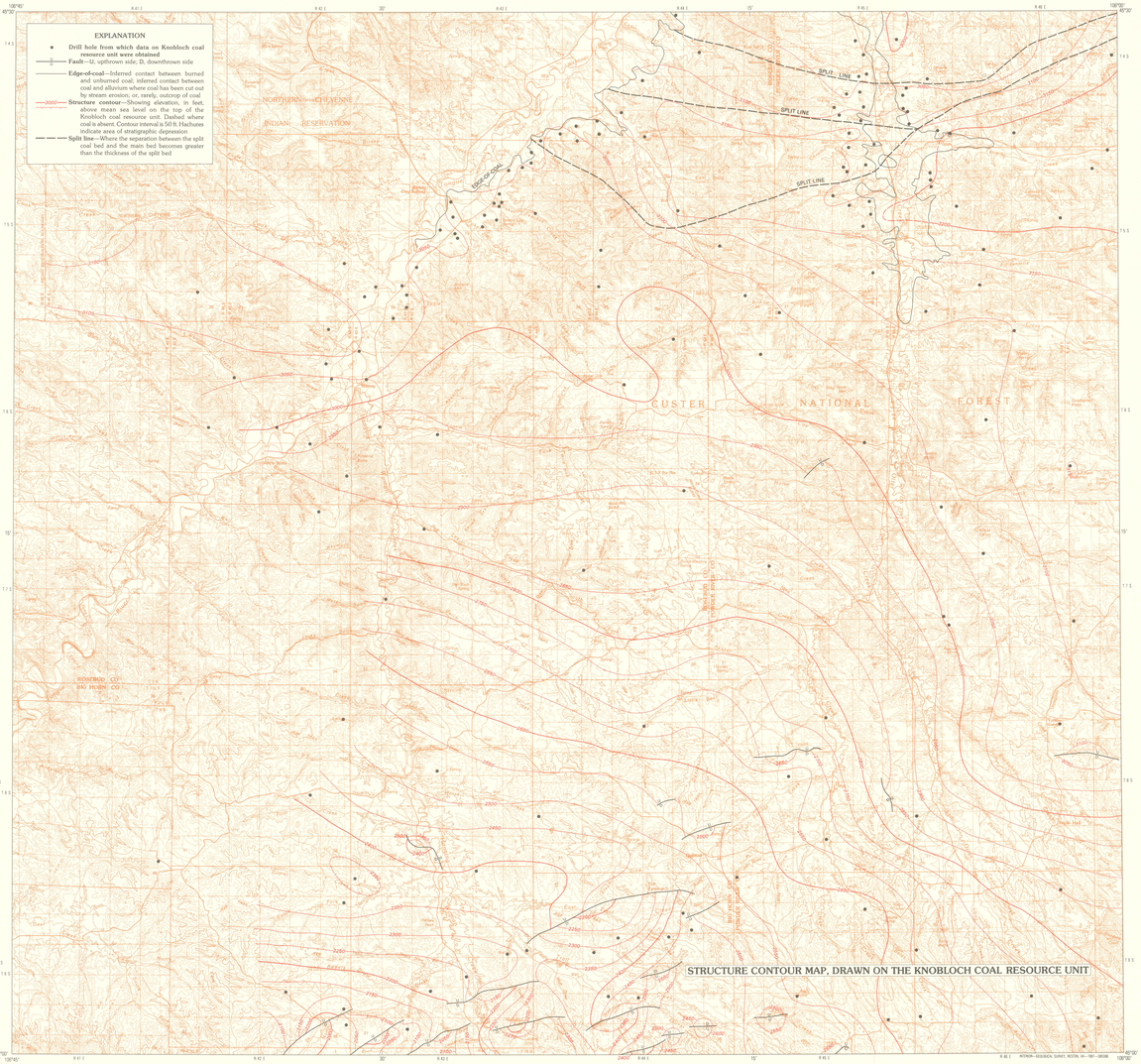
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

COAL INVESTIGATIONS
MAP C-112





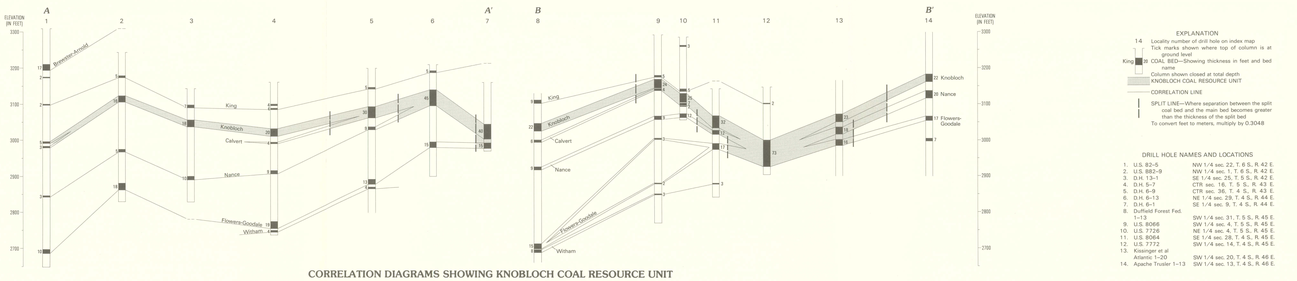
Base from U.S. Geological Survey, 1985

SCALE 1:100000

CONTOUR INTERVAL 20 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MONTANA
MAP LOCATION

INDEX MAP SHOWING LINES OF SECTION AND LOCATIONS OF DRILL HOLES



CORRELATION DIAGRAMS SHOWING KNOBLOCH COAL RESOURCE UNIT

DRILL HOLE NAMES AND LOCATIONS

1.	U.S. 82-5	NW 1/4 sec. 22, T. 6 S., R. 42 E.
2.	U.S. 882–9	NW 1/4 sec. 1, T. 6 S., R. 42 E.
3.	D.H. 1-3–1	SE 1/4 sec. 25, T. 5 S., R. 42 E.
4.	D.H. 5–7	CTR sec. 16, T. 5 S., R. 43 E.
5.	D.H. 6–9	CTR sec. 36, T. 4 S., R. 43 E.
6.	D.H. 6–13	NE 1/4 sec. 29, T. 4 S., R. 44 E.
7.	D.H. 6–1	SE 1/4 sec. 9, T. 4 S., R. 44 E.
8.	Duffield Forest Fed. 1–13	SW 1/4 sec. 31, T. 5 S., R. 45 E.
9.	U.S. 8066	SW 1/4 sec. 4, T. 5 S., R. 45 E.
10.	U.S. 7726	NE 1/4 sec. 4, T. 5 S., R. 45 E.
11.	U.S. 8064	SE 1/4 sec. 28, T. 4 S., R. 45 E.
12.	U.S. 7772	SW 1/4 sec. 14, T. 4 S., R. 45 E.
13.	Kissinger et al Atlantic 1–20	SW 1/4 sec. 20, T. 4 S., R. 46 E.
14.	Apache Trusler 1–13	SW 1/4 sec. 13, T. 4 S., R. 46 E.

STRUCTURE, COAL THICKNESS, AND OVERBURDEN THICKNESS OF THE KNOBLOCH COAL RESOURCE UNIT, BIRNEY AREA, BIG HORN, ROSEBUD, AND POWDER RIVER COUNTIES, MONTANA

By
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INTRODUCTION

The Birney quadrangle is located in southeastern Montana in the northwestern part of the Powder River coal region, about 12 miles north of the town of Sheridan, Wyoming. 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. These maps show trends of thickening, thinning, and splitting of coal beds, areas of coal resources based on thickness of overburden, and structure of the coal beds. The coal is mostly subbituminous in rank, and low in sulfur and ash content.

The Knobloch coal occurs in the lower part of the Tongue River Member of the Fort Union Formation of Paleocene age. The Knobloch is a single bed, as much as 73 ft thick, near the northern margin of the quadrangle. Southward the thick Knobloch coal splits into four coal beds. The uppermost bed continues as the Knobloch, named after the Knobloch ranch in T. 5 S., R. 43 E. The other three, in descending order, are the Calvert, Nance, and Flowers-Goodale (see correlation diagrams). Locally the overlying King bed may coalesce with the Knobloch. The accompanying isopach and structure map shows only to a single coal bed, here called the Knobloch coal resource unit. This single bed is either the thick coal bed at the north edge of the quadrangle, or the coal bed remaining after each of the underlying coal beds have successively split so far away from the thick coal bed that the split bed is no longer considered part of the resource unit. This occurs when the thickness of the rock interval separating the split bed from the Knobloch coal resource unit becomes greater than that of the split coal bed. Locations where this occurs define the split lines, which are used as boundaries to delineate 4 subareas of the Knobloch coal resource unit for resource purposes. The thickness of the coal in each subarea is isopached separately.

The isopach and structure map shows the location of the drill holes that were used in constructing these maps. Sixty percent of the holes are coal exploration holes that were drilled by State and Federal agencies, and private companies. Most of these holes are located in the valleys of Tongue River and Otter Creek, where the Knobloch coal resource unit is at shallow depth. Forty percent of the drill holes are oil and gas test holes; data on the Knobloch were obtained from these holes by interpretation of the geophysical logs. The logs of oil and gas holes provide almost the only available information for Knobloch coal in the southern one-third of the area and under the high divides.

The faults shown on the structure map are from published geologic maps of the U.S. Geological Survey and Montana Bureau of Mines and Geology, and geologic mapping by the authors.

Historically, coal has been mined intermittently from short adits on the Knobloch bed in sec. 18, T. 5 S., R. 43 E. (Warren, 1959); the Knobloch is undeveloped in the rest of the quadrangle. Currently (1983), planning is underway for a surface mine in the Knobloch on the east side of Tongue River in Tps. 4 and 5 S.

At the Otter Creek study site in Tps. 3 and 4 S., R. 45 E., analyses of cores of the 59- to 66-ft-thick Knobloch coal resource unit show that this coal ranks as subbituminous C and has remarkably low sulfur content (U.S. Bureau of Land Management, 1975, p. 48). On an as-received basis, the average heating value is 8,110 Btu per lb, the average ash content is 5.5 percent, and the average sulfur content is 0.15 percent.

The Knobloch coal, in common with other subbituminous coals, crumbles into small pieces ("slakes") and tends to ignite spontaneously where exposed to prolonged weathering. The coal has burned along much of its former outcrop and the burned areas extend back from the outcrop for as much as a mile. The resulting heat has baked and fused the overlying beds of shale and sandstone into brittle, resistant, reddish or grayish rock called *clinker* (not shown on the map). Where the coal has not burned, its previous outcrops are now covered almost everywhere by alluvium or slump material. As a result, there are few exposures of the Knobloch coal resource unit in this quadrangle.

On the accompanying maps the line shown as edge-of-coal represents the outcrop, the concealed coal-alluvium contact, or the subsurface contact between burned and unburned coal. The contact between the clinker and unaltered rocks at the surface (edge-of-clinker) is assumed to lie vertically above the subsurface contact between burned and unburned coal, so the edge-of-clinker contact is used here as edge-of-coal. However, the use of the edge-of-clinker contact may locally misrepresent the amount of coal present. For example, in places a thick bed of coal is known to have burned a short distance beyond the edge-of-clinker contact without altering the appearance of the surface rocks; in other places only the upper part of a thick bed of coal has burned, turning the overlying rocks into clinker and thereby concealing the presence of the lower unburned coal. It is not known how much burned coal has been inadvertently included within the coal area, or how much good coal is excluded because it is concealed beneath clinker, but the amount is probably negligible compared to the enormous volume of coal present in this area.

Otter Creek and some of its tributaries have cut deep channels in the bedrock, locally in excess of 50 ft deep, which have subsequently filled with alluvium. In Tps. 4 and 5 S., the Knobloch coal resource unit is inferred to have been removed by channel-scouring under parts of the alluvial valley of Otter Creek and its tributaries. In this area, portions of the edge-of-coal line represent the inferred position of the concealed coal-alluvium contact along the edge of the channel.

The edge-of-coal line was derived in part from the map of McKay (1976), and in part from unpublished mapping by the U.S. Geological Survey.

THICKNESS OF COAL

The Knobloch coal resource unit is from 55 to 73 ft thick in the northernmost subarea, where it consists of four coalesced coal beds (see correlation diagrams). It is from 41 to 48 ft thick in the next subarea to the south, where it consists of the coalesced Knobloch, Calvert, and Nance coal beds. It is from 27 to 34 ft thick in the next subarea, where it is the coalesced Knobloch and Calvert beds and is from 2.5 to 24 ft thick in the remaining large subarea, where it consists solely of the Knobloch bed. In the northern part of the latter subarea, the Knobloch bed is consistently 19–24 ft thick across an area of about 270 mi² and is only 5–10 ft thick in most of the southern part. The Knobloch coal bed pinches out to the west. The 2.5-ft isopach is used as the subsurface boundary of the Knobloch coal resource unit because 2.5 ft is the minimum thickness of subbituminous coal that is considered to be a coal resource, according to the Coal Resource Classification System of the U.S. Geological Survey (Wood and others, 1983).

OVERBURDEN

The overburden on the Knobloch coal resource unit consists of sandstone, siltstone, shale, mudstone, coal, and a few lenticular beds of limestone. These rocks were deposited in predominantly fluvial and paludal environments. Rocks deposited in a lacustrine environment occur locally in the lower 200 ft of overburden. The gross composition of the overburden differs from place to place because much of the sediment now comprising the overburden was deposited by shifting, meandering rivers. Locally isolated, thick, sinuous, channel-fill sands were laid down; elsewhere broad sheets of silt and sand were deposited as crevasse splays where river levees were breached. In general, the overburden is poorly consolidated, and only locally are some beds of sandstone so well cemented as to form resistant ledges.

The overburden ranges in thickness from a few feet to about 1,900 ft. Three isopach contours of 200, 500, and 1,000 ft outline four areas of Knobloch coal resources according to thickness of overburden. Coal resources in the categories of less than 200 ft, and 200–500 ft of overburden are considered to be potentially recoverable by surface mining methods (Wood and Others, 1983). Coal in the categories of 500–1,000 ft and more than 1,000 ft of overburden are presumed to be recoverable by underground mining, or *in situ* gasification methods.

Coal beds that occur in the lowest 500 ft of overburden could be recovered during surface mining of the Knobloch coal resource unit. However, they are few in number and generally less than 10 ft thick (see Culbertson, in press).

STRUCTURE CONTOUR MAP

The Knobloch coal resource unit lies in the axial trough of the asymmetric Powder River structural basin. The Knobloch generally dips less than 1/2 degree southward and southwestward, but it locally dips as much as 5 degrees near faults. A westward-plunging anticline trends east-west across the northern edge of T. 5 S., Rs. 44, 45, and 46 E.

Structural relief on the Knobloch coal resource unit is about 1,250 ft. The elevation at its top ranges from 2,000 ft above mean sea level in the southwest to 3,250 ft in the northeast.

Within the map area there are at least 21 normal faults, most of which trend northeast or east, that range in length from less than 1 mi to 6 mi. The maximum displacement of the Knobloch on these faults is inferred to range from about 50 ft to 250 ft, and the displacement is down to the south in 80 percent of the faults. Most of these faults form an en echelon pattern along the southern edge of the map area. They were probably formed as the result of strike-slip movement along the boundaries of basement blocks. Movement in the basement blocks could generate faults in the overlying strata that are at a small angle to those in the basement.

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For sale by U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225