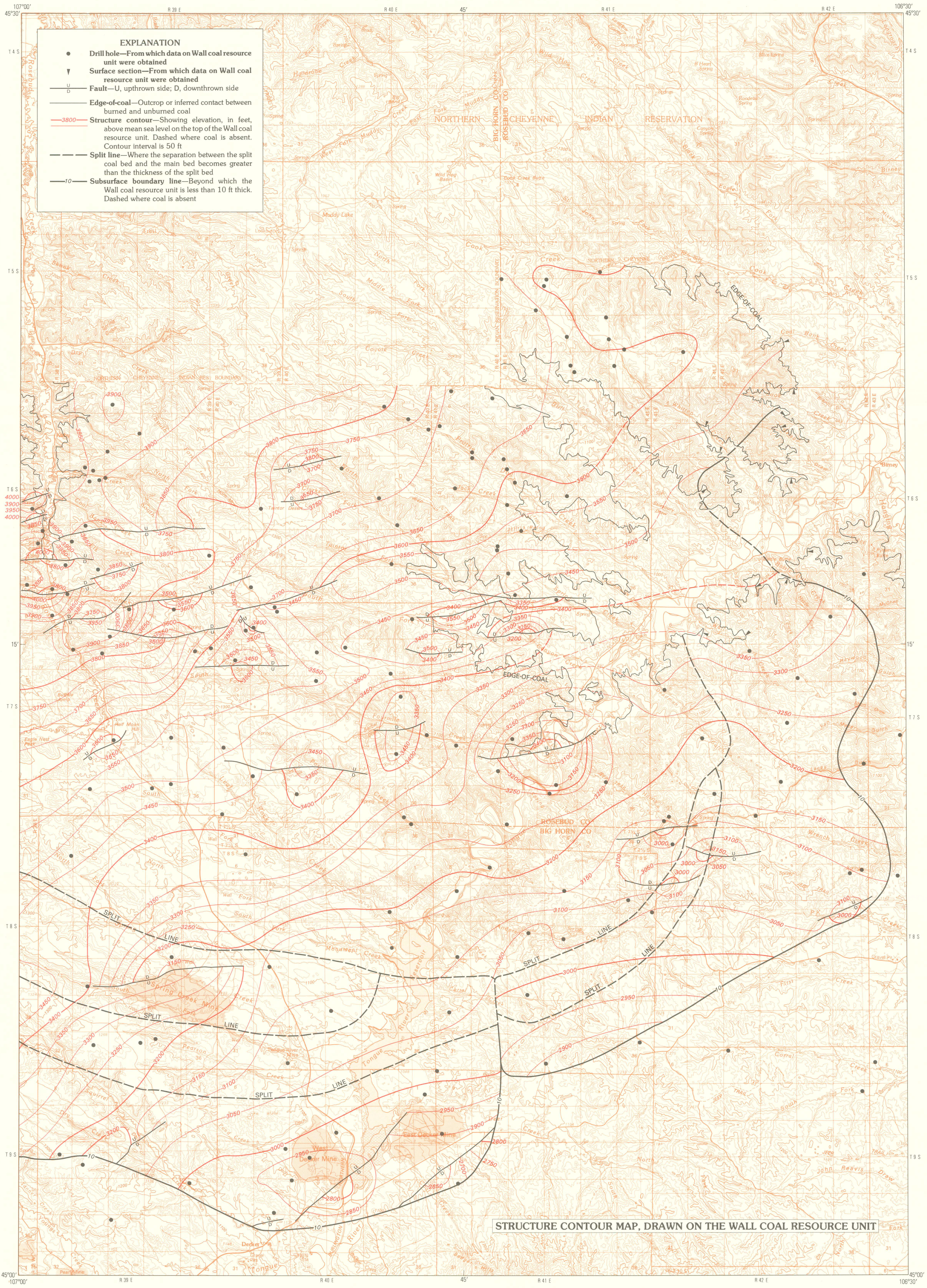
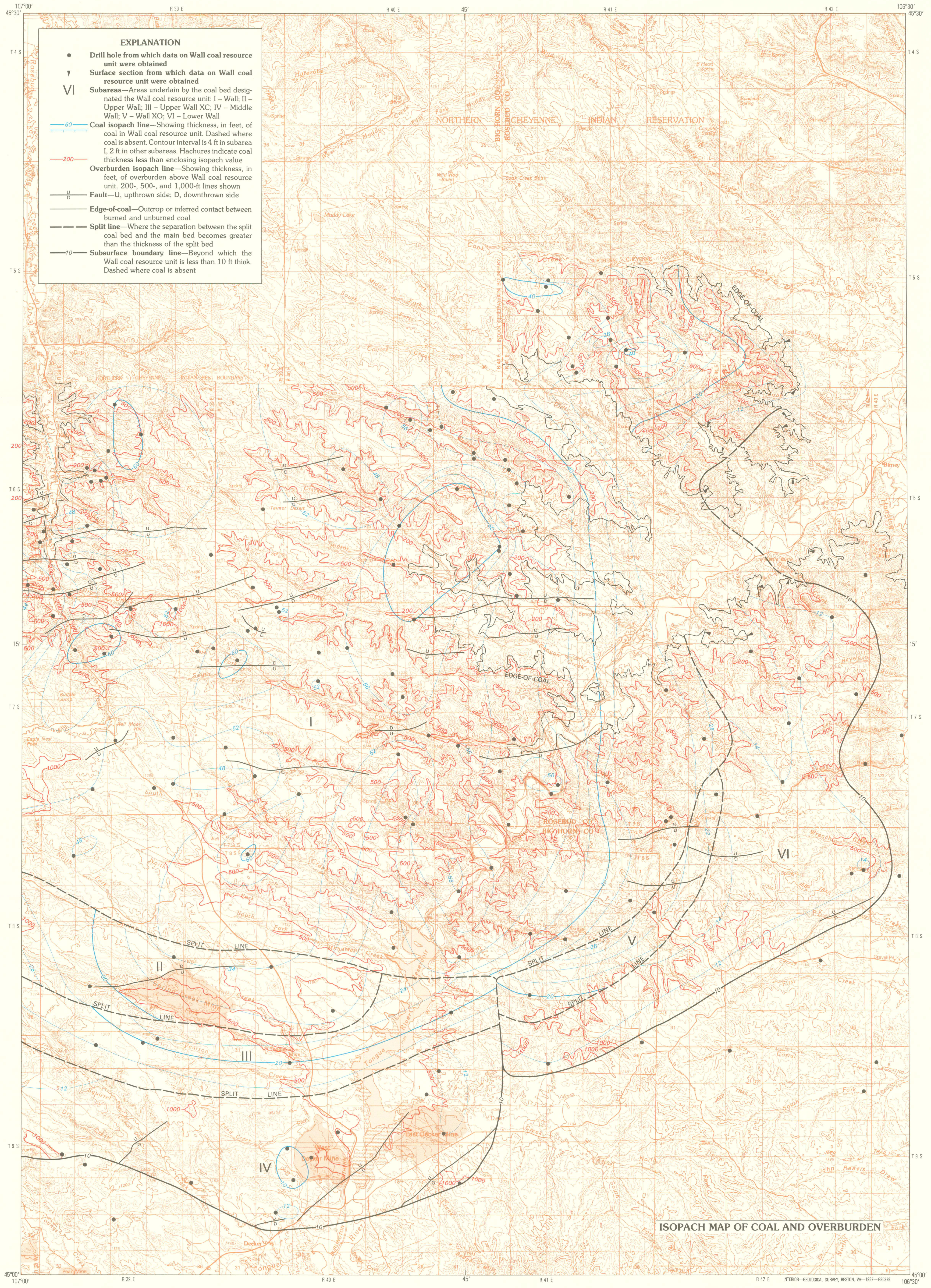
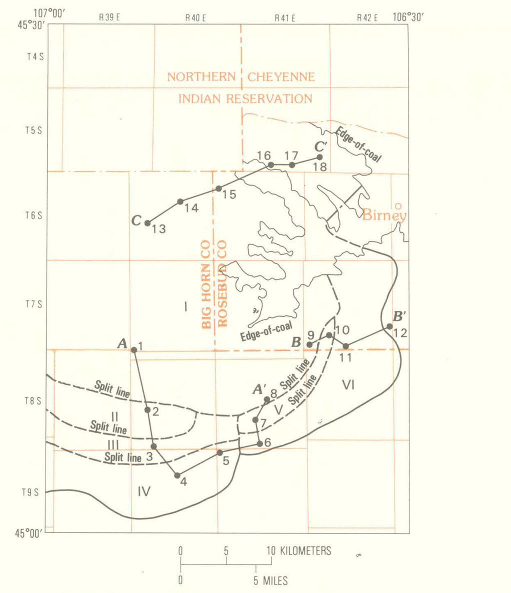


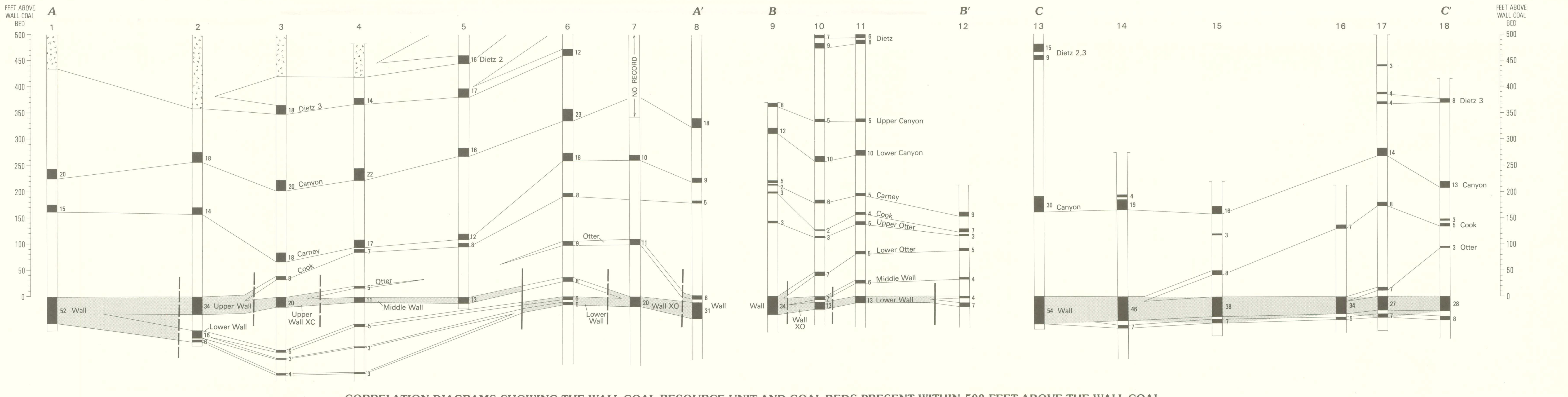
Base from U.S. Geological Survey, 1980



SCALE 1:100 000
5 0 5 10 15 KILOMETERS
5 0 5 MILES
CONTOUR INTERVAL 20 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929



INDEX MAP SHOWING LINES OF SECTION AND DRILL HOLE LOCATIONS



CORRELATION DIAGRAMS SHOWING THE WALL COAL RESOURCE UNIT AND COAL BEDS PRESENT WITHIN 500 FEET ABOVE THE WALL COAL

DRILL HOLE NAMES AND LOCATIONS

1.	L.L.L. Birney 1	sec. 31, T. 7 S., R. 40 E.
2.	US 78145	sec. 20, T. 8 S., R. 40 E.
3.	Vessels Federal-Shell 16	sec. 32, T. 8 S., R. 40 E.
4.	PKS Water Well 3	sec. 10, T. 9 S., R. 40 E.
5.	02628	sec. 6, T. 8 S., R. 41 E.
6.	US 82013	sec. 34, T. 8 S., R. 41 E.
7.	Napco Dinnin Gov't 1	sec. 21, T. 8 S., R. 41 E.
8.	Birney 6	sec. 15, T. 8 S., R. 41 E.
9.	Birney 7	sec. 31, T. 7 S., R. 42 E.
10.	US 7954	sec. 32, T. 7 S., R. 42 E.
11.	Vessels Federal-Shell 12	sec. 33, T. 7 S., R. 42 E.
12.	US 882-14	sec. 25, T. 7 S., R. 42 E.
13.	US 7737	sec. 20, T. 6 S., R. 40 E.
14.	US 81060	sec. 15, T. 6 S., R. 40 E.
15.	OH 78-102	sec. 7, T. 6 S., R. 41 E.
16.	US 81046	sec. 32, T. 5 S., R. 41 E.
17.	US 78184	sec. 34, T. 5 S., R. 41 E.
18.	US 882-1	sec. 36, T. 5 S., R. 41 E.

STRUCTURE, COAL THICKNESS, AND OVERBURDEN THICKNESS OF THE WALL COAL RESOURCE UNIT, WEST HALF OF THE BIRNEY 30′ x 60′ QUADRANGLE, BIG HORN AND ROSEBUD COUNTIES, MONTANA

By
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INTRODUCTION

The Birney 30′ x 60′ 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 accompanying maps of the west half of the Birney 30′ x 60′ quadrangle show coal isopachs, overburden isopachs, and structure contours on the Wall coal resource unit. The Wall coal resource unit consists either of the Wall coal bed or, where the Wall has split, the thickest persistent split of the Wall, as illustrated in the correlation diagrams.

GEOLOGIC SETTING

The Wall coal bed occurs in the lower part of the Tongue River Member of the Paleocene Fort Union Formation. It is one of more than 20 persistent coal beds that occur in the upper part of the Fort Union Formation in the Birney quadrangle (Culbertson, in press). The coal is mostly subbituminous in rank and low in sulfur and ash content. The Fort Union consists of beds of sandstone, siltstone, shale, mudstone, and coal, with minor lenses of limestone, that were deposited as sediments in predominantly fluvial and paludal environments. In Paleocene time, large river systems coexisted with the widespread swamps in which the thick peat deposits accumulated that later became coal. The observed splitting of the Wall coal bed into as many as six beds apparently is the result of repeated spreading of large amounts of sediment across the southern and eastern margins of the Wall peat swamp by a large river system, perhaps as overbank deposits during flooding, or as widespread crevasse splays when the river levee broke. After each episode, the swamp reestablished itself and again deposited peat across the area. Eventually these peat beds became coal beds separated by wedges of sandstone, siltstone, and shale.

COAL QUALITY

In T. 6 S., R. 41 E., coal samples from ten cores of the Wall bed were analyzed in detail (Robinson, Culbertson, and Affolter, 1981). The samples contained an average of 5 percent ash, 0.4 percent sulfur, 24 percent moisture, and had a heat-of-combustion value of 9,200 Btu per lb., all on an as-received basis. The rank of the coal is subbituminous B. In common with other subbituminous coals, during prolonged weathering the Wall coal crumbles into small fragments (slakes) and tends to ignite spontaneously. As a result, at most places along the outcrop the Wall coal has caught fire and burned back from the outcrop for distances of up to a mile. The resulting heat has baked and fused the overlying rocks into a brittle, resistant, reddish, or grayish rock called clinker.

SOURCE OF DATA

On the accompanying maps, the line shown as edge-of-coal represents either the outcrop trace of the Wall coal resource unit, the inferred position of the concealed coal-alluvium contact under the floors of the alluvial valleys or, where the coal has burned, the inferred 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. The edge-of-coal line is derived from published maps by Baker (1929) and Mapel (1976) and from unpublished mapping by the authors, and by S. Volz, and Vicky Niemeier of the U.S. Geological Survey.

Data on thickness and elevation of the Wall coal resource unit were derived from drill-hole and surface measurements. Most drill-hole data are from coal exploration holes drilled by the U.S. Geological Survey, Montana Bureau of Mines and Geology, U.S. Bureau of Reclamation, and private companies; these include 12 cored holes in T. 6 S., R. 41 E. In addition, 29 oil and gas test holes had geophysical logs that were suitable for interpreting the thickness and depth of coal beds. These logs were particularly valuable in the southern part of the area where the Wall coal resource unit is deep.

Surface data consist of at least 13 measured sections by Mapel (1976), some of which are reported as incomplete, from outcrops west of the town of Birney. Measurements of thick coal beds at the outcrop should be treated with caution, however, because in this quadrangle the exposed thickness of thick beds are generally significantly less than the thickness of the coal in a nearby drill hole. This apparent misrepresentation of the thickness of fresh coal may be the result of slow oxidation, or slaking, of the exposed coal and it may also be the result of overburden slumping that conceals the upper contact. Incomplete thicknesses are generally recorded where the base or top of the coal bed could not be exposed by digging.

The structure contour map is based not only on these data, but also on published maps by the Montana Bureau of Mines and Geology (Matson and others, 1973), and on published and unpublished mapping by the U.S. Geological Survey. (Robinson and Culbertson, 1984).

SUBDIVISIONS OF THE WALL COAL RESOURCE UNIT

The area underlain by the Wall coal resource unit is divided into six subareas, bounded by split lines, and by the 10-ft isopach line. The split lines are lines along which a coal bed has split so far away from the Wall coal resource unit that it is no longer considered part of the resource unit (see correlation diagrams). This occurs where the thickness of the rock interval separating the split bed from the Wall coal resource unit becomes greater than that of the split bed. The names of the beds as used in this report are those proposed by Culbertson (in press). In previous reports, many of these beds were not recognized as splits of the Wall coal bed and were either unnamed, called local beds, or miscorrelated with other named beds.

The 10-ft thickness-of-coal isopach is here used as the southern and eastern boundaries of the Wall coal resource unit area because of the scarcity of good data beyond this line and the resulting difficulty in correlating the splits of the Wall.

In the largest of the subareas, subarea I, the coal in the resource unit ranges from 44 to 62 ft in thickness except in the easternmost part. In general, it consists of the unsplit Wall bed. In the northernmost part of this subarea, however, some coal beds that locally lie above and below the Wall coal bed are here interpreted as being splits of the Wall (**C–C′** of the correlation diagrams). No split lines are shown because of the presumed complexity of the splitting and the lack of adequate data to document it. In this area it appears that a parting near the base of the Wall coal bed thickens irregularly northward, locally becoming thicker than the underlying bench of coal, which is 3 to 9 ft thick. Where this occurs, the underlying coal is excluded from the Wall coal resource unit.

In the northeast part of subarea I, the cause of the abrupt thinning of coal from the holes in T. 5 S., R. 41 E. eastward to the outcrop is uncertain. Part of the thinning probably is the result of a bed or beds splitting off of the Wall coal bed, similar to that shown in **B–B′**, but there is insufficient outcrop data to document splitting. Alternatively the thinning may not be as great as shown because the easternmost thicknesses are based on measurements on the outcrop that may misrepresent the true thickness of unweathered coal.

In the southeastern part of subarea I, the Wall coal bed thins rapidly eastward from the Tongue River; then the Lower Otter coal bed splits off, leaving the Wall XO coal bed as the resource unit of subarea V. Further east, the Middle Wall coal bed splits off, leaving the Lower Wall coal bed as the designated resource unit of subarea VI (correlation diagram **B–B′**).

Going south from subarea I, first the Lower Wall splits from the Wall coal bed, leaving the Upper Wall, which is designated as the resource unit of subarea II. Then the Cook coal bed splits from the Upper Wall, leaving the Upper Wall XC bed as the resource unit of subarea III. Finally the Otter also splits off, leaving the Middle Wall as the resource unit of subarea IV (correlation diagram **A–A′**). However, because the west-to-east correlations across Rs. 40 and 41 E. are somewhat tenuous, the relationship of the coal beds in subareas III and IV with those of subareas V and VI is not clear. Further drilling is needed to clarify the correlation of coal beds between columns 4 and 6, and columns 3 and 7 of correlation diagram **A–A′**.

The location of the 10-ft isopach in T. 9 S. is not well documented. Drill holes south of the Birney quadrangle indicate that southward the splits of the Wall coal bed have either pinched out or have joined the overlying Carney bed.

Eastward from the map area the coal beds designated Middle Wall and Lower Wall (correlation diagram **B–B′**) are probably equivalent to the Elk coal beds (Culbertson, in press). On the basis of scattered data points, the Elk beds are less than 10 ft thick everywhere in the eastern half of the Birney 30′ x 60′ quadrangle, except in Ts. 4 & 5 S., R. 46 E., where the Elk coal bed is locally as much as 23 ft thick.

Sparse data also indicate that the Wall coal bed probably exceeds 20 ft in thickness for many miles westward into the Crow Indian Reservation and northward into the Northern Cheyenne Indian Reservation.

OVERBURDEN ON THE WALL COAL RESOURCE UNIT

The maximum thickness of overburden on the Wall coal resource unit is about 1300 ft. The isopach contours of 200, 500, and 1000 ft of overburden outline four categories of coal resources according to thickness of overburden. Coal in the 0–200 and 200–500 ft overburden categories is considered to be potentially recoverable by surface-mining methods; the remainder is potentially recoverable by underground mining or by in place gasification (Wood and others, 1983).

The overburden on the Wall coal resource unit consists principally of sandstone, siltstone, shale, coal, locally thick beds of clinker, and thin lenses of limestone. The composition of the overburden is variable from place to place. In general, the overburden is poorly consolidated, but locally some of the sandstone beds are cemented with calcium carbonate that weathers to resistant ledges in outcrops. As shown by the accompanying correlation diagrams, coal beds are an important part of the overburden and could be recovered during surface mining of the Wall coal.

STRUCTURE CONTOUR MAP ON THE WALL COAL RESOURCE UNIT

The map area of the Wall coal resource unit lies on the northwest flank of the asymmetric Powder River structural basin. The Wall generally dips gently (about 1/2 degree) to the south and southeast, but dips of as much as 5 degrees have been observed near faults. At least 31 east- and northeast-trending normal faults, ranging from 1 to 4 mi in length have been mapped within this area. The maximum displacement of the Wall coal bed on these faults ranges from 100 to more than 300 ft; 70 percent of the displacements are down to the south. Many of these faults have been discovered since 1977 by surface investigations of the U.S. Geological Survey. It is probable that further detailed mapping, supplemented by drilling, will locate additional faults.

Structural relief on the Wall coal resource unit in the map area is about 1400 ft, ranging from 2650 ft above mean sea level in the south to more than 4000 ft in the northwest. A few low-amplitude flexures are present, mostly associated with nearby faulting.

Apparently there are two major sets of faults: a set that trends east along the south edge of the Birney quadrangle in which the individual faults trend northeast; and a set trending about S. 65° E. from the Kirby area (T. 6 S., R. 39 E.), in which the faults trend east. They are probably the result of strike-slip movement along the boundaries of basement blocks, which cause a series of faults to form in the overlying strata, each trending at a low angle to the direction of basement movement.

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