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PRELIMINARY STUDY OF THE COAL DEPOSITS IN THE CIRCLE AREA, McCONE, DAWSON, AND GARFIELD COUNTIES, MONTANA

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Introduction

The Circle area is in northeastern Montana in Garfield, Dawson, and McCone Counties (pl. 1). This report describes the coal beds in the Tongue River Member of the Paleocene Fort Union Formation and includes structure-contour and isopach maps of the four principal coal beds. Correlations based on U.S. Geological Survey-Montana Bureau of Mines and Geology drill-hole data (1977) indicate that the S coal bed is the thickest, most uniform seam in the Circle area. Collier and Knechtel's map (1939, pl. 1) of the baked and fused rock formed from the burning of the S bed was refined by J. H. Taylor (oral commun.) in 1975, using 1:24,000 aerial color photography obtained from Wesco Resources, Inc. The author's subsequent study of aerial photography and drill-hole data (1977) has revised other coal outcrops or burn (pl. 7).

Previous Work and Present Investigation

All of McCone County was mapped by Collier and Knechtel (1939). Relying principally on surface data, they concluded that the thickest and most persistent of the four major coal beds of the Tongue River Member in McCone County was the one they designated the S bed.

The Montana Bureau of Mines and Geology (Matson, 1970) published a preliminary report on the strippable coal resources of McCone County. That report described the coal resources of the S seam and included information which was gathered from 17 drill holes and 4 cores and used to define the extent, thickness, and quality of the coal. All 17 holes are located in the Circle study area (pl. 1).

In addition to the subsurface information of Matson (1970), three other data sources were used in preparation of the present report: (1) geophysical and lithologic logs of holes drilled by the Montana Bureau of Mines and Geology during 1976 in cooperation with the U.S. Geological Survey (1977); (2) geophysical logs from several oil and gas wells; and (3) geophysical and lithologic logs of Wesco Resources' holes drilled on Federal coal land in 1976 under the terms of a contract with the Bureau of Land Management (pl. 1).

The geologic formations, coal seams, and geographic features of Tps. 19 to 23 N., R. 50 E., in Dawson County were mapped in 1929 by A. J. Collier, assisted by Parker, Bramlette, Billings, and Thomas (Parker, 1936).

Development and Access

Coal has been mined intermittently in the Circle area from numerous small strip pits to supply the needs of local residents. The locations of some of these small abandoned coal pits are shown on plate 7. No coal mining is underway at present.

Dreyer Bros., Inc., a wholly owned subsidiary of Burlington Northern, Inc., is planning a plant in the Circle area to produce fertilizer and liquid fuels. The plant is to be located on the 32,000-acre (13,000-ha) Dreyer Ranch, purchased by Burlington Northern, Inc., in 1973, in an area where they already owned the mineral rights to every other section. In January 1975, Dreyer Bros., Inc., filed a Federal coal lease application for 15,108.5 acres (6,114.2 ha) of Federal coal lands on or adjacent to the Dreyer Ranch. Water for the development may be obtainable from the nearby Fort Peck Reservoir (pl. 1).

Major transportation facilities are a branch of the Burlington Northern, Inc., railway; State highways 200, 200S, 24, and 13; and gravel road FAS 252 (pl. 1).

Physiography

Approximately 75 to 85 percent of the Circle area consists of grass-covered rolling hills and broad valleys. The intermittent streams are moderately incised, and the slopes are gradual throughout most of the central and southern areas. Extensive areas are utilized for farming and livestock grazing.

In T. 19 N., Rs. 44 and 45 E., and T. 21 N., R. 45 E., near the S bed crop line, the topography is characterized by deeply incised drainages and steep-sided buttes. Local relief along the trend of the S bed crop line is nearly 200 ft (61 m). The principal land use is livestock grazing.

Stratigraphy

Bedrock exposures throughout the Circle area are of the Tongue River Member of the Paleocene Fort Union Formation. The Tongue River is composed of light-gray, calcareous sandstone, siltstone, claystone, and several lignite beds (Howard, 1960, p. 16). Its total measured thickness is about 700 ft (213 m), but only the member's lower 400 ft (122 m) contains coal beds of significance (Collier and Knechtel, 1939, p. 19).

The Lebo and Tullock Members of the Fort Union Formation, both of which are exposed north of the Weldon monocline and fault, lie stratigraphically below the Tongue River Member.

Locally the Fort Union is unconformably overlain by the Miocene or Pliocene Flaxville Formation, the Pleistocene Cartwright Gravel, Quaternary glacial remnants, or Holocene alluvium (Howard, 1960, pl. 1).

Structure

Collier and Knechtel (1939, pl. 9) constructed a structure-contour map of the base of the Colgate Member of the Fox Hills Sandstone (Upper Cretaceous) and found that a broad northeast-trending syncline lies across the southern townships of McCone County. They also noted the presence of a structural depression on the synclinal axis west of Brockway and centered in T. 18 N., R. 45 E. Matson (1970, fig. 2) mapped the top of the S bed, which forms a broad northeast-trending syncline similar to that mapped by Collier and Knechtel.

The structure-contour map of the top of the S bed for the present report (pl. 1) demonstrates that the Circle study area encompasses most of a broad syncline trending northeastward to the northeast corner of T. 19 N., R. 46 E., where it bends to the east-southeast. The dip of the limbs towards the axis is approximately 35 ft/mi (6.6/1000) or 0.38°, as measured in the northeast quarter of T. 19 N., R. 47 E. The syncline is accentuated by the presence of a structural depression in the southeast part of T. 19 N., R. 47 E., that closely resembles the aforementioned structural low described by Collier and Knechtel (1939, p. 16-17).

Other structural features in the Circle area are the Weldon monocline and the associated Weldon fault. The monocline extends northeastward from T. 19 N., R. 43 E., to the northeastern part of T. 21 N., R. 45 E. Collier and Knechtel (1939, p. 17) described the monocline as dipping 1° to 3° SE.; otherwise, strata in the Circle area generally dip less than 1°.

In the northeast part of T. 21 N., R. 45 E., the associated Weldon fault (pl. 2) breaks the surface and continues in a northeasterly direction to the eastern part of T. 22 N., R. 46 E. The Weldon fault has a displacement of as much as 160 ft (48.8 m) (Collier and Knechtel, 1939, p. 17), and is downthrown to the southeast.

Structural deformation occurred after deposition of the coal beds in the lower part of the Tongue River Member, for in no place

is the depositional thickness of the coal related to the present structural features. The S coal bed has been eroded over the uplifted area of the monocline and the upthrown side of the Weldon fault.

Coal

Collier and Knechtel (1939, p. 20) mapped four principal coal beds in the Tongue River Member and designated them as the P, Q, R, and S beds (in descending stratigraphic order). They noted several other coal beds in the Tongue River and referred to them as "local" beds (Collier and Knechtel, 1939, p. 21). Matson (1970, p. 6-8) described five coal seams in the Circle area. Four of the seams are the P, Q, R, and S seams; the fifth is a local bed between the S and R seams along the Redwater drainage system. That local bed correlates with one of the local beds mapped earlier by Collier and Knechtel (1939, p. 21).

Correlations based on U.S. Geological Survey-Montana Bureau of Mines and Geology drill-hole data (1977) indicate three local beds in addition to the four major seams (pl. 8 and fig. 1).

The lowest coal seam found in the Tongue River Member in the Circle area is the S coal bed, the most laterally persistent and uniform.

Collier and Knechtel (1939, p. 20) reported a maximum outcrop thickness of the S bed of 18.0 ft (5.5 m), including two shale partings totaling 0.67 ft, located in sec. 21, T. 19 N., R. 44 E. Other representative thicknesses are 13.25 ft (4.04 m) in sec. 24, T. 20 N., R. 44 E., and 16.5 ft (5.03 m) in sec. 7, T. 20 N., R. 45 E.

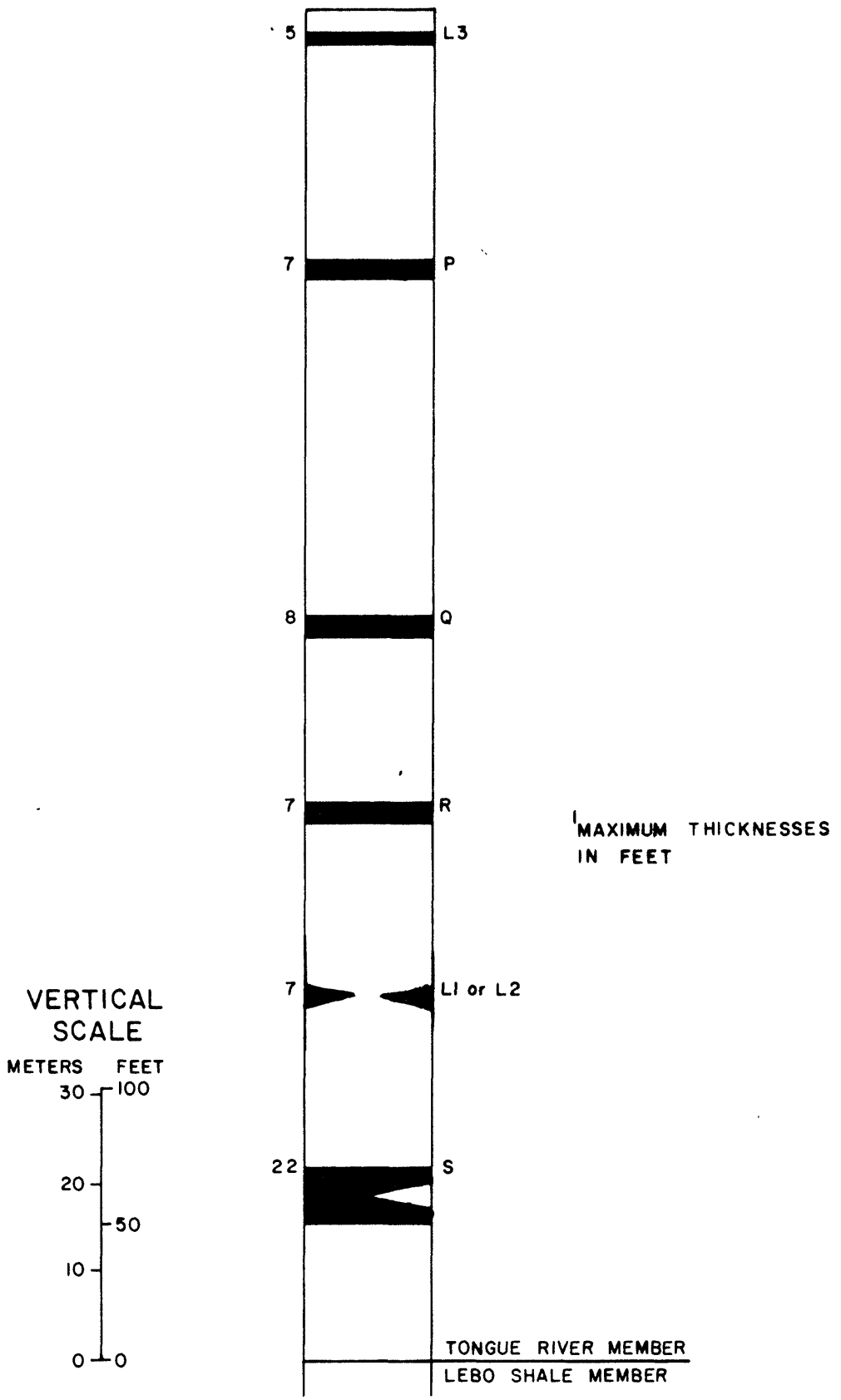

FIGURE 1. GENERALIZED COAL SECTION OF PART OF FORT UNION FORMATION

Matson (1970, p. 6) found the maximum thickness of the S bed to be 21 ft (6.4 m) in sec. 2, T. 19 N., R. 48 E., and the minimum to be 8 ft (2.4 m) in sec. 16, T. 18 N., R. 44 E.

Data from the 1976 drilling program (USGS/MBMG, 1977) indicate that the S bed is 22 ft (6.7 m) thick in sec. 18, T. 19 N., R. 45 E.; however, it thins to the south and is 7 ft (2.1 m) thick in sec. 30, T. 18 N., R. 45 E. The S bed continues to thin to the southeast and is only 3 ft (0.9 m) thick in sec. 20, T. 18 N., R. 49 E.

In addition to thinning, the S bed splays into as many as four distinct lenticular seams of variant thicknesses in Tps. 18 and 19 N., Rs. 48 and 49 E. (pl. 2). It has burned extensively and is represented by baked and fused rock on most of its outcrop along the Weldon fault and the associated monocline.

The as-received analyses indicate the S bed coal varies from 6,750 Btu/lb to 7,660 Btu/lb and, generally, is low in sulfur (table 1).

The next stratigraphically higher coal bed is a local bed (L1 on pl. 6) found throughout Tps. 18 to 20 N., Rs. 47 to 49 E., and ranging in thickness from 0 to 7 ft (2.1 m). The L1 bed is stratigraphically midway between the R and S beds, about 60 ft (18.3 m) above the S (pl. 3).

Another local bed (L2 on pl. 6) at about the same stratigraphic interval crops out in Tps. 18 and 19 N., R. 44 E., and drill-hole data show that it extends into Tps. 18 and 19 N., Rs. 45 and 46 E. (pl. 6). Collier and Knechtel (1939, pl. 1) designated this outcrop

Table 1.--As-received analyses of four cores from the S coal bed (Tongue River Member, Fort Union Formation) of the Circle area (Matson, 1970, p. 7).

[Analyses in percent, except for Btu/lb]

Drill-hole Location	Proximate				Ultimate	Btu/lb[1]
	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	
Sec. 2, T. 19 N., R. 48 E.-----	31.6	24.8	32.9	10.7	0.2	6,750
Sec. 36, T. 21 N., R. 45 E.----	29.9	27.5	36.9	5.7	.2	7,520
Sec. 16, T. 18 N., R. 44 E.----	30.5	27.7	35.9	5.9	.6	7,660
Sec. 16, T. 19 N., R. 44 E.----	31.7	27.2	35.0	6.1	.4	7,400

[1]To convert to kilojoule/kilogram (KJ/Kg) multiply by 2.326

as the R bed; however, study of aerial photographs in conjunction with drill-hole data suggests that beds may have been miscorrelated in sec. 15, T. 19 N., R. 44 E. (see pl. 4). Information on the L2 bed shows a maximum thickness of 6 ft (1.8 m).

Approximately 130 ft (40 m) above the S coal seam lies the R coal bed (pl. 3). The R seam ranges in thickness from 0 to 9 ft (2.7 m) (pl. 4) and, after the S, is the most laterally extensive bed in the Circle area (pl. 4).

Collier and Knechtel (1939, pl. 1) designated the coal seam in Tps. 19 and 20 N., Rs. 48 and 49 E., as a local bed, but correlations using drill-hole data indicate this outcrop to be the R bed; consequently, Collier and Knechtel's (1939, pl. 1) outline of the R bed in these townships is actually the outcrop of the next stratigraphically higher bed, the Q bed.

The Q bed is located about 60 ft (18.3 m) above the R bed throughout most of the Circle area, though in T. 18 N., R. 48 E., the interval increases to approximately 114 ft (35 m) in drill hole US-7656 (pl. 6). The Q bed thickens to 8 ft (2.4 m) in T. 18 N., R. 47 E., but usually is less than 6 ft (1.8 m) thick in the Circle area (pl. 7). The Q bed frequently contains partings and in places consists of two or three benches.

Approximately 120 ft (37 m) above the Q bed lies the P coal bed. The P seam is usually less than 6 ft (1.8 m) thick (pl. 7) and is the most extensively exposed bed in the Circle region. The horizon of the P bed is at nearly the same elevation as the

topography; as a result, the broad valleys and shallow stream or road cuts have exposed this bed widely. Much of the P outcrop was originally mapped as the Q by Collier and Knechtel (1939, pl. 1); this can be attributed to their correlating the highest bed in the section, the L3 bed, to the P bed.

The L3 bed of coal occurs in the highest topographic remnants in the Circle area. This seam is about 80 ft (25 m) above the P seam, and where it is found it is extensively eroded or burned. Of 63 holes drilled in 1976, only 2 were high enough in the section to include the L3 bed; for this reason the outcrop is not shown in any of the plates in this report.

In addition to the seven coal beds (L3, P, Q, R, L1, L2, and S, in descending stratigraphic order) (fig. 1) discussed in this report, there exist several thinner, more localized seams of coal. They are not discussed herein because of the absence of outcrops, limited drill-hole coverage, and their relative unimportance.

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