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COAL GEOLOGY OF THE NORTHEAST CIRCLE AREA, McCONE AND DAWSON COUNTIES, MONTANA

By

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CONTENTS

ILLUSTRATIONS
[Plates in pocket]

Contents--continued

CONVERSION TABLE

To convert	Multiply by	To obtain
Inches	2.54	centimers
Feet	0.3048	meters
miles	1.609	kilometers
sq. miles	2.590	sq. kilometers
Fahrenheit	-32 and ÷ by 1.8	Celsius

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ABSTRACT

The Northeast Circle area is in central McCone and northern Dawson Counties, northeastern Montana. The area encompasses about 940 square miles and has a maximum relief of greater than 1,000 feet. The lowest point (altitude of less than 2,200 feet) is in the Redwater River Valley in the northern part of the area. The highest point (altitude of less than 3,200 feet) is on the Yellowstone-Missouri divide, located in parts of Tps. 18 and 19 N., Rs. 49, 50, and 51 E., and T. 20 N., Rs. 52 and 53 E.

Surface exposures in most of the area consist of yellowish or light-colored sandy shales of the Tongue River Member of the Paleocene Fort Union Formation. The coal beds in the Northeast Circle area occur in the lower 500 feet of this member and are persistent in the field.

The predominant structural features of the area are the northeast end of the Weldon monocline-fault in Tps. 21 and 22 N., R. 47 E., and a small steep depression near Circle in sec. 10, T. 19 N., R. 48 E. Otherwise, the structure of the area is nearly flat.

Coal in the Northeast Circle area is composed of six main beds: the S, L1, R, Q, P, and Pust beds, in ascending stratigraphic order. Of these, the S, Pust, and P beds are the thickest.

The S bed is more than 20 feet thick in some places, but usually ranges in thickness from 6 to 10 feet. The Pust bed, which is about 430-490 feet above the S bed, is more than 18 feet thick in the upper bench and as much as 9 feet thick in the lower bench. Coal thickness in the P bed varies from 0 to 10.5 feet. The other coal seams in the area are generally less than 5 feet thick. All coals are lignite in rank.

INTRODUCTION

Location and Access

The Northeast Circle area is in central McCone and northern Dawson Counties, northeastern Montana (fig. 1). Circle, the McCone County seat, is the largest town, with a population of about 1,100. The area encompasses about 940 square miles and is bounded on the north by T. 22 N.; on the south by T. 18 N.; on the east by R. 52 E., or part of R. 53 E.; and on the west by R. 47 E., or part of R. 48 E. (pl. 2).

The main transportation facilities are State Highways 13, 200, and 200S; FAS 254; and a branch of the Burlington Northern, Inc., railroad. A network of privately owned bladed or graded section-line roads provides access to most of the rural area; however, permission from the owner is required to use them.

Previous Investigation

Earlier studies of the coal in Tps. 18 to 22 N., Rs. 47 to 50 E., and Tps. 21 and 22 N., R. 51 E., were done in 1927, 1928, and 1929 by A. J. Collier, assisted by Billings, Bramlette, Thomas, and others (Parker, 1936). F. S. Parker (1936) was mainly responsible for mapping T. 20 N., Rs. 51, 52, and part of 53 E., and Tps. 21 and 22 N., R. 52 E. (fig. 2). The objectives of these studies were twofold: (1) to compile reports of previously unpublished information concerning thickness and extent of coal beds, and (2) to obtain information necessary for the classification of public lands. (See Parker, 1936, p. 123, 124; Collier and Knechtel, 1939, p. 2, 4.)

Matson (1970), in a preliminary report on the coal field in the Circle area, briefly described the coal-bearing areas which he referred to as the Weldon-Timber Creek and Redwater deposits. Seventeen holes were drilled and five coal cores were taken to determine the extent, thickness, and quality of coal in the area. Spencer (1976) reported on the Pust lignite bed using numerous drill-hole data. Wincentsen (1978), using data from more than 60 drill holes, illustrated and described the subsurface attitude and thicknesses of the coal beds in the Circle area.

Present Investigation

This report describes the coal deposits of the Tongue River Member of the Paleocene Fort Union Formation.

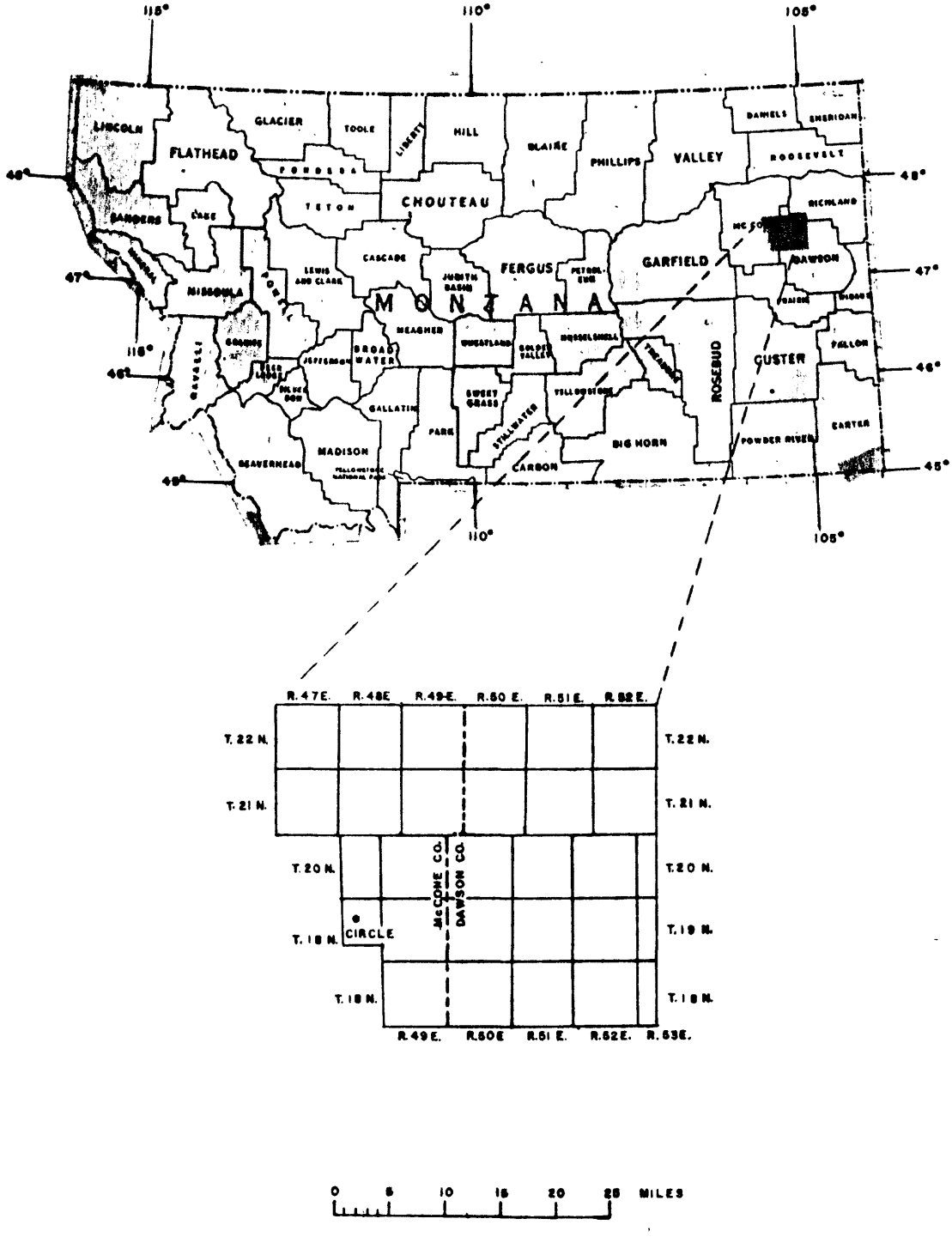
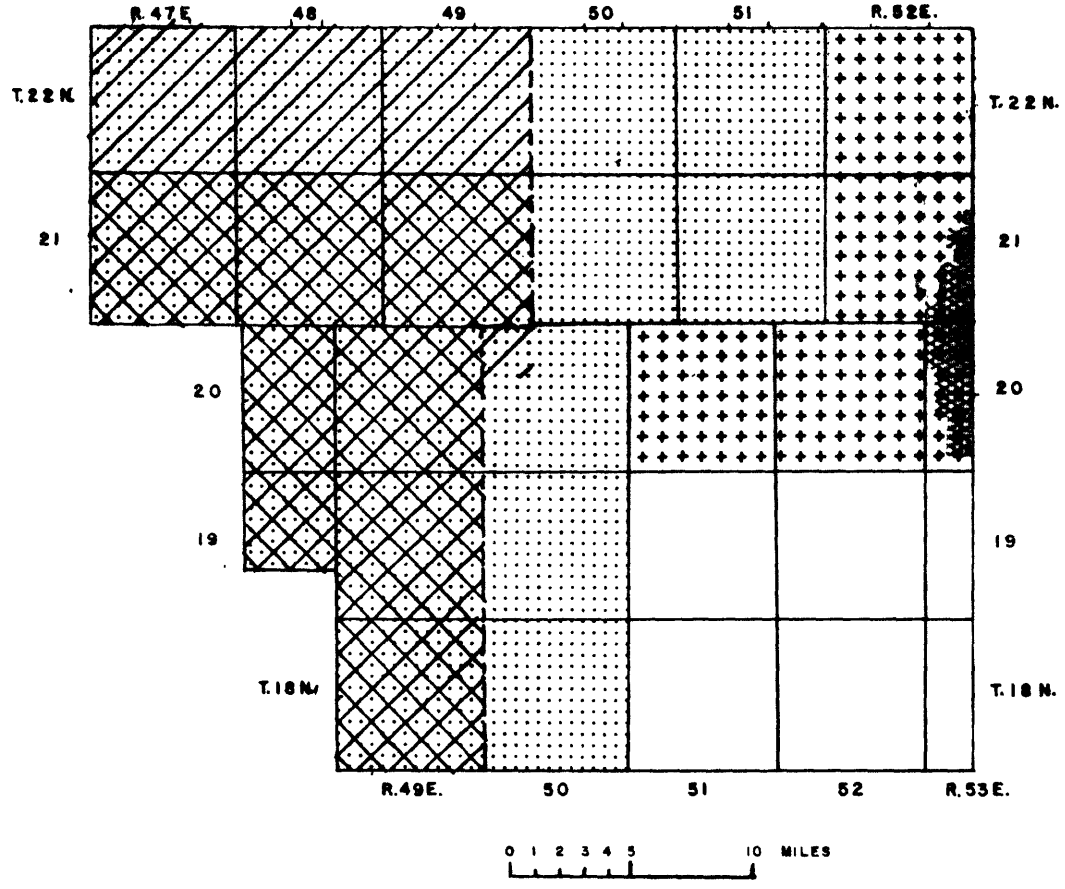


Figure 1. Index map showing location of the Northeast Circle area, McCone and Dawson Counties, Montana



Mapped by A.J. Collier (Parker, 1936; Collier and Knechtel, 1939)

Mapped by F. S. Parker (Parker, 1936)

Matson, 1970

Spencer, 1976

Wincentsen, 1978

Figure 2. Index map showing previous work in Northeast Circle area

Drilling, financed by a grant from the U.S. Geological Survey, was done in the area during 1976 and 1977 (U.S. Geological Survey and Montana Bureau of Mines and Geology, 1977, 1978). Interpretations of the geophysical logs from these holes have expanded the data base from the outcrop of some coal beds and made possible the compilation of four correlation diagrams, seven coal isopach maps, one structure-contour map, and six isopach maps of the interburden between coal beds (pls. 1-8). The information is presented as a part of the U.S. Geological Survey's program to evaluate and classify mineral lands in the public domain. Approximately 46 percent of the coal land in the Northeast Circle area is federally owned.

In some areas the present investigation is an exploratory program and in other areas it is a partial revision of an earlier report (Wincentsen, 1978) (fig. 2). Most of the beds described in the 1978 report are also located in the Northeast Circle area.

Nineteen holes were drilled for the purpose of supplementing and refining data gathered from 1976 drilling (Wincentsen, 1978). An additional 10 holes were drilled to obtain data eastward from the McCone-Dawson County border to Tps. 18-22 N., Rs. 52 or 53E., where it was correlated with existing data (Spencer, 1976) (fig. 2). Several oil-, gas-, and water-well geophysical logs were used to gather subsurface information.

Coal-bed outcrops and measurements on plates 2 through 7 were obtained from earlier reports (Parker, 1936, pl. 22; Collier and Knechtel, 1939, pl. 1). Where drilling indicated coal was present, but outcrops were lacking, the outcrop lines were projected using the Glendive Army Map Service topographic map (scale 1:250,000, 1966) for horizontal and vertical control.

GEOGRAPHY

Topography and Drainage

The area is in the Missouri Plateau region and is generally characterized by a rolling surface (Howard, 1960, p. 8). The mature to submature regional topography is mainly the result of stream erosion. In the northern part of the area the surface has been modified by Pleistocene glacial deposits.

The Yellowstone-Missouri ("Sheep Mountain") divide is the highest topographic feature in the area with an altitude of more than 3,200 feet. The divide lies in parts of Tps. 18 and 19 N., Rs. 49, 50, and 51 E., and T. 20 N., Rs. 52 and 53 E. The surface adjacent to the divide has been deeply cut by streams, causing sharp grades and in some places nearly vertical cliffs.

Most of the area is drained by the Redwater River (Howard, 1960, pl. 2), which has a lowest altitude of less than 2,200 feet in T. 22 N., R. 50 E. The total relief of the Northeast Circle area is greater than 1,000 feet.

Climate, Vegetation, and Economy

The mean annual precipitation of the area is from 8 to 16 inches. The mean monthly precipitation is less than 1 inch from October through March and from 1 to 3 inches the rest of the year. There are about 30 days annually when the mean daily high temperature is 90°F and above, and an average of 160 days annually with daily temperatures of 32°F and below. (See U.S. Geological Survey, 1970, p. 97-99, 108.)

The natural vegetation (if undisturbed by man) varies from wheatgrass-needlegrass (Agropyron-Stipa) to grama-needlegrass-wheatgrass (Bouteloua-Stipa-Agropyron) (U.S. Geological Survey, 1970, p. 90-91).

Economic development in the area has been closely connected to the agricultural use of the land. The area is mostly used as cropland and grazing land, but some areas have such a light rainfall that dry farming is limited and grazing is kept to a minimum. (See U.S. Geological Survey, 1970, p. 108, 158-159.)

STRATIGRAPHY

The Northeast Circle area is almost entirely underlain by the Tongue River Member of the Paleocene Fort Union Formation. The stratigraphically lower Lebo Member of the Fort Union crops out in secs. 6, 7, and 18, T. 22 N., R. 47 E. (Collier and Knechtel, 1939, pl. 1) and in secs. 1 and 2, T. 22 N., R. 50 E. (Parker, 1936, pl. 22). The Tongue River Member is composed of yellowish or light-colored sandstone and sandy shale (Collier and Knechtel, 1939, p. 12) and contains coal beds that are useful as marker beds for stratigraphic and structural control.

Interpretations of drill-hole logs indicate that six laterally extensive beds (S, L1, R, Q, P, and Pust, in ascending stratigraphic order) occur in the lower 500 feet of the Tongue River Member. Readings of various logs show the strata to be virtually barren of coal for hundreds of feet above and below the lower 500-foot interval (pl. 1). The remaining deposits in the area are surficial and consist of non-glacial gravels, glacial drift material, and flood-plain deposits (Howard, 1960, p. 17, pl. 1).

THIS REPORT	WINCENTSEN, 1978	MATSON, 1970	COLLIER AND KNECHTEL, 1939	PARKER, 1936
PUST	———	———	———	PUST
P	P	P	P	STILLSON
Q	Q	Q	Q	GAINES
R	R	R	R	BUTTERFIELD LANE SOLACK
LI	LI LOCAL	LOCAL	LOCAL	LOCAL
S	S	S	S	CARROLL

Figure 3. Correlation of the names of the coal beds, Tongue River Member, Fort Union Formation

STRUCTURE

The structural interpretation of the Northeast Circle area is based on a structure-contour map of the top of the S coal bed. The S bed was selected because of its large areal extent and lateral continuity.

The area is located in the Williston basin. However, the regional dip of about 25 feet per mile (0.27°) to the northeast, as reported by Denson and Gill (1965, p. 26), is not apparent. At most places, the beds of the area are very gently folded to nearly flat. The northeast end of the Weldon monocline fault (Collier and Knechtel, 1939, p. 17) is present in Tps. 21 and 22 N., R. 47 E., and dips in that area vary from 0.23° S to 0.49° SE. A small basin is located near Circle in sec. 10, T. 19 N., R. 48 E. (pl. 4).

COAL

Stratigraphic Position and Character of Coal Beds

The names applied to the coal seams in this report are derived in part from earlier reports (fig. 3). The Pust, P, Q, R, Ll, and S beds occur in a well-defined zone in the lower 500 feet of the Tongue River Member (Collier and Knechtel, 1939, p. 12). In some deep wells, coal beds of the Lebo Member have been found (pl. 1). These beds are identified as the T and U (Collier and Knechtel, 1939, p. 13) and they lie more than 380 feet below the base of the S bed. Because the T and U beds could not be identified in more than two holes, detailed work was not done on these beds.

The lowest coal bed in the Tongue River Member is the S bed which occurs as a single unit in about half the area, and in the other half it usually splits into two main benches (pl. 5). Interburden between the splits becomes as great as 56 feet in sec. 26, T. 21 N., R. 51 E. Coal thickness in the lower bench is greater than 10 feet near Circle and thins to the east, north, and south (pl. 3). The upper bench ranges in thickness from 0 to 14 feet in T. 19 N., R. 49 E. (pl. 2), and also thins in all directions except west (Wincentsen, 1978).

Where both benches merge into a single bed, a maximum thickness of 21 feet is obtained in sec. 2, T. 19 N., R. 48 E. (pl. 2). The S bed maintains a thickness greater than 6 feet along the Redwater River but splits and thins to the north along Cow Creek (pl. 2).

The L1 bed is the next stratigraphically higher coal seam. The interburden between the L1 and S beds ranges in thickness from slightly less than 30 feet to at least 80 feet. The seam is generally less than 5 feet thick, but in T. 20 N., R. 49 E., it thickens to 9 feet, not including a 3-foot parting. In the northern part of the area the L1 bed thins to 2 feet or less (pl. 6).

The R bed, about 130 feet above the S bed, ranges in thickness from 0 to 8 feet (pl. 7) in the upper seam. This bed is generally found as two benches, sometimes separated by about 20-30 feet of interburden. In addition to the two benches of the R bed, some lenticular seams are located in the R horizon along the eastern edge of the area. These seams do not correlate with either bench of the R bed and are designated RL.

Bed Q, the next higher bed, is commonly found as two or more benches, each usually less than 4 feet thick. Interburden between the S and Q beds ranges in thickness from slightly less than 220 feet to at least 310 feet (pl. 8).

The P bed overlies the S bed by 230 feet to greater than 380 feet. The thickness of the coal varies from 0 to at least 10 feet, not including a small rock split that is sometimes present (pl. 8).

The Pust bed is the highest bed studied in the area and is found near the top of the Yellowstone-Redwater divide. Interburden between the S and Pust beds ranges in thickness from slightly less than 430 feet to at least 490 feet. The Pust bed has several splits in the area. The three upper splits belong to an upper bench and there is a single lower bench (Spencer, 1976, pl. 8). Discounting the interburden between splits, the coal ranges in thickness from 0 to 18 feet in the upper bench, and drill-hole data for the lower bench show a maximum thickness of 9 feet and a minimum thickness of 2 feet (pl. 4).

Rank and Quality of the Coal

All coals in the area rank as lignites (Parker, 1936, p. 144; Collier and Knechtel, 1939, p. 22). Physical properties of the coal include a subconchoidal fracture and a brown streak from a fresh surface. Exposure to the air allows moisture to escape from the coal, which reduces the mass to fine grains or powder (Parker, 1936, p. 142-143).

Coals thicker than a few feet have sometimes burned along their exposures and, in some instances, several feet beneath the overburden. This burning has produced areas consisting of red- or pink-colored baked and fused rock.

History of Mining and Future Prospects

During the past, small-scale operations produced coal for local domestic use from all coal seams (Parker, 1936, p. 145 - 146; Collier and Knechtel, 1939, pl. 1), but production declined rapidly in the late 1930's and early 1940's. At present, there are no known active mines in the area.

The future development of the Northeast Circle area coal deposits will be in those areas where large-scale mining could be economic. Those areas include the deposits of the S bed along the Redwater River drainage, Duck Creek, and part of Cow Creek (pl. 2); parts of the Pust bed in T. 20 N., Rs. 52 and 53 E. (pl. 4); and possibly certain areas of the P bed (pl. 8). Structural and topographic conditions, the character of each coal bed, and future demands influence the extent of minable coal.

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