UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COAL GEOLOGY OF THE GIRARD AREA, RICHLAND AND ROOSEVELT COUNTIES, MONTANA

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Open-File Report 80-213

1980

This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

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[Plates in pocket]

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CONVERSION TABLE

To convert English units	Multiply by	To obtain metric units
Feet	0.3048	meters
Miles	1.609	kilometers
Short tons	.9072	metric tons
Acres	.4047	hectares

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INTRODUCTION

A study of the Girard area is being conducted by the U.S. Geological Survey as part of a program to evaluate and classify coal lands in the Paleocene Fort Union Formation. The area is located in eastern Richland and southeastern Roosevelt Counties, Montana (fig. 1). Twenty-five townships, approximately 538,000 acres, are included in the area. It is irregularly bounded on the east by the Montana-Dakota border, on the north by T. 27 N., on the west by R. 54 E., and on the south by T. 23 N.

There are four main coal beds in the area. From oldest to youngest, these beds are the D, Elvirio, Bruegger, and Prittegurl. A fifth bed, the E, is exposed in a limited area in T. 27 N., Rs. 54 and 55 E.

Previous Work

The coal beds in T. 27 N., Rs. 54-56 E., were first described by Smith (1910) as part of the Survey's program to classify coal lands. Prichard and Landis (1975) mapped the Girard coal field and Beekly (1912) mapped the Culbertson lignite field. Figure 2 shows the location of the areas discussed in these previous reports.

The U.S. Geological Survey and the Montana Bureau of Mines and Geology (USGS-MBMG) conducted several drilling programs in the area during 1976-78.

Present Investigation

This report describes the lignite-rank coal deposits of the Tongue River Member of the Fort Union Formation.

Data from the holes drilled by the USGS-MBMG (1976, 1977, 1978), as well as detailed mapping by the author in the Twomile Creek and Cedar Coulee quadrangles (unpublished; fig. 2), were used to compile this report.

GEOMORPHOLOGY

The Missouri and Yellowstone Rivers flow across the study area. Their confluence is several miles east of the Montana-North Dakota border.

The topography of the Girard area ranges from badlands along the Missouri and Yellowstone Rivers to rolling uplands covered by glacial drift. The badlands along the Missouri River reach a maximum relief of 460 ft in T. 26 N.,

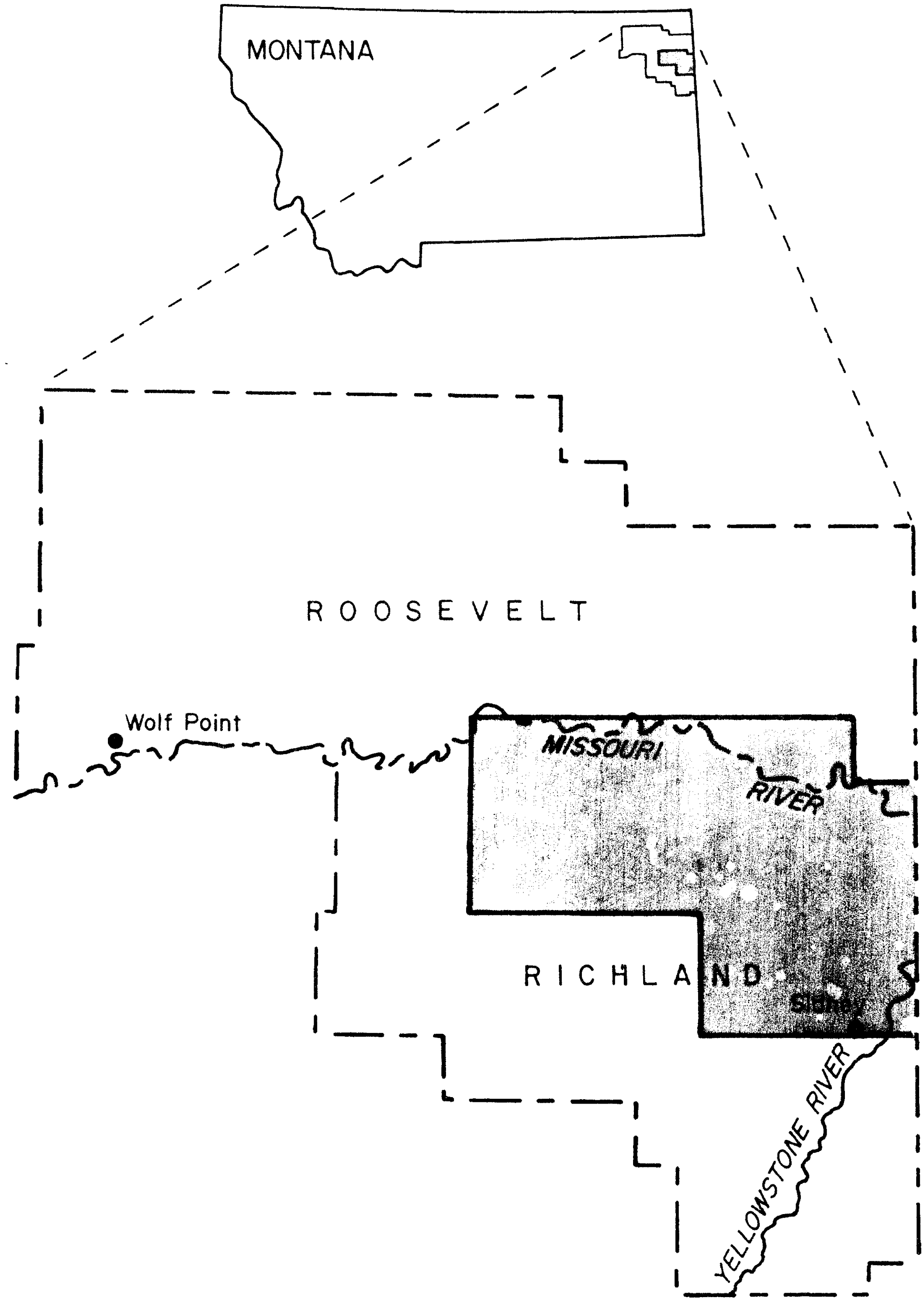

Figure 1.--Location of the Girard area within Richland and Roosevelt Counties, Montana

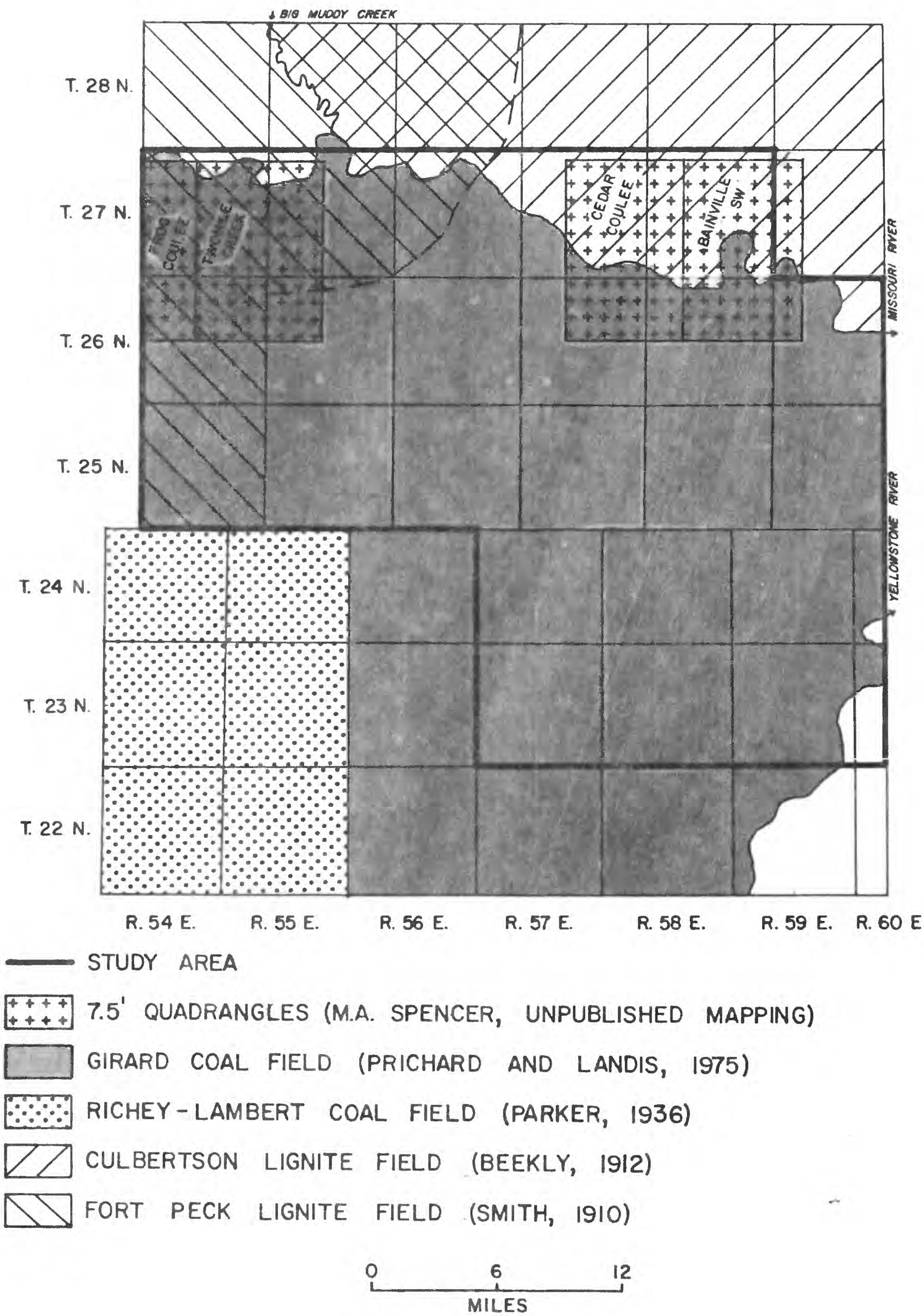

Figure 2.--Index map showing areas of previous work and unpublished mapping in the Girard study area, Richland and Roosevelt Counties, Montana

R. 57 E. Many of the narrow ridges in the badlands are capped by a thin cover of glacial material. The amount of glacial cover on the uplands is greatest south of the Missouri-Yellowstone-drainage divide, which trends from the southeast quarter of T. 25 N., R. 56 E., to the central part of T. 26 N., R. 59 E. Numerous glacial diversion channels were mapped by Prichard and Landis (1975, pl. 1), most of them south of the divide. On the terraces marking former positions of the Yellowstone River valley in Tps. 23 and 24 N., the glacial drift is underlain by gravel.

The Missouri River valley and its tributaries exhibit several stages in evolution as a result of glaciation. In reaches where the river flowed prior to glaciation, the valleys are broad. The tributaries in these reaches have broad alluvium-filled valleys in which the present streams are incised. In drill-hole US-7576, sec. 15, T. 27 N., R. 55 E., 180 ft of undivided Quaternary deposits were penetrated. The surface elevation of 1,960 ft is about 30 ft above the Hardscrabble Creek valley floor and about 60 ft above the Missouri River. Bedrock was not penetrated in this hole. No other data are available on the depth of fill in this reach of the Missouri River.

The post-glacial reach of the Missouri River valley, between sec. 3, T. 27 N., R. 56 E., and sec. 32, T. 27 N., R. 58 E., is narrow by comparison with the reaches upstream and downstream. Also, in this reach, the tributaries generally occupy much narrower valleys. In sec. 35, T. 27 N., R. 57 E., Beekly (1912) reported that a 20-ft coal bed was penetrated at 90 ft below the flood plain. No other data on the depth to bedrock are available for the post-glacial reach.

STRUCTURE

The Girard area is located on the western flank of the Williston basin. The regional dip averages 25 ft/mi to the northeast, but exceeds 100 ft/mi locally. The coal beds dip more steeply in an area from T. 27 N., R. 54 E., to T. 25 N., R. 56 E. This trend is indicated by the D bed and Elvirio bed structure-contour maps (pls. 1, 2) and parallels the Poplar anticline that is west of the study area.

The coal beds are gently undulating. This is especially apparent in exposures along the Missouri River bluff in the Cedar Coulee quadrangle (fig. 2).

STRATIGRAPHY

The bedrock in the area is the Tongue River Member of the Paleocene Fort Union Formation. Stratigraphically, the Tongue River lies above the Lebo Shale Member and below the Sentinel Butte Member, also in the Fort Union Formation.

The rock types are interbedded sandstone, siltstone, claystone, and coal. The sandstone, siltstone, and claystone weather to a light-gray to buff color although the rock cuttings from drill holes are generally gray with blue or green tint occasionally seen. The coal beds are the most laterally continuous rock type in the Tongue River Member and are used for regional correlations.

The Lebo Shale-Tongue River contact is chosen primarily on the basis of color change. Using this criterion, a tentative conformable contact can be identified in sec. 7, T. 27 N., R. 54 E., in the Frog Coulee quadrangle. Prichard and Landis (1975) suggested that a small area of the Girard field may have remnants of the Sentinel Butte Member overlying the Tongue River. This contact may coincide with the nonpersistent coal bed 170 ft above the L bed of the Tongue River (Prichard and Landis, 1975; generalized section, pl. 4).

COAL

Five coal beds mapped by Prichard and Landis (1975) have been identified on drill-hole logs. Four of these beds--the D, Elvirio, Bruegger, and Pritteगurl--are evaluated in this report. The fifth bed, the E, is exposed in a limited area in T. 27 N., Rs. 54 and 55 E., and thins rapidly eastward from a maximum thickness of 10 ft in sec. 22, T. 27 N., R. 54 E. Where the E bed is present in the subsurface, it is indicated on the log data. Other coal beds are reported for some drill holes, especially in the eastern part of the study area; however, because of limited data, these beds have not been evaluated.

The C bed, mapped by Smith (1910), is not thick enough to evaluate. It can be identified in drill holes where it occurs below the D bed in the northern part of the study area (pls. 1, 6; pl. 5, line A-A').

Table 1 shows the correlation of coal beds as proposed by Prichard and Landis (1975). On the basis of drilling information acquired since 1975, some revisions in correlation are proposed in table 2. Chemical analyses of the coal beds are given in table 3. Three samples from locations outside the Girard base-map area are included to show representative values for the beds in question. The Elvirio Mine is located one mile south of sec. 34, T. 25 N., R. 54 E. The Bruegger mine is approximately 5 miles north of sec. 5, T. 27 N., R. 56 E. Mines in the Girard area are shown on plate 1.

D bed.--The D bed was first mapped by Smith (1910). Prichard and Landis (1975) used the same terminology for the bed in the Girard coal field. This same bed was mapped in detail by the author in Twomile Creek and Frog Coulee quadrangles (fig. 2).

Table 1.--Correlation of coal beds in the Girard and adjoining coal fields
[Modified from Prichard and Landis, 1975,
----- dashes quoted from original source]

Coal field				
			Girard	
Fort Peck (Smith, 1910)	Culbertson (Beekly, 1912)	Richey-Lambert eastern part (Parker, 1936)	Northern (Prichard and Landis, 1975)	Southern (Prichard and Landis, 1975)
-----	G bed	-----	L bed	Gardner bed
-----	Unnamed beds	-----	K bed	K bed
-----	F bed	Prittegurl bed	H bed	Prittegurl bed
G bed	E bed	Pust bed	G bed	Pust bed
F bed	DD bed	Elvirio bed	F bed	Sears bed
E bed	CC bed	-----	E bed	-----
D bed	D bed	Lane bed	D bed	-----

Table 2.--Proposed coal bed correlations in the Girard and adjoining coal fields with names used in this report

[----- No correlative bed surface-mapped in given coal field]

	Coal field				
				Girard	
This report	Fort Peck	Culbertson	Richey-Lambert eastern part	Northern	Southern
Prittegurl	-----	F	Prittegurl	H	Prittegurl/ Gardner
Bruegger	G	E	-----	G	Prittegurl
Elvirio	F	DD	Elvirio	F	-----
E	E	CC	-----	E	-----
D	D	D	-----	D	-----
C	C	-----	-----	-----	-----

Variations in thickness of the D bed are illustrated by the isopach map (pl. 6). In exposures along the Missouri River, two or three thin partings can be identified in the coal. On the basis of structure contours drawn on top of the D bed (pl. 1), the dip exceeds 100 ft/mi in the northwestern part of the study area.

The heating value of a core sample from the D bed in sec. 22, T. 27 N., R. 54 E., is 6,790 Btu/lb on an as-received basis. The results of other analyses of the samples are given in table 3.

Prichard and Landis (1975) suggested that the D bed is correlative with the Lane bed of the Richey-Lambert field (Parker, 1936). No correlation of the D and Lane beds is proposed in this report for three reasons: (1) No surface mapping has been done between the Lane bed in T. 24 N., R. 53 E., and the D bed; (2) data acquired from drilling in the unmapped area during 1975 (U.S. Geological Survey and Montana Bureau of Mines and Geology, 1976) are inconclusive; and (3) there are uncertainties in correlations of other beds in the stratigraphic sequence.

Elvirio bed.--The Elvirio bed was first mapped as the F bed by Smith (1910) in T. 27 N., Rs. 55 and 56 E. Prichard and Landis (1975) continued the use of the letter designation when they mapped the northern part of the Girard coal field (table 1). The name Elvirio was established by Parker (1936) from the Elvirio mine in sec. 12, T. 24 N., R. 54 E. The outcrop of the bed in the Richey-Lambert field can be followed to the F bed at the southern edge of T. 25 N., R. 55 E., in the Girard field.

The isopach map of the Elvirio bed (pl. 7) shows the complex nature of the bed. Near the center of deposition in Tps. 25 and 26 N., Rs. 57 and 58 E., the coal has no partings and attains a maximum thickness of 19 ft in sec. 24, T. 26 N., R. 57 E. To the north and west, the bed splits into a thin upper bench and a thick lower bench. To the east and south, the bed also splits--a thick upper bench and a thin lower bench. In T. 26 N., R. 59 E., the relationship of the benches is uncertain, as indicated on the isopach map (pl. 7). In several locations it is difficult to determine the presence or thickness of benches: (1) in Tps. 25 and 26 N., R. 55 E., because of the relatively poor exposures and lack of drilling data; (2) in T. 27 N., Rs. 54-56 E., because massive baked and fused rock, formed by the burning of the Elvirio bed, caps the ridges; and (3) in the southern part of the study area, where the bed is thinnest (pl. 7), only subsurface data are known. Total coal thicknesses are shown on plate 8.

Table 3.--Analyses of lignite samples from four beds in Richland and Roosevelt Counties, Montana

[A, as received; B, moisture free; ----, no data]

Name of bed	Location			Type of anal-ysis	Proximate analysis (percent)				Ultimate analysis (percent)	Heating value Btu/lb	Source[1]
	Sec.	T.N.	R.E.		Moisture	Volatile matter	Fixed carbon	Ash	Sulfur		
D, US-7580------------------	22	27	54	A	34.9	27.1	30.4	7.6	0.5	6,790	1
				B	----	41.6	56.8	11.6	.8	10,433	
Elvirio, US-7595------------	13	26	55	A	38.0	26.4	28.5	7.1	1.2	6,667	1
				B	----	42.5	46.0	22.5	1.9	10,747	
Elvirio at Jennison mine----	17	27	56	A	38.9	24.9	29.1	7.1	.4	6,540	2
				B	----	40.7	47.7	11.6	.7	10,710	
Elvirio at Elvirio mine-----	12	24	54	A	38.3	25.7	30.0	6.0	.5	6,710	3
				B	----	41.6	48.6	9.8	.8	10,880	
Bruegger at Bruegger mine---	8	28	56	A	43.2	22.0	29.0	5.8	.3	5,999	4
				B	7.3	35.9	47.3	9.5	.5	9,787	
Bruegger at Bruegger mine---	8	28	56	A	32.6	27.4	30.9	9.1	1.3	6,710	5
				B	11.8	35.9	40.4	11.9	1.7	8,790	
Prittegurl at Crosby mine---	20	25	56	A	38.2	26.7	27.6	7.5	.8	6,670	2
				B	----	43.3	44.6	12.1	1.4	10,790	
Prittegurl at O'Connor mine-	9	26	57	A	41.5	24.6	27.2	6.7	.7	6,270	2
				B	----	42.1	46.4	11.5	1.1	10,730	

[1] 1, U.S. Geological Survey and Montana Bureau of Mines and Geology (1976); 2, Prichard and Landis (1975); 3, Parker (1936); 4, Smith (1910; 5, Beekly (1912).

Because of the wide areal extent of the Elvirio bed, the structure-contour map of this bed (pl. 2) best illustrates the regional structure of the study area.

A sample from the Elvirio bed (sec. 13, T. 26 N., R. 55 E.) has a heating value of 6,667 Btu/lb on an as-received basis. Results of this analysis and two analyses from other localities of the Elvirio bed are given in table 3.

Bruegger bed.--The Bruegger bed was first mapped by Smith (1910) as the G bed (tables 1, 2) on both sides of the Missouri River. At that time, it was being mined at the Bruegger mine, sec. 8, T. 28 N., R. 56 E. Beekly (1912) mapped the same bed in the Culbertson lignite field, although he called it the E bed. Prichard and Landis (1975) mapped the G bed east of the area of Smith's report. The name Bruegger has been adopted for use in this report.

West of Tps. 25-27 N., R. 57 E., the Bruegger bed is less than 5 ft thick and has not been included for evaluation (pl. 6). The Bruegger bed is thickest in the vicinity of T. 26 N., R. 58 E., and north of the Missouri River.

On the basis of detailed mapping of the Cedar Coulee and Bainville SW quadrangles, the author has revised the mapping of the Bruegger, Prittegurl, and K beds of Prichard and Landis (1975, pl. 1). These beds are exposed in the bluff between secs. 3 and 6, T. 26 N., R. 58 E. (pls. 6, 9). The Bruegger bed dips beneath the surface in sec. 8 and is exposed again at an abandoned drift mine in the NE¼ of sec. 9, where it exceeds 7 ft in thickness (including a thin claystone parting and a thin coal bench at the base). At this location, the interval between the Bruegger and overlying Prittegurl bed is 51 ft (pl. 10). In sec. 6, the interval is 76 ft and in sec. 1, T. 26 N., R. 58 E., at drill-hole US-75122, the interval is 37 ft.

Three USGS-MBMG drill holes and two oil wells are located in T. 25 N., R. 56 E. The Bruegger bed is not present in the subsurface at any of these locations. In T. 25 N., R. 55 E., there is no coal mapped in the interval between the Elvirio and Prittegurl bed exposures (Prichard and Landis, 1975).

In the southern part of the study area, the Bruegger bed is known mainly from subsurface data. In three oil wells (OW-22, OW-32, OW-41) in Tps. 23 and 24 N., the bed, if present, is too thin to be interpreted from the logs. The Bruegger is exposed in a limited area in Tps. 23 and 24 N., R. 59 E. On the basis of regional subsurface correlations (pls. 4, 5), it was mapped in those townships as the Prittegurl by Prichard and Landis (1975).

Analyses of samples of coal from the Bruegger mine are shown in table 3. The average heating value is 6,355 Btu/lb on an as-received basis.

Prittegurl bed.--The Prittegurl bed was mapped by Prichard and Landis (1975) as the H bed in the northern part of the Girard field and as the Prittegurl bed in the southern part in Tps. 23 and 24 N., R. 56 E. (table 1). The name originated from the Prittegurl mine (sec. 26, T. 24 N., R. 55 E.) in the Richey-Lambert field (fig. 2), which is west of the Girard area where Parker (1936) mapped the bed. Beekly (1912) mapped this bed as the F bed north of the Missouri River. The name Prittegurl is adopted for use in this report. It is the uppermost coal that is thick enough to be evaluated in this study (pl. 12).

The Prittegurl bed is thickest in the vicinity of its outcrop in T. 25 N., R. 56 E. (pl. 9). In exposures along Otis Creek in the NW¼ of T. 26 N., R. 58 E., the bed splits and thins eastward. The author has revised the mapping of the Prittegurl and Bruegger beds east of sec. 6, T. 26 N., R. 58 E. Between secs. 8 and 3, T. 26 N., R. 58 E., the Prittegurl was mapped as the K bed by Prichard and Landis (1975, pl. 1). The bed thins eastward toward the SW¼SE¼ of sec. 3, where it dips below the flood plain of the Missouri River. Changes in the thickness of the interval between the Prittegurl and the Bruegger are observed in the exposures and in drill-hole US-75122, located along the bluff (pl. 1).

On the basis of subsurface data, exposures of the coal mapped as the Gardner bed by Prichard and Landis (1975) in the southern part of the Girard field are correlative with the Prittegurl bed. These exposures are located near OW-37 in sec. 24, T. 23 N., R. 57 E., and in Tps. 23 and 24 N., R. 59 E., north of Sidney.

The average heating value of two samples of the Prittegurl bed is 6,470 Btu/lb. Both samples were obtained from mines in the Girard field. Results of other analyses of the samples are given in table 3.

Resources.--Two criteria were used to determine the identified resources of the four coal beds: lignite must be at least 2.5 ft thick and must not occur at depths greater than 6,000 ft (U.S. Bureau of Mines and U.S. Geological Survey, 1976). Coal resources are not reported by overburden categories because overburden isopachs (pls. 10, 11, 12) cannot be drawn for areas lacking topographic coverage. Most of the coal reserve base under less than 120 ft of overburden is in the valleys and badlands of the Missouri and Yellowstone Rivers, areas not generally suitable for surface-mining operations.

Identified resource estimates for the four principal beds, calculated from currently available data, are:

Bed	Tons
Prittegurl------	2.2×10^9
Bruegger--------	1.9×10^9
Elvirio---------	8.2×10^9
D---------------	$.3 \times 10^9$
Total--	12.6×10^9

Coal is not being mined in the area covered by this report. Small abandoned open-pit and drift mines are scattered across the area. No accurate figures are available for the amount of coal removed by these operations, but the past production is insignificant when compared to the total estimated resources of the field.

REFERENCES CITED

Beekly, A. L., 1912, The Culbertson lignite field, Valley County, Montana: U.S. Geological Survey Bulletin 471-D, p. 319-358.

Parker, F. S., 1936, The Richey-Lambert coal field, Richland and Dawson Counties, Montana: U.S. Geological Survey Bulletin 847-C, p. 121-174.

Prichard, G. E., and Landis, E. R., 1975, Coal resources and Cenozoic geology of the Girard coal field, Richland County, Montana: U.S. Geological Survey Bulletin 1310, 89 p.

Smith, C. D., 1910, The Fort Peck Indian Reservation lignite field, Montana: U.S. Geological Survey Bulletin 381-A, p. 40-59.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

U.S. Geological Survey and Montana Bureau of Mines and Geology, 1976, Preliminary report of coal drill-hole data and chemical analyses of coal beds in Campbell, Converse, and Sheridan Counties, Wyoming; and Big Horn, Richland, and Dawson Counties, Montana: U.S. Geological Survey Open-File Report 76-450, 382 p.

_____ 1977, Preliminary report on 1976 drilling of coals in Campbell and Sheridan Counties, Wyoming; and Big Horn, Dawson, McCone, Richland, Roosevelt, Rosebud, Sheridan, and Wibaux Counties, Montana: U.S. Geological Survey Open-File Report 77-283, 403 p.

_____ 1978, Geophysical logs for Dawson, McCone, Richland, and Rosebud Counties, Montana, Chapter F of Preliminary report of 1977 coal drilling in eastern Montana and northeastern Wyoming: U.S. Geological Survey Open-File Report 77-721-F, 74 p.