UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY DIAGRAMS SHOWING CORRELATION OF COAL BEDS IN THE FORT UNION AND WASATCH FORMATIONS ACROSS THE NORTHERN POWDER RIVER BASIN, NORTHEASTERN WYOMING AND SOUTHEASTERN MONTANA

By

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Open-File report 79-1201
1979

LOCATION, PURPOSE AND SCOPE

The Fort Union (Paleocene) and Wasatch (Eocene) Formations in the Powder River Basin of northeastern Wyoming and southeastern Montana contain numerous economically important coal beds the ownership of which is largely vested in the Federal Government. The coal deposits have been studied periodically by geologists of the U.S. Geological Survey since the early 1900's, chiefly for the purposes of classifying the Public Lands and evaluating the coal resources.

In recent years much new information from coal exploratory drilling and from logs of holes drilled for oil and gas, has revealed inconsistencies in some of the earlier coal-bed correlations, has shown some duplication in the naming of beds in different areas or drainage basins, and has revealed deep coal beds that are not readily correlated with named beds at the surface.

The accompanying diagrams show correlations of coal beds in selected drill holes and surface sections along two lines of section across the Powder River Basin near the Montana-Wyoming border. The identification of the beds and their correlation are based on interpretations of the geophysical logs of all holes drilled for oil and gas in the area, supplemented by information from the logs of shallow holes and from surface mapping. The area studied extends from the vicinity of Sheridan, Wyoming and Decker, Montana eastward for about 130 km (80 miles) to the vicinity of Recluse, Wyoming. Sheet 1 shows the correlation of coal beds in northern Wyoming. Sheet 2 shows the correlation of coal beds mostly in Montana. Two of the drill holes (9 and 13) are common to both diagrams.

The diagrams show the distribution of coal across the Powder River Basin, and relate coals on the west side of the basin to those on the east side. They show, also, coal-bed names used in current reports by the U.S. Geological

Survey in the part of the basin covered by the diagrams, including names used for the deeper coals that are remote from their outcrops. The diagrams are intended to help clarify the correlations and nomenclature of coal beds for use in coal resource and other geologic studies in the basin.

ACKNOWLEDGEMENTS AND RELATED WORK

Many people have contributed to the work shown here, either by their own field studies, or by their review and discussion of the correlation diagrams. These contributors include D. J. Allen, B. E. Barnum, N. M. Denson, G. L. Galyardt, G. H. Horn, W. R. Keefer, B. E. Law, E. R. Landis, N. E. Micklich, and E. M. Schell, and we hereby acknowledge their help. However, the correlations and nomenclature shown on the diagrams are those preferred by the authors; they do not everywhere reflect the unanimous opinion of the other workers in the basin.

Matson, Blumer, and Wegelin (1973) published several correlation diagrams of the upper coal beds in southeastern Montana that they prepared in connection with their investigations of strippable coal deposits. One of their correlation diagrams, D-M, roughly parallels the diagram on sheet 2 of this report. Law, Barnum, and Wollenzien (in press) have prepared a fence diagram correlating surface and subsurface coal beds in the Sheridan, Wyoming-Decker, Montana areas. It presents an integrated picture of the distribution of coal in the area west of, and including, the west ends of the two diagrams shown here.

FORMATIONS INCLUDED

The Tongue River Member of the Fort Union Formation contains most of the coal in the area studied. The member is locally more than 2000 feet (610 m) thick and consists of sandstone, siltstone, and shale, occasional thin lenses of limestone, and thick, persistent beds of coal. The underlying Lebo Shale

Member of the Fort Union Formation which partly intertongues with Tongue River Member is a sequence up to 1400 feet (427 m) thick consisting largely of mudstone, shale, a few beds of sandstone, and minor beds of coal. The Tullock Member of the Fort Union Formation which underlies the Lebo Shale Member is mostly thin-bedded siltstone and sandstone that locally contains a few stringers of coal.

The Wasatch Formation overlies Tongue River Member of the Fort Union Formation and also consists of sandstone, siltstone, shale, and coal. The contact between the Fort Union and Wasatch Formations was defined by Thom and Dobbin (1924) to be at the Roland bed as identified by Taff (1909) near Sheridan, Wyoming. This bed, however, pinches out a short distance from where it was named. In Montana, Baker (1929) placed the contact at a stratigraphically higher bed, which he and Bass (1924) thought to be the Roland. This bed is now referred to as the Roland of Baker (1929). Because no other contact is obvious in the gradational and changing lithologies of the Fort Union and Wasatch Formations near the Montana-Wyoming State line, most subsequent investigators in this area have used the persistent Roland coal bed of Baker (1929) as the contact between the formations, including Bryson and Bass (1973), Olive (1957), Matson, Blumer, and Wegelin (1973), and Culbertson and Mapel (1976).

The rank of the coal in the Fort Union and Wasatch Formations ranges from lignite to subbituminous A.

IDENTIFICATION OF COAL BEDS ON GEOPHYSICAL LOGS

Gamma ray and electric logs are commonly available and have been used for identifying coal in the wells shown on the diagrams and in the nearby wells consulted in making coal-bed correlations. Gamma ray logs are excellent for showing coal because of the low natural radioactivity of coal, and because

gamma ray logs are unaffected by the steel casing generally present in the upper part of the oil and gas test holes. Electric logs cannot be made where the hole is cased.

The electrical resistivity logs are fairly reliable for identifying coal because of the high resistivity of coal; however, sandstone saturated with fresh water and limestone are also highly resistive, and may be mistaken for coal on resistivity logs. The spontaneous-potential log that accompanies the resistivity log cannot be used alone for identifying coal, but locally may be helpful in distinguishing between coal and sandstone. If available, the acoustic velocity log is diagnostic in distinguishing between coal and limestone. Density logs also are useful in identifying coal, but density logs are not common. Where gamma ray, density or acoustic velocity logs are available, investigators generally agree on the identification of coal beds. Where resistivity and self-potential logs are the only logs available, investigators may disagree about the presence of a coal bed at a given horizon.

RELIABILITY OF THE CORRELATIONS

Coal beds in this area offer many problems of correlation over long distances. The coals and other strata of the Fort Union and Wasatch Formations were deposited in complex paludal and fluvial systems in an unevenly subsiding basin. Individual coal beds thicken, thin, disappear, reappear, split, and merge as they are traced from one locality to another in outcrop areas or from one drill hole to another in the subsurface. Some coals that are correlated as a single bed among widely spaced points of observation may actually be unconnected lenses of coal that were deposited more or less contemporaneously. Because of these complexities, reliable coal-bed correlations require drill holes or other points of information that are

closely spaced. Deep holes useful in correlating coal beds are relatively abundant east of drill hole 13 on sheet 1. West of drill hole 13, however, the density of deep holes for both diagrams ranges from 0 to 6 per township, averaging only about 3 wells per township. Although all available drill hole data was examined, locally the spacing of holes is inadequate for correlating some coal beds with confidence, or for determining details of coal-bed distribution. As a result, correlations of some coal beds, particularly the deeper coal beds in areas of sparse drilling, are regarded as tentative. The correlations shown on the diagrams may be revised locally as more holes are drilled and better logs for identifying coal become available, and as the regional distribution of the coals becomes better known.

COAL BED NAMES

Origins of the coal-bed names used on the diagrams are listed in table 1. The index map accompanying the diagrams shows the places where the beds were named.

Taff (1909) in his work in the Sheridan coal field, north of Sheridan, Wyoming, established the first systematic nomenclature for coal beds in the Tongue River Member of the Fort Union Formation in the northern part of the Powder River Basin. In Montana, in the northern extension of the Sheridan coal field, Baker (1929) established a nomenclature that used some names from Taff (1909) some from Bass (1924) and a few new ones. For the Moorhead coal field, which adjoins Baker's area on the east, Bryson and Bass (1973) based their nomenclature on that of Baker (1929) but also used names from Warren (1959) who mapped the Birney-Broadus coal field to the north. Because of uncertainties in correlation across broad stream valleys or broad divides, Bryson and Bass (1973) used a total of 29 names and numbers to identify the Tongue River coal beds. In Wyoming, Olive (1957) followed the nomenclature of

Baker (1929) for coal beds in the Spotted Horse coal field, which lies south of the Moorhead field. Subsequent authors, in general, have followed the nomenclature of one or more of the previous investigators, but some have created new names for coal beds in drill holes or outcrops where the coal beds could not be correlated with previously named beds. The names used on the accompanying diagrams are those in common use in the areas indicated.

The names Cook, Wall, Pawnee, and Cache were tentatively introduced into the Recluse area, Wyoming by McKay (1973). Those coal beds have not been traced with certainty from the Recluse area to the places in Montana where they were previously named. New names would probably be appropriate for those coal beds on the east side of the Powder River Basin in Wyoming.

Table 1.-- Origin of coal bed names used on correlation diagrams

Anderson	Baker (1929)
Arkansas	Culbertson and Mapel (1976)
Arvada	Stone and Lupton (1910)
Badger	Baker (1929)
Bar N	Culbertson and Mapel (1976)
Brewster-Arnold	Bass (1924)
Burgess	Culbertson and Mapel (1976)
Cache	Warren (1959)
Canyon	Baker (1929)
Carney	Taff (1909)
Cook	Bass (1932)
Dietz 1	Taff (1909)
Dietz 2	Taff (1909)
Dietz 3	Taff (1909)
Heppner	Culbertson and Mapel (1976)
Kendrick	Culbertson and Klett (1979)
King	Warren (1959)
Knobloch	Bass (1924)
Monarch	Taff (1909)
Otter	Bryson and Bass (1973)
Pawnee	Warren, W. C. (unpublished map, 1938)
PK	Culbertson and Mapel (1976)
Roberts	Culbertson and Klett (1975)
Roland	Taff (1909)
Smith	Taff (1909)
Waddle	Culbertson and Klett (1979)
Wall	Baker (1929)
White	Culbertson and Klett (1979)
Wyarno	Culbertson and Mapel (1976)

Table 2.--Names of 7 1/2 minute quadrangle maps outlined on Index Map

Map number	Name
A	Pearl School
B	Decker
C	Holmes Ranch
D	Pine Butte School
E	Forks Ranch
F	Quietus
G	Bear Creek School
H	Sayle Hall
I	Acme
J	Bar N Draw
K	Cedar Canyon
L	O T O Ranch
M	Roundup Draw
N	Box Elder Draw
O	Cabin Creek NW
P	Cabin Creek NE
Q	Black Draw
R	Dead Horse Lake
S	Corral Creek
T	Homestead Draw

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ADDITIONAL COMMENTS
(keyed to numbers shown on lines of section).

1. See discussion of Wasatch-Fort Union contact in text under "Formations included".
2. The Smith coal bed could not be identified on the gamma ray log of this well although it is believed to be present. The gamma ray log appears to be defective from the surface to a depth of about 550 feet.
3. The correlation of the thick Wall bed in Montana with the thin beds below the Otter in column 24 is uncertain. West of the locality where it was named in Montana (see index map) the Wall bed is 30 to 60 feet thick. The Wall pinches out southward in Wyoming, and thins abruptly eastward, but it is unclear whether it pinches out, continues as a much thinner bed or splits into two or more beds in a southeasterly direction. Until further drilling clarifies the relationship of the Wall to the thin beds below the Otter, it seems unwise to continue the name Wall in the eastern part of the basin.
4. East of locality 9 the one main coal bed between the Anderson and Canyon coal bed is referred to as Dietz, following the usage of Baker (1929). Its correlation with the Dietz 2 or 3 of the western area is uncertain.
5. Pawnee, Odell, Poker Jim, Dunning, and Cache are names used in southeastern Montana for coal beds near the level of the Brewster-Arnold bed. Additional exploration may show that one of these names is more appropriate than Brewster-Arnold for the bed shown here.
6. The names Cook, Wall, Pawnee, and Cache are used in the sense of McKay (1973) for columns 14 to 19. See discussion in text under "Coal Bed Names".
7. Smith is used here in the sense of Olive (1957), although it is doubtful that the bed can be traced into the bed named Smith on the western side of the Powder River basin.