

# Map Showing Principal Coal Beds and Bedrock Geology of the Ucross-Arvada Area, Central Powder River Basin, Wyoming



Pamphlet to accompany Scientific Investigations Map 3240

**Cover photograph:** Hills along the east side of the Powder River in the Arvada NE 7½-minute quadrangle. Note the dark continuous zones of coal or carbonaceous shale (photograph by Carol Molnia).

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By Carol L. Molnia

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**U.S. Department of the Interior  
U.S. Geological Survey**

**U.S. Department of the Interior**  
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# Contents

Geographic and Geologic Setting—Central Powder River Basin .....	1
Description of Study Area .....	1
Previous Investigations.....	1
Current Investigation.....	2
Methodology.....	2
Stratigraphy .....	3
Coal Beds of the Ucross-Arvada Area .....	5
Smith Coal Bed .....	5
Roland Coal Bed (of Baker, 1929) .....	8
Arvada Coal Bed .....	8
Felix Coal Bed .....	8
Truman Coal Bed.....	9
Healy Coal Bed (also known as Ulm 2) .....	9
Walters Coal Bed (also known as Ulm 1).....	9
Monument Peak Coal Bed.....	10
Acknowledgments.....	10
References Cited.....	10

## Figures

1. Index map showing location of Powder River Basin, Wyoming and Montana, and Ucross-Arvada study area within the Wyoming part of the basin .....	2
2. Index map showing the geographic setting of the study area .....	3
3. Generalized stratigraphic section showing relation of principal coal beds in the Ucross-Arvada study area .....	4
4. Coquinoid beds which represent the contact between the Tongue River Member of the Fort Union Formation and the overlying Wasatch Formation .....	5
5. Arvada coal bed at locality number 11.....	8

## Tables

1. Small interval of the Wasatch Formation in the Clearmont 7½-minute USGS quadrangle.....	6
2. Location information for localities referenced in text.....	7

## Conversion Factors

Inch/Pound to SI

<b>Multiply</b>	<b>By</b>	<b>To obtain</b>
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

Altitude, as used in this report, refers to distance above the vertical datum.

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## Geographic and Geologic Setting— Central Powder River Basin

The Ucross-Arvada area is part of the Powder River Basin, a large, north-trending structural depression between the Black Hills on the east and the Bighorn Mountains on the west (figs. 1, 2) within the Northern Great Plains physiographic province. The basin is an asymmetric syncline with a long, gently dipping eastern flank and a steeply dipping western flank. The study area is near the geographic center of the basin, on the westward-dipping east limb of the structure. Detailed information on the Powder River Basin's depositional setting, coal resources, coal quality, coal-bed methane resources, and coal mining activity is given by Flores and others (1999), Scott and others (2010), and Osmonson and others (2011).

In the study area, strata typically dip less than 1 percent to the west. However, several small-scale structures cause local increases in dip and changes in dip direction. Near some faults, dips increase to as much as 50 percent for short distances. Intervals between strata are relatively consistent over large areas, but can change significantly over small distances because of facies changes.

## Description of Study Area

The study area is within the southern half of the Sheridan 30' × 60' quadrangle, Wyoming and Montana (fig. 2). (See Ver Ploeg and Boyd (2003) for a geologic map of the Sheridan 30' × 60' quadrangle.) Most of the study area is within Sheridan and Johnson Counties, Wyoming; the extreme eastern edge of the area includes part of Campbell County, Wyoming.

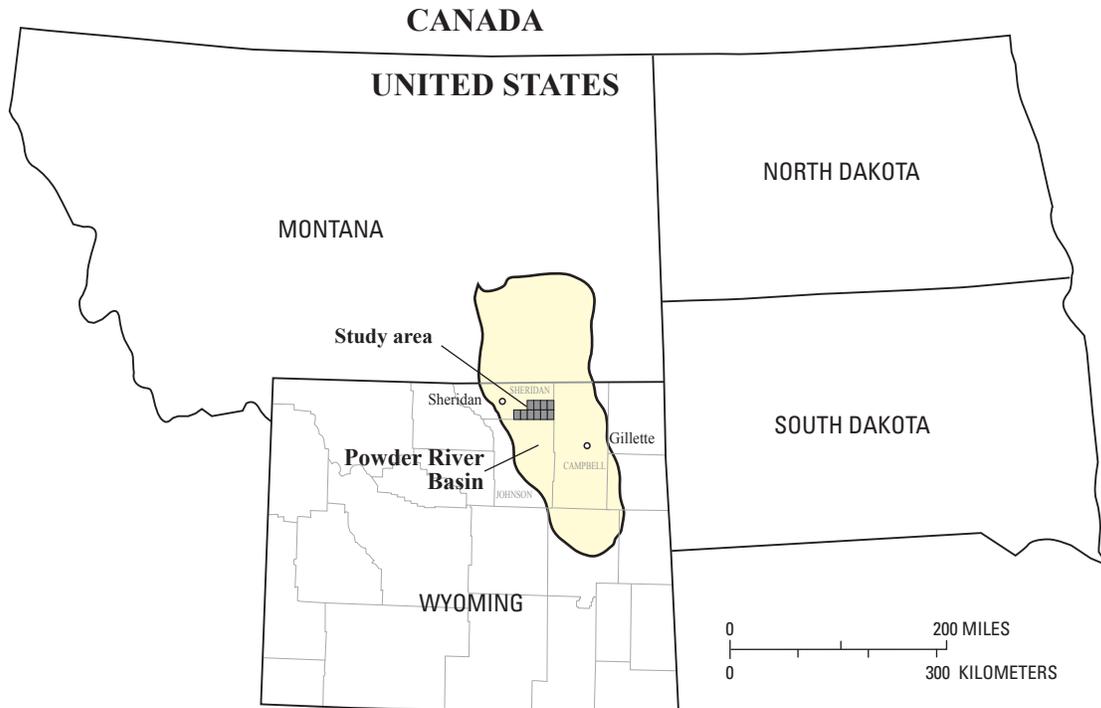
Most of the Ucross-Arvada area lies within the outcrop of the Wasatch Formation of Eocene age (fig. 3); the extreme northeast corner falls within the outcrop of the Tongue River Member of the Fort Union Formation of Paleocene age. Within the Powder River Basin, both the Wasatch Formation and the Tongue River Member of the Fort Union Formation contain significant coal resources.

The Ucross-Arvada area is located between the modern-day coal mining areas around Sheridan, Wyoming, to the west and Gillette, Wyoming, to the east. Scott and others (2010) carried out an assessment of the coal geology, resources, and reserves of the Sheridan coalfield, and Luppens and others (2008) carried out a similar assessment of the Gillette coalfield. There are no active coal mines within the study area. Major named coal beds (fig. 3) can be traced across large parts of the study area. The strata also contain local coal beds that are much less extensive, but can reach significant localized thicknesses. Thin coal beds (less than 2.5 ft thick) are also common, as are zones of carbonaceous shale. The coal is mostly subbituminous in rank (Stricker and others, 2007).

## Previous Investigations

The Ucross-Arvada area is located in parts of several historically designated Powder River Basin coal fields. All lands in Ranges 76, 77, and 78 W., (the approximate eastern half of the study area), fall within the Powder River Basin coal field of Stone and Lupton (1910). Lands in Rs. 79 through 82 W. and Townships 54 and 55 N., (the northwestern part of the study area), are in the southeastern part of the Sheridan coalfield of Taff (1909). The remainder of the study area falls within the Buffalo coalfield as defined by Gale and Wegemann (1910). The lands in Ts. 52 and 53 N., Rs. 80, 81, and 82 W., specifically, are within the Buffalo–Lake DeSmet area of Mapel (1959), which contains much of the coal within the Buffalo coalfield. Many of the coal beds named in the Spotted Horse coalfield (Olive, 1957) just east of the study area, extend into the area.

Although much of the study area has been previously represented in the reports referenced above, those publications contained planimetric maps without topographical data to show the vertical position of features. Furthermore, the coal bed maps in Stone and Lupton (1910), Taff (1909), and Gale and Wegemann (1910) are presented at a scale of approximately 1:250,000, which is too small a scale to easily relate map features to specific ground features. In addition, these



**Figure 1.** Index map showing location of Powder River Basin, Wyoming and Montana, and Ucross-Arvada study area (black polygons) within the Wyoming part of the basin (basin area in yellow).

early mappers faced the problem that the area had not yet been completely surveyed. Taff (1909) stated, “The traverse lines between known section corners were long, and even when these lines are adjusted to each other and to the known corners the locations of many points are only approximately correct.”

It should be noted, however, that three coal bed maps of limited extent within this study area were previously published on 1:24,000-scale topographic base maps: the northern part of the Horse Hill quadrangle (Mapel, 1978a), the northern part of the Ucross quadrangle (Mapel, 1978b), and the Clearmont quadrangle (Molnia, 1988) (fig. 2). These three maps are included within the map of this report for sake of completeness in depicting the area’s coal beds.

Principal coal beds in eight 7½-minute quadrangles directly north of this study area, in the Buffalo Creek-Clear Creek area, were mapped at 1:50,000-scale by Molnia and Orrell (1988) following the same photogrammetric and field methods as described below.

## Current Investigation

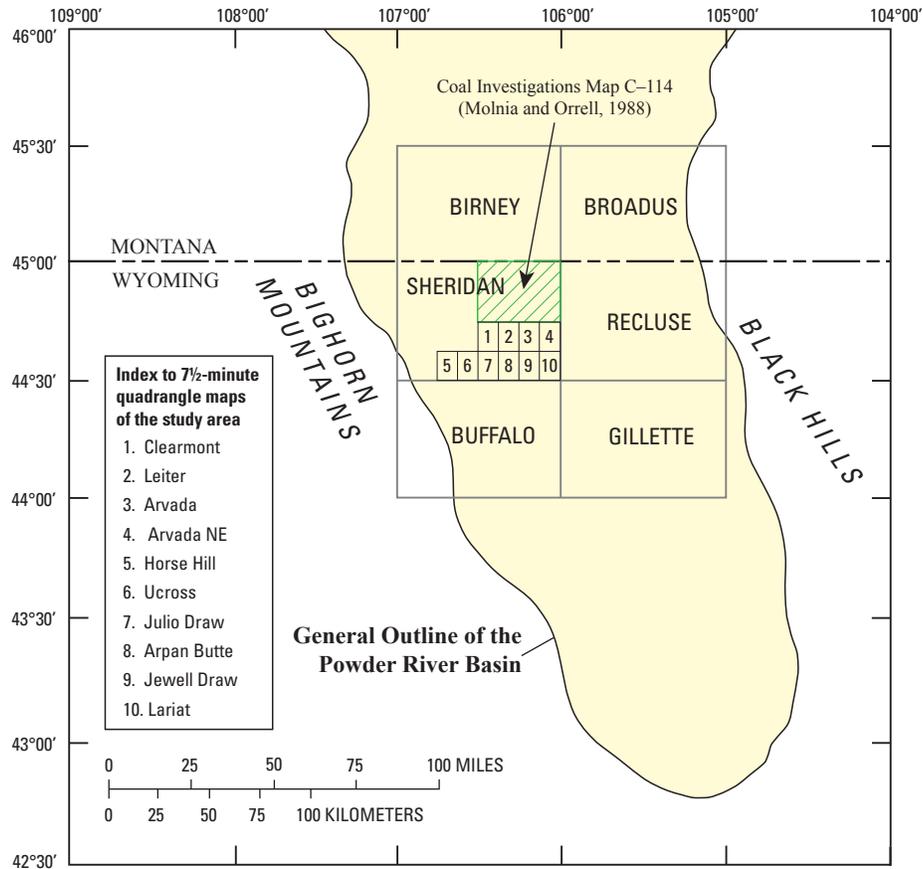
The locations and elevations of coal beds are shown on a topographic base map (1:50,000 scale) for an area that includes ten 7½-minute quadrangles covering some 500 square miles. The plotting of data on this base offers many advantages over the earlier planimetric maps because it

enables a more accurate depiction of coal bed location; correlation of map features to ground features; calculation of unit thickness, dip, overburden, and interburden (interval between coal beds); and modeling of regional structure.

## Methodology

The entire study area was mapped by the author during 1980–1983, using photogrammetric techniques as described in Molnia (1983). By these means, geologic features were plotted precisely and automatically onto 1:24,000-scale topographic maps with use of true-color aerial photographic 1:24,000 models. In areas where major coals have burned at the outcrop, the resulting red-orange clinker (rocks baked and fused by the burning of underlying coal) is in sharp contrast to the light-colored underlying rocks and marks the elevation of the base of the coal bed. In areas where coals have not burned, the elevation of the base of the coal bed was determined by tracing outcrops and by identifying intervals to marker beds. In both cases, the photogrammetric plotter drew the coalbed traces onto the topographic map.

Parts of the Ucross-Arvada area were also field-mapped during 1980–1983 to check photogrammetric mapping accuracy and to map coal bed outcrops that were not discernible on aerial photographs. Because of the size of the study area, not all coal beds were followed to their farthest extents in the field. Symbols shown on the map indicate places where a coal bed appeared to pinch out or split into minor coal beds,



**Figure 2.** Index map showing the geographic setting of the study area, the Sheridan 30' × 60' quadrangle and adjacent 30' × 60' quadrangles (outlined in gray), and the individual 7½-minute quadrangles (numbered) that constitute the Ucross-Arvada study area. Also indicated (striped) is the adjacent U.S. Geological Survey (USGS) Coal Investigations Map C-114 (Molnia and Orrell, 1988).

or could not be mapped farther because of lack of outcrop of coal or clinker. Other symbols shown on the map indicate places where a coal bed is buried by alluvial deposits. Hinrichs (1984) and Hallberg and others (1999) prepared maps of the surficial geology of the Sheridan 30' × 60' quadrangle.

## Stratigraphy

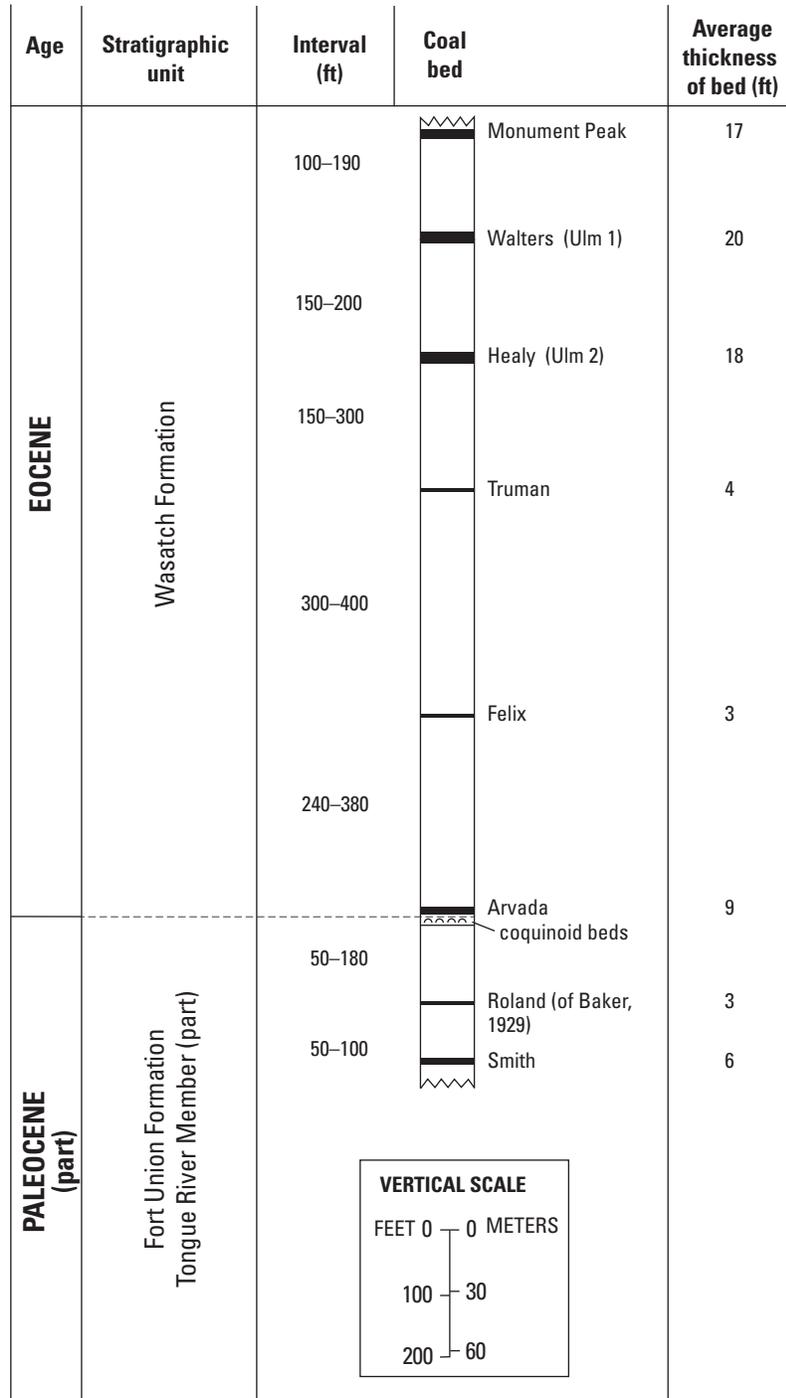
The coal beds (fig. 3) mapped in the Ucross-Arvada area are in the Tongue River Member of the Fort Union Formation of Paleocene age and the overlying Wasatch Formation of Eocene age. These beds represent the youngest of the Wyoming Powder River Basin coal beds; they are stratigraphically above the major Wyodak-Anderson coal zone (Ellis and others, 1999), which is also part of the Tongue River Member and is mined in the Gillette coalfield. In the study area, the contact between the Tongue River Member of the Fort Union Formation and the overlying Wasatch Formation stratigraphic units is conformable. The units are fairly similar in color—moderate brown, gray, and tan—and also in lithologic composition. Both units include sandstone and siltstone, gray mudstone or

gray shale, and dusky-red-brown carbonaceous shale. Also both have coal beds, coquinoid limestones, and widespread deposits of red-orange clinker.

Olive (1957, p. 13) described the formational contact between the Wasatch Formation and the Fort Union Formation that was chosen within the Spotted Horse coalfield:

“Inasmuch as the Roland bed is not continuous in the Spotted Horse field and its top cannot be used as a convenient mappable horizon; the top of the (Tongue River) member was mapped on the top of a persistent, highly fossiliferous (coquinoid) unit of shale, sandstone, and limestone which occurs 5-65 feet above the Roland bed....At most places the fossiliferous unit is easily recognized because of numerous pelecypod and gastropod shells that litter its outcrops; the most conspicuous components are beds of coquinal limestone that weather into grayish-white ledge-forming blocks.”

In the Recluse, Wyoming, area, directly east and northeast of this study area, Kent and Berlage (1980) also placed the Wasatch-Fort Union contact at the top of these same beds



**Figure 3.** Generalized stratigraphic section showing relation of principal coal beds in the Ucross-Arvada study area. Vertical scale drawn on the basis of typical range of intervals (shown on left side of column) from base of one coal bed to base of the overlying coal bed. See text for description of coal beds.

of freshwater mollusk fossils. In the Ucross-Arvada study area, as in the Buffalo Creek–Clear Creek area (Molnia and Orrell, 1988), the author also placed the Wasatch-Fort Union contact at the top of the coquinoid beds (fig. 4), because they are a persistent, obvious feature. The Arvada coal bed directly overlies the coquinoid beds in many places, and is within 20 ft of the top of the coquinoid beds in most other places. So for the purposes of this map, the trace of the Arvada coal bed serves as the approximate contact between the Fort Union and Wasatch Formations.

The measured section (table 1) shows the composition and character of a small interval of the Wasatch Formation in the Clearmont 7½-minute quadrangle (from Molnia, 1988). The trace of the measured section is shown on the accompanying map in T. 55 N., R. 80 W., secs. 26 and 35. The measured section begins in a covered interval at an elevation of about 4,160 ft, estimated to be the elevation of the Truman coal bed at this location, and continues to the elevation of the Walters (Ulm 1) coal bed at approximately 4,530 ft.

## Coal Beds of the Ucross-Arvada Area

In ascending order; see figure 3 for positions of coal beds and table 2 for locality information. In the years since the author completed field mapping (1983), Scott and others (2010) and Osmonson and others (2011) completed correlation of all significant coal beds in the Wyoming part of the Powder River Basin through use of extensive recent drilling data from coalbed methane development. This subsurface correlation system resulted in a regional standardization of coal bed names that may vary from coal bed names used in this report. Any differences in nomenclature are noted in the following discussions of each coal bed.

### Smith Coal Bed

The only outcrops of the Smith coal bed in the study area are near the northeast boundary, in the Arvada NE 7½-minute



**Figure 4.** Coquinoid beds which represent the contact between the Tongue River Member of the Fort Union Formation and the overlying Wasatch Formation. The Arvada coal bed directly overlies the coquinoid beds in much of the Arvada-Ucross area as well as in the Buffalo–Clear Creek area (Molnia and Orrell, 1988). Photograph taken approximately three miles north of the study area, on the east side of the Powder River.

## 6 Map Showing Principal Coal Beds and Bedrock Geology of the Ucross-Arvada Area, Central Powder River Basin, Wyoming

**Table 1.** Small interval of the Wasatch Formation in the Clearmont 7½-minute USGS quadrangle. Trace of measured section shown on map in T. 55 N., R. 80 W., secs. 26 and 35. Thickness in feet (from Molnia, 1988).

<b>Clinker of Walters coal bed (Ulm 1) at top of hill; elevation of base of clinker approximately 4,530 ft</b>	<b>32</b>
Cover	18
Sandstone, fine, with concretions	3
Shale, gray	3
Siltstone, beige	3
Shale, gray and tan	15
Shale, dusky-red-brown	2
Shale, tan, top of mollusk shell horizons	6
Siltstone, ledge-forming	1
Shale, gray and tan, with shell horizons; forms light band due to whitish-gray (caliche?) veneer	63
Shale, dusky red-brown	5
<b>Coal (local bed), some clinker laterally</b>	<b>1.5</b>
Shale, red-brown and gray	3
Siltstone and shale, gray and tan; forms light-colored band due to whitish-gray veneer	10.5
Shale, dusky-red-brown, <b>with 2 in. coal bed in middle</b>	1
Shale, gray and tan, with mollusk shell horizons	12
Sandstone, whitish-gray, with trough crossbeds and log-shaped concretions	3
Shale, gray and tan	10
<b>Clinker of the Healy coal bed (Ulm 2); elevation at base approximately 4,360 ft</b>	<b>10</b>
Cover	22
Cover, outcrops of coquinoid slabs laterally	4
Cover	10
Shale, dusky-red-brown	1
Shale, carbonaceous	0.3
Shale, dusky-red-brown	0.3
<b>Coal (local bed)</b>	<b>1.2</b>
Shale, dusky-red-brown and gray	6
Shale, gray and tan, with mollusk shells	6
Mudstone, light-tan, forming prominent white band due to whitish-gray veneer; one thin shell zone	20
Siltstone, coarsening-upward, with resistant nodules	4
Mudstone, light-tan, forming prominent white band due to whitish-gray veneer; one thin shell zone	19
Sandstone, resistant	2
Shale, tan and gray	10
Shale, carbonaceous and red-brown, forming dark band, with <b>coals as much as 3 in. thick</b> ; silicified wood, shell hash in top 4 in.	6
Shale, dusky-red-brown	2
Shale	24
Cover, base elevation approximately 4,160 ft	65
<b>Total measured section (rounded)</b>	<b>405</b>

**Table 2.** Location information for localities referenced in text. Numbers preceded by "Mapel" are locality numbers taken from Mapel's publications as stated in this report. Locations not shown on map.

Locality number	Coal bed	Quadrangle	Township	Range	Section	Aliquot part
1	Smith, Roland, Arvada	Arvada NE	55N	77W	23	W 1/2
2	Arvada	Arvada NE	54N	77W	10	NE 1/4
3	Arvada	Arvada NE	55N	77W	34	E 1/2
4	Arvada	Arvada NE	54N	77W	15	N 1/2
5	Arvada	Arvada NE	54N	77W	2	NW 1/4
6	Arvada	Arvada NE	54N	77W	3	NE 1/4
7	Arvada	Arvada NE	54N	77W	2	SW 1/4
8	Arvada	Arvada NE	55N	77W	34	SE 1/4
9	Arvada	Arvada NE	55N	77W	34	SE 1/4
10	Arvada	Arvada NE	55N	77W	34	SE 1/4
11	Arvada	Arvada	54N	77W	21	NW 1/4
12	Arvada	Arvada	54N	77W	16	N 1/2
13	Felix	Lariat	52N	77W	3	W 1/2
14	Felix	Arvada	54N	77W	18	SW 1/4
15	Felix	Arvada	54N	78W	12	NW 1/4
16	Felix	Arvada	54N	77W	19	E 1/2
17	Felix	Arvada	55N	77W	30	S 1/2
18	Felix	Leiter	55N	79W	36	NE 1/4
19	Felix	Arvada NE	55N	76W	28	unknown
20	Felix	Leiter	55N	78W	29	W 1/2
21	Felix	Arvada	55N	78W	27	NW 1/4
22	Truman	Arpan Butte	54N	78W	31	N 1/2
23	Truman	Arpan Butte	53N	78W	6	NW 1/4
24	Truman	Arvada	54N	78W	2	N 1/2
25	Truman	Jewell Draw	54N	78W	34	NW 1/4
26	Truman	Leiter	55N	79W	14	unknown
27	Healy	Arpan Butte	53N	78W	19	unknown
28	Healy	Arpan Butte	53N	79W	26	unknown
29	Healy	Arpan Butte	53N	78W	17	unknown
Mapel 14	Healy	Horse Hill	53N	82W	14	SW 1/4
Mapel 1	Healy	Horse Hill	53N	82W	2	SE 1/4
Mapel 25	Healy	Horse Hill	53N	82W	33	W 1/2
Mapel 43	Healy	Ucross	53N	80W	5	NW 1/4
Mapel 93	Healy	Ucross	53N	81W	11	W 1/2
Mapel 200	Healy	Julio Draw	53N	80W	34	NW 1/4
Mapel 19	Walters	Horse Hill	53N	82W	23	NW 1/4
Mapel 2 (1959)	Walters	Horse Hill	53N	82W	4	S 1/2
Mapel DH 1	Walters	Horse Hill	54N	81W	29	W 1/2
Mapel 10	Walters	Ucross	53N	81W	2	SW 1/4
Mapel 128	Walters	Ucross	53N	81W	33	S 1/2
Mapel 5	Walters	Ucross	54N	80W	30	W 1/2
Mapel 22	Monument Peak	Horse Hill	53N	82W	26	SW 1/4
Mapel 2 (1978a)	Monument Peak	Horse Hill	54N	82W	36	NE 1/4

quadrangle, along the banks of the Powder River. Olive (1957) described the Smith coal bed to the north, between Clear Creek and the Powder River, as having a total coal thickness of as much as 11 ft, broken by a parting 8–30 ft thick. At one locality (locality no. 1; number here and henceforth, refers to left column, table 2), the author measured the Smith coal bed to be 6.8 ft thick, which included a 0.3-ft parting about 2 ft below the top. The Smith coal bed is associated with a rosy pink clinker, which aids in identifying the coal bed.

### Roland Coal Bed (of Baker, 1929)

The only outcrops of the Roland coal bed in the study area are near the northern boundary, along the Powder River and its small tributaries, and along the tributaries to Clear Creek. Almost all outcrops are in the Arvada NE 7½-minute quadrangle. The coal bed is thin in this area, with thicknesses ranging from 2–4 ft. At locality no. 1, it exists only as a zone of carbonaceous shale about 2 ft thick. Just north of the study area, in the Buffalo Creek–Clear Creek area (Molnia and Orrell, 1988), the Roland consists of a zone of three to five thin coal beds separated by partings as much as 30 ft thick. In Scott and others (2010) and Osmonson and others (2011), this bed is called the Roland (from Baker).

### Arvada Coal Bed

The Arvada coal bed crops out along the Powder River and its tributary creeks, and was mapped in the Arvada NE and Arvada 7½-minute quadrangles. In these quadrangles, the Arvada coal bed was measured at twelve localities (locality nos. 1–12) as a solid bench of coal 5–11 ft thick (fig. 5). The Arvada coal bed overlies prominent coquinoid beds in many places, which aids in identifying the coal bed. The base of the Arvada coal bed is used here as the approximate contact between the Fort Union and Wasatch Formations. In Scott and others (2010) and Osmonson and others (2011), this bed is called the Upper Roland Rider.

### Felix Coal Bed

The Felix coal bed is present in the eastern half of this study area, but is considerably thinner than that described in the Spotted Horse coalfield to the east. In Scott and others (2010) and Osmonson and others (2011), this coal bed is also called the Felix. In that part of the Spotted Horse coalfield to the east, the bed has an average thickness of about 15 ft and at one locality is over 28 ft thick (Olive, 1957, p. 30).



**Figure 5.** Arvada coal bed at locality number 11. The coal bed was measured as a solid bench of coal 11 ft thick.

In the Lariat 7½-minute quadrangle, the author measured a Felix outcrop (locality no. 13) where some coal has burned, but 5 ft of coal remains. In the Arvada 7½-minute quadrangle, measurements were made at four localities in which the Felix occurs essentially as a solid coal, with thicknesses of 2.5 ft (locality no. 14), 3.4 ft (locality no. 15), and 2.4 ft (locality no. 16), as well as a thickness of 2.4 ft that included a parting of 0.5 ft approximately in the middle (location no. 17). In the Leiter 7½-minute quadrangle, the Felix coal bed at locality no. 18 is at least 6.1 ft thick, which included two partings of 0.3 ft each. In the Arvada NE 7½-minute quadrangle, the Felix coal bed at locality no. 19 is a solid bed 4.5 ft thick. In other localities in both the Leiter and Arvada 7½-minute quadrangles (localities no. 20 and no. 21 respectively), the Felix coal bed forms zones of several thin (thickness from 0.5 – 2 ft) coal beds interbedded with carbonaceous shales.

## Truman Coal Bed

The Truman coal bed was traced from the Recluse, Wyoming, area (Kent and Berlage, 1980) east of the study area, where it originates as an upper split of the Ulm 2 bed as used by Olive (1957) in the Spotted Horse coalfield. (Note: This Ulm 2 bed is *not* equivalent to the Healy bed; see Healy discussion below.) The Truman coal bed extends westward in the study area to about the middle of the Clearmont quadrangle. In Scott and others (2010) and Osmonson and others (2011), this bed is called the Ucross.

In the northeast quarter of the Arpan Butte 7½-minute quadrangle, the author measured two outcrops of the Truman coal bed: at locality no. 22 it is 4 ft thick, and at locality no. 23 is 5 ft thick, with no partings at either locality. In the Arvada 7½-minute quadrangle, the bed (locality no. 24) was measured to be about 4 ft thick, which included a 1-ft parting approximately in the middle. In the Jewell Draw 7½-minute quadrangle (locality no. 25), an incomplete section of Truman coal is 2.9 ft thick, and in the Leiter 7½-minute quadrangle (locality no. 26), it forms a coal zone 11.2-ft-thick, containing (in ascending order) 2 ft coal, 2 ft parting, 3.1 ft coal, 1.6 ft parting, and 2.5 ft coal.

## Healy Coal Bed (also known as Ulm 2)

The Healy coal bed as used by Mapel (1959) in the Buffalo–Lake De Smet area is also known as the Ulm 2 coal bed, but is stratigraphically higher than, and not equivalent to, the Ulm 2 bed as used by Olive (1957) in the Spotted Horse coalfield. The Ulm name comes from Gale and Wegemann (1910), who considered the main coal beds in the Buffalo field to belong to the Ulm coal group as designated by Taff (1909) in the Sheridan coalfield to the north.

In the study area, the Healy coal bed has burned in many places along its outcrop, forming thick clinker deposits. The bed is thickest in the west half of the Horse Hill quadrangle. It has a minimum thickness at a complete exposure of 13 ft,

including thin shale partings, at locality Mapel 14 (Mapel, 1959, p. 102 and pl. 18), but an incomplete section (locality Mapel 1) has 29.5 ft of solid coal, and a section containing a caved mine entry (locality Mapel 25) has over 20 ft of almost solid coal (Mapel, 1959, pl. 18). In the east half of the Horse Hill quadrangle, the Healy coal bed averages about 15 ft in thickness (Mapel 1959, p. 100).

Mapel (1978b) showed a maximum Healy coal thickness of 17.7 ft, including only a 0.3-ft parting, in the east half of the Ucross 7½-minute quadrangle (locality Mapel 43), and a minimum thickness of 11.3 ft (locality Mapel 93) of solid coal in the west half. In the southwest quarter of the Julio Draw 7½-minute quadrangle (locality Mapel 200), the Healy coal bed contains 14.9 ft of solid coal (Mapel, 1959, p. 98).

In the Arpan Butte 7½-minute quadrangle, the author measured three outcrops of the Healy coal bed. The first, locality no. 27, is an 11.7-ft zone composed of (in ascending order) 2 ft coal, 1 ft parting, 3 ft coal, 1.2 ft parting, and 4.5 ft coal. The second (locality no. 28) is 15 ft thick, which included a 2-ft parting below the top 5 feet of coal. The third outcrop (locality no. 29, close to the southeastern extent of the Healy coal bed in the study area) consists of an 8-ft-thick carbonaceous zone of only coaly shale and dusky-red-brown shale at the Healy coal level.

Approximately two miles west of the western edge of the study area, northwest of Lake DeSmet, drill holes described by Mapel (1959, p. 84–85) encountered a thick coal bed tentatively correlated with the Healy bed and referred to as the Healy(?) bed. This coal bed is as much as 223 ft thick, but has limited extent, complex stratigraphy, and in many places is partially or totally missing because it has burned (Mapel, 1959, pl. 14).

In Scott and others (2010) and Osmonson and others (2011), the Healy zone is divided into Upper Healy and Healy, with numerous coal and shale splits in between. In those reports, this bed is also called the Healy.

## Walters Coal Bed (also known as Ulm 1)

The Walters coal bed as used by Mapel (1959) in the Buffalo–Lake DeSmet area is also known as the Ulm 1 coal bed. The Ulm name comes from Gale and Wegemann (1910), who considered the main coal beds in the Buffalo field to belong to the Ulm coal group as designated by Taff (1909) in the Sheridan coalfield to the north. In Scott and others (2010) and Osmonson and others (2011), this bed is called the Upper Healy.

The Julio Draw 7½-minute quadrangle is essentially the easternmost extent of the Walters coal bed on this map. In the Horse Hill, Ucross, and Julio Draw 7½-minute quadrangles, the unit has burned extensively and produced large areas of clinker. In the Horse Hill quadrangle Mapel (1959, p. 102) reported isolated unburned exposures of the Walters coal bed that include a zone of carbonaceous shale in the southwest quarter of the quadrangle. He also noted 4.3 ft of coal in the northeastern part of the quadrangle (locality Mapel 2 (1959))

and 23.5 ft of coal broken by many thin partings of shale in the middle of the quadrangle (locality Mapel 19). Mapel (1978a) described the Walters bed from a drill hole in the northeast part of the Horse Hill quadrangle (locality Mapel DH 1), in ascending order, as containing 21 ft coal, 5 ft carbonaceous shale, and 11 ft coal.

In the Ucross 7½-minute quadrangle, Mapel (1959, p. 100) reported two incomplete exposures of Walters coal with thicknesses of 6.6 ft (locality Mapel 10) and 17 ft (locality Mapel 128). Mapel (1978b) also reported a complete section of over 14 ft of coal with only a 0.2 ft parting in the northeast quarter of the quadrangle (locality Mapel 5).

## Monument Peak Coal Bed

The Monument Peak coal bed is represented by isolated remnants of coal and clinker on high peaks in the Horse Hill 7½-minute quadrangle. Mapel (1959, p. 102) stated that in the southwest quarter of the quadrangle (T. 53 N., R. 82 W., locality Mapel 22):

“...the bed contains an aggregate of 19 feet 6 inches of coal and 5 feet 4 inches of shaly coal and partings. Gale and Wegemann (1910, pl. 9) report that it contains 16 feet of coal without partings in a caved mine entry in the N½ sec. 34 ....”

Mapel (1978a) described an outcrop of the Monument Peak coal bed in the northeast quarter of the Horse Hill quadrangle (locality Mapel 2 (1978a)) as being 18.5 ft thick, of which 17.2 ft is coal, with the other 1.2 ft made up of six thin partings spaced approximately equally throughout the coal bed.

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