

## Chapter GN

# COAL RESOURCES, GREATER GREEN RIVER BASIN

By M.S. Ellis,<sup>1</sup> G.L. Gunther,<sup>2</sup> A.M. Ochs,<sup>2</sup>  
J.H. Schuenemeyer,<sup>1</sup> H.C. Power,<sup>3</sup> G.D. Stricker,<sup>1</sup> and Dorsey Blake<sup>1</sup>

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<sup>1</sup> U.S. Geological Survey

<sup>2</sup> Consultant, U.S. Geological Survey, Denver, Colorado

<sup>3</sup> University of Delaware, Newark, Delaware

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# **COAL RESOURCES—DEADMAN COAL ZONE, POINT OF ROCKS-BLACK BUTTE COALFIELD, GREATER GREEN RIVER BASIN, WYOMING**

## **DEADMAN COAL ZONE RESOURCE ESTIMATES—AN OVERVIEW**

- Coal resources are calculated using the specific gravity of the coal calculation from apparent coal rank, which is the weight of coal per unit volume, net coal thickness, and areal extent of the coal.
- Resource tables for the Deadman coal zone in the Point of Rocks-Black Butte coalfield include coal and overburden thickness categories from Wood and others (1983) that are based on apparent coal rank. Additional categories were included to provide more detail. Resources are also reported by Federal coal and surface ownership categories and by 7.5-minute quadrangles in the Black Butte and Jim Bridger study areas.
- Following USGS published guidelines (Wood and others, 1983), coal resource estimates are divided into measured, indicated, and inferred categories according to relative abundance and reliability of data.
- Measured resources are tonnage estimates of coal in the coal zone within a radius of 0.25 mi of a control point where the net thickness of coal is measured.
- Indicated resources are tonnage estimates of coal that is within a radius of 0.25-0.75 mi of a control point where the net thickness of the coal is measured.
- Inferred resources are tonnage estimates of coal that is within a radius of 0.75-3 mi of a control point where the net thickness of the coal is measured.

- These resource categories assume a high to low degree of geologic certainty. A statistical method, which measures levels of uncertainty (confidence limits) for the Deadman resource estimates in the Point of Rocks-Black Butte coalfield, is also included in this study.
- Resource estimates are reported in millions of short tons with two significant figures.

## DEADMAN COAL ZONE COAL RESOURCES

The Deadman coal zone was investigated in two different study areas; the Jim Bridger to the north, and the Black Butte to the south. These two areas are referred to collectively as the Point of Rocks-Black Butte coalfield. The coalfield is along the east side of the Rock Springs Uplift. The lateral extent (study limit) of the Deadman coal is defined by the coal outcrop to the west, modified from unpublished mapping by the Bridger Coal Company, and by a three mile buffer from our data points (drill holes or measured sections) to the east, south, and north. The Black Butte and Jim Bridger study areas are divided Interstate Highway 80. The total study limit for the Deadman coal zone is about 101,000 acres (40,873 hectares) in size.

Deadman coal resources in the Point of Rocks-Black Butte coalfield in the Greater Green River Basin of Wyoming were calculated using several software packages and custom programs. Details of the resource calculation methodology are given in Ellis and others (1999, in press).

To calculate the Deadman coal resources, data were compiled in a StratiFact\* (GRG Corporation, 1996) relational database. The coal zones to be included in the

Deadman coal zone, including the Deadman 1 through 5 and the A through C coal zones, were correlated in the database. Data were initially managed in two separate datasets, one for the Black Butte area, and the other for the Jim Bridger area. The data for coal in the Deadman coal zone were downloaded and a custom program was used to calculate the net coal thickness at each data point (drill hole or measured section) location.

The net coal thickness and overburden thickness were gridded, and isopach maps were produced using EarthVision\* (Dynamic Graphics, Inc., 1997) software. The grids were made using an isopach grid option (special handling of 0 values and terminated data) with grid spacings of 100 x 100 meters.

The spatial parameters for querying coal resources (for example, 7.5-minute quadrangle map (figs. GN-1 and GN-2) area (U.S. Geological Survey National Mapping Division unpublished data, undated), Federal coal and surface ownership (fig GN-3 and GN-4) (Bureau of Land Management, unpublished data, undated), reliability, net coal thickness (fig. GN-5 and GN-6), and overburden (fig. GN-7 and GN-8) categories) were created on individual layers as ARC/INFO\* (ESRI, 1998a) polygon coverages. The coverages were unioned to make one polygon coverage for each study area, with many attributes for each polygon. The polygons in the union coverages were edited in ARC/INFO\* and ArcView\* (ESRI, 1998b).

Coal resources were calculated for each study area using the EarthVision\* (EV) volumetrics tool, which calculates tonnages in each polygon in the union coverage using the net coal thickness grid, the area of each polygon, and a conversion factor of 1,770 short tons per acre-ft for subbituminous rank coal (Wood and others, 1983). Data from the EV volumetrics reports and the union coverage polygon attribute tables for the Jim Bridger and the Black Butte study areas were combined

in Excel\* (Microsoft, 1997) spreadsheet software. Data for polygons containing mine areas (figs. GN-9 and GN-10) or in areas of net coal less than 2.5 ft in thickness were deleted from the data set. Resource tables were created using the data from the remaining polygons (tables GN-1 through GN-3). The final resource area (fig. GN-5 and GN-6) (area that met all coal resource criteria) was about 71,000 acres (28,733 hectares) in size.

\*Commercial software package

## CONFIDENCE LIMITS FOR DEADMAN COAL ZONE COAL RESOURCES

A confidence interval is a statistic designed to capture uncertainty associated with a point estimate. In this study we computed 90-percent confidence intervals on the volume (total resource in millions of short tons) of coal in the Deadman coal zone in the measured, indicated, and inferred categories.

The three main potential sources of error that might bias the confidence intervals are preferential sampling, measurement errors, and model fitting. The probabilistic interpretation of a confidence interval is based upon a random sample, which does not apply in this situation, because there is preferential sampling in those areas deemed to be minable. Measurement error can be caused by an error in recording the coal bed thickness or in the definition of coverage areas. Modeling fitting variability and bias result from the choice of models and fitting procedures.

Confidence limits for coal resources of the Deadman coal zone in the Point of Rocks-Black Butte coalfield were calculated by J.H. Schuenemeyer and H.C. Power. The data set that they used contained net coal measurements from 2,823 locations. This data set only included locations that contained Deadman coal (no 0

net coal thickness values) and data that were representative of the entire coal zone (no terminated holes).

The confidence limits were derived through a complex series of steps. These steps included investigating coal thickness trends and spatial correlation (neither were found to be statistically significant). The standard deviation of coal thickness was obtained directly from the data. Differences in point densities were compensated for by calculating sample size, called a pseudo  $n$ , within each reliability category and calculating the variability of volume for each of the reliability categories. Volumes of Deadman coal were then calculated at a 90-percent confidence interval with measurement error. Some of the parameters used and results of the confidence interval calculations are shown in [tables GN-4](#) and [GN-5](#). A detailed description of the methodology used is given in Schuenemeyer and Power (in press) and in Ellis and others (1999, in press).



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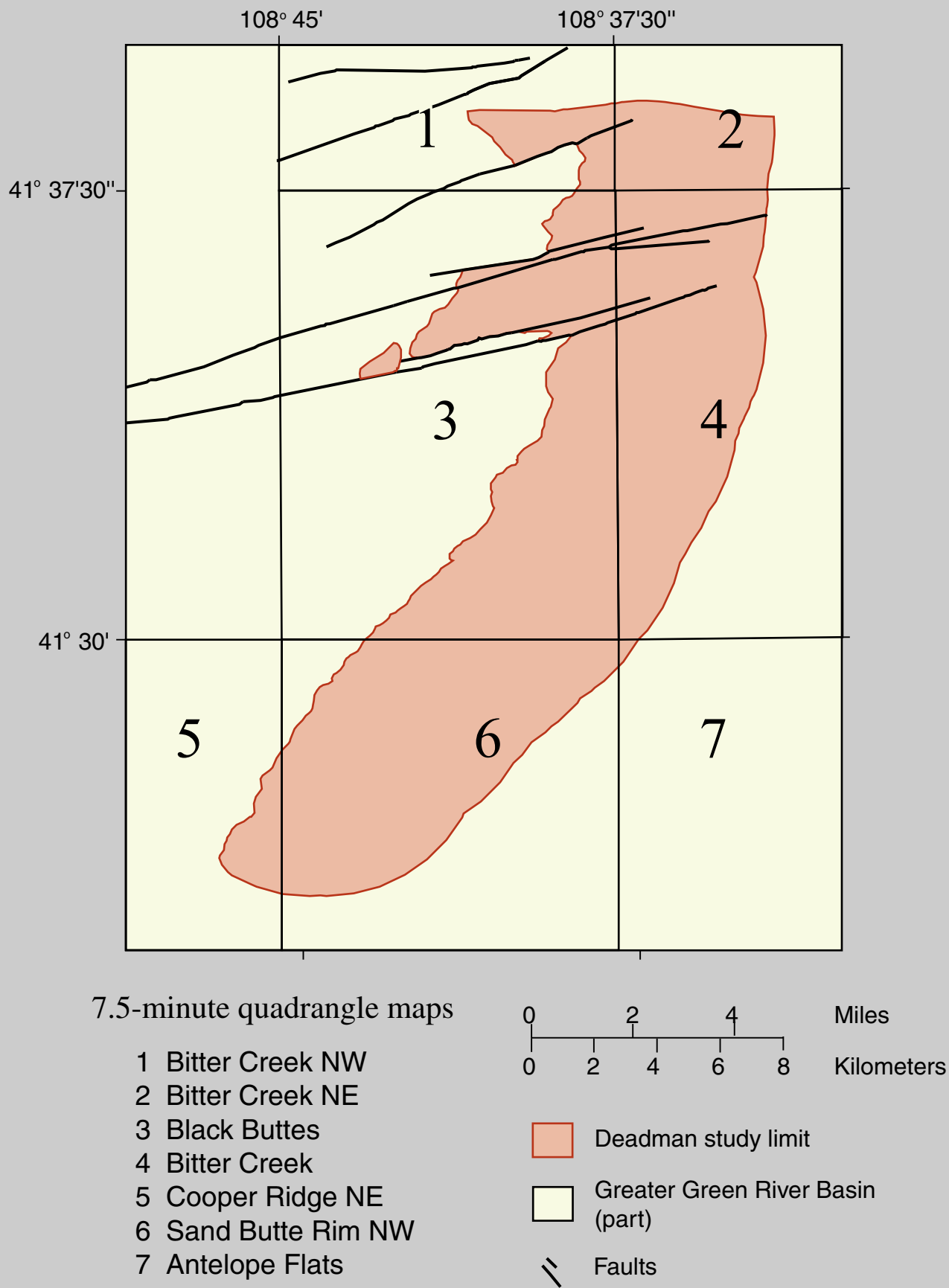
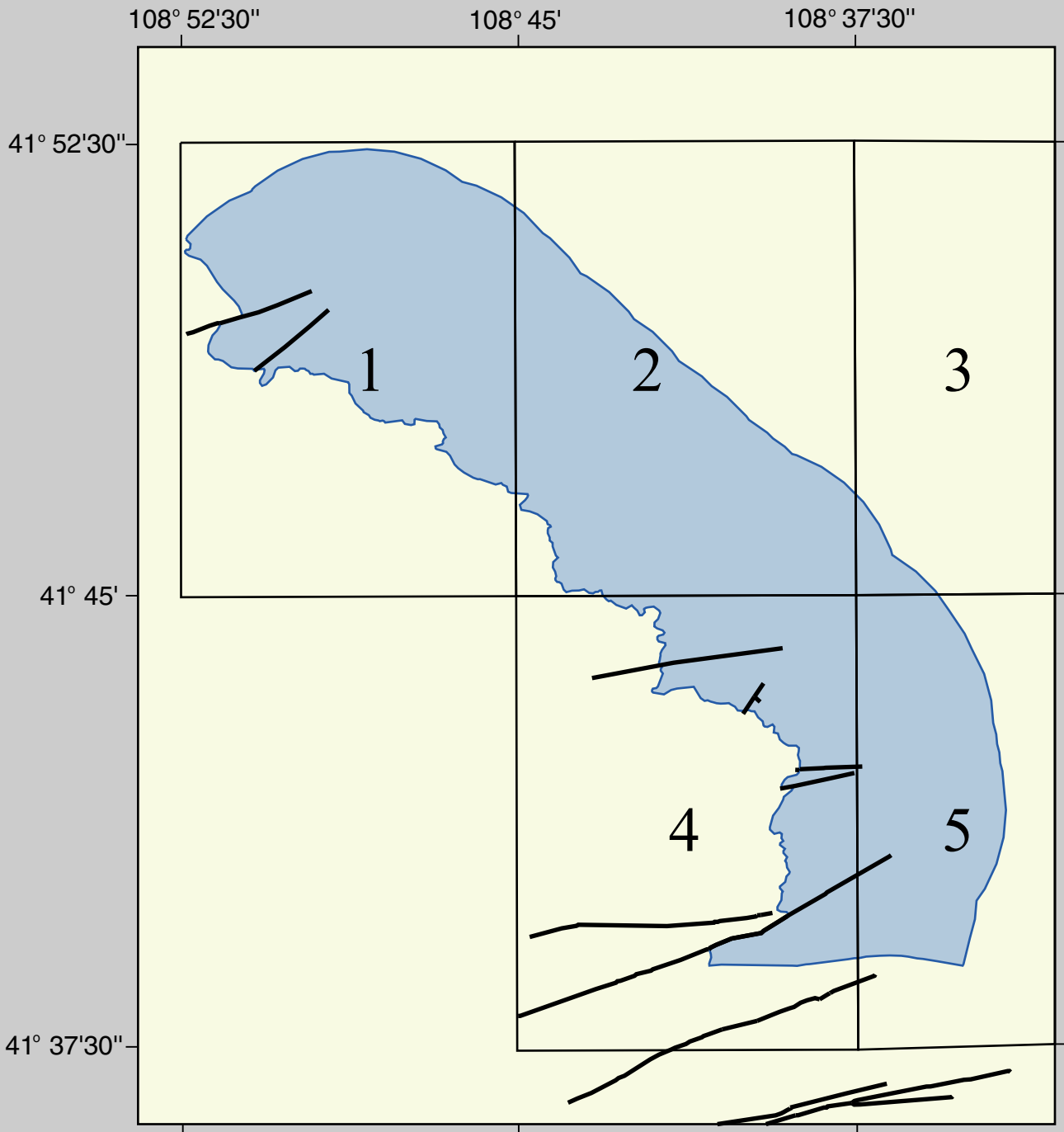


Figure GN-1. 7.5-minute quadrangle maps in the Black Butte area of the Point of Rocks-Black Butte coalfield.



7.5-minute quadrangle maps

- 1 Black Rock South
- 2 Tenmile Rim
- 3 Twelvemile Well
- 4 Bitter Creek NW
- 5 Bitter Creek NE






-  Deadman study limit
-  Greater Green River Basin (part)
-  Faults

Figure GN-2. 7.5-minute quadrangle maps in the Jim Bridger area of the Point of Rocks-Black Butte coalfield.

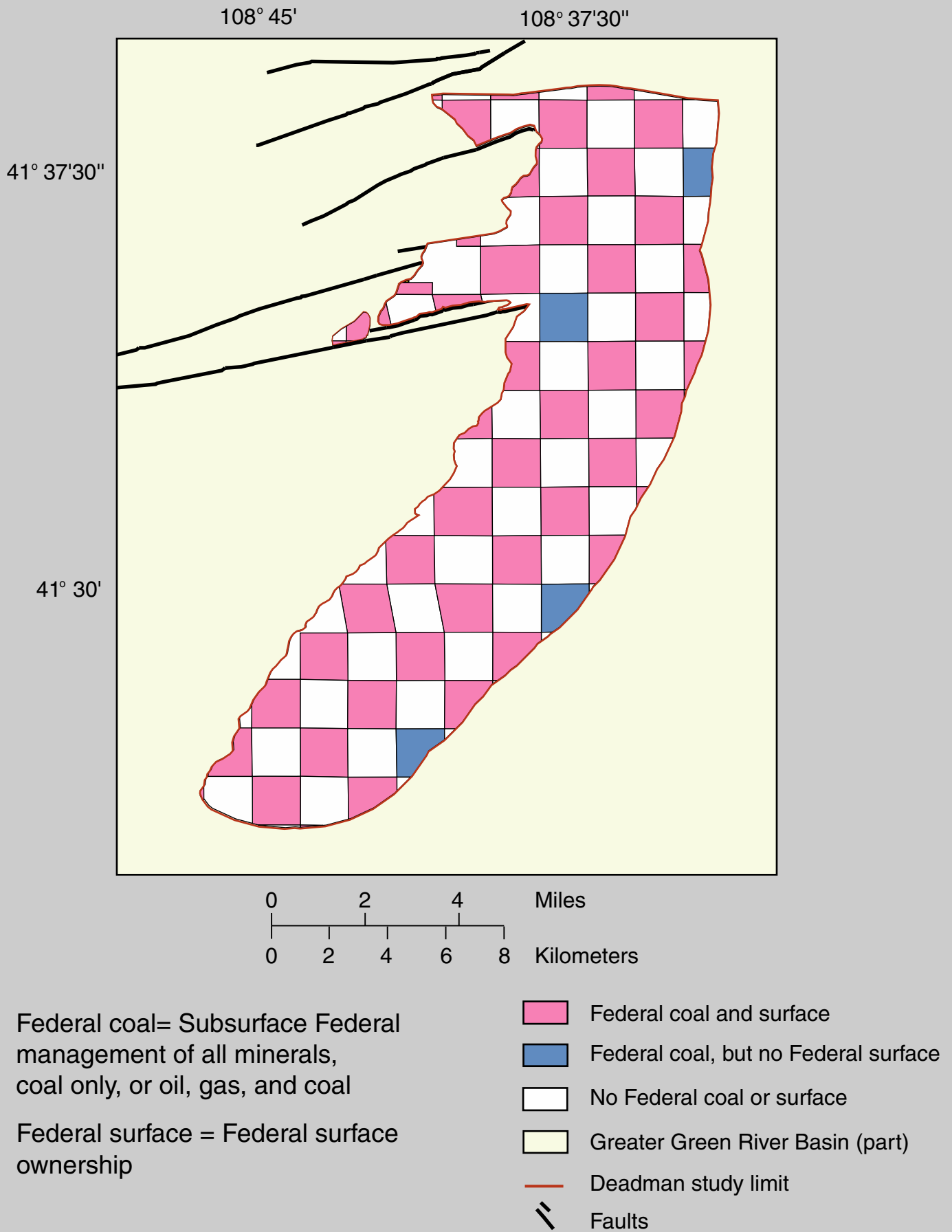
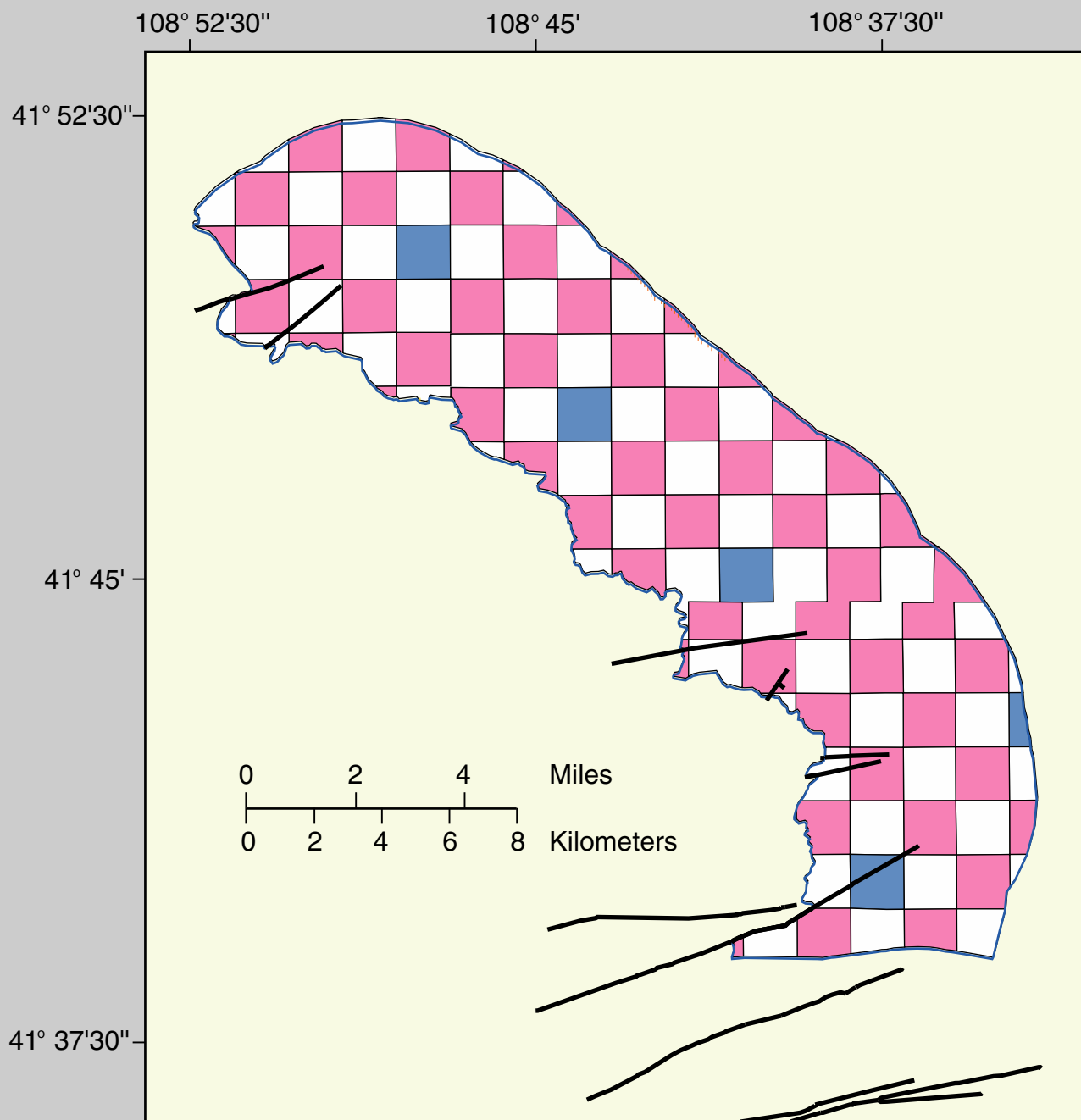


Figure GN-3. Federal coal and surface ownership in the Black Butte area of the Point of Rocks-Black Butte coalfield.



Federal coal = Subsurface Federal management of all minerals, coal only, or oil, gas, and coal

Federal surface = Federal surface ownership

- Federal coal and surface
- Federal coal, but no Federal surface
- No Federal coal or surface
- Deadman study limit
- Greater Green River Basin (part)
- Faults

Figure GN-4. Federal coal and surface ownership in the Jim Bridger area of the Point of Rocks-Black Butte coalfield.

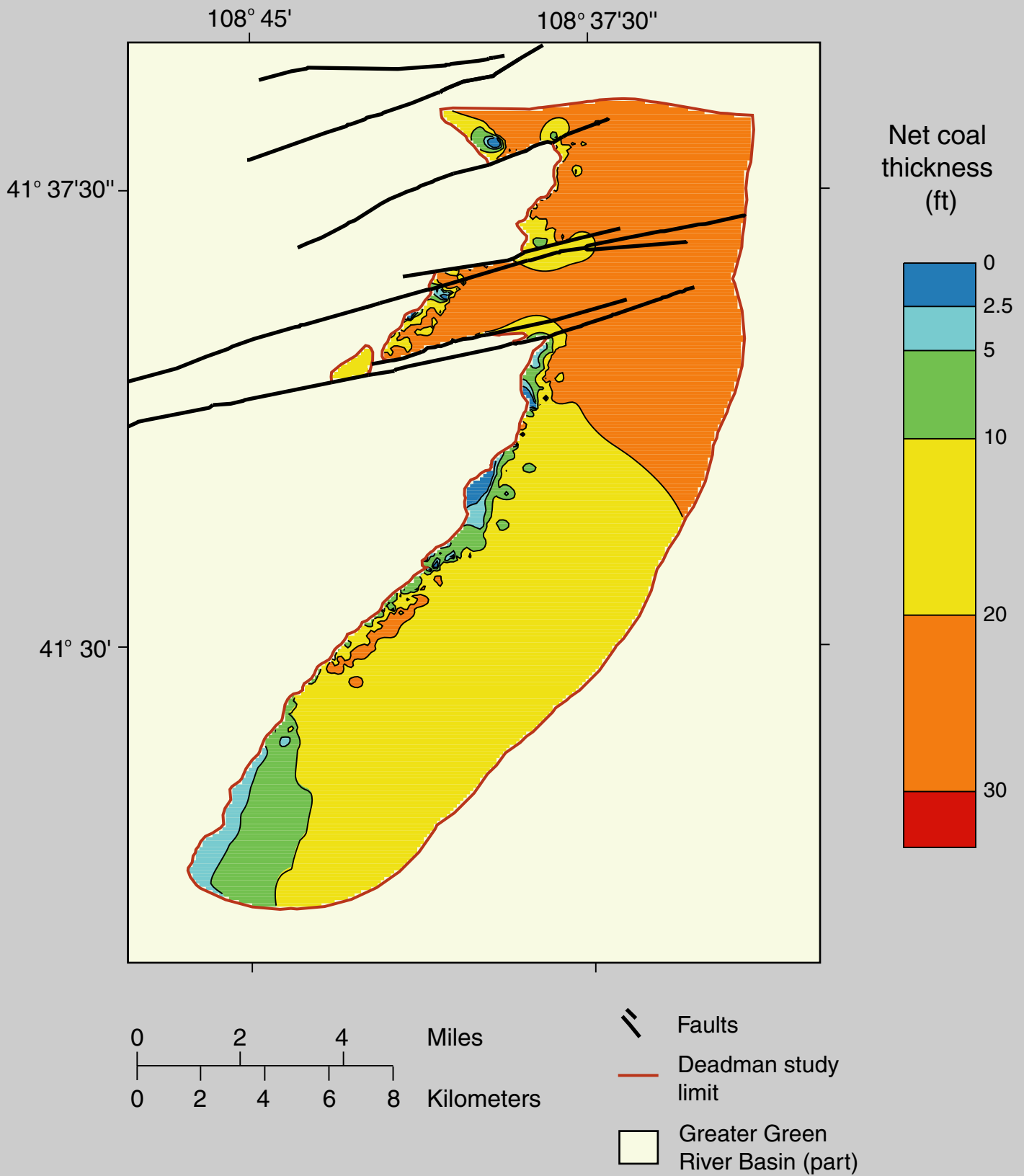


Figure GN-5. Deadman net coal isopach map in the Black Butte area of the Point of Rocks-Black Butte coalfield.

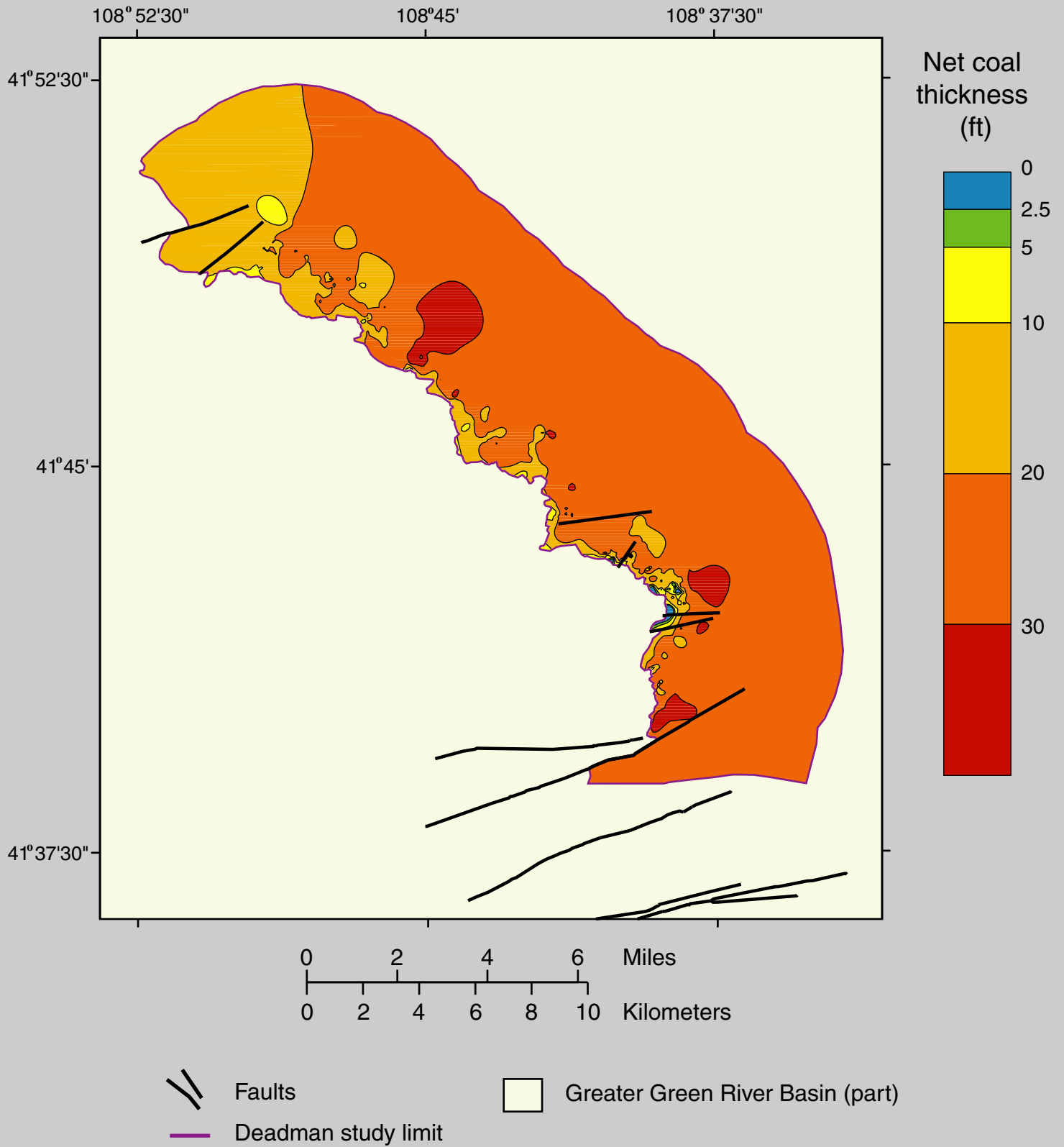


Figure GN-6. Deadman net coal isopach map in the Jim Bridger area of the Point of Rocks-Black Butte coalfield.



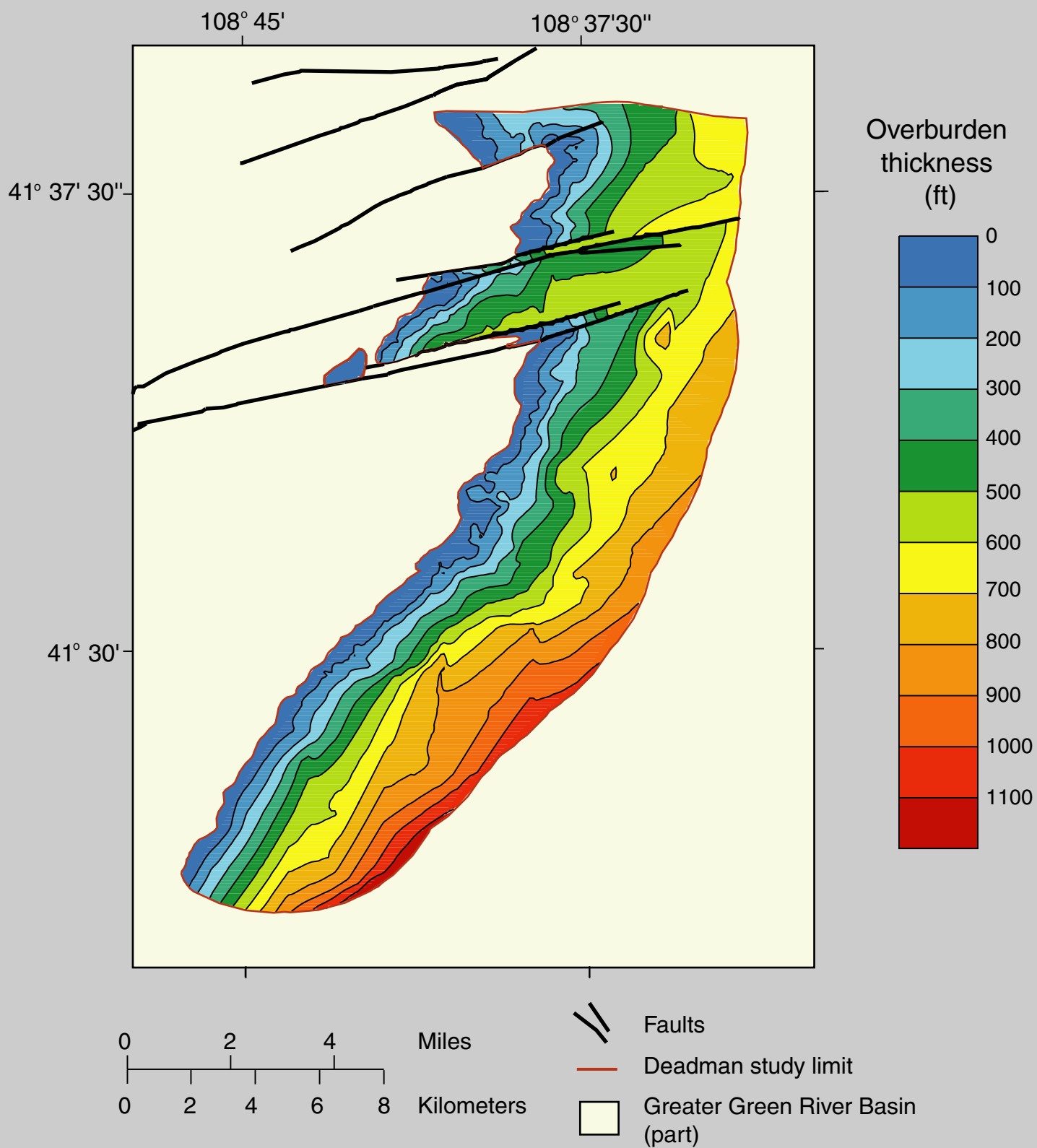


Figure GN-7. Deadman overburden isopach map in the Black Butte area of the Point of Rocks-Black Butte coalfield.

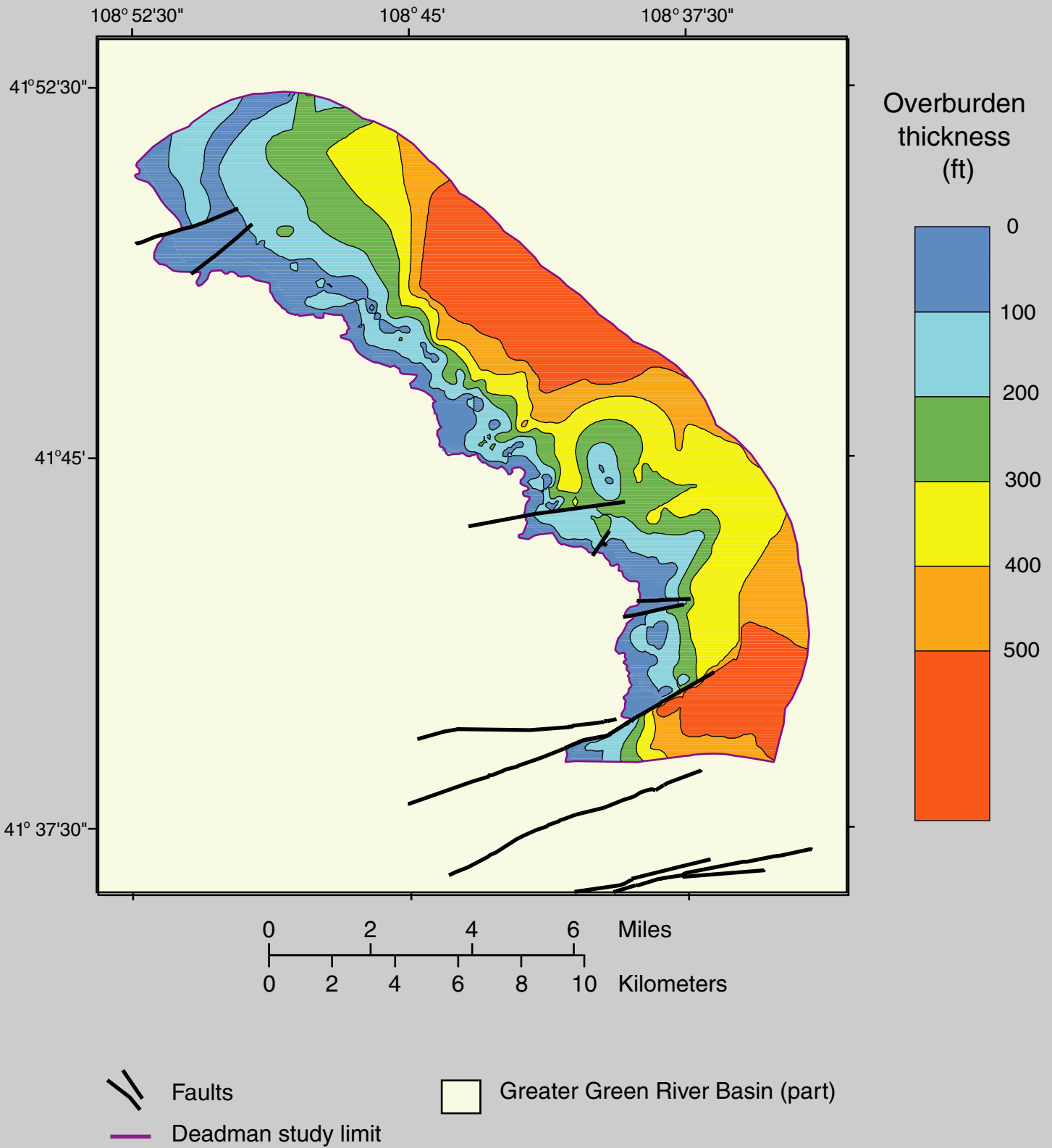
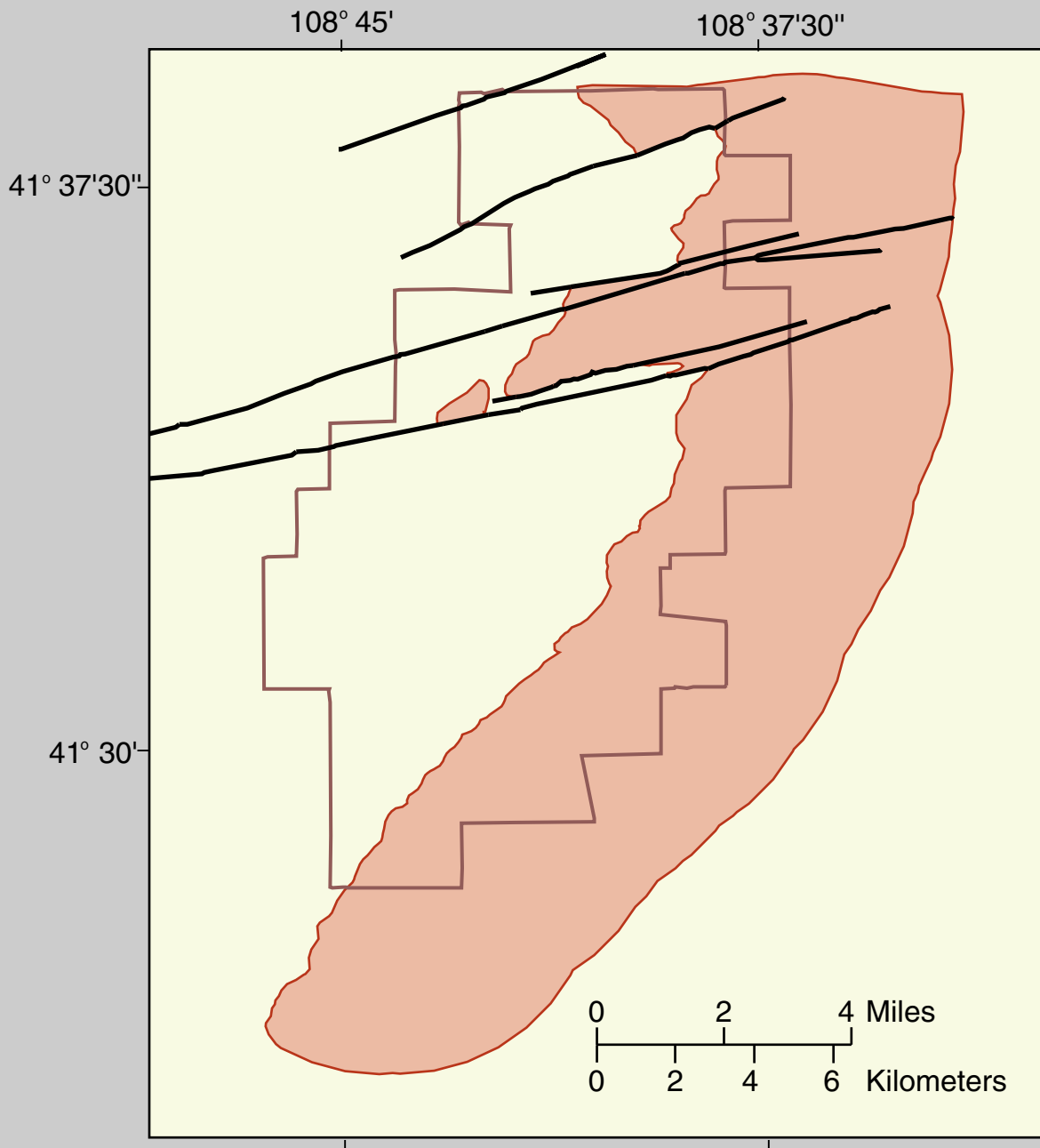


Figure GN-8. Deadman overburden isopach map in the Jim Bridger area of the Point of Rocks-Black Butte coalfield.



Index map showing area included in resource calculations

(does not include areas of mines, or net coal < 2.5 ft thick)

- Deadman study limit
- Greater Green River Basin (part)
- Black Butte mine area
- Faults
- Resource area

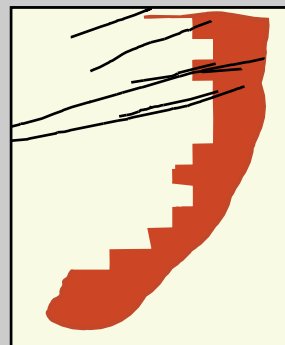
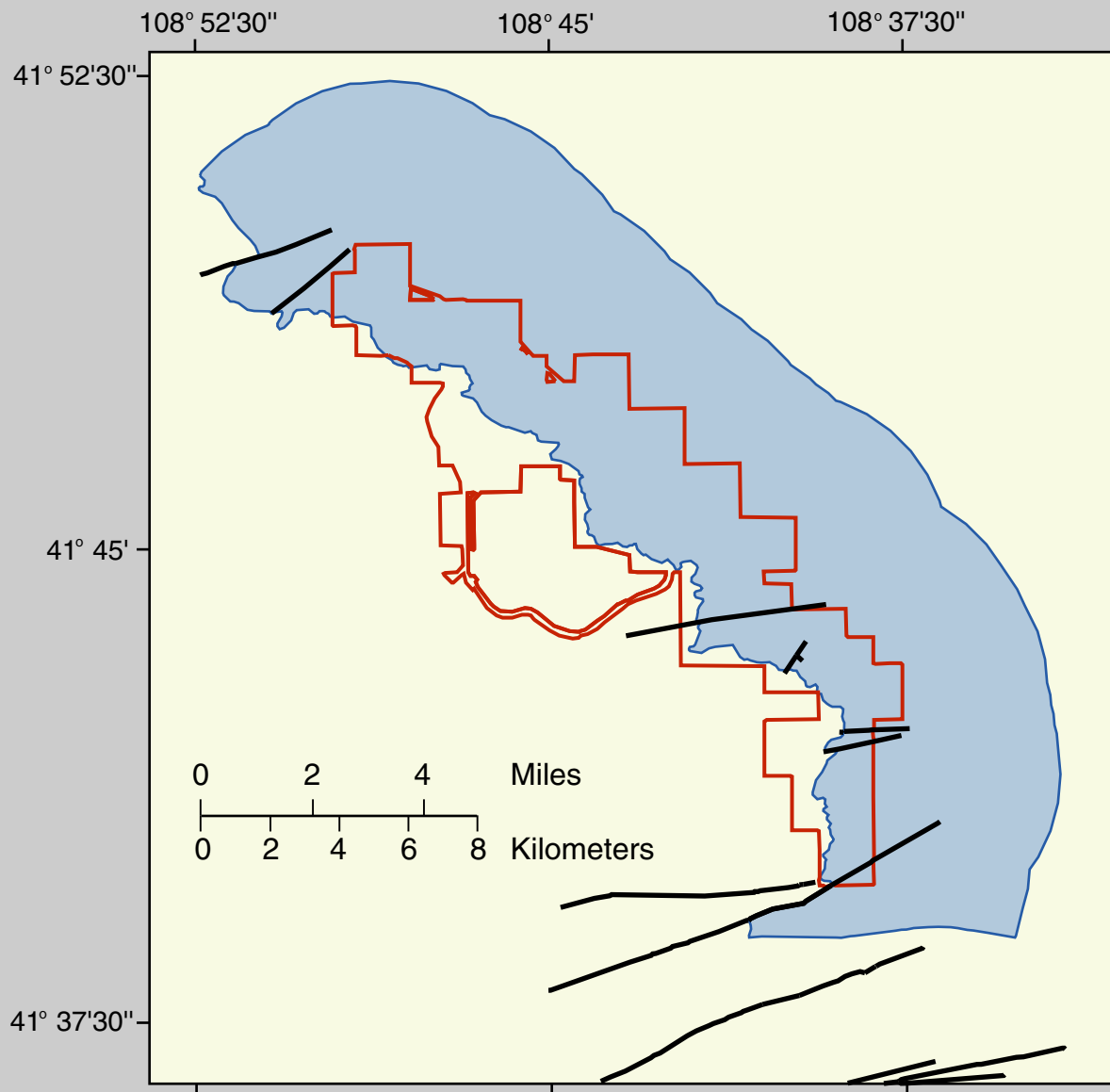


Figure GN-9. Mine and resource areas in the Black Butte area of the Point of Rocks-Black Butte coalfield.



Index map showing area included in resource calculations  
 (does not include areas of mines, or net coal < 2.5 ft thick)

- Deadman study limit
- Greater Green River Basin (part)
- Jim Bridger mine area
- Faults
- Resource area

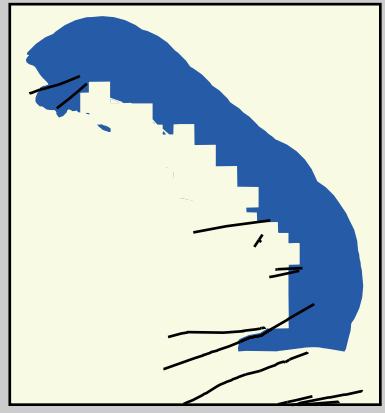


Figure GN-10. Mine and resource areas in the Jim Bridger area of the Point of Rocks-Black Butte coalfield.

Table GN-1. Coal resources of the Deadman coal zone in the Point of Rocks-Black Butte coalfield, Greater Green River Basin, reported by overburden (figs. GN-7 and GN-8), net coal thickness (figs. GN-5 and GN-6), and reliability categories. Coal resources are reported in millions of short tons (MST) with two significant figures. Zeros (0) indicate areas where no resources were calculated. The table does not include coal resources for coal less than 2.5 ft thick or coal in mine areas (figs. GN-9 and GN-10). Resource numbers will not sum to match totals due to independent rounding

Overburden thickness	Net coal thickness	Reliability categories (distance from control point)			Total (MST)
		Measured (<1/4 mi)	Indicated (1/4-3/4 mi)	Inferred (3/4-3 mi)	
0-100 ft	2.5-5 ft	0.015	0.44	2.8	3.2
	5-10 ft	0.36	0.54	0.38	1.3
	10-20 ft	5.4	12	58	75
	20-30 ft	11	2.3	11	24
	30-40 ft	0.39	0.81	0	1.2
0-100 ft total		17	16	72	110
100-200 ft	2.5-5 ft	0	0	1.5	1.5
	5-10 ft	0.32	2.4	1.3	4.1
	10-20 ft	2.4	1.1	49	52
	20-30 ft	25	25	6.2	56
	30-40 ft	0.54	0.56	0	1.1
100-200 ft total		28	30	58	120
200-300 ft	2.5-5 ft	0	0	0.18	0.18
	5-10 ft	0.29	1.2	3.4	4.9
	10-20 ft	2.9	4.2	16	23
	20-30 ft	18	75	150	250
	30-40 ft	3.1	9.5	0	13
200-300 ft total		25	90	170	290

Table GN-1. Deadman coal resources—continued

Overburden thickness	Net coal thickness	Reliability categories (distance from control point)			Total (MST)
		Measured (<1/4 mi)	Indicated (1/4-3/4 mi)	Inferred (3/4-3 mi)	
300-400 ft	2.5-5 ft	0	0	0.082	0.082
	5-10 ft	0.37	1.5	4.5	6.4
	10-20 ft	5.5	13	18	36
	20-30 ft	11	93	360	470
	30-40 ft	2.5	9.5	0	12
300-400 ft total		20	120	380	520
400-500 ft	5-10 ft	0	0.15	5.6	5.7
	10-20 ft	0.3	13	8.4	22
	20-30 ft	0.76	32	310	340
	30-40 ft	0	3.8	0.66	4.4
400-500 ft total		1.1	49	320	370
500-1,000 ft	5-10 ft	0	0	8.4	8.4
	10-20 ft	1.3	6.4	140	140
	20-30 ft	0.59	12	850	870
	30-40 ft	0	0.37	11	12
500-1,000 ft total		1.8	19	1,000	1,000
1,000-1,500 ft	5-10 ft	0	0	0.024	0.024
	10-20 ft	0	0	230	230
	20-30 ft	0	0	14	14
1,000-1,500 ft total		0	0	240	240
Grand total (MST)		93	320	2,300	2,700

Table GN-2. Coal resources of the Deadman coal zone in the Point of Rocks-Black Butte coalfield, Greater Green River Basin, reported by Federal coal and Federal surface ownership (figs. GN-3 and GN-4) in the Jim Bridger and Black Butte study areas. The table does not include coal resources for areas containing coal less than 2.5 ft thick, or coal in mine or lease areas (figs. GN-9 and GN-10). Coal resources are reported in millions of short tons (MST) with two significant figures. Resource numbers will not sum to match totals due to independent rounding

Study area	Federal ownership	Total (MST)
Black Butte	No Federal coal or surface ownership	440
	No Federal coal, but Federal surface ownership	45
	Federal coal and surface ownership	480
Black Butte total		960
Jim Bridger	No Federal coal or surface ownership	880
	No Federal coal, but Federal surface ownership	65
	Federal coal and surface ownership	760
Jim Bridger total		1,700
Grand total (MST)		2,700

Table GN-3. Coal resources of the Deadman coal zone in the Point of Rocks-Black Butte coalfield, Greater Green River Basin, reported by 7.5-minute quadrangle (figs. GN-1 and GN-2) in the Jim Bridger and Black Butte study areas. Coal resources are reported in millions of short tons (MST) with two significant figures. The table does not include coal resources for areas containing coal less than 2.5 ft thick or in mine or lease areas (figs. GN-9 and GN-10). Resource numbers will not sum to match totals due to independent rounding

Study area	7.5-minute quadrangle	Total (MST)
Black Butte	ANTELOPE FLATS	2.6
	BITTER CREEK	450
	BITTER CREEK NE	120
	BITTER CREEK NW	25
	BLACK BUTTES	94
	COOPER RIDGE NE	10
	SAND BUTTE RIM NW	250
Black Butte total		960
Jim Bridger	BITTER CREEK NE	480
	BITTER CREEK NW	210
	BLACK ROCK SOUTH	420
	TENMILE RIM	570
	TWELVEMILE WELL	32
Jim Bridger total		1,700
Grand total (MST)		2,700



Table GN-4. Data used for computation of confidence intervals within reliability categories for Deadman coal resources in the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming. Volume refers to the calculated resource in millions of short tons (MST). NA, not applicable

Parameter	Reliability category			Entire area
	Measured	Indicated	Inferred	
Area (in square meters)	9,717,109	34,140,292	243,970,445	287,827,847
Percent of area	3	12	85	100
Acres (area x 0.0002471)	2,401	8,436	60,286	71,124
SD (standard deviation (in ft) derived directly from the data)	6.317	6.317	6.317	NA
Acre feet (acres x SD)	15,169	53,294	380,842	NA
Volume standard deviation (MST)	6	35	369	410
Pseudo <i>n</i>	19	7	3	NA

Table GN-5. Estimates of uncertainty (calculated with measurement error) for Deadman coal resources in the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming. To show detail, resources calculations are reported in millions of short tons (MST) with four significant figures

Parameter	Reliability category			Entire area
	Measured	Indicated	Inferred	
Total calculated resource (MST)	92.74	320.5	2,258	2,671
Lower 90% confidence limit (MST)	83.00	264.0	1,651	1,997
Upper 90% confidence limit (MST)	103.0	377.0	2,866	3,346