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COAL MINING IN THE BIGHORN COAL BASIN OF WYOMING

GARY B. GLASS,[1] KATHERINE WESTERVELT,[2]
CHARLES G. OVIATT[3]

INTRODUCTION

The Bighorn Coal basin of northwestern Wyoming includes portions of Park, Hot Springs, Washakie, and Big Horn Counties (Fig. 1). This coal-bearing region, which is areally the third largest in the State, coincides with the topographic and structural basin of the same name. As defined, however, the coal basin is limited to that portion of the Bighorn Basin underlain by Mesaverde or younger rocks. This definition was chosen because the Mesaverde Formation is the oldest important coal-bearing formation in the basin.

Based on early mining activity, the U. S. Geological Survey named eight coal fields within the basin. The exact boundaries of the fields were not defined, and seams were not correlated between them. Areas barren of coal mining serve to roughly delimit one field from the other. Since the coal-bearing formations are only exposed along the flanks of the coal basin, the coal fields also lie within this peripheral zone. Clockwise from the Montana border, the eight fields are: Silvertip, Garland, Basin, Southeastern, Gebo, Grass Creek, Meeteetse, and Oregon Basin (Cody) coal fields.

Structurally, these eight coal fields are on the flanks of a broad syncline bounded on the east by the Big Horn Mountains, on the south by the Owl Creek Mountains, and on the west by the Absaroka Plateau and Beartooth Mountains. To the north, the Bighorn Basin continues into Montana and narrows where it is flanked by the Beartooth and Pryor Mountains before it merges with the Crazy Mountains syncline. Local folding characterizes the marginal areas of the basin where the coal fields are located. These small anticlines and synclines create local dips at various angles to the overall synclinal structure of the basin. Dips from 15 to 50 degrees are common in these border areas. There are also numerous normal faults on the flanks of the syncline, especially in the northern half of the basin. Most of these faults trend northeast-southwest with vertical displacements up to 250 feet reported.

The topography of the central basin is characterized by buttes, badlands, irregular ridges, and gravel terraces. Badland topography is particularly well developed in the southeastern portion of the basin. The marginal areas are more rolling with strike ridges and valleys. Rainfall is small, at times less than 10 inches per year, and accounts for the semi-arid conditions that prevail throughout vast portions of the basin. Drainage is northward into Montana through the Bighorn River and its tributaries.

[1] Wyoming Geological Survey, Laramie, Wyoming.

[2] Laramie, Wyoming.

[3] University of Wyoming, Laramie, Wyoming.

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COAL-BEARING FORMATIONS

GENERAL

Although coals are reported in the Cloverly, Frontier, Lance, Willwood, and Tatman Formations, the thicker and more important beds are limited to the Upper Cretaceous Mesaverde and Meeteetse Formations and the Paleocene Polecat Bench Formation (Fig. 2). The geographic distribution of the Mesaverde and younger rocks can be seen in Figure 1. The older formations crop out beyond the margins of the coal basin and have not been illustrated. The younger Willwood and Tatman rocks are depicted in the more central portions of the basin where they overlie the major coal-bearing rocks.

CLOVERLY FORMATION

Fisher (1906a) reports coaly shale and coal are sometimes found associated with the basal sandstones of the Lower Cretaceous Cloverly Formation. He noted an area just outside the boundary of the defined coal basin where 8 feet of coal was mined. He only described the mine location as being near Tensleep on No Wood Creek.

FRONTIER FORMATION

Only thin coals have been found in the Upper Cretaceous Frontier Formation of the Bighorn Basin. Thicknesses of over a few inches are seldom mentioned.

MESAVERDE FORMATION

Although Upper Cretaceous Mesaverde coals occur throughout the basin, they are thin in the southeastern corner where they seldom exceed 14 inches in thickness. The thickest and most persistent Mesaverde coals are in the southern and southwestern portions of the basin where seam thicknesses range up to 12 feet. Four- to 6-foot beds are more common maximums, however. The coals in the Mesaverde Formation have historically been the most important seams in the basin, and have been mined in all but the Basin and Southeastern coal fields. The mineable coals of the Mesaverde are normally found in the basal portion of the formation, but are not limited to there. Splitting and rapid thinning of Mesaverde coals are common.

MEETEETSE FORMATION

Apparently coals are distributed throughout the Upper Cretaceous Meeteetse Formation everywhere in the basin, but they are not as thick nor as persistent as the older Mesaverde coals (Fig. 2). The thicker Meeteetse coal beds

coincide with areas where numerous thin coals coalesce into interbedded shale and coal units. These thicker coals commonly range from 4 to 6 feet, although 8- to 11-foot beds have been reported. Meeteetse coals have been mined in all but the Silvertip, Gebo, and Grass Creek coal fields. Because the Meeteetse and Lance Formations in the Bighorn Basin are not always mapped separately, the distinction between upper Meeteetse coals and basal Lance coals is often not possible. Of the two formations, however, the Meeteetse Formation normally contains the thicker and more persistent seams of coal.

LANCE FORMATION

Where the Upper Cretaceous Lance can be separated from the Meeteetse, it contains only thin coals. These thin coals are usually reported in the top of the formation and are less than 6 inches in thickness. Separating Lance from the overlying Polecat Bench Formation is difficult; therefore, the age of the coals near that contact is not always correctly identified.

POLECAT BENCH FORMATION

Polecat Bench (formerly Fort Union) Formation coals are found in all the coal fields of the basin except the Silvertip Coal Field. These Paleocene coals reach their maximum reported thickness in the Grass Creek and Southeastern coal fields where they are as thick as 38 feet and 10 feet, respectively. The maximums in the other field range from 3.5 to 8.8 feet thick. In all cases the thicker and more important coals occur in the lower part of the formation (Fig. 2). Interest in the coals of the Polecat Bench Formation has heightened recently as the search for thick, low sulfur coals continues. The shallower dips exhibited by these younger Paleocene coals compliment their greater thicknesses.

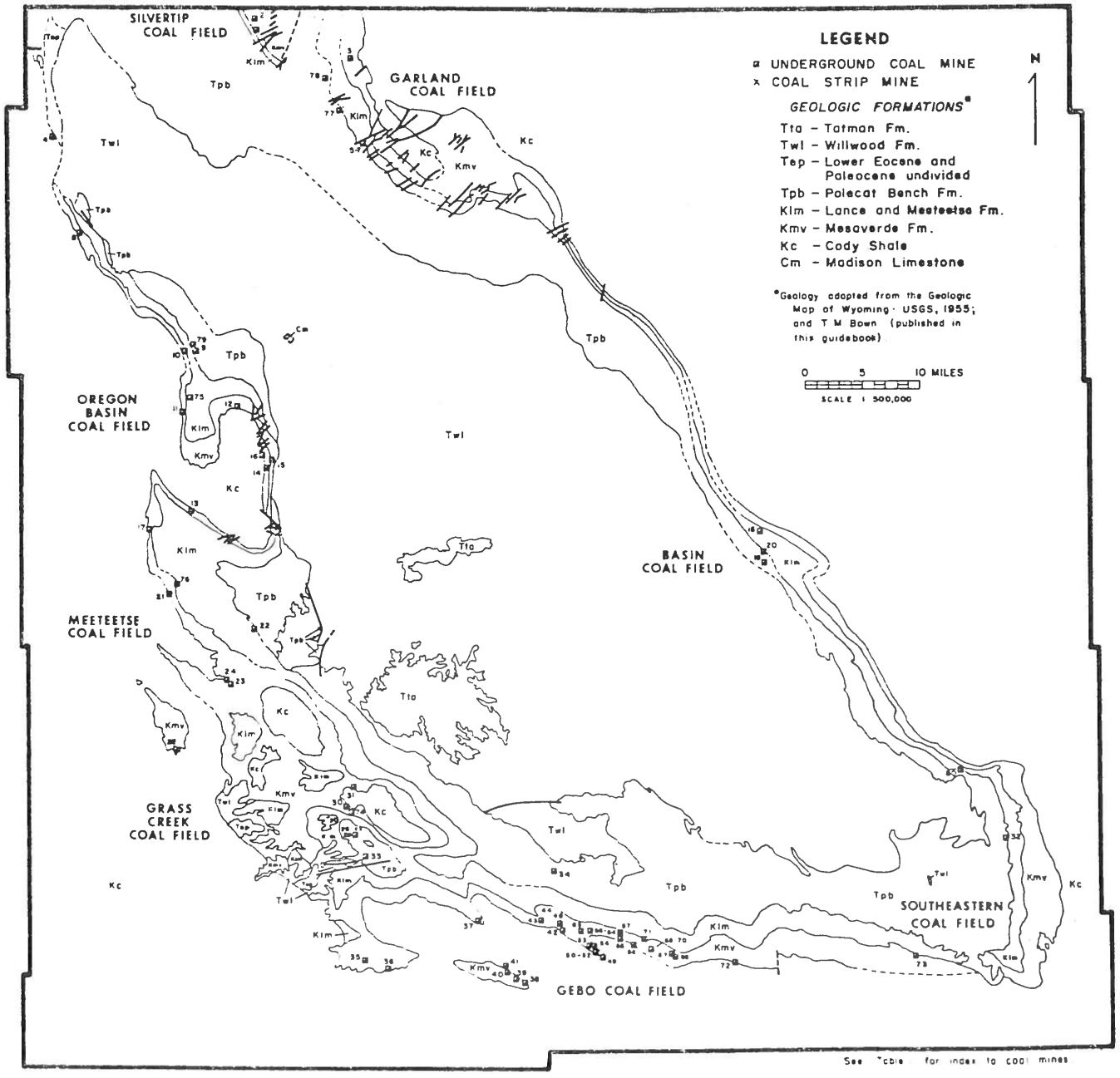

Figure 1: Coal fields in the Bighorn Coal basin of Wyoming.

Table 1: Index to coal mines on Figure 1.

1. Silvertip
2. Oldham
3. Unnamed
4. Brown
5. Duncan
6. Mike Rachelski
7. Honeysett
8. Allison
9. Cody
10. Unnamed
11. Schwab
12. McGuffey
13. West Wiley
14. East Wiley
15. Unnamed
16. Eagle
17. Orr
18. Unnamed
19. Flagstaff
20. Rogers & Gapin
21. Horse Creek
22. Black Diamond
23. Greybull
24. Erskine
25. Unnamed
26. Spring Gulch Strip
27. Grass Creek Strip*
28. Grass Creek
29. Mayfield No. 1
30. Unnamed
31. Dickie No. 1
32. Kimball Draw
33. Gwynn Prospect
34. Unnamed
35. Putney
36. Berry Brothers Prospect
37. Wright
38. Eade
39. M & M
40. Hiline
41. Smith
42. Unnamed
43. Ferelli
44. Unnamed
45. Unnamed
46. Unnamed
47. McPherson
48. Coleman
49. Price & Jones
50. Osborn
51. Valley No. 2
52. Valley
53. Roncco*
54. Osborn
55. Gebo No. 2
56. Crosby
57. Gebo No. 1
58. Burnell No. 2
59. Burnell No. 10X
60. Burnell No. 1½
61. Burnell No. 6
62. Burnell No. 5
63. Burnell No. 4
64. Burnell No. 3
65. Miller
66. Cowboy
67. Wyckoff
68. Eagle
69. Crosby
70. Stein No. 2
71. Stein No. 1
72. Unnamed
73. No Water
74. Dickie No. 2
75. Rader
76. Conie
77. Unnamed
78. Unnamed
79. Navine
80. Cottonwood Creek

* Active mines (others are closed or abandoned)

ALTERNATE MINE NAMES

Ace of Spades (see Grass Creek)
Beall (see Flagstaff)
Ben Goe (see Hiline)
Big Horn (see Crosby in T44N, R95W)
Blake (see Greybull)
Burns & Roger (See Schwab)
Dusky Diamond (see Grass Creek)
Gebo (see Gebo No. 1)
Goe (see Hiline)
Halbert & Malicky (see Valley)
Haverlock & MacCallum (see Valley)
K & R (see Eagle in T44N, R94W)
Lester Snyder (see Rogers & Gapin)
Malliot (see Silvertip)
Mayfield No. 2 (see Grass Creek)
Nagode & Oblak (see Eagle in T44N, R94W)
Native (see Cody)
New Burnell (see Burnell No. 10X)
Owl Creek No. 1A (see Burnell No. 1½)
Owl Creek No. 2 (see Burnell No. 2)
Owl Creek No. 3 (see Burnell No. 3)
Owl Creek No. 4 (see Burnell No. 4)
Owl Creek No. 5 (see Burnell No. 5)
Puteney (see Putney)
R. J. Ireland (see Burnell Nos. 4 & 5)
Schwoob (see East Wiley)
Stagg & Dodge (see Greybull)
T & K (see Coleman)
T & T (see Grass Creek)
Thompson (see West Wiley)
Valley No. 1 (see Valley)
Wilson (see Greybull)
Woodruff (see Black Diamond)

MINES NOT LOCATED

Antlers
Big Seven
Blue Blaze
Buckeye
Carey
Cedar Ridge
Diehl & Bell
Draw
Frost
Hopkins
Hutchinson
Ishawooa
Jones
Little Ridge
Mantua
McDonald & Cottle
Mecklen
Mondell
Nevins
Partners
Quick Service
Sarver
Schultz
Shoopman
Stonewall
William Luster
W. P. Jones

WILLWOOD FORMATION

The Eocene Willwood Formation reportedly contains a few low quality coals. Rohrer (1966) reports thicknesses up to 2 feet and gives an analysis of one Willwood coal with a heat value of only 4110 Btu/pound.

TATMAN FORMATION

Rohrer (1966) also found a 19-inch coal in the Eocene Tatman Formation. He reports the coals in the Tatman are typically less than 8 inches in thickness and very low in quality.

COAL QUALITY

RANK

Mesaverde coals are highly volatile C bituminous in rank in the Silvertip Coal Field, but decrease in rank to subbituminous A or B in the rest of the basin. None of the other coal-bearing formations contain coal higher in rank than subbituminous A or B.

MOISTURE CONTENT

As-received moisture contents of all mined seams in the basin range from 10.4 per cent to 28.2 per cent and average 15.0 per cent (Table 2). There is a slight indication that Mesaverde coals are 1.5 per cent to 2 per cent higher in moisture content than younger coals. Because many of the Mesaverde analyses come from the larger and deeper underground mines, their apparent higher moisture may merely be a function of greater depth below the surface. Mesaverde coals in the Silvertip Coal Field exhibit the lowest average moisture content (11.6 per cent) of any coals in the basin, possibly a function of their higher rank. The basin's highest moisture contents were reported for the Southeastern Coal Field, but the average of 20.8 per cent was based on only two analyses.

ASH CONTENT

Although the average as-received ash content of all the mined coals of the Bighorn Basin is moderately low at 9.5 per cent, it is slightly above the current State average of 7.2 per cent (Glass, 1975). Analyzed coals from the basin exhibit a range of 1.6 to 22.1 per cent ash (Table 2). Stratigraphically, the Mesaverde coals are lowest in ash, averaging 5.7 per cent; the Meeteetse coals are the highest, averaging 10.9 per cent. Since the Mesaverde coals contain the lowest ash content of all coals mined in the basin, it is not surprising that the Gebo Coal Field exhibits the lowest average ash content at 5.4 per cent. Mines in this field were almost exclusively on Mesaverde coals.

SULFUR CONTENT

The average as-received sulfur content is 0.8 per cent (Table 2). The range is from 0.2 to 2.2 per cent. There is some suggestion that sulfur contents of the Basin Coal Field may be higher than average, but the 1.9 per cent average is only based on two analyses. While Meeteetse coals show the lowest average sulfur content in the basin at 0.5 per cent, the Mesaverde and Polecat Bench coals are close seconds at 0.6 per cent. The lower average shown by the Grass Creek Coal Field stems from 6 of the 8 analyses coming from the Mayfield seam which averages only 0.4 per cent sulfur. (Table 2).

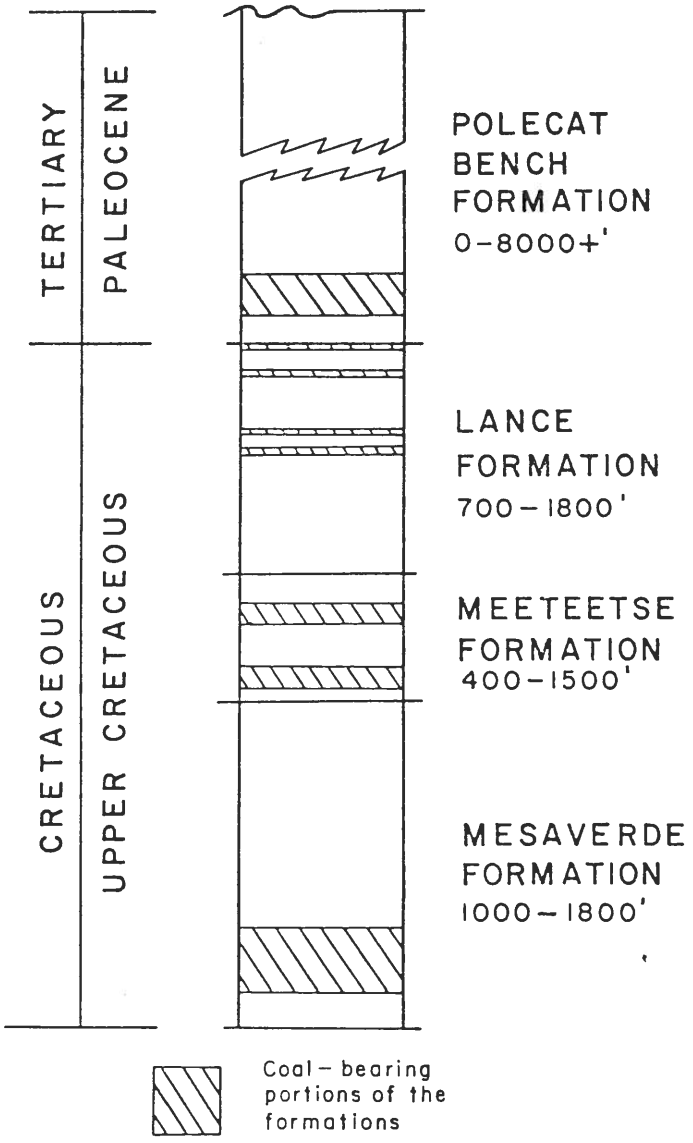

Figure 2: Coal-bearing rocks of the Bighorn Coal basin.

HEAT VALUE

As-received heat values in the Bighorn Coal basin range from 7,063 to 11,781 Btu/pound. The average heat value is 9,995 Btu/pound (Table 2). Higher heat values are typical of the Garland, Gebo, Grass Creek, and Silvertip coal fields. Although the average heat value of the bituminous coals in the Silvertip Coal Field is less than these other three coal fields, the Silvertip coals are still bituminous because they are either agglomerating or nonweathering. Stratigraphically, the Mesaverde coals have the highest heat values, averaging 10,560 Btu/pound; the Polecat Bench coals are next with an average of 10,150 Btu/pound; and the Meeteetse coals last, averaging only 9,800 Btu/pound.

COAL MINING

HISTORY

Coal mining in the Bighorn Coal basin dates back into the 1890's. Larger commercial mines, however, did not open until the early 1900's as the Chicago, Burlington & Quincy Railroad extended its rails into Hot Springs County. Prior to the railroad, coal was mined by local ranchers for their own use or sold as domestic fuel to customers in nearby communities. After completion of the railroad, production climbed to a record high in 1919, and hovered between 450,000 and 550,000 tons per year through 1929 (Fig. 3). From 1930 to 1956, production wavered from 90,000 to 200,000 tons per year. When the railroad converted to diesel engines in the mid-1950's, annual tonnage dropped to the pre-railroad level of less than 10,000 tons.

Although commercial coal mining in this basin has an 84 year history, production even in its best years was meager when compared to the State as a whole. The record annual production for the basin was set in 1919 when the combined tonnage from two mines reached 631,330 tons. Even then, Bighorn Basin mines accounted for only 7 per cent of the State's total annual production. Currently, the basin's 5000 to 8000 tons per year output is a mere 0.025 per cent of Wyoming's yearly total.

Overall, the 12,271,664 tons of recorded coal production from the Bighorn Coal basin accounts for only 2.6 per cent of the State's cumulative production through January 1, 1974. At least 90 per cent or 11,032,114 tons of that came from 13 mines located in the Gebo Coal Field. Output from the Grass Creek Coal Field was a distant second at an estimated 67,337 tons. Records show that none of the other six coal fields produced any significant tonnage. Additionally, with the exception of a few thousand tons from several very small strip mines, all Bighorn Basin coal has been mined by underground methods.

Since 1892, there have been no less than 108 coal mines opened in the Bighorn Basin coal fields. Of these, 80 have been located (Fig. 1). The names of 66 of these mines are included in Table 1. Obviously, some of the unnamed mines may be equivalent to some of the mines which were not located. Of the total 108 mines, only 27 deep mines and

Table 2: As-received coal analyses (in per cent).

		NUMBER OF ANALYSES	Moisture		Volatile Matter		Fixed Carbon		Ash		Sulfur		Btu/pound	
			Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
COAL SEAMS	MAYFIELD SEAM (Polecat Bench Fm.)	6	10.7-12.8	12.3	34.0-38.0	35.6	42.2-48.1	44.7	5.0-9.4	7.4	0.3-0.6	0.4	10,730-11,246	10,970
	GEBO SEAM (Mesaverde Fm.)	69	12.4-17.8	15.5	31.1-40.3	34.2	43.0-49.7	46.0	2.3-9.1	4.3	0.4-0.8	0.6	10,080-11,780	10,970
COAL-BEARING FORMATIONS	POLECAT BENCH FORMATION	12	10.7-17.8	14.3	27.3-48.1	34.8	32.6-48.1	42.2	5.3-15.3	9.8	0.2-2.1	0.6	8,858-11,246	10,150
	MEETEETSE FORMATION	10	12.8-15.2	13.8	32.1-49.7	38.0	23.7-45.4	37.3	6.5-16.6	10.9	0.3-0.7	0.5	7,773-10,965	9,800
	MESAVERDE FORMATION	111	10.4-28.2	15.8	29.2-47.6	34.9	15.6-50.8	43.5	1.6-22.1	5.7	0.3-2.2	0.6	7,063-11,781	10,560
COAL FIELDS	BASIN	2	14.9-16.5	15.7	33.4-34.3	33.9	38.0-37.9	37.9	11.2-13.7	12.4	1.7-2.1	1.9	9,506-9,740	9,623
	GARLAND	1		13.3		29.2		50.8		6.7		0.8		10,870
	GEBO	101	10.4-28.2	15.8	31.1-49.7	35.4	15.6-49.7	43.4	1.6-22.1	5.4	0.3-1.7	0.6	7,063-11,781	10,632
	GRASS CREEK	8	10.6-14.7	12.5	33.9-37.9	35.7	38.0-48.1	43.3	5.2-12.2	8.3	0.3-0.7	0.4	9,985-11,246	10,732
	MEETEETSE	10	14.2-17.6	15.7	27.2-35.8	32.9	37.7-47.4	49.9	7.5-14.7	10.6	0.2-1.0	0.6	9,270-9,925	9,568
	OREGON BASIN	6	13.4-17.2	15.2	31.3-35.9	34.2	39.3-45.8	41.8	5.4-11.8	8.9	0.3-0.9	0.6	9,266-10,214	9,894
	SILVERTIP	3	11.3-11.9	11.6	31.0-34.1	32.7	43.0-44.3	43.7	9.7-13.6	12.0	0.6-0.8	0.7	9,980-10,300	10,096
	SOUTHEASTERN	2	16.3-25.4	20.8	35.8-38.6	37.2	27.8-32.6	30.2	8.1-15.2	11.7	0.3-0.9	0.6	8,231-8,858	8,544
	AVERAGE OF ALL ANALYSES	133	10.4-28.2	15.0	27.2-49.7	33.9	15.6-50.8	41.5	1.6-22.1	9.5	0.2-2.2	0.8	7,063-11,781	9,995

one strip mine ever reported tonnages to the Wyoming State Inspector of Mines. These 28 mines, however, are believed to account for the bulk of the coal ever mined in the basin. The mines that did not report tonnages probably never produced more than a few hundred to possibly a thousand tons of coal.

SILVERTIP COAL FIELD

The Silvertip Coal Field has been an unimportant field in the Bighorn Basin and accounts for less than 1300 tons of reported production. The Silvertip and Oldham mines are the only two mines reported in the coal field. They deep-mined two Mesaverde coals. While the upper seam ranged from 3 to 5.5 feet thick, the lower seam ranged from 2.8 to 6.9 feet. A third seam, below these, ranged from 0.8 to 3.8 feet thick, but was not mined. There are no active coal mines in this field.

GARLAND COAL FIELD

The Garland Coal Field has also been unimportant with no recorded production attributed to it. The reasons for the lack of activity in this field are unclear, but there is some reason to think the lenticular nature of the coal seams may have prevented any moderate-scale mining. The Duncan, Rachelski, Honeysett, Sarver, and Hopkins mines dug coals from what was probably the basal Polecat Bench Formation. The mined seams ranged from 4.4 to 7 feet in thickness. At least two unnamed mines were opened on stratigraphically higher Polecat Bench coals in the 2.5- to 3.5-foot range. One unnamed mine is located in the Mesaverde Formation, but the coal thickness is unknown. Prospecting shows one 5-foot coal and several 3-foot coals in the Meeteetse Formation as well as at least one 4.1-foot thick Mesaverde coal. There are no active mines in this coal field.

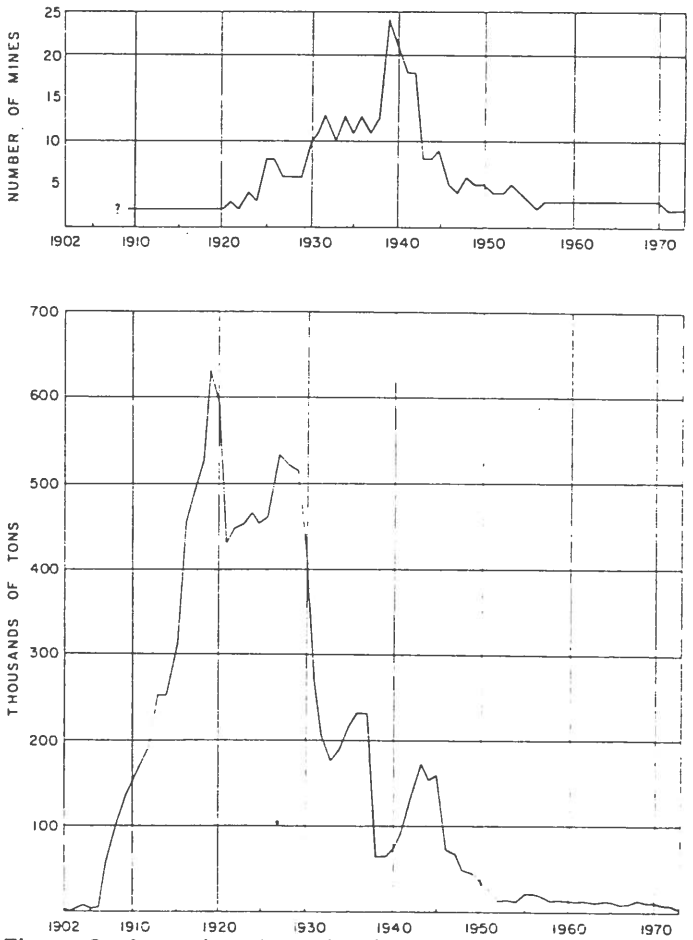

Figure 3. Annual coal production and number of active coal mines by year.

Table 3: Calculation of remaining recoverable bituminous coal resources in the Bighorn Coal basin to January 1, 1974 (modified from Berryhill and others, 1950)

	ORIGINAL BITUMINOUS RESOURCE (MILLIONS OF TONS)			
Coal Thickness	0 - 1000 feet Overburden	1000 - 2000 feet Overburden	2000 - 3000 feet Overburden	Total
14-28 inches	4.27	2.20	0.3	6.77
28-42 inches	7.2	2.81	0.06	10.07
> 42 inches	1.06	-	-	1.06
Total	12.53	5.01	0.36	17.90

Original resource in seams > 28 inches and under less than 1000 feet of overburden	8.26 million tons
Production	negligible
Mining losses	negligible
Remaining resource	8.26 million tons
Remaining recoverable resource (assume future mining losses will equal production)	4.13 million tons

BASIN COAL FIELD

Coal mining activity in the Basin Coal Field has been greater than the previous two fields. Recorded production from the Flagstaff, Rogers & Gapin, and Mecklen mines totals 17,542 tons and ranks this coal field as the third largest producer in the basin. This meager tonnage shows that the Basin Coal Field never supplied more than a domestic market. The three previously mentioned mines produced coal from the Polecat Bench Formation. The mined seams were from 3 to 8.7 feet thick, averaging 6.5 feet in both the Flagstaff and Rogers & Gapin mines. A small unnamed mine was also opened on an undescribed Mesaverde coal. Although not mined, one 4.7-foot and one 11-foot coal are reported in the Meeteetse Formation. Mesaverde prospects all show less than 14 inches of coal. There is no longer any mining in this coal field.

Table 4. Calculation of remaining recoverable subbituminous coal resources in the Bighorn Coal basin to January 1, 1974 (modified from Berryhill and others, 1950)

	ORIGINAL SUBBITUMINOUS RESOURCE (MILLIONS OF TONS)			
Coal Thickness	0 - 1000 feet Overburden	1000 - 2000 feet Overburden	2000 - 3000 feet Overburden	Total
2.5-5 feet	275.17	96.56	41.62	413.35
5-10 feet	90.85	30.27	12.21	133.33
>10 feet	17.10	-	-	17.10
Total	383.12	126.83	53.83	563.78

Original resource in seams > 5 feet and under less than 1000 feet of overburden	107.95 million tons
Production[1]	-12.27 million tons
Mining losses (equal to production)	-12.27 million tons
Remaining resource	83.41 million tons
Remaining recoverable resource (assume future mining losses will equal production)	41.70 million tons

[1] Most of the major mined seams were 5 feet or greater in thickness.

SOUTHEASTERN COAL FIELD

Because of its rugged terrain and remote location, the Southeastern Coal Field has seen the least activity of all the Bighorn Basin coal fields. No production from the field has been reported even though three small mines once operated there. The Kimball Draw and Cottonwood Creek mines were drifted into 5.8-foot and 3.5-foot coals of the Polecat Bench Formation, respectively. The 6-foot coal in the No Water mine was probably in the Meeteetse Formation. A 5.6-foot and a 10-foot coal in the Polecat Bench Formation also occur in this field. Prospecting has shown several 3.5-foot thick coals as well as a 4.9-foot, a 6-foot and an 8.1-foot coal in the Meeteetse Formation. Mesaverde coals are rare and less than 14 inches thick. There has not been any active coal mines in this field for many years.

GEBO COAL FIELD

As stated earlier, 90 per cent of the coal produced in the Bighorn Coal basin came from mines in the Gebo Coal Field. This coal was used by the railroad until the mid-1950's. There have been at least 41 mines in this coal field, probably more. Twenty-two of them reported their production to the Wyoming State Inspector of Mines. Thirty-two of these mines are located on Figure 1 and are identified by name on Table 1. The others are either unnamed or the name is not known.

The Gebo seam has been the most widely exploited bed in the coal field. At least the Crosby, Burnell Nos. 5, 6, and 10X, Gebo Nos. 1 and 2, Valley, Miller, Osborn, and Roncco mines mined this 6- to 11-foot thick Mesaverde coal. The quality of the Gebo seam is good. An average as-received analysis shows 5.4 per cent ash, 0.6 per cent sulfur, and 10,632 Btu/pound (Table 2). The Coleman, Cowboy, and Eagle mines worked stratigraphically higher Mesaverde coals from 3.5 to 7 feet thick. The Burnell No. 2 mine was on a bed below the Gebo coal. This older coal had a maximum thickness of 12 feet. The Smith mine was opened on an undescribed Mesaverde coal. An unnamed mine on a Polecat Bench coal is the northernmost mine in the field. Although they have not been mined, at least 7 seams in the Meeteetse Formation exceed 3 feet in thickness. While the thickest of these coals is 7 feet, they average 4 feet.

The one active coal mine in the field, the Roncco mine, sells only to a domestic market. This deep mine produces about 3,000 tons of coal a year from the Gebo seam, which ranges from 6 to 9 feet in the mine. Dips in the Roncco mine vary from 17 to 45 degrees.

GRASS CREEK COAL FIELD

The Grass Creek Coal Field accounts for the second largest coal production in the Bighorn Basin. Of the reported 67,337 tons of coal mined in this field, 66,422 tons came from one underground mine that finally closed in 1973. Of the three mineable coals in the Polecat Bench Formation of the Grass Creek Coal Field, the abandoned Spring Gulch, Grass Creek, and Mayfield No. 1 mines and

the active Grass Creek strip mine are all on the Mayfield seam. This seam ranges from 8 to 38 feet in thickness. Six as-received analyses of the Mayfield seam show an average ash content of 7.4 per cent, a sulfur content of 0.4 per cent, and a heating value of 10,970 Btu/pound. The Gwynn seam, which is below the Mayfield seam, is much thinner at 3.1 feet. On the other hand, an unnamed seam about 100 feet above the Mayfield seam ranges from 8 to 22 feet in thickness.

The Dickie Nos. 1 and 2 mines also operated in this field, but they worked 4-foot and 8.8-foot thick Mesaverde coals, respectively. Another small unnamed mine also mined a 4-foot Mesaverde coal. Prospects on the Mesaverde coals suggest up to 5 seams exceed 3 feet in thickness and at least one reaches 10.8 feet. Meeteetse coals exhibit little more than 3.5 feet of clean coal and as much as 5.1 feet of shaly coal.

Currently, Northwestern Resources' Grass Creek strip mine is stripping about 3,000 to 8,000 tons of the Mayfield seam each year. They have announced intentions to expand their output to as much as 700,000 tons per year in the near future. A recent estimate by the U. S. Geological Survey suggests that there may be 18,600,000 tons of strippable coal in the Grass Creek Coal Field when the reserves of the Mayfield seam are combined with the reserves of the overlying coal.

MEETEETSE COAL FIELD

The Meeteetse Coal Field is another minor coal field of the Bighorn Basin with little more than 8,000 tons of production reported. The Black Diamond and Conie mines were probably both working coals of the Polecat Bench Formation. Of the two mines, the 4-foot coal in the Black Diamond was the thicker. The Erskine, Horse Creek, Greybull, and an unnamed mine were on Mesaverde coals ranging from 4.8 to 8 feet thick. Prospects and outcrops of coals in the Meeteetse Formation show one seam as thick as 9.1 feet and another only 6 feet. Most of the Meeteetse coals, however, are less than 2.5 feet thick. There is no active mining in this coal field.

OREGON BASIN COAL FIELD

The Oregon Basin (formerly the Cody) Coal Field is also an unimportant coal field in the basin. Recorded production is less than 3,000 tons. Of the 13 mines in this field, the Brown, Allison, Schwab, Mc Guffey, West Wiley, East Wiley, Eagle, Orr, and an unnamed mine were on Mesaverde coals ranging between 10 inches to 7.8 feet thick, but averaging 4.5 feet. Only the Rader and an unnamed mine were on the Meeteetse coals. At the Rader opening the coal was 3 feet thick. The maximum thickness of clean Meeteetse coal is believed to be 3.5 feet. One shaly coal was measured at 4.5 feet. The Cody and Navine mines were on coals in the Polecat Bench Formation. The 4.5-foot thick coal exposed at the Cody mine is the thickest mention of coal in this formation.

MINING PROBLEMS AND OUTLOOK

Traditionally, the biggest problem facing coal mining in the Bighorn Coal basin has been the lack of nearby markets. Couple this with the rugged terrain and remoteness of many of the coal fields, the steep dips, faulting, and thin nature of many of the coal beds, and it is not hard to see why little mining has occurred. Demand for low sulfur coal alone cannot offset these handicaps because relatively thin coals that must be deep mined will find strip mines in thick coals pretty stiff competition to beat. Although the outlook for strippable seams in the Bighorn Basin is slightly more optimistic, strip mining is also complicated by topographic and structural features of the basin. Rugged terrain and local folding severely reduce the chances of finding large blocks of strippable coal. The opening of several relatively small strip mines is more likely than the development of any large mine-mouth plant complexes.

Based solely on seam thicknesses, mineable coals still exist in all the coal fields of the basin. The greatest potential for future conventional mining, however, is in the Gebo and Grass Creek coal fields. Of course, there is also the possibility of tapping the energy of the deeper coals on both the flanks and central portions of the basin by in situ extraction methods. This alternative is many decades in the future at best.

COAL RESOURCES

Berryhill and others (1950) estimate both bituminous and subbituminous coal resources for the Bighorn Coal basin. The bituminous resource is limited to the Silvertip Coal Field where an estimated 17.9 million tons of coal lie between the surface and 3,000 feet (Table 3). Of this, only 8.26 million tons includes seams greater than 28 inches thick and under less than 1,000 feet of overburden. These parameters delimit today's potentially recoverable portion of the bituminous resource. Allowing for future mining losses equal to production, this resource reduces to a remaining recoverable resource of 4.1 million tons.

The original subbituminous coal resource for the Bighorn Coal basin is estimated (Berryhill and others, 1950) at 563.78 million tons (Table 4). Berryhill's estimate only takes the marginal areas of the basin into account. Subtracting the subbituminous resources calculated for seams less than 5 feet thick and for coals deeper than 1,000 feet, the resource becomes 107.95 million tons. Previous production and mining losses further reduce this figure to 83.41 million tons. Again assuming that future mining losses will remain equal to production, the remaining recoverable subbituminous resource becomes 41.7 million tons. Admittedly, Berryhill's estimate of original resources is very conservative, and some of the remaining coal may be strip mined with less mining loss than calculated. It is still apparent, however, that there is not a great deal of shallow mineable coal left in the Bighorn Coal basin.

The only known strippable coal resources in the Bighorn Basin are located in the Grass Creek Coal Field. Combined, there is an estimated 18.6 million tons of strippable coal in two thick seams of the Polecat Bench Formation.

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