

CONTRIBUTIONS TO ECONOMIC GEOLOGY, 1928

PART II. MINERAL FUELS

THE PUMPKIN BUTTES COAL FIELD, WYOMING

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INTRODUCTION

The Pumpkin Buttes coal field as here defined embraces about 1,800 square miles in the central part of the Powder River Basin, a broad structural depression in northeastern Wyoming lying between the Black Hills and the Big Horn Mountains. The field includes parts of Campbell, Converse, and Johnson Counties, as is shown by Figure 1, which also shows the relation of the field to the surrounding coal fields described in reports of the United States Geological Survey. Detailed maps of the coal-bearing portions of the Pumpkin Buttes field are given on Plates 2 and 3.

The original field work upon which this report is based was done in 1915 by C. H. Wegemann, assisted by R. W. Howell, C. W. Hammen, C. Griffin, and H. C. Evans. Only such portions of the field as were found to contain coal of economic value were studied in detail; the remainder of the area was covered by a careful reconnaissance examination. The data thus originally collected have been reviewed and revised by C. E. Dobbin, who restudied the area in 1924 and compiled the report.

GEOGRAPHY

ACCESSIBILITY AND SETTLEMENT

The roads shown on the accompanying maps (pls. 2, 3) are the principal ones in the area traversable by automobile, according to the county surveyors' maps of Campbell, Converse, and Johnson Counties, supplemented by information compiled by the writers. As

shown by these maps and by Figure 1, the northern part of the Pumpkin Buttes field east of Powder River is most readily accessible from Gillette, on the Chicago Burlington & Quincy Railroad, 20 miles to the northeast of the field, and Buffalo, 25 miles to the northwest, is the main trading center for the part of the field west of Powder River. The nearest railroad points for the central and southern portions of the field are, respectively, Salt Creek, the northern terminus (in 1924) of the North & South Railway, and Douglas, the northern terminus (in 1924) of the North & South Railway, and Douglas,

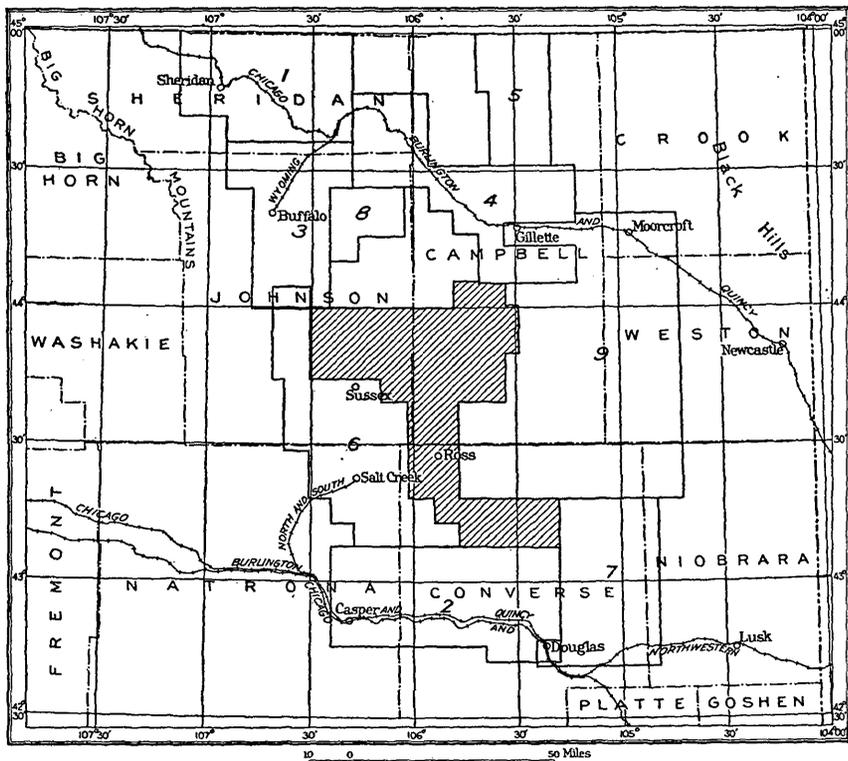


FIGURE 1.—Index map of northeastern Wyoming showing relation of the Pumpkin Buttes coal field (shaded area) to other coal fields. 1, Sheridan; 2, Glenrock; 3, Buffalo; 4, Powder River; 5, Little Powder River; 6, Sussex; 7, Lost Spring; 8, Barker; 9, Gillette

on the Chicago, Burlington & Quincy and Chicago & Northwestern railways. The Black and Yellow Trail between Gillette and Sussex crosses the northern portion of the field and is well traveled, and a good road between Gillette and Douglas crosses the field in a north-south direction, passing through Savageton and Ross. A branch of this road starting in sec. 18, T. 42 N., R. 74 W., leads to Salt Creek and Casper. Near Powder River the country is much more broken and the few roads are for the most part in poor condition, but near Belle Fourche River and Dry Fork of Cheyenne River the surface

is a rolling upland and good roads are common. The largest settlements in the area are those at Savageton, Ross, and Sussex, where a few dwellings and stores combined with post offices are maintained. There are also post offices at Clarkelen, Bonnidée, Cactus, and Bear Creek.

TOPOGRAPHIC FEATURES

The Pumpkin Buttes field lies in the Northern Great Plains, and altitudes within it range from 4,400 to nearly 7,000 feet above sea level. The Pumpkin Buttes, four flat-topped buttes in T. 43 N., R. 75 W., and T. 44 N., Rs. 75 and 76 W., stand about 1,000 feet above the level of the surrounding country and are clearly visible for 60 miles. These buttes served as landmarks to the early pioneers who traveled the Bozeman trail, and it is from them that this field is named. The conspicuous pine-covered ridge known as Great Pine Ridge forms the western limit of the field and marks the termination of the coal-bearing area in that direction. In the portions of the field drained by Powder River the land is much dissected by ravines and deep, narrow valleys, but elsewhere the surface consists of a rolling, treeless upland, best adapted for grazing cattle. This difference in the rate of erosion is chiefly due to the fact that headward cutting by Powder River has enabled it to capture the headwaters of Belle Fourche River, as originally developed,¹ with the result that Powder River has an abundant and continuous supply of water and is therefore an effective erosion agent, whereas the present Belle Fourche River and Dry Fork of Cheyenne River rise in the semiarid plains area east of the mountains and are dry during large parts of the year, so that they have little cutting power.

DRAINAGE AND WATER SUPPLY

The Pumpkin Buttes field is drained by Dry Fork of Cheyenne River in the south, Belle Fourche River in the northeast, and Powder River in the northwest. Powder River is the only perennial stream. Dry Fork of Cheyenne River is dry throughout the greater part of the year, and its bed is so filled with fine sand that all but the heavy run-off sinks beneath the surface during the infrequent torrential rains which are characteristic of the country. This stream nowhere offers opportunities favorable for the construction of reservoirs to conserve flood waters, but on some of its smaller tributaries the water is stored and used for stock in the dry season. Belle Fourche River has a small intermittent surface flow in its lower courses during the dry season. Springs issuing from sandstone and coal beds occur at many places in the field; the largest are the perennial Hoe Springs,

¹ Rubey, W. W., personal communication.

in the NW. $\frac{1}{4}$ sec. 31, T. 47 N., R. 74 W. Irrigated flats along Powder River are highly productive, but such areas are very small in proportion to the total area of the field. Small lakes are fairly common in the rolling plains east of the Pumpkin Buttes and are shallow, though in times of heavy rains areas half a mile or more in extent become inundated.

GEOLOGY

STRATIGRAPHY

The Wasatch formation, of Eocene age, covers the surface of the Pumpkin Buttes field and consists mainly of gray shale and fine-grained grayish-white sandstone, with some beds of coarser sandstone, especially in the upper part. Thin layers of conglomerate are found at its base in many places. In certain zones there are layers of pink shale and pink sandstone whose color—in the sandstone at least—is variable from place to place. Ferruginous layers, which are so abundant in the underlying Fort Union formation, are absent in the Wasatch. Distributed through the formation at several horizons are beds of subbituminous coal, which range in thickness from a few inches to 15 feet. Some of the beds are apparently very lenticular and can be traced for only a few miles along their outcrop. Others are persistent and underlie hundreds of square miles of territory. The following section shows the character of the Wasatch formation in this area, where its base is drawn at the top of coal bed H:

Section of the Wasatch formation between the Great Pine Ridge and the top of the Pumpkin Buttes, T. 43 N., Rs. 75-78 W., Wyoming

	Ft.	in.
Gravel.....	8	
Sandstone, buff, fine to coarse and conglomeratic, cross-bedded; is a cap rock on the Pumpkin Buttes.....	95	
Sandstone, white and yellow, coarse, softer than that above.....	95	
Sandstone, dark, containing much iron.....	10	
Sandstone, yellow, coarse.....	30	
Shale, with some sandstone beds, poorly exposed.....	105	
Shale, pink and blue variegated.....	80	
Shale, gray, containing streaks of carbonaceous shale....	30	
Sandstone, buff, containing large concretionary masses of harder sandstone.....	42	
Shale.....	16	
Sandstone.....	2	
Shale.....	15	
Coal.....	1	
Shale.....	23	
Coal.....	6	
Shale.....	10	

	Ft.	in.
Sandstone, pink-----	30	
Shale-----	70	
Sandstone-----	10	
Coal-----		7
Shale-----	50	
Sandstone, pink; conglomerate at base-----	15	
Coal-----		1
Shale-----	10	
Coal-----		8
Shale-----	10	
Coal-----		6
Shale, gray, light and dark-----	30	
Sandstone, white, containing large, long, light concretions of harder sandstone-----	35	
Conglomerate-----	1	
Coal-----		5
Shale, dark gray-----	20	
Sandstone, pink and white, containing immense numbers of sandstone concretions like cannon balls-----	80	
Shale; Coryphodon teeth found at top just below sand- stone. Coal beds A, B, and C occur near middle of unit in Tps. 46 and 47 N., R. 74 W.-----	220	
Sandstone, pink-----	35	
Shale-----	120	
Sandstone, containing in some places near its middle streaks of coal and at its base on Pumpkin Creek coal bed E-----	80	
Shale, light and dark gray, containing several thin sand- stone beds and having in its lower half several beds of pink shale-----	1,000	
	<u>2,330</u>	9
Coal bed H, regarded as equivalent to the Roland coal, the top of which marks the boundary between the Wasatch formation and the underlying Fort Union formation-----	10	

STRUCTURE

The structure in the Pumpkin Buttes field as determined where coal beds were mapped clearly shows that the major stream valleys in general follow synclines or structural troughs in the strata, and this relation probably holds true for the field as a whole. In most places the dip of the rocks is comparatively slight, but along the Great Pine Ridge, which borders the field on the west, the beds dip 4°-20° NE. A short distance from the ridge the dip is very much less. In the southern part of the field Dry Fork of Cheyenne River appears to follow in a general way the axis of a shallow syncline. This is particularly noticeable in Tps. 37 and 38 N., R. 72 W., where the coal beds show a decided dip toward the river near the junction of Willow Creek.

In the northeastern part of the field, particularly in T. 44 N., Rs. 73 and 74 W., and T. 45 N., R. 73 W., Belle Fourche River follows the axis of a pronounced syncline, the direction and shape of which can be determined from altitudes taken along the coal beds that crop out in its valley. The head of the Belle Fourche, however, in T. 43 N., R. 73 W., appears to cross the axis of a narrow anticline that lies south of the syncline, followed by the river farther down its course. In T. 47 N., R. 74 W., on the crest of the divide between Belle Fourche and Powder Rivers, the crest of a low anticline is clearly shown by the coal beds, which dip from the divide both to the east and to the west. The dip to the west into Powder River valley is also shown in T. 46 N., R. 76 W., where the coal along Pumpkin Creek dips about 250 feet in $3\frac{1}{2}$ miles. Powder River in this vicinity apparently follows the axis of a broad syncline lying between the anticline of the Belle Fourche-Powder River divide and the uplift of the beds along the Big Horn Mountains. The Great Pine Ridge, described as lying on the southwest side of the field, crosses the western part of T. 45 N., R. 81 W., just beyond the limits of the Pumpkin Buttes field, and the beds along the ridge dip at angles of 10° to 15° in a direction a little north of east, toward the Powder River valley. The syncline indicated is occupied by Powder River as far upstream as the mouth of Dry Fork of Powder River, which occupies the continuation of the syncline to the south. The syncline in this locality is bounded on the southwest by the steeply tilted rocks of the Great Pine Ridge and on the northeast by the broad, low anticlinal fold that forms the divide between the drainage basins of Powder and Belle Fourche Rivers. Altitudes taken on the thick sandstones that cap the Pumpkin Buttes show a gentle dip to the northwest all the way from South Butte to North Butte. The anticline that forms the divide appears to be by no means regular, and its highest part lies in the southeast corner of T. 43 N., R. 74 W.

Over the parts of the Pumpkin Buttes field not included in the above description poor rock exposures make it difficult or impossible to work out in detail the structure, which must be inferred from the present topography. The anticlines mentioned are scarcely to be looked to as places for the accumulation of oil, as the Shannon sandstone, the highest productive bed in the Salt Creek field, presumably lies at a depth of almost 10,000 feet below the surface at the foot of Pumpkin Buttes, and the Parkman sandstone, which is reported to have yielded traces of oil in the vicinity of Salt Creek, would lie at a depth of about 8,900 feet near the buttes. It is conceivable that oil and gas may be found in the fresh-water beds in the Lance, Fort Union, and Wasatch strata, which overlie the marine Cretaceous rocks in this region, but the possibility is a most remote one.

COAL

DISTRIBUTION

The coal in the Pumpkin Buttes field crops out in separate areas here called the Divide, Pumpkin Creek, Belle Fourche, and Dry Cheyenne coal areas. In addition to the coals exposed in the four areas named, coal beds may possibly underlie the divide between the Divide and Pumpkin Creek coal areas at moderate depths. The coals that crop out in the Dry Cheyenne area may also extend northward under cover, but the extent and value of these beds and such deeply buried coals as may be present near the base of the Wasatch or the top of the underlying Fort Union can be determined only by exploratory drilling, which is not warranted by the present economic value of the coal reserves that might be thus disclosed. Plate 2 shows the outcrop lines of coal beds in the southernmost basin, here called the Dry Cheyenne area. Similarly, Plate 3 shows those in the three northern basins, the Belle Fourche, Divide, and Pumpkin Creek coal areas. The vertical distribution of the coal beds is shown by the columnar sections in Plates 4 and 5.

The lowest coal bed in the section is bed H, which crops out in the Dry Cheyenne coal area and ranges in thickness from 1 foot or less to 4 feet 4 inches at location 94, in sec. 32, T. 38 N., R. 72 W. It is regarded as equivalent to the Roland or D coal bed of the Gillette coal field,² which adjoins the Pumpkin Buttes field on the east, and also to one of the several coal beds above the sandstone of Great Pine Ridge in the Sussex field on the west.³

Bed G lies 220 feet above bed H and is equivalent to the "Lower bed" of the Sussex field. It averages about 2 feet in thickness.

Bed F is 160 feet above bed G and is equivalent to the "Upper bed" of the Sussex field and to bed C of the Gillette field. It has a minimum thickness in this area of about 1 foot and a maximum of 11 feet 6 inches at location 66, in sec. 9, T. 37 N., R. 74 W.

Beds D and E crop out in the valley of Belle Fourche River and are correlated, respectively, with beds A and B of the Gillette field. Detailed tracing of these beds in the upland country near the source of the Belle Fourche was almost impossible because of lack of exposures; hence the measured sections of them shown on Plate 3 could be obtained only at widely separated localities. The minimum thickness of bed D in the area was 1 foot 9 inches of bone at location 22, in sec. 25, T. 45 N., R. 73 W., and its maximum observed thickness was 7 feet 8 inches at location 15, in sec. 17, T. 44 N.,

²Dobbin, C. E., Barnett, V. H., and Thom, W. T. jr., The Gillette coal field, north-eastern Wyoming; U. S. Geol. Survey Bull. 796, pp. 14-15, 1927.

³Wegemann, C. H., The Sussex coal field, Johnson, Natrona, and Converse Counties, Wyo.; U. S. Geol. Survey Bull. 471, pp. 441-471, 1912.

R. 73 W. Bed E is nearly 18 feet thick at location 35, in sec. 7, T. 45 N., R. 72 W., and 15 feet at location 23, in sec. 21, T. 45 N., R. 73 W., where its base is unexposed. Its minimum thickness of 2 feet 9 inches occurs at location 16, in sec. 8, T. 44 N., R. 73 W. A coal bed probably equivalent to bed E of the Belle Fourche area crops out in the valley of Pumpkin Creek in T. 46 N., R. 76 W., where it contains from 2 to 7 feet of impure coal, split by many partings. (See pl. 3.)

Beds A, B, and C crop out in the Divide area—that is, on the divide between Powder and Belle Fourche Rivers—in Tps. 46 and 47 N., R. 74 W. (See pl. 3.) They are the highest coal beds observed in the Pumpkin Buttes field. Bed A averages 2 feet in thickness and is of no economic value because of the small area occupied by it. Bed B is 85 feet below bed A and has a maximum thickness of nearly 11 feet at location 52, in sec. 3, T. 47 N., R. 74 W., and is almost as thick at other places where it was measured, but, like bed A, it crops out only on the highest divides and the area underlain by it is small. Bed C is 80 feet below bed B and crops out only in T. 47 N., R. 74 W. It is made up of two benches of coal, each averaging less than 2 feet in thickness, separated by a shale parting 2 inches to 1 foot 3 inches thick.

OUTLOOK FOR DEVELOPMENT

Development work upon the coal beds in the Pumpkin Buttes field has been limited to that done by the local residents, who obtain coal for domestic use by picking it from the outcrops along streams. In view of the fact that an abundant supply of easily recoverable coal exists along the railroad near Gillette, Buffalo, Sheridan, Douglas, and other points both north and south of the Pumpkin Buttes field, it is certain that the commercial development of this area on a large scale is a matter for the future rather than for the present.

PHYSICAL AND CHEMICAL PROPERTIES

The coal of the Pumpkin Buttes, like that of other fields in the Powder River Basin, is subbituminous. It is either shiny or dull-black when fresh but quickly becomes dull when exposed to the air and soon checks and falls to pieces. The coal burns easily, at first emitting a white smoke, but when combustion has continued for a short time the smoke is almost imperceptible.

No sample of strictly fresh coal for analysis could be obtained in the field owing to the lack of active development. However, three samples of coal were obtained at localities where settlers had dug coal but a short time before, and the analyses are given below. In addition analyses of representative samples of coal from the Sheridan,

Gillette, and Douglas fields are given for comparison. The air-dried samples in the Pumpkin Buttes field show an average of 11.2 per cent moisture, 10.3 per cent ash, and 1.7 per cent sulphur, and a heating value of 9,797 British thermal units. The indicated heating value is thus superior to that of the coal at Gillette and Douglas, and it is probable that the absolutely fresh coal has a composition similar to that of the coal in the Sheridan field.

The analyses in the accompanying table are given in four forms. Form A is the analysis of freshly mined coal. Form B represents the sample after it has been dried for a certain time at a standard temperature. Form C is an analysis of the sample after all moisture has been theoretically eliminated, and form D an analysis after all moisture and ash have been eliminated by calculation. The coal as represented by forms C and D does not exist in nature, but form C is used by mechanical engineers, and form D is valuable for comparing the quality of the pure coal and the effect on its heating value of the impurities present, and it is also used by petroleum geologists as an index of the degree of regional metamorphism at the point of sampling.

Analyses of coal samples from the Pumpkin Buttes coal field and of representative samples from near-by fields

[Made at the laboratory of the Bureau of Mines]

	Location				Laboratory No.	Air-drying loss	Form of analysis	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Heating value	
	Quarter	Sec.	T. N.	R. W.									Calories	British thermal units
Location 42 (Bed B)	SE. ¼	3	46	74	22973	21.7	A	31.0	30.5	28.4	10.1	1.4	4,022	7,240
							B	11.8	39.0	36.2	12.9	1.8	5,138	9,248
							C	-----	44.2	41.1	14.7	2.1	5,827	10,489
							D	-----	51.8	48.2	-----	2.4	6,828	12,290
Location 15 (Bed D)	NE. ¼	17	44	73	22904	25.3	A	35.5	30.5	29.7	6.2	1.2	4,082	7,348
							B	11.0	40.9	39.8	8.3	1.6	5,464	9,835
							C	-----	45.9	44.8	9.3	1.8	6,141	11,054
							D	-----	50.7	49.3	-----	1.9	6,772	12,190
Location 23 (Bed E)	NE. ¼	21	45	73	22885	20.3	A	29.0	32.0	31.1	7.8	1.4	4,564	8,215
							B	10.9	40.2	39.1	9.8	1.7	5,728	10,310
							C	-----	45.1	43.9	11.0	2.0	6,428	11,570
							D	-----	50.7	49.3	-----	2.2	7,225	13,005
Composite analysis of 5 samples of Roland coal bed at Peerless mines, 5½ miles east of Gillette.	-----	-----	-----	-----	A2965	17.8	A	33.0	29.7	31.5	5.8	.5	4,311	7,760
							B	18.4	36.1	38.5	7.0	.6	5,244	9,440
							C	-----	44.3	47.1	8.6	.8	6,433	11,580
							D	-----	48.4	51.6	-----	.8	7,033	12,660
Average of 20 samples from Sheridan Field	-----	-----	-----	-----	-----	10.4	A	23.3	32.2	41.1	3.5	.3	5,194	9,350
							B	14.3	35.9	45.9	3.9	.4	5,801	10,442
							C	-----	41.9	53.6	4.6	.5	6,771	12,188
							D	-----	43.9	56.1	-----	.5	7,091	12,756
Average of 5 samples from Douglas Field	-----	-----	-----	-----	-----	11.9	A	26.8	28.6	35.7	8.8	.9	4,377	7,676
							B	16.9	32.5	40.6	10.0	1.0	4,972	8,970
							C	-----	39.1	48.8	12.0	1.3	5,986	10,774
							D	-----	44.2	55.6	-----	1.4	6,806	12,254

THE COAL BEDS

DRY CHEYENNE COAL AREA

TPS. 37 AND 38 N., R. 72 W.

Bed H is the only coal bed of economic importance that crops out in Tps. 37 and 38 N., R. 72 W. Sections of it were measured at locations 93 to 102 and 104 to 106, and all of these except 100, 101, 105, and 106 are represented graphically on Plate 4. The maximum thickness of the bed for these townships is 4 feet 4 inches at location 94, and its minimum thickness 1 foot 2 inches at location 102. At location 100 bed H is 1 foot 3 inches thick; at 101, 1 foot 6 inches; at 105, 1 foot 4 inches; and at 106, 1 foot 10 inches.

TPS. 37 AND 38 N., R. 73 W.

Bed H crops out in secs. 11 and 12, T. 37 N., and probably underlies the remainder of the township and also T. 38 N., though no data regarding its thickness are available. The outcrop of bed G in these townships is confined to the valley of Dry Fork of Cheyenne River, where it contains 1 foot 4 inches of coal split by a 5-inch shale parting at location 90, and 1 foot 9 inches at location 76b. How much of bed G lying south of its outcrop in T. 37 N. is of workable thickness is not known, but it is probably less than a foot thick beneath most of the area. Bed G becomes thinner to the northeast in T. 38 N. and was not mapped east of sec. 31. Bed F ranges in thickness from 9 inches at location 77b to 4 feet 7 inches at location 77, but at location 77 it contains clay partings 4 and 6 inches thick. (See pl. 4.) Other measurements of bed F in these townships are represented on Plate 4 by Nos. 77a, 83, 84, 85, 86, 88, and 89. At location 87 it contained only 6 inches of coal and consequently was not mapped farther southeastward.

A number of thin coal lenses 50 feet above bed F crop out on both sides of the divide near the center of T. 38 N., but none of them are of workable thickness. The outcrop of one of these lenses is shown on Plate 2, and sections of it containing less than 2 feet of coal are represented graphically on Plate 4 by Nos. 107a, 107b, and 107c. At location 107d this lens contained 8 inches of coal and was not mapped.

T. 37 N., R. 74 W.

The strata in T. 37 N., R. 74 W., lie in a broad, open syncline, the axis of which crosses the township diagonally from southeast to northwest and plunges to the north. Bed G underlies most of the township and is exposed at locations 70, 91, and 92, where its average content of workable coal is about 2 feet. (See pl. 4.) Bed G is present beneath the level of Dry Fork of Cheyenne River upstream from its outcrop in the SW. $\frac{1}{4}$ sec. 3 to the SW. $\frac{1}{4}$ sec. 19, where it is brought above stream level by a sudden westward rise of the rocks.

Near the west quarter corner of sec. 25, T. 37 N., R. 75 W., in the bank of Dry Fork of Cheyenne River, this bed is over 14 feet thick but contains many small partings and thin unworkable benches of coal.

Sections on bed F in this township show a considerable variation in thickness, ranging from a maximum of 11 feet 6 inches at location 66, in sec. 9, to a minimum of 1 foot 6 inches at location 82, in sec. 23. Other measurements of bed F in this township are represented on Plate 4.

Section at location 58, SE. ¼ sec. 22, T. 37 N., R. 74 W. (bed F).

Shale.	Ft.	in.
Coal.....	1	8
Shale.....		7
Coal.....	3	
Total coal.....	4	8

Bed F is best developed on Phillips Creek at locations 60 to 64, where the coal occurs in a single bench, though usually there are smaller beds of coal both above and below the main bed. Elsewhere in the township the coal occurs in two or more benches separated by beds of shale that range in thickness from a few inches to 4 feet. (See pl. 4.)

At location 107 a coal lens 50 feet above bed F has the following section:

Section at location 107, sec. 6, T. 37 N., R. 74 W.

Shale.	Ft.	in.
Coal.....	2	8
Shale.....		4
Coal.....		8
Shale.....	2	4
Coal.....		10
Total coal.....	4	2

T. 38 N., R. 74 W.

The rocks in the eastern part of T. 38 N., R. 74 W., dip to the north or northwest at about 100 feet to the mile, and those in its western part at a somewhat greater rate to the east or northeast, resulting in the formation of a northward-pitching syncline crossing the township near the middle from south to north.

Bed G crops out in sec. 36 in the north bank of Dry Fork of Cheyenne River, and it contains 2 feet 4 inches of coal at location 76a. Bed F is not exposed in this township north of location 79, in sec. 13, though traces of coal occur in prairie-dog burrows at its horizon in secs. 1 and 12. Exposures of this bed in Bear Creek valley range in thickness from 7 feet 3 inches at location 79 to 8 feet 10 inches at location 80. (See pl. 4.) Intermediate measurements were made at locations 78 and 81. These measurements indicate a thickening of

the bed westward, which is in accord with observations made on the bed in the southeastern part of the township. Bed F also crops out in the valley of Dry Fork of Cheyenne River and averages about 9 feet in thickness, as shown by sections 68, 73, and 76, on Plate 4. At location 74 bed F was on fire at the time of the examination. One additional measurement of bed F in this township, not shown on Plate 4, is given below.

Section at location 75, SE. $\frac{1}{4}$ sec. 26, T. 38 N., R. 74 W. (bed F)

	Ft.	in.
Coal	5	
Bone	2	
Coal	2	9
Total coal	7	9

BELLE FOURCHE COAL AREA

TPS. 42, 43, AND 44 N., RS. 73 AND 74 W.

The lowest coal bed exposed in Tps. 42, 43, and 44 N., Rs. 73 and 74 W., is bed E, which crops out on Belle Fourche River in T. 44 N., R. 73 W. At location 16 bed E consists of an upper bench of coal 1 foot 5 inches thick and a lower bench 2 feet 9 inches thick, separated by over 8 feet of shale. At location 17 it contains about 9 feet of coal split by numerous thin shale partings. (See pl. 5.) Bed D has a minimum thickness for these townships of 1 foot 2 inches at location 2 and a maximum of 7 feet 8 inches at location 15, where the bed was sampled. (See analysis, p. 10.) Four other coal beds, ranging in thickness from 1 foot 2 inches to 2 feet 10 inches and separated by beds of shale less than 1 foot thick, occur 18 feet above bed D at location 15, as shown on Plate 5. Other measurements of bed D in these townships are also shown graphically on this plate. Tracing of coal beds in these townships was exceedingly difficult because of grass-covered slopes and almost total lack of relief. Except where sections were measured the position of the outcrop line of bed D in these townships is largely inferred.

TPS. 45 AND 46 N., RS. 72, 73, AND 74 W.

Beds D and E can be traced fairly well in the valley of Belle Fourche River and its tributaries in Tps. 45 and 46 N., Rs. 72, 73, and 74 W. Bed E has a maximum thickness for these townships of over 17 feet at location 35 and is about 15 feet thick at location 23, with its base unexposed. An analysis of a sample of bed E taken at location 23 is given on page 10. The minimum thickness of bed E in these townships is 3 feet 6 inches, at location 29. (See pl. 5.) Other measurements of bed E in these townships are shown graphically on Plate 5 by Nos. 26, 30, and 32.

Bed D has a maximum observed thickness in these townships of 6 feet 5 inches at location 39 and a minimum of 2 feet 3 inches of im-

pure coal at location 22. Intermediate measurements of bed D in these townships are represented graphically on Plate 5.

DIVIDE COAL AREA

The rocks in Tps. 46 and 47 N., R. 74 W., are folded into a low anticline whose axis lies in a north-south direction and coincides roughly with the divide between Powder and Belle Fourche Rivers. The anticline plunges gently to the north, and the strata on its limbs slope away from the crest at a rate of about 50 feet to the mile. Detailed work on the west flank of this fold revealed the presence of minor spur anticlines lying transverse to the main fold. Local steepenings of the general dip of the rocks exist along the flanks of these minor anticlines, notably in the SE. $\frac{1}{4}$ sec. 8, T. 47 N., where the dip is 200 feet to the mile.

The lowest coal that crops out in these townships is bed C, which contains 4 feet of coal split by a 2-inch shale parting at location 51 and 1 foot 4 inches of coal at locations 47 and 54. Other sections of bed C of intermediate thicknesses are shown on Plate 3 by Nos. 49, 50, and 53.

Bed B occurs 80 feet above bed C and is the most valuable coal bed in these townships. At location 52 it has a maximum thickness of about 11 feet and at location 42 a minimum of about 6 feet, below which occurs 18 feet of shale and then 3 feet 8 inches of coal. Other measurements made at locations 46 and 48 are shown graphically on Plate 5. An analysis of a sample of bed B taken at location 42 is given on page 10.

Bed A occurs 90 feet above bed B and crops out along the crest of the divide between Powder and Belle Fourche Rivers. Measurements of it made at locations 40, 41, and 43 are represented graphically on Plate 5 by sections correspondingly numbered, which show its average thickness in these townships to be 2 feet.

PUMPKIN CREEK COAL AREA

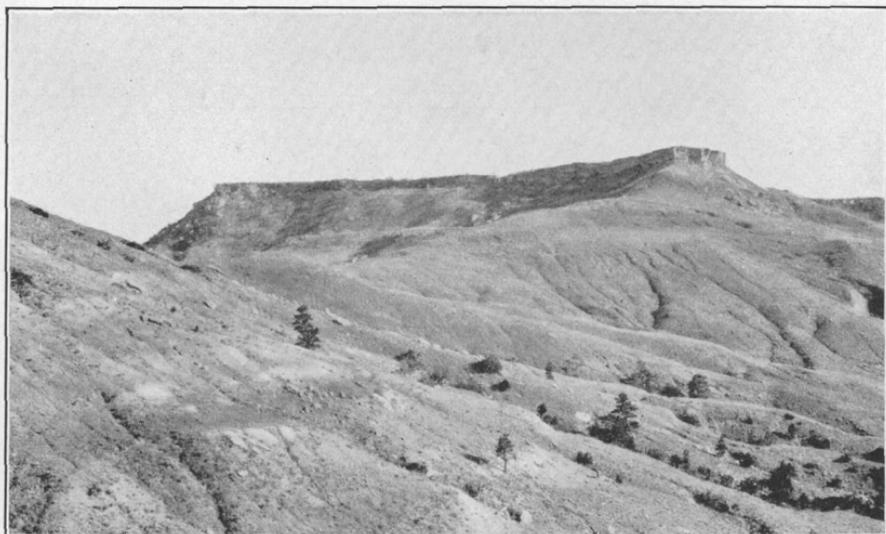
In T. 46 N., R. 76 W., the rocks dip to the northwest at a rate varying from half a degree in sec. 11 to 1° in the eastern part of sec. 9. This general northwesterly inclination is shown on Plate 3 by the outcrop of coal bed E, which stays just above the level of Pumpkin Creek nearly across the township. In sec. 9 a slight steepening of the dip causes the bed to pass beneath the level of the creek, only to reappear 3 miles farther downstream, where it can be traced just above stream level to Powder River.

Bed E is badly broken by shale partings along its outcrop on Pumpkin Creek. Its maximum thickness of about 7 feet occurs at location 124, and its minimum of about 1 foot 6 inches at location 118. Other measurements of it are shown graphically on Plate 5.

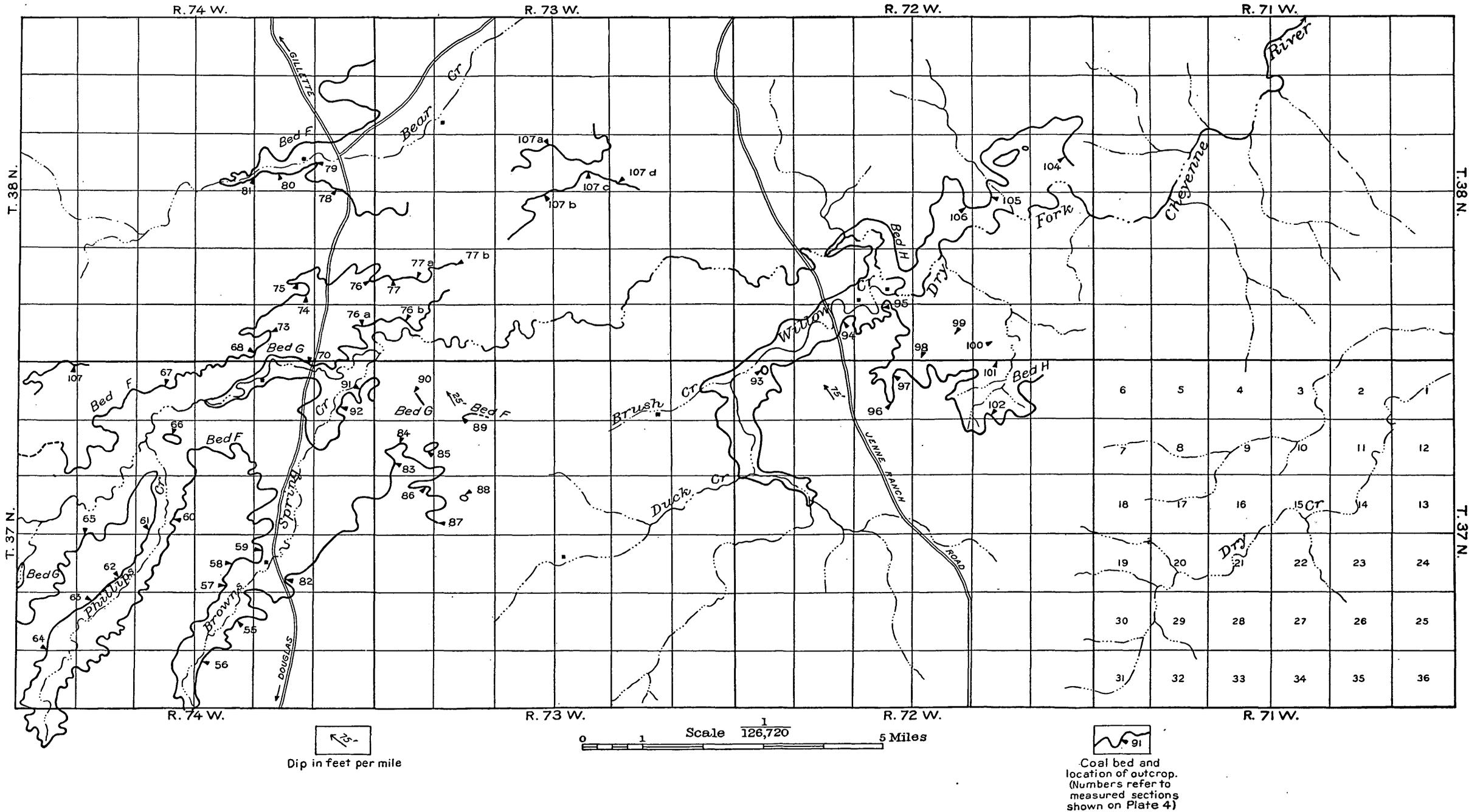


A. NORTH SIDE OF NORTH PUMPKIN BUTTE, SEC. 11, T. 44 N., R. 76 W.,
WYOMING

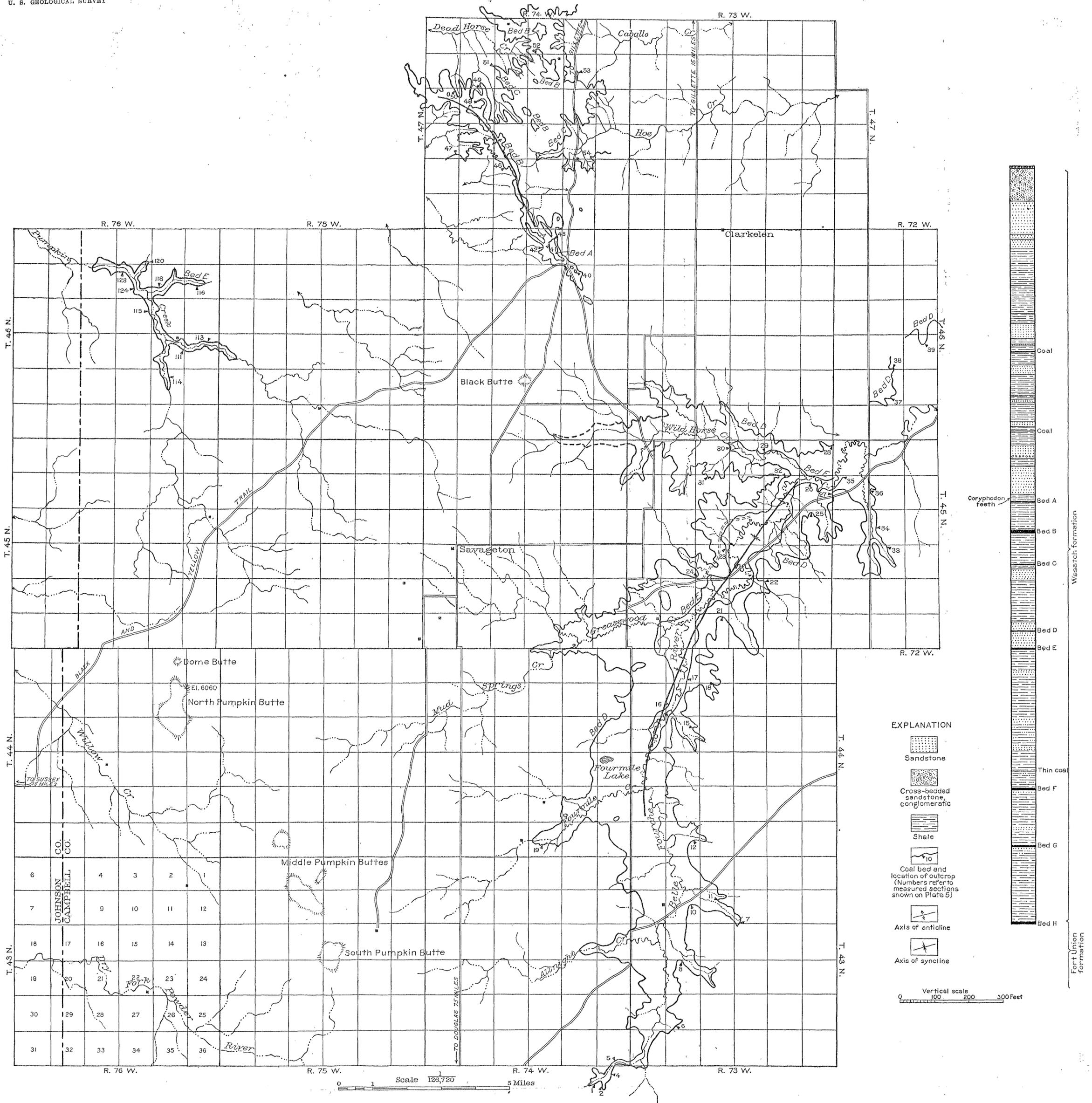
Showing the massive sandstone that makes the cap rock on the butte and the soft variegated shale of the Wasatch formation that makes the lower slopes



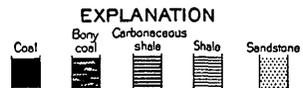
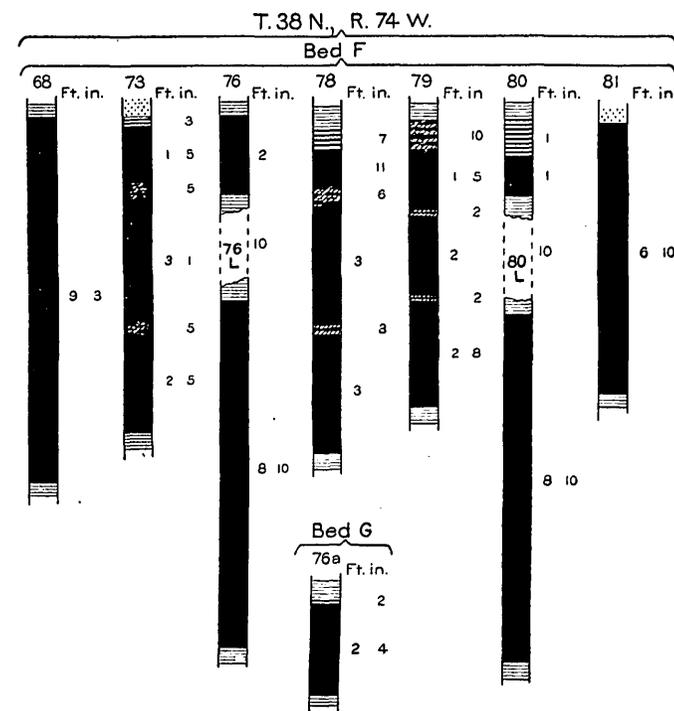
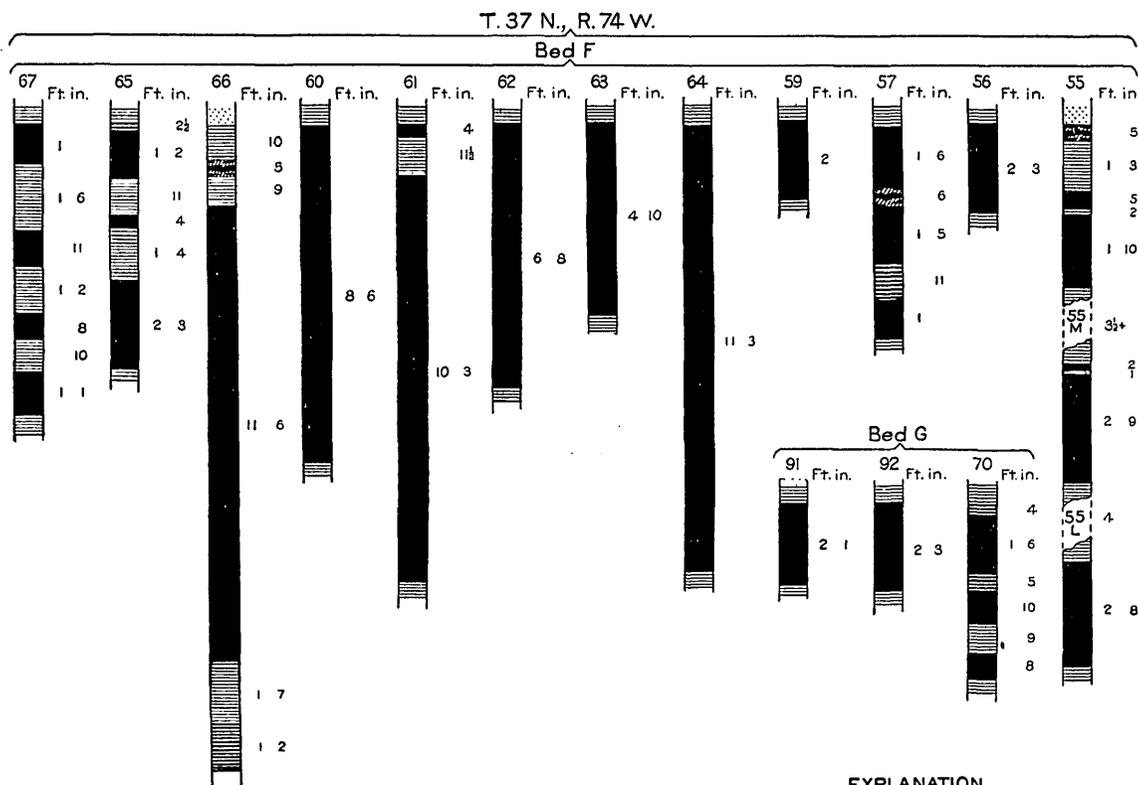
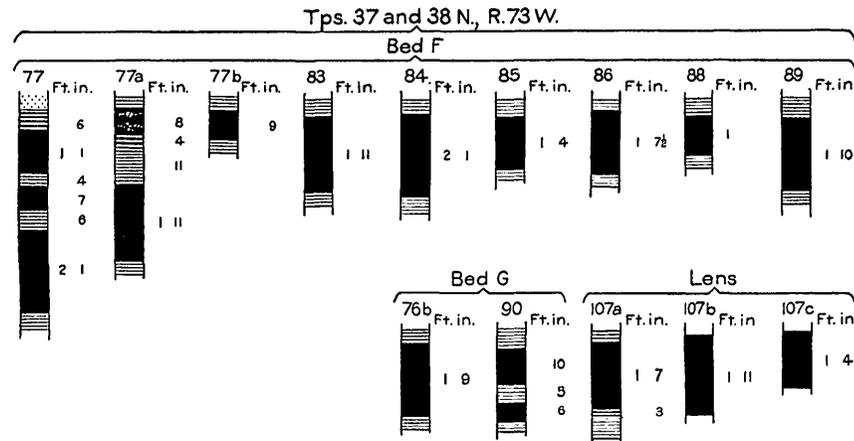
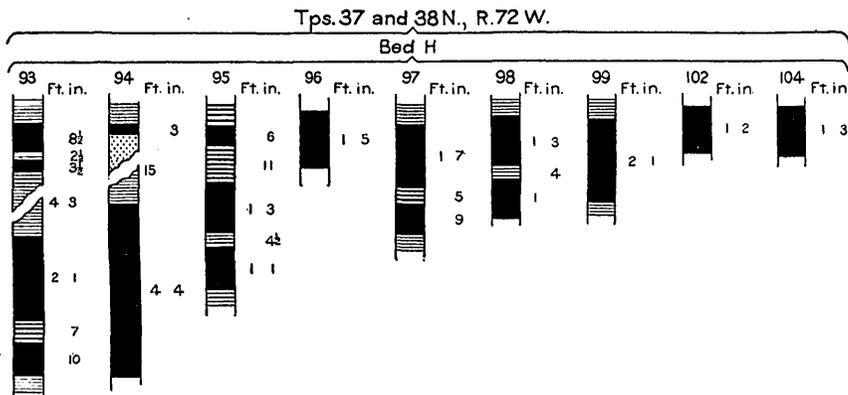
B. NEAR VIEW OF A



MAP SHOWING LOCATION OF COAL OUTCROPS IN THE DRY CHEYENNE COAL AREA OF THE PUMPKIN BUTTES COAL FIELD, WYOMING



MAP SHOWING LOCATION OF COAL OUTCROPS IN THE BELLE FOURCHE, DIVIDE, AND PUMPKIN CREEK COAL AREAS OF THE PUMPKIN BUTTES COAL FIELD, WYOMING



SECTIONS OF COAL BEDS IN THE DRY CHEYENNE COAL AREA OF THE PUMPKIN BUTTES COAL FIELD, WYOMING

