THE LITTLE POWDER RIVER COAL FIELD, CAMPBELL COUNTY, WYOMING.

By JOHN A. DAVIS.

INTRODUCTION.

PREVIOUS WORK.

The following report contains the results of an investigation of the Little Powder River coal field, which is only a small part of an immense area of coal and lignite bearing rocks in northeastern Wyoming, eastern Montana, western North Dakota, and northwestern South Dakota. Almost no definite information about the coal resources of this area was available previous to 1907, when the United States Geological Survey began the examination of the coal fields in the Western States for the purpose of classifying the public lands. Since that time reports covering various parts of this territory have been published in Geological Survey Bulletins 316, 341, 381, and 431.

LOCATION AND ACCESSIBILITY.

The Little Powder River coal field lies about midway between the Black Hills and Bighorn Mountains and embraces an area on the west side of Little Powder River nearly 15 miles wide, extending southward about 35 miles from the Montana-Wyoming State line. The eastern limit of the important coal beds forms the eastern boundary of the field. The other boundaries are more or less arbitrary and are fixed chiefly by the extent of the season's work. The position and general relations of the field are shown on the small index map on Plate XXXIV (p. 440).

There are no railroads in this area, but the main line of the Chicago, Burlington & Quincy Railroad passes within 15 miles of the southwest corner of the field. The Chicago, Milwaukee & Puget Sound and Northern Pacific railways run along Yellowstone River about 100 miles to the north. The construction of branch lines into the field up the valleys of Powder and Little Powder rivers would not be difficult. At present the main depots for supplies are Gillette and Moorcroft, small but thriving towns on the Chicago, Burlington & Quincy Railroad.

DRAINAGE AND TOPOGRAPHY.

The main streams in the field are Little Powder River and Wildcat, Horse, Elk, Olmstead, and Bitter creeks. Ordinarily these streams have a small flow during the summer months, but even Little Powder River becomes dry at times. They form part of the Mississippi drainage system through Yellowstone and Missouri rivers. Springs are rather common during the average summer season, especially around the edges of the larger clinker beds described below, and furnish sufficient water for the stock which graze upon the range, but in dry weather the majority of the springs become mere mudholes.

Topographically the field is a rather intricately dissected level plain in which the average relief is from 300 to 400 feet. The valleys of the larger watercourses are moderately broad and the streams meander through alluvium-filled bottoms. The smaller and more intricate drainage channels are sharply cut, and many of them present typical badlands with characteristic narrow ridges and sharp steep-sided gullies devoid of vegetation.

Some of the coal beds of this field, like others throughout the coal-bearing area, have been burned extensively, producing slag or clinker and altering the overlying rocks. These partly fused or baked rocks are of all shades from a light pink to a dark violet, the most common being a deep red, and the colors give a striking and brilliant appearance to the landscape. As the baked rocks are hardened by partial or complete fusion, they are much more resistant to erosion than the unaltered rocks and form the caps of many hills, buttes, and conical knobs.

TIMBER.

There are no forests in the area. Straggling cottonwoods and willows grow in the stream bottoms and scattering jack pine, piñon, and scrub cedar on the hills, especially in the burned areas, probably because the combustion of the coal bed destroys the gumbo-like character of the overlying clay and shale, and the rocks are so shattered and broken by the subsidence of the strata that they retain enough of the rainfall, which is usually very heavy but of extremely short duration, to maintain vegetation.

FIELD WORK.

The field examination was made between July 10 and November 1, 1910, by a party consisting of the writer (in charge), D. P. Hynes, and W. A. Price, jr. Prospects and natural exposures of the several coal beds were visited and measured, the outcrops of the principal coal beds were mapped by meander traverses and hand level, and stratigraphic sections were measured at favorable localities to correlate the various beds. Diligent search was made for corner stones of

the public-land surveys, and the positions of all that were found are shown on the map. The scarcity of corners throughout the field rendered imperative the constant use of stadia measurements, and in addition the mapping was checked by an interlocking system of planetable triangulation which contained a number of very carefully measured base lines.

LAND SURVEYS.

Evidence obtained during this examination and corroborated by the best local authorities shows that the subdivisional surveys of the public lands in this area, which were made in 1882 and 1883, were but partly completed. South of the fourteenth standard parallel, which is about 9 miles from the State line, the scattering corners with one or two exceptions agree with one another within a reasonable limit of error and establish with a fair degree of certainty the position of the land lines. North of the parallel, however, no authentic corners were discovered, and the official plats contradict and conflict with the actual condition of things in so marked a manner that the conclusion is unavoidable that very little if any of this work was performed in the field. Many of the ridges and streams as shown on the official plats prepared for the several townships comprising this field are seriously at variance with the actual topography, not only in the interiors of the sections but also along the lines which are reported as measured. This evidence, combined with the positions of the monuments remaining at present, apparently indicates that the field work of these surveys was confined chiefly to measuring lines in the larger stream valleys and that corners were placed only here and there in rough country.

On the accompanying map (Pl. XXXIV) the land surveys represented by solid lines are adjusted as nearly as possible in conformity with the field notes and the actual position of the corners located in this investigation. The lines north of the parallel are projected from known corners farther south; they do not attempt even to approximate the true position of the lines and are intended solely for convenience of description.

GEOLOGY.

FORT UNION FORMATION.

With the exception of recent alluvium, practically all the rocks which outcrop in the Little Powder River field belong to the Fort Union formation (early Eocene) and consist of alternating beds of shale, clay, sandstone, and coal. The thickness and sequence of the various members are extremely diverse, even through a very small horizontal range, but except for these irregularities the beds are apparently conformable. The stratigraphic sections shown graphically on Plate XXXI give many details of this feature. Neither the

top nor the bottom of the formation is contained in the strata, 800 to 1,000 feet thick, which outcrop in this field.

The predominating color of the upper 200 feet of beds is light yellow, except where it has been changed to red by heat. In the next 400 to 600 feet below it is usually a somber gray, whereas the lower beds are prevailingly light yellow. These divisions are not constant, however, and many exceptions are to be found.

The unbaked rocks are comparatively soft and fine grained. The shales vary greatly in composition, ranging from sandy to carbonaceous shale and to shaly coal. The sandstone is usually soft and weathers readily to loose sand but locally is sufficiently indurated to form projecting ledges. The cementing material may be iron, silica, or lime, and nodular concretions of iron as well as silicified tree stumps and logs are common, especially in the somber-colored rocks. The coal beds usually weather more readily than the other strata and are often found covered by débris under an overhanging shelf.

FOSSILS.

Fossil leaves are very abundant, especially in the carbonaceous shale near the coal, and some of the more calcareous sandstones contain fossil shells, but owing to the soft and friable nature of the rocks it is very difficult to obtain paleobotanic specimens that will bear transportation. A number of collections were made, however, in different parts of the field from various portions of the stratigraphic section. Those containing fossil leaves were submitted to F. H. Knowlton for identification and he reports the following species, which are all of Fort Union age:

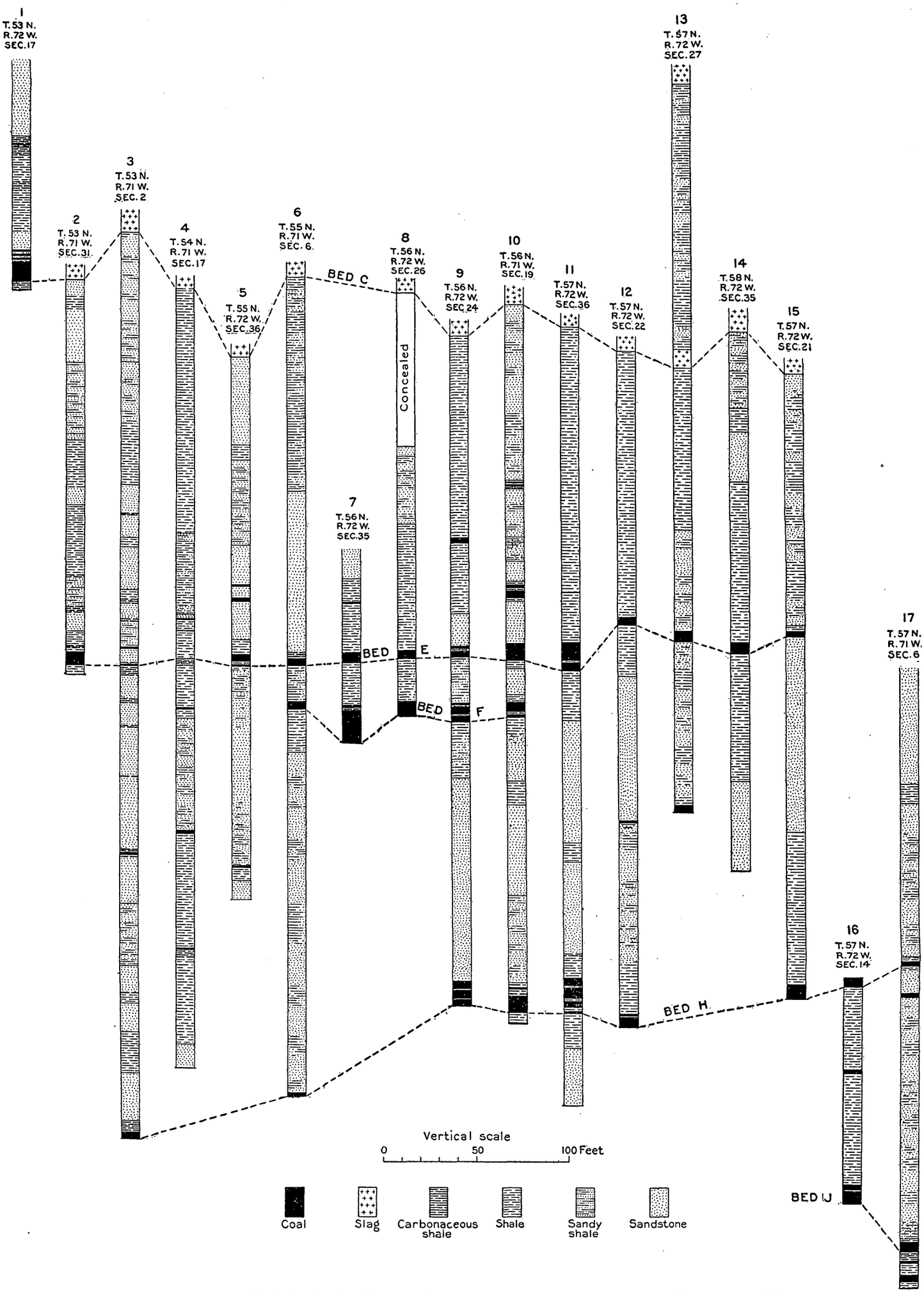
Glyptostrobus ungeri Heer.
Glyptostrobus europæus Heer.
Populus amblyrhyncha Ward.
Populus cuneata Newb.
Populus daphnogenoides Ward.
Taxodium occidentale Newb.
Leguminosites arachioides Lesq.
Corylus rostrata Ait.
Celastrus curvinervis Ward.
Celastrinites sp.?
Sequoia langsdorfii? Brongn.
Sequoia nordenskioldi Heer.
Sapindus grandifolius Ward.
Onoclea sensibilis fossilis Newb.
Viburnum sp.
Dicotyledon, probably new.

T. W. Stanton reports the following species in the collections of shells examined by him, which are also Fort Union:

Unio priscus M. and H.
Sphærium formosum.
Viviparus trochiformis M. and H.
Viviparus leidyi M. and H.
Viviparus leidyi var. formosus M. and H.
Campeloma producta White.
Goniobasis tenuicarinata M. and H.
Goniobasis sp.?
Limnæa tenuicostata M. and H.
Hydrobia? sp.

STRUCTURE.

The rocks in this area lie nearly horizontal except where they are folded locally into flat, shallow synclines and anticlines, few of which are more than 100 feet in altitude from crest to trough. The



SECTIONS OF COAL-BEARING ROCKS IN THE LITTLE POWDER RIVER COAL FIELD, WYOMING.

general dip of the rocks is less than 1° W. in the southwestern part of the field, but to the east it gradually increases toward the Black Hills uplift.

THE COAL.

PHYSICAL CHARACTERISTICS.

The coal in the Little Powder River field is subbituminous and is often called "black lignite." The unweathered coal is black, shiny, and hard. Although some pieces are brittle it is usually tough and difficult to break or pulverize. On exposure to the air the shiny luster gradually disappears, giving place to a dull black or brown color; the coal loses moisture, shrinks, and cracks in various directions. If subjected to alternate wetting and drying it is soon reduced to small fragments and dust, but if protected from the action of the elements it will retain its shape much longer. Much of the coal shows the texture of the wood from which it was formed, but it breaks with a conchoidal fracture without respect to the grain. The streak or powder formed by pulverizing the coal is dark brown. Mineral charcoal and resin are present in some localities. The percentage of sulphur in the fresh coal is low, but where the coal is greatly weathered calcium sulphate and other salts leached from the neighboring rocks fill the cracks. The coal burns with a yellowish sooty flame, gives a smoke with a strong bituminous odor, and when free from impurities leaves a fine and light-colored ash.

CHEMICAL COMPOSITION.

As thick coal beds lie much nearer the railroad than those in this field, there are no mines here sufficiently developed to furnish coal free from the effects of surface weathering. One sample was taken from under a cover of 15 to 20 feet at a prospect (No. 97) opened by J. P. Rockefeller in sec. 26, T. 56 N., R. 72 W., to obtain coal for domestic use. The coal 50 to 75 feet farther in would undoubtedly show somewhat better results than the analysis of this sample, in which the coal is somewhat weathered.

Analysis of coal sample from the Little Powder River field, Wyo., laboratory No. 9219.

[Made at the Pittsburgh laboratory of the Bureau of Mines. A. C. Fieldner, chemist in charge. Air-drying loss of moisture, 26 per cent.]

	As received.	Air-dried.	Dry coal.	Pure coal.
Moisture	32.7	9.1	.....	.....
Volatile matter	28.1	37.9	41.7	45.2
Fixed carbon	34.1	46.0	50.7	54.8
Ash	5.1	7.0	7.6	.....
Sulphur	1.07	1.45	1.59	1.72
Calories	4,370	5,905	6,495	7,035
British thermal units	7,870	10,630	11,690	12,660

Averaging the values from analyses of 36 coal samples from the neighboring Sheridan, Buffalo, and Powder River fields, Wyo., gives the following results:

Average of analyses of 36 air-dried coal samples from territory adjoining the Little Powder River coal field.

Moisture	13.8
Volatile matter	37.5
Fixed carbon	40.7
Ash	6.6
Sulphur	1.4
British thermal units	9,910

NUMBER AND THICKNESS OF COAL BEDS.

The accompanying map (Pl. XXXIV) shows the position of the outcrops of 10 coal beds recognized during this investigation. For convenience they are lettered consecutively, beginning with the uppermost bed. It will be noticed that some of the coal beds are persistent and extend over large areas, whereas others are probably more or less lenticular in form and can be traced for only short distances, a feature especially true of some of the beds in the somber-colored portion of the formation. Bed C is undoubtedly the one correlated by Stone and Lupton [1] with the Roland bed described by Taff.[2] This bed and the zone of red rocks produced by its burning are most valuable aids in correlating the other coal beds in this field. Bed A is probably the Arvada bed of Stone and Lupton and bed E may possibly correspond to the Smith bed of Taff.

The following list shows the maximum observed thicknesses of the various beds and the average distances between them:

Maximum observed thicknesses of coal beds and average distances between them.

	Feet.
Bed A	7
Interval	95
Bed B	5
Interval	30
Bed C	26
Interval	110
Bed D	7
Interval	55
Bed E	16
Interval	20
Bed F	15
Interval	55
Bed G	4
Interval	110

[1] Stone, R. W., and Lupton, C. T., The Powder River coal field, Wyo., adjacent to the Burlington Railroad: Bull. U. S. Geol. Survey No. 381, 1910, p. 121.

[2] Taff, J. A., The Sheridan coal field, Wyo.: Bull. U. S. Geol. Survey No. 341, 1909, pp. 130 and 142.

	Feet.
Bed H	14
Interval	20
Bed I	4
Interval	100
Bed J	13

More than 150 sections of the coal beds which were measured in the field are shown graphically on Plates XXXII and XXXIII. The total thickness of coal, as well as the number and size of partings and the amount of carbonaceous shale, varies greatly in the different sections. This is to be expected in coal beds of Fort Union age and bears witness to the unstable conditions which must have prevailed at the time the coal beds were formed. The localities where the sections were measured are indicated by reference numbers on the accompanying map (Pl. XXXIV).

DETAILED DESCRIPTION BY TOWNSHIPS.

In describing the details of the various coal beds each township is considered separately and in order, beginning with the southeast corner of the field. Each coal bed will be described and an estimate given of the total amount of coal available in each township. In making these estimates a coal bed 1 foot thick and 1 acre in extent is regarded as weighing 1,800 tons. In actual practice it is seldom possible to remove all of the coal and therefore a second estimate is given of the amount of coal actually available on the basis of 1,000 tons recovery to the acre-foot.

T. 53 N., R. 71 W.—Two coal beds outcrop in this township, as shown on Plate XXXIV. The lower, designated bed H, is generally thin, much broken by partings, and probably below the minimum thickness except for a short distance where its outcrop crosses the valley of Little Powder River. At location 104 [1] the coal is only 20 inches thick and is underlain by black shale. At location 105 it maintains the same thickness, but the underlying shale, 4 feet thick, contains much coaly material. Its condition at locations 106, 107, 108, and 109 is shown by sections bearing the same numbers on Plate XXXII. At location 110 the coal bed is 3 feet thick, overlain by an equal amount of carbonaceous shale and underlain by similar material. Its condition at locations 111 and 112 is shown on Plate XXXII, but north of location 112, which is on the township line, the bed is below the minimum limit of thickness at every place in which it was examined.

Coal bed E is likewise above the minimum thickness where its outcrop crosses the valley of Little Powder River, but it dies out in sec. 10 and at every place in which its outcrop was examined in sec. 2

[1] Numbers refer to locations on Pl. XXXIV, at which sections of coal beds were measured, and most of them also to the sections shown graphically on Pls. XXXII and XXXIII.

of this township; also entirely across T. 54 N. it is less than 2 feet thick. Its condition in the township under discussion is shown by sections 38 to 55. As shown by these sections, the bed is badly broken by partings along the south line of the township as far west as sec. 32. In sec. 31 it is at its best, and from this place it holds a fair thickness as far as it was mapped in this township.

Slag and baked sandstone resulting from the combustion of the Roland coal (bed C) mantle the major portions of secs. 3 to 10, 16 to 20, and 30. Oxidation of the iron in the rocks, as shown by the very bright red color, is pronounced and complete, indicating a large amount of heat, and the rocks are so brittle and so thoroughly shattered by shrinking after the coal bed was burned out that it is highly improbable that any considerable portion of the coal bed is left unconsumed in the area above outlined. To the west, however, it is undisturbed.

In other parts of the field several coal beds are present in the stratigraphic section corresponding to that part of the Fort Union formation exposed in the highland in the northwest quarter of the township, but careful search failed to reveal any coal bed in this area. The position of bed G in sec. 2 is indicated, however, by two bands of highly carbonaceous shale 18 inches thick.

A study of the strata for several hundred feet below the rocks outcropping in this township revealed three or four small lenticular coal beds, but at no place in this vicinity were they found to exceed 2 feet in thickness, and so they were not regarded as sufficiently important to be mapped.

The total amount of coal in this township is estimated to be 128,600,000 short tons, of which about 71,400,000 short tons may be regarded as recoverable under present mining methods.

T. 53 N., R. 72 W.—The coal beds occurring in T. 53 N., R. 71 W., are so low in the geologic column that they do not show in outcrop in T. 53 N., R. 72 W., except bed E, which is exposed for a short distance in sec. 36. At location 46 it contains nearly 7 feet of coal, but it is broken into a number of benches by thin shale partings which would interfere seriously with economical mining. Although no drilling has been done in this township to determine the presence of these beds west of their outcrop, it seems probable that bed E may underlie at least two-thirds of the township.

The main coal bed in T. 53 N., R. 72 W., is the Roland (bed C), which is from 15 to 21 feet in thickness and outcrops in secs. 8, 9, 15 to 22, and 26 to 34. At location 14, in T. 52 N., R. 72 W., this bed shows the following section:[1]

[1] Stone, R. W., and Lupton, C. T., The Powder River coal field, Wyo., adjacent to the Burlington Railroad: Bull. U. S. Geol. Survey No. 381, 1910, p. 129, Pl. VIII.

Section of coal bed in sec. 3, T. 52 N., R. 72 W., location 14.

	Feet.
Coal and brown shale	4
Coal, good, black	16
Coal, fair, brownish	5
	25

Natural exposures of the bed were visited at several places in this township, but at none of them was it possible to measure the complete thickness of the coal. A small gully has exposed near the center of sec. 17 at least 11 feet of coal, and it is from the open pit at this locality that most of the coal is obtained for domestic use at the neighboring ranches on Wildcat Creek. As in T. 53 N., R. 71 W., slag and baked sandstone produced by the burning of this bed are found over large parts of secs. 6 to 8, 10, 12 to 15, 22 to 26, 35, and 36, so that it is highly improbable that any large area of the bed remains unburned in this township.

As bed C contains 21 feet of coal at location 14 and 23 feet at location 15, it seems reasonable to suppose that it will average 20 feet throughout this township. Bed E, as stated previously, may underlie two-thirds of this township with a thickness of 4 feet. On this basis the township contains 276,100,000 short tons of coal, of which 153,300,000 short tons may be considered as recoverable under present mining methods.

T. 53 N., R. 73 W.—The eastern half of this township, which was the only part examined, contains the outcrop of beds A and C. The Roland coal (bed C) outcrops in secs. 1, 2, 10, 13 to 15, 22 to 24, and 26. Only one of several exposures seen afforded opportunity to measure a complete section (No. 15). Here the bed has two benches of coal, 10 and 13 feet thick, separated by 4 feet of shale. Red rocks caused by the burning of the bed are present on both sides of Wildcat Creek, but it is unlikely that there is any coal remaining beneath them.

Bed A, the upper bed, has been almost wholly removed by erosion, the only remnants being an outlier in sec. 24 and one in secs. 26, 27, and 35, in which measurements (Nos. 1 to 3) show the coal to be approximately 5 or 6 feet thick.

The lower coal beds noted in the description of T. 53 N., R. 71 W., are probably not present under this township, but no direct evidence was obtainable regarding them.

The estimated tonnage of beds A and C in this township is 251,900,000 short tons, which would represent a recoverable amount of 139,900,000 short tons.

T. 54 N., R. 71 W.—Only the lower coal beds are present in this township and they are thin and of little value. The horizon of bed H was traced across the township, but the bed is generally thin and carries no coal, except as shown on Plate XXXIV. At location 112, on the south line of the township, it contains 2 feet 5 inches of coal

and at location 113, in the SW. ¼ sec. 24, it contains only 2 feet of coal. For a space between these locations it consists only of carbonaceous shale. Bed G was observed in sec. 17, where it has a thickness of 2 feet (No. 101) and probably represents a local development of coal in a band of carbonaceous shale which occurs at this horizon elsewhere in the township.

A band of dark shale, which is a very prominent feature in the bluffs on the west side of Little Powder River, marks the position of bed E, which occurs in the township to the south (T. 53 N., R. 71 W.), but, although it was examined at a number of places, both in these bluffs and in those on Wildcat Creek, no coal was found.

The slag produced by the burning of the Roland coal (bed C) mantles large portions of secs. 9, 15, 16, 21, 22, 26, 27, and 32 to 34, but the combustion was evidently so complete, as shown by the oxidation of the iron and the shattering of the hardened shale and sandstone, that it seems unlikely that any considerable portion of the bed remains unconsumed.

A study of the strata for several hundred feet below that part of the Fort Union formation exposed in this township revealed several lenticular beds of coal; but as they were not found over 2 feet thick anywhere in this vicinity they were regarded as unimportant. The total tonnage of coal for this township is small, being estimated at only 900,000 short tons.

T. 54 N., R. 72 W.—Bed E is represented in this township by a band of very carbonaceous shale which was traced in the bluffs along the north side of Wildcat Creek and the south side of Horse Creek. It was examined at a number of places but so far as observed contains no coal, and it seems probable that no coal will be found in this township at the horizons of beds H and E, even by drilling.

The Roland coal (bed C) where measured (No. 16) in sec. 20 contains about 9 feet of coal. The outcrop of this bed is confined to secs. 19 to 21, 29, and 30, but slag and baked sandstone produced by its burning cover the major portion of the township. The melted, baked, and minutely shattered rocks indicate that the coal in this bed was probably consumed under the entire slag-covered area.

Bed A, which is the higher of the two coal beds outcropping in T. 54 N., R. 72 W., contains about 5 feet of available coal (No. 5) and underlies only a small part of sec. 21.

The total tonnage of coal in this township amounts to only about 10,200,000 short tons, and of this only about 5,700,000 short tons may be regarded as recoverable under present mining methods.

T. 54 N., R. 73 W.—The examination was confined to the eastern half of this township and it shows that two coal beds are present. The outcrop of the Roland coal (bed C) was traced largely by means of slag and burned rock across the township, but no exposures per-

mitted its measurement. To judge, however, from its condition in adjacent townships where it is well exposed, it probably ranges in thickness from 9 to 13 feet throughout secs. 2, 3, 10, 15, 22–24, and 36. Slag and baked sandstone covering large parts of secs. 1, 2, 11 to 15, and 22 to 24 suggest that no considerable portion of this bed remains unconsumed beneath this area.

Bed A is largely eroded from the eastern part of the township, a small area only remaining in sec. 23. It is nevertheless a very good bed, showing 7 feet of coal at location 4.

Coal beds lower in the stratigraphic section, which are noted in the description of T. 54 N., R. 71 W., are probably not present under this township, although no definite statement can be made until the region has been tested by the drill.

The amount of coal in this part of the township in beds A and C is about 122,500,000 short tons, representing a recoverable amount of 68,100,000 short tons.

T. 55 N., R. 71 W.—This township contains the outcrop of three coal beds, as shown on Plate XXXIV. Bed H was not measured in this township but is probably from 4 to 7 feet thick. Its outcrop crosses secs. 6 and 7. Bed F outcrops only in secs. 6 and 7. It is the same bed as that opened in sec. 26, T. 56 N., R. 72 W., by J. P. Rockefeller and is only 3 feet thick (No. 95) where it was measured in sec. 6. Bed E, which is the uppermost one exposed in the township, shows in outcrop in secs. 6, 7, 19, and 30. In the northern part of the township it has a thickness of 3 feet 4 inches (No. 57) and in the southern part 3 feet 11 inches, as shown by a section (No. 56) in the next township to the west. Although no measurement was made between these two places it seems probable that it holds a thickness of about 3 feet across the township.

A study of the strata for several hundred feet below that part of the Fort Union formation here represented shows the presence of several small lenticular beds; but at no place in this neighborhood were they found to exceed 2 feet in thickness, and therefore they were disregarded in this investigation.

The total tonnage of the three beds in this township is about 15,000,000 short tons, which represents a recoverable amount of 8,300,000 short tons.

T. 55 N., R. 72 W.—Four coal beds outcrop in this township. Bed H, the lowest bed in the series, outcrops only in the valley of Whitetail Creek. It is poorly exposed and no complete section was obtained. An exposure of 20 inches of coal was seen at location 114, but the top is burned and it seems probable that the bed is about 4 feet thick.

Bed F is exposed only north of Whitetail Creek. No measurement of its thickness was obtained in this township, but just over the line in T. 55 N., R. 71 W., it is 3 feet 2 inches thick (No. 95) and at the

Rockefeller prospect (No. 97) in the township to the north it is more than 16 feet thick.

Bed E, which probably does not contain more than 4 feet of available coal in this township (No. 56), outcrops in secs. 11 to 14, 24, 35, and 36. It is represented in secs. 33 and 34 by a band of carbonaceous shale.

The principal bed in the township is the Roland coal (bed C), which ranges from 14 to 26 feet in thickness (Nos. 18 to 20), outcrops in portions of secs. 4, 5, 7, and 16 to 21, and is very extensively burned in the remainder of the township.

The estimated tonnage of this township is 196,800,000 short tons, which represents a possible recovery of 109,300,000 short tons.

T. 55 N., R. 73 W.—The examination of T. 55 N., R. 73 W., was confined to the eastern half and disclosed the outcrop of but one bed of coal, the Roland (bed C), which varies from 13 to 16 feet in thickness (Nos. 17 and 18). It outcrops in secs. 1, 10, 12 to 15, 22 to 26, and 34 to 36. The slag and baked sandstone distributed over a large part of secs. 1, 13, 14, 15, 24, 25, 35, and 36 suggest by the very bright red color and by the brittleness and minuteness of the fragments of shattered rock that no considerable amount of coal of this bed is left unconsumed beneath the scoria.

Bed E does not outcrop here, but from evidence in adjoining townships it is probably 2 to 4 feet thick under a large portion of this township. The other coal beds below bed C that are mentioned in the description of T. 55 N., R. 71 W., are probably absent here, but no direct evidence could be obtained regarding them without recourse to drilling.

The total coal tonnage of this township contained in beds C and E is 264,900,000 short tons, which represents a recovery under present mining methods of about 147,200,000 short tons.

T. 56 N., R. 71 W.—This township contains the outcrop of five coal beds, as shown on the map. Bed J, which is very prominent in the township to the north, becomes much broken toward the south, as shown by section No. 148. South of this location it probably continues into secs. 5 and 6, T. 56 N., R. 71 W., but it is thin and unimportant.

Bed H was not measured in this township, but at location 116, in the SW. ¼ sec. 31, T. 57 N., R. 71 W., it is thick, containing 13 feet of coal, and at location 115, in the NE. ¼ sec. 25, T. 56 N., R. 72 W., it contains almost 12 feet of coal. In both places, however, the bed is badly broken by shale partings which will make mining expensive. The bed also outcrops in the southwest corner of the township, but its thickness south of location 115 is uncertain, as at the next exposure the full thickness of the bed was not seen. It is probably, however, more than 4 feet thick throughout the township.

Bed F apparently has but a local development in this field, being known in outcrop only from Whitetail Creek to the north line of T. 56 N. It seems to be lens-shaped, reaching its maximum thickness of 17 feet near the ranch of J. P. Rockefeller in T. 56 N., R. 72 W., and dying out in all directions from this point. It was measured at only one place in this township, at location 100, in sec. 19, where it has a thickness of only 4 feet 10 inches, as shown on Plate XXXII. North of this location the bed is thinner and it could not be traced beyond the south line of sec. 6.

Bed E shows a regular increase in thickness toward the north across this township, ranging from 3 feet 4 inches at location 57, in the township to the south, to 4 feet 4 inches at location 60, in sec. 24 of the township to the west, 8 feet 5 inches at location 61, in sec. 18 of the township under consideration, and 13 feet 2 inches at location 62, in sec. 31, T. 57 N., R. 71 W.

Bed D appears as only a small lens extending along the outcrop from sec. 25, T. 56 N., R. 72 W., to sec. 6, T. 56 N., R. 71 W. Only two sections were measured on this bed, one at location 33, in sec. 19, and the other at location 34, in sec. 18 of this township. The sections at these locations, as shown on Plate XXXII, indicate a very impure and not very thick lens of coal.

A study of the strata for several hundred feet below that part of the Fort Union formation which outcrops in this township shows the presence of several small lenticular beds, but as none of them was found to be more than 2 feet thick they were disregarded.

The estimated total tonnage of this township is 104,000,000 short tons, of which 57,800,000 short tons may be regarded as recoverable under present mining conditions.

T. 56 N., R. 72 W.—Six coal beds outcrop in T. 56 N., R. 72 W. Bed H undoubtedly underlies most, if not all, of this township, but it is exposed only in secs. 25 and 36. As exposed at location 115, in sec. 25, it contains 11 feet 8 inches of coal, but in the northeast corner of the township it is even thicker, showing 13 feet at location 116. Although the bed is thick, it is badly broken by shale partings, which detract considerably from its value.

The outcrop of bed G is confined almost wholly to sec. 4. Nearly 4 feet of coal is present in this bed, as shown by section 103, which was measured just north of the township line.

Bed F is exposed in the valley of Elk Creek, in the eastern part of the township, but it is not present in the northern part where its horizon is exposed. It is a lens, reaching its greatest thickness in sec. 26, where it has been opened by J. P. Rockefeller to obtain coal for domestic use. Its character is well shown by sections Nos. 96, 97, 98, and 99. At location 100, in the township to the east, it is only 4 feet 10 inches thick, and from this place it decreases to less

than the minimum thickness near the south line of sec. 6, T. 56 N., R. 71 W.

Bed E, although thin, is one of the most persistent beds in the field. Its thickness and character are well shown by sections Nos. 57, 58, 59, 60, 62, 67, 68, 69, and 70. The average thickness of these sections is 6 feet 5 inches.

Bed D, which outcrops in secs. 23 to 25, is probably not more than 3 feet thick (No. 33) in this area, but in the township to the east it reaches a maximum of 7 feet.

The most important bed so far as thickness is concerned is the Roland (bed C), which ranges from about 11 feet in sec. 4 to nearly 26 feet in sec. 32. A measure taken on a small outlier in sec. 4 shows a little more than 11 feet of coal (No. 21). This bed was also mapped in secs. 7 to 9, 18, 29, and 30 to 33. It is evidently burned out in the remainder of the township wherever it has not been removed by erosion.

It was not possible to obtain any direct evidence concerning the lower coal beds mentioned in the description of T. 56 N., R. 71 W., but it is probable that they are not present under this township.

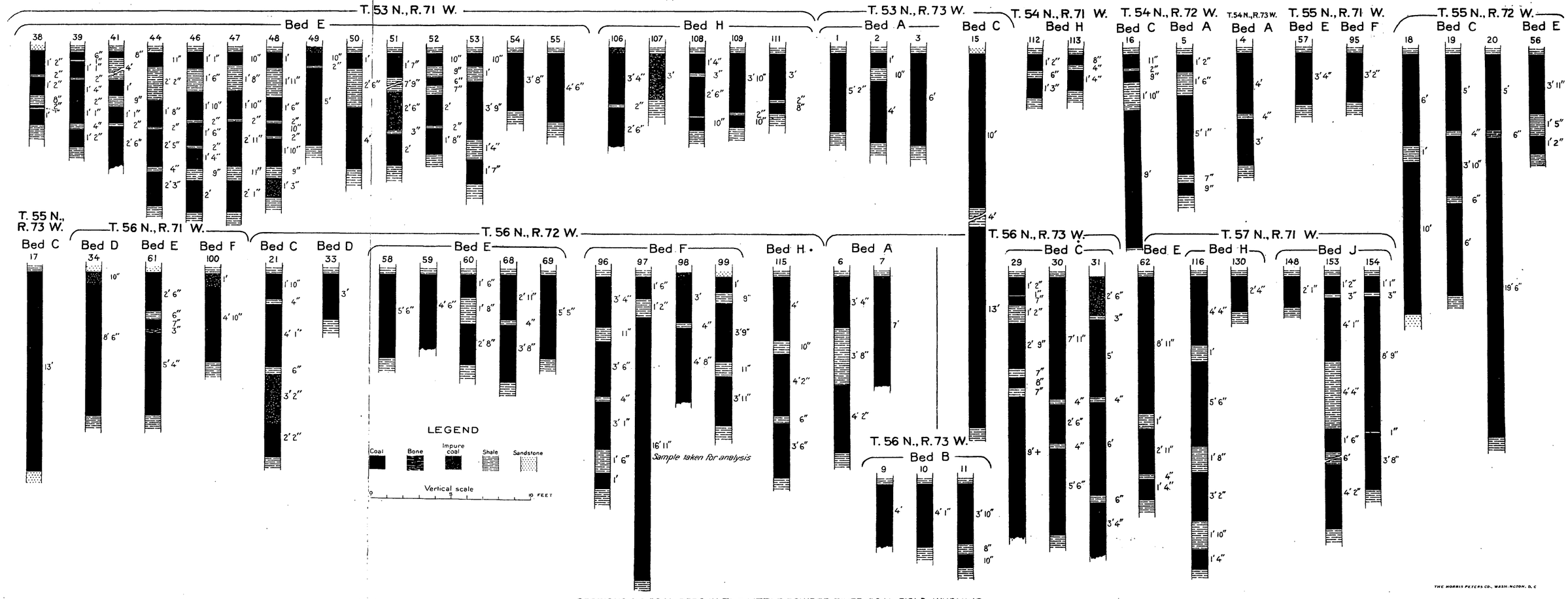
The estimated tonnage for this township is 952,900,000 short tons, which would permit a recovery of about 529,400,000 short tons.

T. 56 N., R. 73 W.—In the examination of this township the outcrops of four coal beds were located, as shown on the map. Bed E was not measured along its outcrop in sec. 6, but it underlies nearly the whole of the township and probably ranges from 4 to 8 feet in thickness.

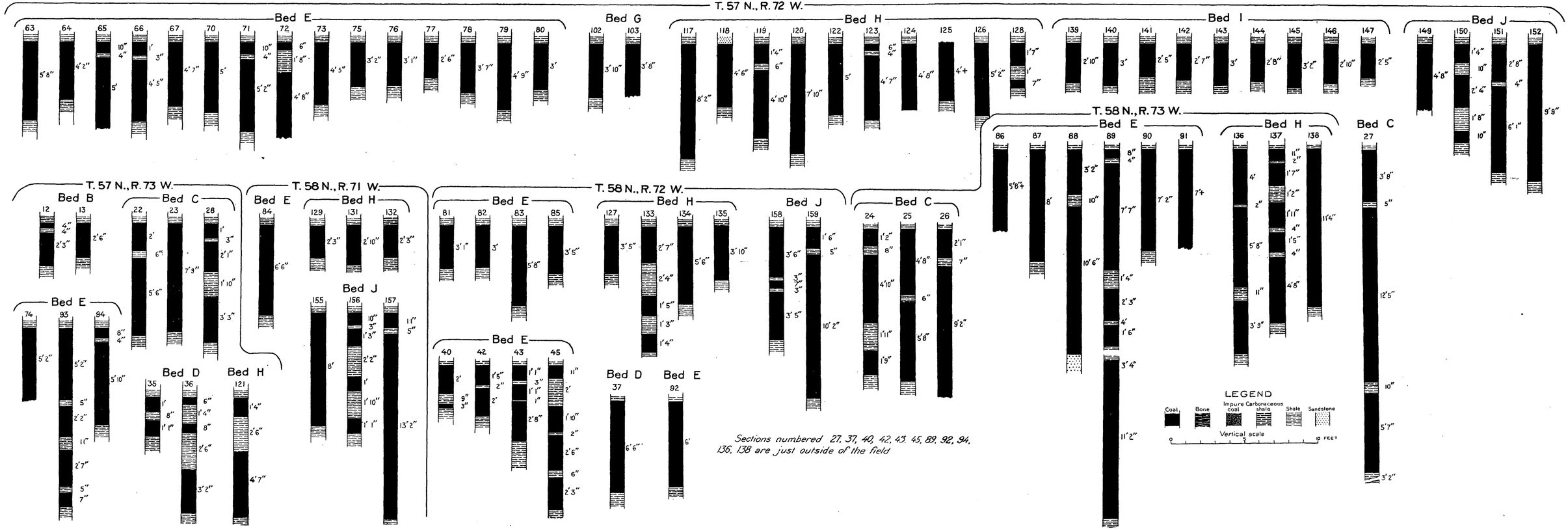
The main bed is the Roland coal (bed C), which varies from 10 to 17 feet in thickness (Nos. 29 to 31) and outcrops in secs. 1, 4, 5, 7 to 18, 21, 22, 24, 25, and 36. This bed continues into the township to the west, where it contains over 12 feet of coal at location 32. Slag and baked sandstone produced by the combustion of this bed near the outcrop were found at a number of places and it is evident that there is no considerable amount of coal under the area occupied by the clinker.

Bed B was seen only in secs. 1, 4, 9, 10, 11, and 12. It is generally thin, ranging from 2 feet 10 inches at location 8 to 4 feet 8 inches at location 11 (Nos. 8, 9, 10, and 11, Pl. XXXII). The highest bed (A), which is 4 to 7 feet thick (Nos. 6 and 7), occupies only very small areas in secs. 20 and 28.

From the evidence in townships to the east it seems quite likely that bed H underlies the major portion of the area and is probably 2 to 4 feet thick. The other beds mentioned in the description of T. 56 N., R. 71 W., however, are in all likelihood not present, though no definite evidence regarding them could be obtained.



SECTIONS OF COAL BEDS IN THE LITTLE POWDER RIVER COAL FIELD, WYOMING



SECTIONS OF COAL BEDS IN THE LITTLE POWDER RIVER COAL FIELD, WYOMING

THE HORRIS PETERS CO., WASHINGTON, D. C.

The estimated tonnage of this township is 766,300,000 short tons, which permits a recovery of at least 425,700,000 short tons.

T. 57 N., R. 71 W.[1]—The outcrops of three coals, beds H, I, and J, are mapped in secs. 5, 6, and 31 of this township.

Bed J makes its appearance near the south line of the township. As shown by the section measured at location 148, in sec. 31, it consists of three separate benches, the greatest thickness of coal in any one bench being 2 feet 1 inch. It holds this broken character generally, but the individual beds or benches of coal are much thicker, as shown by the various sections measured in T. 57 N., R. 72 W. North of Olmstead Creek it again enters the township under discussion in sec. 7. Its thickness in secs. 4, 5, 6, and 7 is shown by sections 153 and 154, and in the next township to the north by section 155.

Bed I is present only in the SW. ¼ sec. 6, where it measures 2 feet 5 inches thick at location 147. Bed H extends into this township only a short distance in secs. 5, 6, and 31. At location 130, in sec. 5, it is only 2 feet 4 inches thick, but at location 116, in sec. 31, it contains more than 14 feet of coal, which is, however, badly broken by shale partings.

A study of the Fort Union formation for several hundred feet below bed J showed the presence of several small lenticular beds which along the north township line attain a thickness of at least 3 feet. Although they are undoubtedly present in some portions of the township, they were not regarded as sufficiently important to be considered during this investigation.

As most of the known coal beds are in the territory to the west, the tonnage in this township is small, being estimated at 7,000,000 short tons, of which 4,000,000 short tons may be regarded as recoverable under present conditions.

T. 57 N., R. 72 W.—Five coal beds outcrop in this township. The lowest is bed J, which underlies most of the southwestern part of the township and is of considerable thickness, but it is badly broken by shale partings. Its character is shown by sections Nos. 149, 150, 151, and 152 on Plate XXXIII, and also by section 153, which was measured just across the township line on the east.

Bed I outcrops continuously across the township but does not extend into the township to the north. It is generally thin but fairly regular, as shown by sections Nos. 139, 140, 141, 142, 143, 144, 145, 146, and 147.

Bed H lies only a few feet above bed I and is persistent from Elk Creek to the Montana line. Its character is well shown by sections

[1] Land lines in Tps. 57 and 58 N., Rs. 71, 72, and 73 W., are projected arbitrarily for convenience of description only.

Nos. 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, and 128. At locality 128 it is thin and of little importance.

Bed G is probably lenticular, the maximum being 4 feet of coal (Nos. 102 and 103), and outcrops in secs. 22, 27, and 32 to 34. Bed E is one of the most persistent coal beds in the field. It has a fairly good thickness in the southern part of the township, as shown by sections Nos. 63, 64, 65, 66, 67, 70, 71, 72, and 73. In the northern part of the township it is generally less than 4 feet thick, as shown by sections Nos. 75, 76, 77, 78, 79, and 80. Lower coal beds mentioned in the description of T. 57 N., R. 71 W., may be present under parts of the township, but no data were obtainable regarding them.

The tonnage of the coal beds outcropping in this township is 493,300,000 short tons, of which 274,000,000 tons may be regarded as recoverable under present mining methods.

T. 57 N., R. 73 W.—This township contains the outcrop of five coal beds. The lowest coal bed showing in the township is bed H, which is exposed at one place only in sec. 1. Its thickness at location 121 is 4 feet 7 inches, and it seems reasonable to suppose that it maintains about the same thickness under the other part of the township.

Bed E is exposed in various parts of the township, and its thickness increases toward the west, as shown by sections Nos. 73, 74, 91, 93, and 94, some of which were measured within the township and some just outside of its boundaries. A bed of coal 2 to 4 feet in thickness (Nos. 35 and 36), which occurs practically at the same horizon as bed D in T. 56 N., Rs. 71 and 72 W., outcrops in sec. 19, but it is probably a local development at this place. The Roland coal (bed C), which is nearly 8 feet thick (Nos. 22, 23, and 28), is found in secs. 3, 5 to 9, 14, 15, 18, 22, and 27. The slag and red baked sandstone from the combustion of this bed are distributed over secs. 1 to 4, 8, 11, 12, 18, 25, and 36. Above bed C is a small coal bed, here called bed B, which is present in the high land near the center of the township. Its character is shown by sections 12 and 13 on Plate XXXIII.

Some of the lower coal beds mentioned in the description of T. 57 N., R. 71 W., may be present under parts of this township, but direct evidence regarding them can be obtained only by drilling.

The coal tonnage of this township is estimated to be 591,500,000 short tons, of which 328,600,000 tons may be regarded as recoverable under present mining methods.

T. 58 N., R. 71 W.—The investigation of this township disclosed three coal beds, which outcrop chiefly in secs. 31 and 32. Bed J is the most important coal bed showing in this township, but though the aggregate thickness of this bed is large, it is badly broken by shale partings, as shown in sections Nos. 155, 156, and 157. The next

higher coal is bed H, which is represented by sections Nos. 129, 131, and 132. The uppermost, or bed E, was found in three small buttes, capped with slag produced by the burning of the Roland coal (bed C), and is 6½ feet thick where measured (No. 84).

A study of the strata for several hundred feet below these coal beds indicates that several lenticular beds are probably present in this township. They do not exceed 3 feet in thickness, however, and were not regarded as sufficiently important to be considered during this investigation.

The amount of coal contained in this township is small, being estimated at 27,000,000 short tons, of which 15,000,000 short tons may be regarded as recoverable under present mining methods.

T. 58 N., R. 72 W.—Three coal beds were recognized and traced in this township. The lowest is bed J, which is an important bed in the eastern part, as shown by sections 158 and 159. Bed H is present throughout much of the township, but the country is so dissected by streams that no large areas of the coal bed remain. Its character is shown by sections Nos. 127, 133, 134, and 135, measured in the township, and by section No. 136, measured near the State line and 1½ miles west of the northwest township corner. Bed E underlies several sections in the western part of the township and isolated areas on the ridge in the southeast corner. Its character and thickness are shown by sections Nos. 81, 82, 83, and 85, measured in the township, and by No. 86, measured in the township to the west.

Slag and baked sandstone produced by the combustion of the higher coal (Roland or bed C) mantle parts of secs. 19, 20, and 28 to 31. The strong oxidation of the iron and minute shattering of the rocks suggest that little or none of this coal remains under the area outlined above.

Although it was not possible to obtain any direct evidence regarding them, the lower coal beds occurring in T. 58 N., R. 71 W., may be present under parts of this township.

The amount of coal in the township is estimated to be 209,300,000 short tons, of which 116,300,000 tons may be regarded as available under present mining methods.

T. 58 N., R. 73 W.—In the examination of this township the outcrops of three coal beds were located as shown on Plate XXXIV. Bed H is one of the most important in this township. Its thickness is shown by sections Nos. 136, 137, and 138. Bed E is thicker in this township than in any other part of the field, as shown by sections Nos. 86, 87, 88, 89, 90, 91, and 92.

A coal bed at about the correct position for bed D is exposed in the township to the west, where it has the thickness shown in section 37. It is not known to extend into T. 58 N., R. 73 W., but may do so

for a short distance. The Roland coal (bed C), which is 8 to 10 feet thick (Nos. 24, 25, and 26), outcrops in secs. 25, 28, 29, 31, 33, and 34. Slag and baked sandstone produced by the burning of this bed cover parts of secs. 28, 29, and 32 to 34, and evidently combustion was so complete that no considerable amount of coal remains unburned beneath the slag. This bed was also measured at location 27, in the township to the west, where it has the thickness shown on Plate XXXIII.

Lower coal beds mentioned in the description of T. 56 N., R. 71 W., may possibly be present here, but no definite evidence regarding them could be obtained.

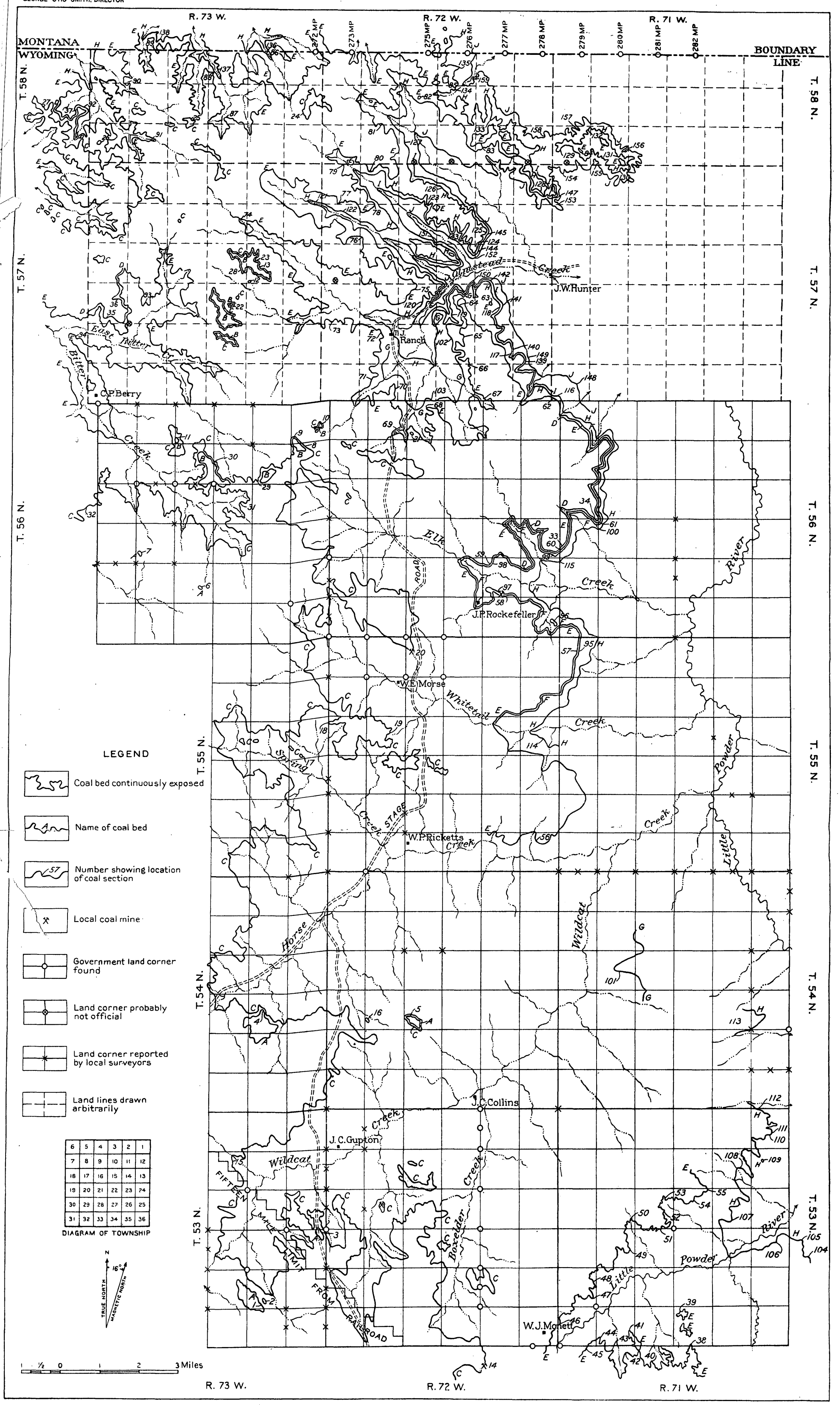
The amount of coal in this township is estimated to be 353,000,000 short tons, of which 196,000,000 tons may be considered available under present mining conditions.

ESTIMATED TONNAGE.

The estimated tonnage given under the description of each township is summarized as follows:

Estimated amount of coal in the Little Powder River field, in short tons.

Township.	Total tonnage.	Available tonnage under present mining conditions.
T. 53 N., R. 71 W.	128,600,000	71,400,000
T. 53 N., R. 72 W.	276,100,000	153,300,000
T. 53 N., R. 73 W.	251,900,000	139,900,000
T. 54 N., R. 71 W.	900,000	500,000
T. 54 N., R. 72 W.	10,200,000	5,700,000
T. 54 N., R. 73 W.	122,500,000	68,100,000
T. 55 N., R. 71 W.	15,000,000	8,300,000
T. 55 N., R. 72 W.	196,800,000	109,300,000
T. 55 N., R. 73 W.	264,900,000	147,200,000
T. 56 N., R. 71 W.	104,000,000	57,800,000
T. 56 N., R. 72 W.	952,900,000	529,400,000
T. 56 N., R. 73 W.	766,300,000	425,700,000
T. 57 N., R. 71 W.	7,000,000	4,000,000
T. 57 N., R. 72 W.	493,300,000	274,000,000
T. 57 N., R. 73 W.	591,500,000	328,600,000
T. 58 N., R. 71 W.	27,000,000	15,000,000
T. 58 N., R. 72 W.	209,300,000	116,300,000
T. 58 N., R. 73 W.	353,000,000	196,000,000
	4,771,200,000	2,650,500,000



LEGEND

- Coal bed continuously exposed
- Name of coal bed
- Number showing location of coal section
- Local coal mine
- Government land corner found
- Land corner probably not official
- Land corner reported by local surveyors
- Land lines drawn arbitrarily

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

DIAGRAM OF TOWNSHIP

TRUE NORTH — MAGNETIC NORTH — 16°

½ 0 1 2 3 Miles

MAP OF LITTLE POWDER RIVER COAL FIELD, CROOK COUNTY, WYOMING

By John A. Davis
1912

THE NORRIS PETERS CO., WASHINGTON, D. C.

THE SUSSEX COAL FIELD, JOHNSON, NATRONA, AND CONVERSE COUNTIES, WYOMING.

By CARROLL H. WEGEMANN.

INTRODUCTION.

LOCATION.

The Sussex coal field, covering an area of about 800 square miles, is situated southeast of the Bighorn Mountains of Wyoming and includes portions of Johnson, Natrona, and Converse counties (Pl. XXXV). It lies between the Buffalo coal field on the north, which was examined by H. S. Gale and the writer in 1908,[1] and the Glenrock coal field on the south, examined during the previous year by E. W. Shaw and C. T. Lupton.[2] The area described follows in general the outcrop of a group of Fort Union coal beds, the eroded edges of which are brought to the surface along the southwestern side of the broad basin lying between the Black Hills on the east, the Bighorn Mountains on the west, and the Laramie Range on the south. Over much of this basin the Fort Union strata are practically horizontal, but around its margins the rocks are bent upward, so that the entire thickness of the Fort Union (over 4,000 feet of strata) is exposed. In the area considered in this report the Fort Union, which in many parts of northern Wyoming and southern Montana contains coal beds through most of its thickness, does not contain important coal beds except in one zone a little below the middle of the formation. The study of the coal of this zone and the valuation of the land underlain by it were the principal objects of this investigation.

In general it may be said that in this region the formations older than the Fort Union do not contain important coal beds. Thin beds, however, occur in certain parts of the upper Montana; some good coal is found in the Fox Hills sandstone or just above it in the base of the Lance formation; and a few beds of somewhat doubtful quality are developed in the upper part of the Lance. In this report, therefore, the geologic formations from the Montana group to the Fort Union, both inclusive, are described, but descriptions of the older rocks are omitted as not pertinent to the present study.

[1] Gale, H. S., and Wegemann, C. H., The Buffalo coalfield, Wyo.: Bull. U. S. Geol. Survey No. 381, 1910.
[2] Shaw, E. W., The Glenrock coal field, Wyo.: Bull. U. S. Geol. Survey No. 341, 1909.

FIELD WORK.

The field work on which the report is based was done in the summer of 1910, the writer being assisted in the mapping by C. J. Hares and William Mulholland. The coal sections were measured by O. B. Hopkins. T. W. Stanton spent several days in the field and gave valuable aid in working out the stratigraphy of the region. The fossil determinations were made by T. W. Stanton, J. W. Gidley, C. W. Gilmore, and F. H. Knowlton.

Field mapping was done on a scale of 2 inches to 1 mile, a 15-inch planetable and telescopic alidade being used. The area was mapped township by township. In beginning the work a base line was measured, from the ends of which control was expanded by means of triangulation, monuments on prominent hilltops being used as signals. On each sheet two prominent points were located near the margin of the next township to be mapped. These points transferred to the margin of a new sheet served as a base line for establishing control in that township. Wherever inaccuracies appeared in the mapping, the locations of various points failing to check exactly with one another, a new base line was measured and control again started. Stadia traverse was not employed, locations being obtained entirely by triangulation.

LAND SURVEYS.

Land corners were located wherever possible, especial search being made for them near the coal outcrops. The land lines were drawn connecting the corners after the various field sheets were compiled into one large map. The old surveys made in the early eighties show many irregularities in the field which are not recorded on the township plats submitted by the surveyors to the General Land Office. In drawing the land lines, therefore, the locations of the corners as made in the field were accepted and the Land Office plats followed only where no corners were found. The reader is left to judge as to the accuracy of the land lines in any given locality. Where corners are recorded as found the lines are exact; where no corners are recorded the position of the land lines is more or less theoretical.

TOPOGRAPHY.

RELIEF.

The upturned rocks of the lower part of the Fort Union form a marked ridge which runs across the field, having the outcrop of the coal beds on its northeastern side. In T. 47 N., R. 81 W., at the north end of the field, the crest of this ridge is about 5,000 feet above sea level, the ridge itself rising 200 to 400 feet above the surrounding country. It increases in height toward the south and reaches an

altitude of 6,300 feet in T. 40 N., R. 77 W., where it rises 800 or 1,000 feet above the adjacent valleys and forms a conspicuous topographic feature which may be seen for many miles. In this region it is covered by a growth of pine trees. So far as the writer is aware the ridge bears no specific name, but the term Great Pine Ridge will be unmistakable, and this name is therefore used in the present report. Except for the river bottoms of the larger streams, the country on either side of Great Pine Ridge is broken by numerous gulches cut by the torrential rains, which at certain seasons of the year deluge this otherwise arid region. Where the gulches are deep and the divides narrow a type of topography results which is usually termed badlands. The name was given by the early explorers because of the difficulty of travel across it.

The climate of the region is semiarid. Practically no rain falls from the 1st of July to the last of September. The days of summer are often hot but seldom oppressive, and the nights are cool. The winters are sometimes severe but comparatively short, as little or no snow falls before Christmas time. Agriculture is carried on in the stream valleys where irrigation is practicable, but the principal industry is stock raising, as the region is preeminently a grazing country. Here, as elsewhere, sheep are supplanting cattle and horses on the range.

DRAINAGE.

Powder River is the largest stream in the field. Its three main branches, North, Middle, and South forks, unite just west of Great Pine Ridge and break through it in T. 43 N., R. 80 W. The river here flows east and is joined from the south by Salt Creek in T. 43 N., R. 79 W. It then turns north and 50 miles below the mouth of Salt Creek is joined by Crazy Woman Creek, which enters it from the southwest. Crazy Woman Creek near its head crosses T. 47 N., R. 81 W., at the north end of the field. The townships at the southeastern end of the field are drained by tributaries of Northern Cheyenne River, a branch of the Missouri.

GEOLOGY.

STRATIGRAPHY.

CRETACEOUS SYSTEM.

MONTANA GROUP.

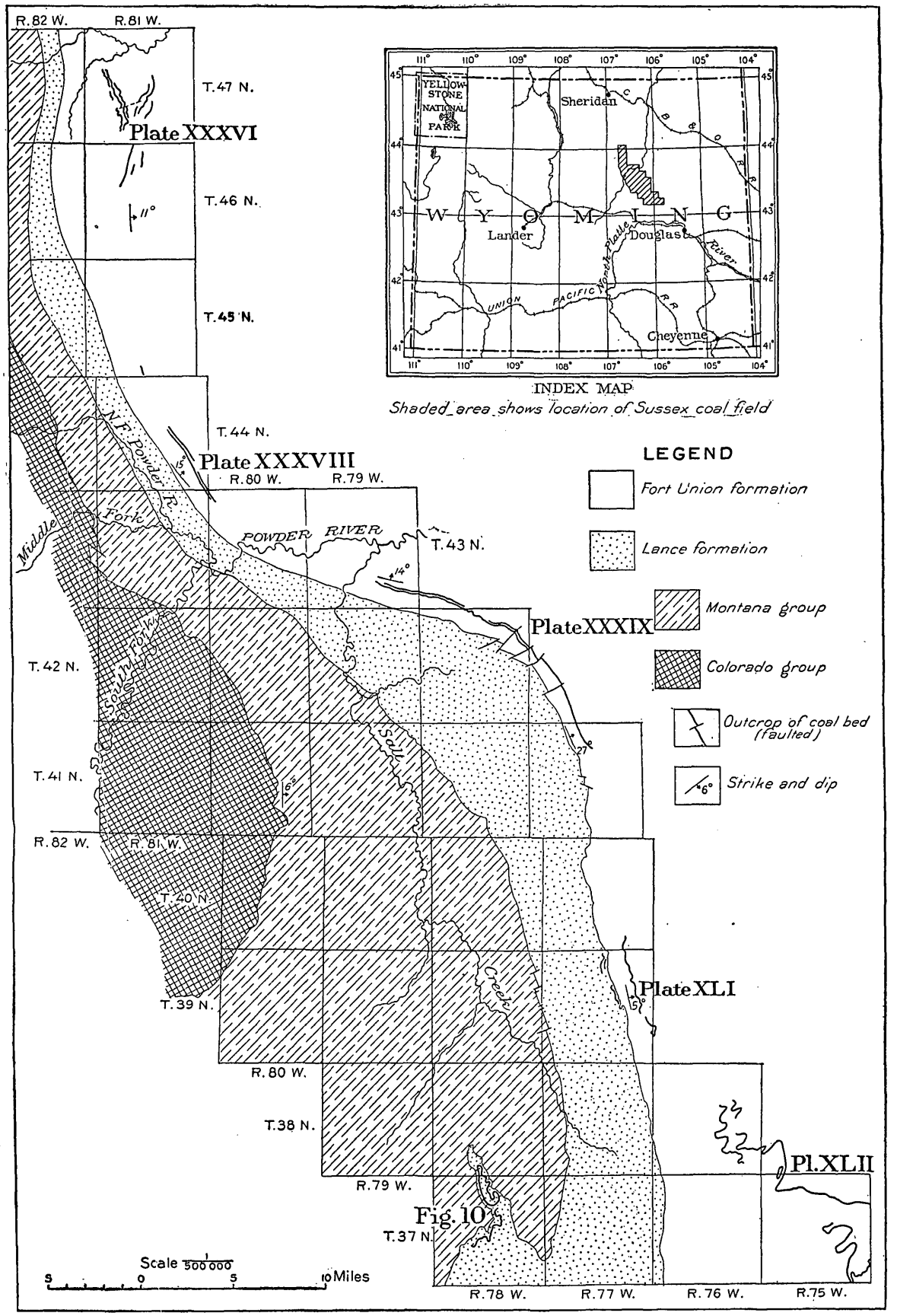
The Montana group, which has a total thickness of 4,650 feet, is composed of the Pierre formation and the Fox Hills sandstone. As stated in the introduction, its rocks are the oldest which need be considered in this report, as important coal does not exist in the

underlying Colorado in this general region. The areal distribution of the formation is shown on Plate XXXV.

Pierre formation.—The Pierre formation rests in apparent conformity upon the Niobrara shale, which in this area is approximately 700 feet in thickness. The transition from the Niobrara to the Pierre is by no means marked, and the two formations are separated principally on the basis of the fossils which they contain. The Niobrara bears thick-shelled Inocerami, the fragments of which are coated by the shells of the small pelecypod *Ostrea congesta.* A few baculites occur in the Niobrara, but they are of small size. The baculites which occur in the Pierre, in contrast to those of the Niobrara, are of large size, usually 1 to 2 inches in width and many of them 2 feet or more in length. The Inocerami are small and thin-shelled, in striking contrast to the unusually large individuals of the Niobrara. *Ostrea congesta* is, moreover, absent in the Pierre. As stated above, the lithologic change from the Niobrara shale to the shale of the Pierre formation is not marked. The Niobrara weathers somewhat lighter in color. The surface of the shale is not usually coated with white "alkali" as is that of the Pierre, and thin layers of reddish-brown ferruginous shale, present in the latter formation, were not observed in the Niobrara. These differences, though slight and probably of little general importance, serve as distinguishing marks between the formations in this particular region. At the top of the Niobrara shale occur one or more thin beds of limestone which are from 4 to 6 inches in thickness and dirty white in color. Apparently they do not contain fossils. The lowest beds of the Pierre consist of dark-gray shale and show little or no variation in character from place to place.

In the southern part of the field, about 1,000 feet above the base of the Pierre, occurs a sandstone 175 feet thick, which in the Salt Creek anticline contains oil and which, in the report on the Salt Creek field,[1] was termed the Shannon sandstone lentil. This sandstone was not recognized in the northern part of the Sussex field, though it should also be stated that exposures of the Pierre are much concealed to the north by the gravel terraces and alluvium of broad valleys which lie near the foot of the Bighorn Mountains. Above the Shannon sandstone lentil is 1,100 feet of shale, much resembling that near the base of the formation, but bearing in its upper portion numerous large calcareous concretions which contain Inocerami and baculites. Above this shale, or 2,300 feet above the base of the formation, occurs the Parkman sandstone member, about 350 feet in thickness. The lower part of this member is composed of a massive buff sandstone, 150 feet in thickness, which forms a marked escarpment throughout the region. This sandstone bears marine shells and also contains

[1] Wegemann, C. H., The Salt Creek oil field, Wyo.: Bull U. S. Geol. Survey No. 452, 1911.



GEOLOGIC MAP OF THE SUSSEX COAL FIELD, JOHNSON, NATRONA, AND CONVERSE COUNTIES, WYO.

By Carroll H. Wegemann.

masses of petrified wood, turtle shell, and large bones of the dinosaur Trachodon. Above the massive sandstone is 200 feet of alternating sandstone and shale, with several thin beds of low-grade subbituminous coal near the base. The coal is not more than 24 inches in thickness throughout this region and is usually high in ash. Near Casper, however, it is an important bed.[1] Certain thin calcareous beds which occur associated with the shale contain marine shells, but near the top of the member dinosaur remains, turtle shell, and the remains of the large crocodile *Deinosuchus hatcheri*[2] occur, associated with fragments of petrified wood. The Parkman evidently represents alternate marine, brackish-water, and fresh-water conditions. Its fauna is said by Stanton to be similar to that of the Claggett formation of Montana and the Mesaverde formation of Colorado. The rocks overlying the Parkman sandstone member are predominantly shale with thin beds of sandstone and bear Montana fossils. In the southern half of the area, 300 feet above the top of the Parkman, occurs a bluish-white sandstone, 50 feet in thickness, which usually forms a small escarpment. Associated with this sandstone are one or more thin beds of coal, which in the vicinity of Shannon, in the Salt Creek oil field, reach a thickness of 24 inches or more. The coal is, however, high in ash and, though occasionally mined for use at Shannon, can scarcely be considered of commercial value. In the vicinity of Casper, south of the field, this bed has been mined.[1] The bluish-white sandstone described above can be traced north to Powder River but has not been recognized north of that stream. As stated above, the rocks overlying the Parkman are predominantly shale to the top of the Pierre, a thickness of about 1,000 feet.

Fox Hills sandstone.—Resting upon the Pierre formation are beds about 700 feet in thickness in which sandstone predominates. At the base is a white and brown sandstone 100 feet in thickness, which usually forms an escarpment but is in places concealed. At the top is a white sandstone from 100 to 150 feet in thickness, with which one or more coal beds are commonly associated. The rocks between these two sandstones are predominantly sandy and contain Halymenites. Fox Hills fossils have been found in shale associated with the upper sandstone. The whole formation, 700 feet in thickness, is provisionally classed as Fox Hills, though at present the lower limit of the formation is by no means certainly fixed. The coal bed associated with the Fox Hills is of unusual variability in thickness and quality. In places it is absent, and in one locality, in sec. 6, T. 38 N., R. 77 W., it increases to 6 feet in thickness, but this thickness does not hold beyond this one exposure.

[1] Shaw, E. W., The Glenrock coal field, Wyo.: Bull. U. S. Geol Survey No. 341, 1909.

[2] Holland, W. J., Deinosuchus hatcheri, a new genus and species of crocodile from the Judith River beds of Montana: Annals Carnegie Museum, vol. 6, No. 1, 1909.

CRETACEOUS OR TERTIARY ROCKS.

Lance formation.—The Lance formation is by some authors considered to be Tertiary in age; by others it is regarded as Cretaceous; the question is by no means settled. Resting directly upon the Fox Hills sandstone are about 50 feet of shale and thin sandstone strata which contain several thin coal beds and which may probably be considered as transitional from one formation to the other. They do not, so far as observed, contain fossils. Overlying these beds are the buff sandstone and darker shale of the Lance formation, which bears the bones of Triceratops and Trachodon.

The Lance formation consists, for the most part, of yellow and buff sandstones which contain numerous large brown sandstone concretions that are conspicuous in the weathered rocks. Many shale beds are present and at places throughout the formation occur beds of carbonaceous shale and coal. So far as known the coal is too thin to be of value in this field except in two localities—in T. 37 N., R. 78 W., where a group of beds lies at the base of the formation, just above the Fox Hills sandstone, and in T. 39 N., R. 77 W., where another group occurs at the top of the formation, just below its contact with the Fort Union. The Lance formation, as measured in T. 43 N., R. 80 W., is 3,200 feet in thickness. It contains the remains of Triceratops and Trachodon in its lower and middle parts, but no fossils were found in the upper 1,200 feet of beds.

TERTIARY SYSTEM.

EOCENE SERIES.

Fort Union formation.—Sandstone and shale, which compose the lower beds of the Fort Union, rest with apparent conformity on the Lance formation. The transition from the Lance to the Fort Union is marked by a rather abrupt change in color of the rocks from buff to bluish white, by the absence of large sandstone concretions, which appear to be characteristic of the Lance, and by the presence of numerous thin beds of ferruginous sandstone, many of which contain botryoidal masses of iron. These ferruginous sandstone beds are reddish brown in color and on weathering commonly stain the underlying sandstone pink and brown. There are, however, near the base of the Fort Union in certain localities beds of sandstone which are uniformly pink in color throughout their mass, the color in no way being due to weathering. The lower part of the Fort Union is, as a rule, fine-grained sandstone. Certain beds are shaly or might even be termed shale. Fossil leaves are numerous in the ferruginous layers. The lower part of the Fort Union thus described is about 2,000 feet in thickness. It forms a high ridge which extends throughout the length of the field and which is described elsewhere as the Great Pine Ridge. Thin coal beds in the mass of the sandstone are found at

certain localities, and in T. 39 N., R. 77 W., these beds are important commercially. In other portions of the area, however, where coal 2 feet or more in thickness is present, it lies at the top of the bluish-white sandstone. Above it the beds are predominantly dark shale, which in places weathers into badlands contrasting strongly with the lofty ridge formed by the lower beds of the formation. In the strata overlying the coal are one or more layers of pink shale which are conspicuous, particularly in the northern part of the field, and occur in the first 800 feet of strata above the coal group. The overlying beds of the Fort Union consist of light-yellow sandstone and dark shale with local beds of brown carbonaceous material and thin streaks of coal, the whole resembling closely the Fort Union as exposed in the Buffalo field to the north, except that the baked rock, formed by the burning of numerous beds of coal, is here absent. The formation in this locality contains no coal beds 2 feet or more in thickness except those associated with the sandstone of Great Pine Ridge.

Whether or not the top of the Fort Union is exposed in this area may be questioned. The highest strata in this general region are those in the top of the Pumpkin Buttes—four lofty, flat-topped hills situated in Tps. 43 and 44 N., R. 75 W., about 15 miles east of the area covered by this report. The rock forming the crest of these buttes is a sandstone 50 feet in thickness, which is somewhat different in lithologic character from the sandstones of the Fort Union. In a hasty examination of the buttes no fossils were collected from it, and its age is uncertain. If it is Fort Union, as the writer is inclined to believe, the thickness of strata from the base of the Fort Union to the top of the buttes is estimated as 4,550 feet.

Perhaps the most interesting fossils obtained from the Fort Union were found near the northern of two badland spires or pinnacles which stand in the NE. ¼ NW. ¼ sec. 25, T. 43 N., R. 79 W. These fossils were identified by J. W. Gidley, of the National Museum, and consist of vertebræ and scales of the fish Lepisosteus and a mammalian jaw described by Mr. Gidley as follows: "Portion of lower jaw containing three teeth identical generically and probably specifically with an undescribed species of insectivore from the Fort Union of Sweet Grass County, Mont." Bits of turtle shell were also found at the same locality. The fossils occurred in a 3-inch bed of coarse sand about 15 feet below the top of the pinnacle and 765 feet stratigraphically above the top of the coal group, which is present in this township at the top of the sandstone of Great Pine Ridge.

STRUCTURE.

As stated in the introduction, the Sussex coal field is located on the southwestern side of a broad basin lying between the Black Hills on the east, the Bighorn Mountains on the west, and the Laramie

Range on the south. Throughout most of this basin the rocks are practically horizontal, but along the margins near the mountains the strata are upturned. In the northern part of the Sussex field the structure is comparatively simple, the rocks of the upper portion of the Fort Union, at a distance of 2 or 3 miles east of the coal outcrop, being practically horizontal and the dip increasing abruptly toward the mountains to 18° or 20° at the outcrop of the Parkman sandstone member. Small irregularities occur, as in T. 47 N., R. 81 W., where a slight doming of the strata changes the strike of the coal beds that are present in that township. The strike of the highest coal bed is practically north-south, whereas that of the lowest is about N. 20° W. In the southern part of the field the structure is complicated by minor domes, which, though doubtless connected with the Bighorn uplift in origin, are structures entirely distinct from it. Examples of such are the Salt Creek dome, the Powder River dome,[1] and the dome which lies just west of Kaycee. These structures are west of the area described in this paper, but the direction of strike of the coal beds is greatly affected by their presence. In the northern part of the field the coal outcrop parallels the mountains, but toward the south, in the vicinity of Powder River, it turns rather abruptly to the east and then to the south, describing a broad curve, which swings around these minor domes (Pl. XXXV).

A few miles southeast of Sussex post office an arch of the strata greatly widens the outcrop of the Lance formation. This arch is by no means so pronounced as the structures of Salt Creek and Powder River but is sufficiently large to widen the outcrop of the Lance from 2 miles in T. 43 N., R. 80 W., to 7 miles in Tps. 41 and 42 N., R. 78 W. To the northwest and southeast the arch gradually flattens and gives place to an eastward-dipping monocline.

The line of outcrop of the Fort Union coal is, as shown above, affected only in a general way by the domes of Salt Creek and Powder River. The distribution of the coal at the base of the Lance formation, lying much nearer the sharply folded rocks of the Salt Creek anticline, is more materially affected by the structure. This coal reaches its maximum thickness in T. 37 N., R. 78 W., where it occupies a synclinal basin about 5 miles in length and from half a mile to 1½ miles in width, lying west of the extension of the Salt Creek anticline.

Faults are not numerous in the Sussex field. They break the coal beds only where the strike of the coal is affected by secondary structures, as in T. 47 N., R. 81 W., or where it is abruptly bent, as in T. 42 N., R. 77 W. The bend at the crossing of Powder River, in T. 43 N.,

[1] For a detailed description of these structures, see the writer's reports on the Salt Creek oil field, Wyo. (Bull. U. S. Geol. Survey No. 452, 1911), and the Powder River oil field, Wyo. (this volume, pp. 56–75).

R. 80 W., apparently did not produce faulting, as the strata were there compressed in a synclinal fold instead of affected by tension on the axis of an anticline. The largest faults in the field are those in T. 42 N., Rs. 77 and 78 W. These are in the nature of block faults, but besides the mere dropping of a block of strata between two faults the block has been affected by torsional stresses so that the movement at one end has often been considerably greater than at the other. In one or two places faults apparently join in V shape, the triangular block between being dropped. The horizontal displacement has in some places been as great as half a mile. The faults in T. 47 N., R. 81 W., are apparently connected with a slight doming of the strata in the middle of that township and have a displacement of not more than 300 or 400 feet. Several interesting faults are found in the Salt Creek, Powder River, and Kaycee domes, but these lie outside the province of this paper. It seems somewhat remarkable that the great fault occurring northwest of Mayoworth, at what is known as "The Horn," is not observed in the strata 6 or 7 miles to the east, but such is the case. The displacement at the Horn, which is for the most part vertical, decreases rapidly toward the east, and the fault runs into folds which soon die out, leaving the structure of the coal-bearing rocks undisturbed and regular.

THE COAL.

CHARACTER.

All the coal of this field is of the grade known as subbituminous, between lignite on the one hand and bituminous coal on the other. Like the former, it slacks or crumbles on exposure to the weather, but it differs from lignite in color, being almost black instead of brown and presenting less woody structure, although the original grain of the wood which formed it is observed in many places. The fracture of subbituminous coal is ragged and sometimes conchoidal. Joints are present but not so pronounced as in bituminous coal. The quality of slacking, which is characteristic of all subbituminous coal, is due in all probability to the high moisture content. The drying of the coal, especially in sunlight, tends to contract and check the surface, breaking the lumps into smaller fragments which are in turn further reduced in size by the same process.

DISTRIBUTION.

As stated under the head "Stratigraphy," the important coal beds of this region occur in two formations, the Lance and the Fort Union. Coal beds under 24 inches in thickness are not considered in the present work, as it is doubtful if they could be mined with profit. The coal lies in six distinct basins, which are separated one from another

by areas in which there is no coal outcropping at the surface. In treating of the different areas, that called coal basin No. 1, which contains the lowest or oldest coal group—the coal at the base of the Lance—is first discussed. The five Fort Union coal basins are described in order, beginning at the north.

COAL BASIN No. 1.

Coal basin No. 1 occupies a syncline, the axis of which trends approximately north-south across T. 37 N., R. 78 W. (See Pl. XXXV and fig. 10.) The coal occurs at or just above the contact of the Fox Hills sandstone and the overlying Lance formation and thus is older than the coal of the five other basins described in this report. The syncline in which the coal lies is shallow. On the east limb the rocks dip toward the west at angles of 8° or 10°; on the west limb they dip in the opposite direction at angles of 4° to 6°. In the SE. ¼ sec. 24, T. 37 N., R. 78 W., a coal bed 15 inches thick is associated with Fox Hills sandstone. From that place northwestward for about 3 miles the coal-bearing rocks are for the most part concealed, and no coal bed of any importance was observed. At location 262,[1] however, in the NE. ¼ sec. 10, T. 37 N., R. 78 W., a bed 26 inches in thickness appears somewhat above the horizon of that in sec. 24, being apparently in the lower beds of the Lance formation. It increases in thickness toward the northwest and at location 261, in the NW. ¼ of the same section, contains about 32 inches of coal, although broken by partings of bone. A mile farther north, at location 260, in the NE. ¼ sec. 4, of the same township, two beds of coal were found; the lower, in two benches measuring 24 inches and 23 inches, lies at about the contact of the Fox Hills sandstone and the Lance formation, and the upper bed, which contains over 5 feet of coal, broken by a 3-inch parting of bone, is at about the horizon of the coal at location 261. At location 259 the same bed is exposed, but the bone parting is here 6 inches in thickness. Whether or not the lower bed is present at this place is difficult to say, as the rocks are partially concealed. At location 258, at the contact of the Fox Hills sandstone and Lance formation, 30 inches of coal was found, and at location 257 the upper bed is represented by two beds which, as shown in the upper part of coal section 258, are thicker than the bed at location 259. It seems probable that these coal beds do not extend for a great distance and they may be expected to vary greatly from place to place both in quality and thickness. On the west side of the syncline, in the NE. ¼ sec. 9, T. 37 N., R. 78 W., at location 264, a group of beds was noted which appears to be the same as the beds at location 262. The thickest bed of the group measures only 26 inches. At location 263, how-

[1] Numbers refer to measured coal sections shown graphically on plates; also to the locations of these sections on the maps.

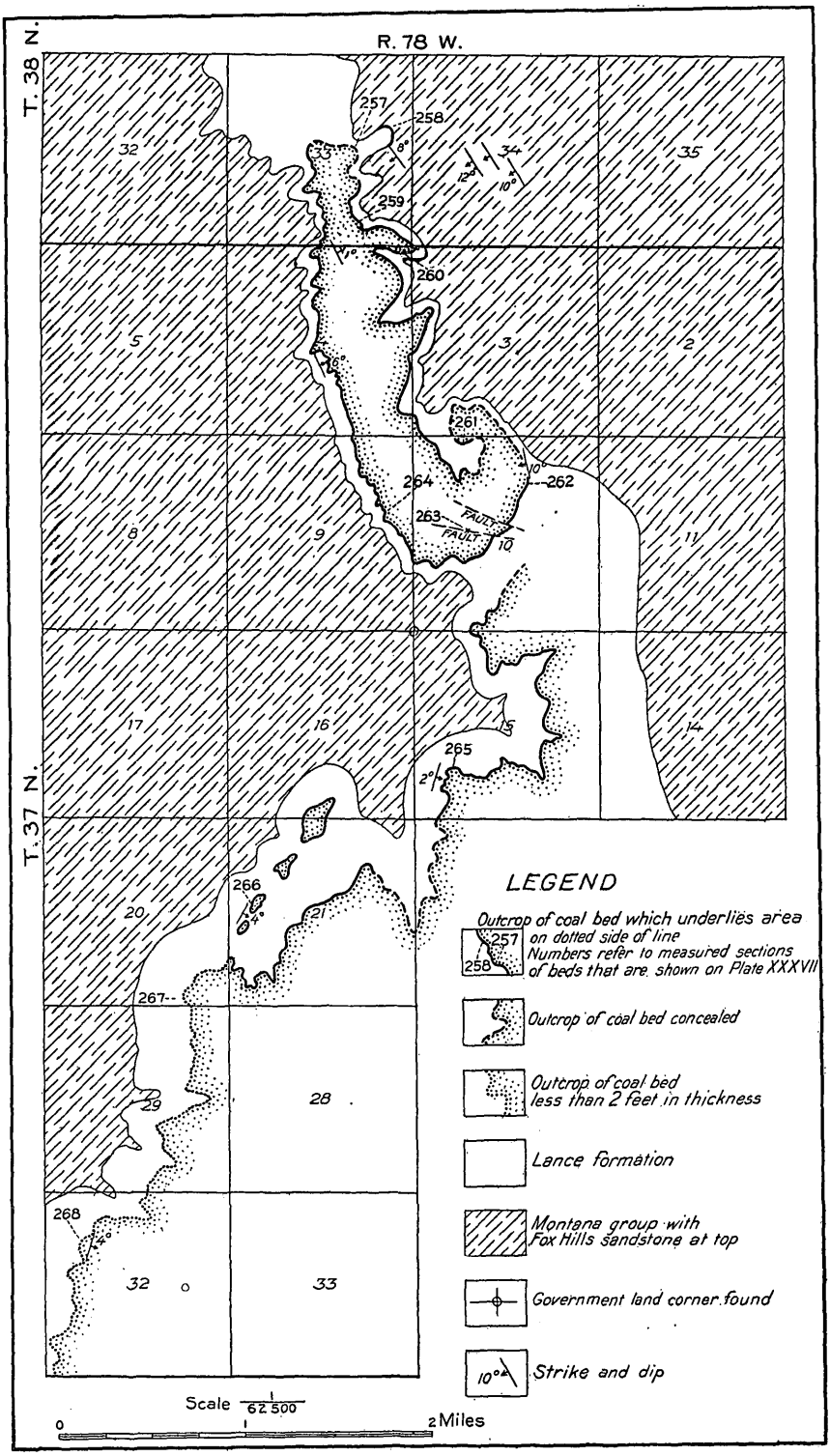


FIGURE 10.—Map of coal basin No. 1, Sussex coal field, Wyo. By Carroll H. Wegemann.

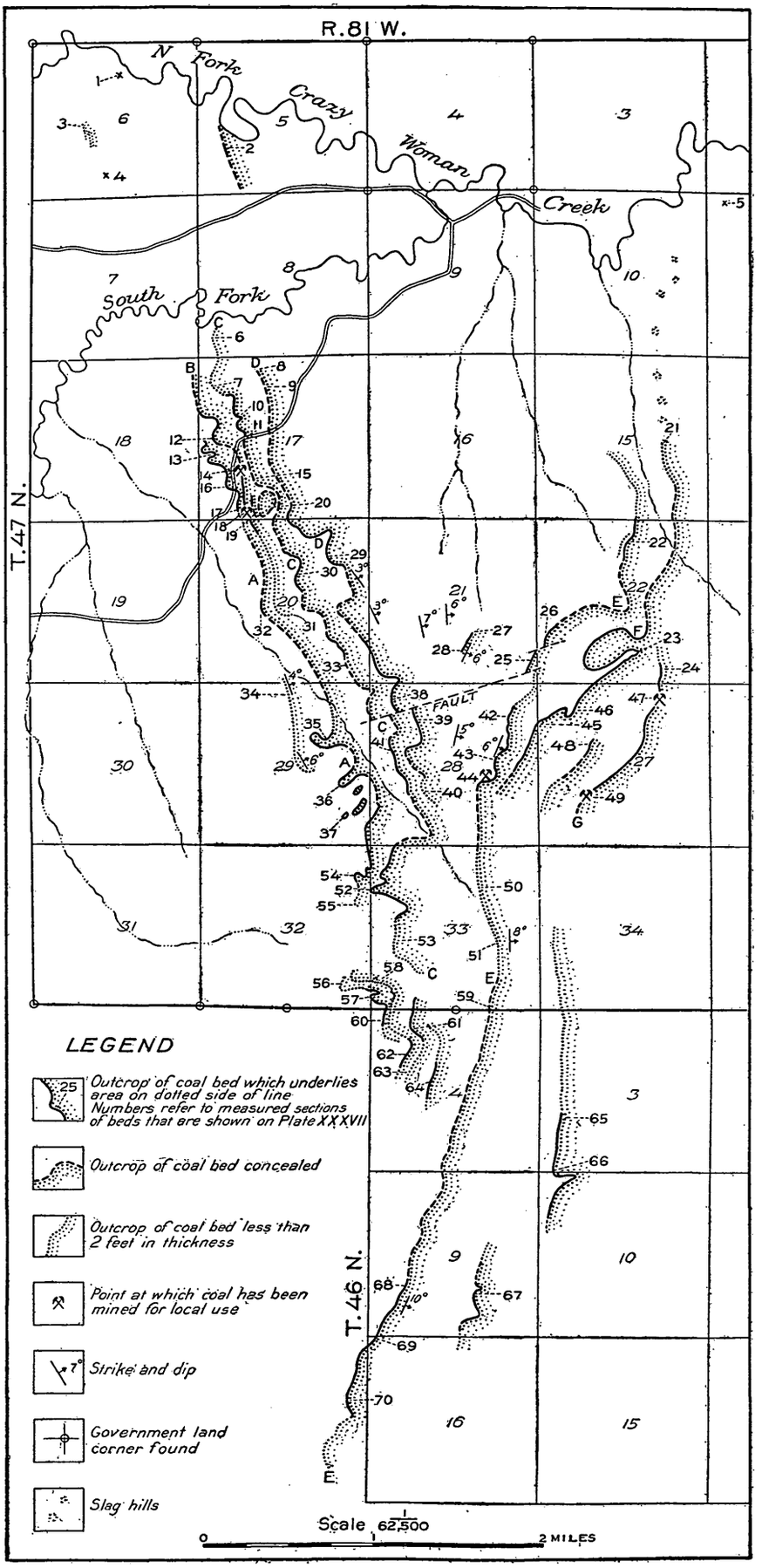
ever, just south of the fault shown on the map and only half a mile east of location 264, a bed was found which contains 54 inches of coal. Its relation to the coal bed measured at locations 262 and 264 is not known, as exposures are few and the structure complicated by faults. A block of strata between the two parallel faults, near the central part of sec. 10, has been dropped slightly with reference to the rocks both north and south, so that the coal outcrop is here offset somewhat to the east, as shown on the map. Just south of the middle of sec. 10 the coal has been removed by erosion along a narrow valley which here cuts through the coal basin. South of the valley the outcrop of a single bed appears and may be traced for several miles to the southwest. At location 265, in the SW. ¼ sec. 15, T. 37 N., R. 78 W., this bed measures 32 inches. At location 266, in the NW. ¼ sec. 21 of the same township, two beds measuring 25 inches and 34 inches and separated by 3 feet of shale were found, but three-fourths of a mile southwest of this place, at location 267, the coal is too bony to be of value. Its horizon can be followed south to location 268, but the coal is no longer of economic importance. As already stated, on the east side of the coal basin, except at its northern extremity, the rocks are mainly concealed and it is impossible to predict how far across the basin the coal extends from its western outcrop.

No analysis of this coal was made, but it is apparently of good quality and much resembles the coal of the Fort Union; it is brownish black in color, has a conchoidal fracture, and, like all subbituminous coal, slacks upon exposure to the air and sunlight.

As already stated, the coal of this basin is found in beds which immediately overlie the Fox Hills sandstone. These consist of dark shale, thin sandstone, and carbonaceous shale, with several coal beds which are throughout most of the area thin and unimportant. The thickness of the coal-bearing strata is 50 or 75 feet. At one place a small collection of fossil leaves was obtained, but for the most part these rocks do not contain fossils. Marine shells were found in the Fox Hills below them and the bones of Triceratops in the Lance formation above. These beds appear to represent a transition from one formation to the other. Coal also occurs in the Fox Hills sandstone at a slightly lower horizon than the beds here described, and at one locality (sec. 6, T. 38 N., R. 77 W.) it reaches a thickness of 5 feet, being found in shale which lies between two beds of white sandstone near the top of the Fox Hills. This coal bed can be traced but a few rods and where next exposed is less than 24 inches in thickness.

COAL BASIN No. 2.

As already stated, under "Stratigraphy," the Fort Union in the area under discussion contains no coal beds over 24 inches in thickness with the exception of the bed or group of beds lying near the



MAP OF COAL BASIN No. 2, SUSSEX COAL FIELD, WYOMING.

By Carroll H. Wegemann.

middle of the formation. As the Fort Union strata are bent upward along the Bighorn uplift, this group of coal beds is brought to the surface and outcrops in a line in general parallel to the mountains but swings to the east around the smaller domes which lie to the southeast of the mountains. This line is interrupted in many places. The coal was apparently not deposited in one great marsh which covered the entire area, but was rather put down in small basins which, although existing at about the same epoch, were not necessarily connected with one another. The coal group is represented by a single bed or a succession of beds one above another.

In T. 47 N., R. 81 W., and the northern part of T. 46 N., R. 81 W., is a group of coal beds (Pls. XXXVI, XXXVII), which consists of seven principal beds, referred to on the map as A, B, C, D, E, F, and G, and also several minor beds. The lower strata of the Fort Union in this locality are poorly exposed, and exact measurements are difficult to obtain. The beds consist, however, of the bluish-white sandstone and shale described on page 446, which are usually about 2,000 feet thick. The lowest bed of the coal group occurs at or a little above the top of this mass, and the succeeding beds are distributed through a stratigraphic thickness of perhaps 500 feet of sandstone and shale, the lower portion of which is dark in color, whereas the upper is prevailingly light yellow or buff.

In T. 47 N., R. 81 W., there is a pink sandy shale some distance above coal D, and in T. 46 N., R. 81 W., three such strata are present. One of these, which occurs above coal E, can be traced almost to T. 44 N., R. 81 W., and serves as a horizon marker, by which the stratigraphic relation of the coal in the north basin (No. 2) to that in the next south (No. 3) can be determined.

Coal A, the lowest important bed of the group, was first noted in the SW. ¼ sec. 17, T. 47 N., R. 81 W. (location 13), where it contains about 27 inches of coal. Another bed 7 feet above it measures 26 inches. At locations 16 and 17 only one bed is exposed, and at the latter locality this is only 23 inches thick. South of location 17 the outcrop is concealed by valley wash, but the coal is again exposed in the SW. ¼ sec. 20 at location 32, where it measures 4 feet. Coal at about this horizon is exposed in the NE. ¼ sec. 29 and measures 40 inches in thickness at location 35; but the correlation of this bed with bed A, farther north, is somewhat uncertain, as the coal is concealed between the two outcrops last mentioned and the fault noted in the northern part of sec. 28 may cross the NE. ¼ sec. 29 and thus offset the coal outcrop. The coal at location 35 can be traced southward to location 36, where it is 2 feet 4 inches thick. It is also exposed in a small outlier at location 37 (SE. ¼ sec. 29), where it has a thickness of 2 feet 9 inches. The main outcrop near the east line of sec. 29

continues southward into the NE. ¼ sec. 32, where it measures 27 inches at location 54. At location 55, however, its thickness is only 19 inches. A bed of about this horizon outcrops near the southeast corner of sec. 32. At the most northerly outcrop observed (location 56) the bed is thin, containing only 10 inches of coal. Farther south, at location 57, it contains more than 6 feet of coal, but the bed is badly broken by shale partings and is not particularly valuable. Still farther south, at location 60 (NW. ¼ sec. 4, T. 46 N., R. 81 W.), the bed consists of only one bench of coal 2 feet 6 inches thick. Beyond this place the bed appears to be thin and its outcrop was not traced.

At location 34 a coal bed below coal A was noted, which consists of two benches, 13 and 14 inches in thickness, separated by 16 inches of shale.

Coal bed B outcrops a short distance east of bed A in sec. 17 and its most northerly exposure is at location 12, where the bed contains more than 7 feet of coal. At two places south of location 12 this bed has been opened to supply coal for local use. In the northern opening (No. 14) the bed measures 86 inches but is broken by a 3-inch shale parting; in the southern opening (No. 18) the bed is thicker but contains several partings of shale. An analysis was made of a sample from the northern opening, and the results are given under No. 10683, in the table on page 469. The section of the bed showing the part included in the sample is given on Plate XXXVII, No. 14. At the south line of sec. 17 the coal bed has the section shown in No. 19. The bed can be traced one-eighth of a mile south of the line between secs. 17 and 20, but there it apparently thins and disappears. It is probably represented by the 12-inch coal bed exposed at location 31. To the north it can be traced beyond the west line of sec. 17, its total outcrop being scarcely a mile in length. In the valley of South Fork of Crazy Woman Creek and on the divide between the North and South forks the rocks are almost entirely concealed by alluvium and terrace deposits. Several thin beds of coal outcrop, however, in sec. 6, at locations 1, 3, and 4. The thickest of these, at location 1, measuring 18 inches, is at about the same horizon as coal B, but there is no indication that it is continuous with that bed.

South of sec. 20 coal bed B was not recognized except possibly near the south line of the township. At location 58 (SW. ¼ sec. 33) the coal bed consists of an upper bench 1 foot thick and a lower bench 1 foot 8 inches thick, separated by 2 feet of shale. At location 62 (NW. ¼ sec. 4, T. 46 N., R. 81 W.) the bed is 2 feet thick. South of this place the bed is thin and was not mapped.

Coal C is 6 inches thick in the SW. ¼ sec. 8, T. 47 N., R. 81 W. (location 6), and can be traced with some difficulty to location 7

and thence to location 10. At the place last mentioned it is represented by two beds 3 feet apart which measure 29 and 26 inches in thickness. At location 11 the section of the bed is similar to that shown at location 10, except that the entire bed is somewhat thinner.

The thickness of the main shale parting diminishes southward, as shown by section No. 15, measured in the SW. ¼ sec. 17. South of this place the bed is represented by a single bench 2 feet 8 inches thick, as shown by section No. 20. At location 30 the same thickness was found as at location 20, but to the south it increases as shown by section No. 33, measured in the SE. ¼ sec. 20. Here the coal has burned at several places and baked the overlying rocks. In sec. 28 the bed is broken by a fault, which throws the outcrop some 600 feet to the east, and shale partings again appear, separating the bed into three benches at location 41. The horizon may be traced southward to location 52, where the coal is over 24 inches in thickness, but at location 53 the bed is only 22 inches thick. A bed at about this horizon appears near the township line, and at location 61, in the NW. ¼ sec. 4, T. 46 N., R. 81 W., it measures over 30 inches but is broken by shale partings. A short distance to the south the bed is thin, consisting at location 63 of a single bench 20 inches thick. Beyond this place the bed is too thin to be traced.

Coal D outcrops at location 8, in the NW. ¼ sec. 17, T. 47 N., R. 81 W., where it lies in two benches, 11 inches and 22 inches thick, separated by 10 inches of shale. At location 9 it is much thicker, as shown by the section on Plate XXXVII. North of these outcrops the coal is concealed by alluvium in the valley of South Fork and by gravel on the terraces beyond, but a coal bed at about the same horizon is exposed at location 2, in the SW. ¼ sec. 5, which measures 36 inches in thickness and resembles in the arrangement of its benches the bed showing at location 9, south of the creek. Whether the bed is continuous across the South Fork Valley or not is uncertain. It has not been observed north of the North Fork of Crazy Woman Creek. From location 9, in sec. 17, it can be traced southeastward to location 29, in sec. 30, and to location 38, in the NW. ¼ sec. 28, where it is offset by the fault mentioned in the description of coal bed C. South of this fault the character of the coal bed is almost the same as that north of the fault line, as shown by section No. 39, measured in the NW. ¼ sec. 28.

At location 40 the whole bed is only 22 inches thick and it soon disappears to the south. A group of coal beds is found at about this horizon in the NW. ¼ sec. 4, T. 46 N., R. 81 W., one of which, supposed to represent bed D (No. 64), consists of a number of thin beds, the thickest being 30 inches, but the coal is local in extent, thinning in a short distance both north and south.

A short distance above coal D a bed is locally developed in the SE. ¼ sec. 21, T. 47 N., R. 81 W., which at location 28 is in two benches of 24 inches and 36 inches separated by 6 inches of shale. At location 27, however, only 24 inches was found in this bed. The bed could not be traced beyond these two exposures.

The outcrop of coal E diverges widely from the strike of the beds previously described, on account of a slight structural dome (see p. 448) which is present in secs. 16 and 21, T. 47 N., R. 81 W. For example, coal E in sec. 28 has a strike of N. 20° E., whereas the outcrop of coal D in the same section trends N. 34° W. To the south this local dome dies out and the beds are practically parallel in sec. 33. Coal E first appears as a bed over 24 inches in thickness at location 22, in sec. 22, where it measures 46 inches but is broken by two shale partings. From this place it can be traced to the southwest, although it is partially concealed, across sec. 22 to location 26, where it is repsented by a group of beds, only the lowest of which is of value. Just south of this location the bed is broken by a fault which offsets the outcrop about 300 feet to the west. At location 25, in the SE. ¼ sec. 21, the coal measures 27 inches. Just south of location 25 the outcrop is offset 300 feet to the east by a fault, and where again found the coal is less than 24 inches in thickness. South of the fault it increases in thickness for at least half a mile, as shown by sections Nos. 42 and 43, but the beds, although containing in the aggregate a large amount of coal, are so badly broken by partings that mining would be difficult and expensive. At location 44 the bed consists of only two benches, but they are thicker and the bed has a corresponding greater commercial value. At this place the bed was formerly mined for local use. South of the old mine the outcrop is concealed for three-fourths of a mile, but at location 50, where it is next exposed, the coal is only 22 inches thick, and at location 51 it is 20 inches in thickness. Near the township line, however, the bed again increases in thickness and at location 59 is an important bed, though badly broken by shale partings. In T. 46 N., R. 81 W., there are no good exposures of this bed across sec. 4, but its horizon could be traced to the SW. ¼ sec. 9, where at location 68 it contains one bench 35 inches in thickness. At location 69 the bed contains many more benches; the one at the bottom is thicker than the one shown in section No. 68. From this place southward the bed decreases in thickness, as shown by section 70, measured in sec. 17. South of this place the bed is too thin to be considered and no coal bed more than 24 inches in thickness occurs at or near this horizon for a distance of 8 miles. It seems probable, however, by the tracing of a stratum of red shale which occurs a little above coal E, that the coal beds of basin No. 3 lie at approximately the same horizon as this coal. It will be noted that the outcrop of this bed (E) is the most extensive in basin No. 2.

An exposure of coal F was found at location 21, in sec. 14, T. 47 N., R. 81 W., where it measures 19 inches. North of this place the outcrop is marked by a line of slag hills formed by the burning of the coal. An exposure at location 5, in the NE. ¼ sec. 11, which is rather doubtfully correlated with coal F, measures 24 inches. Coal bed F may be traced southward from location 21 into sec. 22, where it has the thickness shown in section 23. It is an important bed at location 46 and also at location 45, where the coal is in two benches, the thicker measuring 36 inches. It is covered in the SE. ¼ sec. 28 and does not again appear to the south. Coal F is probably to be correlated with the coal bed exposed in the northwest bank of Crazy Woman Creek about a mile below Trabing. This correlation is somewhat doubtful, but if coal F is not the exact equivalent of the coal below Trabing it is at very nearly the same stratigraphic horizon.

Coal G at location 24, in the SE. ¼ sec. 22, T. 47 N., R. 81 W., is represented by a group of beds of rather doubtful value. North of this outcrop the beds thin abruptly and disappear in a short distance. The group can be traced into sec. 27, where at location 47 it consists of a single bed that has been worked to supply the local demand. At location 49 it consists of two benches having a total thickness of 6 feet 5 inches and here also it has been mined for local use.

South of location 49 the rocks are concealed. A thin coal bed appears at about the same horizon, in the SW. ¼ sec. 34, but this bed is not over 24 inches in thickness north of the SW. ¼ sec. 3, T. 46 N., R. 81 W. At location 65 it is made up of two benches, one of which is 36 inches thick. The bed can be traced a short distance south of location 66 into sec. 10 but is soon concealed and does not again appear farther south.

An isolated exposure of coal, somewhat below the horizon of coal G, was found in the SW. ¼ sec. 9, T. 46 N., R. 81 W., which at location 67 reaches a thickness of 24 inches. The bed thins, however, both to the north and to the south, and is of small importance. A bed at about the same horizon outcrops at location 48, in sec. 27, T. 47 N., R. 81 W., but can not be traced far beyond the single exposure.

As has been stated, coal F is probably the same bed as that exposed 1 mile below Trabing post office. The bed below Trabing was mapped in the survey of the Buffalo coal field,[1] being traced down Crazy Woman Creek to the vicinity of the John Hepp ranch, in sec. 30, T. 50 N., R. 79 W. Thence it was followed north and east to its exposures on Dry Creek. In the report above cited it is referred to as the Dry Creek coal. A bed or group of beds at about the same horizon was found by the writer to be exposed along Powder River in the vicinity of Barber post office, where it is at an elevation of about 4,100 feet above sea level. It is not to be inferred that the

[1] Gale, H. S., and Wegemann, C. H., The Buffalo coal field, Wyo.: Bull. U. S. Geol. Survey No. 381, 1910.

coal is continuous as a single bed over this broad area; in fact, the beds in the coal basin just described show great variability in thickness and disappear in short distances, but it is probably true that the group of beds of basin No. 2 is in general equivalent to the group near Barber, the Dry Creek coal of the Buffalo field, and the upper beds of the intermediate group described by Taff[1] in the report on the Sheridan coal field.

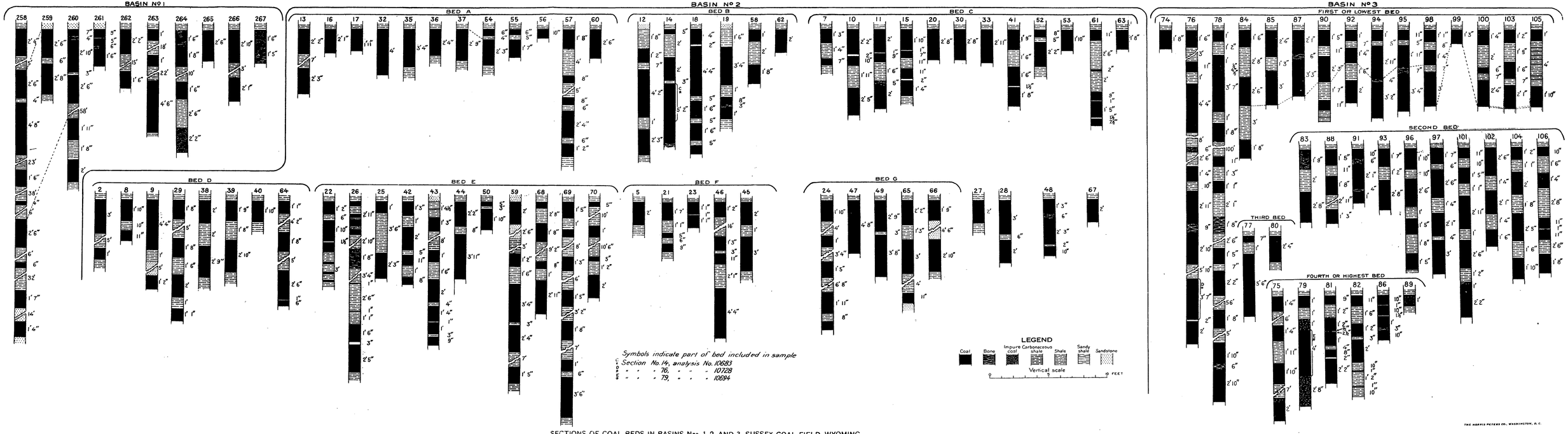
AREA BETWEEN COAL BASIN No. 2 AND COAL BASIN No. 3.

In the 12 miles intervening between the southern end of coal basin No. 2 and the northern limit of basin No. 3 coal is practically absent. In one locality only—sec. 14, T. 45 N., R. 81 W.—is there a bed worthy of note. Here a coal bed 24 inches thick is exposed on the south side of a draw, but it apparently thins both to the north and to the south, as it can be traced for only a few rods.

COAL BASIN No. 3.

The coal beds of basin No. 3 (Pls. XXXVII and XXXVIII) are four in number, distributed through a stratigraphic distance of 175 to 200 feet. The group of beds lies at or just above the top of the bluish-white sandstone and shale forming Great Pine Ridge, or about 2,000 feet above the base of the Fort Union formation. The lowest and most extensive bed appears in the SW. ¼ sec. 15, T. 44 N., R. 81 W., where at location 74 it measures 20 inches. It thickens rapidly toward the southeast and the single bed is replaced by a group of beds, one of which has been mined at location 76 for local use. (See coal analysis No. 10728, p. 469.) One-fourth mile southeast of this mine the coal is burned and the rocks overlying it are baked to a brick-red color. No exposures appear for a distance of about one-half mile, but a ridge is formed by the clinker or baked rock produced by the burning of the coal. In the SE. ¼ sec. 23 a bed supposed to be the same as that showing at location 76 is exposed but is much broken by shale partings, the thickest bench of coal being only 26 inches. (See middle part of coal section No. 78.) At this place a lower bed of coal is present, which lies in two benches of 34 inches and 22 inches, separated by 6 inches of bone (lowest part of No. 78). This may, in fact, be the equivalent of the bed mined at location 76, as correlation here is difficult owing to the lack of exposures. The bed can be traced for a short distance south but appears to decrease in thickness in that direction. The middle bed at location 78, which is thus doubtfully correlated with the bed mined at location 76, can be traced across the NE. ¼ sec. 26 and the SW. ¼ sec. 25, the benches decreasing in number but increasing in thickness (Pl. XXXVII, Nos.

[1] Taff, J. A., The Sheridan coal field, Wyo.: Bull. U. S. Geol. Survey No. 341, 1909.



SECTIONS OF COAL BEDS IN BASINS Nos. 1, 2, AND 3, SUSSEX COAL FIELD, WYOMING

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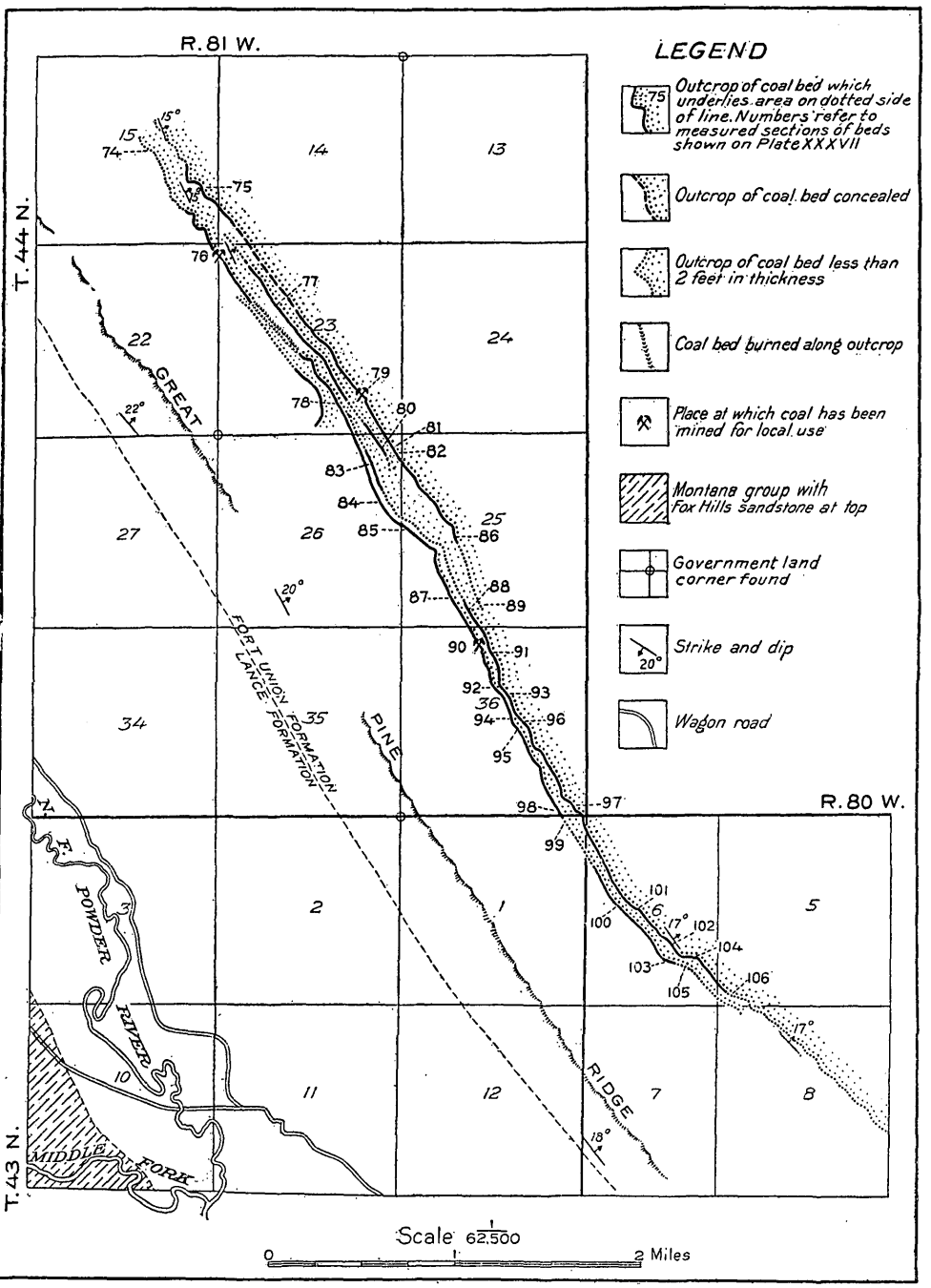

MAP OF COAL BASIN No. 3, SUSSEX COAL FIELD, WYOMING.

By Carroll H. Wegemann.

84, 85, and 87) to location 90, where it has been mined for local use. At location 92 the bed is considerably thinner than at location 90, but it increases in thickness at locations 94 and 95. At location 98 the benches of coal are thinner than at location 95, and at location 99, in the NE. ¼ sec. 1, T. 43 N., R. 81 W., the bed is only 15 inches thick. In the NW. ¼ sec. 6, T. 43 N., R. 80 W., however, the bed is thicker and at location 100 measures 28 inches. It is thicker than this at location 103 but drops to 22 inches at location 105 and disappears farther south.

About 60 feet above the coal bed just described is a second bed. This appears as a thin streak of coal and brown shale at the north line of sec. 26, T. 44 N., R. 81 W. At location 83 the coal is 32 inches thick, but it thins to the south. It may be traced as a thin and unimportant coal bed to location 88, in the SW. ¼ sec. 25, where it lies in two benches of 20 and 17 inches separated by 11 inches of shale. It gradually increases in thickness across sec. 36, as shown by sections 91, 93, and 96; and at location 97, near the southeast corner of the township, it consists of four benches, which contain in all 9 feet of coal. It continues as an important bed across sec. 6, T. 43 N., R. 80 W., as shown by sections 101, 102, and 104, but at location 106 measures 22 inches. From this place its horizon may be traced southeastward, but the coal is gradually replaced by shale.

About 150 feet above the coal bed first described in this basin occurs the fourth important coal bed of the group. At location 77, in the NW. ¼ sec. 23, T. 44 N., R. 81 W., it contains 66 inches of coal. In the SE. ¼ of the same section this bed thins to less than 24 inches, but it measures 28 inches at location 80. Southeast of this place it is thin and disappears in a short distance, the total outcrop of the bed being not more than a mile in length.

The fifth or highest coal bed of the group appears first in the SE. ¼ sec. 15, T. 44 N., R. 81 W., where, at location 75, it consists of four thin beds of doubtful importance. The outcrop is partially concealed across the NW. ¼ sec. 23, but at location 79 the several thin beds are represented by one bed 7 feet 6 inches in thickness, about 4 feet of which is clean coal. At this place the bed has been mined for local use. (See coal analysis No. 10694, table, p. 469.) At location 81 the coal is broken by several partings. It is in better shape for mining at location 82 but at location 86 is broken by numerous partings. At location 89 it has dropped to 12 inches in thickness.

As previously mentioned under the discussion of coal basin No. 2, a stratum of red shale may be traced from the south end of that basin across the southern part of T. 46 N., R. 81 W., and the greater part of T. 45 N., R. 81 W., to the small coal lens mentioned as outcropping in sec. 34 of that township. From the relation of this stratum of red shale to the coal beds it is believed that the lens of

coal in sec. 34 is at practically the same stratigraphic position as coal E, discussed under coal basin No. 2. Between the exposure of this coal lens in sec. 34 and the northern exposure of the coal group in basin No. 3, a distance of about 2½ miles, there are no exposures of coal, but a prominent bed of sandstone which forms the pine-covered ridge a little west of the coal outcrop may be traced across the intervening space and used as a horizon marker. From the relations of the coal beds to this sandstone it is apparent that the coal beds of basin No. 3 lie at practically the same horizon as the coal lens in sec. 34, T. 45 N., R. 81 W., and so are at about the same stratigraphic position as coal E in basin No. 2.

AREA BETWEEN COAL BASIN No. 3 AND COAL BASIN No. 4.

None of the coal beds in basin No. 3 reach a thickness of 24 inches southeast of the SW. ¼ sec. 5, T. 43 N., R. 80 W. They are apparently replaced by shale. In the broad alluvial flat of Powder River, which crosses the middle part of T. 43 N., R. 80 W., all rocks are concealed. On the divide between Powder River and Salt Creek the rocks at the coal horizon are fairly well exposed at several places, and the only coal present is a bed 10 inches in thickness. It seems certain, therefore, that the coal beds of basin No. 3 are in no way connected along the outcrop with those of basin No. 4.

COAL BASIN No. 4.

The group of coal beds of basin No. 4 (Pls. XXXIX and XL), like the two others previously described, is at the top of the bluish-white sandstone forming the Great Pine Ridge, or about 2,000 feet above the base of the Fort Union formation. In its northwestern part the coal group consists of two beds. The lower of these, exposed at location 111, in the SE. ¼ sec. 27, T. 43 N., R. 79 W., lies in three benches, one of which is 30 inches thick. West of this place the coal appears in the earth thrown out from prairie-dog holes, but there are no exposures in the valley of Salt Creek. Across that stream, in the NE. ¼ sec. 28, T. 43 N., R. 79 W., the coal is again exposed, as mentioned above, but here measures only 10 inches. To the northwest of this locality it soon disappears, apparently being replaced by shale. From the exposure in sec. 27, on the east side of Salt Creek, the bed may be traced continuously through the southeast part of T. 43 N., R. 79 W., the southwest part of T. 43 N., R. 78 W., and secs. 4, 3, and 2, T. 42 N., R. 78 W. As shown in the upper line of sections on Plate XL, it is, throughout this distance, everywhere more than 24 inches in thickness. The measured sections of this coal bed furnish an unusually good illustration of the variability of coal beds, as most of the sections, especially in the western part of the basin, can be exactly correlated, owing to the excellence of exposures. Partings,

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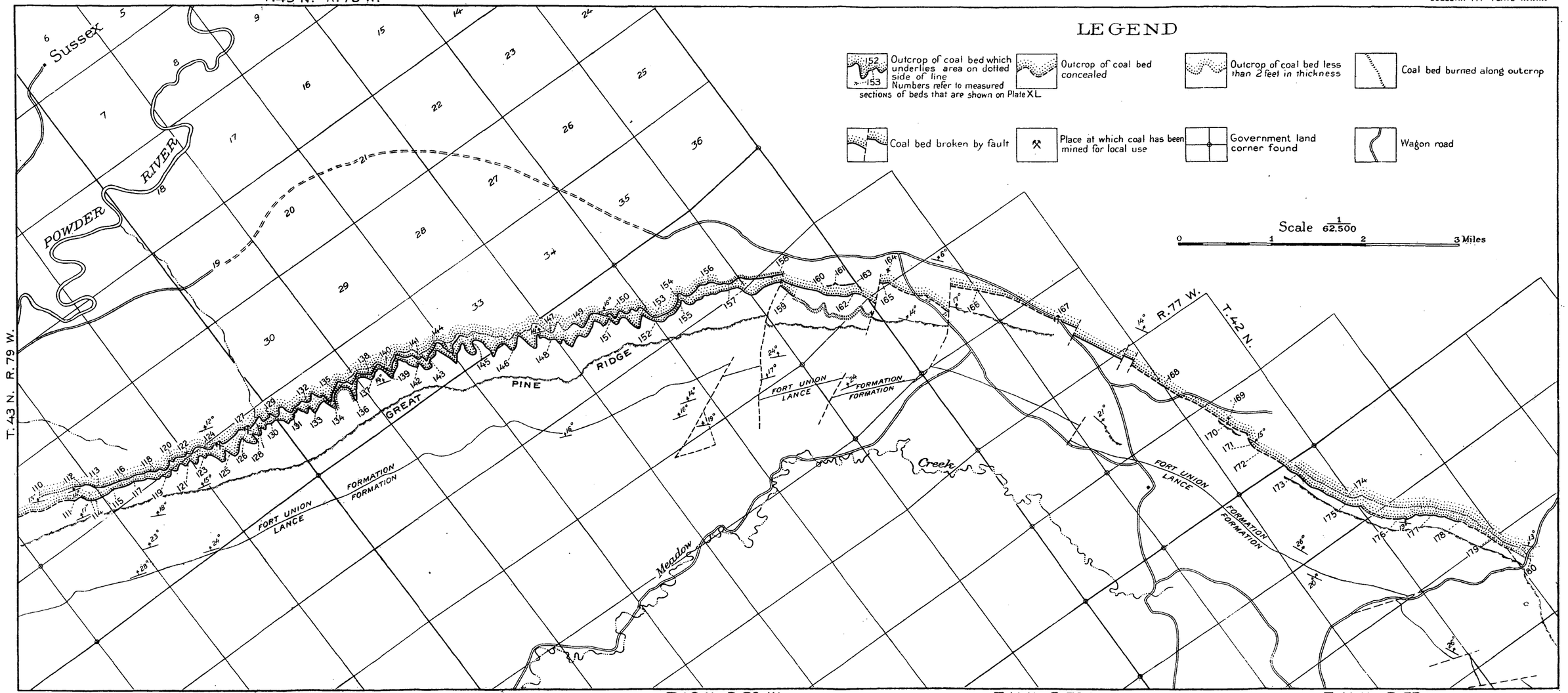


MAP OF COAL BASIN NO. 4, SUSSEX COAL FIELD, WYOMING

By Carroll H. Wegemann

THE NORRIS PETERS CO., WASHINGTON, D. C.

which in many places make the coal difficult to mine, increase in thickness, rendering parts of the bed worthless, or decrease, leaving the coal that was divided into several benches merged into one thick bed.

In the NW. ¼ sec. 12, T. 42 N., R. 78 W., the coal bed is broken by a fault which throws the outcrop on the southern or downthrown side somewhat to the west. Just south of the fault, at location 159, the bed contains 28 feet of coal, exclusive of partings. From this place southeast for three-fourths of a mile the bed is burned along the outcrop. In the NE. ¼ sec. 13, T. 42 N., R. 78 W., a coal bed is exposed which apparently is identical with that exposed at location 159 and measures about 49 feet in thickness, including some shale and bone partings. Just south of this exposure the bed is again broken by a considerable fault, the downthrow at this place being on the north. The outcrop of the coal is offset 1,200 feet to the east, where it is exposed at location 165 with the unusual thickness of about 50 feet. From this place southward only one important bed can be found, and there is some doubt as to whether or not it is the same as the bed thus far described. The coal beds are much concealed by grassy slopes, faulting has broken the continuity of the beds, and burning along the outcrop has tended to conceal their character. It is believed, however, that the lower bed of the coal group which has been described thus far is the one which continues 7 miles farther to the southeast. In the SE. ¼ sec. 18, T. 42 N., R. 77 W., the bed is broken by a fault which shifts the outcrop 1,500 feet to the east. At location 166, in the same section, the bed contains about 18 feet of coal, which lies in three benches. Near the middle of sec. 20, T. 42 N., R. 77 W., the coal has been mined for local use (location 167) and a sample was here taken for analysis. (See analysis No. 10827, p. 469.)

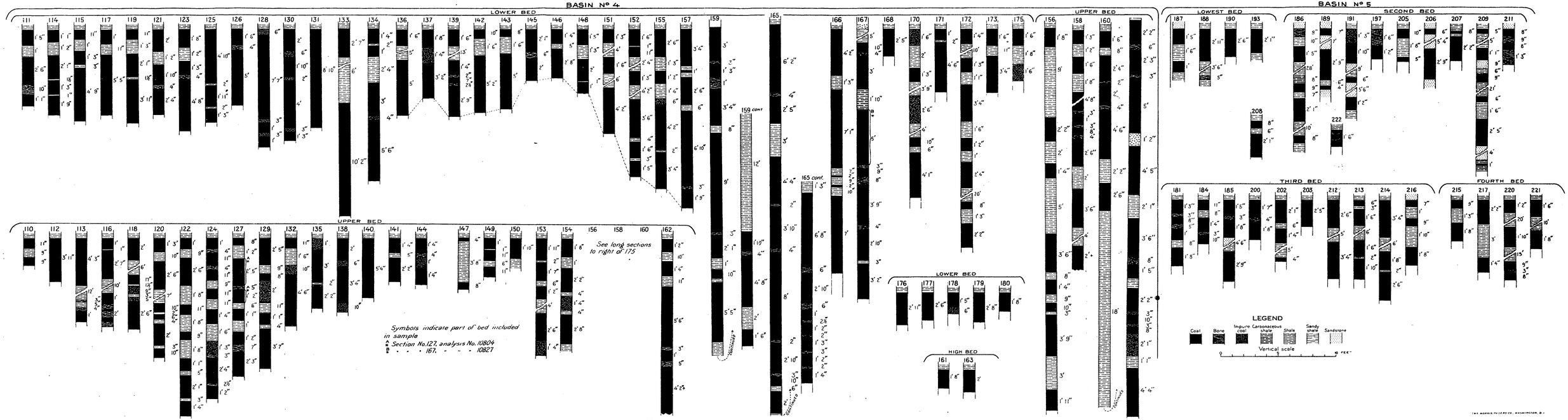
One-fourth mile south of this mine the coal is broken by a fault with the downthrow on the south side, which shifts the outcrop 400 feet to the west. In the NE. ¼ sec. 29 of the same township there are two parallel faults 600 feet apart, the block between them being upthrown, thus shifting the coal outcrop 250 feet to the east. From this place south, for a distance of 2 miles, the beds are almost entirely concealed. At location 168, however, the coal of the bed seems to have been partially replaced by shale, for two or more thin beds of coal are exposed, the thickest measuring 29 inches. It seems probable that the whole bed is not exposed at this place. Three-fourths of a mile southeast, at location 170, the whole bed is exposed, but it is considerably thinner than at location 167. It varies greatly in the number and thickness of benches which compose it, as shown in sections Nos. 171, 172, and 173. At location 175, in the SE. ¼ sec. 4, T. 41 N., R. 77 W., it is only 18 inches thick. From this place it thins abruptly. As it thins, however, another bed appears only a few feet above it, which thickens to the southeast and at location

176, in the NW. ¼ sec. 10, T. 41 N., R. 77 W., measures 35 inches. This bed is 24 inches or more in thickness for over a mile along its outcrop (Nos. 177, 178, and 179), but it has dropped to 20 inches at location 180, in the NW. ¼ sec. 14, T. 41 N., R. 77 W., and was not seen farther south.

The upper bed at the northwestern end of the coal basin first appears at location 110, in the NW. ¼ sec. 27, T. 43 N., R. 79 W., where it lies in two benches, 9 and 11 inches in thickness, separated by 9 inches of shale. At location 112, in the same section, its thickness is 47 inches and the bed may be traced continuously (see Pl. XL, Nos. 113, 116, 118, 120, 122, 124) to sec. 36 of the same township, where it has been mined for local use at two or three places. At location 127 a sample was obtained for analysis. (See analysis No. 10804, p. 469.)

The bed is 24 inches or more in thickness for a distance of 2½ miles to the east but gradually decreases in thickness, as shown in sections 129, 132, 135, 138, 140, and 141, until at location 144, in the SW. ¼ sec. 32, T. 43 N., R. 78 W., it lies in two benches of 18 inches and 16 inches, separated by 16 inches of bone. Beyond that point it is thin and is replaced by shale. A glance at the sections taken along the outcrop of this bed and given graphically on Plate XL will show that the coal bed, considered broadly, is lens-shaped, beginning on the west as a small bed and increasing in thickness to the middle of its basin, at about location 122, then decreasing toward the east until it is replaced by shale. Near the west mine shown on the map, in sec. 36, T. 43 N., R. 79 W., a thin parting of shale and sandstone not shown in any of the graphic sections appears near the top of the bed, separating a few inches of the coal from the main bed. The parting increases along the outcrop until it is 10 or 20 feet in thickness, the coal above it, originally part of the first bed, becoming a second bed overlying the first. Thus it is apparent that the surface of the coal swamp was not everywhere horizontal, but that the trees and plants which formed the coal of the upper bed grew on a slope sufficient to drain off all standing water except that held by the vegetation which covered it. In such places the tree trunks which entered into the composition of the coal could hardly have been preserved from decay by falling directly into pools of water of sufficient depth to cover them.

In the NW. ¼ sec. 32, T. 43 N., R. 78 W., a bed of brown carbonaceous shale containing a few coal streaks appears a few feet above the upper of the two principal beds at this place. This bed may be traced for 2¼ miles to the southeast. At location 147, in the NE. ¼ sec. 4, T. 42 N., R. 78 W., it contains only 8 inches of coal, but at location 149, in sec. 3 of the same township, it abruptly increases to 35 inches, although broken by shale partings. From this place it



SECTIONS OF COAL BEDS IN BASINS Nos. 4 AND 5, SUSSEX COAL FIELD, WYOMING

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increases in thickness for the next 2 miles, as shown by sections Nos. 150, 153, 154, and 156, until at location 158, just north of the fault, in the NW. ¼ sec. 12, T. 42 N., R. 78 W., the bed contains, exclusive of numerous shale partings, a total of 20 feet of coal. It is here offset slightly to the west by the fault in much the same way that the lower bed of the group is offset. Within half a mile of this place, at location 160, a bed is exposed which is so unusually thick that its correlation with the bed at location 158 and with that exposed at location 162 may well be questioned. Exposures are by no means good and the correlation of the beds here involved is correspondingly difficult. A thick bed of coal is exposed at location 162, which may represent a part of that exposed at location 160. In the northeast corner of sec. 13, T. 42 N., R. 78 W., a thick bed apparently 55 feet below that at location 162 outcrops in a gulch. A detailed section could not be obtained, but the bed was believed to be the same as that exposed at location 165. In that case, however, the only possible conclusion seems to be that the thick bed at location 162 is to be correlated with 11 inches of coal at location 164, which is, to say the least, improbable. The thin bed shown at locations 161 and 163 is much more likely to be the same as the 11-inch bed at location 164, and it is possible that the bed at location 165 is the same as that at location 162, but in that case the thick bed in the northeast corner of sec. 13 does not, so far as known, outcrop south of the fault. The correlation given on the map and plate of sections is to be regarded only as tentative. From location 165 southeastward only one important bed has been found, as already described. At location 169 a coal bed 12 inches thick lies a short distance above the principal bed and at location 174 at about the same horizon 27 inches of coal is exposed, but it is so broken by shale partings as to be of no value.

The group of coal beds in basin No. 4 occupies a stratigraphic position approximately equivalent to that of the group of beds in basin No. 3, as both occur at or just above the upper limit of the sandstone and shale, 2,000 feet in thickness, forming Great Pine Ridge.

AREA BETWEEN COAL BASIN No. 4 AND COAL BASIN No. 5.

For about 10 miles along Great Pine Ridge, south of the southern limit of basin No. 4, no coal is exposed, the beds being absent in this area.

COAL BASIN No. 5.

Coal basin No. 5 lies, for the most part, in the eastern half of T. 39 N., R. 77 W. (Pls. XL and XLI). The coal beds in this basin occur in two different formations—the lower group at or just below the top of the Lance formation and the upper group 1,000 feet above the base of the Fort Union formation.

The lower group consists of three beds, the lowest of which, in the NW. ¼ sec. 3, T. 39 N., R. 77 W., outcrops at location 187, where it contains 17 inches of coal. The bed thickens toward the south, containing 35 inches of rather poor coal at location 188 and 30 inches at location 190. At location 193, in the NW. ¼ sec. 10 of the same township, the bed is 25 inches in thickness, but from that place it thins to the south and at location 195 has only 12 inches of coal. A little below this bed, in the NW. ¼ sec. 10, a small lens of coal 18 inches thick was found at location 194.

About 200 feet above the coal bed just described there is, in the NE. ¼ sec. 15, T. 39 N., R. 77 W., a local lens of coal, which at location 208 is 25 inches in thickness. It thins both north and south, at location 204 containing 9 and 12 inches of coal separated by 6 inches of shale, and at location 196 containing 22 inches of coal.

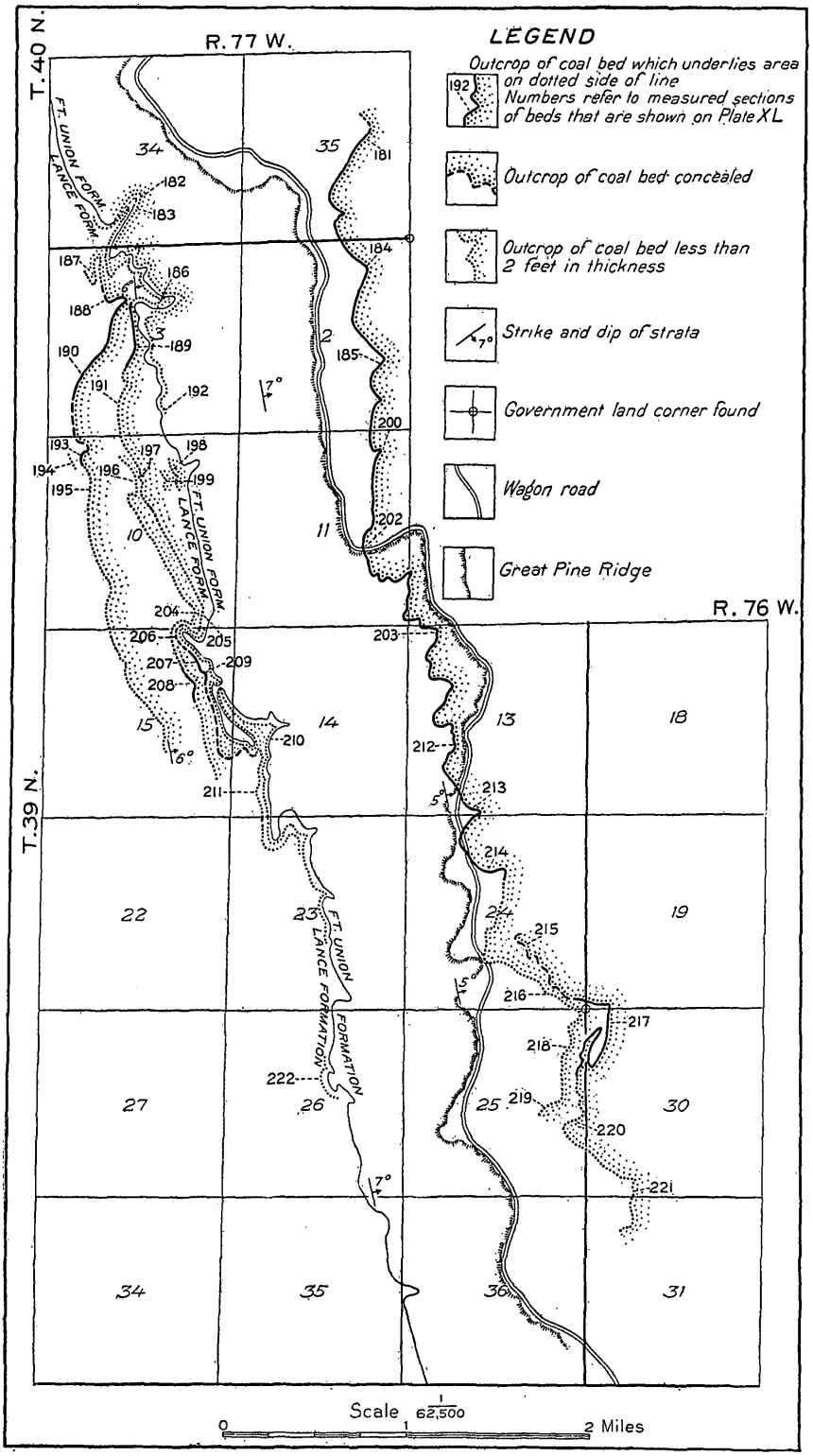
About 100 feet above this bed a third bed appears in the central part of sec. 3, T. 39 N., R. 77 W., which at location 186 is 25 inches thick but of doubtful quality. At location 189 this bed contains 33 inches of coal. To the north it thins and disappears in a short distance. To the south, at location 191, the bed is 22 inches thick. It is less than 24 inches in thickness across sec. 10, being 14 inches thick at location 197 and 10 inches at location 205, but in the NE. ¼ sec. 15, at location 206, it reaches a thickness of 33 inches. It continues over 24 inches in thickness for about a mile along its outcrop, measuring 26 inches at location 207 and 29 inches at 209, but is much thinner at location 211 and is replaced by shale to the south. This coal bed is only a few feet below the boundary between the Lance and the Fort Union formations. Just above it a thin bed contains 24 inches of poor coal at location 210 and 18 inches at location 222, and the local lenses at locations 198 and 199 contain 15 inches and 12 inches, respectively.

A thin coal bed at the base of the Fort Union formation was traced in outcrop across sec. 3, T. 39 N., R. 77 W., and into sec. 34 of the township to the north. The character of the bed is shown by the following sections:

Sections of coal bed at base of the Fort Union formation.

Location 182.

	Ft.	In.
Shale.		
Coal		6
Shale		10
Coal, impure	2	6
Shale.		
	3	10



MAP OF COAL BASIN No. 5, SUSSEX COAL FIELD, WYOMING.

By Carroll H. Wegemann.

Location 183.

	Ft.	in.
Shale.		
Coal		8
Shale		4
Coal, impure	2	
Coal	1	
Shale.		
	4	

Location 192.

	Ft.	in.
Shale.		
Coal	1	3
Shale	4	6
Coal		8
Shale.		
	6	5

North of location 182 and south of location 192 the bed is so thin that its outcrop could not be traced.

No samples for analysis were obtained from the beds described above because of lack of fresh exposures. From field examination, however, it appears that the coal is considerably poorer in quality than that of the Fort Union, as it contains numerous thin seams of shale and particles of mud throughout its mass, which render the ash content high.

The coal bed of most importance in coal basin No. 5 lies about 1,000 feet above the base of the Fort Union formation, near the middle of the bluish-white sandstone and shale which form the pine-covered ridge. The bed appears in sec. 35, T. 40 N., R. 77 W., where at location 181 it contains 55 inches of coal lying in four benches. North of this place it apparently thins abruptly and is not an important bed. South of location 181 the bed can be traced for about 4 miles through secs. 2, 11, and 13, T. 39 N., R. 77 W., and its variation in thickness is shown on Plate XL (Nos. 184, 185, 200, 202, and 203). At locations 212, 213, and 214 it is represented by two beds, both minable. At locations 216, 218, and 219, however, it is under 24 inches thick, and to the south it is thinner, although its horizon can be traced for a couple of miles. A short distance above this bed, in the SE. ¼ sec. 24, T. 39 N., R. 76 W., is a coal bed which at location 215 is of rather doubtful value. No exposures were found north of this place, and to the south the outcrop is partly concealed for one-third of a mile. At location 217, however, in the NW. ¼ sec. 30, T. 39 N., R. 76 W., coal is again exposed and measures 26 inches. At location 220 it lies in three rather thin benches and at location 221 has dropped to 20 inches in thickness.

In many places in the Sussex field coal beds of good quality are found in the upper part of the Lance formation, but so far as observed they do not reach a thickness of 24 inches except in this locality. The Fort Union coal beds of basin No. 5, occurring at about the middle of the white sandstone and shale forming Great Pine Ridge,

are not represented at any other locality in the field. Thin beds of coal were noted at various places in the white sandstone and shale, but except in this one coal basin they do not attain a thickness of 24 inches.

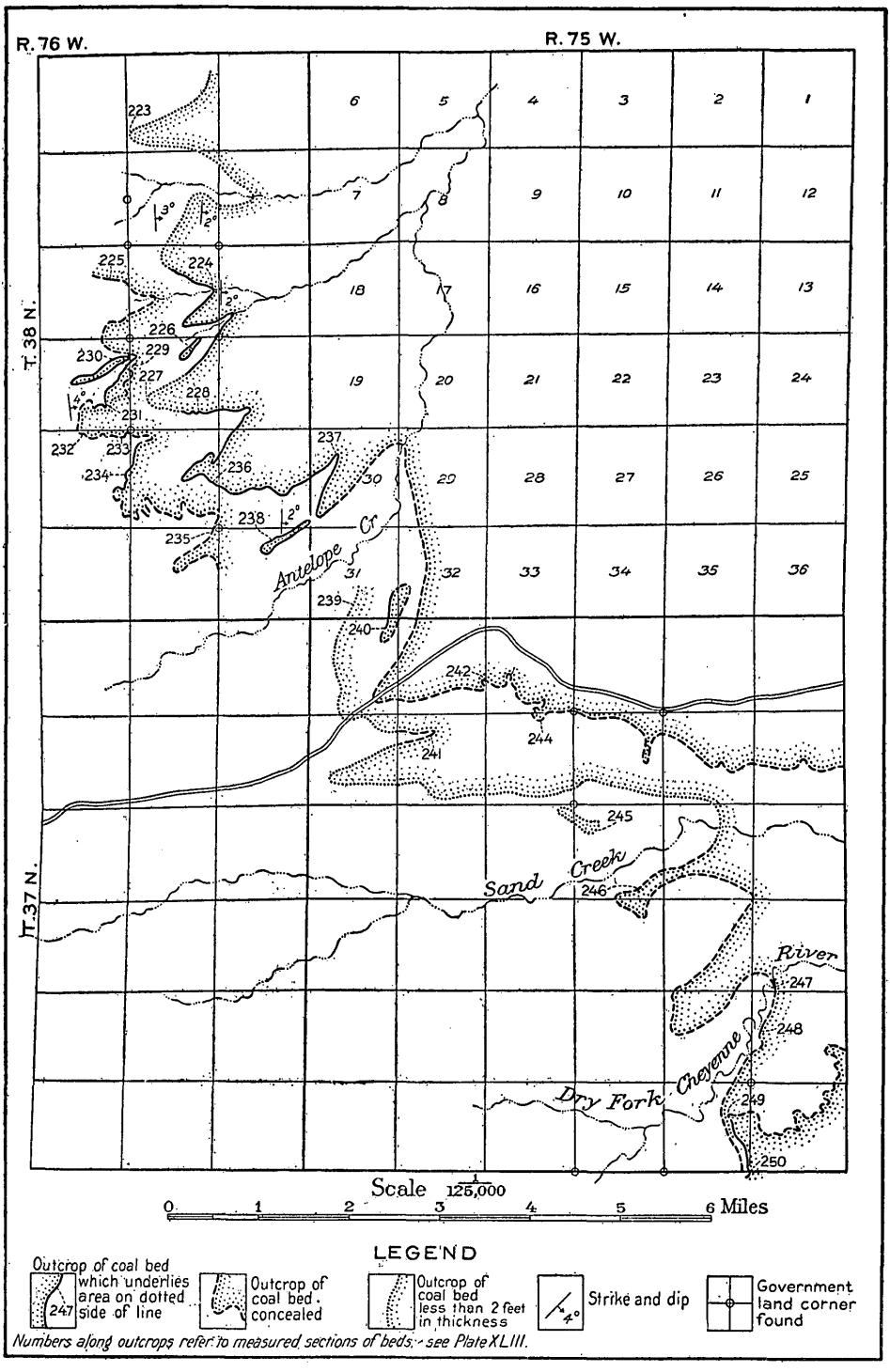
AREA BETWEEN COAL BASIN No. 5 AND COAL BASIN No. 6.

For about 6 miles between coal basin No. 5 and coal basin No. 6 no coal was found. As the coal beds of basin No. 7 are considerably higher than those of basin No. 5, this fact is not at all remarkable. It would perhaps be more interesting to note the distance between the southern limit of coal basin No. 4 and the northern limit of coal basin No. 6, as the coal beds of these basins are more nearly at the same stratigraphic positions. Between the basins last named no coal is present for about 20 miles.

COAL BASIN No. 6.

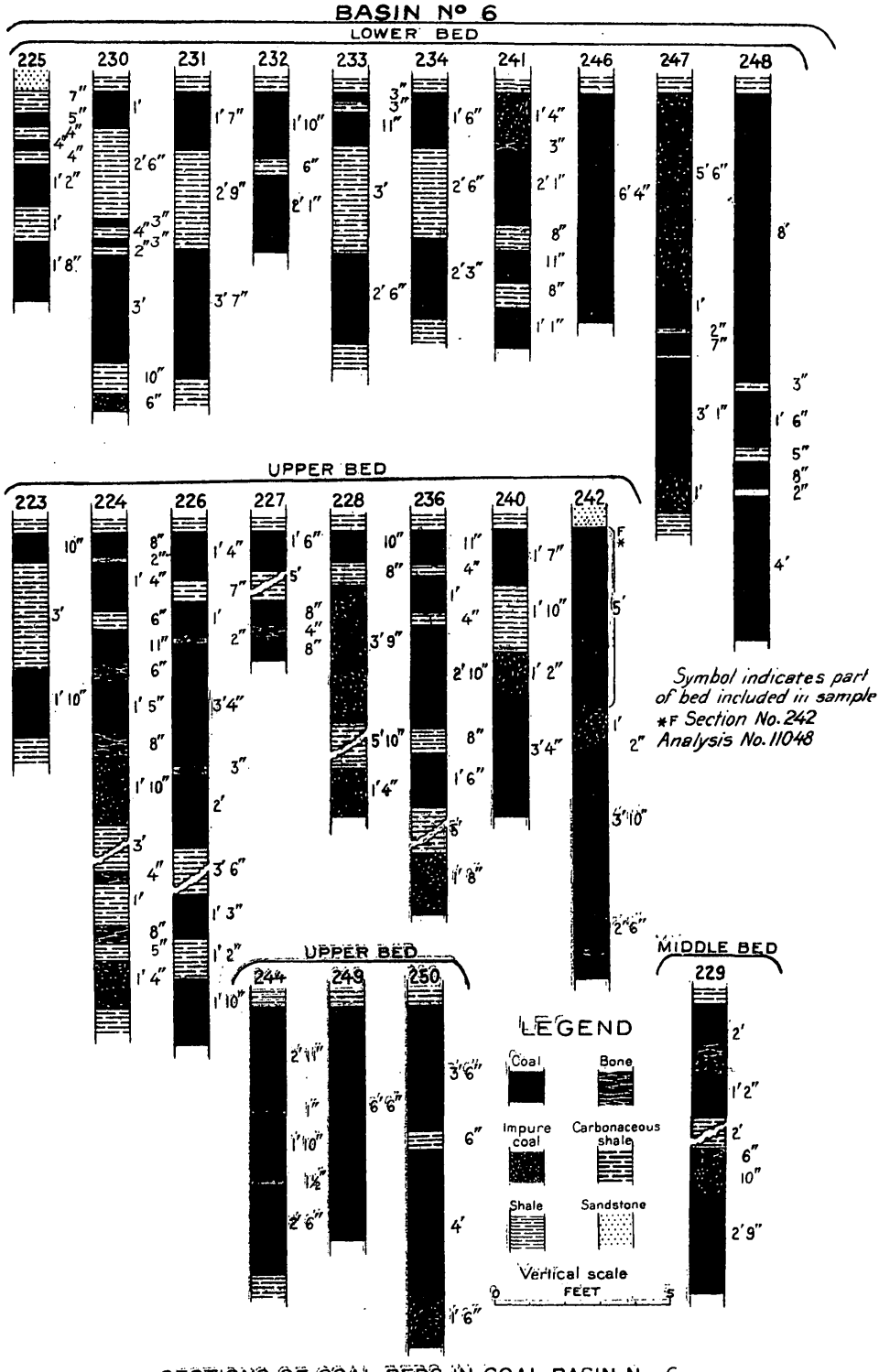
The coal beds of basin No. 6 are two in number and are separated by about 100 feet of shale and sandstone. (See Pls. XLII and XLIII.) They lie, as nearly as can be determined, just below the top of the bluish-white sandstone and shale which form Great Pine Ridge and constitute the lower half of the Fort Union formation. The lower bed, at location 225, in sec. 15, T. 38 N., R. 76 W., lies in two thin benches. It is 36 inches thick at location 230 and continues above 24 inches, as shown on Plate XLIII, Nos. 231, 232, 233, and 234, to location 235, in the NE. ¼ sec. 35, T. 38 N., R. 76 W. Beyond this place there are no exposures in the valley of Antelope Creek. A local lens of coal is found at location 229 just above the lower bed, but it can not be traced far. In sec. 31, T. 38 N., R. 75 W., the lower bed is also exposed but is less than 24 inches in thickness (location 239). In the NW. ¼ sec. 8, T. 37 N., R. 75 W., there is a local development of coal which at location 241 is 25 inches thick, with two thin benches below the main bench. It apparently thins to the southeast, but it is so poorly exposed that its thickness is uncertain. In the NW. ¼ sec. 15, T. 37 N., R. 75 W., an exposure of this coal occurs in the side of a knoll (location 245). The coal is so poor in quality that the bed has little or no value. Apparently the shale partings disappear toward the southeast and the various benches of coal form one solid bed, for at location 246, in the SE. ¼ sec. 15, 76 inches of coal was measured, which, though rather poor in quality, is probably to be considered of economic importance. As shown by section 247, the coal thickens toward the south, and at location 248, in the NW. ¼ sec. 25, it is almost 13 feet in thickness. The bed may be traced to the south township line and probably extends south of it, though lack of time prevented a detailed study of the bed in that area.

About 100 feet above the bed just described is a second coal bed which was first noted in sec. 2, T. 38 N., R. 76 W. (location 223). It



MAP OF COAL BASIN No. 6, SUSSEX COAL FIELD, WYOMING.

By Carroll H. Wegemann.



SECTIONS OF COAL BEDS IN COAL BASIN No. 6,
SUSSEX COAL FIELD, WYOMING

does not reach a thickness of 24 inches north of sec. 14 of the same township, but in this section, at location 224, it is considerably more than 24 inches thick, though the coal lies in a number of thin benches. At location 226, in the NE. ¼ sec. 23 of this township, the bed contains 7 feet of coal, though it is broken by several shale partings. Half a mile southwest of this place, at location 227, the coal is thin and the bed is worthless. Half a mile east, however, the coal thickens and though rather poor in quality is 45 inches thick at location 228. From this place it may be traced southeast across the southwest corner of T. 38 N., R. 75 W., and the northern part of T. 37 N., R. 75 W. It is so concealed that comparatively few measurements could be obtained. It appears, however, to be considerably over 24 inches thick throughout this distance (Pl. XLIII, Nos. 236, 237, 238, and 240), although at some places it is rather poor in quality, as at location 238. At location 242 it contains about 9 feet of coal and has been mined for local use. A sample for analysis was obtained at this place. (See analysis No. 11048, p. 469.) At location 244 the bed contains a little over 7 feet of coal.

This coal bed was not traced beyond the east line of T. 37 N., R. 75 W., although it extends into T. 37 N., R. 74 W. The outcrop of the bed appears again in sec. 25, T. 37 N., R. 75 W., and may be traced across sec. 36 into sec. 35, where at locations 249 and 250 it is a thick bed. Its outcrop continues into T. 36 N., R. 75 W., but was not examined in that township.

The coal beds exposed in basin No. 6 are probably at about the same horizon as those of basin No. 4. They are apparently just below the top of the sandstone so often mentioned as composing the lower half of the Fort Union formation. This sandstone is but a local phase of the Fort Union and in the vicinity of coal basin No. 6 differs considerably in character from its representative farther north. Its top can not be supposed to be regular or to lie always at the same stratigraphic horizon. In fact, wherever exposures are sufficiently good to permit tracing for any considerable distance, it is found to be irregular, appearing in places below and in other places above some definite horizon marker, such as a coal bed which can be followed. Correlations, therefore, based on the relations of coal beds to the top of this sandstone are only approximate.

COAL ANALYSES.

The following table gives analyses of six samples of coal from the Sussex field. The number in the column on the left refers to the section of the coal bed from which the sample was obtained. These sections are given on Plates XXXVII, XL, and XLIII, and the parts of the bed included in the samples are indicated by brackets. In the

text the analyses are referred to under the description of the coal beds from which the samples were obtained.

In the table the analyses are given in four forms, marked A, B, C, and D. Analysis A represents the composition of the sample as it comes from the mine. This form is not well suited for comparison, because the amount of moisture in the sample as it comes from the mine is largely a matter of accident, and consequently analyses of the same coal expressed in this form may vary widely. Analysis B represents the sample after it has been dried at a temperature a little above the normal until its weight becomes constant. This form of analysis is best adapted for general comparison. Analysis C represents the theoretical condition of the coal after all the moisture has been eliminated. Analysis D represents the coal after all moisture and ash have been theoretically removed. This is supposed to represent the true coal substance, free from the most significant impurities. Forms C and D are obtained from the others by recalculation. They should not be used in comparison, for they represent theoretical conditions that never exist.

In the analytical work it is not possible to determine the proximate constituents of coal or lignite with the same degree of accuracy as the ultimate constituents. Therefore the air-drying loss, moisture, volatile matter, fixed carbon, and ash are given to one decimal place only, whereas the ash (in the ultimate analysis), sulphur, hydrogen, carbon, nitrogen, and oxygen are given to two decimal places. The determination of the calorific value to individual units is not reliable, hence in the column headed "Calories" the values are given to the nearest five units, and in the column headed "British thermal units" they are given to the nearest tens, the value of a British thermal unit being about one-half that of a calorie.

Analyses of coal samples from the Sussex coal field.

[Pittsburgh laboratory, Bureau of Mines, A. C. Fieldner, chemist in charge.]

Laboratory No.	No. on map and section.	Location.				Air-drying loss.	Form of analysis.	Proximate.			Ultimate.						Heat value.	
		Quarter.	Sec.	T. N.	R. W.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
10683	14	SW...	17	47	81	19.6	A	28.8	.....	.....	6.7	0.56	.....	.....	.....	.....	4,405	7,930
							B	11.5	.....	.....	8.3	.70	.....	.....	.....	.....	5,480	9,860
							C	.....	.....	.....	9.4	.79	.....	.....	.....	.....	6,190	11,140
							D	.....	.....	.....	.....	.87	.....	.....	.....	.....	6,830	12,290
10728	76	NW...	23	44	81	11.8	A	23.6	.....	.....	7.8	.68	.....	.....	.....	.....	4,690	8,450
							B	13.4	.....	.....	8.8	.77	.....	.....	.....	.....	5,320	9,580
							C	.....	.....	.....	10.2	.89	.....	.....	.....	.....	6,140	11,050
							D	.....	.....	.....	.....	.99	.....	.....	.....	.....	6,835	12,310
10694	79	SE....	23	44	81	10.4	A	.....	.....	.....	14.6	.56	.....	.....	.....	.....	4,430	7,980
							B	.....	.....	.....	16.3	.62	.....	.....	.....	.....	4,945	8,900
10804	127	NE...	36	43	79	8.1	A	18.8	35.7	37.9	7.6	.57	.....	.....	.....	.....	5,085	9,160
							B	11.7	38.9	41.2	8.2	.62	.....	.....	.....	.....	5,535	9,960
							C	.....	44.0	46.7	9.3	.70	.....	.....	.....	.....	6,265	11,280
							D	.....	48.5	51.5	.....	.77	.....	.....	.....	.....	6,910	12,430
10827	167	.....	20	42	77	9.4	A	23.5	35.6	35.7	5.17	.49	6.50	51.24	0.70	35.90	5,030	9,050
							B	15.5	39.4	39.4	5.71	.54	6.03	56.56	.77	30.39	5,950	9,990
							C	.....	46.6	46.7	6.75	.64	5.08	66.95	.91	19.67	6,570	11,820
							D	.....	49.9	50.1	.....	.69	5.45	71.79	.98	21.09	7,045	12,680
11048	242	SE....	5	37	75	14.3	A	28.1	31.6	35.7	4.62	.45	6.55	48.32	.69	39.37	4,640	8,350
							B	16.1	36.9	41.6	5.39	.53	5.79	56.38	.81	31.10	5,415	9,740
							C	.....	44.0	49.6	6.42	.63	4.77	67.18	.96	20.04	6,450	11,610
							D	.....	47.0	53.0	.....	.67	5.10	71.79	1.03	21.41	6,890	12,410

ESTIMATED TONNAGE.

A bed of coal 1 foot thick and covering an acre of land contains approximately 1,800 tons. The thickness of a coal bed and the amount of land underlain by it being known, it is a simple matter to estimate tonnage except when variable or unknown factors enter the problem. Important among these is the variation in quality and thickness of the coal. In a field like the one under discussion, in which only one edge of the coal bed in any particular basin is exposed at the surface, it is possible, by measuring the bed at numerous places, to determine its thickness and quality and thus to estimate tonnage accurately along the outcrop; but back from the outcrop, where the local variations of the bed are not determined, the estimate of tonnage becomes to some extent theoretical. For such fields the estimates made are moderate and are usually under rather than over the actual amount. It frequently happens that a coal bed is so broken by layers of shale or bone that it is not practical to utilize, even by careful mining, more than a portion of the bed, and the estimates of tonnage are reduced accordingly. The extent of the coal basins in the Sussex field is another fact which can not be determined from surface exposures and probably is much underestimated. There is no reason to suppose that the coal basins are less in extent from east to west than they are from north to south along the outcrop, yet they are so considered simply because the facts are known along the outcrop and are unknown in a direction at right angles to it. The coal beds in basins 2, 3, 4, and 6 of the Sussex field are at about the same stratigraphic positions and, as stated on page 458, probably represent the coal group near Barber post office, 50 miles north of Sussex. If this correlation is correct, the broad area of the Powder River drainage basin between these two places may be and probably is underlain by several more or less extensive coal basins occurring at about the same horizon near the middle of the Fort Union formation and separated from each other by areas containing no coal, but until the area is prospected by the drill no more definite statements can be made.

In estimating the tonnage in the Sussex field the extent of the coal basins was determined arbitrarily. The point at which any particular coal bed reaches its maximum thickness along its outcrop was considered as a center from which the bed thinned not only north and south, but east as well. The rate of thinning along the outcrop from the center to the limits of the basin being known, a corresponding rate was assumed to hold from the center in all directions back from the outcrop, and a curve drawn for each bed limiting its extent. Coal beds under 24 inches in thickness were not considered, the limit of each bed being placed at the line along which the coal fell below that thickness.

The estimates of tonnage for the several coal basins in the Sussex field are given below. As stated on page 47, the outcrop of the coal in basin No. 6 was not traced beyond the limits of T. 37 N., R. 75 W., and T. 38 N., R. 76 W., although it is known to extend far beyond those townships. The estimates given under the head of "Coal basin No. 6," therefore, are estimates for the coal in the two townships mentioned and not for the whole basin.

Estimates of tonnage for the Sussex coal field.

	Short tons.
Coal basin No. 1	9,590,000
No. 2	69,130,000
No. 3	65,450,000
No. 4	644,413,000
No. 5	24,722,000
No. 6 (part only)	95,563,000
	908,868,000

THE LOST SPRING COAL FIELD, CONVERSE COUNTY, WYOMING.

By DEAN E. WINCHESTER.

INTRODUCTION.

The Lost Spring coal field forms the southeastern part of the broad area of coal-bearing strata in northeastern Wyoming, eastern Montana, and the Dakotas, known as the Northern Great Plains

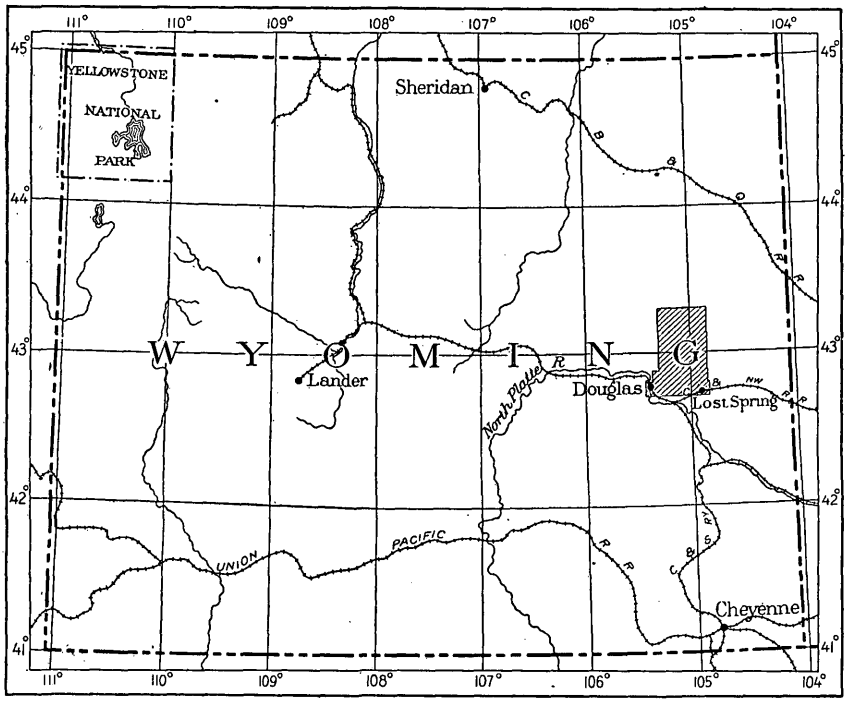


FIGURE 11.—Index map showing location of Lost Spring coal field, Converse County, Wyo.

region. The field, as shown on the map (fig. 11), comprises a rectangular area of about 1,060 square miles lying northeast of Douglas in Converse County, Wyo.

In 1907 E. W. Shaw examined the Glenrock coal field, which lies immediately west of the one discussed in this paper, and the results were published in Bulletin 341 of the United States Geological Survey.

During the season of 1910 V. H. Barnett made an examination of part of the Upper Belle Fourche River coal field, which lies immediately north of the Lost Spring coal field.

In the examination of the Lost Spring field in 1910, the writer was assisted in the field by E. T. Hancock, A. C. Reeds, R. Z. Pierce, and P. E. Brown, each of whom collected data. The work was under the general supervision of A. R. Schultz. Until this examination was made, very little was known concerning the coal resources of eastern Converse County. The examination was made primarily to collect data upon which to classify and value public coal land and therefore it was necessary to locate accurately all coal outcrops, mines, prospects, etc., with reference to section corners. This was done with planetable, telescopic alidade, and stadia rod. Numerous well-marked section corners were found and their location is shown on the maps (Pls. XLIV and XLV). There are in the field a few prospects and mines which afforded an opportunity to study the coal in its unweathered condition and to obtain samples for chemical analysis, but in most of the area very little development work had been done, and it was necessary to prospect beds by digging in order to obtain measurements from which to judge of their thickness and continuity. According to the regulations of the Interior Department, no coal bed in the upper group less than 18 inches thick and none in the lower group less than 29 inches thick was considered valuable. In addition to the detailed examination of the coal beds considerable time was spent in collecting fossils, measuring stratigraphic sections, and gathering other geologic data.

TOPOGRAPHY.

The surface of the Lost Spring field is more or less of a plain, but within the area there is a variety of topographic forms, which are very distinct one from another. Along the southern margin is an area having an undulating surface of moderate relief which is well adapted for farming. Along the eastern margin, where the surface is intricately dissected, stream courses occupy deep valleys with steep, rugged sides. A considerable part of this area of rugged topography is covered with pine trees suitable for railroad ties, fence posts, mine timbers, etc. In the extreme northeastern part of the field the coal along the outcrops of the several beds is burned and the surrounding material baked and fused into clinker, which forms the cap rock to numerous detached buttes and sharp ridges. The Cow Creek Buttes are prominent examples of features of this type. The western part of the field is less minutely dissected, the features are more rounded, and nearly the entire surface is covered with grass, exposures of bedrock being rare.

The elevation of the field varies from about 4,500 feet above sea level along the stream courses in the northeast corner to about 5,700 feet on Flat Top Mountain, in T. 33 N., R. 68 W., but the average relief is as a rule not more than 200 feet in any locality. Although North Platte River crosses the southwest corner of the field, only a small portion of the area is drained by that stream, Shawnee and Lost creeks being its only important tributaries. At least three-fourths of the area is drained by Cheyenne River and its tributaries, Harney, Twenty-mile, Walker, Lightning, Box, and Dry creeks. With the exception of North Platte River, there is no stream in the area which is not dry for a considerable part of the year, but during rainy seasons these streams which are usually dry become impassable for short periods.

A few good springs in the area issue from rocks near the base of the White River formation. The largest and best spring is in sec. 3, T. 33 N., R. 67 W., where a good supply of pure, cool water issues from a coarse sandstone near the base of the White River formation. So far as known to the writer, this spring never runs dry and the water is used by ranchers and herders for miles around. On the north side of Flat Top Mountain several small springs of good water issue from the conglomerate at the base of the White River. Only a few springs originate in the Fort Union formation and these are of small capacity and the water is usually of questionable quality. The best of these are two at the Conner ranch, in sec. 17, T. 33 N., R. 68 W.

Wells drilled in Fort Union rocks have so far developed no good supply of water. Those that have been located in areas in which the White River formation is the surface rock, however, have invariably developed a good supply of excellent water at moderate depths.

The Lost Spring field derives its name from the town of Lost Spring, situated at the junction of the Wyoming & Northwestern Railway with the Chicago & Northwestern Railway, in T. 32 N., R. 67 W. Prior to 1909 the town consisted of a box-car railroad station, store, post office, and blacksmith shop, but since the opening of the coal mines to the north the town has grown rapidly and it seems probable that it will soon become a place of considerable importance. The territory in the immediate vicinity is rapidly being settled by dry-land farmers who are meeting with considerable success in raising potatoes and small grains without irrigation.

Douglas, the only other town in the field, is the county seat of Converse County and has a population of several thousand. It is one of the principal shipping and trading points for a large sheep and cattle producing territory in eastern Wyoming. To the north of these towns several well-established ranches constitute the settlement. The main line of the Chicago & Northwestern Railway

LEGEND

White River formation

Fort Union formation (coal bearing) not patterned

Coal bed continuously exposed
Numbers along beds refer to measured sections

Coal bed concealed location inferred

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

DIAGRAM OF TOWNSHIP

Coal mine
Coal prospect

Strike and dip

Government land corner found

Wagon road and house

Scale 62 500 — 0 1 2 3 Miles

R 68 W — R 67 W

T 34 N — T 33 N — T 32 N R 69 W

TJ Ranch
Harney
Harney Creek mine
Twentymile Cr
Sunset Mine
Rosin mine
Connor's Ranch Spring
Flat Top Mtn
Onyon mine
Abandoned shaft
Lost Spring
C. B. & Q. R. R.
CHICAGO AND NORTHWESTERN R R

DETAILED MAP OF THE SOUTHEASTERN PART OF THE LOST SPRING COAL FIELD. WYOMING

By Dean E Winchester
1912

crosses the field along its southern margin. During the summer of 1910 final surveys were made for the extension of the Chicago, Burlington & Quincy Railroad, connecting its Bighorn Basin line with the Colorado & Southern at Orin Junction. When constructed this new line will pass through Douglas and probably parallel the line of the Chicago & Northwestern Railway from Douglas to Orin Junction.

GEOLOGY.

STRATIGRAPHY.

FORT UNION FORMATION.

The coal-bearing rocks of the Lost Spring field belong to the Fort Union formation, although they have been referred by some previous authors[1] to the Laramie. The base of the formation is not exposed in the field, but the coal zone on Shawnee Creek is probably not over 600 feet above the base. The coal beds of this zone correspond directly to the beds which have been prospected just west of Douglas.

The Fort Union formation is composed of alternating beds of sandstone and shale. The sandstone in many places is very hard and ferruginous, but in others it is massive, white or yellowish in color, and sugary in texture. The sandstone commonly contains large concretion-like masses which, being more resistant than the other part of the bed, weather into natural bridges, dams, balls, and fantastic forms. The shale is usually dark in color, soft, generally sandy but in many places carbonaceous. Coal beds which locally attain commercial importance occur in this formation. In this field two distinct groups of coal beds, separated by 600 to 700 feet of strata, are exposed. The beds of the lower group are lenticular and none attains a thickness of more than 6 feet or extends for more than a few miles, whereas the beds of the upper group are persistent over large areas.

A section of the rocks above the coal beds of the lower zone, measured along the divide between East and West forks of Shawnee Creek, represents the general character of the formation.

[1] Hatcher, J. B., The Ceratops beds of Converse County, Wyo.: Am. Jour. Sci., 3d ser., vol. 45, 1893, p. 140. Trumbull, L. W., Bull. School of Mines, Univ. Wyoming, No. 7, 1905.

Section of part of the Fort Union formation along the divide between the East and West forks of Shawnee Creek, from the base of Flat Top Mountain to the center of sec. 7, T. 32 N., R. 69 W.

	Ft.	in.
Sandstone, hard, brown; contains abundant leaf fragments; weathers to flags 6 by 12 inches, top of ridge		6
Shale, sandy, drab to brown	10	
Sandstone, soft, white, massive	5	
Shale, sandy, drab, with one or two beds of dark-red sandstone	20	
Sandstone, dark brown, hard; weathers to blocks 2 feet square; contains many leaf fragments	1	
Shale, sandy, drab	18	
Sandstone, brown, soft	15	
Shale, drab, with alternating beds of dark reddish-brown sandstone and a few beds of soft yellow sandstone; the reddish-brown sandstone weathers into small flakes, which cover the surface, giving a dark reddish-brown appearance	135	
Sandstone, white, weathering yellow; contains abundant leaf remains (fossils in list D, p. 61)	15	
Shales, drab, gray, and brown, with beds of reddish-brown sandstone at intervals of about 20 feet	205	
Shales, drab and gray, with several beds of reddish-brown sandstone	50	
Coal	2	
Shale and sandstone; considerable carbonaceous matter	140	
Sandstone, gray, soft	4	
Shale and sandstone, brown	20	
Coal	1	4
Shale, clayey, carbonaceous, and gray	11	
Sandstone, white, weathering brown	10	
Shale, sandy, alternating gray, and carbonaceous	17	
Coal, poor	1	10
Shale, sandy, alternating gray, carbonaceous, yellow and reddish brown; dip 8° N	25	
Lowest Fort Union exposed.		
	706	8

The individual beds of the formation are irregular in thickness and character. The formation contains numerous leaf remains, and several fairly good collections were made by F. H. Knowlton and the writer and were reported by the former to be of Fort Union age. A list of fossils is given on pages 481–483.

A section of the Fort Union and underlying beds was measured from the highest beds exposed in Cow Creek Buttes to the mouth of Lance Creek, 20 miles east of the field. This section shows the relation of the various coal beds in the Fort Union formation to the base of the Fox Hills sandstone.

Section from top of East Cow Creek Butte to mouth of Lance Creek.[1]

	Ft.	in.
Fort Union formation:		
Shale, dark, sandy, with thin sandstone	15	
Shale, dark, carbonaceous, sandy	2	3
Bed E: Coal	7	6
Bed E: Shale, brown	2	
Bed E: Coal	2	2
Shale, brown, drab, sandy, with soft shaly sandstone	50	
Sandstone, gray, coarse grained	3	
Shale, drab, with carbonaceous bands	42	
Bed C: Coal	1	6
Bed C: Shale, brown	2	
Bed C: Coal, poor	1	
Shale, sandy, with some sandstone	40	
Shale, coaly	1	
Shale, drab, and soft sandstone	10	
Coal, poor		8
Shale, sandy, and soft sandstone; these beds are irregular and varicolored	33	
Sandstone, gray; weathers dark	4	
Bed B: Coal	3	7
Bed B: Shale, sandy		2
Bed B: Coal	3	11
Shale, brown, and gray sandstone	14	
Shale, brown		8
Sandstone, brown, shaly at top, massive below, soft, white; fossils (I, p. 62) at top; usually covered with pine trees	120	
Shale, soft, sandy, and friable sandstone	400	
Shale, soft, carbonaceous, and soft sandstone (approximately the zone in which the coal beds mined at the Rosin and Harney Creek mines occur)	200	
Shale, soft, sandy, and friable sandstone	320	
Coal, poor	2	
Shale, carbonaceous, drab, sandy, with some thin soft sandstone	400	
Sandstone, friable, yellowish, massive	25	
Coal		4
Shale, carbonaceous		3
Coal		1
Shale, carbonaceous		4
Coal		5
Shale, bony		1
Coal		10
Shale		1
Coal		1
Clay shale, bluish gray	2	4
Sandstone, friable	2	6
Coal		8
Shale, carbonaceous, brownish blue	3	
Shale, carbonaceous, dark, sandy, with a few thin beds of sandstone	200±	
Shale, dark, carbonaceous	40	
	1,957	5±

[1] Measured by V. H. Barnett and D. E. Winchester.

	Ft.	in.
Lance formation:		
Sandstone, yellowish, friable, with some soft light shale (bone fragments at 90 feet below top; Triceratops skull at 180 feet below top; shells at 229 and 250 feet below top)	320	
Shale, sandy, with some hard brown, slightly carbonaceous bands and friable sandstone	147	
Sandstone, massive, friable; shells at base (lists of fossils, P and M, p. 63)	47	
Sandstone, shaly, concretionary	3	
Sandstone, massive, yellowish brown, friable; Trachodon skeleton at base	30	
Shale, dark bluish gray, slightly carbonaceous	7	
Shale, sandy	5	6
Sandstone, massive, yellowish brown	22	
Shale, sandy, bluish gray	6	
Sandstone, friable, yellowish, with soft, sandy light-colored shale	1,150	
Sandstone, friable, massive, concretionary, shaly in places, with some hard brown, slightly calcareous sandstone and a few bands of soft sandy shale; Unios found at top	570	
Shale and sandstone, banded	30	
Sandstone, massive, yellowish brown (fossils in list O, p. 63)	25	
Sandstone, shaly, with some shale	25	
Sandstone and shale; light colors prevailing; fossils near middle (J, p. 62)	120	
Sandstone, massive, yellowish brown, friable	12	
Shale, carbonaceous, sandy, and sandstone, soft	20	
	2,539	6
Fox Hills sandstone:		
Sandstones, yellowish brown, soft, interbedded with sandy, light-colored shale	310	
Shale	355	
Sandstone, hard, rusty brown	3	
Sandstone, massive, yellowish brown, containing numerous shells of Fox Hills sandstone in slightly calcareous concretions (fossils in lists K and L, p. 62)	80	
Below this sandstone the beds grade into the bluish-drab shale of the Pierre formation (fossils, list N, p. 63).		
	748	
	5,244	11±

In the Fort Union formation there are numerous more or less lenticular beds of coal. The outcrop of each coal bed sufficiently thick to be considered valuable is shown on the maps (Pls. XLIV and XLV) and the sections measured along the outcrops are shown graphically in Plates XLVI to XLVIII or given in the text, in the description of coal resources by townships.

U S GEOLOGICAL SURVEY
GEORGE OTIS SMITH DIRECTOR

BULLETIN 471 PLATE XLV

R 70 W. R 69 W R 68 W R 67 W

T 38 N
T 37 N
T 36 N
T 35 N
T 34 N
T 33 N
T 32 N

LEGEND

White River formation

Fort Union formation (coal bearing) not patterned

625 Outcrop of coal bed and reference numbers

Clinker area (result of burning of coal)

Coal mine

Coal prospect

B Point where fossils were collected Letter refers to description

Government land corner found

STRIKE DIP 3° Strike and dip

Wagon road

Dry Cr
Cow Creek Butte
Ferguson's Ranch
Dry Cr
Lightning Cr
Mt Home Ranch
Box C
Lee Moores Ranch
Foy Ranch
Creek
Roy Moores Ranch
Walker
TJ Ranch
Hurrell Cr
HARNEY CREEK MINE
Twentymile Cr
SUNSET MINE
ROSIN MINE
Spr
Connors Ranch
Spr
Flat Top Mtn
CANYON MINE
DOUGLAS
NORTH PLATTE RIVER
C. B. & Q. R. R.
CHICAGO, NORTHWESTERN R. R.
Shamrock Cr
Lost Cr
Lost Spring

MAP OF THE LOST SPRING COAL FIELD, WYOMING

By Dean E Winchester

Scale 1/125000

1 0 1 2 3 4 5 Miles

1912

WHITE RIVER FORMATION.

Unconformably overlying the Fort Union formation is a mass of light-colored clay, soft cross-bedded sandstone, and coarse conglomerate, of White River (Oligocene) age. A collection of bones, which contains specimens of Titanotherium, Stylemys (turtle), and Merycododon (Oreodon), was obtained by F. H. Knowlton and the writer in sec. 35, T. 32 N., R. 71 W. (See list of fossils, A, p. 481.) With the exception of the Titanotherium, the fossils belong to the Brule, the upper formation of the White River group. These fossils were obtained from a bed of clay, which is probably not far above the base of the formation. A section of the beds above the clay is as follows:

Section of White River formation measured in sec. 35, T. 32 N., R. 71 W.

	Feet.
Conglomerate; contains large pebbles, some 7 inches in diameter..	20
Clay, drab, with some sandstone.....	48
Conglomerate, heavy bedded, composed of irregular fragments of quartz and some feldspar.....	12
Clay, drab	60
Conglomerate, coarse, massive, cross-bedded.....	5
Clay, drab	58
	203

The section given above represents in general the character of the material. The individual beds of the formation are very irregular in thickness and character. The conglomerates at other localities contain partly rounded bowlders of all sizes up to 12 inches in diameter. The lowest bed of clay, in some parts of the field, is light green and pink in color, but the whole formation usually has a very light gray aspect.

Dips from 1° to 22° were observed near the northern boundary of the formation, but these are thought by the writer to be entirely depositional, as no conclusive evidence was found suggesting deformation since the beds were laid down.

The coarse conglomerate that forms the uppermost bed in the section given above is the cap rock of a long series of buttes and narrow ridges which extend across the field just south of the northern boundary of the main mass of White River formation. There seems to be a gradual change in the composition of this conglomerate from west to east. In the vicinity of Platte River fragments are larger and more angular, whereas to the east the material appears to be better sorted and the pebbles of smaller size.

The following section of the beds exposed in the north side of Flat Top Mountain was measured by A. R. Schultz and T. W. Stanton;

Section of White River formation on north side of Flat Top Mountain.

	Feet.
Limestone, light gray, partly filled with calcite crystals (secondary replacement)	1
Shale, green	10
Limestone, light gray	2
Shale, green	25–30
Clay, green, and shale (lower part red to pink)	20–40
Sandstone, yellowish gray, loosely cemented, conglomeratic at base; pebbles in places angular with shale fragments; base of White River formation	50–75
	108–158

The White River formation occupies a considerable territory along the southern border of the field, together with several small isolated areas, the largest of which is Flat Top Mountain. In the vicinity of the Onyon coal mine, in the southeast part of T. 33 N., R. 68 W., erosion has removed the formation and exposed the coal-bearing rocks below. In excavating for a mine tipple in sec. 36, T. 33 N., R. 68 W., the contact between the Fort Union and overlying rocks was unusually well exposed. The dark sandy shale of the older formation exhibits a dip of 5° NW., and lying across its upturned edges is a well-cemented conglomerate 4 feet thick, containing rounded pebbles, some of which are 2 inches in diameter, and dipping slightly to the south. At this location the White River formation is represented by about 300 feet of white clay, coarse sandstone, and conglomerate.

N. H. Darton [1] gives a map, which includes the area described in this report, on which is shown the areal distribution of the White River formation approximately as determined by the present investigation. Just north of Lost Spring and extending westward to Shawnee Creek and eastward beyond the limits of the field he shows a narrow band of granite and schists of Algonkian age. Evidently the coarse conglomerate of the White River formation which caps the prominent ridge in this vicinity was mistaken for the older rocks; although these beds, even at a distance, bear very little resemblance to the type of rocks indicated on Darton's map.

TERRACE GRAVEL.

Along the divide between the drainage ways in the southern part of the field there occurs a thin veneer of gravel comprising well-rounded bowlders as much as 8 inches in diameter and a greater number of small pebbles of varying composition. One of the bowlders taken from the divide between Harney and Twentymile creeks in T. 34 N., R. 67 W., contained fossils which were identified

[1] Preliminary report on the geology and underground water resources of the central Great Plains: Prof. Paper U. S. Geol. Survey No. 32, 1905.

by G. H. Girty as early Mississippian (fossil collection Q, p. 483). These bowlders appear to have been transported at least 75 miles, as the nearest exposed rocks of early Mississippian age are in the Bighorn and Casper mountains to the west and in the Black Hills to the northeast.

FOSSILS.

A. Sec. 2, T. 31 N., R. 71 W. Identified by J. W. Gidley. From clay bed at base of buttes.
Hyracodon nebrascensis.
Merycoidodon culbertsoni.
Merycoidodon gracilis, Chadron and Brule formations of the White River group.
Mesohippus bairdi.
Stylemys nebrascensis.
Titanotherium sp.

B. Sec. 6, T. 32 N., R. 71 W. Identified by F. H. Knowlton. From roof of coal prospect No. 1.
Leguminosites arachioides.
Grewia alastroides.
Populus amblyrhyncha.
Sapindus sp.
Fort Union.

C. Sec. 10, T. 32 N., R. 69 W. Identified by F. H. Knowlton. From brown sandstone, less than 50 feet above coal bed.
Taxodium occidentale.
Fragments of dicotyledons.
A Fort Union species.

D. Sec. 35, T. 33 N., R. 69 W. Identified by F. H. Knowlton. From soft gray massive sandstone 435 feet above coal prospected on Shawnee Creek.
Taxodium occidentale.
Sequoia nordenskioldi.
Populus amblyrhyncha.
Populus sp.
Platanus haydenii.
Zizyphus sp.
Fort Union.

E. Sec. 35, T. 33 N., R. 68 W. Identified by F. H. Knowlton. From dump at Onyon mine. Fossils come from shale over coal.
Sequoia nordenskioldi.
Glyptostrobus europæus.
Celastrus ovatus.
Populus amblyrhyncha.
Sapindus grandifoliolus?
Platanus? sp.
Fort Union.

F. Sec. 14, T. 33 N., R. 68 W. Identified by F. H. Knowlton. From brown sandstone on top of high hill above coal mined at Rosin mine.
Onoclea sensibilis fossilis.
Sapindus grandifoliolus.
Fort Union.

G. Sec. 35, T. 34 N., R. 68 W. Identified by F. H. Knowlton. From massive soft white sandstone 40 feet above coal at Sunset mine.
Sequoia nordenskioldi.
Sapindus affinis.
Ginkgo adiantifolia.
Platanus raynoldsii.
Populus amblyrhyncha.
Grewiopsis populifolia.
Zizyphus? sp.

H. Sec. 26, T. 34 N., R. 68 W. Identified by F. H. Knowlton. From brown sandstone above coal mined at Sunset mine.
Platanus haydenii.
Leguminosites arachioides.
Laurus sp.
Sapindus grandifoliolus.
Fort Union.

I. Sec. 19, T. 38 N., R. 68 W. Identified by F. H. Knowlton. From brownish sandstone below coal bed at base of Cow Creek Buttes (p. 477).
Platanus haydenii.
Populus amblyrhyncha.
Sapindus sp.
Fort Union.

J. Sec. 32, T. 39 N., R. 62 W. Identified by F. H. Knowlton. From yellow sandstone in lower part of Lance formation (Lance Creek section, p. 478).
Sapindus obtusifoliolus Ward.
Fragment.
Fort Union?

K. Sec. 36, T. 38 N., R. 62 W. Identified by T. W. Stanton. From Fox Hills sandstone (Lance Creek section, p. 478).
Veniella humilis M. and H.
Protocardia subquadrata E. and S.
Dentalium gracile H. and M.
Fasciolaria? sp.
Scaphites conradi (Morton).
Sphenodiscus lenticularis (Owen).
Fox Hills.

L. Sec. 1, T. 39 N., R. 62 W. Identified by T. W. Stanton. From Fox Hills sandstone (Lance Creek section, p. 478).
Avicula nebrascana E. and S.
Avicula fibrosa M. and H.?
Modiola sp.
Veniella humilis M. and H.
Sphæriola cordata M. and H.
Protocardia subquadrata E. and S.
Tellina scitula M. and H.
Cuspidaria? sp.
Corbula sp.
Pholadomya subventricosa M. and H.?
Haminea sp.
Scaphites conradi (Morton).
Fox Hills.

M. Sec. 36, T. 39 N., R. 65 W. Identified by T. W. Stanton. From sandstone near top of Lance formation (Lance Creek section, p. 478).
Sphærium sp.
Campeloma multilineata M. and H.
Viviparus? sp.
Lance.

N. Sec. 31, T. 40 N., R. 61 W. Identified by T. W. Stanton. From drab shale in transition zone at base of Fox Hills sandstone (Lance Creek section, p. 478).
Lingula sp.
Leda evansi M. and H.
Entalis paupercula M. and H.
Probably Fox Hills.

O. Sec. 30, T. 39 N., R. 62 W. Identified by C. W. Gilmore. Sandstone in lower part of Lance formation (Lance Creek section, p. 478).
Tooth of Triceratops.
Fragment of the carapace of a soft-shelled turtle, probably belonging to the genus Aspiderates.

P. Sec. 31, T. 40 N., R. 64 W. Identified by T. W. Stanton. Near top of Lance formation (Lance Creek section, p. 478).
Unio sp.
Sphærium sp.
Tulotoma thompsoni White.
Campeloma multilineata M. and H.
Lance.

Q. From bowlder taken from divide between Harney and Twentymile creeks. Identified by G. H. Girty.

"The species represented are *Schuchertella inequalis*, Spirifer sp., and Lithodomus? sp. There can be little doubt that the geologic age of these fossils is early Mississippian. Similar material occurs in place in the Leadville limestone of Leadville, Colo., and in the Millsap limestone of Colorado. The same fauna, though more variously represented, has been found northwest of Greeley, Larimer County, Colo., in somewhat similar geologic relations. That is, it was collected from pebbles in a conglomerate which, as I suppose, forms part of the red beds."

STRUCTURE.

The coal fields of northeastern Wyoming form part of a broad structural basin known as the Powder River basin, the main axis of which trends north-south. Around the edges of the basin are outcrops of numerous coal beds which attain considerable thickness. The Lost Spring field is located at the southeastern extremity of the basin and embraces parts of the southern and eastern margins. In the vicinity of Douglas the coal-bearing rocks at their outcrop dip as much as 15° N., but at the Onyon coal mine, in sec. 35, T. 33 N., R. 68 W., the coal bed dips 5° N. 45° W. Near the head of Harney Creek dips of 10° are present, and at the eastern edge of the field, in sec. 13, T. 34 N., R. 67 W., Fort Union rocks dip as much as 25° and strike approximately N. 45° E. These rather steep dips occur along the outcrop of the lower coal group, but the beds assume a nearly horizontal position within a mile back from this outcrop and preserve this attitude under the major portion of the field.

At the northeastern corner of the area the rocks strike nearly north-south and dip only slightly to the west. This generally regular basin structure is slightly disturbed near the junction of the two forks of Twentymile Creek, in the eastern part of T. 34 N., R. 68 W., by a slight anticlinal flexure, and local dips of as much as 5° are evident.

This structural basin was probably completely formed and subsequent erosion well progressed before the White River formation was laid down. The present distribution of this formation does not conform to the basin structure, but the beds constitute a comparatively thin mantle which overlaps the southern margin of the Fort Union rocks. There is no evidence of deformation since the deposition of the White River formation.

THE COAL.

CHARACTER.

All of the coal which is exposed in the Lost Spring field belongs to the Fort Union formation but may be divided into two groups. The lower group, composed of somewhat inferior coal beds which occur in lenticular masses, outcrops along the south and east margins of the field. All of the development in the field has taken place on coal beds of this group. The upper group, composed of thicker, more persistent beds, outcrops in and west of Cow Creek Buttes in the northern part of the field. A single analysis (sample No. 11447) of coal from the upper group gave a heat value of 10,100 British thermal units on the air-dried sample, whereas the analysis of the best coal of the lower group gave only 9,260 British thermal units.

The coal of this region has been referred to as lignite by most writers, but under the present scheme of classification of the United States Geological Survey it should be termed subbituminous. A fresh sample of the coal is bright, black, hard, and usually very homogeneous. On being exposed to a dry atmosphere for a short time the surface cracks and the coal gradually breaks up into small angular, irregular fragments. However, a large lump may develop a thin outer coating of weathered coal and the interior remain practically unaltered. This characteristic of breaking down on weathering has a serious effect upon the marketability of the coal and serves to distinguish it from bituminous coal. The coal commonly contains aggregations of resin as large as walnuts.

Samples for analysis were obtained from the various coal mines which were being opened and from prospects where no mines had been opened. Conditions of sampling are described on page 487. The analyses are given in the following table:

Chemical analyses of coal samples from Lost Spring and near-by fields, Wyoming.

[A. C. Fieldner and F. M. Stanton, chemists in charge.]

Laboratory No.	No. on maps and sections.	Location.				Thickness of coal bed.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heat value.	
		Quarter.	Sec.	T. N.	R. W.				Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
						Ft. in.													
10711	47	NW...	11	32	69	4 2	7.6	A	24.8	32.9	36.5	5.8	1.18	.....	.....	.....	.....	4,610	8,300
								B	18.6	35.6	39.5	6.3	1.28	.....	.....	.....	.....	4,990	8,980
								C	.....	43.7	48.5	7.8	1.57	.....	.....	.....	.....	6,135	11,040
								D	.....	47.4	52.6	.....	1.70	.....	.....	.....	.....	6,650	11,970
10740	242	SW...	36	33	68	5 9	10.0	A	27.9	27.1	36.7	8.29	.89	6.25	47.47	0.80	36.30	4,405	7,930
								B	19.9	30.1	40.8	9.21	.99	5.71	52.74	.89	30.46	4,895	8,810
								C	.....	37.6	50.9	11.50	1.23	4.37	65.85	1.11	15.94	6,110	11,000
								D	.....	42.4	57.6	.....	1.39	4.94	74.40	1.25	18.02	6,905	12,430
10775	427	SE....	35	34	68	5 1	15.7	A	27.6	26.7	35.7	9.99	1.03	6.26	45.75	.68	36.29	4,340	7,810
								B	14.2	31.7	42.3	11.85	1.22	5.36	54.27	.81	26.49	5,145	9,260
								C	.....	36.9	49.3	13.81	1.42	4.42	63.24	.94	16.17	5,995	10,790
								D	.....	42.8	57.2	.....	1.65	5.13	73.37	1.09	18.76	6,955	12,520
10835	419	NE...	35	34	68	5 3½	9.7	A	24.0	28.4	34.9	12.7	.61	.....	.....	.....	.....	4,270	7,680
								B	15.9	31.5	38.6	14.0	.67	.....	.....	.....	.....	4,725	8,510
								C	.....	37.4	45.9	16.7	.80	.....	.....	.....	.....	5,620	10,110
								D	.....	44.9	55.1	.....	.96	.....	.....	.....	.....	6,740	12,140
10911	33	SW...	13	34	67	5	16.6	A	29.9	28.1	34.7	7.3	.79	.....	.....	.....	.....	4,260	7,660
								B	15.9	33.7	41.6	8.8	.95	.....	.....	.....	.....	5,105	9,190
								C	.....	40.0	49.5	10.5	1.13	.....	.....	.....	.....	6,070	10,930
								D	.....	44.7	55.3	.....	1.26	.....	.....	.....	.....	6,780	12,210
11447	650	SE....	8	37	68	4 3	16.8	A	27.8	29.4	38.5	4.3	.27	.....	.....	.....	.....	4,675	8,410
								B	13.2	35.3	46.3	5.2	.33	.....	.....	.....	.....	5,615	10,110
								C	.....	40.7	53.4	5.9	.37	.....	.....	.....	.....	6,470	11,650
								D	.....	43.2	56.8	.....	.39	.....	.....	.....	.....	6,880	12,380
5318	5	NE...	7	32	71	1 10	4.3	A	22.9	42.6	22.3	12.2	.58	.....	.....	.....	.....	4,070	7,330
								B	19.5	44.5	23.2	12.8	.61	.....	.....	.....	.....	4,255	7,660
								C	.....	55.3	28.9	15.8	.75	.....	.....	.....	.....	5,280	9,510
								D	.....	65.7	34.3	.....	.89	.....	.....	.....	.....	6,275	11,300

Chemical analyses of coal samples from Lost Spring and near-by fields, Wyoming—Continued.

Laboratory No.	No. on maps and sections.	Location.				Thickness of coal bed.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heat value.	
		Quarter.	Sec.	T. N.	R. W.				Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
						Ft. in.													
5326	.....	.....	25	34	77	4 8	4.2	A	22.9	33.9	36.7	6.5	0.97	.....	.....	.....	.....	4,955	8,920
								B	19.5	35.4	38.3	6.8	1.01	.....	.....	.....	.....	5,175	9,310
								C	.....	43.9	47.6	8.5	1.26	.....	.....	.....	.....	6,425	11,570
								D	.....	48.0	52.0	.....	1.37	.....	.....	.....	.....	7,020	12,640
6712	Indian mine, Hudson, Wyo.....					?	11.6	A	21.3	32.8	42.8	3.15	.89	6.13	55.91	0.75	33.17	5,435	9,780
								B	10.9	37.1	48.4	3.56	1.01	5.48	63.25	.85	25.85	6,145	11,060
								C	.....	41.7	54.3	4.00	1.13	4.79	71.02	.95	18.11	6,900	12,420
								D	.....	43.4	56.6	.....	1.18	4.99	73.98	.99	18.86	7,190	12,940
5386	Monarch mine.		19	57	84	?	8.4	A	21.4	35.4	40.0	3.2	.31	.....	.....	.....	.....	5,365	9,660
								B	14.2	38.6	43.7	3.5	.34	.....	.....	.....	.....	5,860	10,550
								C	.....	45.0	50.9	4.1	.39	.....	.....	.....	.....	6,825	12,290
								D	.....	46.9	53.1	.....	.41	.....	.....	.....	.....	7,120	12,810

NOTE.—Analyses Nos. 5326, 6712, 5386, and 5318, inserted for comparison, were made of samples taken from adjacent fields.

Sample No. 10711.—This sample was taken from an abandoned prospect (No. 47) in sec. 11, T. 32 N., R. 69 W., known locally as Fred Haynes's prospect. Considerable coal had been removed during the previous year, and the face of the coal from which the sample was taken was only slightly weathered. The workings consisted of a well-timbered main entry about 60 feet long, with a second entry about half the length of the first and parallel to it. The sample was taken near the end of the main entry, where the coal bed measures 4 feet 2 inches thick. The sample was dry but slightly weathered.

Sample No. 10740.—Onyon mine (No. 242) of Lost Spring Coal Co., in sec. 36, T. 33 N., R. 68 W. The sample was taken from room 15 off first entry, about 1,800 feet from the mine mouth and under about 180 feet of cover. The coal was fresh. The mine has considerable water; in August, 1910, about 1,200 gallons was being pumped from it daily. At the place sampled the coal bed has a thickness of 5 feet 9 inches. The sample was somewhat wet.

Sample No. 10775.—Rosin mine (No. 427) of Rosin Coal Co., in sec. 35, T. 34 N., R. 68 W. This sample was taken from the end of first left entry, 200 feet off the main entry. The coal was taken from a fresh-working face and was free from weathering. Sample was dry.

Sample No. 10835.—Sunset mine (No. 419) of Sunset Coal Co., in sec. 35, T. 34 N., R. 68 W. This sample was taken from the end of the main entry, about 500 feet from the mouth of the mine. No work was being done in the entry from which the sample was taken, but the coal was very little weathered. This bed is the same as that being worked in the Rosin mine. Sample was dry.

Sample No. 10911.—Harney Creek mine (No. 33) of Harney Creek Coal Co., in sec. 13, T. 34 N., R. 67 W. The sample was taken from the end of the main entry about 80 feet from the opening. The mine was just being opened at the time of examination. Work had progressed far enough so that the coal was nearly free from weathering. The mine was dry and the coal was hard and bright.

Sample No. 11447.—This sample was taken from a strip pit (No. 650) in sec. 8, T. 37 N., R. 68 W., from which a near-by rancher had obtained coal during previous winters. The coal bed lies beneath a heavy sandstone and is fairly well protected. The face of the coal was cleaned by removing about 3 feet before sampling. The coal was somewhat weathered and rather wet but hard and bright. The bed from which the sample was taken belongs in the upper group of coal beds, which is exposed in the northern part of the field. At the place sampled the bed consists of clear coal 4 feet 3 inches thick.

Sample No. 5318.—Old prospect No. 5 in NW. ¼ NE. ¼ sec. 7, T. 32 N., R. 71 W. This sample was taken by E. W. Shaw, in 1907, from an abandoned prospect, at a point 70 feet from the mouth of the opening, where the coal bed has a thickness of 1 foot 10 inches of good coal. (Published in Bull. U. S. Geol. Survey No. 341, 1909.)

Sample No. 5326.—This sample was taken from the Big Muddy mine of the Cole Creek Coal Co., in sec. 25, T. 34 N., R. 77 W., Wyo., by C. T. Lupton, in 1907. At a point 960 feet down the slope, where the sample was obtained, the coal bed measured 4 feet 8 inches in thickness. (Published in Bull. U. S. Geol. Survey No. 341, 1909.)

Sample No. 6712.—This sample was taken from the Indian mine of the Hudson Coal Co., in sec. 2, T. 2 S., R. 2 E., Wind River meridian. The sample was taken from No. 3 west entry, off the main slope about 600 feet from the mouth, where the coal is under sufficient cover to protect it from alteration. The coal was dry. Sampled by E. G. Woodruff. (See pp. 533, 535.)

Sample No. 5386.—Sheridan coal. This sample was taken 3,000 feet from the mouth of the main entry of the Monarch mine of the Wyoming Coal Co., in sec. 19, T. 57 N., R. 84 W., Wyo. The coal bed at the point of sampling measured 18 feet in thickness. The coal was dry and unweathered. (Taff, J. A., Bull. U. S. Geol. Survey No. 341, 1909, p. 135.)

Analyses Nos. 10711, 10740, 10775, 10835, 10911, and 11447 were made at the Pittsburgh laboratory of the Bureau of Mines.

In the table the analyses are given in four forms, marked A, B, C, and D. Analysis A represents the composition of the sample as it comes from the mine. This form is not well suited for comparison, because the amount of moisture in the sample as it comes from the mine is largely a matter of accident, and consequently analyses of the same coal expressed in this form may vary widely. Analysis B represents the sample after it has been dried at a temperature a little above the normal until its weight becomes constant. This form of analysis is best adapted to general comparisons. Analysis C represents the theoretical condition of the coal after all the moisture has been eliminated. Analysis D represents the coal after all moisture and ash have been theoretically removed. This is supposed to represent the true coal substance, free from the most significant impurities. Forms C and D are obtained from the others by recalculation. They should not be used in comparison, for they represent theoretical conditions that never exist.

In the analytical work chemists generally recognize that it is not possible to determine the proximate constituents of coal or lignite with the same degree of accuracy as the ultimate constituents. Therefore the air-drying loss, moisture, volatile matter, fixed carbon, and ash are given to one decimal place only, whereas the ash (in an ultimate analysis), sulphur, hydrogen, carbon, nitrogen, and oxygen are given to two decimal places. It is also understood that calorific determinations to individual units are not reliable; therefore in the column headed "Calories" the heat values are given to the nearest five units, and in the column headed "British thermal units" they are given to the nearest tens (the value of a British thermal unit being about one-half that of a calorie).

MARKET.

Until late in 1910 practically no coal had been shipped from the Lost Spring field. What little had been mined was used in Douglas and Lost Spring and by the few ranchers who inhabit the region.

The coal makes a fair domestic and steam fuel but on account of its rapid disintegration on weathering is not suitable for shipment to great commercial centers. Coal of the general type found in this field has been used for locomotives on the Chicago, Burlington & Quincy Railroad for many years, but until November, 1910, the Chicago & Northwestern had shipped coal for its engines from the fields of the Middle West. This railroad, however, has recently installed a large number of "lignite-burning" freight engines on its Wyoming branch, and this should furnish a market for a large quantity of coal from the Lost Spring field. In supplying locomotive coal the oper-

ators in this field will have to compete with coal from Glenrock, Inez, Hudson, and other near-by mines, but there seems to be no reason why a large quantity of the coal used by the Chicago & Northwestern Railway between Lost Spring, Wyo., and Omaha, Nebr., should not come from mines in the Lost Spring field.

There is a growing local demand for the coal among the ranchers and dry-land farmers as well as residents of the towns near by. It makes a very good domestic fuel if used soon after mining. Shipment of the coal to distant towns is almost out of the question, for even with the most careful handling in closed box cars the coal becomes greatly weathered and air-slacked. Experiments have proved that it is impossible to ship this coal more than 400 or 500 miles and still dispose of it profitably as a steaming and domestic fuel.

AVAILABLE COAL.

In computing the amount of available coal in the Lost Spring field only lands which are known to be underlain by coal of sufficient thickness to be classified as coal land by the Survey were considered. As explained in the discussion of the character of the coal in this field (p. 484), there are two distinct groups of beds, which differ in the quality of the coal they contain as well as in extent. Coal beds of the lower group were found to be very lenticular and of such quality that a thickness of 29 inches of coal was determined to be necessary in order to classify land underlain by it as coal land. Coal beds of the upper group were found of better quality and more persistent, so that a bed of only 18 inches of coal was assumed to be classifiable.

In calculating the tonnage of any lens of coal its area was determined and the average of the several measurements along its outcrop was assumed to represent the average thickness of the bed. The total content of the lens was determined by multiplying the area in square miles by the average thickness in feet, and this by 1,152,000. The last figure represents the number of short tons of coal having a specific gravity of 1.3 contained in a bed 1 foot thick over an area of 1 square mile. This procedure gave the following figures: Coal in beds of lower group, 140,993,604 tons; coal in beds of upper group, 1,295,924,270 tons; total coal represented by lenses outcropping in the field, 1,436,917,874 tons.

Inasmuch as it is very probable that there are numerous other areas in which coal beds attain a thickness sufficient to classify, but which do not show such thickness at the outcrop, it is safe to assume that the above figure represents possibly not more than two-thirds of the actual tonnage of the field, and that a nearer estimate of the total coal in the Lost Spring field is 2,155,376,000 short tons.

DESCRIPTION BY TOWNSHIPS.

In the detailed description of the coals and their development in the Lost Spring field the area is considered by townships from west to east, each tier of townships being treated in order from south to north. The outcrops of the various coal beds exposed in the field are shown on the maps. On the plates the sections are arranged according to beds, so that the measurements taken along a single coal outcrop appear together.

Coal beds of the lower group are not persistent and attain only local importance; therefore it was deemed inadvisable to refer to them by name. Beds of the upper group, however, are of considerable thickness at many places along their outcrop; they are named A, B, C, D, and E, A being the lowest and E the highest exposed in the group.

T. 32 N., R. 71 W.—Fort Union coal-bearing rocks are exposed only in the two northern tiers of sections of this township. (See Pls. XLV and XLVII.) The remainder is covered by the White River formation. The rocks dip about 15° N. where the coal is exposed but assume a nearly horizontal position a short distance to the north. A single bed of coal is exposed in the hills west of North Platte River. Several abandoned prospects were noted along the bed, but the thinness of the bed has prevented extensive mining. The maximum thickness observed is 24 inches (location 4). At location 1 a slope has been driven about 75 feet down the dip on a bed which shows the following section:

Section of coal bed at location 1, sec. 6.

	Inches.
Shale, carbonaceous, with streaks of coal	11
Coal	3
Shale	2
Coal, impure	10
Shale, carbonaceous.	
Total coal	13

At location 2 a prospect has been driven about 100 feet on the same bed and a maximum thickness of 20 inches was found. The thicknesses at locations 3 and 4, in sec. 6, are shown graphically on Plate XLVII. At location 5 an entry about 200 feet long has been driven but abandoned, probably because of the small thickness of the bed. In 1907 E. W. Shaw took a sample from the prospect at location 5, the analysis of which is given in the table on page 485 (No. 5318). A description of the sample is given on page 487. This prospect is one of the oldest in the Lost Spring field.

T. 32 N., R. 70 W.—Fort Union rocks in this township dip 3° to 10° N., whereas the White River formation, which occupies the southern two-thirds of the area, shows a depositional dip to the south. No bed of coal was found to outcrop in this township, although numer-

ous carbonaceous beds were found which belong in the same group as the coal bed in T. 32 N., R. 71 W., described above.

T. 32 N., R. 69 W.—North of the limit of the White River formation, in secs. 3, 9, 10, 11, and 12, there are exposed a number of lenticular beds of coal in the Fort Union formation (Pls. XLIV and XLVII). These dip 3° to 7° N. at their outcrop but assume a nearly horizontal position within a short distance. In that portion of the township which lies adjacent to Shawnee Creek there are several beds of coal exposed in a stratigraphic distance of about 100 feet. The coal beds range in thickness up to 56 inches and as a rule are traceable for only short distances. However, the outcrop of one bed was followed from near the center of sec. 9 eastward across secs. 10, 11, and 12 and into the township to the east, and its thickness was found to vary from 13 inches to 56 inches. This is the only bed in the township which has attracted the attention of prospectors. The maximum thickness was found at an old prospect in the bed of Shawnee Creek (location 25) which was caved in so that it was impossible to determine the extent of the workings, but the entry had been driven at least 50 feet along the strike of the bed. Farther to the east (location 47) a second prospect has been driven recently on the same bed. This opening, known locally as the Fred Haynes prospect, consisted in July, 1910, of an entry about 65 feet long with a back entry about half that length. Coal had evidently been removed during the winter of 1909–10 and the entries were fairly clean. Sample No. 10711 was taken from a slightly weathered surface and the analysis of it is given on page 485. As shown by sections Nos. 8, 13, 17, 18, 24, 25, 40, 42, 45 to 48, 54, 56*a*, 70, 72, and 73, this bed of coal is variable, ranging in thickness from 1 foot 1 inch to 4 feet 8 inches.

Several thinner coal beds outcrop at various places in the township, but none attain importance for any great distance. Sections Nos. 15, 20, 21, 27, and 43 were measured along a bed which attains a maximum thickness (as shown by the graphic sections) of 4 feet 2 inches. In sec. 12 a bed represented by sections Nos. 69, 74, and 75 attains sufficient thickness to be important, whereas westward along its outcrop only thin coal is present. At locations 39 and 56, in sec. 11, and at location 68, in sec. 12, beds of coal are present which are sufficiently thick to come within the limit of classifiable coal as determined by the Geological Survey. The accompanying section shows the stratigraphic relation of the various coal beds and gives the numbers of the sections measured along each.

Section showing the stratigraphic relation of coal beds in T. 32 N., R. 69 W.

	Feet.
Coal: Sections Nos. 6, 10, 14, 44.	
Interval	15
Coal: Sections Nos. 7, 11, 12, 15, 20, 21, 27, 43.	
Interval	10
Coal: Sections Nos. 16, 19, 22, 26, 41, 71.	
Interval	10
Coal: Sections Nos. 8, 9, 13, 17, 18, 23–25, 40, 42, 45–48, 54, 55, 56a, 60, 61, 70, 72, 73.	
Interval	15
Coal: Sections Nos. 38, 39, 49–51, 53, 59, 62, 69, 74, 75.	
Interval	50
Coal: Sections Nos. 52, 58, 63, 68, 76.	
Interval	50
Coal: Sections Nos. 64, 67.	
Interval	50
Coal: Sections Nos. 56, 57, 65, 66, 77.	

Sections Nos. 28 to 37 are on lower local beds the stratigraphic position of which was not determined. Sections not represented graphically on Plate XLVII are given below:

Sections of coal beds in T. 32 N., R. 69 W., in addition to those shown on Plate XLVII.

No. on map.	Location.	Section.	Inches.
6	NW. ¼ sec. 9..	Shale, brown.	
		Coal, impure	15
		Shale, brown.	
7	NE. ¼ sec. 9...	Shale, brown.	
		Coal	3½
		Shale, brown	8
		Coal	12
		Shale, brown.	
			23½
8	NE. ¼ sec. 9...	Shale.	
		Coal	13
		Shale, brown.	
9	NE. ¼ sec. 9...	Shale, brown.	
		Coal, impure	21
		Shale, brown.	
10	NW. ¼ sec. 10..	Shale, brown.	
		Coal	14
		Shale, brown.	
11	NW. ¼ sec. 10..	Shale, brown.	
		Bone	2
		Coal, impure	15
		Shale, brown.	
			17
12	NW. ¼ sec. 10..	Shale, yellow.	
		Coal, impure	10
		Shale, brown.	
14	NW. ¼ sec. 10..	Shale, carbonaceous.	
		Coal	12
		Shale, brown.	
16	NW. ¼ sec. 10..	Shale, gray.	
		Coal	24
		Shale, brown.	
19	NW. ¼ sec. 10..	Shale, brown.	
		Coal	12
		Shale, brown.	
22	NE. ¼ sec. 10..	Shale.	
		Coal	16
		Shale, brown.	
23	NW. ¼ sec. 10..	Shale, brown.	
		Coal	33
		Shale, brown.	
26	NE. ¼ sec. 10..	Coal	10
		Shale, brown	10
		Coal	12
		Shale, brown.	
			32
28	NE. ¼ sec. 10..	Shale, brown.	
		Coal	8
		Shale, brown.	
29	NE. ¼ sec. 10..	Shale, brown.	
		Coal	8
		Shale, brown.	
		Coal	6
30	NE. ¼ sec. 10..	Shale, brown	30
		Coal	20
		Shale, sandy.	
			56
31	NE. ¼ sec. 10..	Shale, brown.	
		Coal	17
		Shale, brown.	
32	NW. ¼ sec. 11..	Shale, yellow.	
		Coal	21
		Shale, brown.	
33	NW. ¼ sec. 11..	Shale, brown.	
		Coal, impure	10
		Shale, brown.	
34	NW. ¼ sec. 11..	Gravel.	
		Coal	13
		Shale.	
35	NW. ¼ sec. 11..	Shale, brown.	
		Coal	17
		Shale, brown.	
36	NW. ¼ sec. 11..	Shale.	
		Coal	13
		Shale, brown	30
		Coal, impure	14
			57
37	NW. ¼ sec. 11..	Shale.	
		Coal	10
		Shale	33
		Coal	20
			63
38	NW. ¼ sec. 11..	Shale, brown.	
		Coal	12
		Shale, brown.	
44	NW. ¼ sec. 11..	Shale, brown.	
		Coal, shaly	13

Sections of coal beds in T. 32 N., R. 69 W., in addition to those shown on Plate XLVII—Continued.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
			Inches.				*Inches.*
		Shale, brown.				Shale, brown.	
		Coal	12			Coal	36
49	NW. ¼ sec. 11.	Shale, brown	28	60	NE. ¼ sec. 11.	Shale, brown.	
		Coal, impure	10			Shale, brown.	
		Shale, brown.				Coal	34
			50	61	NW. ¼ sec. 12.	Shale, brown.	
		Shale, brown.				Shale, brown.	
		Coal	14			Coal	17
50	NW. ¼ sec. 11.	Shale, brown.		62	NW. ¼ sec. 12.	Shale, brown.	
		Shale, brown.				Shale, brown.	
		Coal	24			Coal	14
51	NW. ¼ sec. 11.	Shale, brown.		63	NW. ¼ sec. 12.	Shale, brown.	
		Shale, brown.				Shale, brown.	
		Coal	12			Coal	16
		Shale, brown	60	64	NW. ¼ sec. 12.	Shale, brown.	
52	NW. ¼ sec. 11.	Coal	17			Shale, brown.	
		Shale, brown.				Coal	24
			89	65	NW. ¼ sec. 12.	Shale, brown.	
		Shale, brown.				Shale, brown.	
		Coal	7			Coal	18
		Shale, brown	7	66	NE. ¼ sec. 12.	Shale, brown.	
53	NE. ¼ sec. 11.	Coal	11			Shale, brown.	
		Shale, brown.				Coal	16
			25	67	NW. ¼ sec. 12.	Shale, brown.	
		Shale, brown.				Shale, brown.	
		Coal	40			Coal	14
55	NE. ¼ sec. 11.	Shale, brown.		71	NW. ¼ sec. 12.	Shale, brown.	
		Shale, brown.				Shale, brown.	
		Coal	25			Coal	17
57	NE. ¼ sec. 11.	Shale, brown.		76	NW. ¼ sec. 12.	Shale, brown.	
		Shale, brown.				Shale, brown.	
		Coal	12			Coal	18
58	NE. ¼ sec. 11.	Shale, brown.		77	NE. ¼ sec. 12.	Shale, brown.	
		Shale brown.					
		Coal	18				
59	NE. ¼ sec. 11.	Shale, brown.					

T. 32 N., R. 68 W.—Except a small area in secs. 4, 5, 6, 7, and 8, the surface of this township is composed of the White River formation (Pls. XLIV and XLV). The Fort Union rocks, where exposed, dip about 5° N. and strike nearly east and west. Several lenticular beds of coal outcrop in the township, but only one could be traced for any great distance. The bed of coal which was prospected in the township to the west continues into this township and was measured at several places (locations 78 to 83). The maximum thickness observed is 48 inches (location 79). At location 88 a bed of coal is exposed which is 60 inches thick in one bench; this thickness, however, continues for only a short distance, as illustrated by the section at location 87. Several old outcrop prospects were found in the township, but none was accessible. A shaft, reported to have been 160 feet deep, was sunk in sec. 6 about 1886, but the developments are now entirely concealed and no definite information could be obtained as to the amount of coal found. In addition to the sections of coal beds shown on Plate XLVII the following were measured at the locations given on the map:

Sections of coal beds in T. 32 N., R. 68 W.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
			Inches.				*Inches.*
81	NE. ¼ sec. 7...	Shale, brown.		88b	SW. ¼ sec. 5 ..	Shale, brown.	
		Coal	39			Coal, shaly	8
		Shale, brown.				Shale, brown	9
84	NE. ¼ sec. 7...	Shale, brown.				Coal	12
		Coal	14				29
		Shale, brown.					
85	NE. ¼ sec. 7...	Shale, brown.		89a	SW. ¼ sec. 5 ..	Shale, brown.	
		Coal	16			Coal, shaly	23
		Shale, brown.				Shale, brown.	
88a	SW. ¼ sec. 5...	Shale, brown.		89b	SE. ¼ sec. 5 ...	Shale, brown.	
		Coal, shaly	28			Coal, shaly	23
		Shale, brown.					

T. 32 N., R. 67 W.—The coal-bearing Fort Union rocks are concealed by the White River formation in this township.

T. 33 N., R. 71 W.—The Fort Union coal-bearing rocks underlie this township. Numerous carbonaceous bands occur, but no coal is exposed. The rocks lie nearly horizontal.

T. 33 N., R. 70 W.—The surface of this township is composed of rocks of the Fort Union formation, which lie practically horizontal. No bed of coal was found to outcrop, although there are numerous good exposures of the rocks. There may, however, be coal at a horizon which is lower than the rocks exposed in the township.

T. 33 N., R. 69 W.—Along Shawnee Creek the Fort Union formation is well exposed, but no bed of coal over 14 inches in thickness was found, although numerous thin beds of coal and dark carbonaceous shale are present. The coal-bearing rocks which outcrop in the area to the south dip beneath this township at a low angle. The surface of the township is partly covered with a fair growth of pine trees, especially along the sandstone ridges east of Shawnee Creek.

T. 33 N., R. 68 W.—A thin veneer of the White River formation is present in the southeast part of this township, but the lower coal-bearing group of the Fort Union formation outcrops along the south and east margins (Pls. XLIV and XLVI), in secs. 35 and 36, where erosion has removed the thin cover of White River formation. The coal beds at their outcrop dip 5° W. and strike N. 45° E.; the dip, however, decreases rapidly toward the northwest, as shown in the main entry of the Onyon mine. In the northeast corner of the township the beds dip only slightly toward the west and strike about N. 10° E. Between the two areas where Fort Union rocks are exposed it is impossible to make correlation of coal beds, but it is probable that the coal beds in the southern part of the township are mainly below those of the northern part.

The coal beds in the township have received considerable attention by mining men and prospectors. About 30 years ago, when the Chicago & Northwestern Railway first built into Converse County,

an entry was driven about 80 feet along the strike of the bed near the present opening of the Onyon mine of the Lost Spring Coal Co. About the same time prospecting was done along Twentymile Creek in the northern part of the township. In 1903 the first actual development work began on the property of the Lost Spring Coal Co. In 1906 a mine was opened in sec. 36 (location 242) and development work was pushed so that at the time of examination in 1910 the mine consisted of a main entry and airway driven down the dip of the bed about 1,600 feet, with two pairs of entries 400 and 200 feet long to the south and one pair of entries 600 feet long to the north. Room necks were being turned preparatory to the actual commercial operation of the mine. At that time it was necessary to pump about 1,200 gallons of water from the mine daily in order to keep it in workable condition. The operators obtain pine timber for the mine from the hills in the vicinity, thus avoiding one of the difficulties encountered by miners in adjacent coal fields. In August, 1910, the company was building a new cross-over tipple, equipped to handle a large production. Rope haulage is to be installed and as soon as the railroad spur which is being constructed to connect the mine with the Chicago & Northwestern Railway is completed the mine will be in condition to market a large quantity of coal. The actual production during the winter of 1910–11 is reported to have reached a maximum of 200 tons a day, most of which was sold for generating steam. A sample of the coal was taken from an unweathered face in the mine and its analysis is given as No. 10740 in the table of analyses, page 65.

Sections Nos. 207 to 219 and 230 were measured along the outcrop of a bed which is exposed in secs. 35 and 36 and attains a maximum thickness of 4 feet 3 inches of good, clean coal at location 219. About 30 feet below this bed is another, which exhibits a thickness of 3 feet at location 220, in sec. 35, but thins to the southward (locations 222 and 223). Two other beds exceed 29 inches in thickness, but the extent of the beds is not great (sections Nos. 232, 233, 237, 238, and 241).

Several coal beds of more or less value were found to outcrop in the southeastern part of the township. Sections measured along the outcrops of the several coal beds illustrate the variability in thickness of the beds and their lack of continuity. Part of the sections measured along the beds are shown on Plate XLVI; others are given in the following table:

Sections of coal beds in southern part of T. 33 N., R. 68 W., in addition to those shown on Plate XLVI.

No. on map.	Location.	Section.	Inches.
204	SE. ¼ sec. 32...	Coal	24
205	NE. ¼ sec. 35...	Gravel.	
		Coal	21
		Shale, brown	11
		Coal	9
		Shale, brown.	
			41
206	NE. ¼ sec. 35 ..	Shale, carbonaceous...	9
		Coal	21
		Shale, brown.	
			30
210	NW. ¼ sec. 36..	Clay.	
		Coal, poor	15
		Shale, brown.	
212	NW. ¼ sec. 36 ..	Shale, brown.	
		Coal, poor	20
		Shale, brown.	
213	NW. ¼ sec. 36..	Shale, brown.	
		Coal	27
		Shale, brown.	
221	NE. ¼ sec. 35 ..	Surface.	
		Coal	30
		Shale, brown.	
224	SE. ¼ sec. 35....	Shale, brown.	
		Coal	12
		Shale, brown.	
225	SW. ¼ sec. 35...	Shale, brown.	
		Coal	18
		Shale, brown.	
226	SW. ¼ sec. 35...	Shale, brown.	
		Coal	15
		Shale, brown.	
227	NW. ¼ sec. 36..	Shale, brown.	
		Coal	12
		Shale, brown.	
228	NW. ¼ sec. 36..	Shale, brown.	
		Coal	15
		Shale, brown.	
229	NW. ¼ sec. 36..	Shale, brown.	
		Coal	17
		Shale, brown.	
231	SE. ¼ sec. 35....	Shale, gray.	
		Coal	17
		Shale, brown.	
234	SE. ¼ sec. 35....	Shale, brown.	
		Coal	17
		Shale, brown.	
235	SE. ¼ sec. 35....	Shale, brown.	
		Coal	23
		Shale, brown.	
236	SE. ¼ sec. 35....	Shale, brown.	
		Coal	23
		Shale, brown.	
239	SE. ¼ sec. 35....	Shale, brown.	
		Coal	14
		Shale, brown.	
240	SE. ¼ sec. 35....	Shale, brown.	
		Coal	25
		Shale, brown.	

The accompanying section shows the stratigraphic relation of the various beds outcropping in the southern part of the township, as well as the numbers of sections measured along each.

Section showing stratigraphic relation of coal beds in southern part of T. 33 N., R. 68 W.

	Feet.
Coal: Sections Nos. 205, 206, 224–226.	
Interval	50
Coal: Sections Nos. 220–223.	
Interval	25
Coal: Sections Nos. 227–229, 231.	
Interval	20
Coal: Sections Nos. 207–219, 230.	
Interval	30
Coal: Sections Nos. 232–236.	
Interval	30
Coal: Sections Nos. 237–241.	
Interval	160
Coal: Section No. 242.	

As indicated on the map, six beds of coal outcrop in the northern portion of the township. The thickness of each bed is rather variable (see sections Nos. 89 to 203), and although none show more than 40 inches of solid coal one bed reaches a maximum thickness of 68 inches (location 145) but is split into three benches. The accompanying section shows the stratigraphic relation of sections measured along each bed.

Section showing stratigraphic relation of coal beds in northern part of T. 33 N., R. 68 W

	Feet.
Coal: Sections Nos. 118, 119, 121–127, 152.	
Interval	20
Coal: Sections Nos. 89–117.	
Interval	17
Coal: Sections Nos. 128–145, 180.	
Interval	20
Coal: Sections Nos. 120, 148–151, 153–155, 160–166.	
Interval	119
Coal: Sections Nos. 167–179, 181–192.	
Interval	50
Coal: Sections Nos. 193–197.	
Interval	50
Coal: Sections Nos. 198–203.	

The stratigraphic relation of sections Nos. 146 and 147 was not determined. In addition to the sections given on Plate XLVI, the following measurements were made on coal beds in this township:

Sections of coal beds in northern part of T. 33 N., R. 68 W., in addition to those shown on Plate XLVI.

No. on map.	Location.	Section.	Inches.
89	NW. ¼ sec. 3	Shale, brown.	
		Coal	22
		Shale, brown.	
90	NW. ¼ sec. 3	Shale, brown.	
		Coal	21
		Shale, brown.	
91	SE. ¼ sec. 3	Shale, brown.	
		Coal	21
		Shale, brown.	
92	NW. ¼ sec. 11	Shale, brown.	
		Coal	24
		Shale, brown.	
93	SW. ¼ sec. 11	Sandstone, white.	
		Coal	25
		Shale, brown.	
94	NW. ¼ sec. 14	Shale, brown.	
		Coal	12
		Shale, brown.	
97	NW. ¼ sec. 2	Shale, brown.	
		Coal	33
		Shale, brown.	
98	NW. ¼ sec. 2	Shale, brown.	
		Coal	34
		Shale, brown.	
104	NW. ¼ sec. 11	Shale, brown.	
		Coal	30
		Shale, brown.	
107	SE. ¼ sec. 11	Shale, brown.	
		Coal	36
		Shale, brown.	
111	NE. ¼ sec. 11	Shale, brown.	
		Coal	25
		Shale, brown.	
114	SE. ¼ sec. 2	Shale, brown.	
		Coal	32
		Shale, brown.	
117	NE. ¼ sec. 2	Shale, brown.	
		Coal	19
		Shale, carbonaceous.	
118	NW. ¼ sec. 2	Shale, brown.	
		Coal	19
		Shale, brown.	
119	NW. ¼ sec. 2	Shale, brown.	
		Coal	15
		Shale, brown.	
121	SE. ¼ sec. 2	Shale, brown.	
		Coal	17
		Shale, brown.	
122	SE. ¼ sec. 2	Shale, brown.	
		Coal	20
		Shale, brown.	
123	NE. ¼ sec. 11	Shale, brown.	
		Coal	19
		Shale, brown.	
124	NE. ¼ sec. 11	Shale, brown.	
		Coal	20
		Shale, brown.	
125	NE. ¼ sec. 11	Shale, brown.	
		Coal	20
		Shale, brown.	
126	NE. ¼ sec. 10	Sandstone, white.	
		Coal	9
		Shale, brown	4
		Coal	7
		Shale, brown.	20
127	SW. ¼ sec. 11	Shale, brown.	
		Coal	12
		Shale, brown	14
		Coal	5
			31
131	NW. ¼ sec. 11	Shale, carbonaceous	12
		Shale, brown	20
		Coal	25+
		Bottom not exposed.	57+
132	NW. ¼ sec. 11	Shale, carbonaceous.	
		Coal	14
		Bottom not exposed.	
135	NW. ¼ sec. 13	Shale, brown.	
		Coal	17
		Shale, brown	25
		Coal	12
		Shale, brown.	54

Sections of coal beds in northern part of T. 33 N., R. 68 W., in addition to those shown on Plate XLVI—Continued.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
		Shale, brown.	*Inches.*			Shale, brown.	*Inches.*
		Coal	10	165	NE. ¼ sec. 14	Coal	19
136	NE. ¼ sec. 14	Shale, brown	30			Shale, brown.	
		Coal	12			Shale, brown.	
		Shale, brown.				Coal	19
			52	166	NW. ¼ sec. 13	Shale, brown	2
		Shale, brown.				Coal	8
		Coal	7			Shale, brown.	
136A	NE. ¼ sec. 14	Shale, brown	18				29
		Coal and shale	5	167	SE. ¼ sec. 1	Sandstone, shaly.	
		Shale, brown.				Coal	16
			30			Shale, brown.	
		Shale, brown.		168	NE. ¼ sec. 12	Shale, carbonaceous.	
		Coal, shaly	10			Coal	15
137	SE. ¼ sec. 11	Shale, brown	10			Shale, brown.	
		Coal, shaly	14	169	NW. ¼ sec. 12	Sandstone, shaly.	
		Shale, brown.				Coal	15
			34			Shale, brown.	
		Shale, brown.		170	SW. ¼ sec. 12	Shale, gray, sandy.	
		Coal	10			Coal	25
138	SE. ¼ sec. 11	Shale, brown	10			Shale, brown.	
		Coal	10	171	SW. ¼ sec. 12	Shale, carbonaceous.	
		Shale, brown.				Coal	25
			30			Shale, brown.	
		Shale, brown.		172	SE. ¼ sec. 12	Shale, brown.	
		Coal	6			Coal	25
139	SW. ¼ sec. 12	Shale, brown	4			Shale, brown.	
		Coal	14	173	SE. ¼ sec. 12	Shale, brown.	
		Shale, brown.				Coal	23
			24			Shale, brown.	
		Shale, brown.		174	SE. ¼ sec. 12	Shale, gray.	
		Coal	10			Coal	15
140	SE. ¼ sec. 11	Shale, brown	6			Shale, brown.	
		Coal	10	175	NW. ¼ sec. 13	Shale, brown, sandy.	
		Shale, brown.				Coal	18
			26			Shale, brown.	
		Shale, brown.		176	NW. ¼ sec. 13	Shale, gray.	
		Coal	15			Coal	18
141	SE. ¼ sec. 11	Shale, brown	10			Shale, brown.	
		Coal	6	177	NE. ¼ sec. 13	Shale, carbonaceous.	
		Shale, brown.				Coal	18
			31			Shale, brown.	
		Shale, brown.		178	SE. ¼ sec. 13	Shale, carbonaceous.	
		Coal	12			Coal	22
		Shale, brown	5			Shale, brown.	
142	SE. ¼ sec. 2	Coal	14	179	SE. ¼ sec. 13	Shale, brown.	
		Shale, brown	6			Coal	28
		Coal	12			Shale, brown.	
		Shale, brown.		181	SE. ¼ sec. 13	Shale, gray.	
			49			Coal	23
		Shale, brown.				Shale, brown.	
146	SE. ¼ sec. 2	Coal	10	182	SE. ¼ sec. 13	Shale, carbonaceous.	
		Shale, brown.				Coal	19
		Shale, brown.				Shale, brown.	
147	SE. ¼ sec. 2	Coal	13			Shale, carbonaceous.	
		Shale, brown.		185	NE. ¼ sec. 24	Coal	10
		Shale, brown.				Shale, brown	3
148	NE. ¼ sec. 2	Coal	20			Coal	15
		Shale, brown.				Shale, brown.	
		Shale, brown.					28
149	NE. ¼ sec. 2	Coal, poor	22			Sandstone.	
		Shale, brown.		187	NE. ¼ sec. 24	Shale, carbonaceous	3
		Sandstone, white.				Coal	16
152	NW. ¼ sec. 2	Shale, brown	12			Shale, brown.	
		Coal	16				19
		Shale, brown.		188	NE. ¼ sec. 24	Shale, gray.	
			28			Coal	21
		Shale, brown.				Shale, brown.	
161	SE. ¼ sec. 11	Coal, shaly	20			Shale, gray.	
		Shale, brown.		189	SE. ¼ sec. 13	Coal	22
		Shale, brown.				Shale, brown.	
162	SE. ¼ sec. 11	Coal	28			Shale, brown.	
		Shale, brown.		190	NE. ¼ sec. 24	Coal	22
		Shale, brown.				Shale, brown.	
163	SW. ¼ sec. 12	Coal	26			Shale, brown, sandy.	
		Shale, brown.		191	NE. ¼ sec. 24	Coal, shaly	14
		Shale, brown.				Shale, brown.	
164	NE. ¼ sec. 14	Coal, shaly	26				
		Shale, brown.					

Sections of coal beds in northern part of T. 33 N., R. 68 W., in addition to those shown on Plate XLVI—Continued.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
			Inches.				*Inches.*
192	NE. ¼ sec. 24...	Shale, brown.		195	SE. ¼ sec. 13....	Shale, brown.	
		Coal	13			Coal	13
		Shale, brown.				Shale, brown.	
193	SE. ¼ sec. 13....	Shale, brown.		196	NE. ¼ sec. 24...	Shale, brown.	
		Coal	23			Coal	14
		Shale, brown.				Shale, brown.	
194	SE. ¼ sec. 13....	Shale, carbonaceous.		197	NE. ¼ sec. 24...	Shale, brown.	
		Coal	17			Coal	12
		Shale, brown.				Shale, brown.	

T. 33 N., R. 67 W.—All but the northeast quarter of this township is covered by the White River formation (Pls. XLIV and XLVI). Where the Fort Union formation is exposed five beds of coal were found to outcrop, one attaining a maximum thickness of 52 inches (No. 262).

No prospecting has been done in the township, although beds more than 29 inches thick are exposed in several places. In sec. 13 of the township to the north a mine has been opened by the Harney Creek Coal Co. on the bed which is represented in this township by sections Nos. 259 to 266. This is the most important bed exposed in the township.

The coal beds are extremely variable in thickness, as is well illustrated by sections Nos. 251, 252, 253, 255, and 256, which were measured about one-fourth mile apart. The highest bed outcropping in the township is represented by sections Nos. 246 to 249 and varies in thickness from 16 inches to 43 inches. Other important beds were exposed at locations 243, 267, and 270.

The stratigraphic relation of the various beds and the numbers of the sections measured along each are shown by the accompanying section:

Section showing stratigraphic relation of coal beds in T. 33 N., R. 67 W.

	Feet.
Coal: Sections Nos. 245–250.	
Interval	10
Coal: Sections Nos. 251–257.	
Interval	40
Coal: Sections Nos. 259–266.	
Interval	25
Coal: Section No. 267.	
Interval	25
Coal: Sections Nos. 268, 269.	

The stratigraphic relation of sections Nos. 243, 244, 258, 270, 270*a*, and 270*b* was not determined. Additional sections measured in this township are given below:

Sections of coal beds in T. 33 N., R. 67 W., in addition to those shown on Plate XLVI.

No. on map.	Location.	Section.	No. on map.	Location.	Section.
244	NE. ¼ sec. 6....	Shale, carbonaceous. *Inches.* Coal..... 17 Shale, drab.	264	NE. ¼ sec. 8....	Shale, brown. *Inches.* Coal..... 32 Shale, brown.
245	NE. ¼ sec. 5....	Shale, brown. Coal..... 24 Shale, brown.	266	NW. ¼ sec. 8...	Shale, brown. Coal..... 25 Shale, brown.
250	NE. ¼ sec. 7....	Shale, brown. Coal..... 24 Shale, brown.	268	NE. ¼ sec. 4....	Shale, drab. Coal..... 26 Shale, carbonaceous.
254	NW. ¼ sec. 9...	Shale, brown. Coal..... 17 Shale, brown.	269	NE. ¼ sec. 4....	Shale, drab. Coal..... 24 Shale, carbonaceous.
257	SW. ¼ sec. 8....	Sandstone, white. Coal..... 23 Shale, brown.	270*a*	NW. ¼ sec. 19..	Shale, brown. Coal..... 25 Shale, brown.
258	NW. ¼ sec. 7...	Shale, brown. Coal..... 15 Shale, brown.	270*b*	NW. ¼ sec. 19..	Shale, brown. Coal..... 24 Shale, brown.
259	NE. ¼ sec. 4....	Shale, brown. Coal..... 25 Shale, brown.			

T. 34 N., R. 70 W., and T. 34 N., R. 69 W.—Although the Fort Union rocks form the surface of these townships they are grass-covered over a large part of the area and no coal beds are known to outcrop. Coal beds of more or less importance belonging to horizons exposed to the south and east may be present at considerable depth beneath this township.

T. 34 N., R. 68 W.—Numerous coal beds were found to outcrop in the eastern half of this township, but, like all other coal beds in the southern part of the Lost Spring field, they are irregular in thickness and of small extent (Pls. XLIV and XLVI). The beds dip gently to the west. North of Twentymile Creek seven beds were found, none of which exceeds 30 inches in thickness. The highest bed was traced for a little over 3 miles (Nos. 336–347), but the others are not so continuous. No prospecting has been done on these beds and they could not be correlated with the beds exposed south of the creek. The accompanying section shows the stratigraphic relation of the beds as well as the numbers of sections measured along each.

Section showing the stratigraphic relation of coal beds north of Twentymile Creek, in T. 34 N., R. 68 W.

	Feet.
Coal: Sections Nos. 336–347.	
Interval	60
Coal: Sections Nos. 348–352.	
Interval	50
Coal: Sections Nos. 353–356.	
Interval	10
Coal: Sections Nos. 357–359.	
Interval	55
Coal: Sections Nos. 360–362.	
Interval	15
Coal: Sections Nos. 363, 364.	
Interval	20
Coal: Sections Nos. 365–373.	

The area south of Twentymile Creek is rough and covered with a fair growth of pine trees. Nine beds of coal of varying thicknesses were found, and their relations, as well as the numbers of sections measured along each, are shown in the following section:

Section showing the stratigraphic relation of coal beds south of Twentymile Creek, in T. 34 N., R. 68 W.

	Feet.
Coal: Sections Nos. 441–456.	
Interval	20
Coal: Sections Nos. 379–402.	
Interval	10
Coal: Section No. 439.	
Interval	7
Coal: Sections Nos. 403–408, 410–423, 425–427.	
Interval	20
Coal: Sections Nos. 424, 428–438, 440.	
Interval	60
Coal: Sections Nos. 457–459.	
Interval	25
Coal: Sections Nos. 460–471.	
Interval	35
Coal: Sections Nos. 472–481, 488.	
Interval	30
Coal: Sections Nos. 482–484, 487.	
Interval	35
Coal: Sections Nos. 485, 486	

The stratigraphic relation of sections Nos. 374–378, 489–495, and 497 was not determined.

Five of the beds outcrop continuously along the ridge and have been prospected at a number of places. One of these beds, in which two local mines have been opened, occurs well up in the formation and is represented by sections Nos. 379–402.

The most important operator in this township is the Rosin Coal Co., which has opened a mine in sec. 35. In August, 1910, the

mine consisted of a main entry about 700 feet long, with one pair of entries driven about 250 feet each way. Other entries which run parallel to the main haulage ways and from which rooms are to be worked were being turned from the side entries. The mine is well laid out for economical working, and all entries were being well timbered. It was being equipped with heavy rails and wired for electric power. The equipment also includes an electric coal-undercutting machine. All work was being done with a view to secure maximum production as soon as the outside equipment was ready to handle the output. A well-equipped power house and machine shop, together with cross-over dump and shaker screens, were being installed. The chief obstacle met in the equipment of the mine was in obtaining an adequate water supply for the power plant. Wells drilled to a depth of 200 feet had failed to develop water in sufficient quantity, so that the company was forced to haul water in tank cars from Lost Spring. A standard-gage railway had just been completed by the Wyoming & Northwestern Railway Co. connecting the mine with the Chicago & Northwestern Railway at Lost Spring.

The Sunset Coal Co. was opening a mine about a mile north of the Rosin mine, in sec. 35. The development consisted of a single entry about 500 feet long, driven on the same bed as that mined by the Rosin Co. No extensive equipment had been installed during the season of 1910. Since the writer left the field in November, 1910, it has been reported that this mine has been connected with the railroad at Rosin mine by a narrow-gage tramway. Sections measured along this coal bed are represented by Nos. 410 and 412 to 427, Plate XLVI. The coal, like all other coal of the Lost Spring field, weathers rapidly on exposure to the atmosphere.

Samples of the coal were taken from the Rosin and Sunset mines, and the analyses are given on page 485 (Nos. 10775, 10835).

The hills in the vicinity of the coal mines furnish abundant pine timber for mine use, thus eliminating one of the difficulties experienced in many coal fields.

Coal beds in this township are lenticular and irregular in thickness, as exhibited by sections Nos. 447–456, measured along one bed, and sections Nos. 427 to 436, measured along another. The bed along which sections Nos. 472 to 481 were measured is probably the same as that reported in a well near the Sunset mine, where 4 feet of coal is reported at a depth of about 86 feet. Along its outcrop this bed varies in thickness from 4 inches to 20 inches. Beds of diverse thickness outcrop along the east side of East Fork of Twentymile Creek and were measured at locations 488 to 492*a*.

In addition to the sections of coal beds shown on Plate XLVI, the following measurements were made in T. 34 N., R. 68 W.:

Sections of coal beds in T. 34 N., R. 68 W., in addition to those shown on Plate XLVI.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
			Inches.				*Inches*
336	NW. ¼ sec. 2	Shale, brown.		361	SE. ¼ sec. 2	Shale, brown.	
		Coal	19			Coal	18
		Shale, brown.				Shale, brown.	
337	NW. ¼ sec. 11	Shale, brown.		362	NE. ¼ sec. 11	Shale, brown.	
		Coal	23			Coal	22
		Shale, brown.				Shale, brown.	
338	NE. ¼ sec. 10	Shale, black, carbonaceous.		363	NW. ¼ sec. 1	Shale, black, carbonaceous	7
		Coal	26			Sandstone, shaly	60
		Shale, brown.				Coal	12
339	SW. ¼ sec. 10	Shale, brown.				Shale, brown.	79
		Coal	23			Shale, brown.	
		Shale, brown.				Coal	7
340	SW. ¼ sec. 10	Shale, brown.		364	NE. ¼ sec. 11	Shale, brown	60
		Coal	17			Coal	12
		Shale, brown.				Shale, brown.	79
341	SW. ¼ sec. 15	Shale, brown.				Shale, brown.	
		Coal	24	365	NW. ¼ sec. 12	Coal	17
		Shale, brown.				Shale, brown.	
342	SW ¼ sec. 15	Shale, brown.				Surface clay.	
		Coal	25	366	NW. ¼ sec. 12	Coal	10
		Shale, brown.				Shale, brown.	
343	NE. ¼ sec. 15	Shale, brown.		367	SE. ¼ sec. 11	Shale, brown.	
		Coal	13			Coal	13
		Shale, brown.				Shale, brown.	
347	NW. ¼ sec. 22	Shale, brown.		368	SW. ¼ sec. 11	Shale, brown.	
		Coal	13			Coal	10
		Shale, brown.				Shale, brown.	
		Shale, brown.		369	NW. ¼ sec. 14	Sandstone.	
		Coal	8			Coal	10
348	SW. ¼ sec. 15	Shale, brown	30			Shale, brown.	
		Coal	16	370	SW. ¼ sec. 14	Sandstone, shaly.	
		Shale, brown.				Coal	13
			54			Shale, brown.	
		Shale, brown, sandy.				Shale, brown.	
		Coal	14			Coal	8
349	SW. ¼ sec. 2	Shale, drab	24	371	SE. ¼ sec. 15	Shale, brown	20
		Shale, black, carbonaceous	18			Coal	15
			56			Shale, brown.	43
		Shale, black, carbonaceous	6			Shale, brown.	
350	NW. ¼ sec. 11	Shale, brown	47	372	NE. ¼ sec. 22	Coal	6
		Coal	15			Sandstone, shaly	24
		Shale, brown.				Coal	12
			68			Shale, brown.	42
		Shale, brown.				Shale, brown.	
		Shale, black, carbonaceous	7			Coal	6
351	NE. ¼ sec. 10	Shale, brown	47	373	SW. ¼ sec. 22	Shale, brown	22
		Coal	16			Coal	13
		Shale, brown.				Shale, brown.	41
			70			Shale, brown.	
		Shale, brown.		374	SW. ¼ sec. 27	Coal	18
		Coal	7			Shale, brown.	
352	SW. ¼ sec. 10	Shale, brown	18			Shale, brown.	
		Coal	15	375	NW. ¼ sec. 27	Coal	23
		Shale, brown.				Shale, brown.	
			40			Shale, brown.	
		Shale, brown.		376	SW. ¼ sec. 27	Coal	26
		Coal	12			Shale, brown.	
353	NE. ¼ sec. 2	Shale, brown	20			Shale, brown.	
		Coal	7	377	SW. ¼ sec. 27	Coal	8
		Shale, brown.				Shale, brown.	
			39			Shale, brown.	
		Sandstone, white.		378	SW. ¼ sec. 27	Coal	15
		Shale, black, carbonaceous	7			Shale, brown.	
354	SW. ¼ sec. 2	Coal	12			Clay.	
		Shale, brown.				Coal	12
			19	379	SE. ¼ sec. 34	Shale, brown	1
		Shale, brown.				Coal	2
355	NE. ¼ sec. 11	Coal	18			Shale, brown.	15
		Shale, brown.				Shale, brown.	
		Shale, brown.				Coal	17
356	SE. ¼ sec. 11	Coal	12	380	SE. ¼ sec. 34	Shale, brown	23
		Shale brown.				Coal	10
		Shale, brown.				Shale, brown.	50
360	NW. ¼ sec. 1	Coal	20				
		Shale, brown.					

Sections of coal beds in T. 34 N., R. 68 W., in addition to those shown on Plate XLVI—Continued.

No. on map.	Location.	Section.	No. on map.	Location.	Section.
		Inches.			Inches.
381	SE. ¼ sec. 34....	Shale, brown. Coal..... 24 Shale, brown.	424	NE. ¼ sec. 35...	Shale, brown. Coal..... 16 Shale, brown.
383	SE. ¼ sec. 34....	Shale, brown, and coal. 14 Coal..... 18 Shale..... 26 Coal..... 12 Shale, brown. 70	433	NE. ¼ sec. 23...	Shale, brown. Coal..... 19 Shale, brown.
385	SE. ¼ sec. 34....	Shale, brown, and coal. 13 Coal..... 25 Shale, brown. 38	434	SW. ¼ sec. 23...	Shale, brown. Coal..... 22 Shale, brown.
386	SE. ¼ sec. 27....	Shale, brown. Coal..... 11 Shale, brown.	435	SE. ¼ sec. 23....	Shale, black, carbonaceous. Coal..... 19 Shale, brown.
387	SE. ¼ sec. 27....	Shale, black, carbonaceous. Coal..... 21 Shale, brown.	436	SE. ¼ sec. 23....	Shale, brown. Coal..... 21 Shale, brown.
388	NE. ¼ sec. 27....	Shale, brown. Coal..... 15 Shale, brown..... 24 Coal..... 19 58	437	NE. ¼ sec. 35...	Shale, brown. Coal..... 14 Shale, brown.
389	NE ¼ sec. 27...	Shale, brown. Coal..... 21 Sandstone, shaly... 20 Coal..... 12 Shale, brown. 53	438	NE. ¼ sec. 35...	Shale, brown. Coal..... 14 Shale, brown.
392	SW. ¼ sec. 23...	Shale, brown and black. Coal..... 13 Shale, brown.	439	NE. ¼ sec. 35...	Shale, brown. Coal..... 18 Shale, brown.
403	NE. ¼ sec. 34...	Clay, gravelly. Coal..... 21 Shale, brown..... 44 Coal..... 20 85	440	SE. ¼ sec. 35....	Shale, brown. Coal..... 14 Shale, brown.
404	NE. ¼ sec. 34...	Shale, black, carbonaceous..... 30 Coal..... 6 Shale, black, carbonaceous..... 8 44	441	SW. ¼ sec 34....	Shale, brown. Coal..... 6 Shale, brown..... 3 Coal..... 5 Shale, brown. 14
405	NE. ¼ sec. 34...	Shale, brown. Shale, black, carbonaceous, with some coal..... 17 Coal..... 23 Shale, brown..... 30 Coal..... 6+ Bottom not exposed. 76+	442	SE. ¼ sec. 34....	Shale, gray. Coal..... 19 Shale, brown.
406	NE. ¼ sec. 34...	Shale, brown. Shale, black, carbonaceous..... 18 Coal..... 23+ Bottom not exposed. 41+	443	SE. ¼ sec. 34...	Surface. Coal..... 20 Shale, brown.
407	NE. ¼ sec. 34...	Shale, brown. Coal..... 10 Shale, brown.	444	SE. ¼ sec. 34....	Shale, brown. Coal..... 20 Shale, brown.
408	SE. ¼ sec. 27....	Shale, brown. Coal..... 16 Shale, brown, with some coal..... 7 Coal..... 18 Shale, brown. 41	445	SW. ¼ sec. 35...	Sandstone. Coal..... 20 Shale, brown.
411	SW. ¼ sec. 23...	Shale, brown. Coal..... 25 Shale, brown	446	SW. ¼ sec. 35...	Shale, sandy. Coal..... 21 Shale, brown.
			457	NW. ¼ sec. 36..	Shale, brown. Coal..... 12 Shale, brown.
			458	NW. ¼ sec. 36..	Sand. Coal..... 10 Shale, brown.
			459	SE. ¼ sec. 26....	Shale, brown. Coal..... 14 Shale, brown.
			460	SW. ¼ sec. 36...	Shale, brown..... 24 Coal..... 8 Shale, brown. 32
			461	NW. ¼ sec. 36..	Shale, brownish black, carbonaceous..... 16 Coal..... 8 Shale, brown. 24
			462	NW. ¼ sec. 36..	Shale, brown. Coal..... 14 Shale, brown.
			463	SE. ¼ sec. 26....	Shale, light gray, sandy. Coal..... 19 Shale, brown.
			464	SE. ¼ sec. 26....	Shale, gray. Coal..... 11 Shale, brown.

Sections of coal beds in T. 34 N., R. 68 W., in addition to those shown on Plate XLVI—Continued.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
			Inches.				*Inches.*
465	NE. ¼ sec. 26...	Shale, brown.		483	NE. ¼ sec. 36...	Coal	22
		Coal	16			Shale, brown	24
		Shale, brown.				Coal	2
466	NE. ¼ sec. 26...	Shale, brown.				Shale, brown.	
		Coal	12				48
		Shale, brown.		484	SW. ¼ sec. 25...	Shale, brown.	
467	NE. ¼ sec. 26...	Shale, brown.				Coal	20
		Coal	20			Shale, brown	14
		Shale, brown.				Coal	3
468	SE. ¼ sec. 23....	Shale, brown.				Shale, brown.	
		Coal	19				37
		Shale, brown.		485	SE. ¼ sec. 36....	Shale, brown.	
469	SE. ¼ sec. 23...	Shale, brown.				Coal	19
		Coal	13			Shale, brown.	
		Shale, brown.		486	NE. ¼ sec. 36...	Shale, brown.	
470	SE. ¼ sec. 23....	Shale, brown.				Coal	15
		Coal	18			Shale, brown	15
		Shale, brown.				Coal	26
471	NE. ¼ sec. 23...	Shale, brown.				Shale, brown.	
		Coal	19				56
		Shale, brown.		487	SE. ¼ sec. 36....	Shale, brown.	
474	NW. ¼ sec. 36..	Sandstone, shaly.				Coal	13
		Coal	40			Shale, brown.	
		Shale, brown.		492	SE. ¼ sec. 13....	Shale, brown.	
478	SE. ¼ sec. 23....	Shale, white, sandy.				Coal	24
		Coal	25			Shale, brown.	
		Shale, brown.		493	SE. ¼ sec. 24....	Shale, brown.	
479	SE. ¼ sec. 23....	Shale, brown.				Coal	23
		Coal	28			Shale, brown.	
		Shale, brown.		494	SE. ¼ sec. 13....	Shale, sandy.	
482	NW. ¼ sec. 36..	Shale, brown.				Coal	20
		Coal	20			Shale, brown.	
		Shale, brown.		495	SE. ¼ sec. 13....	Sandstone, white.	
482a	NW. ¼ sec. 36..	Coal	20			Coal	19
		Shale, brown	14			Shale, brown.	
		Coal	2	497	NW. ¼ sec. 13..	Shale, brown.	
		Shale, brown.				Coal	18
			36			Shale, brown.	

T. 34 N., R. 67 W.—The White River formation covers a small area in the southeastern part of this township; elsewhere the Fort Union rocks are exposed and several beds of coal outcrop. (See Pls. XLIV and XLVI.) Along the southeast edge of the Fort Union territory the beds dip 4° to 6° NW., but at the east edge of sec. 13 the dip increases to 25° NW. In the northwest part of the township the dip is much less and the strike is nearly north-south.

The highest important coal bed stratigraphically was found to outcrop along the sides of a small valley west of Harney Creek and to continue into the adjacent townships to the south and north. This bed, as shown by sections Nos. 271 to 291, ranges in thickness from 11 inches at location 290, in sec. 20, to 59 inches at location 275, in sec. 4. About 50 feet below this is a bed represented by sections 316 to 330, whose outcrop was followed for a considerable distance and whose thickness varies from 21 inches at location 320, in sec. 28, to 59 inches at the Harney Creek mine, in sec. 13. This is practically the only bed of coal which has been prospected and with the bed above it forms the main body of valuable coal in the township. The Harney Creek mine, in sec. 13, was opened in 1909 and at the

time of examination in September, 1910, consisted of a single entry driven about 80 feet along the strike of the bed. The coal at the mine is clean and, according to the analysis (No. 10911, p. 485), has a heat value of 9,191 British thermal units. In secs. 30 and 31 several exposures of coal occur and sections Nos. 305 to 309 were measured at locations shown on the map.

The accompanying section shows the stratigraphic relation of the coal beds as well as the numbers of sections measured along each:

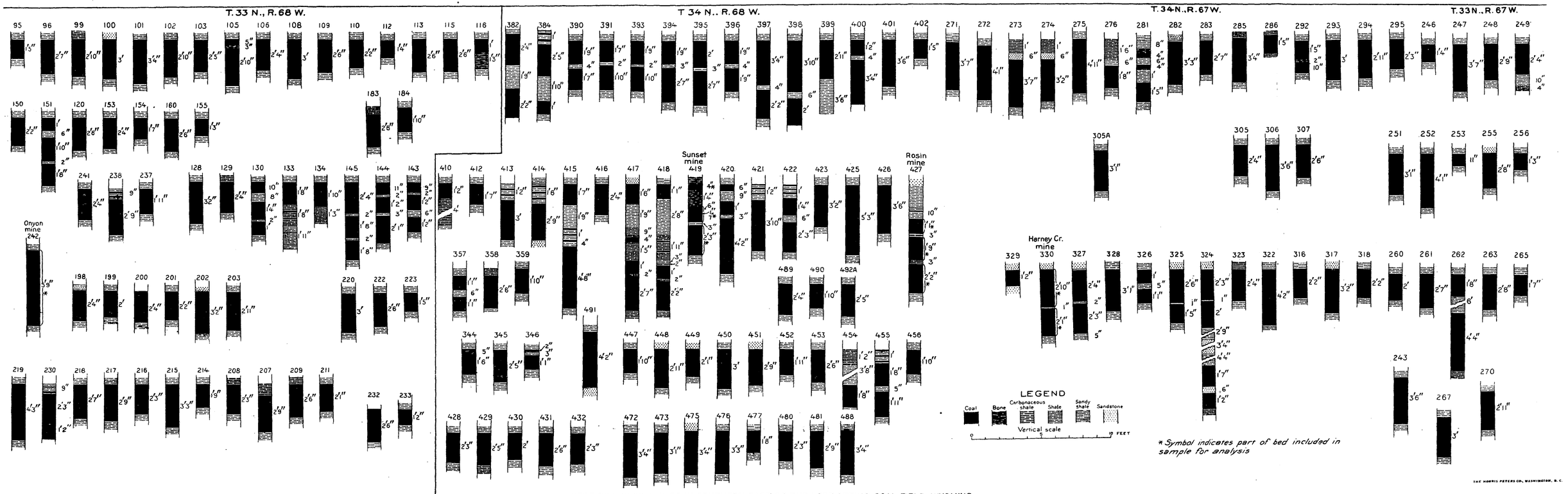
Section showing the stratigraphic relation of coal beds in T. 34 N., R. 67 W.

	Feet.
Coal: Sections Nos. 311, 312.	
Interval	50
Coal: Sections Nos. 311*a*, 312*a*.	
Interval	35
Coal: Sections Nos. 309, 310, 313–315.	
Interval	35
Coal: Section No. 308.	
Interval	40
Coal: Sections Nos. 271–299.	
Interval	50
Coal: Sections Nos. 316–330.	
Interval	30
Coal: Sections Nos. 334, 335.	
Interval	20
Coal: Sections Nos. 331–333.	

The stratigraphic relation of sections Nos. 300–307 was not determined. Additional sections measured in this township are as follows:

Sections of coal beds in T. 34 N., R. 67 W., in addition to those shown in Plate XLVI.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
			Inches.				*Inches.*
		Shale, gray, sandy.				Shale, brown.	
		Shale, brown	6	284	SE. ¼ sec. 7	Coal	38
277	SE. ¼ sec. 4	Shale, carbonaceous, and bone	10			Shale, brown.	
		Coal	18			Sandstone, grayish yellow.	
		Shale, brown.				Coal	6
			34			Shale, brown and carbonaceous; about	84
		Shale, gray, sandy.		287	NW. ¼ sec. 17	Coal	14
		Bone	4			Shale, brown, and carbonaceous; about	96
278	NW. ¼ sec. 10	Coal, impure	18			Coal	12
		Shale, brown	4			Shale, brown.	
		Coal	6				212
		Shale, brown.				Shale, brown.	
			32	288	NE. ¼ sec. 17	Coal	28
		Shale, gray, sandy.				Shale, brown.	
		Shale, brown, carbonaceous	4			Shale, brown.	
279	SW. ¼ sec. 3	Coal	11			Coal	12
		Shale, brown, carbonaceous	19	289	SW. ¼ sec. 17	Shale, brown	24
		Coal	12			Coal	10
		Shale, brown, sandy.				Shale, brown.	
			46				46
		Shale, gray, sandy.				Shale, brown.	
		Shale, carbonaceous, and bone	8	290	NW. ¼ sec. 20	Coal	11
280	NW. ¼ sec. 3	Coal	9			Shale, brown.	
		Shale, brown	50			Shale, carbonaceous.	
		Coal	6	291	SW. ¼ sec. 20	Coal	22
		Shale, brown.				Shale, brown.	
			73				



SECTIONS OF COAL BEDS IN SOUTHERN PART OF THE LOST SPRING COAL FIELD, WYOMING

Sections of coal beds in T. 34 N., R. 67 W., in addition to those shown on Plate XLVI—Continued.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
			Inches.				*Inches.*
		Coal	4	313	SE. ¼ sec. 31	Sandstone, white.	
296	SE. ¼ sec. 32	Shale	24			Shale, brown	4
		Coal	8			Coal	22
		Shale.					26
			36			Sandstone, white.	
		Coal	10	314	SE. ¼ sec. 31	Shale, brown	2
297	NE. ¼ sec. 32	Shale, about 15 feet.				Coal	20
		Coal	13			Shale, brown.	
		Shale.					22
			23			Shale, drab.	
		Sandstone, white.		315	SE. ¼ sec. 31	Coal	8
		Coal	20			Shale, brown.	
298	SE. ¼ sec. 32	Shale, brown.				Shale, sandy.	
		Sandstone, soft, gray.		319	NE. ¼ sec. 33	Coal	26
		Coal	26			Shale, hard, brown.	
		Shale, brown; about	96			Shale, gray, sandy.	
299	SE. ¼ sec. 32	Coal	13	320	SW. ¼ sec. 28	Coal	21
		Shale, brown.				Shale, hard, brown.	
			135			Sandstone, gray.	
		Shale, brown.		321	NW. ¼ sec. 28	Shale, brown	6
		Coal	20			Coal	22
300	SW. ¼ sec. 6	Shale, brown.				Shale, hard, brown.	
		Shale, brown.					28
		Coal	6			Shale, drab.	
		Shale, brown	6			Shale, carbonaceous	2
301	NW. ¼ sec. 7	Coal	10			Coal	9
		Shale, brown.		331	SW. ¼ sec. 34	Shale, carbonaceous, drab; about	60
			22			Coal	25
		Shale, brown.				Shale, hard.	
302	SW. ¼ sec. 7	Coal	12				96
		Shale, brown.				Shale, brown.	
		Shale, brown.				Shale, carbonaceous	4
303	NW. ¼ sec. 18	Coal	12			Coal	10
		Shale, brown.		332	SW. ¼ sec. 34	Shale, brown; about	60
		Shale, brown.				Coal	22
304	SW. ¼ sec. 19	Coal	22			Shale, brown.	
		Shale, brown.					96
		Shale, black, carbonaceous	7			Sandstone, yellow.	
308	SW. ¼ sec. 31	Shale, brown	30			Shale, carbonaceous, and coal	15
		Coal	15			Shale, brown	72
		Shale, brown.		333	SE. ¼ sec. 27	Coal	23
			52			Shale, brown	96
		Shale, brown.				Coal, poor	17
310	SW. ¼ sec. 31	Coal	11			Shale, brown.	
		Shale, brown.					223
		Shale, brown.				Shale, brown.	
311	SW. ¼ sec. 31	Coal	28	334	SE. ¼ sec. 33	Coal	20
		Shale, brown.				Shale, brown.	
		Shale, brown.				Shale, dark.	
311a	SW. ¼ sec. 31	Coal	27	335	NE. ¼ sec. 33	Coal	9
		Shale, brown.				Shale, hard, brown.	
312	SE. ¼ sec. 31	Coal	27				
		Sandstone, white.					
312a	SE. ¼ sec. 31	Coal	13				
		Shale, brown, sandy.					

T. 35 N., R. 70 W.—Although the entire surface of this township is composed of the Fort Union formation, the only evidence of coal is in sec. 1, where a bed about 4 feet thick was reported in a well at a depth of 150 feet. The township is almost entirely grass-covered and exposures are poor.

T. 35 N., R. 69 W.—Horizontal Fort Union rocks form the surface and most of the township is grass-covered. No bed of coal having a thickness of more than 18 inches is known in the township. Coal horizons exposed in the townships to the south and east dip beneath this and may contain valuable coal beds.

T. 35 N., R. 68 W.—As indicated on the map the Fort Union formation dips about 3° W. in this township and several beds of coal were found in outcrop along the divide between Twentymile and Walker creeks (Pls. XLV and XLVII). On the south side of the ridge three beds are exposed for short distances, but none were found to attain valuable thickness. On the north side of the ridge two beds were found, the lower of which attains a considerable thickness and was traced beyond the limits of the township. This bed consists of about 55 inches of coal separated into two benches of nearly equal thickness by 40 to 50 inches of shale. The parting thickens in the townships to the north and northeast until it was necessary to map two beds of coal instead of one. Sections Nos. 535 to 538 and 550 to 553 are shown on Plate XLVII and all others in the following table:

Sections of coal beds in T. 35 N., R. 68 W., in addition to those shown on Plate XLVII.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
			Inches.				*Inches.*
		Shale, brown.				Shale, brown.	
		Coal	15	544	NW. ¼ sec. 13	Coal	24
		Shale, brown	3			Shale, brown.	
539	SW. ¼ sec. 25	Coal	12			Shale, brown.	
		Shale, brown.		545	SW. ¼ sec. 12	Coal	24
			30			Shale, brown.	
		Shale, brown.				Sandstone, brown.	
540	NE. ¼ sec. 25	Coal	13	546	SW. ¼ sec. 1	Coal	18
		Shale, brown.				Shale, brown.	
		Shale, brown.				Shale, brown.	
541	NE. ¼ sec. 25	Coal	21	547	NE. ¼ sec. 2	Coal	21
		Shale, brown.				Shale, brown.	
		Shale, brown.				Shale, brown.	
542	SE. ¼ sec. 13	Coal	20	548	NE. ¼ sec. 12	Coal	28
		Shale, brown.				Shale, brown.	
		Shale, brown.				Shale, brown.	
543	SW. ¼ sec. 13	Coal	19	549	NE. ¼ sec. 12	Coal	21
		Shale, brown.				Shale, brown.	

T. 35 N., R. 67 W.—The territory along both sides of Twentymile Creek is rough and the rocks are in most places well exposed (Pls. XLV and XLVII). Several coal beds of considerable importance outcrop in the township, particularly along the west side of the main valley. As shown by the following section, in a stratigraphic distance of a little over 200 feet there are seven coal beds:

Section showing the stratigraphic relation of coal beds in T. 35 N., R. 67 W.

	Feet.
Coal: Sections Nos. 506, 507, 513.	
Interval	45
Coal: Sections Nos. 508, 509, 512.	
Interval	17
Coal: Sections Nos. 510, 511.	
Interval	30
Coal: Sections Nos. 498–505.	
Interval	50
Coal: Sections Nos. 514–519.	
Interval	30
Coal: Sections Nos. 520–525.	
Interval	40
Coal: Sections Nos. 526–528.	

The stratigraphic relation of sections Nos. 529 to 534 was not determined.

The coal beds range in thickness from 13 inches to 60 inches. The upper bed was measured at only three places, locations 506, 507, and 513, in T. 35 N., R. 67 W., as its outcrop appears mainly in the township to the west. The next lower bed is found only in scanty outcrop in this township but was traced for several miles to the north and is very persistent, although variable in thickness. The third bed is not important in either thickness or extent. The fourth bed outcrops near the top of a ridge and has only a thin cover. The bed itself is separated into three or more thin benches and is of little value. Probably the most important bed of coal exposed in the northern part of the township is found along the sides of a rather prominent ridge and attains a thickness of 60 inches (No. 517). All the measurements obtained along the outcrop of this bed (Nos. 514 to 519) show coal more than 29 inches thick, although the bed thins toward the south.

About 30 feet below the bed just described is another of nearly equal importance (sections Nos. 520 to 525). This coal is usually split into two benches, either of which may be 30 to 40 inches thick. Other beds in the northern part of the township are unimportant.

The bed along which sections Nos. 530 to 533 and 534 were measured has been traced across the township to the south and beyond and in most places shows a good thickness. The land within the outcrops in secs. 28, 32, and 33, although underlain by a bed of considerable thickness, does not contain valuable coal, because the coal is within 10 feet of the surface. No prospecting had been done on the coal beds of this township prior to the field work of 1910. In addition to the sections shown on Plate XLVII, the following were measured in the township:

Sections of coal beds in T. 35 N., R. 67 W., in addition to those shown on Plate XLVII.

No. on map.	Location.	Section.		No. on map.	Location.	Section.	
			Inches.				*Inches.*
498	NW. ¼ sec. 6	Shale, brown.				Shale, brown.	
		Coal	18			Coal	18
		Shale, brown.				Shale, brown	17
499	NE. ¼ sec. 6	Sandstone, friable.		504	SW. ¼ sec. 17	Coal	12
		Coal	18			Shale, brown	35
		Shale, brown.				Coal	18
		Shale, brown.				Shale, brown.	
		Coal	12				100
		Shale, brown	26			Shale, brown.	
500	NW. ¼ sec. 9	Coal	11	505	SW. ¼ sec. 17	Coal	19
		Shale, brown, about	60			Shale, brown.	
		Coal	8			Shale, brown.	
		Shale, brown.		508	NW. ¼ sec. 18	Coal	18
			117			Shale, brown.	
		Sandstone, white.				Shale, brown.	
		Shale, brown	8	509	NW. ¼ sec. 18	Coal	10
		Coal	8			Shale, brown.	
		Shale, brown, with layers of coal	12			Shale, brown.	
500a	SE. ¼ sec. 5	Sandstone, shaly	10	510	SE. ¼ sec. 7	Coal	16
		Coal	8			Shale, brown.	
		Sandstone, with some brown shale	108			Shale, brown.	
		Coal	13	511	SW. ¼ sec. 7	Coal	18
		Shale, brown.				Shale, brown.	
			167			Shale, brown, weathering white.	
		Shale, gray.		512	NW. ¼ sec. 7	Coal	26
		Shale, carbonaceous	2			Shale, brown.	
		Coal	6			Sandstone.	
		Shale, brown, about	36			Shale, black, carbonaceous	5
		Coal	16	525	NE. ¼ sec. 17	Coal	24
501	NE. ¼ sec. 17	Shale, brown, about	72			Shale, brown.	
		Coal	4				29
		Shale, brown, about	120			Sandstone, gray.	
		Coal	12	526	NE. ¼ sec. 9	Coal	16
		Shale, brown.				Shale, brown.	
			268			Shale, brown.	15
		Shale, brown.		527	NE. ¼ sec. 9	Coal	
		Shale, carbonaceous	3			Shale, brown.	
		Coal	18			Shale, gray.	
		Shale, brown, about	36			Coal	8
502	NW. ¼ sec. 17	Coal	11	528	SE. ¼ sec. 8	Shale, gray	5
		Shale, brown, about	72			Coal	5
		Coal	6			Shale, brown.	
		Shale, brown.					18
			146			Shale, sandy.	
		Shale, brown.		529	SE. ¼ sec. 10	Coal	22
		Coal	19			Shale, brown.	
		Shale, brown	18				
503	SW. ¼ sec. 17	Coal	10				
		Shale, brown	35				
		Coal	18				
		Shale, brown.					
			100				

T. 36 N., R. 70 W.—The Fort Union formation, which forms the surface of the entire township, lies practically horizontal. A single bed (E) of coal is known to outcrop in secs. 1 and 12 of the township and was followed continuously for several miles in the townships to the east and north. No measurement was obtained in this township, but from those taken in townships to the east its thickness is believed to be more than 18 inches in places in this township. Bed D, which is 95 feet below E, outcrops in T. 36 N., R. 69 W., and this, too, probably underlies a portion of T. 36 N., R. 70 W. The following table shows the stratigraphic relation of coal beds of the upper group measured in the northern part of the Lost Spring field:

Section showing stratigraphic relation of coal beds of upper group in northern part of Lost Spring coal field, Wyoming.

	Feet.
Coal bed E: Sections Nos. 615–619, 622, 624–628, 630, 632, 635, 647, 649, 655, 657–659, 662, 676–686.	
Interval	95
Coal bed D: Sections Nos. 611–614, 620, 621, 623, 629, 631, 633, 634, 648, 650, 651, 653, 656, 669–675.	
Interval	14
Coal bed C: Sections Nos. 652, 654.	
Interval	76
Coal bed B: Sections Nos. 636–646, 663–668, 687–691, 693, 695, 696.	
Interval	15
Coal bed A: Sections Nos. 692, 694.	

T. 36 N., R. 69 W.—The Fort Union rocks which outcrop in this township lie practically horizontal (Pls. XLV and XLVIII). Exposures are fairly good and two beds of coal, D and E of the section, were found to outcrop in the northern part of the township. The thickness of bed E (sections 615, 616, and 617) decreases southward and at location 615 it measures only 18 inches. Bed D was found in the townships to the north and east to be very persistent and fairly regular in thickness, but in this township (Nos. 611–614) toward the south it thins and practically disappears. Exposures along the divide between Lightning and Box creeks were good, but on the south side of the ridge no bed of coal having a thickness of over 18 inches could be found.

T. 36 N., R. 68 W.—Along the north side of Walker Creek in secs. 24, 25, and 35 several sections of coal beds were measured (Pls. XLV and XLVIII). The bed, which is composed of two benches (No. 589), was traced several miles to the northeast. The parting increases in thickness, so that it was deemed advisable to map the benches as two separate beds. Sections 589 to 593, measured along the coal outcrops, are shown graphically on Plate XLVIII.

T. 36 N., R. 67 W.—The surface of this township is composed of Fort Union rocks which dip gently westward (Pls. XLV and XLVII). In the western half of T. 36 N., R. 67 W., several beds of coal are exposed. These beds, for the most part, are local lenses and their outcrops could be followed only short distances. In T. 36 N., R. 68 W., to the west, a single bed with a small parting is exposed; in this township, however, the same bed is separated into two benches by a parting 10 to 12 feet thick and is represented as two beds. Sections Nos. 559 to 566 represent the upper and Nos. 570 to 576 the lower bench. About 10 feet above the upper portion of this bed in secs. 7 and 18 there is a lens of coal which shows 32 inches at location 568 but thins either way along its outcrop (567 and 569). The maximum thickness of coal found in the township is in one of the lowest beds (No. 554), where a single bench of coal measures 44 inches.

The bed, however, is not persistent, as is shown by sections Nos. 554 to 557. In fact, it splits up into several small beds (No. 555) only a short distance from the point of maximum thickness. The accompanying section shows the stratigraphic relation of the various beds and the numbers of sections measured along each:

Section showing the stratigraphic relation of coal beds in T. 36 N., Rs. 67 and 68 W.

	Feet.
Coal: Sections Nos. 567–569.	
Interval	10
Coal: Sections Nos. 559–566, 589–591.	
Interval	2–12
Coal: Sections Nos. 570–576, 589, 592, 593.	
Interval	10
Coal: Section No. 577.	
Interval	40
Coal: Sections Nos. 578–582.	
Interval	Not determined.
Coal: Section No. 583.	
Interval	Not determined.
Coal: Sections Nos. 584–588.	

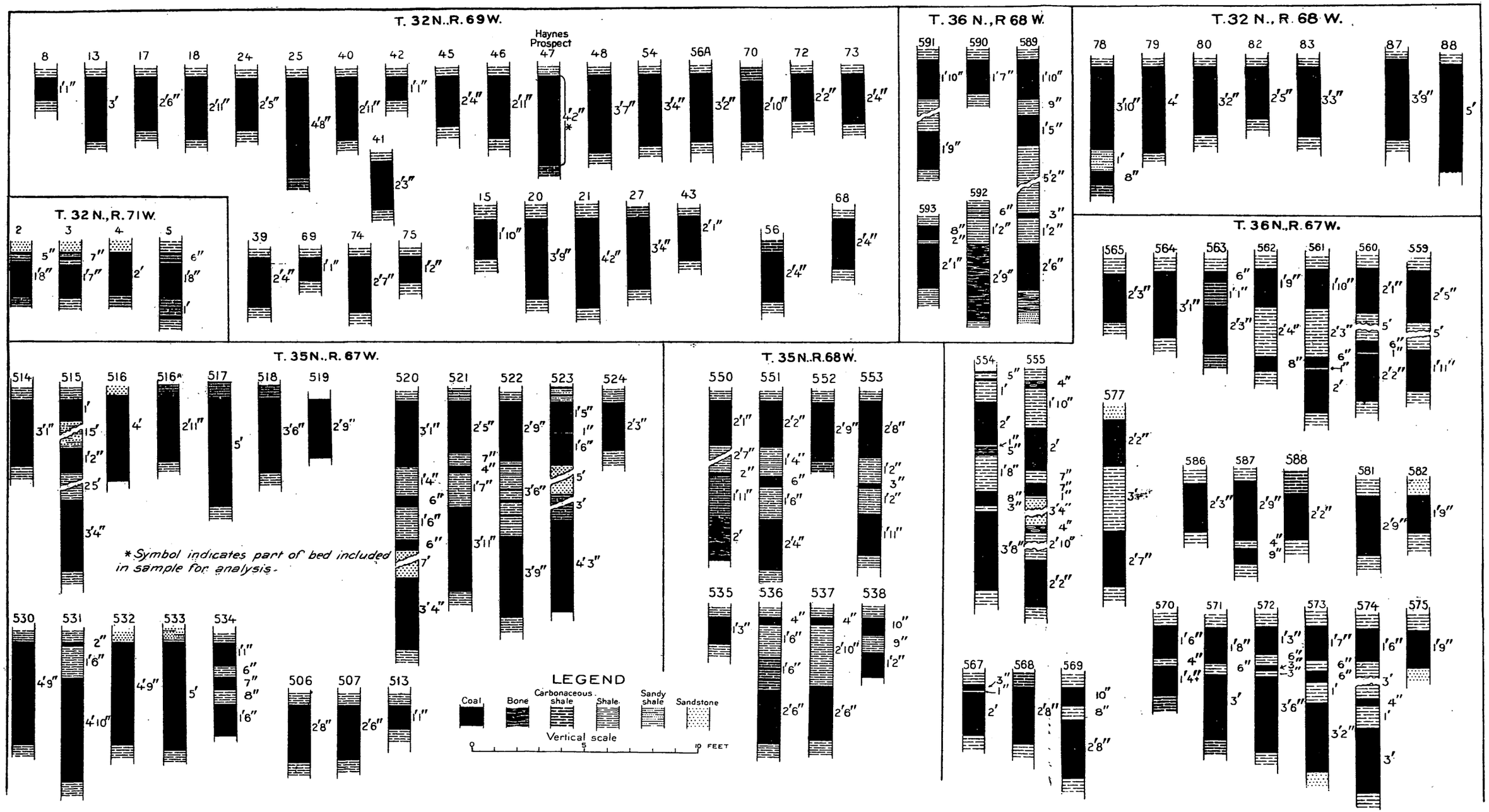
The stratigraphic relation of sections Nos. 554 to 558 was not determined.

Several beds which attain fair thicknesses as indicated by the sections, Plate XLVII, locally were measured at locations 577, 581, 582 to 588 in secs. 4, 7, 8, and 17.

The following sections of coal beds were measured in this township in addition to those shown on Plate XLVII.

Sections of coal beds in T. 36 N., R. 67 W., in addition to those shown on Plate XLVII.

No. on map.	Location.	Section.	Inches.
556	SE. ¼ sec. 30....	Shale, brown.	
		Coal	21
		Shale (15 feet).	
		Coal	26
		Shale, brown.	
			47
557	SE. ¼ sec. 19....	Shale, brown.	
		Coal	12
		Shale (15 feet).	
		Coal	14
		Shale, brown.	
			26
558	SW. ¼ sec. 19...	Sandstone, white.	
		Coal	10
		Shale, brown	45
		Coal	22
		Shale, brown.	
			77
566	SE. ¼ sec. 7.....	Shale, brown.	
		Coal	6
		Shale, brown	17
		Coal	10
		Shale	8
		Coal	25
		Shale, brown.	
			66
576	SE. ¼ sec. 7.....	Sandstone, white.	
		Coal	25
		Sandstone, white.	
578	SE. ¼ sec. 18....	Sandstone, gray.	
		Coal	6
		Shale, brown	12
		Coal	27
		Shale, brown.	
			45
579	NW. ¼ sec. 17..	Shale, brown.	
		Coal	24
		Shale, brown	9
		Coal	21
		Shale, brown.	
			54
580	SW. ¼ sec. 8....	Shale, brown.	
		Coal	23
		Shale	19
		Coal	23
		Shale, brown.	
			65
583	SE. ¼ sec. 8.....	Sandstone, white.	
		Coal	25
		Shale, brown.	
584	SW. ¼ sec. 9....	Shale, brown.	
		Coal	21
		Shale, brown.	
585	SW. ¼ sec. 9....	Shale, brown.	
		Coal	23
		Shale, brown	7
		Coal	3
		Shale, brown.	
			33



* Symbol indicates part of bed included in sample for analysis.

SECTIONS OF COAL BEDS IN SOUTHERN PART OF THE LOST SPRING COAL FIELD, WYOMING

THE NORRIS PETERS CO., WASHINGTON, D. C.

T. 37 N., R. 70 W.—The Fort Union formation in this township lies practically horizontal. Although no coal bed is known to outcrop, parts of the township are supposed to be underlain by one or more beds which outcrop in the township to the east. The thickness and extent of these beds are discussed under T. 37 N., R. 69 W.

T. 37 N., R. 69 W.—Two of the three important coal beds of the Fort Union formation of the northern part of the Lost Spring field outcrop along the southern and eastern margins of this township (Pls. XLV and XLVIII). Bed D (fig. 20), was measured at three places (Nos. 620, 621, and 623) and found to average 51 inches, whereas bed E varies in thickness (sections Nos. 618 to 628) from 11 inches to 33 inches. These beds were both traced for considerable distances outside of the township, as explained in the description of T. 37 N., R. 68 W. In this township several small strip pits have been opened along the outcrop of the coal beds to supply the few ranchers in the neighborhood with fuel.

T. 37 N., R. 68 W.—In the northern part of the Lost Spring field three more or less persistent coal beds belonging to an upper group in the Fort Union formation were found (Pls. XLV and XLVIII). These had not been prospected to any extent, although the ranchers have obtained their fuel supply from the places where thick beds were naturally exposed.

The outcrop of bed B of the upper group, along which sections Nos. 636 to 646 were measured, extends beyond the limits of this township across the townships to the north and east and was found by Mr. Barnett in 1911 to continue several miles to the north beyond the limits of the Lost Spring field.

Bed C outcrops only in secs. 5 and 8 of this township, where sections Nos. 652 and 654 were measured.

Bed D occurs 14 feet above bed C and extends across the township into the adjoining areas. The measurements at locations 629, 631, 633, 634, 648, 650, 651, 653, and 656, give an average thickness of about 51 inches. A sample of the coal of this bed (No. 11447, p. 485) was taken at location 650, where a near-by rancher had obtained his fuel during the winter of 1909 and the coal was fairly free from weathering.

Bed E, the highest exposed in the Lost Spring field, occurs along the ridge between Dry Creek and Lightning Creek in this township. Its thickness varies from 26 inches to 32 inches (sections 630, 632, 635, 647, 649, 655, and 657 to 659), but in adjacent townships a maximum of 116 inches was attained (686). This is the most persistent coal bed outcropping in the Lost Spring field; in fact, the bed was traced by Mr. Barnett in 1911 nearly to the north line of T. 41 N., R. 68 W., but at no place did the thickness exceed that found at location 686.

In addition to the coals of the upper group there are a few beds occurring much lower in the formation, which outcrop along the eastern margin of the township, where thicknesses of 15 inches (661), 27 inches (599), and 31 inches (660) are exhibited.

T. 37 N., R. 67 W.—Several local beds of coal appear at different places in this township, but none were found to attain sufficient thickness to be of value over any large area (Pls. XLV and XLVIII). At one place a bed measured 40 inches (No. 600), whereas other measurements showed 28 inches or less. Sections Nos. 594 to 610 were measured at corresponding locations shown on the map. These beds belong to the general group of coal beds which is mined at the Rosin and Onyon mines farther to the south. North of this township there is practically no coal in this group.

Section showing the stratigraphic relation of coal beds of the lower series in T. 37 N., R. 67 W.

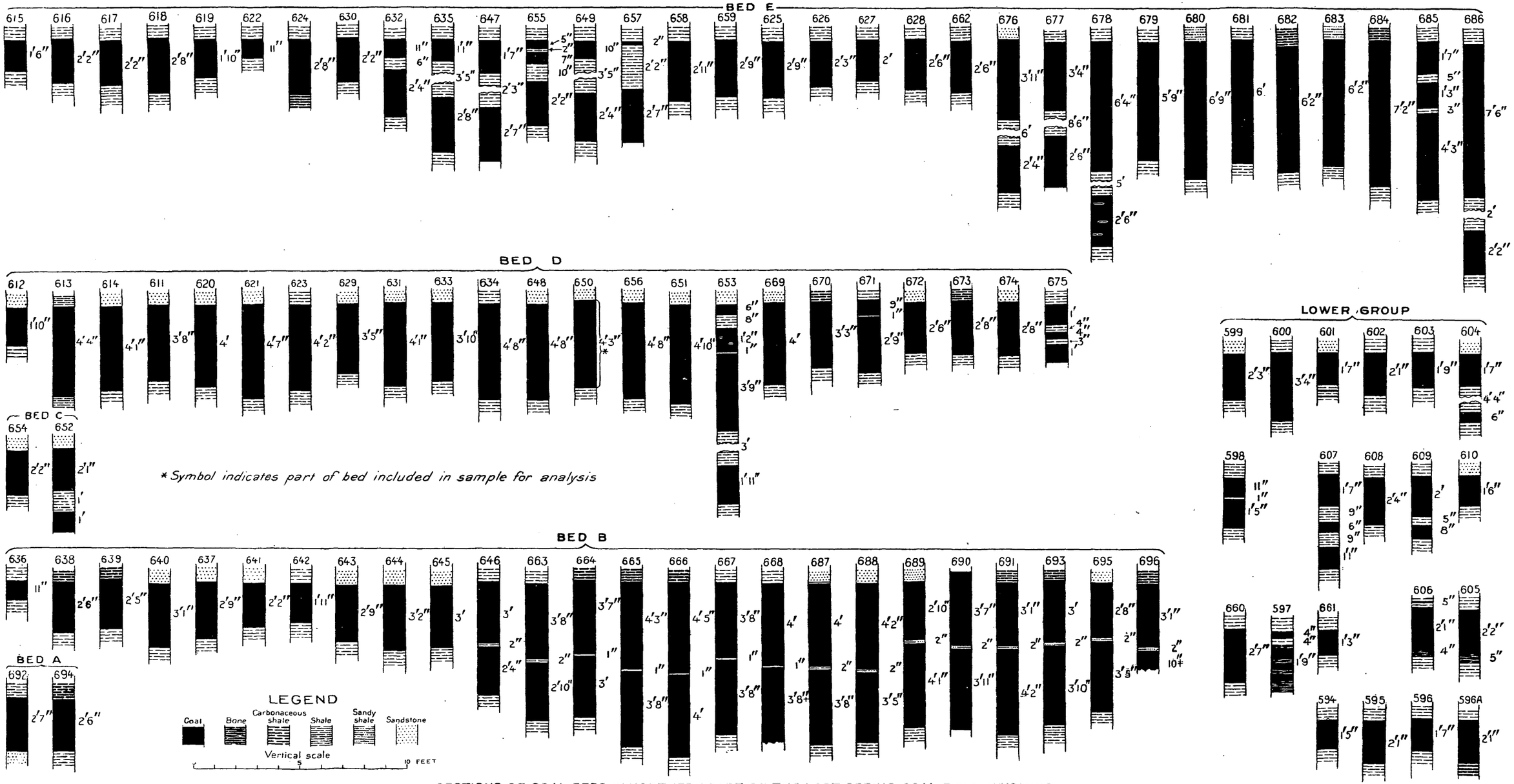
Coal: Sections Nos. 605, 606.
Interval.....50 feet.
Coal: Sections Nos. 599–604.
Interval.....Not determined.
Coal: Section No. 607.
Interval.....20 feet.
Coal: Sections Nos. 608–610.

The stratigraphic relation of sections Nos. 594 to 598 was not determined.

T. 38 N., R. 70 W.—No coal bed was found in this township, but the uppermost of three exposed in the townships to the east is believed to underlie nearly the whole of this township. A discussion of the extent and variability of the several beds exposed in the northern part of the Lost Spring field is given in detail in the treatment of T. 37 N., R. 68 W.

T. 38 N., R. 69 W.—This township is mainly grass-covered, but from the few exposures the Fort Union formation is known to lie practically horizontal. A single measurement of coal bed E, exposed in this township, was made in sec. 36 (No. 662, Pl. XLVIII). This bed, which is the upper of three persistent coal beds, shows a thickness of 30 inches at the place of exposure north of Dry Creek. From data collected in the adjoining townships not only this but beds D and B, which occur below E, are supposed to underlie most of this township.

T. 38 N., R. 68 W.—The rocks in this township lie practically horizontal and are for the most part well exposed (Pls. XLV and XLVIII). Three important coal beds were traced across the township and into those adjoining. The numerous sections along each illustrate the variability of the beds. Bed E, sections 676 to 686, which occurs at the top of the group, varies in thickness from 70 inches, separated into two benches by about 8½ feet of shale (No. 677), to



SECTIONS OF COAL BEDS IN NORTHERN PART OF THE LOST SPRING COAL FIELD, WYOMING

THE NORRIS PETERS CO., WASHINGTON, D. C

116 inches, separated into two benches by 2 feet of shale (No. 686). In secs. 1, 2, 11, 12, and 14 this bed has been burned and the overlying shale baked, forming a resistant clinker which caps numerous buttes and ridges.

Bed D, which occurs 95 feet below bed E, does not attain the thickness exhibited by either of the other beds exposed in the township but reaches a maximum thickness of 48 inches (No. 669). To the north the bed is less important and just east of location 675, in section 13, there is practically no coal present at the horizon. (See sections 669 to 675.)

Bed B, the lowest exposed in the township, outcrops in secs. 24, 25, 26, 27, 33, 34, and 35, and exhibits a good thickness of coal at all places (sections 663 to 672). This bed is everywhere divided into two benches of nearly equal thickness by a band of sandy shale about an inch thick. Outside the main outcrop of this bed there is an area about one-half mile wide where the coal has been burned and there are numerous small buttes capped by the resulting clinker.

Although this township contains two of the thickest coal beds in the Lost Spring field, there has been almost no prospecting here. This is probably due to the fact that the township contains very few ranches and is about 35 miles from the nearest railroad.

T. 38 N., R. 67 W.—In this township (Pls. XLV and XLVIII) bed D is thin and worthless (sections 692 and 694), whereas bed B, which is exposed at the base of Cow Creek Buttes, contains coal of considerable thickness (sections 687 to 691, 693, 695, and 696). This bed is somewhat remarkable in that along nearly its entire outcrop in the Lost Spring field it is characterized by a thin parting of sandy shale near the middle of the bed. In 1911 V. H. Barnett found the bed continuing northward across T. 39 N. and at all points retaining the characteristic parting. So far as known to the writer no other bed of coal in the Lost Spring field, or for that matter in this general region, exhibits such a marked regularity. The maximum thickness observed in this township is 92 inches at location 687. An area of clinker buttes, about half a mile in width, occurs just outside of the outcrop of bed B.