THE SCOBEY LIGNITE FIELD, VALLEY, DANIELS, AND SHERIDAN COUNTIES, MONTANA.

By ARTHUR J. COLLIER.

INTRODUCTION.

Location, purpose of investigation, and acknowledgments.—The possible value of the lignite of eastern Montana and the Dakotas, both as a fuel and as a source of by-products, has been more fully realized since 1914 than before that date, and many inquiries have been made during recent years about the quality of the lignite and its geographic distribution. This paper was prepared for the pur-

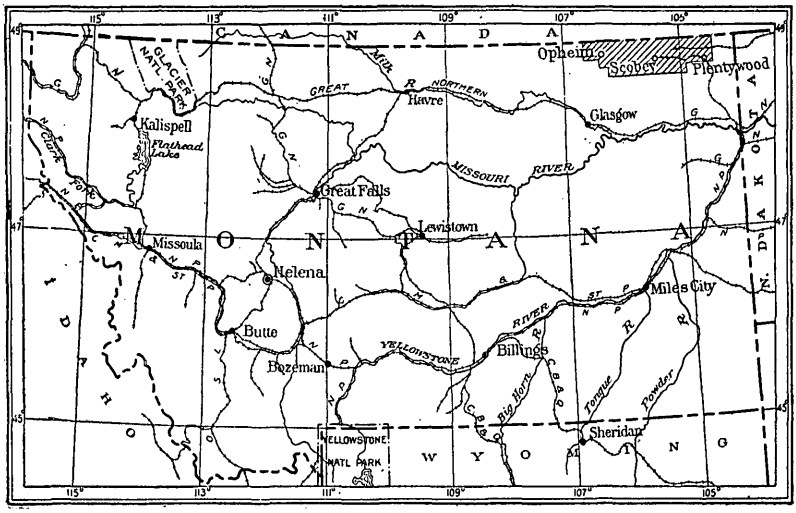


FIGURE 19.—Index map showing location of the Scobey lignite field, Mont.

pose of furnishing information of this sort regarding a field in the extreme northeast corner of Montana, which is a small part of the great lignite region mentioned above. The field is here called the Scobey lignite field, from the county seat of Daniels County.

The Scobey lignite field, as shown on the index map (fig. 19), extends within 20 miles of the Montana-North Dakota line. It is a

strip of land 25 miles wide by 100 miles long, including 53 full townships and parts of 9 townships in Valley, Daniels, and Sheridan counties. Before the passage of the coal-land leasing act this land had been withdrawn from entry because lignite was known to be present in most of it, and in 1915–16 it was examined by the writer mainly to obtain data for classification.

The field lies north of the Fort Peck Indian Reservation, the geology and mineral resources of which have been described by Smith.[1] Two townships north of the reservation in the neighborhood of Scobey and six townships near Plentywood were examined by Bauer,[2] and brief descriptions of these townships adapted from his report are given on pages 202–204 and 227–229 of this paper. A strip of land three townships wide, adjoining the Scobey field on the east and extending to the North Dakota line, was examined by Beekly [3] in 1910. The geology of the region to the north across the international boundary has been described by Dawson [4] and McConnell,[5] and reports on its mineral resources have been made by Dowling [6] and Rose.[7] The field work on which the present report is based was done by the writer, assisted by W. T. Thom, jr., R. F. Baker, E. T. Conant, and H. R. Bennett during the field seasons of 1915 and 1916. To these assistants, as well as to the inhabitants of the Scobey field, the writer is indebted for much of the information contained in this report and for the general success of the work. The identification of the members of the Lance and Fort Union formations in the Scobey field is based upon a reconnaissance by Mr. Thom and C. E. Dobbin in October, 1923.

Base map.—The accompanying map (Pl. XXIX) is based on township plats furnished by the General Land Office. These plats give accurately the location of streams at points where they cross section lines, but the direction of the flow is not always correctly indicated, and the courses of the streams between section lines are not shown accurately. On Plate XXIX the courses of a few of the streams have been changed from those given on the township plats,

[1] Smith, C. D., The Fort Peck Indian Reservation lignite field, Mont.: U. S. Geol. Survey Bull. 381, pp. 40–59, 1910.

[2] Bauer, C. M., Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont.: U. S. Geol. Survey Bull. 541, pp. 293–315, 1914.

[3] Beekly, A. L., The Culbertson lignite field, Valley County, Mont.: U. S. Geol. Survey Bull. 471, pp. 319–358, 1910.

[4] Dawson, G. M., Geology and resources of the forty-ninth parallel, Montreal, British North American Boundary Comm., 1875.

[5] McConnell, R. G., Report on the Cypress Hills, Wood Mountain, and adjacent country: Canada Geol. Survey Ann. Rept., new ser., vol. 1, 1885.

[6] Dowling, D. B., The coal fields of Manitoba, Saskatchewan, Alberta, and eastern British Columbia: Canada Geol. Survey Pub. 1035, 1909.

[7] Rose, Bruce, The Willowbunch coal area, Saskatchewan: Canada Geol. Survey Summary Rept. for 1913, pp. 153–164, 1914; The Wood Mountain coal area, Saskatchewan; Idem for 1914, pp. 64–67, 1915; Wood Mountain-Willowbunch coal area, Saskatchewan: Canada Geol. Survey Mem. 89, 1916.

but all such streams were relocated in the field so as to show their true relation to the outcrops of lignite near them.

As these lands had all been surveyed by the General Land Office since 1914 the land net is in good condition, the townships are regular in size and shape, and the corners were found in the positions indicated.

Field work.—This field is well adapted to rapid examination, as there is no timber and the surface configuration is such that all parts of it are easily accessible. As the prime object of this survey was the classification of the land with regard to lignite, a careful inspection was made not only of mines, wells, and other openings but of the surface of the ground in general to detect by the color of the soil, the materials thrown out by badgers and gophers, or the scoria left by burned beds the possible presence of concealed lignite deposits. The locations of the lignite outcrops, mines, etc., were determined as accurately as possible by tying them to section corners, sometimes by triangulation, but more frequently by stadia measurements, with a telescopic alidade and plane table. The boundaries of the geologic formations shown on the map (Pl. XXIX) were not determined with the same degree of accuracy, except in so far as the D or Redstone coal bed is present at the base of the Fort Union. Elsewhere the boundary between the Lance and the Fort Union formations is rather indefinite, and in a great many parts of the field it is more or less concealed. The contact between the somber beds of the Hell Creek member of the Lance and the yellow beds of the Tullock member can be seen in many places in the Big Muddy Creek valley, in the eastern part of the field. The boundary of the Flaxville gravel shown on the map is not drawn with the same degree of accuracy as that between the Fort Union and Lance formations, but the larger areas of the Flaxville have been roughly mapped and their general positions indicated.

SURFACE FEATURES.

TOPOGRAPHY.

The Scobey lignite field is a part of the Great Plains. This statement may convey to the reader who is not familiar with the region the impression that it is a vast expanse of level land, but that is true only in a broad way. When examined critically the surface features of the Scobey field are found to consist of well-marked plains at three levels, separated by abrupt escarpments, by more or less irregular sloping hillsides, or in places by badlands. The flood plains along the major streams are the lowest lands and range in altitude from 2,100 feet on Big Muddy Creek near Plentywood to about 2,800 feet on the West Fork of Poplar River at the international

boundary. The next higher level is a somewhat irregular surface from 100 to 300 feet above the flood plains, from which it is separated in many places by a steep escarpment. This plain is very extensive in the eastern part of the field north of Big Muddy Creek and is represented in the western part by wide benches bordering the stream valleys. (See Pl. XXI, *A*.) It is a feature that extends eastward for many miles into North Dakota. A third plain from 100 to 200 feet higher than the second forms the surface of several large plateaus on which are situated the towns of Opheim, Tande, and Flaxville. In many places a steep escarpment separates the second and third plains. These plateaus have a general slope to the east of about 5 feet to the mile and ranges in altitude from about 2,700 feet to about 3,100 feet. Unlike the second plain or bench the plateaus have a very smooth surface. They are underlain by a thin sheet of gravel, sand, and silt from which the fossil remains of some very interesting animals have been obtained. This sheet of gravel has been named the Flaxville gravel.[8]

The plateaus, benches, and flood plains are all features of erosion and sedimentation and represent various stages in the general reduction of this region. The plateaus are probably remnants of a general surface at this level which once extended throughout much of the Montana portion of the Great Plains; the second level represents a partial reduction of the surface below the level of the plateaus; and the flood plains are the result of processes going on to-day—erosion by the streams at and near their headwaters and deposition of the eroded material farther down their courses.

The surface of the region has been altered more or less by great ice sheets that moved across it from the north during the glacial epoch. On the plateau the movement of the ice had little effect upon the surface features, and the only visible evidence of glaciation consists of a few granite boulders, which are believed to have been transported by the ice from the Hudson Bay region. On the second or intermediate level the features of glacial origin are very well marked and largely account for the irregularities of the upland at this level, especially in the eastern part of the Scobey field. The most striking of these features are the small lake basins that in the spring are filled with water and dot the surface of the upland with myriad pools, and an indefinite system of shallow watercourses in an uneven sheet of clay and sand containing many boulders of granite and limestone. In many places the boulders have to be cleared off the land before plowing. On the flood plains the marks of the ice

[8] Collier, A. J., and Thom, W. T., jr., The Flaxville gravel and its relation to the other terrace gravels of the Great Plains: U. S. Geol. Survey Prof. Paper 108, pp. 179–184, 1917. Collier, A. J., The geology of northeastern Montana: U. S. Geol. Survey Prof. Paper 120, pp. 17–39, 1918.

sheets are usually concealed, but along Big Muddy Creek and Poplar River terraces of gravel and boulder clay are probably products of the glaciation.

DRAINAGE.

The major perennial streams have their sources in Canada and flow southward across this field to Missouri River. Big Muddy Creek drains the western part, the Middle and East forks of Poplar River drain the central part, and the West Fork of Poplar River drains most of the western part of the field. The two western townships are drained by tributaries of Rock Creek, and the drainage of about two southwestern townships is tributary to Porcupine Creek. Big Muddy Creek flows over a wide muddy valley floor, on which it meanders intricately and is in many places difficult to ford on account of the muddy bottom. It has three tributaries from the west within the field here described. Beaver Creek, at the north, is so named because there are in its course a great many beaver dams with long stretches of quiet water above them. This creek, which carries more water than the Big Muddy above its junction, has a very sinuous course, and its meanders are intrenched about 100 feet in an old valley floor. Whitetail and Eagle creeks carry a considerable volume of water and are deeply intrenched for a few miles above their mouths. The branches of Poplar River flow over gravel bottoms and can be forded easily at nearly all places. The East and Middle forks of Poplar River unite just north of Scobey; and two large tributaries, Coal and Butte creeks, enter the Middle Fork from the west. Coal Creek is about 24 miles long and for 12 miles has a perennial flow. Butte Creek, also about 24 miles long, has a perennial flow for some distance above its mouth. The West Fork of Poplar River carries a considerable volume of water from the international boundary to the south side of the field, but in this field it has no tributaries that flow at all seasons of the year. It can be forded anywhere on account of its gravel bottom. A notable feature of the drainage of the western part of this field is its prevailing southeastward flow. This habit is best illustrated by the West Fork of Poplar River, whose valley follows a straight course for about 50 miles, but it is also exhibited in the Middle Fork of Poplar River and in Police and Bog coulees.

WATER SUPPLY.

Springs emerge near the contact of the gravel and glacial drift with the bedrocks, especially where this contact is cut by the streams. (See Pl. XXVII, *B*.) Wells dug or drilled on the plateaus usually yield water from the base of the gravel. The water from such a source, although it may carry many impurities, is not considered

alkaline. The wells that penetrate the rocks underlying the gravel, however, yield water which, though not extremely alkaline, in many places contains sulphur and iron or other impurities that make it somewhat objectionable. In the eastern part of the field nearly half the wells yield water of this character. Many of the streams that rise in the gravel and glacial drift have water holes, and the larger streams carry an abundance of good water.

CLIMATE, VEGETATION, AND ANIMAL LIFE.

The climate of this area is a little more severe than that of the country along Missouri and Yellowstone rivers, farther south and at lower altitudes in Montana. In the summer the temperature seldom rises to 100°, and the winter persists at least two weeks later than it does along the Missouri. The harvest season does not ordinarily begin before August 15, and threshing may continue until late in the autumn or early in the winter.

This part of Montana has the reputation of being dry, and the homesteaders are referred to as "dry-land farmers." The average annual rainfall is about 13.5 inches, a large part of which falls during the summer, when it is most needed by the growing crops.

There is no forest in this field, but along the forks of Poplar River there are a few small willows and scattered cottonwood trees. On Big Muddy Creek and its tributaries, Beaver, Whitetail, and Eagle creeks, willow, buffalo berry, cottonwood, box elder, ash, and elm grow and afford fence posts for use in the surrounding country. No woody plants larger than the wild rose, which blossoms nearly all summer, are to be found on the uplands away from the streams.

The creek valleys produce a rather luxuriant growth of grass, which is generally cut for hay. The short grass above the heavy sod of the uplands is also cut by the farmers. It yields about half a ton of hay to the acre and affords nutritious forage for both cattle and horses.

SETTLEMENT OF THE REGION.

For many years this region was part of the public range, and cowboys were practically its only human inhabitants. An influx of settlers began in 1908 or 1909 and has continued until there is scarcely a single quarter section of public land unentered. Two of the most important factors in the settlement of any new region are fuel and water for domestic use, both of which are abundantly supplied here. Good water is found in many streams, springs, and shallow wells, and fuel can be had by stripping the outcrops of the numerous lignite beds. Plate XXVII, *B*, shows one of the natural watering places, and Plate XXII, *B*, shows a group of farmers

getting out a winter's supply of fuel. On account of the rapid settlement of the region the roads that were formerly traveled by the cattlemen have been abandoned, and new roads have been built along section lines. These roads were not yet completed in 1915 and 1916 and for this reason have not been shown on the map that accompanies this report. The settlers have broken the sod and planted wheat, oats, barley, and flax. In the season of 1915, which was comparatively moist, the crops generally were good, and some farmers who took exceptional care reported very large yields.

This country is reached by two railroads. The Plentywood branch of the Great Northern Railway leaves the main line at Bainville and follows Big Muddy Creek to Plentywood, beyond which it runs westward to Scobey, about 45 miles from Plentywood. The other road, a branch of the Minneapolis, St. Paul & Sault Ste. Marie Railway, commonly known as the "Soo Line," enters the field from the east and runs westward to the village of Whitetail, its present terminus, a distance of about 40 miles. Both railroads have surveyed lines to the extreme western limit of the field, and that one or both of these proposed extensions will be built is certain, for in the future great crops of wheat and other grains will be produced along them, necessitating facilities for transportation to market. At present these farms produce thousands of bushels of wheat that must be hauled as much as 50 miles before it can be shipped by railroad.

The towns that are situated on railroad lines and may be considered permanent are Scobey, Madoc, Flaxville, Navajo, and Redstone, on the Great Northern; and Whitetail, Daleview, Outlook, and Raymond, on the Soo Line. Each of these towns has from one to four large wheat elevators, which seem to insure their permanency. Opheim and Glentana, in the western part of the field, each has a bank, post office, and stores, but they may not be permanent, for as yet they have no railroad connections. A few of the post offices shown on the map, such as Roanwood, Coalcreek, West Fork, Avondale, Richland, Tande, and Julian may be shifted at any time by the action of the Government in appointing postmasters.

GEOLOGY.

As the primary object of this survey was the classification of the lands with regard to lignite, and as the time for this work was short, the study of the general geology was necessarily of secondary importance. Furthermore, this region is one of grass-covered plains and slopes, in which outcrops are scarce, and to determine the character of the underlying rocks in many places would be difficult, even if the time available were unlimited.

STRATIGRAPHY.

GENERAL SECTION.

The composition and stratigraphic relations of the formations of the Scobey field are shown in the following table:

Geologic formations in the Scobey lignite field, Mont.

Age.	Formation.		Thickness.	Character.
Recent.				Alluvium in valleys; prairie soils; filling of glacial lake beds; beaver dams.
Pleistocene.			A few inches to 100 feet.	Glacial drift consisting of boulders of granite, limestone, etc., strewn over the surface. Thick cover of boulders, clay, and gravel in some valleys and in the entire eastern part of the field.
Unconformity				
Early Pleistocene.				A few small exposures of stratified gravel, sand, and silt on an extensive erosion level about 200 feet below the Flaxville gravel.
Unconformity				
Miocene or Pliocene.	Flaxville gravel.		0 to 100 feet.	Cross-bedded clay, sand, gravel, volcanic ash, and marl; gravel consists of well-rounded pebbles of argillite and quartzite, traceable to the mountains on the west and cemented with calcite in many places. Formation characterized by nearly level upland surfaces.
Unconformity				
Eocene.	Fort Union formation.	Tongue River member.	600± feet.	Fine-grained sandstone, shale, and lignite of prevailingly yellow color.
		Lebo shale member.	200 to 275 feet.	Local somber sandstone and shale. Base of formation commonly marked by thick coal bed (coal D), in places impure.
Tertiary (?).	Lance formation.	Tullock member.	30 to 40 feet.	Yellow fine-grained sandstone and sandy shale with lignite, in places merging laterally into somber beds resembling Hell Creek member.
		Hell Creek member.	150 to 180 feet.	Clay, shale, and sandstone, generally of a somber gray color, in some places cross-bedded; lignite beds in upper part.
Upper Cretaceous	Fox Hills sandstone.		80± feet.	Soft massive yellowish sandstone and minor shale containing lenticular concretions.
	Bearpaw shale.			Dark-gray marine shale.

BEARPAW SHALE.

The Bearpaw shale is the oldest formation exposed in this field and is seen only in the two western townships. It consists of dark-gray marine shale containing fossiliferous concretions and is destitute of lignite.

FOX HILLS SANDSTONE.

The Fox Hills sandstone is exposed along the western border of the field and consists of about 80 feet of yellowish fluviatile sands not known to be lignite bearing. This sandstone has been variously

designated Fox Hills,[9] Fox Hills (?),[10] and Colgate sandstone member of the Lance formation.[11] The Colgate sandstone is now treated as a member of the Fox Hills sandstone.[12] Bones of a dinosaur identified by C. W. Gilmore as *Trachodon annectens*, which also occurs in the Lance formation, were the only fossils obtained from the Fox Hills in this field.

LANCE FORMATION.

Hell Creek member.—The Hell Creek member of the Lance is exposed at the western edge of the field, along the forks of Poplar River, and in the valley of Big Muddy Creek and consists of 150 to 180 feet of somber gray clay, shale, and sandstone. A persistent lignite bed (A) in the upper part of the member contains workable lignite beneath extensive areas of the field, and a thinner but equally persistent lignite (C) marks the contact of the Hell Creek with the overlying Tullock member.

The Hell Creek member of the Lance is well known in Montana and the Dakotas, and its fauna is widely distributed. In some places it has yielded a great many fossil plants, which are similar to those of the Tullock member and of the Fort Union formation, and it is characterized by large fossil bones of dinosaurs of Cretaceous affinities.

The Hell Creek member is poorly exposed on the forks of Poplar River, and its presence there is largely inferred from a few outcrops of a somber color in contrast with the brighter color of the overlying rocks. A good but rather small exposure of this member near the east fork of Poplar River is shown in Plate XXI, *B*. The best exposure of the upper part of the member is that found on Big Muddy Creek (Pl. XXVII, *A*) and its western tributaries above Redstone, where its relation to the overlying Tullock member can be determined with a good deal of precision. The strata of the Hell Creek member exposed here consist of about 100 feet of somber-colored sandstone and clay. The sandstone in many places shows irregular cross-bedding due to wind action and water currents while it was being deposited, and some of the thicker beds appear to be composed of dune sand.

Tullock member.—The Tullock member of the Lance crops out along the valleys of Big Muddy Creek and Poplar River and to a

[9] Dawson, G. M., Geology and resources of the forty-ninth parallel: British North American Boundary Comm. Rept., p. 106, Montreal, 1895.

[10] Smith, C. D., The Fort Peck Indian Reservation lignite field, Mont.: U. S. Geol. Survey Bull. 381, p. 42, 1910.

[11] Beekly, A. L., The Culbertson lignite field, Valley County, Mont.: U. S. Geol. Survey Bull. 471, p. 329, 1912.

[12] Thom, W. T., and Dobbin, C. E., Stratigraphy of the Cretaceous-Eocene transition beds in eastern Montana and the Dakotas (unpublished manuscript).

minor extent along the westward-facing escarpment northwest of Opheim. It usually consists of 30 to 40 feet of fine-grained yellow sandstone and sandy shale, very similar in aspect to the yellow strata of the overlying Fort Union, with a lignite bed (C) at its base. The yellow color of the member is not a universal characteristic, for in some areas its strata resemble those of the Hell Creek member. Plate XXVII, *A*, shows the Hell Creek member of the Lance overlain by about 30 feet of the Tullock member.

FORT UNION FORMATION.

The rocks of the Fort Union exposed in this field belong to the Lebo and Tongue River members of the formation recognized in other fields.

Lebo shale member.—The strata corresponding to the Lebo member are 200 to 275 feet thick and contain some fairly persistent beds of somber clay and sandstone resembling typical Lebo shale. The top of these dark strata lies about 60 feet above the Richardson lignite bed of Bauer,[13] and their base is marked by lignite D, which commonly is a thick bed, locally much broken by partings (Pls. XXIII, *B*, and XXIV).

Tongue River member.—The upper part of the Fort Union formation, corresponding to the Tongue River member of Thom and Dobbin,[14] is lighter colored and closely resembles the yellow phase of the Tullock member of the Lance. The Fort Union is almost completely eroded west of West Fork of Popular River and attains a thickness of 200 to 300 feet only within small areas west of Big Muddy Creek. East of this creek, however, the rocks dip toward the east more rapidly (see fig. 20), and it is estimated that possibly as much as 600 feet of the Tongue River member of the formation is concealed beneath the glacial drift that mantles this part of the field.

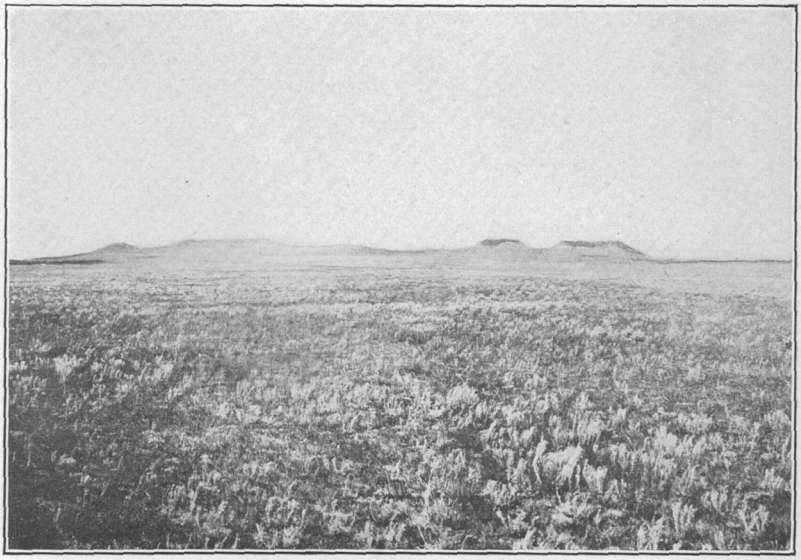
FLAXVILLE GRAVEL.

A mantle of sand, gravel, clay, marl, and volcanic ash, of Miocene or Pliocene age, unconformably overlies the Fort Union and Lance formations in a series of plateaus ranging in altitude from 2,700 to 3,100 feet and has been named the Flaxville gravel.[15] Within extensive areas it completely covers the outcrops of the underlying rocks, which can be found only where wells have been dug. The thickness of this cover reaches a maximum of 100 feet. The forma-

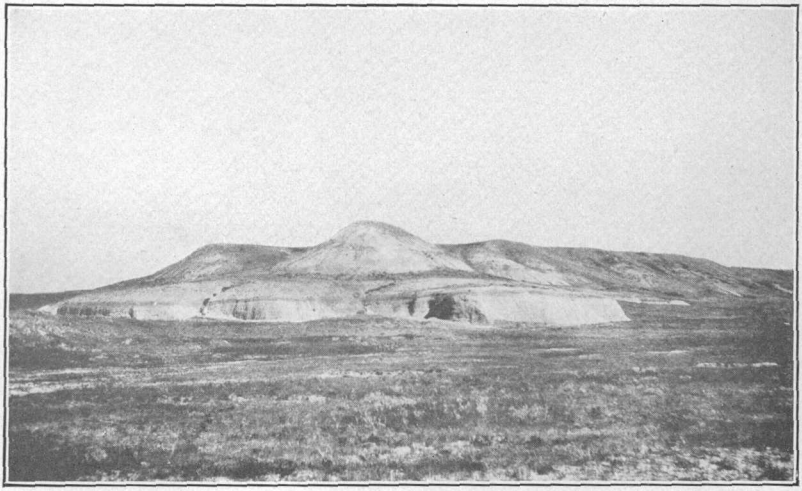
[13] Bauer, C. M., Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont.: U. S. Geol. Survey Bull. 541, pp. 293–315, 1914.

[14] Thom, W. T., and Dobbin, C. E., op. cit.

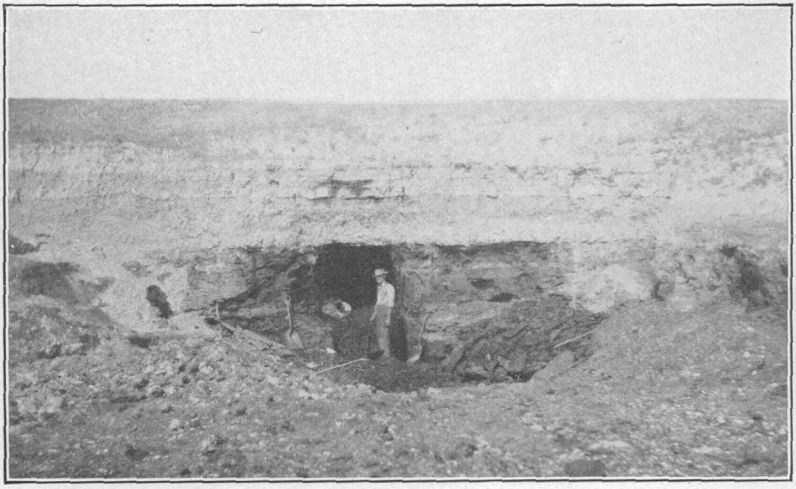
[15] Collier, A. J., and Thom, W. T., jr., The Flaxville gravel and its relation to the other terrace gravels of the northern Great Plains: U. S. Geol. Survey Prof. Paper 108, pp. 179–184, 1917.



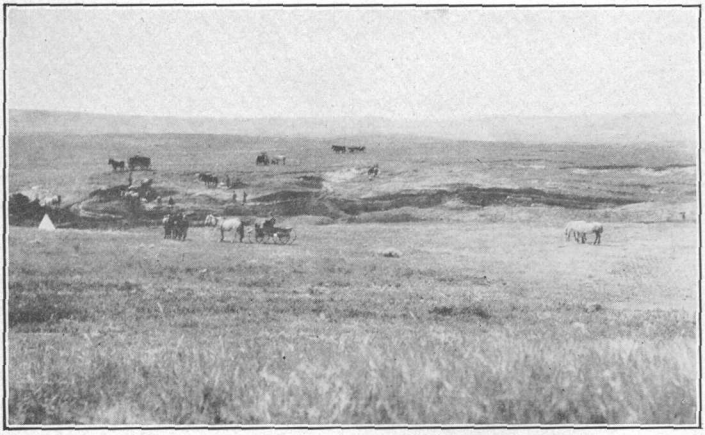
A. EAST SIDE OF WHISKEY BUTTES, SEC. 36, T. 36 N., R. 46 E., SCOBEY LIGNITE FIELD, MONT.



B. ESCARPMENT OF HELL CREEK MEMBER OF LANCE FORMATION, SEC. 23, T. 36 N., R. 48 E., SCOBEY LIGNITE FIELD, MONT.



A. FISHER MINE, LOCALITY 63, SEC. 36, T. 37 N., R. 42 E., SCOBEY LIGNITE FIELD, MONT.



B. FARMERS OPERATING SIOUX CITY MINE, SEC. 34, T. 35 N., R. 43 E., SCOBEY LIGNITE FIELD, MONT.

tion appears to have been deposited in the flood plains of streams, and, as is natural in such deposits, it consists of gravel in some places and of sand and mud in others, and in many places it shows a great deal of cross-bedding. In the western part of the field the upper layer of the formation is composed of impure limestone or marl containing scattered quartzite pebbles and ranges in thickness from a few inches to 10 feet. Wells dug in the Flaxville gravel have yielded many fragments of fossil bones and teeth of the horses, camels, rhinoceroses, and other animals that inhabited the region during the time the formation was being deposited. The Flaxville in general consists of uncemented material, but in wells that have penetrated it there are hard layers cemented by lime. This formation has been referred to by some previous writers as the "quartzite gravel," and those who have studied it report that it consists mainly of quartzite and argillite pebbles of varying size but usually small. On Dawson Coulee, a branch of the West Fork of Poplar River, this formation contains well-rounded quartzite cobbles that measure fully a foot in diameter.

EARLY PLEISTOCENE GRAVEL.

After the deposition of the Flaxville gravel this region was subjected to erosion, which in some places removed the gravel and produced an extensive bench about 200 feet below the level of the plateau.[16] The high lands east of Big Muddy Creek are all included in this bench, whereas west of Big Muddy Creek the bench consists of long, gentle slopes from the base of the escarpment below the Flaxville gravel to the steep slopes leading down to the creeks. Stratified gravel is to be found at only a few places on this bench and has yielded no fossils in this field, but in the region to the west a single tooth identified by J. W. Gidley as that of a horse, resembling the living species, was found. Owing to this discovery and because of the relations of the bench to the Flaxville gravel and to the glacial drift and the features produced by recent erosion it is assigned to early Pleistocene time. Plate XXI, *A*, is a view of this early Pleistocene bench.

GLACIAL DRIFT.

After the erosion that produced the early Pleistocene bench the streams did less cutting for a time, but later they again became active and cut down their present valleys, forming a third gravelly terrace, which is now 50 to 100 feet above the flood plain. Still later a considerable part of Montana was covered by a great ice sheet that moved down from the vicinity of Hudson Bay. When the ice

[16] Idem, p. 182.

melted the surface was strewn with débris which had been gathered by the glacier from the country over which it passed. On the plateaus the drift is represented only by a few granite boulders, but on the second erosion level there are usually more boulders and clay. In the northeastern part of this field the glacial drift is very deep and its surface is very irregular, as it includes the terminal moraine formed at one of the latest advances of the ice sheet. The débris consists of boulders of granite from the west shore of Hudson Bay, boulders of limestone from the neighborhood of Lake Winnipeg, many pebbles from the Flaxville or other gravels, and clay from various sources.

RECENT DEPOSITS.

The large streams of the field flow in valleys intrenched from a few feet to 300 feet. This cutting was accomplished before the glaciers invaded the region, for some of the valleys are partly filled with glacial drift. A notable example of such filling is to be seen on the East Fork of Poplar River, where there are several large mounds of glacial drift as well as many scattered boulders. In the Big Muddy Creek valley the evidence of glaciation must have been largely obscured, for during the final melting of the ice the valley contained a larger stream than at present, and the old valley floor has been extensively covered with silt in postglacial time.[17] In Recent time a thin soil has been developed over the whole upland. This soil, which is usually less than 3 feet thick, is dark and has several inches of tough sod at its top, which has to be broken up with the plow and allowed to decay before crops can be put in. In the areas covered by the uneven surface of the glacial drift there are numerous depressions, once occupied by lakes and ponds, which have been filled by the accumulations of recent time. These old lake beds are dry except after unusual storms and are generally sod-covered like the prairies. Along Beaver, Whitetail, and Eagle creeks, tributaries of the Big Muddy, are many old beaver dams, and above them are long stretches of beaver-dam lands that were formed by the silting up of the ponds since the glacial epoch.

GEOLOGIC STRUCTURE OF THE LIGNITE-BEARING FORMATIONS.

The Fort Union and Lance formations, which underlie the entire area investigated, show a gentle regional dip toward the southeast. (See fig. 20.) Local variations from this regional dip are not readily

[17] Rose, Bruce, Wood Mountain-Willowbunch coal area, Saskatchewan: Canada Geol. Survey Mem. 89, p. 54, 1916.

discernible, because the dips are slight, and much of the surface is covered by the Flaxville gravel and terrace deposits. The plateaus of the region have an easterly slope of approximately 5 feet to the mile, and, considering the fact that a comparatively small thickness of rocks is exposed in the whole field from west to east, the geologist is tempted to infer that these rocks have a uniform dip in the same direction. The distribution of the Lance and Fort Union formations, however, shows that their outcrops are not always in the position which they would naturally take if the structure were as regular as the surface, and when a survey of the individual lignite beds is made and their altitude at several points is determined, it is evident that the formations carrying these beds have been gently folded into minor synclines and anticlines that do not conform to the general slope of the surface. In places enough of a lignite bed is exposed by stripping operations to determine its dip and strike

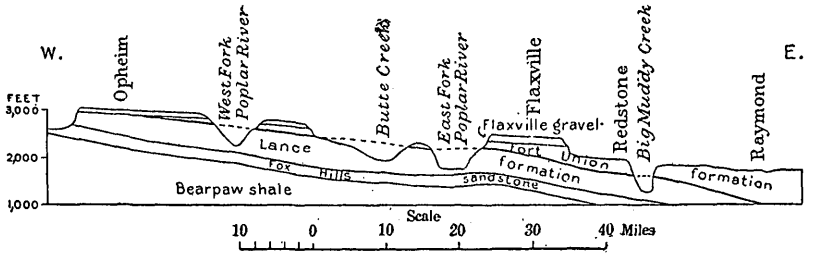


FIGURE 20.—Cross section showing regional southeastward slope of strata in the Scobey lignite field, Mont.

by ordinary methods, but as the strip pits are usually situated at or near springs, some of which probably owe their position to small flexures of the bedrocks, the dips observed at such exposures are usually somewhat greater than the general dip, and the strike may not be parallel to that shown by a more extended survey of the outcrop. No large faults have been observed in this field, and it is thought that none exist, but two small faults with a displacement of less than 15 feet may be seen on the north side of Coal Creek in T. 37 N., R. 45 E., and a third fault of similar proportions affects the Ranous lignite bed near the northwest corner of T. 36 N., R. 52 E.

Except in the townships crossed by Big Muddy Creek none of the lignite beds have been traced far enough to determine the exact location of such features as anticlines and synclines, but the general results of the observations made have been described by Thom,[18] and further details are given in the following pages.

[18] Thom, W. T., jr., Possible oil in northeastern Montana: U. S. Geol. Survey press notice, May 6, 1921.

West Fork of Poplar River.—Along the West Fork of Poplar River in T. 37 N., R. 41 E., there is a broad exposure of the Lance formation and the Fort Union-Lance boundary is 100 feet or more above the river bed. At the Mersch mine, in sec. 17, T. 37 N., R. 42 E., there is a dip of 4° NE. Near the south line of T. 37 N., R. 42 E., and for about 6 miles down the river from this point the Lance outcrop is narrow, and the Fort Union-Lance boundary is near river level. The surface of the exposed lignite bed that is worked at the Fisher mine, in sec. 36 of the same township, shows a dip to the southwest toward the river. On the south side of the river opposite this place there are few exposures of the underlying bedrock, but at the Nehoff mine, in sec. 15, T. 36 N., R. 42 E., on what is thought to be the same bed as that at the Fisher mine, a dip of 3° a little north of east was observed. In nearly all of T. 35 N., Rs. 43 and 44 E., the Lance formation forms the surface, and the Lance-Fort Union boundary is about 100 feet above the river bed. Farther down the river, near the southern boundary of the Scobey field, in T. 34 N., Rs. 45 and 46 E., the Lance-Fort Union boundary again approaches water level. On the north side of the river a lignite bed exposed for several miles dips toward the river, and at the Taylor-Green mine, in sec. 13, T. 34 N., R. 45 E., a dip of 2° SW. has been noted. On the south side of the river the dips are toward the northeast wherever they could be observed. At the Greenup prospect, in sec. 28, the relatively high dip of 6° was noted. Apparently, therefore, on the West Fork of Poplar River there are two anticlines and two synclines.

Coal Creek.—A survey of the lignite bed in T. 37 N., R. 45 E., indicates a syncline with a northeasterly axis. On the south side of the axis the northwest dips are pronounced, but on the north side the dips are slight. South of Coal Creek, near the east side of T. 37 N., R. 45 E., the outcrops of the same bed show a low dome about 3 miles across.

Butte Creek.—The exposures of the Lance formation along Butte Creek in Tps. 35 and 36 N., Rs. 55 and 58 E., probably indicate an anticline extending in a northwesterly direction for about 18 miles.

T. 36 N., R. 47 E.—A survey of the large lignite bed exposed in T. 36 N., R. 47 E., indicates that this part of the field lies in a syncline extending northwestward for about a mile.

East Fork of Poplar River.—The bedrock in the valley of the East Fork of Poplar River is so thoroughly concealed by glacial drift that its structure can not be determined. At two places on the east side of the valley, however, westward dips can be seen. One of these is in a series of cuts on the Great Northern Railway extending for about 2 miles in secs. 1 and 11, T. 35 N., R. 48 E.,

where several thin lignite beds dip westward at a slightly steeper angle than the descending grade of the railroad. About 3 miles north of the railroad in sec. 25, T. 36 N., R., 48 E., a lignite bed was traced northwestward for half a mile from the Callahan mine, and in that distance it showed a dip to the west of 24 feet, or approximately half a degree.

T. 37 N., R. 51 E.—The rocks along Beaver Creek, from sec. 1 to sec. 15, T. 37 N., R. 51 E., dip about half a degree to the northeast. An anticlinal axis extends from the northeast corner of sec. 33 to the western part of sec. 25. A short distance west of Daleview there is probably a syncline with an axis extending northeast, and from 1 to 2 miles southeast of Daleview there is an anticline or dome from which the beds dip westward to this syncline.

Townships east of Daleview.—The bedrock east of Daleview is thickly covered with glacial drift, but from the surveys along Big Muddy Creek in the townships to the south, made in 1912 by C. M. Bauer,[19] it is believed that the rocks dip southeast, as at the east end of the field the Fort Union formation is thought to have a thickness of at least 600 feet.

POSSIBLE OCCURRENCE OF OIL AND GAS.

Apparently most of the structure above described was produced before the Flaxville gravel was laid down, for the Flaxville rests unconformably on eroded surfaces of the Fort Union, Lance, and Bearpaw formations. After the deposition of the Flaxville gravel the drainage took a southeasterly direction, either because of a general slope to the southeast or, as seems more probable, because the surface may have been subjected to gentle folding or warping, which produced structural valleys with low anticlinal ridges between them. Since the last advance of the ice sheet the surrounding country has been uplifted more on the west than on the east.

In the summer of 1915 a company was organized to drill for oil near Plentywood. Although no discoveries of either oil or gas have been made in this field and neither the Lance nor the Fort Union formation is known to be oil bearing, beds of sandstone that contain oil or gas in some places not very remote may underlie these formations in the Scobey field. The gas well near Havre, Mont., about 190 miles west of Scobey, is reported to derive gas from the Eagle sandstone, a formation which may or may not extend as far east as this field.[20] Drilling for oil has been done and small flows of gas

[19] Bauer, C. M., Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont.: U. S. Geol. Survey Bull. 541, pp. 309, 310, 312, 1914.

[20] Stebinger, Eugene, Possibilities of oil and gas in north-central Montana: U. S. Geol. Survey Bull. 641, pp. 41–91, 1916.

have been found near Malta, Mont., about 120 miles from Scobey,[21] and small amounts of gas have been obtained in the northwestern part of North Dakota.[22]

Several small flows of gas are reported from wells in Canada[23] within 100 miles of this field, but the vertical depth below the Lance formation at which these flows were struck is not known.

The most favorable places for the accumulation of oil or gas are the high parts of the anticlines, from which the beds dip away on all sides. If the interpretation of the geologic structure given on pages 168–171 of this report is correct, and the beds are folded into small anticlines and synclines, it is possible that in some of these anticlines oil or gas may be found by drilling to a considerable depth. Before attempting to drill, however, the structure should be determined by more thorough surveys than have yet been made.

THE LIGNITE.

PHYSICAL AND CHEMICAL CHARACTER.

Lignite, as the name implies, is brown coal but little changed from wood and generally shows a woody texture. The lignite beds of this field are in part composed of material showing a woody texture, yielding a brown powder, such as logs and branches of trees, and in part of darker material showing no structure and affording little evidence of its origin. In a few of the mines there are thin layers of so-called mineral charcoal, or "mother of coal," and some of the lignite beds contain layers of black carbonaceous clay, called by the miners "blackjack," which when first mined can not be distinguished from dense lignite except by its weight. Residents of northeastern Montana prefer to burn the woody material rather than the denser parts of the beds, and if distinct samples of the two kinds had been taken for analysis it is probable that the woody lignite would show a lower percentage of ash than the dense lignite.

As fresh lignite contains from 30 to 45 per cent of moisture, it disintegrates readily on exposure to the air and has a low heating value. Air-dried samples of fresh lignite carry from 8 to 14 per cent of moisture, whereas weathered samples generally retain 20 per cent or more. Lignite from this field as it comes from the mine contains from 7 to 10 per cent of ash.

The unweathered lignite is found either in springs where the water runs constantly over the lignite and prevents the oxidizing action of

[21] Collier, A. J., The Bowdoin dome, Mont.: U. S. Geol. Survey Bull. 661, pp. 193–209, 1917.

[22] Collier, A. J., The Nesson anticline, Williams County, N. Dak.: U. S. Geol. Survey Bull. 691, pp. 211–217, 1918.

[23] Clapp, F. G., Petroleum and natural gas resources of Canada: Canada Mines Branch Pub. 291, vol. 2, pp. 249–251, 1915.

the atmosphere, or in deep underground workings; most of the surface croppings yield only weathered material. Samples of the least-weathered lignite obtainable were taken for analysis from eight localities well distributed throughout the field, and these show an average heating value of about 5,940 British thermal units[24] per pound of lignite as mined, or 8,570 British thermal units per pound of air-dried lignite, which is slightly below the average for lignite mined in North Dakota. The samples taken represent both the Lance and Fort Union formations. Three samples from the Lance formation are described below:

23008. From mine of the Ranous Coal Co., at Daleview (locality 377, Pls. XXVII, *A*, XXVIII, XXIX), in sec. 36, T. 37 N., R. 51 W., on Minneapolis, St. Paul & Ste. Marie Railway. Taken at face of main entry, 400 feet northeast of drift mouth and under about 100 feet of cover. Represents 4 feet 11 inches of lignite, the thickness of the bench mined. The sample is slightly weathered, although it was taken far underground.

23025. From Dawson mine, near Opheim (locality 21, Pls. XXVI and XXIX), in sec. 6, T. 36 N., R. 40 E., 66 miles north of Glasgow on Great Northern Railway. Represents a bed of dense lignite having little woody texture, 4 feet 3¾ inches thick. Cut in main entry 120 feet east of drift mouth and under 30 feet of cover. The analysis shows that it is slightly more weathered than sample 23008.

23006. From Baldwin mine, 7 miles northwest of Opheim (locality 20, Pls. XXVI and XXIX), in sec. 7, T. 36 N., R. 40 E., 65 miles north of Glasgow on Great Northern Railway. Represents a bed of lignite 3 feet thick. Cut at face of main entry, 150 feet south-southwest of drift mouth, under 40 to 50 feet of cover.

Analyses of samples from the Fort Union formation do not show any characteristics that will distinguish them from those of the Lance formation. Five samples were taken as follows:

23009. From Hudson Bay mine, in Canada (locality 93, Pls. XXVI and XXIX), three-quarters of a mile north of sec. 1, T. 37 N., R. 44 E., and 25 miles northwest of Great Northern Railway at East Scobey. Represents 1 foot 1 inch of woody lignite. Cut from face of an open pit which was continually wet. The bed was traced continuously from this point to Coal Creek, in Montana, where the next sample was collected.

23007. From Coal Creek mine (locality 129, Pls. XXVI and XXIX), in sec. 16, T. 37 N., R. 45 E., 20 miles northwest of Great Northern Railway at East Scobey, from a short drift 20 feet back from strip face of old workings. Represents 6 feet 4½ inches of lignite from lower part of bed. Showed some signs of weathering, as the bed here has only a thin cover. About half of the material of the bed is dense, and the other half woody. The woody layers when burned give better results than the dense lignite, but this may be due to the fact that the dense material disintegrates or slacks more readily when exposed to the air.

[24] A British thermal unit is the quantity of heat required to raise the temperature of 1 pound of water from 63° to 64° F. The heating value as given means that the complete combustion of a pound of lignite would yield the stated number of British thermal units.

23005. From Fisher mine (locality 63, Pls. XXII, XXVI, and XXIX), in sec. 36, T. 37 N., R. 42 E., 36 miles west-northwest of Great Northern Railway at East Scobey. Represents 5 feet of lignite at face of a drift 6 feet north and back of face of old open pit, under about 5 feet of cover.

23595. Cut under about 30 feet of cover from face of a mine in sec. 9, T. T. 35 N., R. 55 E., opened to supply Plentywood with fuel for heat, light, and power. A power plant and an electric transmission line to Plentywood were under construction at the time of the writer's visit. Sample represents 3 feet 6 inches of woody lignite from lower part of bed. Total thickness of lignite exposed in mine about 9 feet 4 inches.

14670. Taken in 1913 by Bauer at Pierce mine (locality B–52, Pl. XXIX), in sec. 10, T. 35 N., R. 55 E., 2½ miles northeast of Plentywood. Represents 3 feet 9 inches of lignite in lower part of bed.

These samples were collected according to the method in use by the United States Geological Survey and were analyzed by the United States Bureau of Mines. The results of the analyses are given in four forms in the following table—A representing the sample as received at the laboratory, B after air drying under uniform conditions, C water free, and D water and ash free. For comparison with analyses of other lignites the Geological Survey uses the air-dried form (B), it being considered the most uniform. Lignite from the same mines, however, varies greatly in the amount of moisture it holds after air drying, which depends on the condition of weathering and shipment.

Analyses of the following lignites and coals that are shipped into the Scobey field and sold in competition with the local lignite are appended for comparison:

12533. Lignite collected by F. A. Herald at the mine of the United States Bureau of Reclamation 2½ miles northeast of Williston, N. Dak.

4115. Bituminous coal from Sand Coulee, in Great Falls field, Mont., taken in 1905 by C. A. Fisher. Although the coal from Sand Coulee contains a high percentage of ash, this analysis shows a heating value of 11,150 British thermal units without air drying, which is nearly double the heating value of the Scobey lignite as mined. The Great Falls field is on the Great Northern Railway about 500 miles west of the Scobey field.

29004. Subbituminous coal from Bull Mountain field, Roundup, Mont., which is used by some of the residents in the Scobey field. The analysis indicates that it will produce about three-tenths more heat than the Scobey lignite. It can be shipped to this field only over a roundabout railway route at least 400 miles long.

7712. Bituminous coal from Hocking Valley, Ohio, which was on sale at nearly every railroad shipping point in the Scobey field in 1916. The analysis indicates that it will produce twice as much heat as the local lignite.

Analyses of coal samples from the Scobey lignite field, Mont.

[Made at the Pittsburgh laboratory of the Bureau of Mines; A. C. Fieldner, chief chemist.]

Source.	Location.			No. on Pl. XXIX.	Laboratory No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating value.	
	Sec.	T. N.	R. E.					Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Fisher mine, 10 miles northeast of Glentana, Mont.	36	37	42	63	23005	31.6	A	41.3	23.3	26.7	8.7	0.29					3,130	5,630
							B	14.1	24.1	39.1	12.7	.42					5,480	8,240
							C		39.7	45.4	14.9	.49					5,330	9,600
							D		46.6	53.4		.58					6,260	11,270
Coal Creek mine, 20 miles northwest of Scobey, Mont.	16	37	45	129	23007	32.6	A	41.3	23.0	26.4	9.3	.53					3,155	5,680
							B	13.0	34.1	39.2	13.7	.79					4,675	8,420
							C		39.2	45.0	15.8	.90					5,370	9,670
							D		46.6	53.4		1.07					6,375	11,480
Hudson Bay mine, in Canada, 25 miles northwest of Scobey, Mont.				93	23009	28.1	A	38.1	26.1	28.3	7.5	.43					3,535	6,360
							B	14.0	36.3	39.3	10.4	.60					4,915	8,850
							C		42.2	45.7	12.1	.70					5,710	10,280
							D		48.0	52.0		.80					6,495	11,690
Pierce & Fishbeck mine, 1½ miles northeast of Plentywood, Mont.	9	35	55	449	23595	34.5	A	41.3	24.9	27.1	6.7	.42					3,260	5,870
							B	10.3	38.0	41.4	10.3	.64					4,980	8,970
							C		42.4	46.1	11.5	.72					5,555	10,000
							D		47.9	52.1		.81					6,275	11,290
Pierce mine, 2½ miles northeast of Plentywood, Mont.	10	35	55	B-52	14670	5.9	A	34.3	29.6	28.0	8.1	.66					3,755	6,760
							B	30.2	31.4	29.8	8.6	.70					3,990	7,180
							C		45.0	42.7	12.3	1.00					5,715	10,290
							D		51.3	48.7		1.14					6,520	11,730
Baldwin mine, 6 miles northwest of Opheim, Mont.	7	36	40	20	23006	33.0	A	42.7	23.6	25.0	8.72	.55	6.95	34.51	.59	48.68	3,130	5,640
							B	14.4	35.2	37.4	13.02	.82	4.90	51.52	.88	28.86	4,675	8,420
							C		41.1	43.7	15.21	.96	3.85	60.19	1.03	18.76	5,460	9,830
							D		48.5	51.5		1.13	4.54	70.99	1.21	22.13	6,440	11,600
Dawson mine, 7 miles northwest of Opheim, Mont.	6	36	40	21	23025	37.3	A	45.9	22.4	24.6	7.10	.29	7.22	33.11	.61	51.67	3,035	5,470
							B	13.6	35.9	39.2	11.33	.47	4.90	52.84	.97	29.49	4,845	8,720
							C		41.5	45.4	13.11	.54	3.92	61.16	1.13	20.14	5,610	10,090
							D		47.8	52.2		.62	4.51	70.39	1.30	23.18	6,455	11,620
Ranous mine, Daleview, Mont.	36	37	51	377	23008	26.5	A	36.6	23.1	30.3	9.89	.24	6.27	38.30	.49	44.81	3,410	6,140
							B	13.8	31.5	41.3	13.45	.32	3.47	52.11	.67	28.92	4,640	8,350
							C		36.5	47.9	15.61	.38	4.11	60.45	.77	19.32	5,380	9,680
							D		43.3	56.7		.45		71.63	.91	22.90	6,375	11,480

Analyses of coals with which the Scobey coal may have to compete.

	Location.			Laboratory No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating value.	
	Sec.	T.	R.				Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Lignite from Williston, N. Dak.	7	154N	100W	12533	33.2	A	43.9	24.9	25.4	5.8	0.49	----	----	----	----	3,300	5,940
						B	16.0	37.2	38.1	8.7	.73	----	----	----	----	4,940	8,890
						C	----	44.3	45.3	10.4	.87	----	----	----	----	5,875	10,580
						D	----	49.5	50.5	----	.97	----	----	----	----	6,555	11,800
Bituminous coal from Sand Coulee, Mont.	36	19N	4E	4115	2.4	A	6.0	28.5	51.4	14.14	2.38	4.46	63.61	0.91	14.50	6,195	11,150
						B	3.7	29.2	52.7	14.49	2.44	4.28	65.18	.93	12.68	6,350	11,430
						C	----	30.3	54.7	15.04	2.53	40.3	67.67	.97	9.76	6,590	11,870
						D	----	35.6	64.4	----	2.98	4.75	79.66	1.14	11.47	7,760	13,970
Subbituminous coal from Roundup, Mont.	22	8N	25E	29004	3.5	A	13.6	32.9	45.5	8.05	.70	5.56	61.98	.98	22.73	5,935	10,690
						B	10.5	34.0	47.2	8.34	.72	5.37	64.20	1.01	20.36	6,150	11,070
						C	----	38.0	52.7	9.31	.81	4.69	71.70	1.13	12.36	6,870	12,360
						D	----	41.9	58.1	----	.89	5.17	79.06	1.25	13.63	7,575	13,630
Bituminous coal from Hocking Valley, Ohio.	2, 8	13	----	7712	5.5	A	9.7	32.5	53.4	4.43	.54	5.70	69.50	1.25	18.58	6,805	12,250
						B	4.5	34.4	56.5	4.69	.57	5.38	73.55	1.32	14.49	7,200	12,960
						C	----	35.9	59.2	4.91	.60	5.12	76.99	1.38	11.00	7,535	13,570
						D	----	37.8	62.2	----	.63	5.38	80.96	1.45	11.58	7,925	14,270

CLASSIFICATION, TONNAGE, AND USE.

The Geological Survey classifies as coal land all land on which there is 30 inches or more of lignite as determined by subtracting from the total thickness of coal contained in the several benches of a bed the sum of the partings of clay, bone, and impure coal.[25] By this ruling many tracts of land on which thin beds of lignite have been mined by farmers are classified as noncoal land.

The total tonnage of lignite in beds more than 30 inches thick in this field is estimated to be 8,971,100,000 short tons, which would make a cube nearly 6,000 feet on a side. In making this estimate the quantity of lignite contained in a bed 1 foot thick is assumed to be 1,800 short tons to the acre, or 1,152,000 short tons to the square mile. This approximates the actual quantity of lignite contained in a 1-foot bed, but in mining a variable portion is not recovered and is therefore usually wasted. Probably a more easily remembered estimate is 100 tons an acre for each inch of thickness, or 1,200 tons to the acre-foot, which will usually represent more nearly the lignite that is actually obtained by present mining methods. Inasmuch as the loss is variable, however, and can be reduced by more careful mining, the maximum figures are here used. Estimates of the lignite contained in each township will be found in the description of the field by townships. For the eastern part of the field these estimates are necessarily based on very meager data, and when the field is thoroughly tested with deep drill holes they may be found to be either very much too high or very much too low. From the evidence now at hand they seem to be the best obtainable.

In regions where high-grade fuel is abundant lignite would not be prized, but in northeastern Montana, which is almost treeless and has been settled within the last few years, lignite has been searched for, opened, and mined by the farmers in many places and has been one of the most valuable factors in the development of the country. (See Pls. XXII, XXIV.) Eventually the greater part of the fuel for the region will be obtained from more elaborate lignite mines, which are in process of development. The Ranous mine, at Daleview (see Pl. XXVII, *A*), had an equipment in 1915 capable of supplying 50,000 tons of lignite annually. The development of another mine and the installation near it of a plant to supply electric heat, light, and power to Plentywood furnish examples of what may be expected in other parts of the field.

Doubtless new and more efficient methods of using lignite will be introduced. Among these is the automatic stoker, by which crushed

[25] Smith, George Otis, and others, The classification of the public lands: U. S. Geol. Survey Bull. 537, p. 70, 1913.

lignite is spread over wide grates and burned under steam boilers. The gas producer and internal-combustion engine have been used in an experimental way with gratifying results. Experiments are also being made with a view to converting lignite into more efficient domestic fuel by briquetting, and recently a process has been devised in which the lignite is charred by partial combustion, and the carbon residue is then briquetted into a fuel comparable to anthracite for domestic purposes.[26]

DISTRIBUTION.

The lignite of the Scobey field is found in the Lance and Fort Union formations. The Fort Union formation is composed of comparatively regular bedded yellowish sandstone and shale having lignite beds at many horizons; the Lance formation is more irregular, and although it carries lignite beds in many places these are apt to thicken or thin greatly within short distances. The lignite beds of the Lance formation throughout much of the field are too thin to be of commercial value, but the bed mined in Tps. 36 and 37 N., Rs. 39 and 40 E., at the western edge of the field, and at the Mead mine, in sec. 3, T. 35 N., R. 44 E., near the West Fork of Poplar River, are in the Lance formation. Near Big Muddy Creek in Tps. 36 and 37 N., Rs. 51 and 52 E., several beds of lignite of the Lance formation, including that at the Ranous mine, the only shipping mine of the district, have been traced along the outcrop for considerable distances. In the western part of the field the Fort Union formation has been more or less eroded, and only a few feet containing the lowest lignite beds remains, whereas farther east several good beds at higher levels are found.

A few small lignite beds have been found in the Flaxville gravel. The best known is in a well in sec. 33, T. 35 N., R. 49 E., where two small lignite beds overlying gravel are reported. This may be either Fort Union lignite eroded and redeposited during the Miocene epoch or an original deposit in the bed of a small Miocene pond or lake.

The vertical distribution of the lignite beds in the Lance and Fort Union formations (see fig. 21) in the eastern part of the field is given in the following section:

Section showing lignite beds in the Fort Union and Lance formations.

[Compiled from measurements in Tps. 34 and 35 N., R. 51 E.]

Fort Union formation:	Ft.	in.
Lignite, McMahan bed, horizon J	6	3
Shale and sandstone, in part concealed	30	
Lignite, Eagle's Nest bed, horizon I	4	

[26] Odell, W. W., Report of lignite carbonization experiments conducted at Grand Forks in 1922: U. S. Bur. Mines Repts. Inv. 2441, February, 1923.

	Ft.	in.
Fort Union formation—Continued.		
Shale and sandstone, in part concealed	50	
Lignite, horizon H		10
Shale and sandstone	19	
Lignite, horizon G	1	2
Sandstone, shaly	18	
Lignite, horizon F	2	
Shale grading upward into yellow sandstone	27	
Lignite, horizon E	1	6
Shale and sandstone, in part concealed	20	
Lignite, Redstone bed, horizon D	6	
Lance formation:		
Shale and sandstone	22	
Lignite, horizon C	1	
Shale and sandstone	30	
Lignite, horizon B	1	10
Shale and sandstone	21	
Lignite, horizon A	6	
	268	7

The interval between the top of this section and the Richardson and other beds exposed near Plentywood, at the east end of the field, can not be determined exactly, because the bedrocks are not well exposed east of R. 51 E., but considering the eastward dip of the strata along Big Muddy Creek as given by Bauer and along the Missouri as given by Beekly, the writer believes that the thickness of the Fort Union formation north of Plentywood must be about 600 feet.

The distribution and variation of lignite beds in the central part of the field is shown by a section partly exposed near the east side of T. 36 N., R. 48 E., and a section measured in T. 36 N., R. 47 E., and T. 37 N., R. 46 E.

Section of the lignite-bearing rocks on the east side of the Middle Fork of Poplar River, in T. 36 N., R. 48 E.

	Feet.
Fort Union formation:	
Sandstone and shale.	
Lignite	2
Sandstone and shale, yellowish	50±
Lignite (horizon E, Callahan bed)	4
Shale and sandstone, yellowish	24
Lignite (horizon D)	3
Lance formation:	
Shale and sandstone, yellowish	15
Lignite (horizon C, Barber bed)	3
Shale, sandstone, and thin lignite beds	46
Lignite (horizon B)	2
Shale and sandstone.	
	149

Section of the lignite-bearing rocks in the vicinity of Coal Creek.

[Compiled from field notes taken in Tps. 36 and 37 N., Rs. 46 and 47 E.]

	Ft.	in.
Fort Union formation:		
Sandstone and shale.		
Lignite (horizon D, Coal Creek bed)	20	
Lance formation:		
Sandstone and shale	40	
Lignite (horizon C)	2	6
Sandstone, yellow	8	
Lignite (horizon B)	2	
Shale and sandstone	50±	
Lignite (horizon A)	1	
Shale and sandstone.		
	123	6

The following section shows the position of the lignite beds near the West Fork of Poplar River in T. 34 N., R. 45 E.:

Section of lignite-bearing rocks in T. 34 N., R. 45 E.

	Ft.	in.
Fort Union formation:		
Sandstone and shale.		
Lignite (horizon E)	3	
Sandstone and shale	35	
Lignite (horizon D)	2	6
Lance formation:		
Sandstone and shale	60	
Lignite (horizon C)	2	
Sandstone and shale	50	
Lignite (horizon B)	1	
	153	6

Section of the Lance and Fort Union formations showing the position of the lignite bed in T. 37 N., R. 39 E.

	Feet.
Glacial drift, scattered boulders.	
Flaxville gravel	27
Tullock member of Lance formation: Sandstone, yellowish, shaly	42
Hell Creek member of Lance formation:	
Shale, gray	10
Shale, brown to black, fissile	5
Shale, gray, sandy	28
Shale, carbonaceous, with streaks of lignite	1
Shale, gray	8
Lignite	4
Shale, gray	74
Fox Hills sandstone:	
Sandstone, yellowish, shaly	80
Bearpaw shale, dark gray	221
	500

These sections, from west to east across the field, are shown graphically in Figure 21.

The horizons of the lignite beds are designated by the letters A, B, C, etc., and on the map (Pl. XXIX) the same letters are placed on lignite beds found at approximately the same horizons, but it must not be assumed that any individual bed has been traced throughout the field or that its character is such as to make it identifiable in all parts of the field.

DETAILS BY TOWNSHIPS.

The lignite exposures found in each township are described in detail to facilitate reference by anyone interested in particular tracts of land. The townships are numbered from south to north, the ranges from west to east. The descriptions begin with T. 36 N.,

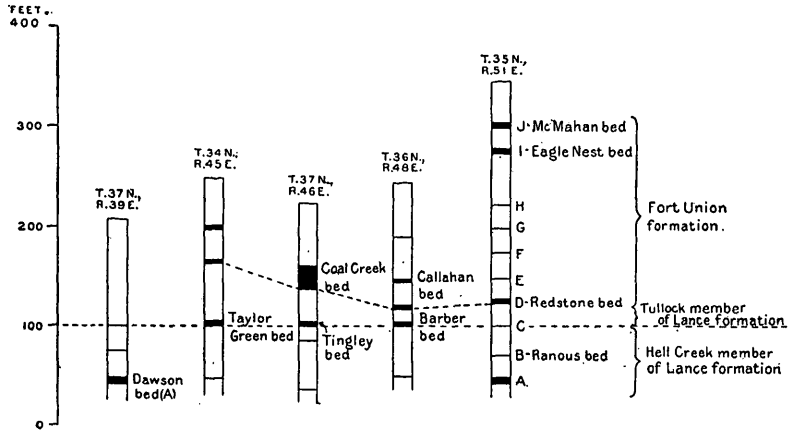


FIGURE 21.—Cross section showing vertical distribution of lignite beds in the Scobey field, Mont.

R. 39 E., and end with T. 37 N., R. 55 E. Each measured section of a lignite bed is given a serial number, which is used in the township descriptions and is also used to show the location of the section on the map (Pl. XXIX). These numbers run from 1 to 451 and are consecutive with the arrangement of the townships. The sections of lignite beds that could be measured and contain more than 2½ feet of lignite after subtracting the partings of shale, clay, or bone, the minimum thickness required for classification of the land as coal land, are shown graphically on Plates XXVI and XXVIII; those that are not well exposed or are less than 2½ feet thick after deducting a thickness equivalent to the partings are given in the text. The vertical relations of the beds or their places in the stratigraphic section are indicated on the map and the section plates by the letters A, B, C, etc., A representing the lowest lignite zone noted in the field and J about the topmost.

T. 36 N., R. 39 E.—Only two small salients of the western boundary of the Scobey lignite field (see Pl. XXIX) lie within T. 36 N., R. 39 E., in the greater part of which about 300 feet of the Bearpaw and Fox Hills formations is exposed. A lignite bed called the Dawson bed, at horizon A or B, in the Lance formation, was measured at locality 1, in sec. 12, where its thickness is about 3 feet 8¾ inches exclusive of the shale parting. It is shown graphically on Plate XXVI. The lignite in this township is estimated at about 10,000 tons.

T. 37 N., R. 39 E.—The Lance formation is present in about half of T. 37 N., R. 39 E., but the lignite beds are near the east line. The Dawson bed, in the upper part of the Lance, near horizon A or B, has been traced more or less continuously across the township. The bed is more than 2 feet 6 inches thick at locality 2, sec. 35; locality 3, sec. 36; locality 4, sec. 25; locality 7, sec. 24; localities 8 and 9, sec. 23; locality 10, sec. 14; locality 11, sec. 13; locality 14, sec. 12; and locality 15, sec. 1. The measurements at these places are shown graphically on Plate XXVI. Lignite has been mined from strip pits at localities 2, 3, 4, 7, 11, 14, and 15.

At locality 6 the lignite is less than 2 feet 6 inches thick.

Section of lignite bed at locality 6, sec. 24, T. 37 N., R. 39 E.

	Ft.	in.
Shale.		
Lignite	1	2
Clay	3	4
Lignite	1	
Clay.		
Total bed	5	6
Total lignite	2	2

At localities 12 and 13, sec. 11, the bed is without partings and measures 2 feet and 2 feet 1 inch, respectively.

Masses of clinkers and a small area in which the lignite may not be entirely burned, in the N. ½ sec. 2, are shown by Plate XXIX. At locality 5 lignite has been found, but not measured, in a well 80 feet below the surface. A lens of lignite 1 foot thick about 25 feet above the large bed is exposed at locality 16, sec. 26. The quantity of lignite in beds more than 2½ feet thick in this township is estimated at 13,800,000 tons.

T. 36 N., R. 40 E.—Exposures of the underlying rocks are good near the northwest corner of T. 36 N., R. 40 E. The only lignite bed known in the township is in the Lance formation near horizon A or B, a short distance below the Lance-Fort Union contact. At the Baldwin and Dawson mines, localities 20 and 21 (see Pl. XXIX), graphic sections of which are given on Plate XXVI, drift mining has been begun and a combined annual production of over

2,000 tons is reported. Sample 23006 was collected at the Baldwin mine, and sample 23025 represents the lignite at the Dawson mine.

Sections measured at localities 17, 18, and 19 show less than 2½ feet of lignite. At locality 17, sec. 19, the bed is without parting and contains 1 foot 1 inch of lignite.

Section of lignite bed at locality 18, sec. 18, T. 36 N., R. 40 E.

	Ft.	in.
Shale.		
Lignite		5½
Shale		2¾
Lignite		9
Shale.		
Total bed	1	5¼
Total lignite	1	2½

Section of lignite bed at locality 19, sec. 7, T. 36 N., R. 40 E.

		in.
Shale.		
Lignite		4
Shale		5½
Lignite		8
Shale, carbonaceous.		
Total bed	1	5¼
Total lignite	1	

At locality 22, in sec. 22, 5 to 5½ feet of lignite is reported from near the bottom of a well 90 feet deep.

It is estimated that this township contains at least 13,800,000 tons of lignite in beds more than 2½ feet thick. Should future development prove that the report of lignite struck in the well in sec. 22 is correct, this estimate will be too low.

T. 37 N., R. 40 E.—The lignite beds exposed in T. 37 N., R. 40 E., are in the Lance formation, at horizon A or B, not far below the Fort Union contact. A bed much burned in places has been traced across secs. 6 and 7, and at localities 28, 29, and 30, sec. 6, its thickness is slightly more than 2 feet 6 inches, as shown on Plate XXVI. This bed is thinner in some old workings at locality 27, sec. 7, where the following section was measured:

Section of lignite bed at locality 27, sec. 7, T. 37 N., R. 40 E.

	Ft.	in.
Shale, blue	2	2
Lignite		6
Shale		8
Lignite	2	4
Total bed	5	8
Total lignite	2	10

At the other localities in this township, shown on Plate XXIX, the lignite beds are thin and divided by partings. The following section is exposed in a shallow well at locality 23, sec. 20:

Section of lignite bed at locality 23, sec. 20, T. 37 N., R. 40 E.

	Ft.	in.
Shale	8	
Shale, black	1	
Shale	21	
Lignite		8
Shale	1	
Lignite	1	3
Shale.		
Total bed	2	11
Total lignite	1	11

A well 150 feet deep at locality 25, sec. 17, is reported to have cut seven layers of lignite from 5 to 15 inches thick, between 36 and 85 feet from the surface. A well at locality 26, sec. 17, passed through three small layers of lignite between 30 and 50 feet from the surface, and a well at locality 24, sec. 20, passed through a layer of lignite at 3 feet and another at 45 feet from the surface.

The whole township is estimated to contain 17,200,000 tons of lignite in beds from 2½ to 5 feet thick.

T. 35 N., R. 41 E.—Lignite has been found in a well at locality 31, sec. 1, T. 35 N., R. 41 E., where it is commonly reported to be about 2 feet thick, but when the well was visited little evidence of lignite was revealed. One of the men who dug the well stated that only an inch or two of disintegrated lignite or "slack" was found. This well probably penetrates a weathered lignite bed in the underlying Lance formation, as its water is not fit to drink.

T. 36 N., R. 41 E.—A lignite bed at horizon B or C is reported to have been found in the town well of Opheim, locality 32, sec. 30, T. 36 N., R. 41 E. This well is 140 feet deep, but reports disagree as to the thickness of the bed. Mr. Opheim stated that it is a small bed, whereas one of the men who own mines west of Opheim declared it to be at least 5 feet thick.

At locality 33, sec. 8, horizon not determined, the following section was measured:

Section of lignite bed at locality 33, sec. 8, T. 36 N., R. 41 E.

Shale.	Ft.	in.
Lignite, dirty		8
Shale		3½
Lignite		7½
Bone		3
Total bed	1	10
Total lignite	1	3½

About 40 feet stratigraphically below this section a bed of carbonaceous shale and bone is exposed in a shallow well at locality 34, sec. 4. A lignite bed more than 5 feet thick is reported to have been found in locality 35, sec. 10, and at locality 36, sec. 15, the following

section, which is probably higher than the bed reported, was measured:

Section of lignite bed at locality 36, sec. 15, T. 36 N., R. 41 E.

	Ft.	in.
Sandstone, yellow	7	
Lignite "smut"		3
Shale, gray	4	2½
Lignite		2½
Shale		⅜
Lignite	1	5
Shale.		
Total bed	6	1⅜
Total lignite	1	10½

From the evidence available this township is considered noncoal land.

T. 37 N., R. 41 E.—At locality 37, sec. 30, and locality 38, sec. 18, T. 37 N., R. 41 E., beds of lignite, probably near horizon B, measuring 1 foot 2 inches and 1 foot 3 inches, respectively, are exposed. At locality 40, sec. 9, 1 foot of lignite was exposed in the bottom of a pit 6 feet deep, and at locality 39 a bed slightly lower in the same section, about 2 feet thick, showed in a well 8 feet below the surface. At locality 41, sec. 4, the outcrop of a small bed of carbonaceous shale or much weathered lignite was noted. At locality 45, sec. 1, the formation is clearly the Fort Union, and a lignite bed near horizon C has been reached in a well and is reported to have shown the following section:

Section of lignite bed reported in a well 42 feet deep at locality 45, sec. 1, T. 37 N., R. 41 E.

	Feet.
Sandstone.	
Lignite	4
Sand, hard	3
Lignite	2
Total bed	9
Total lignite	6

At locality 42, in Canada, about 1½ miles a little north of east of the northwest corner of the township, lignite near horizon C is being mined at the present time. At this place 4 feet of lignite overlain by sandstone is exposed, but the bottom of the bed is concealed; hence its full thickness is not known. The same bed is present under thin cover in sec. 4, where its outcrop, consisting of very much weathered lignite, was found at localities 43 and 44; it measures approximately 29 inches and 23 inches, respectively, but the exact thickness of the bed could not be determined.

This township is estimated to contain 4,600,000 tons of lignite in beds having more than the minimum thickness for classification.

T. 33 N., R. 42 E.—Fractional T. 33 N., R. 42 E., lies upon the high plateau described on page 160, and its surface is composed of the Flaxville gravel, above which there is a very thin sprinkling of glacial boulders. Snow Coulee crosses its western part. The underlying rocks are not exposed, but they are presumably of the Lance formation. No lignite has been found in this township, and it is considered noncoal land.

T. 34 N., R. 42 E.—The bedrocks, which are believed to belong to the Lance formation, are completely concealed in T. 34 N., R. 42 E., by the Flaxville gravel, upon which there is a thin coating of glacial drift consisting of scattered granite boulders. No lignite beds are exposed or reported by well diggers, and the township is considered noncoal land.

T. 35 N., R. 42 E.—At locality 46, sec. 33, T. 35 N., R. 42 E., fragments of lignite and accompanying rocks were found scattered about the dump of a well recently drilled. The thickness of the bed is reported to be about 2 feet. Lignite of undetermined thickness is also reported to have been found in some shallow wells at locality 47, sec. 32. At locality 48, sec. 2, about 40 feet of somber-colored clay shale is exposed in an escarpment, at the top of which gophers have brought a small amount of lignite "smut" to the surface.

The township is considered noncoal land.

T. 36 N., R. 42 E.—At the Nehoff mine, locality 52, sec. 5, T. 36 N., R. 42 E., a bed of lignite at horizon D, 6 feet 5 inches in thickness exclusive of partings, is exposed. This bed is shown graphically on Plate XXVI. At this mine a dip of about 3° E. is plainly visible. The Nehoff bed is also exposed in a well at locality 53, sec. 13, where its thickness is variously reported from 2½ to 6 feet. At locality 49, sec. 34, 5 feet of disintegrated lignite, which may be the Nehoff bed, is reported from a well. At the other localities noted small beds above or below the Nehoff bed are exposed. At locality 50, sec. 7, about 2½ feet of carbonaceous material mixed with soil rests on clay. At locality 51, sec. 8, 1½ to 2 feet of lignite is reported in an abandoned prospect. At locality 54, sec. 23, 2 feet of lignite is reported from an old strip pit; at locality 55, sec. 24, a bed about 2 feet thick was measured; and at locality 56, sec. 25, 2 feet of lignite was encountered in a well at a depth of 116 feet. On the assumption that the Nehoff bed underlies 17 sections and has an average thickness of 5 feet, about 97,900,000 short tons of lignite is estimated for the township.

T. 37 N., R. 42 E.—A thick lignite bed, presumably at horizon D, in the Fort Union formation, crops out across T. 37 N., R. 42 E., from the northwest corner to the southeast corner. It is worked at the Fisher mine (see Pl. XXII, *A*), locality 63, sec. 36, and the Mersch mine, locality 61, sec. 17. The Mersch mine is a local strip

pit; at the time of visit the Fisher mine was being developed in preparation for operation as a drift mine. A sample of the lignite from the Fisher mine was taken in a short drift started during the summer of 1915 by Jack Kerrigan, the operator. (For analysis see No. 23005, p. 175.) At locality 62, sec. 27, the thickness of the bed was tested with an auger. Sections of the lignite beds at these localities are shown graphically on Plate XXVI. The position of the bed is known, but complete measurements could not be made in old prospect pits at locality 60, sec. 17, and locality 59, sec. 8, where 2 feet or more of lignite is exposed. Probably the same bed, though it may be a higher one, is exposed, showing a thickness of 8 feet (for section see Pl. XXVI) in a mine at locality 66, in T. 1 N., R. 2 W., Saskatchewan, 1½ miles north of the northwest corner of sec. 6. A bed about 40 feet below the Fisher bed, presumably at horizon C, is reported at locality 45, sec. 1, of the township west of this (see Pl. XXIX), the position of which in this township is indicated by an old prospect at locality 58, sec. 7, where no measurement was possible. Sections of a small bed in the Fort Union formation above the Fisher bed are as follows:

Section of lignite bed at locality 65, sec. 26, T. 37 N., R. 42 E.

	Ft.	in.
Sandstone, yellow.		
Lignite		4
Clay	1	8
Lignite		6
Sandstone, yellow.		
Total bed	2	6
Total lignite		10

Section of lignite bed at locality 64, sec. 25, T. 37 N., R. 42 E.

	Ft.	in.
Shale.		
Lignite		5
Clay		4
Lignite	1	2
Shale.		
Total bed	1	11
Total lignite	1	7

At locality 57, sec. 27, a bed of lignite 1 foot 10 inches thick in the Lance formation is exposed in an old strip pit.

This township is estimated to contain about 110,600,000 tons of lignite in beds from 2½ to 7 feet thick.

T. 33 N., R. 43 E.—No lignite has been found in fractional T. 33 N., R. 43 E., and probably no beds more than 2½ feet thick are present.

T. 34 N., R. 43 E.—No lignite beds are exposed in T. 34 N., R. 43 E., and there are probably no beds thick enough to justify its classification as coal land.

T. 35 N., R. 43 E.—A bed of lignite 3 feet thick, near horizon B, crops out east of what is known as the Dawson Coulee mine, at locality 67, sec. 17, T. 35 N., R. 43 E., and is shown graphically on Plate XXVI. In the old mine workings in the southeast corner of sec. 18, locality 68, it is less than 2½ feet thick. This mine was not in operation in the summer of 1915, and the farmers in the neighborhood were operating the Sioux City mine, at locality 70, sec. 34, which may be in the same bed. (See Pl. XXII, *B*.) The method of operating the strip pit at the Sioux City mine may be seen in Plate XXIII, *A*.

Sections of the lignite bed at these two mines are as follows:

Section of lignite bed at locality 68, sec. 18, T. 35 N., R. 43 E.

	Ft.	in.
Shale.		
Lignite		2
Shale		1
Lignite	1	6+
Total bed	1	9+
Total lignite	1	8+

Section of lignite bed at locality 70, sec. 34, T. 35 N., R. 43 E.

	Ft.	in.
Shale.		
Lignite		1¼
Bone	1	5
Lignite		9½
Bone		2
Lignite	1	3½
Shale.		
Total bed	3	9¼
Total lignite	2	2¼

Lignite beds which may be at the same horizon as those noted above are exposed at locality 69, sec. 13, and locality 71, sec. 25. At locality 71 there is 1 foot 6 inches of lignite exposed. The measured section at locality 69 is as follows:

Section of lignite bed at locality 69, sec. 13, T. 35 N., R. 43 E.

	Ft.	in.
Shale.		
Lignite	1	7
Shale		4
Lignite		4
Shale		2
Lignite	1	
Shale	10	
Lignite		10
Total section	14	3
Total lignite	3	9

It is estimated that not more than 20,000 tons of lignite in beds more than 2½ feet thick is present in this township.

T. 36 N., R. 43 E.—A bed of lignite, thought to be at horizon D, exposed in the Bonnabel mine, at locality 74, sec. 25, T. 36 N., R. 43 E., has a thickness of 4 feet 3 inches and is shown graphically on Plate XXVI. Smaller beds observed short distances north and south of this mine may be on the same bed, but they more probably represent strata overlying or underlying it. The sections are as follows:

Section of lignite bed at locality 75, sec. 24, T. 36 N., R. 43 E.

	Ft.	in.
Shale.		
Lignite		5½
Shale		¼
Lignite	1	2
Shale	7	3
Lignite	1	6½
Shale.		
Total section	10	5¼
Total lignite	3	2

Section of lignite bed at locality 73, sec. 25, T. 36 N., R. 43 E.

	Ft.	in.
Shale.		
Lignite		8½
Shale		2
Lignite		7½
Shale.		
Total bed	1	6
Total lignite	1	4

The lignite bed exposed at the Fisher mine, locality 63, sec. 36, T. 37 N. R. 42 E., has been traced southward to the northwestern part of this township by the "smut" thrown out by badgers. The outcrop probably turns northward along the northwest side of the anticline already noted, making an area of coal land in the northwestern part of the township, separated from that in the southeastern part by a barren area of undetermined extent. At a small abandoned strip pit (locality 72, sec. 26) in the Lance formation 2 feet of lignite is reported to have been exposed.

The data for an estimate of the amount of lignite in this township are very meager; but from the outcrops found and the fact that large beds of lignite have been traced across the lines from adjacent townships, it seems reasonable to suppose that at least 13,000,000 tons is present.

T. 37 N., R. 43 E.—It is probable that the eastern extension of the Fisher bed from the township on the west covers at least 12 sections of T. 37 N., R. 43 E., and contains about 55,000,000 tons of lignite.

T. 33 N., R. 44 E.—No lignite has been found in T. 33 N., R. 44 E., and in the writer's opinion no large beds of lignite are present.

T. 34 N., R. 44 E.—At localities 76 and 77, sec. 9, T. 34 N., R. 44 E., a small lignite bed measuring 1 foot 5 inches and 1 foot 6 inches thick, respectively, crops out and has been mined by stripping. At locality 78, sec. 17, what is probably the same bed is reported in a well to be 2 feet thick and 30 feet below the surface. This township contains no lignite of classifiable thickness.

T. 35 N., R. 44 E.—At localities 81 and 82, sec. 3, T. 35 N., R. 44 E., a bed of lignite, at horizon B or C, is exposed in the Mead mine, which is shown in Plate XXIII, *A*. The bed is more than 6 feet thick, and sections of it are shown graphically on Plate XXVI. West of the Mead mine, at locality 79, sec. 6, and locality 80, sec. 4, about 1 foot of badly disintegrated lignite is exposed. Southeast of the Mead mine what is probably the same bed is exposed at three localities, where the following sections were measured:

Section of lignite bed at locality 83, sec. 10, T. 35 N., R. 44 E.

	Ft.	in.
Shale.		
Lignite	2	2
Shale		½
Lignite		2½
Shale		⅜
Lignite		1
Shale.		
Total bed	2	6⅜
Total lignite	2	5½

Section of liginte bed at locality 84, sec. 11, T. 35 N., R. 44 E.

	Ft.	in.
Shale.		
Lignite	1	11
Shale		¾
Lignite		2
Shale.		
Total bed	2	1¾
Total lignite	2	1

Section of lignite bed at locality 85, sec. 14, T. 35 N., R. 44 E.

	Ft.	in.
Shale.		
Lignite	1	5
Shale		3
Lignite		2
Shale.		
Total bed	1	10
Total lignite	1	7

This township is estimated to contain about 2,000,000 tons of lignite in beds more than 2½ feet thick.

T. 36 N., R. 44 E.—The partly exposed section of a lignite bed about 3 feet 7 inches thick at locality 89, sec. 36, T. 36 N., R. 44 E., shown

graphically on Plate XXVI, is probably at or near horizon C, although this bed may be the same as that exposed at the Mead mine, in sec. 3, T. 35 N., R. 44 E. A lignite bed exposed at locality 88, sec. 27, is 1 foot 1 inch thick and is probably slightly above the bed exposed at locality 89. At locality 86, sec. 30, a lignite bed 2½ feet thick is exposed, and its section is shown graphically on Plate XXVI. A short distance north of this point, at locality 87, in another outcrop which can not be correlated definitely with the bed at locality 86, the following section is exposed:

Section of lignite bed at locality 87, sec. 30, T. 36 N., R. 44 E.

	Ft.	in.
Shale.		
Lignite		11
Shale	1	
Lignite	1	5
Shale		1½
Lignite		5
Shale.		
Total bed	3	10½
Total lignite	2	9

These beds are at or near horizon D and correspond to the beds exposed near the Bonnabel mine, in sec. 25, T. 36 N., R. 43 E. At locality 90, sec. 11, a bed 2 feet thick was mined by stripping in the summer of 1915.

This township is estimated to contain 48,400,000 tons of lignite in beds 2½ feet and more in thickness.

T. 37 N., R. 44 E.—Two beds of lignite were found at locality 92, sec. 14, T. 37 N., R. 44 E. The upper of these, at horizon C, rests on about 7 feet of yellow sandstone, below which is 1 foot 9 inches of lignite. A section showing these beds is given on Plate XXVI. At locality 91, sec. 23, about a mile south of locality 92, a great deal of disintegrated lignite "smut" around some badger holes probably marked the outcrop of the same lignite bed as at locality 92.

The lignite in this township is estimated at 24,300,000 tons.

T. 33 N., R. 45 E.—Two beds 30 inches or more thick assumed to occur at horizons C and D, with an interval of about 45 feet between them, are exposed in fractional T. 33 N., R. 45 E. The lower of these beds, from 2½ to 3 feet thick, was measured at localities 96 and 97, sec. 11, and sections are shown graphically on Plate XXVI. A section of the upper bed about 5 feet thick exposed at locality 95, sec. 11, is also shown on Plate XXVI. The following stratigraphic section, showing two smaller beds of lignite, is exposed in the hillside above locality 95:

Section of strata at locality 95, above horizon D, sec. 11, T. 33 N., R. 45 E.

	Ft.	in.
Lignite	1	8
Shale, yellow	6	
Lignite		4
Shale, yellow	19	
Lignite	5	
Clay	1	6
Lignite	2	
	35	6

A lignite bed indicated by "smut" was found at locality 94, sec. 10. A small bed of lignite in the Lance formation is reported from a well at locality 98, sec. 2, north of locality 97. The lignite in this fractional township lies along the northern margin of a large area of coal land in the Fort Peck Indian Reservation. The reserves are estimated at about 800,000 tons.

T. 34 N., R. 45 E.—The lignite beds in the southwestern part of T. 34 N., R. 45 E., occur approximately at horizons B and C, and those in the northeastern part at horizons C, D, and E. The lowest bed is exposed at locality 99, sec. 18, where about 1 foot of disintegrated lignite crops out. About 50 feet higher several small beds, the lowest probably at horizon C, have been worked in secs. 20 and 28, sections of which are as follows:

Section of lignite beds and overlying strata at locality 100, sec. 20, T. 34 N., R. 45 E.

	Ft.	in.
Lignite		6
Shale, sandy	23	
Lignite		3
Shale	8	
Lignite		3
Shale	7	
Lignite	1	3½
Shale	22	
Lignite	1	5
Shale		7
Lignite (horizon C)		7
Shale	2	
Lignite		7
Shale.		
	67	5½

Section of lignite bed at locality 101, sec. 20, T. 34 N., R. 45 E.

	Ft.	in.
Lignite, eroded at top	2	1+
Shale		8
Lignite		10½
Shale.		
Total bed	3	7½+
Total lignite	2	11½+

At locality 102, sec. 28, there is a single bench of lignite 1 foot 9 inches thick. At localities 103 and 104, sec. 4, in the northern part of the township, disintegrated lignite is brought to the surface by badgers. The bed reached by them is probably a small one, at horizon B. The bed at horizon C is represented by exposures at localities 105, 106, 107, and 108. At locality 105, sec. 3, no measurement was possible, the outcrop being near the base of the overlying gravel, but at locality 106, sec. 15, locality 107, sec. 14, and locality 108, sec. 13, the thickness of the bed as measured is more than 5 feet and is shown graphically on Plate XXVI. Excavations at the Taylor-Green mine, locality 108, sec. 13, indicate a total extraction of more than 1,000 tons.

At locality 109, about 70 feet stratigraphically above the Taylor-Green mine, there is a bed of more or less disintegrated lignite about 2½ feet thick, at horizon D, a measured section of which is given on Plate XXVI. At locality 111, sec. 13, and locality 110, sec. 14, a bed 35 feet higher than the one just mentioned and assumed to be at horizon E is exposed. Its thickness is about 3 feet, and sections are shown graphically on Plate XXVI.

This township is estimated to contain at least 4,800,000 tons of lignite in beds more than 2½ feet thick.

T. 35 N., R. 45 E.—At locality 112, sec. 6, T. 35 N., R. 45 E., a lignite bed, estimated to be at horizon C, has a thickness of 3 feet 4 inches, after deducting partings, and is shown graphically on Plate XXVI. South of this point, at localities 113 to 115, what is probably the same bed is exposed, with the following sections:

Section of lignite beds at locality 113, sec. 6, T. 35 N., R. 45 E.

	Ft.	In.
Shale.		
Lignite	1	5½
Shale	5	
Lignite	1	2
Shale.		
Total section	7	7½
Total lignite	2	7½

At locality 114, sec. 8, 1 foot 6 inches of lignite in one bench is exposed, and at locality 115, sec. 20, about 2 feet of lignite separated by partings into three nearly equal benches is reported from a well. Above this bed, at a distance not determined, is another bed about 2½ feet thick, assumed to be at horizon D. The measurement at locality 116, sec. 5, shows that the bed is more than 2½ feet thick, and its section is given graphically on Plate XXVI. At locality 117, sec. 8, and locality 118, sec. 8, what appears to be the same bed is exposed showing the following section:

Section of lignite bed at locality 117, sec. 8, T. 35 N., R. 45 E.

	Ft.	in.
Shale.		
Lignite		2½
Shale		1
Lignite	1	6
Shale		1
Lignite		6½
Shale.		
Total bed	2	4
Total lignite	2	1½

At locality 118, sec. 8, only one 5-inch bench of lignite is exposed. It is estimated that the township contains 5,800,000 tons of lignite in beds above the minimum thickness for classification.

T. 36 N., R. 45 E.—At locality 119, sec. 31, T. 36 N., R. 45 E, a bed correlated with horizon D has over 3 feet of lignite and is shown graphically on Plate XXVI. Two miles north of this locality, at locality 120, sec. 19, a 7-inch bed is exposed at the surface, and at locality 121, sec. 19, a bed more than 4 feet thick, assumed to be identical with that exposed at locality 119, is reported from a well 20 feet deep. The section is said to be as follows:

Section of lignite bed at Fay's well, locality 121, sec. 19, T. 36 N., R. 45 E.

	Ft.	in.
Clay, yellow and white	20	
Lignite	4	6±
Shale, blue	56	
Lignite	1	
Total section	26	6±
Total lignite	5	6±

Three more layers of lignite are reported at intervals of 5 to 7 feet in blue shale at the bottom of the well, 52 feet from the surface. On the north side of the township a bed at horizon D is exposed in two places. At locality 123, sec. 1, measurement shows it to be 4 feet thick, and the detail of its benches is shown graphically on Plate XXVI. At locality 122 the following section was measured:

Section of lignite bed at locality 122, sec. 5, T. 36 N., R. 45 E.

	Ft.	in.
Lignite, top eroded	1	1+
Shale		½
Lignite	1	
Shale	1	9
Lignite	1	2
Shale		¼
Lignite		3½
Shale.		
Total bed	5	4¼+
Total lignite	3	6½+

A bed in the Lance formation exposed at locality 124, sec. 15, has the following section:

Section of lignite bed at locality 124, sec. 15, T. 36 N., R. 45 E.

	Ft.	in.
Soil.		
Lignite		11
Shale		1
Lignite		8
Shale	1	4
Lignite	1	10
Shale.		
Total bed	4	10
Total lignite	3	5

This township is estimated to contain 35,000,000 tons of lignite in beds more than 2½ feet thick.

T. 37 N., R. 45 E.—The Coal Creek lignite bed, at horizon D, crops out at many places in T. 37 N., R. 45 E., and wherever it is well exposed it has a total thickness of about 20 feet, including numerous partings. In many places where the bed is wholly or partly burned its presence is indicated by large masses of clinker. The bed is best exposed at the Coal Creek mine, locality 129, sec. 16 (see Pl. XXIII, *B*), where its total thickness is 20 feet. Excavations here indicate a total extraction of 12,000 to 20,000 tons. The mine is an open strip pit in the bluff on the north side of Coal Creek. A sample for analysis, No. 23007, was taken from a short drift extending about 20 feet into the face of the old strip workings. Other points where measurements were made are locality 130, sec. 9; locality 131, sec. 10; locality 127, sec. 20; locality 133, sec. 36; and at two mines at localities 93 and 135, in Canada near the northwest corner of the township. Plate XXIV, *B*, is made from a photograph taken at the Burton mine, locality 135. The sections measured at each of these localities are shown graphically on Plate XXVI. No measurement was made at locality 125, sec. 19, a prospect showing a large bed of disintegrated lignite; locality 126, sec. 17, a natural exposure of the bed in a bluff above the creek; or locality 134, sec. 25, where the following section is reported:

Section of lignite beds reported from a well at locality 134, sec. 25, T. 37 N., R. 45 E.

	Ft.	in.
Soil and shale	7	
Lignite	5	
Interval	3	
Lignite	1	
Interval	3	6
Lignite	3	
Total section	22	6
Total lignite	9	

A well at locality 132, sec. 36, is reported to have passed through 18 feet of burned lignite and to have reached another bed at 65 feet from the surface. A partly exposed section was measured at locality 128, sec. 20, showing 2 feet 7½ inches of lignite with a ½-inch parting.

The total amount of lignite in this township is estimated at 253,000,000 tons.

T. 33 N., R. 46 E.—A lignite bed in the Lance formation at locality 136, sec. 6, T. 33 N., R. 46 E., measures 1 foot 5 inches, and at locality 139, sec. 11, a well brought to the surface a few pieces of lignite. At locality 137, sec. 8, a bed correlated with horizon C is 3 feet 8 inches thick; this bed is shown graphically on Plate XXVI. A lignite bed about 5 feet thick, at horizon C or D, is reported 80 feet from the surface in a well at locality 138, sec. 1.

It is estimated that 2,300,000 tons of lignite is present in this fractional township.

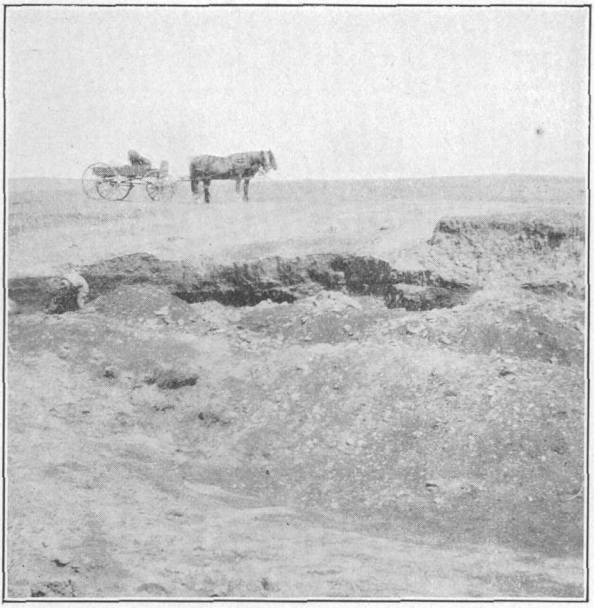
T. 34 N., R. 46 E.—A lignite bed, probably at horizon C, ranging from 2 feet 7½ inches to more than 6 feet thick, was measured at the Henry Shipstead mine, locality 140, sec. 17, T. 34 N., R. 46 E.; at locality 141, sec. 21; and at the Dutchman mine, locality 142, sec. 21. Sections at these places are shown graphically on Plate XXVI. The two mines mentioned were not operated during the summer of 1915, but an inspection of the strip pits showed a total production of about 1,000 tons. At locality 143, sec. 28; locality 144, sec. 27; and locality 145, sec. 27, the position of the bed is known, but no measurements were possible. At the locality last mentioned there is a large mass of clinkers, indicating burned coal. At locality 146, sec. 21, an upper bed, approximately at horizon D, shows 1 foot of disintegrated lignite.

The total quantity of lignite in beds more than 2½ feet thick in this township is estimated to be about 86,000,000 tons.

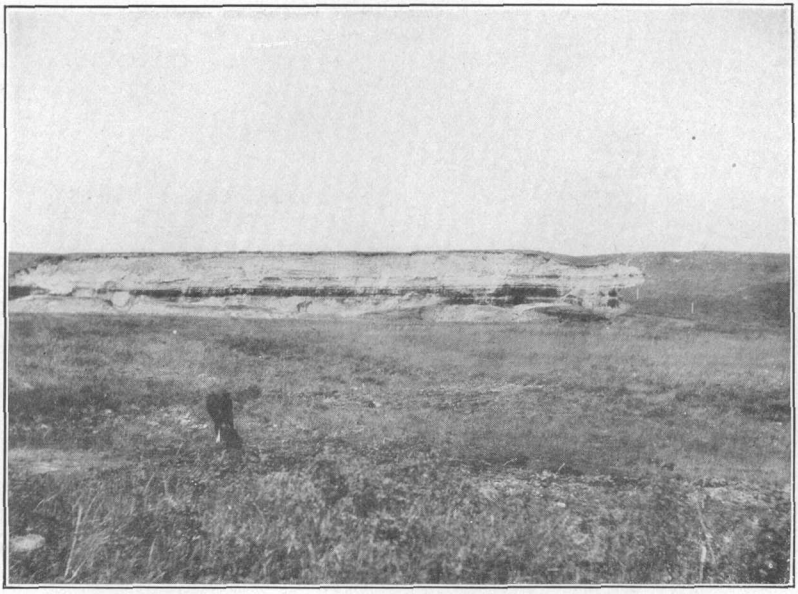
T. 35 N., R. 46 E.—Lignite has been found in T. 35 N., R. 46 E., at only one place—locality 147, sec. 11. The following section is exposed, but whether it is in the Lance or the Fort Union formation could not be determined.

Section of lignite bed at locality 147, sec. 11, T. 35 N., R. 46 E.

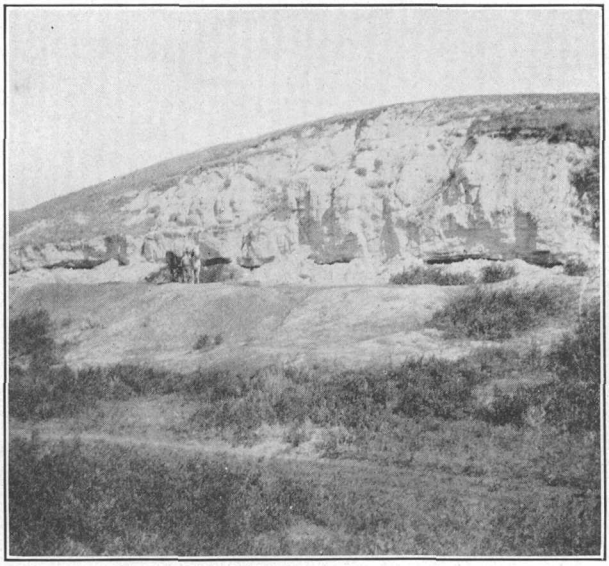
	Ft.	in.
Gravel and sand.		
Sandstone, hard, micaceous		8
Sandstone, yellow, shaly	15	
Shale, carbonaceous		3
Shale, gray	2	4
Lignite		9
Shale, darker than sandstone above	15	
Total lignite		9



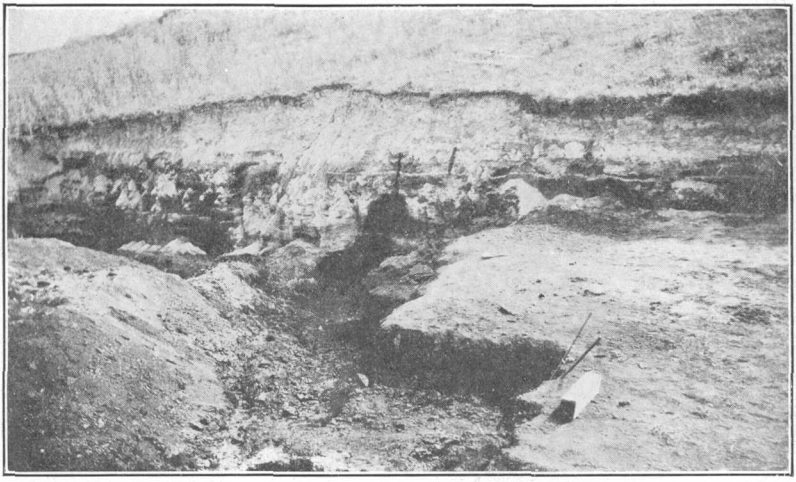
A. MEAD STRIP MINE, SEC. 3, T. 35 N., R. 44 E., SCOBEY LIGNITE FIELD, MONT.



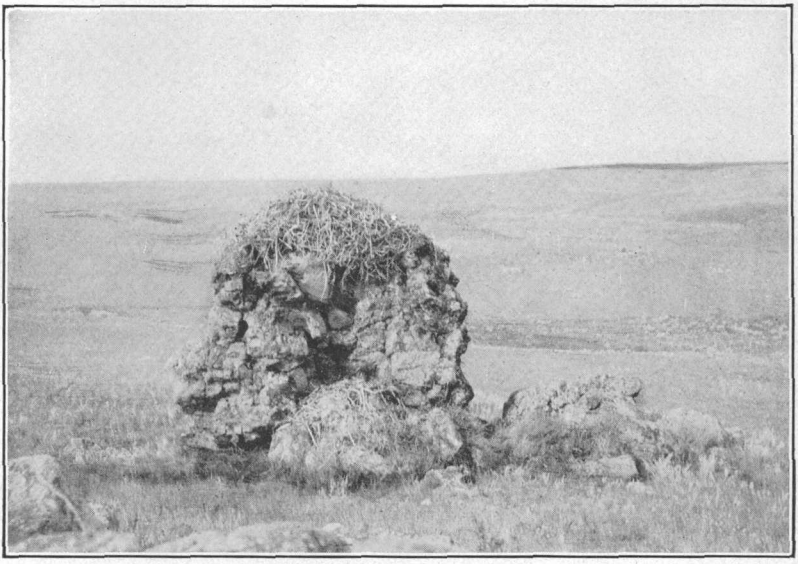
B. STRIP PIT AT COAL CREEK MINE, SEC. 16, T. 37 N., R. 45 E., SCOBEY LIGNITE FIELD, MONT.



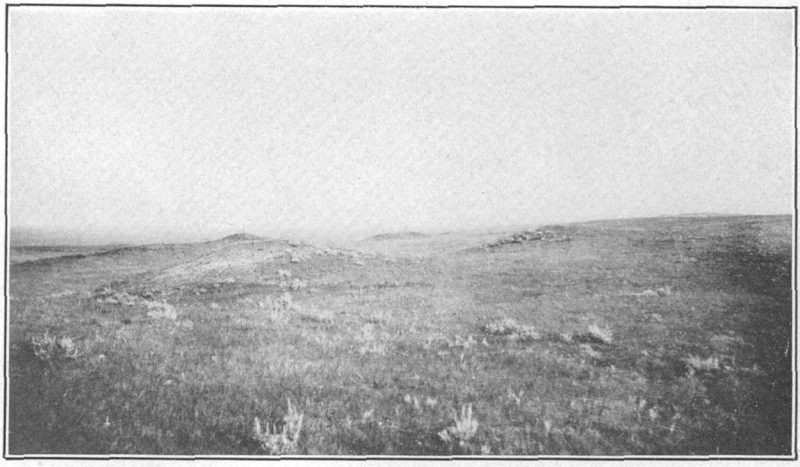
A. STRIP MINE AT LOCALITY 201, SEC. 33, T. 37 N., R. 47 E., SCOBEY LIGNITE FIELD, MONT.



B. BURTON MINE, ON COAL CREEK BED IN SASKATCHEWAN NORTH OF T. 37 N., R, 45 E.



A. CLINKER MASS SURMOUNTED BY AN EAGLE'S NEST, SEC. 20, T. 37 N., R. 46 E., SCOBEY LIGNITE FIELD, MONT.



B. SLOPE MADE BY MASSES OF CLINKER LEFT BY BURNING OF COAL D SEC. 20, T. 37 N., R. 46 E., SCOBEY LIGNITE FIELD, MONT.

It is assumed that the Fort Union formation in the southern part of the township contains at least one bed of lignite of more than the minimum thickness, for such a bed is present in the northeastern part of T. 34 N., R. 45 E., and near the middle of T. 34 N., R. 47 E. If this lignite bed averages 3 feet in thickness, the amount of lignite in the township is about 35,000,000 tons.

T. 36 N., R. 46 E.—The following are sections of a lignite bed in the Lance formation in T. 36 N., R. 46 E.:

Section of lignite bed at locality 148, sec. 32, T. 36 N., R. 46 E.

	Ft.	in.
Shale.		
Lignite		5
Shale		½
Lignite		8
Shale.		
Total bed	1	1½
Total lignite	1	1

Section of lignite bed at locality 149, sec. 33, T. 36 N., R. 46 E.

	Ft.	in.
Sandstone.		
Lignite		8
Shale	1	1
Lignite		1
Shale		1½
Lignite		2½
Shale		¼
Lignite	1	3
Shale.		
Total bed	3	5¾
Total lignite	2	2½

A bed at locality 150, sec. 35, is reported from a well as being 1 to 1½ feet thick. Two sections of lignite at or near horizon C in the southern part of the township are as follows:

Section of lignite bed at locality 151, sec. 32, T. 36 N., R. 46 E.

	Ft.	in.
Shale and yellow sandstone	14	
Shale, gray	2	
Lignite	1	6
Shale, yellow		8
Total lignite	1	6

The lignite bed at locality 152, sec. 34, which has been partly eroded at the top, measures 10 inches. In the northern part of the township, at locality 153, sec. 13, a small lignite bed, supposed to be at horizon C, has a thickness of 10½ inches. At locality 157, sec. 13, a well dug below the clinkers left by the burned out Coal Creek bed is reported to have penetrated two layers of lignite, the larger being

about 2½ feet thick. This should be correlated with the bed at horizon C. The bed at horizon D which is correlated with the Coal Creek bed (see p. 195) is partly exposed at locality 154, sec. 6, where 2 feet 3 inches of lignite is overlain by disintegrated lignite in the soil. The same bed is reported in a well in sec. 10, where it has the following section:

Section of lignite beds at locality 155, sec. 10, T. 36 N., R. 46 E.

	Ft.	in.
Soil, shale, and sandstone	38	
Lignite		6
Interval	12	
Lignite	4	6±
Total lignite	5±	

At locality 156, sec. 14, it is partly exposed and shows 1 foot 6 inches of soil and disintegrated lignite overlying 3 feet 4 inches of badly disintegrated lignite.

The Coal Creek bed at horizon D is generally burned in this township, and it can be traced with great difficulty, because the burning occurred at a very remote date and much of the slag has been removed and otherwise obscured by erosion. Owing to the extent of the burning the amount of lignite in beds above the minimum thickness left in this township is very small. It is estimated at 70,000 tons.

T. 37 N., R. 46 E.—The Coal Creek bed at horizon D, having a thickness of 7 to 22 feet, was measured at locality 159, sec. 19; locality 160, sec. 3; and locality 161, sec. 14, T. 37 N., R. 46 E., where a mine has recently been opened. All these measurements are shown graphically on Plate XXVI. At 40 feet below this bed a bed slightly more than 2½ feet thick correlated with horizon C is exposed at locality 158, sec. 27. About 8 feet below this is the bed which has been opened at the Tingley mine, at the same locality. It lies immediately above the Hell Creek member of the Lance formation and is less than 2½ feet thick but is shown on Plate XXVI as a lower bench at locality 158. West of the river the outcrop of horizon D is marked by a continuous line of clinkers like those shown in Plate XXV, but east of the river there is little evidence of burning.

The total amount of lignite in this township in beds thicker than the minimum for classification is estimated at 110,000,000 tons.

T. 33 N., R. 47 E.—Although none of the localities shown on Plate XXIX exhibit lignite beds more than 2½ feet thick, the outcrops of a bed averaging about 4 feet thick which must underlie T. 33 N., R. 47 E., are known in the townships to the east, west, and north. At locality 162, sec. 2, 1 foot of lignite is reported from a well at a depth of 44 feet. In a well 60 to 70 feet deep at locality

163, sec. 1, several feet of lignite is reported, and a well at locality 164, sec. 12, reached lignite, but no measurement of the thickness was obtained.

The quantity of lignite in beds more than 2½ feet thick in this fractional township is estimated at 21,000,000 tons.

T. 34 N., R. 47 E.—A lignite bed about 4 feet thick, tentatively correlated with horizon C, is exposed along the coulee in the northeastern part of T. 34 N., R. 47 E. Measurements were made at locality 165, sec. 9; locality 166, sec. 10; locality 167, sec. 10; and locality 168, sec. 13. At locality 169, sec. 13, a measurement was made by Bauer.[27] Graphic sections of the bed at these localities are given on Plate XXVI. The same bed was probably reached in a well at locality 172, sec. 27, but no measurement of its thickness could be obtained, and a higher bed a few inches thick is reported from a well at locality 171, sec. 2. In a spring at locality 170, sec. 2, a bed of lignite in the Flaxville gravel has the following section:

Section of lignite bed at locality 170, sec. 2, T. 34 N., R. 47 E.

	Inches.
Clay.	
Lignite (strong flow of water)	2½
Clay (too much water to get accurate measurement)	10
Lignite.	
Gravel (apparently present in two auger holes below the lignite).	

This occurrence of Miocene or early Pliocene lignite is interesting but of no economic value. At locality 183, about 2 miles northwest of this locality, there is a similar occurrence of lignite in the Flaxville gravel.

This township is estimated to contain 156,000,000 tons of lignite in beds 2½ feet or more thick.

T. 35 N., R. 47 E.—A small lignite bed, presumably near horizon B, in the Lance formation, is present at locality 173, sec. 6, T. 35 N., R. 47 E., but no measurement was made. Above this bed, at horizon C, there are one or more lignite beds the outcrops of which extend across the township in an east-west direction 2 miles from the north line of the township. At locality 174, sec. 8, 3 feet of soil, mixed with particles of lignite, is exposed. At locality 175, sec. 14, the following section was measured:

Section of lignite bed at locality 175, sec. 14, T. 35 N., R. 47 E.

	Ft.	in.
Thin alternating layers of shale, gypsum, bone, and lignite	2	8
Lignite, much weathered	2	5
Shale.		
Total bed	5	1
Total lignite	2	5

[27] Bauer, C. M., Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont.: U. S. Geol. Survey Bull. 541, p. 307, 1914.

A lignite bed 4 feet thick is exposed at locality 176, sec. 11, and is shown graphically on Plate XXVI. At the Butler prospect, locality 177, sec. 13, the following section was measured by Bauer [28] in 1913:

Section of lignite bed at locality 177, sec. 13, T. 35 N., R. 47 E.

	Ft.	in.
Shale, sandy, yellow.		
Lignite		3
Shale, sandy, yellow	8±	
Bone		6
Lignite	1	6
Shale.		
Total lignite	1	9

About a quarter of a mile southeast of this prospect, at locality 178, sec. 13, 2 feet of lignite was found with an auger. At locality 179, sec. 24, an exposure shows 1½ inches of lignite, and at a well in the same section, at locality 180, lignite was found scattered over the dump, but no statement of the thickness could be obtained. The following section was reported from a well at locality 181, sec. 27:

Section of lignite beds at locality 181, sec. 27, T. 35 N., R. 47 E.

	Feet.
Depth from surface	14
Lignite	2
Interval	5
Lignite	1
Interval	2
Lignite	3
Interval	4
Lignite.	
Total lignite	6+

At locality 182, sec. 26, about 1 foot of lignite is reported. The following section of lignite in the Flaxville gravel at locality 183, in the NW. ¼ sec. 33, is reported from a well dug by Martin Presnell:

Section of lignite bed reported at locality 183, sec. 33, T. 35 N., R. 47 E.

	Ft.	in.
Gravel	6	
Clay and gumbo	52	
Lignite, slack		6
Clay	2	
Lignite	1	
Gravel and bones; a good flow of water.		
Conglomerate.		

This occurrence of lignite, younger than that in the Fort Union formation, resembles that noted at locality 170, about 2 miles to the southeast.

[28] Bauer, C. M., op. cit., p. 306.

The township is estimated to contain 51,800,000 tons of lignite in beds more than 2½ feet thick.

T. 36 N., R. 47 E.—In T. 36 N., R. 47 E., there are many masses of clinkers from burned lignite that are so closely associated with glacial drift boulders as to indicate that the burning must have occurred here as long ago as the glacial epoch. Although there is in this township a great deal of lignite in a bed corresponding to the Coal Creek bed at horizon D, which appears to lie very favorably for mining, no mines have been opened. The lignite was discovered in the spring of 1915 in sec. 22 of this township by Mr. Paradis, who, in drilling a well, is reported to have gone through 20 feet of good lignite. He afterward, with his neighbors, dug down to the upper surface of this bed, but while these operations were in progress one of the men lost his life by being suffocated by carbon dioxide gas or choke damp from the lignite bed, and the work was discontinued.

The lowest bed in this township, which is in the Lance formation, correlated tentatively with horizon A or B, is exposed at locality 184, sec. 32; locality 185, sec. 33; and locality 186, sec. 13, and has been mined at the two last-mentioned places. The section of the bed is as follows:

Section of lignite bed at locality 184, sec. 32, T. 36 N., R. 47 E.

	Ft.	in.
Shale.		
Lignite	1	2
Shale		4½
Lignite	1	6½
Clay		6½
Lignite		5½
Clay.		
Total bed	4	1
Total lignite	3	2

At locality 185, sec. 33, there is 1 foot 4½ inches of lignite, and at locality 186, sec. 13, 1 foot of lignite is exposed.

A bed correlated with horizon C is 60 feet above the bed at horizon A or B. At locality 187, sec. 13, the bed is exposed and shows only a few inches of lignite, but in a spring at locality 188, sec. 34, 1 foot 6 inches of lignite is reported to have been found.

Two sections made with an auger by boring down through 2 feet or more of soil give evidence that the bed is at least 2½ feet thick at locality 189, sec. 35, and locality 190, sec. 36, and these sections are shown graphically on Plate XXVI. The large bed correlated with the Coal Creek bed, at horizon D, and lying about 60 feet above the bed last mentioned has been found at localities 191 to 198, at each of which, in the writer's opinion, there is at

least 8 feet of lignite that can be mined. Some of the measurements are reported by well drillers, and if the beds could be examined carefully parts of them would undoubtedly prove to be carbonaceous shale, bone, or other materials. At localities 191, sec. 19; 192, sec. 29; 193, sec. 29; 197, sec. 14; and 198, sec. 9, parts of the bed are exposed as shown on Plate XXVI. At localities 191, sec. 19; 194, sec. 28; 195, sec. 22; and 196, sec. 23, the following complete sections have been reported from wells:

Reported section of lignite beds at locality 191, sec. 19, T. 36 N., R. 47 E.

	Ft.	in.
Shale.		
Lignite (see Pl. XXVI)		6
Shale	1	
Lignite	1	10
Total section	3	4
Total lignite	2	4

At locality 194, sec. 28, and locality 195, sec. 22, the bed is reported to be 20 feet thick, and at locality 196, sec. 23, the well drillers reported passing through 9 feet of lignite 60 feet from the surface.

This township is estimated to contain 119,800,000 tons of lignite in beds above the minimum thickness.

T. 37 N., R. 47 E.—The large Coal Creek bed, at horizon D, is exposed at locality 199, sec. 19, T. 37 N., R. 47 E., where it is 8 feet 8 inches thick, and at locality 201, sec. 33, where it is 14 feet 4 inches thick. Sections are shown graphically on Plate XXVI. A view of this strip pit at locality 201 is given in Plate XXIV, *A*. Either the same bed or a bed below it has been found in a well at locality 200, sec. 29, where more than 4 feet of lignite is reported. East of locality 201 no exposures were found, and on account of the heavy covering of glacial drift, the continuation of the outcrop is conjectural. A small bed of lignite, only 1 foot thick, was examined at locality 202, in Canada, near the north quarter corner of sec. 5.

The township is estimated to contain 156,700,000 tons of lignite.

Tps. 33, 34, and 35 N., R. 48 E.—The following descriptions of Tps. 33, 34, and 35 N., R. 48 E., adapted from Bauer's report previously cited, are inserted because these townships contain the outcrops of lignite beds that underlie adjoining townships east and west of them.

These townships are crossed from north to south by Poplar River. The flood plain of the Poplar is about a mile wide and is bounded by irregular escarpments which rise about 100 feet to rolling benches. The plateau surface described on page 160 of this report is about 400 feet above the flood plain. A thickness of about 150 feet of the Lance formation is represented near the river and is overlain by the Fort Union formation.

Lignite beds crop out in secs. 3 and 5, T. 33 N., R. 48 E. At locality B 16,[29] sec. 3, there is a strip pit from which considerable lignite has been taken within the last few years. As exposed in the pit the bed ranges from 1 foot 8 inches to 2 feet 6 inches, which suggests that it is elsewhere variable and probably belongs to the Lance formation. At locality B 15, sec. 5, the lignite, which was measured on a hill, shows 3 feet of lignite, but the bottom of the bed was not reached owing to the presence of water from a spring. The bed is higher than the one measured at locality B 16 and is believed to be near horizon C. The total amount of lignite in beds more than 2½ feet thick in this township is estimated at 6,400,000 tons.

In T. 34 N., R. 48 E., a thin bed of lignite crops out at locality B 7, sec. 1, where it carries 1 foot 2 inches of lignite. At locality B 8, in the SW. ¼ sec. 1, a bed of lignite about 3 feet thick, probably at horizon C, is reported in a well at a depth of about 30 feet. At locality B 9, sec. 11, there is a bed at horizon A or B which contains 2 feet of much weathered lignite. At locality B 10, sec. 16, a bed of lignite at horizon A or B, less than 10 inches thick, is exposed, the outcrop being marked for a considerable distance by springs and seeps. At localities B 12 and B 13, sec. 30, a bed of lignite, probably at horizon C, shows the following section:

Section of lignite bed at localities B 12 and B 13, sec. 30, T. 34 N., R. 48 E.

	Ft.	in.
Shale.		
Lignite	3	4
Shale	1	3
Lignite	1	3
Bone.		
Total bed	5	10
Total lignite	4	7

The quantity of lignite in beds more than 2½ feet thick in this township is estimated at 10,700,000 tons.

In T. 35 N., R. 48 E., at locality B 2, sec. 2, a bed of lignite, probably at horizon C, is exposed, the base of which is concealed by the water of a spring. Above the water level 2 feet 1 inch is exposed, and this portion of the bed has been stripped for local use. At locality B 3, sec. 11, two thin beds crop out. The lower bed contains 1 foot 6 inches of weathered lignite, and the upper bed, which is about 20 feet higher stratigraphically, contains about 8 inches of lignite. At locality B 4, sec. 24, a bed contains about 1 foot 6 inches of lignite. Several thin beds occur lower down in the stratigraphic section, one of which crops out at locality B 5, in the SE. ¼ sec. 24, where it carries less than 6 inches of lignite. When the field was

[29] Numbers taken from Bauer's report (op. cit., pl. 15) are indicated by the initial B.

revisited in 1916 an open strip pit, locally called the Butler mine, was in operation at locality 235, in the SE. ¼ sec. 24. The bed is probably at horizon C, and its section is as follows:

Section of lignite bed at Buller mine, locality 235, sec. 24, T. 35 N., R. 48 E.

	Ft.	in.
Gravel.		
Lignite	1	6½
Shale		1
Lignite		1
Shale		6½
Lignite	2	3½+
Shale.		
Total bed	4	6½
Total lignite	3	11

At locality B 6, sec. 26, a 10-inch bed of lignite in about 40 feet of somber shale is exposed. The quantity of lignite in beds more than 2½ feet thick in this township is estimated at 26,700,000 tons.

T. 36 N., R. 48 E.—There are two more or less pronounced escarpments in T. 36 N., R. 48 E., one bounding the flood plains and the other bounding the high plateau. The total relief of the township between the flood plains and the plateau is about 400 feet. Plate XXI, *B*, is a view of the Lance formation exposed in sec. 23 in the lower of these escarpments.

At locality 203, sec. 19, a small bed of lignite is exposed, which was measured about a mile up the river at locality 186. Two small strip pits on a bed or beds in the Lance formation, each less than 2 feet in thickness, at localities 206 and 207, sec. 23, were examined, but their positions were not closely determined. At locality 204, sec. 14, the following section of a bed, assumed to be at horizon B, is exposed in a strip pit, and on the hill above it a large bed, probably at horizon C or D, is partly exposed:

Section of lignite beds at locality 204, sec. 14, T. 36 N., R. 48 E.

	Ft.	in.
Lignite (horizon C?)	2+	
Shale	10	
Lignite		5
Shale and sandstone	10	
Lignite		5
Shale and sandstone	25	
Lignite		6
Clay		6
Lignite (horizon B?)	1	8
Total section	50	6
Total lignite	3	

Lignite probably at or near horizon B has been found in a well at locality 205, sec. 24. A bed, tentatively assumed to be at horizon C or D, is indicated by slack brought to the surface by badgers at localities 208, sec. 35, and 209, sec. 36. Several holes were bored with an auger here, but no bed of lignite more than 13 inches thick was indicated by the disintegrated material penetrated. The bed probably at horizon C or D is exposed near the center of sec. 2, T. 35 N., R. 48 E., where it was measured by C. M. Bauer at his locality B 2, and found to contain 2 feet 1 inch of lignite above the water.

At locality 210, sec. 23, in an old strip pit, 3 feet 6 inches of lignite, at horizon C or D, was found by the use of an auger, and at the Barber mine, locality 211, sec. 13, the same bed is well exposed. The sections are shown graphically on Plate XXVI. An exposure of the same bed was found but not measured at locality 212, sec. 14. A lignite bed 15 feet above this horizon is exposed in an old strip pit at locality 214, sec. 24, where it was tested with an auger and found to be 3 feet thick. About 24 feet above this bed, at locality 215, sec. 24, a bed more than 3 feet 5 inches in thickness was revealed by the auger. This bed is well exposed at the Callahan mine, locality 216, sec. 25, where it measured 4 feet 2 inches after deducting the parting. The sections at these localities are given on Plate XXVI. The lignite beds in this township could not be traced far on account of a thick cover of glacial drift, and their identity can not be determined with certainty.

The total amount of lignite in beds more than 2½ feet thick in this township is estimated at 27,600,000 tons.

T. 37 N., R. 48 E.—In a well 70 feet deep at locality 217, sec. 36, T. 37 N., R. 48 E., a small bed of lignite, probably in the Lance formation, is reported. At locality 218, sec. 26, and the Julian mine, locality 219, sec. 36, the Julian bed, supposed to be at horizon C or D, is exposed. The bed is more than 6 feet thick and is shown on Plate XXVI. Excavations at the Julian mine show a production of about 1,000 tons. The surface north of this mine for several miles is composed of glacial drift, but at localities 221, sec. 12, and 223, sec. 1, a large bed of lignite supposed to be the Julian bed is exposed, and sections are given on Plate XXVI. At locality 222, sec. 12, the digging of a well was stopped at a depth of 36 feet on account of the gas from a lignite bed, and at locality 224, in Canada, three-quarters of a mile north of the northwest corner of sec. 1, a 6-foot bed of lignite which is probably the Julian bed is reported from a well below 49 feet of soil, gravel. and clay.

The total amount of lignite in this township in beds above the minimum thickness is estimated at 41,400,000 tons.

T. 33 N., R. 49 E.—A bed of lignite about 3 feet 7 inches thick, provisionally assigned to horizon C, is exposed at locality 225, sec. 8, T. 33 N., R. 49 E., and at the Lindsay mine, locality 226, sec. 5, sections of which are shown on Plate XXVI.

The quantity of lignite in beds more than 2½ feet thick in this fractional township is estimated at 27,700,000 tons.

T. 34 N., R. 49 E.—A lignite bed, probably 8 or 10 feet above that at the Lindsay mine, in sec. 5, T. 33 N., R. 49 E., is exposed at locality 228, sec. 32, T. 34 N., R. 49 E. Its thickness is 3 feet 8 inches, and it is shown graphically on Plate XXVI. At locality 227, sec. 32, 1½ feet of disintegrated lignite is exposed, and at locality 229, sec. 29, a large bed, probably the same as that at locality 228, is reported in a well. The same bed may be present at locality 231, sec. 7, where disintegrated lignite mixed with gravel is exposed. At locality 232, sec. 8, and locality 233, sec. 9, 1 foot 4 inches and 2 feet 1 inch of lignite are exposed in a bed or beds above horizon C. Simondson's well, at locality 230, sec. 21, is reported to have passed through 18 inches of lignite and stopped in a lower bed.

The quantity of lignite in this township in beds more than 2½ feet thick is estimated at 114,000,000 tons.

T. 35 N., R. 49 E.—At locality 234, sec. 19, T. 35 N., R. 49 E., in Montagnac Coulee, a bed of lignite 3 feet thick is reported from a well, and a short distance farther west, at the Butler mine, locality 235, sec. 24, T. 35 N., R. 48 E., the same bed is exposed and measured 3 feet 3½ inches after deducting partings. The bed is provisionally assigned to horizon C. No other bed of lignite as much as 2½ feet in thickness is exposed in this township. The following six sections were measured in the course of the field work, but their exact correlation can not be given:

At locality 236, sec. 17, 1 foot 6 inches of lignite is exposed.

Section of lignite bed at locality 237, sec. 18, T. 35 N., R. 49 E.

	Ft.	In.
Shale.		
Lignite		1
Shale		1½
Lignite		¾
Shale		½
Lignite	1	1½
Shale.		
Total bed	1	5¼
Total lignite	1	3¼

Section of lignite bed at locality 238, sec. 18, T. 35 N., R. 49 E.

	Ft.	in.
Shale.		
Lignite		3½
Shale		11
Lignite		3½
Shale		6½
Lignite		4
Sandstone.		
Total bed	2	4½
Total lignite		11

At locality 239, sec. 7, 2 feet of lignite is reported, and at locality 240, sec. 6, 10 inches of lignite is exposed.

Section of lignite bed at locality 241, sec. 5, T. 35 N., R. 49 E.

	Ft.	in.
Sandstone, yellow.		
Lignite		4
Shale, yellow	8	
Lignite		1
Shale		1
Lignite	1	1
Clay		4
Lignite		7
Shale.		
Total section	10	6
Total lignite	2	1

The quantity of lignite in beds more than 2½ feet thick in this township is estimated at 124,400,000 tons.

T. 36 N., R. 49 E.—The maximum relief of T. 36 N., R. 49 E., is about 300 feet. A bed of lignite provisionally assigned to horizon C has been traced across sec. 6. At locality 242, sec. 6, its thickness has been determined by the use of an auger, and the section is given on Plate XXVI. At locality 243, sec. 6, its position is probably indicated by a spring, but no measurement was possible. The same bed is believed to be present in a well at locality 245, sec. 7, where from 2 to 3 feet of lignite is reported. A short distance above this bed, at locality 244, sec. 5, and locality 246, sec. 19, the following sections were measured:

Section of lignite bed at locality 244, sec. 5, T. 36 N., R. 49 E.

	Ft.	in.
Sandstone.		
Lignite		3
Clay	3	
Lignite		10
Shale.		
Total section	4	1
Total lignite	1	1

Section of lignite bed at locality 246, sec. 19, T. 36 N., R. 49 E.

	Ft.	in.
Shale, sandy, yellow.		
Lignite	1	
Clay		9
Lignite		4
Shale		2
Lignite		1
Shale.		
Total bed	2	4
Total lignite	1	5

A bed at horizon F or G is exposed at locality 247, sec. 19, where it measured 1 foot 3 inches. Probably the same bed has been opened in strip pits at localities 248 and 249, sec. 30. The lignite at both localities has a bright luster. The bed at locality 248 is without partings and measures 2 feet 1 inch.

Section of lignite bed at locality 249, sec. 30, T. 36 N., R. 49 E.

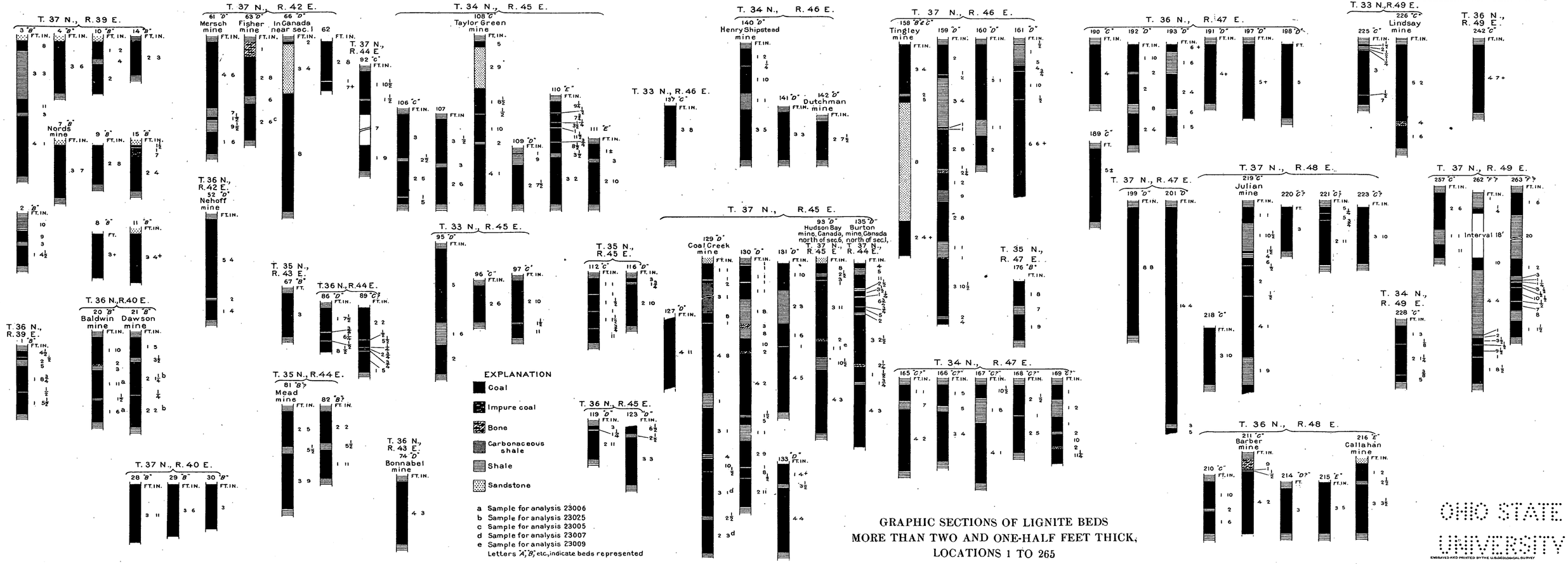
	Ft.	in.
Shale.		
Lignite		2
Shale, white		2
Lignite	1	11
Sandstone.		
Total bed	2	3
Total lignite	2	3

By testing with an auger, a bed at nearly the same horizon as that at locality 248 was found at locality 250, sec. 31, where it measured 10 inches, and at locality 251, sec. 32, where it measured 2 feet 4 inches.

The quantity of lignite in this township is estimated at 207,000,000 tons.

T. 37 N., R. 49 E.—At locality 252, sec. 19, T. 37 N., R. 49 E., a well is reported to have penetrated a few inches of lignite at a depth of 65 feet. This bed is probably in the Lance formation, not far from horizon B. A bed provisionally assigned to horizon C has been found in wells at localities 253, sec. 18; 254, sec. 7; and 255, sec. 7; this bed is reported to be 3½ feet thick at localities 253 and 254. At locality 255, sec. 7, the bed was reached at a depth of 55 feet, but the thickness was not reported, and at locality 256, sec. 5, 4 feet or more of lignite is reported at a depth of 64 feet. This bed is 2½ feet thick where exposed at locality 257, sec. 5, and its section is given on Plate XXVI.

One or more thin beds, referable to horizon D or E, are exposed at localities 258, sec. 4; 259, 260, and 261, sec. 3; and 265, across the international boundary, half a mile north of the northwest corner of sec. 4. Their sections are as follows:



GRAPHIC SECTIONS OF LIGNITE BEDS
MORE THAN TWO AND ONE-HALF FEET THICK,
LOCATIONS 1 TO 265

Section of lignite bed at locality 258, sec. 4, T. 37 N., R. 49 E.

	Ft.	in.
Shale.		
Lignite		2½
Shale		¾
Lignite		1
Shale		1
Lignite	1	2
Shale.		
Total bed	1	7¼
Total lignite	1	5½

Section of lignite beds at locality 259, sec. 3, T. 37 N., R. 49 E.

	Ft.	in.
Shale.		
Lignite		10
Shale	19	
Lignite		4½
Shale		¾
Lignite	1	4
Shale	2	
Lignite	1	½
Clay.		
Total section	26	7¾
Total lignite	3	7

At locality 260, sec. 3, a single bench containing 10 inches of lignite is exposed.

Section of lignite bed at locality 261, sec. 3, T. 37 N., R. 49 E.

	Ft.	in.
Shale.		
Lignite		1
Shale		½
Lignite		3½
Shale		¼
Lignite		10
Shale		6¾
Lignite		11
Shale.		
Total bed	2	3
Total lignite	2	1½

At locality 265, in Canada, the bed is without partings and measures 2 feet in thickness.

Beds still higher, provisionally assigned to horizon F or G, are exposed at localities 262 and 263, sec. 1, and 264, sec. 12. More than 3 feet of lignite is exposed at each of these localities, and the first two sections are shown graphically on Plate XXVI.

The quantity of lignite in this township is roughly estimated at 221,000,000 tons.

T. 33 N., R. 50 E.—A few inches of lignite is reported from a well at locality 266, sec. 6, T. 33 N., R. 50 E. From beds of lignite outcropping in surrounding townships, this fractional township is known to be coal land. The tonnage of lignite present depends upon the number and thickness of the beds. It is assumed that a bed at horizon C or D has a thickness of 3 feet, and the quantity of lignite present is estimated at 8,000,000 tons.

T. 34 N., R. 50 E.—A lignite bed, 3 feet thick, exclusive of partings, provisionally assigned to horizon H, is exposed at the Foster mine, locality 272, sec. 13, T. 34 N., R. 50 E. Its section is given graphically on Plate XXVIII. At the other localities noted on the general map lignite is reported from wells. Probably at the first six localities listed below the Foster bed is exposed, at the last two localities smaller beds either above or below the Foster bed are exposed. The sections are as follows:

Lignite reported in logs of wells in T. 34 N., R. 50 E.

Locality.	Sec.	Depth from surface.	Thickness of lignite reported.
		Feet.	*Ft. in.*
267	5	40	4
268	18	50	1 2
269	21	20	3
270	15	80	5 6
271	23	77	4
273	24	18	1 6
274	27	70	2
275	29	48	1

The Foster bed exposed in this township is provisionally assigned to horizon I, below which there are two large beds of lignite and several small beds exposed in T. 35 N., R. 51 E., northeast of this township. It can safely be assumed, in the writer's opinion, that 8 feet of lignite in beds more than 2½ feet thick underlies the whole township; and if this assumption is correct, the quantity of lignite present in the township is 331,800,000 tons.

T. 35 N., R. 50 E.—A bed of lignite 5 feet thick, tentatively assigned to horizon I, is reported from locality 279, sec. 32, T. 35 N., R. 50 E. There are no reports of large beds of lignite having been found elsewhere in this township. The whole of the township is considered coal land from the fact that two lignite beds more than 5 feet thick and several smaller beds exposed in T. 35 N., R. 51 E., underlie horizon I, which is near the surface in this township. The sections reported are as follows:

Lignite reported in logs of wells in T. 35 N., R. 50 E.

Locality.	Sec.	Depth from surface.	Number of benches.	Reported thickness.
		Feet.		*Ft. in.*
276	11	8	2	1 4
277	22	70	2	2 6
278	21	23	----------	Not reported.
279	32	27	1	5
280	34	1	1	1 6+

It is assumed by the writer that the beds below horizon I which are exposed in T. 35 N., R. 51 E., and which carry a thickness of 11 feet of lignite extend westward and underlie this township, carrying at least 8 feet of lignite. If this assumption is correct the quantity of lignite in beds more than 2½ feet thick in this township is 331,800,000 tons.

T. 36 N., R. 50 E.—The lowest bed of lignite exposed in T. 36 N., R. 50 E., is at the Reuben Ames mine, locality 283, sec. 12. It is near the Lance-Fort Union contact and is assigned to horizon D. The section is as follows:

Section of lignite bed at locality 283, sec. 12, T. 36 N., R. 50 E.

	Ft.	in.
Clay.		
Lignite	2	5
Clay	1	9
Lignite		6
Clay.		
Total bed	4	8
Total lignite	2	11

About 30 feet higher than the Reuben Ames mine is the Goodale mine, at locality 284, sec. 13, at horizon E. Its section containing 3 feet of lignite is shown graphically on Plate XXVIII. Above the Goodale bed is the Ames mine, at locality 285, sec. 14, where the bed measures 3 feet 9 inches. It is assigned to horizon F and is shown graphically on Plate XXVIII. What is probably the same bed is partly exposed at locality 282, sec. 10, where it shows 2½ feet of disintegrated lignite, the top being eroded. The owner of a well at locality 281, sec. 9, a short distance south of Whitetail Creek, probably struck the same bed, and he reports that it contains 7 feet of lignite. Small beds of lignite are reported from wells at locality 286, sec. 15, and locality 287, sec. 22.

The quantity of lignite in this township in beds more than 2½ feet thick is roughly estimated at 331,800,000 tons.

T. 37 N., R. 50 E.—A bed at horizon B, in the Lance formation, is exposed in a mine at locality 288, sec. 35, and locality 289, sec. 24, T. 37 N., R. 50 E., at each of which it is more than 6 feet thick, as shown graphically on Plate XXVIII. A bed at localities 290,

sec. 24; 291, sec. 34; and 292, sec. 35, is supposed to belong to horizon C. At locality 290 the bed is eroded at the top and shows 2 feet 9 inches of weathered lignite. The other two sections, containing from 3 to 4 feet of lignite, are shown graphically on Plate XXVIII. At locality 293, sec. 10, 7 feet of lignite reported in a well at a depth of 75 feet is probably this bed. About 30 feet above horizon C is horizon D, represented at localities 294, sec. 34; 295, sec. 33; 296, sec. 28; 297, sec. 2; and 298, sec. 2. At localities 297 and 298 the lignite measures more than 2½ feet thick, and sections are shown graphically on Plate XXVIII. Sections at the other three localities are given below:

The bed at locality 294, sec. 34, is eroded at the top and shows only a 2-foot bench of lignite.

Section of lignite bed at locality 295, sec. 33, T. 37 N., R. 50 E.

	Ft.	in.
Gravel	4	
Shale	1	6
Lignite		3
Shale		2½
Lignite		11¼
Shale		1¾
Lignite		¾
Sandstone		1¼
Lignite		1
Sandstone		1
Lignite	1	11
Shale.		
Total bed	3	9½
Total lignite	3	3

Section of lignite bed at locality 296, sec. 28, T. 37 N., R. 50 E.

	Ft.	in.
Soil, "smutty," gravelly	1	6
Shale		8
Lignite		5
Shale		2
Lignite		¾
Clay		½
Lignite		1¼
Clay, sandy		1
Lignite	1	10
Clay.		
Total bed	4	10½
Total lignite	2	5

At locality 296, sec. 5, there is a lignite bed which may be at horizon E. It measures 3 feet 3 inches after the partings are deducted and is shown graphically on Plate XXVIII. A bed at the same horizon, exposed across the international boundary at locality

304, north of the northwest corner of sec. 5, has the following section:

Section of lignite beds at locality 304, north of the northwest corner of sec. 5, T. 37 N., R. 50 E.

	Ft.	in.
Shale.		
Lignite	1	3½
Sandstone	2	6
Shale		3
Lignite		½
Shale		1¼
Lignite	2	8½
Shale	8	2
Lignite	1	2½
Shale		¼
Lignite	1	4¼
Shale		3½
Lignite		2
Shale.		
Total section	18	1¼
Total lignite	6	9¼

At locality 300, sec. 5, 17 feet higher in the stratigraphic section, a small bed at horizon F was measured, and 20 feet above this three exposures of beds at horizon G were seen. The sections are as follows:

Section of lignite bed at locality 301, sec. 5, T. 37 N., R. 50 E.

	Ft.	in.
Shale.		
Lignite	1	6
Shale		5
Lignite		9
Shale.		
Total bed	2	8
Total lignite	2	3

Section of lignite bed at locality 302, sec. 6, T. 37 N., R. 50 E.

	Ft.	in.
Shale.		
Lignite		11
Shale		2¼
Lignite		2
Shale		½
Lignite	1	8
Shale		8¼
Lignite	1	1
Shale		6
Lignite		1
Shale		5
Lignite		1½
Shale		6
Lignite		2
Shale.		
Total bed	6	6½
Total lignite	4	2½

The bed at locality 303, sec. 6, measures 1 foot 2½ inches of lignite.

The quantity of lignite in this township in beds more than 2½ feet thick is roughly estimated at 331,800,000 tons.

T. 33 N., R. 51 E.—In the Phelps mine, at locality 306, sec. 1, T. 33 N., R. 51 E., the lignite, provisionally assigned to horizon I, is about 3 feet thick. (See Pl. XXVIII.) What is probably the same bed of lignite is reported at locality 305, sec. 3, but this locality was not visited. The whole of this fractional township is underlain by at least 300 feet of the Fort Union formation, and below horizon I, which is exposed in the Phelps mine, there are at least two beds of lignite each more than 4 feet thick exposed in the townships to the north. The quantity of lignite in beds more than 2½ feet thick in this township is estimated at 65,000,000 tons.

T. 34 N., R. 51 E.—At localities 307, sec. 3, and 308, sec. 9, T. 34 N., R. 51 E., a small bed of lignite, probably at horizon F, is exposed, and at locality 309, sec. 9, a bed at horizon G was found. Sections of the beds at these localities are as follows:

Section of lignite bed at locality 307, sec. 3, T. 34 N., R. 51 E.

	Ft.	in.
Shale.		
Lignite		9½
Shale		¼
Lignite		8¼
Shale.		
Total bed	1	6
Total lignite	1	5¾

The bed at locality 308, sec. 9, is without partings and measures 1 foot 4 inches in thickness, and the bed at locality 309, sec. 9, is also without partings and measures 10 inches.

A bed at one of these horizons is reported from a well at locality 310, sec. 35. A larger bed of lignite, provisionally assigned to horizon I, is exposed in a local mine at locality 311, sec. 2, where it is about 5 feet thick, and at the abandoned Winch mine, locality 313, sec. 34, where it is 4 feet thick. (For graphic sections see Pl. XXVIII.) A well at locality 312, sec. 11, probably reached this bed, but no measurements were made. At locality 315, sec. 12, a bed at horizon J is exposed, but it could not be measured. The bed at the McMahan mine, locality 314, sec. 24, measures over 6 feet, of which 4 feet is lignite of very good quality. It is assigned provisionally to horizon J, and its section is shown on Plate XXVIII.

The beds more than 4 feet thick that crop out in this township are assigned to horizons I and J and are about 300 feet above the base of the Fort Union formation. As two large beds of lignite aggregating 11 feet in thickness near the base of the Fort Union formation are exposed in the township to the north, it can be safely

assumed, in the writer's opinion, that there is an average thickness of 9 feet of lignite in beds more than 2½ feet thick in this township, and the quantity of lignite is therefore estimated at 384,800,000 tons.

T. 35 N., R. 51 E.—Along the canyons of Eagle Creek in T. 35 N., R. 51 E., the bedrock, consisting of about 60 feet of the Lance formation overlain by 297 feet of the Fort Union formation, is generally well exposed. A bed of lignite more than 5 feet thick at horizon A is exposed at localities 316 and 317, sec. 1, detailed sections of which are given on Plate XXVIII. At locality 317 the bed has been opened by a drift 30 feet long, ending in a room 15 feet square. This bed is in the Lance formation about 88 feet below the Fort Union contact. In the hill above the mouth of the drift the following section is exposed:

Section of Lance formation exposed at locality 317, sec. 1, T. 35 N., R. 51 E.

	Ft.	in.
Tullock member:		
Sandstone and shale, light grayish yellow; contains fossil snail shells	35	
Lignite and bone, contact bed, horizon C		10
Hell Creek member:		
Shale, dark gray	5	
Sandstone, somber	21	
Shale, light gray	3	1
Lignite, horizon B	1	10
Shale, carbonaceous	1	6
Shale, light gray	9	3
Shale, black, carbonaceous	1	
Shale, somber	9	6
Lignite and bone, horizon A	6	
Shale	8	6
Total section	102	6
Total lignite	8	8

The next higher important bed, which is from 2 feet 5 inches to 5 feet 10 inches thick, is known as the Redstone bed and is at horizon D, about 88 feet above horizon A. It is exposed at localities 318, sec. 13; 319, sec. 13; 320, sec. 11; 321, sec. 15; 322, sec. 15; 323, sec. 21; and 324, sec. 24. Sections at the first five localities are shown on Plate XXVIII. At locality 323, sec. 21, the bed is less than 2½ feet thick after deducting partings, and its section is as follows:

Section of lignite bed at locality 323, sec. 21, T. 35 N., R. 51 E.

	Ft.	in.
Shale.		
Lignite		5
Shale		10
Lignite	2	
Shale.		
Total bed	3	3
Total lignite	2	5

At locality 324, sec. 24, the same bed is reported in a well log as being about 5 feet thick. This bed has been worked extensively both in this township and the one to the east. At locality 319 there is a strip pit about 100 by 45 feet, back of which a room 10 by 20 feet has been excavated. A small bed of lignite at horizon E, about 20 feet above the Redstone bed, is exposed at locality 325, sec. 11, and locality 326, sec. 21, sections of which are as follows:

Section of lignite bed at locality 325, sec. 11, T. 35 N., R. 51 E.

	Ft.	in.
Shale, carbonaceous		5¾
Lignite		1½
Shale		1¼
Lignite	1	3
Shale, carbonaceous	1	
Total bed	2	5¾
Total lignite	1	4½

Section of lignite bed at locality 326, sec. 21, T. 35 N., R. 51 E.

	Ft.	in.
Shale, yellow, sandy.		
"Smut" and shale	1	6
Lignite		10
Bone		3½
Lignite		½
Bone		2
Lignite		1
Shale, carbonaceous.		
Total bed	2	5
Total lignite		11½

The next bed, at horizon F, about 27 feet stratigraphically above horizon E, is thin as exposed in this township. Exposures were found at localities 327, sec. 11; 328, sec. 13; 329, sec. 13; 330, sec. 28; and 331, sec. 27, sections of which are as follows:

Section of lignite bed at locality 327, sec. 11, T. 35 N., R. 51 E.

	Ft.	in.
Shale.		
Lignite	1	¼
Shale		2¾
Lignite		6½
Shale.		
Total bed	1	9½
Total lignite	1	6¾

At locality 328, sec. 13, the bed is without partings and measures 1 foot 6½ inches.

Section of lignite bed at locality 329, sec. 13, T. 35 N., R. 51 E.

	Ft.	in.
Drift, gravel, etc.		
Lignite, top eroded	2	2½+
Shale, carbonaceous		5
Lignite		4½
Shale.		
Total bed	3+	
Total lignite	2	7+

Section of lignite bed at locality 330, sec. 28, T. 35 N., R. 51 E.

	Ft.	in.
Sandstone.		
Shale		5
Shale, carbonaceous		4
Lignite		7½
Shale		¾
Lignite		1½
Clay		1¾
Lignite	1	½
Clay.		
Total bed	2	4
Total lignite	1	9½

Section of lignite bed at locality 331, sec. 27, T. 35 N., R. 51 E.

	Ft.	in.
Shale.		
Lignite		11
Bone		2½
Lignite		9
Total bed	1	10½
Total lignite	1	8

Section of lignite bed at locality 332, sec. 34, T. 35 N., R. 51 E.

	Ft.	in.
Shale.		
Lignite		9½
Shale		1¼
Lignite		7½
Shale.		
Total bed	1	6¼
Total lignite	1	5

At 20 feet above the bed at locality 332 there is at locality 333, sec. 34, a thin bed assigned to horizon G, which has a thickness of 1 foot 2 inches. A poor exposure of lignite a short distance west of Navajo, at locality 334, sec. 17, is provisionally correlated with this bed. Horizon H is represented by a bed exposed in the township to the south but not seen in this township. Horizon I, about 70 feet above horizon G, is represented by the Eagle's Nest bed, exposed at localities 335, sec. 20; 336, sec. 21; 337, sec. 28; 338, sec. 34; and 339,

sec. 34. In the section measured at locality 335 the top of the bed is eroded and the bed as exposed contains 2 feet 7 inches of lignite, but it has an 8-inch parting near the middle. Sections at the other localities, carrying from 3 to 9 feet of lignite, are given on Plate XXVIII. The bed takes its name from a high hill at locality 337, on which the Eagle's Nest mine is situated. The upper Eagle's Nest bed, at horizon J, correlated provisionally with the McMahan bed in the township to the south, is 30 feet above horizon I and has the following sections in this township:

Sections of upper Eagle's Nest lignite bed in T. 35 N., R. 51 E.

Locality 340, sec. 34.

	Ft.	in.
Shale.		
Lignite		9
Shale		5
Lignite	1	9
Bone		5½
Lignite		2
Shale.		
Total bed	3	6½
Total lignite	2	8

Locality 341, sec. 34.

	Ft.	in.
Sandstone.		
Coal, impure		3½
Lignite		9
Shale		4
Lignite	1	8½
Bone		7
Lignite		2½
Shale.		
Total bed	3	7
Total lignite	2	8

Locality 342, sec. 28.

	Ft.	in.
Shale.		
Lignite, impure		11
Shale		2½
Lignite	2	
Bone		7
Lignite		4
Shale.		
Total bed	3	10½
Total lignite	3	1

Locality 343, sec. 21.

	Ft.	in.
Shale.		
Lignite		5
Shale		4
Lignite	1	6
Bone		5¼
Shale.		
Total bed	2	8¼
Total lignite	1	11

The position of the bed at locality 344, sec. 18, is indicated by disintegrated lignite or "slack" thrown out by badgers.

The quantity of lignite in this township in beds more than 2½ feet thick is roughly estimated at 414,700,000 tons.

T. 36 N., R. 51 E.—The lowest bed known in this field, horizon A, is exposed in strip pits at localities 345, sec. 3, and 346, sec. 35, T. 36 N., R. 51 E., where, with partings deducted, it measures 5 feet 9 inches and 3 feet 5 inches, respectively. The measured sections are given on Plate XXVIII. About 24 feet above this bed the Ranous mine bed, horizon B, is exposed at localities 347, sec. 3; 348, sec. 3; 349, sec. 3; 350, sec. 1; and 352, sec. 35, and measures from 2 feet 9 inches to 3½ feet. The details of the sections measured at these localities are given on Plate XXVIII. At locality 351, sec. 35, the bed consists of only one bench of lignite 2 feet 5 inches thick. This bed has been worked rather extensively at locality 349, sec. 3.

A bed at horizon C, 25 feet higher in the section, is exposed at localities 353, sec. 7; 354, sec. 5; 355, sec. 5; and 356, sec. 3. It is mined from a strip pit at locality 353. At locality 354, sec. 5, it is less than 2½ feet thick, as shown by the following section:

Section of lignite bed at locality 354, sec. 5, T. 36 N., R. 51 E.

	Ft.	in.
Sandstone.		
Bone		6
Lignite	1	
Shale	5	
Lignite		6
Shale.		
Total section	7	
Total lignite	1	6

Graphic sections at each of the other localities where the bed is from 3 to 4 feet thick are shown on Plate XXVIII.

A bed at horizon D is exposed at localities 357, sec. 7; 358, sec. 7; 359, sec. 34; 360, sec. 34; and 361, sec. 36. At locality 357 it shows the following section:

Section of lignite bed at locality 357, sec. 7, T. 36 N., R. 51 E.

	Ft.	in.
Sandstone.		
Lignite	2	5
Clay	1	9
Lignite		6
Clay.		
Total bed	4	8
Total lignite	2	11

Sections at the other localities, where the bed is from 2½ to 4 feet thick, are given on Plate XXVIII.

A bed less than 1 foot thick, exposed at locality 362, sec. 26, is about 5 feet above the thick bed at locality 360. The distance between horizons C and D is 32 feet on the north side of this township. A bed of lignite 2 feet 8 inches thick after deducting partings and about 60 feet above horizon D is exposed at locality 363, sec. 36, and its section is shown on Plate XXVIII.

The total amount of lignite in beds more than 2½ feet thick in this township is estimated at 345,000,000 tons.

T. 37 N., R. 51 E.—A lignite bed at horizon A exposed at locality 364, sec. 34, and locality 367, sec. 15, T. 37 N., R. 51 E., where it is 2 feet 6 inches and 3 feet 4 inches thick, is represented by graphic sections on Plate XXVIII. At locality 365, sec. 34, the bed measured 2 feet 5 inches of lignite, and at locality 366, sec. 22, the following section was measured:

Section of lignite bed at locality 366, sec. 22, T. 37 N., R. 51 E.

	Ft.	in.
Shale.		
Bone	1	3
Lignite		3
Bone	1	
Lignite		2
Bone	1	
Shale.		
Total bed	2	5
Total lignite		5

A bed from 2½ to over 18 feet thick at horizon B is exposed at localities 368, sec. 32; 371, sec. 28; 372, sec. 16; 373, sec. 10; 374, sec. 14; 376, sec. 36; and 377, sec. 36. (For sections at these places see Pl. XXVIII.) The same bed has been noted, but not measured, at locality 375, sec. 14. At localities 369, sec. 30, and 370, sec. 29, the following sections, which probably include horizons A and B, were measured:

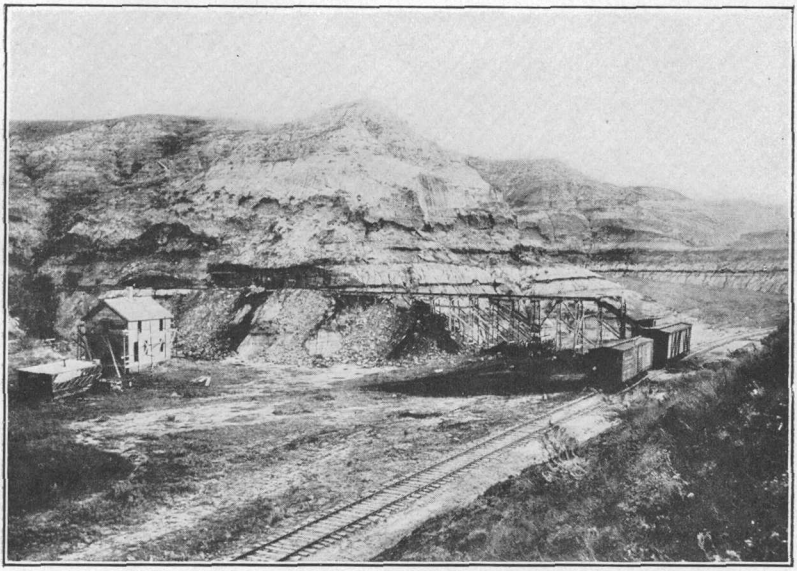
Section of lignite beds at locality 369, sec. 29, T. 37 N., R. 51 E.

	Ft.	in.
Lignite, weathered, top eroded	3	4+
Shale and sandstone	40	
Lignite	1	10
Shale		½
Lignite		3
Shale.		
Total section	45	5½+
Total lignite	5	5+

Section of lignite beds at locality 370, sec. 30, T. 37 N., R. 51 E.

	Ft.	in.
Shale.		
Lignite		10
Shale		3
Lignite	1	4
Shale	20	
Lignite		3
Shale		½
Lignite		11
Clay	1	
Lignite	2	1
Clay.		
Total section	26	8½
Total lignite	5	5

Small mines have been operated at localities 372, 373, and 374, and the only shipping mine in the field, a view of which is given on Plate XXVII, *A*, is situated at locality 377, in sec. 36, and is operated by the Ranous Coal Co. A sample for analysis (No. 23008) was cut at the face of the main entry, 400 feet N. 45° E. from the drift mouth, on a bench of lignite which measured 4 feet 11 inches and



A. RANOUS MINE, DALEVIEW, MONT., SEC. 36, T. 37 N., R. 51 E.

B. A LARGE SPRING EMERGING FROM THE GLACIAL DRIFT, SEC. 18, T. 36 N., R. 55 E., SCOBEY LIGNITE FIELD, MONT

which probably corresponds to the bench measuring 3 feet 11 inches at the mine mouth. The output of this mine during October, 1915, was estimated at 3,500 tons.

A variable bed at horizon C measures from 10 inches to more than 6 feet in thickness. Sections at localities 379, 380, and 381, sec. 5, and 383, sec. 8, are shown on Plate XXVIII. This bed has been stripped for local needs of farmers at localities 379, 381, 382, and 383. At locality 378, sec. 7, it contains only 10 inches of lignite; at localities 382, sec. 4, and 384, sec. 16, it has the following sections:

Section of lignite bed at locality 382, sec. 4, T. 37 N., R. 51 E.

	Ft.	in.
Shale, yellow.		
Clay, dark, with streaks of lignite		8
Lignite		3
Shale		5
Lignite, bottom not exposed	3+	
Total bed	4	4
Total lignite	3	3+

Section of lignite bed at locality 384, sec. 16, T. 37 N., R. 51 E.

	Ft.	in.
Shale.		
Lignite		3
Clay		5
Lignite		6
Clay	1	3
Lignite		7
Total bed	3	
Total lignite	1	4

The quantity of lignite in beds more than 2½ feet thick in this township is estimated to be about 210,800,000 tons.

T. 36 N., R. 52 E.—The Lance formation and the lignite beds contained in it vary greatly from place to place in T. 36 N., R. 52 E., and the townships to the north and south, and the exact correlation of the lignite beds can not be accurately determined. The lowest bed at or near horizon A is represented at localities 385, sec. 8, and 386, sec. 17, where it measures about 3 feet after deducting partings. The sections are shown on Plate XXVIII. At locality 388, sec. 16, 3 feet of decomposed lignite was found in the bank of the creek. At locality 387, sec. 17, the bed is without partings and measures 1 foot 9 inches thick. At locality 389, sec. 21, the following section was measured:

Section of lignite bed at locality 389, sec. 21, T. 36 N., R. 52 E.

	Ft.	in.
Shale.		
Lignite	2	2
Shale	2	7
Lignite	2	5½
Shale.		
Total section	7	2½
Total lignite	4	7½

A bed 20 feet or more above horizon A, at horizon B, contains from 3 to 11 feet of lignite at localities 390, sec. 30; 392, sec. 21; 395, sec. 8; 396, sec. 7; 397, sec. 6; 398, sec. 6; 399, sec. 4; 400, sec. 3; 401, sec. 3; 402, sec. 9; and 403, sec. 15. (For sections see Pl. XXVIII.) This bed is less than 2½ feet thick after deducting a thickness equivalent to the partings at the following localities:

Section of lignite bed at locality 391, sec. 21, T. 36 N., R. 52 E.

	Ft.	in.
Clay shale.		
Lignite	2	
Shale		3½
Lignite		8½
Clay shale.		
Total bed	3	
Total lignite	2	8½

Section of lignite bed at locality 393, sec. 17, T. 36 N., R. 52 E.

	Ft.	in.
Clay shale.		
Lignite		6
Shale		9
Lignite	2	1
Clay shale.		
Total bed	3	4
Total lignite	2	7

At locality 394, sec. 8, the bed is without partings and carries 1 foot 8 inches of lignite. This bed is mined extensively at localities 400 and 401, sec. 3, at the Good Luck mine.

A lignite bed about 20 feet above horizon B was measured at the following localities:

Section of lignite bed at locality 404, sec. 17, T. 36 N., R. 52 E.

	Ft.	in.
Shale, yellow.		
Lignite		2½
Shale		¾
Lignite		10
Shale		¼
Lignite		11½
Shale.		
Total bed	2	1
Total lignite	2	

Section of lignite bed at locality 407, sec. 28, T. 36 N., R. 52 E.

	Ft.	in.
Lignite	1	2
Shale	8	
Lignite		4
Shale		4½
Lignite	1	2
Shale.		
Total bed	11	1½
Total lignite	2	8

Section of lignite bed at locality 408, sec. 15, T. 36 N., R. 52 E.

	Ft.	in.
Shale, yellow.		
Lignite		4½
Shale		1¼
Lignite	1	10
Shale.		
Total bed	2	3¾
Total lignite	2	2½

This bed is represented by a single bench at locality 405, sec. 21, where it measures 1 foot 11 inches; at locality 406, sec. 28, where it measures 1 foot 6 inches; and at locality 409, sec. 3, where it measures 1 foot 10 inches.

About 25 feet higher stratigraphically is the Redstone bed, at horizon D, sections of which at localities 411, sec. 33, and 412, sec. 34, have a thickness of 2 feet 7 inches and 3 feet and are shown graphically on Plate XXVIII. At the two following localities the lignite measures less than 2½ feet:

Section of lignite bed at locality 413, sec. 23, T. 36 N., R. 52 E.

	Ft.	in.
Shale.		
Shale		2
Lignite		2½
Shale		2½
Lignite		11½
Shale		1
Lignite		10
Shale.		
Total bed	2	7½
Total lignite	2	2

Section of lignite beds at locality 414, sec. 2, T. 36 N., R. 52 E.

	Ft.	in.
Sandstone.		
Lignite		5
Shale		8½
Lignite		2½
Shale		3
Lignite	1	½

	Ft.	in.
Shale	4	2
Lignite		4
Shale		7
Lignite		3
Shale.		
Total section	7	11½
Total lignite	2	3

Approximately 30 feet above the Redstone bed a lignite bed, at horizon E, is exposed at locality 415, sec. 34, where the bed is without partings and measures 1 foot 7 inches, and at locality 416, sec. 14, where the section is as follows:

Section of lignite bed at localities 416, sec. 14, T. 36 N., R. 52 E.

	Ft.	in.
Shale.		
Lignite		1
Shale		3
Lignite	1	6½
Shale.		
Total bed	2	½
Total lignite	1	9½

A lignite bed at horizon F, 30 feet higher in the section than horizon E, is exposed at localities 417, sec. 23; 418, sec. 33; and 419, sec. 34. Its thickness at each of these localities is about 3½ feet, and it is shown on Plate XXVIII.

The estimated tonnage of lignite in beds more than 2½ feet thick in this township is about 191,500,000 tons.

T. 37 N., R. 52 E.—Most of T. 37 N., R. 52 E., is underlain by the Fort Union formation, but near Big Muddy Creek, in the western part, the Lance formation is exposed.

The lignite bed at horizon B, exposed at the Ranous mine, near the southeast corner of the township, has several partings, the largest of which is 4 feet thick, but when the bed is traced northward and eastward from the Ranous mine these partings are found to thicken very rapidly and really divide the bed into three beds. In the sections measured at localities 420, sec. 31; 421, sec. 30; and 422, sec. 19, given on Plate XXVIII, the three beds are shown and the thickness of the interval between them is indicated. The thickness of the lignite after deducting partings ranges from 11 feet in sec. 21 to 4 feet in sec. 19. The bed has been stripped at several places in this township. At locality 422 each of its benches has been worked. At localities 423, sec. 7, and 424, sec. 17, what are thought to be upper benches of the Ranous bed are exposed, and the following sections were measured:

Section of lignite beds at locality 423, sec. 7, T. 37 N., R. 52 E.

	Ft.	in.
Shale.		
Lignite	1	7
Shale	15	
Lignite	1	5
Shale		1
Lignite	1	4
Shale.		
Total section	19	5
Total lignite	4	4

The bed is without partings at locality 424, sec. 17, and measures 2 feet.

The bed at horizon C, 20 feet above the Ranous bed, is exposed at locality 425, sec. 19.

Section of lignite bed at locality 425, sec. 19, T. 37 N., R. 52 E.

	in.
Lignite	1
Clay	1
Lignite	1 10
Clay.	
Total bed	2
Total lignite	1 11

A bed at horizon D, from 4 to 5 feet thick, has been stripped at locality 426, sec. 9, and locality 427, sec. 4, and the sections measured are given on Plate XXVIII. At locality 426 it is stripped for about 300 feet along the hillside, and at three places drifts have been run back of these pits.

Lignite has been found in wells dug through the glacial drift at localities 428, sec. 28; 429, sec. 25; and 430, sec. 13, but the beds reported are small.

The total tonnage of lignite in beds more than 2½ feet thick in this township is estimated at 327,000,000 tons.

T. 36 N., R. 53 E.—T. 36 N., R. 53 E., is a part of the rolling plain or plateau that extends eastward into North Dakota. The altitude of this plateau is about 300 feet above that of the flood plain of Big Muddy Creek. No remnant of the high plateau represented at Flaxville, in T. 35 N., R. 50 E., and the townships to the west is present here.

At locality 431, sec. 11, 1 foot 7 inches of lignite is exposed; at locality 432, sec. 36, 9 inches.

The adjoining township on the west carries at least 12 feet of lignite in three beds. The dip of the bedrock can not be determined here, but from the work done by Bauer in the township to the south, it is believed that the beds dip to the southeast at about 15 feet to the mile. It seems reasonable to suppose, therefore, that

the beds exposed in the township to the west are present beneath this township, and perhaps some higher beds not seen on account of the glacial drift. The total quantity of lignite in this township is estimated to be 487,600,000 tons.

T. 37 N., R. 53 E.—The only lignite yet found in T. 37 N., R. 53 E., is recorded in the logs of wells. At locality 433, sec. 5, in a well 143 feet deep, lignite is reported, but the thickness is not given. At locality 434, sec. 5, 7 feet of lignite is reported to have been found at a depth of 60 feet. At locality 435, sec. 3, lignite is reported to have been reached in a well 14 feet deep, but no thickness is given. At locality 436, sec. 17, lignite was found on the dump of a well, but neither the depth of the well nor the thickness of the lignite was learned. At locality 437, sec. 33, lignite probably less than 2½ feet thick was found in a well 60 feet deep. At locality 438, sec. 35, 4 or 5 feet of lignite, 120 feet from the surface, is reported.

Owing to the thick coating of glacial drift in this township, it was impossible, with the time and resources at the writer's disposal, to ascertain the thickness of the several lignite beds. In T. 37 N., R. 52 E., near the base of the Fort Union formation, there is about 9 feet of lignite in beds more than 2½ feet thick which probably underlie this township, and the report of lignite in sec. 5 makes it seem probable that there is at least one large bed of lignite about 200 feet above the base of the Fort Union formation. The quantity of lignite in beds that are more than 2½ feet thick in this township is therefore estimated rather arbitrarily at 487,600,000 tons.

T. 36 N., R. 54 E.—A bed exposed at localities 439, sec. 28; 440 and 441, sec. 27; and 442, sec. 34, T. 36 N., R. 64 E., carries from 2½ to 5½ feet of lignite. Sections are shown on Plate XXVIII.

In T. 36 N., R. 52 E., there are several beds containing at least 12 feet of lignite not far above and below the base of the Fort Union formation, which underlies this township at a considerable depth. In the township immediately south of this township at least two beds of lignite more than 2½ feet thick and a considerable distance above the base of the Fort Union formation are reported by Bauer. The tonnage of lignite in this township must be estimated from rather meager data, and if all the facts regarding the deeply buried beds could be known, the estimate might be found to be very much too high or very much too low. It is placed at 487,600,000 tons.

T. 37 N., R. 54 E.—At localities 443 and 444, sec. 6; 445, sec. 7; 446, sec. 8; and 447, sec. 17, T. 37 N., R. 54 E., there are wells in each of which a large lignite bed, indicated by the following sections, is reported to have been struck:

Lignite recorded in logs of wells in T. 37 N., R. 54 E.

Locality.	Section.	Depth from surface.	Lignite reported.
		Feet.	*Feet.*
443	6	75	6±
444	6	75	6±
445	7	94	(a)
446	8	20	6±
447	17	0	4±

a Thickness unknown.

At the Hendricks mine, locality 448, sec. 23, lignite as much as 1 foot 9 inches thick was measured, but it was claimed that the bed has a thickness of 4 feet.

From the estimated thickness of the Fort Union rocks and the beds of lignite exposed near the base of the Fort Union in Tps. 35 and 36 N., R. 52 E., the beds exposed on the north side of Big Muddy Creek in T. 35 N., R. 54 E., and the bed reported from the wells in this township, the total quantity of lignite in beds more than 2½ feet thick in this township is estimated at 663,500,000 tons.

T. 36 N., R. 55 E.—A large spring near Raymond, in sec. 18, T. 36 N., R. 55 E., rising from the glacial drift and forming a long pool of water in the bed of Lone Tree Creek, is shown in Plate XXVII, *B*. The thickness of the Fort Union formation underlying the glacial drift is estimated from the eastward dip of the rocks exposed in the escarpments on either side of Big Muddy Creek from Redstone, in T. 35 N., R. 52 E., to Plentywood, in T. 35 N., R. 55 E., to be about 600 feet. Near Redstone there are two beds of lignite aggregating at least 11 feet thick. Between Redstone and Plentywood there are two beds above those noted near Redstone which aggregate about 7 feet thick, and northeast of Plentywood, in T. 35 N., R. 55 E., there is a bed which carries about 4 feet of lignite. It seems reasonable to suppose that the Fort Union and Lance formations underlying this township will carry at least 19 or 20 feet of lignite in several beds more than 2½ feet thick, and the total quantity of lignite in this township is therefore estimated at about 663,000,000 tons.

T. 37 N., R. 55 E.—No lignite has been reported in T. 37 N., R. 55 E., for the wells visited are comparatively shallow and obtain water from the glacial cap. The eastward dip of the rocks found along Big Muddy Creek between Redstone and Plentywood indicates that about 600 feet of Fort Union rocks underlie this township, and if these rocks carry as much lignite here as they do in the townships to the west and south, the total quantity of lignite in this township should be about 663,000,000 tons.

T. 35 N., Rs. 52, 53, 54, and 55 E.—The following description of T. 35 N., Rs. 52, 53, 54, and 55 E., is adapted briefly from

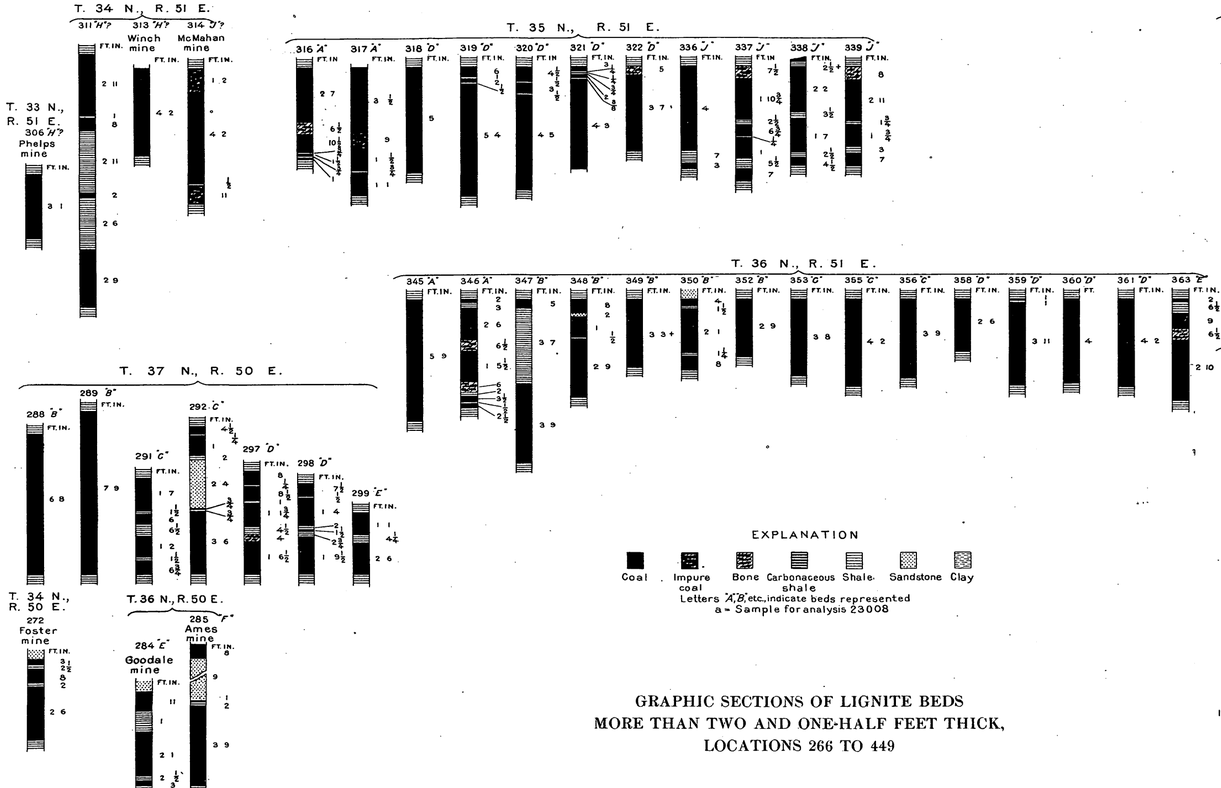
Bauer's report,[30] as nearly all the evidence regarding the dip of the beds underlying the townships north of them is to be found in these townships. Across each of these townships the valley of Big Muddy Creek is cut from west to east. The creek flows through intricate meanders on a flood plain about a mile wide. Back of the flood plain on either side of Big Muddy Creek there is a line of terraces, and back of these are the steep escarpments by which the land surface rises to the rolling prairie at the second erosion level, from 200 to 300 feet above the flood plain. Bedrock is exposed in these escarpments, from which it has been determined that in T. 35 N., R. 52 E., the Redstone lignite bed dips southeastward about 15 feet to the mile, passing below the flood plain near the east side of the township, and in Tps. 34 and 35 N., R. 55 E., the Richardson lignite bed has a southeastward dip of about 16 feet to the mile. Minor undulations in the strata alter this dip locally, but these measurements illustrate the general attitude of the beds.

At least three beds of lignite crop out in T. 35 N., R. 52 E. The lowest bed exposed at locality B 22, sec. 8, measures 1 foot 7 inches thick and is probably at horizon B of this report. At locality B 19 a bed partly exposed 10 feet above the water of Eagle Creek and measuring, after deducting partings, 2 feet 8 inches in thickness may correspond with either horizon A or B of this report. The Redstone lignite bed, 50 feet above the bed at locality B 19, is exposed at localities B 20, B 21, B 25, and B 29 and at a point in sec. 5 visited by the writer in 1916, carrying from 3 feet 4 inches to 5 feet 10 inches of lignite after deducting partings. A lignite bed 80 feet above the Redstone bed, exposed at localities B 27, B 28, B 30, B 31, B 33, and B 35, has an average thickness of 2 feet 8 inches and ranges from 1 foot 2 inches to 4 feet.

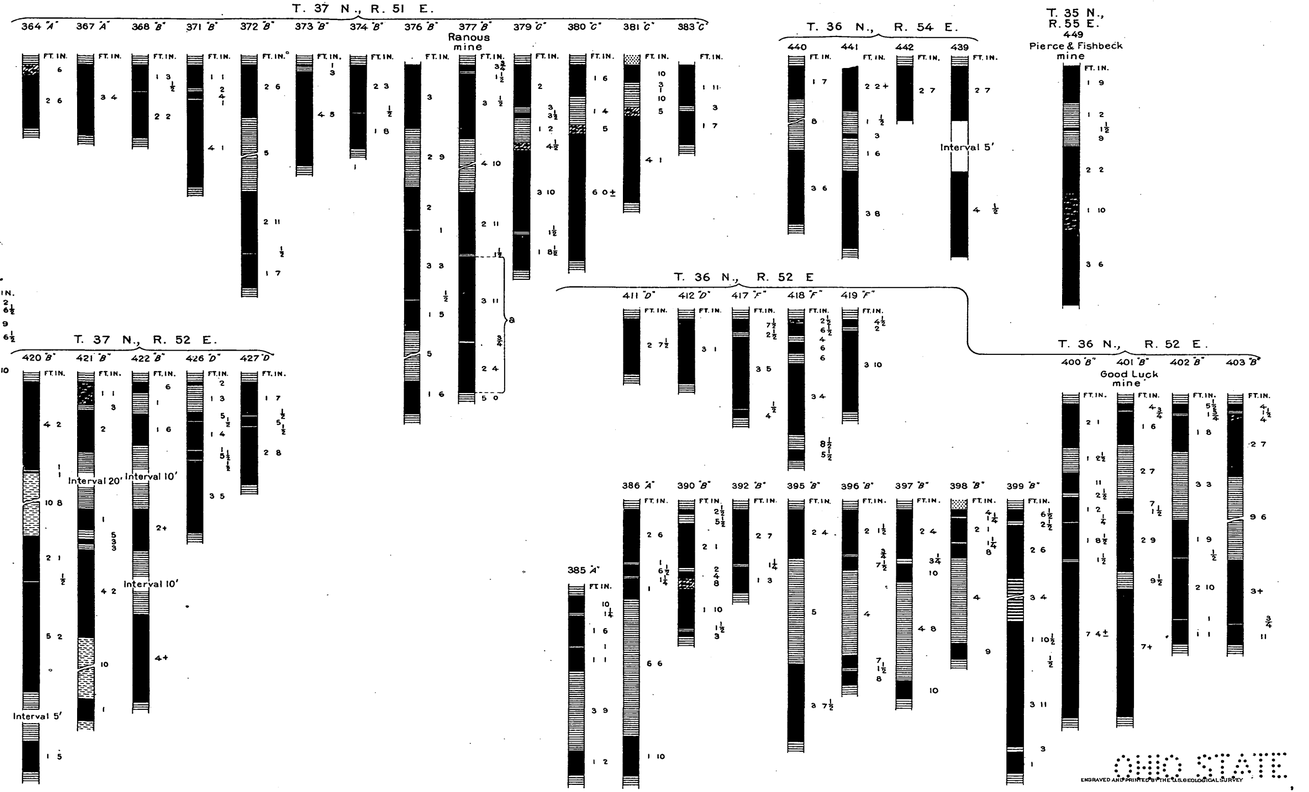
In T. 35 N., R. 53 E., the beds dip about 16 feet to the mile toward the southeast. What is probably the same bed as that noted at locality B 35, in the township immediately west of this, crops out at locality B 36, B 37, and B 38. At locality B 36 it measures 3 feet 4 inches minus the partings, but at the other localities noted it is less than 2½ feet thick. The thickest bed exposed in the township is at localities B 39 and B 40, where it measures 3 feet 6 inches and 8 feet thick, respectively. This bed is probably at least 75 feet above the bed measured at locality B 36. The other exposures of lignite are so isolated that their relative positions in the strata were not determined.

The exact structure could not be determined in T. 35 N., R. 54 E., but the strata probably dip about 16 feet to the mile toward the southeast, as indicated by the dips in the townships east and west of

[30] Bauer, C. M., Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont.: U. S. Geol. Survey Bull. 541, pp. 293–315, 1914.

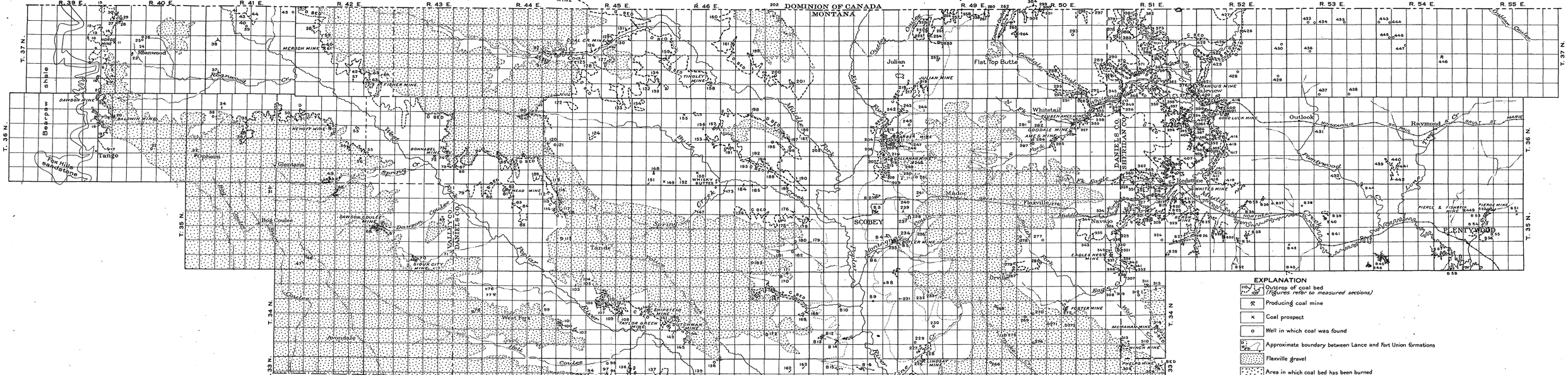


GRAPHIC SECTIONS OF LIGNITE BEDS MORE THAN TWO AND ONE-HALF FEET THICK, LOCATIONS 266 TO 449



U. S. GEOLOGICAL SURVEY

BULLETIN 751 PLATE XXIX



GEOLOGIC MAP OF THE SCOBEY LIGNITE FIELD, VALLEY, DANIELS, AND SHERIDAN COUNTIES, MONTANA

Scale 250,000

2 0 2 4 6 8 10 MILES

1924

ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

EXPLANATION

- Outcrop of coal bed (figures refer to measured sections)
- Producing coal mine
- Coal prospect
- Well in which coal was found
- Approximate boundary between Lance and Fort Union formations
- Flaxville gravel
- Area in which coal bed has been burned
- Fault

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it. Two beds of lignite separated by 15 to 20 feet of sandstone were mapped at localities B 45 and B 46. The upper bed is about 2 feet 8 inches thick in both localities; the lower bed is 2 feet 10 inches thick at B 45 and only 1 foot 8 inches at B 46. An isolated outcrop of lignite near the north line of sec. 5, at locality B 4, shows only 1 foot 10 inches of lignite.

The beds in T. 35 N., R. 55 E., dip about 15 feet to the mile toward the southeast. Probably two beds of lignite have been found in this township. The Richardson bed is exposed in the bluffs south of Big Muddy Creek and along Spring Creek north of the Big Muddy at localities B 52 to B 56 and at the Pierce & Fishbeck mine, north of Plentywood, in sec. 449. (See Pl. XXVIII.) Measurements made at the eight localities noted indicate that it contains at least 3 feet 3 inches of lignite after deducting partings. Samples for analysis have been taken at two localities, and the results are given in the table and analyses (p. 175) under laboratory Nos. 14670 and 23595. At the Pierce & Fishbeck mine a plant was being installed in 1915 to supply Plentywood with electric light, heat, and power. What is supposed to be a higher bed of lignite has been struck in a well at locality B 51 at a depth of 18 feet. The bed is reported to be 3 feet 6 inches thick.

ESTIMATED RESERVES.

The estimates given in the foregoing descriptions are summarized below:

Estimated reserves of lignite in the Scobey field, Mont., in tons.

T. 36 N., R. 39 E.	10,000	T. 35 N., R. 46 E.	35,000,000
T. 37 N., R. 39 E.	13,800,000	T. 36 N., R. 46 E.	70,000
T. 36 N., R 40 E.	13,800,000	T. 37 N., R. 46 E.	110,000,000
T. 37 N., R. 40 E.	17,200,000	T. 33 N., R. 47 E.	21,000,000
T. 37 N., R. 41 E.	4,600,000	T. 34 N., R. 47 E.	156,000,000
T. 36 N., R. 42 E.	97,900,000	T. 35 N., R. 47 E.	51,800,000
T. 37 N., R. 42 E.	110,600,000	T. 36 N., R. 47 E.	119,800,000
T. 35 N., R. 43 E.	20,000	T. 37 N., R. 47 E.	156,700,000
T. 36 N., R. 43 E.	13,000,000	T. 33 N., R. 48 E.	6,400,000
T. 37 N., R. 43 E.	55,000,000	T. 34 N., R. 48 E.	10,700,000
T. 35 N., R. 44 E.	2,000,000	T. 35 N., R. 48 E.	26,700,000
T. 36 N., R. 44 E.	48,400,000	T. 36 N., R. 48 E.	27,600,000
T. 37 N., R. 44 E.	24,300,000	T. 37 N., R. 48 E.	41,400,000
T. 33 N., R. 45 E.	800,000	T. 33 N., R. 49 E.	27,700,000
T. 34 N., R. 45 E.	4,800,000	T. 34 N., R. 49 E.	114,000,000
T. 35 N., R. 45 E.	5,800,000	T. 35 N., R. 49 E.	124,400,000
T. 36 N., R. 45 E.	35,000,000	T. 36 N., R. 49 E.	207,000,000
T. 37 N., R. 45 E.	253,000,000	T. 37 N., R. 49 E.	221,000,000
T. 33 N., R. 46 E.	2,300,000	T. 33 N., R. 50 E.	8,000,000
T. 34 N., R. 46 E.	86,000,000	T. 34 N., R. 50 E.	331,800,000

T. 35 N., R. 50 E.	331,800,000	T. 37 N., R. 52 E.	327,000,000
T. 36 N., R. 50 E.	331,800,000	T. 36 N., R. 53 E.	487,600,000
T. 37 N., R. 50 E.	331,800,000	T. 37 N., R. 53 E.	487,600,000
T. 33 N., R. 51 E.	65,000,000	T. 36 N., R. 54 E.	487,600,000
T. 34 N., R. 51 E.	384,000,000	T. 37 N., R. 54 E.	663,500,000
T. 35 N., R. 51 E.	414,700,000	T. 36 N., R. 55 E.	663,000,000
T. 36 N., R. 51 E.	345,000,000	T. 37 N., R. 55 E.	663,000,000
T. 37 N., R. 51 E.	210,800,000		
T. 36 N., R. 52 E.	191,500,000		8,971,100,000