THE MOORCROFT OIL FIELD, CROOK COUNTY, WYOMING.

By V. H. Barnett.

INTRODUCTION.

The Moorcroft oil field lies 12 miles north of the town of Moorcroft on the Chicago, Burlington & Quincy Railroad. The presence of oil in this field has been known for at least a quarter of a century and many wells have been drilled in the hope of developing a commercial pool, but in only seven of these wells has oil been found in appreciable amounts. The present investigation, made in June, 1913, followed a withdrawal of the land from entry pending examination, and the object of the investigation was to determine, as far as might be, the possibilities of the field by a study of the geologic structure, the various formations involved, and the conditions under which the accumulation of oil has taken place. The results of the work are not on the whole encouraging to further development of the field.

The first operations in the field, as shown by Territorial Geologist Ricketts's report,[1] began prior to 1888. He stated that oil of high specific gravity was pumped from one well and collected from over a dozen springs, and was "transported to mining towns in the Black Hills, where it commanded a ready sale as a lubricating oil at a price of $28 per barrel." The well, owned by the Wyoming Standard Oil Co., was 300 feet deep and produced 5 barrels of oil a day. Some of the springs were said to have yielded 20 gallons a day, but this is probably excessive, as Ricketts says that the spring in the SE. ¼ sec. 27, T. 52 N., R. 67 W., when first cleaned out yielded about 90 gallons of oil a month. The oil at this spring collected on top of the water and was secured with a dipper.

Different companies have drilled in the Moorcroft field at various times since 1887, until at present there are about 60 holes scattered throughout the field.

The only wells which have yielded enough oil to warrant capping and attaching pumps are seven that form a small group in sec. 34, T. 52 N., R. 67 W. These, if pumped, would probably yield for a short time about 5 barrels each a day. They are owned by the Butte Crude Petroleum Co., a Montana corporation, which some years ago installed a pumping plant and wooden tanks.

[1] Ricketts, L. D., Annual report of the Territorial geologist to the governor of Wyoming, p. 43, 1888.

The Moorcroft oil field, including parts of Tps. 50 and 51 N., Rs. 66 and 67 W., and T. 52 N., R. 67 W., as shown in figure 2, lies for the most part in an open plain bordered on the east by a ridge, which rises from 200 to 400 feet above the main part of the field. On the west there is also higher land, a more or less distinct escarpment rising to about the same level as the ridge on the east. The ridge and the escarpment are parallel, extending north and south. There are other smaller ridges near the west foot of the high ridge and parallel to it. The valley of Belle Fourche River, which with its tributaries drains the field, is broad and flat, except in T. 51 N., R. 66 W., where

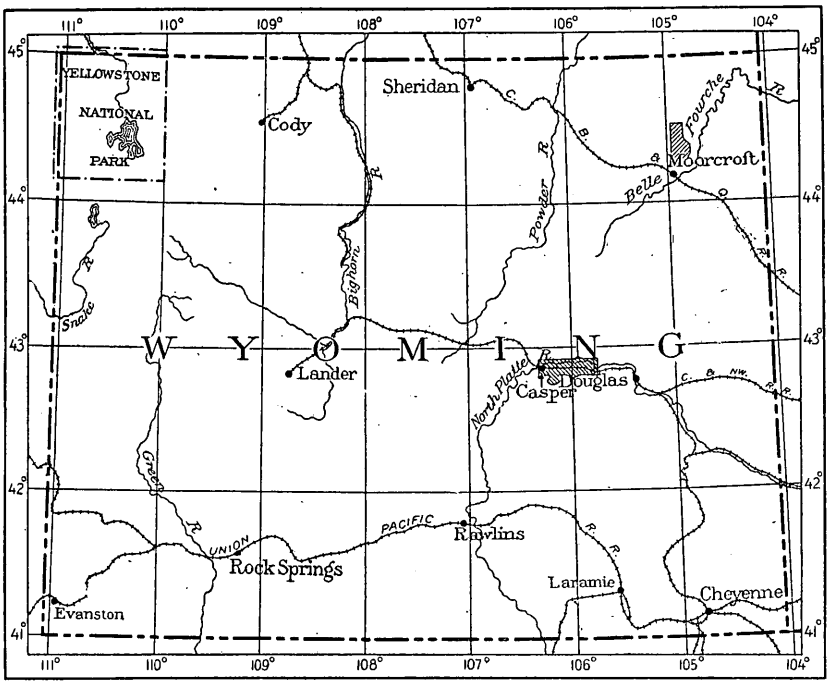


FIGURE 2.—Map of Wyoming showing the location of the Moorcroft oil field and the Big Muddy dome.

it flows between more or less precipitous bluffs which rise abruptly a short distance back from the stream. The high ridge on the east side of the field is trenched by deep ravines and in some places dissected into badlands.

The elevation of the field ranges from about 4,050 feet above sea level on Belle Fourche River, in sec. 29, T. 51 N., R. 66 W., to 4,650 feet on the ridge in sec. 36, T. 52 N., R. 67 W., the average elevation being about 4,200 feet above sea level.

Certain small areas in the Moorcroft field are cultivated and fair crops of grain, alfalfa, and timothy are raised. Some irrigation is done, especially along Belle Fourche River, but up to June, 1913, only a small part of the irrigable land was in use. The valley of

Belle Fourche River, in places over 2 miles wide, is for the most part uncultivated and covered by sagebrush and native grasses. If an adequate irrigation system could be established it might well be put under cultivation. Considerable success also is attending cultivation without irrigation, and such farms are at present as numerous as those which are irrigated. A large part of the Moorcroft field is suitable only for grazing and a few small tracts yield a sufficient growth of grass to be cut for hay. Local areas along the eastern border of the field are covered by pine trees, some of which are sufficiently large for building material.

Fuel for domestic use consists of wood from the timbered areas in the eastern part of the field and of coal shipped from places along the Chieago, Burlington & Quincy Railroad or hauled by wagon from mines in the coal field southwest of Moorcroft.

The principal water supply is obtained from Belle Fourche River, which crosses the southern part of the field in a general northeasterly course, and from a number of springs of fairly good water along the foot of a ridge which extends across the east side of the field from northwest to southeast. Water is also obtained in very shallow wells in the vicinity of this ridge and some of the borings for oil have developed flowing wells of water, all of which are of low pressure.

ACKNOWLEDGMENTS.

The writer was assisted in the field work by Frank Elliott, for whose aid he desires to express his appreciation. Mr. B. M. Campbell, a resident of the field, rendered valuable assistance. Mr. W. I. Lippincott, of the Butte Crude Petroleum Co., Butte, Mont., and Mr. J. H. Russell, of the Mineral Oil Co., supplied information in regard to the wells drilled by their respective companies. To Mr. Charles Louis credit is also due for information regarding developments in the field.

METHOD OF FIELD WORK.

The Moorcroft field was mapped on a scale of 2 inches to the mile by means of a plane table and telescopic alidade, the township being the unit represented by each field sheet. A complete system of triangulation was established covering the field, and the stations of this system served the purpose of horizontal and vertical control and supplied the means of tying together in the final compilation of the map the different plane-table sheets. In beginning the primary control or triangulation a base line 7,300 feet in length was measured by stadia along a fairly level stretch between two intervisible points, the line extending from well No. 44 in sec. 27, T. 52 N., R. 67 W., in a northwesterly direction to a prominent point in sec. 22. From this line as a base a system of triangulation was carried over the field and supplemented by stadia traverses from triangulation stations.

The triangulation system was tied by a stadia traverse to a bench mark, established by the topographic branch of the United States Geological Survey, in the NW. ¼ NW. ¼ sec. 7, T. 52 N., R. 66 W. (see Pl. III, p. 104), and from this bench mark the altitudes of the various triangulation stations and stadia points were calculated.

The map (Pl. III) was assembled after returning to the office by joining the individual plane-table sheets, using the points common to two or more of them.

THE OIL.

SEEPS AND WELLS.

At several localities in the Moorcroft field oil finds its way to the surface in the form of seeps or springs.

In the SE. ¼ sec. 2, T. 51 N., R. 67 W., at a small spring seeping from the shale and sandstone of the Fuson shale[1] oil collects on the surface of the water; in the NE. ¼ NE. ¼ sec. 34, T. 52 N., R. 67 W., a very small amount of oil occurs in a ravine in the sandstone member of the Graneros shale; in the NE. ¼ SE. ¼ sec. 27, T. 52 N., R. 67 W., there is a spring of water on the surface of which oil collects in sufficient quantity to be dipped up with a ladle; and about one-quarter of a mile farther north, in the next ravine, at another spring of water, oil collects in very small quantities. In the sandstone member of the Graneros shale exposed in a ravine in the SE. ¼ sec. 22, T. 52 N., R. 67 W., there is oil in sufficient quantity to give a brownish color to the rock and impart a distinct odor of petroleum. Oil also seeps to the surface in three of the old drill holes along the west flank of the anticlinal ridge, as follows: Well No. 4, in sec. 36, T. 51 N., R. 67 W.; well No. 14, in sec. 12, T. 51 N., R. 67 W.; and well No. 30, in the NE. ¼ sec. 34, T. 52 N., R. 67 W. Oil is obtained at a depth of about 600 feet from six wells in the NW. ¼ sec. 34, T. 52 N., R. 67 W., where it occurs either in the sandstone member of the Graneros shale or in the Mowry shale member of the Graneros and is reported to have been struck at a depth of about 600 feet.

Of the 65 seeps and wells described in the following pages, 3 are oil springs, 21 are shallow holes which should not be considered wells, and 41 are wells which are perhaps fair tests for oil at the localities where they were drilled. Of these 41 test holes 15 are reported to have struck "showings" or small quantities of oil. One well is reported to have yielded a small amount of gas and 4 wells gave flowing water. All the wells in the field but 7 have been abandoned as oil wells.

In the following description the wells and seeps of the Moorcroft field are taken up by number, each number in the text having a corresponding number on the map. The most southerly well in the field

[1] For descriptions of formations see pp. 94-104.

is No. 1 and wells and seeps are numbered in consecutive order northward, so that the highest numbers are in the northern part of the field and the lowest ones in the southern. These numbers have no reference to the order in which the wells were drilled or to the companies drilling them.

Well No. 1.—Well No. 1 is located on the flat along Wind Creek in sec. 12, T. 50 N., R. 67 W. At the time of the writer's visit (June, 1913) a Star rig was at the place and drilling had been started by the Wyoming Fuel & Oil Co., but operations had been stopped, apparently for repairs. The well has since been abandoned. The depth was not ascertained. The altitude of the surface is 4,110 feet.

Well No. 2.—Well No. 2, located in sec. 1, T. 50 N., R. 67 W., is probably the well mentioned by Darton [1] as the "Rapid City No. 1." Its depth is given by that author as 1,300 feet. At present the only evidence of the well is blue clay on the surface, a slight depression, and some old timbers strewn about. The altitude of the surface is 4,100 feet.

Well No. 3.—Well No. 3 was drilled in the spring of 1913 by the Mineral Oil Co. and according to a statement of J. H. Russell, field manager, no oil was obtained. As shown on the map (Pl. III) the top of the well is below the oil-bearing sandstone in the lower part of the Graneros shale, so that the only probable oil-bearing rocks which the well could enter are the Dakota and Lower Cretaceous formations.

Log of well No. 3, sec. 5, T. 50 N., R. 66 W.[a]

[Altitude of surface, about 4,230 feet.]

Probable formation.	Driller's description of the rock.	Content.	Thickness.	Depth.
			Feet.	*Feet.*
Graneros shale	Black shale		156	156
Dakota sandstone	Sand	Water	40	196
Fuson shale	Black shale		109	305
Lakota sandstone	Sand	Water	45	350
Morrison shale	Black shale		110	460

[a] This log is taken in part from a report by L. W. Trumbull, State geologist of Wyoming, on the Moorcroft oil field (in press).

Well No. 4.—Well No. 4 is located in sec. 36, T. 51 N., R. 67 W., and is probably the "Northwestern No. 2" of Darton,[2] 800 feet deep. According to a statement of Mr. B. M. Campbell, an old driller, some oil was struck. The well starts in the upper part of the Dakota sandstone and probably goes down nearly to the Sundance formation (Jurassic). At the time of the writer's visit (June, 1913) a little oil was standing on top of the water in the depression surrounding the drill hole. The altitude of the surface is 4,090 feet.

[1] Darton, N. H., Geology and water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming: U. S. Geol. Survey Prof. Paper 65, p. 95, 1909.

[2] Loc. cit.

Assessment wells.—At locations 5, 6, 7, 11, 12, 21, 26, 40 to 43, inclusive, 45, 46, 53 to 57, inclusive, 59, 60, and 62 very shallow holes have been drilled, the deepest probably not over 125 feet and most of them much less. A number of these were put down in 1913 and some were cased with "down spout" (tin tubing about 4 inches in diameter) at the time of the writer's visit. Some of these shallow wells apparently were drilled by the use of a spring pole and a tool similar to a post-hole digger, as the material on the dump pile was in cylindrical chunks 6 inches in diameter.

Well No. 8.—Well No. 8 is located in sec. 21, T. 51 N., R. 66 W., in the valley of Eggy Creek, a small tributary of Belle Fourche River. This well was drilled in 1904 and is reported to be 1,650 feet deep. A standard rig was used and some of the timbers were still on the ground at the time of the writer's visit. The well starts in the Fuson shale, and the red material on the surface indicates that it may have penetrated the Spearfish formation of probable Triassic age which outcrops farther east in the Black Hills.[1] The well was cased with wooden casing, which in June, 1913, was open and filled with water within 40 feet of the surface. The altitude of the surface is 4,100 feet.

Well No. 9.—Well No. 9 is located in sec. 24, T. 51 N., R. 67 W., and at the time of the writer's visit was still cased, the casing projecting 4 feet above the surface of the ground. The well was open and filled with water within about 45 feet of the surface. The altitude of the surface is 4,100 feet.

Well No. 10.—Well No. 10, in the SW. ¼ SE. ¼ sec. 24, T. 51 N., R. 67 W., was drilled a number of years ago by the Monumental Oil Co. with a standard rig and is about 300 feet deep. Part of the timbers of the rig were still on the ground at the time of the writer's visit and the well was used by a near-by ranchman as a stock well. He obtains the water in a bucket 7 feet long and 4½ inches in diameter, fitted with a valve in the bottom, which was lowered by a windlass into the casing. Water stood in the casing within about 40 feet of the surface of the ground and is of good quality. The well is located below (or east of) the outcrop of the main oil-bearing sandstone, so that the probabilities of finding oil were very poor. The altitude of the surface is 4,110 feet.

Well No. 13.—Well No. 13 is located in the SE. ¼ sec. 7, T. 51 N., R. 66 W., on the east side of the anticlinal ridge. The only evidence at the time of the writer's visit that a well had been drilled here was a hole in the ground and some old logs lying about the dump pile. It is reported to have been drilled by the Monumental Oil Co. to a depth of 700 feet and to have shown no evidence of oil. The altitude of the surface is 4,350 feet.

[1] Darton, N. H., and O'Harra, C. C , U. S. Geol. Survey Geol. Atlas, Aladdin folio (No. 128), 1905.

Well No. 14.—Well No. 14, in the SW. ¼ sec. 12, T. 51 N., R. 67 W., is abandoned. In a depression surrounding the old casing there was water at the time of the writer's visit, and on its surface a thin film of oil had collected. The top of the well (altitude 4,180 feet) is below the base of the oil-bearing sandstone of the Graneros shale, so that the small amount of oil which collects on the surface of the water probably seeps from the Dakota sandstone or underlying rocks.

Well No. 15.—Well No. 15, in sec. 11, T. 51 N., R. 67 W., was drilled a number of years ago by the Butte Crude Petroleum Co. to a depth of 440 feet. Apparently little or no oil was encountered, for the casing was drawn and the well abandoned. The altitude of the surface is 4,150 feet.

Well No. 16.—Well No. 16, in sec. 11, T. 51 N., R. 67 W., was drilled a number of years ago by the Butte Crude Petroleum Co. to a depth of 550 feet. Flowing water was obtained, and after the metal casing was drawn a ranchman drove in a casing of boards, which for a time permitted the flow of water. At present, however, the position of the well is indicated only by a mud hole. The altitude of the surface is 4,120 feet.

Well No. 17.—Well No. 17, in sec. 1, T. 51 N., R. 67 W., was drilled a number of years ago by the Butte Crude Petroleum Co. to a depth of 700 feet. No oil was obtained, and at the time of the writer's visit the only evidence of a well having been drilled here was the hole from which the casing had been drawn and a pile of blue clay on the surface. The altitude of the surface is 4,425 feet.

Well No. 18.—Well No. 18, in sec. 1, T. 51 N., R. 67 W., was drilled a number of years ago by the Butte Crude Petroleum Co. to a depth of 1,280 feet, but a set of tools was lost in the well and operations ceased. No oil is reported to have been found. The altitude of the surface is 4,450 feet.

Locality No. 19 (Bird Oil Spring).—At locality No. 19, in the SE. ¼ sec. 2, T. 51 N., R. 67 W., there is a small spring where oil collects on the surface of the water. Birds coming here to bathe get the oil on their feathers and are unable to fly away. Many of these birds never get out of the spring. Because of this fact the spring is known as the Bird Oil Spring. At the time of the writer's visit (June, 1913) there were no less than a dozen carcasses in and about the spring and the bottom was covered with bones of birds. There was just enough oil to make a thin coating over the surface of the water. Birds that get only a little oil on them are able to hop away, and the rocks and sticks and ground around the spring are stained with the oil. The oil seeps from a sandstone in the Fuson shale. In the side of the draw a little above the spring there is a bed of very tough impure asphalt about 8 inches thick, a sample of which was analyzed in

the laboratory of the United States Geological Survey by David T. Day. Mr. Day states that it "contains 17½ per cent of oil, fairly soluble in ether. The oil, after extraction, shows 8 per cent of asphalt." The altitude of the spring is 4,330 feet.

Well No. 20.—Well No. 20, in the SW. ¼ sec. 2, T. 51 N., R. 67 W., is a shallow well drilled about 25 years ago. The well has long since been abandoned, hence it is probable that no oil was found. The altitude of the surface is 4,190 feet.

Well No. 22.—Well No. 22, in the SE. ¼ NW. ¼ sec. 3, T. 51 N., R. 67 W., was drilled in 1905 by Mr. Carnahan to a depth of about 500 feet. No oil is known to have been found in the well. When first visited by the writer in 1911 the only indications of the well were some pieces of rope and the blue clay brought up by the drilling. The altitude of the surface is about 4,125 feet.

Well No. 23.—Well No. 23, in the NE. ¼ sec. 3, T. 51 N., R. 67 W., was drilled a number of years ago to a depth of 220 feet and is said to have produced enough gas to flame 5 feet high. There is little evidence of the well on the ground at the present time. The altitude of the surface is about 4,150 feet.

Well No. 24.—Well No. 24, in the NE. ¼ sec. 3, T. 51 N., R. 67 W., was drilled in 1905 by Mr. Conway and yielded flowing water until the casing was pulled. It is located a few hundred feet northwest of well No. 23. The altitude of the surface is about 4,150 feet.

Well No. 25.—Well No. 25, in the NE. ¼ sec. 3, T. 51 N., R. 67 W., was drilled 25 years ago and yielded oil, which was freighted to Deadwood and sold at $1 a gallon. In June, 1913, it was difficult to find the location of the well. The altitude of the surface is about 4,150 feet.

Well No. 27.—Well No. 27, in the NW. ¼ sec. 36, T. 52 N., R. 67 W., was drilled in the spring of 1913 by the Mineral Oil Co. and is 810 feet deep. No oil was found, but water sufficient for drilling was encountered at 790 feet. The well is situated on the crest of an anticline and starts in the Dakota sandstone. It probably enters rocks of Jurassic age near the bottom. The altitude of the surface is about 4,630 feet.

Well No. 28.—Well No. 28, in the SE. ¼ sec. 35, T. 52 N., R. 67 W., is an old well probably put down about 25 years ago. It was drilled by a standard rig, some of the old timbers of which were still on the ground at the time of the writer's visit. The well was without casing of any kind. The altitude of the surface is about 4,250 feet.

Well No. 29.—Well No. 29, in the SE. ¼ sec. 34, T. 52 N., R. 67 W., was drilled by the Butte Crude Petroleum Co. a few years ago. It is 550 feet deep and flows a constant stream of water about one-half inch in diameter. The well is used as a stock well, having been cased and fitted with a small pipe, which conducts the water into a wooden tank. No oil was reported. The altitude of the surface is 4,180 feet.

Well No. 30.—Well No. 30, in the NE. ¼ sec. 34, T. 52 N., R. 67 W., was drilled several years ago by the Butte Crude Petroleum Co. and is 1,050 feet deep. Some oil was struck in the first 15 feet and a little oil is reported to have been found at 285 feet. This well is located just above the outcrop of the oil sand of the Graneros shale, the outcrop being in many places saturated with oil. At the time of the writer's visit in June, 1913, there was no casing in the well, but the hole remained open and water stood at a depth of 25 feet. A tin can lowered to the water brought up clear water with a very small amount of oil floating on it. The altitude of the surface is 4,290 feet.

Well No. 31.—Well No. 31, in the NW. ¼ NE. ¼ sec. 34, T. 52 N., R. 67 W., was drilled several years ago by the Butte Crude Petroleum Co. to a depth of 550 feet. No oil is known to have been found but water was apparently obtained, as the casing was left in the well, which is rigged with a pump. The altitude of the surface is 4,230 feet.

Wells Nos. 32 to 36, inclusive.—Wells Nos. 32 to 36, inclusive, in the NW. ¼ sec. 34, T. 52 N., R. 67 W., were drilled a few years ago by the Butte Crude Petroleum Co. They are each about 615 feet deep and would yield a small quantity of oil by pumping, probably from 3 to 5 barrels daily for a short time. The company a few years ago installed a stationary engine and built three wooden tanks each with a capacity of 250 barrels. The five wells still had pump jacks attached at the time of the writer's visit in June, 1913, and one (No. 35) was rigged so that it could be pumped by hand. A sample obtained in this way from this well was analyzed by David T. Day, of the United States Geological Survey. (See analysis No. 1, p. 94.) The altitude of the surface at these wells is about 4,200 feet.

Well No. 37.—Well No. 37, in the NW. ¼ NW. ¼ sec. 34, T. 52 N., R. 67 W., was drilled some years ago by the Butte Crude Petroleum Co. to a depth of 830 feet. The casing was pulled and the well abandoned. The altitude of the surface is about 4,230 feet.

Well No. 38.—Well No. 38, in the NW. ¼ NW. ¼ sec. 34, T. 52 N., R. 67 W., was drilled some years ago by the Butte Crude Petroleum Co. to a depth of 830 feet. This well, with five others, Nos. 32 to 36, have pump jacks attached. The altitude of the surface is 4,230 feet.

Well No. 39.—Well No. 39, in the NW. ¼ NW. ¼ sec. 34, T. 52 N., R. 67 W., was drilled some years ago by the Butte Crude Petroleum Co. to a depth of about 830 feet. A small amount of oil is reported to have been obtained in this well. At the time of the writer's visit the casing was still in the well and was plugged with a piece of wood. The altitude of the surface is 4,230 feet.

Well No. 44.—Well No. 44, in the SE. ¼ sec. 27, T. 52 N., R. 67 W., was drilled a few years ago by Mr. Vandersall, the ground having been leased from the Butte Crude Petroleum Co. A set of drilling tools and

the casing were left in the well. The altitude of the surface is 4,210 feet.

Locality No. 47.—At locality No. 47, in the NE. ¼ SE. ¼ sec. 27, T. 52 N., R. 67 W., there is a spring, locally known as the Park Oil Spring, in which the oil collects and may be dipped up with a ladle. The oil burns readily with a crackling sound due to water associated with it. The altitude of the surface is 4,260 feet.

Well No. 48.—Well No. 48, in the NW. ¼ SE. ¼ sec. 27, T. 52 N., R. 67 W., was drilled in 1911 by the Butte Crude Petroleum Co. to a depth of 130 feet. A small quantity of oil was obtained, but the casing was drawn and the well abandoned. The altitude of the surface is 4,250 feet.

Locality No. 49.—At locality No. 49, in the SE. ¼ NE. ¼ sec. 27, T. 52 N., R. 67 W., there is an old oil seep. A hole has been dug about 4 feet square in the bottom of a draw and walled with boards. At the time of the writer's visit water was standing in this excavation and the only evidence of oil was the stain on the board walls. The altitude of the seep is 4,265 feet.

Well No. 50.—Well No. 50, in the SE. ¼ NW. ¼ sec. 27, T. 52 N., R. 67 W., was drilled in the spring of 1913 by the Mineral Oil Co. to a depth of 440 feet. A little oil is reported. The casing was drawn and the well abandoned. At the time of the writer's visit water was seeping from the hole. The altitude of the surface is about 4,240 feet.

Well No. 51.—Well No. 51, in the SE. ¼ NE. ¼ sec. 28, T. 52 N., R. 67 W., was drilled in 1904 by E. P. Clark to a depth of 950 feet. The casing has been drawn and the well abandoned. The altitude of the surface is 4,315 feet.

Well No. 52.—Well No. 52, in the SE. ¼ NE. ¼ sec. 28, T. 52 N., R. 67 W., was drilled in 1904 by E. P. Clark to a depth of 1,240 feet. The casing has been drawn and the well abandoned. The altitude of the surface is 4,350 feet.

Well No. 58.—Well No. 58, in the NW. ¼ SE. ¼ sec. 22, T. 52 N., R. 67 W., was drilled in the spring of 1913 by the Mineral Oil Co. to a depth of 680 feet. Water was struck in this well and a showing of oil is reported. The altitude of the surface is 4,300 feet.

Well No. 61.—Well No. 61, in the SE. ¼ SE. ¼ sec. 21, T. 52 N., R. 67 W., was drilled a number of years ago with a standard rig and is said to be 1,100 feet deep. The casing has been pulled and the well abandoned. The altitude of the surface is 4,320 feet.

Well No. 63.—Well No. 63, in the SE. ¼ SW. ¼ sec. 15, T. 52 N., R. 67 W., was drilled in the spring of 1913 by the Mineral Oil Co. to a depth of 510 feet. A little oil (about a gallon) is reported to have been found in the well and flowing water was also obtained, but the casing was drawn and the well abandoned.

Log of well No. 63, SW. ¼ sec. 15, T. 52 N., R. 67 W.[a]

[Altitude of surface, 4,210 feet.]

Probable formation or member.	Driller's description of the rock.	Content.	Thickness.	Depth.
			Feet.	*Feet.*
Mowry shale member of Graneros shale.	Black shale		220	220
Sandstone member of Graneros shale.	Dry sand		10	230
Lower shale member of Graneros shale.	Black shale		240	470
Dakota sandstone	Sand	Water	35	505
(?)	Black shale		5	510

[a] This log is taken in part from a report by L. W. Trumbull, State geologist of Wyoming, on the Moorcroft oil field (in press).

Well No. 64.—Well No. 64, in the SW. ¼ SW. ¼ sec. 15, T. 52 N., R. 67 W., was drilled in the spring of 1913 by the Mineral Oil Co. to a depth of 340 feet. A little oil is reported, but the casing was drawn and the well abandoned. The altitude of the surface is 4,195 feet.

Well No. 65.—Well No. 65, in the SE. ¼ sec. 16, T. 52 N., R. 67 W., was drilled to a depth of 982 feet in the spring of 1913 by the Mineral Oil Co. A little oil and water is reported, but the casing was drawn and the well abandoned. The altitude of the surface is 4,230 feet.

CHARACTER AND COMPOSITION OF THE OIL.

From the analyses which follow it is evident that there are in the Moorcroft field two distinct oils, differing widely from each other in character. Each of these is a heavy oil, having a specific gravity above 0.9000. The lighter of the two has a specific gravity of 0.9198 and according to David T. Day is a paraffin-base oil. It contains a small amount of water and little or no sulphur. The sample analyzed had apparently by exposure lost gasoline and other of its more volatile constituents. Mr. Day states that "the oil is easily refined and a fresh sample will probably show considerably greater proportions of gasoline and illuminating oil. The sample analyzed is suitable for the manufacture of lubricants." (See analysis of sample No. 1, p. 94). The well from which this oil came (No. 34, Pl. III) is reported to be capable of producing about 5 barrels a day, but at the time of the writer's visit (June, 1913), it was not in operation. The well was fitted with a pump, and any one desiring a small quantity of oil could obtain it by pumping by hand.

Another much heavier oil seeps from the Fuson shale at the Bird Oil Spring (location 19, Pl. III), in the SE. ¼ sec. 11, T. 51 N., R. 67 W. An analysis of this oil was not made, but according to Mr. Day it contains 8 per cent of asphalt and is composed entirely of unsaturated hydrocarbons.

Sample No. 2, in the following table of analyses, was obtained from a piece of the asphalt taken from the bank above the Bird Oil Spring. Regarding this sample, Mr. Day says:

This is a rock which is shown by analysis to contain 17½ per cent of oil, fairly soluble in ether. The oil, after extraction, contains 8 per cent of asphalt. It is, however, composed entirely of unsaturated hydrocarbons and does not owe its dark and thick character to surface oxidation but has seeped out in very much the condition in which it is found. The fact that this oil consists of unsaturated hydrocarbons would indicate that the usual proportion of saturated hydrocarbons had been lost by diffusion into some wall rock.

Analyses of oils from the Moorcroft oil field, Wyo.

[Made in the laboratory of the United States Geological Survey, David T. Day in charge.]

Sample No.	Location number on Pl. III.	Depth (feet).	Physical properties.			Distillation.						Asphalt.	Paraffin wax.
			Specific gravity.	Baumé gravity (°).	Color.	Begins to boil.	Gasoline.	Kerosene.		Residuum.			
						°C.	*Per cent.*	*Per cent.*	*Sp. gr.*	*Per cent.*	*Sp. gr.*	*Per cent*	*Per cent.*
1	35	615	0.9198	22.2	Dark green	130	0.5	24.0	0.858	76.0	0.9400	None.	2.5
2	19	.....	Thick.	.....	Very dark	.....	.....	.....	.....	.....	.....	8.0	.....

PRODUCTION AND FUTURE DEVELOPMENT IN THE FIELD.

The production of oil in the Moorcroft oil field is very small, being limited at the time of the writer's visit in June, 1913, to an occasional small quantity for lubrication, pumped by hand from one of the seven wells in the NW. ¼ sec. 34, T. 52 N., R. 67 W. It is reported, however, that each of these seven wells would yield by pumping for a short time about 5 barrels each a day.

The amount of money which has been invested in prospecting and trying to develop the Moorcroft field is estimated at about $200,000, which is perhaps $199,000 more than has ever been realized from sales of oil.

The field, according to the development already done, has shown little of value, and as it has been thoroughly prospected it probably will never have any great production. In spite of this fact the writer is informed that in February, 1914, several companies were engaged in drilling wells in the field.

GEOLOGY.

STRUCTURE.

The Moorcroft oil field is on the extreme west edge of the Black Hills uplift. The attitude of the rocks of this field is monoclinal, with a general westward dip, but the amount of dip differs somewhat in different parts of the field. In general it is steepest (about 10°)

near the foot of the high ridge on the east side of the field and lower (from 2° to 7°) at a distance from the ridge. Exception is found to this general monoclinal structure in a rather irregular anticline in the eastern part of the field. In the northwest part of T. 50 N., R. 66 W., this anticline dies out, the rocks becoming nearly flat. A similar condition obtains at the north end of the anticline axis in T. 52 N., R. 67 W. In sec. 12, T. 52 N., R. 67 W., there is a very shallow syncline parallel to and on the eastern side of the anticline.

The two cross sections, A–B and C–D, show the general attitude of the formation along the lines designated by these letters.

STRATIGRAPHY.

SEQUENCE OF THE ROCKS.

The Moorcroft oil field is bounded on the north by the Devils Tower quadrangle, of which the Mesozoic formations, comprising about 4,500 feet of sandstone and shale with local bands and concretions of limestone, have been mapped and described by Darton and O'Harra.[1] The formation boundaries in the northernmost two tiers of sections in T. 52 N., R. 67 W., are taken from their map (see Pl. III), and the following generalized section is also taken in part from their work, differing from their section mainly in the thickness of the formations. For the areal distribution of the formations given in the section see the general map (Pl. III, p. 104).

[1] Darton, N. H., and O'Harra, C. C., U. S. Geol. Survey Geol. Atlas, Devils Tower folio (No. 150), 1907.

Generalized section of rocks in the Moorcroft oil field, Wyo.

System.	Series.	Group.	Formation.	Character.	Thickness.	Character of topography and soil.
					Feet.	
Cretaceous.	Upper Cretaceous.	Montana.	Fox Hills sandstone.	Friable sandstone and sandy shale.		Rolling hills and rounded ridges; sandy soil with good grass.
			Pierre shale.	Dark shale with calcareous concretions.	2,000	Wide plains with shallow valleys; thin, clayey, and not very fertile soil, supporting fair growth of grass.
		Colorado.	Niobrara shale.	Gray calcareous shale.	100	Shale slopes; limy soil.
			Carlile shale.	Gray shale with oval concretions and thin sandstones.	500	Rolling hills with thin clay soil, mostly covered with grass.
			Greenhorn formation.	Shale with impure concretionary limestone.	175	Small bare ridges.
			Graneros shale.	Black shale with concretions. Hard gray shale containing many fish scales (Mowry shale member). Sandstone, oil bearing. Black shale with small concretions.	1,245	Wide valleys containing extensive alluvial deposits. Shaly ridges, partly wooded. Valleys with clay soil and badlands.
			Dakota sandstone.	Gray to buff sandstone, mostly very massive; weathers reddish brown.	50+	Plateaus, canyons, and high cliffs with rocky slopes; thin sandy soil.
	Lower Cretaceous.		Fuson shale.	Shale and sandy shale with local sandstone.	70	Slopes below cliffs of Dakota sandstone.
			Lakota sandstone.	Light-colored coarse massive sandstone.	25–50	Canyons with cliffs; thin sandy soil.
Jurassic or Cretaceous.			Morrison shale.	Massive pale greenish-gray to maroon shale with limestone nodules.	125±	Steep slopes below cliffs of Lakota sandstone; poor soil.

JURASSIC OR CRETACEOUS SYSTEM.

MORRISON SHALE.

The Morrison shale outcrops at two localities in the Moorcroft oil field—in the narrow, deep valley of the Belle Fourche in the southwest part of T. 51 N., R. 66 W., and in a gorge occupied by a tributary of Cabin Creek in secs. 11 and 14 of T. 52 N., R. 67 W. At both these places the outcrop consists of shale, prevailingly bluish gray, but containing also some maroon and purplish tints. The formation is predominantly shale, but contains a bed about 2 feet thick of very fossiliferous impure limestone, which lies near the base of the exposure.

The sections of the Morrison shale exposed in the Moorcroft oil field were not measured, but Darton and O'Harra [1] give a number of sections of the Morrison in the Devils Tower folio. The section nearest the Moorcroft oil field which was measured is near Lytle Creek, about 10 miles northeast of this field, and is as follows:

Section of Morrison shale 4 miles east-southeast of Devils Tower, north of Lytle Creek.

	Feet.
Fire clay, impure, rough, nodular, overlain by Lakota sandstone	2
Shale, green	12
Fire clay, sandy	1
Shale, green, locally with purple tinge	70
Shale, lime-clay	6
Shale, green and drab, fine	12
Shale, green, with some lime-clay nodules	16
Limestone, slightly argillaceous, lying on Sundance formation	6
	125

Darton and O'Harra state, regarding the fossils and age of the Morrison shale in the Devils Tower quadrangle, that:

> The Morrison shale contains many large bones, and in other areas it has yielded a varied vertebrate fauna, consisting of many genera of dinosaurs, some of which are of huge size, and of primitive forms of small mammals. This fauna, which is often called the Atlantosaurus fauna, is thought by some paleontologists to be of early Cretaceous age and by others is assigned to the late Jurassic. The invertebrate fossils are all fresh-water forms which furnish no positive evidence as to age.

CRETACEOUS SYSTEM.

LOWER CRETACEOUS SERIES.

Lakota sandstone.—The Lakota sandstone outcrops about the areas of Morrison shale in secs. 19, 29, and 30, T. 51 N., R. 66 W.; in secs. 11 and 14, T. 52 N., R. 67 W.; and also at a number of other places where erosion has cut through the Dakota and Fuson formations in

[1] Op. cit., pp. 2-3.

the area indicated on the map (Pl. III) as Dakota. The latter areas were considered too numerous and of too small extent to warrant mapping in the short time at the writer's disposal. Wherever noted in the Moorcroft field the Lakota sandstone consists of light-colored coarse-grained massive sandstone which forms cliffs. It is similar to the Dakota sandstone, and without knowing the relative positions one might easily confuse the two. Darton and O'Harra [1] state that the Lakota sandstone "is not so continuously massive, and, although hard in some localities, it is generally softer than the Dakota and forms a less marked feature in the topography."

These authors state further that "the thickness of the Lakota varies considerably and in many places [in the Devils Tower quadrangle] it is difficult to separate it from the overlying Fuson formation. Near the head of Burnt Hollow it is apparently only 25 feet thick, and near the head of Deer Creek and on Sourdough Creek it is 30 feet thick." The thickness of 30 feet agrees closely with the writer's observations in the Moorcroft field and also with the thickness measured by Darton and O'Harra on Cabin Creek a mile or so from the Moorcroft field.

The Lakota was not studied in detail in the Moorcroft field, but a section measured several miles to the northeast on Sourdough Creek is given by Darton and O'Harra as follows:

Section of Lakota sandstone northeast of the Moorcroft oil field on north side of Sourdough Creek.

	Feet.
Sandstone, yellowish gray, massive, overlain by Fuson shale	10
Sandstone, purplish gray, soft	1
Sandstone, purplish, flaggy, with several bands of iron oxide	14
Sandstone, massive	1
Sandstone, shaly	1
Sandstone, massive, soft, lying on Morrison shale	3
	30

No fossils were obtained from the Lakota sandstone in the Moorcroft field, but fossil cycads and petrified wood have been collected from it in various parts of the Black Hills.

Fuson shale.—The Fuson formation consists largely of clay and shale with some thin beds of sandstone. It forms the slope between the Dakota and Lakota sandstones and locally is developed into badlands, especially along the west side of the highest ridge in the eastern part of the field.

Two areas of the Fuson shale are shown on Plate III. Other smaller exposures also occur, but the time at the writer's disposal would not permit of mapping. These small outcrops of the Fuson not shown on the map are included in the area mapped as Dakota.

[1] Op. cit., p. 3.

Darton and O'Harra [1] state that:

Sandstones appear in nearly every exposure of the formation, and in general in this area the Fuson is much more sandy than in other parts of the Black Hills uplift, where it contains much soft shale and fire clay. The thickness varies from 50 to 100 feet, but some of the measurements are indefinite on account of the changeable nature of the various beds.

In the Moorcroft field no detailed sections of the Fuson were measured but from altitudes determined on the base and top of the formation and a measurement of the dip the thickness in sec. 14, T. 52 N., R. 67 W., is calculated to be 70 feet. This exposure contains a rather prominent sandstone bed near the middle of the formation. A detailed section of the Fuson shale north of Cabin Creek near the northeast corner of the Moorcroft oil field is given by Darton and O'Harra as follows:

Section of Fuson shale north of Cabin Creek, near northeast corner of Moorcroft oil field.

	Feet.
Shale, yellowish gray, sandy, darker near top, overlain by Dakota sandstone	36
Sandstone, yellowish, massive	3
Shale, yellowish, sandy	6
Sandstone, yellowish, massive	5
Shale, yellowish gray, darker near the top, lying on Lakota sandstone	50
	100

In connection with this section Darton and O'Harra state that:

Some of the sandy clays of the Fuson formation contain fossil plants, mostly ferns and conifers, which have been collected extensively in the neighboring Aladdin quadrangle. The species are numerous and their age is Lower Cretaceous.

No fossils were collected from the Fuson shale in the Moorcroft oil field.

The Bird Oil Spring in sec. 2, T. 51 N., R. 67 W., described on pages 89–90, comes to the surface in friable sandstone of this formation.

UPPER CRETACEOUS SERIES.

Dakota sandstone.—The Dakota sandstone, which lies at the base of a thick mass of shale, is the most conspicuous formation of the Cretaceous system in this region. It rises gently toward the east, forming dip slopes which are especially notable on the higher parts of the anticline on the east side of the field.

An exposure in sec. 14, T. 52 N., R. 67 W., shows the following section:

Section of Dakota sandstone in the SW. ¼ NW. ¼ sec. 14, T. 52 N., R. 67 W.

	Feet.
Sandstone, brown, cross-bedded and massive	20
Sandstone, light brown or yellowish gray, rather friable and thin-bedded (indistinctly exposed in upper 10 feet)	30
	50

[1] Op. cit., p. 3.

In the Moorcroft field the Dakota differs somewhat from the above description. Isolated monument-like forms of weathered material have a distinct gray color with some reddish-brown tints In at least a part of the area there is some carbonaceous shale in the upper part. At one exposure in sec. 31, T. 51 N., R. 66 W., the shale contains 1 foot 6 inches of bony coal.

No fossils were collected from the Dakota sandstone in the Moorcroft field, but according to Darton and O'Harra it carries in the Black Hills "remains of dicotyledonous plants of late Cretaceous age."

Graneros shale.—The Graneros shale is described by Darton and O'Harra [1] as follows:

> The Graneros formation in this quadrangle [the Devils Tower] consists of four distinct members—the lower black shale, a massive sandstone, the Mowry beds, and the upper shale—the total thickness being about 1,250 feet. These divisions are clearly defined lithologically and widely exposed. They are also distinct topographically, the massive sandstone and the overlying Mowry beds rising in ridges of moderate prominence from valleys of the adjoining shales.

The sandstone of this formation is the main oil-bearing bed of the Moorcroft field and probably is also the oil-bearing sandstone in the vicinity of Newcastle.

In the Moorcroft field the Graneros outcrops in a zone about 2 miles wide along the west side of the anticlinal ridge. At both the north and south ends of the ridge the outcrops swing toward the east and as the dip becomes less the zone of outcrop becomes wider.

The lower shale of the Graneros formation occupies a rather narrow zone, generally a valley between the more resistant sandstone of the Dakota below and the oil-bearing sandstone above. As stated by Darton and O'Harra:[1]

> The rock is a fissile shale of dark-gray or intensely black color. Small deposits of sandstone and sandy shales occur near the bottom, and here and there iron-charged concretions 1 to 2 feet in diameter are scattered through the middle and upper portions, but they show at few places, except in the extensive exposures, and are nowhere abundant. * * * The thickness of the shale varies considerably, but is prevailingly greater in the central and northern portions of the quadrangle. On the southern border it is 120 feet. In Barnard Canyon, due north of Devils Tower, it is 150 feet. On T. L. Creek it is a little more than 200 feet, but the full thickness is not revealed. It can not, however, be much over 200 feet.

In the Moorcroft field the thickness at several points along the outcrop is calculated by the writer to be about 300 feet, but there may be a thickening of the shale in this region due to its being folded between the more resistant Dakota sandstone below and the oil-bearing sandstone above.

The sandstone overlying the black shale outcrops in a narrow ridge parallel to the exposure of the shale. It is immediately over-

[1] Op. cit., p. 4.

lain by the Mowry shale member and is composed of beds of sandstone, shale, and clay. A section in the SE. ¼ sec. 22, T. 52 N., R. 67 W., shows a thickness of 45 feet as follows:

Section of sandstone part of the Graneros shale in the SE. ¼ sec. 22, T. 52 N., R. 67 W.

	Ft.	in.
Shale, drab, friable (overlain by Mowry shale member)	2	0
Sandstone, rusty brown, concretionary, containing fossil invertebrates		8
Shale, bluish gray, soft, sandy	2	0
Sandstone, grayish brown, friable, shaly; a few fossil invertebrates and plant stems	4	0
Shale, black, very carbonaceous		6
Clay, light brown, soft	3	0
Shale, black, carbonaceous		5
Shale, light bluish gray, sandy		10
Sandstone, grayish brown, hard, containing plant stems and a deciduous leaf	1	6
Shale, dark, sandy	6	0
Sandstone, gray on weathered surface, brown on fresh surface	5	0
Sandstone, gray, friable, soft, shaly	4	6
Shale, dark, very carbonaceous	2	0
Clay, light bluish gray, soft	1	4
Shale, bluish gray	7	0
Shale, dark, carbonaceous, sandy	2	0
Sandstone, gray on weathered surface and brown on fresh surface, with strong odor of oil; friable and containing plant stems	2	10
	45	7

The sandstone of the Graneros shale probably is not as well developed in the Moorcroft oil field as farther north in the Devils Tower quadrangle. It is described by Darton and O'Harra[1] in the Devils Tower folio as follows:

The rock is a massive sandstone of medium to coarse grain and in a few places it becomes a conglomerate. The conglomeratic character is well developed in the two areas west and northwest of the Missouri Buttes. The rock in the outcrops nearest the buttes consists largely of pebbles about the size of a pea, while in the larger area 2 or 3 miles away many of the pebbles are 1 inch in diameter and there are some reaching 2, 3, or even 4 inches. The thickness of the sandstone varies from 8 feet, as the approximately general amount south of Poison Creek, to 50 feet in the area south and west of Elkhorn Creek.

Of the areas mentioned by Darton and O'Harra the nearest to the section given above from the Moorcroft field is about 12 miles distant. In the Moorcroft field the whole of the sandstone is not well exposed except in very few places, but certain beds may be seen almost anywhere along the line of outcrop, which is shown on the map (Pl. III).

The Mowry shale member of the Graneros shale outcrops in a zone about one-half mile wide immediately west of the outcrop of the

[1] Op. cit., p. 4.

sandstone. The top of the shale is not clearly defined in the Moorcroft field. Nearly everywhere it is located on grassy slopes and is therefore concealed. In mapping this boundary the line was in most places drawn at the west border of the strip of pine timber, which in this region is largely limited in its growth to the soil of the Mowry shale. This line may be stratigraphically a little too high to conform with the calculated thickness (300 feet) of the Mowry. This mapping in fact makes it nearly twice as thick as in the Devils Tower quadrangle where it was measured by Darton and O'Harra,[1] although the total thickness of the Mowry and that of the upper shale member of the Graneros as mapped in the Moorcroft field is about the same as that of these two members in the Devils Tower quadrangle.

Darton and O'Harra describe the Mowry as follows:

> The material is a compact shale of dark color, containing large numbers of detached fish scales. These scales are found in all portions of the member, but vary in abundance. In places they are closely packed together, while in some beds they are somewhat widely scattered. In general they are sprinkled singly over the shale surfaces, in the proportion of one to four scales in 6 square inches. They range mostly from one-half to three-fourths of an inch in diameter.
>
> In the hand specimen of fresh rock the shale differs little in general appearance from that of the lower Graneros except in fissility, the lower beds being thin and papery, while the Mowry scale shales are thicker or more slabby and considerably harder. Owing to the fact that the Mowry beds are much harder than the adjoining shales, they give rise to hills and ridges of moderate prominence. They afford a fairly firm hold for tree roots, and as a result the Mowry hills are generally well covered with pines and scrub oaks. The shales are dark gray or decidedly black when fresh, but, unlike the other Graneros shales, weather through drab to a light gray, and this light color, together with the wooded hills and ridges, causes the Mowry outcrop to be very conspicuous. The contact of the Mowry beds with the underlying sandstone is in most places distinct, but the contact with the overlying upper Graneros shale is as a rule concealed by the mingled shales of the two members.

In the Moorcroft field the contact of the Mowry shale with the underlying sandstone is less definite than the description in the Devils Tower folio would indicate it to be in that region. In most places there is at least a low valley between the pine-clad ridge of the Mowry on the west and the sandstone ridge to the east. It appears, therefore, that the lower part of the Mowry is less resistant than the upper part.

The soft shale constituting the upper part of the Graneros formation occupies a more or less distinct valley about three-fourths of a mile wide, lying immediately west of and parallel with the outcrop of the Mowry shale member. This upper shale in general is similar to the lowest shale of the Graneros but contains more calcareous concretions, especially in the upper 150 feet. They are in fact so numerous that locally they form ridges. The upper shale also con-

[1] Op. cit., p. 4.

ains some very hard iron carbonate concretions, ranging in diameter from 6 to 10 inches.

Calculations made from the distances between the boundaries as mapped in the field indicate that the upper shale is about 600 feet thick, but Darton and O'Harra[1] state that west of Little Missouri River, about 20 miles north of the Moorcroft field, it is approximately 850 feet thick.

Greenhorn formation.—The Greenhorn formation outcrops in a narrow zone less than one-fourth of a mile wide and forms a rather prominent ridge west of the outcrop of the upper part of the Graneros shale. It is described as follows by Darton and O'Harra:[1]

> It consists of alternating beds of lime-clay concretions and black shales, the shales being almost identical in general appearance with the Carlile and upper Graneros shales and the concretions not differing greatly from those of the Carlile. The concretions are of sufficient importance, however, to give a perceptible topographic effect, and with careful observations, in the absence of good exposures, the general position of these beds may be traced over the gently undulating surface. The concretions vary from a few inches to several feet in diameter, the usual size being 1 to 4 feet. They have a bluish-gray color and are spherical or ellipsoidal in shape. Here and there they show a well-developed septarian character, and a fair proportion contain fossils, chiefly *Inoceramus labiatus*, a fossil which is characteristic of this formation. The thickness of the formation varies between 60 and 80 feet, but its stratigraphic limits are somewhat indistinct.

The Greenhorn formation as mapped in the Moorcroft field is about 175 feet thick, but the stratigraphic limits are so indefinite that some of this thickness, as given in the table, may include a part of the Graneros shale below or some of the Carlile shale above.

Carlile shale.—The outcrop zone of the Carlile shale is parallel with that of the other formations of the Moorcroft field and occupies a strip of country a little over a half mile in width, as indicated on the map (Pl. III). The greater part of the outcrop consists of gentle grass-covered slopes. Darton and O'Harra[2] describe the Carlile shale in the Devils Tower quadrangle as—

> made up of three fairly distinct divisions. The upper division is about 300 feet thick and is nearly all shale; few concretions are present and these occur at indefinite horizons. The middle division is 125 feet thick and consists of concretions and shale, the concretions being of considerable size and in sufficient number to leave an impress on the topography in favorable localities. The lower division is 200 feet thick and, like the upper division, is chiefly shale, only a few concretions being observed. The middle series much resembles the Greenhorn formation, but lacks the distinctive Inoceramus.

Niobrara shale.—The outcrop zone of the Niobrara shale was mapped as shown on Plate III on the evidence of material brought to the surface in drilling a well (No. 41) in sec. 33, T. 52 N., R. 67 W., and by extending the boundaries mapped by Darton and O'Harra in

[1] Op. cit., p. 4.

[2] Idem, pp. 4 and 5.

the Devils Tower quadrangle (the north two tiers of sections of T. 52 N., R. 67 W., are a part of the Devils Tower quadrangle).

The material on the dump pile of well No. 41 in sec. 33, T. 52 N., R. 67 W., consists of bluish-gray, very calcareous shale. No outcrop of the shale was seen in the Moorcroft field, as it is concealed by grassy slopes, but a thickness of about 100 feet is probably present, as in the Devils Tower quadrangle to the north. Darton and O'Harra[1] describe the lithologic character of the Niobrara shale as follows:

> The lithologic character of the Niobrara in this quadrangle is identical with that which is so uniformly peculiar to it throughout the Black Hills region—that is, it consists of soft, light-gray, slabby shales, weathering to creamy yellow and chalky gray, finely dotted with white specks and carrying thin, irregular aggregates of *Ostrea congesta*.

Pierre shale.—The outcrop zone of the Pierre shale is about 2 miles wide and is parallel to the outcrop of the other formations of the Moorcroft field. Its strike is nearly north and south (Pl. III). The Pierre shale in this field as elsewhere consists chiefly of dark soft shale, weathering into broad gentle slopes and low rounded hills. In the SE. ¼ sec. 20, T. 52 N., R. 67 W., there is a change in the character of the thinly grassed sagebrush soil of the Pierre shale area from a surface covered with chips of iron oxide on the east to one barren of such iron oxide chips on the west.

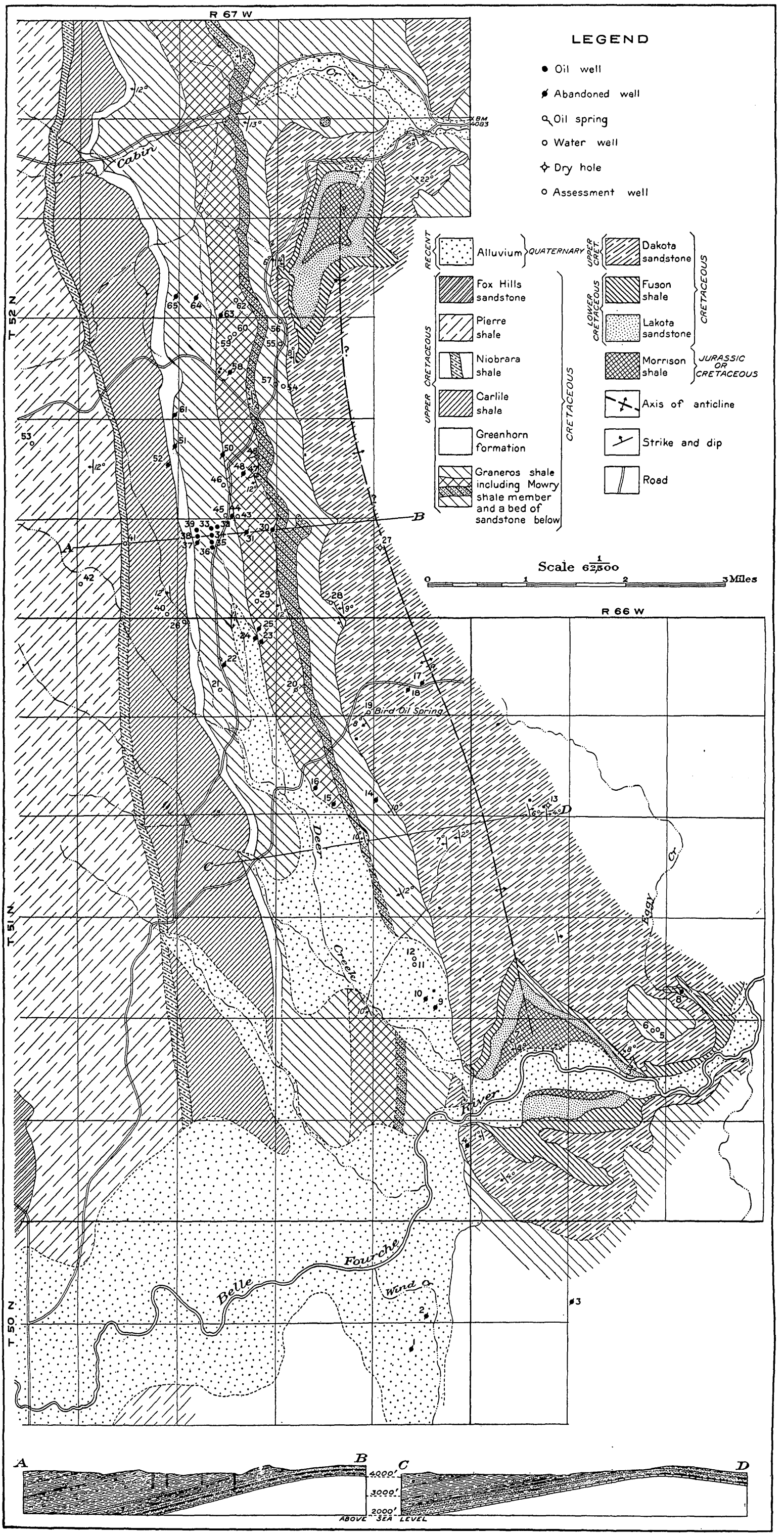
The thickness of the Pierre shale in the Moorcroft oil field is calculated from field observations to be about 2,000 feet. It rests on the Niobrara shale below and is overlain by the Fox Hills sandstone.

Fox Hills sandstone.—The outcrop of the Fox Hills sandstone occupies a zone of grass-covered hills with gentle slopes lying immediately west of the Pierre shale. It outcrops in a belt about three-fourths of a mile wide and, like the outcrops of the other formations, extends in a north-south direction (Pl III). It occupies only a small area in the region mapped. The sandstone is not well exposed, but there is no reason to believe that it differs materially from that at a locality in T. 48 N., R. 66 W., several miles to the southeast, where in 1911 the writer measured the following section:

Section of Fox Hills sandstone in sec. 20, T. 48 N., R. 66 W.

	Feet.
Sandstone, light brown	38
Shale, light and dark gray, sandy	83
Sandstone, light brown	27
Shales, tan and blue gray, sandy (transitional shale at base of Fox Hills)	38
	186

[1] Op. cit., p. 5.



MAP OF THE MOORCROFT OIL FIELD, CROOK COUNTY, WYO.

By V. H. Barnett.

POSSIBILITIES OF OIL IN THE BIG MUDDY DOME, CONVERSE AND NATRONA COUNTIES, WYOMING.

By V. H. Barnett.

INTRODUCTION.

Since the successful development of the Salt Creek oil field on a pronounced dome-shaped structure 50 miles north of Casper, prospectors have been busy searching similar structures in different parts of the State, and though the search has in few places been rewarded by the discovery of oil in commercial quantity, it still continues and probably will not cease until every such structure has been tested by the drill. Although this method of prospecting involves the expenditure of a large amount of money, it is the only one by which the question of the presence or the absence of oil can be determined. The United States Geological Survey desires to aid the prospectors, and with that object in view is constantly searching for domes or other structures favorable for the accumulation of oil, for by pointing out these more favorable locations a large amount of entirely useless drilling may be prevented. Although the Survey does not guarantee that oil will be found in any of these domes, its position is that such domes are the most promising localities; and if the drill proves that they do not contain oil, it is useless to search in other places. The object of the present paper is to describe such a dome or anticline in the vicinity of Big Muddy Creek on the south side of North Platte River.

LOCATION AND DEVELOPMENT OF THE FIELD.

The area described in this paper extends along both sides of North Platte River from the vicinity of Casper to a point beyond Glenrock (fig. 2, p. 84). It comprises an area of about 325 square miles, about half of which lies in Converse County and the other half in Natrona County. (See Pl. IV, p. 116.)

In this area, as in many other undeveloped oil fields, the first drilling has been done near surface indications and some distance from the locality most favorable, so far as structure is concerned, for an oil well. In 1912 the Wyoming Oil, Gas & Power Co. drilled two

shallow wells in T. 33 N., R. 74 W., within a mile or so of an oil seep. It is not surprising that oil in commercial quantities was not obtained in either of these wells in view of the fact that they were drilled into a monocline, where the dip of the rocks is uniform. Oil seeps are reported also near the southwest corner of the area shown on Plate IV and some drilling has been done near Casper, but none of the wells have been producers. The most favorable place for oil in this area, and in the judgment of the writer the most favorable place within 50 miles of Douglas, is in the flat south of the Northwestern Railway between Glenrock and Big Muddy Creek, near the north-central portion of the area. In this vicinity the structure is favorable, and oil, if present at all, is probably about 2,500 feet below the surface.

ACKNOWLEDGMENTS.

In presenting this report the writer wishes to express his thanks for courtesies extended during the progress of the field work by the people of Glenrock and by every ranchman with whom he came in contact. The writer is indebted to the members of his party, Messrs. J. B. Reeside, jr., Y. T. Wang, Frank Elliott, and Bernard Jackson, for assistance in the examination of the area.

PURPOSE AND METHOD OF THE INVESTIGATION.

The primary object of the investigation of this field was to ascertain the mineral resources, especially oil and coal, for the purpose of classifying the land by legal subdivisions into mineral land and non-mineral land. A secondary object and one closely connected with the first was to determine, as far as possible, the geologic structure, the various formations involved, and the conditions favorable for the accumulation of oil or gas.

The field was mapped on a scale of 2 inches to the mile by means of a plane table and telescopic alidade, the township being the unit represented by each field sheet. A complete system of triangulation[2] was established covering the field, and the stations of this system served the purpose of both horizontal and vertical control and formed the means for tying the different plane-table sheets together. In beginning the primary control or triangulation a base line 12,800 feet in length was measured with a steel tape along a straight stretch of the railroad, extending from the NE. ¼ SE. ¼ sec. 23, T. 33 N., R. 72 W., to the SW. ¼ NE. ¼ sec. 31, T. 33 N., R. 71 W. When the field work had advanced to the Big Muddy locality a second base line was measured as a means of checking locations. This second base line extended 14,340 feet along the straight stretch of railroad track

[1] These wells are described in U. S. Geol. Survey Bull. 541, p. 74, 1914.

[2] The triangulation was done on a larger sheet, the Johnson 24 by 24 inch plane table being used.

om the SE. ¼ sec. 8 to the NE. ¼ sec. 2, T. 33 N., R. 76 W., and is consequently near the center of the area here discussed.

All the section corners that were found in the course of the field work were located on the map with respect to triangulation stations, and their locations are therefore correct in so far as the scale of the map and the methods of location would permit. No attempt was made to find all the section corners, but in each township a considerable number were found. Attitudes were determined throughout a large part of the area by means of vertical angles. Stadia traverses were employed in conjunction with triangulation for mapping formation boundaries and similar purposes. The net shown on the map is based on section corners located in the field and supplemented by the General Land Office plats.

TOPOGRAPHY.

The area of the Big Muddy dome may be described in a general way as a rolling prairie bordered on the south by a low range of mountains. In detail there are many variations from this type in the form of numerous ridges, table-like buttes, gentle slopes, and broad valleys. Several small streams, which emerge from the mountains through deep canyons, cross the area in flat-bottomed valleys and empty into North Platte River. The part of the field most favorable for oil accumulation lies in the broad shale valley of the North Platte, mainly in T. 33 N., R. 76 W. A rather prominent ridge borders the southeast side of this valley, separating it from Deer Creek valley.

The elevation in the valley of North Platte River, the lowest part of the field, is about 5,000 feet above sea level, but the land rises toward the south until at the foot of the mountains it is about 6,000 feet above sea level. Thence to the summit of Casper Mountain, a horizontal distance of about 2 miles, the surface rises about 1,500 feet, or to 7,500 feet above sea level.

Farming is carried on extensively in favorable localities, where alfalfa, timothy, and small grain are profitably raised by irrigation. The part of the area not under cultivation yields a good growth of grass, which supplies perennial range for stock.

The rainfall is not sufficient to support a growth of timber, except scattered cottonwood and boxelder trees along the streams and a few scrubby pine and cedar trees on some of the rocky hills. However, marketable pine timber grows in the mountains to the south, especially on the high slopes of Casper Mountain.

Fuel for domestic use consists, for the most part, of pine and cedar wood from the mountains and coal from Glenrock or Big Muddy mines.

The several streams which rise in the mountains and flow across the field to North Platte River yield a good supply of fresh water for

domestic use. All these streams are fed by springs in the mountains and so maintain a fairly constant flow of water, which is utilized for irrigation in the broad bottom and on some of the bench lands. A much greater area might be irrigated if large storage reservoirs were constructed.

GEOLOGY.

STRATIGRAPHY.

SEQUENCE OF THE ROCKS.

The rocks in the vicinity of the Big Muddy dome include about 10,000 feet of Paleozoic and Mesozoic formations, ranging in age from Carboniferous to late Cretaceous, and also some beds of Tertiary and Quaternary age. The Paleozoic rocks are not described in this paper.

The following generalized section shows the character and thickness of the Mesozoic and later formations and their relations to each other:

Generalized section of formations involved in the Big Muddy dome, Wyo.

System.	Series.	Group.	Formation and member.		Character.	Type of topography and soil.	Thickness.
							Feet.
Quaternary.					Alluvium, gravel, and sand.	Sand dunes, gravel-topped hills, and valley flats.	25+
			—Unconformity—				
Tertiary.	Oligocene.		White River formation.		Clay, conglomerate, and sandstone.	Flat-topped hills and gentle slopes; thin soil.	1,000
			—Unconformity—				
Tertiary(?).	Eocene (?).		Lance formation.		Friable sandstone and shale, with local beds of coal.	Rolling hills and broad gentle slopes; thin sandy soil and alkali flats.	200+
Cretaceous.	Upper Cretaceous.	Montana.	Fox Hills formation, base uncertain.		Friable sandstone and shale with local coal beds near top.	Ridges of sandstone and valleys in shale; sandy soil.	860
			Pierre formation.		Sandy shale.	Valleys; thin clay soil.	400
				Teapot sandstone member.	Gray and buff sandstone and carbonaceous shale.	Low ridges, barren rock slopes, and pine-clad hills.	160
					Sandy shale.	Valleys; thin clay soil.	320
				Parkman sandstone member.	Friable sandstone and beds of shale and coal.	Ridges of some prominence and broad grassy slopes.	330
					Dark shale.	Broad valleys; thin soil.	2,000
		Colorado.	Niobrara shale.		Gray to buff calcareous shale.	Low rounded ridges and brown slopes.	100–650
			Benton shale.		Dark shale.	Narrow valleys; thin soil.	200
				Wall Creek sandstone member.	Gray and buff sandstone and beds of shale.	Ledges and hogback ridges covered with small pines.	100–200
					Dark shale including Mowry shale member.	Broad valley with low rounde pine-clad ridge of Mowry shale. Thin soil.	1,200
	Lower Cretaceous.		"Cloverly" formation.		Buff sandstone and shale with conglomerate in lower part.	Ledges, hogback ridges, and barren slopes of rock; thin sandy soil.	140
Jurassic or Cretaceous.			Morrison formation.		Green, buff gray, and maroon shale and thin beds of sandstone.	Gentle slopes below ridges of "Cloverly" rocks.	700
Jurassic.	Upper Jurassic.		Sundance formation.		Greenish-gray limestone and sandstone.		

JURASSIC SYSTEM.

SUNDANCE FORMATION.[1]

The Sundance formation outcrops locally in a narrow belt along the north and east sides of Casper Mountain and along the north slope of the mountain range immediately south of the field. It is lithologically similar to the overlying Morrison formation, each consisting predominantly of shale, in which there are intercalated beds of sandstone and limestone. The Sundance is of marine origin and contains more limestone than the overlying Morrison. No estimate of the thickness of the Sundance was obtained in this field, but the total thickness of this formation and the Morrison in sec. 33, T. 32 N., R. 78 W., is about 700 feet.

JURASSIC OR CRETACEOUS SYSTEM.

MORRISON FORMATION.[1]

The Morrison formation is poorly exposed in this field, being almost wholly concealed by talus from the overlying sandstone of the "Cloverly" formation. With the Sundance and "Cloverly" formations it occupies a narrow belt along the southern part of the field as shown on the map (Pl. IV, p. 116).

The Morrison formation consists of a bluish-gray and maroon-colored shale interbedded with thin bands of limestone and sandstone. No estimate of the thickness of the Morrison was obtained, but from a measurement in T. 31 N., R. 71 W., several miles to the east, it is estimated to be about 200 feet.

CRETACEOUS SYSTEM.

"CLOVERLY" FORMATION.[1]

The "Cloverly" formation is exposed in a narrow belt along the north and east slopes of Casper Mountain and near the foot of the mountain range along the south side of this field. A section of the formation at the east end of Casper Mountain reveals about 140 feet of sandstone, conglomerate, and shale. The section in detail is as follows:

Section of the "Cloverly" formation in SE. ¼ sec. 11, T. 32 N., R. 76 W.

	Feet.
Sandstone, brown and gray (gray on fresh surface)	20
Shale and sandstone (largely covered)	60
Sandstone, gray, fine grained	10
Concealed, probably shale	5
Sandstone, brown to gray, fine grained, sharp grit (gray on fresh surface)	25
Conglomerate, brown and gray, pebbles generally one-sixteenth to one-half inch in diameter (about 100 feet north this conglomerate is 27 feet thick)	17

[1] Not shown on the map.

Only the more resistant members of the "Cloverly" are well exposed, the more shaly portion being in most places concealed. In this field the dip of the "Cloverly" formation ranges from 12° to vertical, or the formation is slightly overturned, and its outcrop is in most places marked by a hogback ridge. The lower part of the formation is locally conglomeratic. Loose blocks of the conglomerate cover slopes in places several hundred yards from the outcrop. The conglomerate ranges in thickness from a few inches up to about 30 feet.

In the vicinity of the Black Hills the formations between the Benton above and the Morrison below consist of Dakota sandstone, Fuson shale, and Lakota sandstone, the Dakota sandstone being of Upper Cretaceous and the others of Lower Cretaceous age. Westward from the Black Hills the Dakota is generally absent, and in the Bighorn Basin the beds occupying this interval are all supposedly of Lower Cretaceous age and have been named the "Cloverly" formation, but as there is some doubt about the validity of the term, it has generally been inclosed in quotation marks. In the vicinity of Casper and Douglas the Dakota has not been recognized and hence the term "Cloverly" is used in this report.

BENTON SHALE.

The Benton shale consists of about 1,600 feet of dark and light colored shale with a thick sandstone member near the top. It lies directly upon the "Cloverly" formation and is followed above by the hard and chalky Niobrara shale. The Benton shale comprises a lower 220 feet of dark soft shale overlain by about 175 feet of dark-bluish hard shale, the Mowry shale member, which weathers light bluish gray to yellowish and produces low ridges. Above the Mowry shale is about 870 feet of dark soft shale which is overlain by 100 to 250 feet of gray to yellowish brown sandstone and shale, locally containing abundant fossils. Above the sandstone and below the Niobrara shale there is about 300 feet of dark shale similar to the dark shale in the lower part of the formations.

Section of the Benton shale in sec. 29, T. 33 N., R. 74 W.

	Feet.
Shale, dark	300
Sandstone, ridge forming, fossiliferous Wall Creek sandstone member	100
Shale	867
Shale, dark, weathering light bluish gray; yellowish gray in upper half, and locally forming pine-clad ridges (Mowry shale member).	175
Clay (bentonite?), gray and yellow mottled, interbedded in darker clay. (One bed of the light clay is 8 inches thick)	3
Shale, dark	215
	1,660

The fossiliferous sandstone of the Benton shale in the foregoing section appears to correspond with the Wall Creek sandstone member of the Salt Creek field, as described by Wegemann,[1] and for this reason the term Wall Creek is here tentatively applied.

The Wall Creek sandstone member was measured at two localities farther west and at each was found to be over 100 feet thick. These sections are as follows:

Sections of the Wall Creek sandstone member.

In sec. 5, T. 32 N., R. 78 W.

	Feet.
Sandstone, brown, thin-bedded, friable in lower half	75
Sandstone, yellowish gray, massive, with large brown calcareous concretions, about 6 feet in diameter	125
	200

East bluff of Big Muddy Creek in T. 32 N., R. 78 W.

Sandstone, dark grayish, coarse grained, becoming rather massive above and firm. Develops hogback ridges where dip is steep	35+
Sandstone and shale, in alternating bands, the shale in bands not over 1½ inches but the sandstone bands as much as 4 inches thick. Upper half, bedded sandstone. (Sandstone is dark gray; shale is dark with carbonaceous material)	32
Shale, dark, laminated	16
Sandstone, gray, greenish tinged, friable, thin bedded	9
Sandstone and dark shale in alternating layers from half an inch to 3 inches thick, thickest bands near the top	27
Shale, dark.	
	119+

In T. 32 N., R. 78 W., east of Casper Mountain, there is a sandstone bed in the Benton shale about 320 feet below the Wall Creek sandstone. This sandstone is 15 feet thick, hard in the upper half but massive and friable below. The upper part of this sandstone is ripple marked and contains the marine fossil plant *Halymenites major* Lesquereux.

NIOBRARA SHALE.

The Benton shale is overlain by 100 to 650 feet of chalky shale, which contains a few marine fossils of the species *Ostrea congesta* (Conrad) and some fragments of an Inoceramus characteristic of the Niobrara shale. The outcrop of this shale is exposed in a narrow belt along the south side of the field and is shown on the map (Pl. IV). The exposures of the shale are not continuous throughout this belt, but it appears at a sufficient number of places to justify the mapping. In T. 32 N., R. 77 W., there is 650 feet of shale exposed, the lower part of which is dark bluish gray and the upper part yellowish in color. *Ostrea congesta* was obtained from the dark shale, but only

[1] Wegemann, C. H., The Salt Creek oil field, Natrona County, Wyo.: U. S. Geol. Survey Bull. 452, pp. 37-83, 1911.

ish scales from the yellow upper part. The shale throughout is calcareous and is characterized by small specks of white chalk. The yellow shale portion is firmer than that below and contains some concretions of hard compact limestone about 10 inches in diameter.

PIERRE FORMATION.

The Niobrara shale is overlain by about 3,210 feet of shale and sandstone, constituting the Pierre formation, which in this field is composed of five members. The lower member is a dark soft shale 2,000 feet thick, containing some calcareous concretions bearing marine fossils. The next member is about 330 feet thick and composed of sandstone and shale with thin coal beds. This member appears to correspond in stratigraphic position to the Parkman sandstone member as described by Wegemann.[1] In the description of the Pierre formation in the Douglas oil field the writer[2] compared the section with that of the Salt Creek field but stated that "Further detailed work may prove also that the 150-foot sandstone, here referred to the Parkman, is a much higher sandstone and the 300± feet of sandstone, referred to the Shannon sandstone lentil, is the Parkman member, the Shannon sandstone lentil being absent." In the Big Muddy dome the Shannon sandstone lentil does not appear.

Above the Parkman sandstone there is another sandy shale 320 feet thick, yielding marine Montana fossils. Above this shale there is another sandstone about 160 feet thick which contains carbonaceous shale and thin coal beds. This sandstone seems to agree in character and stratigraphic position with the sandstone described by Wegemann[3] as forming the Little Pine Ridge east of the Salt Creek oil field. At the time Wegemann's report was published the geographic extent and the value of this sandstone as a key were not known, but the work of Mr. Hares west of Casper and of the writer east of that place has shown that this sandstone is probably the most easily identified member of the Pierre formation. On this account it seems desirable to map it and give it a name. Wegemann describes this member as forming Little Pine Ridge, a name given by him to an escarpment of sandstone next east of that formed by the Parkman sandstone member, but he did not apply the name to the bed. As the name Little Pine Ridge is cumbersome and as it is not in current use in the county, it is thought best to select another. Accordingly the name Teapot sandstone member is given to this sandstone from the "Teapot Rock," a well-known topographic feature carved from this sandstone about half a mile east of the Casper-Salt Creek road.

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[1] Wegemann, C. H., The Salt Creek oil field, Natrona County, Wyo.: U. S. Geol. Survey Bull. 452, pp. 46–48, 1911.

[2] The Douglas oil and gas field, Converse County, Wyo.: U. S. Geol. Survey Bull. 541, p. 64, 1914.

[3] Wegemann, C. H., loc. cit.

The Teapot sandstone member consists of gray and buff sandstone including some carbonaceous shale, which has a thickness of 50 feet in the type locality and 160 feet in the Big Muddy dome. Overlying the Teapot sandstone there is about 400 feet of dark soft shale with calcareous concretionary masses containing marine Montana fossils.

FOX HILLS FORMATION.

Overlying the 400 feet of dark soft shale forming the upper member of the Pierre formation there is about 860 feet of friable sandstone, sandy shale, and soft dark shale, some part, or all of which, represents the Fox Hills sandstone. Its section is as follows:

Generalized section of the Fox Hills formation near Glenrock.

	Feet.
Sandstone, gray in upper half, buff below	100
Shale and shaly sandstone and coal beds	120
Sandstone, gray and buff	70
Shale	320
Sandstone, friable, and sandy shale	250
	860

TERTIARY (?) SYSTEM.

LANCE FORMATION.

Rocks of the Lance formation outcrop in the eastern part of this field mostly north of the river, but there is also a small area south of the river in T. 33 N., Rs. 74 and 75 W. The Lance formation, by a recent decision of the United States Geological Survey, has been provisionally classified as of Tertiary (?) age. It consists of friable sandstone, sandy and carbonaceous shales, and coal beds. It is not within the scope of this paper to describe the Lance formation in detail.

TERTIARY SYSTEM.

WHITE RIVER FORMATION.

A small portion of the southeast corner of this field, as shown on the map (Pl. IV), is covered with rocks belonging to the White River formation. This formation rests unconformably on older rocks and is composed largely of clay, though beds of fine sand, limestone, and conglomerate occur at different places in the formation. The total thickness in the area shown on the map is probably not over 200 feet, but farther east, in the Douglas oil field,[1] there is 580 feet exposed, and it is there believed by the author to have a total thickness of about 1,000 feet.

[1] Barnett, V. H., The Douglas oil and gas field, Converse County, Wyo.: U. S. Geol. Survey Bull. 541, p. 66, 1914.

QUATERNARY SYSTEM.

Alluvium along the streams, some local beds of unconsolidated gravel, and loose sand and sand dunes constitute the only beds of Quaternary age in the vicinity of the Big Muddy dome. North of the river the older rocks are largely concealed by the covering of sand and sand dunes, as shown on the map (Pl. IV). There are some terraces and hills capped with gravel, but only a few of these are mapped.

IGNEOUS ROCKS.

Red granite, cut by basic dikes of different kinds, underlies the Paleozoic rocks in the southern part of the Big Muddy field and forms the core of the mountains. Only a small area of the granite is indicated on the map. There are doubtless other exposures in the deep canyons in the southern part of the field.

STRUCTURE.

The Big Muddy dome is a slight arch of the strata extending over an area of about 72 square miles. It is elongated in a southwest-northeast direction, being about 8 miles across in this direction, but only about 3 miles from north to south.

The general shape of the dome is indicated by the outcrop of the formations as shown on Plate IV. Unfortunately in this area the indurated rocks are badly concealed by alluvium along the river and its principal tributaries by sand dunes and gravel-covered terraces, and by the White River formation, which consists of a heterogeneous mass of unconsolidated material that was laid down in a broad lake that once occupied this valley as well as a large area to the east. On account of this cover of soft material the outcrops of the underlying formations are difficult to follow on the map, but the broken lines indicate the probable location of the boundary lines beneath the surface cover.

Thus it will be seen that the anticline extends northeastward from the upward fold in the older rocks in sec. 12, T. 32 N., R. 78 W. The axis of the fold descends gradually from that place to the southeast corner of T. 33 N., R. 77 W. Here the axis either dies out or turns to the north and the fold develops into an elongated dome, the axis of which extends through secs. 7, 8, 9, 3, 2, and 1, T. 33 N., R. 76 W. The magnitude of this dome is such as to bring to the surface that part of the Pierre formation which lies below the Parkman sandstone member. The outline of the dome is shown by the outcrop of the Teapot sandstone member, which dips steeply northward and crosses the southern part of T. 33 N., R. 75 W. This outcrop can be followed southwestward to sec. 31, T. 33 N., R. 76 W.,

where it turns sharply back under cover and is next seen in sec. 1. of the same township. Here it passes around the point of the anticline and then it extends westward along North Platte River, though concealed by alluvium, to sec. 5. West of this place the Teapot sandstone member makes a big swing across the river, indicating the presence of a local fold, and then it can be traced to the southwest, crossing Dry Muddy Creek in secs. 14 and 15, T. 33 N., R. 78 W. From this place it trends northwestward across the river and is last seen in sec. 31, T. 34 N., R. 78 W.

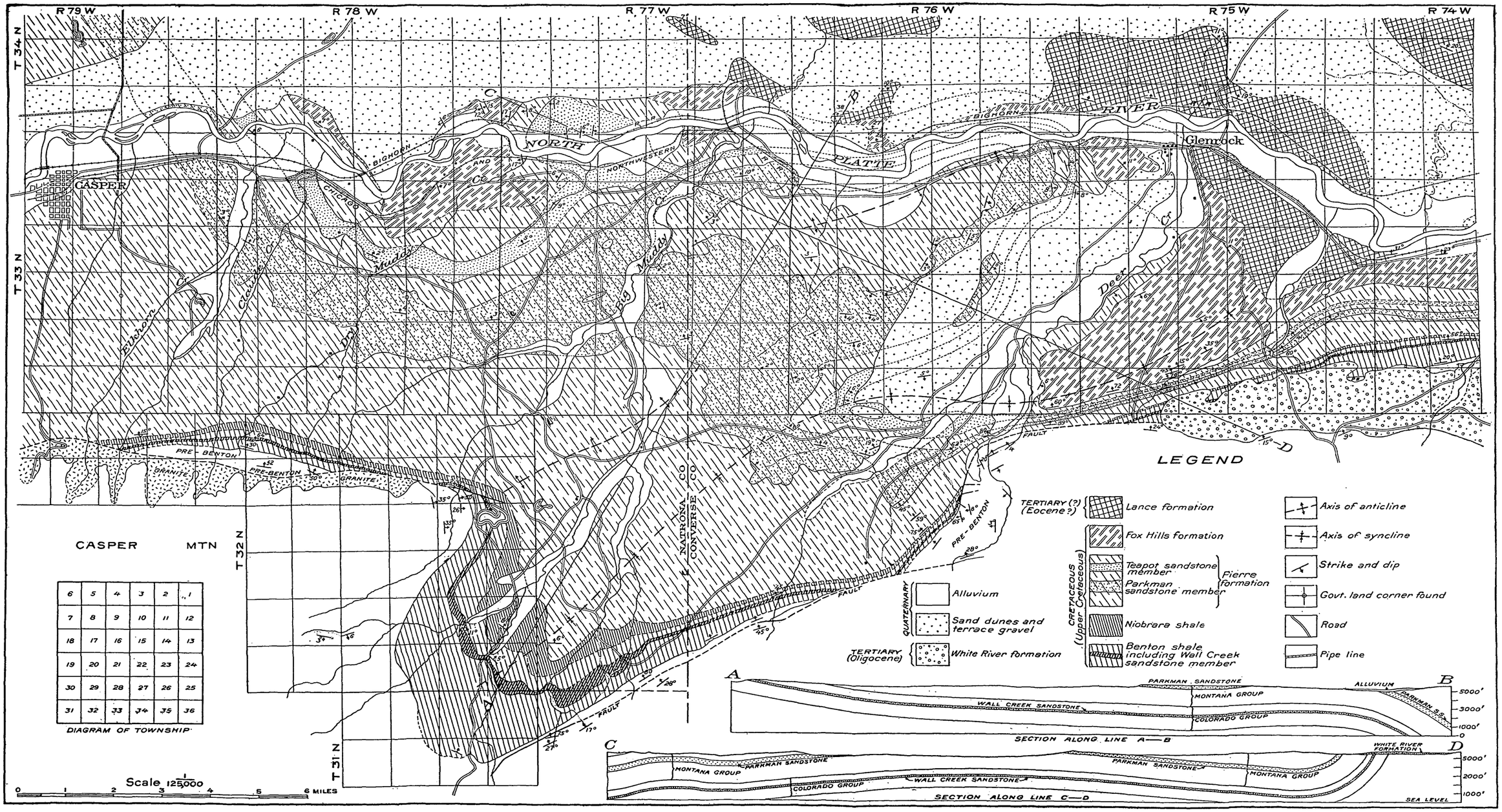
From the axis of the dome in T. 33 N., R. 76 W., the rocks dip in all directions, but toward the southwest the dip is very light, ranging from 1° to 3°. In other directions the dip may be easily read with the clinometer. On the north edge of the dome the rocks dip from 10° to 38°, on the east and southeast from 2° to 11°, and on the west from 1° to 17° away from the central portion. Most of these dips were obtained by clinometer readings, but some were determined by the three-point method, that is, three stadia locations with relative elevations were obtained on a coal bed or some other mappable stratum, and from these data the direction and amount of dip were calculated. The outline of the dome on the north and northwest is rather indefinite on account of the mantle of wind-blown sand.

Near the south side of the Big Muddy field there is a syncline whose axis extends in a rather sinuous course for a distance of about 18 miles (see Pl. IV) from a point near the east end of Big Muddy Mountain in a general northeasterly direction to sec. 31, T. 33 N., R. 76 W., where it bends toward the east, crossing Deer Creek, then bends back toward the northeast again, and finally dies out near the center of T. 33 N., R. 75 W. This syncline is here designated the Deer Creek syncline, because it is best developed in the vicinity of Deer Creek. The dips of the rocks in the eastern half of the syncline on the north side of the axis are from 5° to 7° S., but on the south side of the axis the dips are from 5° to vertical, or the rocks are slightly overturned toward the north. In the western half of the axis the syncline is rather obscure.

There are several large faults in the edge of the mountains along the south side of this field. As stated by Darton,[1] there is a big fault along the north face of Casper Mountain. Other more or less extensive faults also occur in this part of the field, but they are too far from the Big Muddy dome to have any direct bearing on the presence or absence of oil and for this reason they are given no further consideration.

There is, however, a small fault in sec. 1, T. 33 N., R. 76 W., which strikes directly toward the north edge of the Big Muddy dome. The evidence at hand is not sufficient to prove whether or not this fault

[1] Darton, N. H., Preliminary report on the geology and underground water resources of the central Great Plains: U. S. Geol. Survey Prof. Paper 32, pp. 53-55, 1905.



GEOLOGIC MAP OF THE BIG MUDDY DOME, NATRONA AND CONVERSE COUNTIES, WYO.

By V. H. Barnett.

xtends beyond the limits indicated on the map (Pl. IV), but it appears to be of little importance. A maximum dip of 46° was measured near the Lockett mine, which is in the line of strike of the fault.

PROBABILITIES OF OIL OR GAS.

In the Salt Creek oil field the Wall Creek sandstone is the chief oil sand, and contains a better grade of oil than any of the other sands of that field. This sandstone doubtless underlies the Big Muddy dome, as its outcrop was traversed along the entire south border of the field, as shown on the map (Pl. IV). It should be reached by drilling near the crest of the dome on the broad shale flat between Glenrock and Big Muddy at a depth of about 2,500 feet, but whether it contains oil or whether it is "dry" can be learned only by the use of the drill. The presence of oil in the dome will, of course, primarily depend upon whether or not the rocks in this field contain oil; if they do, it will probably be found in this dome, but its position in the dome will depend upon the quantity of water carried by the Wall Creek sandstone. If it is saturated to such an extent that the water extends upward above the crest of the dome, then the oil should be found in the crest, as it has been found at Salt Creek, but if the upper limit of saturation does not reach to the crest, then the oil, if it is present, will be found immediately above the upper limit of the water.

It must be clearly understood that the United States Geological Survey has no means of knowing whether oil is present in this dome or not, but it does maintain that if oil is contained in these rocks the chances are decidedly in favor of its having accumulated at some place in the dome. If a test at the highest point should show only water, then it is probably useless to test further, but if a test in the top should reveal dry rock or gas, then it might be possible to find oil lower down in the flank of the fold.