# THE STATE OF WYOMING

## GEOLOGIST'S OFFICE

**BULLETIN No. 13**

# The Pilot Butte Oil Field

### Fremont County

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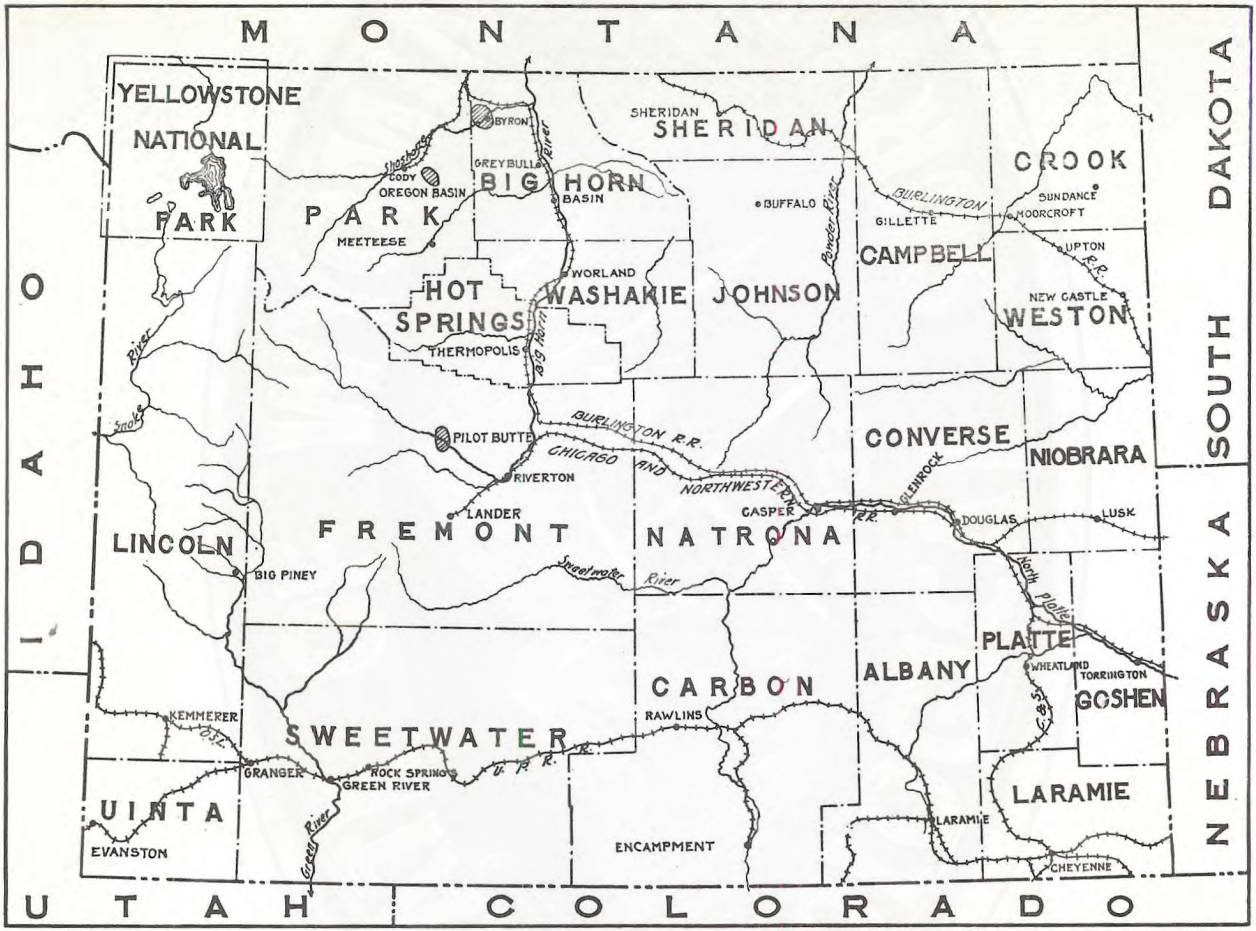
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# The Pilot Butte Oil Field

## INTRODUCTION

The occurrence of oil in Fremont County has been known for a considerable time. As a matter of fact, it was here that the first oil in Wyoming was discovered early in the 19th Century.* This was due to the existence of several prominent oil or tar springs. The first wells were drilled in 1885, but economic production did not start until about ten years later.

There are several oil-producing domes in Fremont County. These are located on the Shoshone Anticline, a prominent uplift parallel to the Wind River Mountains, and extending in a general northwest and southeast direction about 20 and 25 miles north and south of Lander, respectively. There are four prominent domes along the axis of this anticline, in each of which, except at Plunkett, the Triassic "Red Beds" are exposed. They are known as the Dallas, Lander Valley, Plunkett and Sage Creek Fields, or are spoken of collectively as the Lander Fields. In each of the domes except the Plunkett the underlying Carboniferous formations furnish the oil, which is a dark brown to black colored, heavy asphaltic oil. The oil of the Plunkett is the typical light paraffin base, asphalt- and sulphur-free oil of the Upper Cretaceous.

The Pilot Butte Field lies a little east of north of the northern end of the Shoshone Anticline and represents apparently a domal uplift on its flank, a fold *en echelon*. It is of especial interest because it is a rather recent discovery and because the oil produced is a paraffin base oil and is obtained from Cretaceous sandstones.

*C. E. Jamison, Geol. and Mineral Res. of a Portion of Fremont Co., Wyo. Bull. No. 2, Series B, Wyo. Geol. Survey, p. 19.

ACKNOWLEDGMENTS

The material incorporated in this report represents the result of field work during the summer of 1916, when the writer spent part of the months of August and September at Pilot Butte. During the entire field season Mr. R. W. Gibson acted as instrument man and deserves full commendation for his excellent and conscientious work. Mr. Walter Storrie, Mr. Max T. Hofius and Mr. Albert K. Chan acted in the capacity of field assistants. Their careful work and cheerful willingness to do everything demanded of them greatly expedited the undertaking. Mr. L. W. Trumbull also spent some time in the field, and, by his presence as well as his interest and advice in the preparation of the report, contributed much to whatever value this report may have.

Mr. Ralph Schaefer, Engineer for the Hall Oil Company, kindly put his excellent map of the Pilot Butte Field at the disposal of the writer and also gave freely such other information regarding the field as was available to him. To Mr. Turner of the Midwest Oil Co. and to the following gentlemen of the Hall Oil Co., Messrs. Norris, George Nicholson, and Jensen, the writer is greatly indebted for courtesies shown and information given while carrying on the field work.

METHODS OF WORK

The land net of Mr. Ralph Schaefer's map of the Pilot Butte Field has been used as a base. Formation boundaries and certain lithological members were located by means of stadia traverses tied to land corners at convenient points for purposes of checking. Wells, location of rigs and exposures, pits, etc., were located in a similar manner. Elevations were carried in by differential levelling from a U. S. Geological Survey bench mark located about seven miles east of Pilot post office and were tied into each traverse run.

Sections of the rock formations were also measured by means of stadia traverses. The most complete sections were found southwest of the field at Sage Creek on the north end of the Shoshone Anticline, and north of the field at the head of Dry Creek, northeast of Black Mountain. From all the data plotted the structure contours were subsequently calculated and drawn on the map.

## LOCATION

The Pilot Butte Field is located near the center of Fremont County in the west central part of the State, about 40 miles southwest of Thermopolis and 26 miles north of Lander. The name is derived from Pilot Butte, a noted landmark on the eastern edge of the field. The Big Wind River cuts across the southern end of the field. Riverton, on the North-Western R. R., is the closest railroad point, 33 miles by wagon road to the southeast.

The field extends a distance of about six miles in a general northwest direction and is about three miles wide. All producing wells have so far been restricted to an area within one mile of the Big Wind River in Sections 21, 22 and 27, R. 1 W., T. 3 N. The general location of the field is shown on the outline map of the State (Fig. 1.).

## STATUS OF TITLE TO PUBLIC LANDS

All lands north of the Big Wind River were ceded to the Federal Government by the Indians and were thrown open to homestead entry in 1906. The lands south of the Big Wind River are a portion of the present Shoshone Indian Reservation.

Much of the bottom lands on the north side of the river had been allotted to Indians in severalty before the area in general was ceded to the Federal Government, and some have passed by sale into the ownership of white men.

Part of the lands on the south side of the river are owned by Indians under allotments, but much still belongs to the tribe in common.

Under date of August 2, 1912, President Taft ordered "withdrawn from settlement, location, sale, or entry, and reserved for classification and in aid of legislation" the following lands:

Twp. 3 N., R. 1 W., Sec. 9, S½ NE¼, SE¼.
Sec. 10, S½ NW¼, SW¼, W½ SE¼, SE¼ SE¼.
Sec. 14, W½ NW¼, SE¼ NW¼, SW¼, W½ SE¼, SE¼ SE¼.
Sec. 15, all.
Sec. 16, NE¼, N½ SE¼, SE½ SE½.
Sec. 21, E½ NE¼, NE¼ NE¼.
Sec. 22, all.
Sec. 23, all.
Sec. 24, W½ SW¼.
Sec. 25, W½ NW¼.
Sec. 26, Lots 1, 2, 3, and 4, N½ SE¼.
Sec. 27, Lots 1, 2, 4, 5 and 6, N½ NE¼, SE¼ NE¼.

The lands which have been drilled and found oil-bearing in the Pilot Butte Field, were leased by Mr. Earl Warren of Riverton early in 1914 from white owners of dead Indian lands, from Indian owners of allotted lands, from The Tribal Council of the Shoshone Tribe, by and with the consent of The Department of Indian Affairs and the Secretary of the Interior, and from the claimants of petroleum placer claims lying outside the Federal withdrawal. These leases have since been assigned to The Hall Oil Company, The Pilot Butte Oil Company, and Norbeck & Nicholson.

The Valentine Well, which is reported to have struck oil, was drilled upon withdrawn ground early in 1916, *i. e.*, before Congress ordered the leasing of withdrawn lands.

In September, 1916, Congress passed a bill ordering the leasing of the withdrawn lands on the ceded portion of the Indian Reservation, lying north of the Big Wind River. The Indian Department and the General Land Office are now squabbling over which branch of the Government shall have the administering of these leases.

## TOPOGRAPHY AND PHYSIOGRAPHY

The field is situated in the center of a broad valley lying between the Owl Creek Mountains to the north and northwest, and the Wind River Mountains to the west and southwest. Both of these mountain ranges are anticlinal in structure, while the valley between them is structurally a syncline. This, however, is broken by minor irregularities, such as the Shoshone Anticline mentioned before.

The Big Wind River cuts with a general east-west course across the area in question. Apparently there have been several erosion cycles as shown by rather extensive gravel terraces, which seem to indicate several prolonged periods of erosion. Thus on the south edge of the Pilot Butte Field, the upper one of these terraces is exposed as a high cliff along the south side of the Wind River at a general elevation of about 5900 feet. On the north side of Big Wind River the second terrace level is well shown as a broad flat between the enclosing rim of Tertiary sandstones. The general elevation is about 5600 feet. The lowest terrace formed by the present cycle of erosion is represented by the broad flats characterizing both sides of the river at a general elevation of 5500 feet. Remnants of each of these erosion planes can be found everywhere within the region lying between the Wind River and the Owl Creek Mountains. The terraces, and especially the upper, are characterized by heavy accumulations of gravel in which metamorphic and igneous rocks dominate, although sedimentaries are occasionally quite abundant. The large size of the boulders and the abundance of limestone blocks prove that the material of the gravel terraces has not been transported far.

The drainage of the district is through Big Wind River to the east. The only tributary worthy of note is Dry Creek, which has cut a deep and broad valley on the western edge of the field back to the Owl Creek Mountains and which affords near its head good exposures of the Cretaceous series.

## GEOLOGY

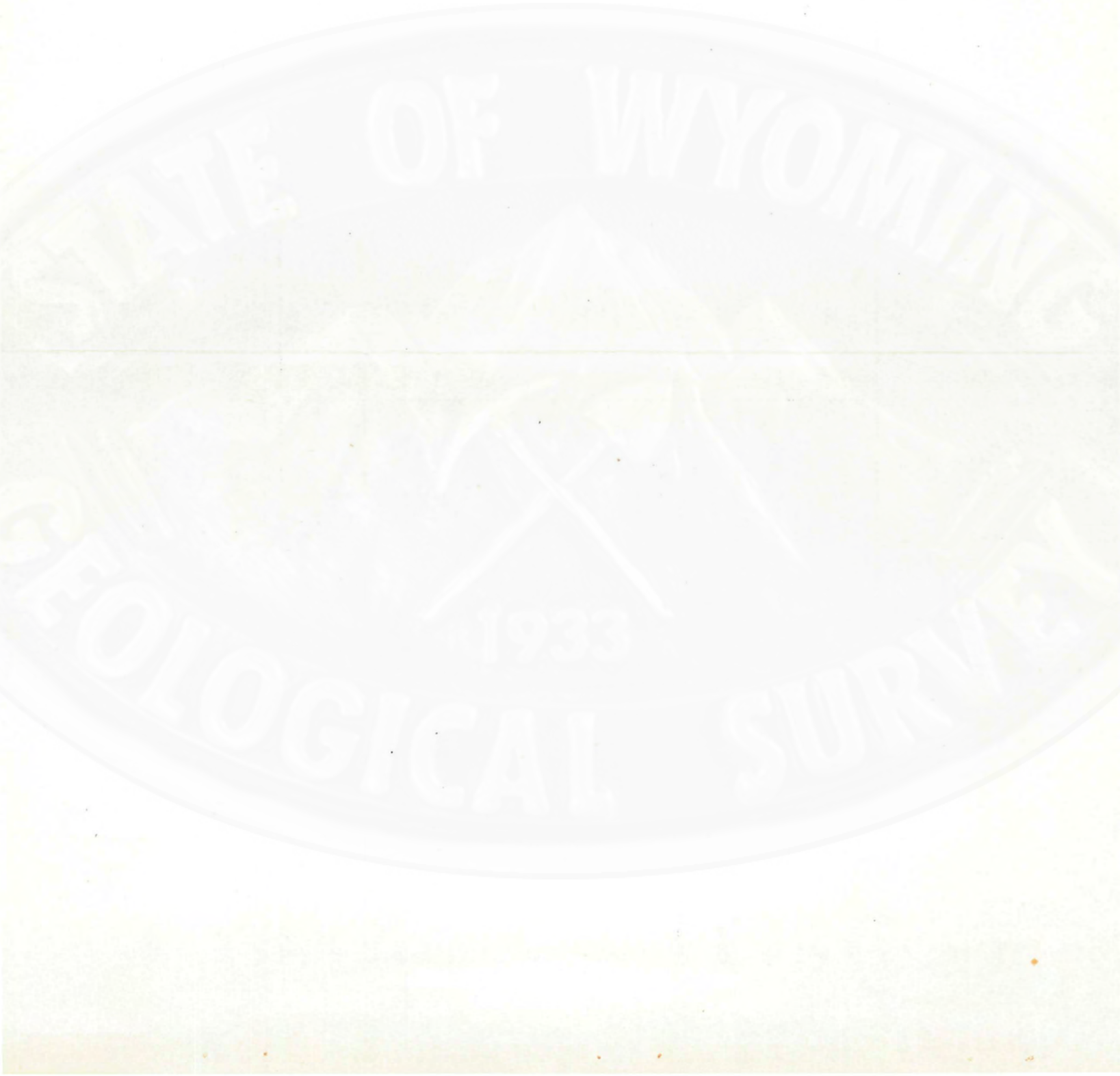
### Stratigraphy

Not much detailed work on stratigraphy has been done in this part of Wyoming. Nearly everything done so far has been more or less in the nature of reconnaissance, or work incidental to the investigation of economic resources such as oil and coal. In practically all of the published work, no attempt has been made to subdivide the Cretaceous series and correlate it with that of other parts of the State, although this is very easily possible.

In the Pilot Butte Field proper there are exposed only the very top of the Cretaceous series and the base of the Tertiary. To the south, however, along Sage Creek, and to the north along Dry Creek, a section extending down to the Paleozoics is exposed.

## STRATIGRAPHIC TABLE OF FORMATIONS IN THE WIND RIVER BASIN

| Darton (Bull. Geol. Soc. Am. Vol. 19) | | Woodruff (Bull. 452 U. S. G. S.) | | | | Jamison Bull. 2 Wyo. Geol. Sur.) | | Present Paper | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PERIOD | FORMATION | SYSTEM | SERIES | GROUP | FORMATION | AGE | FORMATION | SYSTEM | SERIES | GROUP | FORMATION |
| | | Quaternary | Recent | | (Alluvium) | Quaternary | | Quaternary | Recent | | |
| | | | | | | | | | Pleistocene | | |
| Eocene | Bridger-Wasatch | Tertiary | Eocene | | Wind River | Tertiary | Wind River | Tertiary | Eocene | | Wind River |
| | | | UNCONF. | | | UNCONF. | | | | UNCONFORMITY | |
| Cretaceous | Laramie, etc. | Cretaceous | Upper Cretaceous | Montana | Mesaverde | Cretaceous | Mesaverde | Cretaceous | | Montana | Mesaverde |
| | Fox Hills-Mesaverde | | | | | | | | | ? | Cody: Pierre |
| | Pierre | | | | | | | | | | |
| | Niobrara | | | Colorado | Mancos | | Mancos | | | Colorado | Cody: Niobrara |
| | Benton | | | | | | | | | | Benton: Frontier / Mowry / Thermopolis |
| | Cloverly | | | | Dakota | | Dakota | | | Cloverly | Dakota |
| ? | | | Lower Cretaceous | | | | Lower Cretaceous | Commanchean | | | Fuson |
| | | | | | | | | | | | Lakota |
| | Morrison | Jurassic? | | | Morrison | Jurassic? | Morrison | Jurassic? | | | Morrison |
| Jurassic | Sundance | Jurassic | | | Sundance | Jurassic | Sundance | Jurassic | | | Sundance |
| Permian-Triassic | Chugwater | Triassic? | | | Chugwater | Triassic | Chugwater | Triassic? | | | Chugwater |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## Description of Formations

### THE PALEOZOIC SYSTEMS

Rocks of Paleozoic age are exposed only at the Wind River and Owl Creek Ranges. The nearest exposure to the Pilot Butte Field is about 25 miles north, near the head of Dry Creek.

As far as known, the Cambrian, Ordovician, Mississippian and Pennsylvanian Systems are represented by the following formations.*

*Carboniferous:*

Embar—Cherty limestones, sandstones, and shale—source of asphaltic oil; 200-450.

Tensleep—Massive sandstones; 200-550.

Amsden—Bright-colored red, purplish and gray shales and sandstones; 200-450.

Madison—Hard gray massive limestone; 250-600.

*Ordovician:*

Bighorn—Massive gray dolomitic limestone with streaks of chert; 100-570.

*Cambrian:*

Deadwood—Red to brown conglomerates and sandstones, glauconitic shales and some slabby limestones; 750-1325.

The data for the above table were compiled from the literature and no attempt will be made to describe these formations in detail.

### THE MESOZOIC SYSTEMS

The Mesozoic is represented by rocks of Triassic, Jurassic, Comanchean and Cretaceous Age. The appended table shows the Mesozoic and younger rocks.

*Darton—Paleozoic and Mesozoic of Central Wyoming. Bull. Geol. Soc. Amer., Vol 19, pp. 403-474. Jamison—Bull. 2, State Geol. Sur. Wyo.

## TABLE OF FORMATIONS

| SYSTEM | SERIES | FORMATION | | THICKNESS IN FEET | CHARACTERISTICS |
|---|---|---|---|---|---|
| Quaternary | Recent | | | 0-40 | Alluvium and low terrace gravels. |
| | Pleistocene | | | 0-50 | High terrace gravels. |
| Tertiary | Eocene | Wind River | | 250+ | Sandstones, arkose grits locally conglomeratic. Sandy shales, red and green clays. Basal sandstones from high escarpments. Rimrock south, west and north side of the Pilot Butte field. |
| | UNCONFORMITY | | | | |
| Cretaceous | Montana | Mesaverde | | 300+ | Buff colored massive sandstones, brown carbonaceous shales and thin coal seams. Prominent ridge. Rimrock east side of field. |
| | | Cody | Pierre | 4100± | Sandy shales and thin bedded sandstones on top. Dark sandy shales with clay concretions. |
| | Colorado | | Niobrara | 1200± | Yellow friable sandstones and carbonaceous shales. |
| | | Benton | | 111± | Dark carbonaceous shales and impure thin coal seams. |
| | | | Frontier | 430± | Gray sandstones, locally conglomeratic. Some bentonite. |

## Table of Formations—Concluded

| SYSTEM | SERIES | FORMATION | THICKNESS IN FEET | CHARACTERISTICS |
|---|---|---|---|---|
| | | Mowry | 400-700 | Hard gray fissile shale. Fish scale member. High ridge. |
| | | Thermopolis | 200± | Gray to black adobe shale. |
| | Cloverly or Dakota Group | Dakota | 20-50 | Hard massive sandstone. High ridge. |
| Comanchean | | Fuson | 360± | Alternating shales and sandstones, gray to buff in color. |
| | | Lakota | | |
| Jurassic | | Morrison | 210-250 | Alternating maroon, purplish and red shales, and soft sandstones. |
| Jurassic | | Sundance | 350± | Olive green shaly limestones, sandy shales and friable sandstones. Fossiliferous. |
| Triassic | | Chugwater | 1500± | Red sandstones and shales with gypsum beds and shaly limestones. High ridge. |

TRIASSIC SYSTEM

*Chugwater Formation:*

The Chugwater formation is usually considered to represent the Triassic system. The formation is widely distributed in Wyoming, but fossils are exceedingly rare and those found are not diagnostic. Considered on the basis of the overlying Jurassic and underlying Permo-Carboniferous, they are correlated as indicated. There is, however, some evidence that the lower part may represent beds of Permian Age. The formation consists dominantly of bright red sandy shales and sandstones with thin intercalated gray to purplish limestones, and heavy gypsum beds. Determinations of the thickness in the Wind River Basin have varied from 1000 to 2500 feet.* The most satisfactory measurements indicate about 2000 feet. The lower sandstones of the Chugwater are productive of asphaltic oil at Dallas, Lander and Sage Creek.

JURASSIC SYSTEM

*Sundance Formation:*

The Sundance formation is essentially a series of gray to green shales and soft sandstones, locally indurated, with a few thin layers of limestone. The formation is usually characterized by an abundance of fossils, which are of undoubted Jurassic Age. Determinations of thickness range from 300 to 370 feet.

COMANCHEAN SYSTEM

*Morrison Formation:*

The Sundance formation is succeeded by a group of variegated, usually brightly colored clays, sandy shales and sandstones, which are only locally indurated. The prominent colors are maroon and pale olive green. The forma-

*Jamison—loc. cit. p. 11.
Darton—loc. cit. p. 432.

tion is widely distributed in Wyoming and has yielded many dinosaur remains. On the basis of these the Morrison is considered by some paleontologists to be of Jurassic Age. There is, however, a decided tendency of assign the Morrison to the Lower Cretaceous, or Comanchean.

CRETACEOUS SYSTEM

*Dakota Group:*

In the vicinity of Pilot Butte the Morrison clays are overlaid by about 400 feet of buff to gray colored sandy shales and sandstones with occasional fine conglomeratic streaks. These are succeeded by dark gray shales usually carbonaceous, 100 feet in thickness, which in turn are overlaid by about 300 feet of interbedded sandstones and sandy shales buff to brown in color, with a massive hard sandstone at the top. Most of the sandstones are soft, cross-bedded and ripple marked. They are, however, resistant enough to form prominent hogbacks, usually with a double crest. The entire series is here included under the name Cloverly or Dakota Group. In a rough way it corresponds to the three-fold division of the Dakota Group into Lakota, Fuson and Dakota made by Darton in the Black Hills and Bighorn Mountains. The central shales and the lower sandstones are considered to be Comanchean in age; the upper sandstone, basal Cretaceous. This sandstone is referred to the Dakota proper. Darton applied to this upper layer the name Cloverly, which, as has been pointed out by Woodruff*, is inconsistent. The latter term would be appropriate for the whole group as here described.

*Mancos:*

The whole Cretaceous shale series above the Dakota Group has been included under the name Mancos Shale, and in previous work in the Wind River Basin no attempt was made to subdivide this formation, except that the

*Darton—op. cit. p. 448. Woodruff—Bull. 452 U. S. G. S. p. 19.

possibility of such division was indicated by Jamison.* There is a distinct similarity to the rocks of the Big Horn Basin, both lithologically and faunally, so that practically the same divisions can be recognized here. An attempt has hence been made to make such subdivision.

## TABLE OF CRETACEOUS SHALE SERIES
### Wind River Basin

| Darton, Bull. Geol. Soc. Amer. Vol. 19, p. 450 | Woodruff, Bull. 452 U. S. G. S. | Present Paper | |
|---|---|---|---|
| Pierre | Mancos | Cody | Pierre |
| Niobrara | | | Niobrara |
| Benton | | Benton | Unnamed shale member |
| | | | Frontier |
| | | | Mowry |
| | | | Thermopolis |

The following is a generalized section of the series:

| | |
|---|---|
| 6. Sandy shales buff to drab color, increasingly sandy near top | 4350.0 |
| 5. Yellow friable sandstones with shaley layers. Fossiliferous | 1179.0 |
| 4. Carbonaceous shales with bentonite and near coals | 111.0 |
| 3. Gray sandstones, bentonite and thin carbonaceous shales | 430.7 |
| 2. Dark blue shale, hard and fissile, weathering light gray, fish scale beds | 425.0 |
| 1. Gray to black soft shale with thin rusty sandstones at base | 198.0 |
| Total | 6695.0 |

Of the above section the basal portion, Nos. 1, 2, 3, 4 and 5, were measured on Sage Creek on the northern end of the Shoshone Anticline (measurements Nos. 1 and 2 are by Jamison). The sandy shales above the yellow sandstones of No. 5 were measured at the head of Dry Creek. Measurements of this same shale member on the

*Jamison, C. E.—Geology and Mineral Resources of a Portion of Fremont County, Wyo. Wyo. Geol. Sur. Series B., Bull. 2.

Shoshone Anticline near the Plunkett oil well, made by Jamison (op. cit.), show a thickness of 4585 feet. The total thickness of the Mancos at that locality is 6698 feet; according to Woodruff* it is 6110 feet west of Hudson; and according to Darton it is 4248 on Dry Creek. The last figure, however, is too low. Measurements made by the writer on Dry Creek show a thickness of 4350 feet between the yellow fossiliferous sandstones and the massive coal-bearing formation above, which is correlated with the Mesaverde. To this portion a thickness of only 2600 feet is assigned by Darton. The shales are exceptionally well exposed and have a practically constant strike, with a dip varying from 26°-27° for the entire exposure. In no case were dip and strike observations more than 200 feet apart stratigraphically. The section was measured by a stadia traverse, making corrections for differences in elevation and for deviations in the course of the traverse from perpendicularity to the strike line. Hence the writer feels certain of the correctness of his measurement. According to Darton the underlying shales and sandstones down to the Dakota are 1648 feet thick, which checks the writer's estimate. Taking the writer's measurement of the upper shale member and Darton's measurement of the lower members, the thickness of the Mancos becomes practically 6000 feet which is in close accord with the other independent measurements cited above.

The lower shale member (No. 1) in the formation is correlated with the shale below the fish-scale member of the Big Horn Basin, to which Lupton† applies the name Thermopolis. The hard gray fissile shale characterized by many fish scales is the Mowry. The prominent sandstone series, No. 3, is included under the term Frontier. The yellow sandstones (No. 5) on the basis of their fossil content, are considered the equivalent of the Niobrara, while the

*Woodruff, U. S. G. S. Bul. 452. Darton—op. cit.
†Lupton, U. S. Geol. Sur. Bull. 621, part L, p. 167.

overlying sandy shales (No. 6) are referred to the Pierre, also on the basis of the fossils they contain.

Fossils on the whole are rare except in the strata marked No. 5 and in the central and upper part of the thick shale member No. 6. Such few forms as are found indicate that the lower members (Nos. 1, 2, 3 and 4) are of Benton age.

*Thermopolis Shale:*

To this is referred about 200 feet of black shale, weathering dark gray and carrying near the base a few rusty, very thin, sandy shales. Weathering produces a very heavy sticky adobe like clay, which has a peculiar spongy appearance.

*Mowry Shale:*

About 400-700 feet of dark blue, very hard and fissile shale are referred to this member. Upon weathering the shale turns a light bluish gray. It forms a very prominent, steep hogback, usually bare of vegetation and presenting a characteristic banded gray appearance. It can readily be recognized even at a distance of several miles. The slopes are usually littered with fragments of the shale which on being struck give off an almost metallic clink. Practically every fresh surface shows the presence of fish scales, often in profusion. These on weathering lose their shape and produce rusty spots. Oil seepages occur in the outcrops. In the Plunkett Field the Washakie oil spring is located on this formation.

*Frontier Sandstones:*

Lupton (op. cit.) applied the name Frontier to all the sandstone members of the Benton above the Mowry shale. This usage is adopted in this report. The name Frontier was first proposed by W. C. Knight* for a series of coal bearing sandstone of Benton age in southwestern Wyoming

*Bull. Geol. Soc. America, Vol. 13, pp. 542-544.

where the coal is being mined at Kemmerer and Frontier in Lincoln County. The name was carried into south central Wyoming by A. C. Veatch* and was applied to the prominent sandstones of the Colorado series there exposed.

The following detailed section of the Colorado series was measured on Sage Creek:

| | | |
|---|---|---|
| | Sandy shales—Cody formation | |
| | Soft, pale-yellow sandstones forming three benches and separated by brown carbonaceous shales, poorly exposed | 190.0 |
| | Gray sandstones with heavily fluted pelecypod fragments | 7.6 |
| | Buff sandstone | 10.0 |
| | White friable sandstones | 15.0 |
| | Brown carbonaceous shale and gray sandy shale | 27.4 |
| | Massive greenish buff sandstone | 2.0 |
| | Sandy buff shale and brown carbonaceous shale | 14.1 |
| | Hard gray laminated sandstone | 8.7 |
| | Shales and thin shaly sandstones (poorly exposed) with alternating brownish black carbonaceous shale | 392.0 |
| | Massive gray sandstone | 10.9 |
| 4. | Bright yellowish buff poorly cemented sandstone | 196.0 |
| | Thin bedded slabby pale buff sandstone with rusty spots and streaks. Fossiliferous (Base of Niobrara) | 6.3 |
| | Brownish black carbonaceous shale with streaks of poor coal and bluish black shales alternating. Thin seams of bentonite | 107.0 |
| | Bentonite | 4.0 |
| | Quartzite, gray with conchoidal fracture. (Top of Frontier) | 0.6 |
| 3. | Gray sandstone and sandy shale with few thin conglomeratic streaks | 70.0 |
| 2. | Gray sandstone with few thin layers of shale | 167.1 |
| | Conglomerate, small shiny black chert pebbles | 2.0 |
| 1. | Gray sandstone with few layers of shelly hard bluish gray shale near top | 141.0 |
| | Gray to buff sandstone, hard, thin bedded, irregularly breaking | 50.0 |
| | TOTAL | 1720.7 |
| | Mowry—hard gray fissile shale. | |

Thus it will be apparent that a threefold division of this series is indicated by the section. The lower member, consisting essentially of fairly well cemented sandstones and totalling 430.7 feet is considered to be the Frontier. The sandstones because of superior hardness form prominent ridges on the dip slopes of the high Mowry hogback. The characteristic color of the sandstones is gray. They are also characterized by carrying occasional streaks of small

*U. S. Geol. Sur. P. P. 56, p. 65. Bull. 316, p. 246.

shiny black chert pebbles, a feature also noted in the Frontier sandstones of the Big Horn Basin.

Above the Frontier lie four feet of bentonite and 107 feet of shales with thin seams of bentonite. These are considered to represent a shale member so far unnamed, which has also been recognized in the southern part* of the State as indicated on the accompanying comparative sections. (pp. 159, 160.)

*Niobrara:*

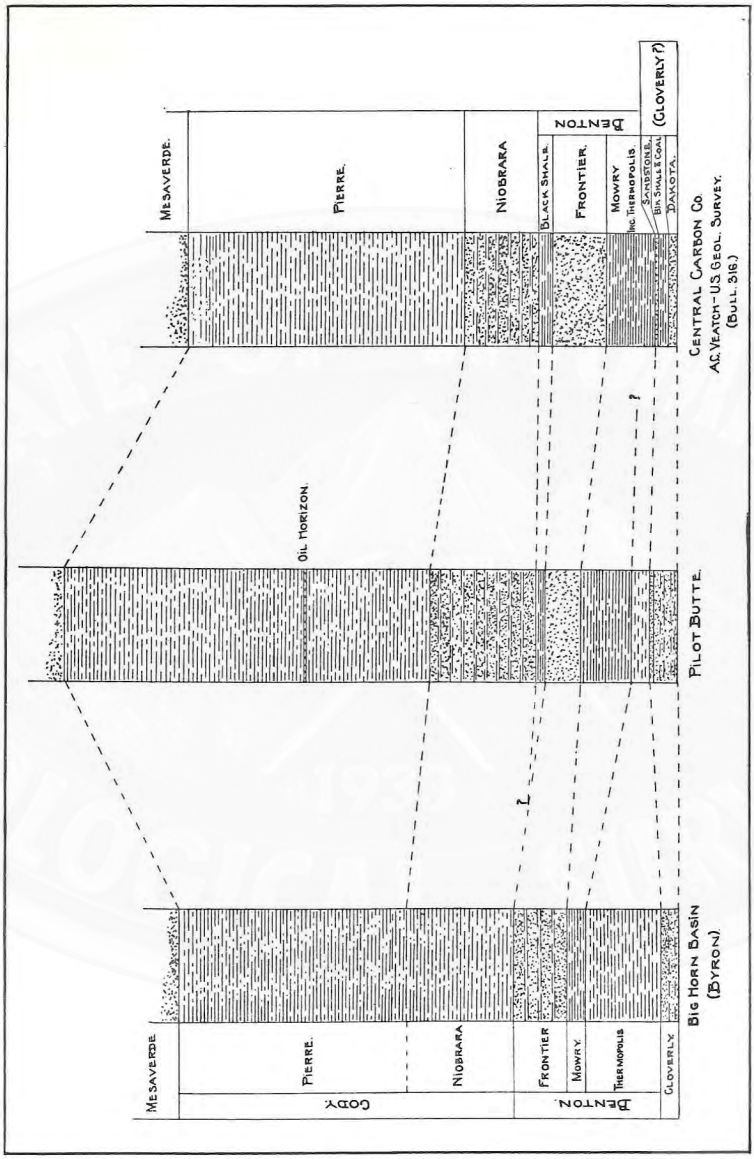
The Niobrara differs from the Frontier in the decided lack of induration of its sandstones and in the fact that these on weathering take on a bright yellow color. Only a few of the thin sandstones are well enough cemented to give prominent outcrops and these are confined to the basal portion.

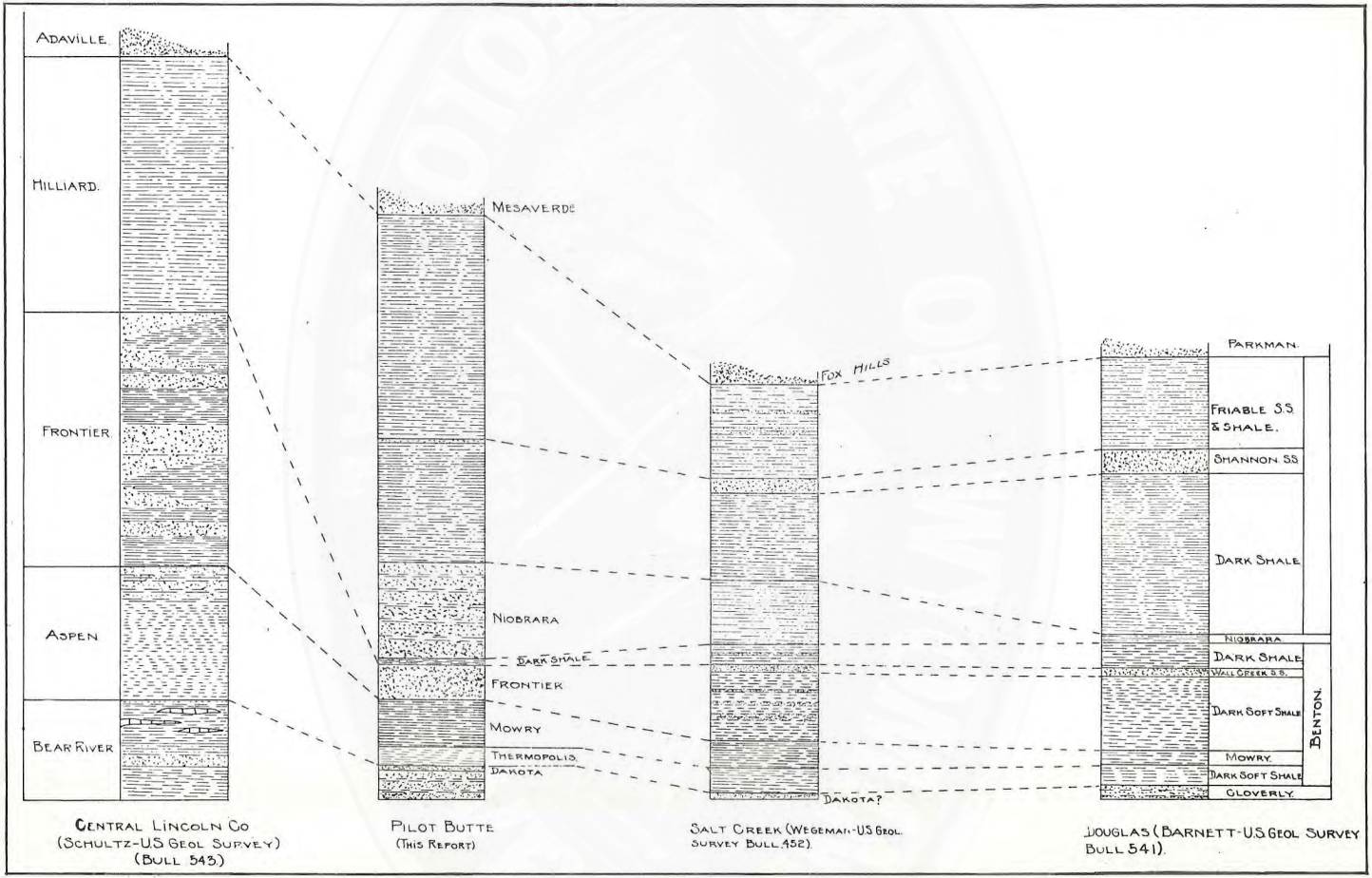
The upper part consists of about 190 feet of sandstones, forming three benches separated by carbonaceous dark colored shales. The sandstones are very soft and weather to a light yellow color. They are characterized by an abundance of fossils, chiefly *Inoceramus*. The outcrops are usually obscured because of lack of induration. At times the top sandstones form low, bright yellow hogbacks.

*Pierre:*

Immediately overlying the yellow sandstones of the Niobrara is a thick series of shales, very soft, and usually masked by heavy residual soil. The only locality where really good exposures of this member can be seen is near the head of Dry Creek. The series consists of dark shales weathering to a light yellow or buff color. It becomes increasingly sandy near the top and shows a gradual transition into the overlying massive buff sandstones referred to the Mesaverde. In spite of the great thickness of these shales (4350 feet) no division on lithological ground is possible.

*U. S. G. S. Bull. 316-d. Coal of East-Central Carbon County, Wyo.


MESAVERDE
PIERRE.
GODY
NIOBRARA
FRONTIER
MOWRY
THERMOPOLIS
BENTON
GLOVERLY
BIG HORN BASIN
(BYRON)
OIL HORIZON.
PILOT BUTTE.
MESAVERDE.
PIERRE.
NIOBRARA
BLACK SHALE.
FRONTIER.
MOWRY
INC. THERMOPOLIS
SANDSTONES.
BR. SHALE & COAL
DAKOTA.
BENTON
(GLOVERLY?)
CENTRAL CARBON CO.
AC. VEATCH - U.S. GEOL. SURVEY.
(BULL. 316.)


ADAVILLE.
HILLIARD.
FRONTIER
ASPEN
BEAR RIVER
MESAVERDE
NIOBRARA
DARK SHALE
FRONTIER
MOWRY
THERMOPOLIS
DAKOTA
FOX HILLS
DAKOTA?
PARKMAN.
FRIABLE S.S. & SHALE.
SHANNON SS
DARK SHALE
NIOBRARA
DARK SHALE
WALL CREEK S.S.
DARK SOFT SHALE
MOWRY.
DARK SOFT SHALE
GLOVERLY.
BENTON.
CENTRAL LINCOLN CO (SCHULTZ-US GEOL SURVEY) (BULL 543)
PILOT BUTTE (THIS REPORT)
SALT CREEK (WEGEMAN-US GEOL. SURVEY BULL 432).
DOUGLAS (BARNETT-U.S. GEOL SURVEY BULL 541).

Clay shales in the central part of the formation are characterized by large round concretions of clay ironstones, up to two feet in diameter. They are non-fossiliferous. As a matter of fact fossils are rare in this formation. *Scaphites nodosus* and *Baculites ovatus* were collected from a thin argillaceous sandstone immediately above the layer of concretions referred to above. This also carried fragments of a pelecypod not distinct enough for identification, but suggesting *corbula*.

In the publications of the United States Geological Survey, this shale member is included in the Colorado shale. Nevertheless, Stanton refers the fossils collected from this upper shale member to the Montana group.* Because of this fact, and because no fossils referrable to the Colorado have been found above the yellow sandstones of the Niobrara, they are assigned provisionally to the Pierre shale. The upper part of the Mancos series, including the two members here called Pierre shale and Niobrara sandstones, are the equivalent of the Cody shale of the Bighorn Basin.†

This term is here used to include both because of its convenience of application and the difficulty of making the division into Niobrara and Pierre in the field.

*Mesaverde:*

Near the top the Pierre Shale becomes increasingly sandy, grading into a succession of flaggy, thin bedded, argillaceous sandstones. These in turn grade into massive, heavy bedded, buff sandstones and at the base of the lowest of these the dividing line between Pierre and Mesaverde is drawn.

In the Pilot Butte field only the basal part of the Mesaverde is exposed, the unconformably overlying Tertiary formations masking the greater part except in a narrow strip from Sec. 13 to Sec. 4, T. 3 N., R. 1 W. The basal

*Bull. 452 U. S. G. S., p. 21, 1911.
†Bull. 621 L. U. S. G. S. p. 171, 1916.

part shows an alternation of heavy massive buff sandstones and sandy shales. Both texture and color are characteristic. The color is a uniform light buff. The sandstones show an even fine grained texture. Laterally the massive layers change suddenly into platy, ripple-marked sandstones. Above these we find shaly sandstones interbedded with thin coal seams (one of which attains a thickness of three feet) alternating with massive buff and gray saccharoidal sandstones. Brown carbonaceous shales occur in minor amounts.

## CENOZOIC SYSTEM

### TERTIARY

*The Wind River Formation:*

Unconformably overlying the Cretaceous system we find a series of Tertiary sands and clays. These have been included under the term Wind River formation, by Woodruff.* Darton includes it under the term Wasatch.† On the basis of fossil plants it is referred by Knowlton to the Eocene and later than the Fort Union.*

The basal sandstones are massive, crossbedded, poorly cemented arkoses, white with rusty streaks. They are coarse in texture and show very little sorting. Pebbles are scattered through them, occasionally in well defined streaks. They average less than ½ inch in diameter, although an occasional isolated one as much as 6 inches in diameter is present. Clay lenses occur. Iron concretions, irregularly shaped and often centrally hollow, form layers in the sandstones. Due to differential cementation queer erosion forms result which are picturesque and castellated, and occur at times in such profusion as to form regular "Monument Parks". Locally lenticular bodies of conglomerate are found, none of which are, however, of any great extent.

*Bull. 452 U. S. G. S. p. 23.
†Bull. G. S. Am. Vol. 19, 1908, p. 463.

Sandy shales are also quite abundant above the massive sandstones, and in the middle and upper portion clays, olive green and red in color, occur.

## GEOLOGIC HISTORY

The geologic history of the Wind River Basin is rather complex and no attempt will be made to trace it out completely. Conditions during and since the Mesozoic only will be considered.

### Triassic Time

The Paleozoic rocks are as a whole the results of marine deposition. The highest member, the Embar, represents comparatively clear and quiet water deposition of limestones, occasionally broken by periods of shale deposition. At the beginning of Permo-Triassic time there was a gradual withdrawal of the ocean and a change in climatic condition during which the Chugwater formation was laid down. This is essentially made up of clastic sediments which by their lithological characteristics, such as cross bedding, their red color, the complete absence of fossils, etc., suggest continental deposition in an arid or semi-arid climate.

### Jurassic Time

During Jurassic time the sea again advanced over this area, never, however, attaining any great depth. Thus the deposits of Jurassic age, the Sundance, are essentially a succession of shallow water deposits. The great abundance of fossils proves that the Jurassic seas must have been crowded with animals. *Belemnites* are probably the most characteristic and most widespread.

### Comanchean Time

The basal Comanchean rocks indicate another period of continental deposition, hence a withdrawal of the sea.

The variegated clays and sandstones of the Morrison represent fresh water deposition, probably along streams, lakes and ponds very near the ocean, perhaps on a coastal plain. The Cloverly also indicates fresh water deposition along streams, but with a sudden change in conditions because of the coarse character of the sediments. Conditions of sedimentation continued to fluctuate rapidly, hence the alternation of shales and sandstones characterizing the greater part of the Comanchean.

### Cretaceous Time

A return to marine conditions is indicated by the highest sandstone of the Cloverly, the Dakota, which is the basal member of the marine Cretaceous, and represents deposition in disturbed shallow water. The Thermopolis indicates a gradual deepening of the sea, and quiet water conditions which prevailed during its deposition as well as that of the overlying Mowry. The abundance of the fish scales in the latter shows that the Cretaceous seas were crowded with fish. A shallowing of the sea followed the deposition of the Mowry shale, resulting in the deposition of the sandstones of the Frontier and Niobrara formations. As a matter of fact, at this time there must have been slow subsidence with rapid deposition, resulting in repeated slight elevations above sea level, as the presence of the carbonaceous shales and poor coals interbedded with massive sandstones proves. This period was followed by a more rapid submergence of the continent during which the Pierre shale was deposited. The whole of the Pierre is a succession of black muds and sandy shales, consequently a shallow water deposit. Its great thickness (4500 feet) indicates a submergence so slow that deposition was able to keep pace with it. During the late Cretaceous the sea became filled in and deposition took place in brackish water, lagoons, swamps and lakes, which resulted in the formation of the Mesaverde sandstones with their coal seams and carbonaceous shales.

### Tertiary Time

The close of the Cretaceous and beginning of the Tertiary were marked by great crustal deformation manifested in the Wind River Basin by sharp folding in the Cretaceous and older rocks. Outside of the Pilot Butte field, extensive faulting accompanied the folding. The Owl Creek and Wind River Mountains as well as smaller elevations, such as the anticline east of Dallas, Lander and Fort Washakie, were formed at this time. Subsequent to this folding, a prolonged period of erosion ensued, truncating the edges of the uplifted rocks so that the whole surface of the basin was cut down to a flat plain.

Upon this plain during late Eocene time were deposited by swift flowing streams the coarse sandstones, and in quieter waters, the clays of the Wind River formation. Subsequent to their deposition, there was a second period of deformation, resulting in very gentle folding of the Tertiary rocks, a decided tilting, and in a few instances in non-important normal faults. Erosion then carved out the high terraces upon which were deposited the coarse gravels, probably as fans and outwash plains, subsequent to which the present erosion cycle was initiated.

### Summary

To recapitulate, then, the Mesozoic group includes both marine and continental deposits which, at the close of the Cretaceous period, were folded into anticlines and synclines and locally much faulted. In early Eocene time these were eroded to a flat plain upon which, in late Eocene time, the continental deposits of the Wind River formation were laid down. In Post-Eocene time there was another period of slight folding and minor faulting. This in turn was followed by the development of the present day topography.

## GEOLOGIC STRUCTURE

The structure of the Pilot Butte field is difficult to work out because of the few available exposures in the Cretaceous, due to masking by the overlying Wind River formation and heavy terrace gravels.

The salient structural features show that there have been two periods of folding, each with minor faulting; one post-Cretaceous, the other post-Eocene, separated by a prolonged period of erosion.

The Eocene rocks, that is the Wind River formations, are arched into a low anticline with a north and south axis. The dips of the limbs are gentle, varying from 4 to 10 degrees. A few normal faults of small displacement have also taken place. The Wind River formation rests upon the truncated edges of the underlying Cretaceous in a strong angular unconformity. Thus, at well exposed contacts, the differences in dip angles range from 8° to 41°. The contact is a comparatively smooth plane showing profound erosion and practical peneplanation of the Cretaceous previous to the deposition of the Wind River.

The Cretaceous series forms a dome fold showing an elongation along a N. N.W. axis. The highest part of the dome is near the Wind River in Secs. 21 and 22, T. 3 N., R. 1 W. On the east side of the fold the average dip is about 20°. On the west side the dip averages slightly over 30°. Only a limited part of the west side of the dome is exposed and that only on the south side of the Big Wind River. That this dome is not a simple fold is indicated by a series of steep, practically vertical, dips exposed in test pits near the ¼ corner common to Secs. 16 and 21 in the south edge of the terrace. The observations, going from west to east, show the following dips and strikes: A general N. W. strike and N. E. dips increasing from 20° to 87° in a distance of about 1500 feet. Then a N. E. strike and a N. W. dip at 70°, and about 800 feet east of these a N. W. strike and a dip of 7° N. E. These are interpreted as due to

a sharp synclinal fold with a N. W. axis, in the southeast quarter of Section 16. That this synclinal fold plunges northwestward is indicated by the logs of the Valentine well and the Hall Oil Company well, both of which are located about 300 feet south of the line of these exposures. The logs show that these two wells, although over 400 feet apart, strike the oil sand at practically the same level (845 and 837). This is due to the northwesterly plunge of the syncline and the flattening of the curve of folding with descent.

As may be inferred, the above interpretation of these dip and strike records implies that there is another anticlinal fold in the Cretaceous to the west. Could this be accurately located it might have commercial possibilities sufficient to warrant drilling. The Cretaceous formations to the west are covered by the overlying Tertiaries and hence nothing can be ascertained by direct observation regarding the possible location of such a fold. In this connection it is interesting to note that the axis of the Shoshone anticline, as determined from the map by Jamison*, has a general northwest direction and if projected forward passes to the west of the Pilot Butte field near the corner on the south line of T. 3 N. and R. 2 W.

There are several normal faults in this field. One, rather prominent because of its clear exposure, lies on the center of the escarpment south of the Big Wind River west of ¼ corner common to Secs. 33 and 34. This is a block fault of very slight displacement.

Sandstone dikes are present, but none are of any consequence. They are superficial features, and mark once open fissures in the rocks which have been filled by sands, either from above or from below. The fissuring is considered the result of tension due to folding. Because of superior hardness these dikes usually project several feet above the surrounding rocks, forming sharp serrated blade-like ridges. Along the Tertiary escarpment on the west side of the field several such occur, more or less along the same general line

*Bull. No. 2, State Geol. Sur. Wyo.

of strike. Those in this field are very small, not at all comparable in size to the sandstone dikes found in the Big Horn Basin.

Here also at several points some more resistant sandstone has been left in projecting tabular ridges from two to three feet high. These do not represent sandstone dikes in the ordinary sense, but rather a well cemented part of the sandstone beds along channels of water circulation. Calcite occurs frequently accompanying them. Evidences of brecciation are also shown. There has been, however, no noticeable disturbance in the sandstone along the line of these supposed sandstone dikes. They are mentioned here at some length because of the supposed effect on oil accumulation. It happens that they line up roughly with the peculiar steep dips on the river terrace mentioned, with the two deep unproductive wells in Secs. 16 and 17, as well as with the small block fault on the south side of the Big Wind River, hence an altogether undeserved importance has been attached to them. In the case of both of the wells mentioned the oil horizon lies deeper than would be expected, because of the northwesterly plunge of the syncline described above, and not because of any effect due to the dikes. The available data show that the sands would be found in both wells by increasing the depth. It is believed that the above described sandstone dikes have no influence whatever on the oil accumulation.

On the accompanying map the structure of the top sand of the Niobrara is shown by means of structure contours, *i. e.*, lines drawn on top of this sandstone through points of the same elevation. The structure contours are located with respect to sea level and are spaced 500 feet apart. Thus all the points on the top Niobrara sandstone lying directly under the 4000 foot contour line are 4000 feet above sea level. The depth of this sandstone at any point can readily be determined by finding the difference between the elevation of the surface and the elevation of the structure contour directly below.

The contact of the Pierre shale with the Mesaverde sandstones is the only horizon exposed at the surface, the position of which is definitely known. The contours were hence calculated from the position of this contact line and the exposures giving the various dip and strike observations. Well logs, where possible, were used to check up dip and strike observations as well as depths to known horizons.

No great accuracy can be claimed for these contours because of the poor exposures and the fact that the only definite horizon line, the Pierre-Mesaverde contact, is exposed only about ¼ the distance around the field. Nevertheless, while not reliable as to depth, especially in the western half of the field, the contours are believed to show with accuracy the general geological structure. This reason is considered sufficient for their presence on the map.

## DESCRIPTION OF THE OIL AND GAS HORIZON

The sandstones now yielding oil in the Pilot Butte field are those in the Pierre shale member of the Cody formation. The depth of erosion, as worked out from the dip and strike observations carried inward and checked by the well logs, is about 2400 feet. The Midwest Refining Company's well No. 2, located on the east line of the northwest quarter of Sec. 22, is the deepest well near the top of the fold and hence penetrates to the lowest horizon. The well log shows essentially blue shale down to 2150 feet, when sandy shales and sands appear. These must be Niobrara, as these are the highest sands below the upper Cretaceous shales in which the well starts. Thus for this well the depth of erosion is roughly 2200 feet. On the basis of this depth of erosion and the well logs, the oil horizon is an interbedded sandstone located approximately 1500 feet above the base of the Pierre. On Dry Creek a poorly indurated sandstone was found in the Pierre about 1450 feet above the base. This is believed to be the upper oil horizon

of Pilot Butte. The sandstone here is friable, porous, buff in color and has a few streaks of grit with grains up to ¼ inch in diameter. It is accompanied by sandy shales above and below, the total thickness of the sandy zone being forty feet while the sand proper is about 15 feet thick. This horizon is approximately the same as that of the Shannon sandstone which produces oil in the Salt Creek and Big Muddy fields.

There are other horizons which may prove to be productive. Thus 1500 feet below the above horizon is the top of the Niobrara which consists of a series of sands separated by shales. The sands are porous and physically capable of carrying gas and oil. In the Midwest Refining Company's well No. 2, the top sand of the Niobrara was struck at a depth of 2240 feet, yielding a heavy flow of artesian water. This well was struck almost half a mile to the east of the apex of the dome. Underneath the Niobrara lies the Frontier formation which, in its exposure on Sage Creek, shows at least three horizons capable of carrying oil. These three horizons would lie within 500 feet of the base of the Niobrara. Thus, not considering any sands below the top of the Mowry, there are at least seven possible oil horizons below the upper oil sand of the Pilot Butte field, including the most productive Cretaceous oil horizons of the State. In addition there is a possibility of obtaining production from deeper horizons, the Rusty Beds at the base of the Thermopolis, and the Dakota sandstones. Both of these horizons furnish gas and oil in the Big Horn Basin.

## DESCRIPTION OF WELLS

1. Midwest Refining Co. No. 1:

This well was drilled by the Standard Exploration Co. for the Midwest Refining Co. It was spudded in on May 2, 1916, and completed on May 26, 1916. The well is entirely in Pierre shale.

The following well log was furnished by Mr. J. M. Douglas of the Standard Exploration Co:

LOG OF MIDWEST REFINING CO., WELL NO. 1

| | FT. | | FT. | |
|---|---|---|---|---|
| | 1 | to | 15 | Coarse gravel |
| | 15 | to | 18 | Gray sandy shale |
| | 18 | to | 38 | Lighter shale |
| | 38 | to | 45 | Gray sandy shale |
| | 45 | to | 60 | White, purple shale |
| | 60 | to | 300 | Blue shale |
| | 300 | to | 303 | Hard shell |
| | 303 | to | 395 | Blue shale streaked with sandy shell |
| | 395 | to | 408 | Blue shale streaked with sandy shell |
| | 408 | to | 420 | Blue shale hard streaked |
| | 420 | to | 450 | Blue shale hard streaked |
| | 450 | to | 460 | Hard shell, sandy |
| | 460 | to | 480 | Blue shale |
| | 480 | to | 515 | Muddy shale |
| | 515 | to | 520 | Hard shell and water sand, dry |
| | 520 | to | 530 | Blue shale |
| | 530 | to | 545 | Hard blue shale |
| | 545 | to | 575 | Blue shale |
| | 575 | to | 1175 | Hard blue shale |
| | 1175 | to | 1245 | Soft muddy blue shale |
| Oil | 1245 | to | 1255 | Sandy, streak gray |
| Horizon | 1255 | to | 1275 | Blue shale |
| | 1303–6 | | | Blue shale (Bottom of hole) |

The sandy streak reported at 1245 feet is considered to represent the oil horizon.

2. Midwest Refining Co. No. 2:

This well was drilled by the Standard Exploration Co. for the Midwest Refining Co. The following well log was furnished by Mr. J. M. Douglas:

LOG OF MIDWEST REFINING CO., WELL NO. 2

| | FT. | | FT. | |
|---|---|---|---|---|
| | 0 | to | 30 | Gravel |
| | 30 | to | 35 | Water gravel |
| | 35 | to | 50 | Blue shale |
| | 50 | to | 57 | Blue shale |
| | 57 | to | 65 | Water streaked shale |
| | 65 | to | 100 | Muddy shale |
| | 100 | to | 355 | Blue shale |
| | 355 | to | 365 | Hard shell |
| | 365 | to | 573 | Blue shale |
| Oil horizon | 573 | to | 584 | Oil sand (would make one bbl. per day) |
| | 584 | to | 604 | Sandy shale |
| | 604 | to | 1245 | Blue shale |

| | | |
|---|---|---|
| | 1245 to 1250 | Gray sand (hard) |
| | 1250 to 1303 | Blue shale |
| | 1303 to 1310 | Slate shell |
| | 1310 to 1380 | Slaty shale |
| | 1380 to 1430 | Blue shale |
| | 1430 to 1580 | Blue shale |
| | 1580 to 2115 | Blue shale |
| | 2115 to 2130 | Blue shale |
| Base of Pierre | 2130 to 2150 | Blue shale |
| | 2150 to 2180 | Sandy shale |
| | 2180 to 2200 | Sandy shale 2150 ft. |
| Niobrara | 2200 to 2205 | Light sandy shale |
| | 2205 to 2240 | Sandy shale |
| | 2240 to 2256 | Water sand |
| | 2256 to 2266 | Water sand |
| | 2266 | Blue shale |

This is the only well that penetrates the Pierre shale completely. At 2150 it cuts into the Niobrara.

3. Hall Oil Co. No. 1:

This well is the property of the Hall Oil Co. and was drilled by the Standard Exploration Co. The well log was furnished by Mr. J. M. Douglas.

LOG OF HALL OIL CO., WELL NO. 1

| | |
|---|---|
| 0 to 6 | Gravel |
| 6 to 25 | Gravel |
| 25 to 30 | Gravel and water |
| 30 to 40 | Water sand |
| 40 to 50 | Shale |
| 50 to 75 | Shale |
| 75 to 110 | Shale |
| 110 to 175 | Gray shale |
| 175 to 260 | Light blue shale |
| 260 to 350 | Blue shale |
| 350 to 395 | Blue shale (hard shell) |
| 395 to 400 | Blue shale |
| 400 to 430 | Blue shale |
| 430 to 530 | Blue shale (sandy shale showing gas and oil) |
| 530 to 600 | Blue shale |
| 600 to 615 | Sandy shale with oil and gas. 70 feet of oil in hole |
| 615 to 620 | Sandy shale, bottom of well |

This well is entirely in Pierre shale.

4. Hall Oil Co. No. 2:

Drilled by the Standard Exploration Co. Well was

spudded in July 26, 1916. Completed August 10, 1916. Log furnished by Mr. J. M. Douglas.

LOG HALL OIL CO. WELL NO. 2

| | | |
|---|---|---|
| 0 | 20 | Gravel |
| 20 | 30 | Gravel |
| 30 | 45 | Shale |
| 45 | 68 | Shale |
| 68 | 72 | Sand carrying water |
| 72 | 95 | Shale |
| 95 | 108 | Sand and shale |
| 108 | 140 | Shale |
| 140 | 175 | |
| 175 | 224 | Blue shale |
| 224 | 236 | Dark shale (very hard) |
| 236 | 268 | Dark shale |
| 268 | 305 | Dark shale |
| 305 | 400 | Blue shale |
| 400 | 410 | Dark shale (very hard) |
| 410 | 440 | Dark shale (soft) |
| 440 | 495 | Dark shale |
| 495 | 500 | Blue shale |
| 500 | 520 | Dark shale |
| 520 | 725 | Blue shale (showing oil at 610. Slight increase at 680 ft. and 720 ft.) |
| 725 | 750 | Blue shale. (gas showing at 725 ft. Increase of oil from 740 ft. to 750 ft. Hole filled with oil 110 ft.) |
| 750 | 788 | Sandy shale (bottom of hole) |

This well is entirely in Pierre shale.

5. Hall Oil Co., Well No. 3:

This well was drilled by the Standard Exploration Co. Spudded in August 19, 1916. Completed Sept. 6, 1916. The well log was furnished by Mr. J. M. Douglas.

LOG HALL OIL CO. WELL NO. 3

| | | |
|---|---|---|
| 0 | 22 | Gravel |
| 22 | 32 | Water sand |
| 32 | 41 | Shale |
| 41 | 290 | Blue shale |
| 290 | 308 | Dark hard shale |
| 308 | 335 | Blue shale |
| 335 | 435 | Dark hard shale |
| 435 | 570 | Blue shale |
| 570 | 685 | Sandy shale (Muddy and sticky. Light showing of oil at 685 ft.) |
| 685 | 705 | Blue shale (very muddy) |

| | | |
|---|---|---|
| 705 | to 760 | Blue shale (cavy and thick) |
| 760 | to 770 | Dark shale |
| 770 | to 815 | Dark shale (Increase of oil 790 ft.) |
| 815 | to 865 | Sandy shale |
| 865 | to 875 | Blue shale (sticky) |
| 875 | to 1015 | Sandy shale |
| 1015 | to 1028 | Slate |
| 1028 | to 1040 | Gray sand (oil from 1028. Well filled 380 ft.) |
| 1040 | to 1067 | Shale (bottom of hole) |

This well is entirely in Pierre shale.

6. Smith Well No. 1:

Owned by the Hall Oil Co. The following partial log was furnished by Mr. Ralph Schaefer, Engineer for the Hall Oil Co:

LOG SMITH WELL NO. 1

| | | |
|---|---|---|
| 0 | to 903 | Shale |
| 903 | to 908 | Sand |
| 908 | to 1120 | Shale |
| 1120 | to 1150 | Sandy shale |
| 1150 | to 1272 | Shale |
| 1272 | to 1298 | Sand |
| 1298 | to 1335 | Shale |
| 1335 | to 1342 | Hard sand and oil colors |
| 1342 | to 1360 | Sandy shale |
| 1360 | to 1531 | Shale |
| 1531 | to 1560 | Sandy shale, bottom of well |

7. Well No. 1. Apex Claim No. 3:

Owned by the Hall Oil Co. The following log was kindly furnished by Mr. Ralph Schaefer:

| | | |
|---|---|---|
| 0 | to 28 | Sand and gravel |
| 28 | to 90 | Blue clay |
| 90 | to 740 | Shale |
| 740 | to 742 | Sandy shell |
| 742 | to 850 | Sandy shale |
| 850 | to 875 | Sand—oil |
| 875 | to 1175 | Shale |
| 1175 | to 1200 | Sand |
| 1200 | to 1330 | Shale |
| 1330 | to 1350 | Sandy shale |
| 1350 | to 1610 | Shale |

8. Well No. 1. Claim No. 5:

Property of the Hall Oil Co. Log was furnished by Mr. Ralph Schaefer:

LOG WELL NO. 1, CLAIM NO. 5

| | | |
|---|---|---|
| 0 | to 34 | Gravel |
| 34 | to 65 | Brown sandy shale |
| 65 | to 860 | Shale |
| 860 | to 865 | Shell (showing oil and gas) |
| 865 | to 1240 | Shale |
| 1240 | to 1245 | Shell |
| 1245 | to 1408 | Shale |
| 1408 | to 1420 | Hard sand |
| 1420 | to 1590 | Shale |
| 1590 | to 1630 | Sand and sandy shale |
| 1630 | to 1635 | Slate shell |
| 1635 | to 1870 | Shale and sandy shell on top |
| 1870 | to 2390 | Shale bottom of hole |

9. Norris Well No. 1:

Property of Hall Oil Co. Partial well log furnished by Mr. Ralph Schaefer:

LOG NORRIS WELL NO. 1

| | | |
|---|---|---|
| 0 | to 30 | Gravel |
| 30 | to 600 | Shale (here showing gas and oil in sand) |
| 600 | to 790 | Shale |
| 790 | to 815 | Sand and little oil |
| 815 | to 980 | Shale |
| 980 | to 1010 | Oil sand |
| 1010 | to 1078 | Shale (bottom of well) |

10. Hurst & Valentine No. 1:

This well is the property of Hurst & Valentine. No well log is available, but the following information was given by Mr. Ralph Schaefer:

| | FT. |
|---|---|
| Total depth of well | 1000 |
| Showing gas at | 600 |
| Showing of oil at | 833 |
| Showing of oil at | 950 |

11. Valentine Well No. 1:

Property of the Valentine Oil Co. No well log is available. The following information was given by Mr. Ralph Schaefer:

| | |
|---|---|
| Showing of oil | 830 |
| Total depth slightly over | 900 |

12. Midwest Oil Co. Well No. 1:

No information regarding this well is available except that the total depth is said to be 2050 feet.

13. Casper Development Co. Well No. 1:

No information regarding this well is available except that the total depth is 1760 feet.

14. Hurst Co. Well No. 1:

Property of the Hurst Oil Co. No well log is available. The total depth of the well is 2300 feet.

15. Midwest Refining Co. Well No. 2:

Well being drilled at time of visit.

16. Pilot Butte Oil Co. Well No. 1:

LOG OF PILOT BUTTE OIL CO. WELL NO. 1

| | | |
|---|---|---|
| 0 to | 60 | Surface drift |
| 60 to | 65 | Hardpan |
| 65 to | 618 | Shale |
| 618 to | 750 | Sandy shale |
| 750 to | 870 | Shale |
| 870 to | 934 | Sandy shale |
| 934 to | 944 | Sand (oil) |
| 944 to | 1190 | Sandy shale |
| 1190 to | 1359 | Shale |
| 1359 to | 1369 | Shale and lime-shells |
| 1369 to | 1590 | Shale |

17. Ohio Oil Co. Well No. 1:

Under litigation. No information available.

18 and 19. Wells being drilled. Property of Hall Oil Co. and Norbeck & Nicholson.

20. Susanna Enos Well No. 3:

LOG SUSANNA ENOS WELL NO. 3

| | | |
|---|---|---|
| 0 to | 20 | Gravel |
| 20 to | 29 | Water sand |
| 29 to | 66 | Blue shale |
| 66 to | 88 | Sandy shale |



| | | |
|---|---|---|
| 88 to | 160 | Blue shale. (120 ft. 10-in. casing) |
| 160 to | 250 | Sandy shale |
| 250 to | 605 | Blue shale |
| 605 to | 705 | Sandy shale. (First oil 605 ft., increase at 675 ft.) |
| 705 to | 890 | Slate and shells |
| 890 to | 1190 | Sandy shale |
| 1190 to | 1200 | Blue shale |

Total depth of well 1200 feet, cased to 596 feet with 8¼ inch casing.

21. Well No. 1, Dora Enos Lease:

LOG DORA ENOS WELL NO. 1

| | | |
|---|---|---|
| 680 to | 690 | Sand—some gas |
| 690 to | 915 | Shale |
| 915 to | 930 | Oil sand |
| 930 to | 1220 | Shale |
| 1220 to | 1325 | Shale, sand and limestone intermittent |
| 1325 to | 1330 | Oil sand |
| 1330 to | 1495 | Shale |

## DESCRIPTION OF THE OIL

The oil is a high grade paraffin base oil similar to the Cretaceous oils found elsewhere in the State. With the present methods of refining as practised in Wyoming practically all of the oil, with the exception of a fraction of a per cent. of coke, can be converted into gasoline, kerosene and motor spirits. The oil contains no sulphur and no asphalt.

The following is a report of the State Chemist, Ross B. Moudy, on distillation tests on a sample of oil from well No. 1 of the Hall Oil Co.

Gravity of oil 30° Be.
Contains 19% gasoline of 59.3 Be.
Distillation tests on the gasoline fraction as follows:

| | FT. |
|---|---|
| Start | 115° F. |
| 10% | 175° F. |
| 20% | 194° F. |
| 30% | 207° F. |
| 40% | 219° F. |
| 50% | 232° F. |
| 60% | 245° F. |
| 70% | 262° F. |
| 80% | 290° F. |
| 90% | 330° F. |
| 94.5% | 350° F. |

## PRODUCTION

So far there has been no production except from Well No. 1 of the Hall Oil Company. The crude oil has been used as fuel in the exploratory work so far carried on in the district. That a fair production of oil is to be expected from the upper horizon is indicated by the rise of the oil in the wells, being from 70 to 400 feet, according to the officials of the Hall Oil Co., and the capacity of the wells now drilled is estimated to total 2000 barrels per day.

## FUTURE DEVELOPMENT

The possibilities of future development in this district are good. So far the wells have prospected only a horizon considerably above the base of the Pierre shale. Very promising, and in other parts of the State heavily productive, horizons lie below the top of the Niobrara. As has been shown there are at least seven promising sands between the base of the Pierre and the top of the Mowry, and these lie within 3500 feet of the surface at the center of the dome. Until these have been prospected the chances of future production from the lower sands must be considered good.

As this goes to press, word comes that arrangements have been completed for the drilling of a deep test well and for the building of a pipe line from the field to the railroad.

The State of Wyoming
Office of State Geologist
Cheyenne

L. W. TRUMBULL. STATE GEOLOGIST.

# PILOT BUTTE OIL FIELD.

BY
VICTOR ZUGLER.
1916

SCALE: 1" = 2000'

• — WELLS, FIGURES—ELEVATIONS
Twr — WIND RIVER FORMATION.
Kmv — MESAVERDE SANDSTONE.
Kc — GODY SHALE.
STRUCTURE CONTOURS ON TOP OF NIOBRARA SANDSTONE, SHOWING ELEVATION ABOVE SEA LEVEL.

T. 4 N.

T. 3 N.

R. 1 W. W.R.M.

U.S. PETROLEUM RESERVE

GRAVEL DESERT

GRAVEL

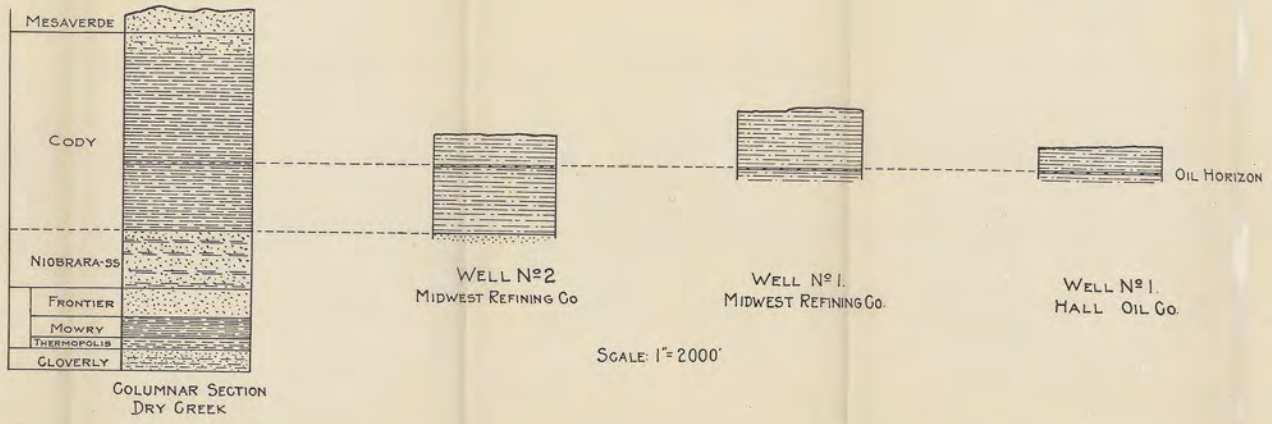
TERRACE

BIG WIND U. S. PETROLEUM

RESERVE RIVER

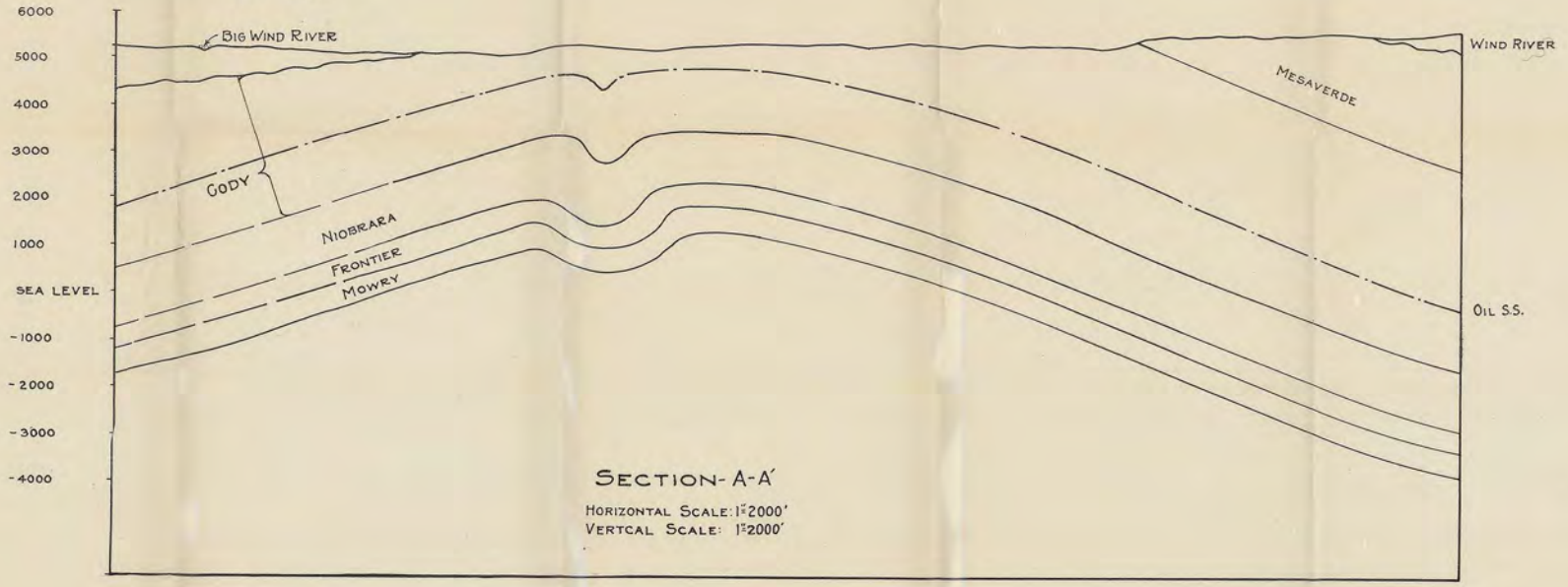
A — A'

B — B'



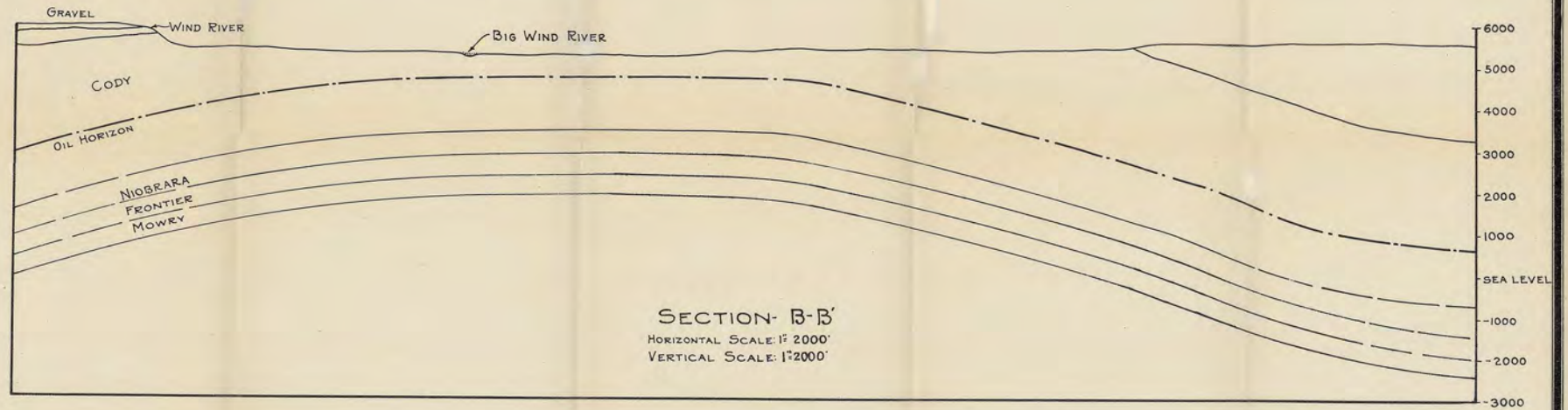

COLUMNAR SECTION
DRY GREEK

SCALE: 1"= 2000'




SECTION- A-A'

HORIZONTAL SCALE: 1"=2000'
VERTCAL SCALE: 1"=2000'




SECTION- B-B'

HORIZONTAL SCALE: 1"= 2000'
VERTICAL SCALE: 1"=2000'