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The Byron Oil and Gas Field
Big Horn County

By VICTOR ZIEGLER

L. W. TRUMBULL, STATE GEOLOGIST
CHEYENNE, WYOMING

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The Byron Oil and Gas Field

INTRODUCTION

The Byron field is one of the oldest oil producers of the Big Horn Basin, having supplied a small refinery at Cowley for almost ten years. The production, however, has been small and has been obtained from shallow wells. Recently gas wells of exceptionally large capacity have been brought in from deep sands. This fact has called attention to the possibility that other oil horizons capable of commercial exploitation may be present.

Previous Work

The general geology of the Big Horn Basin has been discussed in some detail by Fisher.* No reference is made to the Byron field except that attention is called to the fact that natural gas was escaping in considerable quantity from alluvial sands near Byron and that attempts were then (1906) being made at development. Washburne† discussed briefly several of the promising anticlinal structures of the Bighorn Basin and among them gives a brief description of part of the area under discussion, as follows:

> "One of the sharpest and most pronounced anticlines of the region is known as the Garland anticline. This fold is about 7 miles long, extending from Polecat Creek, near the crossing of the Cody branch of the Chicago, Burlington and Quincy Railroad, to Shoshone River, one mile above Byron, Wyo. Three wells have been drilled in this anticline about 2 miles west of Byron for the purpose of obtaining oil, but the boring did not penetrate to the base of the Colorado. The

*U. S. Geol. Survey, P. P. 53, 1906.
†U. S. Geol. Survey, Bull. 340, pp. 348-363, 1907.

wells were drilled by the Montana and Wyoming Oil Company, of Billings, Mont. The depth of the wells is about 900 feet. The well first drilled furnished sufficient gas to run the engine during the drilling of the second and third wells. Moreover, gas has been observed by Fisher escaping from alluvial sands overlying this anticline. The wells do not reach the horizon of the beds that yield the gas near Greybull, and it is not known whether or not the anticline contains commercial quantities of gas.

The Greybull gas horizon at the base of the Colorado would be found at a depth of about 1,500 feet beneath the highest point of the axis of the Garland anticline. Gas might occur in commercial quantities at a higher horizon if sandstone were encountered of sufficient thickness to serve as a reservoir. This may be inferred from the occurrence of gas in the wells near Byron at various horizons in the lower part of the Colorado shale. A satisfactory test of the gas field can be made only by drilling entirely through the Colorado into the underlying sandstone.

The three wells mentioned above, which were drilled about 100 yards apart, have all furnished small quantities of oil. Accurate logs of the wells could not be obtained from the officers of the company, and hence the oil horizon cannot be located closely. Descriptions furnished by the drillers, however, leave no doubt that the oil is obtained from a thin sandstone, not over 3 feet thick, in the upper part of the black basal Colorado shales. This 'oil sand' is overlain by 3 or 4 inches of fine-grained limestone. So far as the writer knows, this is the only limestone ever found in the Colorado formation in the Bighorn basin. If the limestone outcrops at the surface, it has never been observed. * * * *

The quantity of oil that could be obtained from these wells is not known to the writer. They are kept tightly closed, and no tanks or other means of storing the oil have been prepared. Until the wells are opened and their flow is measured for a period of

several days, their capacity must remain unknown. In the absence of such tests the general inference is that these wells have not yielded oil in commercial quantities."

Field Work

The writer spent the month of July, 1916, at Byron, in charge of a party consisting of Mr. R. W. Gibson, as instrument man, and Messrs. Max T. Hofius, Albert K. Chan and Walter Storrie as field assistants.

The land map of the area made by the Nowell-Atherly Engineering Company of Basin, Wyo., was used as a base map. Elevations were carried in by differential levelling from a U. S. Geological Survey bench mark at Garland. Wells, outcrops, contacts of formations, lithological units, etc., were located by means of stadia traverses tied to land corners. All traverses were tied to points of known elevations, hence the altitudes of all stations were determined. Profiles were run as indicated on the map with frequent dip and strike observations from which the structure sections were drawn.

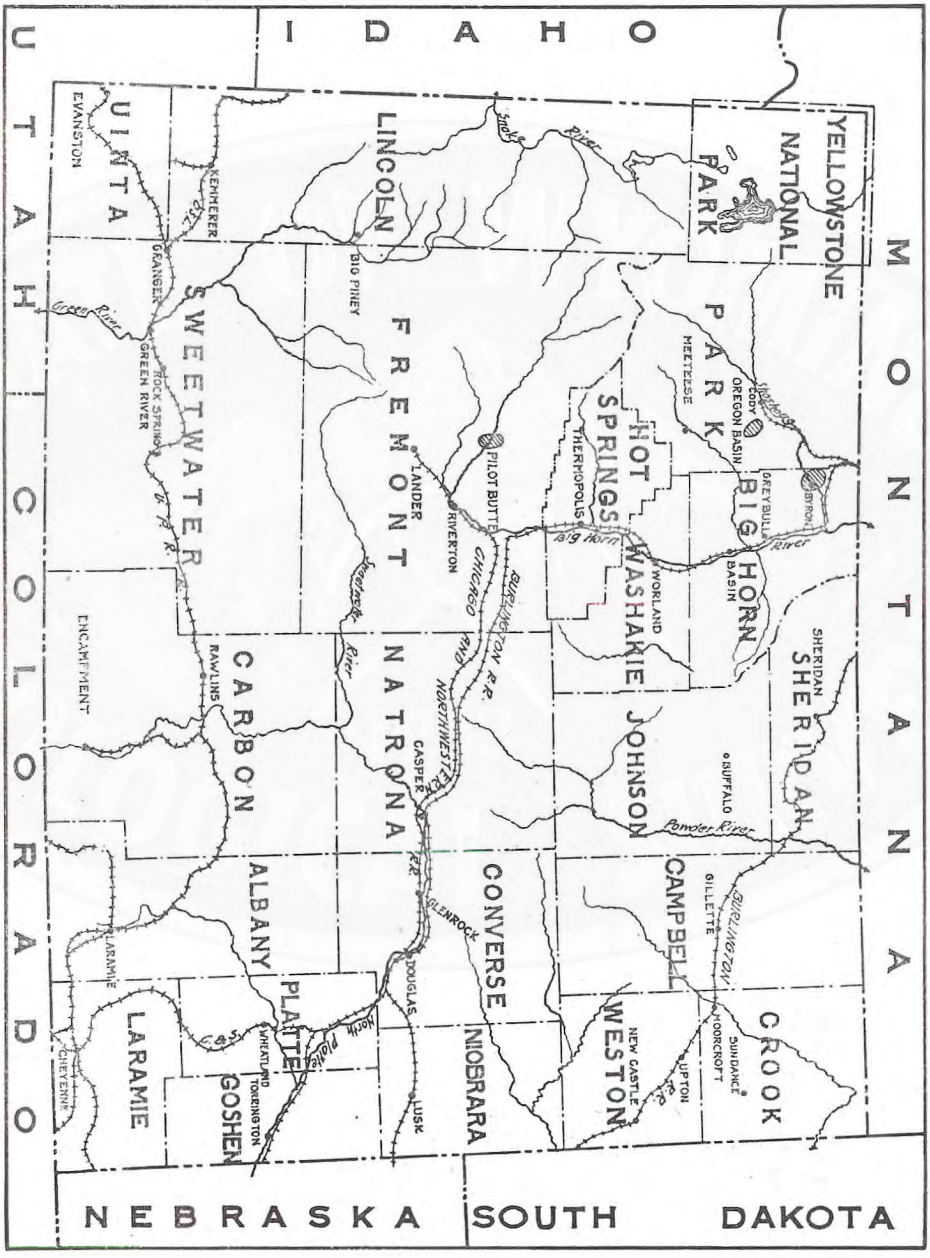
Acknowledgments

My thanks are due to the Nowell-Atherly Co. of Basin, Wyo., for kind permission to use their land map of the Byron field. To Mr. F. A. Senff thanks are due for much information while in the field. Mr. L. B. Hancock of the Pure Oil Company, and the Ohio Oil Company have furnished well logs. My thanks are due to the State Geologist, L. W. Trumbull, for valuable advice given in the preparation of this report.

LOCATION OF THE FIELD

The Byron field is located in the north central part of Big Horn County near the Park County line in the northern end of the Bighorn Basin. The Bighorn branch of the Burlington Railroad passes to the east and north of the field, the two nearest stations being Lovell, seven miles east, and Cowley, five miles north. Garland, nine miles northwest, is on the Cody branch of the Burlington. Fair

wagon roads connect the field with these points. The accompanying sketch map shows the general location.



GEOLOGY

Topography and Physiography

The great structural valley lying between the anticlinal uplifts of the Bighorn Mountains to the east, the Park Ranges to the west and the Owl Creek Range to the south is known as the Bighorn Basin. This is in general a flat, broad structural valley broken by numerous ridges and elevations of dissected anticlines, among the most prominent of which are Big Sheep Mountain and Little Sheep Mountain.

The Byron field is located in the northern part of the Basin on both sides of the Shoshone river. It has a general north and south length of about 8 miles and a width of from 2 to 4½ miles. The field is completely surrounded by a high ridge of the Gebo sandstones, except in the extreme southern part where these ridges are cut by the transverse valley of the Shoshone.

The "rim rock" is in most places a compound ridge showing two or three parallel crests formed by benches of massive sandstones. On the east side of the field these sandstones are repeated as a result of a minor uplift on the side of the main fold, and swing in a semi-circular curve about two miles north of the Shoshone river.

Stratigraphy

In the Byron field only Cretaceous formations are exposed, practically all being of the Montana series. Wells have, however, penetrated all the remainder of the Cretaceous system, as well as the underlying Comanchean. Therefore these formations are also summarized in the appended table.

There is also included a table showing the subdivisions of the Cretaceous and younger rocks of the Central part of the Bighorn Basin as recognized in the literature so far published on this subject. This is essentially the table given by Lupton* with a number of additions.

*Bull. 621, U. S. Geol. Survey p. 166.

Table of Formations

System	Series		Formation	Thickness	Characteristics
Cretaceous	Montana		Meeteetse	1200+	Alternating brown carbonaceous shales, gray sandy shales, and buff sandstones. Seams of sub-bituminous coal.
			Gebo	800-1200	Massive light brown sandstones, with sandy shale and a few coal seams. Forms high hogbacks. Rimrock of Byron and Garland domes.
	Colorado	Niobrara	Cody	3500-4000	Soft black shale near base, with clay concretions, buff sandy shales increasingly sandy near top. Fossiliferous near base and middle. Wide strike valley.
		Benton	Frontier	600-630	Massive poorly cemented sandstones, gray to buff in color, interbedded with gray shales. Bentonite seams. Minor hogback.
			Mowry	200	Hard gray sandy shales with good cleavage. Abundant fish scales. Prominent steep hogback.
			Thermopolis	800-900	Black shales weathering to spongy grayish black clay, with an interbedded gray sand. Alternating, thin, rusty brown sandstones and black shales with phosphatic concretions near base. Valley.
			— Disconformity —		
Comanchean			Cloverly	100-250	Massive gray cross-bedded sandstones and sandy shale. Usually a prominent hogback with pine trees.
			Morrison	420	Friable white to gray sandstone, locally indurated. Green, brown, maroon and white clays. Saurian remains.

COMANCHEAN SYSTEM

Morrison.

This is essentially a group of poorly cemented sandstones and bright variegated terrestrial clays, which rests directly upon marine sandstones of Jurassic Age (Sundance). Locally the Morrison sandstones are sufficiently indurated to form high hogbacks. These are never of any great length, usually not more than 200 to 300 yards. Maroon, yellow, white, brown, green and purple are the common colors of the clays.

In drawing the upper contact the usage of Hewett* is followed and the highest maroon clay is considered the top of the Morrison. Darton has drawn the line at a conglomerate horizon below some of these variegated clays, thus including part of the latter in the Cloverly. Hintze† also includes some of the variegated clays in the Cloverly. Since there seems to be no good reason for locating the division line in this way and since climatic and physical conditions have apparently been constant during the entire time of the deposition of these clays, the writer feels it more logical to include all variegated clays in the Morrison. The presence of saurian bones, of gastroliths, and of variegated clays are the dominant characteristics. The total thickness of the Morrison west of Little Sheep Mountain is 420 feet.

Cloverly.

Overlying the variegated, brightly colored clays of the Morrison formation lie a series of sandstones and sandy shales of a gray to buff color. Usually two rather massive sandstone members are present, the lower being by far the thicker, between which occur gray to pale buff shales and thin argillaceous, ripple-marked sandstones. The sandstones are cross bedded, fine grained, and spotted and streaked with rust. Conglomeritic streaks occur, characterized by small black chert pebbles.

The Cloverly varies decidedly in thickness. The

*Bull. 541-c, U. S. Geol. Sur., 1912. †Op. cit.

maximum thickness, measured about six miles southeast of Byron, is 252 feet. In several localities on the west side of Little Sheep Mountain the upper sandstone is missing, while elsewhere the overlying Benton shales rest directly upon the variegated clays of the Morrison.* This disconformity at the base of the Benton is explained as the result of erosion previous to the deposition of the overlying Benton.

CRETACEOUS SYSTEM

Benton Formations.

The Benton is represented by from 1600 to 1700 feet of shales with minor sandstones. On lithological grounds they are readily subdivided, and three members are recognized, the Thermopolis shale, Mowry shale, and Frontier sandstones.

The term Mowry (originally spelled Mowrie), was first used by Darton for shales of Benton age†. The type locality is Mowrie Creek, northwest of Buffalo, on the east side of the Bighorn Mountains. This shale is characterized by an abundance of fish scales, exceptional fissility, and unusual hardness.

Lupton‡ applied the term Thermopolis to all shales of Benton age that lie between the Cloverly and the Mowry fish scale beds. Thermopolis, Hot Springs County, is the type locality.

Hintze** does not differentiate these shales but includes both under the term "lower Benton shales". Hewett†† also includes both shales in one group as the "lower member" of his Colorado shale.

W. C. Knight in his descriptions of the coal-bearing sandstones of Colorado age in southwestern Wyoming, included these under the term Frontier. The type locality is Frontier, on the Oregon Short Line in Lincoln County. These sandstones were subsequently traced into south central Wyoming by Veatch and Ball. Lupton,‡ assuming the correlation of the Colorado sands of the Bighorn Basin

*See also Hintze, Bull. 10, State Geol. Survey, Wyoming, p. 15, 1914. (Also, op. cit. p. 14, at † on previous page)
†U. S. Geol. Sur. P. P. 32 p. 52.
**Op. cit. pp. 21-23.
‡Op. cit. p. 168.
††Op. cit. p. 51.

with the former, also used the term Frontier. It is used in this report for the group of sandstones above the Mowry shale and below the massive black clay shales of upper Colorado age. Thus it includes the Peay sandstone, Upper Benton shale, and Torchlight sandstones of Hintze*, and the "middle member" of the Colorado shale as used by Hewett in his description of the Shoshone river section near Cody.†

Thermopolis Shale.

At the base occurs a succession of dark shales and thin-bedded, argillaceous sandstones, which are ripple-marked and which weather to a rusty color. This basal portion is essentially shales, but with about one-third of the total thickness consisting of sandstones in layers averaging less than one foot each in thickness. The outcrops have a rusty brown color, because of which the term "Rusty Beds" is commonly applied to them. Near Little Sheep Mountain these "Rusty Beds" are 216 feet thick. Near their base everywhere in the Bighorn Basin, as well as to the south, in the Lander fields, occurs a very persistent horizon of small phosphatic concretions with radiating structure, spherical in shape, and varying from one to one and one-half inches in diameter. Their very wide distribution at the same horizon is a puzzling feature. The "Rusty Beds" usually rest with apparent conformity upon the top sandstone of the Cloverly, as shown by a well exposed contact west of Little Sheep Mountain, where the massive upper Cloverly sandstone with a ripple-marked surface is followed directly by black shale. About one-half mile north, and also south of the above exposure, the massive ripple-marked sandstone is absent and the black shale rests directly on the shaly sandstones near the middle of the Cloverly. These exposures establish the presence of a disconformity at the base of the Benton, a possibility suggested by Hintze†. South of Cody, near Oregon Basin, a similar relationship was found and at one locality, west of Sage Creek, these interbedded shales and rusty sandstones

*Bull. 10, State Geol. Survey, Wyoming, p. 21-23, 1914. †Op. cit. p. 20.

rest directly upon the maroon clays of the Morrison. Washburne* and also Hintze consider these beds the basal members of the marine Cretaceous, a conclusion fully borne out by the above exposures.

Above the "Rusty Beds" occur a succession of black shales, adobe-like in character, which weather to a spongy black clay. Near the center occur two poorly cemented, white to gray sands, so friable as to leave no exposure except a light gray sandy streak contrasting decidedly with the enclosing black clays. Near the top the shales become increasingly sandy and harder, but lack the perfect lamination of the Mowry. These beds are 641 feet thick on the west side of Little Sheep Mountain.

Mowry.

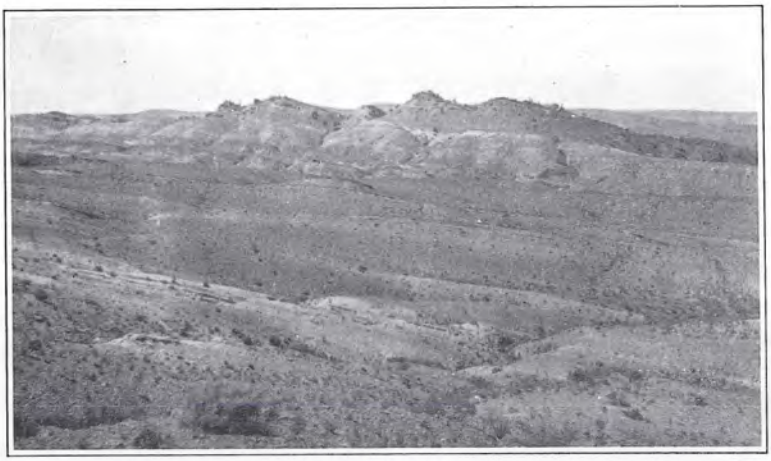
The Mowry consists of hard dark shale, somewhat sandy, which weathers to a very light gray color. The shales have exceptionally perfect lamination and split into very thin sheets. Fish scales occur in them in such abundance that hardly a piece may be broken without showing a number of them. Due to superior hardness, the Mowry forms a prominent ridge with very steep slopes, usually bare of vegetation, and because of its streaked light gray color, recognizable at a distance of several miles. The whole formation is quite uniform, although a few layers tend to be more sandy and lack the good cleavage referred to. The total thickness on the northern end of Little Sheep Mountain is 203 feet.

Frontier.

Above the Mowry shale there are 600 to 628 feet of sandstones and shales, with a few thin bentonite seams, and rare conglomerate streaks. This formation is not exposed on the Byron field, the nearest exposure being on the flanks of Little Sheep Mountain, about six miles to the southeast. The basal 100 to 125 feet is soft dark colored sandy shale. This is succeeded by several benches of massive, buff-colored sandstones from 18 to 50 feet in thickness. These

*Bull. 340-f, U. S. G. S., p. 350.

PLATE I.



A.—Cloverly Hogback. Locally developed, due to presence of massive sandstones. West of Little Sheep Mountain. Byron.

B.—Black Shale Member (Niobrara) of Cody Formation.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in turn are followed by a succession of sandstones and sandy shales with several massive benches near the top.

The sandstones are a light gray to buff color. They are massive, uniform in texture and indistinctly cross-bedded. They are poorly cemented and hence readily eroded. Outcrops occur on the dip side of the high, prominent Mowry hogbacks, where this formation forms a minor crest about half way down the hogback slope.

The Frontier sandstones are of especial interest because they include the most important Cretaceous oil horizons of the State.

CODY FORMATION

Between the top sandstones of the Frontier formation and below the massive sandstones of the overlying Mesaverde, occur a thick series of black clay shales and buff sandy shales which are usually very poorly exposed. These shales give rise to a wide strike valley between the Mowry-Frontier hogback on one side and the Gebo hogback on the other. Occasionally small ridges following the valley longitudinally are due to thin interbedded sandstones. These are more abundant near the top. The formation includes shales of Niobrara and Pierre age, but these are not clearly separable in this field, hence are mapped as a unit under the name Cody shale as suggested by Lupton.* The Cody as named by Lupton† includes the thick series of shaly rocks above the Colorado sandstones and below the coal bearing sandstones of upper Cretaceous age. The type locality is Cody, Park County, in the northwestern part of the Bighorn Basin. There Hewett‡ measured and described the Cretaceous rocks in great detail, but included all formations above the Cloverly and below the prominent coal-bearing sandstones under the name Colorado shale. This has then the same significance as the term Mancos in southwestern Wyoming.** The Colorado shale, however, he divided into an upper, middle and lower member. The

*Bull. 621-L, U. S. G. S., 1915, p. 171.
†Op. cit. p. 171.
‡Op. cit. p. 52.
**See Woodruff, Bull. 452, U. S. Geol. Sur.

"upper member" corresponds to the Cody shale. At the town of Cody it is 2150 feet thick according to Hewett; at Basin, 3360 feet according to Lupton. They are the equivalent of the Basin and Pierre shale of Hintze.* The total thickness of this series is 3656 feet, 26 miles south of Byron, on the west side of Sheep Mountain; six miles southeast of Byron it is 3581 feet. Another measurement at an intermediate locality, which, however, due to variability in dips is not as reliable, indicates a thickness of about 4000 feet. At the base is an alternation of black shales and thin, argillaceous, rusty sandstones. These make a total of about 400 feet. The next 1000 feet is dominantly dark greenish blue to black argillaceous shale, much of which has an excellent cleavage. In this shale are several fossiliferous horizons, from which the following fossils were collected:

Scaphites (?)
Baculites gracilis
Gyroides (?)
Fusus (?)
Inoceramus deformis

These fossils prove this shale member to be the equivalent of Hintze's Basin shale which he considers of Niobrara Age.†

Above this member the shales become brown in color and increasingly sandy near the top. There are a few thin seams of bentonite. The upper 400 feet are very sandy and carry several fairly pure sandstones, one or two of which form occasional minor ridges. There are several horizons characterized by abundant fossils. One horizon about 1700 feet below the top and characterized by the presence of many spherical clay concretions and septaria afforded the following forms:

Baculites ovatus (?)
Ostrea soleniscus
Ostrea cf. haydeni
Inoceramus cf. nebrascensis
Scaphites (?)
Unio cf. vetustus
Corbicula cf. durkei

These forms appear to be of Pierre age. Layers of

*Op. cit. †Bull. 10, Wyo. State Geol. Survey, p. 24, 1914.

fibrous aragonite are common, also layers of cone in cone. One such layer forms a well-defined low ridge practically around the entire Garland dome.

The following detailed section was measured near the northwestern end of the Little Sheep Mountain anticline.

	Massive sandstone—base of Gebo		
	Sandy buff shales and flaggy sandstones	115.4	
7.	Rusty sandstone	3.0	(?)
	Sandy shales	246.0	
6.	Thin rusty sandstones	5.0	(?)
	Alternating sandy shales and dark shales	369.3	
5.	Sandstone	5.0	(?)
	Sandy shales	451.6	
4.	Sandstone	10.0	+(?)
	Sandy shales	277.1	
3.	Sandstone	15.0	
	Dark colored shales	69.2	
2.	Sandstones, very friable. Yields a broad very sandy zone	50.0	± (?)
	Blue black clay shale partly masked	573.0	
1.	Rusty thin sandstone	3.0	
	Blue-black clay shales, much with good paper-like cleavage; partly masked	1063.9	
	Alternating black shales and thin bedded, rusty spotted and ripple marked sandstones	324.4	
	Massive sandstone—top Frontier		
	TOTAL	3580.9	

The total in the above section is correct. The thicknesses given in the case of sandstones marked (?) are only approximations based on width of the residual sand on the surface, the float fragments, and the height and width of the low strike ridges which each formed. The shales on the whole are masked by heavy soil, and from this the character of the underlying shale was inferred.

This section was measured by three independent pacings made by different men. These were averaged and corrected for differences in elevation as determined by aneroid barometer. A section measured about 20 miles north of this locality by means of a stadia traverse gave a thickness of 3656 feet for the Cody. Here, however, practically all of the Cody is so masked as to give no opportunity for the determination of detail.

There is no sharp break at the top, but instead a perfect lithological transition into the massive sandstones of the Mesaverde. For convenience, the division is placed below

the lowest massive sandstone bench, which is hence considered basal Mesaverde.

MESAVERDE FORMATION

The coal-bearing sandstones of Montana age above the thick Cretaceous shales, were included by Fisher* under "Laramie and associated formations". Washburne† divides these into Laramie and Montana, and believes that of the latter the Eagle, Clagget, Judith River and Bear Paw are represented. Hewett‡ recognizes a threefold division of these rocks near Cody into Gebo, Meeteetse and Ilo, of which the first two only are considered of undoubted Cretaceous age. Lupton** includes the Gebo and Meeteetse under the term Mesaverde formation. Since these sandstones have the same stratigraphic position as the Mesaverde formation as traced from Colorado and Utah into Central Wyoming††, this usage is the one followed by the writer.

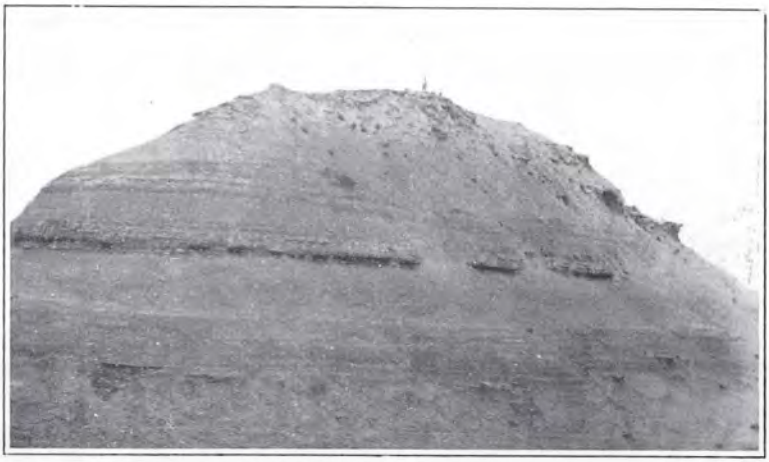
In the Byron district a two-fold division of the Mesaverde is possible, the lower member being essentially a succession of massive sandstones, the upper member a succession of shaly sandstones and shales. These are referred to the Gebo and Meeteetse respectively, following the usage of Hewett.‡‡

Gebo (Lower member of Mesaverde).

This consists of a series of massive heavy bedded, buff-colored sandstones, more or less indurated and usually forming from three to five prominent benches up to 60 feet in height, though occasionally they are so poorly cemented that they give no outcrop. Their crossbedding is usually indistinct, weathering in slabby outcrops, and dipping about four degrees to the plane of stratification. Probably two-thirds of the whole formation is made up of

*P. P. 53, U. S. Geol. Sur.
†Bull. 341, U. S. Geol. Sur.
‡Bull. 541, U. S. Geol. Sur.
**Bull. 621, U. S. Geol. Sur.
††Woodruff, Bull. 452, U. S. Geol. Sur.
‡‡Bull. 541-c, U. S. G. S., p. 54, 1912.

PLATE II.



A.—Court House Rock, Byron Dome.
Gebo Sandstone, with interbedded coal seam.

B.—Lake in Wind-Eroded Basin. Center of Byron Dome.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such sandstones. Locally conglomerates are developed. Thus east of Sheep Mountain a thin lenticular conglomerate, essentially made up of sandstone fragments, occurs near the base.

The sandstones are very uniform in texture, color, and quite pure, and usually weather into nodular rounded shapes much like granite, although some layers due to spotty cementation are eroded into eccentric forms with cavernous surface. Their prominent outcrops form the high escarpments, or so-called "Rim Rock", of the Garland dome.

Intercalated we find a series of very sandy, soft shales and shaly sandstones, with only occasional layers well enough cemented to give an outcrop. Black carbonaceous shales and poor coal seams up to four feet in thickness occur, but not in abundance. Concretions of sphaerosiderite occur in the more shaly layers; also occasional streaks of small dark brown limonite concretions, averaging about an inch in diameter, having polished surfaces and suggesting at first sight conglomeritic streaks. Measurements indicate a thickness of 800-1200 feet.

Meeteetse (Upper member of Mesaverde).

While not clearly divisible from the underlying Gebo, the upper part of the Mesaverde is essentially an alternation of sandy shales with few intercalated, well cemented sandstones, and many dark brown carbonaceous shales and impure coal seams. The general characteristic is the absence of well indurated massive sandstones. The color is buff to rusty, with the latter color characterizing the better indurated sandstones. This rusty color together with the abundant brown carbonaceous shales contrasting with the gray interbedded sands furnishes a rapid color alternation so characteristic of the Meeteetse, as compared to the uniformity characterizing the Gebo.

An occasional sandstone layer suggests the benches of the underlying Gebo. There are, however, no sandstone beds nearly as thick nor as closely spaced as in the Gebo. The contact of the two is taken as the top of the highest

massive sandstone bench above which we usually have a prominent strike valley due to greater softness of the basal part of the Meeteetse. The following fossils were collected about 500 feet above the base, on the south side of the Shoshone River, at the east edge of the Byron dome.

Dosiniopsis sp. (?)
Cardium speciosum
Corbula (?)
Nucula (?)

Geologic History

No attempt will be made to trace out the complete history of the Big Horn Basin. Attention will only be called to events since Comanchean Time.

Comanchean Time.

The Morrison formation was deposited in shallow lagoons and probably fresh water marshes and swamps along a low coast, with occasional periods of deposition by strong currents such as we find along the flood plains of rivers. During Cloverly time such deposition was especially common. Locally, as at Byron, conditions of deposition ceased, and more or less of the Cloverly was removed by erosion.

Cretaceous Time.

The Cretaceous period was inaugurated by an advance of the sea over the area of the Basin. Thus in the shallow water we find deposited as the basal part of the marine transgressive series the "Rusty Beds". These, therefore, lie upon the Cloverly disconformably or in other cases they rest directly upon the Morrison clays. The gradual deepening of the sea is indicated by the greater portion of the Thermopolis and the Mowry formations, both of which were deposited in quiet but comparatively shallow waters. A decided shallowing and a return to deposition in disturbed waters is indicated by the Frontier sandstones. As a matter of fact deposition was probably sufficiently rapid to raise portions of the area of the basin above sea level, and so cause the development of coastal plain swamps

and marshes which supply the conditions necessary for the interbedded carbonaceous shales and poor coals.

Another period of more rapid subsidence followed and in the comparatively shallow and quiet water so formed, the clay shales at the base of the Cody accumulated. Subsidence and accumulation of sediments kept pace at such a rate that from 3000 to 3500 feet of shallow water sediments were formed. A decided shallowing took place near the close of the Cody so that disturbed water conditions with accompanying strong currents and vigorous wave action predominate. The late Cretaceous deposits again represent, in the main, continental deposition upon an area characterized by many fresh-water swamps and ponds, in which the vegetation made a rank growth, and accumulating, produced the many coal beds of the Mesaverde formation. Fluviatile conditions are indicated by the thick interbedded sandstones.

The close of the Cretaceous was marked by great crustal disturbances resulting in the intense folding of all the sedimentaries and the formation of the various mountain ranges. This period of folding was accompanied by faulting, locally quite intense.

Tertiary and Quaternary Time.

Tertiary time was a period of vigorous erosion, and peneplanation of much of the area of the Basin resulted. Upon the plain so developed thick continental deposits not represented at Byron were laid down. Late in Tertiary or early Quaternary time the erosion of the present topography began.

Structure

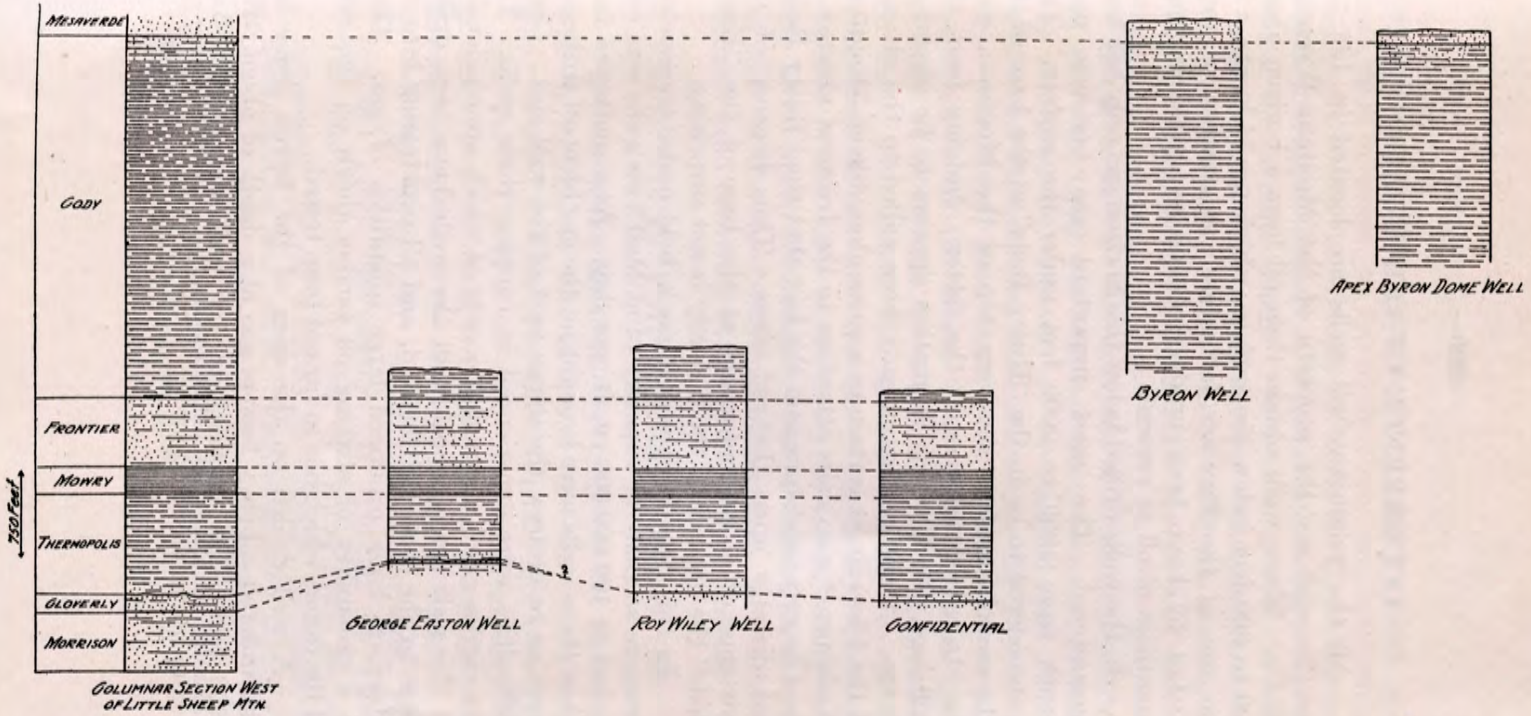
The Byron field consists of a large prominent elongated dome fold with a small low dome on its east flank. The larger dome is generally known as the Garland dome or anticline, the smaller as the Byron dome.

The outer margin of the Garland anticline is defined by the high encircling ridges of the Gebo sandstones, inside which is eroded a broad flat valley in the underlying soft

Cody shale. In the Byron dome only the upper benches of the Gebo are exposed, forming a gentle arch. This dome is not high enough, nor erosion deep enough to expose the underlying shales.

The axis of the Garland dome has a general northwest strike. The fold measuring from crest to crest of the rim rock, is eight miles long and from 1½ to 2 miles wide. The dome widens a little at the southern end, the lowest point in the shales being near the quarter corner common to sections 33 and 34, roughly two miles west of Byron. The fold is not symmetrical but shows decidedly steeper dips on the east limb. Thus the dips here measured on the sandstone rim ranged between 25° and 42° with dips between 30° and 35° the more common. On the sandstones on the west limb the dips run below 20° with 17° near the general average. Only one dip observation exceeded 20°, that was in the southern edge of the fold and only of local importance as it was surrounded by dips of about 16°. There have been no faults of any consequence except that a small slip of possibly 100 feet displacement was noticed in the rim rock at the extreme northern end of the fold.

The Byron dome is, as stated before, only a minor swell on the side of the larger Garland dome. It is also elongated, the axis being parallel to the axis of the Garland dome. As in the case of the latter, the fold is asymmetrical, the steeper dips being on the east limb. Here they average 18° while on the west limb they are lower, none running over 10°, all averaging around 7°. The steep dip on the east limb also flattens very rapidly, so that a few hundred feet on either side of the massive sandstone bench giving the 18° dips they change to flat angles of 7° to 10°. The syncline separating the two domes cannot be very deep as only the Gebo sandstones are exposed between them. For a distance of about half a mile no dip and strike determinations are possible, therefore the determination of the depth of the syncline is only approximate. It is based on the dips of the highest bench of the rim rock of the Garland dome and the highest bench exposed on the Byron dome. Based on these facts, the depth must be in the neighborhood of 500 feet.


MESAVERDE
GODY
FRONTIER
MOWRY
THERMOPOLIS
GLOVERLY
MORRISON
750 Feet
COLUMNAR SECTION WEST OF LITTLE SHEEP MTN.
GEORGE EASTON WELL
ROY WILEY WELL
CONFIDENTIAL
BYRON WELL
APEX BYRON DOME WELL

OCCURRENCE OF OIL AND GAS

All the productive oil wells are located in Lot 52, Sec. 34, and are the property of the Montana-Wyoming Oil Co. These wells obtain their oil from a horizon about 800 to 900 feet below the surface, which would locate it in the top of the Frontier formation. A number of wells in Lot 52 have been productive and are yielding small quantities of oil at present.

In the wells drilled below this horizon gas only has been encountered. The most important gas horizons were struck from 1800 to 2000 feet under the surface. This is considered to be in the "Rusty Beds" at the base of the Thermopolis and at the very top of the Morrison, with the stronger producers in the latter. Judging from the well logs, the Cloverly formation appears to be absent at Byron. Attention has already been called to the absence of the Cloverly at certain exposures along Sheep Mountain. Washburne* also calls attention to the frequent absence of the Cloverly sandstone and the fact that the "Rusty Beds" rest directly upon the red clays. Thus because of the existence of an unconformity at the base of the "Rusty Beds" the absence of the Cloverly is not surprising.

In this deep horizon the gas is held under tremendous pressure so that the capacity of at least two wells was estimated at 100,000,000 cu. ft. per day. As a matter of fact when these wells were brought in, the gas blew off with such force as to destroy the upper part of the well rigs. Great difficulties were experienced in capping these wells. The gas carries gasoline, small amounts of which are condensing at the well heads. So far all the wells have been drilled close to the center of the fold, and all penetrating into the Morrison have produced large quantities of gas. There is a possibility of striking oil farther down on the sides of the dome, which has so far not been tested.

A well drilled on the apex of the Byron dome has encountered a heavy flow of gas at a depth of about 2100-2200 feet. The capacity of the well was estimated at

*Op. cit. pp. 350-351.

6,000,000 cu. ft. This gas was derived from a sandy zone about 2000 ft. below the top of the Cody and one that has consequently been eroded from the top of the Garland dome. It is located approximately 1000 feet above the oil producing zone of the Garland dome. The relationship of the wells is indicated on the accompanying columnar sections. A second well located on the flank of the Byron dome penetrated the zone above, but neither gas nor oil was encountered.

In one locality on the west side of Little Sheep Mountain where the Cody was 3581 feet thick, seven sandy zones were indicated by outcrops or by residual soil. These were located the following distances above the base of the Cody: 1300, 1923, 2000, 2286, 2700, 3070 and 3120 feet, respectively. In the Byron field the Cody shale has a thickness of 3000 feet as determined from the various well logs. This places the horizon yielding gas in the Byron dome 950 to 1000 feet above the base of the Cody or nearly in the same position as the lowest sandy zone along Little Sheep Mountain. It is not taken for granted that this is the same lithological member, but rather a lenticular sand occurring at the same general horizon.

PRODUCTION AND DESCRIPTION OF OIL

The wells of the Montana-Wyoming Oil Co. have been producing for almost ten years, and have supplied a small refinery located at Cowley with which they are connected by pipe line. There is no data available regarding the production but the total is considered to be small. The following description of the oil is by David T. Day.*

> "The oil is light red by transmitted light, with brilliant green fluorescence. It contains no water. The odor is almost like that of Pennsylvania oil, and apparently the oil contains no sulphur, therefore, no determination was made. Specific gravity at 15° C., compared with water at 4° C., is 0.8315 * * Distillation of the sample gave the following results:

* Bull. 340-f, U. S. G. S.—Washburne, C. W.

	PER CENT
Initial boiling point 77° C.	
Naptha (specific gravity 0.722)	14
Illuminating oil (Spec. gr. 0.761)	28
Light lubricating oil	17.5
Residue suitable for cylinder oil	36
Loss	4.5

Such an oil as this would make a very satisfactory refining oil, if transportation facilities were afforded, for by properly adjusting the distillation method a larger percentage of illuminating oil could be obtained. This is shown by the low specific gravity of the distillates."

Several wells furnish the gas used in Byron and Lovell for domestic and street lighting purposes. The expectation is to use the gas also in the production of power, etc., in a new beet sugar plant just being erected at Lovell. At present the total quantity of gas so used is small.

FUTURE DEVELOPMENT

Of the three horizons that yield oil and gas at Byron only the lower offers promise of future yield. The upper horizon is eroded from the Garland dome, and in the case of the Byron dome offers only slight inducement to future drilling because of the low flexure in the fold and the limited lateral extension of the productive zone in this horizon as proved by Well No. 1 of the Central Petroleum Development Co. of Sheridan.

The second horizon (the one furnishing the oil of the Montana-Wyoming Oil Company's wells) has proven to be only a local reservoir, probably a lenticular sand. It has only furnished small amounts of oil so far, while the wells surrounding indicate that the extension of the productive area is not to be expected.

The third and lowest horizon is the one in which all the strong gas wells are located. The possibilities of striking oil in this horizon are bright for the following reasons:

1st. All the wells sent down to this horizon have carried gas under great pressure.

2nd. All the wells penetrating to this horizon are located near the apex of the fold.

3rd. The gas in every case has carried gasoline.

4th. The Garland dome, because of its decided dips and size, furnishes an ideal reservoir of large capacity.

Until a well has been sent down on the side of the fold and proved the contrary, the chances of striking oil in this horizon outside the gas area must be considered good.

The above does not apply to the Byron dome. In this case conditions are not so favorable. The dome is arched only slightly and the amount of flexure decreases with depth so that the reservoir would be very limited areally. There is a slight possibility of oil production from the middle horizon. This would be approximately 3100 feet below the surface at the center of the dome. The lower and most promising horizon is about 5000 feet below the apex and due to the decrease in flexure with descent, probably does not afford a reservoir. The writer considers the chances for striking oil most promising along the sides of the Garland dome and would consider drilling on the Byron dome inadvisable unless the presence of oil in quantity in the former dome were demonstrated.

DESCRIPTION OF WELLS

Wells of the Montana-Wyoming Oil Company.

Wells numbered 1 to 13 except No. 8. Numbers those used on map.

These include the only wells producing oil in this district. All are located near the center of the Garland dome. No information regarding these wells could be obtained except that the oil horizon is a thin sandstone from 800 to 900 feet under the surface. Based on the depth of erosion in the Garland dome and the logs of adjacent wells this horizon is placed in the top of the Frontier and is probably one of the thin sandstones interbedded with shales at the top of this formation.

PURE OIL CO. WELL NO. 1 (WELL NO. 8).

This well is located at the margin of the producing area and penetrated into the Morrison shales. The well log was kindly placed at my disposal by Mr. L. B. Hancock, with the request that it be kept confidential. Gas in quantity was encountered in the lower horizon.

BIGHORN BASIN COLONIZATION CO. WELL NO. 1 (WELL 23).

This well is located on Lot 57, Twp. 56 N., R. 97 West, and was drilled for the Ohio Oil Co. The latter company has furnished the following log:

	0– 10	Gravel
	10– 390	Shale
	390– 420	Light sand (oil and gas 390-420)
	420– 594	Sand and shale
	594– 714	Sand and shell (water 629)
	714– 719	Soapstone
Base of Frontier	719– 846	Sand and shale
	846– 915	Black shale
	915– 922	Black lime
	922–1545	Shale and shell (water 975) (gas 1535)
Rusty Beds	1545–1594	Gas and gray sand (gas 1545-94)
	1594–1737	Shale and sand (gas 1621)
Top of Morrison	1737–1757	Shells and red shale
	1757–1782	Lime shells and shale
	1782–1804	Gas sand (gas 1782-04)
	1804–1842	Red rock and lime shells
	1842–1868	Big gas sand (gas 1842-68)

The capacity of this well has been estimated at 100,000-000 cubic feet per day.

GEORGE EASTON WELL NO. 1 (NO. 26).

This well also was drilled for the Ohio Oil Company on land the property of George Easton. The log was kindly furnished by the Ohio Oil Co.

	0– 610	Black shale
	610– 625	Hard sand (gas 610)
	625– 712	Black shale—hard
	712– 720	Black shale and shell
	720– 725	Hard sand (water 720)
	725– 752	Hard sand (gas 725)
	752– 815	Hard sand (water 752-85)
Base of Frontier	815– 820	Sand
	820– 878	Hard black shale
	878– 880	Soft shale
	880– 887	Shells
	887– 907	Black shale

	907– 912	Soft shale
	912– 919	Shells and shale
	919– 931	Hard black lime
	931–1465	Shale
Rusty Beds	1465–1470	Hard gray sand
	1470–1540	Shale and shell
Cloverly?	1540–1590	Sand (gas 1540-60)
Top of Morrison	1590–1611	Red sand shale
	1611–1624	Hard sand (gas 1611-24)
	1624–1640	Red rock
	1640–1665	Gas sand

This is the only well log that shows any quantity of sand above the upper red clay of the Morrison. This may represent a remnant of the massive Cloverly sandstone which elsewhere is removed by erosion.

ROY WILLEY FARM WELL NO. 1 (WELL NO. 19).

This well was drilled by the Ohio Oil Co. It is located on Lot 59, Twp. 56 N., R. 97 W. The well was drilled in 1914. The following log was furnished by the Ohio Oil Co.

	0– 40	Clay
	40– 175	Black shale
	175– 425	Brown shale
	425– 456	Green sand and shell
	456– 506	Brown shale and shell
	506– 577	Black shale and shell
	577– 620	Brown shale and sand
	620– 660	Black shale and sand (water 764)
	660– 810	Brown shale and sand
	810– 975	Brown sand and shell (water 810) (gas 964)
	975–1085	Brown and black shale
Base of Frontier	1085–1180	Sand (water 1085)
	1180–2012	Shale and shell
	2012–2026	Black and gray sand
	2026–2036	Sand (gas and oil 2028)
	2036–2068	Shale and sand
Top of Morrison	2068–2082	Red rock and black shale
	2082–2101	Red shale
	2101–2169	Sand (water 2115) (oil 2169) (gas 2169)
	2169–2170	Hard shell
	2170–2180	Red rock

BYRON WELL NO. 1 (WELL NO. 16)

This well is the property of the Central Petroleum Development Co. of Sheridan. It is located near the northwest corner of Sec. 36, Twp. 56 N., R. 97 W. It was drilled by J. R. Greenlees who furnished the well log.

Well was spudded in March 21, 1915, and completed February 14, 1916.

0– 15	Gravel and boulders
15– 22	Quicksand
22– 100	Sandy shale
100– 130	Sand (water)
130– 190	Sandy shale
190– 305	Shale
305– 310	Hard shell
310– 375	Shells and shale
375– 490	Shale
490– 540	Sand (little water)
540– 560	Shale
560– 565	Sand (water)
565– 635	Shale
635– 690	Sand (little water)
690– 715	Shale
715– 734	Gumbo
734– 985	Shale
985–1005	Hard shell
1005–1830	Shale
1830–1870	Soft shale and cave
1870–1950	Cavy shale
1950–2100	Sandy shale
2100–2210	Shale
2210–2240	Shale and cave
2240–2250	Soft and cavy
2250–2310	Shale
2310–2360	Shale and cave
2360–2440	Shale and cave
2440–2480	Shale
2480–2550	Shale and shells
2550–2630	Sand and shale
2630–2675	Sandy shale and cave
2675–2695	Sand
2695–2700	Cavy

The well is entirely in Cody shale except the upper 200 feet.

Subsequently (1916) further drilling was done on this well. Full information was given the writer by Mr. F. A. Senff with the request that it be kept confidential.

Apex Byron Dome Well No. 1.

This well is the property of the Bighorn Colonization Co., and was drilled by J. R. Greenlees, who kindly furnished the well log. Well was spudded in, February 19, 1914, completed February 19, 1916. It is located on the southwest corner of Sec. 24, Twp. 56 N., R. 97 W.

	Surface– 60	Gravel and shale
Base Gebo	60– 100	Hard sand
	100– 107	Soft and cavy
Top Cody	107– 118	Shale
	118– 185	Cavy shale
	185– 200	Sandy shale
	200– 245	Sand
	245– 255	White shale
	255– 285	Broken shale
	285– 345	Shale
	345– 352	Sand
	352– 915	Shale
	915– 970	Broken shale
	970–1828	Shale
	1828–1980	Shale
	1980–1985	Cavy
	1985–2020	Shale
	2020–2095	Sandy shale
	2095–2161	Shale
	2161–2166	Gas sand
	2166–2190	Shale
	2190–2210	Gas sand
	2210–2270	Shale
	2270–2275	Broken sand and shale
	2275–2285	Hard shell and shale
	2285–2295	Sand
	2295–2335	Shells and shale
	2335–2475	Shale
	2475–2515	Shale
	2515–2590	Heavy water sand

The flow from the upper gas sand was estimated at 6,000,000 cubic feet.

WELLS NOS. 14, 15, 18, 20 TO 22, 24, 25, 27-32.

No logs or information regarding these are available except as stated below.

WELL NO. 24. This well is a very heavy gas producer and in all respects similar to No. 23 for which a well log is given. The capacity of this well has been estimated at 100,000,000 cubic feet per day.

WELL NO. 14. This represents only a well rig. Drilling has not yet started.

WELL NO. 26. Well being drilled. No data regarding depth, etc., was available. Location is considered poor.


STATE OF WYOMING
1933
GEOLOGICAL SURVEY


STATE OF WYOMING
1933
GEOLOGICAL SURVEY


STATE OF WYOMING
1933
LOGICAL SURVEY

R. 98 W.

R. 97 W.

T. 56 N.

T. 55 N.

LEGEND

Kg = Gody
Kmg = Gebo } Mesaverde
Kmm = Meeteetse }
Contours on Base of Frontier.
= Oil Well
= Water Well
= Gas Well
= Well Being Drilled

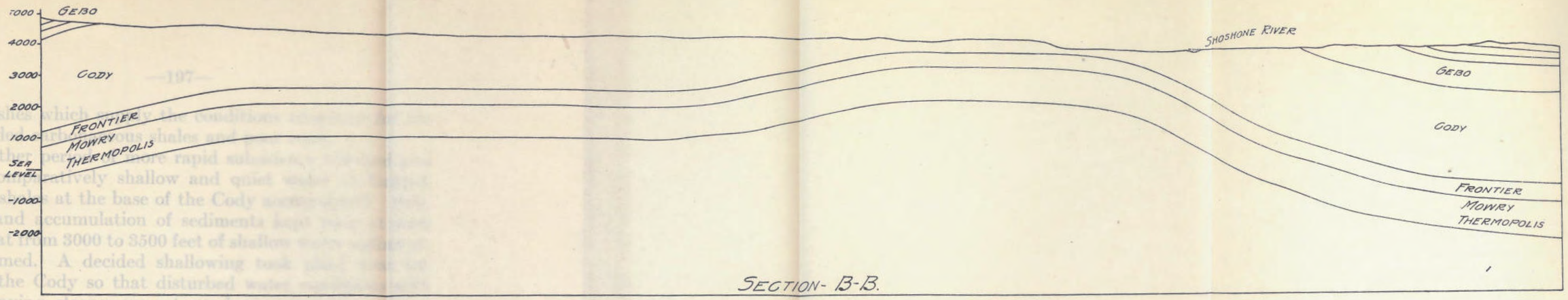
The State of Wyoming
Office of State Geologist
Cheyenne

L.W. TRUMBULL STATE GEOLOGIST

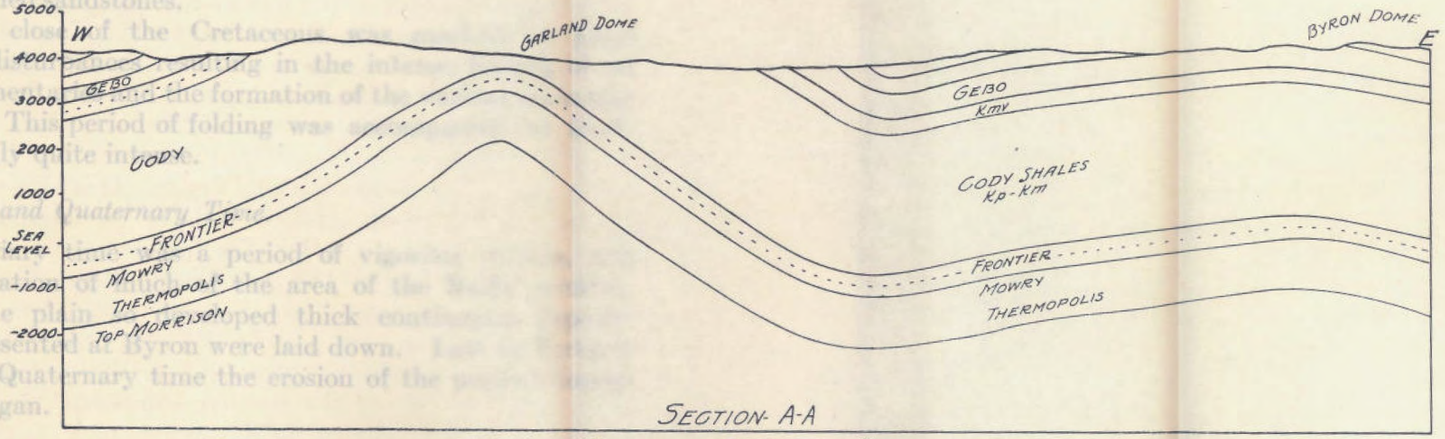
GARLAND — BYRON OIL & GAS FIELD

BY
VICTOR ZIEGLER.
1917

SCALE
0 2000 4000 6000 Feet



SECTION- B-B.



SECTION- A-A

GARLAND AND BYRON DOMES