

PETROLEUM GEOLOGY  
OF  
WYOMING

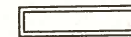
BY  
L. W. TRUMBULL



PETROLEUM GEOLOGY OF WYOMING - Trumbull



# PETROLEUM GEOLOGY OF WYOMING



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# PETROLEUM GEOLOGY OF WYOMING

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## INTRODUCTION AND ACKNOWLEDGMENTS

No attempt has been made to refer by footnotes to the many geologists who have worked and written upon different areas in the State. A bibliography is given elsewhere, and the writer acknowledges his indebtedness to each and every writer and work in the list.

When the writer began his geologic work in Wyoming in 1904, the published data were very meager. The surveys of Hayden and King covered the south half of the State in a reconnaissance way, but were not, for obvious reasons, tied to the public land survey. During the past dozen years the work of the United States Geological Survey on coal, oil and phosphate has given us many splendid detailed surveys of different areas within the State. This volume, especially the accompanying map, could not be compiled, were it not for these Government reports.

It is not expected nor intended that this volume will take the place of the reports of detailed surveys. It is intended rather as an index to the various detailed reports. To those geologists who come into the State to work for the first time, such an index and



introduction to the geology of the State should be of great assistance. To those who wish to acquire a general knowledge of the oil geology of the State, without going into the details of specific areas, there has heretofore been no publication available. The desire to fill these needs has prompted the publication of this volume, and should it do so in some fair degree, the writer will feel vindicated in having added his share in "the making of books".

## GEOLOGIC HISTORY

### PRE-CRETACEOUS

The earlier history of Wyoming's geology may be passed over with the statement that erosion reduced the area practically to a peneplain in pre-Cambrian time. Upon this leveled surface were laid in practically parallel strata the Cambrian, Ordovician and Carboniferous. Although great time intervals are missing in the record, there was no warping in the surface of sufficient extent to break the parallelism. In Mississippian time a far-reaching thick limestone (Madison) was laid down, which has some evidences of being petroliferous, but no well has ever found oil in quantity, nor are there any considerable breccia deposits along its outcrops.

The Carboniferous consists (naming from the bottom up) of the Madison lime, the Amsden shale, the Tensleep sandstone and the Embar lime and shale members. It is the top member, the Embar, which is the important asphaltic oil-producing zone in the State. This member in its typical limestone type extends over only part of the State. To the

north and east it thins out and loses its limy character, gradually grading into red shales and sands which are with difficulty distinguished from the overlying Chugwater Red Beds. In the western part of the State it is the Park City phosphate-bearing limestone member.

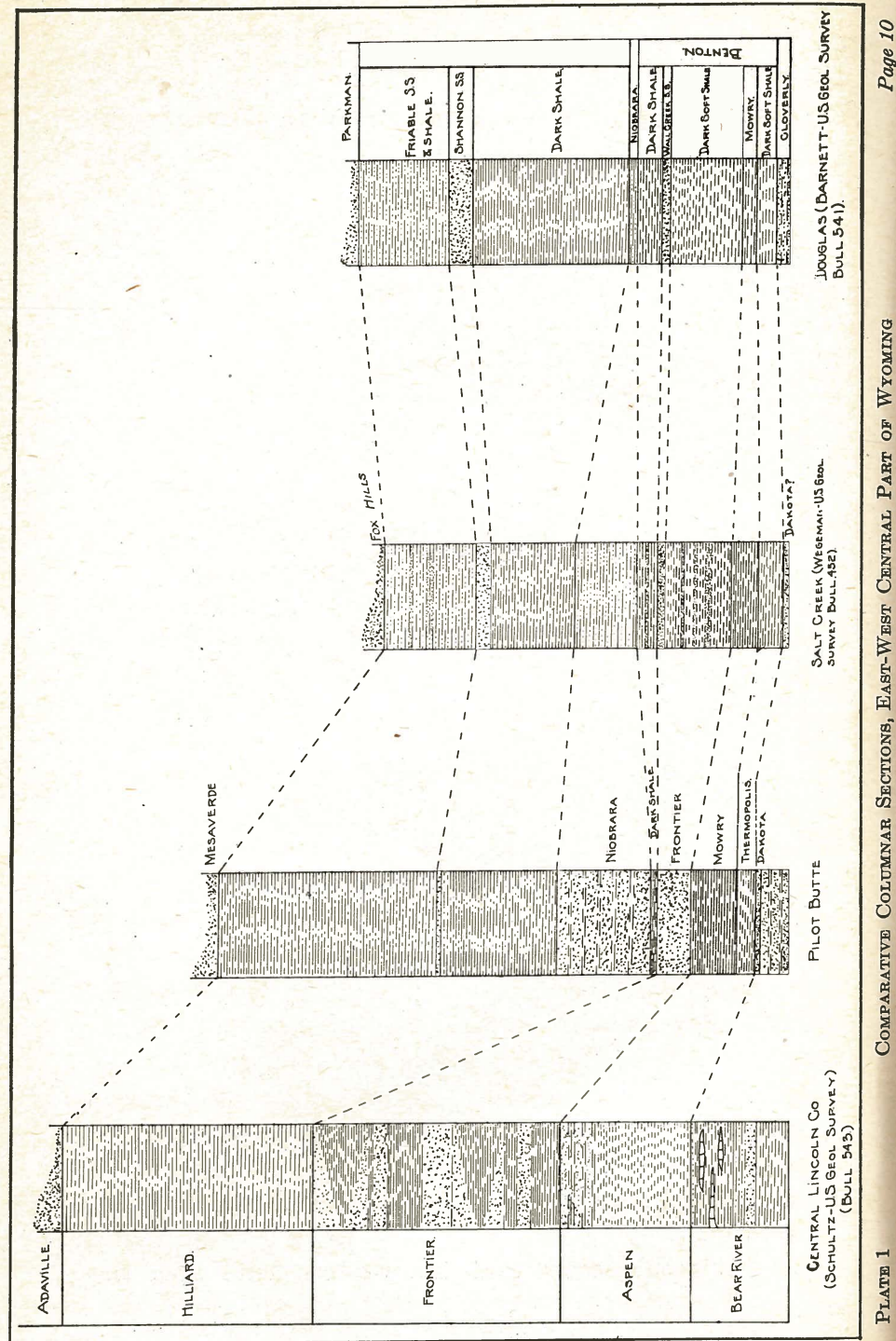
Above the Carboniferous lie the "Red Beds" (Triassic or Permian or both) and above them the Jurassic marine Sundance, followed by the Morrison and a thin lower Cretaceous (Comanchean), and upon that the basal sandstone (Dakota) of the Upper Cretaceous. This sandstone is very widespread, evidently being present wherever the Cretaceous Sea reached. It is invariably a watersand in the southern two-thirds of the State, but contains oil and gas in the northern part of Bighorn Basin, and is the principal gas sand of Montana. At many points in Wyoming its outcrop is oil-saturated. Twenty years ago it was named as one of the probable oil-producing sands of the State, but is not now so considered.

### UPPER CRETACEOUS

Whatever may have been the geologic history during Lower Cretaceous time, it is quite certain that in earliest Upper Cretaceous time the Dakota sandstone was laid down over a vast area in practical parallelism with the lower sediments. This means that a vast leveled land surface extending from eastern Idaho to western Iowa was slowly depressed, causing the Cretaceous Seas to invade gradually from the north and from the south until they met and isolated the western land area from the eastern part of the continent.

It would seem that the western land area was





lifted to great height while no such upwarping occurred upon the eastern side of the great Cretaceous Sea. This resulted in a vastly greater amount of erosional debris being produced from the western shore than from the eastern. While it is impossible to chart ocean currents of the Cretaceous Sea, it seems probable that there was a very pronounced northward current in the western part. This caused the sands, derived from the Idaho highland area, which were laid down as Bear River and Frontier, to spread to the north and northeast much more than to the south.

The sinking of the sea bottom continued intermittently till the close of Cretaceous time, as evidenced by the occasional sands and even fresh water fossils and coal beds which were laid down during periods when the sea became filled with sediments to sea level. A succeeding period of subsidence then again broadened the sea, and marine shales with marine fossils were again laid down. This intermittent subsidence is especially evidenced by the Frontier formation. On the western border of the State this is 2,500 feet thick, consisting of sandstones and innumerable coal beds with occasional beds of carbonaceous shales and marine fossils. This very rapidly thins to the eastward, the coals entirely disappearing, the sands becoming fewer and thinner, and separated by increasing thicknesses of shale, until on the eastern border of the State the last sandstone has disappeared. As these Frontier sandstones are the most richly productive of hydrocarbons in the State they are of particular interest. Numerous comparative geologic sections (Plate 1) are illustrated in groups, which show the rapid thinning near the western edge of the State, the more gradual thinning across the central



half of the State, and the final absence of them along the eastern border.

The attention of the reader should be drawn to the very excellent paper of Willis T. Lee, entitled "Relation of the Cretaceous Formations to the Rocky Mountains in Colorado and New Mexico". (U. S. G. S., Professional Paper 95-C.) As conditions in Colorado and New Mexico during Cretaceous time were similar to those in Wyoming, a study of that paper will be of great help to one interested in the geology of the petroleum-producing horizons in Wyoming. Any such are urged to secure and use that paper as a supplement to this publication.

The great span of Upper Cretaceous time is evidenced by a total deposition of about 8,000 feet of shale (in addition to the more rapidly deposited sandstones) over the south central part of the State. Coal was formed under favorable shore swamp or delta conditions throughout the whole period, but, of course, more abundantly during the close of the period when the whole area had become practically filled to sea level and subsidence had become so slow that sedimentation kept pace with it. That local subsidence continued till a very late time is proven by the finding of marine fossils of Cretaceous type in shales overlying fresh-water sediments that had been accepted as Tertiary because of the fresh-water fossils of Tertiary type found in them.\* Cretaceous time thus passed into Tertiary time by such easy stages and with so little change in conditions that Cretaceous marine and freshwater Tertiary life existed side by side and actually alternated in certain areas.

\* The Cannonball Marine Member of the Lance Formation. Loyd & Hares. Journal of Geology, Vol. 23, p. 523.

## TERTIARY

While the division line between Cretaceous and Tertiary cannot be drawn with certainty upon fossil evidence as in some localities, one dovetails with the other. In general the line is one of marked unconformity, for the mountain ranges received their first uplift at the close of the Cretaceous, and the debris brought down by erosion was different in character from the underlying material and was often laid down at an angle with the underlying strata.

## TIME OF MOUNTAIN FORMATION

The main ranges, and probably the minor folds, were formed at this time. But further folding and uplifting occurred after the first folds had been heavily eroded. This is probably best illustrated by the Pilot Butte anticline, where the lower Tertiary strata are found dipping at about five degrees, while the Cretaceous beveled strata dip at about twenty-five degrees and the overlying younger Tertiary are still practically horizontal.

The time at which a particular fold was formed may be of vast importance. If it were not formed till late in Tertiary time, after the hydrocarbons had collected and migrated, that fold, although forming a perfect trap, might never have had an opportunity to catch and hold any gas or oil. Also if the folding was increased after migration of hydrocarbons had ceased, various changes in the reservoirs and their contents would be expected according to the size and shape of the structure, both before and after the final changes took place.



## EROSION

During later Tertiary and recent time the State has been heavily eroded. Main drainage streams have cut canons across major mountain ranges as the general surface has lowered; vast valleys or basins have been cut out of the soft younger rocks between the mountain ranges; all sediments have been removed from the main ranges, leaving the core of granite or crystalline schists exposed; and the smaller folds and anticlines have been eroded in varying degrees. Some have been eroded so deeply that the oil-bearing horizons have been entirely removed, others eroded so slightly that the oil horizon still lies too deeply covered to be reached by a drill hole; and possibly others exist, unsuspected, under areas whose surface rocks are horizontally-lying late Tertiary.

## STRUCTURE

The Rocky Mountains cross the State, in a direction roughly thirty degrees west of north, in two main ranges. The front range, the eastern, consists of the Laramie and the Bighorn Mountains; the second, of the Medicine Bow, Seminoe, Wind River and Absaroka Mountains. In addition to these are the Black Hills Range in the northeast with its axis lying parallel to the Bighorn Range and the Salt River Range on the Idaho line, which with the Teton Mountains forms a nearly north-and-south barrier along the Idaho-Wyoming line.

The Owl Creek and the Sweetwater Ranges extend east and west between the two great north-

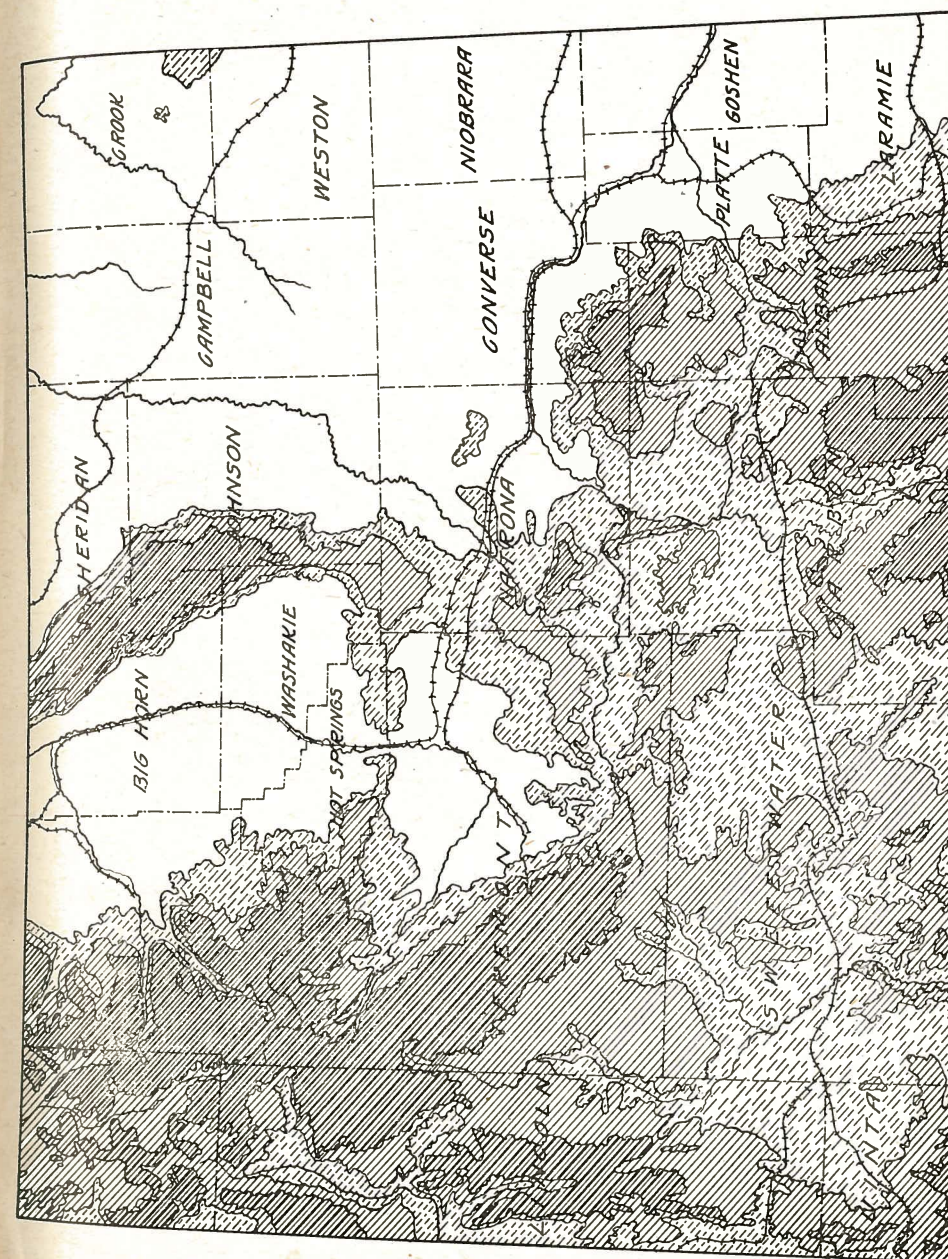


PLATE No. 2.

ELEVATION MAP  
STATE OF  
WYOMING.FROM  
CONTOUR MAP  
PUBLISHED BY  
STATE GEOLOGISTS OFFICE  
1916



and-south ranges, dividing the great trough between the two into valleys, the most northern of which is known as Bighorn Basin, that in the middle of the State as the Wind River Valley, and that farther south as the Hanna coal fields and the Laramie Plains. An east-and-west range, the Gros Ventre, connects the Wind River Range with the Salt River Range and separates Jackson Hole from the Green River Valley. Both the geologic map and the elevation sketch map show the main mountain uplifts.

The lesser folds, anticlines and domes usually parallel the north-south ranges, at varying distances from them. Such a secondary fold almost encircles the Bighorn Basin. At many places the folds are domed into structures which have entrapped and held pools of hydrocarbons.

The first fold paralleling the Wind River Range on the east contains black asphaltic oil in the Embar formation in several domes. The second fold has proved to contain Cretaceous oil on the Pilot Butte field. Other domes along this second fold may be found and drilled later.

It is unfortunate from the oil geologist's standpoint that so much of the State's surface is Tertiary covered. That the later Tertiaries lie horizontal over structure in the Cretaceous is proven, but the earlier Tertiaries frequently show lesser dip, but in the same direction, as do the Cretaceous rocks below. It will probably become worth while to work out from the general geology of a region and the slight dips to be found in the Tertiary, the probable position of folds in the underlying Cretaceous, and take the chances of drilling test wells in such wildcat locations. That some such locations will prove successful, the

writer does not doubt. Of course, many will be failures.

From the tabulation of domes (page 29) it is evident that the relief of Wyoming structures, at least of those now known, is much more pronounced than those of Oklahoma and Texas. As the shale areas of this State have never been surveyed for obscure structure it is probable that as the search becomes more intense, folds of much less dip will be found and prospected.

## NOMENCLATURE AND CORRELATION

To the newcomer to the State there is a hopeless and needless confusion and duplication of geologic names. But the reason is not hard to understand, if one remembers that many of the names have been brought in from the adjoining States. The earliest geologic work was done along the Missouri River, and the nomenclature there established was carried across Wyoming by Hayden and King. Later geologists named formations and subdivisions in their work in Colorado and in Montana, and as the work extended into Wyoming, two sets of names for the same formation were frequently brought in and used, until in the central part of the State one used either or both.

The following table shows the correlation of the Upper Cretaceous as named in different parts of the State by various geologists.



TABLE OF CORRELATION

SYSTEM		ROUTT COUNTY COLORADO	RAWLINS	SPRING VALLEY	PILOT BUTTE
TERTIARY				Wasatch 4000 +	Wind River 250
				Evanston 1600	Missing
TERTIARY (?)		Laramie 900 +			
UPPER CRETACEOUS	Montana	Lewis 1200 ±	Lewis	Adaville 4000	Mesaverde 300 +
		Mesaverde 3500 ±	Mesaverde 1500 +		
	Colorado	Mancos 2500 ±	Pierre 3800	Hilliard 6000	Pierre 4100
			Niobrara 680		Niobrara 1200
					Carlile 111
			Frontier 180	Frontier 2500	Frontier 430
			Mowry 380	Aspen 1600	Mowry 400
					Thermopolis 200
	Cloverly	Cloverly 150	Dakota	Bear River 500-5000	Dakota 40
					Fuson and Lakota 360
	CRETACEOUS (?)				Beckwith 4000
JURASSIC				Twin Creek 3700	Sundance 350
TRIASSIC					Chugwater 1500
PERMIAN					Embar 340

AND THICKNESSES

GRASS CREEK	BYRON	BUFFALO	BLACK HILLS	DOUGLAS	SALT CREEK	LARAMIE PLAINS
Wasatch				White River 1000 +		
Fort Union 3000	Fort Union 5592	De Smet 3000 ±	Fort Union	Fort Union	Fort Union	
Ilo 900	Ilo 1790	Piney 2000	Lance	Lance 4000 +	Lance 3200	
Meeteetse 1000	Meeteetse 1110		Fox Hills	Fox Hills 1650	Fox Hills 1700 +	
Mesaverde 500	Mesaverde 1100	Parkman 350	75-150	Parkman 150	Parkman 350	Mesaverde 1280 +
Cody 1250	Cody including Niobrara 2200	Pierre 3500	Pierre 1250	Pierre 3300 +	Pierre 2300	Pierre 3000
Niobrara 1200		Colorado 1400	Niobrara 200	Niobrara 100	Niobrara 735	Niobrara 180
			Carlile 700	Carlile 300	Carlile 220	Benton 550-1300
Frontier 450	Frontier 550		Greenhorn 50	Wall Creek 100	Wall Creek 120	
Mowry 450	Mowry 420			Shales 870	Shales 760	
Thermopolis 450	Thermopolis 415		Graneros 1000	Mowry 175	Mowry 300	
				Shale 175	Shale 270	
Cloverly 100-300	Part Missing 150	Cloverly 110	Dakota 50-100	Cloverly 115	Cloverly 125	Cloverly 150
			Fuson 25			
			Lakota 175			
Morrison	Morrison 570	Morrison 150	Morrison 150	Morrison 200 +	Morrison and Sundance 700	Morrison 160
Sundance	Sundance 550	Sundance 250	Sundance 350	Sundance 300 +		Sundance 0-150
Chugwater	Chugwater 1000 +	Chugwater 1200	Spearfish 500	Chugwater 1500	Chugwater 1300	Chugwater 1200
			115			



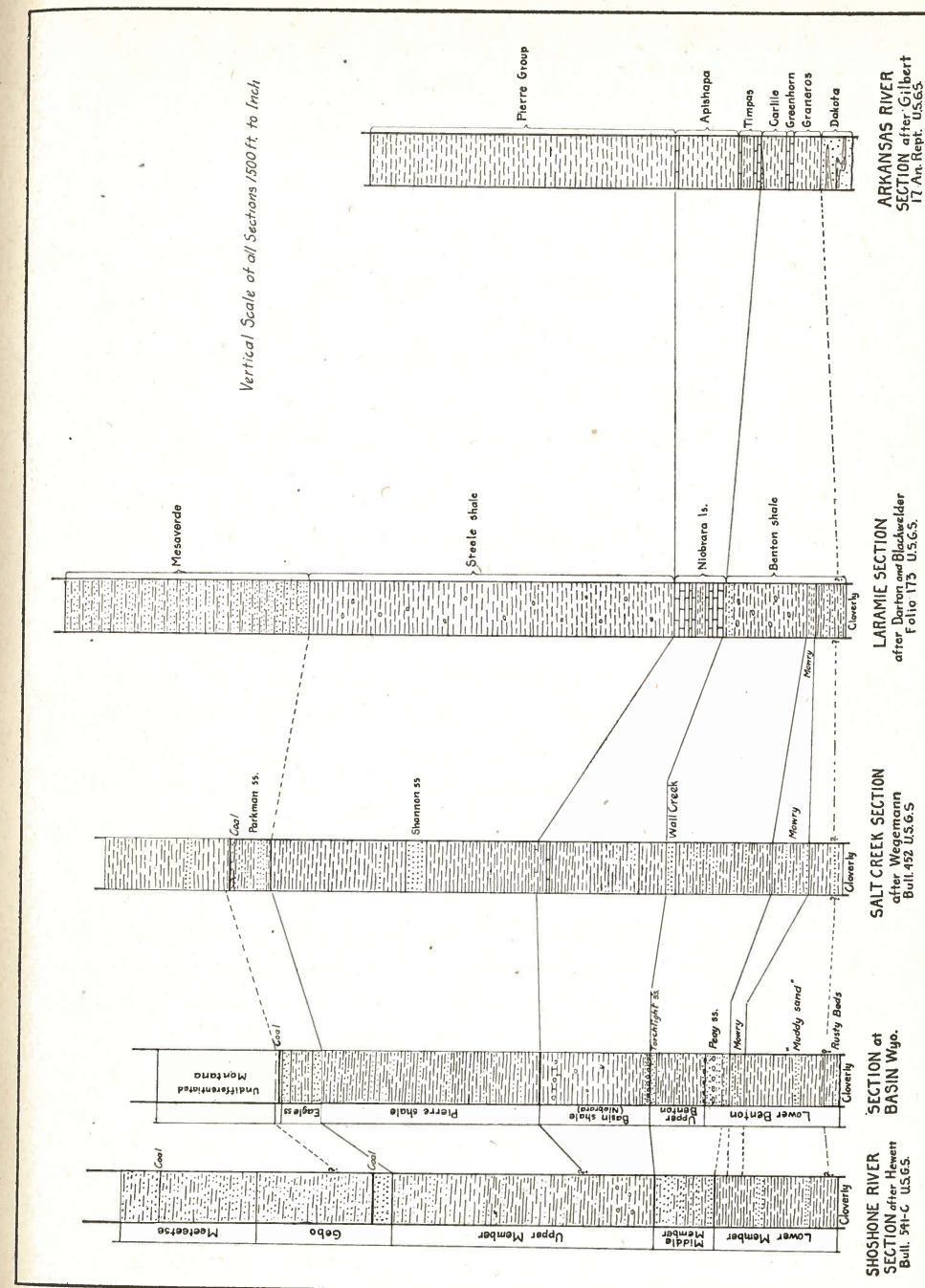
## BENTON

The type locality of this formation is Fort Benton on the Missouri River. The shales of this age were everywhere deposited in the Cretaceous Sea. Limestones were deposited in places and not in others. Darton's divisions of the Benton in the Black Hills area were Graneros shale, Greenhorn limestone, and Carlile shale. The Greenhorn limestone in its type locality is a heavy forty-foot member; in the central and western part of the State it has not been found; in the Laramie Plains it is only a few inches thick; while in northwestern Colorado a heavy limestone member occurs in about the Greenhorn position. Along the eastern side of the State the Frontier sandstones are missing, while at the western edge of the State this formation is twenty-five hundred feet thick.

The Mowry shale member is recognized nearly everywhere in the State, being known as the Aspen, or part of the Aspen, in the southwestern portion. On the southern boundary of the State it lies very close upon the top of the Dakota, but gradually rises in the geologic column toward the north, till in the Bighorn Basin there are hundreds of feet of shale and sandstone between the two. The various illustrations of the columnar sections show this plainly. The Frontier sandstones form the principal oil reservoirs across the central part of the State.

## NIOBRARA

The type locality of the Niobrara is Fort Niobrara on the Missouri River. In the eastern part of Wyoming this formation is similar to the type locality, being very limy and having the typical lemon-yellow color.





In the Bighorn Basin and Lander valleys it is recognizable by its fossils and still shows a hint of its yellow color, but is not noticeably calcareous; and in the southwestern part of the State it has not been identified. While probably present, it is known only as part of the Hilliard, or farther south as part of the Mancos.

### PIERRE

The shales of the type locality at Fort Pierre on the Missouri River are the same as those throughout Wyoming, known in the southern part of the State as Steele shales and in the Bighorn Basin as the Cody shales. These grow more sandy toward the northwest until in Montana they become largely sandstones; the Eagle sandstone of Montana being the bottom of the series. Sandstones occur in these shales at various horizons and often contain oil or gas.

### YOUNGER CRETACEOUS FORMATIONS

Above the shales occur sandstones and coal-bearing sands and shales in every part of the State. These are known under various names in different localities. Along the southern part of the State the word Mesaverde is common; in the Bighorn Basin the name Eagle has become common, although the Eagle proper does not reach into this State. In the eastern part of the State the name Fox Hills was early used, and is still not infrequently heard. In the central part of the State the Parkman sandstone is the term most commonly heard.

All Cretaceous strata younger than Pierre are denoted by one color on the accompanying geologic map.

While important as coal-producers, and very thick in parts of the State, no oil or gas has been found in them. As they vary greatly from place to place, one must refer to detailed surveys of the different districts for information regarding them.

### OIL PRODUCTIVE HORIZONS

Oil is being produced from only two horizons: the Embar producing black asphaltic oil, and the Upper Cretaceous (Colorado and Montana) zones producing the very high grade paraffine base.

A long anticline paralleling the Wind River Mountains on the east side is domed up at Dallas, Lander and Sage Creek, in which structures the Embar and lower sandstones of the Chugwater are found to contain pools of black oil. At several other points, on Pine Mountain in Natrona County, near Douglas in Converse County, on the Tisdale dome in Johnson and Natrona Counties, and at Rocky Ford in Crook County, has the Carboniferous proven to carry hydrocarbons, but none of these points is producing. A well drilled on Pine dome struck a little asphaltic oil and a considerable flow of gas. Shallow wells along the outcrop both south and southwest of Douglas show small amounts of heavy asphaltic oil from which all the volatile portions have evaporated. Shallow wells in the outcropping Dakota, dug years ago, found oil in small amounts on the Tisdale, or Powder River, dome.

Practically every portion of the Cretaceous from the Dakota at the bottom to the coal-bearing Mesaverde near the top contains sandstones which show



saturation along outcrops. Even the shales are, in most parts of the State, sufficiently petroliferous to produce so-called "rainbows" when finely crushed and mixed in water. The most productive light oil horizon is that known as the Frontier. This includes the productive sands of Salt Creek, Grass Creek, Elk Basin, Byron, Big Muddy and Greybull, as well as the gas-producing horizon of Little Buffalo Basin. This formation is discussed under Historical Geology, and the many columnar sections show its position and thickness in the various parts of the State.

Over a vast area in the southern and western part of the State, certain Tertiary strata are saturated with a low-grade asphaltic oil. Pieces broken from the outcrop can be used for fuel, and at some points the material is used as a street facing, being a mixture in proper proportion of asphalt and rock to pack into a splendid road facing. These strata are everywhere nearly horizontal and usually exposed by erosion, so that up to date no pool has ever been found by drilling for this horizon.

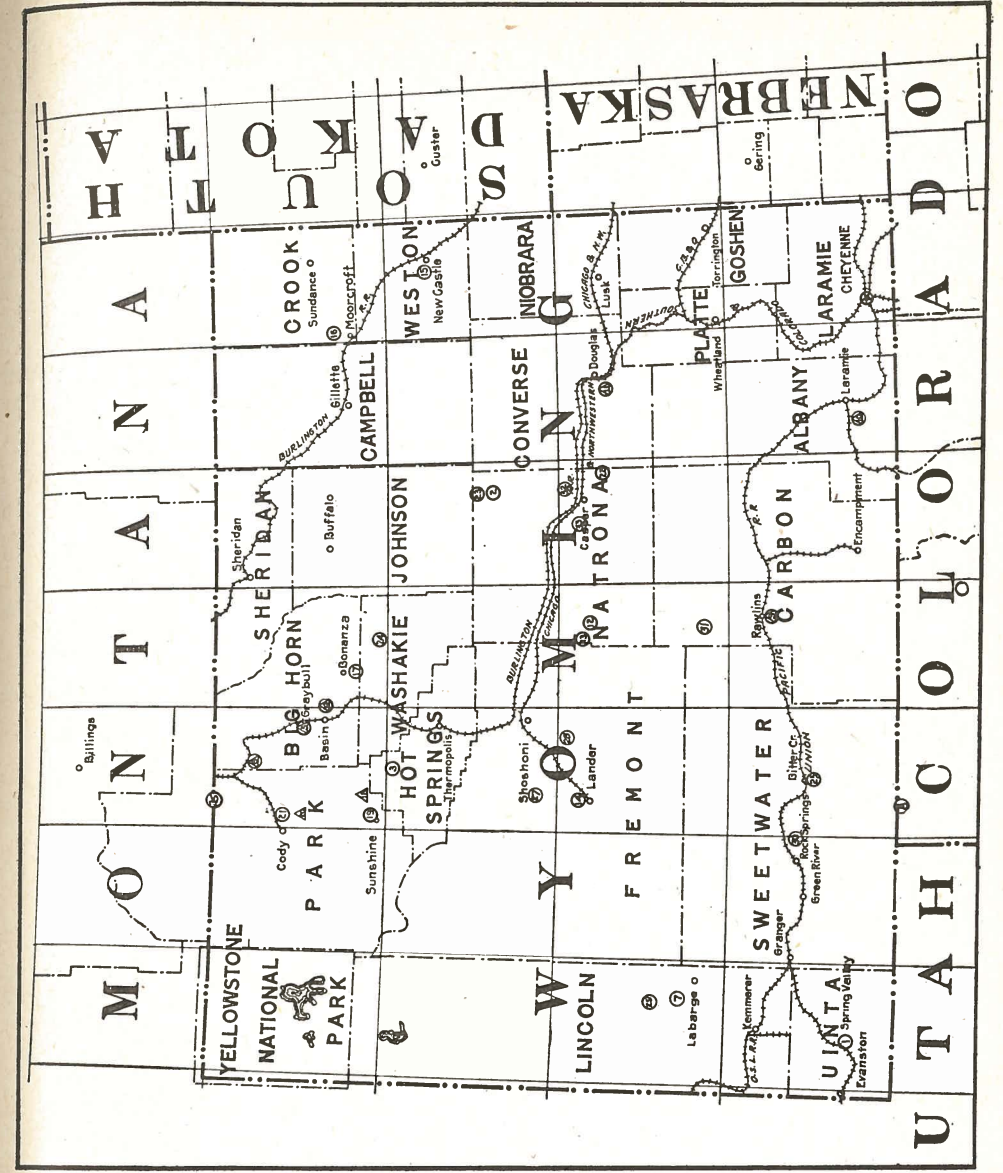


PLATE 4  
KEY MAP  
OF  
CRETACEOUS OIL AND GAS  
FIELDS

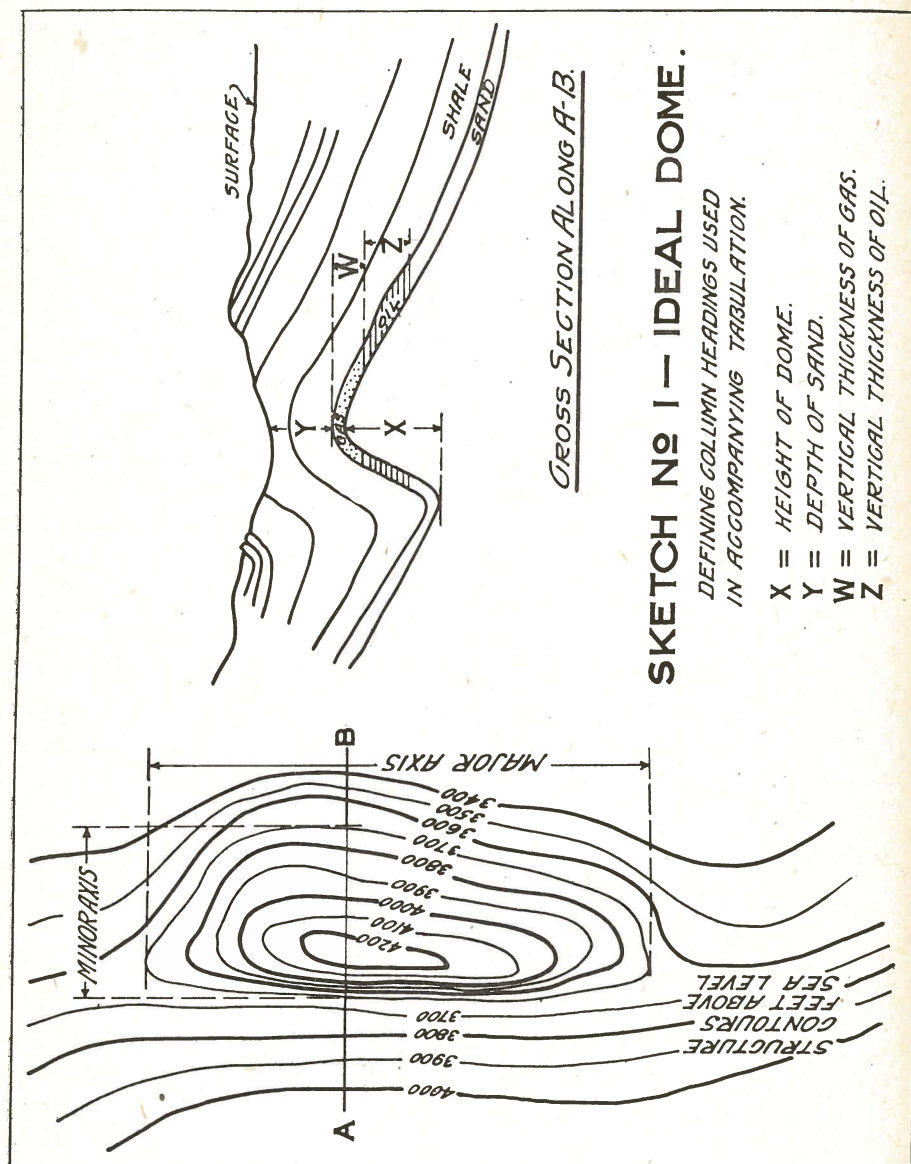


# OIL FIELDS OF THE STATE LIST OF CRETACEOUS OIL AND GAS FIELDS

KEY MAP NO.	NAME	COUNTY	EVIDENCE	STRUCTURE	NOTES
1	Spring Valley	Uinta	Oil wells	Faulted anticline	Production kept small refinery running for several years.
2	Salt Creek	Natrona	Oil wells	Dome	Production, 5,000,000 barrels per year.
3	Grass Creek	Hot Springs	Oil wells	Dome and cross-faulted plunging anticline	Producing.
4	Basin (Torelight)	Big Horn	Oil and gas wells	Dome	Producing.
5	Greybull	Big Horn	Oil and gas wells	Dome	Producing.
6	Byron	Big Horn	Oil and gas wells	Dome	Supplies crude for Cowley refinery.
7	LaBarge	Lincoln	Springs	Faulted (?) anticline	Has never been intelligently prospected.
8	Vermillion	Sweetwater	Seepage	Outcrop	Of geologic interest only.
9	Rawlins	Carbon	Oil and gas in wells (not economic)	Plunging anticline	Small amounts of oil and gas at 3450 feet in 1915.
10	Laramie Plains	Albany	Oil and gas in wells (not economic)	Plunging anticline	Showings in shallow wells 1914 and 1915.
11	Douglas	Converse	Oil and gas wells	Tertiary over beveled outcrop	No production.
12	Oil Mountain	Natrona	Springs and seepages	Anticline	Drilled 1912. Water.
13	Rattlesnake Mts.	Natrona	Springs and seepages	Outcropping monocline	Much prospected in early days.
14	Washakie	Fremont	Spring and oil wells	Dome on anticline	Fractured and eroded into Mowry shale
15	Newcastle	Weston	Seepages	Monocline	Several dry wells.
16	Moorecroft	Crook	Springs and wells	Outcrop eroded dome	No production.

KEY MAP NO.	NAME	COUNTY	EVIDENCE	STRUCTURE	NOTES
17	Bonanza	Big Horn	Springs	Plunging anticline	Well in '90s plugged and abandoned.
18	Buffalo Basin	Park	Gas wells	Dome	Wells of 20,000,000 feet per day.
19	Sunshine	Park	Spring	Eroded anticline	Flowed up to 1910.
20	Oregon Basin	Park	Gas wells	Dome	Very heavy gas flow.
21	Cody	Park	Oil in wells	Narrow anticline	Shallow wells drilled several years ago show little oil.
22	Big Muddy	Natrona	Oil in well	Broad flat anticline	Shallow shale oil in 1915.
23	Shannon	Natrona	Oil in well	Outcrop	Small amount of heavy paraffine oil free of gasoline.
24	Cottonwood	Washakie	Spring	Faults in slight dome	Globules of heavy oil in water springs.
25	Bitter Creek	Sweetwater	Spring	(?)	Reported globules of heavy oil in water springs years ago. Now dry.
26	Elk Basin	Park	Flowing wells	Dome	Drilled Fall of 1915.
27	Pilot Butte	Fremont	Wells	Dome	Production
28	Alkali Butte	Fremont	Springs and holes	Outcrop of monocline	Eroded below the Dakota.
29	Dry Piney	Lincoln	Wells	Dome	Oil at shallow depth.
30	Rock Springs	Sweetwater	Gas wells	Dome	Two gas sands at about 1800 feet depth.
31	Lost Soldier	Carbon	Wells	Dome	Oil under pressure at 350 feet depth.
32	Wheeler	Natrona		Dome	Drilling for Shannon sand October 1916.
33	Powder River Junction	Natrona		Dome	Gas found in Niobrara.





## CHARACTERISTICS OF SEVERAL DOMES

NAME OF DOME	Major Axis (Miles)	Minor Axis (Miles)	Dip of Limbs	Altitude of sands at crest	Altitude of lowest closing contour	Height of Dome	Depth of Sands	Thickness of Gas Body	Thickness of Oil Body	REMARKS
Salt Creek	13	5	20 & 8	4100	2800	1300	900	None	500	
Teapot	4	1½	10 & 4	3300	3000	300	2000	Not drilled		Part of Salt Creek anticline
Grass Creek	8	3	50 & 12	5300	2500	2800	900	None	600	
Buffalo Basin	7	4	40 & 15	4900	3000	1900	1700	Exceeds 500	Not drilled	
Torchlight	5	3	15 & 7	2900	2300	600	400	Slight	200	
Lamb	3	1	6	2700	2600	100	600	100	Slight	Part of Torchlight anticline
Oregon Basin	6	2	Low	5100	4500	600	1000	Not known	None	Gas in Dakota sands
Garland	6	1	High	3750	0	3750	3700	Not known	None	Gas in Morrison
Byron	2	1	Low	500	0	500	1900	Not known	None	Secondary dome on Garland uplift
Elk Basin	1	½	High	3400			900	None	Not known	Not surveyed
Big Muddy	6	1	Very low	2400	2100	300	3100	Not drilled	Not known	Oil at 940 feet and 3150 feet
Greybull	4	2	10 & 4	3100	2800	300	800	Blown off	300	Complicated by faults
Pilot Butte	3	1	15 & 5	4200	3000	1200	750	None	Not known	Oil in the Shannon horizon



## SALT CREEK

T. 40 N., R. 79 W., Natrona County

The Salt Creek structure lies in Townships 39, 40 and 41 N., R. 79 W., about fifty miles north of Casper. The productive area, in which the Wall Creek (highest Frontier) sandstone is productive, is about 5,000 acres in extent. The productive area in the lower sands will probably prove larger. The Niobrara formation is exposed over a small area along the crest of the dome. On the crest of dome, the



depth to the Wall Creek is slightly more than nine hundred feet. The structure is shown in cross-section (Fig. 1) and stratigraphy in columnar section (Plate 1) and well log (P. 59).

The first well drilled in the field was brought in a gusher in 1908 at a depth of 1,175 feet with an initial production of 600 barrels. Previous to this oil had been obtained in the shale at depths ranging less than 100 feet at many locations. Oil had been oozing from a spring, and locators had filed over the area twenty years earlier. Both Aughey, Territorial Geologist, and Knight, Professor of Geology at the State University, had visited this spring years before, but it remained for Dr. Porro, a Milanese geologist, to recognize the possibilities and recommend drilling to the underlying Benton sands.

In spite of the infamous Federal land withdrawals and the persecution of operators by government agents under the pretext of fraudulent entry, the field has been developed to exceed 5 million barrels annual production. Two pipe lines carry the crude to Casper where the Standard refineries (Midwest and Indiana) skim and crack it, producing a process gasoline from a blend of about 50% motor spirits and 50% gasoline. As the crude is sulphur-free and with but a trace of asphalt, high grade products are produced at minimum cost.

That this field can be caused to produce much more heavily is beyond question. That the lower sands of the Frontier series will be found productive when drilled is not doubted. In view of the fact that the ownership of the lands can not be split up into small holdings, it is reasonable to expect that overdrilling will not occur, and that under the efficient field management, which now seems certain, the life of the field is sure to be a long one.

## SHANNON

T. 41 N., R. 79 W., Natrona County

The Shannon sandstone of the Pierre formation forms an escarpment about the Salt Creek Dome. This sandstone formed, at one time, an oil reservoir and the outcrop still shows saturation. Beginning in 1889 wells were drilled back of this outcrop and for many years a small amount of heavy paraffine oil was secured from them and freighted by teams fifty miles to Casper, where the crude was worked up into lubricants.

The field is not now producing. Its structure

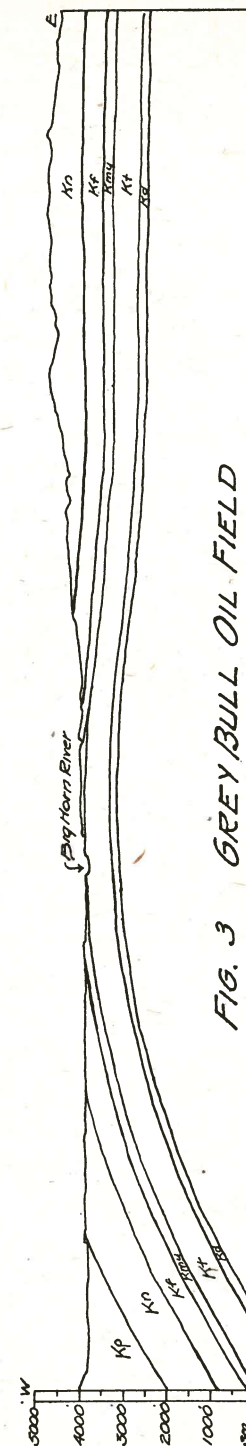
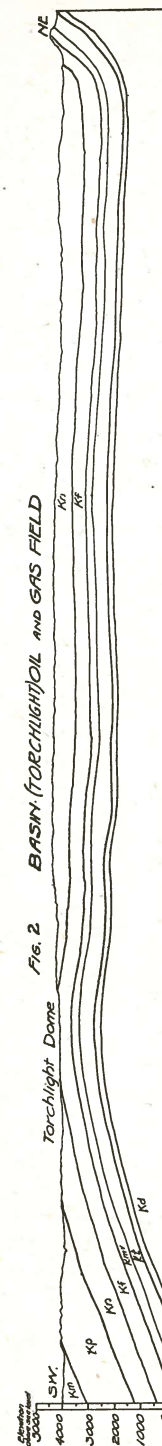


precludes the possibility of economic production. Its structure and oil are similar to Moorcroft and Rattlesnake Mountain and differ from Brenning Basin (Douglas) only in that at Brenning the Cretaceous outcrops are covered by a thick layer of horizontally-lying White River Tertiary.

BRENNING BASIN (DOUGLAS)  
T. 32 N., R. 72 W., Converse County

The Brenning Basin field lies to the southwest of the town of Douglas, which is on the Chicago & Northwestern and the Chicago, Burlington & Quincy Railroads in Converse County. This field has long been annually exploited as one of great possibilities. Even so great an authority as Sir Boverton Redwood once signed a most glowing report upon its geology. Many wells have found a little oil, others some gas, but to date the total production is not sufficient to warrant the building of a pipe line to the railroad.

The geologic structure is such that a large production is not to be expected. Many wells drilled during the past ten years have failed to find large production. It is probable that thirty days' pumping would exhaust the best well in the area. The Cretaceous rocks dip rather steeply to the northeast; have been beveled by erosion, and several hundred feet of White River Tertiary cover the one-time outcrops. What oil is found, occurs in the lower sandy layers of the Tertiary, above and surrounding the outcrops of the Benton oil-bearing sandstones. That these sandstones were fairly well drained of oil during the Tertiary erosion period, would seem certain. (Plate 1).



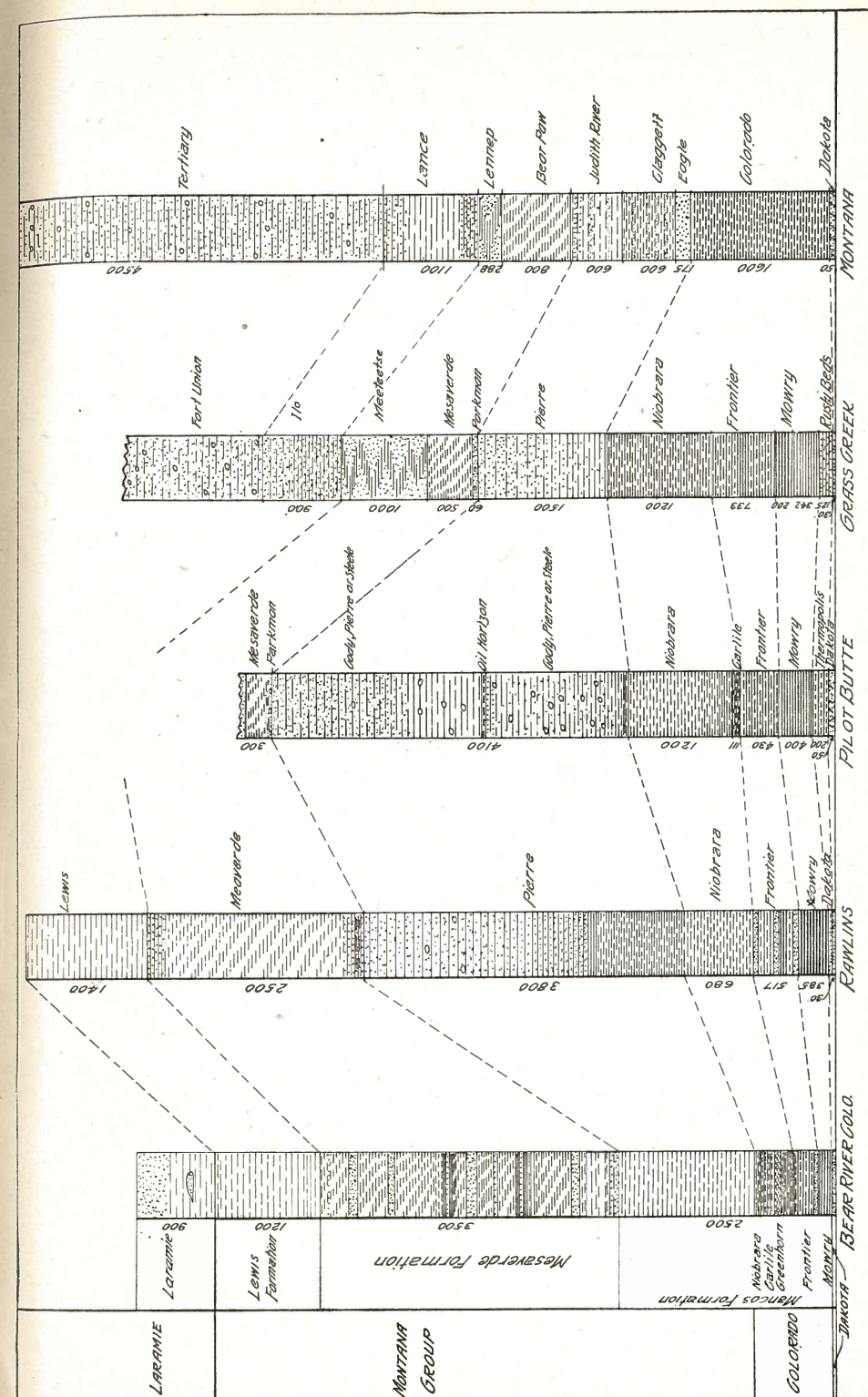


BASIN (TORCHLIGHT DOME)  
T. 51 N., R. 93 W., Big Horn County

The Torchlight dome lies a little east of Basin City in Bighorn County. Erosion has exposed the uppermost of the Frontier sandstones, but oil and gas are obtained from the lower Frontier and the Mowry. The pool is not large and all lands, with the exception of a half section on the crest of the dome, have been withdrawn by presidential order. Small folds lying northeast of Torchlight dome are producing gas for the towns of Greybull and Basin. (Fig. 2 and Plate 7.)

GREYBULL  
T. 52 N., R. 93 W., Big Horn County

The Greybull field is structurally good, although erosion has cut through the Frontier sands. Oil and gas have been and are being produced from the Mowry and Dakota which is known locally as the "Greybull sand". The pool is spotted, probably due to faulting, which has resulted in the escape of the hydrocarbons from certain fault blocks and their retention in others. A boom in the winter of 1915-1916 caused drilling on city lots. The wells were shot with heavy charges, and each well broke through, destroying the one next to it, until the area in question was ruined. A steady production is being made from the field in general, however. A refinery and a cracking plant at Greybull handle crude from Torchlight, Elk Basin and Grass Creek, as well as that being produced locally. (Fig. 3).





**ELK BASIN**  
T. 58 N., R. 99 W., Park County

The Elk Basin field lies partly in Wyoming and partly in Montana. It was drilled during the winter of 1915-1916 and oil found in two of the Frontier sands. The pool is about four hundred acres only, in size. A six-inch pipe line was built from the field to Frannie and by November, 1916, the production was up to the capacity of the pipe line. Much of the crude goes direct to Canadian refineries. The productive area of this field is controlled by the Standard Companies. This is considered one of the good, permanent fields of the State.

**GRASS CREEK**  
T. 46 N., R. 98 W., Hot Springs County

Grass Creek field in Hot Springs County, in the southwestern part of the Bighorn Basin, was drilled in the spring of 1914. It, like Elk Basin, Big Muddy, Lost Soldier and Buffalo Basin had been covered by the federal geologists years before and reports published, but withdrawals were not made until drilling operations were begun on a large scale. Fortunately,

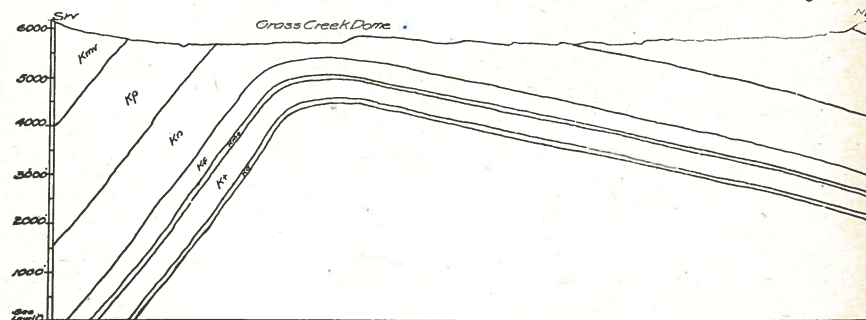


FIG. 4 GRASS CREEK OIL FIELD

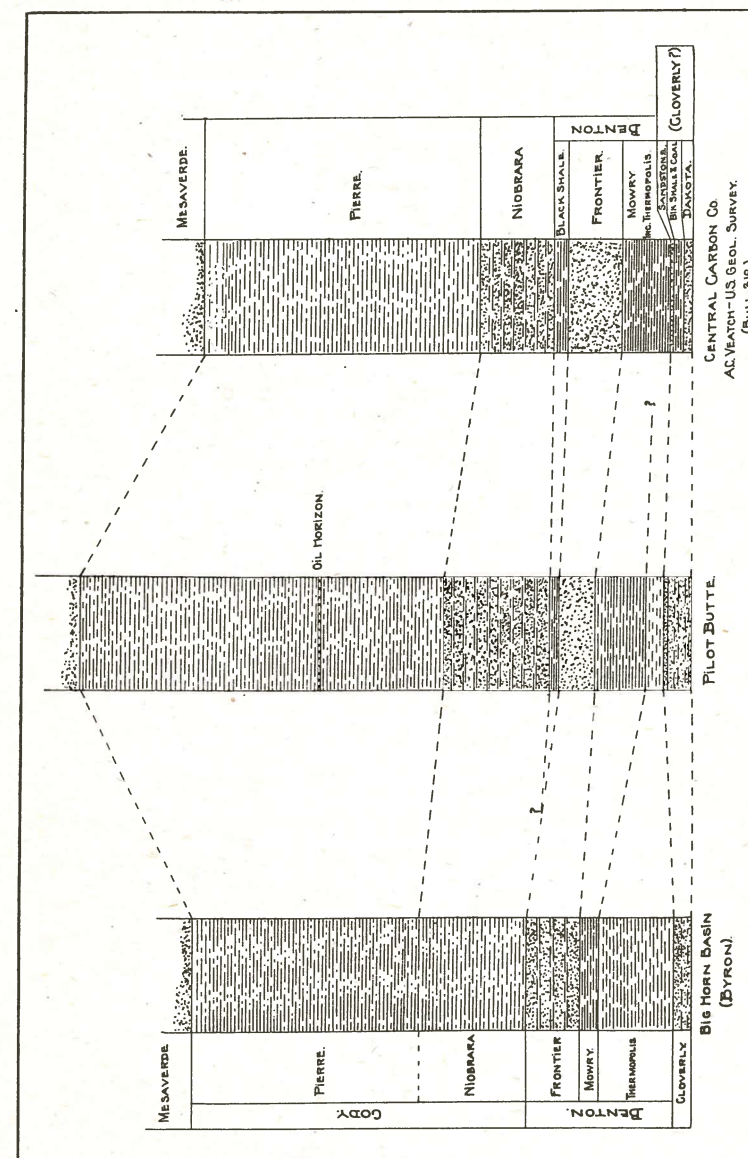


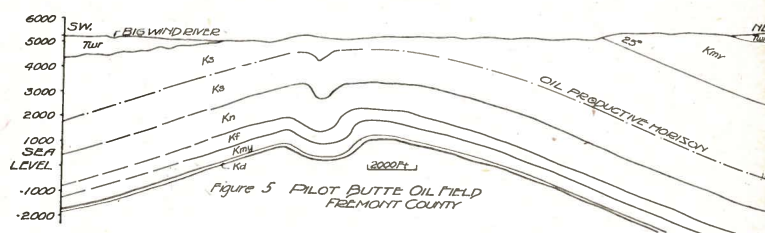
PLATE 6 COMPARATIVE COLUMNAR SECTIONS, NORTH-SOUTH, CENTRAL WYOMING



enough patented lands and state owned lands lie along the crest of the structure to permit of many wells. The production is now up to the capacity of the six-inch pipe line to the Burlington Railroad. The oil is found in the various sandstones of the Frontier formation. Of the fields in the State so far developed, this field is second only to Salt Creek in size and probable length of life. (Plate 7).

PILOT BUTTE  
T. 3 N., R. 1 W., Wind River Meridian  
Fremont County

This field was drilled in the fall of 1915, oil being obtained at the Shannon horizon in the Pierre or Cody



shales. The structure is pronounced but is so closely surrounded, and in part covered by Tertiary rocks, that an exact determination of its form is impossible. The field lies on both sides of Big Wind River, about thirty miles upstream from Riverton, in Fremont County. The lands along the crest of the dome are largely allotted Indian lands. Some on the ceded portion of the Indian Reservation north of the river are being leased by the general government under a special act passed by Congress in 1916; others on the south side of the river are leased by the Shoshone Indians as tribal lands.

The present potential production of the wells drilled to the Shannon horizon is estimated at two thousand barrels per day. A deep test well, to prospect the underlying Wall Creek and other Frontier sandstones, has just been begun early in 1917. A pipe line from this field will probably be built to both the Burlington and the Northwestern lines near the town of Shoshoni during the season of 1917.

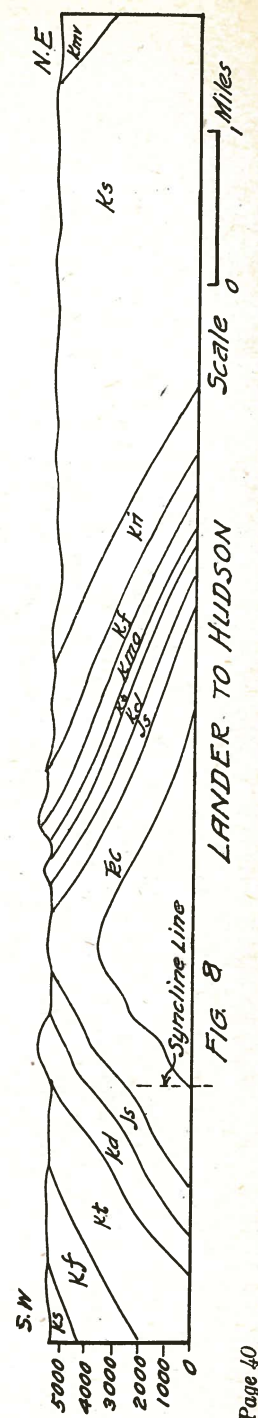
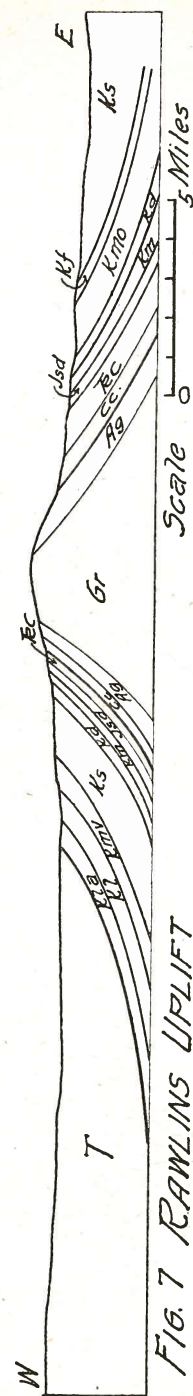
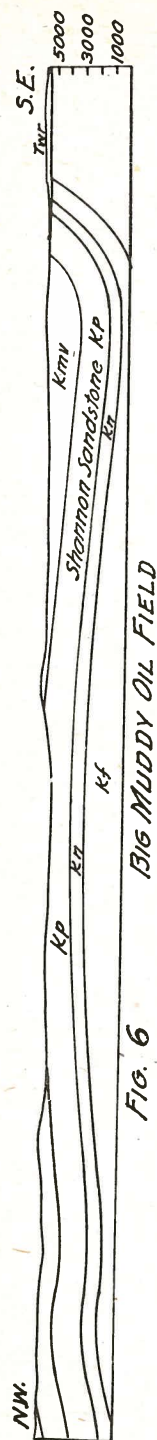
As the structure is good, and the Frontier sands likely to prove productive, this field is expected to enter the list of important producers during the year 1917. (Plates 5 and 6).

BIG MUDDY  
T. 33 N., R. 76 W., Converse County

This structure was surveyed and recommended by V. H. Barnett of the U. S. G. S. in 1913. The Federal Government did not, however, follow the report by a withdrawal. But in 1916, after drilling operations had proved the presence of oil, a blanket withdrawal was ordered.

The structure is better than the map accompanying the U. S. G. S. report shows. There is a trap of about two hundred ninety feet depth. Oil is being produced from lense pools in the Shannon sandstone along the north side of the dome. The Shannon along the crest of the dome does not seem to be economically productive. Oil has also been found in the Wall Creek two thousand feet stratigraphically below the Shannon at a depth of 3150 feet. As the dips in the enclosed portion of the fold are low, the pool will be large if it proves that the whole trap contains oil. The water line is not known, nor is it yet known whether the crest of the pool contains a gas cap or not.





As the Shannon is here very shaley, carrying only lenses of coarse sand, and has a total thickness of less than sixty feet, it is not thought possible that the production from that horizon will be very large or of long life. Should the whole trap in the Wall Creek sand contain oil, its production will rival that of the Salt Creek field. (Fig. 6).

## LOST SOLDIER

T. 26 N., R. 90 W., Carbon County

The Lost Soldier dome is in Twp. 26 N., R. 90 W., about forty miles north of Rawlins in Carbon County. This structure is small, but oil under pressure has been found in several wells at very shallow depth. There seems to be a difference of opinion among the geologists who have worked in this area, as to the position of the sands in which oil has been found. Some claim them to be Frontier, others that the oil is from the Shannon horizon.

During 1916 much prospecting was done on various parts of the Rawlins uplift, which extends from south of the Union Pacific Railroad to Lost Soldier, but no oil was found except upon the Lost Soldier structure. Further drilling is planned for 1917 and should any structural trap be found, it should prove productive. The columnar sections (Plate No. 5) given elsewhere show the great thickness of the shales and the favorable position and thickness of the Frontier sands in this part of the State. (Fig. 7).

## DALLAS

T. 33 N., R. 99 W., Fremont County

The Dallas field lies in Twp. 32 N., R. 99 W., about twelve miles southeast of Lander in Fremont



County. This area was reported as a probable oil field long before its structure was recognized, because of the brea deposits on the surface. It was mentioned by Washington Irving as having been visited in 1833 by Captain Bonneville, and was drilled in 1883, fifty years later, when gushers of black asphaltic oil from the Embar were struck.

Production from this field has never been large, due to lack of railroad facilities, and of recent years to litigation which placed the wells in the hands of a receiver. It is rumored that during the years of delay water has been allowed to enter the oil sands and that it will be difficult to put the field again into a producing condition.

#### LANDER

T. 2 S., R. 1 E., W. R. M., Fremont County

The Lander dome on the Shoshone anticline lies about three miles northeast of Lander. During the past three years (1913-1916) the Hudson Oil Company has drilled a row of wells along this narrow fold and got oil in each well. The wells have to be shot before they make an appreciable quantity of oil. In January, 1917, a well considerably off the crest of the structure was brought in with a reported production considerably greater than that of the wells drilled near the axis. (Cross section Fig 8.)

#### SAGE CREEK

T. 1 N., R. 1 W., W. R. M., Fremont County

This is the most northerly of the Shoshone anticline structures, lying in Twp. 1 N., R. 1 W., Wind River Meridian. It shows brea deposits on the sur-

face, and drill holes have found oil in the Embar horizon, but the field is not yet in the producing list. The structure is such as to warrant the expectation of a considerable production.

#### SPRING VALLEY

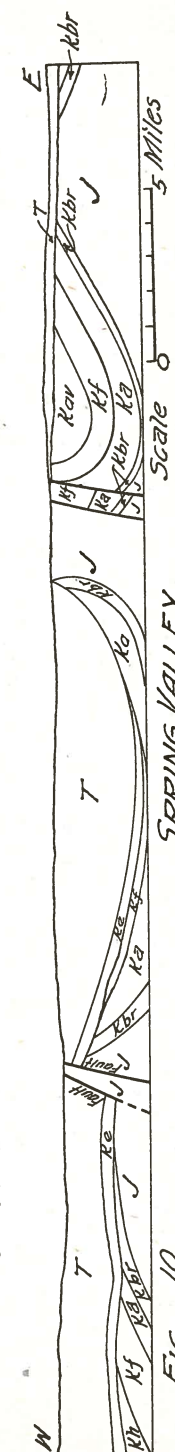
T. 15 N., R. 118 W., Uinta County

This field in Uinta County along the Union Pacific Railroad is of interest from an historical standpoint rather than from its economic or prospective value. The field was drilled in 1900 and still makes about two cars per month. The oil is probably present, due to migration, along the great fault which extends north and south for a hundred miles.

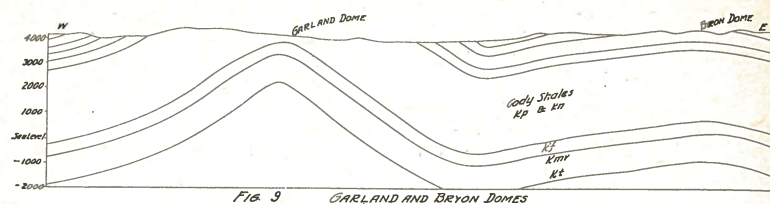
#### BYRON

T. 56 N., R. 97 W., Park County

The Byron-Garland structure is a double fold, or really a lesser fold upon the side of the greater. Oil was found in a small area on the crest of the large, or Garland, fold in the Frontier sands. Gas in great volume has been encountered in the Morrison in wells located almost exactly along the axis of the fold. Gas has also been found in smaller quantity on the secondary fold in the higher horizon. The surface of the Garland dome is eroded nearly to







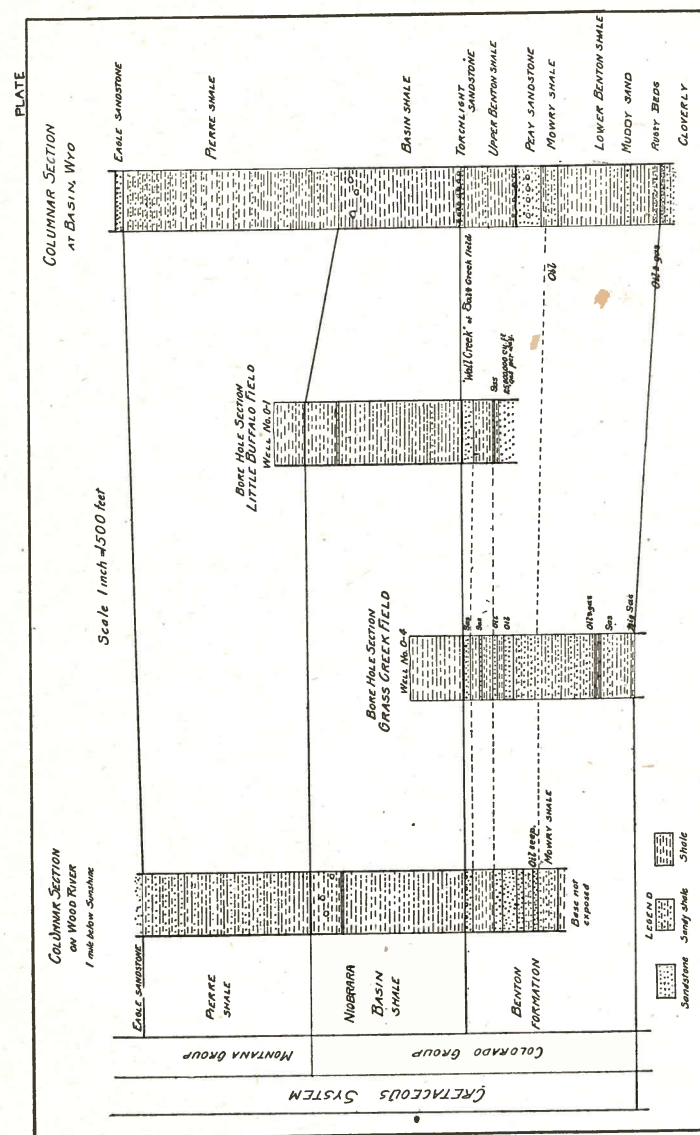
the Frontier, but on the Byron dome a little Mesaverde still remains. (Plate 6).

## GAS FIELDS

Gas has been obtained in large quantities in the following domes: Garland-Byron, Oregon Basin, Little Buffalo Basin, all in the northern part of the Bighorn Basin; and in less amount about Greybull and Basin in the same region, and on the Dry Lake dome on the Rock Springs uplift in Sweetwater County. (Fig. 11). The various oil fields are also, of course, making varying amounts of casing-head gas.

The horizon at which gas has been found is not the same in the various big fields. At Byron the heaviest producing horizon is either the Rusty Beds of the Thermopolis shale or the Morrison immediately below, the Cloverly being here absent due to erosional unconformity. At Oregon Basin the Cloverly is the big gas reservoir, at Buffalo Basin (Plate 7) one of the upper sandstones of the Frontier formation, and at Rock Springs the gas horizon seems to be even higher than the Frontier.

While gas is at present of slight economic value, these vast stores of gas will eventually become of great importance. It is hoped that further prospecting both down dip and in lower strata will develop



COMPARATIVE COLUMNAR SECTIONS, BIG HORN BASIN



oil pools below these gas pools. In many instances the gas lines condense gasoline during cold weather, and gasoline will, no doubt, be manufactured from these gases at a later date. The big gas fields are all covered by Federal withdrawals, but in every case either patented or State lands are well located and permit production despite the Federal prohibition.

### FAVORABLE PROSPECTIVE DISTRICTS

Many areas which may prove productive upon proper prospecting are known to exist. Without claiming that the list is at all complete, the writer wishes to draw attention to the following areas which have not been prospected.

There is a reported dome on the Diamond anticline in Twp. 18 N., R. 77 W., Albany County. The Benton sandstones should be at reachable depth below this structure. It is doubtful if there are any sands at the Shannon horizon in this part of the State.

The Medicine Bow dome in Twp. 21 N., R. 79 W., and the Simpson Ridge anticline in Twp. 21 N., R. 81 W., are evidently enclosed structures, but the depth to the Frontier horizon is probably too great to warrant drilling at the present time. About sixteen hundred feet of Mesaverde still cover the Medicine Bow dome, but the Simpson Ridge anticline is eroded practically to the top of the Pierre.

An area north of Saratoga in Twp. 18 N., R. 85 W., seems to offer some chance of proving to be an enclosed structure. The dips to west, north and east are easily found, but the south end of the area is covered by alfalfa fields, and probably Tertiary soil so that the

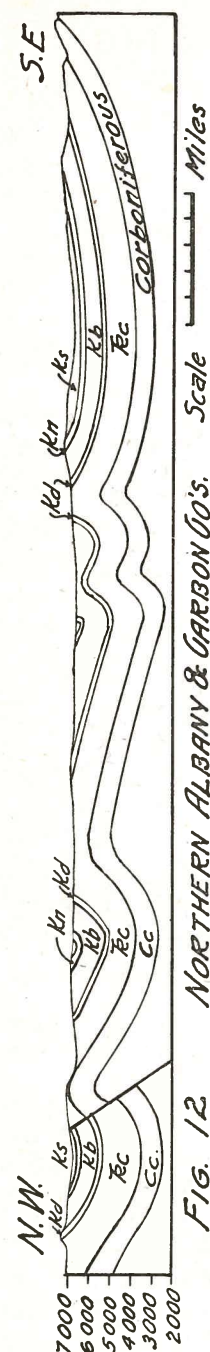


FIG. 12

NORTHERN ALBANY &amp; CARBON CO'S.

Scale

Miles

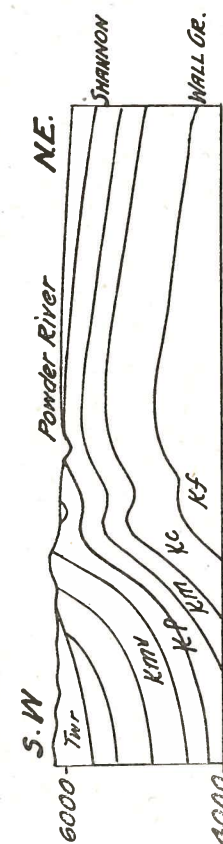


FIG. 13a POWDER RIVER JUNCTION, NATRONA COUNTY



FIG. 14

BIG SAND DRAW-ALKALI BUTTE



dips have never been found, so far as the writer knows.

In Lincoln County two rather indeterminate domes along the LaBarge anticline seem promising. On the southern, known as the LaBarge field, oil seeps into post holes dug to secure it for lubrication of ranch machinery. On the northern, or Dry Piney dome, oil was found in the shales at a depth of a hundred and eighty feet. (Plate 1).

The old Carter oil spring in Twp. 15 N., R. 118 W., while probably escaping along a fault plane, would seem to warrant intelligent prospecting.

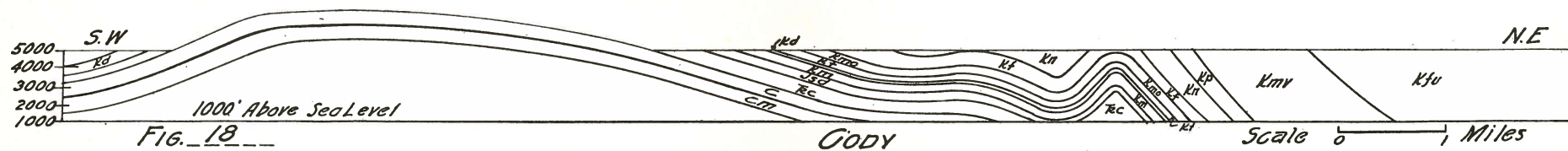
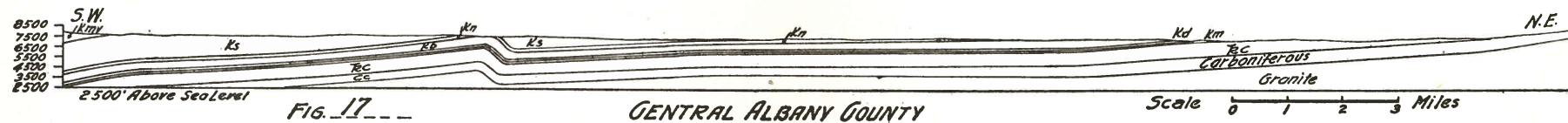
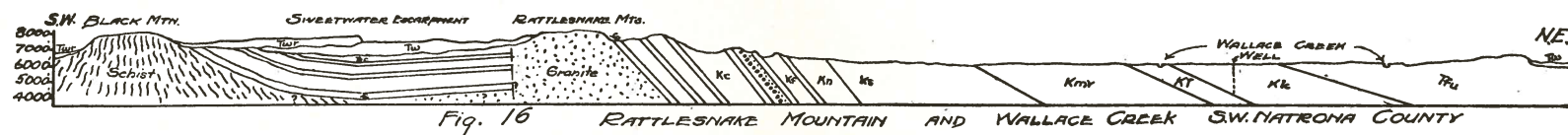
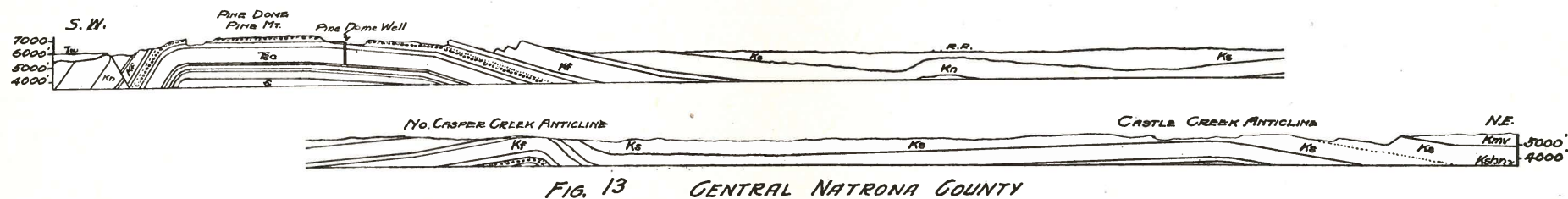
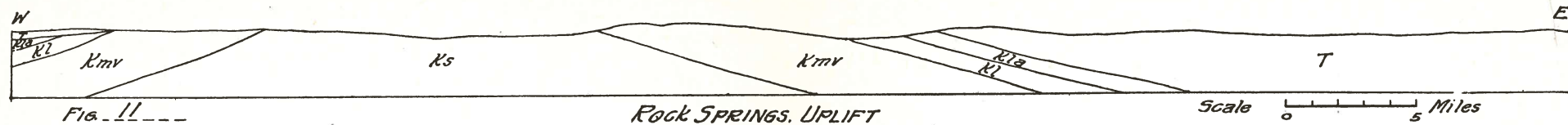
In the central part of the State several undrilled structures appear promising and are now (February, 1917) either being drilled, or preparations are being made to begin drilling in the early spring. The Powder River, or Tisdale dome (~~Fig. 13A~~), has long been known and is now being drilled. There is every reason to think that this area will prove productive of asphaltic oil.

The Wheeler, or Midway dome, Twp. 35 N., R. 79 W., is being drilled and the Shannon should be reached at about 1,900 feet, the Wall Creek about 2,000 feet deeper.

// North Casper Creek, Twp. 36 N., R. 82 W., is eroded into the top of the Frontier, but the lower sands may form a trap along the apex of the dome. Former tests on this dome were not well located. (Fig. 13).

// Big Sand Draw, Twp. 32 N., R. 95 W., should contain hydrocarbons if the structure closes. From the general structure of the region it would appear that this is an enclosed dome paralleling the larger uplifts, rather than a pitching anticline, or nose, running from the larger uplift to the east. The stratigraphy and depth here should be similar to those of Pilot Butte. It may in fact prove that Big Sand Draw







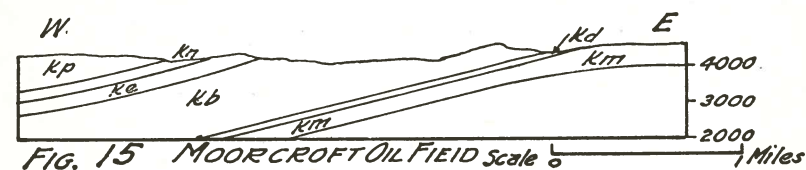
and Pilot Butte are on one and the same anticline paralleling the Shoshone anticline and being the second fold on the eastern flank of the Wind River Mountains. The exposure of Benton shale in Twp. 30 N., R. 94 W., rather encourages this idea. (Fig. 14)

Various folds on which erosion has cut through the Cretaceous rocks may be drilled to prospect the Upper Carboniferous strata, if present drilling in several places finds oil at that horizon. No attempt has been made to list such possible black oil prospective areas.

#### NON-PRODUCTIVE PROSPECTED AREAS

This class of lands is discussed because of the lessons which may be learned by observing previous failures. The great majority of failures have been upon the dip slopes back of outcropping oil-saturated sandstones. The Shannon field cannot be classed as a total failure, for it produced in a very small way for several years. The well back of the outcrop of the Shannon sandstone found a heavy, gasoline-free, paraffine base oil, which seeped in to the extent of two to five barrels per well.

The Moorcroft field is of the same character, the wells being back of the outcrop of a Benton sandstone. The production is too small to be economic.



The Douglas (Brenning Basin) field is slightly different in that here the outcrops of the Frontier are



covered by White River Tertiary and a small seepage results in each well drilled into the lower sands of the White River. There is no structure which would warrant one in expecting economic production.

In the Washakie Spring, or Plunkett field, the Mowry outcrops as the center of a sharp anticline. Oil flows from the shales, and one to three hundred foot wells, back from the outcrop, make a slight seepage of oil along with water. This field cannot in any sense be considered economic in spite of much advertising to the contrary.

Other outcrops which have been prospected are the Bonanza field in Bighorn County, the Rattlesnake and Dutton areas in Natrona County. (Fig. 16). The Big Hollow prospect in Albany County is practically of the same class, although here a plunging anticline carries the Benton sands a few hundred feet below the surface. (Fig. 17.) At Lake Valley, south of Rawlins, the deepest hole in the State, over forty-six hundred feet, was drilled on a plunging anticline. Both oil and gas were found in the Frontier sands, but not in commercial quantities.

The Gooseberry dome, Twp. 47 N., R. 100 W., is a very small dome directly behind or up-dip from the great Little Buffalo Basin dome. The syncline between the two is very sharp, and the smaller structure has no "drainage area". Buffalo Basin has gas in the upper Frontier sands but the little dome proved to be water-bearing in every sand. At the town of Cody several holes have been drilled during the past ten years on sharp anticlines which are eroded into the Frontier formation. (Fig. 18.) Some oil and gas has been found by nearly every well but evidently the quantity obtained is too small to be economic.

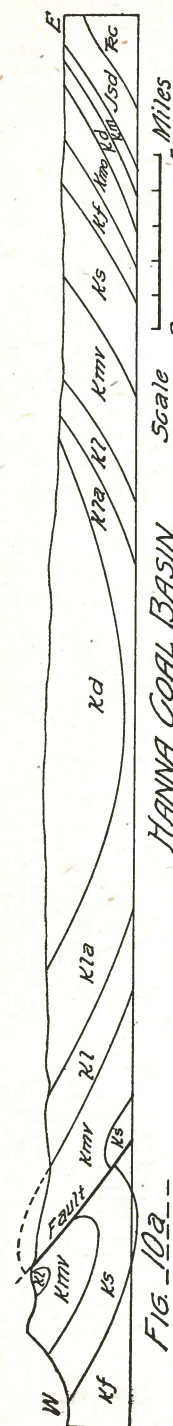


FIG. 10a

Other failures have resulted where drilling has been done "off structure". This has occurred in some cases where "practical oil men" have come into the State and chosen locations without respect to the geology; others have occurred because the locator thought he had found a "dome", but in fact he had not. The worst geologic fiasco was probably the location of a well by a self-styled "geologist" who mistook overturned shales, due to hill-slip, for rock in place, and caused the expenditure of fifty thousand dollars on a well which never got through the shales.

While the State has, of course, a record of many "wildcat" failures, it is true that there have been practically no failures upon proper structure. Economically, of course, the striking of gas at the present time, instead of oil, may spell failure. But either gas or oil has been found in almost every perfect structure drilled. While the Gooseberry dome was a failure, it has always been adversely reported upon by ge-

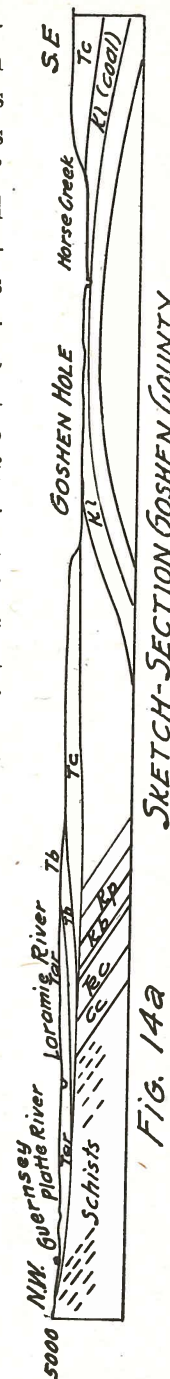


Fig. 14a



ologists because of its position with reference to the other folds in the district. It was finally drilled by people who accepted the favorable report of a county surveyor.

### WELL LOGS

The following well logs are chosen so as to give one or more typical logs of each of the different parts of the State. This is done so that one may have a more detailed knowledge of the stratification than is given in the columnar sections, as well as to give some idea of the difficulties encountered and the different strings of casings required. The logs given are not necessarily those of particular wells; in some cases portions of two or more logs have been combined to form the log printed.

#### ALKALI BUTTE, FREMONT COUNTY

T. 33 N., R. 94 W.

0 to	35	Soil and clay
35 to	174	Dark shale
174 to	177	Hard sand rock
177 to	184	Soft sand (some oil and gas)
184 to	230	Soft muddy sandstone
230 to	825	Soft dark shale
825 to	1070	Hard shells of dark sand rock
1070 to	1190	Hard dark shale
1190 to	1900	Soft dark shale
1900 to	2017	Soft shale, lighter color
2017 to	2947	Shale without change

This well is entirely in Pierre shale.

#### BIG MUDDY LOG. (*Crest of Dome*)

T. 33 N., R. 76 W.

Surface Pierre shales.		
0 to	190	Shale
190 to	215	Water sand
215 to	870	Shale
870 to	920	Cavey shales (very bad)

920 to	965	Shannon
965 to	2990	Shale
2990 to	3000	Fine sand
3000 to	3035	Shale
3035 to	3040	Fine sand
3040 to	3160	Wall Creek

#### BRENNING BASIN, DOUGLAS, CONVERSE COUNTY

T. 32 N., R. 72 W.

Surface White River Tertiary.

0 to	325	Gray shale (surface water at 50 ft., more water at 120 ft.)
325 to	335	Muddy sand
335 to	370	Sticky dark shale
370 to	385	Light red rock
385 to	420	Gray sand
420 to	490	Black sand (oil show)
490 to	705	Black shale (heavy oil at 550 ft. to 625 ft.)
705 to	790	Gray sand (water at 710 and 740 ft.)
790 to	795	Dark shale (oil show)
795 to	796	White water sand
796 to	810	Hard limestone with shells
810 to	812	Light soft shale (oil show)
812 to	820	White water sand
820 to	848	Artesian water sand
848 to	855	Very hard limestone
855 to	863	Dark red shale
863 to	870	Light sandy shale
870 to	881	Blue and brown shales
881 to	883	Coarse gray sand
883 to	936	Bluish gray shale
936 to	940	Pink shale
940 to	951	Maroon shale
951 to	955	Very hard green rock
955 to	960	White rock mixed pink and green shale
960 to	990	Mottled pink, brown and yellow shale

This well passed through the Tertiary and 200 feet of Morrison. Well abandoned as worthless, typical of area.

#### BUFFALO BASIN, PARK COUNTY

T. 47 N., R. 99 W.

Surface in Cody shales (Pierre)		
Shale where not sand.		
480 to	505	Greenish sand (dry)
1220 to	1235	Black sand (dry)



1465 to 1475	Black sand (water)
1475 to 1495	Hard sand (dry)
1495 to 1510	Hard sand (water)
1510 to 1540	Hard sand (dry)
1688 to 1702	Sand (dry)
1730 to 1735	Sand (dry)
1735 to 1750	Sand (gas)
1750 to 1767	Sand (gas and water)
1767 to 1792	Sand (big gas)
924 feet of 12½-inch casing.	
1475 feet of 10-inch casing.	
1756 feet of 8¼-inch casing.	

Estimated to make 30,000,000 feet of gas per day.

#### BYRON, BIGHORN COUNTY

T. 56 N., R. 97 W.

Surface in Pierre shale.

0 to 40	Clay
40 to 425	Shale
425 to 456	Green sand and shell
456 to 1085	Brown and blue shales (Water at 764 and 810 ft. Gas at 964 ft.)
1085 to 1180	Sand (base of Frontier)
1180 to 2068	Shales and sands (Oil and gas at 2028 ft.)
2068 to 2082	Red rock and shale (Morrison)
2082 to 2101	Red shale
2101 to 2169	Sandstone (oil and gas)
2169 to 2170	Hard shell
2170 to 2180	Red rock

#### COTTONWOOD CREEK, NATRONA COUNTY

T. 37 N., R. 85 W.

The surface is here a little below the Wall Creek sandstone.

0 to 30	Earth
30 to 80	Dark sandy shale
80 to 125	Second Wall Creek sandstone
125 to 255	Dark shale
255 to 275	Gray sandstone
275 to 365	Black shale
365 to 395	Sandstone
395 to 600	Black shale (Carlile)
600 to 700	Shale
700 to 800	Soft shale (two beds Bentonite 8 ft.)
800 to 910	Light sandy shale (Mowry)
910 to 970	Sandstones (artesian, hot sulphur water) Dakota
970 to 975	Drab shale

#### DRY LAKE, ROCK SPRINGS, SWEETWATER COUNTY

T. 18 N., R. 103 W.

Surface some 2,000 feet below the Mesaverde.

0 to 1535	Brown shale
1535 to 1536	Hard shell (lime)
1536 to 1690	Brown shale
1690 to 1850	Shale
1850 to 1851	Shell
1851 to 1857	Shale
1857 to 1885	Gas sand
1885 to 1887	Shell
1887 to 1904	White shale (talc)
1904 to 1914	Sand (little water)
1914 to 1957	Shale
1957 to 2008	Sand (oil showing)
2008 to 2390	Dark shale with many hard shells
2390 to 2396	Sand

Log incomplete, still drilling.

#### GRASS CREEK, HOT SPRINGS COUNTY

T. 46 N., R. 98 W.

Surface in Niobrara shales.

423 to 460	Gas sand
530 to 550	Gas sand
640 to 681	Oil sand
728 to 804	Oil sand
1426 to 1441	Small amount oil and gas
1443 to 1463	Gas sand
1685 to 1688	Gas sand
1688 to 1695	Dry sand
1700 to 1715	Big gas sand (6,000,000 ft.)
1739	Water sand

#### LANDER, FREMONT COUNTY

T. 33 N., R. 99 W.

Beginning in the "Red Beds."

0 to 15	Soil
15 to 30	River gravel
30 to 60	Red sandstone
60 to 70	Water sandstone



70 to 85	Gray sandstone
85 to 170	Red sandstone
170 to 220	Water sandstone
220 to 495	Red sandstone
495 to 510	Gray sandstone
510 to 630	Red sandstone
630 to 640	Lime shell
640 to 1010	Red sandstone
1010 to 1100	Lime cap rock
1100 to 1160	Sand oil
1160 to 1245	Shale and slate
1245 to 1285	Sandy lime
1285 to 1320	Soft white shale
1320 to 1355	White shale
1355 to 1362	Sandy shale
1362 to 1372	Oil sand
1372 to 1400	Shale

Well productive, after shooting, about 50 barrels per day.

#### LAKE VALLEY, RAWLINS, CARBON COUNTY T. 20 N., R. 88 W.

0 to 8	Clay
8 to 75	Black shale
75 to 1020	Shale
1020 to 1030	Limestone shell
1030 to 1200	Black shale
1200 to 1310	Sandy shale
1310 to 1450	Sand and sandy shale
1450 to 1775	Brown shale
1775 to 1880	Sandy shale
1880 to 1930	Shale
1930 to 2000	Sandy shale
2000 to 2915	Black shale
2915 to 3085	Sand, dry (top of Frontier)
3085 to 3140	Shale
3140 to 3180	Sand, dry
3180 to 3190	Shale
3190 to 3245	Sand, dry
3245 to 3440	Black shale
3440 to 3460	Sand (about 10,000 ft. of gas)

Well stood open two weeks and began to make water which drowned out the gas. Water from below. This well located on pitching anticline south of Rawlins. A former nearby well had found oil in the shale at shallow depth.

#### OREGON BASIN, PARK COUNTY T. 51 N., R. 100 W.

##### Surface Pierre or Cody shales.

0 to 50	Dark shale
50 to 70	Greenish sand
70 to 115	Shales
115 to 125	Water sand
125 to 163	Shales
163 to 185	Sand (oil and gas)
185 to 208	Muddy sand
208 to 237	Dark shale
237 to 261	Water sand
261 to 277	Dark shale
277 to 285	Water sand
285 to 288	Bentonite
288 to 290	Green gravel
290 to 295	Firm hard sand
295 to 370	Dark sandy shales
370 to 374	Dark sand (oil and gas)
374 to 415	Shales
415 to 419	Hard lime and sand
419 to 430	Black shale
430 to 433	Bentonite
433 to 507	Hard sandy shales
507 to 582	Dark shales
582 to 585	Bentonite
585 to 621	Lighter shales
621 to 630	Hard black sand
630 to 777	Shales (oil and gas at 72 ft.)
777 to 797	Black sand
797 to 907	Dark shales (oil and gas at 784 ft.)
907 to 917	Light muddy sand
917 to 1077	Dark shales (gas in sand streak at 1039 ft.)
1077 to 1250	Light shales
1250 to 1328	Broken sands (increasing gas, estimated 5,000,000 ft.)
1328 to 1340	White sands (more gas)
1340 to 1357	Pink shales
1357 to 1361	Hard black sand (black oil)
1361 to 1430	Variegated shales
1430 to 1470	Grey and white shales
1470 to 1478	Red and pink lime
1478 to 1480	Hard red sand
1480 to 1495	Broken pink lime
1495 to 1498	Red shale
1498 to 1540	Red and white



PILOT BUTTE, FREMONT COUNTY  
T. 3 N., R. 1 W. Wind River Meridian

Surface in Pierre shale.

0 to	25	Gravel
25 to	40	Gravel with water
40 to	110	Shale
110 to	175	Gray shale
175 to	260	Light blue shale
260 to	530	Blue shale
530 to	615	Sandy shale with sand streaks (oil and gas)
615 to	620	Shale

0 to	22	Gravel
22 to	32	Sand (water)
32 to	41	Shale
41 to	570	Dark and blue shales
570 to	685	Sandy shale (oil showing)
685 to	770	Shale
770 to	815	Dark shales (oil at 790)
815 to	865	Sandy shale
865 to	875	Blue shale
875 to	1028	Sandy shale and slate
1028 to	1040	Gray sand (oil)
1040 to	1067	Shale

ROCKY FORD, CROOK COUNTY  
T. 52 N., R. 62 W.

0 to	20	Surface, "Red Beds"
20 to	50	Minnekahta limestone
105 to	175	Opeche redbeds
175 to	235	Sand (with oil 10 to 20 ft.)
235 to	247	Lime
247 to	285	Lime, sand and gypsum
		Oil zone, 5 ft. deep
285 to	345	Lime shale
345 to	369	Sand and shale with gas
369 to	383	Sand and gypsum with oil
383 to	402	White lime
402 to	417	Sandstone (oil and gas show)
417 to	470	Lime, shale and gypsum
470 to	560	Sand (oil show)
560 to	565	Black shale
565 to	600	Lime, gyp and black shale
600 to	635	Sand and soft shale

Not on structure and of no economic importance.

SAGE CREEK (TAR SPRINGS) FREMONT COUNTY  
T. 1 N., R. 1 W. Wind River Meridian

In the "Red Beds."

0 to	25	Soil and gravel
25 to	65	Red rock
65 to	165	Soft blue clay
165 to	171	Lime (water)
171 to	300	Soft blue clay (water and oil showing)
300 to	350	Blue shale (water)
350 to	355	Lime (warm sulphur water)
355 to	405	Blue slate
405 to	420	Brown sandstone
420 to	500	Slate
500 to	540	Lime (warm sulphur water)
540 to	555	Soft blue clay
555 to	570	Lime
570 to	575	Flint
575 to	600	Lime with oil
600 to	625	Lime
625 to	675	Sand (stronger flow of oil)
675 to	800	Very hard formation

Well was abandoned without shooting

SALT CREEK, NATRONA COUNTY  
T. 40 N., R. 79 W.

Surface in the Niobrara shales.

0 to	15	Loose surface sand
15 to	90	Dark blue shale (shale oil at 90 ft.)
90 to	700	Dark blue shale (shale oil in quantity)
700 to	1220	Dark blue shale
1220 to	1295	Sand (much gas and little oil)

Shot with 180 quarts of nitroglycerine, produced over 200 barrels.

0 to	1123	Shale
1123 to	1202	Oil sand

Sand was shaley. Did not show much gas until in sand 75 feet, when it started to flow every fifteen minutes, making 600 barrels. There was no shale oil.

Show of oil at 90 feet  
Shale to 1015 feet

At 300 feet produced 3 to 4 barrels of oil per day  
Oil sand at 1015, bottom at 1115  
Several small pockets of gas struck while drilling  
Production 100 barrels per day



## SHANNON, NATRONA COUNTY

Surface in the Pierre shales.		
0 to 700	Shale	
700 to 745	Water sand	
745 to 1082	Shale	
1082 to 1090	Sand	
1090 to 1145	Water sand	
1145 to 1160	Shale	
1160 to 1180	Oil sand (Shannon)	

Cased with six and five-eighths-inch casing to 1145 feet.

## PIPE LINES

Name not known	Dallas to Wyopo	4-in.	10 mi.
Mont.-Wyo. Pipe Line	Byron to Cowley	4-in.	8 mi.
Natrona Pipe Line	Salt Creek to Casper	6-in.	50 mi.
Midwest Pipe Line	Salt Creek to Casper	8-in.	50 mi.
Illinois Pipe Line	Grass Creek to Chatham	6-in.	30 mi.
Illinois Pipe Line	Elk Basin to Frannie	6-in.	30 mi.
Illinois Pipe Line	Muddy Creek to Casper	6-in.	18 mi.
Small lines from Torchlight and Greybull wells to Greybull Refinery.			

## TO BE BUILT SEASON 1917

Pilot Butte to Shoshoni	6-in.	40 mi.
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## REFINERIES

Midwest Refinery Co., Casper.	Handling crude from Salt Creek and Big Muddy.
Standard Oil Co. of Indiana, Casper.	Cracking residues from Midwest Refinery
Standard Oil Co. of Indiana, Greybull.	Cracking residues from Greybull Refinery.
Greybull Oil and Refinery Co., Greybull.	Handling crude from Grass Creek, Greybull, Basin and Elk Basin.
Mont.-Wyo. Oil and Refinery Co., Cowley.	Crude from Byron and other Bighorn Basin fields.

## PRODUCTION BY YEARS, 1894-1916

YEAR	BARRELS	PRICE PER BBL.	VALUE
1894	2,369	\$6.72	\$ 15,920.00
1904	11,542	7.00	80,794.00
1911	186,695	.664	124,037.00
1912	1,572,306	.507	798,470.00
1913	2,406,522	.493	1,187,232.00
1914	3,560,375	.472	1,679,192.00
1915	4,245,525	.522	2,217,018.00
1916	6,700,000		

It is certain that the production of 1917 will make a larger percentage increase over that of 1916 than 1916 did over 1915. Elk Basin was making production during only part of 1916, and Big Muddy and Pilot Butte should make themselves felt during 1917, as well as possible production from other now prospective fields which may be making a production during the year. Of black oil production the Lander field will show an increase, while Sage Creek probably will not produce during the year. The old Dallas field may get back into production, as it is reported that the legal difficulties have been removed.

There are no statistics available regarding gas production. Basin City, Greybull, Lovell and Cowley are now using gas for domestic purposes. The sugar mill at Lovell operates on gas, and a casing-head gas and lampblack plant is reported to be building at Cowley. Other large manufacturing plants are rumored, but the public does not know of a certainty that such will be built. Several attempts have been made to interest the zinc smelting industry in the large gas fields, but without success to date.



## LAND TITLES

### PUBLIC LANDS

Until Congress passes a leasing law the public lands may be claimed under the placer law. The Act of February 11, 1897 (29 Stat. 526) provides:

"that any person authorized to enter lands under the mining laws of the U. S. may enter and obtain patent to land containing petroleum or other mineral oils, and chiefly valuable therefor, under the provisions of the laws relating to placer mineral claims".

A placer claim usually consists of 160 acres located by an association of eight individuals, but may be of smaller area in multiple of twenty, by using as many names as there are twenties in the claim.

Under the Federal law, discovery of mineral in place is prerequisite to location. Regarding discovery on petroleum placer claims Lindley says in part:

"Discovery is just as essential in case of placers as it is in lode locations. The supreme court of California at one time expressed the view that neither the federal laws nor the local rules and customs of miners required that a discovery should be made as a prerequisite to a placer location, but this is obviously a mere dictum; it is also opposed to the current of judicial authority. The land department has uniformly held that discovery is essential in the case of placers, going so far at one time as to hold that such discovery was essential in each twenty-acre tract within a location of one hundred and sixty acres located by an association of persons.

"In the case of petroleum deposits the courts in California have in recent years been confronted with some serious problems upon the subject of what constitutes a sufficient discovery which will sanction a location of a claim to oil lands under the laws applicable to placers. It is well known that the natural habitat of this class of mineral hydrocarbons is in stratified rock some distance below the surface, and except for the occasional appearance at the surface in the form of oil seepages, springs, or other indications of the subterranean existence of petroleum, there is nothing to guide the miner in making his location. It requires more or less extensive development in the nature of well boring and prospecting to determine the nature, extent, and permanency of the deposit.

"Of course, exploitation on adjacent lands might raise a strong presumption that a given tract contained petroleum. An oil-producing well within each of four sections of land surrounding a fifth would produce a conviction that the oil deposit was underneath the fifth section. This fact might justify the land department in classifying the section in the category of mineral lands, or the government surveyor in returning it as such, but it would not dispense with the necessity of making a discovery."

The local courts in Wyoming have been protecting locators in their possessory right previous to discovery, where they were at work drilling in an effort to make discovery.

Recent decisions have upheld the so-called "validation discovery", *i. e.*, the finding of "colors" or "rainbows" in the drillings from shale holes only a few feet deep. Should the Supreme Court affirm such decisions, the difficulties of the "discovery"



clause of the law will vanish, for it is possible to secure such "colors" or "rainbows" from almost any of the black shales in the Colorado and Montana formations. The Interior Department is, of course, attempting to make the legal definition of "discovery" to read "oil in commercial quantity".

After discovery has been made (but not before) it is necessary to do the annual assessment work to the amount of one hundred dollars per claim, until work to the amount of five hundred dollars has been performed, when the claimant can make application for patent, and upon payment of fees and acreage charges may eventually receive patent from the Government. Theoretically the procedure is very simple; practically, the Government bureaus have been able to prevent almost every claimant from receiving his patent.

#### WITHDRAWN LANDS\*

While a vast area of land within the State has been withdrawn from all forms of entry by presidential order, such withdrawals are not really affecting the production of the State to any appreciable extent. The greatest harm has been done on Salt Creek, but even here there are enough drilled lands to entirely drain the pool, given time enough. The Teapot dome at the south end of the Salt Creek field is the only Naval Reserve in the State. It has never been drilled, so its contents are not known.

Titled, State and unquestioned claim lands on Grass Creek make it possible to drain the field in spite of attempted prohibition by the Federal Government. Elk Basin had *bona fide* "discoveries" on every valuable claim before the withdrawal was made.

\*Petroleum Withdrawals and Restoration affecting the Public Domain. Max W. Ball, U. S. G. S. Bull. 623.

Many of the areas withdrawn are not attractive at all to prospectors. In fact it is a puzzle to understand why certain withdrawals were made.

Of the recent withdrawals at Elk Basin, Big Muddy, Lost Soldier, Rock Springs, and even Little Buffalo Basin and Grass Creek, although the U. S. G. S. had made surveys and published reports years before, no withdrawals were made until after certain interests had secured well-located lands, or had investigated the area and decided not to secure lands and prospect them. This peculiar series of coincidences is one of the main reasons why the smaller oil men of the State have so strenuously fought the passage of a Federal lease law. They consider that they would have no chance of securing leases on promising wildcat areas even, and certainly none on proved areas.

Should a lease law pass it is not probable that the withdrawn lands would be available for drilling very soon after its passage. The law making the lands of the ceded portion of the Shoshone Indian Reservation subject to lease, was passed in September, 1916, and in February, 1917, the lands are still unleased. The Department of the Interior, either through intent to delay or because of inefficiency, has not yet completed its rules and regulations to govern the leasing of such lands. It is a mistake which costs the West very dearly that when Congress passes land laws, it leaves so much "to the discretion of the Secretary of the Interior".

#### STATE LANDS

Sections Nos. 16 and 36 in each township were patented to the State of Wyoming as public school lands. Besides these there is much other land which



has been selected without regard to section numbers or township location. These "State lands" are all leasable under the two forms of lease which follow.

#### OIL AND GAS PROSPECTOR'S LEASE

THIS INDENTURE, Made and entered into this.....day of....., A. D. 19...., by and between the State of Wyoming, through its State Board of.....Land Commissioners, party of the first part, and..... of the County of....., State of Wyoming, party of the second part:

WHEREAS, Said party of the second part has made application for an oil and gas prospector's lease, under the provisions of the laws of the State of Wyoming, on.....

NOW, THEREFORE, THIS INDENTURE WITNESSETH, That the said party of the first part, for and in consideration of the application aforesaid, the representations therein made and the covenants and agreements hereinafter mentioned to be kept and performed by the said party of the second part, his legal representatives or assigns, and upon the further consideration of the sum of One Hundred (\$100.00) Dollars rental paid by the said party of the second part, the receipt of which is hereby acknowledged, has demised and leased to the said party of the second part the lands hereinbefore described for the purpose of prospecting for oil and gas.

TO HAVE AND TO HOLD the said above described premises, with the appurtenances, unto the said party of the second part, his executors, legal representatives or assigns for the term of one year from the .....day of....., 19...., and the said party of the second part, in consideration of the issuance of the prospector's lease on the premises aforesaid by the said party of the first part to the said party of the second part, does covenant and agree to and with the said party of the first part to expend in development work, buildings or machinery during the term of this lease not less than Five Thousand (\$5,000.00) Dollars in prospecting said lands for oil and gas, and the said lessee herein especially agrees that he will, on or before the.....day of....., 19...., commence the active work of drilling upon

said lands, such drilling to be diligently and continuously pursued to the extent that during the term of this lease, a standard oil well shall have been drilled on the said lands to a sufficient depth to thoroughly prospect and test said lands for the discovery of oil and gas thereon, and if the said lessee shall discover oil or gas on the said lands sufficient for commercial production, that the said lessee shall have the right to a five-year lease on the said lands upon such terms and conditions as may be fixed by the Board. That if oil or gas shall be discovered in commercial quantities on the said lands, the lessee agrees to protect the oil and gas that flow from said lands from waste and immediately surrender this lease and take out a development and operating lease on the said lands, upon such terms and conditions as may be fixed by the Board.

It is understood and agreed that if oil or gas is discovered in commercial quantities on the premises described herein and this prospector's lease shall be surrendered to the State Board of.....Land Commissioners and an operating lease taken out under the preference accorded said second party, that the annual rental to be charged under the terms of such operating lease shall not be in excess of.....Dollars, and the royalty to be paid to the State upon the oil or gas produced from the premises described herein, under said operating lease, shall not exceed.....per cent. of the oil or gas produced from said land.

The said party of the second part shall keep a correct log of each well drilled under the terms of this lease, showing the important formations passed through, the depth at which each formation was reached, the thickness of each formation, the water bearing formations and the character of the water therein, elevation to which the water rises, the number of feet of casing set in such well and where placed, its size and the total depth to which such well was drilled, and shall, within thirty days after the completion of each well, file a copy of said log certified to by the person who made the log, in the office of the Commissioner of Public Lands.

The party of the second part further agrees that if oil or gas shall not be discovered in commercial quantities on said land but water is encountered which flows in such force as to flow out of the top of the well, then in that case the party of the first part shall have the right to elect to pay the cost of the casing that is



in the well, and the party of the second part agrees to leave the casing in the well, in so far as is necessary to protect the flow of water from such well, upon the payment by the party of the first part to the party of the second part of the cost of such casing.

It is especially understood and agreed by and between the parties aforesaid that no assignment of this lease shall be made by the party of the second part except with the consent and approval of the party of the first part.

It is understood that this lease is made subject to all legally established rights of way heretofore granted, or that may be hereafter granted, over and across said lands, lessee herein to close gates and otherwise protect property and rights of grazing lessee.

It is expressly understood that this lease carries with it the power to enter upon, occupy and enjoy such surface areas of said described tract as are necessary for the prospecting, developing, mining, drilling wells and for the construction of all buildings and other surface improvements incidental to the work contemplated by this lease.

Default in and of any of the covenants herein contained shall render this lease subject to cancellation at the option of the State Board of.....Land Commissioners, and upon thirty days' notice by the party of the first part to the party of the second part that the term has been declared ended, the said party of the second part agrees to surrender the peaceful possession of the premises to the party of the first part.

IN WITNESS WHEREOF, Said party of the first part hath caused these presents to be signed by its President and countersigned by the Commissioner of Public Lands, and its seal to be hereunto affixed; and the party of the second part has hereunto set his hand and seal the day and year first above written.

President State Board of .....Land Commissioners.

Lessee.

#### OIL AND GAS LEASE

THIS INDENTURE OF LEASE, Made and entered into this .....day of....., 19...., by and between THE STATE OF WYOMING, through its State Board of.....Land Com-

missioners, party of the first part, and....., of the city of....., State of....., party of the second part,

(1) WITNESSETH: That the said party of the first part, for and in consideration of an annual rental of.....Dollars (\$.....) to be applied upon a royalty hereinafter specified and agreed to and payment of which shall be made as hereinafter provided, does hereby lease unto the said party of the second part, his successors and assigns, .....

containing.....acres, more or less, for the purpose of drilling, boring, operating for and producing therefrom, mineral oil and gas, with the right and privilege of using so much of the surface of said land as may be necessary for rights of way over said premises for pipes, pipe-lines, roads, trails, flumes, ditches, and right to use and place on said premises oil and water tanks, machinery, derricks, buildings and telephone lines, necessarily used in connection with the development and operation under this lease and for all purposes connected with the business or work that may be carried on by reason of, or in pursuance of the rights and privileges granted by this lease.

(2) TO HAVE AND TO HOLD the said above described premises, with the appurtenances, unto the said party of the second part, his successors and assigns, for the term of five years from the beginning of the day of the.....day of....., 19....

(3) The said party of the second part, in consideration of the issuance of this lease on the premises aforesaid by the said party of the first part to the said party of the second part, does covenant and agree to and with the said party of the first part, to pay a minimum annual rental unto the State of Wyoming, payable in advance at the office of the Commissioner of Public Lands of said State, of the sum of.....Dollars (\$.....) to apply upon a royalty hereinafter specified and agreed to.

(4) The said party of the second part further agrees, in consideration of the granting of this lease, to pay unto the State of Wyoming, at the office of the Commissioner of Public Lands, as royalty on the production of oil and gas from said described land, ten per cent. (10%) of the market value of the crude oil and gas produced from said land at the mouth of the wells thereon,



or, at the option of the party of the first part, to deliver to said party of the first part, at the mouth of the wells on said lands, as royalty on the production of oil and gas from said land, ten per cent (10%) of the oil and gas produced therefrom; the payment of such royalty to be made on or before the 20th day of each month for the oil and gas produced during the preceding month.

(5) As a further consideration for the granting of this lease, the said party of the second part agrees to commence drilling on said land within sixty days from the date of this lease and drill upon the premises described herein a sufficient number of wells to thoroughly and completely drain the oil from said land, and a sufficient number of wells on the premises described herein to offset producing wells, by whomsoever drilled, upon adjoining, contiguous premises, such competing wells to be drilled within such a distance of competing wells upon adjoining and contiguous premises and to the same oil sands penetrated by such competitive wells as to fully accomplish the offsetting of said competitive wells; all wells shall be driven to such a depth as will penetrate the oil bearing sands penetrated by wells in operation on adjoining lands, and all wells shall be so drilled, cleaned and, if necessary shot, and shall be so operated as to produce the greatest production of oil possible, consistent with the safety of said wells; provided, however, that if fire, or other unavoidable casualty shall destroy the refinery or storage tanks used in connection with the handling of the products from the land described, or if for any other reason the lessee shall not be able to market the oil from said land, then, upon a proper and satisfactory showing to the State Board of ..... Land Commissioners by the party of the second part of his inability to handle and care for the product from the land herein described, the State Board of ..... Land Commissioners shall authorize the reduction of the production of oil from the land described herein, to such extent and for such time as the facts and conditions shall warrant.

(6) The said party of the second part shall keep a correct log of each well drilled under the terms of this lease, showing the important formations passed through, the depths at which each formation was reached, the thickness of each formation, the water bearing formations and the character of the water therein, the elevation to which the water rises, the number of feet of casing set in such well and where placed, its size, and the total depth to

which such well was drilled, and shall, within thirty days after the completion of each well, file a copy of said log, certified to by the person who made the log, in the office of the Commissioner of Public Lands.

(7) It is further agreed by the said party of the second part, that no casing shall be removed from any of the wells heretofore drilled, or which may be hereafter drilled on the land described, without the consent of the party of the first part; and that upon the abandonment or the cessation of use of any well on the said described lands, said party of the second part shall securely plug such well, in conformance with the provisions of the laws of the State of Wyoming.

(8) It is specifically agreed by the party of the second part that in the drilling and operation of wells on the land described, he will exercise the greatest care and diligence to prevent the flow of water into the oil sands, to prevent the escape of gas, and to protect and conserve the oil from waste.

(9) The said party of the second part agrees to keep the oil produced from the land described herein entirely separate from any other oil until the same has been gauged or measured, that he will accurately measure the oil produced under the terms of this lease and keep a record of such production separate and distinct from the records of production of oil from other lands; and it is understood and agreed by and between the parties hereto that the party of the first part, through its Commissioner of Public Lands, or any other duly authorized agent, or agents, shall have the right to measure such oil or observe the measurements made by the party of the second part, and shall have the right to examine the books and records of said party of the second part pertaining to the production of oil from the land described in this lease, and shall at all times during the term of this lease have a right to go upon the said premises and into every part thereof for the purpose of inspecting the same and of examining the books of accounts and records of workings thereon, and of ascertaining whether or not the lessee, or any party holding thereunder, by or from said lessee, is carrying out the terms, covenants and agreements in this lease contained; and the party of the second part agrees to render to the agent of the party of the first part every assistance in his operations under the provisions of this clause.

(10) The party of the second part agrees that, on or before



the 20th day of each month, he will send to the Commissioner of Public Lands, with the remittance of the royalty, a verified statement of the production of oil and gas under the terms of this lease, for the preceding month, itemizing the production from different wells as nearly as possible.

(11) This lease is to be construed under the provisions of the laws of the State of Wyoming; and in case, at the expiration of this lease, the said lands are leased to another party than the lessee herein, then and in that event, the improvements placed on said land, under the provisions of this lease, will be controlled as provided in Section 622 of the Compiled States 1910 as amended and re-enacted by Chapter 80 of the Session Laws of 1915.

(12) It is expressly understood and agreed by and between the parties hereto, that if the payments hereinbefore provided for, or any part thereof, shall be behind or unpaid on the day whereon the same should be paid as aforesaid, or if default shall be made in any of the covenants or agreements herein contained to be kept and performed by the said party of the second part, his successors or assigns, the said party of the first part may declare the term of this lease ended and terminated, and cancel the same and re-enter into the said premises, or any part thereof; in case of default in and of any of the covenants herein contained, by the party of the second part, upon thirty days' notice by the party of the first part to the party of the second part that the term of this lease has been declared ended and the lease terminated and canceled, the said party of the second part agrees to surrender the peaceful possession of the premises to the party of the first part; and that neither the party of the second part or his legal representatives, or his successors or assigns, will permit any loss, or permit or cause to be permitted any waste or destruction in, to or upon said premises or any part thereof, or remove any improvements placed thereon, without the consent of the party of the first part.

(13) It is understood and agreed by and between the parties hereto that no assignment of this lease shall be made by the party of the second part except with the consent and approval of the party of the first part.

(14) It is further understood and agreed that this lease is made subject to all legally established rights of way and subject to the granting of rights of way under the provisions of Chapter

85, Session Laws 1905, but all rights of way granted shall be upon the condition that the use made thereof, or structures to be erected thereon shall be of such character as not to interfere with the operations and improvements of the party of the second part which are being had or are in existence at the time of the granting of such rights of way.

IN WITNESS WHEREOF, said party of the first part has caused these presents to be signed by its President and countersigned by the Commissioner of Public Lands, and its seal to be hereunto affixed, and the said party of the second part has hereunto set his hand and seal.

Done in the city of Cheyenne, State of Wyoming, this..... day of....., A. D. 19....

[SEAL]

.....  
*President State Board of*

Countersigned:

.....  
*Land Commissioners.*

.....  
*Commissioner of Public Lands.*

.....  
*Lessee.*

## OTHER LANDS

Aside from the Government lands and the State lands, there are, of course, in certain parts of the State, lands which have passed into private ownership. Such owners are usually willing to lease at  $12\frac{1}{2}$  per cent. royalty. Certain lands, known as "grant lands", were given to the railroads. These are the alternate sections (the odd numbered sections) for twenty miles upon either side of the railroad right of way, extending across the whole State along the Union Pacific Railroad. In many cases the railroad company has sold the surface rights to such lands, retaining the mineral rights to themselves. As the original grant to the railroad excluded "all lands valuable for mineral, except coal and iron" from the grant, there is some question as to whether the railroad can own



the rights to oil which may be found under such lands.

There is also one Indian Reservation in the State, the lands of which are leased by the Indian Agent, by and with the consent of the Tribal Council and the Secretary of the Interior. Also, a portion of the reservation ceded to the General Government will be leased by either the Department of Indian Affairs, or the Land Office, after the Department of the Interior has decided which bureau shall administer the law passed in 1916.

### THE MAP OF THE AREAL GEOLOGY OF WYOMING

This map has been taken from a general areal map of the State compiled by the writer during the past four years. In its compilation all available records have been used, United States Geological Survey work being the greater part. The Hayden and King maps have been used where no later surveys were available. Surveys by the State Geologist's office and unpublished personal notes and records have been incorporated wherever applicable. To make acknowledgment to everyone whose maps have been used would be to copy the list of names in the bibliography elsewhere given. This large scale map is unpublished, being in manuscript form only, at the State Geologist's office, but there available to public inspection and use.

The reduced-size map accompanying this book does not show the subdivisions of the geology older than the Colorado, nor does it subdivide the Tertiary. Its purpose is only to show the areal distribution of the Upper Cretaceous formations, as the great oil-producing horizons of the State occur in these formations.

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