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Geology and Mineral Resources

of a Portion of

Fremont County, Wyo.

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Big Popo Agie River near head of Popo Agie Canyon.


STATE OF WYOMING
1933
GEOLOGICAL SURVEY

CONTENTS

ILLUSTRATIONS.

Geology and Mineral Resources

of a Portion of

Fremont County, Wyoming

By C. E. JAMISON

INTRODUCTION.

This report, based upon field work carried on during the summer of 1911, discusses an area of about 500 square miles, situated in the south central portion of Fremont County, Wyoming, and extending from the vicinity of South Pass City, some 35 miles south of Lander, to Sage Creek, about 6 miles north of the Wind River Indian Agency. (Plate 2.) A portion of the oil fields embraced in this area lies in the Wind River Indian Reservation, where work can be carried on only under lease from the Indian Council, subject to the rules and regulations of the Department of the Interior.

The immediate cause for taking up the work in this section was the large and increasing demand for information in regard to the several oil fields tributary to Lander, and especial attention was given to the Sage Creek and Plunkett fields. Field work was commenced June 10, 1911, with L. M. Trask as field assistant and Oscar Woolery as teamster, and was closed at Lander July 21.

The oil bearing area is divided naturally into three fields, known as the Dallas field (Popo Agie field of Knight*;

* Knight, W. C., The Petroleum of the Shoshone Anticlinal; School of Mines., Univ. of Wyoming, Petroleum series—Bulletin No. 2, Laramie, Wyo., 1897.

Little Popo Agie district of Woodruff*), the Plunkett field (Lander field of Knight; Big Popo Agie district of Woodruff), and the Sage Creek field (Shoshone field of Knight; Little Wind River district of Woodruff). The names Dallas, Plunkett and Sage Creek are here used because it is by these names the various oil fields are best known to the residents of the Lander district.

On account of the small amount of time that could be devoted to the entire district, no detailed study of the geology of the mining camps was made. As a large proportion of the mines are idle and filled with water, the descriptions of most of them are based on information supplied by residents of the district.

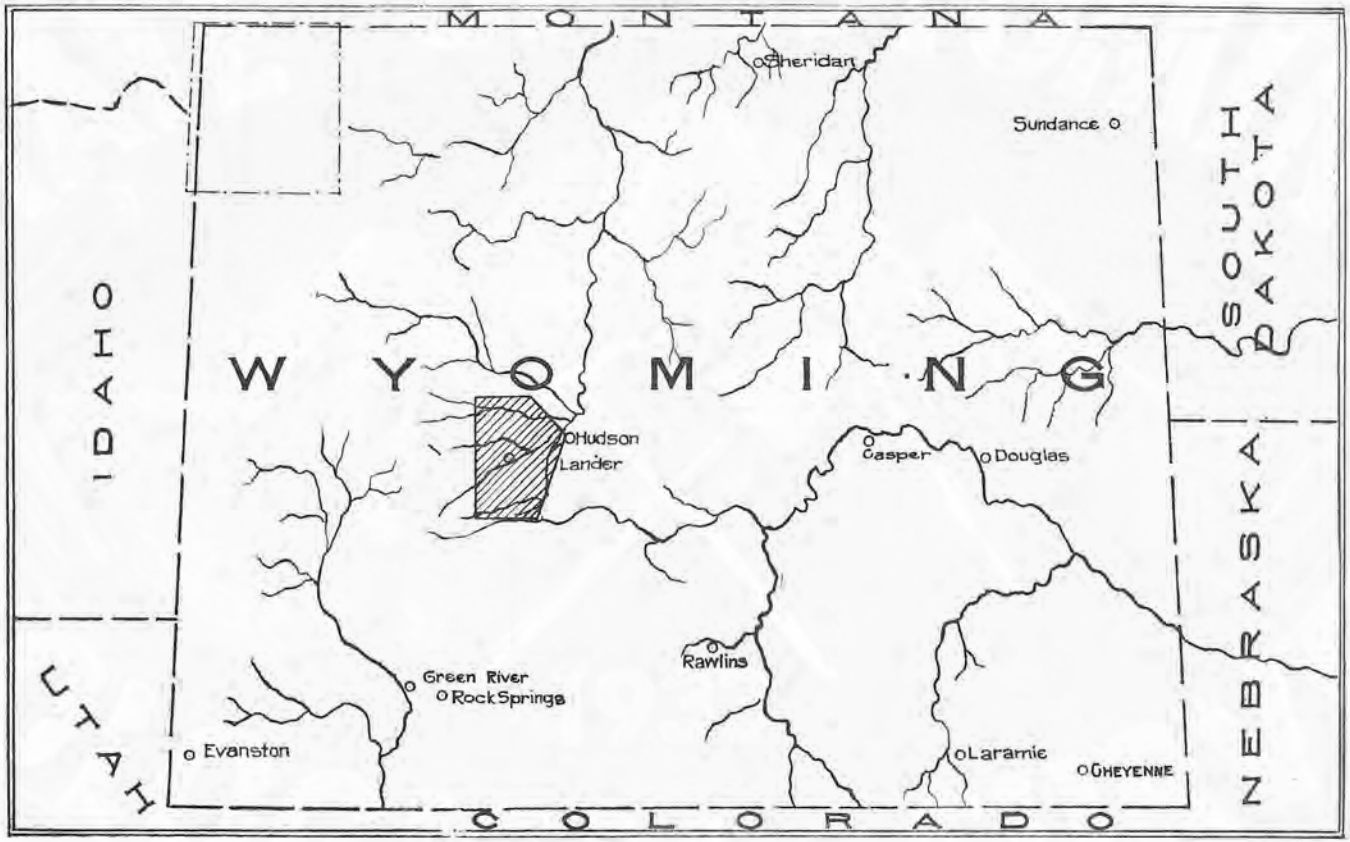
ACKNOWLEDGMENTS.

The writer is indebted to Mr. Chas. Swanson of Lander, to Mr. Jas. MacFarlane of South Pass City, and to Capt. O. M. Beck of Atlantic City, for information and assistance in the South Pass mining district; to Mr. J. H. Sharp and Mr. Geo. D. Case of Lander, and to all of the oil operators for information in regard to the Lander district; to Mr. E. E. Jones, Assistant Engineer U. S. I. S., for maps of the Wind River Indian Reservation; to Mr. E. W. Hainsworth of Lander for maps of Fremont County; to Col. E. H. Power of Lander for maps of the Dallas oil field; and to a lesser degree to nearly all of the residents of the Lander valley.

HISTORY.

The first recorded visit of white men to this region was in 1744, Sieur de la Verendrye having equipped and

* Woodruff, E. G., The Lander Oil Field; U. S. Geol. Survey Bulletin No. 452, 1911.



MAP OF WYOMING, SHOWING AREA DISCUSSED.

sent out an expedition from Canada for the purpose of trading with the Indians. This expedition reached the Wind River valley early in the year 1744, where they met the Shoshone Indians, who advised them that a band of the war-like Sioux were encamped at a pass in the mountains—probably South Pass. After exploring several of the canyons on the east flank of the Wind River Mountains the expedition returned to Canada, and no further explorations were carried on from that quarter.

The earliest extended knowledge of this region was probably that obtained by Gen. Wm. Ashley, Robt. Campbell, Wm. Sublette, Jim Bridger and others, who trapped on all of the streams tributary to Big Wind River as early as 1822, but the first authentic information given to the public was that which resulted from the explorations of Capt. Bonneville in 1833. Capt. Bonneville's first trip to this section, his visit to the "Tar Springs" in the Dallas oil field, and his discovery of the Washakie Hot Spring are described by Washington Irving* in the following language:

"On the 25th of July, 1833, Capt. Bonneville struck his tents and set out on his route for the Big Horn, at the head of a party of fifty-six men. He proceeded along the south point of the Wind River Mountains, and turning to the north-east, soon came upon the waters of the Popo Agie. This stream takes its rise in the Wind River Mountains. Its name, like most Indian names, is characteristic. Popo, in the Crow language, signifying head; Agie, river. It is the head of a long river, extending from the south end of the Wind River Mountains in a north-east direction, until it falls into the Yellowstone. Its course is generally through plains, but twice it is crossed by chains of mountains; the first the Little Horn, the second the Big Horn.

* The Rocky Mountains, or Scenes, Incidents and Adventures in the Far West. Philadelphia, 1837.

After it has forced its way through the first chain, it is called the Horn River; after the second chain, it is called the Big Horn River. Its passage through this last chain is rough and violent; making repeated falls, and rushing down long and furious rapids which threaten destruction to the navigator; though a hardy trapper is said to have shot down them in a canoe.

"Proceeding down the Popo Agie, Capt. Bonneville came again in full view of the 'Bluffs', as they are called, extending from the base of the Wind River Mountains far away to the east, and presenting to the eye a confusion of hills and cliffs of red sandstone, some peaked and angular, some round, some broken into crags and precipices, and piled up in fantastic masses; but naked and sterile. There appeared to be no soil favorable to vegetation, nothing but coarse gravel; yet, this isolated barren landscape, was diffused with such atmospherical tints and hues, as to blend the whole into harmony and beauty.

"In this neighborhood, the Captain made search for the 'Great Tar Spring' one of the wonders of the mountains; the medicinal properties of which, he had heard extravagantly lauded by the trappers. After a toilsome search, he found it at the foot of a sand bluff, a little to the east of the Wind River Mountains; where it exuded in a small stream of the color and consistency of tar. The men immediately hastened to collect a quantity of it to use as an ointment for the galled backs of their horses, and as a balsam for their own pains and aches. From the description given of it, it is evidently the bituminous oil called petroleum or naptha, which forms the principal ingredient in the potent medicine called British Oil. It is found in various parts of Europe and Asia, in several of the West India islands, and in some places of the United States. In the state of New York it is called Seneca Oil, from being found near Seneca Lake.

"At daylight they were in the saddle again, and skirted along the river, passed through fresh grassy meadows, and a succession of beautiful groves of willows and cottonwood. Towards evening, Capt. Bonneville observed a

smoke at a distance from among the hills, direct in the route he was pursuing. Apprehensive of some hostile band, he concealed the horses in a thicket, and, accompanied by one of his men, crawled up a height, from which he could look the scene of danger over. With a spy glass, he reconnoitered the surrounding country, but not a lodge nor fire, nor a man, horse, nor dog, was to be discovered; in short, the smoke which had caused such alarm proved to be the vapor from several warm, or rather hot springs of considerable magnitude, pouring forth streams in every direction over a bottom of white clay. One of the springs was about 25 yards in diameter, and so deep, that the water was of a bright green color."

While Irving speaks of this valley as a sterile, barren section, with no soil favorable to vegetation, other writers have viewed it with a kindlier eye. Bancroft* writes of it in the following terms:

"The Wind River Mountains and valley were from earliest time much talked of by white and red men. This valley, about eight miles wide, and between 150 and 200 miles in length, was regarded as one of the choicest spots on the eastern slope of the Rocky Mountains. The river was rapid and clear, its banks adorned with stately cottonwood trees, while the mountain sides were covered with forests of pine. The soil was dark and rich, the climate mild, and game abundant. Vast herds of buffaloes, antelope, deer and elk roamed through it. At the upper end was a hot sulphur spring.

"Fremont county, established in 1884, contained an area of about 20,000 square miles, inclusive of the whole Sweetwater mining country, the Shoshone reservation and the elevated valley of the Big Horn on the west side of that river, with the Shoshone mountains on the western border. The Wind River valley is a fertile and beautiful region, known as the Garden of Wyoming."

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* Bancroft, H. H., Volume 25, History of Wyoming, San Francisco, 1890.

After the visit of Bonneville, the Lander Valley became a rendezvous for the trapper and fur trader. The region was visited by Fremont in 1842 and by Lander in 1859, while Dr. White's train of emigrants to Oregon passed through the district in 1842, and the first Mormon emigrants encamped at South Pass in 1847.

The Sweetwater Miner, in the issue of March 24th, 1869, is authority for the statement that gold was discovered in this region as early as 1842. The article follows:

"Gold was discovered in the Sweetwater district in 1842 by a Georgian who came here with the American Fur Company for the recovery of his health. After remaining a year he started for home, intending to organize a company and bring them here to work the mines. He never reached home, however, and was supposed to have been killed by the Indians. Thirteen years elapsed when a party of forty men arrived here. They prospected the whole length of the Sweetwater, found gold everywhere in the river as well as in its tributaries and turned the main stream from its channel 400 yards. A small shaft eight feet deep, from which they took from two to ten cents worth of gold per pan, was sunk and worked for some time. When winter approached they abandoned their enterprise to winter at Fort Laramie, where they intended to provision themselves for a year and get a supply of necessary tools in the spring. This done they started, but when on their way two days they were overtaken by United States Dragoons and brought back to the fort. The leader was sent to prison for some imaginary offense and the property of the company confiscated.

"In 1858 the leader returned to this region but did no mining until 1860 when he and eight others commenced mining on Strawberry Gulch. During 1861 mining was abandoned because men could make more money putting up hay and delivering telegraph poles for the Overland Stage Company. In the fall of 1861, however, fifty-two men had collected at South Pass City ready to commence

mining in the early spring of 1862. Their locations were selected, and prospects over promising, when like a thunderbolt the Shoshone Indians broke down upon them, robbed them of everything and drove them off. This put a stop to mining operations until the fall of 1866, when a party, led by the same man who led the former expeditions, came down from Virginia City, Montana. They wintered on the Sweetwater and on June 8, 1867, the Carisa lode was discovered by H. S. Reedall. A mining district was organized and called Shoshone District. Mining laws were agreed upon and regulations entered into by the pioneers.

"Reedall and his party commenced working the Carisa lode when they were attacked by Indians, who killed three of them and drove off the remainder. The survivors returned to the mine July 28, and remained over winter. They succeeded in extracting from the croppings of the lode, which they crushed in a hand mortar, $1,600 in gold. Seven thousand dollars more was washed out of the detritus on the gulch below the vein. The news of their success spread rapidly and was greatly exaggerated. A great rush commenced from the neighboring territories, but the majority of the adventurers not finding the facts to bear out reports left very soon. Only about five hundred remained and went to work. Their labor was well rewarded and gradually more population was attracted, so that in July 1868, 2,000 people had settled there."

In the fall of 1867 the townsite of South Pass City was laid out. In the spring of 1868 the Duncan, the Gould & Curry and several other mines were located, and four stamp mills and a saw mill erected. The Miner's Delight mine was located, a ten-stamp mill erected, and $300,000 in gold produced during the first six months of operations. This mine is stated to have produced a total of $1,200,000. The Soules & Perkins produced about $75,000, the Caribou $50,000 from surface ores, during 1869-70. The Mary Ellen was discovered in 1869 and was a good producer.

In 1869 the placers in the vicinity of Miner's Delight and Atlantic City were worked and produced a large amount of gold. Meadow Gulch is reported to have yielded $1,000,000; Yankee Gulch $500,000; Spring Gulch $30,000; Promise Gulch $30,000; Smith Gulch $20,000. In 1869 and 1870 the South Pass district reached its maximum of production, since which time it has declined to the comparative inactivity of the present day. No records of the production of the district have been kept, the total production being variously estimated at from $4,000,000 to $7,000,000. A figure midway between the two would probably be near the actual production.

BIBLIOGRAPHY.

The literature on this district is not extensive, consisting in part of the following:

1837

BONNEVILLE, CAPT. B. L. E. Map of the sources of the Colorado and Big Salt Lake, Platte, Yellowstone, Muscleshell, Missouri and Snake Rivers, branches of the Columbia River.

In The Rocky Mountains, or Scenes, Incidents and Adventures in the Far West; digested from the Journal of Capt. B. L. E. Bonneville, by Washington Irving. Philadelphia, 1837.

One of the earliest maps to show any of the features of this district.

1859

LANDER, F. W. Report upon the central division of the Fort Kearney, South Pass, and Honey Lake wagon road.

Senate Documents, Vol. 10. 1858-59. 35th Congress, 2nd session.

"All of the large valleys in the vicinity of South Pass are suitable for grazing purposes, and many of them adapted for settlements. The country

in the more elevated ranges is very fertile. * * * Supplies of coal were also discovered on Wind River. * * * The quantities of mineral tar which exists in the vicinity of Wind River, known by the mountaineers as the Oil Springs, a variety of asphaltum or petroleum, would also greatly facilitate the workings of a railroad. This substance is readily converted, by a simple chemical process, into lubricating oil. Excellent iron ore exists thirty miles north of South Pass."

The accompanying map shows Fort Thompson near the present site of Lander; Fort Aspen Hut near Atlantic City; Gilbert's Trading Post at the Burnt Ranch. Beaver Creek is shown flowing into Twin Creek.

1871

HAYDEN, F. V. Preliminary Report of the U. S. Geological Survey of Wyoming and parts of contiguous Territories. (Being a second annual report of progress.) 1871.

"The gold-bearing rocks (of the South Pass district) are composed of thin gneissic slates. Some of the slates are very thin and might be made useful for building purposes. The Cariso lode is about four feet wide; the quartz yields $50 to $75 per ton." The elevation of Atlantic City is given as 7636 feet; South Pass City 7857 feet; Fort Stambaugh 7714 feet. The Cariso, Young America, East End, Miner's Delight and Young Canadian mines are briefly described.

1876

MEEK, F. B. Report on the invertebrate Cretaceous and Tertiary fossils of the Upper Missouri country.

Report of the U. S. Geological and Geographical Survey of the Territories. Vol. IX. 1876.

Describes and figures *Macrocyclis spatiosa* and *Helix veterna* from the Tertiary near Wind River.

1879

ST. JOHN, ORESTES. Report on the geology of the Wind River district.

Twelfth Annual Report of the U. S. Geological and Geographical Survey of the Territories. A report of progress of the exploration in Wyoming and Idaho. Part I. 1883.

Discussion with map of the Wind River district north of Little Wind River. Refers the Cambrian quartzite to the Potsdam; the Bighorn limestone to the Quebec; the Madison limestone to the Niagara; the red beds to the Triassic. "The broad, shallow depression through which the Sage Creek drainage seeks Little Wind River marks the axis of the anticlinal fold, in the crest of which is located the bitumen spring. The flow of water is feeble,

bubbling up in several hardly discernible vents, around which the bitumen is deposited, forming sheets whose consistency in the margin of the overflow becomes the hardness of an asphalt pavement. Birds and small Indians, frequenting the place for water and sport, not infrequently become entangled and besmeared in the soft, viscous substance."

ENDLICH, F. M. 11th Annual Report of the U. S. Geological and Geographical Survey of the Territories. 1879.

Describes the "Tar Spring" near Ft. Washakie.

1886

AUGHEY, S. Report of the Territorial Geologist.

"The first discovery of oil in Wyoming was made near Washakie, on the Little Wind River, the source being the red triassic sandstone from which it emerges. The oil of the Shoshone (Dallas field) is much less dense than that of the Washakie, while of identical origin." States the thickness of the Triassic formation to be nearly 2000 feet. Refers the gypsum beds to the Jurassic. Reports galena from the head of Popo Agie Creek.

1887

BAILEY, G. E. Petroleum in Wyoming.

Reports source of oil in Shoshone (Dallas) and Washakie (Sage Creek) fields as Triassic sandstone. States that oil was first discovered in Wyoming in 1864, at the "Tar Spring" near Ft. Washakie.

1891

NORTON, J. T. The Resources of Fremont County.

States the production of three wells in the Dallas oil field to be 1,000 barrels per day.

1893

KNIGHT, W. C. Notes on the Mineral Resources of the State, Wyoming Experiment Station. Bulletin No. 14.

Contains an extract from the Sweetwater Miner of March 24, 1869, in regard to the discovery of gold in the South Pass district. Estimates the production of the district to be $5,050,000. Contains analyses of the Hudson coals and the Dallas and Plunkett oils. Gives the coal production for the district for 1892 as 3500 tons. States the source of the oil in the Plunkett and Sage Creek fields to be the Triassic sandstone, in the Dallas field, the "Triassic or Carboniferous."

1894

ELDRIDGE, G. H. A Geological Reconnaisance in

Northwest Wyoming, U. S. Geological Survey Bulletin No. 119.

Describes the geology of a portion of this district.

1897

KNIGHT, W. C. The Petroleum of the Shoshone Anticlinal. University of Wyoming. Petroleum Series—Bulletin No. 2.

Describes the geology of the Lander oil fields. States the source of the oil in the Dallas and Sage Creek fields to be upper Carboniferous. Describes, but evidently did not visit, the Plunkett field. Includes analyses of the various oils by E. E. Slosson.

1904

BEELER, H. C. Report of State Geologist.

Briefly describes the Carisa, Dexter, Ground Hog, Pay Rock and Miner's Delight mines. Gives the production of the Miner's Delight mine as over $1,000,000.

BEELER, H. C. Wyoming Mines and Minerals.

Description of the South Pass mining district and the Dallas oil field. Credits the South Pass district with a production of $4,000,000. Gives the source of the oil in the Dallas field as Permian. Includes an analysis of the oil.

1906

SMITH, F. S. and WYNN, E. R. The Shoshone Pathfinder

A general description of the resources of Fremont County.

1907

BEELER, H. C. Mineral Resources of Wyoming.

Describes briefly the geology of the South Pass district, the Carisa, the Dexter and the Miner's Delight mines. Credits the district with an annual production of from $25,000 to $125,000, and a total production of $4,000,000. Contains analyses of coal from Lander. Mentions two mineral springs near Lander. Describes very briefly the Popo Agie (Dallas), Lander (Plunkett), and the Shoshone (Sage Creek) oil fields. "There are thirteen flowing wells in the Popo Agie (Dallas) field, the capacity of each being 200 barrels per day." In part a reprint of the Report of the State Geologist for 1904.

1908

BEELER, H. C. A Brief Review of the South Pass District.

Describes the geology of the South Pass Mining District.

1909

U. P. Railway. Wyoming Resources, Population, Industries, Opportunities and Climate.

Contains analyses of Lander coal and brief mention of the Dallas oil field. Gives the source of the Dallas oil as "Permian or Carboniferous", the source of the Plunkett oil as "probably Permian."

1910

Marshall, R. B. Results of Triangulation and Preliminary Traverse for the years 1906, 1907, and 1908. U. S. Geological Survey Bulletin 440.

Gives the latitude and longitude of Bull Lake, Crowheart Butte, and Fremont Peak.

1911

Jamison, C. E. Mineral Resources of Wyoming. Bulletin 1, Series B.

Contains a preliminary report on the geology of the Plunkett field, and a compilation of various articles on the Dallas and Sage Creek fields.

Woodruff, E. G. The Lander Oil Field, Fremont County. Bulletin 452, U. S. Geological Survey.

Describes the geology of the oil fields and lists numerous fossils from the various formations. Estimates the thickness of the Triassic formation as 1500 feet. Divides the basal Cretaceous Sandstones, into a lower member, "Lower Cretaceous Rocks," of marine origin, and an upper member, the "Dakota sandstone." Contains a geological map of, and sections across the oil fields.

TOPOGRAPHY AND DRAINAGE.

The area under discussion lies east and south of the Wind River Range, south and west of the Owl Creek Mountains, and north of the Sweetwater River. The South Pass district is in the southern end of the Wind River Mountains, while the oil fields are in the valleys of the Big and Little Popo Agie and Little Wind Rivers, elevations above sea level ranging from 5,000 feet, near Lander, to 10,000 feet or more in the Wind River Mountains north of South Pass. In the western portion of the area the sedimentary rocks have been removed down to the base of the Triassic, the rocks dipping from 10° to 15° to the east, producing long slopes which form the eastern flank of the Wind River Mountains, and through

which the streams have cut deep canyons in their course to the Lander valley. East of the mountains are rolling plains, traversed, from north to south, by the Shoshone anticline. Along the course of the anticline the country is rough and broken, consisting of steep hills and short, deep valleys.

The region is watered by Little Wind River, Big and Little Popo Agie, North Fork, Sweetwater, and numerous creeks, which flow east and south from the Wind River Range. Big Popo Agie River rises in the Wind River Mountains and flows east through the town of Lander, combining with Wind River, near Riverton, to form the Big Horn River. About seven miles west of Lander, at a point locally known as the "The Sinks", the Popo Agie flows into a cavern in the upper part of the Madison Limestone and disappears, to reappear some few hundred yards below. This river furnishes water to irrigate a large portion of the Lander valley, and is the source of the water supply of the town of Lander, the intake being about five miles above the town.

Little Popo Agie receives its waters from Christina Lake, in the Wind River Range, and, flowing in a northeasterly direction, passes through the Dallas oil field, and joins the Big Popo Agie near Hudson. Its waters are extensively used for irrigation.

North Fork flows in a general southeasterly direction, forms the western boundary of the Wind River Indian Reservation, and joins the Big Popo Agie near Wyopo.

Little Wind River rises near the foot of Mt. Bonneville and flows through the Wind River Reservation to Arapahoe, where its waters combine with those of the Popo Agie. It is the source of the greater part of the water used in the various irrigation projects on the Wind River Reservation.

Sweetwater River derives its waters from Rock, Willow, Gold, Pine, Beaver and numerous other creeks in the South Pass district and flows in an easterly direction until it combines with the Platte. All of the above mentioned streams, with their numerous creeks and branches, are never failing.

CLIMATE.

The location of this district at an elevation of more than 5,000 feet above sea level gives it a semi-arid climate, but the bountiful supply of water, found in the many rivers and creeks, makes the Lander valley one of the most productive regions in the state. Tables showing the more important climatic features, as taken from the records of the Weather Bureau at Lander, follow:

FIRST AND LAST KILLING FROSTS AND LENGTH OF GROWING SEASON.

Year	Last in Spring	First in Autumn	Length of Growing Season
1892	June 1	September 11	102 days
1893	June 3	September 13	102 days
1894	June 9	September 4	87 days
1895	June 18	September 7	81 days
1896	May 21	September 26	128 days
1897	May 9	September 17	131 days
1898	June 4	September 6	94 days
1899	June 19	September 29	102 days
1900	May 1	September 18	140 days
1901	June 6	September 14	100 days
1902	June 3	September 12	101 days
1903	May 26	September 8	105 days
1904	June 25	August 22	58 days
1905	May 16	September 19	126 days
1906	June 20	September 12	84 days
1907	June 17	September 14	89 days
1908	May 27	August 31	97 days
1909	May 19	September 13	127 days
1910	May 22	August 24	94 days
Average	June 1	September 11	102 days

EXTREMES OF TEMPERATURE FOR EACH MONTH OF THE YEAR.

Year	Jan'y		Feb'y		March		April		May		June		July		August		Sept.		October		Nov.		Dec.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1892	57	—29	54	—13	66	— 4	66	9	79	20	87	32	91	43	93	33	85	28	76	17	64	— 3	50	—29
1893	55	— 5	48	—19	70	— 6	66	2	83	26	83	32	88	38	91	33	84	21	74	16	63	— 5	56	— 8
1894	53	—23	49	—28	61	— 3	70	18	81	20	85	32	94	42	90	42	81	27	74	15	72	—14	51	—17
1895	57	—28	64	—28	70	— 7	75	21	78	28	87	29	91	36	89	39	88	7	72	10	66	—12	49	—11
1896	51	—20	59	— 1	62	—22	69	5	82	19	88	36	95	45	89	39	85	24	79	10	67	—31	52	0
1897	55	—25	51	— 4	61	— 8	76	13	82	29	88	35	91	41	90	42	86	31	75	14	70	5	48	—21
1898	46	—22	52	— 4	60	— 9	78	14	76	24	87	32	91	40	92	45	86	26	71	11	64	— 8	56	—25
1899	54	—16	55	—35	64	—11	74	12	76	17	91	26	93	40	86	33	86	28	77	18	60	12	56	—11
1900	57	— 8	50	—30	70	9	72	9	85	30	95	34	96	38	93	37	86	27	73	12	65	3	54	—29
1901	57	—36	58	—18	64	9	77	13	86	36	86	32	99	37	92	44	85	28	75	24	67	12	57	—24
1902	51	—30	58	—16	54	— 3	77	16	83	23	91	31	94	35	94	36	85	24	75	21	65	6	53	— 8
1903	59	—15	48	—28	65	—13	72	14	83	13	89	37	91	34	93	36	90	26	78	19	67	— 4	61	—12
1904	55	—11	58	— 5	61	4	76	10	81	28	85	31	88	39	89	31	89	25	76	14	64	8	55	—16
1905	54	—17	60	—30	62	14	73	12	79	26	86	31	90	40	90	41	89	31	79	2	60	—19	43	—13
1906	50	—14	54	— 6	62	—24	74	16	79	24	90	35	91	39	94	35	85	30	82	8	63	1	56	4
1907	52	—12	58	— 9	66	13	71	12	76	18	81	28	91	38	90	35	83	31	76	25	63	3	53	—27
1908	50	—13	59	—21	67	— 3	77	8	76	27	84	32	92	37	93	24	90	14	75	13	66	— 8	50	—19
1909	55	—15	54	—24	57	—15	68	6	73	19	90	33	96	41	96	39	83	25	78	16	67	— 4	44	—30
1910	50	—32	51	—22	71	18	82	12	86	23	91	33	94	42	91	23	84	25	80	16	64	7	56	
Extremes for Period	59	—36	64	—35	71	—24	82	2	86	13	95	26	99	34	96	23	90	7	82	2	72	—31	61	—30

RAINFALL DATA FOR EACH MONTH IN THE YEAR—MONTHLY PRECIPITATION IN INCHES.

Year	Jan'y	Feb'y	March	April	May	June	July	August	Sept.	October	Novem.	Decem.	TOTAL
1892....	0.75	0.45	1.25	4.16	3.44	1.18	2.05	0.86	0.06	1.03	1.13	1.60	17.96
1893....	0.02	1.64	1.?4	2.14	1.57	1.05	0.12	0.92	0.29	0.56	0.57	0.76	10.98
1894....	0.49	0.92	3.29	0.75	1.22	0.51	1.09	0.11	2.29	0.03	0.37	0.03	11.10
1895....	0.68	0.21	1.17	5.71	1.32	1.90	0.19	1.04	1.74	1.00	2.30	Tr.	17.26
1896....	0.24	0.26	2.63	1.20	1.75	0.12	3.00	0.49	1.08	0.74	0.81	Tr.	12.32
1897....	0.23	1.11	1.38	1.14	1.25	0.85	1.21	1.04	0.15	1.12	0.44	1.29	11.21
1898....	0.33	Tr.	2.73	1.08	6.02	3.02	0.67	0.62	0.36	2.22	0.25	0.69	17.99
1899....	0.88	0.57	1.65	0.49	2.15	0.82	0.46	0.08	0.54	1.57	Tr.	0.94	10.15
1900....	Tr.	0.06	0.31	7.19	0.51	0.39	0 51	0.25	2.05	0.73	0.33	0.90	14.23
1901....	0.16	0.94	0.38	3.11	3.13	1.87	Tr.	0.58	0.13	0.43	0.22	1.87	12.82
1902....	0.18	0.20	0.77	1.43	1.23	1.93	0.29	0.06	0.75	1.10	0.06	0.25	7.25
1903....	0.25	0.82	2.25	2.41	1.86	1.99	0.21	0.19	2.58	0.57	0.01	0.94	14.08
1904....	0.56	0.63	1.57	1.05	4.49	2.29	1.31	0.24	0.39	1.81	0.01	0.49	14.86
1905....	0.23	0.24	1.07	2.55	3.13	0.88	0.47	0.57	1.11	1.52	1.82	0.55	14.14
1906....	0.63	0.25	3.56	2.24	3.49	0.14	1.01	1.26	0.66	2.04	0.41	0.92	16.67
1907....	0.48	0.12	0.98	1.19	2.67	1.25	0.51	0.69	0.58	0.40	0.49	1.14	10.50
1908....	0.59	1.52	1.49	1.57	3.67	1.50	0.40	1.52	0.66	4.57	0.71	1.03	19.22
1909....	0.43	0.76	2.34	2.01	1.44	0.64	0.31	1.33	0.76	0.55	1.42	2.06	14.05
1910....	2.06	0.39	0.59	1.30	1.91	0.46	0.67	0.36	1.21	0.37	Tr.	Tr.	9.32
Average for Period	0.484	0.584	1.619	2.249	2.434	1.200	0.762	0.643	0.915	1.117	0.597	0.814	13.48

COMMON PLANTS AND ANIMALS.

The common plants in the valleys and lower lands are those which are characteristic of a region which is essentially semi-arid, as shown by the preceding climatic tables, and consist principally of sage brush, with cottonwood and mountain willows along the river banks. The general character of the vegetation is shown in Plate III. In the mountains, pine, fir, spruce, quaking aspen, wild cherry and willows are found, a portion of the district being included in the Bonneville Forest Reserve, while a fairly abundant growth of grass is found at all points in the district, the mountainous region being an excellent summer range and the lower lands a good winter range. Pine and fir are cut for fuel and for mine timbers, though the largest trees observed were not more than eight inches in diameter. Quaking aspen is confined to small thick groves near the heads of the canyons, where there are springs or seepages. Cedar is found in very small quantity on some of the rocky slopes. In some portions of the district the wild grass is cut for hay, though the open range is almost entirely given over to sheep grazing.

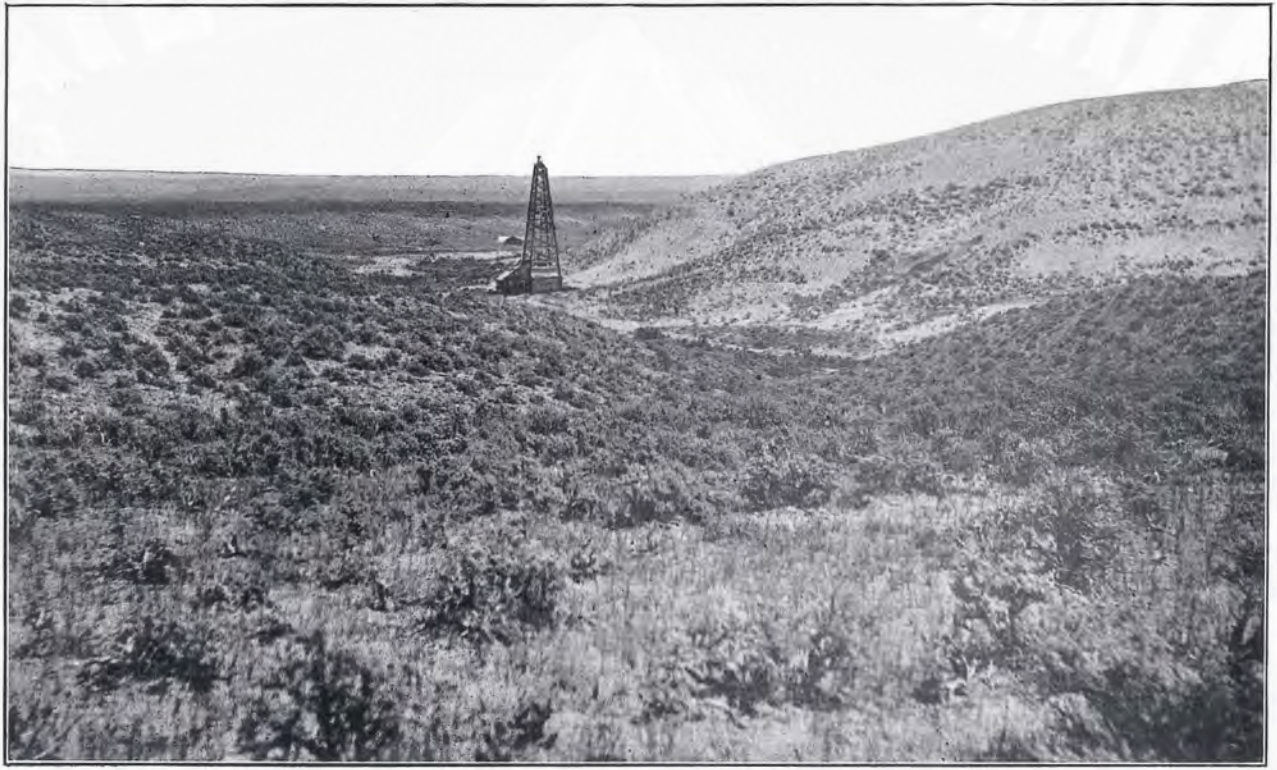
Large game consists principally of deer, although elk are found in the mountains in the fall and winter. Bear and mountain lions are not infrequently seen in the mountains and occasionally an antelope may be found on the plains. Sage grouse are common, trout are abundant in all the streams, and in the fall and spring ducks may be seen along the waterways. Mountain grouse are found in the hills, while rabbits, both common and jack, badgers, woodchucks, prairie dogs, gophers and kangaroo rats are everywhere, and coyotes, wolves and wild cats are not rare. Martens are found in the mountains, while beaver

dams were noted in Red Canyon and beaver were seen on Sweetwater River. Mink and muskrats inhabit nearly all streams and porcupines are occasionally encountered in the timbered districts.

IRRIGATION AND CROPS.

Because of the small amount of rainfall the land in this region is productive only when irrigated. Fortunately, however, the amount of water available for irrigation is practically unlimited. Probably 40 per cent. of the land in this area can be irrigated, but at the present time less than one-half of this amount is under irrigation. A large system of ditches is now being constructed by the Federal Government on the Wind River Indian Reservation, where there are available for irrigation not less than 100,000 acres. It is not probable that this land will ever become productive if left to the Indians to cultivate, the average Shoshone preferring to raise a few ponies rather than attempt systematic cultivation. However, these lands may be leased subject to the rules of the Department of the Interior. About 60,000 acres are now under ditch in this section while 40,000 more will be available upon the completion of the Lewis Lake project, work upon which has just been started.

Alfalfa, wheat, oats and potatoes form the common crops. The alfalfa crop averages somewhat more than two and one-half tons per acre, while the average price obtained is about $8.50 per ton on the ranch. Excellent wheat is raised in this district but on account of the distance from flour mills it is used principally for stock feed. On new lands from 20 to 25 bushels of oats per acre are raised, while on land which has been under cultivation for some time from 50 to 100 bushels are produced. The oats raised



OIL WELL IN THE PLUNKETT FIELD. WASHAKIE OIL SPRING IN RIGHT MIDDLE GROUND.
This view also shows the characteristic vegetation of the Lander region.


STATE OF WYOMING
1933
GEOLOGICAL SURVEY

in this district weigh about 46 pounds per bushel and bring a price of one and one-half to two cents per pound. Fine potatoes are raised, while sugar beets are successfully produced, but as there is no sugar factory in the immediate vicinity the beets are used entirely for stock food. The hardier garden vegetables do well, while near Lander is the Young apple orchard, the Lander valley apples being known over the entire state.

GRAZING.

The farm products of this section are for the greater part utilized in feeding stock. Stock raising is dependent on the free range and the introduction of sheep has, to a great extent, driven out the cattle and horse men. The district is regarded by stock men as an excellent all year range.

RESOURCES.

The region is to be regarded essentially as a stock-raising country, farming, up to the present time, being merely an accessory to stock-growing. The value of the land for agricultural purposes ranges from $5.00 per acre for lands principally valuable for grazing, to $75.00 per acre for the best bottom lands. No doubt in the near future a large portion of this district will be given over to raising wheat and oats, when the value of the land will be largely increased. Aside from the farming and sheep raising this section has great undeveloped resources in its coal and oil, while the South Pass district will, with proper development, become an active gold producer.

TOWNS AND VILLAGES.

The principal town in the district is Lander, the western

terminus of the Chicago & Northwestern Railway, where there is a large acreage suitable for irrigation, a bountiful water supply, and oil fields of great promise. Lander has a population of about 2,000, is the shipping point for the South Pass mining district, for the Wind River Indian Reservation, Dubois and the greater portion of the Wind River valley. It is the county seat and business center of Fremont County, has two banks, a new Federal building erected at a cost of $160,000, the State Home for the Feeble Minded, a grade and a high school, a Carnegie library, and is headquarters for the oil operators of the Dallas, Plunkett and Sage Creek oil fields. It supports three newspapers, a large number of stores, and an electric lighting plant; is the outfitting point for hunting parties to the big game section of the Wind River Mountains, and is headquarters for the State Game Warden. Many parties for Yellowstone Park leave the railroad at Lander, going north by the way of Wind River and Dubois.

Hudson is a settlement which has sprung up since the advent of the railroad in 1906. It is located at the junction of the Big and Little Popo Agie Rivers, is a sheep shearing and shipping point, and is the center of the coal mining industry of Fremont County. Near Hudson are the mines of the Hudson Coal Company, the Mitchell mine and several others, the output being somewhat in excess of 100,000 tons per annum. The greater portion of the coal burned by the Chicago & Northwestern Railway, west of the Missouri River, is mined at Hudson. The present population of Hudson is about 350.

Wind River, 16 miles north of Lander, is located on the site of Fort Washakie, an army post abandoned some few years ago. It is headquarters for the Wind River Indian Reservation and for the U. S. Reclamation Service

in this district, while near it are located large Indian Schools. The population is approximately 1,200, principally Shoshone Indians.

Arapahoe is a sub-agency on the Wind River Reservation, population 700, mostly Arapahoe Indians. Near Arapahoe is the St. Stephen's Mission.

Milford, four miles from Lander, is a small village in the ranching district on North Fork. At one time it was an army post. Population 30.

Dallas is a ranch postoffice near the Dallas oil field.

Wyopo, the railroad terminus of the Powers oil pipe line, is on the C. & N. W. Ry., near the junction of the Big Popo Agie and North Fork Rivers. Located there are machine shops, lime kilns, and a plaster plant.

South Pass City was the first settlement in this district. For many years it was an important point on the Mormon and Oregon trails, and in 1869 was a large mining camp, but with the desertion of the mines it has decreased in importance until to-day it has a population of not more than 50.

Atlantic City, like South Pass City, was an important town in the early mining excitement. Population about 50.

Miner's Delight was a prosperous town before the shut-down of the Miner's Delight mine, but is now entirely deserted.

Lander is the important town of the district, although Hudson is more than a coal mining town. South Pass City and Atlantic City are entirely dependent upon mining, and when metal mining is resumed, will again become of importance, but their fate is inseparably linked with that of the mines.

AGE	FORMATION	CHARACTER	THICKNESS	REMARKS
Carboniferous	Tensleep Sandstone	Massive, buff and gray, crossbedded sandstone.	355 to 390	
Carboniferous	Amsden	Red shales, overlain by hard gray limestone.	409 to 455	
Carboniferous	Madison Limestone	Massive, gray limestone.	452 to 498	
Ordovician	Bighorn Limestone	Hard, massive limestone.	570	
Cambrian	Deadwood	Brown and purple sandstones and fine-grained conglomerates at the base, grayish green shale in middle portion, slabby limestone at the top.	1325	
Pre-Cambrian		Granites, gneiss and schists, cut by dikes of diorite and diabase.		

PRE-CAMBRIAN ROCKS.

Pre-Cambrian rocks, consisting of granites of various kinds, gneiss and schist form the higher portions of the Wind River Range, and are of importance, as it is in them that the gold and copper veins of the South Pass district are found. In that district the granites give away to schists, which are cut by numerous large dikes of diabase and diorite, mineral bearing veins of quartz occurring in connection with some of them. On the east flank of the Wind River Range the pre-Cambrian rocks pass beneath the Deadwood formation and are not again exposed in this district. No detailed study was made of the crystalline rocks.

CAMBRIAN SYSTEM.

DEADWOOD FORMATION.

The oldest sedimentary rocks found in this district occur well up on the flanks of the Wind River Mountains. They consist of brown and purple fine-grained conglomerates and quartzitic sandstones, grayish green shales and sandstones, and gray slabby limestone, and are exposed along the full length of the Wind River Range. At the base is a fine-grained conglomerate, pink, purple and brown on weathered surfaces, and of a dark buff color on fresh exposures. The conglomerate is made up almost entirely of small quartz pebbles, the largest of which do not exceed one inch in diameter, and merges into brown, buff and purple sandstones and quartzites. This portion of the formation is locally known as "Cement" and "Potsdam". Next above this sandstone are grayish shales and sandstone, 350 to 400 feet in thickness which are succeeded by from 350 to 375 feet of gray slabby limestone. The central

portion is usually masked, while the conglomerate at the base and the limestone member form more or less prominent cliffs.

FOSSILS.

But few fossils were found in this formation. From the sandstone near the base of the formation *Dicelamus politus*, *Hiolithes primordialis*, and fragments of trilobites were obtained, while the shales of the middle beds yielded fragments of trilobites, *Lingulepis*, and *Graptolites*. These fossils indicate that the formation is of middle Cambrian age, and no doubt, equivalent to the Deadwood formation of the Big Horn Mountains.

ORDOVICIAN SYSTEM.

BIGHORN LIMESTONE.

This formation, which forms high steep walls in the canyons, the base usually being covered by talus from the cliffs above, consists of hard, massive, gray limestone. The formation is exhibited at all points along the Wind River Range, forming prominent cliffs rising above the softer Deadwood formation.

FOSSILS.

The formation appears to contain few fossils. From the middle and upper portions the following species were obtained: *Buthotrephis succulens*, *B. gracilis*, *Orthis occidentalis*(?), *Zaphrentis sp.*

CARBONIFEROUS SYSTEM.

MADISON LIMESTONE.

The Madison formation consists of hard gray limestones, very massive at the top and bottom, which form long ele-

A CAVERN IN MADISON LIMESTONE.
"The Sinks", Big Popo Agie River, ten miles west of Lander.

vated slopes affording excellent pasture. Beds of marble are locally developed in Big Popo Agie Canyon. Extensive exposures are exhibited in the canyons of all streams which flow east from the mountains. The upper portion is, to some extent, cavernous, Big Popo Agie River flowing into one of the caverns at the "Sinks" eight miles west of Lander.

FOSSILS.

Although fossils were found at various horizons in this formation, they consist of but two species, *Spirifer centronatus*, and *Chonetes loganensis*, which indicate that the formation is equivalent to the Madison limestone of the Bighorn Mountains.

AMSDEN FORMATION.

The Amsden formation consists of red shales and pink sandstones at the base, succeeded by thin gray sandstones and purple sandy shales. Near the top are cherty beds, with which are interbedded buff sandstone, the upper beds forming a pronounced cliff. Complete exposures of this formation are rare, the lower portion usually being masked.

FOSSILS.

But one fossil was obtained from this formation, apparently a fragment of a Bellerophon. From its position above the Madison limestone, and its lithological character these beds are placed with the Amsden formation of the Bighorn Mountains.

TENSLEEP SANDSTONE.

Overlying the Amsden formation is a thick bed of massive, buff, cross-bedded sandstone, its outcrop usually being marked by a prominent ridge, while it forms high, steep walls at the mouths of the canyons. It is a prominent

feature in all of the canyons, being found along the entire length of the Wind River Range in this area.

AGE.

No fossils were obtained from this sandstone, but as it is overlain by the very fossiliferous Embar formation, it is believed to be equivalent to the Tensleep sandstone of the Bighorn and Owl Creek Mountains.

EMBAR FORMATION.

The Embar formation forms the outer slope of the Wind River Range and is of the greatest importance in this district, as it is the source of the fuel oil found at numerous points along the Shoshone anticline. It consists principally of cherty limestone, with shale and sandstone in its middle part and a thin bed of sandy limestone near the base, with beds of chert locally developed at the base and the top of the formation.

The thickness of the formation varies from 347 feet to 360 feet. In Big Popo Agie canyon, six miles west of Lander, it was found to be 347 feet, west of the head of Red Canyon, 356 feet. The following sections illustrate the local variations in this formation.

SECTION OF EMBAR FORMATION IN CROOKED CREEK CANYON, FOUR MILES WEST OF WIND RIVER AGENCY.

Chert, overlain by Triassic Red Beds	6 feet
Limestone, gray and yellow, sandy. Weathers to light tan	20 feet
Limestone, white, weathering gray, with cherty concretions. Contains many fossils, including *Spiriferina pulchra*, corals and pentacrinus stems	36 feet
Limestone, shaly	40 feet
Shale, gray and brown, partly concealed	34 feet
Sandstone, shaly, brown, fossiliferous. The upper oil sand of the Dallas field	10 feet
Limestone, gray and buff, cherty. Contains many fossils	20 feet
Limestone, white, weathering light buff	20 feet
Shale, gray and brown, sandy. Partly concealed	48 feet
Limestone, gray, sandy, cellular. Contains many fossils. The lower oil sand of the Dallas field	3 feet
Limestone, massive, gray	9 feet
Cherty limestone	2 feet
Lower portion masked.	

TENSLEEP SANDSTONE IN BIG POPO AGIE CANYON.
The long slope in the left background is formed by Embar Beds.

SECTION IN BIG POPO AGIE CANYON, SIX MILES WEST OF LANDER.

Chert	4 feet
Limestone, buff, shaly, fossiliferous	19 feet
Limestone, gray, cherty, fossiliferous	70 feet
Shale	18 feet
Masked	30 feet
Limestone, gray and brown, cherty	6 feet
Masked probably shale	42 feet
Limestone, massive, contains many fossils	68 feet
Limestone, shaly	47 feet
Masked	20 feet
Limestone, gray and buff, cherty	21 feet
Chert	2 feet
TOTAL	347 feet

SECTION IN SMALL CANYON, WEST OF THE HEAD OF RED CANYON

Limestone, brown, shaly, overlain by red shale	20 feet
Limestone, massive, gray, contains numerous fossils	71 feet
Shale, sandy, partly concealed	38 feet
Sandstone, brown. The upper oil sand	7 feet
Limestone, cherty	6 feet
Masked	52 feet
Limestone, massive, brown	102 feet
Limestone, cellular, very fossiliferous. The lower oil sand	2 feet
Limestone, in part masked	57 feet
Chert	1 foot
TOTAL	356 feet

FOSSILS.

Fossils occur in abundance at several horizons in the Embar formation, especially at the top and near the bottom. A large number were obtained from the walls of Big Popo Agie and Crooked Creek Canyons. The following species have been identified:

Spiriferina pulchra, Meek
Spiriferina opimus, Hall
Spiriferina cameratus, Morton
Productus multistriatus, Meek
Productus costatus, Sowerby
Productus semireticulatus, Morton
Pleurotomaria sp.
Bellerophon sp.
Aviculopecten occidentalis, Meek
Aviculopecten utahensis, Meek
Sedgwickia concava, Meek
Allorisma ventricosa, Meek
Myalina permiana, M. & H.
Seminula argentia, Hall
Lingula sp.

This formation has been identified in the Bighorn Mountains by Darton as of Pennsylvania age. In the Lander district it forms long, grassy slopes on the outer flank of the Wind River Range. It is, without doubt,

the source of the fuel oil found in this district, although it is nowhere exposed in the oil fields. In the Sage Creek field this formation was reached at a depth of 420 feet in the well of the Washakie Hydro-Carbon Mining Company, and at 1130 feet in the Hannon well. Near Battrum Gap, in Section 35, T. 33 N., R. 99 W., the formation was encountered at 2390 feet, while Woodruff* states that in the Dallas field it is reached at 700 feet.

TRIASSIC SYSTEM.

CHUGWATER FORMATION.

The Chugwater formation, consisting principally of red shales and sandstones, is exposed in a wide belt along the base of the mountains, and forms the crest of the anticline in the Dallas and Sage Creek oil fields, and to a slight extent in the southern portion of the Plunkett field. The outcrop area varies from two to four miles in width, and is a conspicuous feature on account of the bright red color of the formation.

Considerable difference of opinion as to the thickness of this formation is evident among writers who have visited this district. Knight† estimates the thickness as "nearly 1,000 feet", Eldridge‡ as 2,000 feet, Woodruff** as 1,500 feet. Woodruff states that the method used by him in determining the thickness of this formation was the following: "the base of the Jurassic was located * * *

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* Woodruff, E. G., U. S. Geological Survey Bulletin 452, page 14.

† Knight, W. C., Petroleum of the Shoshone Anticlinal; University of Wyoming, Bulletin No. 2, Petroleum Series, 1897.

‡ Eldridge, G. H., A Geological Reconnaissance in Northwest Wyoming, U. S. Geological Survey Bulletin No. 119, 1894.

**Woodruff, E. G., The Lander Oil Field; U. S. Geological Survey Bulletin No. 452, 1911.

from which point a stadia traverse was run across the strata of the Chugwater. Relative elevations were carefully determined and dip and strike measurements were made at frequent intervals. The thickness of the beds was computed from these data and further checked by the known thickness of the beds exposed along Little Popo Agie River, increased by the thickness determined from the logs of the wells". The same method was used by the writer west of Lander and on Little Wind River, where the thickness of the formation was determined to be 2016 feet and 1966 feet, respectively. Well No. 1 of the Battrum Oil & Refining Company penetrated the entire thickness of the Chugwater, being located on the crest of the anticline where the strata are horizontal or nearly so. This well reached the Carboniferous at a depth of 2,500 feet. Well No. 2 was located at a point 170 feet below the top of the formation, the strata dipping 16 degrees. This well penetrated the Red Beds at 2,390 feet, the thickness of the formation based on these figures being 2,472 feet.

The Chugwater formation consists essentially of red shales and sandstones, but also contains several thin beds of limestone and, near the top, a thick bed of gypsum. The gypsum bed varies in thickness from 32 feet, on Big Popo Agie River, to more than 70 feet in the Sage Creek district, much of it being extremely pure. West of Lander, near Big Popo Agie Canyon, the following section of this formation was measured:

Slabby limestone	4 feet
Masked	74 feet
Limestone	4 feet
Gray shale	19 feet
Green shale with thin sheets of gypsum	32 feet
Purple shale	3 feet
Gypsum	2 feet
Gray and green shale	5 feet
Gypsum	4 feet
Limestone	3 feet

Purple shale	1 foot
Gypsum	12 feet
Shaly limestone	10 feet
Gray shale	8 feet
Masked	10 feet
Impure gypsum	24 feet
Gypsum	44 feet
Limestone	2 feet
Brown and buff soft, slabby sandstone	180 feet
Massive gray and buff sandstone	87 feet
Buff sandstone	43 feet
Massive dark red sandstone	56 feet
Gray sandstone conglomerate. Boulders up to 6 inches in diameter	14 feet
Red sandstone	6 feet
Purple shale	21 feet
Soft red sandstone	20 feet
Limestone	1 foot
Soft, shaly red sandstone	212 feet
Limestone	2 feet
Soft slabby red sandstone with harder streaks and thin beds of purple shale	97 feet
Dark red, massive sandstone	274 feet
Soft red shales and shaly sandstone. In part masked	742 feet
TOTAL	2016 feet

SECTION ALONG LITTLE WIND RIVER WEST OF FORT WASHAKIE.

Shaly limestone	2 feet
Buff sandstone	19 feet
Masked	62 feet
Gypsum	1 foot
Gray shale	16 feet
Masked	55 feet
Gypsum	32 feet
Limestone	1 foot
Red sandy shale	150 feet
Limestone	2 feet
Massive pink and light red sandstone. In part cross-bedded	176 feet
Purple shale	2 feet
Massive red and brown sandstone. Forms high ridge	150 feet
Masked	73 feet
Dark red sandstone	81 feet
Limestone	1 foot
Red and buff sandstone	221 feet
Limestone	10 feet
Red sandstone, massive, cross-bedded	50 feet
Red shale and slabby sandstone, ripple marked	726 feet
Gray shale	1 foot
Red sandy shale	135 feet
TOTAL	1966 feet

A section of the gypsum beds, measured on Little Wind River, one-half mile south of the Tar Spring follows:

Hard gray limestone	3.3 feet
Soft white and buff sandstone	6.2 feet
Hard white limestone	2.9 feet
Gray shale	3.0 feet
Hard gray limestone	2.2 feet
Gray shale	2.1 feet
Buff limestone	1.2 feet
Buff shale	2.8 feet
Gray limestone	0.9 feet
Gray shale and clay	2.7 feet
Gray limestone	1.0 foot
Gray shale	1.2 feet
Red shale	1.0 foot
Gray and buff shale	3.0 feet
White sandstone	2.0 feet
Gray shaly limestone	2.2 feet
Gray soft sandstone	4.1 feet
Gray slabby limestone	6.7 feet
Gray shale	4.0 feet
Red shale	14.2 feet
Gray slabby limestone with interbedded red shale	24.0 feet
Red and green shale with thin gypsum beds	20.0 feet
Gypsum	61.0 feet
Gray and buff shale with interbedded gypsum	37.0 feet
Soft sandstone impregnated with oil	17.0 feet
TOTAL	225.7 feet

At the point where this section was measured the upper portion of the Triassic is well exposed, the strata dipping 68 degrees north. The massive gypsum bed forms a cliff, at the foot of which Little Wind River flows. The strata have been diverted from their normal strike and dip by faulting, and the oil which impregnates the lower sandstone of this exposure has clearly seeped upward through one of the fractures of this fault system.

AGE.

Although no fossils were found in this formation, these beds are regarded as Triassic on account of their position above Upper Carboniferous limestone and below beds known to be of Jurassic age.

JURASSIC SYSTEM.

SUNDANCE FORMATION.

Overlying the Triassic Red Beds is the Sundance formation, consisting of buff and greenish gray shales

buff and flesh-colored sandstones, the latter being believed to represent the Dakota group. At the base is a coarse-grained gray sandstone, usually conglomeratic, followed by brown shales and sandstones, and dark carbonaceous shale, with impure coal at some points, and, at the top of the group, massive sandstone, flesh-colored in the lower part and brown at the top. The upper sandstone usually forms a prominent cliff or hogback ridge. In the Plunkett oil field this sandstone is marked by a sparse growth of cedar, the only trees to be found in that field. The thickness of this group as measured on Big Popo Agie River and on Sage Creek is about 424 feet.

SECTION ON BIG POPO AGIE RIVER.

Sandstone, massive. Gray in lower, brown in upper part	51 feet
Shale, soft, dark gray	97 feet
Sandstone, soft, yellow	2 feet
Shale, sandy, soft, gray	26 feet
Sandstone, soft, buff, ripple marked	38 feet
Shale, dark, carbonaceous. Contains thin seams of coal	23 feet
Sandstone, soft, yellow and gray, with interbedded carbonaceous shale	29 feet
Masked	31 feet
Shale, dark gray	100 feet
Sandstone, coarse-grained, gray	22 feet
TOTAL	419 feet

SECTION ON SAGE CREEK.

Sandstone, hard, brown. Forms prominent ridge	20 feet
Sandstone, soft, gray, massive	35 feet
Masked	34 feet
Shale, dark gray	16 feet
Masked	108 feet
Sandstone, soft, buff	62 feet
Shale, sandy, yellow. Gray on weathered exposures	74 feet
Sandstone, massive, gray and buff	64 feet
Conglomerate, fine-grained, gray	8 feet
Sandstone, gray and buff, coarse-grained, cross-bedded	7 feet
TOTAL	428 feet

The lower portion of this group is believed to be the source of the oil found in the Washakie oil spring and in the well of the Lander Oil Syndicate on the Wind River Indian Reservation.

AGE.

No fossils other than a few plant remains, were obtained from this group. Darton* divides the group into the Lakota, consisting "mainly of gray sandstones, mostly hard, massive, coarse-grained and cross-bedded. The basal beds are conglomerate at most places", the Fuson, a "series of shales and thin-bedded sandstones", and the Dakota, "mainly brown sandstones". Woodruff† refers the lower and middle portions of this group to the Lower Cretaceous, and the upper portion to the Dakota Sandstone; Knight‡ refers these beds to the Dakota group, although he states "the Dakota group * * * does not contain the heavy band of conglomerate that is usually seen in central Wyoming."

Although no evidence, sufficient to make a distinction between the Lower Cretaceous and the Dakota formations was obtained by the writer in this region, in the Douglas oil field slight evidences of a planation unconformity were noted at the base of the upper massive sandstone.

The lower sandstone, conglomerates and shales are believed to be of Lower Cretaceous age while the upper sandstone represents the Dakota formation. However, the Dakota and the Lower Cretaceous are shown on the accompanying map by the same symbol.

MANCOS GROUP.

The group of shales and sandstones, 6,500 feet to 7,000 feet in thickness, here treated under the name Mancos

* Darton, N. H., Geology and Water Resources of the Northern Portion of the Black Hills and Adjoining Regions in South Dakota and Wyoming. U. S. Geol. Survey, Prof. Paper 65, 1909.

† Woodruff, E. G., The Lander Oil Field, U. S. Geol. Survey Bulletin 452, 1911.

‡ Knight, W. C., Petroleum of the Shoshone Anticlinal; University of Wyoming. Bulletin No. 2, Petroleum Series, 1897.

Group, comprises the Colorado and a portion of the Montana formations, between which no distinctive line could be drawn in the field. At the base are the Benton shales, consisting of about 200 feet of soft sandy shales which weather readily and form a characteristic valley between the hog-back ridges of the Dakota and the hard shales of the Mowry Beds. Overlying these soft shales and forming the middle portion of the Benton formation are the Mowry Beds, a series of hard, thin-bedded, dark-gray shales, sandy in the upper portion, which weather to light gray. These shales, characterized by the occurrence of fish scales in large numbers, give rise to prominent, bluish-gray ridges and cliffs, which are a conspicuous feature on each side of the Shoshone anticline. It is in the Mowry Beds that the oil of the Washakie Spring in the Plunkett field reaches the surface. The thickness of this member is about 425 feet.

Next above the Mowry shales are 175 feet of soft gray and brown sandstones, which are overlain by a limestone member, probably the representative of the Greenhorn Limestone of Colorado. This member consists of 9 feet of gray limestone, which breaks into small blocks and contains large numbers of *Inoceramus labiatus*, overlain by 50 feet of gray shale, with five feet of shaly limestone at the top.

Overlying the limestone member are 980 feet of gray, buff and brown sandstones, with six feet of impure coal 75 feet above the base. Large numbers of fossils were obtained from these sandstones, which are overlain by from 50 to 75 feet of yellow, extremely fossiliferous sandstone, the principal form being *Ostrea congesta*. This yellow sandstone is believed to represent the Niobrara formation. Above the yellow sandstone, and extending

to the top of the Manços group, are soft, gray and yellowish shales, sandy near the top, 4,700 to 5,000 feet in thickness. These shales, which weather readily and produce a region of low relief, affording but few exposures, are regarded as being equivalent to the Fort Pierre shales.

The Mancos group is widely distributed in this area. It forms the wide flat valley between the Shoshone anticline and the Mesaverde sandstone cliffs near the eastern border of this section, is found on the crest of the anticline in the Plunkett oil field, passes under Tertiary deposits and Quaternary gravels in the synclinal basin of the Lander valley, and reappears a short distance west of Lander, where the Mowry cliffs form a prominent feature of the topography in a belt parallel to the Wind River Mountains. Below is a section of this group as measured east of the Plunkett oil well:

Sandstone, shaly, gray, weathering brown	206 feet
Shale, sandy, gray and yellow, soft. Partly masked	4585 feet
Sandstone, yellow. Contains *Ostrea congesta* and other fossils	68 feet
Sandstone, gray, fine-grained	417 feet
Sandstone, brown	4 feet
Sandstone, gray	409 feet
Shale, dark, carbonaceous, containing 6 feet of impure coal	18 feet
Sandstone, gray	75 feet
Limestone, shaly	5 feet
Shale, soft, gray	50 feet
Limestone, gray, breaks into small blocks. Contains *Inoceramus labiatus*	9 feet
Sandstone, gray	143 feet
Sandstone, buff	32 feet
Shale, hard, dark gray, with several thin sandstone beds. Contains fish scales and other fossils	425 feet
Shale, soft, gray. Forms valley between the Dakota sandstone and the Mowry shale	198 feet
TOTAL	6698 feet

FOSSILS AND AGE.

Fossils were obtained from this group at various horizons, the following species having been identified:

Sandstone in the Mowry Beds near the Plunkett well.

Cyrena securis, Meek
Tellina? isonema, Meek
Turitella sp.
Dentalium gracile, M. & H.

Sandstone 450 feet above Mowry Beds, three miles south of Indian School.

Pinna lakesi, White
Cardium curtum, M. & H.
Cardium pauperculum, Meek
Prionocyclus woolgari, Mantell
Gervillia sp.
Pholadomya papyracea, M. & H.
Inoceramus labiatus, Schlotheim
Inoceramus sp.
Exogyra sp.

Yellow sandstone one-half mile east of Plunkett well.

Ostrea congesta, Conrad
Inoceramus problematicus, Schlotheim

Sandy shales near the top of the group.

Scaphites nodosus var. quadrangularis, M. & H.
Nautilus deKayi, Morton
Inoceramus sagensis, Owen
Corbula subtrigonalis, M. & H.
Placenticeras placenta, DeKay
Modiola sp.
Mactra sp.

All of the fossils listed above, except those last mentioned, are characteristic of the Colorado group. *Ostrea congesta* is typical of the Niobrara formation, but as the yellow sandstone, in which these fossils are found, merges into the shales above, the line between the Colorado and the Montana was not drawn.

MESAVERDE FORMATION.

Overlying the Mancos group, is the Mesaverde formation, the Mancos shales grading upward with no apparent break in sedimentation into the basal sandstones of the Mesaverde. This formation consists of a bed of massive sandstone light buff in color, 320 feet thick, at the base, overlain by drab and buff shales with beds of workable coal in their lower part. The entire thickness of this formation is not exhibited in this district.

FOSSILS AND AGE.

No fossils other than a few baculites were obtained from this formation. The basal sandstone has heretofore been regarded as Fox Hills, and the coal-bearing sandy shales as Laramie. However, Woodruff* has identified it as Mesaverde.

* Woodruff, E. G., The Lander Oil Field, U. S. Geol. Survey Bull. 452, 1911, p. 22.

TERTIARY SYSTEM.

EOCENE SERIES.

Unconformably overlying the Mesaverde formation are strata of Eocene age, consisting of buff sandstones and shale, with local conglomerate. Beds of Eocene age are found in the northern and eastern part of this area, the outcrop extending northwest and southeast from Hudson, and in an isolated area of some twenty square miles in extent, lying north of Lander, between the North Fork of Popo Agie River and Mill Creek, where they are known as the "Sand Hills". No study, further than was necessary to define its limits, was made of this formation.

STRUCTURAL GEOLOGY.

The principal structural features of this region are the high, steep anticline which forms the Wind River Mountains, the synclinal basin of the Lander valley, and the Shoshone anticline, the latter being a secondary fold parallel to the principal mountain chain. The structure of the Shoshone anticline is complicated by faults at several points, by a slight overturning of the arch in the Sage Creek district, and by a minor anticline branching from the principal fold near the northwestern border of this area. As has been pointed out by Knight* and by Woodruff† a series of domes has been developed along the axis of the anticline, one of these domes corresponding to each of the oil fields.

WIND RIVER MOUNTAINS.

The western portion of this region presents an eastward dipping monocline, the eastern flank of the Wind River

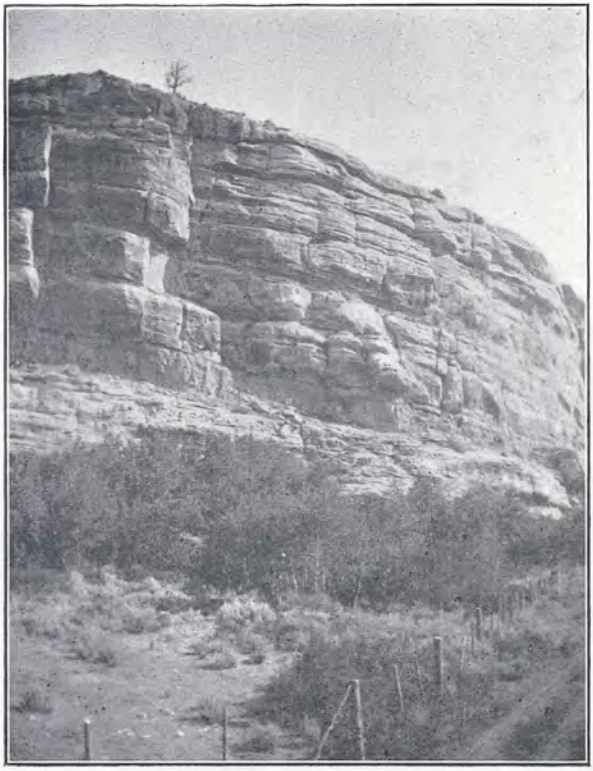
* Knight, W. C., Petroleum of the Shoshone Anticlinal, p. 11.
† Woodruff, E. G., The Lander Oil Field, p. 24.

Mountain anticline. The central portion of this anticline has been removed by erosion, presenting a nucleus of pre-Cambrian granites and schists, from which the sedimentary rocks dip at angles varying from ten to fourteen degrees to the northeast. The most elevated portion of the Wind River Mountain uplift lies west of Lander, where the summit of Fremont Peak rises to an altitude of 13,790 feet.

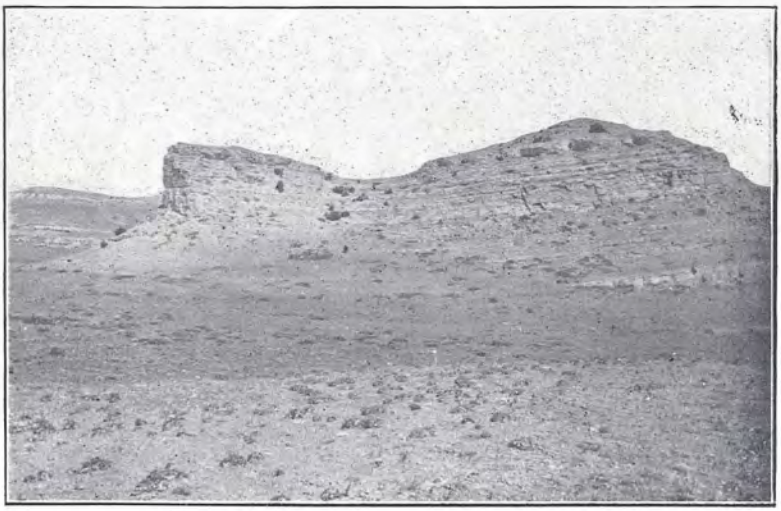
In the South Pass district, which occupies the southern extremity of the Wind River Mountains, the granites give way to schists, which have been penetrated by numerous dikes of diabase and diorite. In this district the anticline is flattened and the elevations are not so great as further north, the greatest altitude being not more than 9,500 feet.

SAGE CREEK DISTRICT.

In the Sage Creek district the crest of the Shoshone anticline is occupied by Chugwater Red Beds, the rocks being sharply folded, and, in the central portion of the field, the anticline overturned and a fault system developed. The fault system, which is quite extensive, consists of a large number of fractures with but slight movement in any one case, although the aggregate movement was sufficient to change the strike of the strata from N. 50° W. to S. 83° W. The lateral pressure which caused this faulting and to which the Shoshone anticline is due, was apparently centered in the valley of the Little Wind River, causing the anticline to be overthrown, the dip of the westward limb being 64 degrees northeast, instead of the normal dip of 40 degrees southwest. On the eastward limb of the anticline the rocks dip more gently, the average dip being 20 degrees. The fault system, which is confined to the westward side of the anticline, extends from the



A. TENSLEEP SANDSTONE WEST OF LANDER.



B. JUNIPER BUTTE, SAGE CREEK DISTRICT.
Showing trough of the secondary syncline.


STATE OF WYOMING
1933
GEOLOGICAL SURVEY

southwest corner of Section 27, T. 1 N., R. 1 W., to the southeast corner of Section 1, T. 1 S., R. 1 W.

In the northwestern portion of this district is the spur from the main anticline, which was previously mentioned, while the dome, which forms this field, terminates on the southeast in Section 8, T. 1 S., R. 1 E.

PLUNKETT FIELD.

In the Plunkett field, which extends from Mill Creek on the northwest, to Big Popo Agie River on the southeast, the crest of the anticline is occupied, principally, by Benton shales, though exposures of the Dakota sandstone, Lower Cretaceous rocks, the Morrison shales, the Sundance formation and the Triassic system are exhibited in the southwestern part of the field. Beds of Tertiary age occupy an area of several square miles a short distance west of the Plunkett oil well, and give rise to steep, conical hills, which are locally known as the "Sand Hills". Two hundred feet north of the Plunkett well is a fault of some 500 feet throw. This fault passes under the alluvium of the Mill Creek valley, the latter being the result of a fault system of which this fault is a member. The rocks here, as in the other fields of this district, dip more steeply to the west than to the east, though the dip is rather steep on each side of the anticline, varying from 20 to 70 degrees.

DALLAS FIELD.

In the Dallas field, which extends from Big Popo Agie River to Twin Creek, the crest of the anticline is occupied for the greater part by Chugwater Red Beds. In Sections 18, 19, 20, 29 and 32, T. 32 N., R. 98 W., is a fault parallel to the strike of the anticline. The maximum throw of this fault is not less than 900 feet. Another

fault was noted about two miles east of the Dallas postoffice, but no study was made of it. In this district the rocks dip very steeply to the west, and more gently to the east, at some places on the western limb the strata being vertical.

LANDER VALLEY.

The Lander valley occupies the synclinal basin between the Wind River Mountains and the Shoshone anticline. The position of the axis of this syncline can only be inferred, as it is covered by alluvium. The eastern limb is much steeper than the western and, as it corresponds to the western limb of the Shoshone anticline, is overturned in the northwestern portion of this region, and probably faulted at several places. The western limb is formed by the monocline on the east flank of the Wind River Mountains, the dip varying from 10 to 14 degrees.

GEOLOGIC HISTORY.

The rocks found in this region comprise granites and schists of pre-Cambrian age, and a series of sedimentary strata, consisting of sandstones, shales and limestones, which afford a more or less complete record of the physical geography of the district from Cambrian time to the present. As practically all sedimentary rocks have been deposited under water, this region has been submerged several times. The composition and appearance of these stratified rocks show, to some extent, the conditions that existed when they were deposited. Sandstones, cross-bedded by currents and ripple marked by waves, and shales were deposited in shallow water. Conglomerates indicate heavy currents or wave action on a beach, while pure limestones were laid down in deep, open seas. If a formation is present in this region it means that a lake or sea existed here during

the period of deposition; if absent this section was land. The fossils that are found in a stratum may be species which are known to inhabit fresh, brackish or salt water, and it is by a study of them that the age of the stratum is determined.

PRE-CAMBRIAN TIME.

In pre-Cambrian time a range of mountains, which extended from the South Pass district a number of miles northeast, was thrown up in this region. This range continued to be land during a long period and the mountains were reduced by erosion to mere hills.

CAMBRIAN SEA.

Land existed in this region until about middle Cambrian time, when the surface was depressed and this area became sea bottom, though near the shore line of a number of islands which occupied the position now held by the Wind River Mountains. These islands were broken down into sand and gravel which afforded the material for the conglomerates and coarse-grained sandstones of the Deadwood formation. Succeeding these sandstones is a thick bed of shales, which indicates that the land surface had now become low and the streams sluggish, while the bottom of the ocean was being slowly depressed. The upper limestones of this formation indicate deeper water conditions, which were followed by an emergence, lasting until the close of Cambrian time.

ORDOVICIAN SEA.

With the beginning of the Ordovician period the land was submerged and a thick bed of limestone was deposited. Late in Ordovician time the sea bottom was again elevated

and this district became land, which it continued to be during all of Silurian and Devonian time.

CARBONIFEROUS SEA.

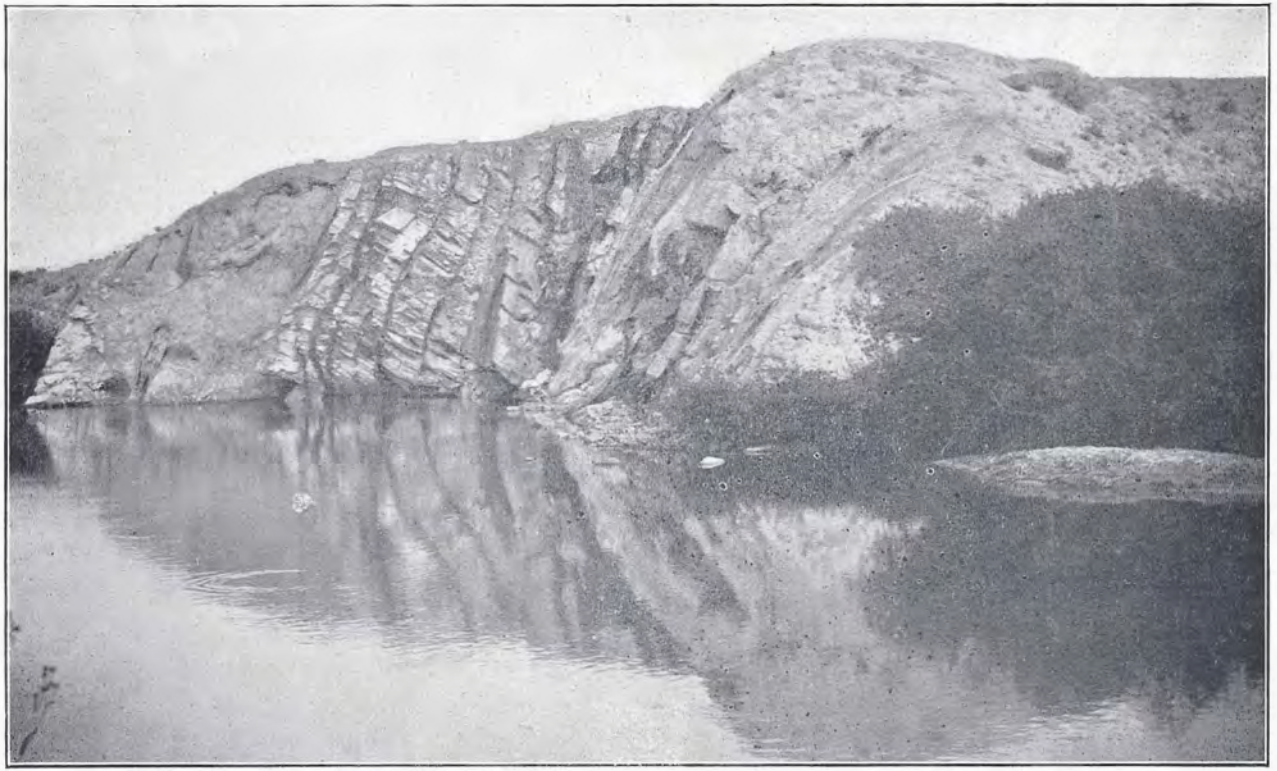
In the early part of the Carboniferous age the land surface was depressed and deep sea conditions prevailed, during which the Madison limestone, a thick, massive formation, was deposited. There was then a change in conditions, with probably shallower seas, and the red shales and sandstones of the Amsden formation were laid down, which were followed by shallow seas with strong currents, and the cross-bedded sandstones of the Tensleep formation were deposited. This condition gave way to a period of quiet seas during which the deposition of the shales and limestones of the Embar formation took place.

TRIASSIC SEA.

Beginning in late Carboniferous time there was a general uplift and a great inland sea was formed, in which the Chugwater Red Beds were deposited. This mass of red shales and sandstones, 2,000 feet in thickness, with its thick gypsum bed near the top, is without doubt, the result of an extremely dry climate. The deposit of pure gypsum, the average thickness of which is not less than 50 feet, is the product of evaporation, a condition which indicates a period of little or no rainfall. During the period of deposition of the Red Beds this inland sea was no doubt very shallow, as is evidenced by the ripple marks found throughout the formation.

JURASSIC SEA.

Following the deposition of the Red Beds was a period of alternating conditions, between deep and shallow marine



MASSIVE GYPSUM OF CHUGWATER FORMATION, ON LITTLE WIND RIVER.

waters. In middle Jurassic time was a period of shallow water, in which the ripple-marked sandstones found at the base of the Sundance formation were deposited. This was followed by deeper and quieter waters while the limestones and shales of the middle portion of this formation were laid down, which were succeeded by shallow waters and the deposition of the sandstone and conglomerate found at the top of the formation. Succeeding the Sundance period in late Jurassic time, was a period of quiet seas during which the many colored Morrison shales were laid down.

CRETACEOUS CONDITIONS.

At the close of the Morrison there was a quick change in conditions and the coarse-grained sandstones and conglomerates of Lower Cretaceous age were deposited in shallow water with strong currents. Quieter seas then prevailed and the shales and sandstones which form the upper portion of the Lower Cretaceous rocks were laid down. The region was then slightly elevated and probably became, for a short time, low land or mud flats. The surface was again depressed and the sandstones of the Dakota formation were deposited.

After Dakota time was a period of slow submergence and 7,000 feet of shales and sandstones of the Mancos group were deposited in shallow water. This was succeeded by strong current conditions and the sandstones of the Mesaverde formation were laid down. In late Cretaceous time a portion of this region was covered by fresh water lakes in which the shales and sandstones, together with the carbonaceous material which now form the coal beds worked near Hudson, were deposited.

TERTIARY CONDITIONS.

At the close of Cretaceous time the Wind River Mountain uplift took place and the Shoshone anticline was formed, due to the lateral pressure caused by the upheaval of the Wind River Range. The Eocene beds were then deposited, a slight tilting of the surface to the eastward took place, a sheet of gravel was laid down over the district, and the production of the present topography was begun.

MINERAL RESOURCES.

OIL.

Oil has been found in the Lander district in springs and wells in the Dallas field in Sections 13, 14, and 24, T. 32 N., R. 99 W., in the Plunkett field in Section 26, T. 1 S., R. 1 E.; and in the Sage Creek field in Sections 22 and 35, T. 1 N., R. 1 W. Oil saturated sandstones, shales and gypsum were noted by the writer in Sections 32 and 27, T. 1 N., R. 1 W.; Section 1, T. 1 S., R. 1 W.; Section 7, T. 1 S., R. 1 E.; Sections 3 and 26, T. 33 N., R. 99 E. Bubbles of oil were noted arising in the bed of Trout Creek in Section 1, T. 1 S., R. 1 W. A slight showing of oil is reported in a well now drilling in Section 12, T. 2 S., R. 1 E. In the early spring of this year a small amount of oil was encountered in drilling a water well some three miles east of the anticline in T. 33 N., R. 98 W.

The oil in the Dallas and Sage Creek fields is heavy, dark brown in color, and of asphaltum base, while that of the Plunkett field is olive green by reflected, and red by transmitted light, and of paraffin base.

DAKOTA SANDSTONE IN THE DALLAS FIELD.

HISTORY OF DEVELOPMENT.

The first discovery of oil in Wyoming was probably made in the Dallas field early in the 19th century. Capt. Bonneville visited these "Tar Springs" in 1833, but even then they had been known to the hunter and trapper for a number of years. The oil spring in the Sage Creek field was discovered in 1864 by Homer Haas of the Eleventh Ohio Cavalry.

No development was attempted in this district until 1880 when Dr. George B. Graff of Omaha sunk a series of shafts, from six to twelve feet deep, and in the bottom of one of them drilled a hole twenty-seven feet deeper. This well was estimated to flow two barrels of oil per day. In 1885 Dr. Graff drilled three wells to depths of 300 feet, 500 feet and 800 feet, respectively. These wells were reported to yield 200 barrels of oil, each, per day, though, no doubt, these figures are far too large. In 1897 Knight* reports that four wells had been drilled in this field and a fifth started. He gives the production of the first three as 200 barrels each, and the fourth, 1,600 feet in depth, as producing water, gas and oil. He makes the following statement in regard to the production:

"The production of oil from these wells has been variously estimated at from 100 to 1,000 barrels each twenty-four hours. From the most reliable data obtainable, they will give 200 barrels each if pumped. The present wells cannot expect to reach this limit, since they have been packed for twelve years and in consequence are injured to some extent. Wells Nos. 1 and 2, when opened, roar so that one can hear them a quarter of a mile away. As soon as the greatest gas pressure has died away the oil shoots into the air thirty or forty feet if the escape is directed

* Knight, W. C., Petroleum of the Shoshone Anticlinal

upwards. The pressure gradually diminishes and the flow seems to remain quite constant."

Since 1897 drilling has been carried on spasmodically in this field and probably forty wells drilled, seventeen of which, according to the best information obtainable, produce oil when pumped.

The logs of the thirteen wells first drilled are taken from U. S. Geological Survey Bulletin 452, The Lander Oil Field, by E. G. Woodruff.

"Well No. 1 (Murphy's No. 1); drilled in 1884: A crevice well drilled along-side natural oil spring. Depth said to be 300 feet. Shows considerable gas pressure and flows spasmodically. Tubing is chained to 'dead men'.

"Well No. 2 (Murphy's No. 2); drilled in 1884-86: A crevice well. Depth said to be 400 feet. Shows considerable gas pressure and flows spasmodically. Tubing chained to 'dead men'.

"Well No. 3 (Murphy's No. 3); drilled in 1884-86: Well drilled just into the oil sand. Depth said to be 750 feet. Shows considerable gas pressure and flows spasmodically. Tubing chained to 'dead men'.

"Well No. 4; drilled in 1901: Spudding commenced June 20, 1901; drilling ceased August 21, 1901. Depth of well 698 feet. Good crevice well; flows spasmodically. Well stopped in limestone capping.

"Well No. 5 (Sulphur Well); drilled in 1901: Spudding commenced September 4, 1901; work stopped October 8, 1901; drilling recommenced November 7, 1901; finished November 17, 1902. Depth of well 1,120 feet. A non-producer; oil sand strong with sulphur water, of which there is a copious flow.

"Well No. 6 (Werlen well); drilled in 1902: Spudding commenced July 2, 1902; drilling finished September 5, 1902. Depth of well, 1,025 feet. A good pumping well.

"Well No. 7 (Anchor well); drilled in 1901-2: Spudding

commenced November 6, 1901; stopped November 26, 1901; recommenced February 19, 1902; stopped again May 14, 1902; recommenced again June 23, 1902, and stopped June 27, 1902. Depth of well 1,520 feet. Sulphur water and very little oil in hole.

"Well No. 8 (Litchfield well); drilled in 1902: Spudding commenced October 13, 1902; drilling finished October 28, 1902. Depth of well, 918 feet. Well just in sand and flows spasmodically.

"Well No. 9 (Skallawag well); drilled in 1902-3: Spudding commenced December 17, 1902; drilling stopped January 7, 1903. Depth of well, 848 feet. Well produced oil and sulphur water and is a good pumper.

"Well No. 10 (Marguerite well); drilled in 1902-3: Spudding commenced November 11, 1902; tools lost November 25, 1902; casing drawn and hole reamed December 28, 1902; tools recovered and well finished March 31, 1903. Well just through capping and yields considerable oil and gas. Depth of well, 825 feet.

"Well No. 11 (Neptune well); drilled in 1903: Spudding commenced January 21, 1903; well finished February 26, 1903. Depth of well 955 feet. A non-producer, yielding only sulphur water with little oil.

"Well No. 12 (Juniper well); drilled in 1903: Spudding commenced March 16, 1903; well finished April 10, 1903. Depth of well, 914 feet. A non-producer, yielding much sulphur water and little oil.

"Well No. 13 (Titania well); drilled in 1903: Spudding commenced April 20, 1903; well finished May 19, 1903. Depth of well, 697 feet. Good well; flows spasmodically."

In 1910 the Battrum Oil and Refining Company commenced operations in this field and drilled one well to a depth of 2,653 feet. A large flow of sulphur water was struck, the casing collapsed, and the well was abandoned.

Another well was started about 250 feet southeast of

the first well, and some 200 feet from the crest of the anticline. The log of this well is as follows:

0-1800 feet.	Red sandstones and shales.
1800-1833 feet.	Limestone.
1833-1900 feet.	Red sandstones and shales.
1900-1935 feet.	Limestone.
1935-2390 feet.	Red shales and sandstones.
2390-2455 feet.	Gray limestones and sandstones.
2455 feet.	Flow of 250 barrels of sulphur water per 24 hours was encountered.
2455-2525 feet.	Hard white limestone.
Depth July 14th, 2525.	Well drilling.

This well was located 170 feet (across the dip) below the top of the Red Beds. Dip of strata 16 degrees east.

In October 1911, it was reported that at a depth of 2,812 feet an artesian flow of warm sulphur water was encountered. Drilling was continued to a depth of 2,875 feet, when, on account of the pressure of the water, operations were discontinued. The temperature of the water is reported to be 98° F.

In Section 3, T. 33 N., R. 99 W., a well, which was drilled some years ago, is now flowing about three barrels of oil and fifty barrels of water per day. The log of this well is as follows:

0-1500 feet.	Red rock.
1500-1560 feet.	White limestone.
1560 feet.	Struck oil.
1560-1860 feet.	White limestone.
Struck water last few feet.	

This well is located about 1,000 feet east of the anticline.

Although oil was discovered in the Sage Creek field in 1864, no development was undertaken until the spring of 1909, when the Washakie Hydro-Carbon Mining Company drilled a well in Section 35, T. 1 N., R. 1 W. This well, which is near the "Tar Spring", was very unfortunately located, the strata in the immediate vicinity being much fractured and the well so situated that it encountered

the oil bearing stratum at a point above the "Tar Spring". The log of this well, furnished by Mr. Russell Thorp, president of the company, follows:

0- 25 feet.	Soil, some gravel.
25- 65 feet.	Red rock.
65-165 feet.	Blue clay, very soft.
165-171 feet.	Lime formation. Cold sulphur water.
171-300 feet.	Blue clay, very soft. Oil present. Artesian flow warm sulphur water. 1450 barrels per day at 300 feet.
300-350 feet.	Blue slate.
350-355 feet.	Lime. Warm sulphur water.
355-405 feet.	Blue slate.
405-420 feet.	Brown sandstone.
420-500 feet.	Slate.
500-540 feet.	Lime, slight conglomerate, Warm sulphur water. Formation hard.
540-555 feet.	Soft blue clay. Oil present.
555-570 feet.	Lime.
570-575 feet.	Flint.
575-600 feet.	Sand carrying oil.
600-620 feet.	Lime.
620-625 feet.	Lime.
625-650 feet.	Sand. Some crystalline formation.
650-670 feet.	Sand. Additional and stronger flow of oil.
670-675 feet.	Sand. Additional flow of oil.
675-800 feet.	Very hard, white gritty formation.

WATER: At 165 feet cold sulphur water.
At 300 feet artesian flow warm sulphur water at rate of 1450 barrels per day of 24 hours
At 350 feet additional artesian flow warm sulphur water up to 3000 barrels per day.
At 540 feet, Feb. 23rd, flow from tar springs stopped entirely.
The continuous flow since March 16, 1908, has settled down to a steady flow of 20 barrels per day. The different flows of water could be plainly noted both by the increase in flow and the fumes and gases, which affected the men's eyes to such an extent that work had to be shut down from one to three days until the gases subsided, although there continues to the present time a decided sulphur odor.
The water was used for some days in the boiler, with some degree of success, but would not advise use of this water as it would undoubtedly corrode and coat the flues and boiler in a comparatively short time.

DRILLING: Spudded in P. M. January 30, 1909.
39 ft. 10-in. conductor.
10-in. bit used to 405 feet, when attempt was made to shut off water in the brown sand formation, without success.
The hole reduced at this point, using 8-in. bit to a depth of 553 ft.
At 500 feet bits wore down rapidly.
At 540 feet tools stuck in blue clay.
At 555 feet to bottom of reaming set in casing with successful shut-off. Unsuccessful in reducing the water bailing.
Casing settled four feet in three days.

Set 672 feet of 6¼-in. casing. 80 lbs. wheat used to swell bottom, apparently without success.
From 675 feet to bottom of hole, 800 feet, in very hard formation that wore the bits rapidly.

The entire drilling was conducted in water continuously, from 165 feet down. Work extended over a period of sixty days, loss of time as follows:

Hauling and setting up rig	6 days
Sundays	7 days
Fumes blinding men	6 days
Tools stuck	4 days
Storms	5 days
Short of coal	7 days
Contractor's failure	4 days
TOTAL LOSS	39 days

21 days drilling, or 38 feet per day actual work.
The hole stood up with practically no casing.

OIL: Oil was present in the formation at 171 feet.
At 650 feet a perceptible flow of oil, which increased.
At 670 feet a second stratum was encountered which shot oil all over the coop. A continuous flow ot oil as long as the tools were in motion; when tools were removed, flow subsided.
The fine white sand to the bottom carries oil.
At the present time there is in the well:
39 feet. 10-in. 35-lb. line pipe conductor.
672 feet 6¼-in. 13-lb. casing.
309.4 feet of 28-lb., eight thread 8-in. casing and 246.5 feet of 16.7-lb., eleven thread, 8-in. casing with 18-in. nipple connections.

From this well is flowing a large amount of luke-warm water, strongly impregnated with sulphur, and a small quantity of very heavy oil.

In the summer of 1909 a well, known as the Hannon well, was drilled in Section 22, T. 1 N., R. 1 W. This well is located 4,800 feet east of the crest of the anticline. An extremely heavy, thick oil, containing 84.9 per cent asphaltum, as reported by Smith & Dunn, chemists of New York, was struck at 1,500 feet.

Below is given the log of this well as furnished by Mrs. L. C. Harnsberger of Lander:

0- 58 feet.	Gravel.
58- 65 feet.	Bone.
65- 450 feet.	Red sandstone.
450- 455 feet.	Gray shale.
455-1130 feet.	Red sandstone, base of Triassic.
1130-1200 feet.	Limestone.
1200-1397 feet.	Gray sandstone.

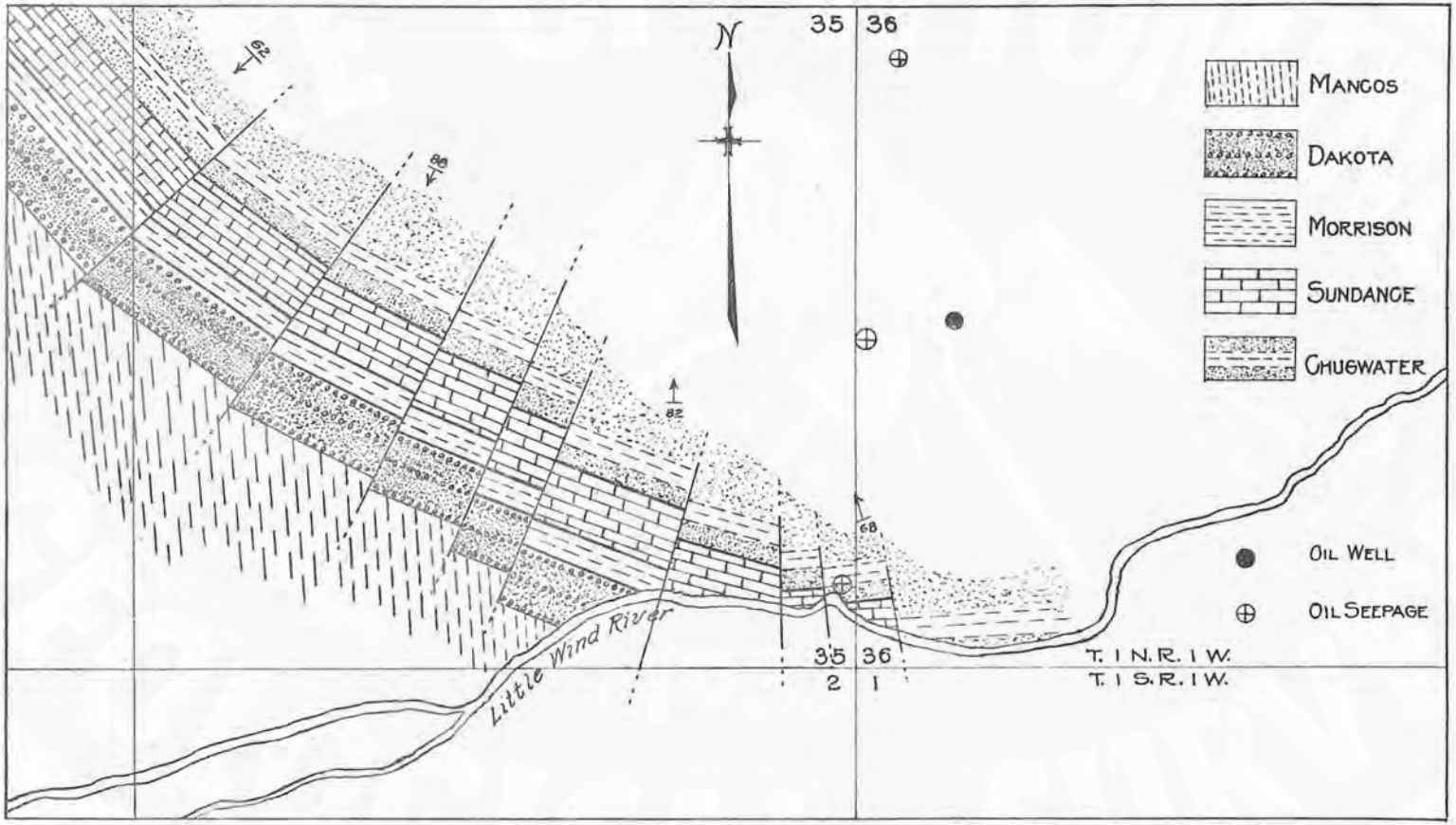


DIAGRAM ILLUSTRATING FAULTING ON LITTLE WIND RIVER, SAGE CREEK DISTRICT.

1397-1409 feet. Blue shale.
1409-1423 feet. Gray sandstone.
1423-1425 feet. Limestone.
1425-1426 feet. Shells.
1426-1430 feet. Limestone.
1430-1435 feet. Coaly matter.
1435-1500 feet. Limestone.
1500-1559 feet. Asphaltum.

Encountered fresh water at ..... 35 feet
Encountered fresh water at ..... 90 feet
Encountered fresh water at ..... 331 feet
Encountered salt, brackish water at ..... 450 feet
Encountered three feet of oil sand at ..... 815 feet
Encountered sulphur water which filled to within 35 feet of well at ..... 1200 feet
Encountered strong sulphur water, flowed over top of the derrick at ..... 1380 feet
Encountered sulphur water at ..... 1410 feet
Encountered thin stratum of coal at ..... 1420 feet
Encountered small amount of mud at ..... 1435 feet
Encountered artesian sulphur water at ..... 1440 feet
Encountered iron formation. Almost pure pyrites at .... 1450 feet
Encountered very thin oil sand at ..... 1465 feet
Encountered very thin oil sand at ..... 1490 feet
Encountered iron formation at ..... 1495 feet
Encountered pool of asphaltum at ..... 1500 feet
Asphaltum all way to bottom of hole. ..... 1559 feet

Well was started June 17th, 1908.
Well was cased with ten-inch pipe to 64 feet, 3 inches.
Well was cased with eight-inch pipe to 200 feet.
Well was cased with six and one-quarter inch pipe to 1265 feet.
Work stopped September 12th, 1908.
Hole reamed and cased with six-inch pipe to 1390 feet.
Hole re-reamed and cased with six-inch pipe to 1435 feet.

The date of the discovery of the Washakie oil spring in the Plunkett field is not known. In 1906 the lands adjacent to this well were leased to Col. Richard E. Plunkett, who transferred a portion of his holdings to the Lander Oil Syndicate, Inc., of Los Angeles, Cal. In 1909 this company drilled a well near the oil spring encountering oil at a depth of 45 feet. The log of this well, furnished by Mr. F. H. Hamilton, manager of the Lander Oil Syndicate follows:

First seepage of oil at ..... 45 feet
Second seepage of oil at ..... 90 feet
Third seepage of oil at ..... 150 feet
First seepage of water at ..... 230 feet
First body of oil at ..... 45 feet
Thickness of oil-bearing shale ..... 13 feet

Cased to a depth of 192.8 feet with ten-inch standard pipe.
Depth of hole.....275 feet
Filled in quickly ..... 17 feet

The thirteen-foot stratum of oil shale is heavy with gas and very lively when shut in. For some time gas pressure goes up to 40 pounds.

This well is cemented on the outside at 125 and 135 feet, using ten sacks of cement.

Well gradually fills with water.

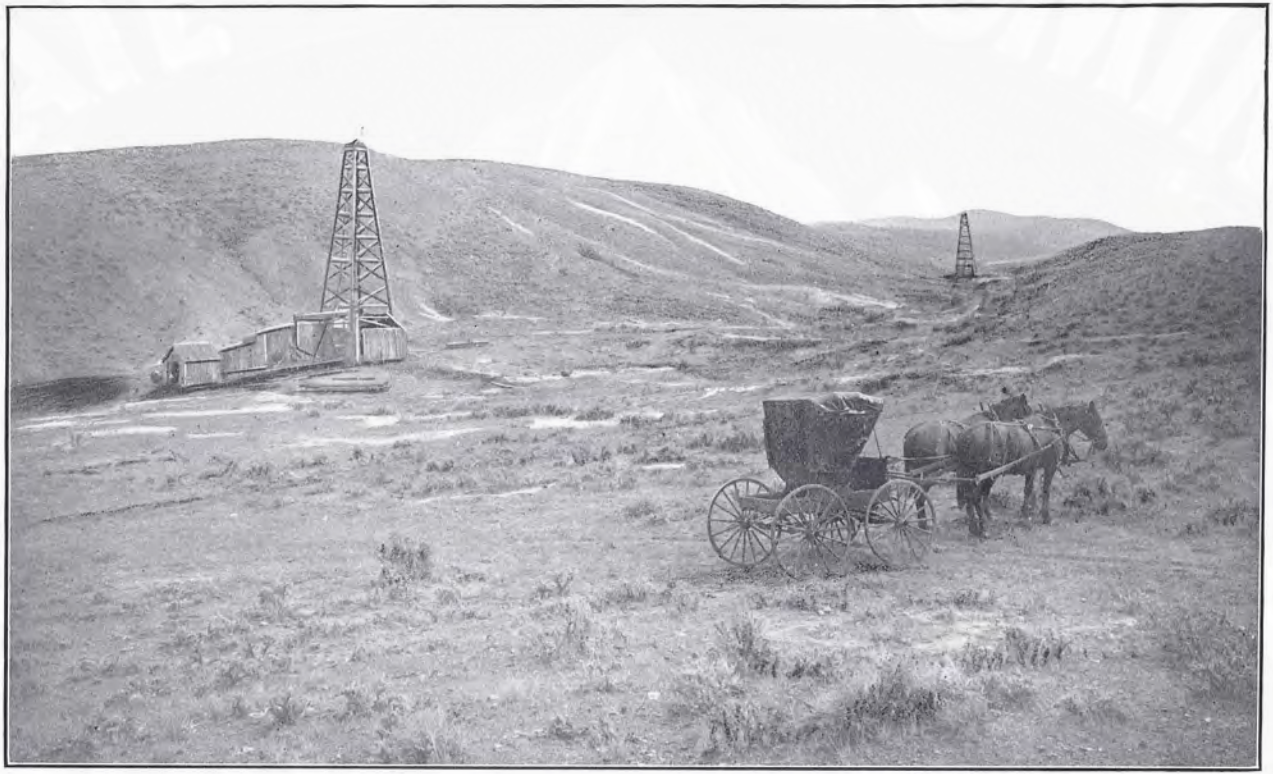
This well is located near the crest of the anticline, within 200 feet of the Mill Creek fault, the surface being Mowry shale. In July, 1911, this well was flowing 2½ barrels of oil and 69 barrels of slightly salt water per day. Mr. Hamilton is authority for the statement that the well yields 30 barrels of oil in 24 hours when pumped. The source of the oil encountered in this well, while not positively determined, is probably Lower Cretaceous Sandstone. The well has not reached the Lower Cretaceous Sandstone, however, the oil obtained being that which has leaked through the Mill Creek fault.

In 1909 two wells were drilled in Section 26, by J. Underwood of Los Angeles, but were abandoned at shallow depths. In 1910 Mr. Underwood drilled another well to a depth of 610 feet and abandoned this hole. This well which is slightly to the west of the crest of the anticline, has not yet reached the oil bearing sandstone.

In 1910 Adam Griesmer drilled a well in Section 27, to a depth of 1304 feet, when work was discontinued on account of cold weather. It is reported that work will be recommenced on this well during the present year.

This well is located about one-half mile west of the anticline. The Lower Cretaceous sandstone should be reached here at about 2,600 feet.

At the present time (September 1911) the Pioneer Oil Co., of Los Angeles is drilling in Section 12, T. 2 S., R. 1 E. A slight showing of oil is reported at 1,250 feet.



OIL WELLS IN THE PLUNKETT FIELD.
The ridge in the background is formed by Mowry Shales.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The log of this well, furnished by Mr. Thos. Smith of Lander, follows:

0- 20 feet.	Wash.	
20- 50 feet.	Shale.	
50- 60 feet.	Sand.	
60- 160 feet.	Shale.	
160- 165 feet.	Putty.	
165- 210 feet.	Shale.	
210- 230 feet.	Slate.	
230- 370 feet.	Shale.	
370- 450 feet.	Black slate.	
450- 660 feet.	Blue shale.	
660- 675 feet.	Water sand, fresh water	Water filled 300 feet of hole
675- 700 feet.	Blue shale.	
700- 785 feet.	Water sand, fresh water.	Stronger flow.
785-1010 feet.	Black slate.	
1010-1250 feet.	White shale or mud.	

Cased to 320 feet with 10-inch pipe.
Well caved bottom 26 feet. Now (September 3, 1911) underreaming.
Twenty-six days lost in waiting for tools.

In Section 1, T. 2 S., R. 1 E., the Wyoming Oil Co., has drilled to a depth of 950 feet, and is now fishing for tools. At 675 feet sulphur water was encountered. The bottom of this well is in gray shale.

The Shoshone Oil & Gas Company has begun drilling in Section 24, T. 2 S., R. 1 E. The well is located on the crest of the anticline in Chugwater Red Beds, and will probably strike oil of asphaltum base when the Embar formation is reached.

A well is now being drilled in Section 30, T. 2 S., R. 2 E., the surface being Red Beds, and the well located on the crest of the anticline. This well will probably be productive of asphaltum base oil.

GEOLOGIC RELATIONS.

The oil springs in this district occur where the strata have been faulted. In the Dallas field two faults were noted, one of which is but a short distance east of the oil springs. In the immediate vicinity of the springs the surface is covered by alluvium, but no doubt, faults would be found in conjunction with the oil springs. In this

field the strata dip at steep angles on either side of the anticline.

Poor judgment has been used in locating many of the wells, one having been drilled at the Reed Ranch, in the trough of the syncline, where the oil-bearing Embar formation would be reached only at a depth of several thousand feet, and the geological conditions are such that water, only, could be obtained. Another well was drilled where the strata are vertical, or nearly so.

The oil bearing portion of the dome in this field seems to be very limited, the water in the strata reaching nearly to its top.

In the Sage Creek field the oil spring is associated with the Wind River fault system, previously described. The country adjacent to the oil spring is much broken and the lighter and more volatile parts of the oil have evaporated, leaving only the heavier oils and the asphaltum base.

At the place where the Washakie Hydro-Carbon Mining Company's well was drilled the anticline is overthrown, and this well, if drilling were continued, would penetrate the strata twice. This well reached the oil horizon at a point above the "Tar Springs", where the stratum had been drained of its oil.

The anticline in this field dips steeply to the west and more gently to the east. The Hannon well, drilled on the eastern limb of the anticline, proves the field to be at least one and one-half miles in length and one mile in width.

It is the opinion of the writer that that portion of the anticline lying north of the Hannon well will prove to be the most productive fuel oil field in this entire area.

In the Plunkett field the oil of the Washakie spring

reaches the surface in the Mowry shales, but it is evident that the oil has leaked through the Mill Creek fault. As no well has yet reached the oil bearing stratum in this field but little is known as to the occurrence of water in that stratum.

In the southern portion of this field the wells located near the crest of the anticline will probably obtain fuel oil, as the well in Section 3, T. 32 N., R. 99 W., which is 1,000 feet east of the crest of the anticline, flows both oil and water.

QUALITY OF OIL.

The oil obtained from the Dallas field is a dark brown, heavy oil of asphaltum base. The specific gravity of this oil as reported by Woodruff* is 22.2° to 24.0° Beaume; by Slosson†, 25.5° Beaume. Slosson describes the oil as follows:

"The Popo Agie petroleum appears almost black, although in thin layers it is reddish brown by transmitted light. There is no perceptible fluorescence, and the distillates are not nearly so fluorescent as those of the Salt Creek oil. The odor and taste are strong and unpleasant, and on distilling the oil vapors of very disagreeable odor are given off, doubtless compounds of sulphur. The per cent. of sulphur in the crude oil is .66, about the same amount as in the Ohio petroleum.

"The present sample, consisting of one barrel of oil, was taken by Prof. Knight, Aug. 15, 1896, directly from the well, and is lighter than the sample taken in 1893 from the pool. The specific gravity of the present sample is .9000 (25.5 Beaume). That taken in 1893 was .9210. Ricketts in 1887 reported the gravity as .9050. One gallon of this oil weighs 7.5 pounds.

* Woodruff, E. G., U. S. Geological Survey Bulletin No. 452, 1911.

† Slosson, E. E., School of Mines, University of Wyoming, Petroleum Series, Bulletin No. 2, page 23.

"The crude oil flashes at 32 degrees C. (90 degrees F.), and ignites at 58 degrees C. (136 degrees F.). It is still fluid at —10 degrees C. (14 degrees F.). The viscosity at 20 degrees compared with water at the same temperature is 1.28.

"The heating power of the Popo Agie petroleum, as determined by the bomb calorimeter, is 10,437 calories per gram, which is equivalent to 14,571,000 foot pounds of energy per pound of oil. One pound of oil will give heat enough to convert 19.40 pounds of water at 212 degrees F. into steam.

"The crude oil shows no paraffin on cooling, and is soluble without residue in light benzene. Absolute alcohol leaves a tarry residue and deposits paraffin on cooling. * *

"All the products of distillation of the Popo Agie petroleum can be utilized, and there need be very little waste in working it. The gas could be used in firing. The coke is very hard and porous and would be useful for metallurgical purposes. The residue from filtration of the heavy oil can be worked up into paraffin or vaseline. It used to be thought that oil containing sulphur was useless, but now most of the kerosene used in the United States comes from the Ohio oil, which is similar in composition to this. Probably copper oxide would have to be used in distilling the Popo Agie oil, as it is for the Ohio. How the oil can be most profitably worked depends on the relative value of the products. The distillation and the combination of the products can be varied in so many different ways that no exact statement can be made of what the oil would yield on a large scale. The experiments here reported give the following results, which probably do not differ much from what will be obtained in the commercial process:

"Naphtha (gasoline) ..... 2-5 per cent.
Kerosene, .810-.830 ..... 30-40 per cent.
Lubricating oil, .910-.940 ..... 35-50 per cent.
Paraffin ..... 3-5 per cent.
Coke ..... 7-10 per cent.
Gas ..... 10-12 per cent."

The results of several analyses of oil from the Dallas field are given below:

(From U. S. Geological Survey Bulletin 452.)

Well No.	Depth of Well	Gravity at 60°F.		Distillation by Engler's Method							Paraffin per cent.	Asphalt per cent.	Unsaturated Hydro-Carbons	
				Begins to Boil °C	By volume									
					To 150° C.	150-300°C.		Residuum		Total Cubic Centimeters				
		Specific	Beaume'		Cubic Centimeters	Cubic Centimeters	Sp. Gr.	Cubic Centimeters	Sp. Gr				Crude per cent.	150-300°C per cent.
2	400	0.9126	23.4	120	2.0	23.5	0.8041	69.9	0.9543	95.4	0.91	4.02	46.4	4
10	825	.9121	23.5	93	2.0	21.0	.8067	75.2	.9589	98.2	1.27	5.69	50.8	4
11	965	.9126	23.4	105	1.5	24.0	.8018	73.9	.9605	99.4	.90	11.04	58.0	4
13	697	.9091	24.0	108	2.5	23.0	.8047	73.1	.9589	98.6	.62	15.26	50.8	9

(By S. F. Aughey, Territorial Geologist, 1886)

Naphtha ..... .63 per cent.
Kerosene, with fire test of 159° ..... 47.00 per cent.
Lubricating oil, neutral and light colored ..... 32.00 per cent.
Coke ..... 12.00 per cent.

The petroleum from the Sage Creek field is reported to contain 84.9 per cent. asphaltum. The oil, which is black in color, and extremely thick and heavy, has been derived from oils similar to those produced in the Dallas field, the more volatile portions having been evaporated.

An analysis of oil from the "Tar Spring" near Sage Creek follows:

(By E. E. Slosson, Professor of Chemistry, University of Wyoming, 1897)

No.	Boiling Point °C.	Specific Gravity	Degrees Beaume'	Flashing Point °F.	Burning Point °F.	Cold Test °F.
1	165-265	0.8590	32.0	81	153	
2	265-295	.8840	28.4	162	279	
3	295-305	.8888	27.5	162	252	
4	305-325	.9065	24.4	180	283	
5	325-335	.9125	23.4	198	297	
6	335	.9235	21.6	225	333	14
7	335	.9175	22.6	207	311	19
8	325	.8800	29.1	108	148	14
9	315	.8995	25.6	99	144	30
10	305	.8955	26.3	104	153	39
11	255	.8790	29.3	99	135	14

Each number represents twentieths of the product.

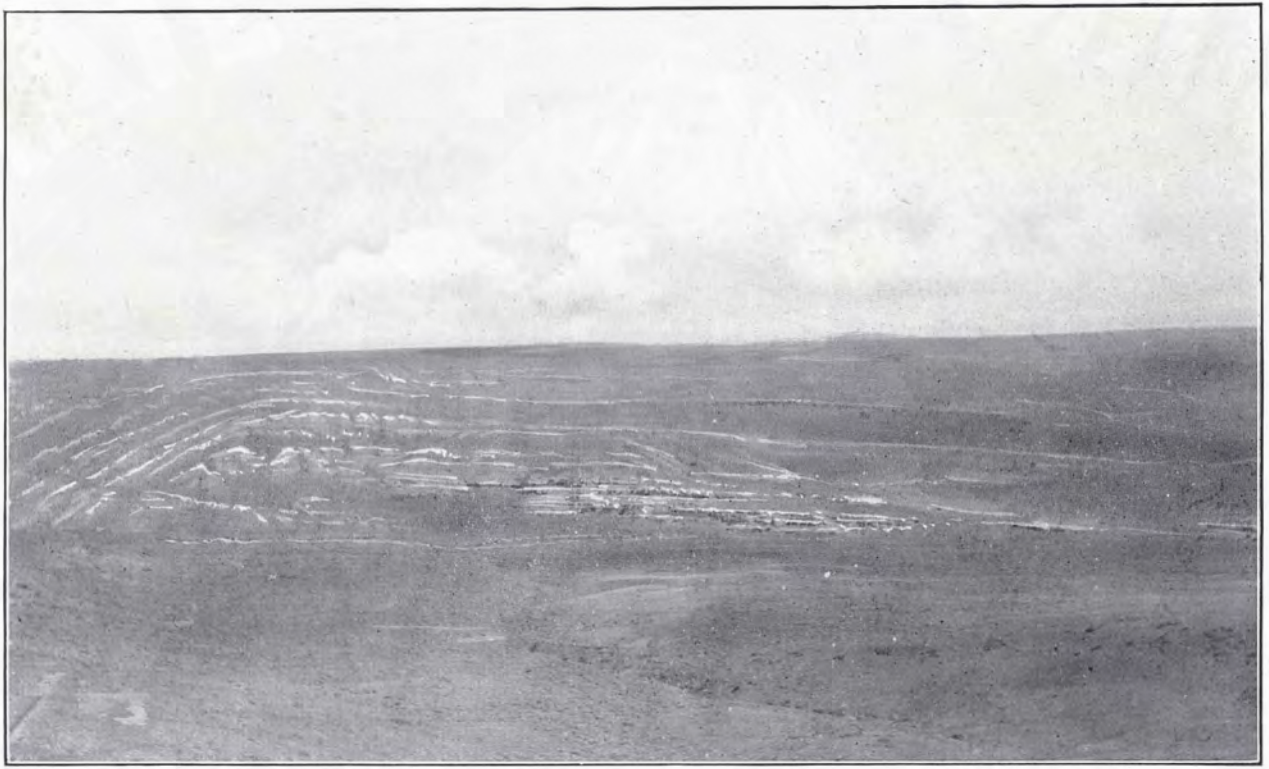
The sample was black and thick.

The specific gravity was .9960 (10.5 B.), and became too solid to flow at 50 degrees F. It has the same disagreeable odor as the Dallas oil.

The distillation is merely a process of decomposition from the beginning and the fractions are all discolored and show by the tests that they are mixtures of light and heavy oils. Only 55 per cent. of the crude oil could be obtained in the distillate, the rest being coke and gas.

It is impossible to tell what would be the value of this oil if it should be obtained in quantity. It is much more like the Popo Agie (Dallas) oil than like the Lander (Plunkett), and probably a well would give the same oil as the former.

The oil obtained from the Washakie oil spring and the Plunkett well is entirely different from the oils produced in the other oil fields of this area, its source, which is believed to be Lower Cretaceous sandstone, being 2,580



THE SHOSHONE ANTICLINE IN THE SAGE CREEK OIL FIELD.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feet above, stratigraphically, the source of the Dallas oil. Dr. David T. Day* states that it is not improbable that this oil was derived from the heavy asphaltum oils through loss of unsaturated hydrocarbons by diffusion.

OIL FROM WASHAKIE SPRING.

(By E. E. Slosson, Professor of Chemistry, University of Wyoming, 1897)

No.	Boiling Point °C.	Specific Gravity	Degrees Beaume'	Flashing Point °F.	Burning Point °F.	Cold Test °F.
1	155-215	.8100	42.8	124	144	
2	215-235	.8218	40.4	148	171	
3	235-250	.8313	38.4	180	200	
4	250-265	.8400	36.7	202	229	
5	265-280	.8452	35.6	225	252	
6	280-285	.8500	34.5	243	275	
7	285-290	.8510	34.4	248	279	
8	290-295	.8565	33.4	256	288	
9	295-310	.8640	31.0	279	315	
10	310-325	.8680	31.3	297	337	
11	325-340	.8740	30.2	306	353	
12	340-345	.8725	30.5	297	333	
13	345-355	.8745	30.1	304	333	16
14	355-365	.8820	28.7	279	364	28
15	365-375	.8835	28.5	288	351	34
16	375	.8705	30.8	226	270	41
17	380	.8505	34.5	135	184	32
18	385	.8800	29.1	135	184	48

The numbers represent twentieths of the product.

The oil is bright red by transmitted and green by reflected light.

Specific gravity of crude oil 0.8725.

Flashing point 171 degrees F.

Burning point 194 degrees F.

Sample did not solidify or show paraffin on being cooled to 14 degrees F.

The heating power is 10,833 calories per gram, which is equivalent to 15,204,000 foot-pounds per pound. One pound of oil furnishes enough heat to change 22.24 pounds of water at 212° F. into steam

The oil distills without much decomposition until the temperature rises to about 365 degrees C. Even at this heat no perceptible amount of paraffin is formed.

The products until about 50 per cent. of the oil has come over are very light colored, with little fluorescence.

In working with large quantities of the fresh oil, probably 75 per cent, and possibly much more of the crude oil could be obtained as kerosene and gasoline.

* U. S. Geological Survey Bulletin 452, page 30.

Company	Field	Productive	Abandoned	Drilling	Total
Adam Griesmer *et al*	Plunkett			1	1
Battrum Oil & Refining Company	Dallas		1	1	2
Geo. Mitchell	Plunkett		1		1
Greater Dallas Oil Field Proprietary, Ltd.	Dallas		1		1
Hannon Oil Co.	Sage Creek	*1			1
Henderson, Smith, *et al*	North Dallas		†1		1
Lander Oil Syndicate, Inc.	Plunkett	1			1
Pioneer Oil Co.	Plunkett			1	1
Shoshone Oil & Gas Co.	Plunkett			1	1
Texas Company	Plunkett			1	1
Washakie Hydro-Carbon Mining Company	Sage Creek		1		1
Wyoming Oil Co.	Plunkett			1	1
Wyopo Oil Co	Dallas	17	15		32
Others			6		6
Total		19	26	6	51

PRACTICAL SUGGESTIONS.

The best fuel oil territory in this district lies in the Sage Creek field, west of the Hannon well. The eastern limb of the anticline, in this field, dips at comparatively small angles, and for a distance of at least one mile from the crest of the anticline may be expected to yield oil of the same character as that obtained in the Dallas field.

The territory adjacent to, and one mile on either side of Little Wind River, should be avoided, as the strata have been much faulted and fractured and the more volatile oils have evaporated.

Oil springs and seepages have been found, and it is not improbable that productive wells may be obtained along the flanks of the Wind River Mountains. These

* Asphaltum.

† Flows three barrels of oil, with water.

wells should be located in the Red Beds, from three-fourths mile to one and one-half miles east of the mountains.

ORIGIN OF OIL.

A number of theories have been advanced to explain the origin of oil, none of which is entirely satisfactory. The theories of the chemists fail to meet certain geological conditions, while those advanced by the geologists are not wholly acceptable to the chemists. The various theories which have been advanced may be divided into two classes, the *organic* and the *inorganic*.

THE ORGANIC THEORY.

The organic theory, the generally accepted view, attributes the origin of oil to the decomposition of animal and vegetable matter. The decomposition may take place in the stratum in which the oil is found, or it may have occurred in adjoining strata, from which the oil has migrated to its present position.

It has been shown in the laboratory that when vegetable or animal matter is distilled, or allowed to decay, in the absence of air, products are obtained which closely resemble petroleum. From a mixture of fresh fish and resinous pine wood a residue closely resembling gilsonite was obtained upon distilling. Fish alone yielded hydrocarbons. Olive oil, butter and beeswax have yielded hydrocarbons upon distillation. Numerous other instances of the production of oils, gases and residues, nearly allied to petroleum, natural gas and asphalt, are on record, but a sufficient number have been cited to establish the fact that petroleum may be derived from animal or vegetable matter. In nature the bodies of terrestrial animals and plants were washed down to the sea, and, with marine life, were deposited in the mud and silt accumulating on the floor of the

ocean. There the further deposition of sediments shut them off from the oxygen of the air, and, in the course of time, a slow distillation took place, converting the organic matter into oils and gases.

The derivation of petroleum from animal matter has a number of advocates. In support of their contentions the association of the petroleum of Galicia with schists in which fish remains are abundant is cited. The Caucasian petroleum is attributed to the decomposition of mollusks. According to Ochsenius petroleum is derived from marine organisms, which, buried by sediments, are acted upon by the mother-liquor salts which form in the last stage of evaporation of sea water. He cites, as an argument in support of his theory, the very common association of petroleum and salt water. It has been noted at many points that bituminous beds were rich in fossils, while the non-bituminous beds were poor.

On the other hand, it has been suggested that great masses of sea-weed, like that of the Sargasso Sea, sink to the bottom, and, decomposing, yield petroleum. That the salt waters associated with some of the oil fields of California are rich in iodine, is a fact which is connected with the well known content of iodine in sea-weed, and regarded as pointing to vegetable matter as the source of this oil.

If the organic theory is correct, wherever sediments are deposited, with animal or vegetable matter, petroleum may be formed. The presence of water, the absence of air, and the existence of a protecting impervious stratum appear to be essential conditions.

THE INORGANIC THEORY.

The inorganic theory, essentially one advanced by chemists, is not generally accepted.

In 1866, Berthelot brought forward the argument that carbonic acid when brought in contact with the alkali metals at high temperatures would produce petroleum. In 1877, Mendeleef argued that in the interior of the earth were metallic carbides, which, in contact with water, would produce hydrocarbons. In recent years it has been proven in the electric furnace that such an action would take place. The presence of marsh gas in volcanic emanations, and of liquid oils and solid paraffin in basaltic lavas near Mt. Etna, are arguments set forth to support the contention that petroleum is of inorganic origin. Other writers have advanced speculations upon the origin of petroleum from inorganic matter, but the arguments of the advocates of the inorganic theory do not seen to be as well founded as those of the adherents of the organic theory.

ACCUMULATION OF OIL.

The conditions necessary for the accumulation of oil are,

(1) A porous stratum, commonly a sandstone, though it may be a shale or limestone, which forms the reservoir for the retention of the oil.

(2) An overlying impervious stratum, to prevent the escape of the oil upwards.

(3) Geologic structure.

The following statement by Griswold* in regard to the movement and accumulation of oil is quoted in full:

MOVEMENT IN POROUS ROCKS.

"The porous rocks into which the oil and gas enter may be dry or they may be completely saturated with water. In most cases it is probable that a combination

* Griswold, W. T., U. S. Geological Survey Bulletin No. 318, 1907.

of these two conditions exists—that the porous rocks are completely saturated with water up to a certain level, but above that point they are dry. The movement of the hydrocarbons through the rocks will not be the same in the two cases, and therefore each condition must be considered separately.

"If small quantities of oil and gas enter a dry porous rock at different points the oil will flow down as long as gravity is sufficient to overcome the friction and the capillary attraction. The gas will diffuse with the air or water vapor contained in the pores of the rock.

"Oil and gas entering a porous rock that is completely saturated with water will be forced up to the top of the porous stratum by the difference in the specific gravity of the hydrocarbons and the water. Here the oil and gas will remain if the porous stratum be perfectly level, but if it has a dip sufficient to overcome the friction the particles of oil and gas will gradually move up this slope, the gas with lower specific gravity occupying the higher places.

"In case the porous rocks are partly saturated a combination of these two actions will take place. The oil entering above the line of complete saturation will flow down to that line and the oil entering below will be forced up to the top of the completely saturated portion.

"The statements given above are based on the assumption that the oilbearing rock is homogenous throughout and that the oil will move with the same degree of freedom in every direction. This is rarely the case. Sandstones are noted for their irregularity in composition, as regards both the size of the individual grains of sand and also the material which cements the grains together. It is obvious that any fluid will move more rapidly through a coarse conglomerate imperfectly cemented than through a dense, fine-grained sandstone the particles of which are thoroughly coated and all the interstices filled with impervious cement. If the oil-bearing rock contains areas practically impervious, these areas, according to their size and position, will be more or less perfect barriers against the movement of the oil or gas.

The Shoshone Anticline in the Plunkett Oil Field.

PLACES OF ACCUMULATION

"(1) In dry rocks the principal points of accumulation of oil will be at or near the bottom of the synclines or at the lowest point of the porous medium, or at any point where the slope of the rock is not sufficient to overcome the friction, such as structural terraces or benches. (2) In porous rocks completely saturated the accumulation of both oil and gas will be in the anticlines or along level portions of the structure. Where the area of porous rocks is limited the accumulation will occur at the highest point of the porous medium, and where areas of impervious rocks exist in a generally porous stratum the accumulation will take place below such impervious stop, which is really the top limit of the porous rock. (3) In porous rocks that are only partly filled with water the oil accumulates at the upper limit of the saturated area. This limit of saturation traces a level line around the sides of each structural basin, but the height of this line may vary greatly in adjacent basins and in different sands of the same basin.

"Partial saturation is the condition most generally found, in which case accumulations of oil may occur anywhere with reference to the geologic structure; it is most likely, however, to occur upon terraces or levels, as these places are favorable to accumulation in both dry and saturated rocks.

"Under all conditions the most probable locations for the accumulation of gas are the crests of anticlines. Small folds along the base of a syncline may hold a supply of gas, or the rocks may be so dense that gas cannot travel to the anticline, but will remain in volume close to the oil."

GOLD.

Very promising veins of quartz containing gold have been worked in the South Pass district since 1867. Although the total output of this district is in excess of $5,000,000 but few of the mines have passed the prospect stage. The work has been carried on, for the greater part, by men of limited means, who are unable to install the machin-

ery necessary to handle the water encountered when deep mining is attempted. Below are given short descriptions of some of the mines:

DUNCAN MINE.

Located one mile south of Atlantic City. The vein varies in width from eighteen inches to five feet and dips 76 degrees north. The value of the ore ranges from $5.00 to $100.00 per ton, the gangue material being quartz and the walls of the vein schist and diabase. The mine is developed by a shaft 225 feet in depth, and by 1,255 feet of drifts, crosscuts and tunnels. At the present time the shaft is being sunk and will be continued to the 450 foot level, while crosscuts are being driven east and west from the 170 foot level to develop quartz veins which appear at the surface.

During the summer of 1911 a mill was erected on this property, consisting of four 1350-lb. Nissen stamps, four 36-in.x10-ft. silver plated amalgamating plates, two 36-in. x5-ft. amalgamating plates, two Pearce amalgamators, 7x12 Blake crusher, 25 horse power gasoline engine, and 10 horse power engine and dynamo furnishing lights for the surface plant and the mine. At the mine are a 15 horse power gasoline hoist, a 32 horse power gasoline engine driving a 10x10 compressor which furnishes compressed air for one 2¼ in. Sullivan drill and two Sinclair air hammer drills.

The machinery at the mill was started September 5, 1911, and up to November 1st had crushed 1,100 tons of ore, working twelve hours per day. The ore, crushed to 40-mesh, is treated by amalgamation, only, the tailings being stored for future treatment. Up to November 1st the cleanup amounted to $8,451.00, the ore averaging

about $14.00 per ton, an extraction of nearly 60 per cent. being made. All of the ore treated up to the present time has been that which was broken down in development work, the reserves in the mine remaining untouched. On the ore dump are 3,500 tons of ore, the average value of which is $30 per ton, while on the waste dump are 1,500 tons of rock containing an average of $6.00 in gold per ton.

In the spring of 1912 this company will erect a power plant on Little Popo Agie River, where a fall of 757 feet can be obtained, the flow of water being 35 second-feet in the dryest season. The company estimates that the cost of this plant, with ten mile transmission line, will be $40,000. It is believed by the management of this company that the proposed plant will generate more power than will be necessary to meet the requirements of the mine, in which case power will be supplied to the other mines of the district.

MARY ELLEN MINE.

Located one-fourth mile east of the Duncan. Quartz vein in diorite, dipping 30 degrees northwest. Developed by shafts 230 feet and 150 feet in depth, respectively, and 670 feet of drifts. The ore occurs in lenses, the average value being $8 per ton, though at the present time ore that carries less than $50 in gold per ton is not worked. The property is equipped with a five-foot Huntington mill.

GROUND HOG GROUP.

One-half mile north of the Duncan mine. Consists of seven claims containing several small veins, the ore being rather high grade. In this group is a dike of altered diorite, varying in width from 20 to 100 feet, which is reported to carry from $5 to $8 in gold per ton. This group

is developed by several shafts ranging in depth from 40 to 100 feet, and a tunnel 200 feet in length.

BIG CHIEF MINE.

One-half mile west of Atlantic City. Developed by a shaft 100 feet deep and a tunnel 1000 feet in length. The vein is reported to be five feet wide and the ore to average $40 per ton.

GARFIELD MINE.

One mile northwest of Atlantic City. This mine has been worked to a depth of 150 feet and is reported to have produced $400,000. The vein, which varies from one to thirty feet in width, was faulted and lost 50 feet north of the shaft. The ore assays $20 in gold per ton, only about 50 per cent. being extracted in the mill, which was equipped with two Tremain steam stamps.

EXCHANGE MINE.

Adjoins the Duncan mine on the west. Developed by a shaft 40 feet in depth. The ore shoot of the Duncan mine is reported to pitch into this property.

DOC BARR MINE.

One-half mile southwest of the Duncan. Developed by a tunnel 150 feet in length, a shaft 65 feet deep and a drift driven 200 feet west from the bottom of the shaft. The vein, which was thirty inches wide, with an average gold content of $35 per ton, was faulted at the bottom of the shaft and was never recovered. From the bottom of the shaft the ore has been stoped to the surface along the full length of the drift.

View of a Portion of the South Pass District.

CARISA MINE.

The Carisa, owned by the Federal Gold Mining Company, is one of the best known mines of this district, having a large record of production. It is developed by a shaft 387 feet in depth, the deepest in this district, and 1,200 feet of drifts and crosscuts. The ore occurs in lenses, the average value being reported as $16 per ton, and the width as seven feet. The mine is equipped with ten 1,000-lb. stamps, Fruevanner, engines and dynamo. At the present time the mill is not in operation and only the pumps are run in the mine.

LANDER BELLE MINE.

A dike of silicified quartz porphyry between granite and schist walls, which is said to contain from $2.50 to $5 in gold per ton, over a width of 200 feet. Developed by a shaft 65 feet in depth.

MINER'S DELIGHT MINE.

The Miner's Delight Mine, which has produced more than $1,000,000 in gold, is idle at the present time, though it is stated that the mine will soon be re-opened. The vein is said to be from four to six feet in width, and the ore high in grade.

XL DREDGING COMPANY.

The XL Dredging Company owns 1,680 acres of placer ground in Little Beaver, Smith, Promise and Big Atlantic gulches and Stambaugh flat. The company has constructed a ditch from Rock Creek, seven miles above Atlantic City to the placers, and will probably begin operations during the current year. A large part of the Stam-

baugh flat ground is reported to have a gold tenor of $1.40 per cubic yard, while that in the gulches yields $0.50 per yard.

Aside from those above mentioned there are a number of mines and prospects, which, on account of limited time, were not visited. The district as a whole is very promising, and when further developed will re-enter the ranks of producing gold camps.

Below is given a list of the mines of the South Pass district with their estimated output:

Miner's Delight	$1,200,000
Carisa	1,000,000
Caribou	500,000
Garfield	400,000
Victoria Regina	350,000
Franklin	300,000
Mary Ellen	125,000
Lone Star	40,000
Carrie Shields	35,000
Ground Hog	30,000
Young America	20,000
Gould & Curry	20,000
Exchange	20,000
Doc Barr	17,000
Duncan	15,000
Diana	10,000
St. Louis	7,500
Rosella	7,500
Europe	7,000
Chas. Dickens	5,000
Rose	5,000
Peacock	5,000
Empire State	5,000
Mormon Crevice	3,000
Lucky Boy	3,000
Klondike	2,500
Payrock	2,000
Clipper	1,500
Independence	1,500
Meadow Gulch Placers	1,000,000
Yankee Gulch Placers	500,000
Spring Gulch Placers	30,000
Promise Gulch Placers	30,000
Smith Gulch Placers	20,000
Red Canyon Placers	20,000
Atlantic Gulch Placers	15,000
Beaver Creek Placers	10,000
Others	100,000
TOTAL	$5,863,000

COAL.

Small amounts of coal have been found in this district in the lower portion of the Mancos group and in the upper portion of the Lower Cretaceous rocks, but it is only in strata of Eocene age that it has been developed in workable quantities. During the past six years a number of coal mines have been developed near Hudson and the annual output exceeds 100,000 tons.

The coal is sub-bituminous, black in color, contains a rather high percentage of moisture and weathers rapidly. The mines supply the Chicago & Northwestern Railway with coal for its engines and also find a market in the towns along that road. It is reported that the Hudson Coal Company has contracted to supply the railway with 1,000 tons of coal per day, but this report has not been verified. At the mines the coal sells for $2.50 per ton while at Lander, eight miles distant, it is sold at $5.00 per ton.

The workable veins vary from four to nine feet in thickness, the dip of the slopes being from 12 to 15 degrees eastward.

Below are given analyses of the coals from the Hudson and the Mitchell mines:

	HUDSON MINE	MITCHELL MINE
Water	13.00 per cent.	11.40 per cent.
Volatile matter	42.30	42.80
Fixed Carbon	42.30	43.00
Ash	2.40	2.80
Sulphur	0.40	0.40

COPPER.

Up to the present time this region has produced no copper, though ores of copper are known to exist at several

points in the Wind River Mountains. At the present time the Wyoming Copper Mining Company is developing a body of copper ore, one mile west of South Pass City. The vein, which is forty feet wide, is developed by a shaft 245 feet in depth, and 300 feet of drifts and crosscuts. The ore as broken down is reported to contain from 4 to 16 per cent. copper, from $2 to $10 in gold and from 1½ to 40 ounces of silver per ton. The gangue material is quartz, the walls of the vein being schist. The surface plant on this property was recently destroyed by fire, since which time operations have been at a standstill.

The Albertson mine, on Peabody Hill, some three miles northeast of Atlantic City, has a quantity of high grade copper ore on the dump. This mine was visited by the writer but as the owners were absent the underground workings could not be inspected.

About ten miles north of South Pass is a large outcrop of copper ore. Although owned by residents of Lander no development has been attempted.

IRON ORE.

For many years a large deposit of high grade iron ore has been reported as existing in the Wind River Mountains north of Atlantic City. Samples of this ore, inspected by the writer, were too low in grade to be of commercial value.

GILSONITE.

Deposits of gilsonite are being opened up in the southern portion of this area, though, as yet, only small pockets

have been found. Samples from these deposits, examined by the writer, were of exceptional purity.

BUILDING STONES.

This region is well provided with building stones, which are found in abundance in the western portion of the area, and include granite, limestone, marble and sandstone. The production of building stone has been but slight, the output being only that necessary to supply the local demand.

GRANITE.

Granites, suitable for building purposes, are abundant in the higher portions of the Wind River Mountains. The varieties are gray, pink and red, all of which weather well and take a good polish.

LIMESTONE.

Limestone is found on the flank of the Wind River Mountains in the Bighorn, Madison and Embar formations. The limestone of the Bighorn formation is very massive, while that of the Madison is only moderately so. The basal limestone of the Embar formation has been quarried and used, to a small extent, in making lime. Some of the limestone from beds found in the upper portion of the Chugwater formation have been burnt in lime kilns at Wyopo.

MARBLE.

Marble, white, pink and dark gray, is found in the upper portion of the Madison limestone, about seven miles

west of Lander. Samples, though taken from the surface and badly weather checked, take a fine polish. A fine-grained white marble is reported from near Beaver Creek, in the South Pass district. No production of marble has been made from this region.

SANDSTONE.

Sandstones, valuable for structural purposes, are found in the Chugwater Red Beds and in the Tensleep formation. The Red Beds in Red Canyon, near Little Popo Agie River, contain a fine-grained, compact, reddish brown sandstone, which is not inferior to the brownstone of the eastern states.

North of Little Wind River, in the Sage Creek district, Triassic sandstones have been quarried for use at Fort Washakie, though these sandstones are inferior to those of Red Canyon.

The Tensleep formation, although in the greater part cross-bedded, soft, and coarse grained, furnishes a gray sandstone of fair quality for building purposes.

GYPSUM.

Near the top of the Chugwater formation are extensive deposits of gypsum of excellent quality, suitable for the production of plaster of Paris. Near the Lander Experiment Farm the beds are forty feet or more in thickness, while those in the Sage Creek district range from 30 to 70 feet. On Little Wind River, in Section 34, T. 1 N., R. 1 W., is an upturned bed of massive gypsum 61 feet thick. (Plate VII). At Wyopo a plaster plant has been built but no production has been made. On account

of the low price obtained for plaster of Paris it is not probable that its manufacture would be commercially successful in this region.

ASBESTOS.

Deposits of asbestos have recently been discovered in the southern portion of this area, but, so far as determined, the material is of short fibre. However, the deposits are not sufficiently developed to determine their true character. Float asbestos has been picked up from time to time in the southern part of the town of Lander but the source has not yet been discovered.

CLAY.

The alluvial deposits of the Lander valley contain clays from which bricks are made near Lander. The lower and middle portions of the Mancos group consist principally of clay shale which should make a good quality of brick.

WASHAKIE HOT SPRING.

Two miles east of Fort Washakie, in Section 1, T. 1 S., R. 1 W., is the Washakie Hot Spring, the waters of which are believed to be an efficient remedy for rheumatism and kindred troubles. The spring, which is in the valley of Little Wind River, is about 150 feet in diameter, the temperature of the water, as determined in the summer of 1911, being 112 degrees F. There is an excellent opening here for a summer and health resort, as the hunting and fishing and the scenery of the Wind River Mountains, and

the 1,200 Indians on the reservation would prove attractions of interest to eastern visitors.

The waters of this spring, no doubt reach the surface through one of the major faults of the Wind River fault system, though the stratum is masked by the alluvium of the valley. The source of the water is difficult to determine. The crest of the anticline, where the spring emerges is occupied by Chugwater Red Beds, but it is not thought that the flow is derived from them. Underlying the Red Beds is the Embar formation, in which both cold and warm water, impregnated with sulphur, are found in the Dallas oil field, while in the well of the Washakie Hydro-Carbon Mining Company, less than one mile northwest of the Washakie spring, that formation yields luke-warm sulphur water. Near Thermopolis, some 60 miles northeast of Lander, are hot springs of similar character, the heat of which, Darton* states, may be due to "deep seated igneous rocks which have not yet cooled".

SURFACE WATERS.

The principal streams of this region are Big and Little Popo Agie Rivers, Little Wind River, Sweetwater River, North Fork of the Popo Agie, Sage, Trout, Baldwin, Squaw, Twin, Beaver, Willow, Strawberry, Rock and Gold Creeks. All of these streams rise in the Wind River Mountains, and on many of them water power can be developed at small cost.

The volume of water in these streams has not been systematically gaged. The following measurements are

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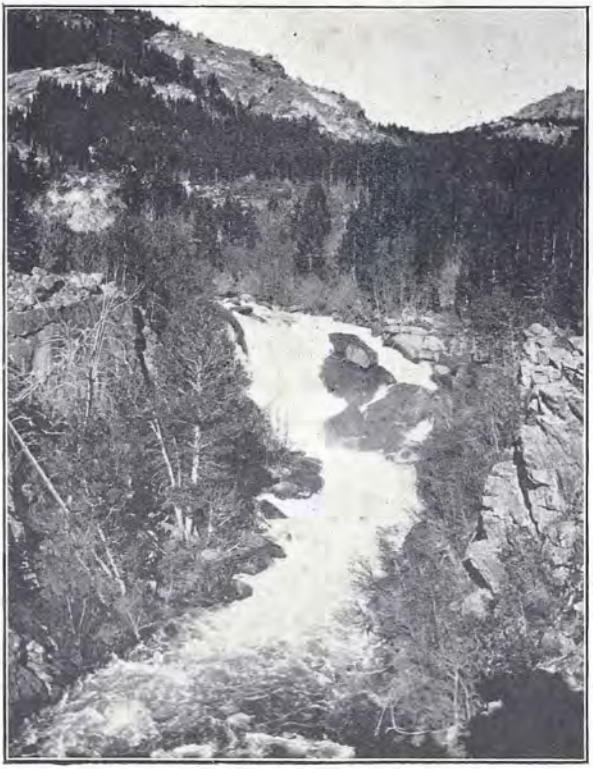
* Darton, N. H., Geology of the Owl Creek Mountains, Senate Doc. 219, 59th Congress, 1st Session, 1906

A. AN OLD TEN-STAMP MILL IN SOUTH PASS DISTRICT.
Driven by 30-foot overshot water-wheel.



B. A PART OF THE FALLS, BIG POPO AGIE RIVER


STATE OF WYOMING
1933
GEOLOGICAL SURVEY

taken from U. S. Geological Survey Water Supply Paper 246:

DISCHARGE MEASUREMENTS OF LITTLE WIND RIVER AT FORT WASHAKIE.

DATE	DISCHARGE IN SECOND-FEET
October 8, 1907	136
October 30, 1908	124
December 29, 1908	92

LITTLE WIND RIVER ABOVE ARAPAHOE.

"Water is diverted from Little Wind River and various tributaries above the station by the United States Indian Service canal systems, which will eventually irrigate several thousand acres of land."

DATE	DISCHARGE IN SECOND-FEET
August 25, 1907	304
October 21, 1907	106
June 15, 1908	1,620
July 24, 1908	643
July 25, 1908	637
August 27, 1908	446
November 5, 1908	142

LITTLE WIND RIVER BELOW ARAPAHOE.

"Many diversions are made for irrigation from Little Wind and Popo Agie Rivers above this station, but opportunities for additional development both for power and irrigation yet remain."

DATE	DISCHARGE IN SECOND-FEET
August 25, 1907	606
October 21, 1907	237
June 15, 1908	4,120
July 25, 1908	1,050
August 26, 1908	830
November 5, 1908	346
December 26, 1908	300

MEAN MONTHLY DISCHARGE OF LITTLE WIND RIVER
In second-feet.

MONTH	ABOVE ARAPAHOE	BELOW ARAPAHOE
March, 1907	83	220
April, 1907	117	364
May 1-20, 1907	192	661
August 9-31, 1907	512	884
September, 1907	182	417
October 1907	120	293
November 1-12, 1907	112	266
April, 1908	140	401
May, 1908	339	908
June, 1908	907	2,310
July, 1908	943	1,890
August, 1908	484	896
September, 1908	158	365
November 1-8, 1908		358

LITTLE POPO AGIE RIVER AT HUDSON.

"For 20 miles or more above this station small ditches take out water to irrigate the valley lands along the stream."

DATE	DISCHARGE IN SECOND-FEET
August 26, 1907	72
October 20, 1907	44
June 13, 1908	662
June 14, 1908	341
June 15, 1908	387
July 26, 1908	96
August 25, 1908	74
November 5, 1908	61

MEAN MONTHLY DISCHARGE OF LITTLE POPO AGIE RIVER AT HUDSON.

MONTH	DISCHARGE IN SECOND FEET
August 26-31, 1907	70.5
September, 1907	51.3
October, 1907	47.0
November, 1907	41.2
December 1-24, 1907	28.3
April, 1908	66.9
May, 1908	138.0
June, 1908	296.0
July, 1908	181.0
August, 1908	81.4
September, 1908	49.5
October, 1908	74.9
November 1-10, 1908	63.5

MISCELLANEOUS MEASUREMENTS. Discharge in second-feet.

DATE	STREAM	LOCALITY	DISCHARGE
1907			
Aug. 26	Big Popo Agie	Hudson	389
Oct. 20	Big Popo Agie	Hudson	142
Oct. 21	Big Popo Agie	Arapahoe	151
1908			
June 13	Big Popo Agie	Hudson	2,090
July 26	Big Popo Agie	Hudson	451
Aug. 25	Big Popo Agie	Hudson	401
Nov. 6	Big Popo Agie	Arapahoe	204
Nov. 7	Big Popo Agie	Above sinks, 10 miles above Lander	45
Nov. 7	Big Popo Agie	Below sinks 10 miles above Lander	60
Aug. 24	North Fork Popo Agie	Lander	164
Aug. 24	North Fork Popo Agie	Lander	169
Oct. 30	North Fork Popo Agie	Milford	50
June 14	Little Popo Agie	5 miles above Hudson	395
June 14	Baldwin Creek	Lander	82
Oct. 30	Baldwin Creek	Lander	8
June 14	Squaw Creek	Lander	5
Oct. 30	Squaw Creek	Lander	3
Nov. 1	Sage Creek	10 miles north of Ft. Washakie	8
Oct. 30	Trout Creek	Wind River	12
Dec. 22	Trout Creek	Wind River	9.6

UNDERGROUND WATERS.

A number of the formations exhibited in this district consist, wholly or in part, of porous sandstones, which, without doubt, contain water in their underground beds. Their outcrops on the flanks of the Wind River Mountains receive water from rain and from streams fed by the melting snows of the higher ranges. The Tensleep and the Dakota sandstones and the sandstone of the lower portion of the Mancos group are overlain by shales which constitute an impervious cover, and, with the synclinal basin of the Lander valley, form ideal artesian conditions, though the dip of the strata on the western limb of the Shoshone

anticline is so great that the water bearing formations can be reached only with deep wells in the eastern portion of the Lander valley. In the immediate vicinity of the town of Lander the Dakota sandstone can probably be reached with wells from 1,500 to 1,800 feet in depth, though it is not improbable that good water may be obtained in the Mancos group sandstones at much shallower depths. Near the Wind River Mountains, in the central part of the outcrop of the Chugwater Red Beds, water can be obtained from the Tensleep sandstone at depths ranging from 1,200 to 1,500 feet. As the region is so well supplied with surface water no wells have been drilled to tap the underground reservoirs, nor is it probable that any will be drilled in the near future.