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ANNUAL REPORT

of

THE TERRITORIAL GEOLOGIST

- to the -

GOVERNOR OF WYOMING

January, 1886

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Territorial Geologist.

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REPORT OF TERRITORIAL GEOLOGIST.

To His Excellency, Governor Francis E. Warren:

Dear Sir:- In accordance with the statutes of Wyoming Territory, I have the honor to transmit to you herewith the following report of the work done by me during the time that I have filled the office of territorial geologist, up to January 1, 1886. It embraces the following:

1. Statement of the work done by the territorial geologist.
2. Condition of the mining industry in the territory.
3. Report on the iron ore bodies in Wyoming.
4. Report on the oil fields in Wyoming.
5. List of the minerals in Wyoming.

I have aimed to be as free as possible from technical methods. My endeavor has been to address the general reader rather than the special investigator. A report on the coal fields and soda deposits is in progress, but another season's work will be required to complete it.

Very respectfully,

SAMUEL AUGHEY,

Territorial Geologist.

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At my appointment as territorial geologist by Governor Hale, I was instructed to use my utmost endeavors to secure the development of the mineral resources of the territory, and to that end to give such directions and such information as the work required. Owing to the fact that the office had been vacant for some time, a large amount of work had accumulated. A portion of this work was the examination of ores sent in by miners who were anxious to know whether their claims were prospectively of any account. This led me to put the assaying material in order, and to supplement it by such additions as were necessary in order to do exact work. Up to this time the number of assays made during my incumbency is 639. Some of the specimens to be assayed came from the Big Horn, Seminoe and Ferris Mountains, Miner's Delight, Silver Crown District and other points. Being constantly called into the field to examine mining property, I employed at my own expense Wilber C. Knight, a former student of mine, during the summer of 1885, to keep the office open during my absence and to do such assay work as was required. In addition to such office work he also went into the field during the time when I could be in Cheyenne myself. He performed the work entrusted to him with fidelity and to the satisfaction of those by whom he was employed. This arrangement added greatly to the efficiency of the office. During the second week of October Mr. Knight returned to the University of Nebraska to complete his studies. Finding myself still crowded, on the 9th of December I employed Lilbun T. Wood, Esq., to take charge of the assay department and to keep the office open during the days when I was necessarily absent engaged in outside duties. His training and ability also adds greatly to the efficiency of the office at the present time.

During the year I have examined over 100 mining prospects, the most of them being in the Silver Crown, Seminole or Ferris Mining Districts. I have given such instruction in each case as those interested needed, and I was capable of giving. Only two detailed reports were made, one on the King David mine in Silver Crown, and the other on the King mine on the Seminoe Mountain. Neither of these were placed on the stock boards, or were sufficiently developed for that purpose.

During the year I was most frequently asked for information in regard to the condition and extent of the oil territory of Wyoming. I made a detailed examination of the Powder River, Big Horn, Rattle Snake, Brago, and Seminole oil basins. To satisfy the demand for information on this subject I have prepared a detailed report of the principal oil belt of the territory, which is included under another head. In that report I have embodied all the facts on this subject gathered in previous years.

As much interest has been manifested in iron ores, a thorough examination was made of the iron ore deposits at the base of Bradley's Peak, on Seminoe Mountain, the results of which are also embodied in this report. It was deemed important to do this, inasmuch as that deposit is one of the finest of the kind in the world. A large number of additional notes were made of our coal deposits, and these will be embodied in a report during the next season.

Owing to the great extent of our territory I have not been able to visit all the mining camps which claimed attention. They will, however, be examined in detail, and during another year such as have not been visited will be visited, and the facts concerning their character and prospective importance reported upon.

During my work in the field I have missed no opportunity of collecting fossils and minerals for a territorial museum. The rooms of the territorial geologist are too much crowded to exhibit these at present, but they will be in order at the earliest possible date. The work in economic geology has so taken up my time that little could be spared for work on the materials for a museum. But in connection with the work in economic geology, several thousand specimens in mineralogy and paleontology have been collected.

NEEDS OF THE OFFICE.

During much of the time the territorial geologist is necessarily absent from his office, engaged in field work. It would more than double the efficiency of the office if provision were made for an assistant, who could keep the office open during the necessary absence of the territorial geologist, and under his direction should mount the minerals and fossils that are now boxed, and that may be collected during the season, in suitable cases for the museum. Such assistant might also do any assay work required, and turn the proceeds into the territorial treasury.

When I entered upon the duties of this office a portion of the contingent fund had already been legitimately expended. Out of this fund the rent of the territorial geologist's office and the room for the storage of the assay apparatus of the territory is paid. In order to be able to give a correct judgment of mining prospects, I fitted up the assay apparatus and supplemented it by new apparatus to take the place of that which was worn out, in order to be able to make assays of minerals when they should be necessary. The means to do that was taken out of the contingent fund. To carry on the office efficiently, and to utilize the mineral and fossil collections, cases with glass doors and sides should be provided, the cost of which would amount to an estimated cost of five hundred dollars. An additional room should also be rented to be devoted exclusively to the purposes of a museum. Properly to utilize the collections that have been made, the providing of the necessary cases, the renting of an additional large room for museum purposes, and defraying the additional expenses for transportation of packages of minerals, etc., would require the increase of the contingent fund of one thousand dollars, allowed by the legislature of two years ago, to eighteen hundred dollars. The importance of museum work can be seen from this that rare minerals and fossils abound here as nowhere else. Wyoming is the principal collecting ground for the scientific men of the nation, but comparatively little has yet been done to secure or save these educational treasures for ourselves.

CONDITION OF THE MINING INDUSTRY IN WYOMING.

The best developed mining interest in Wyoming is the coal industry. The fact that the Union Pacific Railway transports daily from Wyoming over 3,000 tons of coal needs no comment. It supplies the increasing dense populations along the line of their road in Nebraska with fuel. There is a constantly increasing consumption in Wyoming itself. When the railroad now aiming for Wyoming through Northern Nebraska reaches the Territory, five hundred more miles of road must be supplied from our coal fields. Coal beds have been opened for the first time during the last year in many places, among which are banks near the Rattlesnake and Beaver oil basins, to drive the machinery used in boring for petroleum, and on the south side of the Seminoe Mountain, to work the gold mines there. The subject of the development of the oil basins is discussed in another connection.

SILVER CROWN DISTRICT

A great deal of prospect work has been done in this camp at different times for many years past. The only property, however, that has been developed sufficiently to be called a mine is the Copper King and associated lodes. It is an immense lead, the ore body being over three hundred feet in width and two thousand six hundred feet in length. At the surface it is mainly low grade, running less than one per cent. in copper. It regularly improves in grade with depth. It has a shaft one hundred and thirty feet deep. On the lower level on the north side, some twenty feet from the shaft, there is a winze. Here there is a pay streak eight feet wide that runs, from an average of many assays, about eleven per cent of copper and nearly two and a half ounces of gold. The ore is rich beyond the pay streak to the end of this cross drift. In the eighty-foot level above this same streak occurs. The ore is made up of copper pyrites, oxides, especially the sub-oxides, in flakes and metallic copper. The pyrites increase greatly from the eighty-foot level to the bottom of the shaft. A little carbonate and barite and other ores of copper also occur. Owing to causes not connected with the ore bodies, this property is not worked at present.

The King David mine, on a tributary of North Crow Creek, has been considerably prospected during the first half of the year. The ore is mainly copper glance, but occasionally copper pyrites, barite, covellite, oxide, gray copper and other forms of copper ore appear. It is a remarkably good prospect. Unfortunately the mistake was made of putting up a smelter before the property was sufficiently developed, and ore could be continuously supplied. Run was made, however, and the copper produced was of fine character, and vies in this respect with the best in the land. The copper carries considerable silver, but the exact amount has not been satisfactorily determined. Had the money expended on this smelter been used to develop the prospect into a mine the property would have become in all probability a continuous and profitable producer. No work is being done on this property at present.

A few miles south of the King David mine, and northwest of Simmons' ranch , on Middle Crow Creek, Mr. James Adams is developing the Lenox prospect. The ore body runs a little north of west and south of east, and dips towards the northeast. The shaft is down over forty feet.

The ore body has increased from six inches at the surface to thirty inches at the bottom of the shaft, without any breaks in continuity. The ore is a carbonate of lead and galena carrying silver, and towards the bottom a little gold. The ore ranges from ten to sixty per cent. lead; from forty to sixty ounces of silver, and one-third ounce of gold to the ton. Active work is in progress at this time on this property. This lead is remarkable for the occurrence in it of some of the rarer minerals. Among these is wulfenite (molybdate of lead) in beautiful crystals; also aurichalcite, a hydrous carbonate of zinc and copper.

One-fourth of a mile southwest from the Lenox, close to the bank of Middle Crow, W. W. Lewis is prospecting the Julia lode. The ore is mainly free milling gold ore. At the surface the ore was from two and a half to three feet thick, and at the bottom of the shaft, twenty feet deep at this writing, the ore is four feet thick. Assays of this ore give one-half an ounce of gold to the ton.

About one-fourth of a mile northwest from the Julia lode, Mr. Nels Nelson has been working the Agat prospect. A shaft fourteen feet deep and an open cut have been made on this property. The ores assay from one to two ounces per ton. One exceptionally rich specimen yielded $280 in gold and $14 in silver. This is an exceptionally fine prospect.

North of but close by the King David mine, the Eureka lode occurs. It is developed by a ten-foot shaft, and an open cut started for a drift on the lode. Yellow copper pyrites in this lode, mixed with gangue materials, produce by assays $12 in gold per ton. Lead also occurs in this prospect. One specimen gave eight per cent lead and $60 in gold.

The annual assessment work done on the Colorado lode (the old Metcalf) late in autumn, west of the King David mine, produced some unexpected results. The ore previously had beem a yellow copper pyrite carrying gold. This season's work brought to light ore carrying in addition galena bearing silver. This has long been known to be a good property, but an unpleasantness between the owners has prevented it from being worked or sold.

Northeast from the Colorado is the Fairview claim, worked by Mr. Dick Holliday. This is a large fissure from eight to fourteen feet wide, but not developed sufficiently to determine the amount of ore it may produce. At the bottom of the twenty foot shaft copper glance is present, and good ore fills almost the entire fissure; also other forms of copper ores, all carrying more or less silver. This fissure can be traced for a long distance on the surface, and the prospect is an exceptionally good one.

Near by is the Stanton Copper King, owned by Prof. F. Stanton. The ore on this lode is a rich copper pyrite. Some iron pyrites also occur occasionally in this lode, and both iron and copper pyrites are of exceptional beauty. I have not personally visited this property, and only judge it by the samples of its ores submitted to me. But from statements that I consider reliable, it appears to have a well-defined fissure, a thick ore body, and is a very promising lead.

A remarkable mineral belt occurs on the east side of this district. It begins north of Simmons' ranch, and extends northward to Table Mountain, over an extent of nearly six miles. It ranges from fifty to one hundred and twenty-five feet in width. The foot wall on its west side is made up of dioryte, felsite, quartzite, gneiss, etc. The hanging wall on the east side is made up of shale and limestone. In this belt are streaks of different kinds of minerals, among which are uranium and manganese ores, and much talc and related minerals. Selenides and carbonates of lead occur at and near the surface. These gradually change at some distance below the surface into galena, in crystals scattered through the gangue. The lead carries more or less silver. This entire belt has been located by different prospectors under the United States mining laws. On one of these claims, the Carbonate Bell, a shaft has been put down forty feet and timbered, and a shaft house erected over it. A great many assays have been made from samples taken from this and adjoining prospects. They run from one to thirty per cent. of lead, and from one-half to twenty ounces of silver to the ton. To ascertain whether any streaks of ore exist here sufficiently rich to work them profitably, a deep shaft should be sunk, and from the bottom a cross-cut made to each wall, and the ore sampled and assayed every few feet. As yet the ores have averaged too low in grade to mine successfully. But the great extent of this belt, and occurring as a contact vein, makes it sufficiently promising to justify its extensive exploitation.

Many other leads exist in this camp which I have been unable to examine. A new impetus has been given to the camp during the last season, and prospecting has been quite active and more claims have been located than in any previous year. A great deal has been accomplished by poor prospectors by the expenditure of comparatively little capital. There can be no doubt that when once capital is risked to sink the best of these prospects to a depth sufficient to make them mines, and the work managed on business principals, the same financial success will attend the enterprise that has characterized mining in the more fortunate camps in the Rockies.

SEMINOLE MINING DISTRICT.

The eastern parties who, during the last year, purchased the long and well-known Deserted Treasure and Emeletta mines, on Seminoe Mountain, organized the Penn Mining Company. A cross-cut tunnel cuts the Deserted Treasure lode at a depth of over one hundred feet below the surface. The company cleaned out the old workings that had caved, and extended the drifts about two hundred feet. The ore is a free milling gold quartz, carrying some iron and copper pyrites also rich in gold. The ore body averages at least four feet in thickness. The company built a California gold quartz mill of ten stamps, with a concentrator added. A successful run was made in late autumn, and the mill was closed for the winter, but active work is continued on the mine, preparatory to a resumption of milling in early spring.

The Star and Hope gold mines, adjoining the Emeletta, but with a strike at nearly right angles to it on the south, are good properties, but not worked at present. Two shafts have been sunken eighty feet deep. Where I examined the breast at the bottom of the shaft near the Hope line, the ore was four and a half feet thick. The dip of the ore body is towards the west or northwest, and changes from fifteen degrees near the surface to fiftyfive degrees near the bottom. The ore is free milling, but contains copper and iron pyrites carrying gold. Magnesian minerals occur in the gangue. Applications for patents are pending.

The King mine runs almost parallel with the Deserted Treasure, but more southwesterly and northeasterly. It has been developed by a drift one hundred and twenty-five feet long, and from the far end of it a shaft fifty-four feet deep, the bottom of which, owing to the slope of the ground, is one hundred and twenty feet below the surface. The lode dips towards the northwest. At the bottom of the shaft the ore is five feet thick. It is free milling gold quartz, and carries also much copper and iron pyrite rich in gold. Seventy tons of the ore run through a quartz mill produced $700 in gold, but the pyrites were not saved.

The Jennie, on the same ground, and the Meager and Bennett are also free milling gold prospects of high grade. These properties are not worked at present, but applications are pending for patents.

Recently a shaft has been sunken near the East King Mine (an extension of the King), and a cross-cut to it encountered a streak of very high grade gold bearing quartz.

Near by these mines other prospects have been worked during the last season. The ground on which these mines and prospects are located is eruptive material and made up of pyroxene, (silicate of magnesia and lime). The black and dark green crystals that occur with it on this mountain are augite. The slates that stand on end in belts through this mountain are highly metamorphic in places. They evidently lay proximately horizontal before the eruption of the pyroxene mass, and were metamorphosed by the heat developed at that time. The fissures now filled with mineral evidently originated during the period of eruption.

Eastward from this point where these mines are located, important and promising prospects have been opened and worked during the last season, but I had no opportunity to examine them.

FERRIS MOUNTAIN DISTRICT.

In this district considerable work was done during the last year. The carbonates and sulphides of lead are silver bearing. Those engaged in mining here are hopeful that with greater depth their prospects will develop into profitable mines. Considerable galena has been shipped from this camp.

SWEETWATER DISTRICT

In the old mining districts towards the head of the Sweetwater, including South Pass City, Atlantic City, Rock Creek, the Strawberry and Miners' Delight, active work is again in progress, with gratifying promise of success.

The Christina Lake Company, conducted by French interests, and managed by Colonel Emile Granier, has inaugurated work on a large scale. Its purpose is to work the rich placer grounds known to exist in this section. The company intends to conduct the water from the lakes at the head of the Little Popiagie to Rock Creek. The ditch on Rock Creek, nearly seven miles long, is nearly completed. Sixty-five hundred feet have been taken out on the Christina Lake ditch. This ditch when completed will be five miles in length and run 8,000 miners' inches of water. Portions of it will be heavily timbered, one flume having a projected length of five hundred and a height of seventy feet. The company expects to work all the placer ground from Rock Creek to the Strawberry. It has located a great deal of ground, and reports itself well pleased with the results of the prospecting which it has done during the season. One of the results of the work was the finding of gold nuggets of unusual size along Rock Creek. The company has expended in this preparatory work over $100,000. This enterprise is a very important one to the mining interests of the Territory, and if continued cannot fail to be richly rumenerative to its projectors. Heretofore the prime obstacle to placer mining has been the scarcity of water. This difficulty this company is overcoming by their long ditches and canals. It is not, however, engaged in quartz mining.

The placer grounds on Spring Gulch, at Miner's Delight are still successfully worked every spring while the water lasts. Up to date these grounds have yielded over $400,000 in gold.

Formerly much gold was taken from the Carissa mine, at South Pass City, but for some time the property was not worked. Recently one of the original owners, Bolivar Roberts, associated himself with Mr. Van Praag, of Salt Lake, and resumed work on this property. The new shaft is down fifty feet, and as the ore is rich near the surface and the crevice is a genuine fissure, there can be no doubt of the final financial success of the enterprise, provided the work is continued on business principals. The Carrie Shields mine near by is also being worked. The shaft has reached a depth of one hundred and fifty feet. The ore is run through a five stamp quartz mill, and profitable returns are received from it.

At Altanta City there are also some famous mines. Among these are the Cariboo and Buckeye. The Sauls and Perkins mine has a cross-cut tunnel 500 feet long, but it has not yet intersected the vein. It will cut the lode when completed at a depth of one hundred and sixty feet. One of the richest mines here is the Mary Ellen, but its fissure and ore body is small. It is developed by a shaft eighty feet deep.

The Miner's Delight mine at the head of Spring Gulch - the gulch so rich in placer gold, as observed above - is one ot the best properties in this district. When worked in the palmy days of mining here it produced at least $200,000 in gold.

East Miner's Delight mine is owned by Hon. James Kime. The shaft is down one hundred and ten feet. At the surface the quartz lead is twenty feet wide, but at the bottom of the shaft it is only two feet, but the ore is of high grade. A twenty-stamp mill is connected with this property. Neither of the quartz mills at this place are running at this time. The one at Lewiston, also owned by Hon. James Kime, is also idle at this time.

Prospecting has been resumed in this district and new discoveries made during the last season. One of these, at the head of Popoiagie Creek, not far from Wilson's mill, is reported to be rich in galena. This section has never been thoroughly prospected. Gold mining, since its inception, has never ceased in this camp, but as already stated for years it was in a state of decadence, and only recently began to revive. It is not difficult to ascertain the cause of this temporary interruption. Mining was exceedingly profitable while work was confined to and near the surface. At greater depth was reached, some of the mines pinched, but increased in grade of ore. A few came into broken rock masses, where the ore body partially or entirely gave out. Water also became troublesome, and the country rock where it had to be cut away was exceedingly hard. Some of the mining companies that had done well previously had also expended their gains, and when these double difficulties were encountered - the pinching of the ore bodies and the influx of large quantities of water - not sufficient capital was left to drain the mines and work through the contracted areas. Some companies that had done well were afraid to risk any capital in going deeper, and some had no money left for further development. Private individuals interested in the district could not afford the expense involved in deep shafting. Indian difficulties and stampedes to supposed more promising gold camps also lent their influence to deplete this camp of miners and capitalists. The combination of all these causes produced that decadence and interruption to the mining industry which has characterized this district. Most of the mining camps in the Rockies have passed through similar stages from similar causes. But they argue nothing as to the intrinsic value and richness of a camp. The geologic conditions exist here that promise the richest results. The strata are archaean, and of the same geological age as those in which the richest mining districts of the adjoining States and Territories occur. The ore bodies occur in genuine fissures, and they have already yielded large quantities of gold. The contractions of the veins in this district occur to a greater or less extent in all gold mines elsewhere. There are barren spots in all mines. What is needed, and in my judgment the only thing that is needed, is that greater depth should be attained. Whenever capital is sufficiently enlisted to accomplish this - to work these properties on a large scale - the same rich results will be attained as have characterized the best gold camps in the land.

OWL CREEK DISTRICT.

Southeast from Washakie's Needles, on the Big Horn West Mountains, on the headwaters of Owl Creek, prospecting was done as early as 1867 by miners from Atlantic City and Miner's Delight. They were driven out by Indians. In 1877 about sixty miners from the Black Hills again visited this region. None of these remained, owing to the want of mining facilities and the presence of Indians. In the spring of 1884 Lilbun Wood, Esq., and others went into this district and located placer claims, and have retained their interests up to the present time. Considerable prospecting was done during the summer of 1885. The placers were found to be rich in gold, but the deficiency of water made it impossible to work them on a large scale. Mr. Wood estimates that if water could be gotten on to the rolling table lands above the stream beds and the ground sluiced, from $50 to $100 a day to the man could be made. To accomplish this purpose capital, as elsewhere in extensive placer mining, is needed for the construction of long ditches and flumes. The geological conditions indicate not only rich placer grounds, but further up at the source of those streams a region rich in gold bearing quartz leads. The region is well timbered, and the valleys fertile and fruitful in grasses, and when it is once opened by roads and railroad facilities it will be inferior to none of the mining districts of the Territory.

West and north of the Owl Creek district proper, on the headwaters of South Owl Creek, placer grounds have also been located during the last season and considerable gold taken out.

BRIDGER MINING DISTRICT.

During the year considerable work has been done in this district. The Yankee Jack is one of the promising mines. The direction of the lode is northwest and southeast. It dips towards the southwest at an angle of seventy degrees. The fissure is thirteen feet wide. The ore body is from one to three feet thick, and is rich in silver, much of which is in the form of silver sulphide. Fine specimens of metalic bismuth occur in this lode. The foot wall is largely composed of talcose slate, and the hanging wall is primary slate containing chlorite. Mining is here done by means of the Ingersoll drill, and the shafting is proportionately rapid.

The direction of the Mascotte is also northwest and southeast, and the dip southwest. The vein is one foot wide. The lead carries twenty ounces of silver to the ton of ore. There are also two feet of hard slaty shale carrying oxides of iron and copper.

The Charter Oak has a shaft one hundred feet deep. At the surface it has a vein of ore one foot thick, which increases towards the bottom of the shaft, where it is seven feet in thickness. The ore is an oxide and varbonate of copper. Three feet from the surface it assays twenty-five per cent of copper to the ton.

The Battle Creek is a galena lode. The shaft is down eighty feet, and it runs from twelve to seventy ounces of silver to the ton. It is fifteen feet between walls. Gauges of yellow clay occur on each wall and one in the middle. The country rock is a porphyritic trap.

This is an exceedingly promising district. The developments will soon be such that stoping grounds can soon be opened, when there will be nothing to prevent the taking out of mineral in richly paying quantities.

CUMMINS CITY DISTRICT

With two exceptions no mining has been done in this district during the last year. These exceptions are the Copper Queen and the Bismuth mine, on Jelm Mountain.

The Copper Queen is owned and worked by Messrs. Thomas and Metcalf. It lies half a mile southwest from Cummins City. Its direction is northwest and southeast and dips southwest. The fissure is twenty-four feet between walls. One shaft has been sunken eighty feet. Drifts have been run at fifty and eighty feet. The ores are sulphides, red and black oxides and glance. At the bottom of the shaft metallic copper also makes its appearance. One streak of ore eighteen inches thick runs sixty-five per cent. in copper, with a little gold and silver. This property is remarkably favorably situated for successful and cheap working. A stream in Bear Gulch which has a fall of fifteen feet to the hundred, turns an overshot wheel and empties the mine of its water by a lift pump whenever needed. Power can also be supplied from this source for any of the operations of the mine requiring it.

The Bismuth mine, at Jelm Mountain, is a remarkable deposit of this mineral. A lump of the ore before me runs seventy-five per cent. of pure bismuth. At the surface it occurs in lumps weighing hundreds of pounds. Mr. McMullan, the owner, is sinking in order to recover the lead, which was lost after development was commenced.

In this district exceptionally rich free milling gold occurred in surface deposits. Owing to the broken and faulted character of the country the rich leads were lost when sinking was commenced, but there can be little doubt that if mining is resumed here and the old prospects properly exploited, permanent bodies of paying gold ore will be encountered.

Much has been learned and great improvements have been made in mining, milling and the reduction of ores during the last decade. This makes it possible to work many of the prospects and mines of the Territory at a profit, that were formerly financial failures. A misapprehension exists in the public mind in regard to the causes of the losses in mining. The general opinion is that the losses come from the poverty or worthlessness of the mines themselves. This sometimes has been the case, but is by no means the principal cause of failure. The cause that has produced the great majority of failures is lack of proper business management. Too often men have undertaken the management of large mining interests who either had been failures in everything else or knew absolutely nothing about the business. In such cases failure has been certain from the beginning. At present there ought not and need not be any great losses in the selection itself of mining property. The business is now so well understood that such property can be selected with safety, or prospected to determine its character at comparatively small When the business of mining is properly entered upon there will be fewer failures than accompany the mercantile and manufacturing industries, or in professional life.

IRON CARBONATES IN WYOMING.

Iron is much more important to the civilization of the world than gold and silver. Were the supply of iron stopped the wheels of progress would cease to turn. It enters into more important uses than any other metal. It is to the interest of the nations that it be produced cheaply and abundantly, while the men engaged in its manufacture should also be well paid. To accomplish this end a combination of favorable circumstances is required. Among these are an abundance of the best ore easily accessable, and fuels and fluxes also close at hand. These conditions are present at the southwestern base of Seminoe Mountain to a degree found rarely elsewhere on the globe. Only one thing is lacking, namely: Transportation facilities, the nearest point to a railroad being Rawlins or Fort Steele, on the Union Pacific Railway. If the railroad projected down the North Platte should be built, it would run so close to these iron ore bodies that transportation for them could readily be provided.

Location and Kinds of Iron Ores.

There are three kinds of iron ores conspicuously developed in Wyoming, namely: Hematite, iron carbonate (siderite), and magnetic iron. Only bodies of the two former will be discussed in this paper.

Hematite Ore.

The largest body of this ore in Wyoming (and as will be shown hereafter in the United States), occurs in Township 25, north of ranges 85 and 86 west, at the base of Bradley's Peak, on the Seminoe Mountains, nine miles west of the Platte River, and twenty-six miles a little east of north from Rawlins, on the Union Pacific Railway. The Seminoe Mountains, in which this body of hematite occurs, is an extension eastward of the Ferris range, which range is an extension of the Wind River range. About seven miles (proximately) further west the Seminoe Mountains are separated from the Ferris range by Sand Creek Canyon. Access can be had to this ore body at present by the main road from Rawlins to the Seminoe gold mines, which passes within a mile and a half of the southern side of this deposit. A road also extends from here to Hurt's ranch eastward near to the Platte River. With little expense a wagon road could be constructed from the main wagon route directly to the ore body. From these hematite deposits the grade is downward to the coal beds in the valley on the way to the Platte.

Physical Structure.

On approaching the iron beds from the main road going northward, the southern side is first encountered. Here over an area one mile from south to north and two miles from east to west, hundreds of small knolls occur composed of ore. There is an irregular ascent going northward, and the difference in level between its southern and northern side is, commencing it its first out-cropping, six hundred and seventy feet. The top of the highest part is seven thousand nine hundred feet above the sea level, and the lowest cropping seven thousand two hundred and thirty feet. A beautiful streamlet of water courses down over this ore body, reinforced at several places by large springs of the purest water. These streamlets have cut ravines and canyons through the ore body. The physical conditions indicate that the ore extends into the mountain much deeper than appears at the surface. The masses of ore that crop out over all the knolls are of all sizes, from a few pounds to thousands of tons.

KIND AND QUALITY OF ORE.

As already observed the ore is hematite, but of several varieties. Walking over this mountain of ore the observer notices that some of the ore has a metallic lustre; that is specular hematite. Occasionally small patches are observed with a foliated structure; that is micaceous hematite. Large masses, too, are either submetallic or unmetallic in appearance, and of a brownish red color; that is red hematite. I observed very little ore here that was soft and earthy, and what little occurs comes apparently from the pulverization ot the red hematite; this kind is red ochre. On the borders of the deposit a hard unpure siliceous clayey ore occurs with a brownish red jaspery look; this is known as jaspery clay iron. Clay iron stone, which is the same as the last, but with the color and appearance less like jasper, occurs in a few places on the border. These two varieties shade into each other. They often assume the appearance of petrified wood structure. Small quantities of lenticular argillaceous ore, which has small flattened grains also occurs on the western side. More rarely than either of these is the occurrence of itabyrite, a schistose hematite in high metallic laminae scales. But the great mass of the ore here is specular hematite with an iron gray color, and with a high metallis lustre, some of it verging to brownish red and jaspery colors. I know of no one who has made an analysis of the specular hematite except myself, and therefore give them in lieu of anything better. It will be an indication of the general purity of these ores. The only substance present in this ore body that has yet been detected that detracts from its value are occasional streaks of quartz that to a small extent in places are intercollated among the layers or masses of ore. In mining this material would of necessity have to be thrown aside.

Analyses of Hematite Ores from the Base of Bradley's Peak,
Seminoe Mountains, Wyoming Territory.

	No.1	No.2	No. 3	No. 4	No. 5.	No.6
Iron	59.33	62.13	61.47	68.09	67.66	60.88
Oxygen	25.42	26.62	26.34	29.18	28.99	26.09
Silica	12.17	6.11	5.18	1.19	.72	1.11
Lime	2.21	1.01	2.33	.51	1.23	5.79
Magnesia	.50	1.23	2.03	.02	.68	3.25
Alumina	.01	2.18	2.20	.54	.21	1.74
Titanic Acid	Trace			.03	.04	.43
Loss in Analysis	.36	.72	.45	.44	.47	.71
	100.00	100.00	100.00	100.00	100.00	100.00

Pure hematite (iron sesquioxide) contains seventy per cent. of iron. (See Dana's Manual of Mineralogy, page 177). The hematite of this locality approximates the richness of the purest article, as is seen from the above analyses, where the average of six smaples reaches sixty-three and twenty-six one-hundredths per cent. of the ore. It should also be noted that the deleterious matters that are contained are comparatively small in amount. Some of the samples containing not even a trace of titanic acid and no phosphorous at all. The great body of the ores at this locality will probably average equally high in richness and quality.

Quantity of Ore.

Considering that this ore body extends for an unknown distance into the mountain, it is safe to estimate it from the shape of a pyramid two miles long and one mile broad, and six hundred feet high, especially as the mountain does not slope on an average as much and equally from a gradually formed point. The opex is more of a line than a point, and therefore the number of cubic feet would be more than in such a structure as a pyramid. But estimating on the principal of a pyramid six hundred feet high, five thousand two hundred and eighty feet wide and ten thousand five hundred and sixty feet long, and we have eleven billion one hundred and fifty-one million three hundred and sixty thousand cubic feet, or one billion five hundred and sixty-three million nine hundred and seventy-eight thousand tons. In this calculation the specific gravity of the hematite is taken at four and five-tenths, though it varies from those figures to five and three-tenths. Were the estimates based on the latter figures, the number of tons would still be greater in this pyramid of ore. The weight of a cubic foot of ore is, of course, obtained by the weight of a cubic foot of water (sixty-two and three hundred and fifty-five one-thousandths pounds), multiplied by the specific gravity (four and five-tenths) of the ore. All these figures show that the ores here are practicably inexhaustible. The extent, however, and the value of the Seminoe iron ores can be seen by

A Comparison With the Most Noted Deposits of Hematite Elsewhere.

The largest shipments now taking place anywhere in the United States are from the Lake Superior mines, near Marquette. Some years the output has been as high as two hundred and sixty-five thousand two hundred and thirty-five tons, but the average is much below that, and probably near two hundred and fifty thousand tons. But at that rate the Seminoe mines would not be exhausted in six thousand two hundred years. In regard to bulk the Superior mines have more extent but the ore is inter-stratified with more foreign materials. There the hematite is of the schistose variety, the average breadth of the district is about six miles, and extends westward from the lake shore about twenty miles. The strata which are much contorted are chiefly talcose and chlorite schists, passing upwards into parallel laminae of red jasper and hematite, whose united thickness is about one thousand feet and upwards. A large portion is too highly siliceous to pay for working. The beds that are quarried at the Jackson and Superior mines are about one hundred and fifty feet thick. While, therefore, the iron area is here much more extended than at the Seminoe Mountain, it is so much inter-stratified by common rock masses as to make the amount of hematite practically much less. (Phillips' Metallurgy of Iron, page 132). Next to the Superior mines the iron mountains of Missouri are the most celebrated hematite bodies in the Republic. The iron mountain proper is a flattened dome-shaped elevation about three hundred feet high, and forms the western extremity of a ridge of reddish prophyry, which rises considerably above the ore body and stretches over a mile to the eastward. The surface of the mountain is covered by huge blocks of iron ore, which become massed towards the top. Pilot Knob is much higher than Iron Mountain, the height from the base being six hundred and fifty feet, but it is composed of a distinctly leaded siliceous rock, and for two-thirds of its distance to the top quartz predominates, and only the upper portion of the mountain consists of hematite beds, but these alternate even here with siliceous rocks. The richest ores exhibit a distinctly siliceous structure, thus differing from those of the Iron Mountain, which are compact and without clearage. - (Phillips' Metallurgy of Iron, page 135). Thus it will be seen that Pilot Knob approximates in mass to the iron mountain in the Seminoe range under discussion, but in quantity of genuine ore does not compare with it. In fact, there is less ore in both these mountains - Iron Mountain and Pilot Knob - than there is in the hematite deposit on the Seminoe Mountain.

The nearest approach, perhaps, to a hematite deposit like the one at the Seminoe is the one at Glademes, in Spain, which is worked by an English company. Here is a mountain of iron three thousand six hundred feet long and five hundred and ten feet high rises above a river that flows at its base. At that elevation it becomes capped by limestone. Beneath the limestone the whole face of the mountain is composed of iron stone and rocks of solid ore, without any foreign admixture, which stand up vertically one hundred and fifty feet. The ore in sight is estimated to amount to from sixty millions to seventy millions of tons, but it is believed that between three and four times that amount can be made available. That ore is in high repute, and for the purpose of comparison with the Seminoe Mountain ore, the following analyses are given, taken from Phillips' Metallurgy of Iron:

	No. 1.	No. 2	No. 3
Silica	5.55	1.70	7.65
Iron Sesquioxide	78.80	79.20	76.
Alumina	3.50	6.80	5.80
Manganese	0.651	2.88	0.83
Sulphuric Acid	0.068	0.62	0.34
Lime and Magnesia	Trace	Trace	Trace
Water Combined	11.653	9.672	10.128
	100.222	100.872	100.748
Lost in Drying	.066	1.8	1.6
Metallic Iron	55.16	55.44	54.20

It will be observed that these ores are remarkably uniform; have no deleterious ingredients, but have less matallic iron than the hematites of the Seminoe Mountain, and in many respects resemble them closely, the most remarkable difference being the almost entire absence in the former of lime and magnesia.

In Styria the erzberg, or ore mountain, rises two thousand five hundred feet, and this is capped by siderite. But the good ore is only in the lowere where copper pyrites, quartz carbonate of calcium, and more rarely cinnabar is associated with the iron ores. The yield here is one hundred and ten thousand tons annually, and fifty million tons are stated by Phillips to be laid open by the workings. Were it not for the foreign matter here associated with the iron ores, the deposit would surpass in bulk that of the Seminoe Mountain, but their presence makes the former inferior to the latter.

These are among the principal colossal hematite ore deposits in Europe and America. None of them really equal that in bulk on the Seminoe Mountain. Most of them are worked on a very large scale, the ease and cheapness with which they can be worked making it possible for their controllers to compete successfully at all times with producers from less favored mines. In England there are many fine hematite ore bodies, but none are reported of such colossal dimensions as those discussed in this paragraph. The hematite that occurs in Cumberland is among the finest found anywhere, and as it is singularly well adapted, without mixture with other ores, for the manufacture of Bessemer steel, and for purposes of comparison the following analyses, made by A. Dick, are here given.

ANALYSES OF CUMBERLAND (ENGLAND) ORES.

	No. 1	No. 2	No. 3
Sesquioxide of Iron	95.16	90.36	86.50
Manganese	0.24	0.10	0.21
Alumina		0.37	
Lime	.07	0.71	2.77
Magnesia		.06	1.46
Carbonic Dioxide			2.96
Phosphoric Oxide	Trace	Trace	Trace
Sulphuric Acid	Trace.	Trace	0.11
Iron Bisulphide		0.06	
Insoluble Residue	5.68	8.54	6.55
	101.15	102.20	100.56
Metallic Iron	66.60	63.25	60.55

The average amount of metallic iron in these three analyses sixty-three and forty-six one-hundredths per cent. --is but slightly above the average of the Seminoe ores, namely: Sixty-three and twenty-two one-hundredths. The principal difference between them being the presence of more silica - over two per cent. more - in the Cumberland hematite than in the Seminoe, and less lime, magnesia and albumina in the former than in the latter. The former, too, has a small quantity of manganese - one hundred and eighty-three one-thousandth - while in the assays given the latter has none. On the eastern edge of the Seminoe ore body in one streak of ore a little manganese, seventeen one-hundredths per cent., was encountered, but no table of that assay has been given, because it was not carried out entirely. This subject will be more fully discussed under the section on Bessemer steel.

I. - Spathic Iron - Iron Carbonate.

These ores are referred to here because they are present in large quantities on some petroleum properties of Wyoming. The term large is here used because the spathic iron ores no where occur in such prodidious bodies as characterize the hematites in a few localities. Almost the only exception to this statement being the large irregular mass of spathic in Permian rocks, in Thuringia, which have been worked for seven hundred years, the depth of the deposit being three hundred feet, and one mile long. In England, where an immense amount of spathic iron ore is used, some beds are mined where the ore is only six inches thick, as at the Clay Wood mine. At Park Gate the Old Black mine produces one thousand five hundred tons per acre, though the ore body is only eleven inches thick. Compared with these beds, famous in English metallurgy, the spathic ore deposits that occur in Wyoming are large.

Spathic Iron on the Big Horn Oil Basin.

This basin lies north of the Rattlesnake Mountains, and in Townships 34 and 33, north of ranges 87, 88 and 89, west. It is forty-five miles north and from six to twelve miles west of the Seminoe iron beds. The iron occurs here in thin sheets from three to ten inches thick, some of the sheets being in nodules and others in fractional beds, the whole being inter-stratified with beds of the Fort Benton cretaceous shales, and dipping towards the northeast at angles varying from twenty degrees to thirty degrees. This iron ore, though spathic in nature, closely resembles the English black band ores. The nodules contain a large amount of alumina (clay). Owing to the thinness of the beds, the ores would be of no importance were it not that they contain manganese, and spiegeleisen for the manufacture of Bessemer steel is, or can be made from it, or by mixing small quantities of it with hematite, as will be shown further on. An analysis of this ore will be given in the next paragraph.

Spathic Iron on the Powder River Oil Basin.

This basin is in Townships 40 and 41, north of range 81 west, and close to and on the east side of the South Powder. Here in sections 18 and nineteen, seventeen, twenty and thirty, and in other portions of the basin, spathic iron is found in beds from one to four feet thick. It occurs both in nodul and bedded forms. The color is dark brown, blackish and entirely black. Like that on the Big Horn Basin, it closely resembles black band. The following analyses will show the character of these ores. No. 1 is a specimen of nodular ore from the Big Horn Basin. No. 2 is a nodular, and Nos. 3 and 4 bedded ore from the Powder River Basin.

	No. 1	No. 2.	No. 3	No. 4.
Iron Protoxide	42.05	41.22	52.31	52.72
Manganese	1.90	2.01	1.48	1.97
Lime	2.20	1.82	1.20	.80
Magnesia	.88	1.01	.75	.50
Silica	5.60	3.17	.97	1.66
Alumina	3.24	4.12	3.60	4.07
Carbonic Dioxide	40.995	38.02	34.04	33.98
Phosphoric Oxide	Trace	Trace	.01	Trace
Moisture Combined	.75	1.10	.65	.86
Carbonaceous Matter	2.015	6.61	4.21	2.65
Loss in Analysis	.37	.92	.81	.79
	100.00	100.00	100.00	100.00
Metallic Iron	32.70	32.057	40.412	41.001

These analyses show that these ores would alone, or in combination with hematite, be admirably adapted to the production of spiegeleisen for the manufacture of Bessemer steel.

The following analyses of the English spathic iron ores, taken from Phillips, will give, by comparison with the preceding, an idea of their similarity:

	No. 1.	No. 2.	No. 3.
Iron Protoxite	49.77	43.84	47.16
Iron Sesquioxide	0.81	0.81	
Manganese	1.93	12.64	10.61
Lime	3.90	0.28	0.50
Magnesia	2.86	3.63	3.23
Carbonic Dioxide	37.20	38.86	38.50
Phosphoric Oxide	Trace		
Sulphur	0.04		
Water in Combination	0.30	0.18	
Insoluble Residue	3.12	0.08	
	99.96	100.32	100.00
Metallic Iron	38.95	34.67	36.75

The English spathic black band ores vary from the above in containing little or no manganese. The former is extensively worked in Weardale and Durham, and carried to Wales to make into spiegeleisen. As already stated, the spathic iron ore on the Powder can be used for the same purpose, especially after transportation facilities are provided.

II. - Facilities for the Manufacture of Iron at the Seminoe Mountain.

The requirements for making iron cheaply and profitably are: An abundance of first-class, easily-worked ore, cheapness of fuel, and lime for fluxes near by. The first requirements, as we have seem by the foregoing, is present here as nowhere else. Coal of the lignite variety is wighin two miles, though where it is opened not of first-class variety. Seven miles east of the iron mountain an opening has been made into coal beds, which are of first-class quality. The bed is from ten and one-half to eleven feet thick, and at the end of a slope made through solid coal over one hundred feet long, the breast shows hight solid coal. About one hundred feet north of this bed there is another of coal from eight and one-half to nine and one-half feet thick that is remarkably firm and solid. Experiments have not yet been sufficiently varied to tell whether there are good coking coals in Wyoming, but there is no good reason why there should not be. But provided these coals here do not coke, they are of such fine quality that if used like the bituminous coals of Pennsylvania and Ohio that do not coke, they can still be employed in the reduction of the hematite ores. There the use of non-coking bituminous coals in the reduction of hematite ores has been long increasing. The coals near the iron mountain, while belonging to the lignite series, are highly bituminous, but neither coke nor swell in burning. They have but a small quantity of ash and water in chemical union with the carbon. I have no doubt, therefore, that they can be successfully used in the reduction of these hematite ores. In regard to lime, which is always needed and employed as a flux to unite with impurities that exist in all ores, there are immense ledges of it north and east from the hematite mountain. Thus it will be seen that all the crude materials for the manufacture of iron exist here close together. If iron reduction works were established at the rivulet close to the coal bed, the same tramway could be used to bring down the ore and limestone, as the grade is downward from the latter to the former. Or the works could be established at the Platte, a little farther east, along which river a railroad is projected. The coal beds referred to above extend to the river, and a tram-way could bring to the same point the ore and limestone.

Bessemer Steel.

As steel is rapidly taking the place formerly monopolized by iron, the inquiry is legitimate whether the Seminoe hematite is adapted to its manufacture. It is expecially important to know whether Bessemer steel can be made from it.

The requirements of ore adapted to the manufacture of Bessemer steel may vary within certain limits. The pig iron, however, from which it is made must be free from sulphur, phosphorus and copper, as the process is incapable of reducing to any great extent the proportions of these bodies. On the other hand, the presence within certain limits of silicon and manganese is considered desirable, and until the whole of the latter is eliminated the oxidation of the iron takes place to only a limited extent. The silica from oxidation of silicon combines with the manganese oxide and forms a liquid slag. The pig iron should contain at least one and a half per cent. of silicon, and not more than two-tenths per cent. of phosphorus. Somewhat differing from this is the pig iron that is used for Bessemer steel in Westphalia. It is made from a mixture of hematite and spathic ore and contains five per cent. of carbon, two per cent. of silicon, and averages one per cent. of manganese, six one-thousandths per cent. of phosphorus, and four one-thousandths per cent. of sulphur. The former pig iron for Bessemer steel is made from hematite ore at Warwick, Cumberland, England. The analyses of these ores is given on a former page. They contain only one constituent that is absent from the hematite ores of the iron mountain at the Seminoe. That one constituent is from ten one-hundredths to twenty-four one-hundredths per cent. of manganese. No constituent injurious to the manufacture of Bessemer is present in ores of this mountain. They only lack a small quantity of manganese. That, however, can be supplied in either one of two ways, namely: By adding to each charge a small quantity of the spathic ore brought from the Big Horn or Powder River oil basins; or adding to it ores from the east side of iron mountain, which contains more or less manganese. Or what would be better still, for the manufacture of Bessemer steel, take all the ore from the east side of the iron mountain. A thorough exploration of this mountain of iron would probably reveal other streaks of ore that would contain a sufficiency of manganese for this purpose.

Manufacture of Iron with Oil.

This might be profitable on the Powder River oil basin where petroleum and spathic iron occur close together. It is premature to discuss this method of manufacture at the hematite deposits on Seminoe Mountain, where vast coal beds are convenient. And yet even there for some purposes it might be preferable, because of the intense heat devoid of all injurious ingredients that can be obtained in that way. Thus it will be seen that one of the main causes of the failure of iron works throughout the Republic would not be found here. The causes of failure in many instances have been the establishment of iron works where neither nature nor the Creater designed them to be, namely: Far away from the crude material, and where ore, fuel and flux had all to be brought from a distance, thus greatly increasing the expense of manufacture. In the early history of the iron industry in Pennsylvania, furnaces and forges were sometimes established far away from lines of transportation, but close to fuel or ore, or both, or the opposite, but with some one or more elements of success wanting. Where all the essential elements of success are wanting, iron industries must fail sooner or later, as they ought to fail. Where, on the other hand, fuel, ore and fluxes, and means for transportation are concentrated on a small area, as for example at Johnstown, Pennsylvania, the iron industry is the most prosperous, and endures successfully through the various fluctuations of prices to which this business is exposed. All the possible means for success are present at the Seminoe Mountains except transportation, and that will be provided in the future.

III. - Geological Position of the Iron Deposits.

The rock masses of which the iron mountain forms part, are clearly metamorphic, but whether they belong to the Huronian (Taconnic of Emmons) or Laurentian is not so clear. This is not a place to enter into a discussion of that point, and therefore I shall continue for a present working theory to regard this deposit as of Huronian age. If Huronian, then it represents the lower portion, as the deposit is capped further north by limestone. Quartzite, inter-stratified with gneissoid, hornblende, micaceous and chloritic rocks and slates, abound around the iron deposits. Epidotic slates are also present, and the limestone contains jaspery layers. From the character, therefore, of the accompanying and enclosing rocks, it is inferred that the deposits are of Huronian age. This places them in the same general period of geological time as the iron mountains of Missouri, the hematite beds of Marquette, Michigan, on Lake Superior, and the great iron beds of Canada. This is a great iron horizon, and it is remarkable that most of the conspicuously great deposits occur in it. Lying against this Seminoe Mountain are Potsdam sandstone, then carboniferous strata, against which lie triassic red sandstones and then jurassic beds. On these latter lie the cretaceous beds, including the Dakota, Colorado and Fox Hills groups, and against the latter the Laramie group, containing the coal alluded to in a former paragraph. All these strata lie against and dip away from the Seminoe Mountain at an angle varying from sixty degrees to seventy-five degrees and eighty degrees. After going eastward and crossing a narrow valley, the strata dip in the opposite direction, namely: Towards the mountain. The uplift, therefore, which produced this mountain, occurred mainly at the close of the Laramie group epoch, and the erosion that has been in progress during the numberless centuries since that time has bored the mountain top down to its present level. Directly south of the Seminoe Mountain, therefore, there is a synclinal valley through which a rivulet flows, and the coal beds on the two sides of this valley dip towards each other, and must be continuous beneath it.

The geological structure of the Big Horn and Powder River spathic iron is given in my report on those oil basins.

Summary of Results.

1. - In the Seminoe Mountains, at the foot of Bradley's Peak, occurs one of the very largest hematite ore deposits on the globe. This is shown by a comparison of the bulk of this deposit with the largest deposits elsewhere.

2. - In the quality of the ore this deposit is not surpassed anywhere. It contains no injurious ingredients to an injurious extent. It is well adapted to the manufacture of Bessemer steel, requiring only the addition of a small quantity of manganese, and ore containing this can be obtained on the eastern side of the deposits. These facts, too, are ascertained by a comparison of the constituents of this deposit with the best known ores elsewhere.

3. - Within two and seven miles are large beds of coal, one of them from ten and one-half to eleven, and the other from eight to nine feet thick. Though belonging to the lignite series, these coals are bituminous, solid, and free from injurious ingredients. It is believed that they can be used successfully in the manufacture of the iron that is developed on such a colossal scale near by.

4. - Thick ledges and layers of limestone exist within a mile north and east of this hematite ore body. The necessary fluxes are therefore close at hand.

5.- There is a regular descent from the limestone to the hematite ore body, from the ore body to the coal, and from the latter to the Platte River, which is distant nine miles from this iron mountain. They are nearly in line, and a tram-way could unite them all. The coal beds themselves extend to the Platte, and as a railroad will probably be built along that river, that will be a convenient place at which to place reduction works.

6. - Iron could be manufactured here so cheaply and successfully as to compete with the most favored sections elsewhere, provided proper transportation facilities are provided.

7. - In addition to the hematite beds on the Seminoe Mountain, there are fine bodies of spathic iron ore on the Powder River oil basin and on the Big Horn, but especially the former. They will be valuable for the manufacture of spiegeleisen, so largely used in making Bessemer steel, when once there comes railroad communication with these points. The iron industries, therefore, that can be built up here are of very great promise. It only requires business energy and good management to make them a certain success, and of very great financial value even in times of comparative depression to the iron industries.

REPORT ON PETROLEUM.

The economic world was for a long time incredulous as to the existence of petroleum in Wyoming in paying quantities. That doubt is now dissipated. No where in the world are the evidences of the existence of large quantities of oil more certain at such an early stage of development.

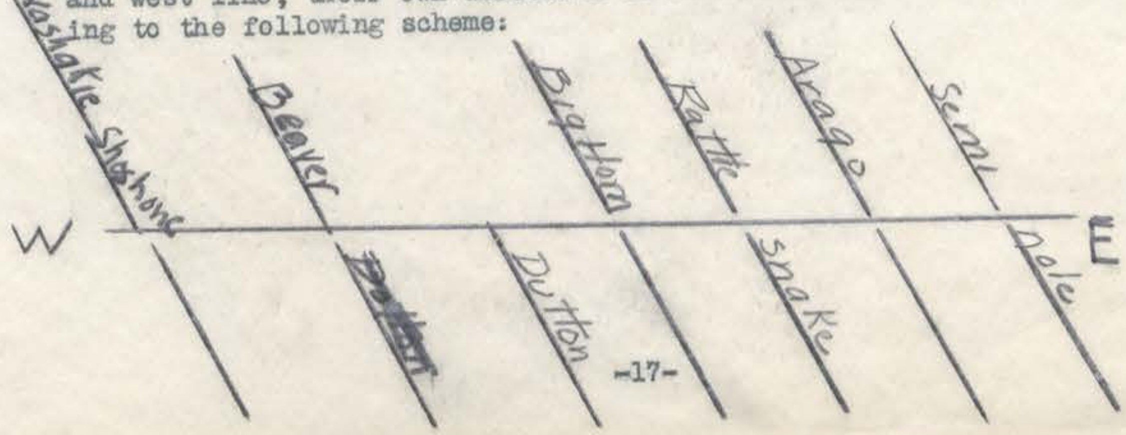
I have, during the last few years, resurveyed a large part of the oil territory of Wyoming, and here submit the conclusions and the data for them which were arrived at. As this report varies slightly from some of my earlier conclusions, it is to be taken as my latest and matured investigations and convictions.

So far as I have been able to ascertain, oil in Wyoming was first observed at Washakie by Homer Haas, Esq., now of Cheyenne, Lieutenant Brown and C. P. Lawhead, all of the Eleventh Ohio Cavalry. It occurred in September, 1864. Mr. Haas had killed an antelope, and seeking water to wash his hands stumbled on the oil springs, on the Little Wind River. Lieutenant Brown rode one hundred and twenty miles to inform Judge Carter, then suttler at Fort Bridger, of the find.

Indications of the existence of petroleum have been found over a much larger territory than was originally suspected. Even the marked proofs of its presence are now found over a comparatively large area - large when compared with that of Pennsylvania, where, according to Carll, (Second Geological Survey of Pennsylvania, Volumes III and IV), the entire productive area covered only thirty-nine square miles. Although the Pennsylvania oil field has since been found to be more extended than at the date of Carll's report, it does not in this respect prospectively compare with that of Wyoming.

Oil Districts.

The most extensive oil district of Wyoming lies east of the Wind River and north of the Rattlesnake Mountains. So far as is now known it commences at Fort Washakie, from where it extends southeasterly to Township 32, north of range 92 west, of the 6th P. M. Thence directly east to the North Platte River, at the Goose Egg ranch, in Township 32, north of range 81 west. This belt is one hundred and thirty miles in length, and along it occur basins where the oil flows out in springs, and where a great deal of the rock masses are saturated with petroleum. While the conspicuous oil basins occur along this east and west line, their own direction is northwest and southeast, according to the following scheme:



In oil fields in other portions of the world, and notably in that of Pennsylvania, the trend or axis of the basins is in an opposite direction, namely: From northeast to southwest.

Oil indications have been observed along this line as far east as Fort Fetterman, fifty miles beyond the Seminoe, but the Territory has not been well explored beyond the latter point.

Another oil district occurs on the Powder River and its tributaries, but it has not been thoroughly enough explored to give definitely its boundaries. Oil springs, however, are known to exist here in Township 41 north, 81 west, opposite the mouth of Willow Creek; in Township 45 north, 82 west; in Township 40 north, 79 west, on Salt Creek, and at other points along this stream; also at other points on the Powder, Belle Fourche and their tributaries.

Oil saturated rock and oil escapes also occur at and near the site of old Bear City, and at and near Bridger. This last district, on and near the line of the Union Pacific Railway, I have explored too imperfectly to venture a description.

Estimating the middle belt along the north side of the Rattlesnake Mountains at six miles in average breadth and one hundred and thirty miles in length, the amount of oil territory would cover seven hundred and eighty square miles. The oil belts outside this territory will swell the amount to double these figures. This I regard as a low estimate, and far within the facts. How much of this territory will be sufficiently productive to make it of pecuniary value can only be determined by actual development. The prospects of great value may be estimated by a fuller description and discussion of each separate basin.

Washakie Oil Basin.

This basin, near Fort Washakie, is fifteen miles northwest from the town of Lander, the latter place being by the windings of the road one hundred and twenty miles northwest from Rawlins on the Union Pacific Railway, the two points being connected by a tri-weekly stage f from the latter place.

A large spring of oil exists here which is of the thick black color. Though not thick enough to justify it, the petroleum flowing here has been called a tar spring. A specimen submitted to me was of sixteen degrees gravity of the Baume scale. It contains a very small amount of kerosene. The Indians, whom I questioned about it, called it Big Medicine. These oil escapes were also formerly known here, owing to the density of the petroleum, as the asphaltum springs. The oil here has not yet been studied to any extent. The source of the oil is the red trassic sandstone from which it emerges. Owing to the fact of it being on the Shoshone Indian reservation, no title could be obtained to it except from the Indians, which would need to be confirmed by Congress.

Shoshone Oil Basin.

This basin is located twenty-six miles southeast of the Washakie oil springs, and seventy-eight miles immediately north of Point of Rocks on the Union Pacific Railway, and by the windings of the road one hundred and nine miles northwest of Rawlins. The Little Popoagie Creek, a tributary of the Big Popoagie, which, in turn, is a tributary of the Wind River, flows through the basin. The general direction of this stream is first northeasterly and then northerly. The location is mainly on Section 13, Township 32, north of range 92 west.

Oil Phenomina.

Oil escapes occur on and near the line that connects this basin with that of Washakie. But the oil of the Shoshone is much less dense than that of Washakie, and while of identical origin they can have no underground connection. At the Shoshone hardened oil occurs, with a constitution very much like that of asphalt, and from eighteen to thirty-six inches in thickness, but overlaid by alluvium from three to five feet thick. It extends continuously over about four acres, and scattered patches extend over a much wider area. Before any improvements were made here a small morass existed made up of oil cake, petroleum, mud and water, and a large number of places where oil escaped. The area over which oil escaped could not have been less than seventy acres. Vast volumes of gas were also continuously escaping. Oil and water were continuously emerging and flowing off through the Little Popoagie. The oil crust, though mixed with sand, is impervious to water and oil. Wherever it is disturbed or penetrated, oil rises in greater or less quantity. The oil cake itself sealed up the oil to a greater or less extent, and thus prevented its flow and loss.

Beneath the hardened oil crust bowlder drift of varying thickness occurs. Next below come fragments of red triassic sandstone, and finally these rocks in place, but slightly fractured.

Development.

Dr. George B. Graff, who first obtained this basin by purchase, was also the pioneer worker in this field. He dug a straight channel four hundred and twelve feet long, for the old and circuitous creek bed, and built a dam across the stream to turn it into its new route. A second dam at the lower end of the old bed turned it into a lakelet for storing oil. Dr. Graff next sunk a series of shafts from six to twelve feet deep. In the bottom of one of them known as No. 2, a hole was bored twenty-seven feet deeper. At all my visits this well was flowing and giving out large volumes of gas. At one visit the well was pumped empty for my inspection. After the bottom was cleaned out the large flagstone that was placed over the hole in the middle (which had been done to prevent the hole from being filled up) was removed, the following phenomena were observed:

A thermometer lowered into the hole showed a temperature of fifty-two degrees, Fahrenheit. The flow of oil was intermittant. It boiled out at intervals thus:

Oil,	$4\frac{1}{2}$ minutes;	Gas	$1\frac{1}{2}$ minutes.
"	5 "	"	3 "
"	2 "	"	4-3/4 "
"	4 "	"	2 "

In five days the well was nearly filled with oil, and by measurement it amounted to over fifty barrels, estimating the barrel at forty gallons. The yield thus was ten barrels per day. In 1881 on my second visit there was a slight increase of flow. Two years later, however, owing to a choking up of the bore hole, there was a slight decrease of flow from this well, but no falling off in the other shafts that had been sunk in this basin. Another well east of the preceding was full of oil to within three feet of the top and was remarkable for the vast volumes of gas that escaped from it with an intonating noise every few minutes. All the wells that were sunk through the oil cake were producing oil at the rate of at least five barrels per day. Some wells not extended through the oil cake were used for storing oil. The flow from all these wells could not have been less than fifty barrels per day. It was stored in the old creek bed already described, and here at some of my visits there were thousands of barrels stored. Periodically, however, the spring freshets overflowed the banks and carried the oil away. Besides the loss occasioned in this way the new creek bed, cut through the hardened oil for four hundred and twelve feet, has permitted the petroleum to escape over that space. The oil, as it comes up through the water and the bubbles burst, produces a beautiful play of colors. All the hues of the rainbow make their appearance.

A curious feature of this basin is that the oil does not rise above a certain level. If a well or reservoir is filled above that point it gradually sinks to the same level as the hardened oil crust. Through this there is no lateral drainage. In all the openings the oil comes up directly from below, and the openings do not communicate, no matter how closely together they may be.

The Origin of the Hardened Oil

Is not difficult to trace. It must have originated by the lighter portions of the escaping oil evaporating and leaving behind the more solid parts, which partially oxidised. When one point of escape became super-saturated and hermetically sealed by the hardened residue, a new opening was forced by gas pressure somewhere else until this material reached its present dimensions. Owing to the great number of oil escapes artificially made, there can be little if any growth of this material at present. The rising of the oil to a fixed level has caused this hardened petroleum to occupy a horizontal position beneath the alluvium. So great was the number of oil escapes in this basin at my last visit that it was impossible to estimate them. Owing to the silt, the dust and dirt blown by the wind, combining with hardening oil, the escapes of one week were closed the next. Gas in many spots was also continuously escaping over the whole basin. It bubbled through the oil and water, and even the oil crust. Where no oil or water was present it could be detected by the odor or a lighted taper.

Latest Development.

During the fall and winter of 1884 and 1885, Dr. Geo. B. Graff and General W. W. Lowe purchased and shipped boring machinery to the Shoshone basin. Their efforts were crowned with success. At a depth of three hundred and fifty feet they struck a flow of oil that gave eighty barrels every twenty-four hours. This verified the theory that an immense reservoir of oil existed here comparatively near the surface, and upset the doctrine of those who held that no great flows could ever be obtained on the site of oil springs. In fact, as will be shown hereafter, the oil basins of Wyoming cannot be gauged by the principals that condition the presence of petroleum in the eastern fields.

Properties of the Shoshone Oil.

The oil is extremely black and the coloring matter is inseparable by any process yet tried, except in the results attained by distillation. By this process the following was obtained:

Naptha	.63
Kerosene, with a fire test of 159°	47.00
Lubricating oil, neutral and light-colored	32.00
Coke	12.00

In its crude state, as it flows from the springs, it has a gravity of twenty degrees in the Baume scale; its flash test is two hundred and ninety-four degrees; fire test three hundred and twenty-two degrees, and cold test sixteen degrees below zero. It will be seen from the above that it could be utilized either for kerosene or lubricating oil, or for both. While not as finely constituted for lubricating oils as some to be noticed hereafter, the amount of kerosene contained in it makes it important and valuable.

By a method of fractional distillation, practiced by Messrs. Wyner and Harland, of England, public analists of London, they obtained the following results:

Kerosene, gravity 807, flashing point 110°, Fahrenheit	17.00
Lubricating oil, gravity 810-824	21.00
Lubricating oil, gravity 840-844	20.00
Lubricating oil, gravity 906	27.00
Coke	14.00
	99.00

They further remark that "The above results prove this to be an exceedingly valuable oil for the production of kerosene and a superior lubricating oil." This oil, in its crude state, was for some time used to lubricate the car wheels of the Union Pacific Railway, and proved eminently satisfactory. Its quality could be immensely immensely improved by distillation, as the analysis of Messrs. Wyner and Harland indicate. The Union Pacific did not discontinue its use from any defect in quality or cost of the oil, but for other reasons. Before employing it the oil was submitted to the Stevens' Institute of Technology, at Hoboken, New Jersey, by Sidney Dillon, Esq. The result of the test was as follows:

Co-efficient of Friction.

Name of Oil	Pressure 50 lbs.	Pressure 200 lbs.	Pressure 300 lbs.
Sperm	.0034	.0051	.0057
Shoshone Oil	.0077	.0085	.0071

Assuming sperm to be 100, the following table gives the relative value of the oils as reducers of friction:

Value in Per Cent.

Name of Oil	Pressure 50 lbs.	Pressure 200 lbs.	Pressure 300 lbs.
Sperm Oil	1.00	1.00	1.00
Shoshone Oil	.44	.60	.80
Lard Oil	---	.75	.75

Endurance.

Name of Oil	Number of Revolutions 1st Trial	Number of Revolutions 2d Trial	Feet Traveled. 1st Trial	Feet Traveled. 2nd Trial
Sperm Oil	21.300	24.400	7.434	8.516
Shoshone Oil	11.700	12.000	4.083	4.188

Sperm, Taken at 100, the Following Represents the Wearing Power.

Value Per Cent.

Name of Oil	1st Trial	2nd Trial	Averages.
Sperm	.00	.00	.00
Shoshone	.55	.49	.52
Lard	---	---	.52

Gumming.

Name of Oil	Value Per Cent.
Sperm	10.
Shoshone	6.25
Lard	5.60

This test was made with the Shoshone oil without any preceding manipulation. Such results have rarely been obtained from petroleums elsewhere, except by distillation and the addition of lard oil, an almost universal practice in the preparation of lubricating oils in the east. Another plan has been, and a more legitimate one, the mixing of various kinds and grades of petroleums. This plan is difficult in the east, owing to the great rarity there of natural oils with a gravity of twenty degrees Baume. Gumming, which increases friction and retards motion, is one of the great enemies of lubricating oils. The Shoshone oil is singularly free from this defect. A part of this superiority comes from the entire absence of paraffine. It has been asserted in some quarters that petroleums free from paraffine were unstable. However this may be elsewhere, it is not the case with the Shoshone oil. One bottle of it in its natural state in my guardianship for four years while connected with the University of Nebraska, experienced no change, though left partially uncorked during all that time. Even chemical tests failed to detect any change. No change whatever, except in odor and a slight increase in gravity, was observed in the petroleum left standing in the reservoirs at Shoshone after three years. Like all other petroleums, long exposure permits the escape of the lighter constituents and a consequent increase in gravity. But this change is as slow and even slower than in other petroleums of the highest value.

How To Develop.

This question has already been settled by the success of the initial borings. The large flow of oil secured, its comparative nearness to the surface, and the character of the rock all indicate that wells are the proper agency here for obtaining the oil.

Probable Quantity of Oil.

Theoretical considerations based on the facts gleaned from this basin indicates that the amount of oil stored here and available is very great.

The very large oil flow from the petroleum springs and wells at this point, and the great escapes of gas have already been presented. Now it is well understood among geologists that such an amount of gas, in connection with the escape and continuous production of oil, indicates a very large reservoir of oil in the strata beneath.

The rocks dip away from the Shoshone basin on every side, and those contiguous to it are of triassic and jurassic age. On top of the latter were laid down the groups of the cretaceous and Laramie beds, but these have been removed by erosion, owing to the great elevation to which they were brought by the uplifting process at this point. They are yet found from two to four miles eastward from this basin, and still closer at some points on the northern and southern sides. Such plications as here exist are formed by latteral pressure, as can easily be illustrated by pressure applied to the sides of a book. Such a pressure applied in this way occasionally leaves hollows beneath the anticlinal ridge or ridges, which in the case of rocks through ages fill with water, or, if the conditions be favorable, with oil. Generally in oil districts the lower portion is water, the middle oil, and the upper the gases generated by the oil, or by the same causes that produce the oil. The break in the strata at the opex of an anticlinal give the initiative for a drainage system, which in the course of ages often wears such fractures, into the creek and bottom forms now here observed. It can easily be seen how water, oil and gas would issue from such a basin, there the rocks have been broken and fissured above. Here the rocks are highly siliceous, porous, soft and massive, and over these limestone and siliceous limestones of jurassic age, with immense beds of gypsum inter-collated among them. The sandstones are brick red, or light red and brown on their faces and joints, but internally often gray or almost white. Much of this color is due to carbonate of iron, which gives the brick red and similar hues when it becomes oxidized. This character of rock is typical of the kinds which it is known constitute the best matrix for holding petroleum. Nearly the entire mass of the triassic, here nearly 2,000 feet thick, is made up of these sandstones, the overlying gypsum and limestone beds belonging to the jurassic. On the flanks of these further back occur the various groups of the cretaceous, the basal member being the Dakota group, made up mainly of dark brown sandstone, much of it comparatively soft. The Colorado group (Fort Benton and Niobrara of Meek and Hayden), made up princiaplly of slates and shales, follows next in order. The Fox Hills group, made up principally of light colored soft sandstone, overlies the whole where it has not been removed by erosion. Still further back over the last, the Laramie, or transition group between the cretaceous and tertiary, the great coal group of the Rockies, has an extensive development.

Beaver Oil Basin.

Thirty miles east of the Shoshone oil basin, and fifteen miles east of the Beaver, a tributary of the Wind River, an area of oil land occurs which is known as the Beaver oil basin. In many respects this basin differs from the Shoshone. This is true in regard to the oil, the physical appearance of the region, the character of the springs, and the geological age of the rocks from which the oil emerges.

Physical Appearance.

The form of this basin where the oil springs occur approximates to an irregular circle, within which and around its rim, the oil makes its appearance. True anticlinal folds have produced this peculiar structure, modified greatly by decomposition of the rocks and erosion. On the southeastern side the rim has been cut down, and through this outlet a streamlet that rises within the cone flows during the spring months. The rim of this circle is an irregular ridge, which rises in places nearly one thousand feet above the bottom of the cone.

Oil Phenomena.

Near the center of the basin, a well sunk six feet square and twelve feet deep, through a peculiar light-colored magnesian shale, (which well was full of water during every visit paid to this basin), is remarkable for the amount of gas constantly escaping from it. It has the appearance, caused by the escaping gas, of a gigantic boiling cauldron. Every inch of surface was in commotion from the escaping gas. Wherever water was standing at the time around and in the basin, more or less gas was bubbling through it. Here in 1880, before any wells were sunken, a lighted newspaper put to one of these jets of escaping gas produced a brilliant illumination. The water in the well here is strongly alkaline. Oil formerly floated on the surface of the water. Oil constantly rises through the water, but part of it unites with the alkaline waters to form a kind of emulsion. Outside of the magnesian shale where this well was sunk, this phenomena was not observed. One hundred feet northwest of this well, another well was sunken (now caved in) four feet deep that contained two inches of oil on top of the water. One-fourth of a mile north and across the enfolding hogback ridge, where a canyon runs east and west, with a depression in the rim corresponding thereto, an immense quantity of oil crust exists from ten to twenty inches thick. This extends over a slope one hundred and fifty feet long and from fifteen to thirty feet wide. A shaft six feet square and ten feet deep had been sunk here which, before it caved in, was full of water, with two inches of oil on top. Northwest from the well in the cone, and over the rim of the basin, is another oil escape surrounded with some hardened oil. It emerges in a spring of water, and flows off of it. There are still other small oil escapes in and around this oil basin, and many small areas of oil cake.

In the fall of 1883, on sinking the well in the basin, aided by Mr. Haftile, a few feet deeper the escape of gas was largely increased, but very singularly the escape of oil in and around the basin decreased. This proves that the oil is forced out by gas pressure, since when an outlet is increased for the latter the pressure on the oil is decreased and is no longer forced out. At least, since the large openings have been made for the escape of gas, not one-tenth of the oil emerges that formerly spontaneously flowed at this place.

A characteristic phenomena of the rock masses constituting this basin is that they are all more or less charged with oil. The saturation is so complete that I have not been able, during any of my visits there, to find rock that did not emit the characteristic odor of oil. The extreme width of the basin is five-eights and the length one and one-fourth of a mile. Gas is everywhere escaping. All the water is tainted by oil. During one visit in late autumn, not being able to get water free from oil, some of our party melted "the beautiful snow," thinking by that method to escape the omnipresent petroleum. Even that was a failure. The coffee made from the melted snow was also contaminated with oil. In fact, gas and oil were penetrating and tainting everything. And this corruption of the water will be the chief difficulty in developing the basin. The oil phenomena that are here brought to light in this basin can be traced four miles southeasterly along the ridge that runs in that direction, until it runs beneath the overlying tertiary rocks, and even there at one point it oozes to the surface.

Geological Conditions.

As already stated, the uplift forming the Beaver basin forms an irregular circle. The dip of the rocks from at least three sides is away from the center. The fourth, or southern side, is made up of several almost vertical ridges or uplifts, dipping, however, apparently southerly. The wearing down of their crests by erosion, and the covering of their sides by superficial materials has very much obscured their structure. On the eastern side the strata are almost vertical, dipping only slightly towards the east; on the north and west the dip approximates more or less closely to forty-five degrees. The highest point is Mount Rogers, five thousand six hundred feet above the sea.

The rocks that form this basin belong to the upper cretaceous or Fox Hills group. This group is here from five hundred and fifty to six hundred feet thick. As the Shoshone oil emerges from the triassic rocks, at least half way down the series, the Beaver oil escapes occur immensely higher up geologically. The whole of the Colorado group, Dakota group, the jurassic and at least the upper half of the triassic - more than two thousand feet of strata - are lying on top of the rocks from which the oil of this basin comes. For the evidence is strong, as will be shown hereafter, that the seat of all these Wyoming oils is the triassic, which is the one group underlying the entire territory where oil basins occur. The Fox Hills sandstone are comparatively soft light-colored, inter-collated with occasional shales. Outside of this basin, and only a few miles north are the strata of the Laramie group, containing immense beds of coal. One bed fourteen feet thick is remarkable for its high quality. The coal is filled with minute specks of rosin that partake partially of the chemical constitution of amber. Sometimes lumps of it appear as large as hazelnuts.

The Amount of Oil.

In this basin is probably as great as at the Shoshone. If my theory is correct that the source of the oil is two thousand feet below in the triassic, the amount there must be great to be forced up through such a thickness of deposits. No oil escape could occur from so great a depth were it not that the strata here have been folded, broken and somewhat faulted. The gas pressure, which is here very great as we have seen, is, however, sufficient to bring the oil from such depths where fissures in the strata have occurred. The immense quantities of the gas, the escape of oil and the vast extent of rock surface around and southeastward from the basin that is saturated with petroleum, all alike testify that there must be here, or close by, an immense quantity of oil stored.

Quality of the Beaver Oil.

The Beaver petroleum is the best lubricating oil yet discovered in America. This statement will appear to those unacquainted with the facts as an exaggeration, but it is here made because the facts compel it. This oil has endured successfully the test of every experiment.

Mr. Taylor, chemist of the Standard Oil Company, pronounced its gravity to be fourteen and one-half Baume (nine hundred and sixty-eight gravity). My own determination made on the ground was thirteen and ninety one-hundredths Baume. The color resembles dark mahogany, and the odor appears to my senses, when the oil is first taken out, a cross between that of linseed and balsam.

Oil experts universally say that it has all the necessary characteristics of a superior lubricant. Even without manipulation it acts better than the majority of cylinder oils. If, however, it is filtered once and then has ten per cent. of tallow added, it becomes the best of oils for this purpose. Even without the addition of tallow, it is superior to anything in the market. Cheap and easy methods of manipulation can readily be devised and employed to change it into such forms as might be the most useful. For common use on engines, etc., it would be more acceptible, owing to its high specific gravity (fourteen and one-half Baume), if mixed with one-third of Seminole oil, whose gravity is thirty-two Baume. (This latter oil will be discussed presently.) By this and other simple methods the best of lubricators could be obtained for any kind of simple or complicated machinery in use.

Concerning the quality of the Beaver oil, H. K. Taylor, Esq., chemist of the Standard Oil Company, Cleveland, Ohio, thus speaks:

"In answer to your inquiries, I will say that the Beaver oil, brought to twenty-eight gravity, Baume, with the Seminole oil would make a splendid axle oil, but unless the Beaver develops in very large quantity I would not advise you to use it as a basis for axle oil, but to use the Rattlesnake oil instead. The Beaver is the best natural oil for cylinder stock that I ever saw. It has a margin of ten or twelve degrees of gravity over the best cylinder stock made in the east. By filtration the gravity becomes lighter, but I am of the opinion that the lightest colored filtered Beaver would be heavier than the heaviest unfiltered eastern oil."

Everyone who knows the high character of Mr. Taylor will accept the above statement as conclusive.

The determination of Mr. Taylor has been fully confirmed by Messrs. Wyner and Harland, public analists of London, England, whose analysis I append:

"Specific Gravity 966.

Volatile below 650° F.	Lubricating Oil, specific gravity 842-847, flashing at 110° F.	19.00
Volatile above 650° F. to a red heat	Lubricating Oil, specific gravity 926-935, flashing at 314° F.	45.00
	Lubricating Oil, specific gravity 957, flashing at 324° F.	12.50
Coke		14.50
Ash		Trace
Loss by volatilization and decomposition		9.00
		100.00

These oils were mixed and tested for lubricating power. The mixture showed: Specific gravity, nine hundred and nineteen; flashing point, one hundred and fifteen degrees Fahrenheit. Submitted to a cold test considerably below zero (centigrade) showed no signs of solidification. When properly treated by distillation, the products obtained would form lubricating oils equal, if not superior, to the best vegetable or animal lubricants."

Other testimonials could be presented testifying to the high character of these oils for lubricating purposes, but the preceding is deemed amply sufficient.

Development.

Reference has already been made to the development work that has been done at this basin. It is doubtful whether shafting can ever reach the source of the oil. It cannot unless at enormous expense, if the seat of the oil is in the underlying triassic rocks. Boring is the only proper method for prospecting this oil, and in engaging in this work provision should be at once made for going down at least two thousand feet. The boring, too, should be done at one side of the gas escapes and gas well, as it is well known that large volumes of gas usually lie on top of subterranean bodies of oil. Borings made immediately over oil often result in nothing but gas wells. But if the borings are made to one side, the effect of the gas is to force the oil out. At this writing the Omaha Oil and Transportation Company are engaged in boring at this place, but I am not advised as to the depth that has been reached. Owing to the extent of the basin, there is room towards the southeast and in other directions for a large number of prospect wells. While water has to be brought from a distance to supply the wants of men engaged at work, the adjoining coal beds supply an inexhaustible amount of fuel.

Dutton Oil Basin.

This basin is located westward from the west end of Rattlesnake Mountain, and about twenty miles west by south of French's upper cabin at the head of Deer Creek. It is about ten miles southwest from Deer Creek, where it curves around and flows towards the northwest, and about thirty miles south of east from the Beaver oil territory. The location is in townships 89 and 90 west, and of Townships 31, 32 and 33 north.

The rocks here are mainly made up of the dark shales of the Fort Benton group. Petroleum escapes from these shales in considerable quantities and in many places, and the evaporation of its lighter portions and oxidation in part of the heavier portions, has left here that asphaltum-like substance, which is called for lack of a better name, hardened oil.

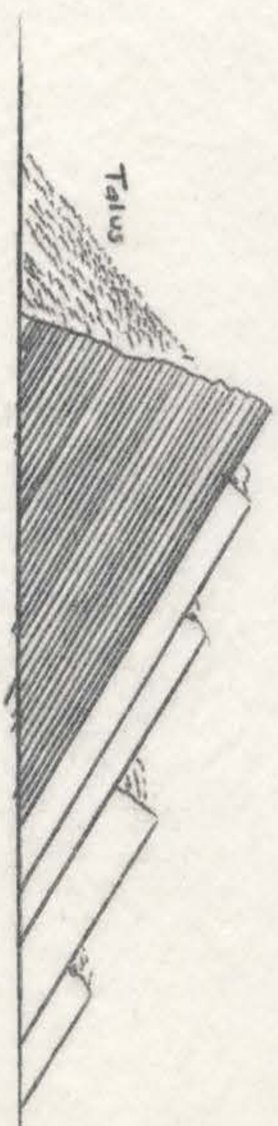
I have not studied this basin and the oil produced here with sufficient detail to give a further description.

Big Horn Oil Basin.

This name was given to an area of oil lands on the headwaters of the Powder River for convenience of description, and because it was deemed important to separate them from the adjoining Rattlesnake territory on the east, from whose product the oil greatly differed. It embraces portions of Townships 33 and 34 north, and of Ranges 87, 88, 89 and 90 west. This oil territory runs parallel with the Rattlesnake Mountain range.

Physical Condition and Geology.

Parallel lines of low ridges, of the hog-back type, extend along this territory. A hog-back, in geological language, means rocks that have been uplifted and weathered into some such forms as the following:



These hog-backs traverse this region at first in lines parallel with the mountain. Further away towards the north and northeast, where the Laramie group makes its appearance, the hog-backs gradually assume a semi-circular form, as if the ends were extended to circle around the mountain. The streams that rise on or at the northerly base of the mountain cut through these hog-backs, proximately at right angles, and constitute the headwaters of the Powder River. The hog-backs dip towards the northeast at angles varying from twenty to thirty-five degrees.

The neucleus of the Rattlesnake Mountain is composed at this point of archaean rocks of the granite type. Lying against these on the northeasterly side are first silurian rocks made up of Potsdam and Quebec limestones and marbles. Lying against these latter are rocks of Mesozoic age, namely: Triassic, jurassic and cretaceous, the terranes of each period having been broken and weathered into hog-backs. The triassic beds are uniformly of some shades of gray and red, the latter color predominating. The jurassic beds are mainly composed here of greenish gray marls and gray limestones, the latter often being shaly. Above the latter is the basal member of the cretaceous, the Dakota group conglomerates andsandstones. This group is oil bearing a few miles further east, and in the western portion of this basin. Conformably to the Dakota group sandstones is a vast development of the Fort Benton gray and black shales and slates. The entire thickness approximates eight hundred feet. As these shales contain an immense amount of organic matter, such geologists as follow Newberry hold that the oil occurring in Wyoming is distilled from them. Against these shales lie beds of impure siliceous limestone, which represent the Niobrara group, and forming with the last the Colorado group comes to the surface in this basin, the upper section is more or less saturated with oil. Next above, and conformable to the last, are the sandstone beds of the Fox Hills group, which is the upper portion or division of the cretaceous. One bed of this group is saturated along its whole length on this basin with oil. Beyond the last Fox Hills hog-backs, at a distance of two to four miles, are ridges of the Laramie group, the great coal-bearing group of the Rocky Mountains. This also is believed to be, by many geologist, a transition group between the cretaceous and tertiary ages. The geological relations of these various hog-backs have been determined by their stratiography and their fossils.

Oil Phenomena.

As already indicated, the most northeasterly hog-back ridge on this basin is of sandrock, which varies from compact to loose and friable material. Much of it is so saturated with oil that it yields on distillation from fifteen to twenty per cent. of petroleum. South of the main oil ridge is another, which is only occasionally visible, owing to it having been eroded or worn away down to the level of, and generally covered by the superficial deposits. While not saturated with oil to the same degrees as the former where it is exposed, its exact relation to the oil has not been ascertained, owing to the fact that so much of its length is covered up. Between these two ridges in summer time quantities of carbureted hydrogen escape. The gas emerges in bubbles through the water that flows from springs. As deposits of oil invariably give off gas, both when diffused through rocks and when it occurs in underground reservoirs, it is a legitimate induction to conclude that the escaping gas indicates the presence, at some depth below the surface, of petroleum. Oil in minute quantities flows at least in a few places, one notable point being on the southwest one-fourth of section 34, township 34, north of range 88 west. The oil emerges along a water course between parallel ridges. Though the flow is small, yet as it comes through a considerable thickness of superficial deposits, and a large quantity of gas was escaping betimes during the summer of 1884 when small excavations were made, it is inferred that a large quantity of oil exists here at some distance below the surface. More or less hardened oil and a few other oil escapes occur a little farther west.

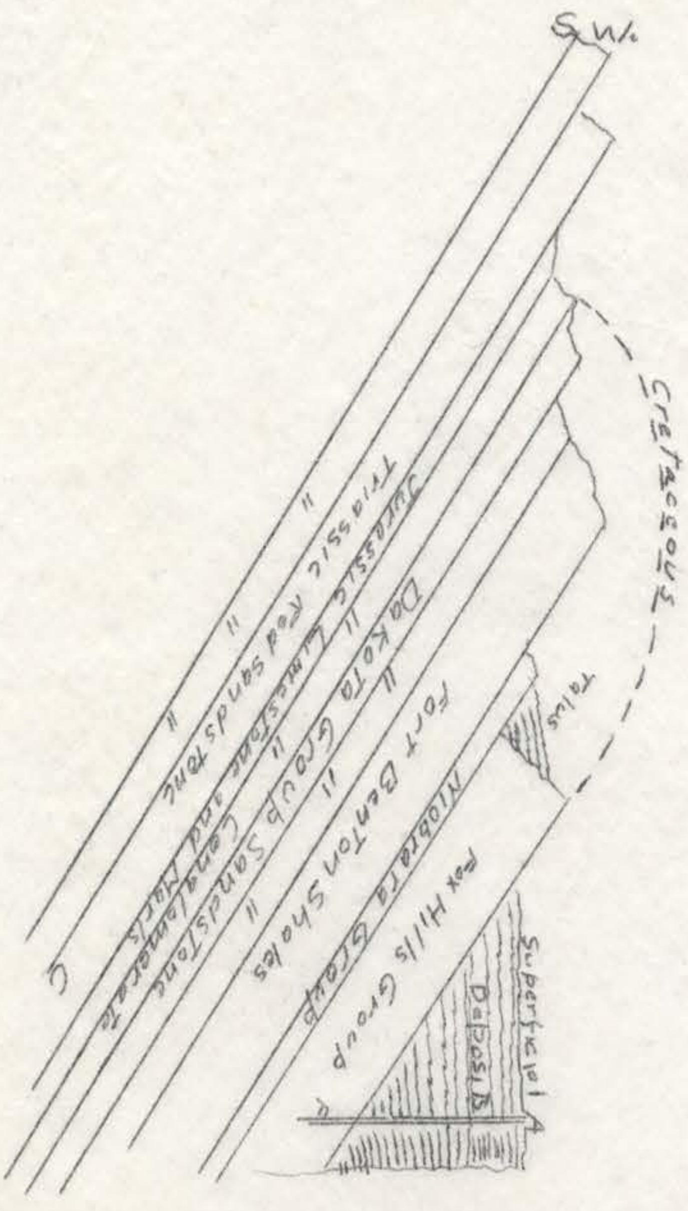
On the northeast corner of section 34, township 34, north of range 89 west, the Fox Hills oil ridge curves around almost in a circle, forming a triclinal, from which the rocks dip in all directions. This is one of the positions in which strata occur, according to LeConte and other geologists, where oil is most apt to occur in large quantities. This is a little west and north of the point at which the Rattlesnake Mountain ceases. A little south of this point the oil ridge again appears, but now runs north and south, and is quite low, and in many places is covered up. Parallel to this north and south extension are the Fort Benton shales and the Dakota group sandstones, which are here again more or less saturated with oil. In fact, at this westerly end, opposite to the west end of the mountain and extending around it, the Rattlesnake and Big Horn oil territory come together. Here, too, the triclinal is seen to extend to the Laramie ridge on the north and west, showing that the uplifting force modified the strata for a great distance.

Character of the Oil.

This oil, compared with that which flows from the Dakota group of rocks near by, is light and thin, though much denser than the Pennsylvania or Ohio crude petroleum. When it first emerges it is of a greenish hue, but soon changes to a mahogany color, and is a first-class lubricant. Its odor is pleasant, balsam-like, and approximates in general character closely to the Beaver oils, the general superiority of which over all other oils for a lubricant has already been stated. An explanation of the similarity of these oils may be found in the fact that they both flow from the Fox Hills sand rock. Even if they originate far beneath this group they appear to be modified and filtered of the heavier ingredients by their passage through these rocks. The amount of kerosene or illuminating oil in this petroleum has not been determined. Its physical appearance, however, places it, as already stated, in the class of superior lubricants.

Development.

Little of this has yet been done. A shaft put down on the southwest quarter of section 34, township 34, north of range 88 west, produced a small amount of greenish colored oil, which soon changed to the usual mahogany hue. Boring was also commenced here, until a depth of nearly one thousand feet was reached, but the result was only the production of only water, a slight amount of oil, and a considerable quantity of gas. Successful boring will depend on the source of the oil, where stored, and how it originated. If it is mainly stored in the Fox Hills sandstones, which at their hog-back outcrop are saturated with it, then the boring should be made on the northeasterly side, and at such a distance from the exposure as to tap the oil at a considerable depth. This depth may vary from five hundred to two thousand five hundred feet. A cross section from northeast to southwest will best explain my meaning.



In this case a boring at A might reach the oil at F, or it might be necessary to go still further towards the northeast and strike the Fox Hills at or near the point where the synclinal fold commenced or where a fault existed. Further study has made it possible that the oil saturated rock at B came by capillary attraction from a considerable distance and depth. It is even possible that, as at the Shoshone, the seat of the oil is in the triassic sandstone. In that case the boring would have to be extended to C, or at least to some point between A and C, where a fracture in the strata would permit the oil to come up from a considerable depth. A reservoir of oil might exist in the Dakota group sandstones and conglomerates, but even in that case the borings would have to be extended to a depth of from one thousand five hundred to two thousand five hundred feet. This point cannot be determined by theoretical considerations; only actual boring tests will settle it, and it may require, as elsewhere, many such. It should not be forgotten by oil prospectors in this district that in some of the most productive oil fields in other sections and lands, many deep holes were bored before the right spot was found to tap the reservoirs of petroleum. Fortunately here water to supply machinery and an inexhaustible supply of coal for fuel are close at hand.

The Rattlesnake Oil Basin Location.

This basin, so named from the mountain chain of the same name, lies immediately east and southeast of the Big Horn oil basin. It lies along and across a series of creeks, which combine lower down to help form the Powder River. Two routes are traveled to reach it. At Sand Creek (Ferris Postoffice) one route goes by way of the Sweetwater bridge, at Merrill's ranch, and thence by way of West Horse Creek to near its source, crossing the Rattlesnake Mountain in a northwesterly direction. The other route from Ferris Postoffice takes westerly to Devil's Gate, thence over the emigrant trail, crossing the Sweetwater opposite Lankin's ranch, thence past this ranch over Sage Hen Creek road to French's upper ranch, and thence down Deer Creek and around the west end of Rattlesnake Mountain. The distance by the former route from Rawlins is one hundred and seven miles; by the latter one hundred and twenty-four miles.

Physical Conditions.

This basin has some features common with the Big Horn basin. Long lines of hog-backs characterize the district. These hog-backs have a general direction of a little south of east and north of west. Beginning at the Rattlesnake Mountain on the south, the first hog-backs are made up of the red triassic sandstones. Where the jurassic limestones and marls occur, the rocks have been eroded into a valley.

The Dakota group hog-backs come next, to the north of those already mentioned. Streams of water have cut canyons through these hog-backs, nearly at right angles to their trend; and where they cut through those of the Dakota group the oil phenomena occur. The upward movement that produced the hog-backs must have been a slow one, since the erosive action of the creeks kept pace with it.

North of the Dakota group hog-backs come the Fort Benton shales, followed in turn by the Fox Hills, and beyond, as in the Big Horn basin, by the rock masses of the coal bearing or Laramie group. The hog-backs all dip towards the northeast.

Oil Phenomena.

Beginning at the most westerly, known as Roger's Creek, two and a half miles east of Owen & French's lower ranch, the first important oil spring is encountered, near the base of the lower Dakota group hog-back. Here at this first escape of petroleum hardened oil occurs four hundred and fifty feet up the easterly slope of the eroded escarpment. Several small oil springs, and one quite large and noted one, occur along the lower half of the line of this oil crust. The largest spring occurs near the base of the ridge at this point. On the opposite, or eastern side of the creek, oil crust also occurs for several hundred feet up the end of the ridge, and several small petroleum springs. North of this point on the same creek, three hundred and seventy-five feet distant, a shaft ten feet deep and six feet square was put down in 1880. Here, at every visit paid to this point, a foot or more of oil was found at the bottom of the well. A second well was sunk during the same season in the bed of the creek two hundred feet from the first. It was put down eight feet to solid rock and six feet square. All around, and covering an area of several acres, was hardened oil, from ten inches to three feet or more in thickness. The hog-backs of the Dakota group, where these phenomena occur, are, as usual, made up of brown sandstone, and in the lower member of pudding stone conglomerate. These rocks are stained, and in places saturated with oil from the bottom to the top of the ridge for half a mile westward, and to the next creek eastward.

One half a mile eastward from Rogers', Murphy Creek flows through another canyon in the same general direction as the last. Here a few oil escapes and a few patches of oil cake also occur. All the rocks, however, from the bottom of the canyon to the top of the escarpments are stained or saturated with oil.

Lovett Creek lies three-fourths of a mile east of the above. Here at the base of two Dakota group hog-backs, on both sides of the creek, a great flow of oil has occurred at some time in the past, and is still in progress. Up the side of the upper (most northerly) hog-back, one hundred and twenty feet from the creek bed, four oil springs emerge. The oil crust is from six inches to three feet thick, and covers an estimated area of two acres. As in the preceding canyon, the upper hog-back furnishes the most oil escapes.

Graff Creek occupies the next canyon, seven-eights of a mile further east. Here about two acres of oil crust also occurs. Many small escapes of petroleum occur here on the sides of the creek. The largest oil spring here is in a morass south of the lower hog-back. Here both oil and water emerge together. The rocks at this place, as in the canyons already described, were stained with oil for half a mile on each side of the creek.

Quinn's Gulch occurs half a mile further eastward. It rises at the base of the lower Dakota group hog-back, and in it occurs some oil crust, but no petroleum escapes were observed.

Wallace Creek,

Half a mile further east, is the most remarkable for oil phenomena. Prodigious quantities of hardened oil occur here. Near the base of the northern hog-back, on the east side, a shaft was put down seven feet without penetrating through the hardened oil. This crust was traced over at least three acres. At the waters' edge a considerable body of oil rises and floats away in the creek. Many other oil escapes occur here on both sides of the creek, at and near the base of these hog-backs. Examining the upper and lower, the rocks were found to be oil stained almost to Garfield Mountain, over a mile distant. Westward the same phenomena are visible to Quinn's Gulch, and, as already stated, for an entire distance of four miles. North of this point, on Wallace Creek, oil escapes also occur at the base and among the hog-backs of the Fort Benton shales. Over this entire district, from Rogers' Creek eastward towards Garfield Mountain (the highest peak in the Rattlesnake range), wherever oil emerges from the rocks more or less gas is constantly escaping. This is specially visible along the shores of the creeks, where oil rises through the water. During the last two years many shafts have been sunk in this basin, but none of them to any great depth, in addition to those noted in this report.

The Rock Formations and Their Thickness

Is an important element in the study of this basin. These can well be seen along Rogers' Creek, passing from south to north. This creek rises in a canyon of the Rattlesnake Mountain, south of the oil springs. After flowing over granitic nucleus, the creek crosses a considerable the thickness ~~the~~ of potsdam (lower silurian) compact, finely crystalized, hard sandstones. Lying conformably on this is a bed of finely crystalized white limestone or marble. In places there is a bed of yellowish hues. Sometimes the white marble has delicate flesh tints. Unfortunately it is too hard to become of importance in the arts. Its thickness, where measured, is twenty-five feet. This bed is almost certainly of calciferous age -- the Quebec group of the Canadian geologists -- and if so is of the same geological age as the marbles of Western Massachusetts and Vermont. The red sandstone hog-backs of triassic age lie unconformably against the calciferous beds. The entire thickness of the triassic beds is at least one thousand three hundred and twenty feet, and probably much greater, as the boundary between them and the jurassic could not be exactly determined, owing to a talus that covered their line of probable junction. The triassic and jurassic together, however, (jura trias, of Powell), have a thickness at this point of two thousand three hundred and sixty feet. Conformably against these lie beds of the Dakota group (in two main hog-backs from which oil escapes), six hundred and sixty feet thick. Next, and conformably to these come the beds of the Colorado group (Fort Benton and Niobrara of M. and H.), made up almost exclusively of black, light brown and ash-colored slates and shales, and at least one thousand two hundred feet thick. The Fox Hills sandstones, that occur conformably on top of the last, range in thickness here from five hundred to eight hundred feet. Some shaly strata are inter-collated among these last. On top of the latter occur the shaly and massive sandstones of the coal-bearing Laramie group, the thickness of which I did not ascertain. Owing to the removal of portions of each of these groups, exposing one after another in the form of hog-backs and gigantic steps, and their inclination towards the northeast at angles from twenty-five to forty degrees, they can easily be studied.

Source of the Oil.

The oil that proceeds from the rocks in this basin along a distance of over four miles, either from the Dakota group rocks or the Fort Benton shales, is of the same gravity, consistency, color and odor. No differences have yet been detected of any kind between any of these springs, and this could not well happen unless they were all connected in some common source. In the Pennsylvania and some other renowned oil regions, wells often no moare than a few rods apart differ greatly in the character if their oil, owing, as is generally agreed, to the fact that in such cases it proceeds from different unconnected sources. In fact, no products vary more than different oil wells, even often when they are close together. Here, however, over the space of four miles, at least, the oil is alike in every known particular, and the only suggested explanation is a common source, and if so nothing could afford it but huge underground storage rooms, approximating the length of this basin, and of unknown width. The great specific gravity of the oil (near that of water and of jelly-like consistency), would prevent it from being forced a great distance latterly. These considerations, and others which cannot be added, convince me that the real source of the oil, as in the case of the Shoshone oil, is the red triassic sandstones. It is true that where the triassic sandstones outcrop on the south side of the basin, no oil has been detected, but in lieu of that gas was in many places found to be escaping from them. As the triassic sandstones at their outcrop occupy a higher level and dip beneath the Dakota and Fort Benton groups from which the oil is escaping, it is probably stored beneath them in the triassic, and proceeds from this group through fissures produced by faulting. Gas pressure would readily, in the course of ages, drive it gradually through the jurassic marls and fractured limestones into the overlying Dakota group, the conglomerates and coarse sandstones of the latter being eminently adapted to holding the oil and permitting its gradual escape where erosion has worn down its strata.

Quality and Character of the Rattlesnake Oil.

This is unique, as the following facts show. Its gravity, as already stated, is only slightly less than water, or near zero in the Baume scale. It burns only at a very high temperature. Physical and chemical tests have failed to detect any paraffine in it. The color is mahogany black. When standing for some time in its crude form, it becomes jelly-like in consistency. Its pungent and petroleum-like odor is lost on exposure. Owing to the extent and importance of this basin and the uniqueness of its oil, and to a controversy that was raised as to its character and value, the analysis by Wyner & Harland, public analysts of London, England, is appended:

"WYNER & HARLAND?"
Public Analysts,
37 Lombard Street, London.

April 19, 1882.

CERTIFICATE OF ANALYSIS
Sample of Oil Marked Rattlesnake
Specific gravity 992.

Submitted to fractional distillation it gave:

Kerosene	None
Volatile below (Lubricating Oil, specific gravity 854-860, 600° F.) flashing point 150° F.	29.80
Volatile at 650°(Lubricating Oil, specific gravity 933, F. to red heat (flashing point 270° F.	7.40
Lubricating Oil, specific gravity 950, flashing point 306° F. , .	23.00
Coke	30.
Loss in distillation, decomposition, etc.	9.80
	100.00

"A portion of these oils, mixed together and tested for lubricating, have: Specific gravity, nine hundred; flashing point, one hundred degrees, Fahrenheit.

"This oil is valuable on account of the hydro-carbon which can be obtained from it by destructive distillation, by far the most important being the heavy lubricating oil, of specific gravity of nine hundred and fifty. This oil distills only at a very high temperature, considerably above the range of a mercureal thermometer, and this, taken in conjunction with its high specific gravity, should render it an exceedingly valuable lubricant for heavy machinery. It is not altered, and shows no signs of solidifying when submitted to many degrees below zero (centigrade).

(Signed) "Wyner & Harland".

How to Develop.

This oil basin is an important question to those who are financially interested in it. If the main portion of the oil is stored in the Dakota group, it could be reached where the springs occur by shafting a few hundred feet. And this would be the most successful way to obtain it, owing to its density and gravity, which would not permit it to flow through an ordinary bore-hole. If, however, its seat is in the triassic rocks, somewhere near the line above which the oil is escaping out of the Dakota group rocks, a boring from one thousand to one thousand five hundred feet deep would have to be made. In this case, owing to the greater depth, little of the lighter constituents of the oil can have escaped, and hence its greater liquidity would permit it to rise in a bore-hole. Only actual boring tests can successfully settle this question.

Along the line of this basin on its northern side, oil escapes and oil saturated rock have been found several miles north of the Dakota group sandstone ridges. Large tracts of land have been located as oil territory. One company is now engaged in boring here. It is probable, however that they will have to reach a depth of from one thousand five hundred to two thousand five hundred feet before oil is struck if the theory of this report is correct.

Arago Oil Basin.

Oil was first discovered here by the writer in 1880 in Township 32, north of range 86 west. Subsequently this oil territory was foundto extend in a southeasterly direction across the Rattlesnake Mountain through Township 31, north of ranges 86 and 85 west. The mountain here is low and covered by the triassic, jurassic and cretaceous series of rocks. The basin lies southeast from Garfield Mountain about five miles. It is reached best from Ferris Postoffice by the route across the Sweetwater at Merrill's, and thence by the West Horse Creek road across the Rattlesnake Mountain, which passes close to this basin, the distance from Rawlins being ninety-five miles.

Physical Structure.

The same rock masses and the same general structure occur here as at the Rattlesnake oil basin, and therefore need not again be discussed in detail. The Dakota group sandstones and conglomerates are the oil producing rocks, these being underlaid by the jurassic marls and limestones, and these in turn by the triassic red sandstones. The Dakota group is overlaid by the Fort Benton shales, and the latter by the soft sandstones and a few strata of shales of the Fox Hills group. The latter are about four hundred feet thick, while the Fort Benton shales have a thickness of eight hundred feet. All these almost parallel lines of hog-backs dip towards the northeast at angles of from twenty-five to forty degrees, and run parallel with the Rattlesnake Mountain. The oil-saturated rocks of the Dakota group are three **hundred** and fifty feet thick. Northward here, where the Laramie group would be looked for, miocene tertiary rocks are seen at the surface, and these in places come into the oil territory and overlie unconformably the Dakota group. They fill depressions caused by erosion before the Miocene lake covered this section. These tertiary rocks dip towards the mountain, while the underlying cretaceous and jura trias dip from it. This shows that in recent geological times the Rattlesnake Mountains have been subsiding. The entire length of this basin from northwest to southeast cannot be less than twelve miles, and of variable breadth.

Oil Indications.

On the southeast quarter of Section 8, where Bath Creek cuts through the Dakota group hog-back, on and at the base of the escarpment on the eastern side considerable quantities of hardened asphaltum-like oil occurs. In summer on the south side small quantities of oil flow from the rocks. A few additional oil escapes occur in the same hog-back a little furtherwest. The rocks are more or less saturated with oil for several miles along this Dakota group ridge. In July, 1884, a shaft was put down about eighty feet north of the face of the escarpment at this place to a depth of twelve feet. At that time oil commenced to flow in at the rate of about one barrel in twenty-four hours. Mr. Dodge, who supervised the work of putting down the shaft, also reported the frequent presence of gas while the work was in progress. The real place of oil storage in this rock, however, was not reached. That exists in the pudding stone conglomerate which here constitutes the lower half of the Dakota group. As the face of the escarpment shows this to be saturated with oil, a larger flow is looked for when the shaft is once extended to that level.

The Fox Hills sandrock that occurs above the Fort Benton shales is also on this territory, in places more or less saturated with oil. Rocks of this group are stained and saturated more or less with oil, in a southeasterly direction across the mountain wherever they exist. On the south side, however, the dominant rock is that of the Dakota group, and in it an oil spring has its source.

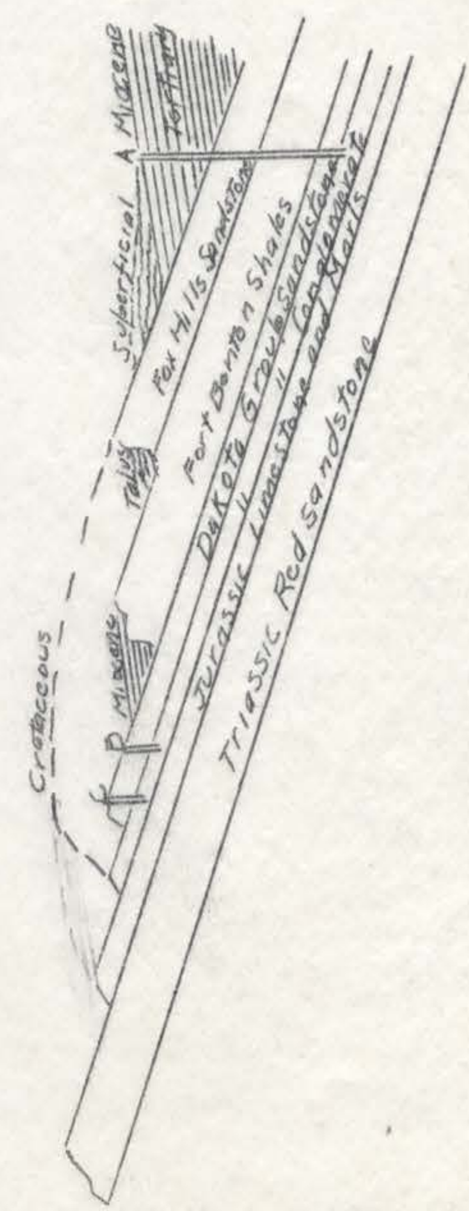
Character of the Oil.

The character of this oil is specially remarkable in its high specific gravity, that being zero of the Baume scale, or over one thousand. Even before exposure, and before losing its lighter constituents, it sinks in water. It is very dense, of a dark mahogany color, and can be cut with a knife like soft butter. It gradually turns black on exposure. It has little odor as it comes out of the shaft, though what escapes from the face of the escarpment has slightly more pungency, which, however, it loses on exposure. It has a remarkably high fire test, and burns only at a high temperature. It contains no paraffine, and does no solidify at any ordinary cold below zero. While it is too thick for ordinary lubricants, it can be manipulated by combining it with lighter oils so as to make it of great value. It can be brought to any required consistency either by the Big Horn or Seminole oils, the latter to be considered hereafter. It is unique in character, and there is no doubt but that some new product can be made from it.

Southeasterly from this well and oil escape on Bath Creek, on the south slope of the mountain, the oil is of a somewhat different character. It is of less gravity and darker color, and more fluid. Although there are oil indications that connect the two points, they can have no underground connection, or less the oils would be similar. Neither of these two oils have yet been sufficiently studied to define more sharply their characters. The oil territory here, owing to its proximity to roads, its greater nearness to the railroad, and especially that portion on the south side of the mountain, promises to be of exceptional importance.

HOW TO DEVELOP.

This will vary with the locality on this territory. On the north side of the Rattlesnake, on the area of the dense oil, the strata dip towards the northeast, and it is obvious that development should be made on that side. It is extremely questionable whether ordinary borings could be made to answer here for the Dakota group horizon, owing to the thickness and heaviness of the oil. It would not rise in a boring less than two feet in diameter. It is probable that the lower Dakota group conglomerate contains thinner oil than is found in the top strata; but the improvement in fluidity with depth will not likely be sufficient to produce a flow. Under these circumstances it will be the part of wisdom to shaft from the start. The expense of going down three hundred feet with a shaft will probably be no greater than boring to the same depth with a large bore-hole. It has also been suggested that as heavy oil is obtained at a depth of twelve feet, an open cut of four hundred feet in length would be the best means of securing the oil. As the present shaft, four feet in width, produced a flow of one barrel per day, an open cut four hundred feet long, made parallel with the Dakota group ridge, should give a flow of one hundred barrels in the same time. The following cut will illustrate the structure of this basin:



It will be seen from the accompanying cut that a shaft put down at B would strike the oil-bearing strata of the Dakota group at such a depth as might determine its productive strength. A boring at A would bring to light the productive capabilities of the Fox Hills oil-bearing rocks, and if extended far enough also those of the Dakota group. A still greater depth of boring at either of those points would definitely decide the question of oil production in any possible oil-bearing rocks, including those of the triassic measures. The present shaft is at C twelve feet deep, and has brought to light, as already stated, the heavy oil of this basin.

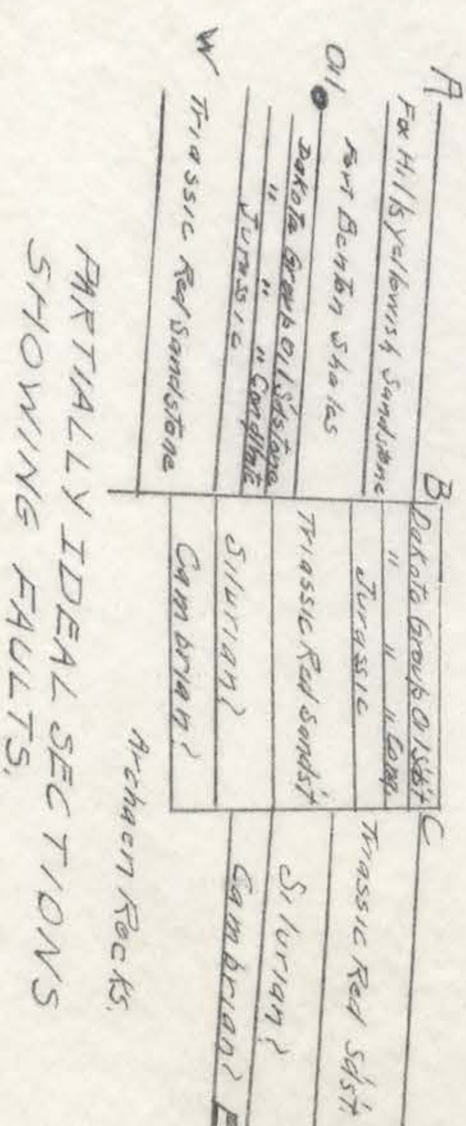
That represents the site, or a place a little north of it, of which this drawing is a cross ssection, and where an open cut was suggested. It is highly probable, however, that the main seat of the oil here is in the triassic rocks, as at the Rattlesnake, and for the same reason, to a discussion of which under that head the reader is referred. It should be remembered that the dip of the rocks as represented is, under the surface, theoretical. It may be, and in cases certainly is, much less towards the north. On that fact many who have located large tracts of supposed oil lands in a northerly and westerly direction, and also eastwardly, have in part based their conclusions. There are also practical grounds for that conclusion, inasmuch as in those directions oil phenomena, in the form of gas and oil escapes, are in places visible. In case the dip of the strata lessens towards the north, the oil horizon would be reached much sooner than the calculated depth would require.

Seminole Oil Basin.

This basin is located in Townships 32 and 33, north of ranges 81, 82 and 83 west. It is about twenty-five miles east of the Arago oil basin. It can be reached by following the overland trail from Averill's ranch, on the Sweetwater, to its intersection with the Lander cut-off road. The point of intersection of the two roads is on the basin. Following the latter road westward for four miles brings one to a point opposite a canyon in the Seminoe or Oil Mountain, as it has been named, where the most striking phenomena occur. By the overland trail from Averill's the distance is thirty-five miles.

Structure.

The geological structure is here more complex than elsewhere in this oil belt. The rocks are of the same geological age as elsewhere in the oil belt, but much more faulted, to which the complexity is owing. The Fox Hills sandstones are the most commonly exposed, and then follow the Fort Benton shales and the Dakota group sandstones and conglomerates. A cross section from west to east through this section of oil lands will best illustrate this point:



As the Dakota group towards the east is raised above the level of the Fox Hills, and the geological distance between them is equal to the combined thickness of the Fort Benton and Fox Hills, the fault in this case must be equal to one thousand six hundred feet or more. There is a fault of equal extent directly north in the Seminoe ridge (Oil Mountain). This ridge was evidently one of the centers of disturbance that produced these changes. The Fox Hills sandstones once evidently covered this entire area, but having been raised up to a great elevation, were gradually removed by erosion, leaving bare the Dakota group, which was itself removed further east, exposing, especially beyond the Platte, the red triassic sandstones. Seminoe ridge (Oil Mountain) is itself an anticlinal fold, the rocks dipping away from it on the south, north and east. Southeast from the end of Seminoe Mountain there is another low area of anticlinal folds in Fox Hills rocks. Towards the northeast from where the oil springs occur, the Fox Hills group spreads out in a long, gentle anticlinal ridge, its strata dipping at an angle of from five to ten degrees. The Dakota group, however, and t and where the Fort Benton shales occur on its flanks, is inclined at an angle of forty-five degrees, and in places even more. From this basin the tributaries flow into the Platte, which bounds it on the southeast side.

Oil Indications.

On the north side of the Dakota group ridge, and on the east side of the canyon-like valley that here cuts through the ridge on the side of the shales, oil escapes occur, and considerable hardened oil. East of this point along the ridge the sandstones are more or less oil-stained and saturated with oil. No oil-stained rock, however, was found east of the fault at B. Whether the Dakota group and Fox Hills there never contained any, or whether it was all distilled by the movements which must have developed great heat when the faulting occurred, has not been determined. It is possible, however, and in my judgment very probable, that beneath the fault at B oil in quantity will eventually be found. The anticlinal uplift, south of the east end of Seminoe Mountain, is elliptical in shape and closed at each end. The larger axis runs northwest and southeast in the direction of Seminoe ridge. One stratum of Fox Hills sandrock, running entirely around this ellipse, is saturated with oil. Directly southeast of the preceding the rocks change to an almost vertical position, but the oil indications continue the same.

In the canyon above Seyright's (Goose Egg ranch), along the Platte, all these series of geological changes can be seen. Owing to the prodigious faulting and other changes that have occurred, the distance that boring needs to be done is perhaps more problematical than elsewhere in the oil belt.

Developments.

Where the oil escapes in the canyon valley, on its east side, one shaft put down fifteen feet deep contained milk-colored water. It was down in Fort Benton slates containing magnesia, much of the slate having an almost mud-like consistency. On the water about two inches of oil was floating at each visit to this place. The oil overflowed and saturated a considerable area. Another shaft, thirty-six feet southeast of the above, was down twelve feet to an offset, from which two additional feet in depth were cut down. This was nearly full of oil. On emptying the oil it was found to emerge from minute cracks in the Dakota group sandstones directly below, and from near the line of junction with the Fort Benton group. The dip of the Dakota group at this point shows that the oil must come from, or through, this formation. The surface here is covered, as already stated, by hardened oil, but not to the same extent as at the Rattlesnake or Beaver. Its area is probably half an acre. The flow from this well was half a barrel per day, as was found by emptying it and timing the inflow of the oil. Unfortunately this well has caved in, and is no longer open to inspection. Other wells have been sunk on this territory, but no record of their output is before me.

Quality of the Seminoe Oil.

The gravity of this oil is between thirty-one and one-half and thirty-two degrees, Baume. It is of an amber or light green color. A large amount of illuminating oil can be obtained from it by distillation. It contains no paraffine, and its flash and fire test are both high, but have not been definitely determined. Though producing much kerosene, it is also remarkably well adapted for making lubricating oils, especially by mixing with the high gravity Rattlesnake petroleum. One singular property of the Seminole oil is its liquefying properties when mixed with heavier petroleums. One-fourth of a pint of this oil mixed with one pint of the heavier Rattlesnake oil makes a liquid, easily-flowing petroleum. Oil experts have taken the ground that mixed with the Rattlesnake both could be piped to any required distance.

How to Develop.

It was observed that in sinking the well already described, the amount of oil increased with every descent. At the same rate of increase it was calculated that at one hundred feet a fifty-barrel well would be produced. The oil here, as in the basins already described, is almost certainly in the triassic rocks. To reach the oil-bearing rocks, therefore, a depth approximating one thousand five hundred feet would have to be reached. Long before that depth would be attained the oil supply would probably be ample. Only actual boring, however, can definitely settle that question. At this place there are no lofty ridges to condense water and act as a source of its supply, to force the oil through strata with the energy which obtains elsewhere. Hence little of the underground treasures havé gone to waste. The stores accumulated through ages are yet comparatively intact.

Powder River Oil Basin.

This basin is located in Townships 40 and 41, north of range 81 west. It probably will be found still more extensive in a northerly and southerly direction. It is twenty-one miles east and fifty-one miles north of the Arago oil territory. It is also fifty-one miles north and six miles west of the Seminoe oil basin.

Route.

The traveled road from the south leaves the Bridger trail near Wades' (F. L.) ranch, and passes due north around the east end of Pine Mountain, crossing South and Middle Casper Creek until it strikes the South Powder. From that point, after crossing the river, the direction is northeasterly along the Powder until Willow Creek, a beautiful, rapidly-flowing stream, is reached. Here the road diverges from the main traveled route towards the east, and the Powder within three miles is recrossed and the oil basin reached. This route has been surveyed by a government engineer, and recommended as the best route for the transportation of government supplies to the northern posts. This route north of Pine Mountain passes over a rolling prairie covered with wild grasses. Water is scarce between Casper Creek and Willow Creek in mid-summer, as the South Powder looses its water for much of the way in the sands of the bottom. The physical structure of the region is, however, such as certainly to make artesian water easily accessable. This entire section is eminently adapted to grazing, and from Township 39 north also to agriculture.

Geological Character and Structure.

Immediately on crossing the Powder River into this oil basin, opposite to the mouth of Willow Creek, Fox Hills cretaceous sandstones are encountered, dipping westward at a small angle beneath the river. Passing eastward, through a canyon made by Munsell Creek, the Fort Benton shales are seen to underlie the Fox Hills group. These shales, where they remain uneffected by erosion, are from six hundred to eight hundred feet thick, and are here worn into numerous buttes and escarpments. They are weathered in places into a great variety of curious architectural forms. Further on, in an easterly direction, at a log cabin there is a strong petroleum odor encountered. Here, at a few points, erosion has cut through the Fort Benton shales into the upper portion of the Dakota group sandrock and conglomerates, from whence oil flows and forms petroleum springs. Immediately east of this point the Fort Benton shales again appear in lofty escarpments, but dipping in an opposite direction. Conformably to these shales, but several miles further eastward, the Fox Hills sandstones appear in lofty escarpments, forming the eastern boundary of Wall Creek. This conformation indicates an anticlinal fold, the axis of which runs slightly east of due north and west of due south, the whole earth movement that produced it resulting in an elliptical form. The central portion along the axis has been much worn away by erosion, and there the Fort Benton shales are thin or entirely worn away. The following cut from west to east will give an idea of the structure across the axis:

SECTION across POWDER RIVER OIL BASIN

As will be observed from the accompanying cross section a fault exists along the axis of this uplift. Southwest of the cabins at one of the oil springs this fault is finely illustrated. There the jurassic marls are brought to the same level on the east side of Munsell Creek as the Dakota group conglomerate. A large number of lateral canyons are eroded across these groups, where the geological structure can readily be detected. Where the Fort Benton shales are worn away and the Dakota group sandstones are exposed, there oil springs either occur or oil springs either occur or oil-saturated rock. The dip of the strata towards the west and east varies from fifteen to thirty-five degrees - generally it is small.

Both north and south, and especially south, for five miles similar anticlinal folds exist. Southward there are many canyons where the erosion extends through the Dakota group, and the jurassic into the red triassic rocks, where characteristic oil phenomena exist. Along the southern side of this basin salt springs of great purity exist, forming a saline rivulet.

Over a large part of this basin fine forests are flourishing. The timber is sufficiently dense to justify the running of sawmills. This will be a great help towards developing this oil territory.

Oil Springs.

While there is some sandrock of the upper (Fox Hills) series stained, and in some places saturated with oil, there is not enough to justify expectations of even small results from that source. The Dakota group sandstones and conglomerates, however, wherever they have become exposed in this basin, show more or less oil, and in places where it is cut into a few feet on and along the line of faults, oil springs occur. Conspicuous among these are the oil springs on the southeast quarter of Section 20, and on the southwest quarter of Section 16. On the former the oil emerges where streamlets have cut into the Dakota group sandrocks. Four of these occur there close together. At one point on Munsell Creek the oil emerges along a line over one hundred feet long, but most strongly at the lower end of its outflow and where the rock is cut into deepest. At some of our visits a considerable amount was stored here, but the exact quantity we have no means of ascertaining. At the most northeasterly spring at this point the amount produced per day was estimated at three barrels in twenty-four hours. Here the oil was seeping from rocks along a line for seventy-five feet. Here the largest quantity of oil was lying in depressions and eddies along the bed of a rivulet. In the remaining springs near this point the flow could not have been over one-fourth of a barrel per day. The largest of all the oil springs in this basin is the one on the southwest quarter of Section 16. Here on the south side of a streamlet on a spot of ground sloping northward, and covering from six hundred to seven hundred square feet, the oil escapes occur. This spring was clogged with dust, sand, leaves and other debris, and partially closed the oil escapes. From the lower end of the slope several barrels of oil were daily escaping during the time of our first visit there. On almost every quarter section, except on the slope towards Wall Creek, oil indications, such as gas escapes and saturated oil rock, occurred. The great thickness of the shales overlying the sand rock prevented the oil from escaping in the form of springs. In fact, much of the territory here and adjoining it will ultimately be found to be rich in oil, the thickness of the overlying bearing strata having prevented all escape of petroleum.

Quality of the Oil.

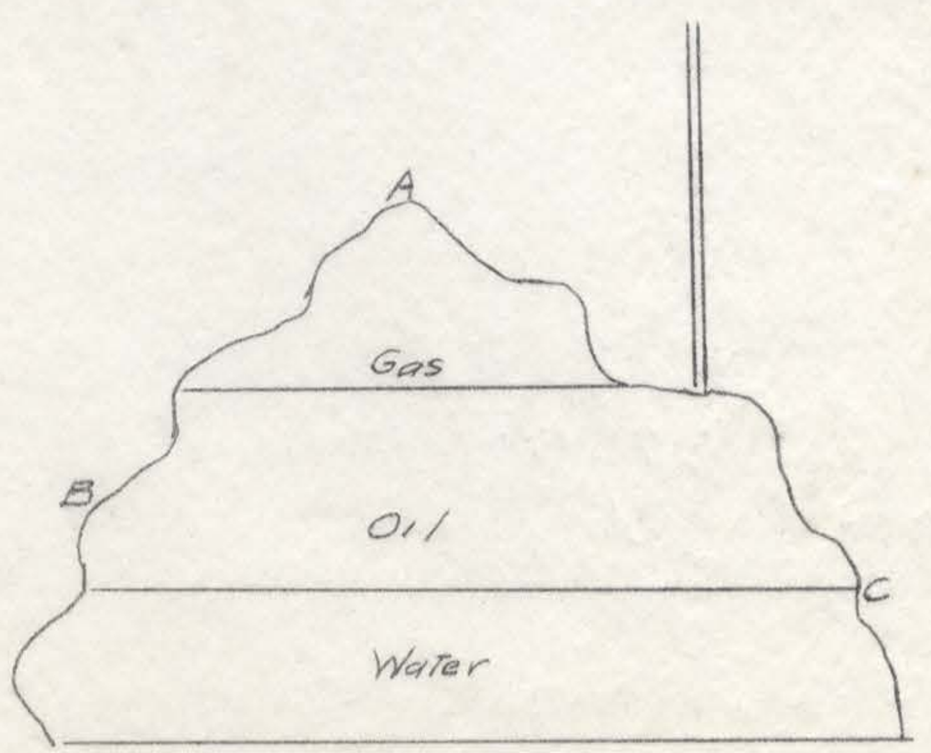
The oil from these various springs vary only slightly in gravity, and ranges between twenty-one and twenty-two degrees of the Baume scale, coming nearest in that respect, and in all other qualities, to the Beaver oil. When the oil first emerges it has a slightly greenish hue, which soon changes to mahogany and then to a black color. These oils are superior even to the Mecca oils for lubricating purposes. They can readily be decolorized and light-colored lubricants of the highest grade manufactured from them.

Source of the Oil.

This at one time was believed to be the Dakota group sandstones and conglomerate. Developments made here, and a more thorough study of all the phenomena, have convinced me that my earlier expressed opinion was a mistake. The real source of the oil, as elsewhere in central Wyoming, is the triassic rocks. The shafts sunken in this basin into the Dakota group and through it showed the oil to be coming still from below. In the southern part of this basin, where the upper edge of the triassic rocks are exposed, show them to be oil-saturated in some places, and in other places small oil escapes come from them. The middle horizon of the triassic measures is in all probability the seat where the petroleum is stored. The fault produced along the axis of the anticlinal created an opening through which the oil forced itself into the Dakota group conglomerates and sandstones, and even rose higher in places by capillary attraction through the shales into the Fox Hills sandstones. Since all the oil along a line eight miles in length is substantially alike, there must be an underground connection, and hence the quantity here must be very great.

Development.

During the fall and winter of 1884 and 1885, shafts were sunk at the springs on Section 16, and near the cabin on Section 20. The former was put down fifty-five feet and cribbed, the entire distance being in the Dakota group rock. The flow at one time into this well was about ten barrels per day, but during the cold weather when the sides became coated with ice it fell off to less than a barrel. What the flow has been during the last summer season is not reported, I, myself, not having been able to revisit it during that time. On Section 20, near the cabin, the shaft reached a depth of twenty feet, and the well here produced a flow of about one barrel per day. The work here was much delayed by an intensely hard cap layer in the Dakota group, through which the shafting was done. The work done at this point confirmed the conclusions at which I had already arrived, that the real source of the oil was much deeper down, namely: In the triassic red sandstone. In the spring of 1885, A. J. Bothwell, Esq., commenced boring at the oil spring southwest from the cabin in the Dakota group sandstone, and penetrated three hundred and fifty feet without, however, getting deeper than into the jurassic rocks. Owing to business reasons the work was suspended temporarily, but at this writing it is about to be resumed. This boring caused the escape of large volumes of gas, water and some oil, but no extensive flow. It had the effect, however, of draining the oil springs near by; or by taking off the gas pressure caused the stoppage of the flow. It is confidentially expected that when this boring reaches the middle of the triassic measures, or sooner, a largely productive well will be the result. If not here, close by, as it is well known that borings over large gas escapes are no assurance of success. More frequently the great productive wells have been found along side and close to, but not over, the gas supply. The reason of this is clear from the following cut:



A boring at A would produce only gas, and would only supply oil after the gas had all escaped, and then would be a pumping well. If the boring extended to C, water would emerge until exhausted, and the oil would sink to that horizon, when it would rise in the bore-hole. If, however, the water came into the rocks as fast as given out, no oil would ever be obtained. Only by striking the oil-holding rock at B could a flowing or spouting well be obtained. This structure of the underground oil store houses makes boring for oil a largely experimental operation.

In the southern part of this basin, along Salt Spring Creek, where red triassic sandstones are exposed, oil naturally will be encountered in much shallower wells.

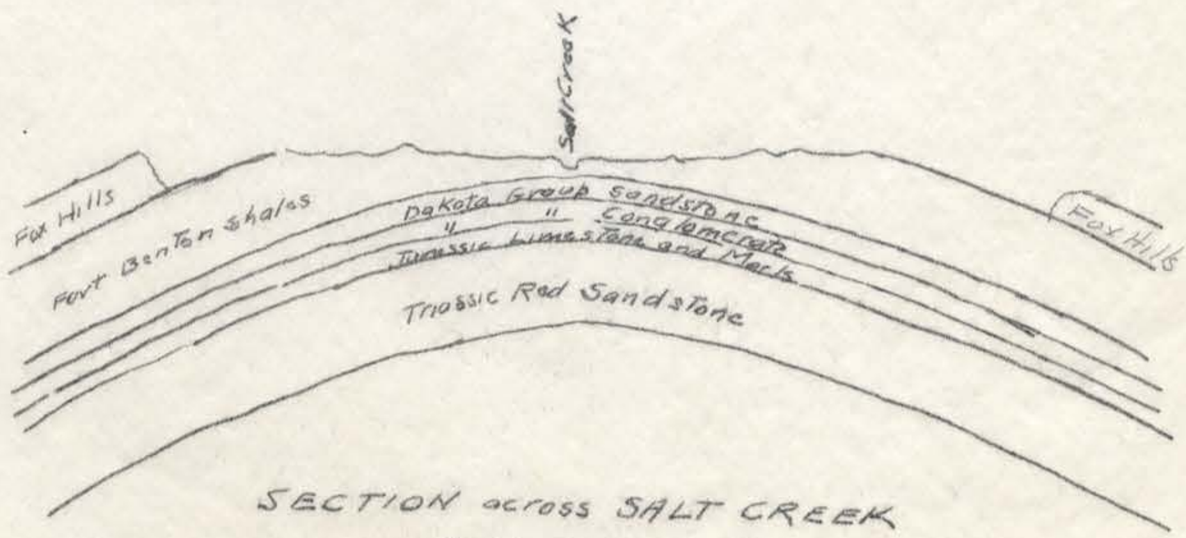
Salt Creek Oil Basin.

Thirteen miles east and six miles south of the Powder River oil district, an area of petroleum lands occur on and along Salt Creek, which is designated from the stream of that name. The road leading to it from the south diverges from the old overland emigrant trail a few miles west of old Fort Casper, on the Platte. For a few miles its direction is northeasterly, then due north to the head of Salt Creek, which stream it then follows to the oil basin, and thence northerly to Fort McKinney, uniting with the Powder River road near the mouth of Salt Creek. A road could readily be constructed from the Powder River oil basin to the one on Salt Creek, as I ascertained by crossing the divide between these streams in a light spring wagon.

Character of the Rocks.

The geological age of the rocks is the same as on Powder River, namely: Fort Benton shales, underlaid by Dakota group sandstones and conglomerates, and these latter in turn by the jura trias. Over the Fort Benton shales the Fox Hills sandstones exist north and west of this oil district, but little of it on the petroleum-bearing territory. A thick bed of hydrated oxide of iron, combined with clay and silica, occurs in many places on this territory. In tracing it for miles its thickness varied from two and one-half to five feet thick. Its position was near the base of the Fox Hills, or at the top of the Fort Benton group. A great number of large nodules of iron carbonate (siderite) are present here in the latter group.

The physical structure of the rock masses differ from those of the Powder River. There, as we have seen, a line of faults exist along the axis of an anticlinal. Here an anticlinal fold exists, but so gentle that no break has occurred, and the shales are not eroded down to the underlying group. A large thickness of shales still remains where the oil emerges. The following cut illustrates this character of structure:



SECTION across SALT CREEK OIL BASIN

This cut illustrates the gentle character of the anticlinal, along the axis of which Salt Creek and its valley extends. The uplift must have been very gradual and long continued to permit the valley to occupy this position, and for the erosion of the creek to keep pace with it. The longer axis is proximately north and south, and the minor east and west, showing, as the surface indicates, that the general shape of the uplift is elliptical, though much less so than the Powder River oil territory. North and south of this area of folding there are similar rock foldings, but no opportunity was afforded for their study.

Extent.

While some thirty quarter sections of land have here been located as oil territory, the exact boundaries have not been ascertained. Both above and below these oil lands along Salt Creek, others are known to exist, but no opportunity was afforded to me for their examination.

Oil Springs.

The largest oil flow is on the southwest quarter of Section 13, township 40, north of range 79 west. The oil comes up vertically from beneath on the edge, and some of it from the bottom of Salt Creek, at a point where a bank twenty-five feet high on the north side constitutes the shore line. When I last visited this spring in May, 1884, not less than twenty barrels of oil had accumulated in the creek bed. The rise of the creek from a rain fall one night washed it away, but it immediately commenced again to accumulate, and in less than a week the original quantity was stored. At that time the amount of flow was estimated at one barrel per day. Some distance from the west side of the creek, and in a northerly direction from the above spring, on the west half of Section 12, two other escapes close together occur. All these oil flows come from the Fort Benton shales, the petroleum coming up directly from below.

Source of the Oil.

This cannot be the Fort Benton group from which the oil emerges, nor the Dakota sandstones and conglomerates directly below. Its source, in all probability, is the same as elsewhere in the basins discussed, namely: In the triassic red sandstones. It comes through all the intervening rock masses through slight fractures along the axis of the uplift. In crossing the divide between the Powder and Salt Creek, and on approaching the latter creek the Fort Benton group, where worn through to the underlying rocks, was measured and its thickness ranged from seven hundred to eight hundred feet. The original thickness of this group, along the anticlinal where the oil springs occur, could not have been less than seven hundred feet. The thickness of this group above the springs was found by measurement to be four hundred feet. This leaves a thickness of black shales of at least three hundred feet at the springs, through which the oil is forced, and also the entire thickness of the Dakota group and the jurassic, supposing our theory is correct that the oil comes from the triassic red sandstone. The entire thickness of strata through which the oil is forced by gas pressure is not less than one thousand feet. The inference is, therefore, legitimate that there must be a large amount of oil stored here, or it could not be forced through such a mass of superincumbent strata. The gentleness of the fold - no faults having occurred - is also favorable to the preservation of the oil.

Quality of the Oil .

The specific gravity of the oil is about twenty-five degrees Baume, or slightly greater than that of Powder River. At first it is of a greenish tinge, but like the Powder River oils, exposure changes it to a blackish hue. The slightest examination, such as rubbing it on glazed papers, shows it to belong, like the preceding, to the lubricating series. Of all the fine oils of Wyoming Territory I regard this, if not the finest, at least as fine as there is anywhere, not even excepting the famous Beaver oil. It will prove itself to be one of the ideally perfect lubricating oils of the globe.

Development Required.

The oils of this basin are sufficiently fluid to rise in a bore-hole. Drilling, therefore, will be the method that must be resorted to. The depth at which a flow of oil will be encountered will depend on the amount of fracturing along the axis of the fold, and the gas pressure. If these two conditions should not be favorable, as we have already seen, the boring must be extended to a depth of at least one thousand feet, or even one thousand five hundred feet. Along the rim of the basin, where the original thickness of the Fort Benton shales remains, borings from one thousand five hundred to two thousand feet in depth would be required.

A practical difficulty in the way of boring exists here. The waters of Salt Creek are intensely saline. Common salt and sulphate of soda exist in it to a large amount, and some purely alkaline substances. It is doubtful whether it could be used in the boiler of a steam engine. Unless neutralized by acid - and even then, sometimes - it produces diarrhea in those who used it. Work, therefore, should be done here in spring time, when melting snows and the spring rains freshen the water. Development work could also be done in winter time, at least until the borings would give fresh water, which is possible, as well as the production of oil. While timber is not abundant, it can be obtained at no great distance, and coal could be obtained within fifteen miles of the wells.

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GENERAL CONSIDERATIONS.

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Oil Sand Rock.

Frequent reference has been made to the triassic, Dakota group and Fox Hills oil-bearing sandstones. The relevancy of these references will presently appear. Sand and sandstone are a matrix for oil, and much of the oil of the globe is stored in it. Says LeConte (Manual of Geology, page 376-379) : "Limestones and sandstones are always the great oil-bearing rocks. In Canada, for example, it is found mainly in limestones; in pennsylvania the sandstones, the under and overlying shales being mostly barren." ****************"It is found in horizontal or gently folded strata, the most productive portion being along anticlinal folds." The red sandrock of the triassic is generally quite soft, and some of it can be rubbed fine between the fingers. At the base of the deposits conglomerates prevail, and generally the contained pebbles are small and well rounded. Some strata are coarse grained, while others are fine. The red color is evidently given to it by oxide of iron. Large beds of it have ash or blueish-colored sandstone, the iron here being yet in a condition of a carbonate, but gradually becoming red by oxidation. These triassic rocks range in thickness from 1,200 to 2,000 feet, or even more, according to locality. They are visibly the great oil-bearing rocks on the Popo-iagie and the Powder River, and are believed to be the great source of oil wherever it exists elsewhere in the territory.

While the Dakota group sandstones are not the primal source of the oil, they are in places oil-bearing. Their dominant color is brown. The thickness of the group in the oil belt varies from 150 to 400 feet. The lower half is generally a pudding stone conglomerate, and often very coarse. Sometimes it is very hard, but often so soft that it readily decomposes, and its debris looks like recent drift material. Above this conglomerate the brownish sandstones occur, which vary from soft to hard. When it is examined closely it is found that the color is given by the oxide and peroxide of iron, which has acted as a cementing material to bind the grains together. This group is a shallow sea deposit.

The Fox Hills sandstones are, where not saturated with oil, of a light yellowish hue, soft, loosely compacted and more finely grained than any of the preceding.

A question often aked is, how much oil can be stored in sandstones and conglomerates? This depends on its porosity, texture, coarseness and compactness. Mr. Carll (Second Geological Survey of Pennsylvania, Volume III, Chapter 24), 'found that the Pennsylvania sandrock absorbed one-tenth of its bulk of oil, and expressed the conviction that, under conditions of the pressure that is known to exist from gases in oil regions, the amount contained might equal one-eighth the bulk of the containing rock.' The amount of oil contained in large areas of such rock would be beyond belief were it not demonstrated by calculation and experiment. Following Carll's method of experiment, I found that the very coarse triassic sandstones abosrbed in a few days one-ninth of its own hulk of oil; the finer samples tested absorbed one-sixteenth, and intermediate specimens one-twelfth. Dakota group sandrock absorbed one-tenth, and the soft conglomerate one-eighth of its bulk. A harder sample absorbed one-fifteenth of its bulk. Fox Hills sandstones absorbed from one-eighteenth to one-sixteenth of their bulk. Sandrock may be saturated fully up to its capacity to hold oil, or only partially so. If entirely saturated, a well with a diameter of four inches, bored through such a stratum ten feet thick, would be more than sufficiently supplied to fill the bore with oil. The amount of flow would now depend principally upon the pressure of water and gases. It might be anywhere between one and 3,000 barrels. However great the quantity of oil stored in the sandrock, the flow would not be great unless there was a corresponding pressure of gas or water, or both. Supposing the pressure to be sufficient, the following calculation might be a close approximation to actual results. If the rock, like the finer and denser Fox Hills, held one-eighteenth of its bulk of oil, then one mile square would contain 4,014,489,600 square inches in a square mile, and as many cubic inches one inch thick. Dividing this by eighteen we have 223,027,200 cubic inches of oil in a mile square of oil sand one inch thick. This would give 22,987 barrels, or 275,884 barrels if the rock were twelve inches thick, or 2,758,440 barrels of oil in a stratum of oil rock ten feet thick and one mile square. Specimens of oil-saturated rock taken from Powder River and distilled were found to contain slightly more oil than specimens artificially saturated. The same was found to be the case with specimens taken elsewhere from the oil belt. This being the case, we can take one-tenth of its bulk of contained oil as the proper amount for a basis of comparison. One square mile one inch thick would then give 4,014,489,600 cubic inches of oil, or 41,378 barrels. A stratum of such rock fifty feet thick would at this rate contain 24,826,800 barrels per square mile. But suppose it contained only half the above quantity, or 12,413,400 barrels,and the amount would be enormous. Even one-fourth the above amount would be prodigious. Is is remarkable that the Dakota group is in places oil-stained and oil-saturated through its whole thickness, though not really the source of the oil. In the triassic the oil-stained and saturated rock is of unknown thickness, but it is known to range in a few spots for 100 feet vertically. From two to seventy-five feet in thickness of oil-saturated rock exists in some of the basins in the Fox Hills sandstones. The Fort Benton shales even contain strata of oil-saturated sandstone. When now it is remembered that in Pennsylvania the oil sands range only from one foot or less to fifty feet in thickness, the superior indications for oil in the Wyoming oil belt is at once apparent.

Underground Oil Cavities.

LeConte remarks that "sometimes, like water, oil is collected in fissures and cavities." The earlier view was that oil, wherever occurring, was principally stored in this way. In Pennsylvania crevices or cavities filled with oil occur principally in shallow wells. At Tidiante they occur in sandrock lying 10 feet below the river bed; at Oil Creek at 450 feet in depth; and in the first sand, near Franklin, at a depth of from 200 to 300 feet. Elsewhere in the Pennsylvania region, in the greatly productive wells, ranging from 800 to 2,500 feet in depth, deep cavities rarely occur, and are probably never the source of the oil. As already explained, the oil is stored in some kind of sand rock. It is becoming more clear that in Wyoming the bulk of the oil is stored in the same way, the probably exceptional places being that of Shoshone and the Beaver. Both forms of storage may, however, exist at the Seminole, owing to the faults in that field; and at Powder River and Salt Creek, owing to the anticlinal folds that there exist. A region of faults contains fissures and cavities, and these are apt to be filled with oil in a petroleum field. Anticlinal folds make cavities beneath them possible; but however that may be, the rocks themselves are of a kind the best adopted for the storage of oil.

Importance of Structure.

Bearing on this point of the possible productiveness of oil territory, is that of physical structure. As already quoted, LeConte says that "the most productive oil territory is along anticlinal folds." That is the case in India, around the Caspian, in Transylvania, in Italy and in Pennsylvania. In six of the oil basins of Wyoming, namely: Shoshone, Beaver, Big Horn, Seminole, Powder River and Salt Creek, this type of structure is dominant. The Arago and Rattlesnake basins have modifications of this type of structure.

Origin of the Wyoming Oils.

None of the theories thus far advanced to account for the origin of petroleum satisfy all the conditions of the problem. The theory that it is a distillation from coal is now generally abandoned. Again, it has been urged that as thick beds of organic matter in the presence of fresh or brackish water, when covered up and subjected to pressure, produced in the course of ages, the various varieties of coal, so the same, or similar kinds of organic matter, when exposed to similar conditions in the presence of salt water, created petroleum. Prof. Newberry has given the most plausible theory, namely: That petroleum has been distilled by pressure and the heat that comes from pressure, from the bituminous shales that underlie the oil sandrock. It is based on the fact that the Hamilton shales which underlie the Pennsylvania oil sands contain from fifteen to twenty per cent. of organic matter, and that on distillation they yet yield oil. A small amount of heat exerted for a long time, it is well known, produces the same results as rapid distillation. In Wyoming the Fort Benton shales are of great thickness, after reaching 1,000 feet, and strata that, combined, reach 600 feet are common. The amount of organic matter contained in them varies from five to twenty per cent. One of the sources of this organic matter was the destruction of shoals of fishes. It is difficult to get, in some of the strata, even a small piece of shale that does not contain scales, or the impression of scales, of these ancient fishes, large numbers of which were identical with, or closely related to, the herring family. Large numbers of algae, or sea weeds, judged from the presence of their impressions, must also have flourished in these ancient Fort Benton seas. The difference between the eastern and the Wyoming oil territory in this respect is that in the former the shales underlie, and in the latter they overlie, the source of the oil. Prof. Newberry's eminence in geology and the related sciences, has attracted much attention to this theory, and most geologists have adopted it as a working theory.

In a former publication I advocated the possibility of the formation of petroleum by chemical reactions is the rocks of the triassic sandstones. These rocks, throughout their entire thickness of from 1,200 to 2,000 feet, are made up of soft sandstones and silicious shales, and contain in their interior more or less iron carbonate. The oxidation of the iron carbonate along the plains of stratification, in the joints, and on the face of the escarpment, has given the rock its characteristic red color. This process is still going on, as can be seen in the red spotted appearance of much of the rock, and the gradual extension of the coloration into the interior. The same chemical conditions exist to a greater or less extent in portions of the Dakota, Fort Benton and Fox Hills groups, which overlie the preceding. The question suggested itself: What becomes of the carbon when the iron carbonate gives it up and takes oxygen? It takes oxygen mainly from water, thus setting free the hydrogen of the latter. The elements then that are freed are hydrogen and carbon, and if these were to unite in certain proportions, carbureted hydrogens, that is petroleums of greater or less density, would be the result. Where free carbons, for example, would be in excess in these hydro-carbons, greater consistency and higher gravity would be the result. The almost infinite variety of proportions in which the iron carbonates occur, and the very great differences in the conditions and minute structure of the rocks, and the very great variety of forms of the folded strata, can be conceived to modify the character of these hydrocarbons. But did this union of elements take place. The possibility of such a union in this way is denied, but I fail to be convinced that such reactions have not occurred. Many facts suggest such an explanation for the origin of petroleum. Among these is the occurence of simple oil stains where the process of oxidation in these rocks is now most active. Where no oil stains occur, the smell of carbureted hydrogen is distinct when rocks in process of oxidation are broken open. By the conditions of this theory the process of oil production has been specially going on ever since the close of the Laramie group epoch, when the mesozoic strata were first folded proximately into their present form. This, however, is not the first theory proposed to account for the chemical origin of petroleum, though at the time of its first publication that was my impression.

As early as May, 1866, Dr. D. P. Kayner, an excellent practical geologist, discussed the origin of petroleumin in the Titusville, Pennsylvania, Herald. He proposed the theory that petroleum originated by chemical reactions in the bowels of the earth. By the heat of the interior of the earth, "carbon vapor and hydrogen gas are evolved, and the interior of the crust being fractured by the various upheavals and subsidencies, which have been produced by igneous action from this central retort or reservoir, they would naturally rise and travel on through fissures, crevices and pores in the interior or primary rocks to seek an exit from the burning vault, leaving solid particles along their track to form asphaltum beds, and rising to a point where the internal forces are balanced by the compressing and cooling powers of the surface, would there condense to form petroleum, paraffine and napthaline, while the lighter elements, which cannot be compressed under that pressure, still retain the gaseous form and push through the superincumbent strata, and travel on to where the seamed slate rock outcrops at the margin of a pond or lake, or in some stream of water, and escapes at the surface."

Ever since M. Berthelot, of Paris, succeeded in forming petroleum by chemical reactions, the opinion has been growing that in some way in the earth's great laboratory petroleum is still in process of evolvement. At least, no strong theoretical objection can any longer be urged against this explanation of the origin of mineral oil. This subject has engaged the attention of many investigators. On of the latest and ablest of these investigators is Dr. Carl Ochsenius, professor of geology in the University of Marburg. As his theory is radically different from that of any other that has come under my notice, it is here reproduced. "Petroleum," he says, "is formed where a strong stream of down-coming mother liquor suddenly destroys all flora and found contained in an oceanic bay. The accumulated cadaverous remains become thus covered up with an impermeable sediment of silt, clay, etc., furnishing then the material for the liquid carbon - hydrogen compounds; these sometimes becoming free, impregnated other strata." (Ochsenius, Petroleum - Bildung, Natur, No. 29, 1882, Halle. Geological Magazine, July 1884, London). What he means by mother liquors are 'magnesium salts in a state of solution, along with chloride of potassium and lithium and some borates, and formed in a bay or estuary separated from the ocean by a horizontal bar." In such a bay, rock, salt, gypsum, and the organic constituents from the shore together with salt clay, are precipitated. The salts remaining in solution are mainly chloride of magnesium, potassium, lithium, along with some borates, and these, as stated above, are mother liquors, and the casual forces that transmute organic matter, when brought into contact with it under proper conditions, into petroleum. As yet few have adopted this theory of oil formation, as it does not account for as many phenomena in the petroleum fields as the view of Newberry.

On any theory of oil production the materials for it exist here in superabundance. If Newberry is correct that petroleum originates from the shales by natural distillation, they exist here in much thicker strata than in Pennsylvania and Ohio. If coal is the source of the oil, it also exists near by,and once overlaid some of these basins before erosion removed it. If sandstones which now hold the oil are also the seat of its generation, they are here in prodigious abundance. If petroleums were formed by mother liquors, as Ochsenius claims, their former abundance is evident from the magnesian earths and shales that occur on the Beaver, Seminole, Powder and Salt Creek oil basins. All the possible sources of petroleum exist here on a colossal scale.

Probable Oil Flow.

The abundance of an oil flow is conditioned by other factors than the quantity stored in the containing rock. The density of the rock, thickness of the oil, the amount of gas generated, and the amount of water present, all effect the flow. The Wyoming oil sandrock will average denser than that of Pennsylvania. The gravity of the oil is also greater, and it is questionable whether gas is so rapidly evolved or whether it is so large in quantity. For these reasons so many large and flowing wells should not be expected here as exist in the eastern oil field. On the other hand, the flow will be long continued, as is almost universally the case in the compacter sands. Wells may be bored that will produce hundreds, but none that will give thousands of barrels per day.

Comparison with Other Oil Regions.

By reference to a map of Wyoming Territory, it will be seen that the Shoshone and Washakie oil basins run nearly parallel to the Wind River Mountains, and the Beaver to a chain south of it. The Dutton, Big Horn and Rattlesnake oil basins run parallel with the Rattlesnake, or to the west of it. The western end of this chain, where the archaean rocks were exposed, was a shore line during the ages when the oil-bearing rocks were laid down as sediments. The Seminole and Powder River oil basins also occur along or near ancient shore lines. The two most westerly basins had the Wind River Mountains for their ancient shore lines. In other words there were dry land surfaces close to the oil basins during the ages of their formation. The rocks of these ages, and notably that of the triassic, exhibit that plunge and flow structure through their entire depth which distinguishes such deposits. Shallow sea or shore lines abounded. The great thickness of rock occurred by a subsidence of the sea bottom, at least near the shores during the progress of the age, about as rapid as the accumulation of sediments. Though the eastern end of the Rattlesnake Mountains are covered by cretaceous deposits, they have all the characteristics of shallow sea deposits. In the Powder River oil territory the underlying rocks show the same marks of an off-shore formation, such as the plunge and flow structure, pudding stone conglomerate and occasionally thin beds of breccias. Often there, when a conglomerate is followed for a short distance, it shades into a coarse and then in a fine sandrock. At the Salt Creek basin the oil rock is not exposed, but there is little doubt that future investigation will there bring to light the same underground conditions. These facts thus far correlate the oil-bearing rocks of Wyoming with those of Pennsylvania and India. Mr. Carll, in the report already quoted, (Second Geological Survey of Pennsylvania, Volume III, Chapter 23), concludes, after an exhaustive examination, that the Pennsylvania sands are shore and off-shore deposits, and "the re-arranged materials of other ancient shore deposits," and that the various wells tap them, and are the most productive where they were originally surrounded by practically impervious rocks.

In regard to the geological horizon at which the oils are found, the Wyoming petroleums differ extremely from those of Pennsylvania. There they occur in the devonian formation, but this formation is entirely wanting in the oil belt of Wyoming. In other words, while the rocks of the Pennsylvania oil fields were in process of being laid down at the bottom of the ancient devonian seas, the oil belts of Wyoming were dry land surfaces. If eventhe shortest estimates of geological time are accepted, millions of years must have elapsed between the close of the devonian age and the beginning of triassic times, when the rocks that hold the Wyoming oils began to be laid down. The two oil-making epochs were separated by the whole of the carboniferous and permian ages. The rocks, therefore, that furnish petroleum in eastern North America were producing, and necessarily, in places, wasting their oil resources countless centuries before the strata where the Wyoming oils had their birth even commenced to be formed.

There is, however, some analogy between the great oil fields of the world. The Pennsylvania oil sands, for example, are in the Chemung group of the devonian, and the source of it, according to Newberry, is the underlying Hamilton shales, the middle member of the same formation. Its store house is the sandrock lying above the shales, and ranging in thickness from two to fifty feet, and rarely as high as seventy-five feet. Above the devonian, sometimes directly above and sometimes far off, are the great carboniferous coal beds. In Wyoming the triassic and the cretaceous, above where the oil of Wyoming is stored, is also composed of sandstones, shales and slates; and the Laramie, which overlies them, is the great source of the lignite coal of the Rocky Mountains. The conditions for oil and coal that existed in Pennsylvania in devonian and carboniferous times, did not occur in Wyoming until triassic, cretaceous and Laramie group epochs. While, however, the oil containing and producing rocks in Pennsylvania are only from 1,200 to 2,000 feet thick, in Wyoming the petroleum strata range from 4,500 to 5,500 feet, or more than twice the thickness of the eastern field.

It is not long since even geologists of note regarded the idea of there being great coal fields in the Rocky Mountains as preposterous. No one doubts that now who has the least idea of this field. Every year's investigation is still further enlarging it, and now it is becoming apparent that it is not inferior to the eastern fields. Judging from the facts observed in the Wyoming oil belts, the petroleum here, in extent of territory occupied by it, and in quantity, promises to be at least correspondingly great, and in quality to be without a peer anywhere in the world.

Being so much more recent, geologically, unique in character, and extended along long lines, it would be a mistake to judge Wyoming oils by the eastern standards. They can only be understood by an independent study of their own present condition and past history.

Value.

When transportation is once provided, and any one of these oil basins are once worked on business principles, they will develop into magnificently paying properties. Remembering that the oils are the best of mineral lubricators, the following calculations will show their value. Most of the basins described could be made to produce at least 600 barrels per day. Composed of kinds always in demand at good prices, it would be safe to count on a profit of five cents per gallon. This would figure out thus:

Six hundred barrels per day (forty-five gallons per barrel at five cents per gallon (22,500 gallons), $1,125; at 300 work days per year, $337,500.

Throwing away for loss in making up the 600 barrels of lubricants what flows on Sunday, and not counting axle grease and other products that could be made, the above amount is a good divident on a large capital. Most of the basins (transportation being provided) could readily be developed into as profitable properties. These properties have great prospective value also, owing to the gradual increase of consumption and exportation over production in the eastern oil field. In 1885 the exportation was greater than in any previous year, equaling ten per cent. over that of 1884. Home consumption is also increasing. At present the production is about 55,000 barrels, while the consumption is close to 68,000 barrels per day. Thus the accumulated stores are being gradually used. up.

Physical Geography.

All the oil basins, except those on Powder River and Salt Creek, lie along or close to the line of forty-two degrees and forty-five minutes, and between or close to the meridians of one hundred and eight degrees and forty-five minutes and one hundred and seven degrees. Those on the South Powder and Salt Creek constitute another line of oil territory. This entire oil territory in turn occupies a large basin surrounded by mountains. On the east is the Casper range; on the north are the Big Horn Mountains, which, west of the river of that name, are known as the Owl Creek range; on the west the Sierra Shoshone; and on the south the Rattlesnake range, which, along most of its course, deserves the name of mountains. The average elevation of the Owl Creek range is 8,250 feet. The peaks of the Sierra Shoshone range reach 10,000 feet, the culminating points being the Washakie needles, 12,253 feet high, near their southeastern end. The height of the Rattlesnake range averages 7,500 feet, the culminating point being Garfield Peak, which reaches an elevation of 8,500feet.

The elevation (barometrical) at some of the principal points is as follows:

Shoshone oil basin (Cap. Jones)	5,000 feet
Beaver oil basin	4,800 feet
Dutton oil basin	5,700 feet
Big Horn oil basin	6,200 feet
Arago oil basin	6,275 feet
Seminole oil basin	5,600 feet
Powder River crossing	5,690 feet
Powder River oil basin	5,250 feet
Salt Creek oil basin	5,190 feet

It will be seen that this oil region of Wyoming is a huge basin surrounded by lofty mountain chains. The drainage of the greater part of this region is towards the north, the exception being the Arago and Seminole, which is eastward. The average elevation of the whole region inside of the mountain chains is somewhere near 5,400 feet. Hayden makes the elevation of the Wind River valley, on the authority of Major Baldwin, 5,000 feet. The extent of this large basin is about 11,000 square miles, it being proximately 75 miles from north to south and 150 miles from east to west. The surface features are varied. Many beautiful broad bottoms border the rivers and smaller streams. Between these are occasional level stretches of land, but many broken districts and low ridges, some of which are of the hog-back type, and often precipitous. Towards the Beaver, and at a few other points, are some bad lands of miocene tertiary age.

Drainage.

The drainage is principally into the Yellowstone through the Wind and Powder Rivers, the exception being the few streams that flow into the Platte. The Wind River, rising in the mountains of that name, flows eastward for seventy miles, then heads north until it reaches the Big Horn Mountains. Its valley is 200 miles long and from one to fifteen miles wide. On the Little Wind River, a tributary of the Big Popoiagie, below Crow Buttes, there is much fertile, gently rolling land. Along the foot of the Wind River Mountains there is also much fine land. The tributaries of the Wind River are, however, specially favored. The Big and Little Popoiagie and their many tributaries have some fine bottoms, and the streams themselves flow over pebbly beds much of their way. The water is clear as crystal, cold and filled with trout. The Beaver, which rises in the Rattlesnake Hills, is at first a clear and beautiful stream. When it strikes the enclosing banks of the miocene deposits, the alkaline earths give the water a milky appearance. The Beaver valley is, however, a fine body of land, and for thirty miles its bottom is composed of the best river alluvium. The bottom is from one to five miles wide, and can be readily irrigated. Many of the tributaries of the Beaver equal it in agricultural promise. Near the base of the Rattlesnake Hills, on the Beaver, is a remarkable hot spring, covering several hundred feet. The water flowing from it is strong enough to turn a mill. In this wild picturesque region there are many other springs, fresh and mineral, that railroad communications would make it a health resort.

Some of the streams that drain into the Wind River from the east only flow over their entire distance during a part of the year. In Mid-summer and autumn, after flowing some distance from their source, they sink into the sands. Some of them have beautiful wide bottoms. On the eastern tributaries of the Wind River there are some alkaline springs and small streams whose waters are unfit for human use and are scarcely fit for cattle.

Powder River.

The main direction of the South Powder from its source in the Rattlesnake range is northeasterly. Early in its course it meanders through a narrow bottom, the northern uplands of which become, near the crossing of the Buffalo road, long gentle slopes. On the south side of the Fort Benton shales are cut into curious architectural forms, the cone and pyramidal shapes being dominant. These localities are sometimes called "Bad Lands," but they have more vegetation than the Bad Lands proper, which also belong to another geological age, namely: The tertiary. Further on the landscape becomes more and more gently rolling, and wide stretches of surface appear of the highest natural fertility, only needing more moisture to make them models of prospective agricultural wealth. Within fifteen miles of its source the South Powder in summer sinks in its bed, and water appears only in places at intervals of from two to five miles. Anywhere, however, water can be obtained by sinking holes in its beds from three to ten feet deep. The structure, however, of the underlying rocks is of such a character as to give promise of abundance of water from artesian wells. In T'p 41 north, Willow Creek, a beautiful, rapid stream, coming from the west, enters the South Powder and causes a full current in its bed to its juncture with the main Powder.

The Casper Creeks - West, Middle and South - drain a considerable area towards the eastern portion of this great basin. West Casper rises at the northeast base of Garfield Mountain. Some of its tributaries rise in Pine Mountain, a lofty ridge twenty miles north of the Rattlesnake range. In many places broad bottoms characterize these streams, containing natural meadows and adapted to agricultural use. The Poison Spider, which rises a little further east than Casper Creek, flows eastward through a bottom that in places spreads out to a width of from one to four miles. The former unites with the Platte a few miles west of old Fort Casper, and the latter near Searight's (Goose Egg) ranch.

Climate.

It has already been observed that the average elevation of this territory approximates to 5,400 feet, which is much less than that of Cheyenne or Denver. It is also surrounded by mountain chains, and the greater part is thus shielded from the severer storms of these latitudes. When severe cold occurs it rarely lasts long. Snow seldom lies long on the ground. The winter of 1881 was one of the severest yet known, and yet the unsheltered cattle lost here was not over two per cent. of the whole. Indian summer weather generally extends to the middle of November, and often far into December. Species of plants flourish here which are common to Southern Colorado. This judgment about the mild climatic conditions is fully confirmed by the experience and statements of cattlemen residing in this basin.

The rain fall in inches has not been ascertained, but it is greatest in April, May and early June. It is sufficient to produce luxuriant growths of grasses, sage crush, grease wood, and on the more elevated ridges and some of the low bottoms a tree flora and a multitude of flowering plants. It cannot be less than twenty inches per annum over this territory, with vastly more on the bordering mountains. The great number of springs in the mountains and streams issuing from them is evidence of this statement. Besides it is well known that a tree flora does not flourish where the rain fall is much less than thirty inches.

Vegetation.

The dominant tree forms on the mountains, especially on the sides, are pines and cedars. Low down on the slopes and on the bottoms, cottonwoods, willows, box elders and the buffalo berry shrub occur. Rarely two species of fir are found on the mountains. The timber often extends a considerable distance down the streams at the foot of the mountains. Some of the low ridges east of the South Powder have in places densely wooded tracts, and elsewhere straggling trees. Large tracts in the interior of this territory are either destitute of or only sparsely covered areas of timber lands. In regard to humbler vegetation forms the same great variety of plowering plants exist here that delights the botanist in the most favored nooks of the Rocky Mountains. The grasses of many varieties flourish everywhere, except in localities where the country has been overstocked with cattle, and where weeds now partially usurp their place. Even the ridges and mountain slopes and parks are clothed with grasses. On the lower lands, various species of sage brush are common. Grease woods and allied forms are also abundant. In April, May and June this almost entire territory is a vast flower garden. Autumn also has its floral riches, but at this season yellowish hues are too common to satisfy the taste for

CHART OF GEOLOGICAL HISTORY, GIVING THE AGE AT WHICH OIL WAS FORMED IN DIFFERENT COUNTRIES.

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ERAS		LIFE	PERIODS	EPOCHS	AGE OF OIL SANDS AND SOURCES
Psychozoic	Age of Angiosperms and Sperms	Age of Man	Human	Historical	–
Cenozoic.		Age of Mammals	Quaternary		
			Tertiary	Pliocene	
				Miocene	California oil
				Eocene	India ex.peninsular oil
Mesozoic		Age of Reptiles	Cretaceous	Laramie	Coal Wyo., Colo. N.M.
				Fox Hills .... Fort Pierre	Further India oil, Wyo. at Beaver, Big Horn, Seminoe, etc.
	Age of Cycads			Niobrara	Oil at Dutton, Salt Creek, Wyo. Shales
				Fort Benton	
				Dakota Group	Oil at Big Horn, Rattle-sn'k, Arago, Seminoe, etc
			Jurassic.		Oil at one point on Powder.
			Triassic		Oil at Shoshone, Washakie, Powder R., and source of all Wyo. oils
Paleozoic	Age of Acrogens	Carboniferous, or age of coal, plants and amphibians	Permian	Permian	
			Carboniferous	Upper Coal Lower Coal Conglomerate	Oils in Ohio.
			Sub.carbonif'rs		Oil in W. Virginia
		Devonian or age of Fishes	Catskill	Catskill	
			Chemung	Chemung Portage.	Oil horizons in Penn'a.
			Hamilton	Genesee Hamilton Marcellus	Oil of Pennsylvania believed to have originated here.
			Corniferous	Corniferous Schoharie Cauda-galli	Oil at Enniskillen, Canada.
			Oriskany		
	Age of Algae	Silurian or age of Mollusks	Upper Silurian: Helderberg	Helderberg	
			Salina	Saliferous.	
			Niagara	Niagara Clinton Medina	Illinois, near Chicago
			Hudson	Hu son Utica	Canada "
			Lower Silurian: Trenton	Trenton Chazy	Canada
			Calciferous	Calciferous	
			Cambrian or Primordial	Potsdam. Acadian	
		Archaean	Archaean	Upper Laurentian Lower Laurentian	

Fauna.

Though it does not come within the province of this report to discuss animal life, the subject cannot be entirely ignored. Perching birds abound. Swimming birds - ducks, geese, etc., are common on the streams during their migrations, and many breed here. The plover family is well represented. Sage hens are in places so common that they soon cease to attract attention. The pine grouse is met with on the timber-covered ridges and mountains. Rodents, from squirrels, mice, cotton-tails, jack rabbits and prairie dogs to the mountain rat are encountered almost everywhere. The noble beaver was formerly common, and is still found on some of the streams. Antelope are still numerous, and deer and elk are yet hunted successfully. A few buffalo still linger in the solitudes. An occasional gray wolf, a few foxes, weasels, mink, mountain lions, and many coyotes well represent the carnivora. In the higher border region the black and cinnamon bears are found, and the mountain sheep is still king. All the larger wild game, except the antelope, often migrate to the mountains when the increasing cold requires the protection of forests,or summer heats make it desirable. Were it not for intrusive and destructive man, this whole region would still be, as it once was, a paradise for wild animal life.

Agriculture.

The home of the antelope, deer, elk and buffalo cannot be a desert. In fact, of the 11,000 square miles of this basin not less than 3,000 can be brought into successful agricultural use. That much land, at least, can be irrigated, and wherever water is supplied crops do well. This is not mere theory. On the Little and Big Popoiagie, fine crops of the cereals are now being produced. The oats yield is from fifty to sixty bushels per acre, weighing from thirty-eight to forty-two pounds per bushel, and equal in grade to the finest produced in Scotland. The land produces fine wheat at the rate of from thrity-five to forty-five bushels per acre, and weighing from sixty to sixty-four pounds. Rye, barley and all the root crops do equally well. All these crops, wherever tried, do equally well in the Powder River region. There attempts are being made to raise the small fruits and apples that promise to be abundantly successful. Add to the agricultural resources the great stock industry, and it will be seen that this basin is of great intrinsic value for many interests beside that of oil.

Mineral Resources.

These can only be alluded to here. Oil has been discussed. Next in importance is coal, which exists in inexhaustible quantities. Gypsum occurs in many places, and on the Little Popoiagie, at the Shoshone oil basin, in beds forty feet thick. Gold exists in Wind River mountains, where there is a revival in that mining industry. Both gold and silver occur in the Big Horn Mountain, and in other portions of the chains that surround this territory. Large beds of spathic iron ore (iron carbonate) and hematite are also known to occur in this territory.

Geological History.

In order to obtain a clear understanding of the oil basins of Wyoming, it is necessary to give a brief sketch of their geological history. The chart on the preceding page should be consulted in order to obtain a clear conception of the relative position of the principal oil basins of the world.

In Wyoming the mountains that bound the oil area described have an archaean nucleus. The rocks are mainly granatic in type, and contain much syenyte, gneiss, and related massed intersected by dikes of greenstone, dioryte, porphry, quartz, etc. These nuclei, which are now sometimes bare, and sometimes covered with sedimentary deposits, probably constituted a portion of the primitive, and so far as we can now see, the first land masses of the Rocky Mountain region. Against them bear the billows of the old silurian ocean, and worn down from them, aided by the rains and storms, and the probable excess of carbonic acid in the atmosphere of those times, the materials to form the old Potsdam sandstone. These lie on the flanks of the mountains. They are hard, sometimes finely grained, and almost quartzitic. They probably overlie the archaean rocks through the greater part of this territory. Overlying these Potsdam sandstones, in the Rattlesnake range, are hard marbles and limestone, which were laid down when the oceans bottoms had subsided, and subsequently were crystalized into their present form. This epoch is the calciferous, and is often called the Quebec group. The marbles of Western Massachusetts and Vermont belong to this epoch. Similar beds occur in the Owl Creek range, but their equivalents along the Wind River Mountains, are dolomytes, the whole there being about 200 feet thick.

No memorials of the next two periods of the lower silurian - the Canada and Trenton - have yet been found anywhere in this section, and therefore it is inferred that this portion of the continent was then a land surface. The next age (upper silurian) is only represented in the Sierra Shoshone Mountains by the Niagara group. A deep sea must have invaded that portion of the basin, and then retired by the beginning of the salina period. From thence onward through the upper silurian, and the whole of the devonian, this section was again a dry land surface. It remained so until the carboniferous age dawned, when that portion of this territory west of the Popoiagie was again submerged, and there the deposits of this epoch are found. At the close of this epoch, as is well understood, the whole continent was rising and continued to rise far into the permian, until it stood at or near its present level.

That the transition from the permian to the triassic, or from the palaeozoic to the mesozoic, was a gradual one is generally admitted. The apparently sudden change in animal and vegetable forms is fully accounted for by the absence of transition rocks. This, in turn, is accounted for by the land surface condition of North America as a whole during the latter half of the permian and the earliest triassic. This portion of the Rocky Mountains under discussion had commenced to subside towards the end of the permian, continued that process until the ocean waters rolled over it. This gave the conditions here needed for recording the coming events of world history - the laying down of sediments in which should be stored the life of those times. That subsidence was in progress during the whole of the triassic is evident from the fact that from the bottom to the top of the deposits, even where 2,000 feet thick, ripple marks are as distinct as on a modern sea beach. At Red Canyon, south of the Shoshone oil basin, the plunge and flow structure and ripple marks are seen from the bottom to the top of the deposits. This structure is common in numberless other basins. They could only have been formed through such a thick mass of deposits by a subsidence so slow as to keep the bottom near the surface - subsidence no more rapid than the deposition of sediments. The triassic rocks underlie the greater part of the area under discussion, and where not observed pass beneath rocks of later geological ages. Exposure in long lines of hogbacks, often assuming the forms of great ellipses or circles, are common over the southern part and especially the southwestern part of this territory. They again crop out in the eastern part, near to and at the Casper, and along the Big Horn Mountains, where the exposures stand in eroded folds, some of which stand almost vertically. The rocks vary little over wide areas. The pudding stone conglomerate, found near the base, only changes to greater or less fineness of its constituents. The characteristic color - brick red - so often alluded to, of various shades, is due to ferric oxide, which generally covers the exposed surfaces, joints, cleanage plains, etc. Often on breaking the rocks the inside is gray, blueish gray or ash color, due to the iron still present in the form of carbonate. It is the slow oxidation of the iron which makes so much of this rock spotted, and is gradually changing the whole into a brick red color. Some of the rock layers are quite hard, while the greater number are soft. In some sections some layers contain allumina and are fissile, and produce fine flagging stone, while the more massive produce a fair quality of building stone. Beds of gypsum come in towards the upper portions of the deposits, some of which approximate forty feet in thickness. At the Shoshone oil basin the gypsum beds in the triassic, combined with those above in the triassic, make a vertical thickness of over 100 feet. Thin beds of gypsum, in the form of selenite, occur as far east as the Rattlesnake oil basin. It is at the middle horizon of the triassic that the large flows of oil come from at the Shoshone. As already explained, the triassic rocks are almost certainly the principal storehouse of the Wyoming petroleum.

The jurassic rocks are not separated from the triassic by any sharp lines of demarkation, and the two are frequently combined under the name of jura trias. Beds of shale, arenaceous, ash colored marls, fissile and compact limestones are the characteristic rock forms.

The physical conditions that characterized the region during the progress of the jurassic were somewhat different from those of the triassic. The subsidence during a portion of the age was more rapid than the filling up, so that deep seas prevailed during its progress, and more calcareous and less arenaceous matter was deposited. There were intervals of interruption of communication with the main ocean when the jurassic sea was losing its waters, mainly by evaporation, when gypsum beds were laid down.

The close of the jura trias was a period of great orographic changes. The Wasatch range was then born and the mountains of the Salt Lake basin produced. The Sierra Nevada uplift also then took place. The continent was so lifted up that the succeeding cretaceous formed no deposits in the early part of its history, and nowhere at any time between the Wasatch and Sierra Nevada. When the earliest cretaceous opened, represented by the Dakota group, the lower European cretaceous had already been laid down. The continent had been raised probably, at least to its present level, by the jura trias revolution, and the slow subsidence which followed finally let in the Gulf of Mexico, which, extending in a northwesterly direction over the plains and through the mountain regions, inaugurated the commencement of the depositions of

The Cretaceous Period

The various groups of this period are well represented in the oil territory. They are here conformable to the underlying jura trias. Shallow seas abounded during the Dakota epoch. Its sediments now appear as dark and light brown sandstones, with occasional layers of yellow type. Colored clays and seams of white sandstone and quartzite are more rarely encountered. Sometimes seams of carbonaceous shales occur. The rocks are generally coarse, and the lower half is conglomerate. The cementing materials are iron oxides.

These rocks at the Popoiagie, some distance back from the oil basin eastward, overlie the jura trias, but contain no trace of oil in that section. Further east along the Rattlesnake, Big Horn, Arago, Seminole, and Powder River, these rocks hold oil as already stated. Its thickness over this territory ranges from 300 to 400 feet.

The Fort Benton group, lying immediately above, has been united with the Niobrara, by Hayden and King, under the name of the Colorado. This was done because of the difficulty in the mountains in distinguishing between them. I prefer the original name, and use it to designate that immense body of grayish, blueish and black slates and shales and siliceous limestones that lie above the Dakota group sandstones. Its plastic black clays characterize vast extents of country along and eastward of the South Powder. Along the Rattlesnake the slaty portions form hog-backs. Some strata are so fissile that they split into uniform slabs the thickness of pasteboard, and even thinner, Almost every piece is marked by fish scales, showing the former existence here of an enormous quantity of this type of vertebrate life. Deeper and quieter seas prevailed than existed in the Dakota group epoch. At the top of the Fort Benton group are layers of yellowish arenaceous and shaly limestones, with casts of shells which represent the Niobrara group, but the exact boundary between the two cannot be made out. The thickness of these two groups, considered together, ranges in this territory between 400 and 1,200 feet. Oil emerges from the Fox Hills shales, on Salt Creek, at the Seminole, and at the Dutton basin, as already stated. Because some of the beds contain from ten to fifteen per cent. of organic matter, color is given to the theory that the oil is distilled in Nature's laboratory from them. Large quantities of siderite (iron carbonate) in the form of nodules, and on the Powder in layers, occur in this group. A large amount of iron carbonate is also disseminated through the gray and ash-colored slates and shales.

The Fox Hills group, lying immediately above the preceding, is now made to include the old Fort Pierre. Soft yellowish and grayish sandstones, some arenaceous clays, and micaceous shaly sandstones near the base characterize this group. A characteristic feature is the presence of cannon-ball concretions, ranging in size from a walnut to five feet or more in diameter. Where they weather out and cover the ground, they simulate piles of cannonballs. Sometimes in breaking them open a fossil is found in the center. Conglomerates occur less frequently in this group than in the Dakota. The thickness of this group in the oil belt ranges from 300 to 800 feet. Ledges of this group are saturated with oil at the Big Horn, Arago and Seminole, and at the Beaver the oil emerges from it. It also surrounds the Salt Creek oil basin, and occurs in massive forms on the flanks of the Powder River petroleum territory. During the deposition of these Fox Hills rock, the cretaceous areas were narrowing. The borders of its oceans on the east had become dry land, and the era itself was inaugurated by shallow seas, whose bottoms, however, were slowly subsiding, making it possible for such great areas and thicknesses of sandrock to be deposited. The Fox Hills group is the closing member of the cretaceous period. Towards its close the continent was slowly rising. From 5,000 to 5,500 feet of sediments had been deposited. It eventually reached that level when it could have only an imperfect communication with the ocean, and was fed to such an extent with fresh water streams that it became a brackish water sea. This change inaugurated the Laramie group epoch. A few times during the progress of this epoch, the ocean invaded the brackish water seas, peopling them again with marine life. These incursions were geologically of short duration. Brackish waters, and brackish water species, characterized this territory during the greater part of its history. Some geologists, who have principally studied its plant life, consider this group as tertiary, while those who have studied its animal life consider it cretaceous. Now it is generally regarded as a transition member between the cretaceous and tertiary, by most geologists - a lost volume of geological history restored in America.

In the region of, and along the oil belt, the Laramie group is made up of sandstones, clays and shales. Often there are strata above and below the coal beds that are made up of very white and soft sandstones. This is the great coal group of the Rocky Mountains, and reaches its maximum of development in Wyoming. Here the coal beds are colossal in size. In thickness and extent the coal fields are not inferior to those of the Appalachain region. The conditions that prevailed in the latter during the carboniferous age existed in the Rocky Mountain region during the progress of the Laramie epoch. It was a time of colossal forests on the uplands, and of vast morasses, in which was accumulated the organic matter that subsequently was transmuted into coal. The coal is called lignite only because in chemical composition it approximates in character to the lignite in Europe, though the coals there are brown, while here they are black and bituminous. Beds of these coals exist from one to seventy feet thick, though their common range is from four to fifteen feet in thickness. From three to eleven coal beds frequently occur together. As already observed it is close to, or within reach of, all the oil basins. The thickness of this group in the vicinity of the oil basins is from 1,500 to 3,000 feet. Elsewhere in this territory it reaches a thickness, according to King, of 5,000 feet.

At the close of the Laramie group epoch occurred one of the greatest revolutions in the history of the globe. The whole series of conformable strata between the beginning of the triassic and the close of the Laramie deposits were thrown into a series of folds, and the whole of the Rocky Mountains was further elevated. The Laramie group beds, and those of the groups beneath it, were turned up at all angles from a few degrees to a vertical position, and faulting occurred on a gigantic scale. A broad depression was left eastward of the Wasatch, and on both sides of the Uintas, into which fresh water streams poured and formed a great fresh water lake that inaugurated the first great epoch of cenozoic times, namely: The tertiary age. In this period of crushing together and folding of strata, a vast amount of heat must have been produced and set free, and this heat may have been concerned in the production of oil by slow distillation.

It does not come within the purpose of this report to pursue the geological history of this region further through the tertiary ages and the quaternary period to our own epoch. The discussion of the fauna and flora of the periods under review had also to be omitted. The purpose simply has been to point out the most important geological events necessary to an understanding of the problems of oil geology in Wyoming.

MINERALS OF WYOMING TERRITORY.

The following list of the minerals of Wyoming are only such as have come under my observation in the field, or have been submitted for determination. It is very far from being complete. It has, however, been thought best to give the list in its yet imperfect form in order to direct attention to this field of investigation; and in order to enlist the services of all who are interested in our resources, and who have the opportunity and inclination, to aid in making such collections. It is hoped that a few years of additional work in this field will enable someone to prepare a complete list and description of all our principal mineral forms. If the inquiries continually made at the office of the Territorial Geologist are a criterion, such a work is very much needed.

PRELIMINARY LIST OF THE MINERALS OF WYOMING.

Ores of Gold.

Gold occurs in gravel and alluvium along many of the streams. The oldest of the placer workings are on the Strawberry and upper Sweetwater and its tributaries. In veins, it occurs in the Wind River Mountains; the Seminoe and Black Hills, west of Cheyenne; also in the Big Horn Mountains, Douglass district, and numerous other localities. Gold occurs only native, unless tellurides be an exception, concerning which it is not yet agreed whether the combination is chemical or mechanical. The gold-bearing ores of Wyoming are

Calaverite, Sylvanite and Petzite. The first detected in minute points in Deserted Treasure mine, Seminoe Mountain. The two latter in minute quantities in the western part of the Silver Crown district. They have not yet been found anywhere in sufficient quantity to be of value.

Chalcopyrite - Copper Pyrites; Barnite - Variegated Copper Pyrites. See copper ores.

Iron Pyrites. See iron ores.

These minerals constitute gold ores where they occur in quartz leads. Sometimes the copper and sometimes the iron pyrites are the richer in gold.

Ores of Silver.

Native Silver. Found at Running Water mine, North Park, but rarely elsewhere.

Argentite, Silver Glance, Sulphuret of Silver. North Park. Ferris Mountain in minute quantities.

Freibergite. Tetrahedrite. Argentiferous Gray Copper. - King David mine, in Silver Crown. Some doubt expressed whether an ore here containing antimony and sulphur is combined chemically or mechanically with the copper. In the latter case it would not be tetrahedrite.

Chalcocite. Copper Glance. Redruthite - King David mine, Fairview mine and other mines in Silver Crown. This ore of copper in this district carries more or less silver.

Palladium.

Detected in ores from Silver Crown in combination with silver and gold.

Mercury.

Occurs as native in the sands of the Big Horn River.

Cinnabar. Mercury Sulphide. Detected in minute quantities in some of the black ores from western part of the Silver Crown district.

Copper.

Found native near Granite Canyon, Sherman and the region north and south of the above; also on Douglass creek.

Chalcocite. Copper Glance. Redruthite. Covellite, or Blue Copper. - King David mine, in Silver Crown district. Silver Crown district. East Seminoe Mountain.

Chalcopyrite. - Copper Pyrites. Copper and Iron Sulphide. Metcalf mine, Copper King (Professor Stanton's), Copper King (Mr. Adam's), King David mine, Fairview, etc., in Silver Crown district, East Seminoe

Mountain, in Copperhead, Blacksnake, Viper and Rattlesnake mines on upper Platte, south of Fort Steele. Generally carries silver and gold.

Burnite, Erubescite. Variegated Copper Pyrites. King David mine, Silver Crown, Blacksnake and Viper mines.

Tetrahedrite. - Gray Copper. Fahlerz - See under silver ores.

Cuprite. - Red Copper Ore. - Often mistaken for native copper; Copper King mine (Mr. Adam's), King David, in Silver Crown, Hartville.

Tenorite . Melaconite, or Black Copper. Copper Oxide.- Occurs sparingly at surface in some of the copper mines in Silver Crown; also, on upper Platte, south of Fort Steele. At Hartville.

Cyanotrichite. Velvet Copper Ore, related to copper sulphate. Occurs among Potsdam sandstones north and northwest of Rawlins.

Olivenite. Hydrous Copper Arsenate. - In Potsdam sandstone northwest of Rawlins.

Malachite - Green Copper Carbonate. - Common at the surface of lodes in Silver Crown, massive at Hartville, East Seminoe Mountain, on upper North Platte, Big Horn Mountains.

Azurite. - Blue Copper Carbonate. - Occurs, but not so abundantly, with the preceeding.

Aurichalcite, or Hydrous Copper and Zinc Carbonate. - Lenox mine, Silver Crown.

Lead.

Galenite. Galena. Lead Sulphide. - Silver Crown district, Ferris Mountain, Seminoe Mountain, etc.

Clausthalite, or Lead Selenide - Carbonate Belle, Grant, Pacific and other lodes; sparingly in Silver Crown.

Nagyagite, or Foliated Tellurium. - In minute quantities and rarely in Carbonate Belle, Silver Crown.

Minium - Oxide of Lead - In minute quantities in Lenox mine, Silver Crown.

Wulfenite. Lead Molybdate. - In fine crystals in Lenox mine, Silver Crown.

Cerussite. - White Lead Ore, Lead Carbonate. - Lenox mine, Carbonate Belle, etc., Silver Crown, on Ferris Mountain.

The lead ores of Silver Crown carry more or less silver; as also those on Ferris Mountain.

Zinc.

Thus far zinc has been found only in minute quantities.

Sphalerite. - Blende. - Zinc Sulphide. - In minute quantities on Seminoe Mountain; also on Ferris Mountain.

Zincite. - Red Zinc Ore. Red Zinc Oxide. - North park in minute quantities.

Cadmium.

Detected in minute quantities in the analyses of some black ores in western part of Silver Crown.

Tin.

Cassiterite. - Tin Oxide. - In northeastern Wyoming, near Rawhide Buttes, in minute quantities; also in small quantities in Silver Crown district.

Titanium.

Ruttle. - Oxide of Titanium. - Rare in Wyoming. One specimen on east end of Seminoe Mountain, near the Platte.

Cobalt. Nickel.

Linnaeite. - Cobalt Sulphide. - With other ores and detected by analysis from Silver Crown, west of Laramie.

Millerite. - Nickel Sulphide. - In Matilda Jane mine on Ferris Mountain. Contains there two per cent of nickel.

Erythrite. - Cobalt Bloom. On Middle Crow Creek, Silver Crown district.

Uranium.

Uraninite. - Uranium Oxide - In Carbonate Belle, Thunder

Cloud, Hermosetta, Grant, Pacific and other claims in Silver Crown district.

Torbernite. - Uranite, Uran-Mica, a Uranium-Copper Phosphate. Same localities as the preceeding.

Autunite. - A Uranium-Calcium Phosphate. - Same localities as the preceeding.

Iron.

Pyrite. - Iron Bisulphide. - Common in most of the gold mines. Generally gold bearing.

Pyrrohotite. - Iron Sulphide. - Douglass district, but rare. Cummins City.

Arsenopyrite. - Mispeckel. Arsenical Iron Pyrites. - Rare. East end of Seminole Mountain.

Hematite. - Specular Iron Ore.

Varieties.

Specular Iron. - Common. Rattlesnake, Seminoe, Ferris, Big Horn and Medicine Bow Mountains, etc.

Micaceous Iron. - Rattlesnake, Seminoe, Ferris and Wind River Mountains.

Red Hematite. - Near Rawlins, Seminoe Mountains, south of Bradley's peak in prodigious masses. In Shirley Basin, etc.

Jaspery Clay Iron. - Seminoe Mountain, Ragged Range, etc.

Senticular Argillaceous Ore. - Seminoe Mountain.

Itabyrite. - South of Bradley's peak.

Menaccanite. Titanic Iron. - On Chugwater in immense beds.

Magnetite. - Magnetic Iron Ore. - South of Bradley's peak along with hematite. Shirley Basin.

Arseniosiderite? - An arsenate of iron occurring in Silver Crown is provisionally referred to this species.

Siderite. - Spathic Iron. Iron Carbonate. - Occurs in Laramie beds with and in proximity to coal beds. Large quantities in Fort Benton group of the cretaceous. Forms beds of rounded and kidney-shaped boulders on South Powder, and on Salt Creek.

MANGANESE ORES.

Pyrolusite.

Manganese Dioxide. Common in Silver Crown district.

Psilomelane.

Hydrated Manganese Dioxide with Baryta or Potassa.- Carbonate Belle, Thunder Cloud, Pacific and other lodes in Silver Crown district.

Wad.

Bog Manganese. - In dendritic delineations. In mines of Seminoe Mountain, Ferris Mountain, Wind River Mountain.

Triphylite.

Carbonate Belle and Pacific lodes, Silver Crown district.

ALUMINUM - Corundum.

Rare. One specimen from East Seminoe, near the Platte. Ragged Range, Wind River Mountains.

Ruby.

Extremely rare. One specimen from limestone on southeast Seminoe Mountain.

Spinel.

Rare. Southeast Seminoe in limestone.

Alunogen.

Alunogen.

Hydrous Aluminum Sulphate. - On Bitter Creek, but rare. The specimens among the finest in existence.

MAGNESIUM - Brucite.

Magnesian Hydrate. - North of the west end of Rattlesnake Mountain.

Magnesite.

Magnesium Carbonate. - Silver Crown, Wind River Mountains, Medicine Bow Mountains.

Epsomite.

Epsom Salt. Magnesium Sulphate. - Occurs in the waters of Salt Creek, in some soda lakes along the Sweetwater, in a cave on south side of Seminoe Mountain.

CALCIUM. - Fluorite.

Fluor Spar. - In limestone south of Seminoe and north of the Rattlesnake Mountains. In limestone in Little Popoiagie canyon.

Gypsum.

Hydrous Calcium Sulphate. - Occurs in beds from forty to sixty feet thick in the jura trias beds on the Little Popoiagie, and in many other localities in rocks of this age. Common in the Fort Benton group.

Selenite. - Also common in the Fort Benton group of the cretaceous.

Satin Spar. - Occasional in the jura trias beds and in the Fort Benton cretaceous.

Alabaster. - In the jura trias on the Popoiagie, intercalated with gypsum.

Anhydrite.

Anhydrous Calcium Sulphate. - Occasional in the rock masses of the Dakota group of the cretaceous as at Seminoe Mountain. Also in the jura trias as on the Popoiagie and Little Wind River.

Apatite.

Calcium Phosphate. - Have not seen it in place. Specimens submitted to me said to have been obtained in the Big Horn Mountains.

Calcite.

Calc Spar. Calcium Carbonate. - Occurs sparingly, but widely diffused in the cretaceous and tertiary rocks and occasionally in mines.

Iceland Spar. - Transparent Crystalline Calcite. - In Platte canyon east of Seminoe Mountain. In canyons of the Popoiagie in paleozoic limestone and many other localities.

Calcareous Tufa. - On the head waters of South Powder, on head of Salt Creek, on Medicine Bow, on head of west Horse Creek, etc.

Stalacite. Stalagmite. - Common in caverns in the jura trias rocks, in limestone cavern on East Seminoe, in caverns in Popoiagie canyons.

Compact Limestone. - Common. Finest found in the jurassic, carboniferous and silurian beds.

Granular Limestone. - Marble. North of the Rattlesnake Mountains in Quebec group of the silurian. In Wind River and Big Horn Mountains.

Anthraconite. - Stinkstone. - In silurian beds in Little Popoiagie canyon.

Lithographic Stone. North side of Wind River Mountains. Obtained by Captain Nickerson.

Aragonite.

Aragonite.

West of Laramie City. On Rock Springs. In the jurassic beds along Rattlesnake Mountains and on the Little Popoiagie.

Dolomite.

Magnesium Carbonate of Lime. - In permian beds north of Wind River Mountains; at head of Twin Creek.

BARIUM - Barite.

Barium Sulphate. - Rare. One specimen from King David mine, Silver Crown district. Lost Cabin mines.

STRONTIUM. - Celestite.

Strontium Sulphate. - In geodes in triassic beds on north side of Rattlesnake Mountain, on head of Rogers creek. Rare.

Strontianite.

Strontium Carbonate. - In same locality as the celestite.

SODIUM - Halite.

Sodium Chloride. - Common Salt. - Salt Spring creek, tributary of South Powder. Also Salt Creek, another tributary of the Powder. Many other localities.

Marabilite. - Glauber Salt.

Hydrous Sodium Sulphate. - More abundant than elsewhere in America. In lakes near Laramie, in comparatively large lakes on the Sweetwater, where it exists from one to forty feet thick; also a few on the Platte. In solution in Salt Creek.

Borax.

Hydrous Sodium Biborate. - Only as yet found in traces in a few soda lakes.

Natron.

Carbonate of Soda. - Occurs more sparingly in small lakes along with the sulphate of soda.

Nitratine.

Sodium Nitrate . - Occurs in traces on Bitter Creek.

SILICA AND SILICATES.
Silica. - Quartz.
I. Vitreous Varieties.

Rock Crystal. - Pure Pellucid Quartz. - Common.
Amethyst. - Rare. East Seminoe Mountain. Owl Creek Range.
Rose Quartz. - Common in Sweetwater Range. Fine specimens near Lankin's Ranch.
False Topaz. Rare. A few crystals found on Medicine Bow and on Sweetwater Range.
Smoky Quartz. - Sierra Madra and in Douglass district.
Milky Quartz. - Common.
Prase. - Common along the Rattlesnake Range.
Aventurine Quartz. - Common in many places among the archaean rocks.
Ferruginous Quartz. - Common.

II. Chalcedonic Varieties.

Chalcedony. - Common, especially in many places along the Sweetwater and its tributaries.
Chrysoprase. - Rare. Occurs north of the Poison Spider and on the south side of the Sand Creek tributary of the Beaver, and on the Little Wind River.

Carnelian. - Around Table Mountain in Silver Crown district. On the Beaver and many other localities.

Sard. - Table land south of Sand Creek tributary to the Beaver. Between Poison Spider and South Casper Creeks.

Agate. - Widely diffused. The variety Moss Agate (Mocha Stone), once extremely abundant, especially along portions of the Sweetwater. Agate Lakes, west of Lankin's ranch on the Sage Hen, a famous locality. Fortification Agate. - Abundant in Bad Lands on Ham's Fork of the Green River and many other localities.

Onyx.- Common in Bad Lands south of Sand Creek, tributary to the Beaver.

Sardonyx. - Rare, but found in same locality as the above. Also between Poison Spider and Casper Creeks.

Flint. Harnstone. - Occur occasionally over the greater part of the territory.

Chert. - In limestone in Silver Crown district. Also occasionally in limestone of jurassic age. On north side of the Rattlesnake.

The chalcedonic varieties of quartz are most abundant where strata of tertiary age occur in a decomposed state. They occur more or less abundantly through the tertiary Bad Land areas.

III. Jaspery Varieties.

Jasper. - Fine specimens around Table Mountain, in Silver Crown district. Common where triassic rocks are decomposed. Abundant along north side of the Rattlesnake range.

Riband Jasper and Egyptian Jasper. Are occasionally found in the same localities as the above.

Fortification Jasper. - Around Table Mountain, in Silver Crown district, in the form of nodules.

Bloodstone - Heliotrope - North of Rattlesnake Mountains in triassic rocks, but with the green and red colors in large blotches.

Lydian Stone. - Touchstone. - North of the Rattlesnake Mountain.

Tabular Quartz. - Granular Quartz. These varieties frequently encountered in the archaean districts.

Silicified Wood. - Common. Occasionally agatized. Magnificent specimens on Ham's Fork of the Green.

Opal.

Fire Opal. - Rare. On the north side of Sweetwater, near Lankin's ranch. In Ragged Range.

Common Opal. - Occasional along the Sweetwater, on Sage Hen and at Agate Lakes.

Wood Opal.- Occasionally found in same localities with petrified wood.

Siliceous Sinter. - Common in the Yellowstone park and in a few localities elsewhere.

SILICATES. - I. Bisilicates.

Wollastonite. - Tabular Spar. - In granular limestone north of Rattlesnake Mountains.

Pyroxene. - Augite. - All three varieties occur on Seminoe Mountain, at and around Young's and Bradley's Peaks.

Malacolite. - White Augite. - On north side of Mill Creek. Seminoe Mountain. Also on south side of Bradley's Peak.

Augite. - Same localities as the above.

Diallage. - On east Seminoe, but rare.

Rhodonite.

Manganese Spar. - In Ragged Range, but rare.

Amphibole.

The following varieties have been observed:

Actinolite. - Seminoe Range. Ragged Range. Sweetwater Mountains.

Asbestus. - Occurs in large quantities about eleven miles northeast from Bradley's Peak, and at a few other points in the Seminoe Range.

Hornblende. - Common. Fine terminations at and around Cummins City.

Beryl.

In Black Hills in northeastern Wyoming.
Aquamarine. - This variety of beryl rare. A few specimens from southeastern Seminoe Range.

UNISILICATES. - Chrysolite.

Olivine. - In Shoshone Range. Wind River Mountains, near Union Pass, In Sierra Madre, south from Rawlins.

Garnet.

From near Union Pass, Wind River Mountains. On east Seminoe. In sands in the North Fork of Clark's Fork.

Zircon.

The single specimen submitted to me was said to have been obtained in Big Horn canyon.

Epidote.

Fine crystals at Devil's Gate, on the Sweetwater. On Seminoe and Ferris Mountains. On Medicine Bow Mountains. Black Hills.

Biotite.

Silver Crown. Rattlesnake Mountains. Douglass district. Wind River and Shoshone Mountains.

Muscovite.

Common Mica. - Common in small scales in regions of archaean rocks.

Astrophyllite.

Bronze Mica. - Found occasionally in the sands of the upper Chugwater.

Anorthite.

Lime Feldspar. - Occasional on Seminoe Mountain, in connection with pyroxene rocks.

Labradorite.

Lime. Soda. Feldspar. - Common where eruptive rocks occur.

Andesite.

Rare. Occasional in the Seminoe Range.

Oligoclase.

Soda. Lime. Feldspar. - Common in granite, syenite and other metamorphic rocks.

Albite.

Soda. Feldspar. - Near Dome Rock and at other points along the Sweetwater Range.

Microline.

Potash. Feldspar. - Rather common in the Laramie Mountains.

Orthoclase.

Common Feldspar. - Common in areas of archaean rocks. Some fine crystals in Silver Crown district.
Sanidin, or Glassy Feldspar. - Found in microscopic masses in Copper King mine.

SUBSICICATES. - Tourmaline.

South from Granite Canyon. Cummins City. Wind River. Sierra Madre and Medicine Bow Ranges.

Topaz.

Rare. In Ragged Range on the head of Camp Creek.

Titanite.

Sphene. - Rare. In Laramie Mountains at the head of the Chugwater.

HYDROUS SILICATES. - Talc.

Common. Fine specimens on Seminoe Mountain.

Foliated Talc. - At Deserted Treasure mine, Seminoe Mountain.

Soapstone. - North side of Rattlesnake Mountains, on head waters of South Powder.

Indurated Talc. - Near Bradley's Peak.

Pyrophyllite.

Specimens of this brought to me and said to have been obtained on East Seminoe. Have not seen it in place.

Glauconite.

Green Earth. - Common in the tertiary beds of the Bad Lands along Dry Sand Creek, east of the Beaver tributary of the Wind River. Exists there in thick beds towards the sources of this bed.

Serpentine.

Silver Crown. Laramie, Seminoe, Ferris and Wind River Ranges. Shoshone Mountains.

Saponite.

Laramie Plains. Presented by Col. S. W. Downey.

Kaolinite.

Only in minute quantities in places along the Sweetwater Range. Wind River Mountains, south of Lander. Silver Crown district. Ordinary clays common.

Damourite.

From west end of Rattlesnake Range. Rare.

HYDRO-CARBON COMPOUNDS.

Marsh Gas.

Light Carburated Hydrogen. - Popoiagie, Wind River and in places along other rivers in Wyoming.

Petroleum.

Extremely abundant in places. See special report.

Amber.

Small masses from the size of a pin head to that of a buckshot in the coal beds of the Laramie group, north of the Rattlesnake Mountains. Less compact and more brittle than the amber of commerce, but resists solvents like them.

Asphaltum.

The hardened oil at the surface in the petroleum basins on the Popoiagie, Beaver, Rattlesnake, etc., comes close in constitution to the asphalt of commerce, and is provisionally classes with them.

Mineral Coal.

One fifth of the territory is underlaid by the coal of the Laramie group - the transition group between the cretaceous and tertiary. It has been classed with the lignite coals because of the amount of water in mechanical and chemical union with the carbon. It is, however, essentially bituminous, and some of the coals approximate in physical structure to the black coals. No good coking coals have yet been discovered. Many of them are exceptionally fine domestic fuels.