December 4, 1937.

Mr. Charles J. Stone,
4555 N. E. 15th
Seattle, Washington

Dear Mr. Stone:

I am enclosing herewith a copy of a letter to Mr. Earle C. Miller, 310 Oregon Building, Portland, Oregon, under date of June 12th, 1937 referring to a general but thorough geologic examination of all outcropping rocks throughout the Burns district made by yourself in late November, 1931. Attached to a copy of the above referred to letter is a copy of a nine page mimeograph copy of your report of November, 1931 referring to the Fay, Island Ranch, Malheur Anticlines and general comment on the possibilities as outlined in your report.

If the report and letter are identical copies of your original report and records, I would very much appreciate your acknowledgment by your signature to the report and letter both enclosed.

If this request causes you undue inconvenience of verification, I will be very glad to compensate you any reasonable amount as a fee.

Enclosed is a self addressed envelope for the return of the above instruments. It is my wish that they be mailed so as to reach the company by Monday or not later than Tuesday, Dec. 7, next.

Trusting you will find it convenient to verify, I beg to remain,

Yours truly,

O. W. Clark, President
State Oil and Gas Co.
223 Pittock Block,
Portland, Ore.

Copy

Charles J. Stone

Petroleum Geologist
and
Mining Engineer

Seattle Washington
4555 N. E. 15th Ave.
December 5th, 1937

Mr. O. W. Clark, Pres.
State Oil and Gas Co.
223 Pittock Block
Portland, Oregon

Dear Sir:

Your letter of the 4th inst. with enclosures is at hand. Herewith are the signed report and letter which you desired. There were a few typographic errors and a line or so left out, otherwise it was an exact copy of the report delivered to Mr. Miller in November 1931. There is no charge for the work.

Should you, in the future, require any work in my line, I would be glad to serve you.

Yours very truly,

(signed) Charles J. Stone.

(The attached Geological Report is a corrected copy)

(signed) O. W. Clark

CHARLES J. STONE

CONSULTING MINING ENGINEER

Mine
Examinations
Reports
Surveys
Management

June
12th
1937

Mr. Earle C. Miller
310 Oregon Building,
Portland, Oregon

Dear Mr. Miller:

In relative to a geological examination and report for oil and gas in Harney Basin in Eastern Oregon, I am pleased to state the following:

Late in November, 1931, at your request I made a general but thorough geologic examination of all outcropping rocks throughout the Burns district, studying particularly the character of rocks that might be expected to underlie the great Harney Basin. I found Cretaceous shales and sandstones that are favorable source rocks for petroleum at a number of locations that indicated these rocks would underlie the Pleistocene and Quaternary formations of the basin. Structural conditions throughout the basin were studied and a plane table survey was made and maps drawn showing the results of this work.

Also, if I remember correctly, a drilling site of location for a test well on the Fay property was made at that time. A report by myself was made and signed, incorporating the principal geologic features as found in the field work.

Yours very truly,

(signed) Charles J. Stone

REPORT ON THE POSSIBILITIES FOR COMMERCIAL OIL AND GAS PRODUCTION IN THE HARNEY COUNTY, EASTERN OREGON, BASED ON A RECONNAISANCE AND PLANE TABLE GEOLOGIC SURVEY.

LOCATION:

Burns, the principal town in southeastern Oregon is located in the northwest corner of Harney Valley. It is reached by the Oregon Short Line Railway branch line from Ontario. Ontario is located on the State line between Oregon and Idaho and on the main line of the Short Line Railway. The distance is 158 miles by rail. Burns is also reached by an auto bus stage from Bend, In Central Oregon. This is a quick approach from the west, and when the state highway is entirely completed in that direction, it will be much the better route to the valley. This will apply to freight from Portland as well as passenger travel.

Burns is a fairly good supply center. Here are located the large mills of the Edward Hines Western Pine Lumber Co. It is a stock raising and lumbering province. The altitude of the valley is about 4100 feet above the sea. The winters are not very severe, the summers are hot and dry. The water supply in the main is good except that there is a shortage for thorough irrigation. Fuel is expensive.

TOPOGRAPHY:

Harney valley has a spread of approximately 500,000 acres. This includes the beds of Lakes Malheur and Harney, which lie on the south side of the valley. They are no longer lakes but dry arid areas. In their immediate basins and within the U. S. meander lines are ranch buildings and the lake bed meadows furnish large tonnages of salt grass and tule hay for winter feeding. The valley floor is so level that one has the impression of elevations at sea due to the earth's curvature. That is, you always appear to be looking up-grade because the house tops are seen first. The water level as late as 1914 in Malheur Lake was about 50 feet below the level of Burns in about that many miles, or approximately a grade of a foot to the mile. The railway across the valley proper has a grade of but a little more than this down to where it crosses the drainage channel, central in the valley and up-grade thereafter to Crane. The run-off from the valley at one time must have been by way of Crane Creek into Malheur and Snake Rivers. This outlet, if it once existed, is now closed and the entire drainage of 7,000,000 acres is into the Harney Valley Basin.

On the North side of the Valley lie the foothills of the Blue Ridge Mountains. They furnish a large part of the water supply for the valley. They are timbered hills and reach elevations of 5,000 to 6,000 feet or more. On the east, is a hilly landscape of barren volcanic rock that reaches well out in to the center of the valley. It is known as Wright's Point. It is some ten miles long, a few hundred feet wide and from 200 to 250 feet high above the valley floor. Saddle Butte, nearly opposite this point, as shown, is another landmark that wrecks the monotony of the valley floor. Through the valley from the northwest and to the southwest are the old channels of Silvies River, and here and there are slight drainage depressions or sloughs. Along the streams is a thin growth of willows, and the balance of the valley is covered by sage brush and grease wood.

Diversified farming, which has been attempted and as witnessed by a large number of deserted ranches, has been a failure. Stock raising, however, has been successful. Large holdings are the rule.

GEOLOGY:

In a province so large as Harney Valley, and its surrounding territory, a study of its economic geology is much above the usual undertaking for an examination upon which to base a report for oil and gas possibilities. There are no published reports on this district by the United States Geologic Survey to assist and simplify the work. It was necessary, therefore to spend about a week in the hills about Burns to gather all the available data that they afforded to arrive at the stratigraphy of the underground throughout the valley. Only here and there could sedimentary exposures be found and the hills and mountains in all directions were ~~xxx~~ examined, except on the extreme south about Steens Mountain, which was covered with snow. This area should be covered in the near future.

Sedimentary rock exposures well into the Cretaceous Geologic horizon were found, however, and established the fact of a petroliferous stratum underlying the valley. Both the dip and the strike of this exposure favored this hypothesis. The beds were massive fossiliferous limestones and shales. Above the Cretaceous are the Tertiary beds of the Eocene and Miocene epochs, which I judge from what I saw are here, both marine and terrestrial sediments. They may contain commercial quantities of oil and gas, as elsewhere, and are composed of clays, shale, sandstones, coal, tuff and intrusive sills of lava. In California, the Tertiary formations are the principal oil producing horizons and in one oil field near the Idaho-Wyoming line, the La Barge field, is a producing oil pool formation. The La Barge field is in the so-called Wasatch stratum, a late Tertiary sediment similar to the beds exposed near Burns; in a rock out near or at Silvies were exposed beds of marine shales, black carbonaceous shales and sandstones, all of which are favorable for hydrocarbon gasses and oils. These beds, beyond doubt, underlie Harney Valley.

At the Burns grave yard hill, on the Bend highway, near the grist mill and up the Seneca Road some ten miles were many sedimentary exposures of probably Pliocene age, the latest of the Tertiary bed. This horizon is usually quite destitute of fossils and none were found to entirely substantiate their geologic age. The beds consisted of kieselguhr or diatomaceous earth, hard earthy shales below and followed by a marine, cross-bedded sandstone of undetermined thickness. Tuff, may or may not be present. Both the diatomaceous earth and the cross-bedded sandstones are found in sloughs in the center of the valley. In my judgment, this connects the valley formation at the surface with the hill exposures. I found no location, however, where the entire thickness of beds from the Tertiary to the Cretaceous could be measured or approximated.

Harney Valley is the extreme north end of the Great Western Desert of North America. It was once an immense inland sea of unknown area. All the Cretaceous beds and much of the Tertiary are older than the mountain ranges that are east, north and west of this lake basin. As the waters of this great sea receded and advanced, the late Pliocene sediments were formed. They were probably undisturbed over vast areas and for long periods of time until recent volcanic action took place, following faulting and uplifting. The volcanic disturbance was regional throughout eastern Oregon. Great areas were punctured and much extruded ash, basalt, rhyolite and allied rocks covered lands and sea. For some unknown reason, that part of the sea which is now Harney Valley was undisturbed, so far as a close examination of the area discloses. On all sides o th valley, flow sheets of basalt and rhyolite are in evidence. There are no plutonic rocks in the immediate neighborhood, the major uplifts being confined to the Blue Ridge Range on the north and Steens Mountain on the south, 50 to 100 miles distant. It is patent to me that the entire strata of sediments of all geologic ages present here have remained undisturbed throughout the valley, except by possibly continental uplift.

Another factor pertinent to the probable presence of commercial quantities of oil in the sediments is metamorphism induced by volcanic disturbances. It is my judgment that metamorphism within the immediate area of the valley has not been intense and would not preclude oil or gas accumulation at any geologic horizon where structural condition are favorable.

The basalt and rhyolite flows have their terminals around the edges of the valley, with one exception, namely that of Wright's Point. There is a recent basaltic tongue resting on a thick bed of tuff, which was laid down on the surface of the sea and after the water of the sea had receded. This tuff deposit, 60 to 100 feet thick, has almost disappeared, by erosion from the valley floor and the bed is now visible only where it has been held in place by volcanic basalt capping.

Thermal springs are not numerous throughout the district, which if present might indicate sufficient metamorphism to dissipate all oil or gas at its source. The hot springs near Crane on the east side of the valley are due very likely to a fault in that neighborhood, and the one southeast of Harney Lake is near a volcanic neck or plug. All other springs with waters from wells are cold or warm only. An extinct thermal spring with an extensive travertine deposit was found north of the valley. It probably came from an inactive volcanic plug, but while it was still hot.

Dog Mountain, 4800 feet elevation, is the nearest approach to a mountain on the immediate edge of the Valley. It is entirely composed of beds of tuff, volcanic mud and basalt sheets, none of which show excessive heat for such a phenomenon. All old volcanic creaters, as far as known, are distant from the valley area. It was interesting to note in certain volcanic extrusions that on the edges of the crater comparatively unaltered shale sediments from great depths had been brought to the surface as though they had been pushed up by a Lacolith and had not been subjected to considerable heat.

A thin layer, two to twenty feet, of Quarternary deposits cover the valley with here and there the top exposures of a Pliocene sandstone in the coulees and a single exposure, a thin remnant of the massive tuff bed above referred to.

STRUCTURE:

Structure, the attitude of sedimentary rock beds, is the all important factor for oil and gas concentration in commercial quantities. The most favorable are the anticline, dome and sealed terraces. The anticlinal structure is the only one here which is in evidence and from which the greatest aggregate production is secured. Much can be written on favorable structure as regards oil, but I will confine myself to my findings in Harney Valley.

Harney Valley was primarily a geosyncline, indicated and as shown on an accompanying map, by the general attitude of the rocks throughout the perimeter of the basin. During the period of mountain uplift, north, east and west, the lake basin was subject to sufficient pressure to produce a gentle folding in the sediments across the valley from southwest to northeast. Their axes are northwest, southeast. They are low anticlinal folds, low as to the degree of dip, two to five degrees, and the distance to their anticlines. Erosion has kept pace with structure building and the anticlines are not in relief. Dips in the beds of tuff and basalt around the south, east and west edges of the valley attest anticlinal developments. This is true especially in the older deposits whose dips are reverse to their primary attitudes. In the younger flows a general trend is toward the valley by reason of grade or gravity flow. At Crane and east of Crane in exposures along the railway cuts, both the basalt and Tertiary rocks dip westward at from 30 to 10 degrees into Harney Valley. Marked faulting is in evidence here with the down side of the displacement to east.

Throughout the valley, more especially in the southern half, there are a number of alkali bogs and salt domes, the latter being at times from three to five feet above the valley level. Well logs that are available do not show at any point a salt stratum. I doubt very much that any of these salt elevations or alkali bogs are in any way connected or associated with oil or gas occurrences underground in quantity that might be termed a pool. The old or recent Malheur Sea was not a particularly saline sea as witnessed by an examination of the terrene, well logs of the district, and the many fresh water wells throughout the area.

To closely locate and map the anticlinal folds and tie in all the geologic and structural data vailable, a plane table survey was made covering these points. The survey extended from the Crane highway on the north to the Leach well on the south. It is shown in detail in Exhibit B to accompany this report. No geologic key bed was found upon which to base a survey for mapping structural contours and only the approximate positions of the axis of the anticlinal are shown. I would advise leasing all lands from one to three miles on each side of the axis of each fold as indicated within the valley.

There are three folds that I was able to trace and survey with a degree of assurance. They are designated upon the map as the Fay, Island Ranch and the Malheur Lake anticline.

THE FAY ANTICLINE:

This anticline is the most northern fold and lies south of the Burns to Crane highway and about twelve miles southeast of Burns. The surface is practically level. In a slough which diagonally crosses the axis, dips are available at the axis and along the southwest flank of the anticline on a cross-bedded sandstone, which at one time was the beach line of the sea, long since departed. This is the sand, in my judgment, found well up in the hills about Burns and which I have called Pliocene as to age. In the valley on the Fay anticline it lies as a hard pan ridge extending northwest and southeast and marked by a rank growth of sage brush that in places attain the proportions of small trees. It is a fresh water sand and when buried is a water supply source. The reverse dip to northeast was obtained by going down old abandoned wells where the hard pan was buried below wind blown sands. Wells were sunk to this horizon to obtain water. It is very probable that a water table and structural contour could be established by sinking wells around the ~~xxxxx~~ fold.

Another argument in placing the axis of the fold is found in the coulee across section 6, where a salt stratum outcrops along the bottom of the slough approximately one-half mile north and south. The salt stratum immediately underlies the Pliocene sand stratigraphically. The axis of the fold here is therefore the highest point where the salt bed outcrops. On the south the salt bed plunges rapidly below the Pliocene sand, while on the north the dip is gradual until it disappears.

Regarding the closure of the anticline to the northwest and southeast, it is not disclosed at the surface and it necessarily must be inferred. Near Burns the beds dip eastward and in the colee in Section 31 north of Fay's house, the same beds dip westward to southwestward. A syncline, therefore, is reached somewhere in the twelve miles between the dips and closure thereby effected. On the southeast the data is not so positive. The best argument is that hydrocarbon gasses have been trapped here in wells and this necessitates structural closure in this direct.

There are no drilled wells on the north end of this anticline, other than the 50 foot hole, but on the south and the west side near the school house, wells deeper than one hundred feet have shown gas in quantity when first drilled. All of these wells were drilled for water and no recognition given to the value or importance to the presence of gas. The cuttings from the Fay well in Sec. 6 and sands along the coulee and other dry wells in this neighborhood were tested by me for oil and each case there was unmistakeable evidence of a clear oil, probably paraffin.

The most favorable location for a test of the anticline for oil and gas, in my judgment, would be in the southwest corner of Sec. 5, 220 feet north and 220 feet east of the section corner.

THE ISLAND RANCH ANTICLINE:

This anticline is also shown on Exhibit B and lies practically parallel with the Fay anticline. Similar to the Fay structure it follows a hard pan Pliocene sand at about the same altitudes and with the same general characteristics. There were no coulee sandstone exposures, however, and it was necessary to sink pits for dips. It has flat top about one mile wide and in all probability 15 to 20 miles long. To the northeast the formations dips below a stream wash gravel such as used for road dressing and to the southwest it dips below wind blown drift. Pits sunk through the drift and abandoned and dry water wells gave the data as to dip and strike. The same argument for closure of this structure to the northwest holds good as in the case of the Fay anticline. To the southeast a number of water wells have been drilled that furnished gas. They were drilled 15 to 20 years ago. One of them, the Johnston well, still has gas with water. It burns with a yellow flame that would seem to place it at better than a methane gas.

It is an attractive anticline for development. The structural high or apex of so long an anticline cannot well be placed without structural control, which is entirely lacking. The northwest portion would seem higher structurally than the southeast and I would place a favorable location in any one of the quarter sections at 220 feet from the common corner of Sections 13, 14, 23 and 24, Township 25 South, Range 32 east. The well could be drilled upon the lease that it would seem advisable to first validate.

MALHEUR LAKE ANTICLINE:

This anticline is undoubtedly an extension of the axis of the Burns anticline, located some ten miles southwest of Burns. It axis is correctly platted by the United States Reclamation Service. The anticline plunges at the edge of the valley and goes to a syncline before it reaches Wright's Point toward which it strikes. The evidence of anticlinal building, the Malheur Lake anticline, is quite conclusive from my study of the field. The structural development came after a massive tuff bed in evidence along the old shore lines was laid down and before the recent or late volcanic flow sheets encroached upon the valley. The tuff bed upon which Wright's Point rests is arched in the attitude of an anticline and the dips on Dog Mountain favor an anticline crossing the valley in the direction of Lake Malheur.

The best evidence of favorable structure for commercial production it strikes me is the reported history of wells drilled in this part of the valley. From the Conrad well on the north to the Howell well on the south, a total of six or eight wells have reported flows of gas and some oil at depths of from 140 feet to 1408 feet. They were drilled from 14 to 20 years ago and, while they are all dead now, I have no doubt of the truth of some of the reports. The Conrad well is reported to have produced gas in volume sufficient to burn continuously for some years, also did the Leach well which blew in with considerable pressure. The Howell well at 1400 feet furnished enough oil to cover their water troughs as reported. The log of this well is sprinkled with oil and gas. In contrast to these reports is the log of the Dog Mountain well drilled to 3800 feet. This well I figure is approximately 1600 feet down structure from the Howell well and the operators reported finding neither oil or gas. It ran true to its location.

The Howell well is probably located on a high structure development, in my judgment, and the neighborhood merits a thorough test well drilled to and into the Cretaceous horizon if possible. I would advise a well to be drilled at a location about midway between the Leach and Howell wells. The location is on a slight ridge.

The Howell well is flowing warm water that may or may not be suitable for boiler feet water until tested out, but would furnish good drilling water.

WELL LOGS:

Exhibit C is a graphic classification of formations shown in the usual symbols, from all the wells logs available throughout the valley. From the log of the Dog Mountain well I would judge that a depth of 3800 feet the bore did not penetrate the Cretaceous stratum. It is entirely Tertiary. Being off structure, it contained nothing but water, throughout its bedded sediments, but furnished worthwhile information. The Howell well, about 1600 feet higher on structure, is also in the Tertiary or Pliocene geologic horizon and furnished nothing new other than valuable information regarding structure and the petroliferous character of the Lake Malheur anticline. The Redess well did not penetrate far enough to give any additional structural information and the first salt water was probably not logged. It is rather negative as to discoveries of either oil or gas. The Culp and Clemmens wells were not drilled deep enough to assist in developing data regarding stratigraphy or structure.

It is interesting in connection with a study of the logs to find the salt water stratum which represented a certain periodin the sea recession when the waters were especially saline, and the sulphur water stratum in the Howell and Dog Mountain wells, that they have approximately the same stratigraphic interval in the two wells. Had the Redess well penetrated to the sulphur water stratum, it would have backed up my belief of two underground key beds upon which structural control can be based. As it is, I am of the opinion that the log of the Dog Mountain well furnishes information upon which to exploit the potential resources of the valley. The logs also show a rather uniform stratigraphy in zones of sand beds and thicker deposits of clay or shale and limestone streaks. They can be co-ordinated in this way as zones rather than an attempt to trace a certain horizon for the several wells.

ECONOMIC FEATURES:

Water, fuel, climatic conditions and accessibility are the only factors, which are usually considered under this heading. The fresh water level and supply throughout the valley can be had usually at from 60 to 150 feet, but it is necessary at times to go to 400 feet or even deeper. Malheur Lake or sea in past geologic times was not a strong salt sea and the reverse seems to have maintained very largely throughout its history. The water is therefore, mainly fresh and not what one would expect. With few exceptions, it can be used for drilling purposes. When a drilling location is not close to a satisfactory supply, it would be advisable to first drill a water well with a portable outfit and properly case it. The test well can be placed close enough so that the walking beam can automatically pump and furnish the necessary supply. No long haul or long pipe lines for water should be necessary.

FUEL:

Coal is expensive, $15.00 to $20.00 per ton in Burns, or possibly as low as $12.00 per ton in car load lots. There is not a sufficient supply of gas available for power purposes at present in the field. I think it is possible or rather probable that a gas supply can be had at any point from 150 feet down. It would be a question of volume as to whether a power supply had been developed or not. To develop gas for power fuel a water shut-off must be had at all times before entering a gas horizon to secure a sufficient volume. This can be done as attested by the Leach well, which, I am told, blew gas for a number of years from a waterless horizon. The Edward Hines Western Pine Lumber Co. has an ample supply of mill wood available. I am of the opinion that its cost and hauling expense would make its use prohibitive. Distillate at eightto nine cents per gallon delivered is probably the most economical fuel thatcan be used, and its use usually requires no extra overhead costs. Special equipment, however, is usually necessary.

CLIMATIC CONDITIONS:

Weather reports indicate that the summers are hot and dry and the winters are not too cold for all year drilling operations. Snow and temporary cold periods may lay up drilling work a few days at a time during the winter. The elevation is about 4100 feet above sea and the precipitation amounts to from five to fifteen inches per year.

ACCESSIBILITY:

The Oregon Short Line Railway from Ontario crosses the north end of the valley from east to west and the sidings at Redess and Lawen are close at hand for the drilling locations with easy hauls. The gravelled highway is also an aid to transportation. Freight, I am told, can be delivered by truck on location. The roads are good to fair except through alkali bogs during the spring season.

In general the economic conditions that maintain throughout Harney Valley are much better than the average for wildcat drilling undertakings.

CONCLUSION:

From the standpoint of great prospective profits in the event of the discovery of an oil or gas field in the State of Oregon, the proposition to exploit Harney Valley is especially attractive. At present there is no production north of California nor west of the Rocky Mountains. It is empire in itself without commercial independence in this respect. It is also attractive in my judgment, as a potential field from a geologic standpoint favorable for oil. The structures are not easy to interpret, but from my study and experience the possible doubt as to their being favorable or not for commercial production has been eliminated. Some twenty years ago gas and reported oil were developed at a number of locations and that demonstrated a very probable structural trap that indicated accumulation underground. I personally tested the formations at the surface and from new pits, old wells and coulees that gave unmistakeable evidence of paraffin. My field work in the outlying sediments throughout the valley were of the correct age and character to satisfy the accepted genesis among geologists, for petroleum. That is, the source rocks for petroleum are present for the drill to develop.

The only deep well drilled to date in the district, sufficient deep to test the formations, was drilled off structure some four miles and had little or no chance to find production. Other attempts to exploit the field lacked 1000 to 2000 feet of reaching the favorable sediments, which are the base or lower beds of the Tertiary age or the top of the Cretaceous rocks.

The economic conditions that maintain here are very much better than the average for exploratory development. There are no serious drilling problems that can be foreseen, as well logs and experience have disclosed.

Reviewing my findings in the field, and backed by experience in geologic surveys and well locations, it would seem to me that you have better than a fifty-fifty chance to secure commercial production. It is much above the average oil venture. I would expect, also, a high grade oil to be found at these formations, which should return the highest profits. You should organize to carry through a thorough development of the structures to assure success. I would recommend that the field be tested by no less than three wells one each on the three folds or anticlines mapped.

On an accompahying map are three well locations, Nos. 1, 2 and 3.

Location No. 1: This location is on the Fay structure. It should be drilled to at least 3500 feet, if a commercial quantity of oil or gas is not found at a lesser depth. This structure is probably higher than the Lake Malheur structure. It is just possible that in beds at the base of the Tertiary in the black marine shales and associated sandstones, production can be had at less than 3500 feet, because of its elevation. It would be advisable, however, to equip and provide for this depth. An 18 inch hole to set 15 inch casing at about 500 or 600 feet, would be well. Below this point, I would recommend that a water shutoff be secured and the well carried forward dry in case gas is encountered. Each water stratum should be handled in this manner. I had drawn these conclusions from a study of the situation as given to me in the field. I am of the opinion that intelligent drilling with good equipment and proper casing has never been done in this field and the resuñts obtained were far short of their purpose or objective. Drilling is a serious undertaking and painstaking care cannot be stressed too much as to its management to keep down drilling costs and make hole, but also to keep reliable records by tests of formations encountered, the salinity of waters, rock characteristics, logs of wells and to determine where to best set casing and to keep the bore straight through the use of modern instruments. The equipment should be completein every respect if possible, since good oil supply houses are not closer than Casper, Wyoming.

Location No. 2. This Location is on the Island Ranch anticline. This test well should also be carried to a depth of 3500 feet, since this anticline is about the same elevation structurally as the Fay anticline. A water well should be put down here preliminary to beginning drilling. From pits sunk in this neighborhood it would seem that a supply can be had at less than 50 feet.

For the two wells above indicated, I would advise a heavy duty portable spudding machine be secured and spudding machine drillers engaged for the work. The spudding drill equipment is the fastest outfit in medium soft or hard rock that is at present put out for cable tools. It has the added advantage for this field in a distillage engine drive, and can be moved off and on a new location and made ready to go in one to two days. It is a strictly up to date equipment, can drill to 3500 feet with only a mast and sheer poles and can accomplish anything that a standard rig can do.

Location No. 3: This location is on the Malheur structure. For a test well I would recommend a No. 6 standard drilling outfit and derrick to drill to 4000 to 4500 to reach well into the Cretaceous formations. From the log of the Howell well it would seem that this depth will not be necessar to obtain commercial production, judging from the showings of oil and gas reported. However, experience has taught not to depend upon the other man's data, but to go after the information yourself when you have concluded that it is worth while. I am strongly impressed with this location. It would be well to equip this test and undertake it as soon as possible. Heavy equipment should be moved in while the ground is frozen this winter for early spring drilling. This location hasthe longest haul from railway or highway.

The above outline for development represents a considerable capital investment, but which I consider necessary to thoroughly exploit Harney Valley for commercial oil or gas. In my judgment, it has the characteristics of a potential oil field and merits a sufficient capital to develop it.

(signed) Charles J. Storm

Harney

Jan. 7, 1969

Mr. Woodson Long
Juntura, Oregon 97911

Dear Mr. Long:

Attached is some preliminary data I have assembled relative to your quicksilver prospect near Drewsey. I will prepare an expanded and more formal report at a later date. Prior to doing so, however, I want to visit the area again in your company. Also, I want to examine thin sections of some of the rocks. These are now being prepared. I have several questions in mind concerning the mode of emplacement of the rhyolitic rocks, the origin of the mineralized breccia zones and the source of the mineralizing solutions. Answers to these questions may tell us whether more drilling should be done and if so, where.

I spent December 12th and 13th on the property. I intended to look you up before returning home but ran clear out of time. Pretty near froze to death. I plan to come over again in early spring.

Best regards,

HOWARD C. BROOKS
Geologist

HCB/aw
enc.

Flaney

Geology: The Long quicksilver prospect is in what has been called the Juntura Basin (see Shotwell 1963)

Shotwell, J.A., 1963, The Juntura Basin: studies in earth history and paleoecology: Am. Philos. Soc. Trans., V. 53 (new ser), pt. 1, 77 p.

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wherein a thick heterogeneous sequence of fresh water sediments, lavas and pyroclastic rocks were laid down during Miocene and Pliocene time. The prospects occur in rhyolitic rocks, that form an irregular-shaped mass more than a mile in longest dimension protruding, in most places, above the surrounding lakebeds and volcanic rocks.

The rhyolitic rocks generally are rich in glass. Textural characteristics vary from place to place. In some areas the rocks are highly vesicular. In others they are relatively dense, commonly exhibit flow (?) banding and locally are spherulitic. Some of the rocks have a fine grained granular texture. A coarse autoclastic breccia is exposed on the ridge west of the cabin.

The manner in which the rhyolitic rocks were emplaced in their present position and the relationships of the textural variants within the mass are questions which cannot be answered fully until more work is done. Probably parts of the mass are intrusive and parts are extrusive.

In the areas where quicksilver mineralization is evident, alteration of the glass and feldspathic material to clays and sericite is well advanced. As a result, the rocks have a white chalky appearance on freshly broken surfaces; some have been so softened they are easily cut with a knife.

The quicksilver minerals are concentrated in small breccia zones within which the fragmented rocks have been recemented and in places almost completely replaced by chalcedony. Pyrite in a very finely divided state imparts a dark grey to black color to some of the siliceous material. Brown to yellow limonite staining is common. (Spongy textured limontized rocks have been misidentified as gossan from which sulfide minerals are thought to have been leached. Most of the cavities were formed by expanding gases during emplacement of the original rock.) The mineralized breccia zones are irregular in shape, differ widely in orientation and are abruptly discontinuous. They vary up to about 100 feet in length and, individually range from a few inches to 2 or 3 feet in width although in one place 4 or 5 such zones were observed in a space of 25 feet. The altered rocks between the breccia zones are cut by knife blade-thin chalcedony filled fractures some of which contain quicksilver minerals.

Cinnabar is the only quicksilver mineral that has been positively identified. Additional quicksilver minerals probably will be recognized as more work is done as cinnabar does not appear to be present in sufficient quantity to produce some of the local anomalies. The cinnabar occurs as fine-crystalline aggregates aligning fractures and other open spaces. It is microscopically visible in some of the chalcedony particularly that rich ~~is~~ in pyrite.

Incomplete evidence suggests autoclastic origin of the breccia zones -- i.e. during differential cooling of the rhyolite, solidified rocks were broken by continued movement of more fluid magma. The quicksilver minerals along with chalcedony and pyrite — all have freezing points lower than the rhyolite — probably were deposited from hot aqueous solutions as one of the final phases of the magmatic activity.

The appended assay results were obtained from hand picked samples of some of the breccia zones in the west area (see sketch map). Material selected was obviously mineralized — i.e. rich in limonite; some contained black pyritic chalcedony veinlets and/or visible cinnabar. No samples for assay were taken of the altered rocks between the breccia zones.

The depth to which the individual breccia zones extend probably will not exceed their length nor is there good reason to anticipate that mercury mineralization will increase with depth. Breccia zones that are larger and richer than any now exposed may exist at greater depth within the mineralized areas. No evidence for or against this possibility has been recognized.

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NE PART OF BURNS AMS SHEET