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crushed ore is fed by a belt-driven plunger feeder of simple type to a tank of hot water in which the wax is melted from the gangue. The first tanks were constructed of steel, and steam jacketed. Later they were built of 3-in. wood planking at small cost. These tanks are 3 ft. deep, 14 in. wide, and 25 ft. long. In the bottom of the tank are placed two 12-in. screw conveyors, each 12 ft. long, operating as one screw, with stuffing boxes at each end, submerged centre-bearing, and driving mechanism outside one end of tank. A 2-in. pipe carrying exhaust steam for heating the water runs along each side of the tank just above the screw. The tank is filled with water and the steam turned through the pipes, rapidly bringing the temperature of the water to 170 to 190°F. The screw is started at the rate of six revolutions per minute, while the ore is fed in at one end of the tank. As the melting point of ozokerite is about 130°F., the wax at once commences to melt and rise to the surface of the water.

The success of the operation just described depends upon the wax being entirely liberated from the rock during the short period of its conveyance from one end of the tank to the other. Arriving at the farther end of the tank, the tailing is either lifted out by an inclined screw or drops into a cone attached to the end of the tank, from which it is discharged intermittently by a quick-acting valve operated by hand; the tailing being too coarse to admit of the continuous discharge used in cone devices for dewatering tailing.

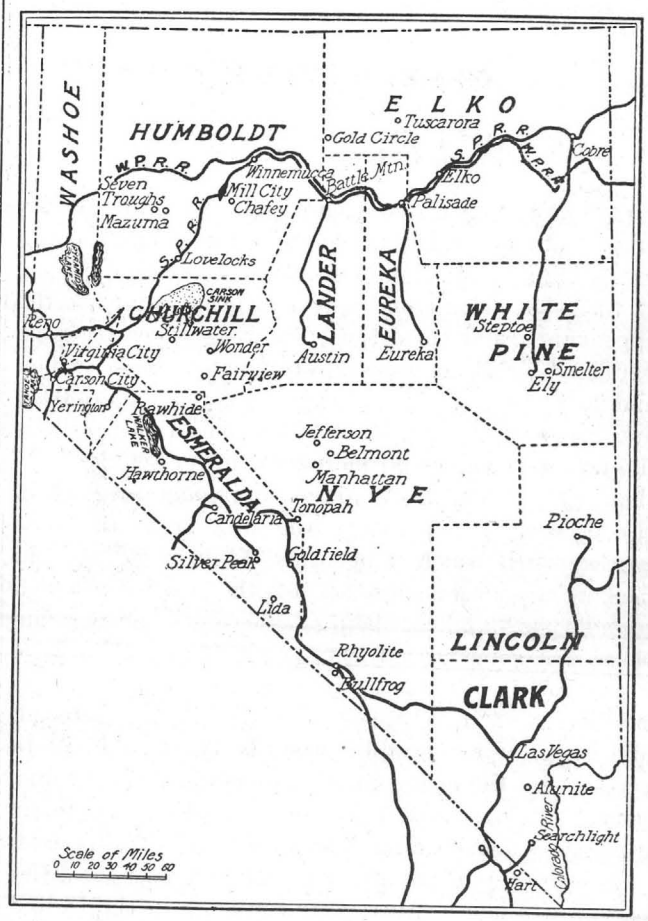
The wax was at first skimmed from the top of the tank into pans. After cooling and hardening, the earthy impurities which had settled to the bottom were chiseled off, when the cake was sacked for shipping. It was soon found that the cakes were not acceptable to the buyers because of bad condition due to the moisture entangled in the wax. This led to the perfection of a continuous method of refining. The wax is drawn constantly from the melting tank to a small steam-jacketed cone tank acting on the principle of a water-clarifying cone, the settled impurities being drawn off from the bottom. Steam coils are used in this cone to assist in keeping the wax melted and to drive off the entangled moisture. The melted wax overflows the cone to pass about more steam coils to further reduce the contained moisture, finally flowing into pans in which it is cooled to form cakes that are satisfactory. The capacity of one of these melting and refining units is from 25 to 50 tons of ore per 24 hours. The amount of coal required to heat the water and wax is remarkably small, so that the whole process may be said to be both efficient and economical.

About five plants for extracting ozokerite have been erected in Utah, resulting in the production of several hundred tons of wax. None of these are now operating. The reason that more has not been done is simple—no extensive bodies of commercial ore have been found. It is impossible to say just what percentage of wax the present known bodies contain, but it can be understood that with ozokerite at 16c. per pound f.o.b. New York City, 2% wax would be valuable. Prospecting for ozokerite is being carried on in many localities.

SEVEN TROUGHS DISTRICT OF NEVADA.

By F. L. Ransome.

*The Seven Troughs district, which is about 30 miles northwest of Lovelock, a flourishing town on the main line of the Southern Pacific railroad, lies on the east slope of a minor range designated on the Fortieth Parallel Survey map as the Pah-tson mountains, but now popularly known as the Seven Troughs mountains, but occasionally referred to also as the Stonehouse range. The higher parts of the mountains are dotted with junipers and the larger ravines contain small perennial streams. Grass flourishes on some slopes and for over 30 years the region has been used as a range for sheep and cattle.



Map of Nevada.

The watering places maintained in connection with this pastoral occupancy have given to the new mining district its name.

Supplies are hauled by teams from Lovelock. Passengers may reach the district most conveniently from the same point by the ordinary stage line or by automobiles, which meet the transcontinental trains and ply over a little better road than is used by horse-drawn vehicles. There are four little towns in the district, three of which, Vernon, Mazuma, and Farrell, are situated at the east base of the range. Vernon, the southernmost of the three, was the chief settlement in the district early in 1908, but had lost its pre-eminence by August of that year, most of the activity then centering about Mazuma, 2½ miles north-northeast of Vernon, and about Seven Troughs, which is 1¼ miles west-northwest of Mazuma, higher up the same canyon. Farrell, three or four miles

*Abstract from Bull. 414, U. S. Geol. Survey.

ceed $2800. This means that the work was done for about 1.3c. per ton of ore. It is true that the work was carried on under more favorable conditions than might obtain in other localities. Nevertheless, it seems to me that the above costs were low considering the work accomplished. Some of the conditions tending to simplify were: (1) The drainage area of the Trinity river does not come under the regulations of the California Débris Commission, which makes it possible to let the sluiced material take care of itself. (2) The fall from the workings to the Trinity river was more than sufficient to carry the material sluiced, even to the size of three inches in diameter. (3) The decomposed condition of the porphyry overburden simplified to a great degree the sluicing operation.

MSP 12/11/09

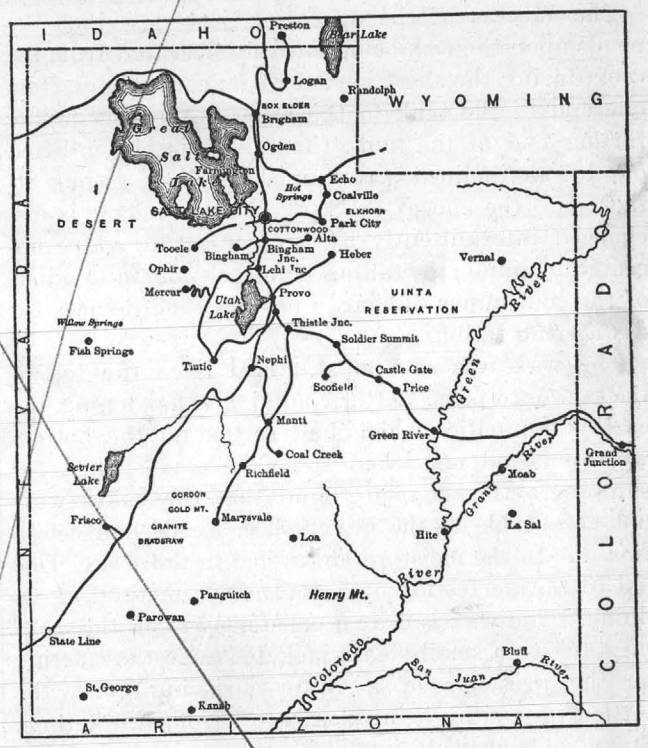
OZOKERITE IN UTAH.

Written for the MINING AND SCIENTIFIC PRESS
By H. W. MACFARREN.

Ozokerite may be characterized as a mineral wax or paraffin occurring in veins in the earth, usually in the vicinity of bituminous and petroleum deposits. It varies in color from brown to black, and has the appearance and consistence of wax, spermaceti, or paraffin. Analysis gives approximately 85% carbon and 15 hydrogen. Its specific gravity is 0.85 to 0.90, and its melting point 50 to 70°C. The fact that it is lighter than water and melts at a lower temperature than water volatilizes, plays an important part in the process of separating the wax from the rock gangue with which it occurs. While ozokerite can be put to practically all of the uses to which paraffin is applied, being essentially a paraffin, there are some uses for ozokerite for which there is no substitute, such as in the manufacture of certain kinds of shoe blacking and insulating material, and making phonographic records. It is refined into ceresin to be made into fine candles, ointments, pomades, floor wax, and similar objects, or to be used as a substitute for beeswax.

It is found in paying quantities in two localities only, in Galicia in Austria and in Utah in the United States. The Galician deposits have been and still are the principal source of supply. The wax occurs there in oil-bearing sandstones, shales, and sandy clays of the Tertiary age, as stringers of wax along the stratification of irregular fissures. The ore is mined by lessees working small blocks of ground. After sorting out the waste, the ore is boiled in water in kettles, the wax rising to the top and being skimmed.

As a result of the lessening yield of this field, the price of high-grade crude ozokerite has risen in late years from 6 to 16c. per pound. Ozokerite is found in the vicinity of Soldier Summit and Colton, Utah, on the Denver & Rio Grande railroad, 120 miles south of Salt Lake. It is noteworthy that it occurs here under the same geologic conditions as in far away Galicia—in shales, shaly sandstones, and limestones of the Tertiary period, and contiguous to great deposits of carbons and hydrocarbons. The wax is not found in the strata to the same extent as in Galicia, but rather in vertical fissures that cut the strata. These fissures form shear-zones, one wall of which is usually perfect, while the other is coarsely broken or brecciated. The wax is found as sheets or films between the walls and as stringers throughout the brecciated mass for a few feet away from the main fracture. It also occurs permeating the ground-up mass. These sheets are usually a fraction of an inch in thickness, but have been known to widen to form pockets of wax two or three feet across. In the museum of the California State Mining Bureau, Ferry Building, San Francisco, is a sheet of wax three-quarters of an inch in thickness that was taken from a Utah mine by me, which shows the characteristic occurrence of ozokerite. These mineralized fissures are generally of great length, and it is presumed of depth also, but uncertain as to width and percentage of wax. At the surface, or where the wax has been exposed, it tends to brittleness, but away from the surface, where it retains more of its volatile substances, it is soft and



Map of Utah.

flexible, and can be picked out and chewed like a paraffin chewing gum. There is a tendency for certain constituents of the wax to ooze out and stain the surrounding rock. This, together with the fact that the wax is approximately three times lighter in weight than the gangue or wall rock is liable to lead to erroneous conclusions as to the percentage of wax in the ore. All evidence tends to the conclusion that this ozokerite is the residual product of a petroleum, having a paraffin base, and was forced into these seams and fissures; the lighter hydrocarbons being subsequently volatilized, leaving the less volatile matter, or wax, behind. The same compound has been obtained from bituminous substances by destructive distillation.

The metallurgy of ozokerite as developed in Utah is simple. The ore is crushed in a breaker capable of crushing to one-quarter inch. Coal crushers and Sturtevant rotary crushers have been used. The

north of Mazuma, has at no time been as important as the other settlements.

The Seven Troughs mountains have a length of 24 miles and trend 20° east of north. The greatest width of the range is eight miles. Its crest culminates in a group of three summits. These attain altitudes of about 3000 ft. above the desert plains that surround the range on all sides but the north. The highest and middle summit is Granite peak. The one southwest of it, of schist, is designated Pahkeah peak on the Fortieth Parallel Survey map. A low broad pass, occupied according to this map by Miocene lake beds belonging to the Truckee formation, separates the north end of the Seven Troughs range from the longer Trinity range and from the Kamma mountains, a small group within which is the Rosebud mining district and the Rabbit Hole sulphur mine.

The known ore deposits of the Seven Troughs range are all in the Tertiary volcanic rocks, and consequently a small part only of the four days spent in the district could be devoted to the older formations. North of Mazuma the so-called Jurassic rocks appear first in Burnt canyon as a northeast-southwest belt of indurated clay slate about half a mile wide. This belt appears to correspond at this place to a low ridge, which, after having been completely buried under lava flows, has been uncovered again by erosion. The slate extends northeast and forms the rounded foothills just west of Farrell. It was found to be exposed westward along Stonehouse canyon nearly to its head. The dip varies and the slate is cut by dikes of a light-colored rock, presumably rhyolite. Near the head of the ravine the slate is intruded and metamorphosed by the 'younger granites', described by Hague and Emmons.

The intrusive granitic rock at the head of Stonehouse canyon is a fresh, medium-granular, rather dark gray rock, which evidently is not very quartzose and contains a large proportion of plagioclase. The microscope shows the rock to be a granodiorite.

The prevailing rock of the low, rounded hills on the edge of the Sage valley at Mazuma, and for a mile or more up Seven Troughs canyon is a pale reddish brown lava, much of which shows conspicuous flow lamination and a platy fracture. The rock is not a rhyolite but, pending chemical analysis, must provisionally be classed as a mica andesite, unusually poor in femic constituents. Much of it is a mica andesite vitrophyre. Associated with the mica andesite, which appears to occur in several thin flows, is at least one flow of vesicular basalt, some of which is exposed on the slope just north of the west end of Mazuma.

Directly under the vitrophyric andesite there is, as a rule, a flow of basalt. The thickness of this is not known but appears to vary greatly. Under this basalt and occupying the bottom of the Seven Troughs amphitheatre is a volcanic complex of rhyolite, basalt, mica andesite, tuffs, arkosic sandstones, and possibly other rocks of which the structural relations are as yet imperfectly known and which probably can be ascertained only by careful mapping and detailed microscopic work.

The most important group of mines is at Seven Troughs. Just southeast of the town, which lies on the south bank of the arroyo running down to Mazuma, are the Kindergarten and Wihuja mines, both on the same vein. The Kindergarten mine, owned by the Seven Troughs Kindergarten Mining Co., is developd by an adit and by an inclined shaft 280 ft. deep on the dip. A new vertical shaft, being sunk at the time of visit in August, 1908, was expected to cut the vein at a depth of about 300 ft. The Wihuja is a lease on the ground of the Seven Troughs Therien Gold Mining Co., and is opened by an inclined shaft to a vertical depth of about 212 ft. The Kindergarten and Wihuja workings are connected. Other leases on Therien ground, in operation but not productive in 1908, were the Bard and Jess (175 ft. deep), the Tyler, and the Sandifer leases. On the north side of the canyon, close to town, are the Mazuma Hills and Reagan mines, both productive. The Mazuma Hills mine is owned and operated by the Mazuma Hills Mining Co.; the Reagan is a lease on a vein lying east of the Mazuma Hills vein, but within the ground of that company. The Mazuma Hills mine is opened by a main adit 700 ft. long. Winzes from this adit connect with a level 100 ft. below and about 500 ft. long. There is also an upper disused adit about 100 ft. above the main level. The Reagan is worked through a shaft that was 165 ft. deep at the time of visit. Only the 65-ft. level, however, could then be examined, the bottom level being temporarily under water, pending the installation of pumps. South of the Mazuma Hills and Reagan mines is the Sandifer lease on Therien ground. Here, in the bottom of the canyon, a shaft is being sunk in expectation of finding ore in the southern parts of the Mazuma Hills and Reagan veins. North of the Reagan shaft, on the same fissure zone, are the Chadbourne and Bradley leases, whose shafts are respectively 135 and 165 ft. deep. Neither had been productive up to August, 1908. On the hillside a short distance above the mouth of the Mazuma Hills adit is the shaft of the Hayes-Mazuma lease. This was being sunk through rhyolite at the time of visit and was not in ore. Between the workings mentioned and the head of the ravine north of Seven Troughs are the Eclipse shaft, Providence adit, and various smaller unproductive openings made by lessees and prospectors. On the north side of Seven Troughs canyon, about a quarter of a mile below the town, is the adit of the Seven Troughs Tomboy Mining Co. This is a cross-cut running N. 50° E. At the time of visit it was 800 ft. long, and the intention of the company was to carry it 400 ft. farther. The adit first penetrates about 150 ft. of rhyolite and then goes through a seam of gouge into soft pyritized tufaceous beds with a general low dip to the northeast. These are cut by many faults, probably of small throw, and contain some masses of basalt. About 350 ft. from the portal the adit goes through another seam of gouge into rhyolitic (or possibly andesitic) breccia cut by dikes of glass or obsidian. Lower down the canyon, near Mazuma, considerable tunneling has been done on the Badger group of claims. These workings were not examined. In Wildhorse canyon prospecting was in

progress in 1908 on the Wild Bull, North Pole, and other claims. The Wild Bull showed a little ore, but no shipments had been made. North of this canyon the only active prospecting appeared to be on the Snow Squall claim in Victor canyon, south of Farrell. It was reported that lessees had found good ore in sinking their shaft, but the workings were not visited. From the saddle south of Seven Troughs a long ravine runs south and then turns southeast, embouching at Vernon. In the upper part of this ravine is the Dixie Queen shaft 230 ft. deep and the Cleghorn Consolidated and Signal adits, from 200 to 300 ft. in length. Some lessees also were operating in 1908 on property of the Signal Peak Mining Co., high up on the ridge south of Seven Troughs, but owing to lack of time their shaft was not visited. About halfway down the canyon and about two miles south of Seven Troughs is the Fairview mine, reported at the time of visit to be 650 ft. deep. This mine is known to have had some bunches of very rich ore in the upper levels and is said to have shipped about $65,000. No stoping was in progress at the time of visit and the shaft was being sunk through hard basalt. The mine is owned by practically the same people that control the Kindergarten and Therien properties at Seven Troughs. In contrast to the attitude of other mine-owners in the district they showed disinclination to impart information and refused access to the Fairview mine. Adjoining the Fairview workings on the north is the Harris lease, on Fairview ground, with a shaft 185 ft. deep. The dump is basalt, much of it being vesicular. There were two mills in operation in the latter part of 1908, one belonging to the Kindergarten company and situated at Seven Troughs, the other belonging to the Mazuma Hills company and situated at Mazuma. Both are 10-stamp mills with amalgamating plates, Wilfleys, and vanners. No attempt is made to cyanide the tailing or save it.

Most of the dikes and fissures near Seven Troughs have a nearly north-south trend. The veins as a whole consist of soft crushed material and do not outcrop above the surface. They represent zones of brecciation or of small fissures, along which movement has continued since the spaces originally formed were filled with quartz. Consequently the typical quartz of the district is friable or sugary, and generally contains or is mingled with many fragments of shattered rock. Clear solid masses of quartz, even of small size, are rare. The veins on the whole are rather narrow, ranging from a few inches up to about two feet in width. It is possible, however, that the average working width may be considerably increased when the district has better facilities for handling and treating ore.

The valuable constituent of the lodes is native gold containing a considerable proportion of silver, and consequently of a rather pale color. In most of the rich ore the gold is visible either as clusters of small irregular particles or as coarse crystalline aggregates. No complete well formed crystals were seen, but there is a noticeable tendency of the coarser gold to form crystal facets. The Mazuma Hills, Reagan, and Fairview mines have afforded some very showy specimens of bright yellow gold interlaminated with firm quartz or enveloping fragments of altered country rock. Loose nugget-like masses up to an ounce in weight have been found in soft crushed vein matter in the Reagan lease. The rich bunches of gold are not uniformly distributed through the veins, and it is difficult in some cases to secure clean sorting. It was found, for example, that material thrown over the Reagan dump as waste or as low-grade ore to be treated later carried small quartz stringers, and that some of these, when broken across, contained coarse native gold.

The tenor of the ores, as is to be expected, has a wide range. A mill run from the Reagan lease in August, 1908, averaged about $130 per ton. Picked ore from the Fairview, Mazuma Hills, and Reagan mines has yielded at the rate of several thousand dollars per ton. In the Kindergarten mine the ratio of gold to silver by weight is said to vary from 1 : 2 to 1 : 3 near the surface, but at the bottom of the mine to be nearly 1 : 1. Assay certificates of rich ore from the Reagan lease, seen in Seven Troughs, showed a ratio of nearly 2 of gold to 1 of silver. At one place on the lower level of the Mazuma Hills mine quartz carrying a little chalcopyrite is reported to have yielded on assay 200 oz. of silver and 0.3 oz. of gold per ton.

The three important veins near Seven Troughs are the Mazuma Hills, Reagan, and Kindergarten veins. The first two, known only on the north side of the canyon, strike about N. 10° E. and dip from 60 to 65° W. The Reagan vein lies about 40 ft. east of the Mazuma Hills vein. The Kindergarten vein, on the south side of the canyon, strikes N. 63° E. and dips south. The dip varies from 60° near the surface to 22° on some parts of the 40-ft. level. The dip at the bottom level is about 35° (vertical depth 212 ft.). The stope length of the ore-shoot is about 130 ft., and the average workable width of ore is probably about 2. At the northeast end of the mine the vein appears to be cut off by a zone of north-south fissures in which no ore had been found at the time of visit.

The country rock varies from place to place in each mine. The Kindergarten and Wihuja workings, as seen in 1908, are mainly in basalt. Part of this is a soft altered amygdaloidal variety, evidently an extrusive rock. Other parts are a dense olivinitic variety that apparently cuts the amygdaloidal flow rock. Masses of soft light-colored rock, either rhyolite or mica andesite, but too decomposed as a rule for satisfactory determination, occur at unexpected places on both sides of the vein. They probably represent intrusions somewhat displaced by faulting.

The Mazuma Hills vein follows a basalt dike that varies in width from a fraction of an inch to more than 6 ft. The general country rock is a nearly white altered rock that the microscope shows to have been originally a highly glassy rhyolitic tuff or flow breccia. It is now devitrified into a fine-grained, obscurely crystalline aggregate and contains minute disseminated crystals of pyrite. The best ore is on the foot-wall or east side of the dike, and appears to be for the most part minutely fissured and silicified rhyolite tuff; but some ore extends into the basalt. At one place there is a second vein, about 10

ft. east of the main fissure zone and with a little lower dip. The horse of rhyolite tuff between the two is said to be all low-grade ore. Some of the best ore in the mine is reported to occur as small gold-bearing stringers traversing hard rhyolitic tuff.

The Reagan vein also follows a basaltic dike and shows considerable resemblance to the Mazuma Hills vein. The general country rock, however, is more varied. Much of it is a highly altered volcanic glass, apparently basaltic, which, owing to its originally brittle character, has been elaborately and minutely cracked and fissured. Many of the cracks are microscopic and have a perlitic arrangement. This rock is generally greenish gray, and much of it is so fine-grained that its mineralogical character can not be ascertained under the microscope. Other varieties show a few microscopic phenocrysts of plagioclase, partly altered to calcite, and a groundmass in which traces of an original microlitic texture can be detected. Much of the rich ore of the Reagan lease consists of this altered basaltic glass, in which the irregular cracks have been filled with quartz carrying free gold. The secondary minerals identified in the glass itself are pyrite, quartz, calcite, and apparently a little chlorite. Calcite is not abundant, which is rather surprising in view of the calcic composition of basalt. In some places altered glass of the kind described passes into a highly amygdaloidal variety that is well exposed in an adit on the Sandifer lease just south of the Reagan mine and in the Bradley lease to the north. In the Sandifer lease the vesicles are only partly filled by clear projecting crystals of quartz. In the Bradley lease some are filled with quartz and some with calcite. Pyrite is disseminated through the light greenish gray altered substance of both varieties, and a few vesicles were noted that were first lined with pyrite and then filled with quartz. Although pyrite is fairly abundant throughout the altered basaltic and tufaceous rocks near the ores, and occurs with quartz in very small, almost microscopic veinlets, it appears to be rare in the generally larger veinlets in which are the visible particles of gold. These veinlets, so far as could be seen in 1908, contain little or no pyrite. According to D. H. Skea, some proustite and possibly some stephanite or polybasite were found with the gold in the Fairview mine, and a little chalcopyrite and specks of a gray mineral resembling bornite were noted in 1908 on the bottom level of the Mazuma Hills mine in quartz similar to that elsewhere rich in gold; but as a rule the auriferous quartz is notably free from any other mineral than gold. Stibnite occurs in friable lenticular masses of considerable size in soft crushed basalt in the Chadbourne lease, and is said to have been found also in the Reagan lease. It does not, however, appear to have any intimate connection with rich ore. A little native silver is said to have been panned from the ore of the Wild Bull mine in Wildhorse canyon.

All of the ore visible in 1908 was within the range of oxidation. The results of weathering, however, owing to the very small quantity of pyrite in the veinlets, are not conspicuous, and there appears to be no very definite change from oxidized to sulphide ores. Pyrite and stibnite, as has been seen, both occur in connection with the ore deposits above the ground-water level. The surface of the underground water near Seven Troughs corresponds approximately to the bottom of the canyon, in which is some running water, and doubtless rises a little higher in the adjacent ridges. In August, 1908, water was just making its appearance in the bottom of the Kindergarten mine at a depth of 212 ft., and the lessees of the Reagan, 165 ft. deep, were putting in a pump in order to work their lower level.

Not enough mining or geologic work has been done to enable anyone to pass final judgment on the future of the Seven Troughs district. The presence of very rich, easily treated gold-silver ore in fair abundance at several places within an area some six miles in length is highly encouraging. On the other hand, it should be noted that the veins are not of great size and apparently are not as a rule of great length or persistence, and their character at any considerable depth below possible superficial enrichment is yet undertermined. Moreover, it is evident that in most of the mines the country rock may be expected to differ at various depths, and it is yet to be proved that the rocks beneath the tuffs and basalt in which most of the known ore occurs will be equally productive. In short, while the district is a most promising one for prospecting and developing, it is yet too early to regard it as one certain to yield largely for a period of many years.

The Prospector.

This department makes a charge of 25 cents to subscribers not in arrears and $3 to non-subscribers for each determination. To ensure promptness in publication of the determinations, payment must be forwarded with specimens.

F. P. S., Robinson, Utah: Altered dioritic rock.

W. H. S., Lundy, California: Limonite with quartz.

R. J. H., Agua Salada, Mexico: No. 1 and 2 are altered gabbroitic rock.

D. A. H., Telluride, Colorado: The black specimen is obsidian and the white rock is quartz porphyry.

E. S., Michoacan, Mexico: No. 1, basalt; No. 2, andesite; No. 3, andesite; No. 4, andesite; No. 5, porphyrite; No. 6, metamorphosed volcanic; No. 7, jasper.

E. C. M., Mazuma, Nevada: No. 1, clay with pyrite crystals; No. 2, chloritic mass with pyrite; No. 3, chlorite and calcite; No. 4, silicious limestone with pyrite.

Zinc ferrocyanide, according to Rupp, may be determined as follows: the Zn solution is made as neutral as possible and Rochelle salt added. It is then mixed with a known volume of ferrocyanide solution, diluted to 50 or 100 c.c., and allowed to stand about ½ hr. for the formation of the denser $K_2Zn_3(FeCy_6)_2$. Then an excess of N/10 I solution (measured) is stirred in, and the mixture allowed to stand for 1 hr., when it is titrated with $Na_2S_2O_3$. Ferricyanide results from the action of the I on the K_2FeCy_6. 1 c.c. N/10 I = 0.00981 Zn.

Discussion.

Readers of the MINING AND SCIENTIFIC PRESS are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes the expression of views contrary to his own, believing that careful criticism is more valuable than casual compliment. Insertion of any contribution is determined by its probable interest to the readers of this journal.

Theory of Volcanic Action and Ore Deposition.

The Editor:

Sir—In a recent paper read before the members of the Institution of Mining & Metallurgy, in London, Hiram W. Hixon advances a new and interesting theory of volcanic action and ore deposition. The basis of this theory is that the earth was at one time an incandescent sun, with a temperature above the critical temperature of all the matter composing it. Dalton showed that gases of different densities, if allowed to mix, would form, in time, a uniform gaseous mixture. Hence it follows that each gas entering into the composition of such a sun would diffuse throughout the whole planet, even though its density at the centre were greater than the density of the corresponding solid. Considering for the moment that the present condition of the earth is derived from the gaseous state mentioned, Mr. Hixon maintains that it differs therefrom only through the pressure of a crust imprisoning the gases and exerting great pressure upon them.

It is said that a rigidity equal to that of a sphere of steel would be required to resist the tidal action. The question immediately arises as to the limit of rigidity to which gases under pressure may attain. Rigidity is a property of solids acquired by the reduction of the amplitude of vibration of their molecules with relation to each other. If by pressure upon a gas, existing at a temperature above its critical temperature, the amplitude of its molecular vibrations be made less than in the corresponding solid, its density must be greater.

It is known that there is an increase in temperature of approximately 1°C. for each 100 ft. of depth. This places the zone of critical temperature about one hundred miles below the surface, and it means that all matter from the limits of this zone to the centre of the earth is in a gaseous state. Through secular cooling the outer surface of this zone is reduced below the critical temperature of a part of some of the elemental or combined gases diffused through it. Since pressure will raise the melting point of a solid, enough pressure will raise it to the critical temperature; and the solid will pass directly to the gaseous state, or vice versa, without becoming a liquid. The gases will pass, then, to the solid state, and expand in so doing, it being assumed that the pressure has given the gas a greater density than the corresponding solid. Thus would result an addition of matter of high critical temperature to the flowage zone of the solid crust. The gases of low critical temperature would saturate the flowage zone and segregate at its outer rim, or just beneath the zone of fracture. Here they would accumulate until super-saturation of the periphery of the flowage zone resulted and sufficient elastic force to rupture the zone of fracture had accrued. In escaping through the zone of fracture, these gases of low critical temperature give rise to the phenomena of volcanic action, earthquakes, elevations, intrusion of dikes and laccoliths, faulting and folding, accumulation of hydro-carbons, and ore deposition. The above theory leads to some interesting deductions, and explains much that has hitherto caused wide differences in opinion.

THORINGTON CHASE.

Concepción del Oro, Mexico, November 21.

The Qualified Mining Engineer.

The Editor:

Sir—Some hold that only the man who has had a university training and can write E. M. after his name has a right to the title of mining engineer. I would suggest that the only degree which a university should grant to a young fellow after three or four years study, should be that of Q. S. M. or Qualified Student of Mining, or possibly A. E. M., Associate Engineer of Mines; never E. M. In my opinion a mining engineer is a man qualified to solve the problems of mining, without regard to how, when, or where he acquired the knowledge. A university student is no more qualified than a junior lieutenant is to be general. An engineering course at a university does not by any means guarantee that a young fellow will ever become a mining engineer. It only gives him a good start. In practical life mining might even be distasteful to him. An engineer, especially a mining engineer, is first born, then discovers that he has the instinct, and is finally molded by circumstances, and proved by his results. I believe that the older men of the profession will endorse this; but what the public and the investor want to know is how to judge an engineer and whom to trust. The routine of another branch of the profession, marine engineering, might be copied.

In the mine the safety of the lives of hundreds of men, and the security of vast investments is just as dependent upon the engineer as in the case of a ship at sea. Why then should not the title of Mining Engineer be given only after examination? Mining is the life of every new country, and everything that can be done to stimulate the industry and to train the rising generation to higher efficiency is of economic value to the nation. To insure that the men directing mines are properly qualified would be the first and most certain method of increasing the wealth resulting from mining and of giving guarantee to the investor. The best means of doing this and of solving the question, who is a Mining Engineer, would be to bring the various universities and schools of mines and the Geological Survey into relationship with a strong Federal Department of Mines. A competent board of examiners should be appointed with powers to confer progressive degrees, titles, and licenses; the routine being more or less as follows: Any person who desires to enter the profession should register as an S. M., that is a Student of Mining. If he enters any school of mines or university and goes through the regular course he might receive the degree of A. E. M., Associate Engineer of Mines, subject to examination. If the individual is actually employed at mining or other work, and is gaining

Influence of Wall Rocks.

Seven Troughs District, Nev. USGS Bul. 414. Abs. in MSP 12-11-09.
Section: Top Mica andesite(?), as several thin flows; associated with it is a flow of vesicular basalt.
Basalt, very variable thickness. Flow.
Volcanic complex. Rhyolite, basalt, mica andesite, tuffs, arkosic ss.

Most of the (basalt) dikes and the fissures trend N-S. Veins are soft, crushed; do not crop out above the surface. They represent zones of brecciation or of small fissures; post-mineral movement along these has made sugar qtz. Native gold, with considerable admixed silver, as clusters of small irregular particles or as coarse crystalline aggregates. No complete crystal form, but coarser gold forms crystal facets. Often interlaminated with form quartz or envelloping fragments of altered country rock. Or as loose nugget-like masses up to an ounce in wt. in soft crushed vein-matter. Gold-silver ratio 1:2 to 1:3 near the surface, but at the bottom of the mine was nearly 1:1. At one place in the lower levels of one of the mines a little ccpy yielded 200 oz. Ag. and 0.3 oz. Au.

The two main N-S veins dip 60-65°W; the Kindergarten vein strikes N63°E, dips S, 60° near surface, 22° in some parts of the 40' level, 35° on the lowest level, 212' vertically below the surface. The country rock of this vein is basalt. Some of this is soft, altered, amygdaloidal, evidently a flow; other parts are dense, olivinitic, apparently cutting the flow.

The Mazuma Hills vein, one of the N-S veins, follows a basalt dike from a fraction of an inch to over 6' wide. Country rock is white, altered originally a highly glassy rhyolitic tuff or flow-breccia. Now devitrified. Best ore is on the FW (E) side of the dike; it is for the most part minutely fissured and silicified rhyolite tuff. Some ore extends into the basalt.

The Reagan vein, the other important N-S vein, also follows a basalt dike. CR varies: much of it is highly altered basaltic volcanic glass; owing to its original brittle nature, it has been elaborately and minutely cracked and fissured. Many of the cracks are microscopic and have a perlitic arrangement. The irregular cracks have been filled with quartz carrying free gold. Secondary minerals identified in the glass are pyrite, quartz, calcite, probably a little chlorite.

Pyrite is nearly absent in the larger veinlets carrying visible gold, tho' present disseminated and with qtz. in microscopic veinlets. Some proustite occurs with the gold, and a little ccpy. The auriferous qtz. is notably free, in general, from any mineral but gold.

The veins are notably narrow, average stoping width 2'.

first-stage gangue, one might suspect that with the footwall block the actively-moving one, pushing upward past a passive hanging wall block, it would be the hanging wall rather than the footwall of the early vein that would be torn open. In the main ore shoot of the Dolores mine followed the hanging wall. The quartz with which the ore minerals were associated was almost devoid of calcite and was later than the bulk of the calcite. The rest of the vein, toward the footwall, carried more calcite than quartz and was barren.

It seems likely therefore that the footwall blocks of these vein-faults moved upward with respect to sea-level; the faults were non-rotational, synthetic, and aided the uplift.

Seven Troughs, Nevada

Source.-

R.L. Ransome (1909), Notes on some mining districts in Humboldt County, Nevada,, U.S. Geol. Survey Bull. 414, p. 14-25.

Title

This minor gold-silver district lies in northwestern Nevada, 40 miles west of the Star Peak district (Plate 1), and in the southeast portion of the isolated Seven Troughs Range, which north-northeast east for 20 miles.

The country rock of the small mining districts consists of bedded volcanics intruded by basalt and andesite dikes. The oldest exposed extrusive series comprises glassy tuff and arkosic grit interbedded with a basalt flow. Apparently overlying this series is a body of rhyolite, either a flow or an intrusive. The highest exposed formation is one of andesite flows similar to the andesite dikes which cut the lower formations.

Structure.- The bedded rocks are folded into a sharp north-south anticline with the tuff-grit series in its core, exposed in a longitudinal valley. The andesite flows rim the valley and dip east and west away

from the anticlinal axis. The dikes strike parallel with that axis.

Mineralization.- The vein fissures strike mainly north and south with the dikes. The veins range from a few inches to several feet in width; the gangue is quartz. Apparently ore mined was entirely oxidized; at any rate the only sulphide mentioned is stibnite. Gold occurred native and alloyed with silver.

The veins are younger than the dikes: ore in one vein following a basalt dike made partly in the dike, although mainly in the rhyolite tuff intruded by the dike.

Tectonic Notes.- The three important veins lie on the east flank of the anticline; two strike north, with the anticlinal axis and dip about 63° west, toward the axial plane. These veins follow basalt dikes. The third vein strikes east-northeast and dips flatly south, showing an attitude anomolous with respect to the normal anticlinal fracture pattern.

Post-mineral fault movements along the vein-fractures are manifested by extensive crushing and brecciation of the quartz.

Here is one more example of dikes intruding tension fissures during axial uplift under vertical forces; of mineralization following dike intrusion; of faulting along the vein-fractures following vein formation. This sequence was pointed out long ago by Spurr (1916, p.601-622) as characteristic of many mining districts.

Chañarcillo, Chile

Source.-

W.L. Whitehead (1942), The Chañarcillo silver district, Chile, in Ore deposits as related to structural features, Princrton Univ. Press.

title

Chañarcillo, with a production of over 75,000,000 punces of silver, lies between the Coast Ranges and the Cordillera.

or punches?
or pounces?

For Edward Wisser

Outline Report
Geology of Seven Troughs District
Pershing County, Nevada

ROCKS OF THE DISTRICT

Oldest rocks in the district are the Mesozoic meta-sediments and the intruding granodiorite. I have generalized the meta sediment - granodiorite contacts. Overlying the Mesozoic rocks unconformably is a white, altered quartz-eye rhyolite with occasional tuff beds that looks very much like the Hartford Hill that we have seen elsewhere. In places this earliest volcanic loses the quartz-eyes and becomes flow-banded and I have called this a latite of the Hartford Hill formation. This latite does not appear to be either a younger or older member of the Hartford Hill but it appears to intertongue with the Hartford Hill quartz-eye rhyolites. Overlying the Hartford Hill formation unconformably is a basalt and basaltic andesite unit that contains scoreaceous beds with the vesicles filled with chalcedony and/or clay. There are in this unit beds of partially devitrified glass. This basalt and andesitic basalt looks very much the same as the Chloropagus formation as mapped by the Nevada Bureau of Mines, just north of Highway 40 towards Olinghouse and I have therefore classified this unit as the Chloropagus. At the southwest end of the Chloropagus outcrop there is a massive white, partially consolidted tuff. This tuff contains fragments and pebbles of the partially devitrified glass but I could find none of the scoraceous basalts or basaltic andesites. I have therefore placed this unit in the Chloropagus formation perhaps as an interbedded tongue. This tuffaceous unit may be somewhat the same thing as the white beds that occur in the Truckee River canyon near Clark Station that have been called ~~Bisbee~~ Thisbee formation. Youngest rocks in the district are Quaternary basalts which overlie the Chloropagus unconformably.

STRUCTURE OF THE DISTRICT

There appears to be three fault systems in the Seven Troughs District and these are: a northeasterly striking system, a northwesterly striking system, and a more or less northerly striking system. In general, it would appear that the northwesterly striking system has had the greatest amount of movement. The northeasterly striking system does not appear to have as much movement associated but does control alteration in the district. The more or less northerly striking system is not too well developed, although it does appear to have some movement.

GEOLOGIC HISTORY

In the Oligocene period, during the time of the Hartford Hill deposition, there was apparently a very thick accumulation of tuffs and ignimbrites in the Seven Troughs area in what may have been a pre-formed basin on the eroded surface of the Mesozoic rocks. Before the Miocene period and the deposition of the Chloropagus formation, the three fault systems must have developed since, at one place or another, Chloropagus age dikes are seen occupying fractures of all three fault systems. There probably was some movement along these fault systems and the development of a topography of some relief. Thus, at the close of the Oligocene and before the Miocene and the deposition of the Chloropagus, the southern block was probably topographically the lowest and stratigraphically the ~~lowest~~ highest, the middle block was probably topographically and stratigraphically intermediate, and the northern block was topographically the highest and stratigraphically the ~~highest~~ lowest.

During the Miocene, the Chloropagus was poured out over this surface of some relief and the deposition of the precious metals probably was the last phase of this activity.

Following and perhaps during the deposition of the Chloropagus formation and the implacement of the precious metal deposits, movement along the fault zones was probably renewed

with further uplift of the middle block relative to the southern, and with uplift of the northern block relative to the middle block. Subsequent erosion stripped off some of the Chloropagus rocks in the southern block, completely stripped off the Chloropagus in the middle block, and removed not only the Chloropagus but most of the Hartford Hill in the northern block.

ORE DEPOSITION

All of the ore deposits and prospects have the Hartford Hill formation on at least one wall. Most of the deposits are entirely in Hartford Hill or are in and along dikes which cut the Hartford Hill formation. There are no deposits of any consequence inthe district with the Chloropagus formation forming both walls.

As elsewhere in Western Nevada, the Hartford Hill formation is extremely altered. The latite member of the Hartford Hill does not appear to be as altered as the quartz-eye rhyolite member. It is a problem to unravel [redacted] alteration connected with the epithermal activity and [redacted] alteration of the pervasive type. In general, the pervasive type of alteration is an albitization, however there is apparently some development of clay minerals with this pervasive alteration. The epithermal alteration always appears to be a softening of the rock and development of clay minerals. This epithermal alteration appears to be in a belt flanking the northeast trending structures. There is some of this type of alteration along the northerly trending structures but it appears to be almost absent along the northwest structures.

In the southern portion of the southern block most of the mineralization appears to be along northeast trending fractures having the Hartford Hill quartz-eye rhyolite on both walls. There are a very few deposits in this area that have one wall of Hartford Hill and the other of Chloropagus.

In the north portion of the southern block and in the middle block, all mineralization appears to be in or along the walls of Chloropagus age dikes or intrusives. In the middle block, the Hartford Hill formation is mostly the latite variety and alteration along the northeast structures is not as widespread. In the northern block there are very few prospects ~~for~~ or deposits and those that do exist are along northeast trending structures.

Since there is fairly good evidence that the epithermal mineralization was contemporaneous with or just after the deposition of the Chloropagus formation, the question arises of why there are no deposits in the areas of thick Chloropagus flows. One [redacted] answer to this question which seems likely is that there [redacted] may be deposits in the areas of thick Chloropagus formation but that, at the time of precious metals deposition, these Chloropagus areas were above the top of ore and that fractures in the Chloropagus which may go down into ore are perhaps weak and insignificant appearing at the present surface.

DEPOSITS & PROSPECTS OF THE DISTRICT

Speaking generally about the deposits, those in the southern block are generally along fractures which show rather heavy gouges on one wall or the other. Quartz is very scarce or absent except in those deposits in the Hartford Hill formation at the north portion of the northern block. Here there is rather intense silicification of the Hartford Hill along the northeast trending structures and occasional white opaque to vitreous quartz veins. Iron oxides and pyrite are in evidence on some of the dumps. Those deposits which are in or along Chloropagus age dikes are devoid of quartz but do contain iron oxides and pyrite. Most of the production from this type of deposit appears to come from stoping along the walls of the dike rather than within the dike.

Descriptions of the various deposits follow:

1. Six to eight feet shearing and gouge. Quartz absent. Iron oxides prevalent.

2. Numeral 2 is not a deposit at all. In looking over my notes on the backs of the ~~sheets~~ photos I note that it is a rock description and not a deposit.

3. Vein is 10 feet gouge and rubble with iron oxide. Very minor quartz with much flanking alteration.

4. Vein is 10 feet gouge and rubble with much flanking clay alteration. Minor iron oxide. No quartz or calcite.

5. Few iron oxide stained shears exposed in ± 100' shaft.

6. Numeral 6 is also a rock description and not a vein description.

7. Vein is 6 feet of gouge and shearing with much iron oxide staining. Minor gypsum and calcite stringers 1/8" to 1/2" wide scattered through shear zone. West wall is very highly fractured and clay altered.

8. Vein is 10 feet gouge and rubble with moderate iron oxide staining. Very few ± 1/4" quartz and calcite stringers scattered through zone. Much flanking clay alteration.

9. Large shaft probably in excess of 500' deep. No structure visible. Dump shows much altered quartz-eye rhyolite with disseminated pyrite, very minor white opaque to vitreous quartz in veinlets 2" to 3" wide. Some pyrite blebs in quartz veinlets.

10. Eight feet gouge and rubble. Strong flanking clay alteration. Very few quartz stringers 1/8" to 1/4" scattered throughout zone. Moderate to minor iron oxide staining.

11. Eight to 10 feet shearing, gouge and rubble. Strong alteration flanking zone. Minor iron oxide with very few 1/2" to 1" vitreous quartz stringers in zone.

12. It appears that most of the Seven Troughs production came from this mine. Judging from what remains there, the main mine entry was by way of a shaft that might have been 500 feet and perhaps more than 1000 feet. There are several other fairly long tunnels in the immediate area and a great number of prospect pits. The shaft went down on a structure which flanks the northeast side of a Chloropagus age dike, but the dumps show a great deal of clay altered quartz-eye rhyolite and Hartford Hill latite which shows evidence of disseminated pyrite. Judging from the general alignment of prospect pits, I imagine the major development was along and within the northwest trending dike. The main shaft is caved at the collar and the steel headframe has fallen into the cave so that very little can be seen of the structure developed by the shaft. As mentioned above, the dumps in this area are mostly altered quartz-eye rhyolite and latite with some Chloropagus dike material. Most of the dump material shows strong alteration and evidence of disseminated pyrite. Quartz and calcite are sparse and appear to have been in small veinlets.

13. This area is the northern continuation of the main Seven Troughs area across Seven Troughs canyon. Here, as in the area just to the south, major development is along and within Chloropagus dikes. The dump material is a mixture of andesite and clay altered rhyolite and latite, showing evidence of disseminated pyrite with very little quartz and/or calcite.

14. This is an area of numeraus prospect pits and shafts. Most of the prospecting appears to be along northeast trending structures which have Chloropagus dikes associated. The greatest amount of work appears to have taken place within the irregular shaped Chloropagus intrusive. Judging from those exposures along dikes which can be seen and from material on the dump, there is no associated quartz with this mineralization inand along the Chloropagus intrusives. Major mineralization appears to have been pyrite with perhaps some other sulfides associated. Where these Chloropagus intrusives have been prospected, the intrusives themselves are highly altered which would seem to indicate that the surge of mineralization came following the extrusion of the Chloropagus rocks.

15. This is again a development along a structure flanking a Chloropagus dike. As elsewhere, quartz is absent, iron oxide is quite plentiful, indicating that the major mineralization was pyrite and perhaps other sulfides. Alteration in the flanking latite and in the Chloropagus dike material is extensive clay alteration

16. This is one of the very few prospects that I saw that is entirely in the Mesozoic basement rocks. It is nothing more than a series of test pits along a northeast trending structure. The structure appears to be perhaps 5 feet of gouge and rubble with extensive clay alteration on either side. There is no evidence of quartz or calcite and iron oxide is not prevalent.

17. This prospect is composed of a shallow shaft, probably not more than 200' deep, and two short prospect adits driven along one of the northeast trending structures. There is some Chloropagus dike material on the dumps but the surface trace of the dike could not be seen. Here, as elsewhere, the mineralization appears to be a 5' to 6' shear zone with flanking clay alteration. Quartz is absent and iron oxide is moderate to weak.

18. This is the only strong quartz vein seen in the entire district. The general zone is 8 feet of shearing with very extensive flanking alteration. At the center of this shear zone is a 2-foot white bull quartz vein with crystal lined vugs. Judging from material on the dump, there was very little sulfide in this quartz vein and whatever values the old prospectors found here must have come from the area immediately flanking the quartz vein where rather strong iron oxide is developed.

19. This prospect has, as its west wall, the Mesozoic granite. Alteration on the granite side of the shear is 3' to 4' of clay alteration. On the Hartford Hill side of the shear, the entire mass of rhyolite is altered. There is on the dump and in the test pits on this structure a few 1/2" to 1" white bull quartz veins. Iron oxide is rather weak.

20. This area is at the extreme northern edge of our northernmost photo and is so distorted that I could not map any of the structure in detail and a verbal description will have to suffice for the prospects in this area. It is described as a thin remnant of Hartford Hill quartz-eye rhyolite lying on granodiorite. The rhyolite is intensely argillized with much pervasive silicification. There are two 10' to 20' silicified ribs trending northeasterly. These silicified ribs are quite vuggy and iron stained but close inspection shows little evidence of sulfides in the silicified ribs.

Gene

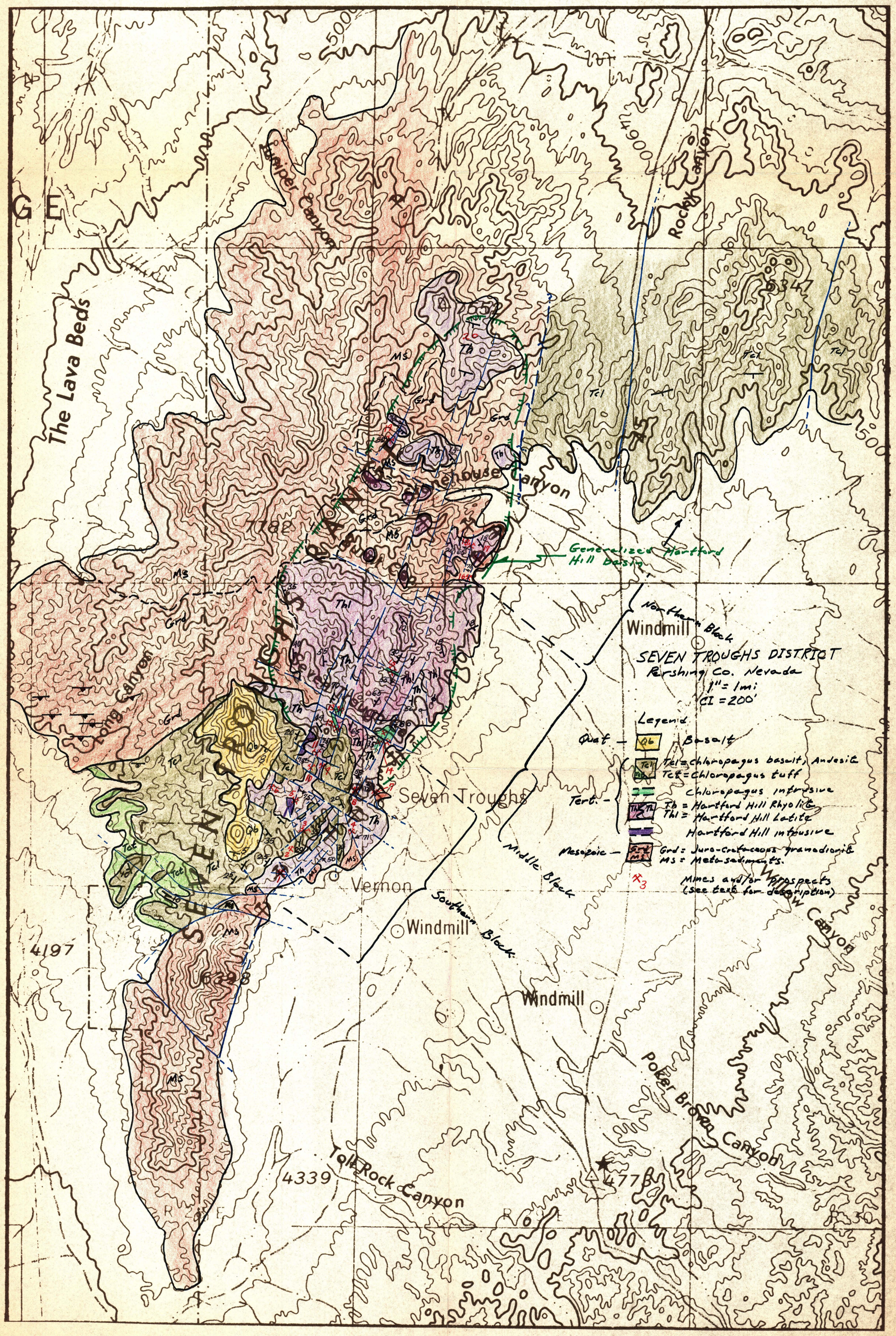
SEVEN TROUGHS, NEVADA PERSHING CO.

F.L.Ransome,1909, Notes on some mining districts in Humboldt Co.,Nev.USGS Bull.414,p.14-25.

3½ miles NW of Lovelock. Production ,1908-1921,$2,610,000. Narrow veins following basalt dikes in Tertiary extrusives consisting of an andesite flow overling a thin basalt flow,below which lie glassy tuffs and arkosic grits.

"The veins as a whole consist of soft,crushed material and do not outcrop above the surface." While stibnite occurs in the veins,it does not seem associated with rich ore;but ruby silvers occur also,so that As and Sb were probably liberated during oxidation.

Fact that veins do not stick up above surface,and presence of ruby silver makes this district a possible bet.


SEVEN TROUGHS DISTRICT
Pershing Co. Nevada
1" = 1mi
CI = 200'
Legend
Quat — Qb Basalt
Tcl = Chloropagus basalt, Andesite
Tct = Chloropagus tuff
Chloropagus intrusive
Tert. — Tb = Hartford Hill Rhyolite
Thl = Hartford Hill Latite
Hartford Hill intrusive
Mesozoic — Grd = Juro-Cretaceous granodiorite
MS = Meta-sediments.
Mines and/or prospects (see text for description)
Generalized Hartford Hill Basin
Northern Block
Middle Block
Southern Block
Seven Troughs
Windmill
Vernon
Juniper Canyon
Rocky Canyon
Long Canyon
Stonehouse Canyon
Poker Brown Canyon
Toll Rock Canyon
The Lava Beds
4197
4339
4778
6228
R 28 E
R 29 E