of these high summits and break through in conspicuous areas along their flanks and at the canyon level. The canyon is an area of depressions of ancient sedimentary formations, as might be expected from the vast accumulation of extrusive igneous rocks exhibited in its walls.

The Wallowa Mountains that border the canyon in Oregon, at a distance of from seven to 20 miles, are known as the Eagle Range on their eastern front parallel to the river. They are in fact an irregularly shaped uplift, 20 by 40 miles in area, predominantly of siliceous biotite granite, flanked with highly altered sedimentary formations. The summits of this great granite uplift present a remarkable exhibition of glaciation. Its drainage is entirely to Snake River through the Powder, Grande Ronde and Imnaha rivers, Eagle and Pine creeks.

All the streams mentioned originate in U-shape glacial valleys from five to 15 miles long, running to all points of the compass from a central nucleus and carrying many tell-tale ice-worn knobs along their floors, with numerous cirques and remnant glacial lakes, present one of the most conspicuous glaciated areas in the northwest, with a number of bare gray-white granite summits and connecting ridges ranging from 8,000 to 9,500 feet above sea level.

One of the high crests of these elevations is of dull brown diabase, 3,000 feet wide, which narrows to 300 feet in width at the foot of the mountain near Minam Lake, with a definite funnel-shape attitude of this basic intrusive into the siliceous gray granite.

In the strike of this intrusive dike to the north, on the opposite side of Minam Lake, a bold reef of mineralized granite or quartz monzanite, a thousand to two thousand feet wide and two miles long, is well stained at the surface with limonite patches and seams and in the sheltered portions of the cliffy outcrop the formation is quite richly stained with copper carbonate.

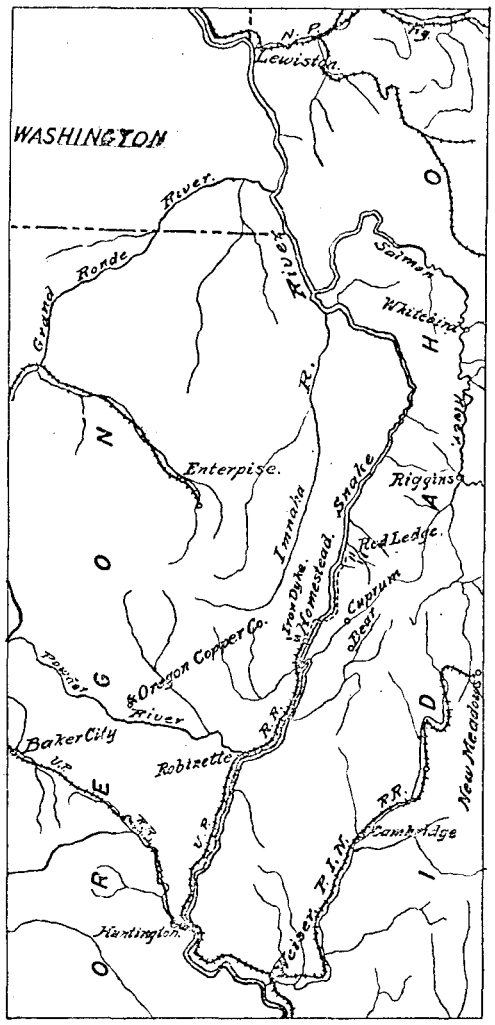
There is no development on this showing beyond a few 10-foot prospect holes which exhibit some conspicuous pitted patches of sericite and some joint plane showings of pyrite and chalcopyrite.

This great reef of mineralized granite is of questionable economic promise as a porphyry copper, but to the few of us who are left who saw the Utah Copper in its early cut stages when Colonel Wall was struggling to bring it to public attention and was considered an optimistic fool for his efforts, the contrast is not without merit. The chief object of this comparison is to emphasize the fact that the plutonic magma base of the formations under discussion is distinctly copper bearing at this and many other points in the Snake River mineral province.

Snake River forms the boundary line between Idaho and Oregon through its canyon course to the mouth of the Grande Ronde River, as illustrated by the accompanying sketch map of the region.

The history of the metal and mineral production of the Snake River Canyon dates back to the early gold discoveries of Baker county, Oregon, and the discovery of the Seven Devils bonanza copper ore belt adjacent to the middle section of the Canyon in Idaho, brought into prominence by the richness of its ores something like 40 years ago.

The gold production from small quartz filled fissures, some of notable richness and occuring in the sedimentary formations and eruptive granite slopes of the Oregon side of the canyon, in Baker



The Snake River Canyon country, eastern Oregon and western Idaho.

county, at distances varying from two to fifteen miles from the river, has totaled upwards of ten millions of dollars, and the production of the Iron Dike mine at Homestead in the same county is credited with an output of five million dollars gross value in crude, gold-bearing copper ore and concentrates, while the production of the mines on the Idaho slopes of the Canyon includes a million ounces of silver from the grey copper ore deposits of the mineral district three miles back from the river, and a conservative estimate of 20,000 tons of crude 20 per cent copper ore, principally in the form of bornite and copper carbonate minerals from the so-called contact metamorphic deposits of the Seven Devils district.

The copper ores of this great mineral province are almost uniformly associated with high ratios of gold and silver that seldom fall below $1.00 of value in the precious metals to one per cent of copper value in the larger disseminated deposits which should prove an imporatnt economic factor in their treatment.

In their surface expression, these ores occur as simple fissure veins, so-called contact metamorphic deposits, distinct disseminated porphyry copper types and as great siliceous shear zones, also fracture zones described by the older geologists as the "Catoctic type," common to the southern Appalachian region. These are usually associated with small veins of chalcocite and disseminated grains and flakes of native copper. Their occurrence so far has proven unimportant although in his Blue Mountain report, made thirty years ago, Lindgren describes a deposit of related character associated with amygdaloidal basalt flows, epidote and calcite minerals, to which he gives some analogy to the Lake Superior deposits. This particular showing described in some detail is situated a short distance west of the Oregon Copper Company's property near Medical Springs in Baker county, Oregon.

The only development activity in this entire field at this time is that of the Oregon Copper Company and Clover Creek Consolidated Mining Company, situated about 18 miles west of the canyon from the mouth of Powder River, and 25 miles east of Baker City, Oregon. These properties were brought to public attention several years ago by a veteran engineer of that region—John Arthur—as the result of development activities at Homestead and the Seven Devils deposits farther north.

The Oregon Copper Company's property is a consolidation of three former groups known as the Goose Creek, the Balm Creek and Poorman, and now carries a consolidated area of 171 mining claims. approximating one mile in width by five miles in length.

The property has recently been equipped with modern camp buildings, capable of accommodating a crew of one hundred men; an electric power line has been extended from Baker to the mine which supplies current for a 1,400-foot compressor and other auxiliary machinery for continuing the development campaign.

The property is being developed through two vertical shafts approximately 2,000 feet apart and now down 400 and 700 feet respectively, with 15,000 feet of underground work, disclosing at this time a proven ore reserve conservatively estimated at 300,000 tons, which from consistent sampling shows an average value of $10.00 per ton in copper and gold, and indicates a very probable additional reserve of equal volume and value in the present total development of the mine. The development is at a stage where the tonnage and values can be reasonably expected to expand very rapidly as the work progresses.

The individual ore courses of the Oregon Copper property vary from 10 to 100 feet in width, striking east and west and dipping south at high angles. They are mostly covered at the surface with a thin veneer of Columbia basalt flows varying from a few feet to 150 feet in thickness which has been eroded through by several shallow tributaries of Powder River, exposing the underlying ore bearing formations in brown and purple stained siliceous and gossany outcrops, in some instances carrying very excellent values up to $5.00 and $6.00 in gold across a width of as much as eighty feet, as at the Balm Creek ore body.

This ore shoot was first developed by surface adit tunnel to a face depth of 200 feet and later through a vertical shaft with three underground levels connected by an independent raise on the ore body. This shaft is now down 700 feet and an exploration of this ore shoot has been undertaken at that horizon.

This interesting ore body is pipe-like in shape, varying from 20 to 80 feet in cross section by 150 to 200 feet in length, its width being governed by economic limits as $4.00 values are taken as a minimum. There is no copper in the outcrop beyond some faint carbonate stains but disseminated chalcocite specks appear in the ore at the first adit level and chalcopyrite and pyrite came in with gradually in-

creasing proportions in both copper and gold as the development in depth progressed.

One of the most interesting cross sections of this ore body is at the 440 shaft level where a cross cut was driven through the ore and at this horizon oxidation was practically absent, the ore being predominantly clean unaltered chalcopyrite with a subordinate amount of associated pyrite.

This particular cross section of the ore body by careful sampling in five foot sections taking channel cuts of 10 pounds to the foot gave 2.9 per cent copper and $7.00 gold per ton, after rejecting one 10-foot section in the middle of the ore body that gave sampling results varying from 5 to 27 ounces gold per ton and as much as 20 per cent copper on some of the cleaner bands of chalcopyrite, for fear that these values would be of erratic occurrence.

The sulphide minerals occur in roughly banded form and indicate an originally sheared or sheeted rhyolite porphyry dike that has subsequently been mineralized with pyrite, chalcopyrite and silica of three distinct periods, according to thin section microscopic studies, giving quite definite evidence of continued and repeated mineralization and prospective deep seated range.

This Balm Creek ore body carries occasional strong showings of barite gangue which is believed to identify it with the vein in the Poorman workings and also with the great vein outcrop 180 feet wide on the Clover Creek Consolidated property to the west and a similar great barite bearing vein on Goose Creek near the east end of the property, extending over a total linear distance of seven miles.

The other developed ore resources on the Oregon Copper property are in the vicinity of the Poorman shaft, 2,000 feet east of the Balm Creek ore body. A drift has been extended at the 500-foot level between these two shafts the full distance and the Poorman shaft is now being deepened to intercept it.

At the Poorman shaft workings, a surface adit has been driven in on the course of the Poorman vein to the east for a distance of 1,200 feet and a similar long drift has been extended on this vein from the 150 foot shaft level. These two avenues are connected by raises.

Crosscuts extended from the adit drift exhibit a continuous vein varying from 10 to 40 feet in width, largely oxidized at this surface horizon but at the 150-foot shaft level this vein exhibited along the drift and in a dozen crosscuts is largely unoxidized chalcopyrite and carries average values of 2½ to 8 per cent copper and $1.80 in gold and silver.

Both from this shaft level and the surface adit, crosscuts have been extended to the south and have encountered the so-called Leached Vein. This is a steeply dipping fissure fifty feet wide and the position of the crosscuts indicates a definite strike length of 400 feet in fairly uniform wall boundaries.

The gangue of this great fissure is almost as porous as a piece of soft coke. It carries about one per cent copper in the form of scattered specks of chalcocite. This interesting leached gangue has been subjected to careful thin section studies and is believed to be a cindery residue of an original massive chalcopyrite ore which should mean a very important horizon of secondary chalcocite and high-grade shipping values when permanent water level is reached. It is confidentally expected that this enriched horizon will be found by the extension of the development from the 500 foot level of the shaft to the east.

Glaciated surface—Wallowa Mountains, Oregon. Taken from an elevation of 8,400 feet.

A crosscut from the 300-foot level of the Poorman shaft to the south passes through a highly mineralized zone of granite porphyry with scattered chalcopyrite and pyrite and some fair sectional values. These workings exhibit several strong dikes of highly chloritized diabase as well as the fresher looking basalt dikes and it is believed that the diabase dikes have a genetic relation to the ore occurrence whose ultimate source, however, as suggested by Lindgren who made a special report on the property in 1925, is the nearby Sparta granite stock.

In addition to the veins described in these workings, shallow development has been extended on six other siliceous ore courses exposed at the surface by the erosion channel of Balm Creek, which has scored away the overlying basalt across the full width of the ore belt at this point. These additional ore courses are just as attractive in their surface expression as the veins already under development. One of them fully 100 feet wide carries surface segregations and silicified bands of gossany gangue containing good values in gold by selection. The future development plans include the crosscut from the 500 foot level across the whole series to test out the ore bearing merits of the other veins.

This property was employing 50 men in its development progress. The work has recently been slowed up by reason of encountering an increased water flow which has involved a change of pumping machinery from air to electrically driven pumps. The work is again in progress and gives eminent promise at this time of developing as many million tons of pay ore as it now measures in hundreds of thousands of tons of well-developed reserves. Although the surface outcrops of these interesting ore courses are obscured over 80 per cent of their linear extent by the thin veneer of lava and its debris and are only exposed in the shallow erosion channels referred to, there can be little doubt of their linear persistency throughout the entire length of the property and the adjacent Clover Creek group with the probable repeated occurrence of valuable ore bodies.

The ore bearing belt is enclosed in a flat dipping series of ancient sedimentary formations made up of slates, shales, quartzites, greenstone sills and tuff beds, together with some surface exposures of pure limestone.

The whole Snake River copper province to the adjacent Blue Mountain area to the west, according to Livingston, represents a coarse mosaic of regional fault block, and the fault courses carry the present main tributary streams to Snake River.

It is very likely that the great ore bearing porphyry dikes that traverse this property are in an area of depression, as a few miles farther north on East Eagle Creek thick horizons of pure limestone are in evidence which probably represent an elevated block that brought the deeper formations to the surface. These conditions afford the strongest promise of more favorable and replaceable wall rock along the Oregon Copper Company's ore belt as deeper levels are attained. This feature of the contiguous geology has been given very little detail consideration so far.

The development on this property has been in progress for several years. The enterprise is supported by public stock subscription, is well financed and well-managed. In addition to Lindgren and the late James F. Kemp, the deposits have been studied by half a dozen prominent northwestern engineers of high standing, all of whom have given them their liberal endorsement, and unless all ordinary signs fail the property is destined ultimately to become a very important and profitable source of copper and gold values.

Adjoining the Oregon Copper Company's property to the west the Clover Creek Consolidated Mining Company is working a small force of men; has recently installed up-to-date camp buildings and an electrically driven compressor. It is extending a crosscut tunnel from Clover Creek through the ore bearing dike series which is now 1,850 feet long; has already passed through three highly mineralized shear zones up to 50 feet in width and will shortly encounter its main surface gossan outcrop whose shallow cut development across a width of 180 feet exhibits some exceptionally promising bands of gossan ore in siliceous and spongy gangue which contain, according to surface assays, from $1.00 to several dollars per ton in gold and some lead bearing barite bands

carrying high silver values. This zone gives the most attractive promise for the anticipation of heavily banded sulphide conditions when it has been fully crosscut at the tunnel level.

Another surface exposure on this property is a zone of highly mineralized rhyolite porphyry 100 feet wide, containing considerable barite and copper stainings with some chalcopyrite with selected values in gold and silver running up to several dollars per ton. This big showing is a thousand feet west of the tunnel portal and is now under test by diamond drilling, preliminary to shaft development. The general conditions on this property are so definitely related to the surface showings and promising underground ore character with those of the Oregon Copper as to leave little doubt of their importance in commercial results as development progresses.

The most productive copper-gold ore deposit to date in this Snake River province is the Iron Dike mine, which carries some remarkably interesting and controversial features from a geologic standpoint. The following quotation from the 22nd Annual Report of the U. S. Geological Survey by Waldemar Lindgren, made thirty years ago, covering this property in its early stages of adit development, is of keen interest in its general application to other outcrop condition of the province.

"The croppings are large masses of black and brown stained rocks, one knoll rising 75 feet above the general slope and measuring 100 feet across. It is said that the croppings can be traced for some distance in a west-northwesterly direction. At any rate, few walls or fissures can be seen; one near the mouth of the highest tunnel strikes north 55 degrees west, and dips 60 degrees south. The maximum width of the croppings is probably 200 or 250 feet. On the rusty surface of the croppings scarcely any copper stain indicates the heavy body of chalcopyrite immediately underlying it. Holes a foot or two deep show somewhat decomposed pyrite, but very little chalcopyrite, the latter appearing only a little farther below the surface. The upper tunnel, for the first 100 feet, is in heavy ore of mixed chalcopyrite and pyrite; then follows 80 feet of poorer ore. A sharp contact here separates the chloritic greenstone from the dark-brown metaandesite. Crosscuts extending 25 feet each way in the best part of the ore show a width of four feet of solid sulphides which may average 15 to 20 per cent in copper. The largest part of the tunnel is, of course, in poorer ore, consisting of disseminated pyrite and chalcopyrite in chloritic greenstone. There are also abundant quartz seams, veinlets and nodules which contain chalcopyrite, and often a regular silicification of the rock may be noted. Zinc blende or galena rarely occurs, and a little antimony is contained in the best ore. The ore contains about $2 in gold and 6 to 30 ounces silver per ton. These amounts are apparently independent of the percentage of copper. The intermediate tunnel, 150 feet long, with a crosscut 125 feet toward the west, also shows a heavy body of sulphides.

"If the lowest crosscut, now being driven, exposes similar bodies of ore the deposit will be of considerable value."

The original owners of this property seriously underestimated its remote situation and transportation difficulties, before the branch railway was constructed. They developed the mine to the 400-foot level by crosscut adits and drifts on the vein, tying up several hundred thousand dollars in the enterprise which failed to pay in such a remote situation. The subsequent history of the property is of keenest interest.

In 1914 the writer called this property to the attention of Thayer Lindsey, now so prominent in Canadian mining progress, who obtained a long lease and option to purchase the property and is said to have paid for it out of royalties on subsequent ore shipments. As the story goes, Mr. Lindsey and his associates invested just $5,000 in re-timbering and shaping up the old development for production. He took hold of the enterprise late in 1914 when copper metal prices were all shot to pieces by the U boat activities of the war, but he apparently had an uncanny foresight as to their early recovery. According to published records of the Oregon Mining Bureau, from December, 1914, to December, 1915, he shipped 480 cars of crude ore; subsequently built an up-to-date 100-ton capacity flotation mill and established an elaborate modern camp, including a large boarding house, bunk houses and 30 bungalow-type cottages for married men. The property was connected with the Idaho Power Company's plant at Copperfield four miles farther south on the river where an abundant supply of electric current was made available for operating the machinery.

A shaft was started from the 400-foot adit level; in fact a winze was already down 100 feet at this point in blank but highly oxidized gangue, which Mr. Lindsey recognized was not the bottom of the deposit. At a short distance below this winze bottom he ran into the most noted ore body of the property which proved to be 150 feet in width, length and depth —an apparently isolated block of ore— that was richly and fairly uniformly sprinkled with pyrite and chalcopyrite in a very hard, siliceous gangue, and is said to have given average mill feed values of 3 per cent copper and $3.00 gold per ton, with a production of 160,000 tons. A new shaft was sunk, near the portal of the lower tunnel, 440 feet deep through which this big ore body and other ore bodies were extracted.

The enterprise was actively operated for five years until shortly after the close of the war, when it was shut down and remained dormant for several years and was subsequently sold in 1925 for $100,000 after a production that is said to aggregate $5,000,000 in gross value of crude ore and concentrate shipments, and $3,500,000 net smelter returns.

The nature of this deposit and its development, subsequent to Lindgren's studies, has proven quite a controversial problem with the geologists who examined it.

In 1926 the property fell into the hands of the Idaho Copper Company, and the three-compartment shaft was extended 200 feet deeper and below the level of the river which is only 2,000 feet distant, some drifting done and a large footage of diamond-drill work accomplished, particularly from the 740 level. This drilling campaign is said to have given some very interesting core results indicating large bodies of ore with values ranging from 1 to 3 per cent copper with the usual associated value in gold. Contrary to the shallow development promise, gold is the predominant associated value with the copper, and the silver unimportant, rarely exceeding a few ounces in the concentrates.

In its present development, the deposit looks like a tabular ore shoot, a thousand feet long, distributed by thrust fault movement and broken into blocks or so-called boulders of ore through the later injection of flat dipping igneous dikes of yellowish and green basic igneous rock and a thick zone of injection breccia which carries, in its matrix, marginal disseminations of chalcopyrite in bodies of ore from a mere pebble to blocks containing several thousand tons. These disturbed ore bodies, including the main 700 stope which is said to have produced 160,000 tons of ore, are scattered through a disturbed zone 300 feet wide between two normal faults. The immediate bounding formation to the north is rhyolite and to the south, the complex of greenstone formations with thick horizons of volcanic and calcareous breccias and conglomerates.

It has been suggested by some geologists that these disturbed ore bodies are fragmental boulders formerly associated with the neck or branch of a volcano of caldera proportions and something on the order of the Braden mine in South America. While there is no conspicuous surface evidence of such an orifice, the suggestion is not without value as the vast accumulation of predominantly plastic material which constitutes the 10,000 feet of associated greenstone formations, tuffs and breccias must have involved one or more vents of such explosive character. There is evidence of two such vents, several miles in diameter, farther down the river near Pittsburg Landing with tell-tale patches of lignite coal indicating former crater lake marginal accumulations of organic matter. Such an orifice may exist near the Iron Dike mine and be obscured by the basalt cap which covers the formation for miles in three directions.

In 1926 the Iron Dike mine was taken over by the Idaho Copper Company and actively operated for over a year with a production of $70,000 in concentrate shipping values.

During its recent operation a ventilation raise was extended from the 740 level on the south side of the zone in virgin ground to the 400 surface adit level. This raise was completed just before the operation was shut down and passed through 100 feet of ore carrying sectional assay values of 1 to 3 per cent copper with the usual associated gold values. The full sectional dimensions of this ore body are as yet unproved.

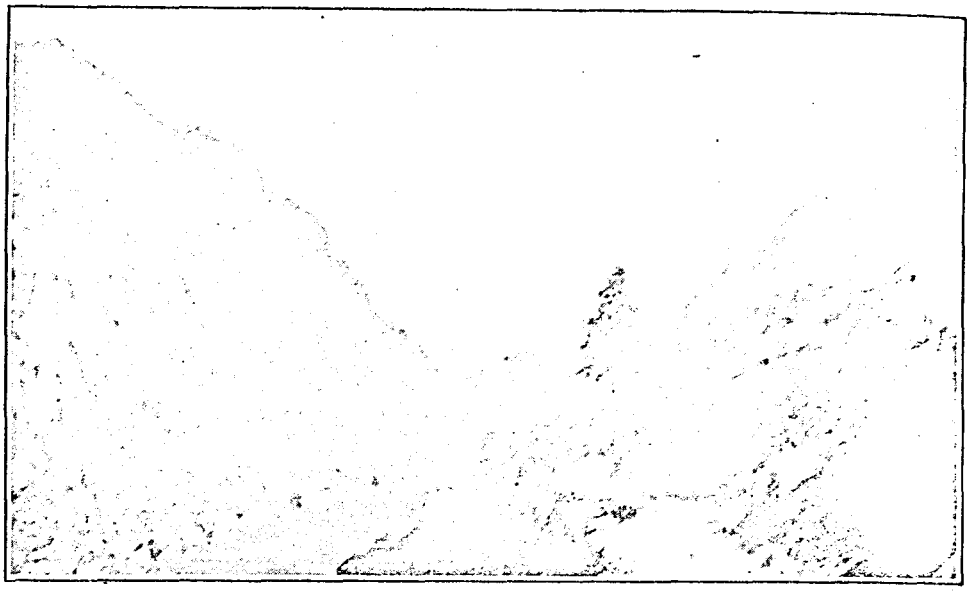
The old mill on the property was partly renovated and in the hands of a competent operator, formerly with the Utah Copper Company, the shipping grade of the concentrates was raised from 12 per cent under some previous leasing operations to 22 per cent with $19.00 gold and a few ounces of silver per ton.

At this stage in 1927, the enterprise with its associated properties, the Red Ledge and the South Peacock mines, got into difficulties resulting apparently from a factional quarrel among the company's directorate for control and the enterprise was put into the hands of a receiver and has been dormant for the past two years. This receivership was terminated during October, 1929, and it is currently reported that this unit of the companys' holdings is to be turned over to a prominent Arizona leasor and operations on its further development and equipment commenced at an early date.

In the vicinity of the Iron Dike mine, there are numerous promising copper prospects. The ore bearing greenstone

formations, however, along this side of the river for 50 miles to the north are obscured by the thick flows of Columbia basalt, except for a narrow belt between the lower beds of the basalt and the river level where the greenstone formations are cut by several copper bearing quartz porphyry dikes up to 2,000 feet in width in the vicinity of Rush Creek and Pittsburg Landing, the latter a notable ferry crossing of the river, about 45 miles north of Homestead.

The Imnaha River, 60 miles north of Homestead, with its source in the granite slopes of the Wallowa Mountains, has scored a canyon through the basalt series to the underlying greenstones, which exposes numerous copper bearing ore courses both of the fissure and zonal type. One of these fissures situated at the confluence of the two rivers has a tunnel about 50 feet above the water level of the two streams through the intervening point that follows a massive vein of hematite, from five to 12 feet thick, carrying 4 per cent copper in the form of disseminated chalcopyrite and bornite. Smaller veins of much higher values are found in this vicinity and they all carry a good gold ratio associated with their copper values.



Snake River Canon, near Homestead, Oregon.

Part II

The mineral deposits and districts on the Idaho side of Snake River Canyon embrace a decidedly interesting variety. The copper-bearing formations of greenstone and granitic rocks are more continuously exposed on the Idaho side of the river than on the Oregon side. Although most of the mines are idle at this time, one of them has been developed within the past few years at a cost of over half a million dollars, with results that justify some competent engineering estimates of a 50-million-dollar reserve of commercial gold and silver-bearing copper ore.

Iron Mountain, so called because of its iron ore deposits, is situated at the head of Dennett Creek, which enters Snake River 16 miles below Huntington. Its eruptive granite summit has an elevation of 6,500 feet above sea level and is five miles back from the river.

The formation at the summit is a contact of eruptive granite limestone and greenstone schist. The granite is sheared for a hundred feet in width and carries rich bands of hematite ore with a pay streak 25 to 50 feet thick and a thousand feet long next to the greenstone wall of 60 per cent Bessemer ore in the form of massive brown hematite. The greenstone is succeeded a few hundred feet farther north by included beds of white marbleized limestone with numerous igneous dikes and a pipe of magnetic ore 100 feet in cross section and almost circular. This is associated near by with a fissure vein of similar ore 10 to 20 feet wide, with some strong showings of copper carbonate at the surface.

Another great vein in the greenstone is 50 to 100 feet wide and exposed at the surface for several hundred feet long of massive hematite and magnetic ore. The iron ore resources of these and other near-by deposits have been variously estimated by different engineers at from half a million to two million tons.

These higher estimates are probably questionable for the reason that on the 100-foot vein-like deposits last mentioned a tunnel has been run in on one wall of the vein and a crosscut through its full width, at less than 100 feet under the surface outcrop, exhibits almost massive iron pyrite and pyrrhotite with kidneys of clean chalcopyrite and disseminations of that mineral which are said to give the body an average value in copper of 1½ per cent, together with $1.50 a ton in gold and silver. The future possibilities of this showing are of course problematical, but in time it is barely possible that these apparently great pyrite deposits may afford a source of marketable pyrite for sulphuric acid manufacture and a profitable source of copper, gold and silver in the subsequent treatment of cinder thus produced. In fact, a possible market for such a by-product is under consideration at this time by one of the chemical companies who have recently acquired a hydroelectric power site farther down the river. This site is designed as the basis for a synthetic nitrogen plant. It has a minimum horsepower capacity four times that of Muscle Shoals and can be harnessed for 10 per cent of the cost of that great project.

On the lower flanks of Iron Mountain to the west, halfway between the summit and the river, is situated the so-called Mineral Mining District. The formation consists of a series of old Permian sediments, igneous dikes and flows, including one sill of rhyolite several hundred feet thick and some conspicuous granite porphyry intrusions and basalt dikes. A number of veins in this locality varying from a few inches to stoping widths of 50 feet carry gray copper rich in silver and have been developed to a maximum depth of about 200 feet.

The principal showings were operated over 30 years ago and intermittently since then. The total production of the camp is estimated at a million ounces of silver and several million pounds of copper. The camp is practically deserted at this time, but its veins carry some attractive opportunities for deeper development.

At Mile 40 on the railway below Huntington, Brownlee Creek enters Snake River from the east. It is 10 miles long and heads under the summit of Cuddy Mountain, which is a flat-topped isolated uplift with a crestal elevation of about 8,000 feet, exhibiting an old plateau surface on the top a thousand acres in extent with large areas flat enough to land an aeroplane. This summit is predominantly monzonite and quartz diorite with some remnant flows of Columbia basalt. At its western edge and probably representing a false scarp face, an area of highly altered and mineralized monzonite is exposed fully 8,000 feet long by 4,000 feet wide, carrying the I X L mine. This granitic exposure stands at a surface angle of 40 degrees with two conspicuous sill-like horizons, each several hundred feet thick, that are more aplitic than the general mass and richly stained at the surface with patches of brown iron oxide. The upper zone is cut at right angles to its flat structure plane with a 10-foot dike of diabase, a small vein six inches to 18 inches wide of pure barite and a breccia filled fissure 10 feet wide richly cemented with green carbonate of copper and carrying surface assays of 3 to 5 per cent copper.

A crosscut tunnel has been run at right angles to the strike of this zone that is 800 feet long; has gained a vertical face depth of 600 feet and is mineralized throughout its full length, particularly on the joint seams of the hard monzonite with chalcopyrite, pyrrhotite and occasional foils of molybdenite.

Through the central portion of this cross section of the formation, with a width of 250 feet, the copper sulphide mineral is better disseminated in the rock and gives five-foot sectional samples varying from half a per cent to 3 per cent copper, with a fairly uniform association of $0.50 silver and $0.10 gold to the unit of copper. This showing has been repeatedly sampled and gives an average across this better 250 feet of 1 per cent copper and $0.50 silver per ton, which is probably too low grade for present use.

The lower zone of similar width and siliceous character carries two or three small parallel basic dikes and a number of shallow open cuts exhibiting similar values to those above described. Between these two zones the monzonite, a thousand feet wide, is extensively fractured and exhibits a network of rusty limonite seams. This part of the exposure carries a parallel dike of quartz porphyry 50 feet thick. Although it has never been tested, it is possibly a better surface phase for underlying disseminated values than the more siliceous horizons of the monzonite exposure.

To the north, this granitic exposure is succeeded by sharply folded greenstone schists, marbleized limestone beds and argellite formations with numerous dikes and

sills of igneous rock. These formations are traversed by strong vertical veins at the marble greenstone contacts, affording some very interesting lenses of pure soft chalcopyrite and bornite ore associated with garnetized gangue minerals which have produced some small shipments of 30 per cent copper values.

On the north edge, 10 miles from the I X L mine, the Cuddy Mountain plateau summit is flanked by a series of ancient sediments, probably of Triassic age, consisting of calcareous shales, slates and fine grained quartzite beds overlying a broad exposure of quartz diorite. These old sedimentary formations at this point carry several interesting fissure courses containing small seams of very rich silver ore up to 2,000 ounces per ton in selected samples and some lenzy occurrences of steel galena. In addition to this a mineralized vein or zone of lead-bearing mineral, standing nearly vertical and 20 to 100 feet wide, traverses the abrupt slope of No Business Canyon for a mile, through a vertical elevation of 2,000 feet. This low, almost continuous outcropping carries shoot-like patches that contain average values of 2 to 5 per cent lead together with an ounce or two of silver and $0.20 to $0.40 gold per ton in a succession of open pits driven into the deposit at intervals throughout its full length and representing widths varying from 10 to 20 feet. This great vein extends on to the flat crest of the mountain for a distance of 1,000 feet, where it is covered by two old patented claims and a couple of dozen cuts and shallow quarry-like openings from which there have been sorted out and shipped 15 or 20 carloads of steel galena kidney ore affording smelter return values of 40 to 60 per cent lead. The waste dumps of many of these open pits carry 8 to 10 per cent lead.

The long outcrop of this great vein is richly stained with black and brown manganese oxide and when broken exhibits yellow and gray colors of friable gangue. Its lead values are mostly in the form of carbonate at the surface, and it presents an interesting opportunity for the development of a probably important tonnage resource of concentrating lead sulphide ore at a comparatively shallow depth under the surface.

Ten miles east of the summit of Cuddy Mountain, Peck Mountain is a related granite magma crest, at a lower elevation, protruding through the neighboring basalt covered plateau. This intrusive mass carries a zone 2,000 feet wide and two miles long of richly iron stained and pyritized rhyolite porphyry, and in a shallow drainage channel, the Glenn-Allen mine, covering a portion of this big mineralized zone, exhibits some interesting sub-zones of disseminated chalcopyrite in shallow surface cut work. A few hundred feet of diamond drilling has been done on these more siliceous zones, and some very interesting cores found exhibiting numerous grains of chalcocite. The deposite seems to justify further attention in development consideration by drilling.

Historically, the most interesting ore deposits on the Idaho side of the canyon are at the original Seven Devils mining district discoveries, which lie three to 12 miles back from the river below the Homestead railhead, with which they are connected by an excellent highway known as the Kleinschmidt Grade. These properties include a dozen groups of claims, most of them patented, extending from Landore on Indian Creek to Helena on the head of Copper Creek, a tributary of Deep Creek. This is known as the Bonanza ore belt of the Seven Devils district, by reason of the high copper contents of its ores.

These deposits were discovered in 1875 as the result of some placer mining activities on Copper Creek, where coarse placer gold was traced into the lime silicate croppings of the Peacock and South Peacock mines.

The strike of this ore belt is nearly northwest and southeast, but the ore courses within it have an oblique angle to the belt in many instances. The formation is within the edge of a large area of coarse-grained granodiorite, which carries included blocks of completely marbleized limestone varying from a mere fragment to masses several hundred feet wide and a mile long. The gangue of the ore is more or less heavy lime silicates consisting predominantly of garnet and epidote and other commonly associated crystal minerals.

These deposits attracted marked attention between 1895 and 1905, when considerable activity prevailed throughout the belt, resulting in several local attempts at smelting, which proved failures on account of high fuel costs and lack of metallurgical knowledge. Some notable figures in northwestern mining history were attracted to these discoveries and an agent of W. A. Clark is said to have started the original shaft on the South Peacock mine. Hauser and Holter of Montana, the Kleinschmidt brothers, and later the Lewisohns became interested in these properties and the estates of these people still retain important holdings.

These deposits, according to Lindgren, are among the first so-called contact metamorphic deposits discovered in this country. Their development in no place exceeds 300 feet in depth and their combined production to date has been variously estimated. A conservative figure would probably be justified at 20,000 tons of 20 per cent crude shipping copper ore, carrying associated values of $4.00 to $10.00 in gold and silver. During these early operations this ore had to be hauled from 60 to 100 miles by team to the railway shipping points, first at Weiser, Idaho, and later to Council, Idaho. Some small leasing operations on the Blue Jacket Queen Group on this belt have shipped within the past year three small carloads of plus 30 per cent crude copper ore, principally bornite and chalcocite.

The largest producer of this belt was the Old Peacock mine, a pipe-like outcrop of massive lime silicate gangue, 100 feet wide and 300 feet long, richly sprinkled with copper carbonate and good-sized lenses of pure bornite, together with remarkable specimens of brilliant flaky specularite. This deposit has been developed to a depth of 150 feet and its big quarry-like cuts and limited underground stoping areas are credited with an output of 10,000 tons of plus 10 per cent ore with values ranging up to 40 per cent copper in carload lots. Its present reserves are estimated at 60,000 tons of 6 per cent copper ore.

The garnet gangue of these deposits is found as tongues projecting into the granodiorite walls as well as replacing the marbleized limestone, and it is an interesting fact that some of the lime diorite contacts are not garnetized. The largest lenzy bodies of this lime silicate mineral, up to 100 feet in cross section, well sprinkled with copper carbonate, favor the limestone formations which appear to have been susceptible to replacement after the manner of irregularly shaped lead ore bodies in limestone, but it is questionable, as Spurr has suggested, whether the limestone acted as a source of the crystalline silicate gangue or simply a replaceable formation for this gangue of independent deep-seated source.

A possible example of this is had at the South Peacock mine, near the north end of the belt. This is the strongest and most vein-like deposit in the list of these old properties. The South Peacock is a steeply dipping fissure that strikes nearly east and west, with an average width of 50 feet and a surface exposure of a thousand feet in length. Its outcrop is partly covered by erosion debris through its middle section, but this has been undercut by a drift at the 200-foot level and there can be little doubt of its linear persistency for the length described.

This deposit is in straight granodiorite walls. There is no limestone in the vein or any contact with it at any point of its present development.

The property is owned by the Idaho Copper Company; was reopened in 1926-7 to the 200-foot level of the old shaft sunk years ago where a shoot of richly disseminated bornite ore was found near the foot wall, with rich stringers of bornite mineral in the foot wall diorite.

This ore body at the 200-foot level produced 212 tons of selected crude ore which was shipped in 1927 and gave assay returns of 11 per cent copper and several dollars gold and silver per ton. The main body of the garnet gangue has a closely banded structure with intervening seams of iron oxide which probably represent a shearing of the gangue after crystalization and subsequent mineralization with rich chalcopyrite bands now altered to residual bornite and copper carbonate minerals. Chalcopyrite has been detected in the workings, but the predominant sulphide is bornite and its alteration products —copper carbonate and chrysocolla.

The original development on this deposit is said to have afforded some small shipments of 50 per cent copper ore and it promises some interesting results when permanent water level is reached and its present almost completely oxidized condition has been passed through.

The granodiorite stock or batholith, in which these so-called contact metamorphic deposits occur, is probably 100 square miles in area and the South Peacock mine under discussion is only five miles southeast of the Red Ledge mine, under the same ownership, but on the edge of the old plateau surface at an elevation of 7,000 feet above sea level, and three and one-half miles from the river, where the elevation is only 1,500 feet.

In addition to the Iron Dike mine in Oregon and the South Peacock mine above described, the Idaho Copper Company owns the Red Ledge porphyry copper deposit situated on Deep Creek at the north end of the Seven Devils District, five miles from the South Peacock by winding trail-down Copper Creek and Deep Creek with a drop of nearly 5,000 feet. This was the only route of access to the Red Ledge until 1927, when the Interstate steel bridge across the river, two miles below Homestead, was completed at the joint cost of the States of Idaho and Oregon, and the company constructed, at a cost of $210,000, a 14-mile automobile highway from the bridge down the canyon on the Idaho side of the river to a deep tunnel site on Eagle Bar near the mouth of Deep Creek,

and a trail of the Bright Angel variety was extended from the tunnel to Deep Creek, greatly improving the accessibility of the Red Ledge.

Before going into a description of the Red Ledge, which is the central and most important figure of this article, a brief description of another mine which carries the deepest development of the Idaho slope of the canyon will probably be advisable.

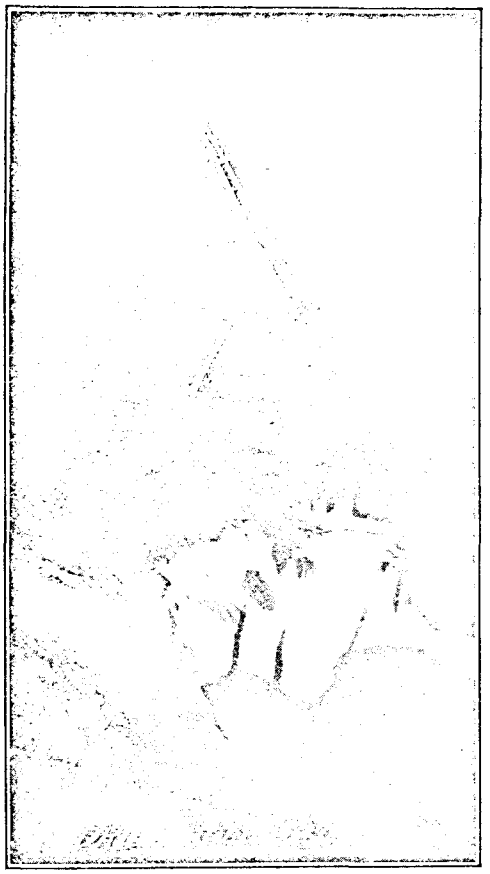
This property is situated in the Cook's Corral district in Idaho county, Idaho, 18 miles north of the Red Ledge mine, and is known as the Northern Blue Jacket mine. The deposit is a siliceous dike in walls of greenstone and diorite that has been proven for a width of 200 feet. It was developed prior to 1909, when the canyon railway was under consideration and while it was subsequently being built to Homestead, during the most constructive period of Union Pacific history, when E. H. Harriman was in the saddle. This property was developed 700 feet deep on a dip of 45 degrees, first by a shaft 200 feet deep and then by a crosscut tunnel and underground connections. The bulk of this development was done at a cost of a corps of Johns Hopkins University staff men and now has an estimated reserve of half a million tons of ore, with an underground map and assay plan exhibiting average values of 2½ per cent copper and $3.00 gold and silver per fon. This ore is oxidized down to the bottom level, where it is still pitted and spongy, but shows one crestal apex of unaltered sulphide of excellent grade. In common with the other siliceous copper-bearing dikes of the province, this dike also carries occasional bands of barite. At its 100-foot level, a short lens of nearly pure chalcopyrite was found encased in chloritic talc, giving assay results of 20 per cent copper and 25 ounces gold per ton, also a lens of lead carbonate ore at this level carrying 44 per cent lead and 42 ounces of silver per ton. It had at its 200-foot level a cross section of chalcopyrite ore which for some reason had resisted oxidation that was 16 feet wide and 30 feet long and averaged 9 per cent copper and $15.00 in gold and silver.

Another interesting feature of this development was the occurrence, at the 200-foot level, in a wall band of rich black oxide mineral, of nuggets of native copper up to 10 or 12 pounds in weight. The assay results on which the average values of this mine are based were from samples taken by Dr. Wm. B. Clark and Dr. Geo. A. Shattock, well known geologists of a former Johns Hopkins staff.

The short lower tunnel of this mine is situated near the bottom of a dry gulch, where a strong spring of very acid water, flowing five or six miner's inches, is in evidence a hundred feet below the tunnel and probably represents the upper water table of the deposit. As the dike dips towards this gulch, this situation presents an exceptional opportunity for a diamond drill test of its primary ore values. This development is three miles distant and 3,000 feet vertically above the river railway survey.

The work on this property was discontinued when the railway was stopped at Homestead in 1909, which killed its transportation prospects.

The Red Ledge deposit on Deep Creek, owned by the Idaho Copper Company, is the present central figure of development and promise of this new copper province by reason of its size and estimated probable ore



The site of the deepest drill holes for exploring the Red Ledge formation on Deep Creek.

resources aggregating between fifty and a hundred million dollars in gross value. This property is at present idle, but under serious consideration by one of the big copper companies for its further development and determination.

The Red Ledge was located in 1912 by some local prospectors as a low-grade gold ore deposit. Its first published recognition as a copper deposit was made by the writer, while state inspector of mines, in his annual report for 1912. The property was subsequently examined by a number of recognized authorities in the copper world, including Louis A. Wright and J. Park Channing, and was under option in 1915 to the late Seeley W. Mudd, whose engineers did 1,000 or 1,200 feet of diamond drill work, and although they offered to greatly extend that line of test, they were prevented from doing so by the adverse attitude of the owners at the time in the matter of terms.

The property was purchased in 1919 by Cooley Butler of Duluth, a prominent Mesaba Iron Range operator, and through the efforts and advice of Walter Harvey Weed was consolidated in 1926 with the properties previously referred to.

During Mr. Butler's administration of the property, the diamond drilling tests and tunnel work were greatly extended and were continued under the consolidation in 1926-7. The deep development tunnel at Eagle Bar was equipped with a 100-horsepower Diesel engine and compressor, and the bore, designed to be approximately 8,000 feet in length, was started and extended in between 700 and 800 feet when the property was tied up by receivership late in 1927.

The Red Ledge deposit consists of an intrusive quartz porphyry dike 3,000 feet wide, with an exposed surface outcrop three miles in length and extending to an elevation of 3,000 feet above the canyon bottom of Deep Creek. It is an intensely sheared, nearly vertical zone of siliceous gangue, striking north 80 degrees E., very highly colored at the surface by mineral oxides in rich tones of red, brown and yellow, in the broad central region of the greenstone formations.

The greenstone formations on the south wall strike north and south, with a flat dip of about 20 degrees to the east. On the north wall the strike of the greenstone formations is northeast and southwest, with a steep dip to the northwest.

The Red Ledge is accompanied on its northern margin by a great dike of so-called cordwood porphyry. This is 100 feet wide and divided by parallel sheeting planes about four feet apart between which the rock assumes a columnar structure at right angles to the vertical attitude, giving it the appearance of piles of cordwood in the surface outcrop. In texture this is a fine-grained white siliceous rock, like fine-grained quartzite.

This dike is of later date than the Red Ledge porphyry, as it throws out small branches, one of which, four feet wide in the intermediate tunnel, penetrates one of the big sulphide ore bodies of the Red Ledge on a rather flat dip, with the characteristic columnar structure at right angles to the dip. This associated later rhyolite dike expands to a width of several hundred feet along the course of the Red Ledge to the east and again splits into narrower dikes in the main quartz porphyry zone at its highest outcrop near the Granite Creek divide, where the zone is 3,600 feet wide and includes a stock of normal biotite granite 600 by 1,000 feet in surface exposure. Farther east on its course this great mineralized quartz porphyry dike traverses a broad exposure of this eruptive granite formation.

Deep Creek is a short tributary of Snake River, rising between two of the high summits of the Seven Devils Range in a source of glacial lakes and ponds. It is 10 miles long and through the upper six miles of its course flows through a U-shaped glaciated valley with conspicuous lateral moraines. From this point to its confluence with Snake River, it has developed a V-shaped, more or less box-like canyon, especially where it cuts the Red Ledge dike almost at right angles to its course where the red-stained porphyry stands up in cliffy buttresses, with short but heavy slide rock slopes down to the creek level. The stream carries a minimum flow of 20 second feet of water on a 14 per cent grade for the last four miles of its course and will afford a valuable hydroelectric power source of several thousand horsepower capacity.

The present development on the Red Ledge is almost wholly confined to the creek canyon bottom and its near-by slopes and is practically all embraced within an area of 20 acres in the middle cross section of the Red Ledge dike. This development consists of fully 12,000 feet of diamond drilling and 2,000 feet of shallow crosscut, tunnel work and drifts, and has exposed four ore zones which seem to represent more definite sub-zones of shearing with a strike north 30 degrees or 40 degrees east, and oblique to the normal strike of the dike. However, this feature is not fully determined. These zones may represent a second period of fracturing and B-hypogene mineralization.

The best of these ore zones, on which the most diamond drilling has been done, has proven to be 180 feet wide. The linear extent of its ore-bearing character has been proven for a thousand feet in length by drilling and drifting. The deepest drill hole, No. 51, on the same set-up as No. 20,

started almost at the creek level on a projecting spur of solid formation, was sunk at an angle of 70 degrees in the direction of the strike of the zone. It is 830 feet deep. Its cores, with some alternating bands of lean pyritized porphyry, were very richly mineralized with pyrite and chalcopyrite, occasional small veinlets of pure quartz, some fluorspar, and slight alterations of the chalcopyrite to bornite.. This hole, designed by its sponsor to demonstrate the persistency of the copper ore values to a depth of a thousand feet, was spoiled, I think, with the loss of several diamonds in a band of loose flinty formations, but exhibited good chalcopyrite core within three feet of the bottom.

Another hole on this zone is 600 feet deep, sunk at the same steep angle with similar results, and still another hole farther up the canyon side to the west, about 300 feet above the creek, sunk at an angle of 45 degrees, demonstrated a total strike length on this particular ore course of 700 feet, which, with some drifting from the intermediate tunnel, gave a fair assurance of the ore-bearing character of this particular zone for a thousand feet in length. Other drill holes along its course quite definitely established its width at 180 feet and substantially justified the tonnage estimates that have been assigned to it as developed and partially developed ore, which together with the drilling and tunneling on the other three zones, 40 to 100 feet wide, respectively, justified an estimate of developed and very probable ore aggregating six million tons, according to the published statement of the local manager, Frank A. Kennedy, under whose charge most of this work was performed. As a result of several thousand samples obtained from all this work, the average mineable values are estimated at 2.20 per cent copper and $2 gold and silver per ton.

In the published testimony of Dr. F. B. Laney, who has watched this development since 1919, given at an Interstate Commerce hearing in 1928 on canyon railway construction, his account of this Red Ledge development and the strong structural features of fracturing and fissuring on these ore zones raised the Kennedy estimate to eight or 10 million tons of probable ore carrying 1½ to 2½ per cent copper, with important associated silver and gold values.

Considering the limited development on this great mineralized porphyry dike, which amounts to hardly 5 per cent of the total mineralized outcrop area of the company's holdings, its immense commercial possibilities will be appreciated and when the extension groups on the dike covered by the Allen-Anderson Mammoth claims and the Darland Oxbow claims of equal surface area on the outcrops are taken into account, the tonnage possibilities of this dike assume enormous proportions, in which a billion-ton figure seems a justifiable anticipation of probable commercial ore values.

The copper deposits of the Seven Devils and adjacent districts were the subject of a co-operative bulletin by the U. S. geological survey and the Idaho bureau of mines and geology. This work, fostered by Dr. Francis A. Thomson, then dean of the School of Mines at the University of Idaho and now president of the School of Mines at Butte, Montana, was published in 1920 under the authorship of Dr. F. B. Laney, representing the government, and Prof. D. C. Livingston, former chief instructor in geology at the University of Idaho. The work was preceded by a U. S. geological survey special topographic map of the district. In this bulletin, Dr. Laney gave the results of his special study of the genesis and paragenesis of the Red Ledge deposit, when the development was at an average depth of about 250 feet and the tunnel work now on the property only partly done. This study gave a masterly discussion of the highly altered conditioning of the ore-bearing dike formation, placed the ultimate genesis of the ore in the near-by granite magma exposure and the paragenesis in the following order after the injection of the dike: Extensive fracturing and mineralization by A-hypogene pyrite, later further extensive fracturing and shearing with the introduction of B-hypogene pyrite, chalcopyrite, zinc blende, a little galena, tetrahedrite and a white silvery mineral, then undetermined, in a gangue of highly altered rhyolite or quartz porphyry with a conspicuous association of barite in one of the zones.

There was exposed in the tunnel work at this time one cross section of No. 2 ore zone showing 30 feet of oxidized and 50 feet of massive sulphide mineral with some slight secondary enrichment, carrying 4.6 per cent copper and $5.00 in gold and silver per ton. In the second tunnel a little lower down the mountain, run later, this same ore body was again cut where it was 100 feet thick of fairly massive unaltered pyrite and chalcopyrite, carrying 2.4 per cent copper and $2.00 gold and silver. This second tunnel was subsequently extended to and penetrated the No. 3 ore zone for 80 feet, exhibiting one band five feet wide of massive sulphide mineral, principally pyrite and chalcopyrite, said to carry combined values of $50 to $100 per ton in gold, silver and copper, and 80 feet in cross section of richly disseminated sulphides. This latter showing was under the bed of the creek in the No. 3 zone, whose full width was later determined by diamond drilling from several stands and shown to be 180 feet in cross section.

In reading a description of the genesis and paragenesis of the United Verde mine in Arizona by Lindgren in U. S. Geological Survey Bulletin No. 782, published in 1926, it will be noted that there is practically no difference in the gangue and ore character of his description and Laney's study of the Red Ledge, except the proportions of the massive mineral in the Verde mine which had the advantage of not 250 feet but 2,500 feet of depth development.

In the present development of the Red Ledge, and in fact in the discovery of its first important massive ore body in the No. 1 tunnel projected by the writer, a pronounced band of brecciation in the outcrop together with a limited dissemination of all the principal copper sulphides in the sheared siliceous porphyry and a stream of 10 miners' inches of rich copper water running out of the short tunnel were the determining factors in its classification as a copper deposit. There were also several small basic dikes parallel to the breccia zones in the outcrop with a strike oblique to the main course of the Red Ledge which seem to be of later date and possibly associated with the zones of better mineralization. These small basic dikes are conspicuous in the diamond drill cores and the first massive sulphide ore body cut proved to be a replacement of a breccia zone with fragments of porphyry foreign to the immediate wall rock, showing conspicuous phenocrysts of feldspar. These breccia fragments were in all stages of replacement in the rich sulphide cement of the mass.

The deepest diamond drill hole, No. 51, is placed on a small inclined bench of solid formation resulting from the displacement of a large block of the porphyry. This bench, only 10 feet above the creek level, was bordered by vertical fissuring and joint planes both on the strike and cross section of the ore course. Its surfaces had the color of a slab of base copper bullion in red and purple tarnish. This color, however, proved to be only skin deep as when this rather massive looking formation was freshly broken it resembled a blue-white fine grained siliceous rock, but contained fine lines of sintry porosity and thin bands of recemented breccia. This is the deepest and best hole of the series with the largest proportion of heavy iron-copper sulphide mineral, but from the standpoint of surface evidence and coloring, the physical conditioning of the porphyry is far superior across the next thousand feet of cross section of the dike toward the south wall.

It is recognized that this mine is not completely out of the woods as a demonstrated porphyry copper deposit of big commercial importance. It is also recognized by the writer that the ore estimates and values above given do not satisfy the convenient term used by many technicians and court witnesses as "blocked out ore" for value estimates. As a matter of practical experience "blocked out ore" for value estimates for taxable or other purposes is a misnomer and has no foundation in fact, as ore is never blocked out until it is mined out, treated and the bullion receipts are in the bank, as the facts of mining development and the history of blocked out ore values and subsequent actual results obtained fully demonstrate to unbiased observers.

From a personal examination of most of the Red Ledge cores obtained, together with an intimate knowledge of sampling results on the original massive sulphide ore body, repeatedly checked by noted engineers, the remarkable strength of fracturing and fissuring and the apparently unquestioned intrusive character of the deposit, it is believed by the writer that the present estimate of tonnage and values on the Red Ledge is fully justified, and the engineer that would not recommend the further extensive exploitation of such a deposit on favorable terms lacks the optimism that such physical evidences justify.

The present development on the Red Ledge, as previously stated, is largely confined to the canyon bottom cross section of the deposit in its least favorable physical aspects. Along its strike up the bluffy canyon side to the east and near the 4,300-foot contour line, the surface of the dike has been cut by a trail, known as the Garden Trail, which is a monument to the engineering skill of an old prospector of that name. This trail extends from the lower end of the glaciated valley of Deep Creek through the canyon cliffs for four miles on a uniform grade of 100 feet to the mile. It extends across the full width of the Red Ledge whose mineralized character was recognized by the prospector but out of 30 or 40 samples, he could obtain only from $.20 to $.80 gold per ton with a little silver and no copper and he did not have any use for that grade of outcrop.

His objective was a quartz vein two to five feet wide, traversing the greenstone formations of Cliff Mountain in the north wall of the Red Ledge. This vein has been developed with 300 or 400 feet of tunnel work, carries a rich dissemination of pyrite and kidney segregations of

pure chalcopyrite with values in gold ranging from $10 to $200 per ton. This small quartz filled fissure is a common feature in this region of similarly associated quartz veins in the wall rocks of other big copper bearing porphyry dikes.

On the Mammoth No. 3 claim of the Red Ledge, at a point 3,000 feet from the canyon bottom and at an elevation of 1,500 feet vertically higher, just below the Gaarden Trail, a prospect tunnel has been extended in through the cappings for a distance of 50 feet in pyritized porphyry. At this point it entered a better mineralized band of the formation which carries a foot of rather massive pyrite with some remnants of chalcopyrite and rich stringers of clean covellite, a variation in secondary enrichment under similar conditions which usually takes the form of chalcocite. In this instance there is no chalcocite present and the secondary sulphide is clean blue covellite, affording selected specimens that run 10 per cent copper.

This interesting showing is valuable principally as an indication of what may follow on subsequent development at this horizon of the Red Ledge, whose outcrop at this point is sharply in contrast with the cliffy outcrops bordering the canyon bottom, and gives a much more interesting surface promise of underlying results in the fact that the outcrop here is at a more moderate slope of about 35 degrees, is intensely sheared, schisted and conditioned across the full 3,000 feet of its width and presents a slightly inverted surface where the full width of the dike can be seen from one wall to the other. Where the trail has cut its tighter ribs, every crack and crevice is oozing yellow sulphate minerals with numerous kaolinized joint planes and rich coloring.

Starting in some large springs a thousand feet above the trail, a small stream branch traverses the outcrop and extends down to Deep Creek just below the diamond drill camp in the canyon. This would afford a convenient water supply for a more thorough and consistent diamond drill test across what appears to be one of the most promising expressions and prospects of underlying primary sulphide values in gold and silver-bearing pyrite and chalcopyrite that the company's property carries. If underlying commercial values are found throughout its full width, the situation presents a feasible opportunity for steam shovel methods of operation through mill hole or rock chute delivery to a lower haulage access from the river or creek canyon.

This great Red Ledge outcrop continues east through two adjoining properties known as the Allen-Anderson group and the Darland Oxbow group, extending to the divide between Deep Creek and a parallel large stream known as Granite Creek. The dike is crossed by several tributaries of Deep Creek, insuring its saturation at shallow depth. On the Oxbow group, the red porphyry is more consistently and uniformly sheared, cross sheared and mineralized through a width of 1,000 to 1,200 feet than any other portion of the entire outcrop. Here the included basic dikes range up to 30 or 40 feet in width and in some shallow openings have proven to be richly mineralized with cupriferous pyrite giving values of one per cent copper and a little gold and silver.

It is recognized that economic forecasts of this nature are a risk and sometimes fool the ablest experts. Nature paints some pretty pictures at the surface of mineral promise which sometimes prove to be chromos, also some drab surface daubs that subsequently develop into masterpieces of production and profit. However, nature's gaudy surface demonstrations are not all chromos, of which the Miami mine is a good example, and where her pertinent pigments and backgrounds of copper ore associations are recognized they justify respectful consideration.

Topographically, this Red Ledge deposit is in just as rugged a situation as the Alaska Kennecott, and is no place for a red-legged Pullman lounge lizard, prone to haggle like a fish-wife over the probable costs of operation in a rough country without due consideration to tonnage capacity. Geologically, the Red Ledge is Kennecott upside down with the greenstones on top and thick horizons of easily replaceable pure underlying limestone between the granitic source of the dike and its greenstone wall rocks, according to river canyon exposures.

While these greenstone wall rocks of the dike probably have little bearing, if any, by direct contribution, on the presence of copper, gold and silver minerals in the dike, as the lateral secretion theory practically passed out with the Posepnyte discussions of 30 years ago, their important relation to the economic possibilities of this great ore deposit is emphasized by the conspicuous association of greenstones or their unaltered equivalents in nature's basic slags with many of the more important copper deposits of the Cordilleran system. This includes the famous Butte deposits in Montana, the Copper River deposits of Alaska, many of the Arizona deposits, the new Flin Flon bonanza in northern Manitoba, the Lake Superior deposits, and is a conspicuous factor in the new African bonanzas as an associated and possibly essential phase of magmatic differentiation for the deposition of copper ore, as the metal seems to be indigenous to this class of basic slags.

In this respect then the Red Ledge deposit is most favorably situated with the necessary genetic phase of granitic magma and cubic miles of its poorly sapped basic differentiates as a contingent source for the copper in the siliceous and highly serecitized and conditioned vents for its precipitation, such as this and other dikes afford.

From the standpoint of natural advantages for operating economics, this deposit is without a peer in the mining world at large. The river canyon, as previously shown, is not a serious railway transportation problem. The proposed deep drainage and transportation tunnel, started at a convenient elevation above the river near the terminus of the new highway, would undercut the present diamond drill development on the Red Ledge in Deep Creek Canyon at a distance of 8,000 feet and at a depth of 1,300 feet, and if continued along the course of the dike under the Granite Creek divide, a distance of three miles, would attain a face depth of over 5,000 feet.

The interesting prospect of permanency in this great porphyry copper deposit is due to the fact that its future does not depend upon a blanket of secondary enrichment, as the deposit goes into primary sulphide ore within 50 feet of its oxidized surface outcrop, and has continued in primary sulphide ore to the deepest point of development at present. In fact the natural erosion of the deposit exhibits primary cupriferous sulphides through a vertical range of more than 3,000 feet. Primary chalcopyrite ore has been developed in paying values at a depth of 200 feet below the river level in the parallel Iron Dike zone, a few miles farther south, and the deep range of this mother sulphide of most copper ore is well recognized.

The river canyon has government-surveyed power sites, aggregating a total capacity of a million hydroelectric horsepower. The camp sites along the river are at a low elevation between 1,400 and 1,600 feet above sea level where snow seldom falls or lies more than a few days in the winter time, affording a climate similar to that of Arizona. The bordering plateaus are densely timbered with desirable pine species and with the prospects of natural drainage, gravity handling and ventilation prospective big scale operations, and assuming that the values found in the present development on the Red Ledge are not exaggerated and the volume of ore continues to expand as anticipated as its further development progresses, there is no reason why, with Miami or Utah methods and technique applied to its extraction and treatment, this source of ore, with full credit for its combined gold and silver values, should not produce copper at a lower cost than any other mine in this country.

Space will not permit any further detailed discussion of this form of deposit in this province. It is only fair to state, however, that there are half a dozen other dikes independent of the Red Ledge in the next 30 miles of the canyon slopes to the north, both on the Oregon and Idaho sides of the river, of somewhat similar great size and in some instances with far superior surface manifestations of copper ore to the Red Ledge. One of these dikes, a thousand feet wide, crosses the river canyon. It is of interest to note that these other great dikes of siliceous quartz porphyry gangue carry similar narrow basic dikes to those found in the Red Ledge, associated with their best ore showings.

The economic possibilities of this great mineral province carry an aspect of national importance that is worthy of serious consideration, and in the opinion of the writer, justify a special detailed study by the U. S. geological survey. The province is important from a national business standpoint because of the fact that its copper ores carry a prevailingly high ratio of gold, especially the larger shear zone disseminations, whose successful development, running into capacity production measured in millions of tons a year, would prove a desirable supporting factor to the present rapidly waning American supply of primary gold, and while our present monetary gold supply is very large, it is mere vest-pocket change compared to the vast business paper credits of which it forms the fundamental standard of value in this country.

Unless the academic conception of the genesis and causes of the concentration of valuable metallic mineral deposits in nature by magmatic differentiation, or in plain English, earth's smelting processes, is unsound, the favorable fundamental conditions for the existence of large capacity porphyry copper, gold and silver ore resources of the disseminated or segregated type or both in this Snake River mineral province challenge adverse criticism.

The moral of this tale to the copper mineral-minded reader, if it has a moral, is, Why go to Africa or the frozen north to help jeopardize the present American prestige in copper production for a mere technical toehold in their enviably guarded national control of those new fields by our able British cousins, with such a virgin field still to conquer in God's chosen mining country and climate?

OREGON COPPER

BAKER

Northwestern Porphyry Copper Prospects

By ROBERT N. BELL, Boise, Idaho. Located in the Grand Canyon of the Snake River, the copper province discussed covers a considerable area in both Idaho and in Oregon, and offers an attractive territory for the developement of a new American field of probable magnitude.

Part I.

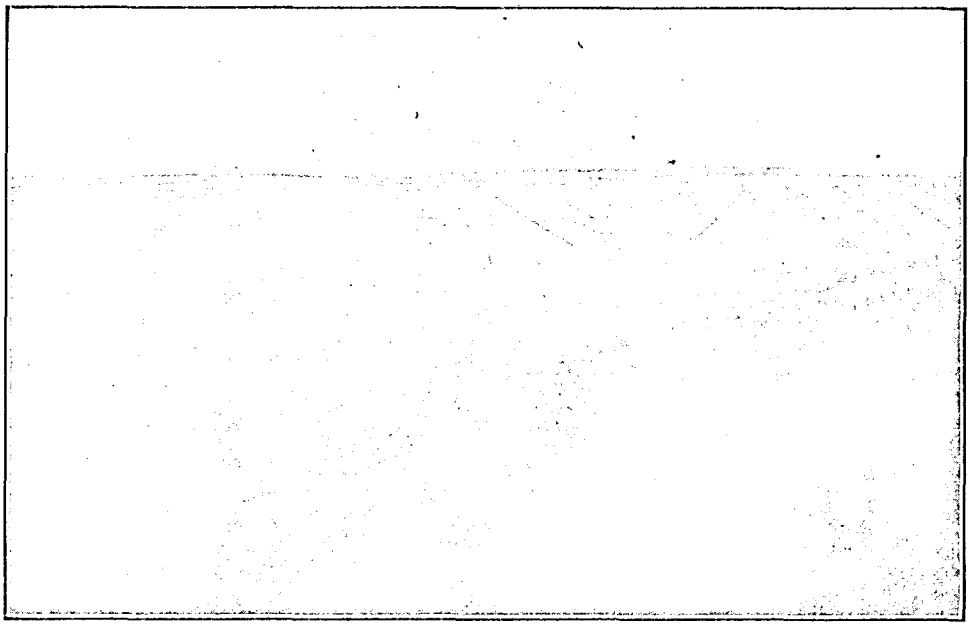
It may seem like the proverbial story f "Bringing coals to Newcastle" to sub- it a story of a probable extensive new opper field to a mining journal pub- shed in Arizona, but Arizona operators ave always been noted for their liber- ity in expression on matters pertaining mining and metallurgical progress. In ite of the immense volume of their ore esources, under their present day rapid- re practice of ore extraction, they doubt- ss recognize the life limitations of in- ividual units and may be interested to arn of a new American field of probable agnitude for reserve consideration.

Another reason for presenting this ar- cle at this time is that this new domestic esource forecast might act as a slight ffset against the new African copper ore esources, their richness, extent and pros- ective competitive importance, which ave been so vividly and pertinently por- rayed in the past few years, and es- ecially in recent issues of the Engineer- ng and Mining Journal in the articles overing the Northern Rhodesian copper eposits and their contiguous concessions n the Belgian Congo, which seem des- ined in a very few years to completely bsorb our foreign market for the red etal and in fact threaten our domestic arket.

These African copper stories are so ably ritten as to cause cold shivers to run lown the spine of the American producer nd high-cost copper security holder, and vould tend to make him commence to think f getting his bricks and mortar together or laying another tier on the American ariff wall, which to date has been unnec- ssary.

There are a few pertinent features in onnection with these great African cop- er resources that these recent authors ave not emphasized, which are as follows: Concession royalties; their geographic sit- ation involving 1,000 to 1,500 miles of ropical, swampy jungle narrow-gauge rail- ay maintenance; a climatic condition in hich it will prove permanently difficult to olonize white labor, with the attendant setse fly and white ant plague; an aborigi- al labor supply of very inferior quality nd the fact that the deposits are situated n a topography of low relief in a definite synclinal attitude. Their admitted sub- surface drainage practically insures some very expensive acid water pumping costs n their operation and altogether a pros- pect of a fairly high-cost finished copper oullion in spite of the richness and vol- ume of the deposits. These contingent cost features when distributed will no doubt soften the competitive prospect of these great new copper resources, at least as they are likely to affect our domestic market.

The able authors of these African stories have no patent on copper tonnage esti- mates based on shallow development and scattered drill-hole tests and their liberali- ty in this respect is just as applicable to this new American field of equal geologic strength and promise for low-cost copper metal production, if credit is given to as- sociated gold and silver values, and Miami



View of the Snake River Canyon, looking west from a point near Helena, Idaho, elevation 7,000 feet. Eagle Range is in the background. Shows 2,500 feet of Columbia lavas on the older rocks, greenstone and limestone.

operating methods are applied to a pros- pective volume of ore that has the new African resources backed off the earth. These new resources are likely to help maintain our present prestige in the pro- duction of the red metal indefinitely.

During the early years of this century, through the metallurgical genius of Brad- ley, Jackling, and other prominent engi- neers, the so-called disseminated porphyry copper ore deposits of very low copper contents, but immense tonnage volume, were brought into prominence and have since cut a remarable figure in the copper metal supply of this country and in its mining investment profits.

When this type of deposit was in great demand, the country was thoroughly ran- sacked for investment possibilities of this class, and by 1914 it was believed that the field had been exhausted of such deposits in this country, although others of the same type had been developed very suc- cessfully in South America.

The new northwestern porphyry copper province herein discussed is situated in the Grand Canyon of the Snake River, cover- ing both slopes of the canyon over a width of 50 miles and a length of 150 miles, be- tween Huntington, Oregon, and the mouth of the Grande Ronde River, 30 miles south of Lewiston, Idaho.

The literature covering this terrane is not extensive, but includes some very in- teresting reconnaissance reviews by Rus- sell, Lindgren and Laney of the United States geological survey, D. C. Livingston, former member of the Idaho state bureau of mines and geology, and Arthur M. Swartley, former member of the Oregon bureau of mines. These publications are now out of print and difficult to obtain. They have been liberally drawn upon by the writer, who acknowledges his indebt- edness to these sources of information on the subject under discussion.

This great canyon is traversed by a branch railway for the first 59 miles of its length below Huntington, terminating at Homestead, Oregon, and is also accessible to this point by excellent automobile high- ways from other railway connections at Baker, Oregon, and Council, Idaho. Two miles below this branch terminal, an inter- state steel bridge has been constructed across the river and the highway extends down the canyon below the bridge for a distance of 14 miles in the deepest and most rugged aspect of the canyon.

The Grand Canyon of the Snake River is probably the deepest earth trench in North America, a thousand feet deeper at an equal rim width than the Grand Can- yon of the Colorado, and presents one of the most profound expressions of igneous activity to be found anywhere in this country.

Its course is north and south through a highly elevated plateau country, 7,000 feet above sea level, with two closely parallel elevations of eruptive granite and grano- diorite which form the summits of the Seven Devils Mountains in Idaho and the Wallowa Mountains in Oregon, with a range in elevation from 5,000 to 9,500 feet above sea level less than 20 miles apart and parallel to the middle section of the canyon where the river has an elevation of 1,400 feet above sea level.

The plutonic formations of the Seven Devils Mountains are prevailingly grano- diorite and quartz diorite, with occasional areas of normal biotite granite. One of the largest granodiorite areas carries the bonanza copper ore deposits of the original Seven Devils mining district discoveries. These formations form the cores of most