of those 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 it.

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 the northern flank 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 500 feet in width at the foot of the mountain near Minam Lake (or Pine creeks, if the dip of the dike is considered), with a definite funnel-shaped 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 monzonite, 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 extension and is of 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.

For Snake River Canyon, 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 mineral production of the Snake River Canyon dates back to the early gold discoveries of Baker county, Oregon, and the discovery of the Snake River mine in the Iron Fork District ten miles north of Baker City, Oregon. 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, distinguished by a proven ore reserve conservatively estimated at 300,000 tons, which from consistent sampling shows an average value of $4.00 on tons, which indicates a very probable additional reserve of equal volume and value in the present total development of the mine. This development is at a stage where the tonnage and values only expected to expand very rapidly as the work progresses.

The individual ore courses of the Oregon Copper property vary from 10 to 100 feet, with a striking direction from east to west, 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 200 feet and later through a vertical shaft in the more underlaid 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 chalcopyrite specks appear in the ore at the first alt level and chalcopyrite and pyrite came in with gradually in-

The Snakc River Canyon country, eastern Oregon and western Idaho.
erasing 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 400 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 chalcocite with a subordinate amount of associated pyrite. This particular cross section of the ore body is a 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 chalcocite, for fear that these values would be erratic occurrence.

The sulphide minerals occur in roughly banded form and indicate an originally sheared or sheared 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 one 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 a similar strong showing in a 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 on this 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 of the Balm Creek ore body 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 adits are connected by raises. A crosscut from the 400-foot level is reached.

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 valuable ore bodies. Glaciated surface—Wallowa Mountains, Oregon. Taken from an elevation of 8,400 feet.
carrying high silver values. This zone gives the most attractive promise for the accumulation of economically recoverable sulphide conditions when it has been fully excavated at the tunnel level.

Another surface exposure on this property is a zone of highly mineralized pyrophyllite porphyry 100 feet wide, containing considerable quantities of disseminated ore with some chalcopyrite with selected values in gold and silver running up to several dollars per ton. This big showing is a thousand feet north 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 underground conditions 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 and mineralogical viewpoint, with significance 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 of the hill and the other 25 feet. 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 the other appears only a little farther below that the croppings can be traced for some distance. The width of the croppings is probably 200 or more feet long, distributed by thrust faulting and injection breccia which carries, in its matrix, marginal disseminations of chalcopyrite in bodies of large to medium size. This ore was more blocky 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 intrusive rocks with calcic intrusive breccias and conglomerates.

It has been suggested by some geologists that these disturbed ore bodies are fragmental boulders formerly associated with the neck 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 based on the noted value accumulation of predominantly plastic material which constitutes the 10,000 feet of associated greenstone formations, tuffs and breccias, which may have 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 a large stock of caldera basalts, 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 to the mouth of the stope in virgin ground to the 400 surface adit level. This raise was completed just before the operation was shut down and presumably carries the section 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 15 per cent 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 fractional quarrel among the officers of the corporation, the directors 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 dissolved in October, 1929, and it is currently reported that this unit of the companies' holdings is to be turned over to a prominent Arizona lessee 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 granitic slopes of the Wallowa Mountains has scored a canyon through the basalt series to the underlying greenstones, which exposes numerous copper-bearing ore zones both of the sulfide and oxidized 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.

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 ores.

Iron Mountain, so called because of its iron ore deposits, is situated at the head of Dennen 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 marbled 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 25 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 nearby districts have been variously estimated by different engineers at from half a million to two million tons.

These higher estimates are probably quite realistic for the reason that 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 chalcopyrite with kidneystone since chalcopryite 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 sulfuric 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.

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 chalcopyrite 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 stringing 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 upland 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 granite exposure stands at a surface angle of 40 degrees with two conspicuous sill-like horizons, each several hundred feet thick, that are more aptly 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 pyrite 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 of six per cent copper and $0.50 silver to 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 granite exposure is succeeded by sharply folded greenstone schists, marbled limestone beds and argillite 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 many 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 many small exposures of very rich silver ores up to 2,000 ounces per ton in selected samples and some lensy occurrences of steel galena. In addition to this a mineralized vein or zone of ore, standing nearly vertical and 20 to 100 feet wide, traverses the abrupt slope of the old plateau. This vein is 2,000 feet long, through a vertical elevation of 2,000 feet. The low, almost continuous outcropping with no adjacent sheat-like patches that contain average values of 2 to 5 per cent lead Excellent with an ounce or two of silver and $0.20 to $0.40 gold per ton in a succession of open pits driven through the deposit at intervals throughout its full length and representing widths varying from 10 to 20 feet. This great vein extends on 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 scattered and shipped ore of 150 to 200 carloads of steel galena. This ore had to be hauled from 60 to 100 feet in length described. A conservative figure would probably be justified at 20,000 tons of 20 per cent crude copper 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 handled by rail, the ore stockpile was located 100 feet from the railway shipping point, first at Weiser, Idaho, and later to Council, Idaho. Some small leasing operations on the Blue Jacket Queen Group on the Red Ledge mine, have shipped much ore from 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 zone of 1,000 feet in length, situated in the foot wall diorite. This ore body at the 200-foot level produced 100,000 tons of high-grade copper, the chief feature of which was 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,

irregularly shaped lead ore bodies in limestone, but it is questionable, as Spurr has suggested, whether the limestone acted as a source for the crystalline silicate gangue or simply a replaceable formation for the 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 mine is located on 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 a depression 900 feet by 250 feet in area, but this has been undercut by a drift to the 200-foot level and there can be little doubt of its linear persistency for the direction of the fissure.

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 who reopen ed in 1926-7 to the 200-foot level of the old shaft. This is 19 years where a shoot of richly disseminated bornite ore was found near the foot wall, with rich stringers of bornite mineral in the 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 this deposit has a closely banded structure with interveins of iron oxide which probably represent a trending of the gangue after crystallization and subsequent mineralization with rich chalcopyrite bands now altered to sidural 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 inability to transport the 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 southwest 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 which is located 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 road to the Interstate steel bridge, this was the only route of access to the Red Ledge until 1927, when the Interstate steel bridge across the river, two miles below Homestake, was completed 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,
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 copper 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. P. Chamberlin, and was under option in 1915 to the late S. A. 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 deposit was purchased in 1919 by Cooke Butler of Duluth, a prominent Minnesota iron and steel manufacturer. The property was consolidated in 1926 with 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 with 80 degrees north, 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 gentle dip to the south.

The Red Ledge is accompanied on its northern margin by a great dike of so-called cordwood porphyry. This is 100 feet wide and divides the tunnel at a right angle in the course of the Red Ledge to the east. The main valley to the east is a V-shaped cut in the main quartz porphyry zone at its highest outcrop near the Granite Creek divide, where the zone is 3,000 feet wide and includes a stock of normal biotite granite 600 by 1,000 feet in surface exposure. Farther east on this course this great mineralized quartz porphyry dike traverses a broad exposure of the 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 gneissic lakes and ponds. It is a 16 feet 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 passes through a V-shaped canyon, 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 cliffs but traverses a big valley slide and slopes down to the river 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, but by slopes of 30 per cent of its grade the creek is practically all embraced within an area of 20 acres in the middle cross section of the Red Ledge dike. This development consists of approximately 5,000 feet of shallow crosscut, tunnel work and drifts, and has exposed four ore zones which seem to represent more discrete bodies of ore, with a strike of 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 sequence 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 150 feet wide. The linear exposure character has been proven for a thousand feet in length by drilling and drifting. The deepest drill hole is 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 800 feet deep. Its core, with some alternating benches of clean 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 of 3000 feet. On this particular ore course are 700 tons, which, with some drifting from the intermedium tunnel, gave a fair assurance of the ore-bearing character of this particular zone for its full 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 a 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 6,000,000 tons, 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. The total thousands 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. Laney, who has watched this development since 1919, given at an Interstate Commerce hearing in 1923 on canyon railway construction against the account of this Red Ledge development, Dr. Laney emphasized features of fracturing and fissuring on these ore zones raised the Kennedy estimate to eight or 10 million tons of probable ore carrying 1 1/2 to 2 1/2 per cent copper and $2.00 gold and silver per ton.

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 and Anderson Mammoth claims, and the Darland Oxbow claims of equal ore character of his description and near-by granite magma extended on the other three zones, 40 to 100 feet wide, the ore body, repeatedly checked by noted mine engineers, the remarkable strength of fracturing and fissuring and the apparently unfissured intrusive character of the deposit, if the ore contents by this writer. The present estimate of tonnage and value on the Red Ledge is fully justified, and the engineer who would not recommend the further extensive exploitation of such a deposit on favorable terms lacks the optimism that such physical evidences justify.

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 1000-foot section of tunnel work, carries a rich disseminated sulphide ore body, repeatedly checked by noted mine engineers, the remarkable strength of fracturing and fissuring and the apparently unfissured intrusive character of the deposit, if the ore contents by this writer. The present estimate of tonnage and value on the Red Ledge is fully justified, and the engineer who 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 eastern end of the 4,000-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 engineer. The surfacing extends from the lower end of the glaciated valley of Deep Creek through the elizabeth valley for four miles on a uniform grade of 100 feet to the main course of the Red Ledge, which extend from the lower end of the glaciated valley of Deep Creek through the elizabeth valley for four miles on a uniform grade of 100 feet, and extends across the full width of the Red Ledge, whose mineralized character was recognized by the prospector but out of 30 or 40 samples of ore, from $2.00 to $2.50 per ton with a little silver and no copper and he did not have any use for that grade of outcrop.

The 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 0 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.

The Red Ledge, No. 1, at a point 3,000 feet from the canyon bottom and an elevation of 1,500 feet vertically higher, just below the Garden Trail, a prospect tunnel has been excavated for a distance of 50 feet in pyritized porphyry. At this point it entered a better mineralized band of the formation which shows a foot of rather massive pyrite with some abundant pyrophyllite and rich stringers of clean covellite, a variation in secondary enrichment under similar conditions which usually takes the form of talc schist. In this dike there is no chalcolite 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. Careful work on outcrops at this point is sharply in contrast with the view of the outcrops bordering the canyon bottom, and gives a much more interesting surface promise of underlying results. The sheer thickness of ore is considerable and at a more moderate slope of about 35 degrees, is intensely sheared, schistled and conditioned across the full 3,000 feet of which the dike is a single exposure; this permits a face where the full width of the dike can be seen from one wall to the other. Where the trail has cut its tighter ribs, evidence is shown of the oxidizing 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 branches through the outer exposure and extends down to Deep Creek just below the diamond drill camp in the canyon. This would afford a convenient water supply for the future. The small stream reaches a depth and an exposure where the ore can be reached by the help of a simple drill and test a few hundred feet down, a method which is a money-saving proposition. If underlying commercial values are found throughout its full width, the situation presents a feasible opsis of this nature in a near level method of operation through mill hole or rock chute delivery to a lower haulage access from the river or creek canyon.

The Red Ledge outcrop continues east through two adjoining properties known as the Allen-Anderson group and the Darland Oxbow group, extending to the south of Deep Creek and in parallel large stream known as Granite Creek. The dike is crossed by several tributaries of Deep Creek, insuring its surface extension. In the Oxbow group, the red porphyry is more consistently and uniformly sheared, cross sheared and mineralized with a width of 1,000 to 2,000 feet than any other portion of the Red Ledge property. This dike included basic dikes range up to 30 or 40 feet in width and in some shallow openings have proven to be richly mineralized. Cross sections of the dike have values of one per cent copper and a little gold and silver.

It is recognized that economic forecast, and a risk and seriously time the appeal of the most recent. Nature points some pretty pictures at the surface of mineral promise which subsequently to be chromatic, also some drab surfaces. Such deposits as these uniformly develop into masterpieces of production and profit. The oxidized surface demonstrations are not all chromes, of which the Miami mine is a good example, and where her pertinent pigmentations and background of copper ore associations are recognized they justify respectful consideration.

Topographically this Red Ledge deposit is just as rugged a situation as the previous one at the Garden Trail. 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.

Kenneckipnd upside down with the greenstones on top and thick horizons of replaceable pure underlying limestone between the rare, the greenstone wall rocks, according to the Red Ledge exposures.

While these greenstone wall rocks of the dike probably have little bearing in any, by direct contribution, on the presence of copper, gold and silver minerals in the dike, as the lateral seclusion theory properly posited out with the Posey mine 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 and granite. This district is of the nature's basic slags with many of the important copper deposits of the Cordilleran system. This includes the great Red Ledge outcrop as of the Copper River deposits of Alaska, many of the Arizona deposits, the new Flin Flon bonanza in northern Illinois, the Lake Superior formation, the rivers and lakes of the new African bonanzas, and 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 granite magma differentiation, for the copper in the siliceous and highly sereitized and conditioned veins for its subsequent oxidation, such as this and other dike norps.

From the standpoint of natural advantages for operating economics, this deposit is without a peer in the mining world at large. The depth of development as 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 underetch the present diamond drill development on the Red Ledge in Deep Creek to a depth of 4,000 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 the total development, attain a face depth of over 5,000 feet.

The interesting prospect of permanency in this great porphyry copper deposit is without a peer in the world. But the 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 southwest along a line of deepest point of development at present. In fact the natural erosion of the deposit exhibits primary cupferiferous sulphides in the deeper down, a feature in this region of similarly asso-
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 development of a new American field of probable magnitude.

Part 1.

It may seem like the proverbial story of "Bringing coals to Newcastle" to submit a story of a probable new copper field to a mining journal published in Arizona, but Arizona operators have always been noted for their liberality in expression on matters pertaining to mining and metallurgical progress. In spite of the immense volume of their ore sources, under their present rapid practice of ore extraction, they doubtless recognize the life limitations of individual units and may be interested to learn of a new American field of probable magnitude for reserve consideration.

Another reason for presenting this article at this time is that this new domestic source forecast might act as a slight check against the new African copper ore resources, their richness, extent and prospective competitive importance.

These African copper stories are so ably written as to cause cold shivers to run down the spine of the American producer and high-cost copper security holder, and would tend to make him commence to think of getting his bricks and mortar together or laying another tier on the American arithmetical pyramid. This of course has been unnecessary.

There are a few pertinent features in connection with these great African copper resources that these recent authors have not emphasized. These are the concessions, their geographic situation involving 1,000 to 1,500 miles of tropical, swampy jungle narrow-gauge railway maintenance; a climatic condition in which it will prove permanently difficult to colonize white labor, with the attendant mosquito, dengue, yellow fever, and white ant plague; an aboriginal labor supply of very inferior quality and the fact that deposits are situated in a topography of low relief in a definite synclinal attitude. Their admitted sub-surface drainage practically insures some very expensive acid water pumping costs in their operation and altogether a prospect of a fairly high-cost finished copper output in spite of the richness and volume of the deposits. These contingent cost features when distributed will no doubt reduce the prospective value 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 estimates based on shallow development and scattered drill-hole tests and their liberality 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 associated gold and silver values, and Miami operating methods are applied to a prospective 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 production of the red metal indefinitely.

During the early years of this century, through the metallurgical genius of Bradley, Jackling, and other prominent engineers, 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 remarkable 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 ransacked 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 successfully in South America.

The new northwestern porphyry copper province herein discussed is situated in the Grand Canyon of the Snake River, covering both slopes of the canyon over a width of 50 miles and a length of 150 miles, between 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 interesting reconnaissance reviews by Russell, 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 indebtedness 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 highways from other railway connections at Baker, Oregon, and Council, Idaho. Two miles below this branch terminal, an interstate 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 elevation than the Grand Canyon 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 granodiorite 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 predominantly granodiorite 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