GEOLOGY OF THE ROBERTSON, HUMDINGER, AND ROBERT E. GOLD MINES, SOUTHWESTERN OREGON

By PHILIP J. SHENON

ABSTRACT

The gold quartz veins described in the following report are similar to many other small or moderate sized deposits in southwestern Oregon which have produced notable amounts of gold.

The mines lie within the Klamath Mountains, a region characterized for the most part by rugged topography and complex geology. The rocks in the vicinity of the Robertson, Humdinger, and Robert E. mines are principally of igneous origin and include fine and coarse grained greenstones, serpentine, and quartz diorite and related rocks. Highly metamorphosed sedimentary rocks of probable Carboniferous and Jurassic age occur also but are much less abundant.

The profitable ore bodies of the mines described have been found entirely in fine-grained greenstone, although no reason is known why good ore should not occur along productive fissures in their extensions into some of the more brittle rocks of sedimentary origin, as, for example, the argillite at the Humdinger mine. At all the mines the gold occurs principally in white quartz, but some is found in the altered wall rock along the veins. The quartz occurs as a series of lenslike bodies and stringers along well-defined fissures. The lenses at the mines described range in width from less than an inch to more than 4 feet, and some of the ore bodies have been followed for several hundred feet horizontally and nearly 200 feet vertically.

The gangue minerals, in addition to quartz and altered wall rock, include calcite and, at the Humdinger mine, apophyllite. Besides the gold, the more common ore minerals are pyrite and arsenopyrite and their oxidation products. Silver occurs in relatively small amounts in all the mines, and petzite was recognized at the Robertson mine. The ore minerals occur in shoots within the quartz veins, but even within the shoots they are irregularly distributed. Some of the shoots have been of exceedingly high grade. In addition to the richer ore, considerable lower-grade material has been developed at the three mines. Fractures have controlled the deposition of the gold in the quartz, and in many of them gold can be observed with the unaided eye.

Veins of gold-bearing quartz that are of low grade but otherwise like the veins here described are common in southwestern Oregon. Most of them are narrow, and although rich ore shoots may occur in some of them, their development beyond shallow depths is probably not justified. On the other hand, some of the veins are larger, and these offer the possibility of considerable production. Experience has shown that the vertical distribution of the quartz is similar to the horizontal distribution. In general, if the quartz consists of a

series of narrow lenses extending for some distance along the strike of the vein, a similar extent downward can be expected. In general also the quartz is somewhat richer in the oxidized zone, but nevertheless careful sampling near the surface should give an idea of what may be expected below, though it will not necessarily indicate the presence of "blind" shoots of high-grade ore.

INTRODUCTION

FIELD WORK AND ACKNOWLEDGMENTS

This report embodies the results of investigations of three gold-mining districts in Josephine and Curry Counties, southwestern Oregon. (See fig. 3.) The investigations were made under the

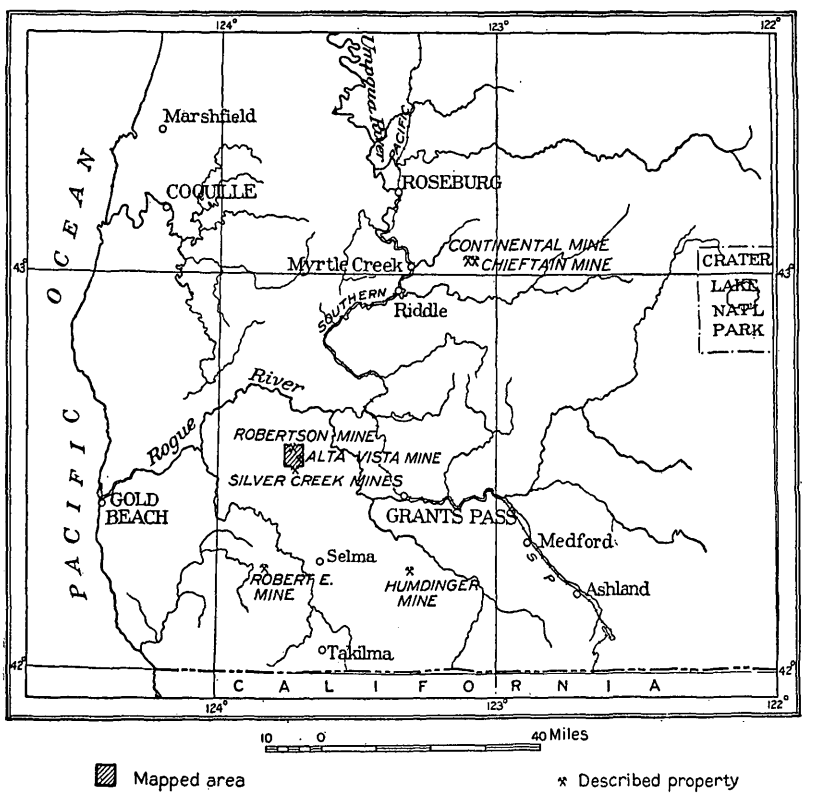


FIGURE 3.—Index map showing location of Robertson, Humdinger, and Robert E. mines, Josephine and Curry Counties, Oreg.

supervision of J. T. Pardee, as a part of the cooperative survey of the mineral resources of Oregon by the State mining board and the United States Geological Survey.

The field work was done in September and October, 1930. The first two weeks in September was spent in the vicinity of the Robertson mine. A map showing the topography and geology of 9 square miles was made, and the underground geology of the mine was

mapped in detail. Examinations were also made of the Alta Vista and Silver Creek mines near by. Two days in the later part of September was spent at the Humdinger mine, during which the underground geology was mapped and a reconnaissance was made of the surface in the immediate vicinity. On October 3 and 4 the Robert E. mine and vicinity were examined and the underground geology was mapped. In this work the writer was assisted by Duncan Johnson and Aubrey Walker at the Robertson mine and by Aubrey Walker at the Humdinger and Robert E. mines. Acknowledgments are due to the mining men of the district for the numerous courtesies extended during the course of the field work. Messrs. K. Dean Butler and G. T. Vandel, of the Robertson mine; W. B. Robinson, of the Humdinger mine; and I. F. Peck, of the Robert E. mine, all gave information and generous amounts of their time.

MAPS AND LITERATURE

The United States Geological Survey topographic map of the Kerby quadrangle includes the vicinity of the Robert E. mine, and the Humdinger mine is within the Grants Pass quadrangle. Both maps are 30-minute sheets on a scale of 1 to 125,000, with a contour interval of 100 feet. The quadrangle including the Robertson mine has not yet been mapped.

The following list includes the principal publications bearing directly on the geology and ore deposits of the areas described in this report:

Diller, J. S., and Kay, G. F., The mineral resources of the Grants Pass quadrangle and bordering districts: U. S. Geol. Survey Bull. 380, pp. 48–79, 1908.

Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, 1914.

Winchell, A. N., Petrology and mineral resources of Jackson and Josephine Counties, Oreg.: Mineral Resources of Oregon, vol. 1, No. 5, Oregon Bur. Mines and Geology, 1914.

Butler, G. M., and Mitchell, G. J., Preliminary survey of the geology and mineral resources of Curry County, Oreg.: Mineral Resources of Oregon, vol. 2, No. 2, Oregon Bur. Mines and Geology, 1916.

The history, production, and general features of the gold lodes in southwestern Oregon as described in the reports listed above are summarized by J. T. Pardee in a press bulletin of the United States Geological Survey, published August 7, 1930, from which the following is taken:

Gold is rather widely distributed in the southern part of western Oregon and is also found in several places on the western slope of the Cascade Range as far north as the basin of the Molalla River, east of Salem. The southern and principal gold-bearing region, generally referred to as southwestern Oregon, comprises Josephine County, the west half of Jackson County, most of Curry County, and adjoining parts of Douglas and Coos Counties, a total area of

more than 6,000 square miles. This region lies mostly in the drainage basin of the lower Rogue River but includes areas drained in the South Umpqua, the Chetco, the South Fork of the Coquille, and the Sixes Rivers. Although gold deposits are found throughout this region, they are most numerous in the parts included within Jackson and Josephine Counties, which to date have yielded four-fifths or more of the total gold produced in western Oregon. Here, as in most other gold-bearing regions, the gold occurs both in lodes and in placer deposits.

Ever since placer mining began in Oregon, about 1852, near Jacksonville, the southwestern part of the State has been known as a gold-producing region. Its early history includes the usual period of rapidily succeeding discoveries, gold rushes, and booms, followed by less intense but steadier activity. The smaller units, which at first constituted separate placer mines, were later combined into larger holdings and the cruder processes of mining gave place to more efficient hydraulic methods. Although less active than formerly, hydraulic mining has continued without interruption to the present time and has exceeded quartz mining as a source of the gold produced. At times in the last 20 years dredging has been attempted, but until the last 2 years it has not been carried on continuously for any considerable time.

Early in the mining period gold quartz lodes were discovered. Since then lode mining has experienced periods of relative activity and quiet but has never been completely suspended.

No records of production were kept during the early part of the mining period, and there is apparently little basis for a satisfactory estimate of the output before 1864. Beginning in 1864 more or less complete records and estimates became available, and for the years since 1882 fairly detailed records are given in the annual volumes of Mineral Resources of the United States, up to and including 1928 (the latest yet issued), published by the Geological Survey until 1925 and by the Bureau of Mines since then. From these sources and including an estimate of the early production of Jackson and Josephine Counties by Winchell,[1] which the writer has taken the liberty of modifying somewhat with respect to silver, and an estimate for Josephine County by Diller,[2] the total metalliferous production of western Oregon appears to be between $24,000,000 and $40,000,000, distributed among the different metals, as follows:

Gold	$22,000,000 to $38,000,000
Copper	1,278,880
Quicksilver	466,344
Silver	325,590
Platinum	59,826
Lead	9,043

From reports by C. G. Yale, J. M. Hill, and V. C. Heikes in the annual volumes of Mineral Resources of the United States and the reports cited above, it appears that the most active and productive period of gold lode mining was the decade 1900–1910. For the latter part of that period (1904–1910) the records show that from 20 to 30 mines were operated and that the total yearly production ranged from about $55,000 to $320,000. Since 1910 the activity in gold lode mining has decreased, and the number of mines operated has fallen

[1] Winchell, A. N., Petrology and mineral resources of Jackson and Josephine Counties, Oreg.; Mineral Resources of Oregon, vol. 1, No. 5, p. 29, Oregon Bur. Mines and Geology, August, 1914.

[2] Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, p. 47, 1914.

at times as low as five. The yearly production has ranged from $3,000 to $87,000; the low figure represents the output of 1919 and 1920, when the postwar depression adversely affected gold mining as well as many other industries. A jump to $87,000 occurred in 1921, chiefly as the result of mining a rich ore body in the Boswell lode, near Holland. High points of production of $59,000 and $43,000, reported in 1925 and 1926, respectively, were caused by the working of similar ore bodies in the Robertson mine, near Galice. In 1928 more than $61,000 in lode gold was produced, a large part of which was contributed by a rich ore body in the Robert E. mine. During the intervals between the exceptional years of low and high production mentioned, an average of about 13 lode mines were operated, and their aggregate average yearly output was $24,000, or a little less than $2,000 a mine. Figures for 1929 are not yet available, but incomplete reports indicate an activity and production equal to if not greater than that of 1928.

Most of the time since 1913 the value of the ore mined from gold lodes has averaged less than $20 a ton. During the highly productive years 1904–1907 the average value of the ore mined was less than $8 a ton. In 1906 it was only $5 a ton. In 1921, however, the rich ore produced by the Boswell mine caused the average for Josephine County to jump to $225 a ton. In 1925 and 1926, when the Robertson mine was productive, the average was nearly $150 a ton. During the intervals of scanty production the ore has ranged in value from $5 to $50 a ton and averaged about $20.

Diller and Winchell together describe more than 150 mines and prospects in southwestern Oregon that are on lodes valuable chiefly or only for gold. A few additional mines are described by Butler and Mitchell. At least five-sixths of all the lodes described by these authors are quartz veins, including simple and multiple veins, stringer lodes, lenses, and pockets. The remainder are chiefly mineralized shear or fracture zones. Of the vein group, about 15 are comparatively large; that is, they are from 3 to 10 feet or more wide and extend continuously for hundreds of feet along the strike and dip. Among these are the lodes in the Ashland, Greenback, Opp, and Granite Hill mines, each of which contains several thousand feet of underground workings and has produced from $75,000 to $1,000,000 or more. All contained small shoots of rich ore, but the bulk of their production came from bodies 2 to 5 feet or more thick and several hundred feet long and deep that yielded from $5 to $13 a ton.

About 40 of the lodes described are between 1 and 3 feet wide, but comparatively large otherwise. The most extensively developed and productive of these are the lodes in the Daisy, Mountain Lion, Golden Wedge, and Braden mines, for which available records show production ranging from $30,000 to $200,000. The ore bodies are mostly 2 or 3 feet thick and from 100 to 500 feet or more long and deep, and their average tenor, exclusive of some small rich shoots and bunches, is from $8 to $20 a ton.

Of the remaining 100 or more lodes, a few are described as 1 foot or less wide and not continuous very far horizontally or vertically. From the incomplete descriptions of the remainder, it may be inferred that most of them are also small. Despite their small size, some of these lodes have been very productive, particularly those containing the ore bodies known as pockets. The most celebrated example, the Gold Hill pocket, is said to have yielded $700,000. It was a body 15 feet deep and of no great horizontal dimensions. The Steam Boat, Revenue, and Town pockets are credited with $100,000 to $350,000 each. Five or six others produced a few thousand dollars each and several yielded smaller amounts. A few of the small lodes contain ore shoots that persist to greater depths than the superficial bodies mentioned. Except

the rich pockets and shoots, the small lodes are of low grade. Extensive underground workings have been made on few of them.

Quartz is the predominant mineral of these lodes. Commonly they contain also calcite and sulphide minerals, which in the aggregate generally do not exceed 2 or 3 per cent. Of the sulphides, pyrite is the most abundant and is found in nearly all the lodes. Several lodes contain one or more of the minerals chalcopyrite, sphalerite, and galena, and a few the gold-silver tellurides sylvanite and petzite. Petzite was identified in ore from the Robertson mine. Native gold is abundant in the richer deposits.[3]

The ore is more or less free milling; that is, part of the gold can be recovered by simple crushing and plate amalgamation. The remainder is mostly saved by concentrating the sulphides to a product that generally assays as much as $75 a ton. Many of the lodes are or were at some time equipped with mills or arrastres. Most of the mills are small, being equipped with 1 to 5 stamps or their equivalent in other machinery. A few range from 5 to 20 stamps, and one at the Greenback mine contains 40 stamps.

Included in the group of gold-bearing or possible gold-bearing lodes are 30 or more bodies that may be described as mineralized shear zones. Most of them are in the Galice-Kerby region and districts farther west in Curry County. They range in width from a few feet to a hundred feet or more, and some are said to extend for long distances horizontally. Although some productive mines, such as the Jewett, near Grants Pass, include such bodies, the workable ore of those mines comes from lenses or veins separate and distinct from the low-grade zones.

No productive mines are yet known that depend on the low-grade zones for ore. The exploration of a few of them seems to have been mainly incidental to the search for rich pockets or other ore bodies. The low-grade zones are characterized usually by disseminated pyrite and the presence of chlorite and other minerals indicative of rock alteration. Evidence as to their value is scanty and conflicting. A zone that is exposed by the extensive workings of the Almeda mine, at Galice, is from 30 to 60 feet or more wide. It occurs along the west or footwall side of a copper-bearing lode and consists of a dike rock (quartz porphyry or dacite porphyry) that has been more or less altered and replaced by quartz and pyrite. Diller[4] quotes an assay reported by an engineer for the company, P. H. Holdsworth, that is claimed to represent an average of this zone in the upper levels. It shows 0.14 ounce of gold (equivalent to $2.80) and 6.4 ounces of silver to the ton and 0.3 per cent of copper. Diller also quotes several higher assays reported by Holdsworth, said to represent material from the same zone but not identified as to location. Diller's own observations and sampling, so far as they go, do not confirm the results given by Holdsworth. Diller says: "The only siliceous material I collected was taken from the crosscut west from the 500 level. The assays of these samples (collected near the shaft and 12 feet west of it) show that they contain but very little gold (20 cents a ton) and only a trace of silver. These samples, however, appear to me to fairly represent much of the material lying immediately west of the copper ore."

The Red Elephant claims, on Howard Creek west of Galice, are mentioned by Diller[5] as containing a mineralized belt several hundred feet wide. He reports a sample as having assayed 0.023 ounce of gold (equivalent to about 46

[3] Arsenopyrite may have been overlooked by the early writers. It occurs in the Robert E. and Humdinger mines and is prevalent in a specimen of ore from the Irish Girl vein of the Greenback mine collected by Mr. Pardee in 1929.—P. J. S.

[4] Diller, J. S., op. cit., p. 77.

[5] Idem, p. 55.

cents) to a ton. Samples collected by Diller from other zones contained no gold. Samples from still other zones are said by the owners to assay from $2 to $12 or more a ton.

The annual volumes of Mineral Resources mention 65 lode mines in southwestern Oregon as having been productive at one time or another since 1912. Only 22 of these are included in the list of mines described by Diller and others. The remaining 43 presumably include mines that were known but were inactive before 1912 and mines that were discovered since that date. The productive period of two-thirds of the lodes mentioned in Mineral Resources was one year or less. Most of the remainder were operated from two to four years, and three, the Great I Am, January First, and Gold Ridge, were operated five or six years each. The largest producers since 1912 are the Boswell, Robertson, and Robert E. In addition to the 65 productive mines, 17 are mentioned in Mineral Resources as being under development but not productive, and one of these, the Millionaire, was being developed through a period of five years. About 10 mines on gold lodes were producing or being developed in 1929. Among these were the Robertson, Robert E., Sylvanite, and Ida.

The available information indicates that many of the larger lodes, such as those in the Ashland, Greenback, and Opp mines, probably contain unexploited ore bodies of good size but mostly of low grade. The prospects for making a valuable mine of the Ashland were considered by Winchell[6] in 1914 as "very unusually good." This mine has been inactive for a long time, as a result, it is understood, of litigation. Except for a little development work done in 1927 and 1928, the Greenback mine has been inactive since 1908. The last considerable production of the Opp mine was made in the period 1914–1924.

GEOGRAPHY OF SOUTHWESTERN OREGON

TOPOGRAPHY AND DRAINAGE

The mines described in this report lie within the Klamath Mountains, as defined by Diller[7] and later described by Diller,[8] Anderson,[9] and others. The region is for the most part extremely rugged and is marked by strong relief. For example, near the Robert E. mine the relief exceeds 2,000 feet within a distance of about a mile, and at places along the lower Illinois River it is more than 3,500 feet within a distance of 2 miles. The altitudes range from over 6,000 feet on the higher peaks to sea level along the coast. The ridges and groups of ridges comprising the mountains of southwestern Oregon trend in various directions and have very little semblance to an orderly arrangement. However, when viewed from the higher summits they present a strikingly uniform outline against the sky and, like so many other mountains that appear extremely rugged from the valleys, resemble a dissected plateau. The high flat-topped summit areas, as pointed out by Diller, are remnants of an erosion surface

[6] Winchell, A. N., op. cit., p. 117.

[7] Diller, J. S., Tertiary revolution in the topography of the Pacific coast: U. S. Geol. Survey Fourteenth Ann. Rept., pt. 2, p. 408, 1894.

[8] Diller, J. S., Topographic development of the Klamath Mountains: U. S. Geol. Survey Bull. 196, pp. 9–66, 1902.

[9] Anderson, F. M., The physiographic features of the Klamath Mountains: Jour. Geology, vol. 10, pp. 144–159, 1902.

which he has termed the Klamath peneplain. In general the peneplain rises gradually from north to south and from west to east. Near the mouth of the Rogue River its altitude is about 2,000 feet, whereas at the Robertson mine, about 30 miles inland, remnants of the old surface are well preserved at an altitude of about 4,000 feet.

The Rogue and Chetco Rivers and their tributaries drain the portions of southwestern Oregon considered in this report. The Rogue River and its larger tributaries flow alternately through wide-open valleys and narrow V-shaped canyons, but the Chetco River, which rises near the boundary of Josephine and Curry Counties, flows its entire distance through a narrow rugged canyon to the Pacific Ocean. The Rogue River rises west of Crater Lake, near the crest of the Cascade Range, and flows westward to the ocean by a circuitous course, along which it is joined by Bear Creek, the Applegate and Illinois Rivers, and numerous smaller tributaries.

CLIMATE AND VEGETATION

The climate of southwestern Oregon is mild and pleasant. The summers are warm and dry; the winters are characterized by considerable rainfall. The light snow that falls in the valleys soon disappears, but the heavier snows in the mountains lie for longer periods.

The undergrowth is dense, in many places almost impenetrable. Thus, progress away from the beaten paths is slow and difficult, and prospecting in certain areas has been more or less delayed.

ROBERTSON MINE AND VICINITY

LOCATION AND ACCESS

In an air line the Robertson mine is about 6 miles directly west of Galice, but the distance by road is 10 miles. The road is serviceable, although steep and narrow and in rainy weather difficult to travel. It terminates on the south of the Robertson mine, but in 1930 the Forest Service started the construction of a branch road to Bear Camp ranger station, about 10 miles to the northwest. Merlin, on the Southern Pacific Co.'s main line 15 miles southeast of Galice, is the nearest railroad shipping point.

TOPOGRAPHY AND DRAINAGE

The Robertson mine is situated in a rugged region traversed by narrow and deep canyons divided by flat-topped summit areas of nearly equal elevation. Within the map limits altitudes range from 2,800 to 4,000 feet, and in places there are differences of 900 feet within a horizontal distance of 1,500 feet. The southern part of the

region is drained by the headwaters of the North Fork of Silver Creek, and the extreme northern part by the headwaters of Howard Creek. Silver Creek flows southward to the Illinois River, and Howard Creek flows northward to the Rogue River.

GEOLOGY

GENERAL FEATURES

Igneous rocks greatly predominate in the vicinity of the Robertson mine. (See pl. 4.) They include metabasalt, metagabbro, serpentine, and quartz diorite and related rocks. Sedimentary rocks belonging to the Dothan formation occur only in the extreme northwestern part of the mapped area. Except for slight schistosity in the metagabbro, the attitude of the igneous rocks is not revealed by their structure, although the contacts, as in most other parts of southwestern Oregon, strike east of north. The bedding in the Dothan formation within the limits of the area mapped strikes N. 30° E. and dips, in general, about 60° SE.

SEDIMENTARY ROCKS

DOTHAN FORMATION

Part of the group of rocks termed by Diller the Dothan formation crop out in the extreme northwest portion of the mapped area. The formation is composed chiefly of massive sandstone, chert, argillite, and fine-grained conglomerate. Of these rocks the sandstone is the most abundant. It is firmly cemented and is light to dark gray where fresh and yellowish brown where weathered. The microscope shows the rocks to be made up largely of angular and irregular grains of quartz, albite, and altered rock fragments in a fine-grained siliceous matrix. The original rock was probably an argillaceous sandstone. The chert where fresh is nearly white, but in most places near the surface it is stained brown by iron oxides. It forms steep bluffs north of the river in sec. 3, T. 35 S., R. 9 W. The fine-grained conglomerate is interbedded with argillite, and both occur in thin beds. Near the contact with diorite the Dothan rocks are changed to hornstone, schist, and vitreous white quartzite.

IGNEOUS ROCKS

GREENSTONE

The term "greenstone" is applied to fine and coarse grained igneous rocks which, owing to the development of much chlorite, epidote, actinolite, and fine granular hornblende, have a prevailing green color. In the fine-grained rocks and in the more intensely

metamorphosed coarse-grained rocks the nature of the original rock is obscure in hand specimens, and hence the term "greenstone" is applied for convenience.

In the vicinity of the Robertson mine there are two distinct greenstones—a very fine-grained altered rock of basaltic composition, which is termed a metabasalt, and a coarse-grained rock, largely recrystallized, which is termed a metagabbro.

The metabasalt and related rocks crop out over an area of about 2 square miles in the vicinity of the Robertson mine, and, as in many other mining districts in southwestern Oregon, contain the most valuable ore deposits. Their attitude is not revealed by flow boundaries or other features of structure. They are dark grayish-green to almost black rock and are usually fine and even grained, though some are porphyritic. Near intrusive contacts the rock is changed in some places to chlorite and talc schists and in others to a pistachio-green rock composed almost entirely of epidote and quartz. Under the microscope the prevailing rock exhibits a basaltic texture. Feldspars usually make up more than half of the rock, and augite, although variable in amount, averages about 30 per cent. The plagioclase feldspars range from laboradorite to andesine and are nearly everywhere considerably altered. Chlorite and epidote are the most abundant alteration products and are plentiful even in the fresher-appearing rocks. Close to the quartz veins the metabasalts are altered largely to epidote and quartz.

The metagabbro occupies a little over 2 square miles in the southeastern part of the Robertson district and occurs in a few small unmapped areas which are included with the quartz diorite. The prevailing metagabbro is medium to coarse grained and dark colored and is almost identical in appearance with the metagabbro in the Riddle quadrangle described by Diller.[10] Some porphyritic and fine-grained varieties occur here and there. One particularly noticeable facies contains dark-green hornblende crystals over an inch long. The minerals of the metagabbro are similar throughout, but the grain size and the proportions differ greatly and the different rocks show various degrees of recrystallization. (See pl. 5.) In general, however, the finer-grained granular rocks exhibit the most complete recrystallization. Granoblastic textures (textures resulting from recrystallization) prevail, and in some rocks gneissic structure is partly developed. In hand specimens the dark minerals appear to make up most of the rock, but thin sections show that the light and dark minerals are about equally divided. The plagioclase feldspars range in composition from bytownite to andesine.

[10] Diller, J. S., U. S. Geol. Survey Geol. Atlas, Riddle folio (No. 218), p. 4, 1924.

Bytownite occurs in the rocks showing the least recrystallization, and fine granular andesine is the prevailing feldspar in some of the more completely recrystallized rocks. Hornblende and actinolite are the most abundant dark minerals. They can be seen replacing feldspar in most of the rock sections, as illustrated in Plate 5. Little or no original quartz is present. Magnetite is fairly abundant, both as grains and as fine dusty-appearing particles disseminated in the hornblende of some sections. Some pyrite is usually present.

SERPENTINE

Serpentine crops out in three small areas near the Robertson mine and is abundant a few miles northeast of the mine. Near the mine it is dense and almost black and has more of a stony appearance than most of the other serpentines of southwestern Oregon. Shearing has developed a parallel structure in it, and in some places, particularly near the top of the hill immediately south of the quarter corner between sections 11 and 12, T. 35 S., R. 9 W., numerous parallel fractures are filled with the green chlorite mica, penninite. In other places, around its contact, the serpentine is changed to talc schist. In the vicinity of the Robertson mine the process of serpentinization is nearly complete, but partly serpentinized olivine occurs. A specimen obtained near the head of Cedar Swamp Creek contains about 50 per cent of olivine and, like most of the other serpentines in the immediate vicinity, has a well-developed parallel structure. In this specimen the most complete serpentinization has occurred along the fracture planes.

QUARTZ DIORITE AND RELATED ROCKS

Quartz diorite and related rocks occupy much of the area in the immediate vicinity of the Robertson mine. A coarse-grained quartz diorite which in the field appears to contain about equal proportions of light and dark minerals prevails, but in places a dark rock of gabbroid composition occurs. Both rocks are in general free from alteration and show little or no evidence of recrystallization.

The microscope shows that the prevailing quartz diorite is composed of about 70 per cent of light-colored minerals and about 30 per cent of dark minerals. Plagioclase constitutes the bulk of the light-colored minerals and, on the average, makes up about 55 per cent of the rock. Quartz is abundant and forms 10 to 15 per cent of the rock. Green hornblende is the most abundant dark mineral. It is present in amounts ranging from 15 to 25 per cent. In some rocks it is slightly altered to chlorite, but in general it is fairly fresh. The hornblende in the quartz diorite is original, but at least

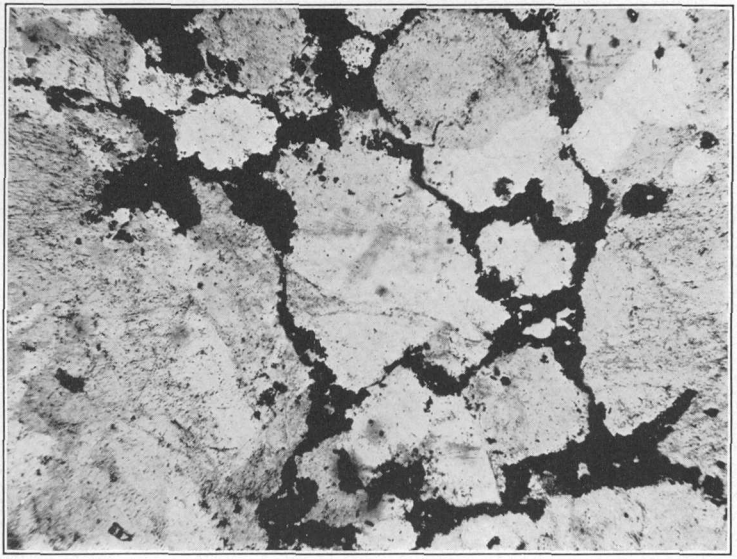
a good proportion of that in the metagabbro is secondary. The magnetite ranges from 1 to 2 per cent, and small amounts of pyrite are usually present. Chlorite is the most abundant alteration product, and sericite and epidote occur in smaller amounts. None of the quartz diorite or related rocks studied contained more than 10 per cent of alteration products, and most of them considerably less.

In the gabbroid rocks, which are coarse grained, the dark minerals prevail. Feldspars form 30 to 40 per cent of the constituents. Little or no quartz is present. Augite is the most abundant dark mineral, although in some rocks hypersthene is almost as plentiful. Together they make up 50 to 60 per cent of the rock. Olivine makes up 5 to 10 per cent, and wherever seen is altered only slightly and only along fractures. About 1 per cent of magnetite is usually present, and in some rocks rutile occurs in small amounts.

AGE RELATIONS

The age relations of some of the rocks in the vicinity of the Robertson mine are not clearly evident. Fossils are rare in the Dothan formation, but those found are so similar to the fossils (late Jurassic) of the Galice formation on the southeast side of the greenstone belt as not to be distinctive, and Diller[11] therefore assigned the Dothan rocks to the Jurassic system. Near the Robertson mine the Dothan formation is separated from the metabasalt by quartz diorite and related rocks, and hence the relation between them is not evident. The metabasalt is, however, the oldest of the igneous rocks. Field relations show that it has been intruded by serpentine and quartz diorite and related rocks, and contact alterations indicate rather definitely that it has been intruded by metagabbro. Certain facies of the quartz diorite resemble some of the metagabbro, and yet the darker color and granulated texture of the metagabbro are usually sufficient to distinguish it from the quartz diorite in the field, and under the microscope they are readily distinguished by the rather intense degree of recrystallization and the absence of quartz in the metagabbro. The quartz diorite and related rocks of the Robertson mine area probably belong to the group of widespread granitic rocks in southwestern Oregon that are believed to have been intruded during late Jurassic or early Cretaceous time. These rocks differ in composition in different localities and have been variously termed "granodiorite," "tonalite," "quartz diorite," etc. They are believed to be closely related genetically to many of the ore deposits in southwestern Oregon.

[11] Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, pp. 17–18, 1914.



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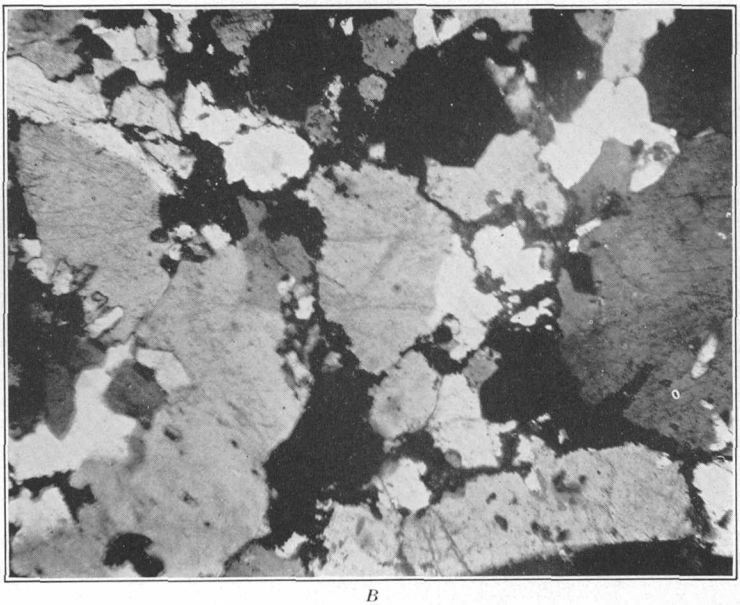


B

PHOTOMICROGRAPHS OF ORE FROM ROBERTSON MINE

A (parallel light) shows gold (black) along fractures in quartz. *B* (crossed nicols) shows gold cutting individual quartz grains; some quartz grains (black) are at extinction. *A* enlarged 86 diameters.

MINES AND PROSPECTS

ROBERTSON (BUNKER HILL) MINE

HISTORY AND PRODUCTION

The Bunker Hill lode was located in 1914 by John Robertson and sons, of Galice, and its history for the next decade, like that of many other prospects, is one of hard work and expenses instead of dividends. In 1925, however, rich ore was struck, and in the next three years, by means of a small 5-stamp mill, a large amount of gold was produced. In 1928 the mine was purchased by the Robertson Mines Co., which, under the direction of K. Dean Butler, did a great deal of underground development and increased the capacity of the mill plant to 30 tons daily by adding five additional stamps and two concentrating tables. In September, 1930, about 30 men were employed in underground development, surface improvements, and the operation of the mill. A main haulage crosscut 520 feet long was completed, and over 1,200 feet of drifts and several raises were driven from it. A winze was sunk on the No. 1 vein to a depth of 91 feet, and most of the mining was being done below the main haulage level and above the 91-foot level. The ore is conveyed from the mine to the mill, a distance of 1,500 feet, by an aerial tram. The mine is well equipped, and good quarters are available for the accommodation of 30 men. The production reported since 1924 is, in round figures, $138,000. This amount was the value of more than 6,900 ounces of gold and 546 ounces of silver obtained from 1,376 tons of ore.[12] The gold content of the ore ranged from 19.50 ounces to the ton in 1925 to 1.97 ounces to the ton in 1929. It averaged 2.04 ounces to the ton in 1930. In 1929 and 1930 the output of the ore was greatly increased because of added milling facilities.

GEOLOGY

The workings of the Robertson mine partly explore a group of small quartz veins formed along fractures in greenstone near a tongue of quartz diorite. Four veins have been prospected underground and on the surface (see pl. 6), but thus far nearly all of the production has come from the No. 1 vein. This vein, like the other principal veins, strikes northwest and dips at steep angles to the southwest. One fairly large quartz vein encountered in the No. 4 drift, however, strikes north and dips east at a steep angle. All the quartz veins are lens-shaped and have slickensided and, in most places, horizontally striated surfaces, and the surfaces are

[12] Data supplied by Victor C. Heikes, of the U. S. Bureau of Mines.

usually in contact with 1 inch to several inches of dark-grayish gouge.

The quartz in the No. 1 vein is continuous horizontally for practically 140 feet, but in places it pinches to almost nothing. The average width is estimated at about 1 foot, although, where observed, the width ranged from less than 2 inches to almost 2 feet within short distances. The vein splits above the haulage level at about 100 feet below the surface and at the surface the two branches are about 35 feet apart. Practically the entire length of the vein, including both branches, contained commercial ore, and in September, 1930, except for several blocks and pillars, the vein was stoped for a vertical distance of 260 feet. The quartz in the vein everywhere contains some gold, but it is not at all evenly distributed, and according to G. T. Vandel, mine foreman, some gold occurs in the mineralized wall rocks next to the veins. In both oxide and sulphide zones free gold is in some places plainly visible scattered through the quartz, though in other places it can be detected only by panning. Mr. Vandel states that the ore in the No. 1 vein, outside of the rich spots, generally runs from $25 to $35 a ton, of which $10 is recovered by plate amalgamation, and most of the remainder is saved in a sulphide concentrate on tables. The Nos. 2, 3, and 4 veins have all been explored on the main working level, but because the quartz in all of them has a low gold content they have not been stoped.

The greenstone inclosing the ore is a very dense greenish-gray to almost black rock which the microscope shows to have a basaltic texture typical of the fine-grained greenstones of the region. Underground, except in close proximity to the quartz veins, it is not greatly different in composition from the normal fine-grained greenstone. Near the veins, however, the greenstone is altered to a light-green greasy-appearing rock consisting largely of fine-grained epidote, chlorite, quartz, and a white, nearly opaque material which under high magnification is seen to be composed largely of epidote and quartz. Where the alteration is most intense—for example, along the walls in contact with the ore—and in rock fragments included in the vein quartz, chlorite is less abundant and the fine-grained alteration product makes up the bulk of the rock. Part of the quartz, calcite, and epidote, as well as the ore minerals, have been introduced. The principal ore minerals are native gold, petzite (a gold-silver telluride), and pyrite, and chemical tests show the presence of some bismuth in the sulphide concentrate. Microchemical tests on the petzite indicate a high percentage of gold and an almost total absence of silver, but the mineral is isotropic, a fact which indicates isometric crystal form; hence it is petzite rather than calaverite or sylvanite. There are at least two generations of quartz.

Coarse-grained quartz was introduced before the ore minerals, whereas fractures filled with fine-grained quartz, epidote, and calcite clearly cut the pyrite. The pyrite, gold, and petzite were introduced along shattered portions of the coarse-grained quartz and are therefore younger. (See pl. 7.) The petzite is locally replaced by gold.

ORIGIN OF THE ORE

The evidence available suggests that the ore at the Robertson mine was formed at moderately shallow depths and under conditions of moderate temperature. The mineral assemblage does not offer conclusive evidence to support this inference, but the presence of gold telluride and the occurrence of open vugs are not characteristic of the deep-zone type of mineralization. On the other hand, neither do the veins exhibit an abundance of features characteristic of very shallow mineralization.

The ore bodies appear to be related genetically to the intrusive quartz diorite. The quartz diorite is not far from the veins and is the most probable source of the ore-bearing solutions. Study of thin sections indicates that during mineralization considerable lime, ferric iron, alumina, and quartz were added to the rock next to the veins, and apparently soda, potash, and magnesia were removed. More or less granular quartz has been introduced into the greenstone inclusions and into the wall rocks immediately adjacent to the veins. The manner in which the quartz has penetrated along fractures of microscopic size shows clearly that the quartz must have been introduced in a very tenuous state and not as a viscous substance.

The ore has been deposited along numerous small fractures and along a few larger and more persistent ones. However, the longest horizontally continuous vein thus far exposed is only 140 feet in length, although the same vein has been followed downward for 260 feet. The parallel alinement of the principal veins, the manner in which they terminate, and the distribution of the numerous fractures near the veins suggest that they have been formed by east-west shearing stresses. Such stresses are believed to have formed the openings along which the quartz was deposited and later to have produced the slickensiding and gouge along the walls of the veins.

ECONOMIC CONSIDERATIONS

The lenslike form of the veins is believed to be largely an original feature and not entirely the result of later faulting. If the evidence is interpreted correctly, long-continuous ore shoots can not be expected at the Robertson mine, but there is a good probability that undiscovered quartz veins exist parallel to the known veins. A favorable area for prospecting appears to be between No. 1 and No. 4 veins, southeast of the stoped area of the No. 1 vein. Prospect-

ing would have to determine whether undiscovered veins would contain sufficient gold to be commercially valuable, because thus far only one out of four of the known veins has proved to be of commercial grade.

SILVER CREEK MINES CO. (INC.)

Eleven claims are owned by the Silver Creek Mines Co. (Inc.), in sec. 24, T. 35 S., R. 9 W., near the headwaters of one of the tributaries of Silver Creek, about three-quarters of a mile south of the mapped area. The mine is reached by a trail from Soldier Camp, on the Robertson mine road. The discovery was made in 1926 by G. L. Howland, of Grants Pass. C. L. Schumacher, of Grants Pass, is now president of the company. About 700 feet of underground openings have been driven, a good camp constructed, and a small Ellis ball mill and amalgamator installed.

The principal workings are on the north side of the creek, along a mineralized fault zone in metagabbro, which strikes N. 55° E. and dips 60° N. Soft gouge along the fault is usually from 2 to 3 inches thick. The vein has been explored for about 250 feet along its strike, and portions of it have been mined from some small stopes.

A small quartz vein 1 to 3 inches wide, striking N. 25° E. and dipping 70° S., has been intersected in a tunnel that runs for about 90 feet into the hill on the south side of the creek. The wall rock here also is dark-colored metagabbro. The quartz contains a little pyrite and chalcopyrite and is said to assay $25 a ton in gold. Two other tunnels, with short crosscuts, and some open cuts have been excavated on the south side of the creek, but no ore is exposed in them. The gravel along the creek bottom has been mined by hand sluicing and is said to have produced considerable gold. It seems likely that the gold was derived from small veins such as those described.

ALTA VISTA MINE

The Alta Vista mine is in the NE. ¼ sec. 13, T. 35 S., R. 8 W. It is reached by a trail from Soldier Camp, on the Robertson mine road. A short tunnel and several open cuts explore a quartz vein in dark-colored metagabbro. The vein, which strikes N. 28° W. and dips 90°, is about 18 inches wide in the face of the tunnel. It contains numerous angular fragments of country rock, and around some of them indistinct banding is visible. No information was gained about the gold content of the quartz.

HUMDINGER MINE

LOCATION AND HISTORY

The claims of the Humdinger mine are in the NW. ¼ sec. 21 and the SW. ¼ sec. 16, T. 38 S., R. 5 W., near the head of a gulch

tributary to Williams Creek. The mine is 4 miles west of Williams and 23 miles south of Grants Pass. Ore was discovered on the property 20 or 30 years ago, and work was done near the present mine, but the excavations made at that time are not now accessible. A Mr. Butcher and associates located the property in 1912 and did some work. In 1925 A. W. Constans and George Pike procured a lease, erected a small 2-stamp mill, and ran what is known as the mill tunnel. In 1926 Mr. Constans bought an interest in the mine, and in November, 1929, the property was sold to D. H. Ferry, who has since, as the result of continued work, developed a considerable body of gold ore. The more recently worked vein is said to have been discovered in 1929 at a spring near the portal to the No. 2 tunnel.

PROPERTY AND DEVELOPMENT

The Humdinger mine property includes 10 claims, several buildings, and mining equipment suitable for prospecting. Recently a shaft has been sunk more than 150 feet down the dip of the vein, to a vertical depth of 138 feet, and over 1,000 feet of drifts have been driven. (See pl. 8.) Most of the work has been concentrated on the three levels near the shaft, but two independent tunnels, known as the No. 4 and mill tunnels, account for about 400 feet of the total drift length. The dumps of older, inaccessible workings, including the St. John tunnel, indicate that they are fairly extensive. In addition to the underground development, placer workings, known as the Anderson placer, extend almost up to the mine.

GEOLOGY

Both greenstone and sedimentary rocks are exposed in the immediate vicinity of the Humdinger mine, and granodiorite or related rocks are exposed a short distance to the east. At the mine the sedimentary rocks are principally argillites, which strike northeast and dip at steep angles to the southeast. The greenstones are fine-grained rocks similar to the metabasalt in the vicinity of the Robertson mine. The attitude of these rocks is not revealed by flow contacts or other structural features.

The recently developed ore at the Humdinger mine occurs in northwestward-striking veins that cut greenstone and argillite. The principal vein in argillite cuts the beds at almost right angles to their strike and dips 45°–60° SW., whereas the vein in greenstone dips about 60° NE. Because they are eroded as readily as the inclosing wall rocks, if not more readily, none of the veins have prominent outcrops. The veins are composed principally of quartz, calcite, apophyllite (a complex hydrous calcium-potassium silicate of uncertain composition which in some occurrences contains fluorine), and

altered country rock. (See pls. 9, 10.) The quartz, calcite, and apophyllite of the recently explored vein in greenstone occur in lens-shaped bodies, bounded by slickensided surfaces, along a well-defined fracture zone which nearly everywhere contains considerable soft altered fault gouge. The slickensided surface in one place may be best defined along one wall of the quartz, whereas a short distance away the reverse may be true, or both walls may be equally slickensided. The quartz lenses in greenstone range in width from over 3 feet down to the vanishing point. The principal vein in argillite is about 9 feet wide where exposed in the No. 4 tunnel. This vein is not unform but consists of altered argillite interspersed with bands and irregular areas of white quartz. The largest band occurs in the face of the tunnel and is about 2 feet wide. Other small veins of quartz in argillite occur in the mill tunnel.

The gangue in the veins consists principally of quartz, altered wall rock, calcite, and apophyllite, named in the order of abundance. Pyrite, arsenopyrite, and native gold are the most abundant ore minerals, and tellurides are reported as being present. The vein quartz is milky white and under the microscope is seen to be prevailingly coarse grained. The greenstone wall rock next to the ore and the fragments included in the quartz are changed to a grayish-green rock composed for the most part of sericite, quartz, calcite, saussurite, and small amounts of zoisite, epidote, chlorite, and disseminated sulphides. In places calcite veinlets are numerous. In some of the less altered greenstones the centers of the larger feldspar crystals have been altered to saussurite, whereas the outer zone has been largely changed to fine-grained scaly sericite and quartz. Apophyllite crystals occur in cavities in the vein on the lower level southeast of the shaft, and the mineral is distributed in small amounts throughout the vein quartz. (See pl. 9.) The crystals lie in more or less parallel arrangement, much after the manner of the lamellar quartz described by Lindgren.[13] At the Humdinger mine, however, the development of the lamallae was probably controlled by fractures. Below the zone of oxidation pyrite and arsenopyrite are irregularly scattered through the quartz and in the wall rocks adjacent to the vein. The depth to which oxidation extends is variable. In the shaft it extends to about 80 feet; in other parts of the mine it is nearer 50 feet. Limonite is the most abundant oxidation product. Free gold occurs in both oxidized and unoxidized ore but is more abundant in the oxidized zone.

ORIGIN OF THE ORE

The ore deposits at the Humdinger mine do not differ greatly from those at the Robertson mine. The ore was probably derived

[13] Lindgren, Waldemar, Mineral deposits, 3d ed., pp. 521–522, 1928.

from the same magma as the granodiorite and related rocks, which are exposed near by. Although the minerals in the vein are not absolutely diagnostic, it is believed that the ore was formed at moderately shallow depths and under conditions of moderate temperature. Pyrite and arsenopyrite are found in deposits formed under various conditions of pressure and temperature. Apophyllite, on the other hand, has not been widely reported as a vein mineral. It occurs in the zeolitic copper deposits of the Lake Superior region,[14] which are now generally believed to have formed at shallow depths and low temperatures, and Wandke and Martínez report apophyllite, arsenopyrite, and pyrite in the veins of Guanajuato, Mexico, which they state were undoubtedly formed under temperatures corresponding with Lindgren's low and middle zones.[15] The placer gold near the Humdinger mine has clearly been derived from the veins, as the placers extend up to them.

ECONOMIC CONSIDERATIONS

The entire vein, including quartz and altered country rock, is said to carry gold. According to W. B. Robinson, superintendent, a mill test on 25 tons of the oxidized ore from the No. 2 tunnel averaged $24 a ton in gold, and 13 tons of oxidized ore from the No. 3 level ran over $40 a ton. Under the direction of Mr. Robinson the mine has been carefully sampled across a mining width, and he states that a considerable quantity of ore averaging $12 a ton in gold is blocked out. The vein has been followed northwest from the shaft for about 350 feet and in that distance shows little or no change in appearance. However, the quartz on the No. 5 level terminates 30 feet from the southeast face, just before the argillite contact is reached. The vein encountered at the face of the No. 4 tunnel is wider than any of the other veins seen on the property. It cuts the argillite at a steep angle and, if it has a satisfactory gold content, appears to be one of the best prospects at the mine. This vein, if continuous, should extend to a point within 20 or 25 feet east of the southeast face of the No. 5 tunnel.

ROBERT E. MINE

LOCATION AND HISTORY

The Robert E. mine is in a very rugged region near the western border of Curry County. It is in the China Diggins district, on Babyfoot Creek, a tributary to the Chetco River. By trail, the mine is 9 miles southeast of Anderson's ranch, on the Illinois River 12 miles by road west of Selma, at an altitude of 1,000 feet. At Ander-

[14] Butler, B. S., and others, The copper deposits of Michigan: U. S. Geol. Survey Prof. Paper 144, p. 61, 1929. Lindgren, Waldemar, op. cit., p. 511.

[15] Wandke, Alfred, and Martínez, Juan, The Guanajuato mining district, Guanajuato, Mexico: Econ. Geology, vol. 23, p. 37, 1928.

son's ranch freight for the mine is transferred to pack horses. Five miles to the southeast the trail passes over a divide at an altitude of about 3,700 feet, and then drops to the mine, at about 2,300 feet.

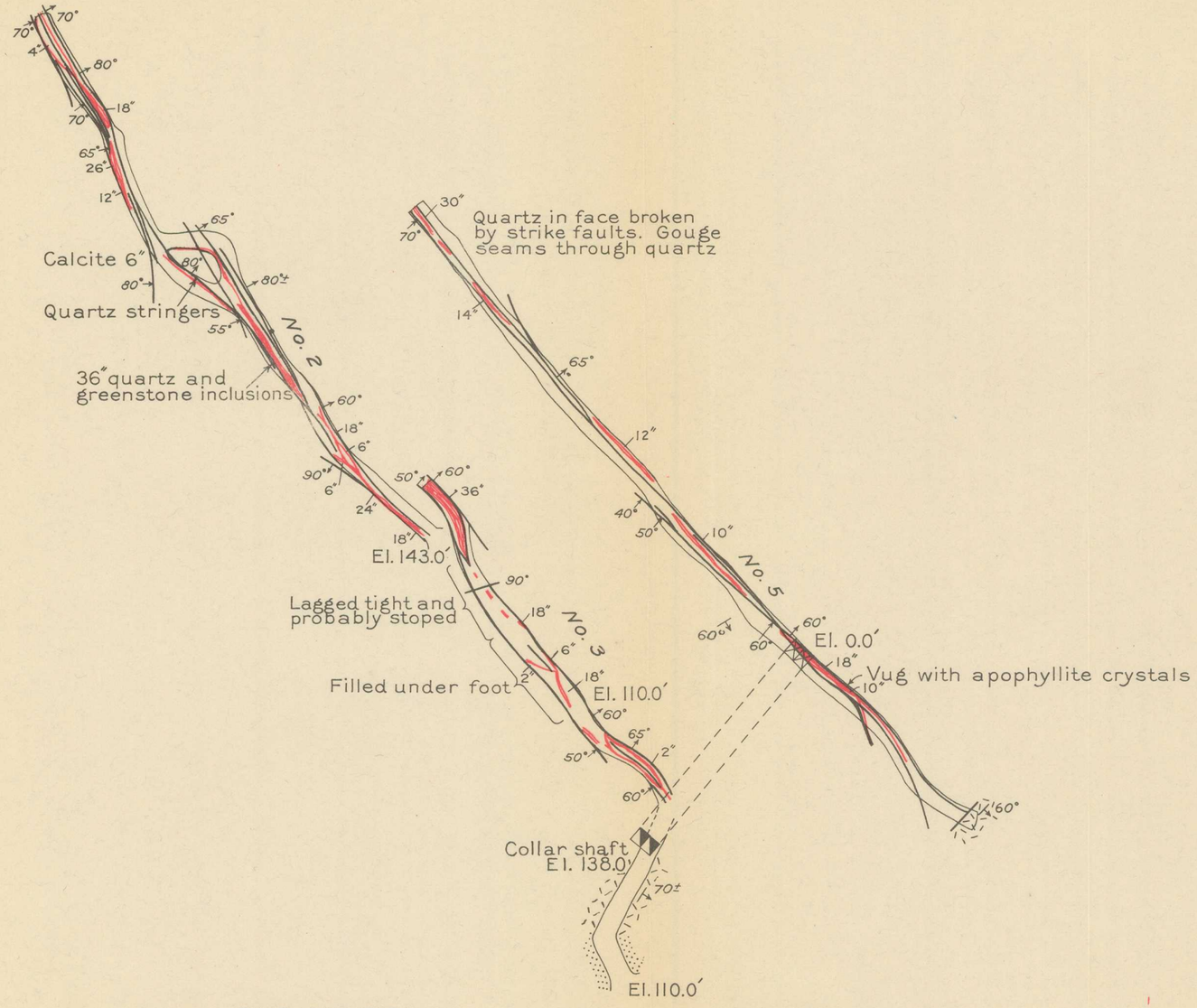
The history of mining in the immediate region of the Robert E. mine dates back to about 1900, when rich gold deposits were discovered at the contacts between greenstone and serpentine. Because the gold in these deposits was set free by decomposition of the rocks, hydraulic mining methods were used. Thus the richer spots along the contacts were worked at the Higgins, Hustis & Anderson, and Miller & Bacon mines [16] and finally at some outcrops near the greenstone-serpentine contact in ground now included in the Robert E. claims. Some of the hydraulic pipe is still to be seen a short distance northwest of the mill. I. F. Peck located some claims in 1919, but the Robert E. Mining Co. was not incorporated until 1922. From 1922 to 1928 most of the work was confined to developing the upper levels of the mine, but in 1928, in running the No. 4 (lower) tunnel, a small though exceedingly rich ore shoot was intersected. In 1928 this small ore body produced ore and bullion worth $36,936.75 and in 1929 ore and bullion worth $42,203.35—a total of $79,140.10 for the two years.[17] A small mill was erected to remove the coarser gold before shipment. The tailings were then shipped as a separate product. One lot of tailings shipped in 1928 contained $398.76 a ton, mostly in gold, after $28,391.43 of free gold had been extracted from it. Since 1929 most of the work has been confined to the development of the quartz veins, and in 1930 considerable ore was partly blocked out. According to Mr. Peck, B. F. Miller produced about $25,000 from the open cut on the Miller Creek slope, and this makes the total production of the Robert E. mine over $100,000.

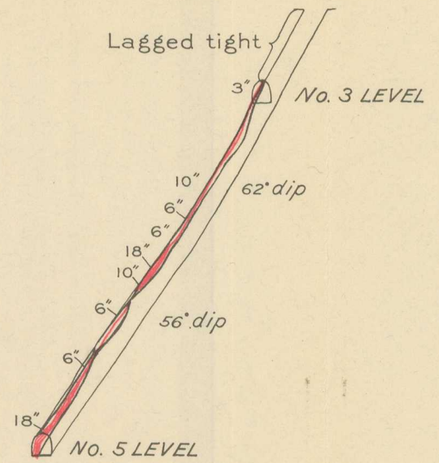
DEVELOPMENT AND PLANT

About 2,000 feet of openings, including raises (see pl. 11), have been driven underground. The No. 4, the principal level, consists of more than 1,000 feet of drifts and crosscuts, about 250 feet of which follow the vein. A sublevel, 18 feet above No. 4, follows the vein for 100 feet. The No. 3 level is 60 feet above No. 4. Nos. 3 and 4 are connected by a raise that follows up the vein. No. 3 consists of 500 feet of drifts and crosscuts and follows the vein for about 300 feet. It is connected with No. 2 level, 40 feet above it, by a raise along the vein. No. 2 level is about 200 feet long but is caved 50 feet from its portal. No. 1 level, 26 feet above No. 2, is entirely closed. Besides the drifts, crosscuts, and raises, the vein has been stoped in several places.

[16] Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, pp. 64–65, 1914.

[17] Production figures largely from smelter and mint returns furnished by Mr. Peck.

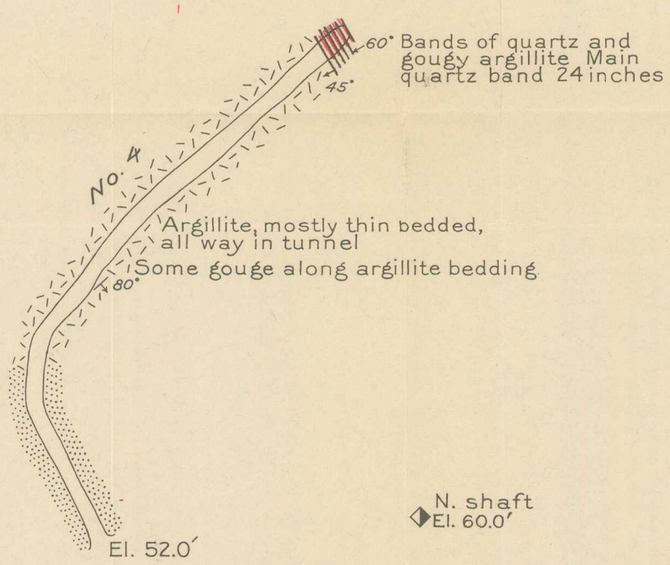


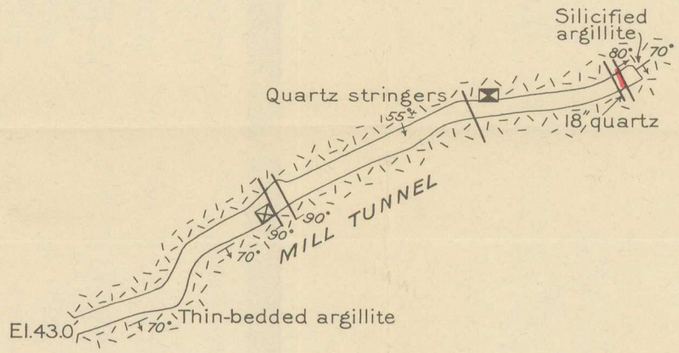


SECTION THROUGH SHAFT
LOOKING SE.

EXPLANATION

- Quartz (Figures show thickness)
- Gouge or slickensiding
- Argillite
- No pattern — Greenstone along tunnels
- Unconsolidated material
- Strike and dip
- Shaft
- Raise
- Winze



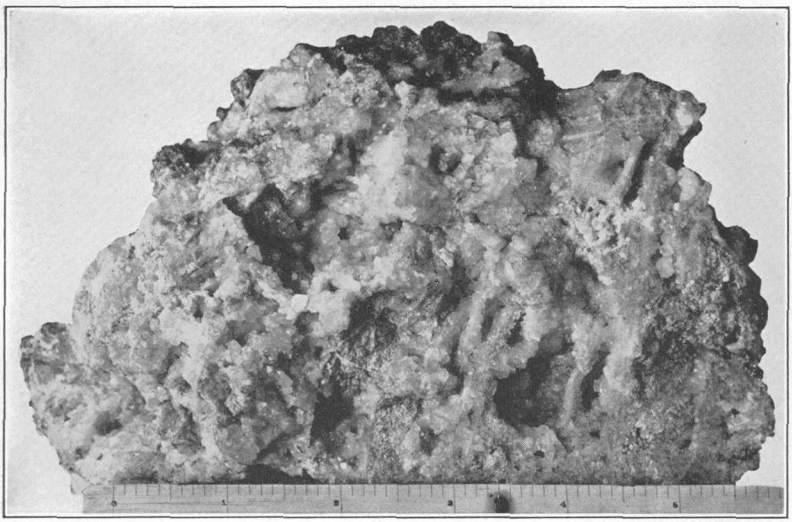


20 0 20 100 Feet

PLAN AND SECTION OF NEW WORKINGS OF HUMDINGER MINE, JOSEPHINE COUNTY, OREGON

From Brunton compass survey by P. J. Shenon

Elevations from survey by W. B. Robinson



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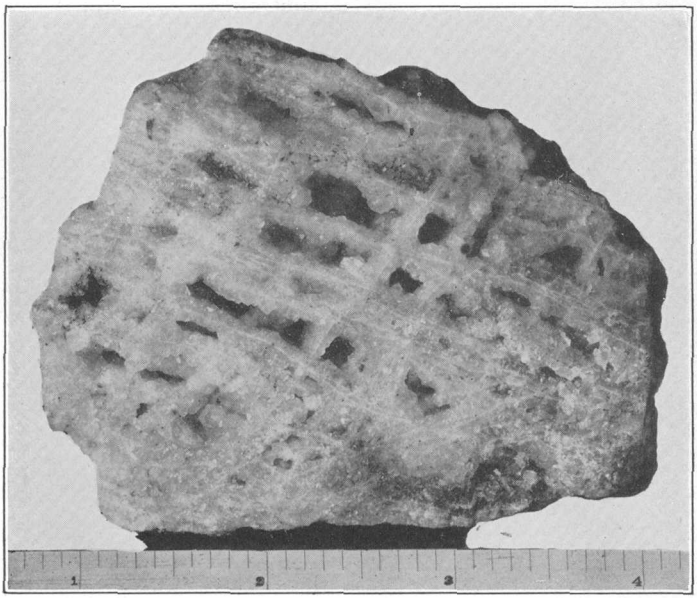
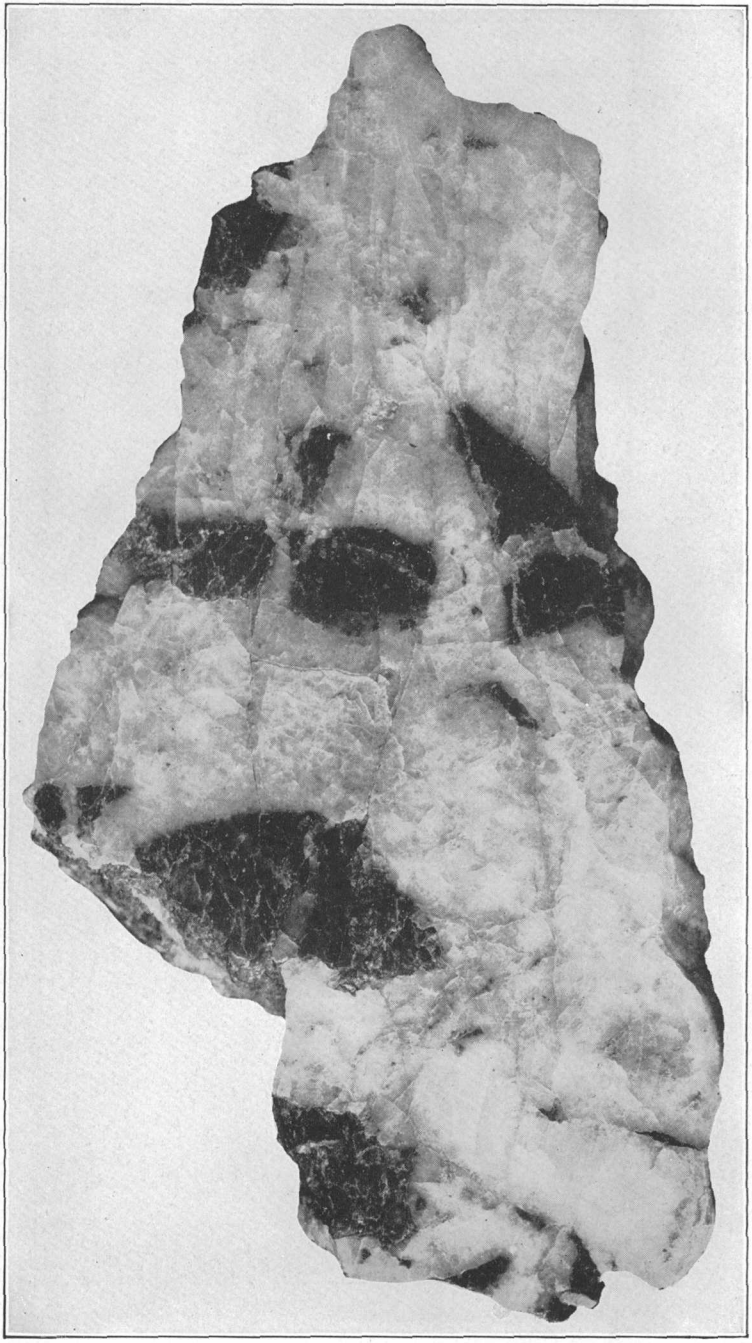


B

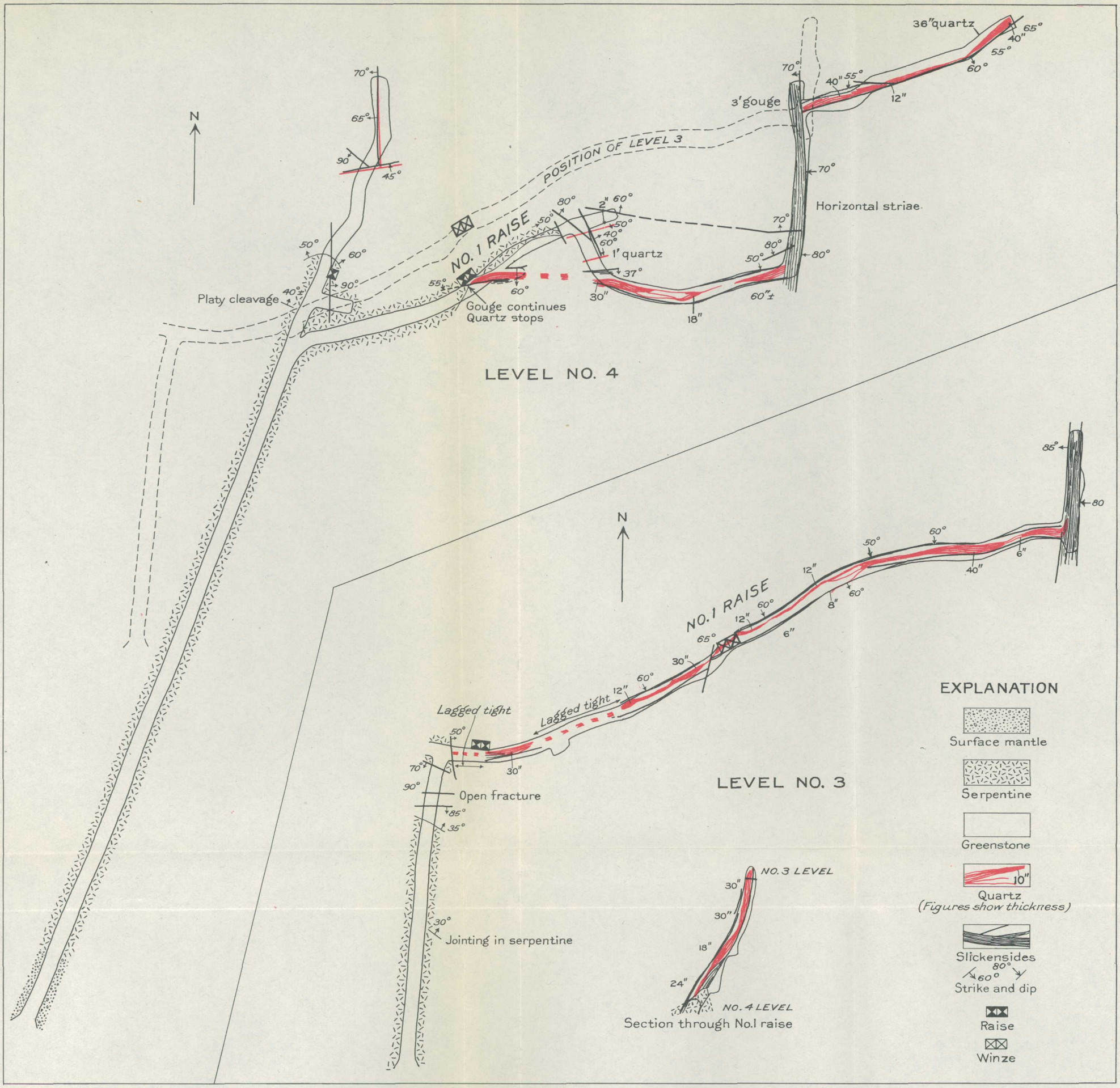
VEIN STRUCTURE IN SPECIMENS FROM HUMDINGER MINE

Apophyllite crystals from vein on No. 5 level. Scales show inches.



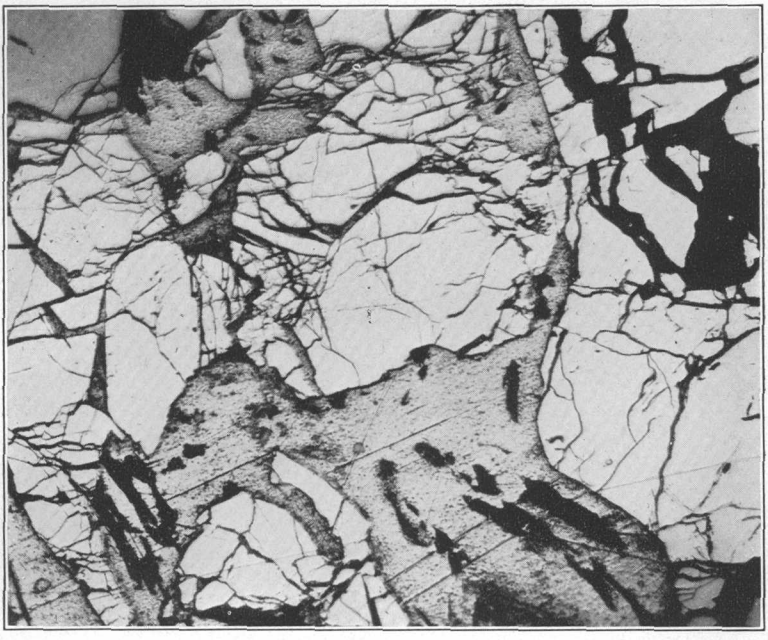
ANGULAR GREENSTONE FRAGMENTS FROM QUARTZ VEIN ON NO. 3 LEVEL IN HUMDINGER MINE

Nearly twice natural size.



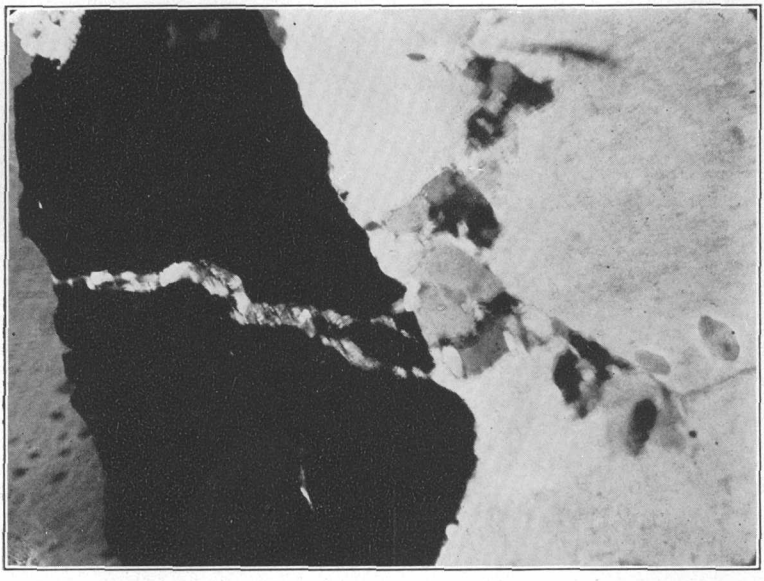
PLAN OF LEVELS 3 AND 4 AND SECTION THROUGH No. 1 RAISE ROBERT E. MINE, CURRY COUNTY, OREGON

From Brunton compass survey by P. J. Shenon



A. GOLD (GRAY) REPLACING ARSENOPYRITE (WHITE) AND OCCURRING ALONG FRACTURES

Black areas are holes. Polished section, enlarged 170 diameters.



B. FINE-GRAINED QUARTZ ALONG FRACTURES IN ARSENOPYRITE (BLACK) AND REPLACING COARSE-GRAINED QUARTZ

Thin section, enlarged 48 diameters.

PHOTOMICROGRAPHS OF ORES FROM ROBERT E. MINE

A mill capable of only a small tonnage but, according to Mr. Peck, adequate for the treatment of the very high grade ore has been built near the portal to the No. 4 tunnel. In addition, there are several substantial buildings suitable to accommodate a small crew of men.

GEOLOGY

Fine-grained greenstone and serpentine are the prevailing rocks in the vicinity of the Robert E. mine. The ore occurs along fractures in greenstone, which strike north of east and dip to the south at steep angles. Where the fractures enter serpentine the ore ceases. A survey with Brunton compass of the recent workings indicates that the vein is split into two branches just east of the No. 1 raise. The No. 3 and No. 4 levels are apparently on different branches of the vein. On both levels the veins terminate at a fault zone several feet wide, and on the No. 4 level a vein has been found on the east side of the fault.

The ore consists for the most part of quartz and mineralized greenstone, both containing arsenopyrite, pyrite, and some gold. The quartz, which contains numerous greenstone inclusions, ranges in thickness from less than an inch to over 4 feet and, on the two lower levels, probably averages 30 inches. One or commonly both walls of the quartz are slickensided, and usually it is in contact with soft dark-gray gouge from less than an inch to several inches thick. The quartz is white and underground has a uniform appearance. The microscope shows, however, that it is made up of coarse-grained quartz into which very fine-grained quartz, sulphides, and gold have been introduced. The greenstone inclusions and the wall rocks immediately next to the quartz have been intensely altered, but 2 or 3 feet from the veins the rock is comparatively fresh appearing. Adjoining the quartz veins the greenstone wall rocks are altered to a mass composed largely of fine-grained quartz and sericite and some epidote. A short distance from the veins the rock is made up principally of sodic plagioclase, partly altered to saussurite and epidote; augite, partly altered to serpentine and chlorite; considerable calcite, in part introduced; fine-grained quartz; and small amounts of magnetite and sulphide. The most abundant ore minerals in the veins are arsenopyrite, pyrite, and native gold. They occur in the quartz and in the wall rock adjacent to the quartz. A very rich shoot of partly oxidized sulphide ore, impregnated with gold, was found on No. 4 level, east of the No. 1 raise, along and in quartz near the serpentine contact. Most of the production of the mine has come from this small shoot. Arsenopyrite occupies fractures in coarse-grained quartz but is itself cut by fine-grained quartz and calcite. (See pl. 12.) Gold is closely associated with the fine-grained quartz,

and it clearly occupies fractures in arsenopyrite, as shown in Plate 12, *A*. A partial analysis of one lot of the sulphide ore by Jesse Sehman, of the American Smelting & Refining Co., furnished by I. F. Peck, follows:

Analysis of sulphide ore from Robert E. mine

Insoluble	per cent	5.4
Sulphur	do	9.0
Iron	do	28.9
Zinc	do	.0
Arsenic	do	28.8
Antimony	do	1.2
Gold	ounces to the ton	15.365
Silver	do	3.55

The ratio of gold to silver varied between about 3.4 to 1 and 7 to 1 in the different shipments and averaged about 6 to 1. Outside of the extremely rich ore shoot from which most of the production has come, adequate information is not available regarding the average gold and silver content of the veins. According to Mr. Peck, a mill test of 300 tons from the No. 3 level yielded $22 in free gold to the ton, but $6 to the ton in gold was lost in the tailings.

ORIGIN OF THE ORE

The veins of the Robert E. mine are similar in general character to those at the Robertson and Humdinger mines. The minerals recognized at the Robert E. mine are, however, not diagnostic of the conditions under which the ore was formed. Arsenopyrite is more characteristic of moderate or deep zone deposits than it is of deposits formed close to the surface. The apparent absence of diagnostic minerals of either the deep or shallow types, and the very common association of arsenopyrite and pyrite in deposits formed under conditions of moderate temperature and pressure, and the fact that other very similar veins in near-by regions have, on more substantial evidence, been classified as belonging to the group of deposits formed at moderately shallow depths seem to afford a sufficient basis on which to include the veins at the Robert E. mine, tentatively at least, in the same classification. The quartz and ore minerals were brought in along numerous small and some larger fractures, striking a little north of east. The manner in which quartz penetrates tiny openings, visible only under very high magnification, seems to indicate that it was introduced along the fractures in a more or less tenuous state. The wall-rock alteration at the Robert E. mine resembles that at the Humdinger mine more than it does that at the Robertson mine. Fine-grained quartz and sericite are the most abundant alteration products next to the veins at the Robert E. and Humdinger mines,

whereas at the Robertson mine epidote and chlorite are much more abundant and sericite is almost lacking. As the rocks at all three mines are essentially the same, the difference in wall-rock alteration must be due, in part at least, to reaction with solutions of different compositions. The wall-rock products next to the veins at all the mines, however, indicate that the ore-bearing solutions were alkaline. The source of the solutions at the Robert E. mine will have to remain undetermined until field work covers a wider area surrounding the mine, but the minerals in the veins and the wall-rock alteration show that the deposits were formed by hot ascending solutions.

ECONOMIC CONSIDERATIONS

Practically all of the production from the Robert E. mine has come from a small shoot of partly oxidized sulphide ore in and along a quartz vein just above the No. 4 level. In addition, a considerable amount of lower grade ore has been partly blocked out along veins by drifts and raises, and a small tonnage has been removed to the dumps. The degree of future success at the mine appears to depend either upon the finding of other high-grade shoots at a reasonable prospecting cost or upon the development of a considerable tonnage of lower-grade ore. The high-grade ore appears to have formed at or near the junction of veins, or branches of the same vein, near the serpentine contract. A carefully made transit survey of the mine and a couple of short but well-chosen crosscuts are needed to prove definitely the relation of the veins and the exact position occupied by the rich ore shoot. If, as appears probable, the rich ore shoot occurs at the junction of two veins, further prospecting down the junction may reveal more high-grade ore.

Lower-grade ore of minable width has been followed on both the No. 3 and No. 4 levels. On these two levels the width of the quartz ranges from less than an inch to over 4 feet but in general averages about 30 inches. A segment of a vein has been followed for about 100 feet on the east side of the fault zone that terminates the ore on both the No. 3 and No. 4 levels. If the vein splits, as its seems to, another segment should be found east of the fault, either north or south of the known segment. So far as known, none of the veins have been carefully sampled. The mill test made on 300 tons of ore from the No. 3 level is not adequate to determine the average gold content in other parts of the veins. It would seem advisable, therefore, that the mine be carefully surveyed and mapped and that the veins be adequately sampled before further development work is done.

NOTES ON THE CHIEFTAIN AND CONTINENTAL MINES, DOUGLAS COUNTY, OREGON

By FRANCIS G. WELLS

LOCATION AND ACCESS

The Chieftain (formerly the Little Chieftain) and Continental mines are situated on South Myrtle Creek, Douglas County, Oreg., in sec. 20, T. 29 S., R. 3 W. Willamette meridian, 12 miles by gravel road from Myrtle Creek, a hamlet on the Southern Pacific Railroad and the Pacific Highway.

HISTORY AND PRODUCTION

Little could be learned of the history of these mines. Both are mentioned in Mineral Resources [1] for 1905, and the Continental mine is listed as producing in 1918, 1920, 1924, and 1928. According to Edward Law, the present manager, the Little Chieftain deposit was discovered about 1898 and developed by Armitage & White, who shipped some good ore. They sold it to Hamilton & Cramer, who did further development work and put in a stamp mill some time between 1903 and 1905. The production to the end of 1905 includes about 1,000 tons of ore ranging in value from $55 to $175 a ton, which was shipped to the Tacoma smelter. Mr. Law obtained the property in 1928 and, after some development work, shipped 20 tons of ore running $110 a ton in gold and silver. Since March 5, 1930, the property has been operated by a company called the Chieftain Mines (Inc.).

The Continental deposit was discovered in 1897 or 1898 by a man named Chancy, who sold it to Kruse & Stewart about 1903. They operated it for about six years. In 1919 the mine was purchased by W. C. Bates, the present owner. In 1931 the mine was under bond and lease to Larsen & Elliot. The production is not definitely known. Evidence given in a law suit claims that ore worth $168,000 has been mined.

[1] Mineral Resources, 1905, p. 291, 1906; 1918, pt. 1, p. 457, 1921; 1920, pt. 1, p. 192, 1922; 1924, pt. 1, p. 231, 1927; 1928, pt. 1, p. 319, 1931.

TOPOGRAPHY

The country surrounding the Continental and Chieftain mines is hilly but not rugged. South Myrtle Creek, the principal stream, flows southwestward along the southeastern edge of its valley, which is from a quarter to half a mile wide. All the perennial tributaries, such as Weaver, Letitia, and Craig Creeks, head toward the north in a ridge about 1,500 feet high that trends northeast. The divides that separate these streams form a series of lower north-south ridges. In the southeast a ridge 1,200 feet high rises directly from the valley and limits the drainage from that side. All the streams have rather steep gradients and flow on bedrock. For the broader topographic features of the region the reader is referred to the Roseburg topographic map.

GEOLOGY

Metagabbro.—Except a small body of dacite, the only rock exposed in the area is metagabbro. As described by Diller,[2] this rock throughout the greater part of its mass has a granitoid texture. Its original pyroxene has been changed into hornblende or chlorite; less commonly the original lime-soda feldspar has been changed to an aggregate of quartz, muscovite, and epidote or kaolin. Although in much of the rock these changes are more or less complete, there are large masses that have especially fine grained and somewhat diabasic textures in which pyroxene and feldspar remain practically unaltered. The relative proportion of feldspar and pyroxene is in general nearly the same, the feldspar being somewhat more abundant than pyroxene, but in a few places the rock is made up almost exclusively of either feldspar or pyroxene. Quartz is a rather abundant primary constituent in a few places.

The rock in the immediate vicinity of the mines is coarse grained, and its feldspar and black minerals are present in about equal amounts. Under the microscope the feldspar, which is bytownite, is seen to be but slightly altered, though the pyroxene or hornblende has been largely altered to chlorite.

Diller[3] believes that the metagabbro is intrusive into the Myrtle formation and hence must be younger than that portion of the Cretaceous.

The only structural features observed in the metagabbro are the east-west fractures, which are followed by the veins, and faults of small displacement that range in strike from northeast to northwest and have offset the veins. Both the fractures and faults are char-

[2] Diller, J. S., U. S. Geol. Survey Geol. Atlas, Roseburg folio (No. 49), 1898.

[3] Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, pp. 33–37, 1914.

acterized by steep dips. Several of the veins in greenstone to the south—for instance, those of the Greenback, Daisy, and Corporal G. mines—strike approximately east and have in some places been offset by faults that strike from northeast to northwest.

Dacite.—Dacite crops out about 3 miles a little west of north of the Chieftain mine. It is fine grained and contains phenocrysts of quartz. The groundmass has been completely altered to quartz and sericite. According to Diller,[4] two varieties of dacite occur near the town of Myrtle Creek. One is decidedly porphyritic, with well-developed crystals of quartz and feldspar, and the other is nonporphyritic and closely resembles quartzite. The second variety is found, under the microscope, to consist of quartz and feldspar, largely plagioclase, with numerous shreds of hornblende. The groundmass of the first variety is similar but much finer grained. Diller states that the age of these rocks can not be determined but that some masses of them are apparently younger than the metagabbro and serpentine.

CHIEFTAIN MINE

The Chieftain mine is on the west bank of Letitia Creek in the NW. ¼ sec. 20, T. 29 S., R. 3 W. (See fig. 4.) The lower adit is a few feet above the creek, at an altitude of about 1,100 feet. The accessible workings include a lower adit 380 feet long, an intermediate or "mill" adit 555 feet long, and an upper adit 80 feet long. (See pl. 13.) The lower and mill adits are connected by a raise along a stope. There are other workings, which are now caved, including an old drift on the lower level, which extended beyond a fault mentioned below.

The mine is on a quartz vein of variable width, which strikes S. 80° W. and dips 65°–75° N. This vein has been traced by discontinuous outcrops and surface float for a distance of 1¼ miles. The most easterly outcrop is at a short adit a few hundred feet east of the Chieftain mine; the most westerly outcrop is marked by two shafts on the Hall homestead.

The lower and mill adits of the Chieftain mine explore the vein for a length of about 640 feet and to a maximum depth of 170 feet. So far as explored the vein consists of lenses and discontinuous stringers of quartz. These lie in a shear zone bounded by slickensided walls that are from less than a foot to about 4 feet apart. Locally the walls are lined with a thin layer of gouge. In some places the zone is composed entirely of quartz; in others it is mostly altered rock. The wall rock is cut by many veinlets of quartz and contains a little pyrite near the vein. In general, however, it is

[4] Diller, J. S., op. cit. (Folio 49).

free from sulphides. Horses of rock included in the vein are largely altered to sericite. The vein itself has been strongly sheared, as is shown by the strain shadows and many microscopic fractures in the vein quartz as well as by the ease with which it shatters.

Irregular grains, patches, and streaks of sulphides in places form as much as 10 per cent of the vein. Coarsely crystalline pyrite is the predominant sulphide. Chalcopyrite and sphalerite occur in subsidiary amounts. The pyrite is mostly bright, though in part dull and dirty, probably owing to granulation. Chalcopyrite forms small patches near the pyrite but is rarely associated directly with it. Sphalerite is likewise commonly associated with the chalcopyrite.

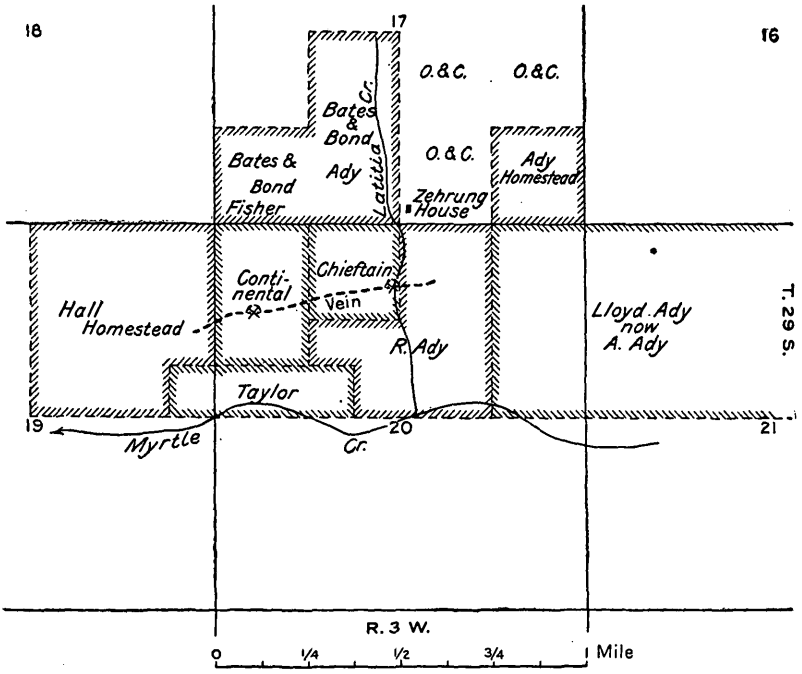
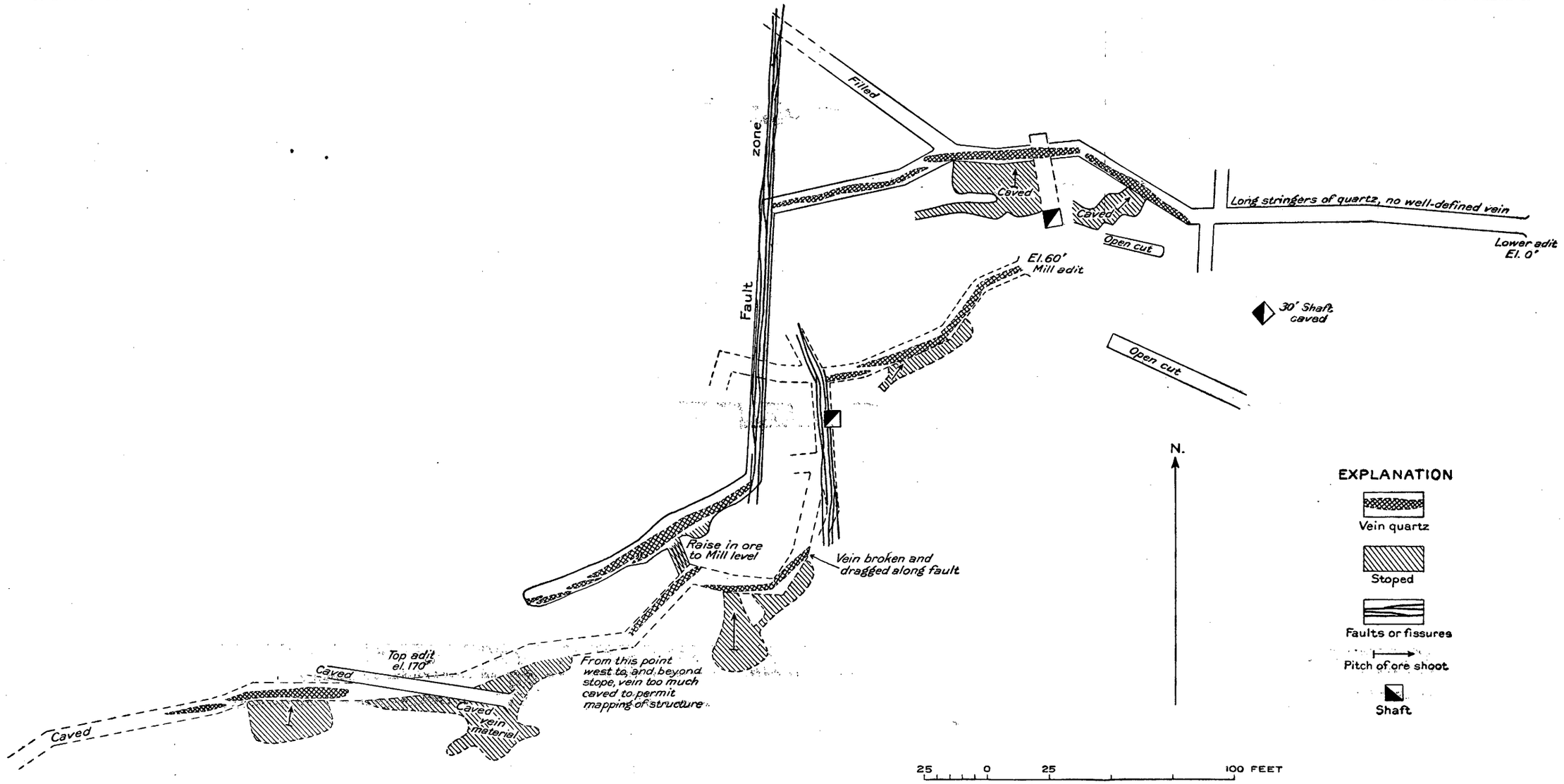
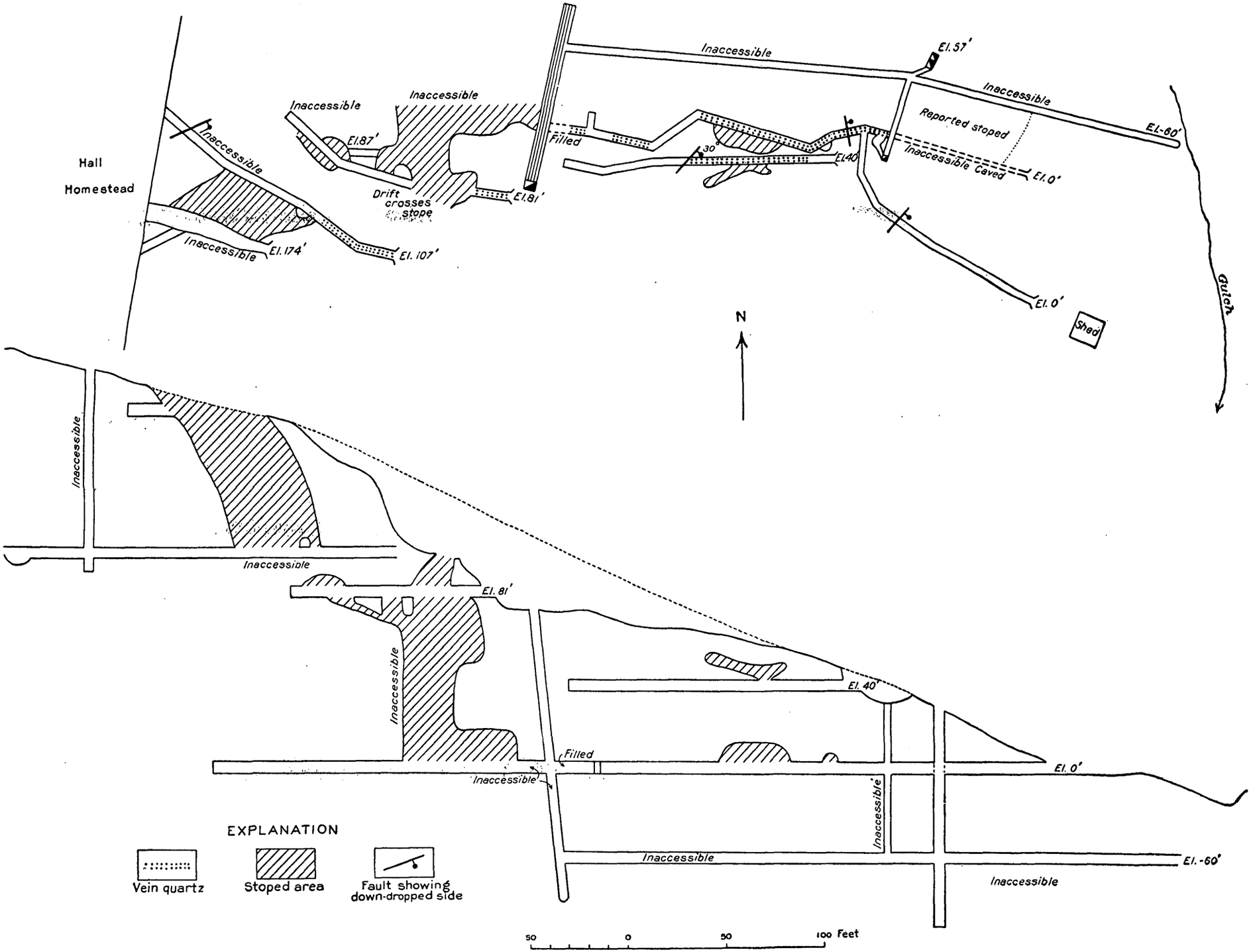


FIGURE 4.—Township map showing Chieftain and Continental mines, Douglas County, Oreg.

Under the microscope the sphalerite is seen to contain blebs and veinlets of chalcopyrite. Sylvanite and petzite (tellurides of gold and silver) occur as small irregular patches or threads in both the chalcopyrite and sphalerite and here and there by themselves in the quartz. Neither was found, however, in the pyrite. Petzite contains a smaller amount of tellurium than sylvanite, and the silver content of both is variable; in the specimens from the Chieftain mine it is low, probably less than 25 per cent. No free gold was seen. During the period of mineralization the deposition of quartz was continuous. Pyrite is the oldest sulphide. Sphalerite was deposited next and was succeeded by chalcopyrite. Sylvanite and



MAP OF CHIEFTAIN MINE, DOUGLAS COUNTY, OREG.



MAP OF CONTINENTAL MINE, DOUGLAS COUNTY, OREG.

petzite were deposited last. The tellurides are almost exclusively associated with chalcopyrite and sphalerite, and the abundance of these sulphides, which are readily seen, is therefore some indication of the value of the ore.

The vein is cut 300 feet from the portal of the main level by a fault zone that strikes due north and dips at a high angle to the west. It has produced a horizontal displacement of 80 feet distributed over a series of slips. Elsewhere some horizontal faults have displaced the vein a few feet.

On the upper level, as well as in an old glory hole that extended down to it, the vein is a typical vuggy iron-stained gossan, and some of the ore in its oxidized portion was probably free milling. On the mill level the vein has been completely oxidized to the east of the fault. West of the fault it shows only slight oxidation and on the lower level none.

The character of the vein and the minerals described indicate that the deposit falls into the mesothermal type of Lindgren.[5] Though the sulphide minerals that carry the gold are abundant in spots they are not concentrated in definite shoots but are distributed irregularly throughout the vein. Much of the quartz now showing carries considerable sulphide, and the vein on the main level beyond the fault is well mineralized. From these facts it is reasonable to assume that the ore continues in depth and that within the limits imposed by the size and tenor of the vein a considerable tonnage can be mined.

CONTINENTAL MINE

The Continental mine is in the NW. ¼ sec. 20, T. 29 S., R. 3 W. Willamette meridian, on a very small stream that flows into South Myrtle Creek. It is located on the same vein as the Chieftain mine but about 1,500 feet to the west and a few hundred feet higher. The dumps are large and indicate that considerable work has been done. Some of the old workings are caved or filled, but about 1,000 feet of tunnel besides two raises and some of the stopes are still accessible. Their distribution is shown in Plate 14.

The vein has been explored along the strike for 500 feet and for a vertical distance of 250 feet. To the west the workings stop at the property line. The vein in general strikes east and dips 60°–75° N. In width it ranges from less than a foot to about 4 feet. There has been very little displacement of the vein along faults that strike northeast and are vertical or nearly so. The character of the vein and the kind of mineralization are the same as in the Chieftain mine. (See pp. 59–61.)

[5] Lindgren, Waldemar, Mineral deposits, 3d ed., pp. 598–627, 1928.

OTHER WORKINGS

Two shafts have been sunk on this vein west of the Continental mine, on the Hall homestead, but both were caved when visited. Some vuggy iron-stained pieces of quartz were found around the collars of the shafts. East of the Chieftain mine there is a short adit on what is probably the eastern continuation of this vein. The quartz showed only a few scattered specks of pyrite.

Mining in the past has been limited to taking out the vein material that yielded a profit. As the sulphide minerals are irregularly distributed the stopes were irregular in outline. The whole width of the vein was mined.

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