STATE OF OREGON

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

1069 STATE OFFICE BUILDING
PORTLAND 1, OREGON

Bulletin No. 49

LODE MINES OF THE CENTRAL PART of the GRANITE MINING DISTRICT, GRANT COUNTY, OREGON

By

George S. Koch, Jr.
Assistant Professor of Geology
Oregon State College

1959

Price $1.00

STATE OF OREGON

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

1069 STATE OFFICE BUILDING
PORTLAND 1, OREGON

Bulletin No. 49

LODE MINES OF THE CENTRAL PART
of the
GRANITE MINING DISTRICT, GRANT COUNTY, OREGON

By

George S. Koch, Jr.
Assistant Professor of Geology
Oregon State College

1959

Foreword

Gold mining was the backbone of Oregon's mineral industry prior to World War II. In the 10-year period from 1930 to 1940, Oregon had an average of 100 producing lode gold mines. In 1940, of the 304 producing gold properties, 112 were lode mines. Seventeen of these mines were in Grant County and 26 in adjacent Baker County. Gold accounted for nearly half of Oregon's mineral production that year.

Since World War II, gold mining has been unable to recover from the 1942 closure brought on by Government order. Oregon's mines are not alone in this respect and only a few gold mines in the United States have been able to reopen and continue operations. The Buffalo mine in the Granite mining district of Grant County is among these few. This Bulletin is to put on record the operation of the Buffalo mine and to call attention to the geological setting of the mines in the central part of the district. Although it is not thought that there will be an early resurgence of gold mining in the State, it was considered essential to the knowledge of the State's mineral resources to record the information that was available in the underground workings of the mines in this district. Unfortunately most of the mines producing prior to 1940 are now caved or unsafe to enter and a great deal of valuable information has been lost. This Bulletin salvages information on the core of a mining district where gold was first found nearly 100 years ago and it may encourage further investigations. It is possible that other properties in the State could be mined profitably if operated on a scale similar to the Buffalo mine.

Geological investigations in this part of northeastern Oregon have been the subject of several published geological works. This report not only takes advantage of the early geological data but relates surface and subsurface geology on a more detailed scale than has been previously used. An appendix by Mr. S.H. Pilcher reports the findings of a study on wall-rock alteration at the Buffalo mine and it should afford clues for future prospecting. Basic studies such as these must be applied when investigating the geology of the various lode mine areas of the State.

The author of this bulletin, Dr. George S. Koch, Jr., is assistant professor of economic geology at Oregon State College. His varied experience while with private mining companies and the U.S. Geological Survey has made him well qualified for this study. It is believed his report will provide information to prospectors and investigating engineers for the immediate future and for many years to come, not only in the Granite mining district but also in contiguous areas of northeastern Oregon.

Hollis M. Dole
Director

February 27, 1959

Contents

Illustrations

Tables

LODE MINES OF THE CENTRAL PART
of the
GRANITE MINING DISTRICT, GRANT COUNTY, OREGON

Abstract

The Granite mining district of easternmost Grant County, Oregon, has produced about $1,800,000 in gold and silver from lode mines since its discovery in 1861. Since World War II almost all of the gold produced from lode mines in Oregon has come from the Buffalo mine, which is in this district.

The central part of the Granite district is described in this bulletin. Two of the mines there, the Buffalo and the Cougar-Independence, have maintained production for some fifty years, mining ore with a recorded gross value of about $1,650,000. Four other mines, the Ajax, Magnolia, Continental, and New York, have an aggregate production estimated at $150,000. Other mines and prospects, of which the Blue Ribbon, Standard, and Tillicum are the best known, have little or no known production.

All of the ore is in fissure veins that cut argillite of probable Permian age and granodiorite of probable Cretaceous age. The veins contain the metallic minerals pyrite, arsenopyrite, chalcopyrite, galena, sphalerite, tetrahedrite, and native gold, and contain the gangue minerals quartz and calcite. Adjacent to the veins the granodiorite and argillite wall rocks have been altered by hydrothermal solutions to produce zones of characteristic alteration minerals. Rocks later than the veins and their country rocks comprise younger basic lavas and Quaternary alluvium.

At the Buffalo mine, which is the only property that has produced ore since World War II, monthly output in 1957 was between 150 and 200 tons for the eleven months of operations. The gross value of ore mined varied widely from year to year, and averaged about $53 per ton in 1957 when operating costs were about $33 per ton. Ore was mined in cut and fill stopes and concentrated in a 35-ton-per-day bulk flotation plant. Development work on a new level below the two existing levels was started in the summer of 1958.

Although the other mines in the central part of the Granite district have not produced ore since World War II, the various owners have developed ore in some places and delimited elsewhere areas for further exploration.

Because of the persistence of the veins in the Granite district and the relatively high gold content of some of them, continuation of mining on a small but profitable scale can be expected in the Granite district.

Introduction

The Granite mining district is in easternmost Grant County, Oregon, (see index map, Figure 1). Gold was discovered there in 1861, and since then the district has produced gold with a gross value of about $1,600,000 and silver and base metals of lesser value. Since World War II gold production has almost ceased in the district. A notable exception is the Buffalo mine, which has continued to obtain a small but consistent production of gold comparable to that produced in the whole district during the best previous years since the district was discovered. In fact, since World War II practically all of the gold produced in Oregon from lode mines has come from the Buffalo mine. Because of the record of consistent gold production from the district and because various mine workings were accessible for study, the Oregon Department of Geology and Mineral Industries made a geological survey of the central part of the Granite district during the summer of 1957. This bulletin reports the work done.

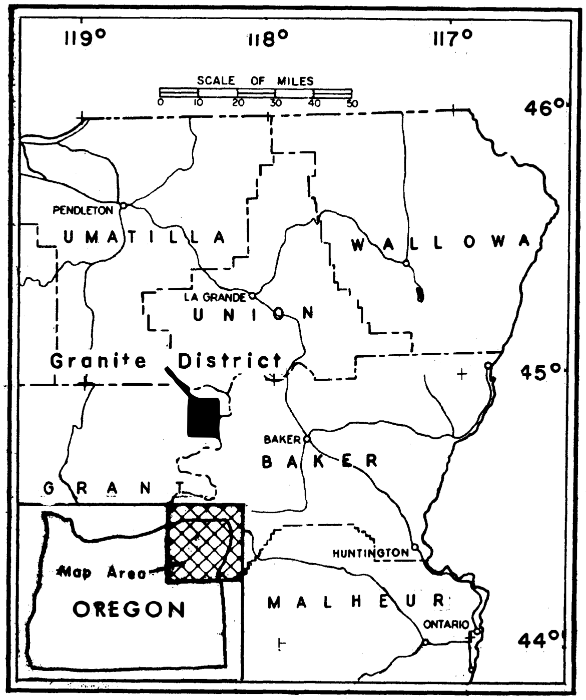

Figure 1 - Index map showing location of Granite mining district, northeastern Grant County, Oregon.

Previous work

Lindgren (1901, especially pages 677-688) * briefly examined the Granite district during a geological reconnaissance of the mines of eastern Oregon. More detailed examinations of some of the mines were made between 1908 and 1914 by geologists and engineers of the Oregon Bureau of Mines and Geology and the U.S. Geological Survey whose reports and maps appear in publication by Pardee (1908, 1910, and 1941), Pardee and Hewett (1914), and Swartley (1914). In 1929 Hewett (1931) re-examined the mines that were then accessible. Additional information on the mines was obtained during the late 1930's by geologists and engineers of the Oregon Department of Geology and Mineral Industries, especially by H. K. Lancaster and J. E. Allen, and published by the Department (1941) in its <u>Oregon Metal Mines Handbook</u>. All of these reports contain valuable information, much of which concerns defunct companies and inaccessible mines and is not otherwise available today.

Present work

The present work was done by the writer, with the able assistance of S.H.Pilcher, during 3 months in the summer of 1957. Because little or no information was available at the inactive mines in the outlying parts of the Granite district, work was restricted to the mines in the central part of the district. These mines are the Ajax, Blue Ribbon, Buffalo, Continental, Cougar-Independence, Magnolia, New York, Standard, and Tillicum. Not described in this report are

---

* References following Appendix.

the La Belleview, Cap Martin, Central, and Monumental mines, and other smaller properties. No placer properties are included.

After Pilcher's work with the Department ended, he did additional independent research at the Buffalo mine which is described in detail elsewhere (Pilcher, 1958) and is outlined in brief as an appendix to this bulletin.

Of the mines described in this bulletin, the Buffalo mine is mostly accessible on the levels and in working stopes but many workings of the other mines are inaccessible. Information about inaccessible workings was obtained from various maps, a number of which are published in this report. New geological maps of the mines made by the writer are based on transit surveys by various engineers and on the writer's tape and compass surveys. Surface maps were made with a plane table or on aerial photographs.

History and geography

In 1861 gold was discovered in the John Day and Powder River valleys. The town of Auburn was founded in June 1862 and mining activity boomed during the summer of that year. The "Daily Oregonian" and the "Weekly Oregonian" for 1861 and 1862 carry a great deal of mining news about eastern Oregon but a random inspection of these newspapers indicates only that the Granite district was in production in 1862. Some reports written years later state that gold was discovered on Granite Creek in the fall of 1861 (Pardee and Hewett, 1914, p. 9). In the first few years mining was mostly for placer gold but in later years mining of lode gold became increasingly important. Interesting accounts of the history of mining in eastern Oregon taken largely from the newspapers of the day were written by Trimble (1914) and Scott (1917).

Although the Granite district is in Grant County, the commercial center for the district is Baker, the county seat of Baker County. The village of Granite is 41 miles by road from Baker via Sumpter. Eleven miles are paved but the thirteen miles between Baker and Sumpter are narrow forest road that is not open during the winter. The eastern half of the district is in the Wallowa-Whitman National Forest and the western half is in the Umatilla National Forest. The district is within the Blue Mountains whose relief is about 2600 feet. The climate is temperate; annual rainfall is about 30 inches of which about half falls as snow in the winter; the average January temperature is 20° and the average June temperature is 62°.

Acknowledgments

The writer thanks all the men concerned with mining in the Granite district for their generous cooperation in allowing access to their properties, maps, and records. In particular, the writer is indebted to Mr. C. M. Boyce, Mr. W. H. Buchanan, Mr. Jack Guinn, Mr. J.L. Gyllenberg, Mr. Barton Haskins, Mr. and Mrs. James H. Jackson, Jr., Mr. Albert Perard, Mr. Irving Rand, Mr. Langdon Rand, and Mr. Arthur Woodwell. The Cougar-Independence Mining Company put a house at the disposal of the writer, and the Boaz Mining Company furnished electricity and various other items.

The writer also acknowledges the valuable advice of the staff of the Oregon Department of Geology and Mineral Industries. In particular, Messrs. N. S. Wagner and H. C. Brooks, Department geologists at Baker, aided the field work through providing many useful suggestions. Mr. L. L. Hoagland and his assistants made the chemical analyses. Mr. Mark Christianson drafted the illustrations with the advice of Mr. Ralph Mason. Miss Margaret Steere and Mrs. Lillian F. Owen edited the manuscript.

Mr. A. J. Kauffman, Jr., Chief, Division of Mineral Industries, U.S. Bureau of Mines, Region 1, Albany, Oregon, supplied production data with the permission of the mine owners. Certain maps are based in part on engineering surveys made by Mr. Philo Anderson, Mining Engineer, Baker, Oregon.

General Geology

Introduction

The geology of the central part of the Granite district is shown by the surface geologic map (Figure 2, opposite p. 5). All of the mines described in this report, except the Continental and Standard, lie within the mapped area. The map represents about $3\frac{1}{2}$ square miles of the Sumpter quadrangle which was mapped geologically between 1908 and 1914 (Pardee, 1941). The geological setting of the Granite district in northeastern Oregon may be understood by studying the maps and reports describing the Sumpter and Baker quadrangles (Pardee and Hewett, 1914; Pardee, 1941; Hewett, 1931; Gilluly, 1937). The rock formations recognized by Pardee (1941) are those used in this bulletin.

Except for the northeastern corner, which is reduced from a plane-table map(Figure 7, in pocket), the surface geologic map was made by plotting observations on aerial photographs and transferring this information to a planimetric map based on the preliminary Sumpter 2 quadrangle of the U.S. Forest Service. Although this does not produce an accurate map, the essential geologic relations are shown. Prospect pits, shallow shafts, short adits, and trenches are so abundant in the mapped area that only the larger ones can be shown on the scale of the map.

Geologic Setting of the Granite District

The rocks of northeastern Oregon may be divided into two groups, those of pre-Tertiary age and those of Tertiary and Quaternary age. All lode gold deposits of the Granite district occur in veins that cut the rocks of pre-Tertiary age but do not cut the rocks of Tertiary and Quaternary age. Therefore the Tertiary and Quaternary rocks contain no veins and their relation to lode mining is only to cover and conceal the veins in places. Most of the following summary of the geology related to lode mining is abstracted or paraphrased from the text of Pardee's (1941) geologic map of the Sumpter quadrangle, which is an excellent introduction to the geology of the quadrangle.

The pre-Tertiary rocks of northeastern Oregon are a group of bedded metamorphic rocks that have been intruded by various igneous rocks. The bedded rocks were originally a thick series of shales, with lesser amounts of limestones and sandstones, and are interbedded with lavas. In the limited amount of geologic mapping that has been done in northeastern Oregon, little attempt has been made to subdivide these rocks into different formations because the rocks have been intensely metamorphosed, their metamorphic forms are rather similar, and outcrops are generally poor.

Pardee (1941) and his co-workers divided the bedded rocks of the Sumpter quadrangle into an argillite series and a limestone formation. The limestone occurs as detached blocks near the top of the argillite series. The only fossils that have been found in the Sumpter quadrangle have come from some of the limestone outcrops. These have yielded crinoid stems and indeterminable bryozoans, except at one well-known locality 3 miles south of the town of Sumpter, where there are also fusulinids, which have been identified by M. L. Thompson as Permian (Taubeneck, 1955b). From the fusulinid identification and other evidence Taubeneck (1955b) concluded that both the argillite series and the limestone formation are probably entirely of Permian age.

Pardee (1941) writes that before deformation of the argillite and limestone was extensive, these rocks were intruded by basic magmas that formed sills, dikes, and irregular bodies. Today these rocks are metagabbros, peridotites, and serpentines. None

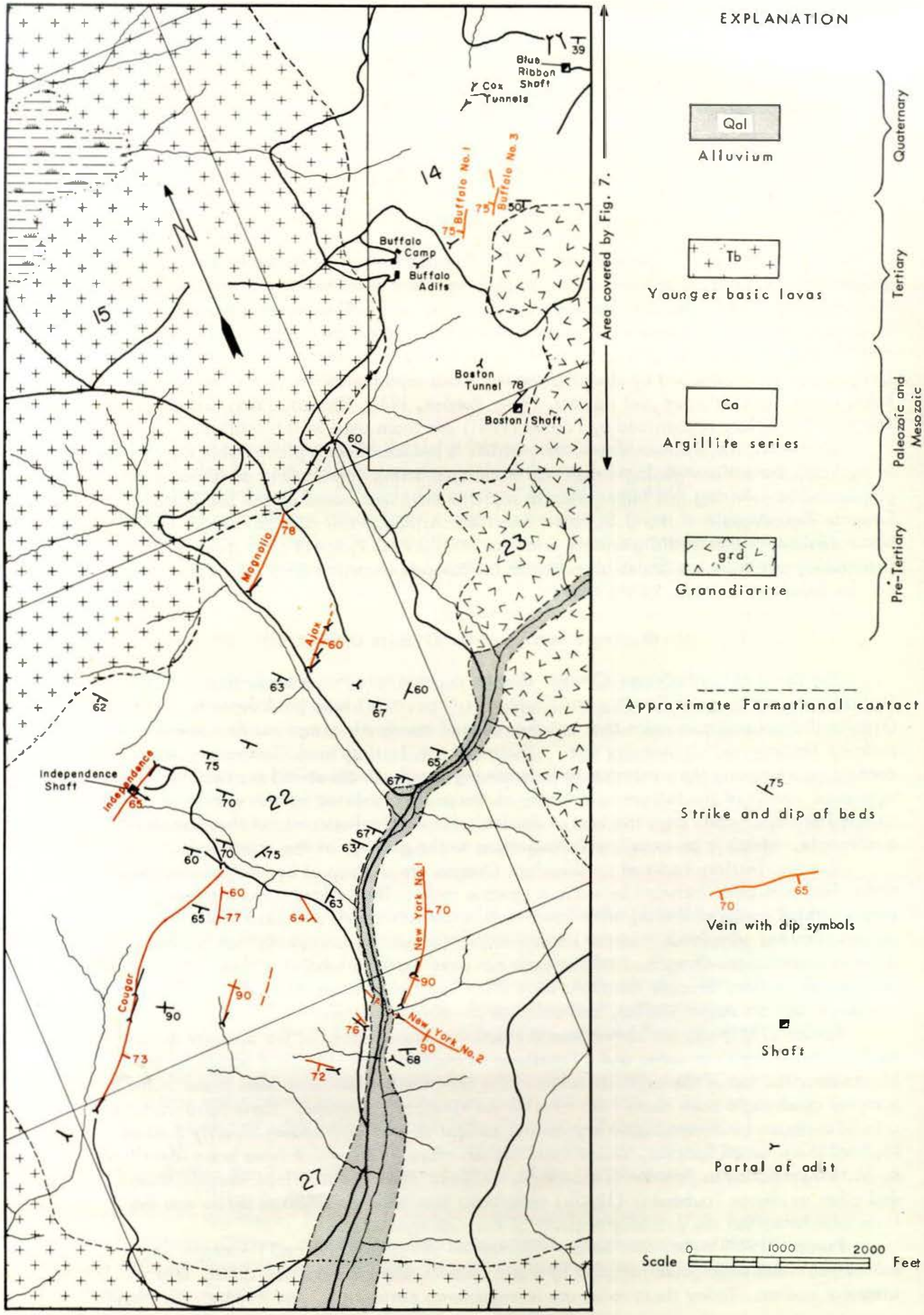

Figure 2 - Geologic map of part of Granite district, showing rock formations and principal veins, mine shafts, and adits. Geology by G. S. Koch, Jr., and S. H. Pilcher.

of these rocks crop out within the central part of the Granite district, so they need not be considered further. Following the intrusion of basic magmas and probably during the early Cretaceous (Taubeneck, 1955a), acid magma was intruded to form a batholith that extends into the northern third of the Sumpter quadrangle. This rock was described as granodiorite by Lindgren (1901) and the name is retained in this report although geologists who succeeded Lindgren in the area have pointed out that part of the batholith is composed of other rock types. The most recent and detailed investigation (Taubeneck, 1957) indicates that the rock ranges in composition from norite to quartz monzonite.

The pre-Tertiary rocks have undergone profound structural deformation and metamorphism. Because the stratigraphy is not well known, the structure of the bedded pre-Tertiary rocks has not been worked out in detail. However, the rocks are known to be compressed into close folds, many of which are isoclinal. The fold axes trend more or less east-west and are horizontal or gently inclined to either the east or the west. An unknown amount of faulting, including at least some thrust faulting, accompanied or followed the folding. At the times of intrusion of the igneous bodies the bedded rocks were further metamorphosed near the intrusive contacts with the formation of new structures and minerals.

The pre-Tertiary rocks are overlain with profound unconformity by rocks that consist successively of gold-bearing gravels, andesite tuff-breccias and lava flows, flows of basalt and pyroxene andesite, flows and tuffs of rhyolite, stream and lake beds, and flows of basic lava. All of these rocks are presumedly of Tertiary age but the only definite indication comes from leaves that were found in the lake beds and dated as Miocene by F. H. Knowlton (Pardee and Hewett, 1914, p. 44). The Tertiary rocks are overlain by terrace gravels, glacial drift, and alluvium of Quaternary age.

The Tertiary rocks have been deformed into open folds and have been cut by a series of faults that trend northwest. Presumedly the faults cut the pre-Tertiary rocks as well, although they can seldom if ever be traced.

Rock Units

Only a few of the rock units recognized by Pardee are present in the area of the surface geologic map (Figure 2 on opposite page). The veins crop out in a central belt of argillite lying between the granodiorite batholith on the east and Tertiary rocks on the west and south. At least some of the veins of each mine crop out. Although no veins were found to crop out in the granodiorite, some cut this rock at depth. The various rock units are described in order of age, that is, argillite, granodiorite, dikes, veins, younger basic lavas, and Quaternary alluvium, with the exception of the veins which are described in the section of this bulletin on "Mineral Deposits."

Argillite

The argillite in the mapped area is a fine-grained and highly cherty or siliceous rock, most of which contains more than 90 percent quartz, with muscovite or biotite as the other main constituents. Some of the argillite is white to light gray but most is dark gray to black due to carbonaceous matter scattered through the rock. Some specimens are so carbonaceous that black stain can be rubbed off with the fingers. Most of the argillite is thin-bedded and much of it has been intensely deformed either into sheared lenses that have areas of only a few inches in cross-section or into tight folds whose crests are a few inches to a few feet apart.

In some places near the contact of argillite with granodiorite, for example near the Boston shaft (Figure 2 on opposite page and Figure 7, in pocket), the argillite has been recrystallized to a coarser-grained schist composed of quartz, biotite, muscovite, and cordierite.

The schist is more resistant to erosion than the argillite or the granite and consequently forms ridges. Many trenches and short adits have been driven at and near the contact between the argillite and granodiorite but there is no evidence that any ore was localized along the contact.

Between the surface exposures of the Cougar vein and Granite Creek there are a number of outcrops of greenstone. This rock presumedly belongs to the metagabbro formation of Pardee (1941) but since the areas of outcrop are few and discontinuous no attempt is made to differentiate the metagabbro from the argillite or to plot it on the map.

Although the argillite unit is widespread in northeastern Oregon, detailed information on its stratigraphy and lithology is lacking because the rocks have been intensely deformed, outcrops are poor, and lithologies are not distinctive. Because the highly siliceous beds crop out more strongly than the shaly beds there is a tendency, remarked on by all workers, to overemphasize their abundance. In the Granite district outcrops are not good enough to allow the measurement of a section, but the argillite is similar to that on Cracker Creek north of the town of Sumpter where Pardee (1908, p. 87) measured a 3000-foot section.

In the Sumpter quadrangle, the argillite unit consisted originally of fine-grained sedimentary rocks, such as sandstones, shales, and cherts, interbedded with volcanic flows and tuffs and cut by dikes. Within these rocks, but lithologically distinctive enough to be mapped separately, are the detached blocks of limestone that contain the only known fossils. In the Granite area the author made no systematic effort to distinguish the metamorphic equivalents of the above-mentioned rock types. The specimens that were collected are mostly siliceous but they may not represent fairly the lithologies present. The author was not able to relocate the limestone outcrop mapped by Pardee (1940) in sec. 23, T. 8 S., R. 35½ E., although limestone boulders were found. Presumedly the outcrop was covered in the construction of the present road.

Table 1.
Chemical Analyses of Rock
Near Bald Mountain (Mt. Ireland)

	Analysis 1.	Analysis 2.
SiO_2	71.23 %	66.18 %
TiO_2	0.34	0.50
Al_2O_3 . . .	14.61	16.58
Fe_2O_3 . . .	0.93	1.40
FeO	1.66	2.59
MnO	0.08	0.09
MgO	1.01	1.81
CaO	3.29	5.09
Na_2O . . .	4.00	3.76
K_2O	1.92	1.19
P_2O_5	0.14	0.15
H_2O + . . .	0.55	0.43
H_2O - . . .	0.17	0.07
ZrO_2	0.02	
BaO	0.08	
SrO	0.02	
Li_2O	Trace	
	100.05 %	99.84 %

Analysis 1 - Typical rock from near lake at northern base of Bald Mountain; elevation, 7000 feet. Analyzed by W.F.Hillebrand. Lindgren (1901, p.587) named this rock normal granodiorite.

Analysis 2 - Collected 3000 feet west of lake at northern base of Bald Mountain. Analyzed by H.B.Wiik. Taubeneck (1957) named this rock Bald Mountain tonalite.

Granodiorite

Granodiorite crops out in the eastern part of the mapped area where it is the wall rock for a few of the veins. The rock is of medium-grain size, has a light-gray color, and consists of intergrown crystals of plagioclase feldspar, orthoclase feldspar, hornblende, biotite, and quartz.

The granodiorite in the Granite district is a part of the Monumental salient of the Bald Mountain batholith recently described by Taubeneck (1957). There have been published two chemical analyses of the rock of the Monumental salient (Table 1) and several visual analyses of the proportions of minerals present (modes), one of which is copied in Table 2, page 7.

Table 2.*

Mode of Analysis 2 of Table 1 (in volume percent)

Potassium feldspar	1.5 %
Quartz	28.1
Plagioclase	54.6
Hornblende	5.0
Biotite	9.6
Opaque accessory minerals	0.9
Nonopaque accessory minerals	0.3

* From Taubeneck (1957, p. 199)

Because most of the visual analyses of the rock as seen under the microscope in thin section indicate that the rock contains less than 2 percent potassium feldspar (mostly orthoclase) its accurate designation is evidently tonalite (or quartz-diorite) as Taubeneck (1957) points out in his careful and detailed study. Nevertheless, in this paper the name granodiorite is retained for three reasons: (1) The difference between a granodiorite and a tonalite is small, depending only on the content of potassium, and has no known economic significance in this district, (2) The term granodiorite is well established in the published descriptions of the mines of the Granite and nearby districts, and (3) One of the chemical analyses (Analysis 1, Table 1) is of a rock designated as granodiorite by Lindgren (1901) who first defined the rock name "granodiorite."

Dikes

In the Sumpter quadrangle, dikes have been found in all the rock units except those of Quaternary age (Pardee, 1941). None of the dikes within the Granite area is large enough to show on the surface geologic map and no particular attempt was made to study them. When some of the mines were more accessible than they are today, numerous dikes were found, especially in the Cougar-Independence mine. Hewett (1931, p. 311) writes:

> "Dikes have been observed in many of the mines, but beyond the fact that they are very fine grained and light colored little is known of their original mineral composition, as they are now much decomposed. Many such premineral dikes are shown in the walls of the Independence and Cougar mines, and they are also present in the North Pole, Columbia, Golconda, Ibex, and Red Boy mines. In several places it seems clear that some dikes were intruded before the vein-bearing fractures were formed; afterward other dikes were intruded on the fractures but before the quartz, gold and associated minerals were deposited."

Pilcher (1958, p. 27) examined dikes in the Buffalo mine where they are quite common in both the granodiorite and argillite following joints that strike northwestward. He found that most of the dikes are of aplite or pegmatite, containing the minerals quartz, potash feldspar, plagioclase feldspar, muscovite, biotite, pyrite, and molybdenite.

Younger basic lavas

Pardee (1941) recognized two ages of Tertiary basic lavas in the Sumpter quadrangle, but only the younger group is present in the Granite district. As these lavas are more recent than the veins, their relation to the ore deposits is only to conceal them. Pardee describes the younger basic lavas as follows:

> "Basic lavas erupted after the rhyolite group occupy the drainage basin of the Middle Fork of John Day River almost exclusively and are widely distributed over other parts of the Sumpter quadrangle except the northeast quarter. Most of them are dense to vesicular, dark-colored rocks that weather to shades of gray. Many contain phenocrysts of plagioclase feldspar or olivine. Over some areas they show a platy structure. They commonly weather to small cliffs and bare knobs, and lands underlain by them are likely to be covered with a red clay soil."

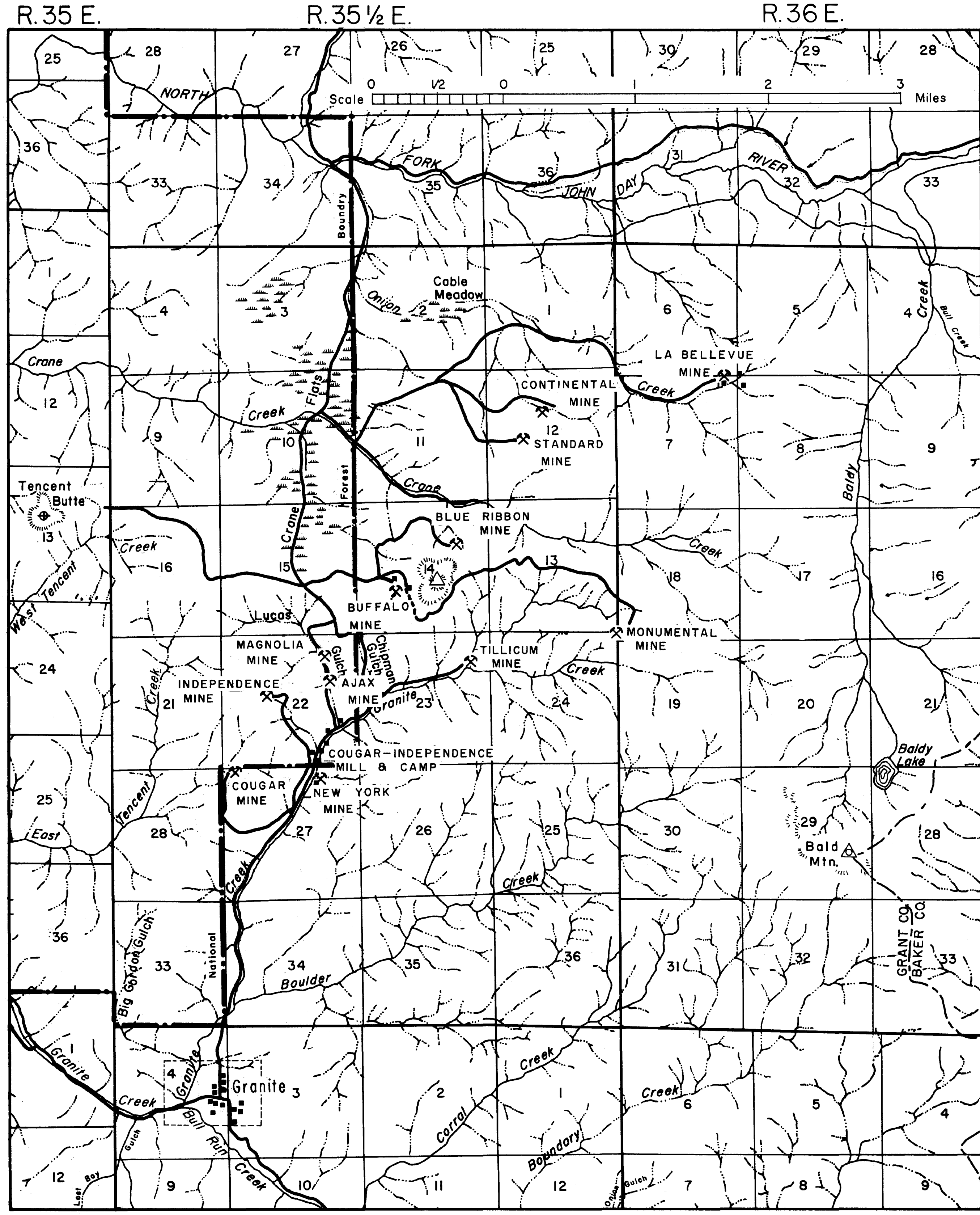

Figure 3 - Granite district, Grant County, Oregon. Index map showing locations of principal mines, roads, and streams.

Quaternary alluvium

Quaternary alluvium occupies the floor of Granite Creek. It consists of sand and gravel that have been worked at various times and places for placer gold.

Geologic Structure

The argillite beds (Figure 2, opposite page 5) strike generally northwestward and dip generally southwestward at steep inclinations. Divergent strikes and dips are found in several places but are too few to be interpreted.

The granodiorite-argillite contact is vertical or dips steeply either into or away from the intrusive. Near the contact the argillite and granodiorite are foliated more or less parallel to the contact.

The younger basic lavas lie unconformably above the older formations in horizontal or subhorizontal layers. The surface on which they poured out was flat or gently rolling. The younger basic lavas probably underwent mild structural deformation here as elsewhere in the Sumpter quadrangle (Pardee, 1941) but evidence is lacking.

Mineral Deposits

General Description

The locations of the mines described in this bulletin are shown on Figure 3 on opposite page. The mines lie in a linear belt and are, from southwest to northeast, the Cougar-Independence, New York, Ajax, Magnolia, Tillicum, Buffalo, Blue Ribbon, Standard, and Continental. Two other Granite district mines, the La Belleview and Monumental (Figure 3), lie to the east and are not described in this bulletin. The principal claims, grouped according to ownership, are shown on Figure 4, opposite page 11.

Veins and mines

The lode mines of the Granite district work typical fissure veins that cut the argillite and granodiorite. Displacements of the fissure walls are not known but are probably not more than a few hundred feet at most. With few exceptions the veins (Figure 2, opposite page 5) strike northeastward and dip either east or west at angles of 60° or more. The veins fall into the following five principal groups: (1) The Independence and Magnolia veins, which lie to the west of the other veins, and are in line with one another if not actually on the same fissure. (2) The Cougar and Ajax veins, which bear the same relationship to one another as do the Independence and Magnolia veins. (3) The New York No. 1 vein to the east of the other veins. (4) The five veins of the Buffalo mine of which only two crop out; although somewhat separated from the other veins, they may follow continuations of the same or closely related fissures. (5) The veins of the Continental mine (Figure 19, page 27).

Each of the veins listed above has been developed by a separate mine, except for the five veins of the Buffalo mine which have been worked as a group, and the veins of the Continental mine which have likewise been worked as a group. The Cougar and Independence mines have been worked by a single company throughout most of their history but the workings are distinct and not connected underground. The Standard, Blue Ribbon, and Tillicum mines worked veins about which little can be learned at present. Detailed descriptions of the mines arranged alphabetically begin on page 13.

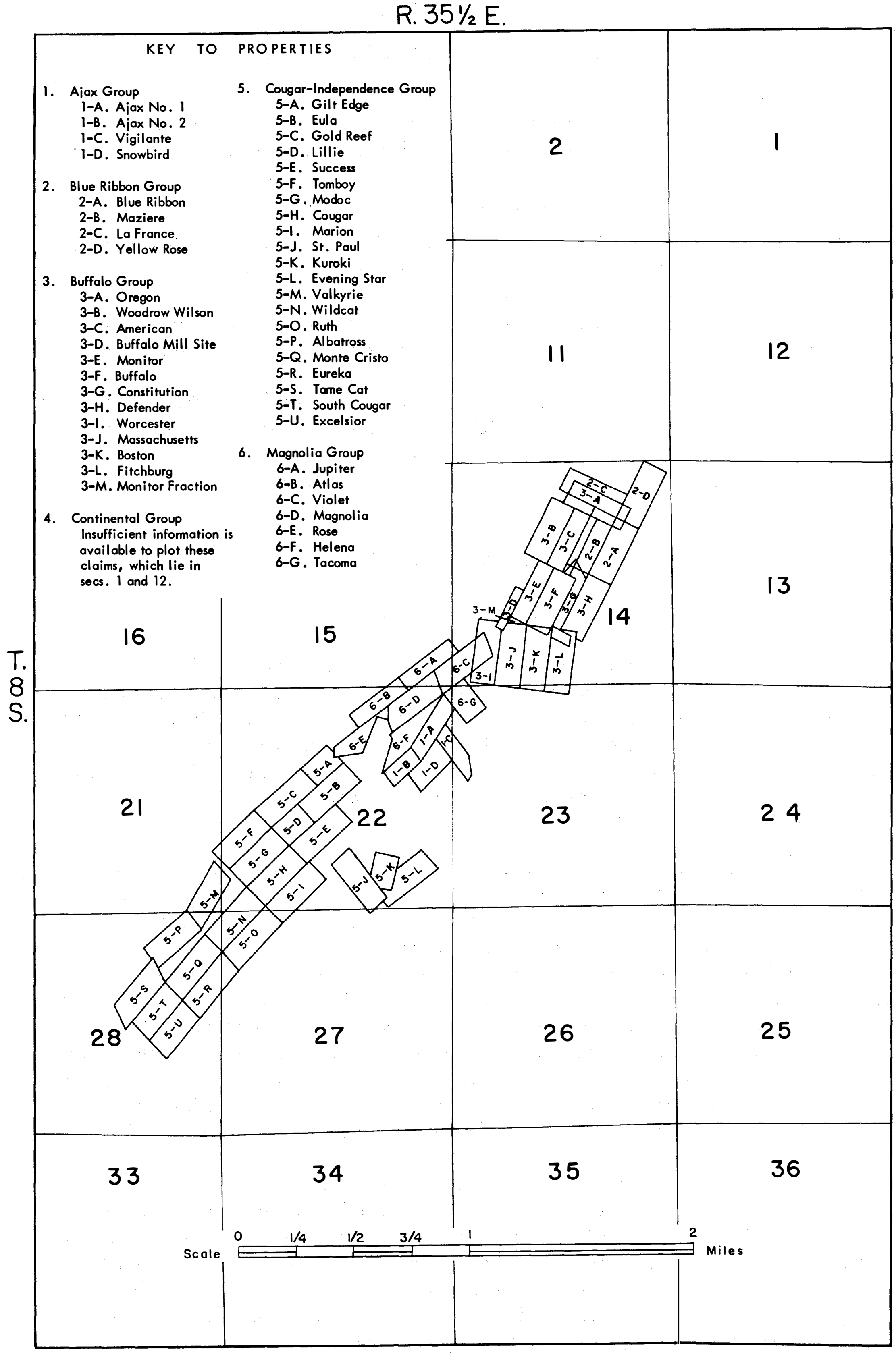

Figure 4 – Granite district. Sketch map showing locations of some of principal claims. Compiled from sources of varying reliability and accuracy.

As the descriptions of the individual mines make clear, the principal veins are similar in size, having, on the average, been explored to lengths of about 1000 feet and depths of 400 feet. Development work on the veins was generally if not always stopped because of lack of ore rather than because a particular vein ended, and so the total lengths and depths of the veins are unknown. Similar mines elsewhere in the Sumpter quadrangle have been developed to depths of 2500, 1200, and 1250 feet (Hewett, 1931, p. 314) and some of the veins of the Granite district can be expected to persist to such depths.

Types of veins

The veins are of two types: (1) a type containing abundant quartz and calcite gangue that results from the filling of open spaces and the nearly complete replacement of fragments of wall rock within the veins and (2) a type composed largely of dike material, gouge, and crushed argillite with sparse quartz and calcite vein matter. The first type is exemplified by the veins of the Buffalo mine and the second type by the veins of the Cougar mine. The principal metallic minerals in the veins are pyrite, arsenopyrite, sphalerite, chalcopyrite, galena, and tetrahedrite, but not all minerals are found in all veins. The veins of the second type contain pyrite as the most abundant if not the sole metallic mineral. Most of the gold occurs in the pyrite and cannot be found by panning.

The veins have been oxidized to depths of about 100 feet below the surface; rarely more. Undoubtedly most or all of the veins were richer at and near the surface than at depth because of residual concentration of gold and secondary silver minerals resulting from the leaching of quartz, calcite, and sulfide minerals, but the evidence of this has long since been stoped out. At depth there was downward enrichment of silver according to Pardee and Hewett (1914) who give details of the oxidation and supergene enrichment.

Zoning of the veins

From the kind and abundance of the minerals present in the veins of the Sumpter quadrangle, Hewett (1931) was able to separate the veins that lie in and around the Bald Mountain granodiorite batholith into four zones. He describes the zones and veins and ascribes the zones to deposition of the minerals at successively lower temperatures away from the batholith.

Origin of the veins

The veins were probably formed by the deposition of minerals from hot gaseous or liquid solutions (hydrothermal solutions) whose origin is related to and probably followed closely after the crystallization of the Bald Mountain batholith. Since some of the veins cut the granodiorite, the magma must have crystallized before the veins were formed. The vein minerals were deposited both by filling open spaces and by replacing previously formed minerals and the minerals contained in fragments of wall rock within the veins. Lindgren (1933, p. 555) classified the veins as those formed at moderate conditions of temperature and pressure (mesothermal) like the well-known veins of the Mother Lode district in California.

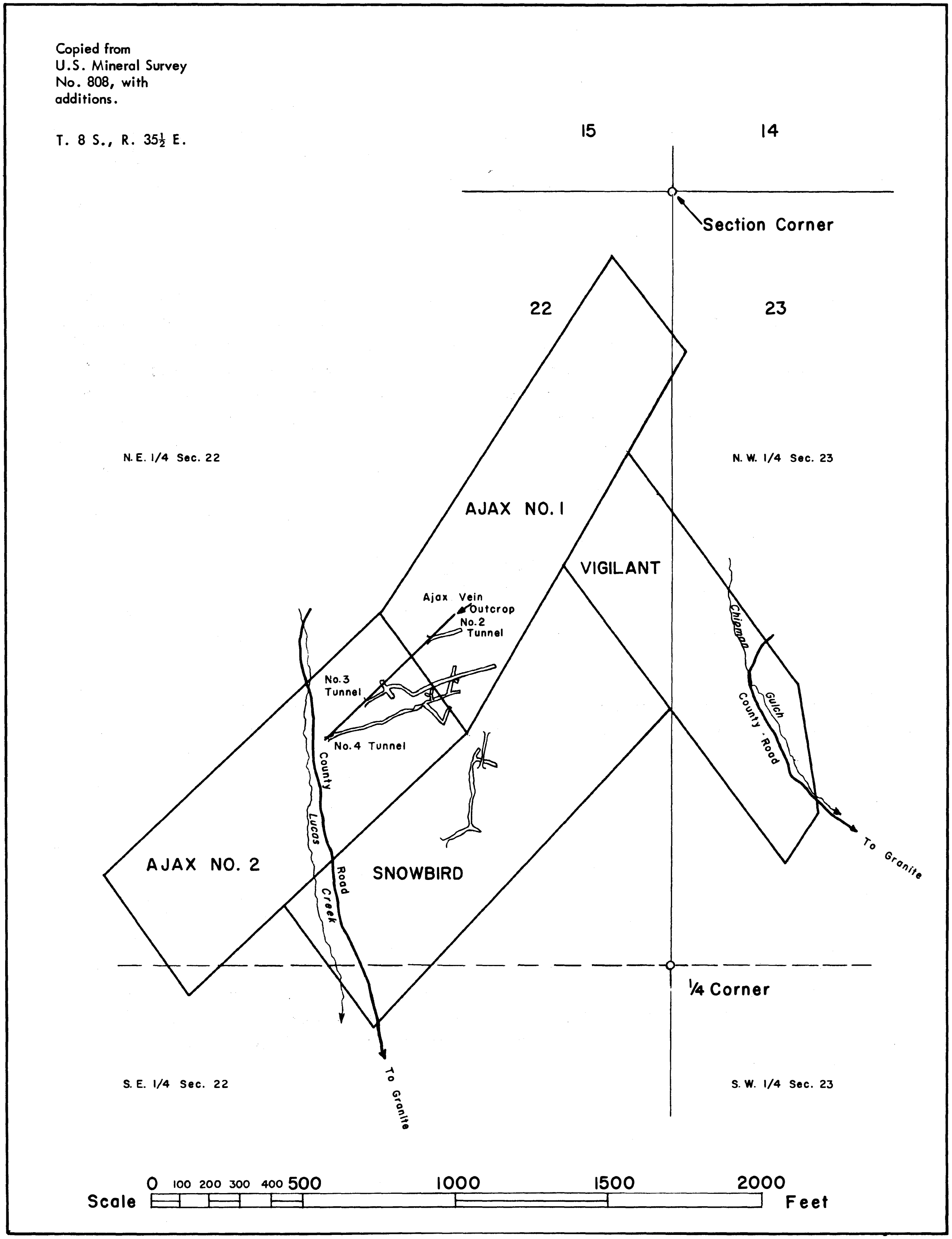

Figure 5 - Ajax mine. Map of claims and principal mine workings.

Ajax Mine

General description

The Ajax mine is about 3 miles north of Granite on Lucas Creek (Figure 3, opposite page 9) and is connected with the forest road along Granite Creek by a good road. The property consists of four unpatented lode claims, Ajax No. 1, Ajax No. 2, Snowbird, and Vigilant (Figure 4, opposite page 11). On these claims two veins crop out, the Ajax vein which is developed by drifts on three levels and the Snowbird vein which is developed by drifts on two levels (Figure 5 on opposite page). Most of the gold production was apparently obtained between 1905 and 1906 when $40,000 worth of ore is said to have been taken from a shoot 90 feet long in the No. 3 tunnel on the Ajax vein. In recent years there has been little development work and little or no production. The present owner is Mrs. Rosemary L. Guinn, Route 2, Box 558, Washougal, Washington. Mr. Jock Guinn allowed the writer to inspect the property and gave useful information.

Geology

The country rock is entirely argillite. Although all of the upper tunnels are caved and only a part of the No. 4 tunnel was accessible in 1957 (Figure 5), surface outcrops and plans of the inaccessible workings indicate that the strikes and dips of the veins and their character probably are like those visible in the No. 4 tunnel.

Where exposed for 370 feet by the No. 4 tunnel (Figure 6) the Ajax vein ranges in width from 1 inch or less to 4 feet, generally widening somewhat where it swings to the left.

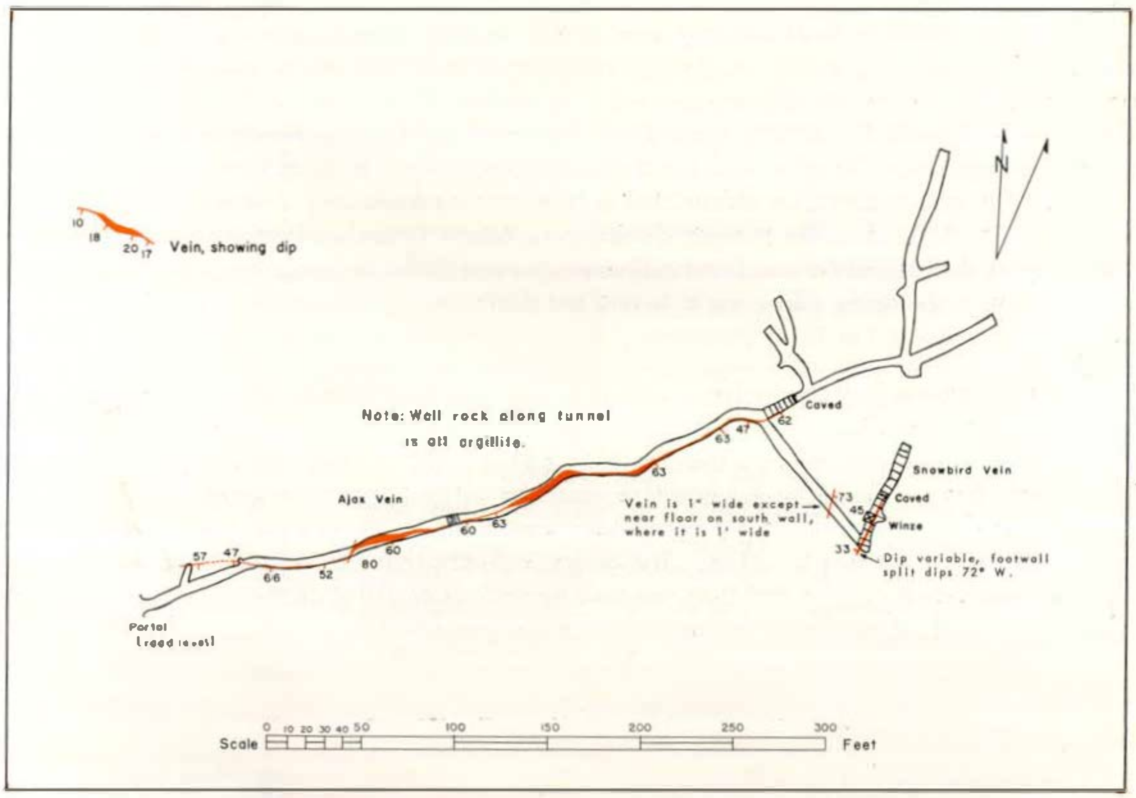

Figure 6 - Ajax mine. Geologic map of No. 4 tunnel (at road level). Caved portions of workings from map by John E. Allen, 1938.

In most places the vein is a brecciated zone of argillite containing numerous paper-thin seams of quartz and calcite with a sprinkling of pyrite crystals, but in a few places there is a fair amount of quartz and calcite vein matter. Elsewhere part of the vein is unidentified dike material whose age is not known. None of the accessible part of the vein has been stoped above this drift, and a grab sample taken by the writer assayed merely traces of gold and silver.

The No. 4 tunnel is connected to a 60-foot drift on the Snowbird vein by an 85-foot crosscut (Figure 6, page 13); presumedly the northern extension of the Snowbird vein was followed by the inaccessible drift to the north. The accessible drift follows a vein that has been stoped about 20 feet above the level and is best exposed in the bottom of a winze sunk 5 feet 6 inches below the level. There the vein was 5 feet 4 inches wide, including a horse of shale 3 feet wide, and assayed 0.06 ounce gold and 0.30 ounce silver across the full width. In appearance the Snowbird vein is like the Ajax vein.

In summary, the maps (Figures 5 and 6) show that the Ajax and Snowbird veins dip toward each other and intersect in a line that plunges southwestward. Figure 6 suggests that both veins exist on opposite sides of the intersection rather than one or both being cut off. Neither vein is strong structurally nor contains encouraging amounts of gold where accessible today. Additional development would soon require sinking as the No. 4 tunnel level is but a few feet above Lucas Creek.

Blue Ribbon Mine

General description

The Blue Ribbon mine is directly north of the Buffalo mine (Figure 3, opposite page 9, and Figure 7, in pocket) and is reached by a fair truck road that starts near the Buffalo mine camp (Figure 3). There are four unpatented lode claims, Blue Ribbon, Maziere, Yellow Rose, and La France (Figure 4, opposite page 11). The total gold production is unknown but is believed to be small. The mine was located some time before 1900 and according to Hewett (1931, p. 319) is developed by about 2000 feet of tunnels following a vein that strikes N. 65° E. and dips 85° S.E. The present owner, Mr. Albert Perard of Granite, states that a second vein is developed on one level. There has been little development work done in recent years and the three adit cross cuts and the shaft were inaccessible in 1957.

Geology

Because the workings were inaccessible almost no new information about the Blue Ribbon mine was obtained in 1957. The strike of the principal vein, as recorded by Hewett (1931, p. 319), and its location indicate that the Blue Ribbon veins may be the continuations of veins in the Buffalo mine. Probably the question could be settled at little expense by cleaning out the underground workings which are very likely caved for only a short distance from their portals and by digging surface trenches. The dumps indicate that the veins contain pyrite in a gangue of quartz and calcite and that the country rock is argillite of the type that has been recrystallized and foliated near its contact with the granodiorite.

Buffalo Mine

Location and ownership

The Buffalo mine is about 8 miles northeast of Granite on a good road that branches from the main Granite road (Figure 3, opposite page 9). There are thirteen claims (Figure 4, opposite page 11) of which Buffalo, Monitor, Boston, and Buffalo Mill Site are patented. During the life of the mine there have been numerous owners (Table 3, opposite page 19); at present the mine is owned by the Boaz Mining Company, Seattle, Washington. Mr. James H. Jackson, Jr., manager, and Mrs. Jackson supplied many data given in this bulletin.

History and production

The early history of the mine is obscure. Since little work had been done by the time of Lindgren's (1901, p. 685) visit in 1900, the record of production beginning in 1903 (Table 3) may be reasonably complete. However, Mr. Jackson and the writer believe that much of the gold extracted in the early days was not recorded. The gross value of the recorded production is roughly $900,000, and a comparison with various accounts of lode gold mines in the Sumpter quadrangle (for example, Hewett's, 1931) shows that this production, while small, is comparable to mines such as the Baisley-Elkhorn, Golconda, Redboy, and Bonanza that are locally considered to be "good producers." In fact, the only mines in the Sumpter quadrangle with a substantially higher production are three that worked the Mother Lode vein in the Bourne district; these, the Columbia, Eureka-Excelsior, and North Pole mines, have a combined production estimated by Hewett (1931, p. 321) at $7,750,000. Monthly production at the Buffalo mine in 1957 was between 150 and 200 tons for the 11 months operated.

Surface and general geology

The Buffalo mine (Figure 7, in pocket) works five veins, named, from west to east, Monitor, No. 1, No. 2, No. 3, and Constitution (or No. 4). Of these veins only No. 1 and No. 3 can be recognized today in surface pits, although various other pits and trenches, not all shown in Figure 7, may once have exposed other veins. In fact, although the Buffalo mine is the largest producer described in this bulletin, its veins make the least conspicuous outcrops. This is because the veins are narrow and, although silicified in many places, do not contrast with their country rock in hardness and resistance to erosion as do other veins in softer country rock. Moreover, outcrops in the area shown in Figure 7 are few and far between. It is possible that some of the stringers and veins exposed in the pits south of the Boston shaft (Figure 7) may be correlated with veins in the Buffalo mine but evidence is lacking.

All of the known outcrops of veins are in the argillite, although underground some veins cut granodiorite as well. In composition the argillite is highly silicic, in most places actually a quartzite, and has undergone contact metamorphism near the granodiorite contact. The few observations that could be made suggest that the argillite strikes northwest and dips southwest. The granodiorite is similar if not alike in composition to that for which chemical analyses are available (Table 1 on page 6). Information about the hydrothermal alteration of the granodiorite and argillite is given on page 24 and in the Appendix.

Veins and mine workings

The five veins of the Buffalo mine are shown in plan, cross section, and longitudinal section by Figure 7, Figure 8 on page 17, and Figure 9 opposite page 17. Figures 10 and 11 (in pocket) are detailed plans of the two mine levels. These illustrations show that the five

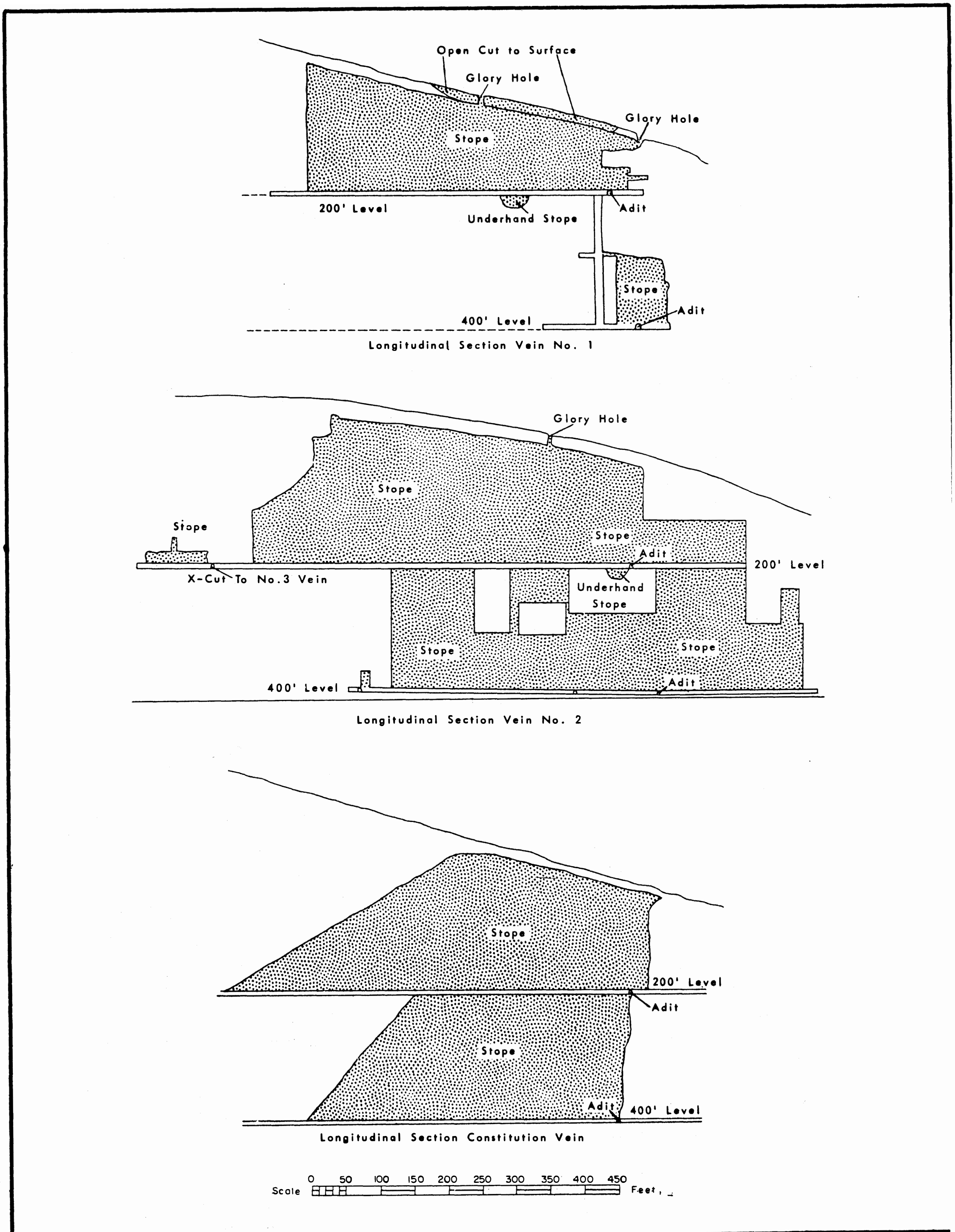

Figure 9 – Buffalo mine. Longitudinal sections of No. 1, No. 2, and Constitution veins. Observer looking eastward.

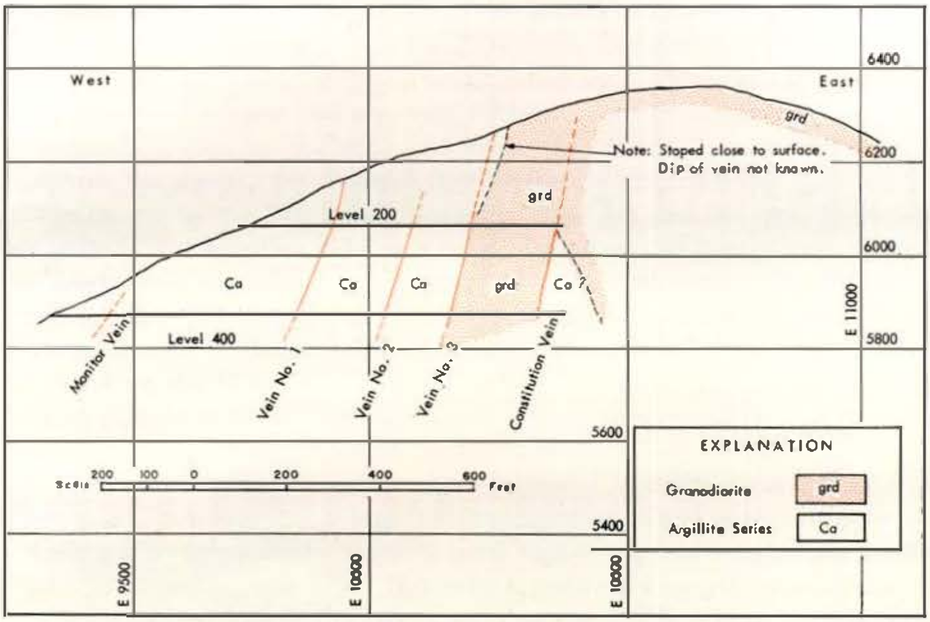

Figure 8 - Buffalo mine. Cross section looking north. The line of section follows the 200-level crosscut, extended at either end of crosscut.

veins are essentially parallel, with strikes of about N. 25° E. and dips of about 75° W. The single major exception to this parallelism is the Constitution vein which near its north end on the 400 level (Figure 11, in pocket) rolls from a west dip to a dip of about 80° E. and changes in strike to about N. 45° E.

Underground, the veins are developed on two levels, 200 and 400 (Figures 7 to 11) and by various raises and winzes. Vein No. 1, Vein No. 2, Vein No. 3, and the Constitution vein (Vein No. 4) have been stoped. In 1957 most of the workings on Vein No. 1, Vein No.2, and Vein No. 3 were inaccessible and production was entirely from the Constitution vein, as it had been since the 1940's.

The 200 level (Figure 10, in pocket) is kept open for ventilation; there was no mining above this level in 1957 and most of the workings were caved. From the portal to just east of the No. 3 vein, the crosscut is in argillite. Most of the drifts in this area are caved and none were mapped but Pardee and Hewett (1914, p. 107) indicate that they are mainly in argillite. The eastern part of the crosscut and the entire accessible drift following the Constitution vein are in granodiorite. The short crosscut driven west from the Constitution vein at N- 10,515 reaches argillite within a few feet; this crosscut was reportedly driven to test the possibility that the contact was mineralized but no ore was found. The main Constitution vein was followed by the short stub drifts that extend north and south from E- 10,340; the stringers found near the face of the crosscut pinch out in a few feet and the Constitution vein drift had to be

Table 3.
Production from Buffalo Mine
(in terms of recovered metal)
(Gold and silver in fine ounces; copper, lead, and zinc in pounds)

Year	Tons	Gold	Silver	Copper	Lead	Zinc	Owners
1903	10	24.19	---	---	---	---	W. K. Cooper, Susanville, Oregon
1904	50	48.38	69	---	---	---	Cooper & Simpson, Susanville, Oregon
1906	134	362.81	567	---	---	---	Wilmer, Granite, Oregon
1907	230	498.74	7,703	---	---	---	J. C. Haskill, Susanville, Oregon
1908	400	870.75	15,094	---	---	---	G. R. Wiegand, Granite, Oregon
1909	10	61.87	300	---	---	---	Buffalo - Monitor, Granite, Oregon
1919	325	1,378.69	6,473	---	---	---	Buffalo Development Company
1921	800	347.19	1,011	---	---	---	Beaver G. M. Company, Mr. Peterson
1922	50	379.09	1,293	---	---	---	" "
1923	102	617.90	2,866	---	---	---	" "
1924	553	701.80	3,974	947	513	---	" "
1925	1,082	1,450.05	6,896	---	---	---	John Wilson, Granite, Oregon
1926	2,487	2,399.56	15,392	2,566	11,273	---	" "
1927	4,310	1,959.79	10,963	1,691	5,300	---	Blaine Hallock, Granite, Oregon
1928	2,233	900.54	10,159	1,103	9,552	752	" "
1929	3,035	1,449.00	20,037	2,835	22,300	---	" "
1930	981	602.89	4,803	773	6,163	---	" "
1931	212	284.36	3,869	473	1,801	---	R. G. Amidon, Seattle, Washington
1932	104	243.14	1,385	142	1,351	---	Buffalo G. M. Company
1933	75	30.20	493	67	171	---	" "
1934	242	93.94	652	226	1,156	---	Tillicum Cons. & Mining, Baker, Oregon
1935	1,000	304.18	3,890	989	1,799	---	Granite G. M. Company, Seattle, Wash.
1936	50	9.24	104	---	---	---	Constitution Mining Company
1938	250	63.00	2,123	238	1,530	---	Amidon & Gibson G.M.Co., Granite, Ore.
1939	862	1,006.00	3,798	2,506	4,600	5,348	Bruce Dennis, Portland, Oregon
1940	1,483	1,013.00	4,335	1,116	6,006	---	" "
1941	3,072	2,261.00	11,695	2,142	10,684	---	" "
1942	540	315.00	1,795	368	1,022	---	" "
1944	23	110.00	900	152	---	---	" "
1946	31	259.00	82	167	1,054	---	" "
1947	622	332.00	1,976	590	4,149	779	" "
1948	1,634	1,396.00	10,302	2,369	14,577	16,078	" "
1949	749	626.00	3,703	1,103	6,924	8,286	" "
1950	574	599.00	4,221	1,092	6,317	4,659	Florence J. Dennis, Vancouver, Wash.
1951	360	270.00	2,565	353	1,719	2,001	" "
1952	286	428.00	2,568	487	2,370	3,190	Boaz Mining Company, Seattle, Wash.
1953	1,034	1,032.00	10,242	1,976	8,868	---	" "
1954	2,004	1,002.00	12,814	2,300	9,100	---	" "
1955	1,824	1,117.00	8,583	1,600	6,000	---	" "
1956	1,390	2,147.00	12,412	2,200	9,400	---	" "
TOTALS	35,213	28,994.30	212,107	32,571	155,699	41,093	

turned to the left to recover the vein after being driven about 150 feet in waste. The short stub drift that extends south from E- 10,340 contains a vein that at the face assayed 0.58 ounce gold and 1.45 ounces silver per ton across a 1-foot width.

The work done between 1952 and 1957 in the Buffalo mine was on the 400 level (Figure 11, in pocket) and between it and the 200 level. Most of the 400 level was open in 1957, although work was confined to the Constitution vein which was being developed by drifting southward on the level and was being mined in stopes above the north and south drifts.

Eastward from the portal, the crosscut first intersected the Monitor vein which is too far to the west to be cut by the 200 level (Figure 8, page 17) and was not found on the surface by the writer. The Monitor vein is a zone of sheared and brecciated argillite containing sparse quartz vein matter and a few grains of sulfide minerals. The footwall of the vein is a strong break with clay gouge in some places but the hanging wall is indistinct. Although the Monitor vein is 25 feet wide where first intersected in the crosscut, it narrows to the north. Work on the Monitor vein has developed no ore. Typical assays of the vein are reported by Mr. Jackson to be from 0.1 ounce to 0.2 ounce gold per ton across widths of 3 or 4 feet.

On the 400 level the No. 1 vein, where followed by drifts north and south of the crosscut, ranges in width from 2 to 6 inches in most places. The content of gold is low and the No. 1 vein was stoped above the 400 level to a much less extent than above the 200 level (Figure 9, opposite page 17). This vein is entirely in argillite.

Parts of the drifts that follow the No. 2 vein on the 400 level are open and the vein, where visible, is composed mainly of quartz and sparse sulfide minerals that fill a strong fracture 6 to 12 inches wide. Presumedly the vein was wider elsewhere and the sections left as roof pillars represent narrow portions of the vein. Like the Monitor and No. 1 vein, the No. 2 vein is entirely in argillite.

Most of the 400 level drift on the No. 3 vein is caved. This vein ranges from 9 inches to 1½ feet where it cuts through argillite at N- 10,630. South of N- 10,630 the vein passes into granite and then back into argillite near the face of the south drift, at about the place where the vein goes into the west wall, so that the last 30 feet of drift is in argillite.

Except for 30 feet south of the main crosscut, the entire 400 level drift on the Constitution vein was open in 1957. Unlike the other veins, the Constitution vein on the 400 level is close to or follows the contact between the granodiorite and the argillite. There is no evidence that the vein is more valuable in one wall rock than the other, although detailed sampling might show this. There is, however, evidence that the vein is less valuable where it follows the contact. This contact is characteristically sheared and faulted, as well shown near the end of the 400 level crosscut. Evidently the gold was disseminated through the sheared zone rather than being confined to a narrow vein. Mr. Jackson states that the vein is generally of low grade where it follows the contact but that 6-foot holes drilled into the walls in these places assay $7.00 or $8.00 per ton (mostly gold, calculated with gold at $35.00 per ounce).

To the north of the crosscut, the Constitution vein is generally from 1 to 4 feet wide on the 400 level. The strike of the vein is generally constant but, where it changes, thin stringers continue into either wall, especially the east wall, following the original strike of the vein. At N- 10,755 where the strike of the vein changes and stringers continue into the east wall, the dip reverses from west to east. This reversal in dip is the only one recognized in the mine and it is possible, although not likely, that it is caused by a strong fault at about N- 10,900 that cuts off the vein. The last 50 feet of drift is along this fault, which was also found in the stope above the 400 level (Figure 9, opposite page 17). Displacement on the fault is not known.

Figure 13 - Constitution vein, level 400, south drift at face (N- 10,270) on September 5, 1957. Footwall not entirely exposed. Across the 18 inches exposed, the vein assayed 0.05 ounce gold and 6 ounces silver per ton.

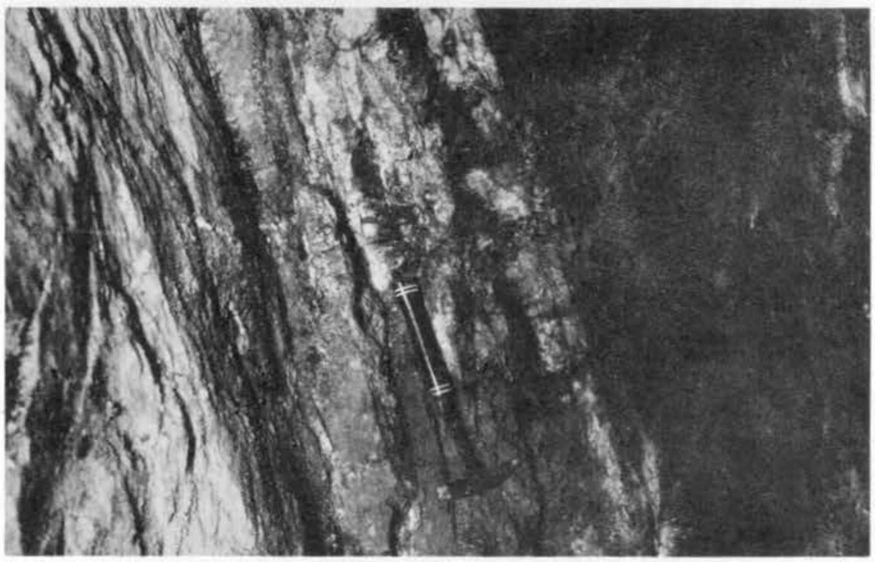

Figure 14 - Buffalo mine. Constitution vein, south face of stope above 400-level south drift, about 30 feet above the level at about N- 10,300.

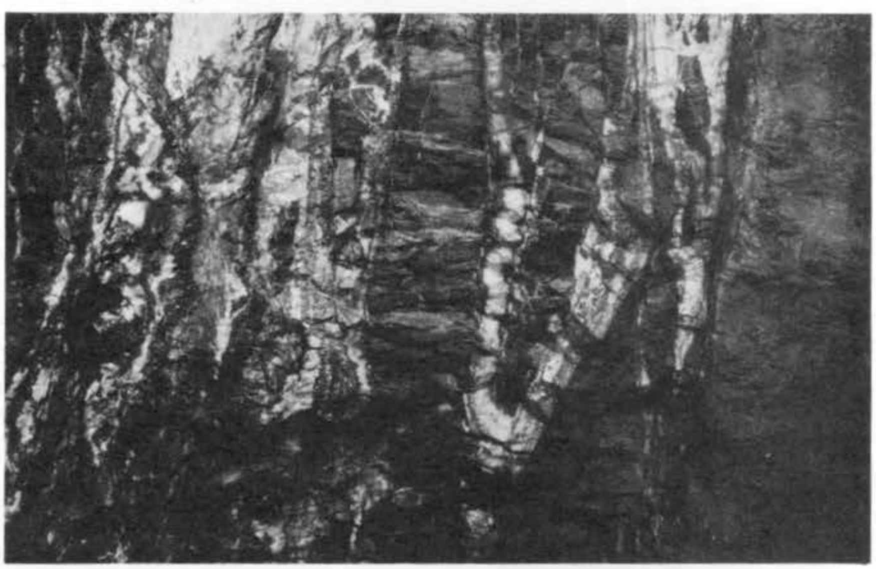

Figure 15 - Buffalo mine. Constitution vein, showing high-grade ore. Back of stope above 400-level north drift, about 170 feet above the level at about N- 10,900. The vein is about 5½ feet wide here. Wall rock is argillite.

To the south of the main crosscut, the 400 level drift on the Constitution vein follows a vein that fills a strong fracture although the vein is generally not so wide as that followed in the north drift. Figure 13 (on opposite page) is a photograph at the face on September 5, 1957, when the vein was 18 inches wide and contained 0.05 ounce gold, 6 ounces silver, and 0.15 percent copper per ton. The photograph shows the strong fracture with clearly defined walls, although the content of sulfide minerals and precious metals was low at this particular place.

The main crosscut (Figure 11, in pocket) continues 50 feet to the east of the Constitution vein. This part of the crosscut was driven entirely in argillite. The argillite-granodiorite contact exposed at the start of the crosscut is a distinct fault, with pronounced shearing and brecciation of both the rocks near the contact. From the face of the crosscut, a horizontal diamond drill hole was bored 260 feet on a bearing of S. 75° E. Drilling was in argillite except for the last 2 feet which was in vein matter. Little or no core was recovered from the vein but Mr. Jackson states that sludge samples assayed $8.00 per ton (mostly gold, calculated with gold at $35.00 per ounce). Drilling was stopped because of bad ground and so the total width of the vein is not known. This showing has not been correlated with veins known elsewhere.

A few scattered workings outside of the operating mine need description. The Boston tunnel (Figures 7, in pocket, and 12, opposite page 23) is an adit whose portal at N- 9270 is at about the elevation of the 400 level. It was first driven on a bearing of N. 42° E. following a zone of weak quartz stringers that was cut off by a fault as shown and then perhaps recovered at a place where the tunnel is caved. Probably the vein followed by the Boston tunnel is one of the veins known in the operating mine, perhaps the Constitution vein. Some useful information might be obtained by opening the tunnel where it is caved even though the size of the dump indicates that the cave is near the face of the tunnel so that the amount of additional information to be expected is small.

The two adits at about N- 9450, E- 8900 (Figure 7) were caved in 1957. In the summer of 1958 the Boaz Mining Company set about opening them but no new information was yet available. Nothing reliable is known about the Cox tunnels, that were driven southward from about N- 12,000 (Figure 7), but they are so near the hilltop that they can have developed little if any ore.

Oreshoots

The stoped portions of the No. 1, No. 2, and Constitution veins are shown by Figure 9, opposite page 17. (The No. 3 vein has also been stoped but the plan is lost.) Most of the production has come from the No. 2 and Constitution veins. The oreshoots of these veins doubtless correspond closely to the outlines of the stopes although certain parts of the stopes were richer than others. Almost all of the few assays that are available indicate less gold than the average in the millheads, suggesting that the gold is erratically distributed in small shoots. Nonetheless, in contrast to the Cougar and Independence veins (Figure 21, page 31, and Figure 22, opposite page 35), most of the developed parts of the veins of the Buffalo mine were worth stoping. There is no evidence that supergene enrichment was instrumental in forming oreshoots. Evidence on the plunge of the oreshoots is scanty, but they are probably steep if not vertical.

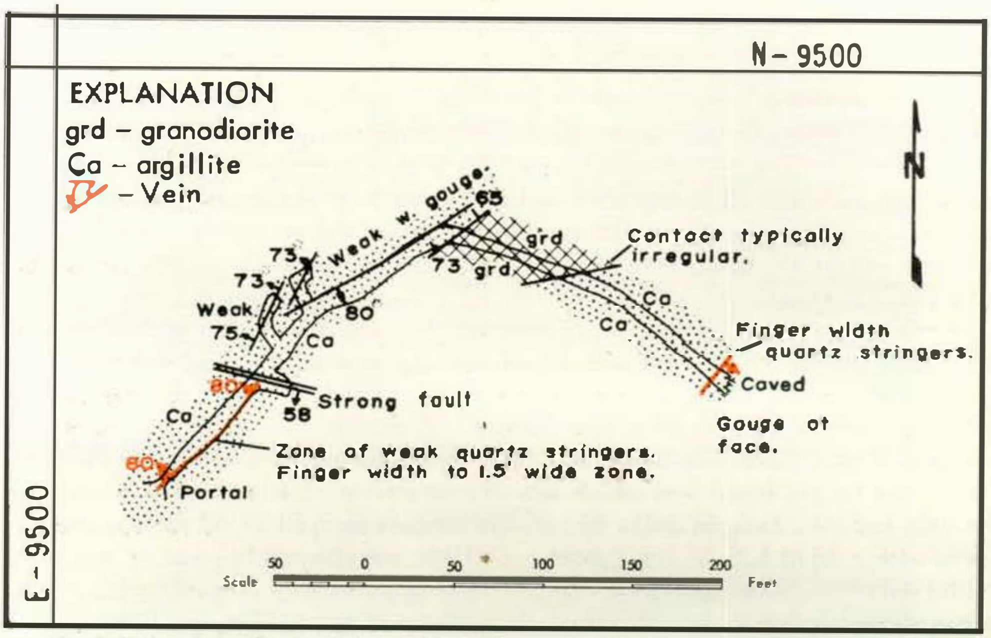

Figure 12 - Buffalo mine. Geologic map of Boston tunnel. (Full coordinate system shown on Figure 7.)

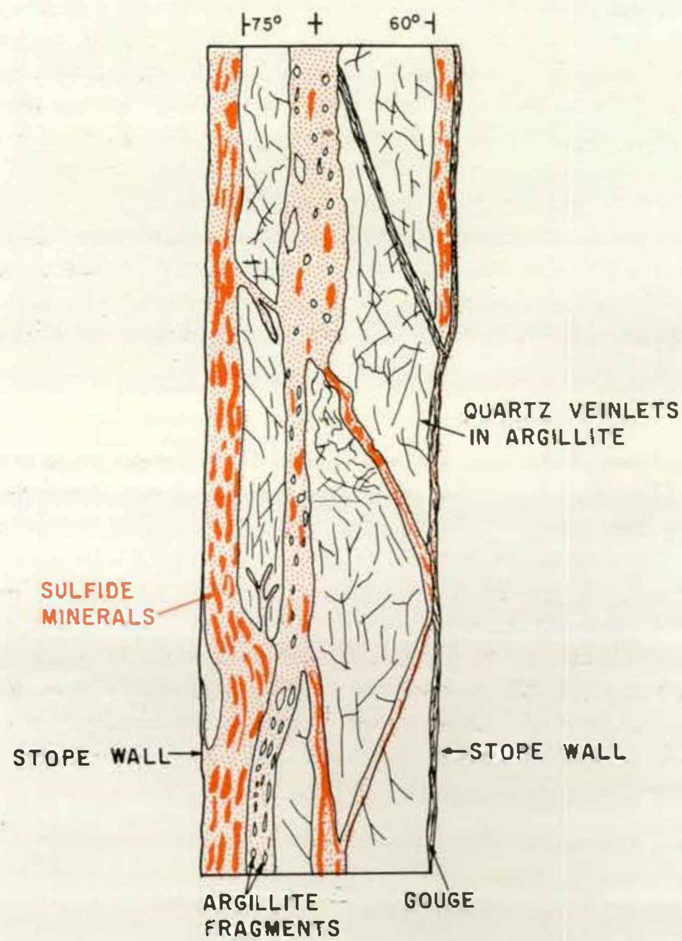

Figure 16 - Buffalo mine. Constitution vein. Sketch map by S. H. Pilcher of vein structure as seen on back of a stope near place where photograph reproduced as Figure 15 was made.

Mineralogy and vein structure

At the Buffalo mine, the four principal veins are similar in vein structure and mineralogy. In 1957 only the Constitution vein was accessible for study and consequently most of this description is drawn from observation made on that one vein. Pilcher (1958) studied the Constitution vein in some detail and his account has been freely used.

The vein minerals are few in number. The metallic minerals are pyrite, arsenopyrite, chalcopyrite, native gold, galena, sphalerite, and tetrahedrite. The gangue minerals are quartz and calcite. In studying veins that are mostly or completely inaccessible today, Hewett (1931, p. 326) found dolomite which Pilcher looked for but did not find.

The metallic minerals have characteristic textures. The arsenopyrite and pyrite are intergrown in coarse- to fine-grained crystals, mostly with distinct faces. These crystals have been fractured and the interstices filled with coarse-to-fine grains of galena or sphalerite, most of which lack crystal faces. Within some galena grains are tiny grains of a mineral with the color and hardness of tetrahedrite. This mineral has been found only with the microscope in polished sections in grains too small to identify positively with the facilities available to the writer. Much of the chalcopyrite is closely associated with the sphalerite, either rimming it or along sphalerite cleavages.

Some of the gold is visible in irregular grains as much as 1/20 of an inch across that are intergrown with sphalerite and galena. But the bulk of the gold is not visible, even under the microscope, and cannot be recovered by panning. Milling data indicate that this gold is trapped within grains of the sulfide minerals. The gold is so erratically distributed that regular channel sampling is not worthwhile and grades are determined in various other ways. Samples taken by Pilcher and the writer contained as much as 16.28 ounces gold per ton across an 18-inch vein width, whereas the average ore mined in 1956 assayed 1.545 ounces gold per ton (Table 6, page 25).

No silver minerals have been recognized and the silver is believed to be present in silver-bearing tetrahedrite or trapped within grains of one or more of the sulfide minerals. The gangue minerals calcite and quartz fill open spaces in the veins and to a lesser extent replace earlier minerals. Some of the calcite was deposited before the sulfides as it occurs in brecciated fragments cut by seams filled with sulfide minerals.

The typical appearance of the Constitution vein is illustrated by Figures 13, 14, 15 (opposite page 21), and 16 (on opposite page). In most places the vein is well defined with sharp hanging walls and footwalls, which in some places are frozen to the wall rock and elsewhere are knife-edge faults with slickensided surfaces. The vein ranges in width from about 1 to 6 feet and averages somewhat less than 2 feet. In places the vein is a simple mineral-filled fissure but elsewhere (Figure 16) it is made up of several interlaced bands of vein matter and wall rock. The content of metallic minerals ranges widely from place to place but rarely comprises more than 10 percent of the vein.

The Constitution vein was emplaced partly by open-space filling and partly by replacement. Open-space filling is indicated by crustification of sulfide minerals, by comb and vuggy quartz, and by sharp and angular fragments of wall rock within the vein. Replacement is indicated by ribbon structure, by partly replaced fragments of wall rock, and by shadowy outlines of fragments of wall rock that have been almost completely replaced. Many parts of the vein were formed by both replacement and by open-space filling.

After the Constitution vein was emplaced, there was some post-ore movement, mostly along the walls of the vein, reopening previous fault fissures. In some places, this resulted in the formation of a gouge of finely ground metallic minerals.

Rock alteration

Near the veins, both the granodiorite and the argillite have been altered so that new minerals replace some of the original minerals found elsewhere in these rocks. The alteration, which is evidently due largely to hydrothermal solutions passing upward through the vein fissures, produced rocks that are very different from the original ones. Pilcher (1958) studied the alteration, and an appendix to this bulletin gives a condensed account of his findings.

In brief, Pilcher found that the granodiorite directly adjacent to the veins and certain parallel fractures was altered to a white, bleached rock through the replacement of hornblende and biotite by muscovite, pyrite, and calcite,and through the replacement of plagioclase feldspar by calcite and sericite. Somewhat farther away from the veins, the granodiorite was altered to a lesser extent through the replacement of hornblende and plagioclase feldspar by chlorite and antigorite, whereas the other minerals were more or less unchanged. Where the wall rock is argillite, alteration was similar but less marked. In general, the alteration consisted of a leaching of magnesium and sodium and an introduction of sulfur, carbonate, and potassium.

Because the alteration surrounds northeast-striking faults and joints as well as veins, no definite relationship exists between the vein mineralization and the wall rock alteration. Indeed, the solutions that produced the wall rock alteration may have been unrelated to those that produced the ore. Therefore the wall rock alteration cannot be used as a definite guide to ore although it does indicate fissures in which mineralization may have occurred.

Mining and milling

Drifting is done with a jackleg enabling a 5-foot round to be set up and drilled in 2 hours using Atlas Copco tungsten carbide insert bits. Mucking is done with an Eimco No. 12-B mucking machine. The stopes are cut and fill, with most of the fill obtained by hand-sorting of the vein and wall rock that is broken to obtain the necessary room to work in the stopes using a slusher. A good deal of timber, all of which is cut on the property, is used in the mine. The ore is trammed in cars drawn by an Eimco No. 401 air locomotive. The mill is a 35-ton per-day bulk flotation plant with a recovery of from 94 to 90 percent and a concentration ratio of from 8:1 to 10:1 depending on the amount of sulfide minerals in the rock. The property works 11 months a year and in recent years usually four men have been employed in addition to the manager, Mr. Jackson. The manager's wife keeps the books and runs the boarding house. Because of the remoteness of the mine and related reasons, wages are high; one miner, for example, earned about $8,000 in 1957. Costs of mining and milling including maintenance are given in Table 4; average grade of concentrates is given in Table 5 on page 25.

Table 4.

Operating Costs per ton of Ore at Buffalo Mine, 1957

Mining costs		
Labor	$7.92	
Supplies	6.57	
Development ($45.10/foot)	7.55	
Total		$22.04
Milling costs		
Labor	2.97	
Supplies	2.45	
Total		5.42
Miscellaneous surface costs (charged to operations) . . .		2.01
Cost of shipping and treatment . . .		3.90
TOTAL		$ 33.37

Table 5.
Average Grade of Concentrates at Buffalo Mine

Gold	9	ounces per ton
Silver	68	" " "
Arsenic . . .	6	%
Zinc	4	%
Copper . . .	0.7	%
Antimony . .	0.4	%
Nickel . . .	trace	
Bismuth . . .	trace	
Lead	not recorded	

Note: Averaged from 16 recent returns from Tacoma smelter, American Smelting and Refining Company.

Economic considerations

Operating costs including maintenance totaled $33.37 per ton at the Buffalo mine in 1957 (Table 4, on opposite page). Comparison of these costs with the grades of ore for representative periods (Table 6 below) indicates that a good operating profit can be made with ore of the grade mined in 1956, but that ore of the average grade mined from 1904 to 1956 and from 1953 to 1956 will pay little more than the operating costs. Important factors in keeping the costs down are the decision to keep production small, the unusual amount of mechanization for a mine of this size and location, and careful management.

The maps and plans show that a substantial amount of ore has been stoped above the 400 level and that, in fact, a high proportion of the total drifting on this level was in ore. Therefore, there must be ore below the 400 level and, from the type of mineralization and persistence of the vein, the writer expects that about the same amount of ore will be developed per foot of depth below the level as was mined above it. Furthermore, there is no reason to expect the oreshoots to bottom within the depth at which another level or two might be driven. Additional ore can also be expected from continued development on the 400 and 200 levels.

Table 6.

Grade of Ore at Buffalo Mine

	Gold oz.	Silver oz.	Copper %	Lead %	Approximate gross value at 1957 prices
1904-1956	0.823	6.03	---	---	$ 34.26
1953-1956 (inclusive)	0.847	7.05	0.049	0.50	37.69
1956	1.545	8.93	0.074	0.38	63.64

Note: This table was calculated from Table 2 on page 7, which is in terms of recoverable metal. Gold and silver are given in fine ounces per ton; copper and lead are given in percent. Gross value of the ore per ton is calculated with gold at $35.00, silver at $0.905, copper at $0.27, and lead at $0.14.

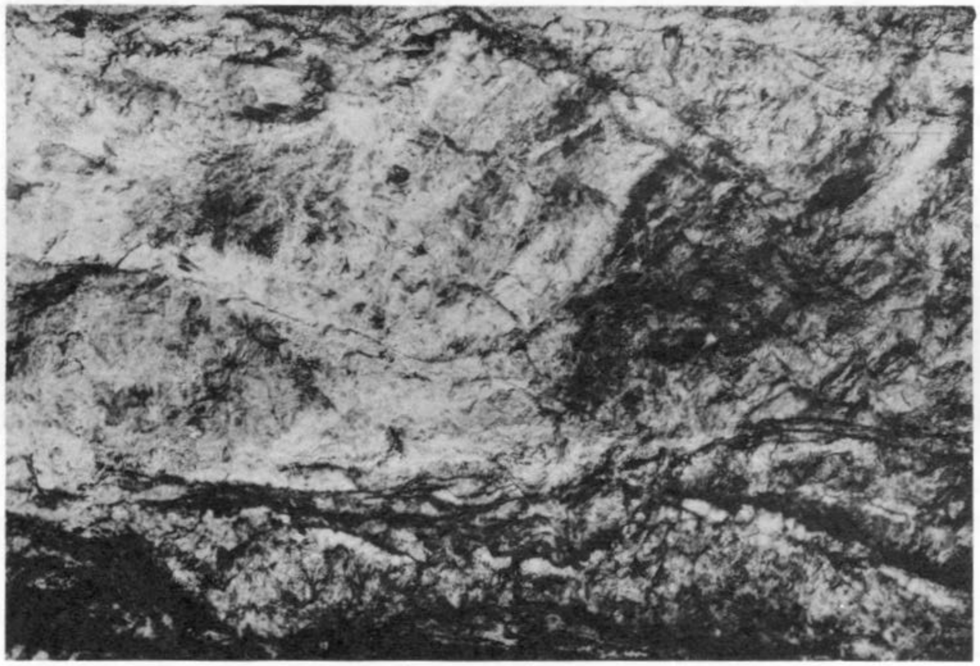

Figure 17 - Continental mine. Typical vein, as exposed in North tunnel, at E- 9440. Observer looking north at vein exposed on north wall of drift. Vein consists of 15 inches of gouge, soft black oxides, and sparse quartz gangue. It assayed 0.08 ounce gold and 0.60 ounce silver.

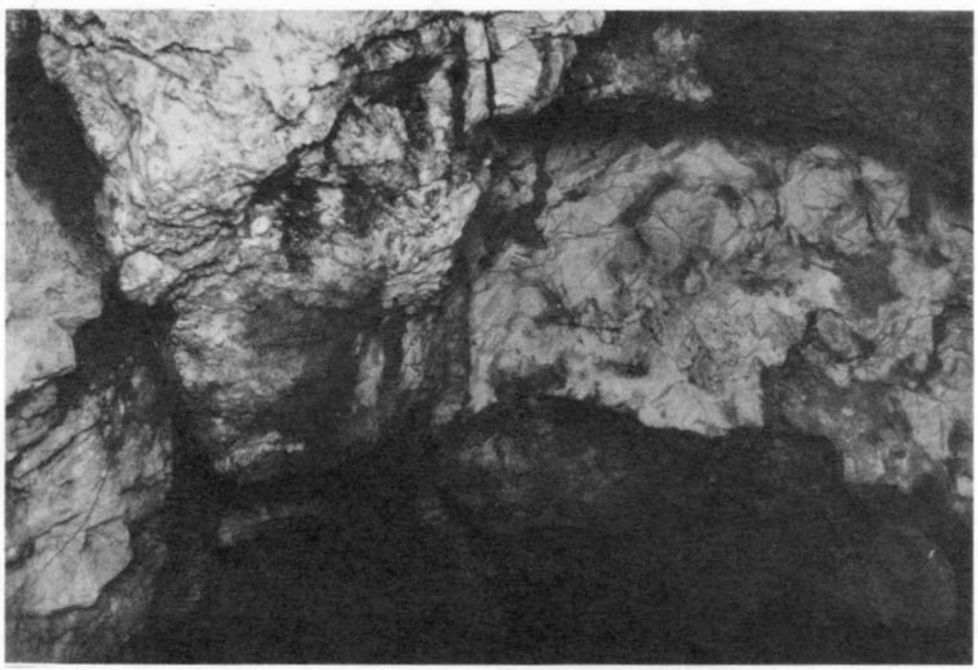

Figure 18 - Cougar mine. Cougar vein, No. 1 tunnel, about 50 feet from portal, looking northward at back of drift. The vein, which is shown on left side of photograph, dips 80° east. On the right side of photograph, a vertical dike is shown coming into the drift from the east wall and then narrowing and turning to follow the vein northward.

Continental Mine

General description

The Continental mine, the most northerly one described in this bulletin, is about 6 miles northeast of Granite on the divide between Crane and Onion creeks (Figure 3, opposite page 9). The property is reached by a fair truck road that extends eastward from the main Granite road. There are six unpatented lode claims which were being reorganized when this bulletin was written. The veins are developed by surface pits, the North tunnel, and by other adits (Figure 19 below, and Figure 20 on page 28). Work was begun at the mine in 1880. Gold and silver ore valued at more than $50,000 is said to have been taken out, mostly from one small shoot (Oregon Department Geology and Mineral Industries, 1941, page 46), but there has been little production since 1926 and the mill has been dismantled. At present the property is owned by Mr. J.L. Gyllenberg of Baker, Oregon.

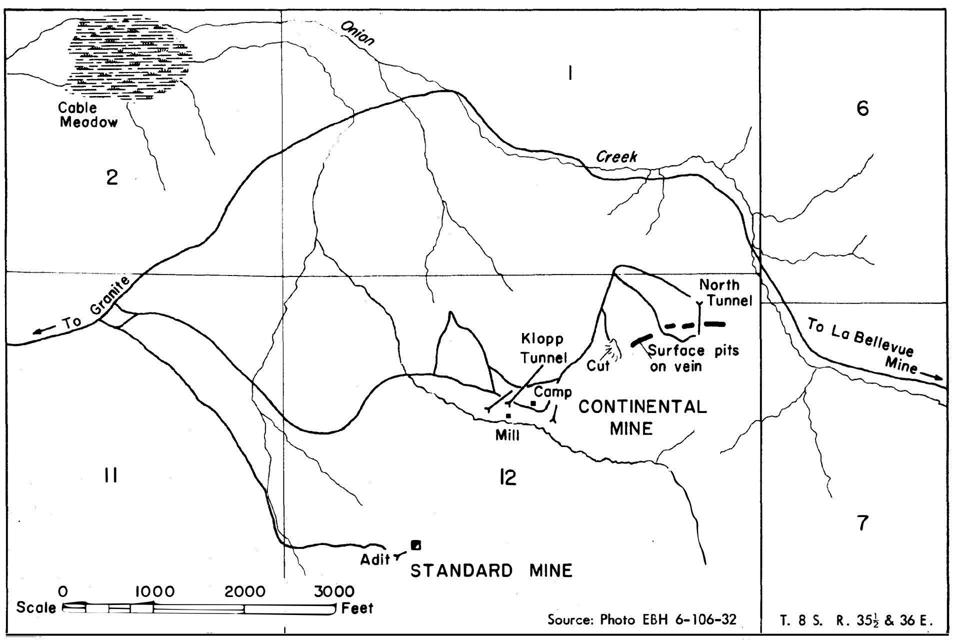

Figure 19 - Continental and Standard mines. Sketch from aerial photograph showing locations of principal adits, shafts, and pits.

Geology

The country rock at the Continental mine is a schist composed mainly of quartz, feldspar, biotite, muscovite, and garnet. This schist is argillite that has been further metamorphosed by the granodiorite batholith which crops out both north and south of the mine (Pardee, 1941) and is probably present in the mine area at no great depth. The schist is intensely contorted so that a strong lineation is more apparent than foliation; the few measurements made of lineation and foliation do not indicate any pattern. The schist contains numerous lenses and veinlets of granitic pegmatite.

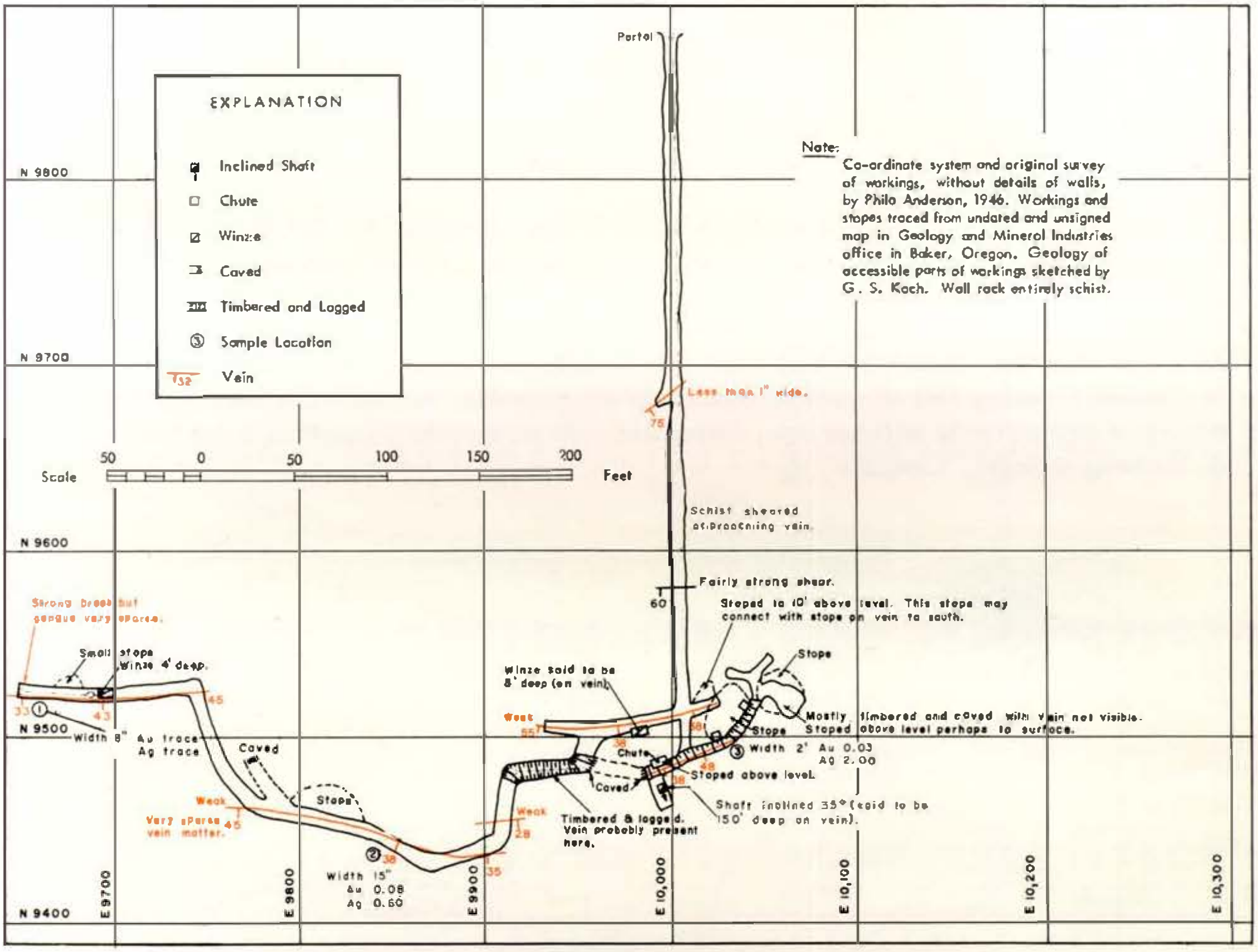

Figure 20 - Continental mine. Plan of North tunnel.

Most of the information available on the veins of the Continental mine comes from the North tunnel (Figure 20). This tunnel was first driven as a crosscut nearly due south for 360 feet to explore at a depth of about 100 feet a reputedly rich shoot of ore found on the surface. (The surface pits sketched in Figure 19 on page 27 are largest and deepest to the east.) At and near the end of this crosscut at least two veins were stoped fairly extensively and two winzes were sunk (Figure 20). Then, in recent years, development work was begun to the west, following the veins and stringers shown on the map. A small amount of stoping was done at both E- 9670 and E- 9800, and a raise may have been driven to the surface from the caved tunnel at E- 9775.

The veins and stringers exposed in the North tunnel strike about east-west and dip south at angles that average about 45°. Figure 17 (opposite page 27) is a photograph of a typical vein. The veins follow fractures that are strong and well defined especially on the hanging walls. The veins are filled with gouge, quartz, and sparsely disseminated sulfide minerals. The widths of the veins and quartz fillings range from paper-thin to as much as 3 feet with the average a few inches. The quartz is typically concentrated in lenses about 8 inches thick that extend for 2 or 3 feet along the strike and are localized by upward warps in the strong hanging walls of the veins. Assays of three samples taken are very low (Figure 20) but may not represent fairly the values of the veins.

Aside from the North tunnel, little is known about the workings of the Continental mine. Klopp's tunnel (Figure 19, page 27), which is reported to be 600 feet long and to follow a high-grade vein (Oregon Department Geology and Mineral Industries, 1941, p. 46) was accessible for but a few feet in 1957 and no vein is present at the portal. This tunnel can scarcely lie more than 100 feet below the surface at any point and so at best little ore was developed above it. Down the hill and to the southwest of Klopp's tunnel is another tunnel (Figure 19) that was driven 360 feet on a bearing of N. 57° E. following a discontinuous structure that dips 68° S.E. and appears to be a pegmatite dike rather than a vein. At the face a grab sample assayed a trace of gold and 0.40 ounce silver. Veins and stringers are also exposed by various pits, trenches, and bulldozer cuts on the surface; the larger pits evidently follow the veins known in the North tunnel.

The veins of the Continental mine can not be expected to extend for more than 200 or 300 feet in any direction. Where the drifts in the North tunnel were stopped in favor of crosscutting (Figure 20, on page 28) the veins were narrow and in places were scarcely visible. Where work was finally stopped at the face of the westernmost drift the vein was extremely narrow although the fracture was still strong. It was impossible to enter the workings to the east of the long crosscut to determine why drifting was not continued eastward, but the plan of the workings suggests that several short tunnels were driven in search of a lost vein and the surface pits do not extend far east of the crosscut.

The best chance of finding additional ore in the Continental mine would be to search for a continuation of the shoot mined near the end of the long crosscut of the North tunnel. Although it is doubtful that enough ore could be developed to pay under present economic conditions, the vein could be tested relatively cheaply at points 50 or 100 feet below the elevation of the North tunnel. Because of the flat dip of the vein and favorable topography this work could be done by diamond drilling from the surface, which should be accompanied by mapping in detail the surface geology and by unwatering the two winzes below the North tunnel level.

* * *

Table 7.
Production from Cougar-Independence Mine*
(in terms of recovered metal)
(Gold and silver in fine ounces; copper, lead, and zinc in pounds)

Year	Tons	Gold	Silver	Copper	Lead	Zinc	Owners
1907	44	108.75					O. C. Wright, Granite
1911	4	4.59	100				W. G. Gleason "
1922	1,550	434.20	2,397	4,724			United Gold Mining Company
1923	800	276.12	1,357				Independence Mining Company
1924	5,497	1,632.00	6,220				" " "
1934	10	5.33	2				Gertie O'Rourke, Susanville
1935	31	25.01	41	106			" " "
1937	1	1.00	20				H. K. Bunker, Susanville
1938	621	501.00	954	329	102		B. T. Isgrig, Baker
1939	9,049	4,609.00	3,585	85	520		Independence Min. Co., Appleton, Wis.
1940	18,427	6,560.00	8,169	1,564	187		" " " " "
1941	21,000	7,364.00	4,116	171			Cougar-Independence Min. Co., Baker
1942	4,011	976.00	628	1,034			" " " " "
1950	80	12.00	40	19	57	19	Langdon Rand, Baker, Oregon
TOTALS	61,125	22,509.00	27,629	8,032	866	19	

* Independence mine, 1907-1911; Independence-Cougar, 1922-1938; Cougar-Independence, 1939-1950.

Cougar-Independence Mine

General description

The Cougar-Independence mine is the second largest described in this bulletin. Aside from the Buffalo, it has the only record of substantial continued production over a number of years and the only sizable amount of developed ore. Unfortunately almost none of the underground workings were accessible in 1957 and so this bulletin adds to the earlier descriptions mainly in the publication of various maps and sections. The Cougar-Independence property comprises two distinct mines, the Cougar and Independence. Ore was concentrated in a single mill, now dismantled, that was about 2½ miles north of Granite on the main road (Figure 3, opposite page 9). The patented and unpatented claims are listed and shown on Figure 4 (opposite page 11). The early history of the two mines is not clear, but the Cougar was working in 1900 (Lindgren, 1901, p. 683) and the Independence in 1907 (Pardee and Hewett, 1914, p. 104). Ownership of the two mines has changed throughout the years; the present owners are Mr. Irving Rand, Attorney at Law, 920 S.W. 6th Avenue, Portland, Oregon, and Mr. John M. Balliet, 123 S. Appleton Avenue, Appleton, Wisconsin.

The combined production of the two mines, as obtained from two different sources, is given in Table 7 (page 29) and Table 8. Table 7 was compiled by the U. S. Bureau of Mines from annual canvass forms submitted by the mine operators and supplemented by additional data received from the smelters concerned. Table 8, which shows the production from the two mines separately, was compiled by Mr. Irving Rand from smelter returns in his files. The relatively small differences in the two tables presumedly result from somewhat different bases of calculation. The data of Table 7 show that the average grade of ore was 0.37 ounce gold and 0.38 ounce silver per ton, with a total gross value of about $750,000. Most of this production was obtained between 1939 and 1942 following which the property was closed down because of World War II. Activity since World War II has been mainly assessment work.

Table 8.

Production from Cougar and Independence Mines
(in terms of recovered metal)
(Gold and silver in fine ounces; copper in pounds)

Year	Gold	Silver	Copper
Independence			
1907	108.75	---	---
1911	4.59	100.00	---
1922	434.20	2,397.00	4,724.00
1923	276.12	1,257.00	---
1924	1,632.00	6,220.00	---
1939	355.91	1,286.00	---
1940	390.62	3,322.00	---
Totals	3,202.19	14,582.00	4,724.00
Cougar			
1938	516.16	20.5	8.23
1939	4,122.59	1,623.1	---
1940	6,313.56	4,772.2	73.52
1941	7,198.60	4,039.1	8.55
1942	975.33	521.4	32.00
Totals	19,126.24	10,976.30	122.30
1950	12.00	40.00	19.00
GRAND TOTALS:	22,340.43	25,598.30	4,865.30

General geology

There are two principal veins, the Cougar and Independence (Figure 2, opposite page 5). These veins are more or less parallel, striking about N. 50° E. and dipping about 70° E. It is entirely possible that the Independence and Magnolia veins are the same and that the Cougar and Ajax veins are the same but to determine this would require examining the intervening ground in detail and trenching the surface. In addition to the two principal veins there are numerous small veins and stringers, some of which are plotted on the surface geologic map (Figure 2, opposite page 5). These small veins and stringers have been extensively explored at the surface by pits, adits, and trenches with results that were presumedly disappointing as there is no evidence that a substantial amount of ore was extracted from any of them. All of the veins are in argillite that strikes consistently northwest and dips southwest. The argillite and veins are cut by numerous dikes that are described below.

Geology of the Cougar mine

The development workings of the Cougar mine, as indicated by a longitudinal section (Figure 21, below) that was up-to-date when the mine closed down in 1942, consist of four adits that follow the vein in from its surface outcrops, an internal shaft from which extend two drifts below the level of the lowest adit, and various raises and winzes. The section shows that the ore occurred in rather small and erratic shoots and that a large proportion of the development work was in waste. Various incomplete maps, not reproduced in this bulletin, show that the vein was cut with little or no apparent displacement by numerous faults and dikes. Only a small portion of one adit was accessible in 1957; this followed the vein illustrated by Figure 17, opposite page 27, which is typical of the vein elsewhere in the mine, judging by the published accounts. The best description of the vein, from a personal communication by Mr. G. T. Vandel,* who was general superintendent of the Cougar mine in 1941, is quoted on page 32.

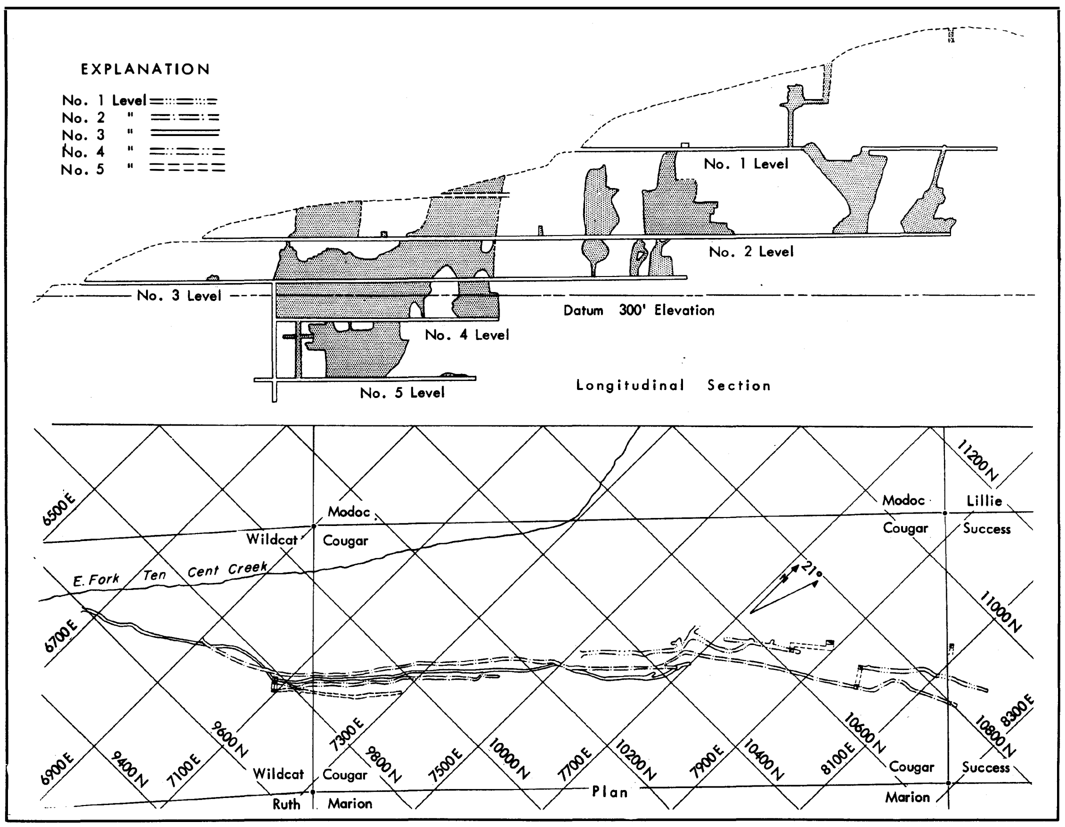

Figure 21 - Cougar mine. Plan and longitudinal section showing stopes. Observer looking northwestward.

---

* Vandel, G. T., 1941, Geology: Cougar mine, 2-page typescript prepared for inclusion in Oregon Metal Mines Handbook, dated February 10, 1941.

"In the vicinity of the Cougar Mine the country rock is grey to black argillite, in general thin bedded. A considerable amount of carbonaceous material is noted in particular near the hanging wall of the vein. Many dikes traverse the argillite having a strike from north to northwest and dipping to the SW from 65° to 85°. The greater percentage of these are light-colored, where possible to study near the vein zone, but several have been noted that have a preponderance of dark-colored minerals and a more granular structure. In the absence of definite data for classification they are locally designated as acidic and basic. They are premineral with respect to the Cougar vein having been displaced a considerable distance by the vein fault with the resulting drag forming a part of the vein-filling.

"The strike of the vein ranges between N 43° E and N 50° E with a dip to the SE from 70° to 83°. Strike is remarkably uniform over a given distance within the ore zone but the dip varies considerably in short distances between the limits given above. Width is from a few inches to two feet outside the productive areas to from three feet to nine feet within the orebodies that have been mined to date.

"Mineralization occurs along a fracture that has approximately 340 feet horizontal displacement with considerably less vertical movement as determined from correlation of footwall and hanging wall dikes. For all practical purposes the dikes may be considered as striking at right angles to the vein fracture and are displaced by the vein fault. In the locality of numerous footwall and hanging wall dikes the vein contains a considerable amount of mineralized, altered dike material and is considered to be present as drag into the vein fissure during movement along the vein walls. The vein fissure is considered to be a normal fault with movement along a northeast direction at a relatively flat angle and as a consequence dike material fills the vein. In other sections of the mine where no dikes on either footwall or hanging wall are in evidence with sufficient width to produce the amount of dike filling that exists it is concluded that a dike was intruded into the vein fracture before the vein minerals.

"The Cougar vein is of the 'composite type' made up of several strands. The width seems to be influenced to a great extent by the enclosing rock as shown where an appreciable increase in vein width results where the vein fracture passes from argillite to a dike zone. The central portion of the vein often is a breccia composed of angular slate fragments cemented by quartz and dolomite with many open vugs lined with needle-like quartz crystals. The hanging wall section of the vein shows considerable black gouge and carbonaceous material whereas in many cases the footwall shows only a very narrow band of broken gougey material; gold values are confined to the area between foot and hanging walls although from assay of material gold is shown a considerable distance from the vein in minor amounts."

Some information about the ore known to remain in the Cougar mine is given in Table 9 on page 33. This table shows that on Level 4 a drift 500 feet long developed a shoot of gold ore 475 feet long with a gross value of $18.10 per ton and that on Level 5 a drift 465 feet long developed two shoots of gold ore totaling 310 feet with an average gross value of $16.59 per ton. Considering that the vein was somewhat wider on Level 5, although of lower grade, it is probable that the grades of the millheads from the two levels were similar because of dilution from mining wall rock on Level 4; nevertheless, the length of the oreshoot is distinctly less on Level 5 although the lengths of the drifts on the two levels are nearly the same. Future drifting northward on Levels 4 and 5 should develop some ore below the stopes that lie above Levels 2 and 3 but most of this drifting could be expected to be in waste.

Table 9.

Cougar Mine
Comparison of Ore Developed on Levels 4 and 5

Level	Length (feet)	Vein Length (feet)	Width (feet)	Assay (oz. Au/ton)	Gross Value per ton ($35/oz)
4	500	475	3.14	0.517	$ 18.10
5	---	215	4.53	0.492	17.22
5	---	95	3.06	0.399	13.97
Combined ore in both shoots on level 5:					
5	465	310	4.14	0.474	$16.59

Geology of the Independence mine

Little work has been done at the Independence mine since 1931, when the workings, all of which follow the Independence vein, were as shown in Figure 22 (opposite page 35). There are three levels reached through an inclined shaft and an 1100-foot adit that is a crosscut to the vein on the lowest level. The original plan and section from which Figure 22 was drawn show that the veins and argillite were cut with no apparent displacement by porphyry dikes of five different types. The original section also shows that on the lowest level an oreshoot was developed 615 feet long and 2½ feet wide with an average value of $9.73, presumedly calculated with gold at about $20 per ounce. The best description of the vein, which was written before the lowest level was driven, is by Pardee and Hewett (1914, p. 104) and is quoted in full below.

> "The vein is explored for about 1100 feet along the strike, N. 50° E., and to a depth of 190 feet below the outcrop. The vein dips 65° S.E. Two shoots, 320 feet and 120 feet long, having average widths of 3 and 2.8 feet respectively, have been developed. The first of these has been stoped to a height of 60 feet above the tunnel, and is known 100 feet lower in a drift from the shaft. In the accessible workings the vein, which contains only a meagre amount of quartz, is composed of sheared argillite and gouge much stained with limonite. Unoxidized ore from the 100-foot level shows altered argillite breccia cemented by dense dolomite with minor quartz. Locally, a breccia of both minerals is cemented by chalcedonic silica. Pyrite and arsenopyrite were observed both in the argillite fragments and in the cement, although tetrahedrite and pyrargyrite appear to be confined to dolomite. Faint stains of proustite occur on fractures. The total content of sulphide minerals does not exceed a few per cent. In the oxidized zone, manganese stains are abundant, both on the walls and in the vein mineral.
>
> "According to Mr. Walter Gleason, an owner, the average of a number of assays in the oxidized zone of the longer shoot is 2.66 ounces silver and .43 ounce gold per ton, and in the unoxidized ore, 100 feet lower, the average is 9.3 ounces silver and 1.06 ounces gold. These averages indicate a ratio of silver to gold in oxidized ore of 6 to 1, compared with 9 to 1 below, as well as considerable increase in the value of the ore. The associations of the rich silver minerals strongly suggest that this increase in value is to be

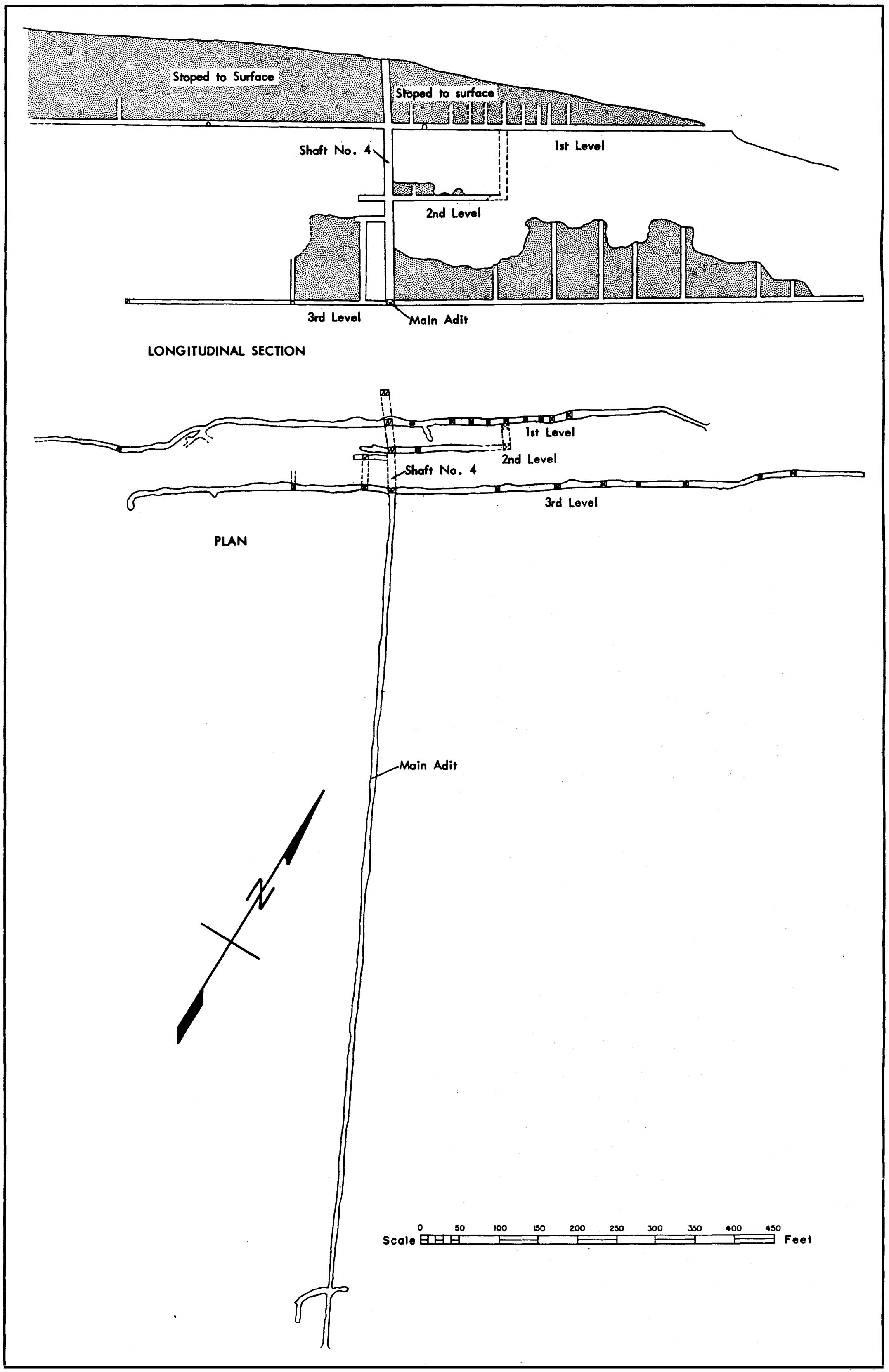

Figure 22 – Independence mine. Plan and longitudinal section showing stopes. Observer looking westward.

attributed to downward enrichment, following the weathering and erosion of the superficial portion of the vein. The extent of exploration on the vein, however, does not warrant a statement of the extent to which ore has been enriched by this process.

"Several light decomposed dikes, 2 to 4 feet wide, with southeast courses, have been found in both walls. These terminate against the vein and indicate that it fills a fault fissure, although the amount of displacement has not been determined."

Mill, camp, and equipment

The mill and equipment were described in the Oregon Metal Mines Handbook (Oregon Department of Geology and Mineral Industries, 1941, p. 49). Most of this is gone, although some of the houses in the once extensive camp remain in good condition.

Magnolia Mine

General description

The Magnolia mine is on Lucas Creek about 3½ miles north of Granite (Figure 3, opposite page 9) and is connected with the forest road along Granite Creek by a good road. There are seven unpatented lode claims: Jupiter, Atlas, Violet, Magnolia, Rose, Helena, and Tacoma (Figure 4, opposite page 11). The mine worked one vein, the Magnolia (Figure 2, opposite page 5), which is developed by an adit (Figure 23, in pocket) about 1050 feet in length whose portal is near the level of Lucas Creek and by shorter adits and pits on the hillside northeast of the creek. Lindgren (1901, p. 684) states that the Magnolia mine began operation in 1899 when a 10-stamp mill was built, and ore containing an unknown, but certainly small, amount of gold was extracted until about 1904 (Pardee and Hewett, 1914, p. 105). Evidently most of the work accomplished after 1904 consisted of driving the principal adit about 100 feet.

The writer was allowed to inspect the Magnolia property through the courtesy of Mr. Richard E. Boyce, West 41-37 Avenue, Spokane, Washington, who holds a 2/5 interest in the mine. Mr. C. M. Boyce of St. Maries, Idaho, has another 2/5 interest, and Mrs. Vida V. Wilder, 816 Westford Street, Lowell, Massachusetts, has the remaining 1/5 interest. Mr. Boyce also supplied an assay map (Figure 23) of the main adit made by Mr. Ed McAllister and Mr. Harold Culp of the Cougar-Independence Company.

Geology

On the surface the Magnolia vein is clearly exposed from the portal of the main adit northeastward to where the vein, if still present, is covered by the younger volcanic rocks of Tertiary age (Figure 2). The vein has not been found to the southwest of the main adit, but it is probable that a detailed inspection of the heavily wooded hillside between the main adit and the outcrop of the Independence vein, perhaps aided by some trenching, would indicate that the Independence and Magnolia veins are the same.

In 1957 the upper workings on the Magnolia vein were caved and the main adit was caved at a point about 650 feet from the portal (Figure 23, in pocket). The accessible part of the vein is almost entirely timbered so that the rocks and vein are not exposed. About 500 feet from the portal the vein is visible where it was stoped to a height averaging about 20 feet above the level. There the vein is 2½ to 3 feet in width and composed of black-to-white gouge with sharp, distinct walls indicating a strong fracture of the argillite. No sulfide minerals or gangue of quartz or calcite were noted. Measurements in the stope and elsewhere indicate that the strike of the vein is consistently about N. 58° E. and that the dip is consistently about 71° SE. Some additional information about the vein and the workings is given in the Oregon Metal Mines Handbook (Oregon Department of Geology and Mineral Industries, 1941, p. 55), from which the following is quoted:

> "At one point 70 feet from the end of the lower tunnel the vein is offset 17 feet to the north by a cross-fault which occurred during or before mineralization (as the quartz vein carries around the curve). The country rock is argillite. The vein consists of spotted gray quartz and silicified argillite up to 14 inches wide but averages much less. There is a black crumbly argillite gouge and the walls are not well defined. Chalcopyrite and some other sulphides are present. There has been some stoping between the lower two levels but none was seen above the central level.
>
> "According to Mr. R. B. McGinnis, manager of the La Belleview mine, the average width of vein is $4\frac{1}{2}$ feet; in the lower tunnel, both north and south of the large fault, widths ran up to $6\frac{1}{2}$ feet."

The assay map of the main adit (Figure 23, in pocket) shows that a small amount of marginal gold ore has been developed in this drift. As the face of the drift is at a point below the contact between the argillite formation and the Tertiary volcanic rocks, nothing is known about the expected continuation of the Magnolia vein below the cover of Tertiary rocks, and the likelihood of additional marginal ore existing there is good. Figure 2, opposite page 5; Figure 22, opposite page 35; and Figure 23 show that extension of the Independence vein workings would both facilitate future exploratory work on the Magnolia vein and make more valuable any new ore found.

New York Mine

The New York mine workings center around the dismantled mill which is on the east side of Granite Creek along the road about $2\frac{1}{2}$ miles north of Granite (Figure 3, opposite page 9). There are two principal veins which have received various names in the past and, in this report, are called for convenience New York No. 1 and New York No. 2. A number of claims have been staked on these veins in the past but no assessment work is known to have been done in recent years. The New York No. 1 vein (Figure 2, opposite page 5, and Figure 24, on page 37) is developed by three adits and by a line of pits and trenches extending the length of the vein. The adits are caved but where the vein is visible it is a strong fracture from 5 to 6 feet wide containing buff-colored gouge and breccia fragments of argillite rather than quartz or calcite vein filling. The New York No. 2 vein was explored by two adits close together of which the lower is plotted on the surface geologic map (Figure 2). The vein consists of sheared argillite that has been silicified and is iron stained; it is about 5 feet wide and makes a distinct outcrop. Two samples taken across 4-foot and 2-foot widths of the vein in different places assayed a trace of gold and no silver; where this vein was cut by a cross-structure resembling a felsite dike, the cross-structure assayed 0.03 ounce gold and 0.30 ounce silver. As the outcrop pattern on the map (Figure 2) suggests, the New York No. 2 vein may crop out on the west side of Granite Creek.

Additional information on the New York mine was recorded by J. J. Grove (1940) in an excellent thesis written when the mine was in operation. Grove writes that the millheads averaged $15.00 per ton in 1938 when he was employed at the mine and that production was entirely from oxidized ores. He gives assays to show that marginal to submarginal gold ore was developed in the surface pits (Figure 24). Near the face of the lowest adit the vein changes

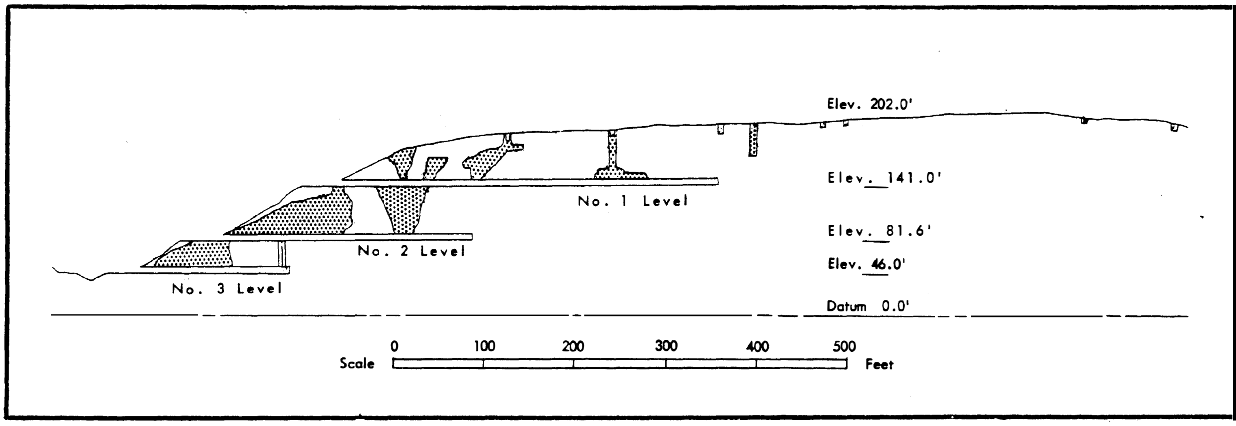

Figure 24 - New York mine. Longitudinal section of New York No. 1 vein showing underground workings and surface pits. Observer looking westward. After Grove (1940) Plate 25.

from oxide ore to sulfide ore, containing the minerals quartz, arsenopyrite, chalcopyrite, and gold. Grove states that the New York and Cougar veins are alike. From Grove's report and map (Figure 24) it is clear that the New York No. 1 vein has not been completely explored below the surface outcrop and that almost all exploration was confined to the oxide zone.

Standard Mine

The Standard mine is in sec. 12, T. 8 S., R. 35½ E., and is connected to the Granite road by a fair truck road (Figure 3, opposite page 9, and Figure 19, on page 27). There are two unpatented lode claims, Roxa No. 1 and Roxa No. 2, located by Mr. W. L. Amos of La Grande, Oregon. The workings consist of a shaft now caved 30 feet below the surface, and a tunnel reported by Hewett (1931, p. 319) to be 400 feet long. The tunnel is caved at the portal; a grab sample of quartz vein matter from the dump assayed 0.01 ounce gold and no silver. The following additional information on the property is given in the Oregon Metal Mines Handbook (Oregon Department of Geology and Mineral Industries, 1941, p. 64):

> "History: First discovered in the early 80's, and last worked in 1899. Leuck (the owner in 1941) started reopening the workings on December 24, 1938. $1100 is said to have been taken out of the old shaft; some of the ore was shipped, some hauled to an old arrastre."
>
> "Development: 100 feet of crosscut and 50 feet of drift reopened in old workings. 25-foot shaft dug. Old workings said to total about 300 feet.
>
> "Geology: Country rocks granite and schist. There are two veins: one is small (up to 8 inches wide) striking northeast and southwest; the other larger (at least 4 feet) striking east-west. Values are said to be most at junction of veins in shaft, with up to $25 gold and 20 ounces silver. Sulfides mostly galena and pyrite, with some arsenopyrite (?), sericite, limonite, etc. The large vein in the shaft is hard quartz at least 6 feet wide. It strikes N. 65° E. and is vertical."

Tillicum Mine

The Tillicum mine (Figure 3, opposite page 9) is on the north side of Granite Creek, in part to the east of the surface area that was mapped (Figure 2, opposite page 5). The principal mine workings (Figure 3) are two caved adits, 50 feet vertically apart, in granodiorite but there are other small adits and pits. Most of the work appears to have been done on short veins and stringers of less than a foot in thickness. In recent years the Boaz Mining Company had six claims (Tillicum Nos. 1 to 6) in the area but in 1958 the ground was believed to be vacant. Additional information about the Tillicum mine was published in the Oregon Metal Mines Handbook (Oregon Department of Geology and Mineral Industries, 1941, p.64).

Conclusions

Two of the mines described in this bulletin, the Buffalo and the Cougar-Independence, have maintained a small but more or less consistent production of gold for some 50 years. Their combined recorded production has a gross value of about $1,650,000 and there is good reason to believe that a substantial additional production was not recorded and so is unknown. Four other mines, the Ajax, Magnolia, Continental, and New York, have an aggregate production estimated at $150,000. In each mine, the bulk was obtained during a brief period of operation although activity at the properties extended over many years. The production of the other mines and prospects is either unknown or is very small.

At the Buffalo and Cougar-Independence mines the veins, although either narrow or low grade, persist laterally and vertically wherever they have been developed. Under the difficult economic conditions prevailing between 1953 and 1958, when the price of gold remained constant while costs of production steadily increased, the Buffalo mine obtained the largest yearly production from the highest-grade ore in its recorded history. Although the Cougar-Independence mine has not operated since 1942, indicated and inferred reserves of ore should permit resuming production under somewhat more favorable economic conditions.

The larger veins of the district persist both laterally and downward and have not been fully developed except in a few places. Because the enriched ore of the near-surface oxidized zone has long since been exhausted, production in the district in the last 25 years has been almost exclusively from primary ores that can be expected to persist at depth. It is possible that new veins not recognized at the surface will be found at depth through exploration, as some of the best veins being mined in the district today, such as the Constitution vein of the Buffalo mine, make inconspicuous outcrops, if they crop out at all.

The full extent of most of the veins is not known, largely because relatively little exploration work has been done in the district in recent years. Some of the veins warrant additional exploration work which could best be done initially by surface trenching and by diamond drilling. These are desirable methods of exploration in this district because much information is concealed beneath a thin soil cover and because the topography in many places favors diamond drilling. It must be recognized, however, that once a vein is delimited by trenching and diamond drilling, information about its grade would require driving development headings, for the gold is distributed so erratically that representative samples can be taken only from actual mine workings.

Therefore, because of the persistence of the veins and the relatively high gold content of some of them, continuation of gold mining on a small but profitable scale is to be expected in the Granite district.

APPENDIX

Rock Alteration at the Buffalo Mine

By

S. H. Pilcher

The granodiorite at the Buffalo mine exhibits two types of rock alteration. One of these is a deuteric alteration produced by a reaction between late magmatic fluids and the earlier-formed crystals. The other is a hydrothermal alteration associated with the veins.

Deuteric Alteration

The deuteric alteration is characterized by a partial alteration of hornblende to biotite and chlorite and a partial alteration of biotite to chlorite. The alteration minerals are usually minor in amount, and in none of the thin sections studied were entire crystals of hornblende or biotite replaced.

The biotite which replaces the hornblende occurs as small rounded flakes or elongate laths scattered throughout the hornblende crystals.

The chlorite is bright-green and is biaxial negative with a 2V of 5° to 10°, an Ny between 1.620 and 1.624, and an anomalous blue interference color. In Winchell's classification (1951, p. 381-385) this mineral is diabantite, a chlorite with nearly equal proportions of iron-magnesium and silicon-aluminum.

There are several occurrences of the diabantite. A small amount that forms isolated masses of interlocking laths appears to have crystallized directly rather than as a replacement of previous mafic minerals. But most of the diabantite occurs as either elongate crystals penetrating large crystals of primary biotite along their cleavages or associated with the hornblende. Where associated with the hornblende some diabantite replaces the small laths and rounded flakes of deuteric biotite which are present in a number of the hornblende crystals and the rest is intergrown in flakes within the hornblende crystals and appears to replace them directly.

Sphene commonly occurs with the diabantite in finely crystalline aggregates that are elongate parallel to the original cleavage in the biotite and are irregular masses in the hornblende.

The occurrences of these deuteric minerals suggest that when biotite was crystallizing directly from the magma, solutions reacted with the earlier formed hornblende to form additional biotite. Apparently, potassium was used up before the magma had completely crystallized, after which chlorite (var. diabantite) crystallized instead of biotite and the residual solutions altered part of the earlier formed hornblende and biotite to chlorite.

Hydrothermal Alteration

<u>Granodiorite</u>

The hydrothermal alteration minerals in the granodiorite are zoned with relation to the veins. The writer distinguishes three zones based on different alteration minerals (Table 10, page 42). In an outer green zone, which is farthest from the veins and grades into fresh rock, the granodiorite is colored pale green by chlorite, antigorite, and a green microcrystalline mineral that may be montmorillonite. These minerals were formed by the alteration of biotite,

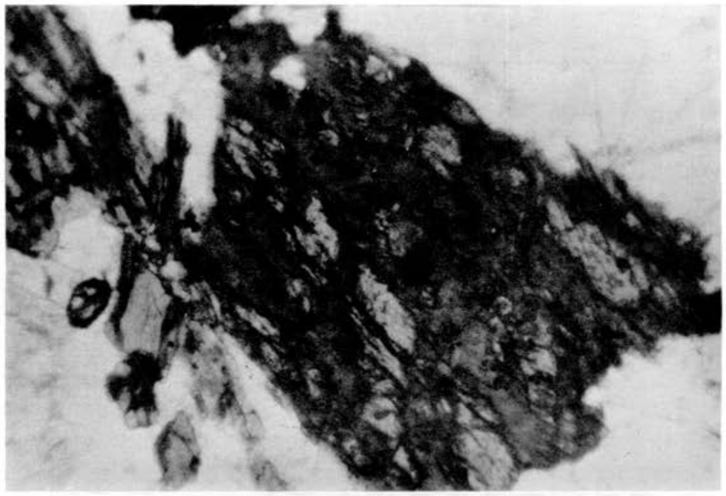

Figure 25-a - Outer green zone. Hornblende partly altered to antigorite. Note remnants of unaltered hornblende. Small black dots are finely crystalline material which may be sphene. Width of field is 2 mm. Plain light.

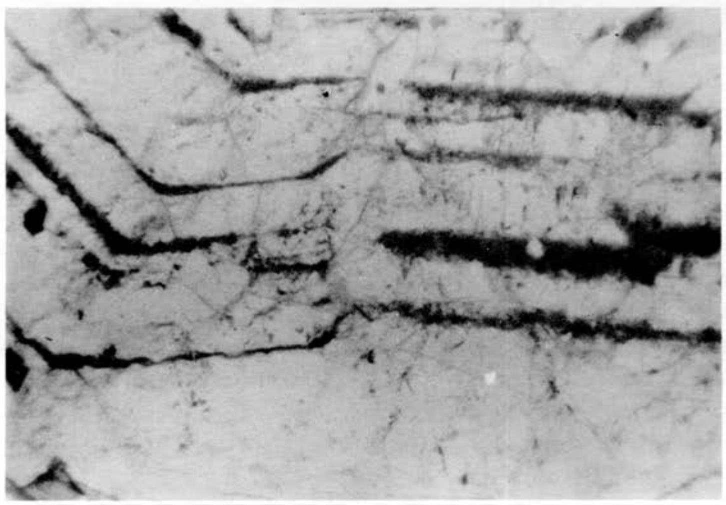

Figure 25-b - Outer green zone. Unknown green, microcrystalline mineral partly replacing plagioclase. Width of field is 2 mm. Plain light.

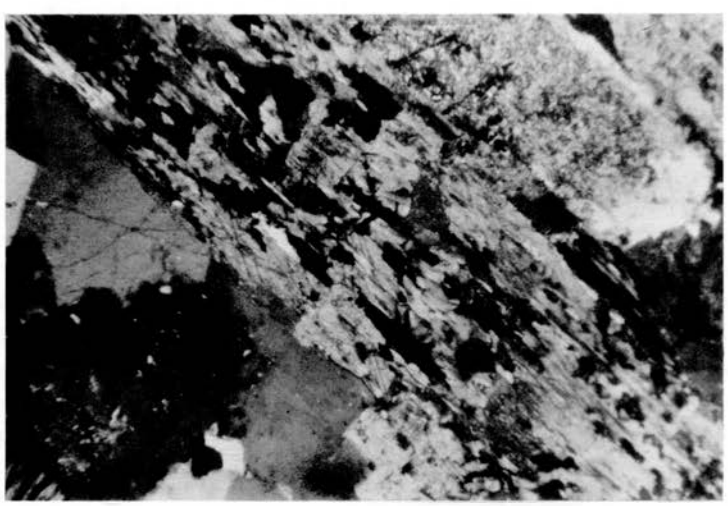

Figure 25-c - Inner green zone. Typical alteration minerals shown in this photograph are an intergrown mass of chlorite, calcite, and pyrite completely replacing an elongate crystal of hornblende. Width of field is 4 mm. Crossed nicols.

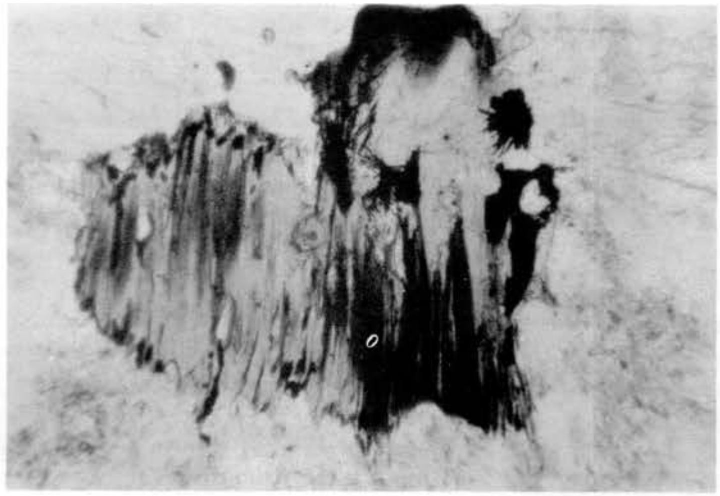

Figure 25-d - Inner green zone. Biotite crystal almost completely replaced by chlorite. Chlorite is light gray; large dark areas are unaltered biotite; and small opaque crystals around edges are pyrite. The radiating needle-like growths are rutile. Width of field is 2 mm. Plain light.

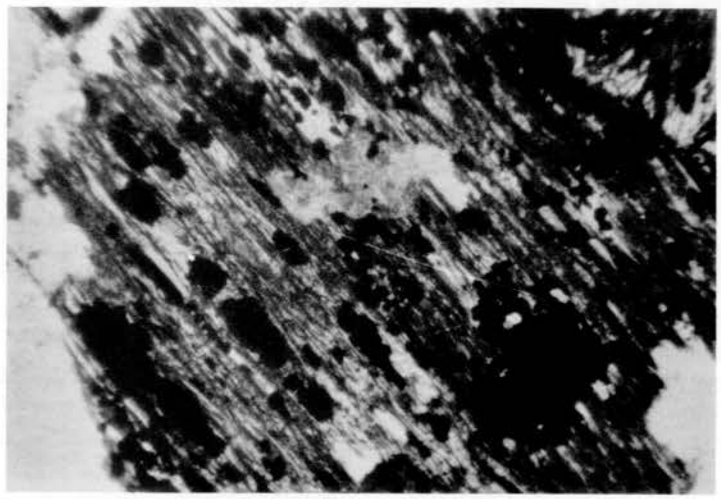

Figure 25-e - Bleached zone. Pyrite, muscovite, and calcite completely replacing biotite. Width of field is 2 mm. Crossed nicols.

Figure 25-f - Bleached zone. Biotite completely altered to calcite, muscovite, and pyrite. Note lenses of calcite parallel to original biotite cleavage. Width of field is 2 mm. Crossed nicols.

hornblende, and plagioclase feldspar. In an intermediate zone (inner green zone), hornblende and biotite are increasingly replaced and some of the plagioclase is altered to sericite. In a bleached zone adjacent to the veins, the granodiorite is bleached white and quartz is the only unaltered mineral. Alteration minerals present in this zone are sericite, muscovite, calcite, and pyrite.

Table 10.
Alteration of Granodiorite at Buffalo Mine

MINERAL	ALTERATION PRODUCTS		
FRESH TONALITE	OUTER GREEN ZONE	INNER GREEN ZONE	BLEACHED ZONE
Hornblende	Antigorite Chlorite (var. jenkinsite) Sphene? * Chrysotile? * Carbonate *	Chlorite (var. repidolite) Chlorite (var. diabanite) Calcite Pyrite Rutile * Quartz *	Muscovite Calcite Pyrite Rutile *
Biotite	Biotite	Chlorite (var. repidolite) Chlorite (var. diabantite) Calcite Pyrite Rutile Quartz *	Muscovite Calcite Pyrite Rutile
Plagioclase	Montmorillonite? *	Sericite Calcite	

*Indicates mineral is present in minor amounts.

The alteration of the granodiorite at the Buffalo mine is similar to that described elsewhere, for example, in a quartz monzonite at Butte, Montana (Sales and Meyer, 1948), in a granodiorite porphyry at Santa Rita, New Mexico (Kerr and others, 1950), and in a quartz monzonite at Castle Dome, Arizona (Peterson and others, 1946).

Outer green zone: In the outer green zone only the hornblende and plagioclase have been altered. In progressing from fresh rock toward a vein, the first noticeable change is an alteration of hornblende to antigorite. The antigorite is green in plain light and greenish yellow in polarized light. It is biaxial negative with a 2V of about 30°, an Nz between 1.572 and 1.574, and an Ny between 1.568 and 1.570. The antigorite forms coarse aggregates, anhedral crystals in a few places, or rarely fills cracks in the minerals surrounding the altered hornblende crystals. In the beginning stages of alteration the antigorite occurs as thin seams penetrating the hornblende crystals along cleavages and cracks. Near the inner margin of the green zone the antigorite has grown outward from the cracks and cleavages until only isolated remnants of unaltered hornblende remain (Figure 25-a, following page 39).

A green chlorite occurs with the antigorite. It is distinguished from the antigorite only by its lower 2V and its higher refractive indices. This chlorite is biaxial negative with a 2V of about 5° and an Ny between 1.600 and 1.602. According to Winchell's classification, this mineral is jenkinsite, a silicon and magnesium-rich chlorite which is very similar in composition to antigorite.

Several minor minerals are also associated with the antigorite. Some of the antigorite contains a small amount of carbonate. There are also some long, pale-green fibers which may be chrysotile. Another mineral occurs as tiny aggregates scattered uniformly throughout the antigorite (Figure 25-a, following page 39). This mineral has a high relief and is probably sphene, but no positive identification could be made because the crystals are too small for the determination of optical properties.

In some of the large biotite crystals which occur near altered hornblende, there is an increase in the amount of diabantite, the deuteric chlorite previously described. This chlorite is more abundant in the granodiorite of the outer green zone than in any of the samples collected for study of deuteric alteration.

The plagioclase in this zone has been partly altered to a pale-green mineral with a microcrystalline aggregate structure. No optical properties could be determined nor could the mineral be separated for analysis. It commonly occurs as thin bands and irregular patches along certain composition zones within the plagioclase (Figure 25-b, following page 39). This mineral gives the plagioclase a greenish color in hand specimens. It is similar in appearance and occurrence to the montmorillonite described by Sales and Meyer (1948) at Butte.

Inner green zone: In progressing toward a vein from the outer green zone, the inner green zone is distinguished by hornblende and biotite increasingly replaced by chlorite, calcite, pyrite, rutile, and quartz. In addition some of the plagioclase is partly altered to sericite.

In the transitional area between the inner and outer green zones the chlorite, calcite, pyrite, rutile, and quartz in some places, where replacing hornblende, surround cores of the antigorite type of alteration which is prominent in the outer green zone. This feature indicates that there has been some growth of the inner green zone at the expense of the outer green zone.

The hornblende crystals in the inner green zone have been completely replaced by an intergrown mass of chlorite, calcite, pyrite, rutile, and quartz (Figure 25-c, following page 39). Repidolite is the most common mineral replacing the hornblende. This chlorite is pale green to colorless in plain light and is dark gray under crossed nicols. It usually forms radiating aggregates. The mineral is biaxial positive with a 2V of about 5°, and an Ny between 1.612 and 1.614. According to Winchell (1951) it has a composition intermediate in iron-magnesium and silicon-aluminum content.

Diabantite, which is a chlorite similar in composition to repidolite, also replaces hornblende in this zone. It occurs as complete replacements of hornblende or as intimate intergrowths with the repidolite. These forms evidently indicate that at least part of the diabantite in this zone was produced along with the repidolite as a result of hydrothermal rather than deuteric alteration.

Calcite, pyrite, rutile, and quartz are other alteration products of the hornblende. The calcite forms irregular aggregates which occupy as much as 40 percent of the volume of the original hornblende crystals. The amount of calcite increases toward the veins. Pyrite commonly occurs as small rounded or elongated crystals within the chlorite and calcite. The amount of pyrite increases toward the veins and in some instances replaces more than half of the original hornblende masses produced by the coalescence of many smaller crystals. Quartz and rutile are minor alteration products of the hornblende. The quartz occurs as small rounded aggregates, and the rutile as a few scattered needles.

In the part of the inner green zone most distant from the veins most of the biotite is fresh, but toward a vein it has been altered to the same minerals which replace the hornblende. That the crystal structure of the biotite had a strong influence on the alteration is indicated by the way the alteration proceeded and by the form of the alteration minerals. At first chlorite penetrated the biotite crystals along cleavage planes. Growth of the chlorite proceeded parallel to the cleavage until entire crystals were replaced (Figure 25-d, following page 39). Most of this chlorite is repidolite; however, some diabantite replaces entire biotite crystals or is intergrown with the repidolite. The repidolite which replaces biotite has a prismatic form rather than the radiating, fibrous form developed where it replaces hornblende. Calcite forms crystals elongated parallel to the biotite cleavage. Larger crystals of pyrite are elongated parallel to the biotite cleavage. Rutile forms radiating or intergrown needles within the chlorite. In some places the rutile and pyrite replaced biotite crystals so completely that these areas appear almost opaque when viewed under low magnification.

The plagioclase alteration changes from the green microcrystalline mineral to sericite near that part of this zone where the biotite exhibits its first stages of alteration. The sericite is biaxial negative with a 2V of about 30°, and Nx between 1.554 and 1.556, and an Ny between 1.588 and 1.590. In the beginning stages of development the sericite is in small isolated flakes replacing the plagioclase along cracks and composition zones within the plagioclase crystals. As the alteration becomes more intense the sericite forms masses of intergrown flakes that in this zone never replace more than 20 percent of any feldspar crystal. Differential thermal analyses indicate that no hydrous clay minerals are mixed with the sericite.

Bleached zone: The bleached zone lies between the inner green zone and a vein. In this zone all of the original minerals of the granodiorite except quartz have been altered to various combinations of muscovite, sericite, calcite, pyrite, and rutile. Only the quartz is unaltered.

In progressing from the inner green zone to the bleached zone the first noticeable changes are an increase in the amount of sericite replacing plagioclase and the appearance of a colorless, highly birefringent mica intermixed with the chlorite-calcite-pyrite alteration of the hornblende and biotite. In the bleached zone the colorless mica takes the place of chlorite which is entirely absent.

The mica is apparently muscovite; however, it has an optic axial angle which is much smaller than that characteristic of most muscovite. The mineral is optically negative and is nearly uniaxial. Ny and Nz are between 1.588 and 1.590, and Nx is between 1.550 and 1.552. Spectrographic analyses indicate that this mica is essentially a potassium-rich aluminum silicate with all other elements each present in amounts of less than 5 percent, therefore corresponding to the composition of muscovite. Muscovite with a small optic axial angle has previously been described (Axelrod and Grimaldi, 1949).

The hornblende crystals in this zone have been altered to irregular groups of muscovite, calcite, and pyrite. A small amount of rutile is sometimes present. The original outlines of the hornblende crystals are completely destroyed.

Biotite is altered to the same minerals as the hornblende, but these minerals tend to have an elongate form where replacing the biotite (Figures 25-e and 25-f, following page 39). The muscovite commonly occurs as single crystals completely preserving the outlines of the original biotite crystals. The calcite and pyrite are present within the muscovite as elongate crystals or as bands of smaller rounded crystals parallel to the original biotite cleavage. Rutile is abundant as masses of intergrown needles within the muscovite.

The feldspar crystals are completely altered to aggregates of small sericite flakes. Irregular calcite grains commonly occur within the sericite. Near the veins some disseminated crystals of euhedral pyrite are present in the altered feldspars. This pyrite does not replace any mafic minerals.

Both pyrite and calcite increase in quantity toward the veins, and in a few places almost the entire space occupied by the former biotite or hornblende crystal is filled with pyrite or calcite. These two minerals are distributed unevenly, for in some of the bleached rock either one is absent even though it may be abundant in the rock a few feet away.

Near the main sulfide veins the amount of quartz in the granodiorite increases. Many tiny veinlets of quartz cut the bleached granodiorite and are so abundant in some places that the rock consists essentially of a series of interconnecting veinlets separated by a small amount of altered granodiorite. Some of these quartz veinlets also contain small rounded crystals of pyrite. There are also some small veinlets of calcite. Some larger lens-shaped bodies of quartz occur in the bleached granodiorite where the bleached zones are widest. The largest of these are several feet long and as much as 2 inches wide. Excess silica is produced by the alteration of feldspar to sericite and it is quite possible that some quartz in the lenses and veinlets was derived from the altered feldspars.

Where the faults cut through the bleached granodiorite there is commonly a pure white gouge zone adjacent to the faults. The gouge consists of finely ground quartz and sericite which are moist and have been compacted into a claylike material. Differential thermal analyses show that no clay minerals are present in the gouge.

Relationships of the alteration zones: Besides surrounding the veins, the alteration zones in the granodiorite surround small fractures and barren faults that are parallel to the veins. The alteration adjacent to the barren fractures is like that near the veins and no difference has been seen on the two levels of the mine. The total width of alteration varies from about 25 feet near some veins and faults to less than a foot alongside small fractures. The alteration zones are narrower near veins which are frozen to the wall rock than near those which are separated from the wall rock by fault surfaces.

The outer green zone is the widest of the three alteration zones and is as much as 20 feet across. In some places the outer green zones from adjacent veins have merged so that no unaltered granodiorite remains between the veins. The inner green zone is much narrower with its greatest width not more than 3 feet. In some places it is represented only by a few biotite and hornblende crystals with chlorite-calcite-pyrite alteration. Bleached zones as much as 10 feet wide occur in the granodiorite in places where there are several closely spaced veins or faults. Beside any single vein bleached zones are not more than 3 feet wide, and they are absent entirely near small fractures which have alteration zones only a few inches wide.

Because the different alteration zones have a definite spatial relationship and grade into one another, one may reasonably assume that they are the result of continually varying physiochemical conditions in the wall rock.

Chemical gains and losses in the altered granodiorite: A quantitative measurement of chemical gains and losses in altered wall rock can be determined only by a series of complete rock analyses which were not feasible. But an estimate of the gains and losses can be made by considering the mineralogical changes in the wall rock. The following is a list of gains and losses determined by the mineralogy in the alteration zones of the granodiorite:

	OUTER GREEN ZONE	INNER GREEN ZONE	BLEACHED ZONE
Gains	None apparent	Sulfur Carbonate.	Sulfur Carbonate Potassium
Losses	None apparent	Sodium Magnesium	Sodium Magnesium

In the outer green zone where hornblende and plagioclase are the only altered minerals, the alteration minerals possibly represent only a rearrangement of the elements present in the fresh granodiorite. The iron, magnesium, silicon, aluminum, calcium, and titanium present in the original hornblende can be accounted for in the antigorite-chlorite-sphene alteration which replaces the hornblende. If the green mineral replacing plagioclase is montmorillonite, then any sodium and potassium from the hornblende could have crystallized with the clay mineral along with sodium, calcium, silicon, and aluminum from the plagioclase.

In the inner green zone sulfur and carbonate have been introduced into the rock, and some sodium and magnesium have probably been removed. The hornblende in this zone has been altered to chlorite, pyrite, calcite, and rutile. Part of the iron from the hornblende has combined with sulfur to form pyrite. The calcium from the hornblende has combined with carbonate to form calcite. The titanium has crystallized into rutile. Sodium and potassium present in the hornblende may possibly be in the green mineral partly replacing the plagioclase. The potassium may also have gone into the sericite which partly replaces the plagioclase.

The repidolite which replaces the hornblende apparently formed from iron, magnesium, silicon, and aluminum derived from the hornblende. The change from replacement by antigorite and jenkinsite in the outer green zone to replacement by repidolite in the inner green zone represents an increase in the iron/magnesium ratio. Because magnesium has been almost completely leached from the adjacent bleached zone, the increase in this ratio is probably a result of removal of some magnesium rather than an addition of iron.

Biotite has also altered to chlorite, calcite, pyrite, and rutile in this zone. The chlorite evidently contains some of the iron, magnesium, aluminum, and silicon present in the biotite. Some of this iron has combined with sulfur to form pyrite. The calcite within the altered biotite crystals apparently represents a migration of calcium from surrounding altered plagioclase or hornblende and a combination with introduced carbonate. The titanium has crystallized into rutile. The potassium from the biotite can be accounted for in the sericite which replaces some of the plagioclase.

The only elements besides oxygen present in the plagioclase which are also present in the sericite replacing it are silicon and aluminum. The potassium present in the sericite may have been derived from hornblende and biotite. The calcium liberated during the alteration of plagioclase to sericite can be accounted for in the calcite occurring in the altered biotite and feldspars. The sodium in the original plagioclase has apparently been removed from the altered rock.

In the bleached zone sulfur, carbonate, and potassium have been introduced and sodium and magnesium have been completely leached. There, the hornblende and biotite are altered to muscovite, calcite, pyrite, and rutile. The iron, calcium, silicon, aluminum, potassium, and titanium present in the fresh homblende can be accounted for in these minerals. The sodium and magnesium have been removed. Sulfur and carbonate have been introduced and have combined with iron and calcium respectively to form pyrite and calcite. The biotite in the bleached zone has also altered to muscovite, pyrite, calcite, and rutile. All the elements present in the biotite except the magnesium can be accounted for in these minerals. The magnesium has been leached. Calcium may have migrated from the surrounding altered hornblende and plagioclase. Sulfur and carbonate have been introduced.

In the bleached zone the plagioclase has been completely altered to sericite and calcite. Potassium and carbonate have been introduced. Aluminum may also have been introduced since there is more aluminum in sericite than in plagioclase per unit volume; however, since part of the original feldspar crystals are replaced by calcite, such an introduction can be determined only by chemical analyses. The sodium of the plagioclase has been leached. The pyrite disseminated through some of the altered feldspars must represent a migration of iron and an introduction of sulfur.

The minerals present in the altered granodiorite show that the solutions producing the alteration carried sulfur, carbonate, and potassium and that they leached sodium and magnesium. Possibly, however, part of the potassium which has been introduced into the bleached zones has migrated into these zones from large volumes of green zone alteration. This potassium would have been derived entirely from biotite and hornblende. Nonetheless, some potassium has been supplied by the altering solutions because in some places where there are many closely spaced veins or fractures, wide bleached zones are surrounded by narrow green zones. Possibly the potassium in the solutions was originally derived from large volumes of green zone alteration at depth; although, if these solutions were related to late magmatic activity, they probably carried potassium from their source.

<u>Argillite</u>

The argillite within several feet of the veins and in the shear zones is lighter gray than the rest because its fine-grained biotite has been altered to sericite. Pyrite and sericite form tiny elongate crystals within the biotite. Pyrite also occurs as anhedral to euhedral crystals disseminated abundantly throughout the altered argillite. The quartz grains in the argillite occurring in the shear zones exhibit extreme granulation. Some chlorite replaces the biotite but there are no well-defined chlorite zones.

Where the argillite has been most intensely altered it has a silky luster. This luster is produced by the large amount of sericite in the rock. The sericite in this highly altered rock replaces quartz as well as biotite. It commonly forms along the boundaries between adjacent quartz grains, and tiny sericite flakes actually penetrate the quartz crystals. Some veinlets of calcite also occur in the highly altered argillite. The argillite exhibiting this intense alteration is very restricted in occurrence, and indeed many of the argillite fragments contained within the veins themselves are unaltered.

Potassium, aluminum, carbonate, and sulfur were introduced into the altered argillite while the magnesium from the biotite was leached. The gains and losses are very similar to those in the altered granodiorite.

Acknowledgments

The writer thanks Professors I. S. Allison and D. O. Cochran of Oregon State College for advice on the original manuscript and the U. S. Bureau of Mines, Albany, Oregon, for spectrographic and certain other mineralogical analyses.

References

Axelrod, J. M., and Grimaldi, F. S., 1949, Muscovite with a small optic axial angle: Am. Mineralogist, v. 34, p. 559-572.

Gilluly, James, 1937, Geology and mineral resources of the Baker quadrangle, Oregon: U.S. Geol. Survey Bull. 879.

Grove, J. J., 1940, The New York mine, Granite, Oregon: Washington Univ. (Seattle) Bachelor's Thesis (Mining Engineering), 56 p., illus.

Hewett, D. F., 1931, Zonal relations of the lodes of the Sumpter quadrangle: Am. Inst. Mining Metall. Petroleum Engineers Trans., Gen. Vol., p. 305-346.

Kerr, P. F., Kulp, J. L., Patterson, C. M., and Wright, R. J., 1950, Hydrothermal Alteration at Santa Rita, New Mexico: Geol. Soc. America Bull., v. 61, p. 275-348.

Lindgren, Waldemar, 1901, The gold belt of the Blue Mountains of Oregon: U. S. Geol. Survey 22nd Ann. Rept., pt. 2, p. 551-776.

__________, 1933, Ore deposits: New York, McGraw Hill.

Oregon Department of Geology and Mineral Industries, 1941, Oregon Metal Mines Handbook, Grant, Morrow, and Umatilla counties: Oregon Dept. Geology and Min. Industries Bull. 14-B, 157 p., illus.

Pardee, J. T., 1908, Faulting and vein structure in the Cracker Creek gold district, Baker County, Oregon: U.S. Geol. Survey Bull. 380, p. 85-93.

__________, 1910, Placer gravels of the Sumpter and Granite districts, eastern Oregon: U.S. Geol. Survey Bull. 430, p. 59-65.

__________, 1941, Preliminary geologic map of the Sumpter quadrangle, Oregon: Oregon Dept. Geology and Min. Industries map with text.

__________, and Hewett, D. F., 1914, Geology and mineral resources of the Sumpter quadrangle, Oregon: Oregon Bur. Mines and Geology, Min. Res. of Oregon, v. 1, no. 6, p. 1-161.

Peterson, N. P., Gilbert, C. M., and Quick, G. L., 1946, Hydrothermal alteration at The Castle Dome copper deposit: Econ. Geology, v. 41, p. 820-840.

Pilcher, S. H., 1958, Rock alteration and vein mineralization at the Buffalo mine, Grant County, Oregon: Oregon State Coll. Master's Thesis, 83 p., illus.

Sales, R. H., and Meyer, C., 1948, Wall rock alteration at Butte, Montana: Am. Inst. Mining Metall. Petroleum Engineers Trans., v. 178, p. 9-33.

Scott, L. M., 1917, The pioneer stimulus of gold: Oregon Hist. Soc. Quart., v. 18, p. 147-166.

Swartley, A. M., 1914, Ore deposits of northeastern Oregon: Oregon Bur. Mines, Min. Res. of Oregon, v. 1, no. 8, 229 p.

Taubeneck, W. H., 1955a, Age of the Bald Mountain batholith, northeastern Oregon: Northwest Sci., v. 29, p. 93-96.

_______________, 1955b, Age of the Elkhorn Ridge argillite, northeastern Oregon: Northwest Sci., v. 29, p. 97-100.

_______________, 1957, Geology of the Elkhorn Mountains, northeastern Oregon: Bald Mountain batholith: Geol. Soc. America Bull., v. 68, p. 181-238.

Trimble, W. J., 1914, The mining advance into the inland empire: Wisconsin Univ. Bull., History ser., v. 3, no. 3, p. 137-392.

Winchell, A. N., 1951, Elements of optical mineralogy, v. II, Descriptions of minerals: New York, John Wiley, 551 p.

* * *

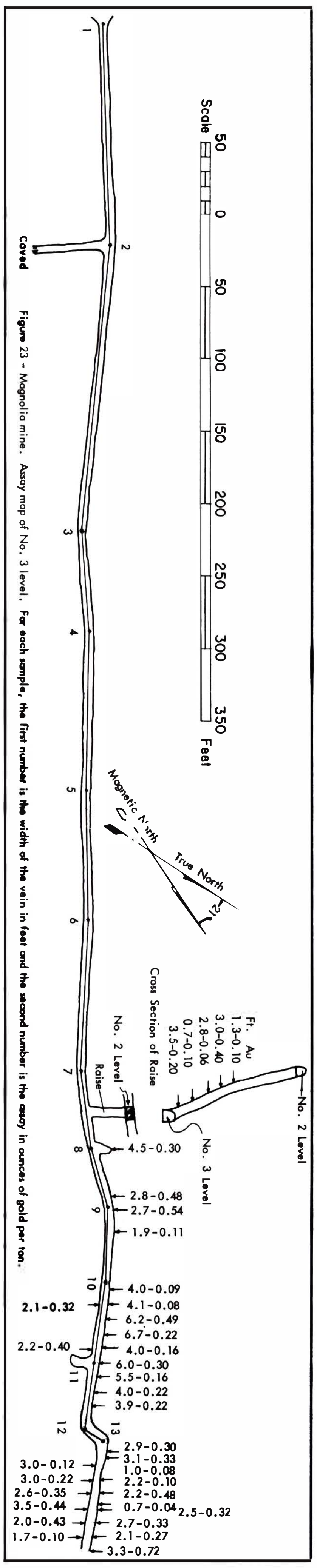

Figure 23 - Magnolia mine. Assay map of No. 3 level. For each sample, the first number is the width of the vein in feet and the second number is the assay in ounces of gold per ton.

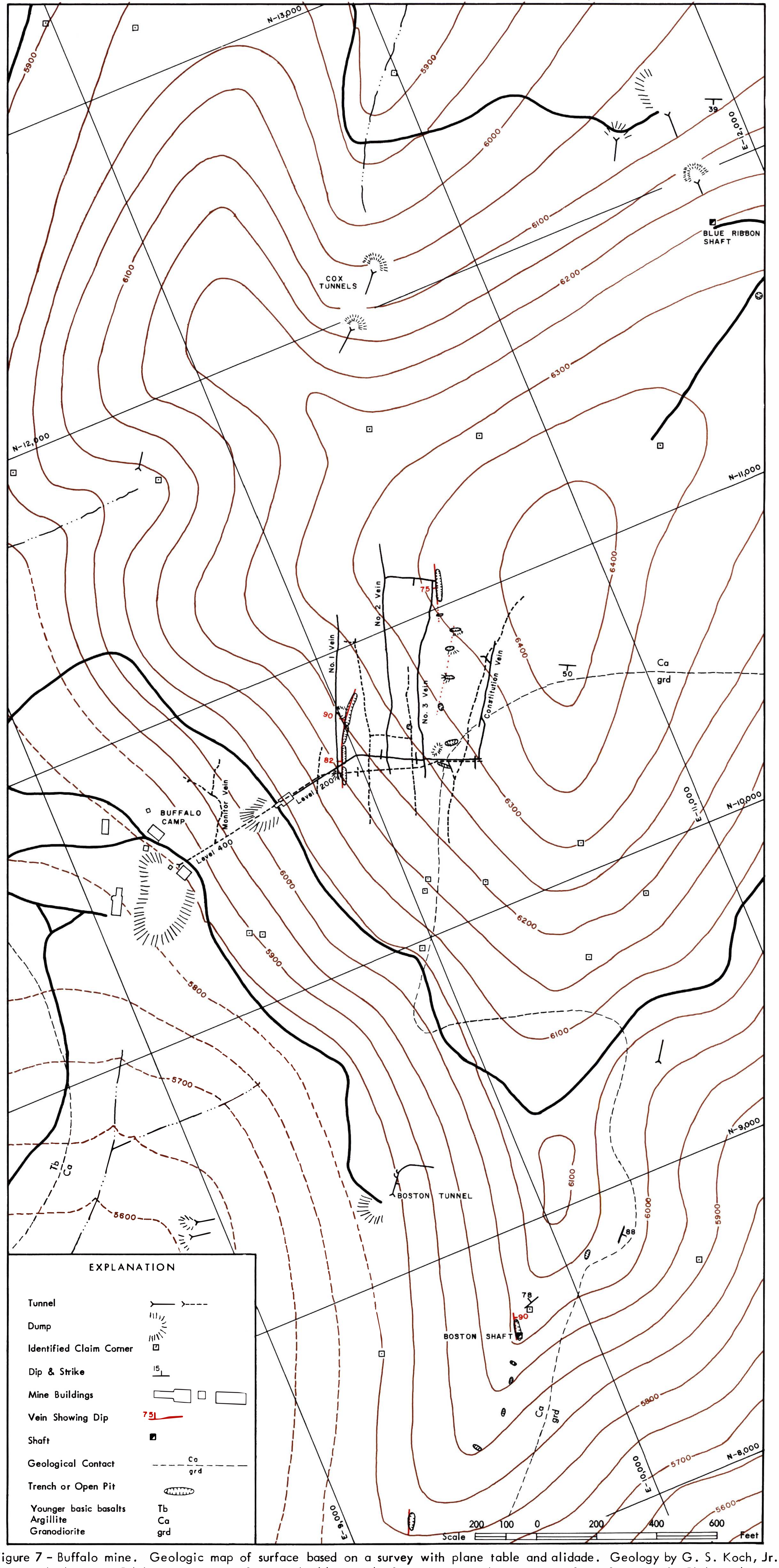

Figure 7 - Buffalo mine. Geologic map of surface based on a survey with plane table and alidade. Geology by G. S. Koch, Jr. Topography by S. H. Pilcher. Locations of certain buildings and information in southwest corner of map from maps by Philo Anderson.

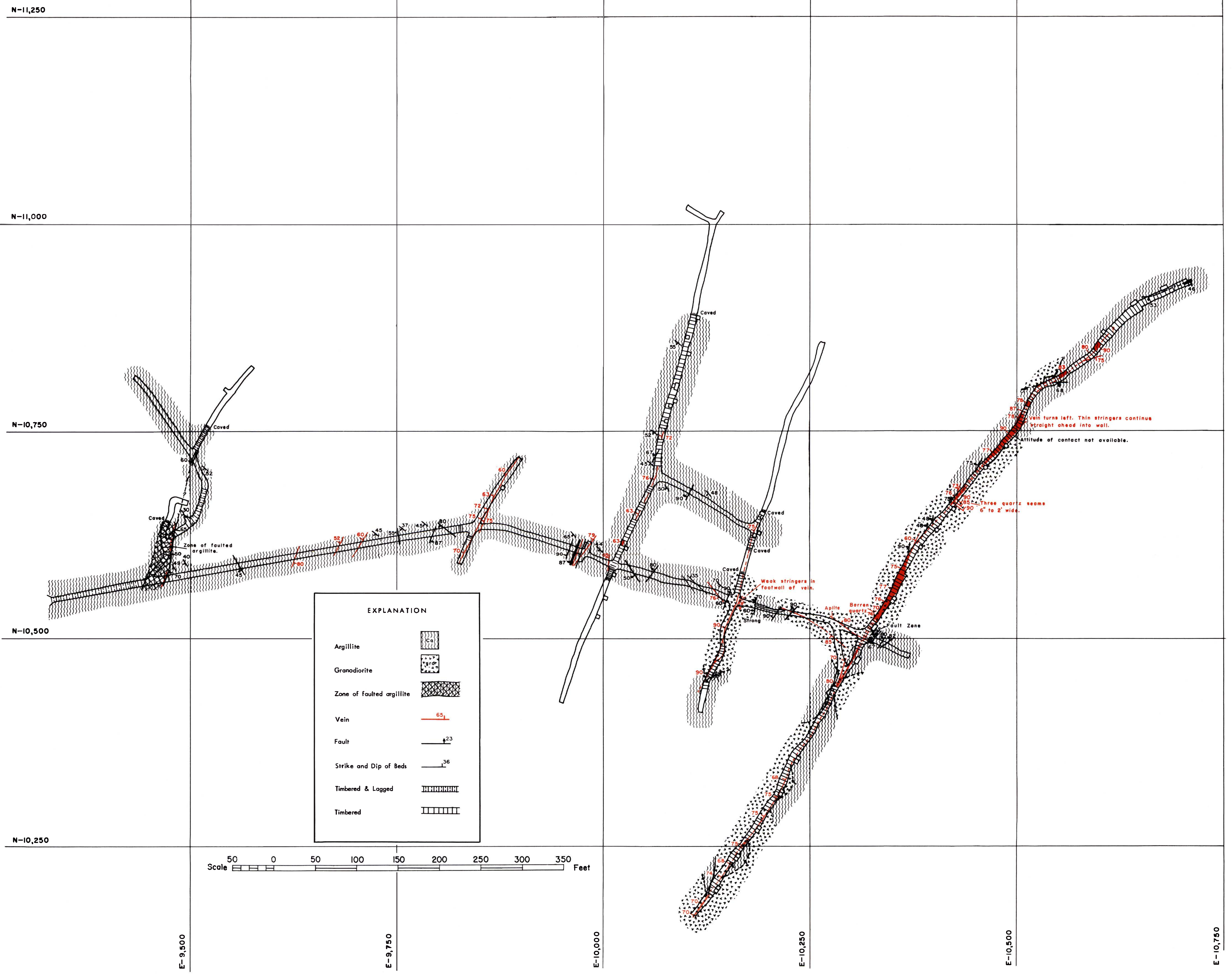

Figure 11 - Buffalo mine. Geologic map of 400 level. Geology by G.S.Koch, Jr., and S.H.Pilcher. Outline of workings from maps by Philo Anderson with additions.

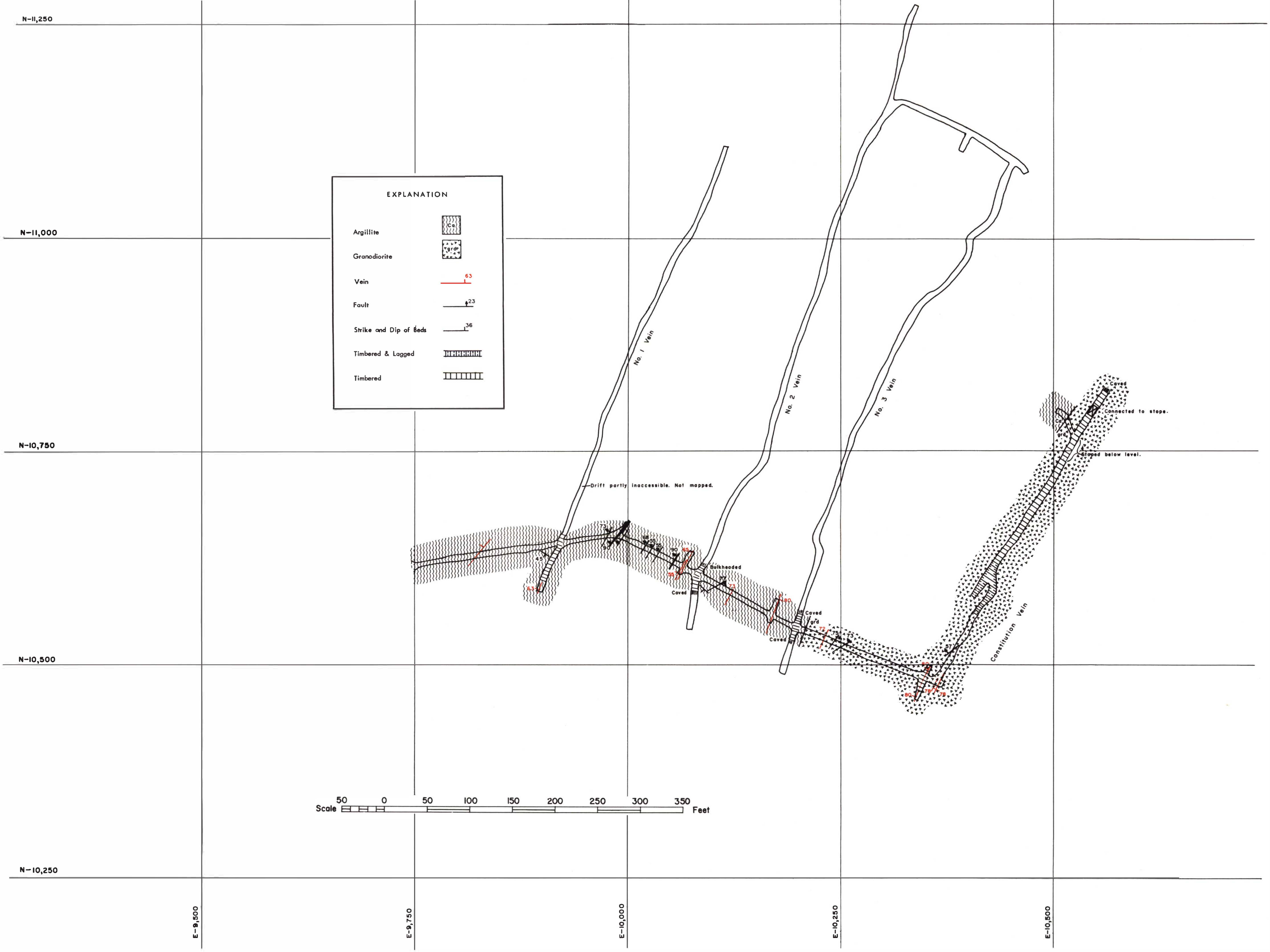

Figure 10 - Buffalo mine. Geologic map of 200 level. Geology by G.S.Koch, Jr., and S.H.Pilcher. Outline of workings from maps by Philo Anderson with additions.