1978 PROGRESS REPORT ON THE WALKER MINE PROJECT

Steve Kilbreath
and
Art Leger

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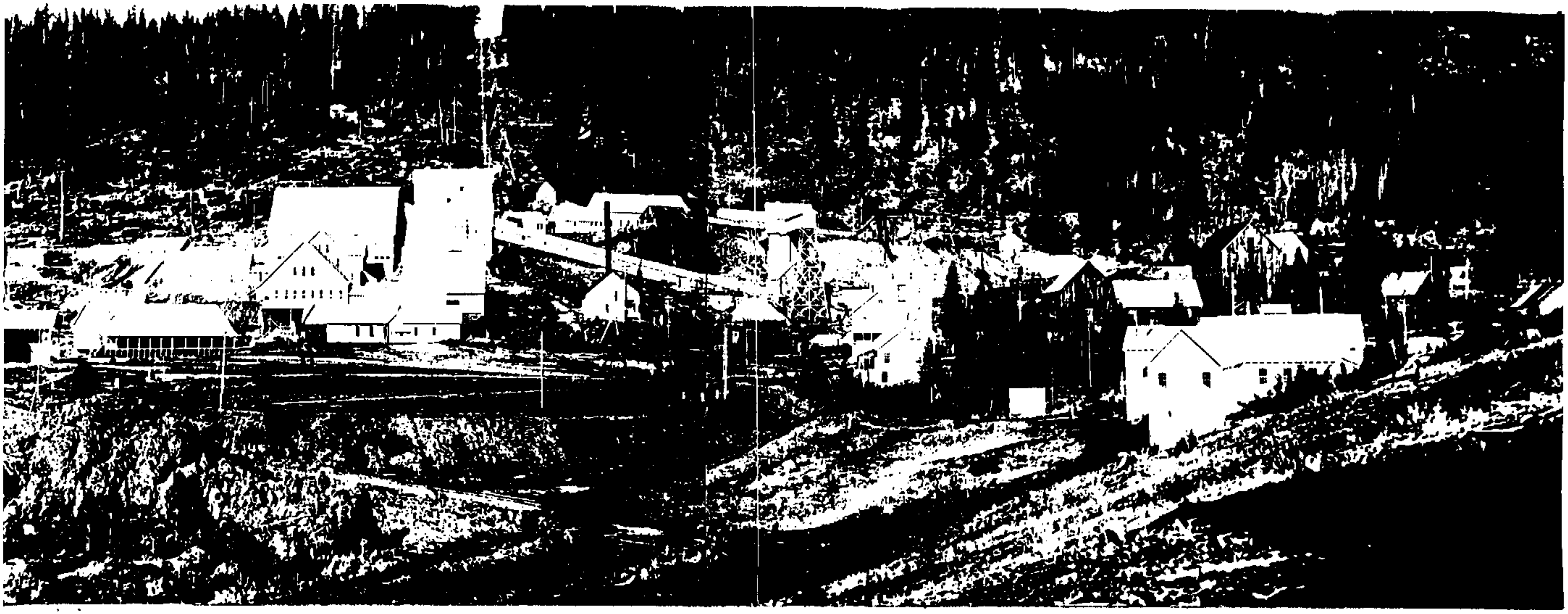

Front piece - Walker Mine Town and Mill, Circa 1928

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SUMMARY

The Walker Mine property in Plumas County, northeastern California, is a steeply dipping, tabular copper-silver-gold deposit localized within an exhalite unit and associated with a sequence of submarine felsic to intermediate pyroclastic rocks. The Walker Mine occupies the southern end of a N-NW striking zone of copper-gold-silver mineralization called the Plumas County Copper Belt.

The Walker Mine was the largest copper producer in Plumas County, yielding about 163 million pounds of copper from approximately five million tons of ore between 1916 and 1941. The Walker Mine ore zone consists of six orebodies aligned along 8000 feet of strike length and separated from each other by 100 to 1000 feet of apparently subeconomic mineralization. From south to north, the orebodies are South, Central, North, 712, Piute, and North Piute. About five million tons of potential mineralization remains in the Walker Mine between levels, in the partially mined North Piute orebody, and in the 712 Footwall orebody.

Norandex conducted exploration on the property from 1969 to 1971 and did extensive geochemical and geophysical surveys as well as drilling 11 diamond drill holes.

Amax acquired an option on the property in 1976. During the summers of 1976 and 1977, they conducted regional geologic reconnaissance, detailed mapping in the Walker-Lena-Con Gold areas, claim surveying, stream drainage and water quality sampling, whole rock geochemistry, and diamond drilling.

Conoco optioned the property by Letter Agreement from Amax on April 1, 1978, and at that time, option payments were re-negotiated with

the owner, Mr. Robert Barry. The Amax terms require Conoco to spend $170,000 by January 31, 1980 to acquire a 51% interest in the property. Conoco has exceeded the $170,000 earning requirement, however, Amax is not required to reimburse Conoco for Amax's share (49%) of the expenditures beyond the earning requirement until 1980.

Active field work done by Conoco in the summer of 1978 consisted of detailed mapping in the Walker Mine Area, a soil geochemical survey, claim surveying, and stream drainage and water quality sampling. In addition to the above work, all of the Amax and Noranda drill holes were re-logged and the assay data for these holes was obtained and evaluated.

The geologic mapping established a stratigraphic sequence of volcanic and chemical sedimentary or deposits as follows:

(1) Footwall-andesitic lithic tuff with minor included felsic pyroclastic zones, and dacitic porphyry dikes and sills.

(2) Exhalite (ore) zones - two major exhalite horizons consisting of chert, chert-magnetite breccia with barite and dispersed sulphides.

(3) Hangingwall - intermediate to felsic agglomerate containing subangular to subround fragments of felsic volcanic material and barite in a fine-to-medium grained siliceous matrix; andesite tuff similar to footwall rocks; felsic lithic tuff; and intrusive dacite porphyry.

The massive form of portions of the ore, the close association of the mineralization with the exhalite zones, and the proximity to felsic and intermediate volcanic rocks suggests a volcanogenic origin for the Walker Mine copper-silver-gold mineralization.

Geochemical surveys conducted by Conoco over the Walker Miner area included:

(1) water quality monitoring to assist in evaluating potential environmental problems attributable to toxic acid mine discharge and

(2) a soil survey on a 200 foot x 200 foot grid, the results of which indicated two prominent copper anomalies coinciding with the two mapped exhalite zones.

Surveying of claims was done in the summer of 1978 to re-establish corners as required by California law.

RECOMMENDATIONS FOR 1979

In the Walker Mine area, the chances of discovering viable copper-silver-gold ± lead-zinc mineralization appears excellent in the following areas:

(1) along a northern extension of the Walker Mine horizon beneath post mineral volcanic cover;

(2) along the recently mapped footwall exhalative zones;

(3) downdip extensions from known orebodies;

(4) in the Northern Walker Area, two miles north of the Piute decline.

It is recommended that ground magnetics and induced polarization be run over the Northern Walker Area to trace the exhalative horizon. Induced polarization should be run over the footwall exhalative horizon by the 712 and Piute Orebodies to test for sulphide content and continuity. A mise-a-la-masse survey should be run over the North Piute area to test for continuity of the exhalative in this area.

The soil samples collected in 1978 should be re-run for Au, Tl and a full emission spectrographic analysis conducted to see if there are any geochemical trends developing that might lead to ore under the young volcanic cover. In addition to the surface geochemistry, the underground workings should be mapped and samples collected to determine if metal zoning exists.

When targets are developed, core drilling of approximately 4000 feet is recommended. This drilling should be divided between three separate targets, the Northern Walker Area, the back exhalative horizon by the 712-Piute Orebodies, and the back exhalative horizon by the Central-North Orebodies. Two to three holes of 400 to 500 foot depth should be drilled in each target area.

INTRODUCTION

LOCATION

The Walker Mine property is approximately 80 miles by road northwest of Reno, Nevada, in east-central Plumas County, California (Figure 1). Access to the property is by a forest service road that leaves State Highway 70 at Portola and heads northwest towards recreation areas at Lake Davis, then onward to the mine and beyond. The 25-mile distance from Portola to the mine is about half paved. The other half, which is dirt and gravel, is impassable by wheeled vehicles during the winter months.

Elevations range from 5,500 to 7,200 feet above sea level. Topography is moderate. Mt. Ingalls, a prominent topographic feature, is two miles east of the Walker Mine.

PROPERTY STATUS

The Walker Mine property consists of 34 patented lode claims, 358 unpatented federal lode claims, several patented mill sites, and a townsite. Total acreage is approximately 7,966 acres. The property was optioned by Letter Agreement from Amax April 1, 1978, and at which time, option payments, etc., were re-negotiated with the owners, Calicopia Corporation and R. R. Barry (see land reports).

ENVIRONMENTAL STUDIES

The Walker Mine property and tailings deposit have an unfortunate history as a significant contributor of pollution to Grizzly Creek. Toxic waters from the mine and tailings are documented by state and federal agencies as being a serious environmental problem.

In May 1978, Dawn Kaback, an environmental geochemist from Conoco's

INDEX MAP - WALKER MINE

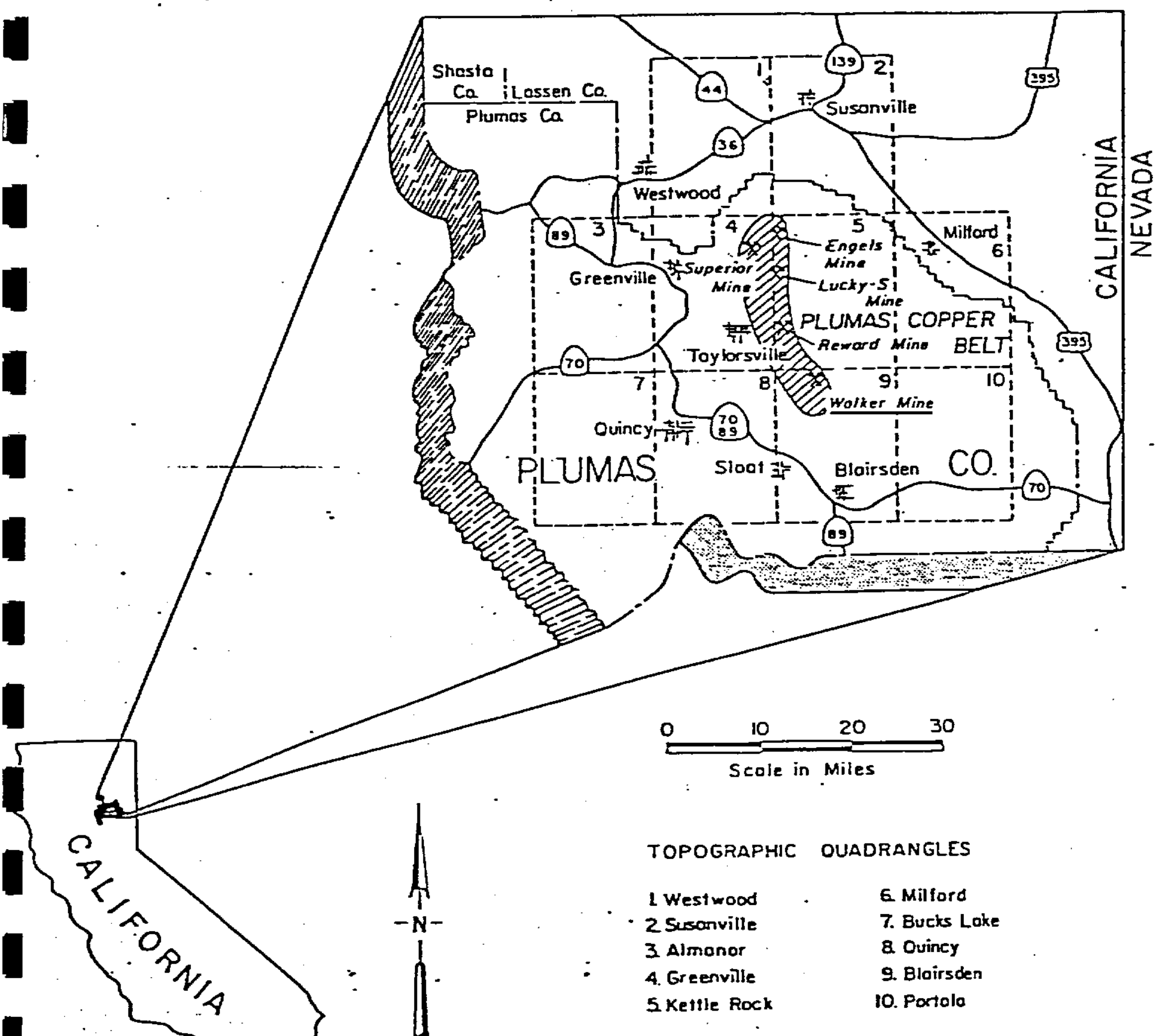


Figure 1. Index map of the Plumas Copper Belt

Ponca City office, visited the Walker Mine property to review and expand the water quality monitoring program. Her comments are recorded in a memo titled "Walker Mine Environmental Monitoring" dated June 7, 1978.

PRIOR WORK

The Walker Mine was one of the largest copper producers in Plumas County, yielding 163 million pounds of copper. The mine was operated almost continuously from 1916 to 1941 by the International Smelting Company, a subsidiary of the Anaconda Mining Company. During this time, the mine produced a total of 5,045,800 tons of ore averaging 1.55% Cu, 0.80 oz. Ag and 0.04 oz. Au (Reith, 1972).

Norandex conducted an exploration program on the property from 1969 to 1971 consisting of geologic mapping, geochemical and geophysical surveys as well as drilling 11 diamond drill holes.

Amax Exploration Inc. acquired the property in 1976 and conducted exploration activities during the summers of 1976 and 1977. Their work consisted of regional geologic reconnaissance, detailed geologic mapping, claim surveying, stream drainage and water quality sampling, whole rock geochemistry and diamond drilling (Hursh, 1977).

CONOCO EXPLORATION PROGRAM - 1978

INTRODUCTION

The Conoco exploration program at the Walker Mine started in late 1977 and continued to the present time. In December 1977, Ron Long and Ray Threlkeld visited the area and recommended acquiring the property.

Active field work began in June 1978 and consisted of re-establishing

Norandex's survey grid, surveying control lines between Norandex's lines, and soil sampling at 200 foot intervals along the grid lines (Figure 2). Approximately 900 soil samples were collected and analyzed for Cu, Pb, and Zn. Geologic mapping began in August and was concentrated on the Main Walker Area (Plate 1). The mapping was at a scale of 1" = 200' and consisted of detailed observations of the mineralized zone and surrounding area. In order to ascertain rock type, alteration, mineralization, and degree of metamorphism, 275 samples were collected for thin section examination. In addition, both Norandex and Amax drill holes were re-logged and samples taken for petrographic investigation. No regional mapping was completed during the 1978 program.

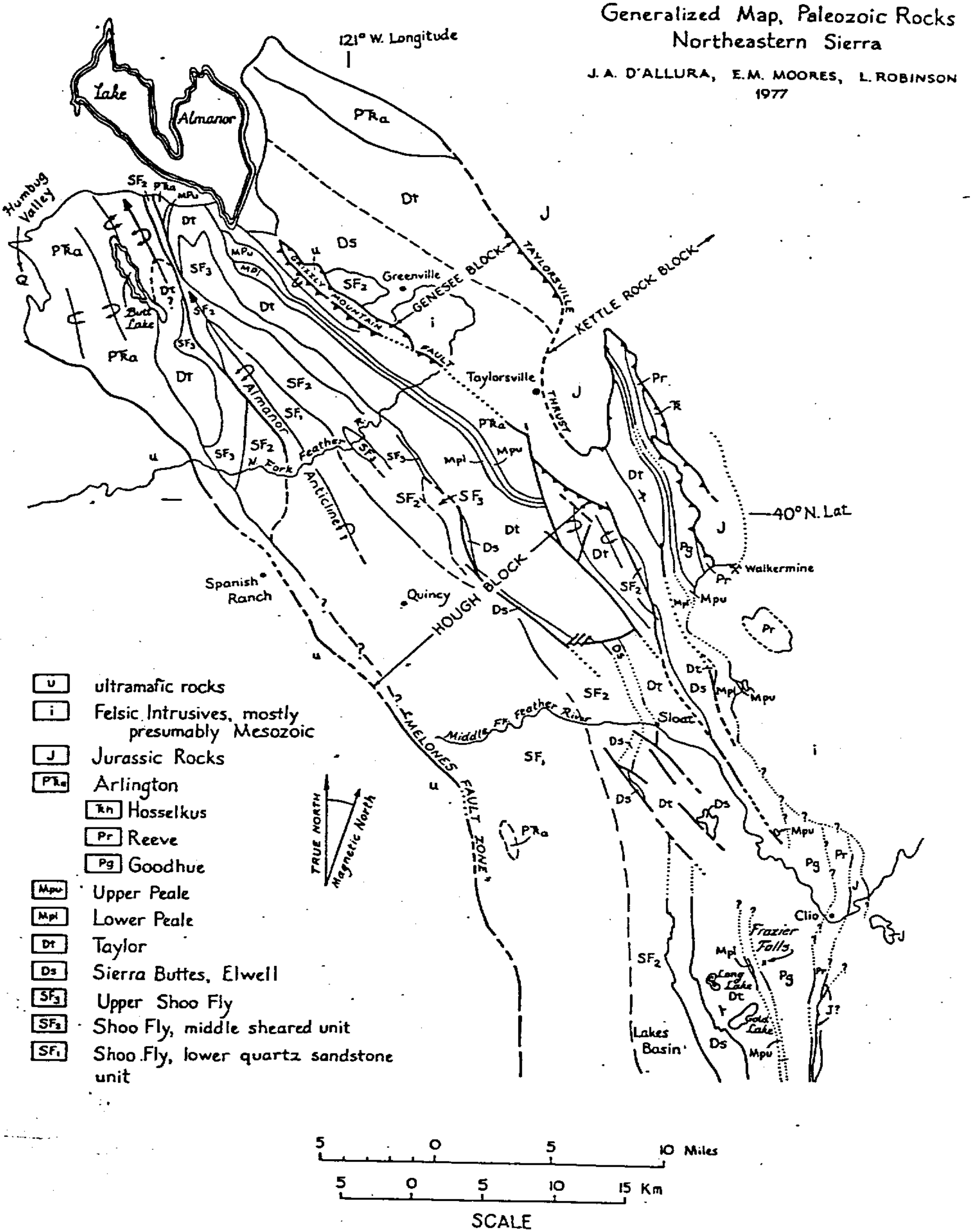
REGIONAL GEOLOGIC SETTING

The Walker Mine is located on the eastern margin of a complex series of northwest striking marine volcanic and sedimentary rocks that range from pre-late Devonian to Jurassic in age (Figure 2). Two Paleozoic and one Mesozoic volcanic assemblages are present in this sequence (D'Allura and others, 1977). The oldest of the volcanic assemblages is represented by the Upper Shoo Fly (SF), Sierra Buttes and Elwell (Ds), Taylor (Dt) and Lower Peale (Mpe) Formations (see Figure 2). This older volcanic assemblage was deposited on the Lower (SF) and Middle (SF 2) Shoo Fly basement rocks. Separating the old Paleozoic volcanic assemblage from the young Paleozoic assemblage is a period of volcanic quiescence represented by cherts and epiclastic sediments of the Upper Peale (Mpu) Formation. The young Paleozoic volcanic assemblage is represented by the Goodhue (Pg) and Reeve (Pr) Formations. Overlying these volcanic rocks are sediments and limestones of the Arlington Formation (Pra). The Arlington is overlain by a series of Jurassic

Figure 2

Generalized Map, Paleozoic Rocks
Northeastern Sierra

J. A. D'ALLURA, E.M. MOORES, L. ROBINSON
1977



volcanic and sedimentary rocks. The Jurassic rocks are represented by the submarine andesites of the Kettle Formation and the epiclastic sediments of the Trail Formation. It is believed that the Walker Mine is contained within the andesites of the Kettle Formation. This northwest striking band of Jurassic rocks is the host for the Plumas Copper Belt.

The Paleozoic-Mesozoic rocks of the northern Sierra Nevada can be divided into three distinct structural blocks (see Figure 2), the Hough Block, Genesee Block, and the Kettle Rock Block (McMath, 1966, D'Allura and others, 1977). All three of the structural blocks are bounded by northwest striking faults. The Hough Block is thrust over the Genesee Block on the Grizzly Mountain Fault and the Genesee Block is in turn thrust over the Kettle Rock Block on the Taylorsville Thrust. The Walker Mine is in the Jurassic rocks in the Kettle Rock Block which forms the lower plate of the Taylorsville Thrust.

PROJECT GEOLOGY

The Walker Mine is a volcanogenic sulphide system that occurs in a thick sequence of intermediate to felsic submarine volcanic rocks that are thought to be a part of the Jurassic Kettle Formation. The structural footwall of the ore zone is a thick accumulation of andesitic to dacitic crystal lithic tuffs. Scattered through these tuffs are irregular zones and lenses of coarse fragmental tuff of the same composition. Locally within these intermediate tuffs thin zones of more felsic tuff occurs. East of the above tuffs are two sub-parallel exhalative horizons that are separated by 100-300 feet of altered, intermediate pyroclastics. The exhalatives consist of 6 to 150 foot-thick zones of chert and chert magnetite breccia. The easternmost of these exhalatives is the main Walker Mine Ore Zone. Immediately east of the exhalative is a zone of felsic breccia that is thought to be a vent breccia. East of the vent breccia is another zone of intermediate pyroclastics similar to those in the footwall. Within these rocks is a zone of felsic tuffs that are similar to those in the footwall. Intruding all of the above rocks is dacite porphyry which occurs as a large sill-like mass east of the above rocks and as small dikes and sills throughout both the hanging and footwall volcanic sequence. Intruding all of the Jurassic rocks described above is a large body of Sierran granodiorite. Unconformably overlying all of the rocks in the Walker Mine area are intercalated flows of laharic breccia and basalt to dacite flows.

Within the main Walker Mine area the only stratigraphic marker is the exhalite horizons. It is assumed that the rocks are right side up and the stratigraphic top of the section is to the east. In the following sections the rocks will be discussed from footwall to hanging wall, which should be from oldest to the youngest.

Footwall Sequence

The footwall sequence of rocks consists of three dominant types, intermediate pyroclastics, sericitic pyroclastics and dacite porphyry intrusive. The intermediate pyroclastic rocks are the most abundant rock type and contain scattered lenses of the sericitic pyroclastics in addition to dikes and sills of dacite porphyry.

The intermediate pyroclastics (ip, Plate1) are a series of sub-aqueous lithic tuffs with scattered zones of tuff breccia all of which are andesitic to dacite in composition. These lithic tuffs are light gray to dark gray in color (weather reddish brown), contain a well developed foliation, and are moderately to strongly magnetic. Locally the abundance (up to 70%) and size (up to 20 cm) of the fragments increase to the point where fragments are more abundant than matrix and the rock grades into tuff breccia. Close examination indicates the foliation consists of aligned elongate mafic clots set in a very fine grained matrix of quartz and sericite. Randomly scattered through the matrix are small (4 mm) grains of pink garnet and radiating clusters (1 - 2 mm) of andalusite.

In thin section, these rocks are seen to consist of aligned phenocrysts of plagioclase and hornblende that range from 0.5 to 5 mm in size. The phenocrysts range in shape from euhedral to angular broken portions of originally euhedral crystals. The total number of phenocrysts ranges from 5 to 60 percent of the rock with roughly equal proportions of plagioclase and hornblende, although locally one or the other may be dominant. These phenocrysts are no longer primary hornblende and plagioclase, they are the metamorphic equivalent of the alteration products of these minerals. The plagioclase is pseudomorphed by two assemblages, one consists entirely of sericite and the other is an equal mixture of sericite and quartz. The hornblende phenocrysts are pseudomorphed predominantly by a biotite + magnetite assemblage but assemblages of biotite, biotite + magnetite + cordierite, biotite + quartz, magnetite + quartz, magnetite + quartz + sericite, magnetite + sericite, garnet + magnetite + biotite, and garnet + sericite + magnetite + biotite exist. These various pseudomorphing assemblages are thought to represent variations in alteration prior to metamorphism but this is not very well understood at this time. The lithic fragments, when present, consist of an intergrown mass of biotite and magnetite with minor amounts of schorl. The schorl occurs in the fragments or in the matrix as a halo around the fragments. The matrix of the intermediate pyroclastics consists dominantly of quartz, sericite and biotite with lesser amounts of magnetite, garnet, andalusite, schorl, cordierite and green spinel (gahnite/hercynite). The quartz grains intersect at triple points, this is indicative of thermal recrystallization. Sericite and biotite occur randomly through the matrix interstitial to the quartz and seem to show an antithetic relationship to each other. Small disseminated grains of magnetite are scattered throughout the rocks.

The sericitic pyroclastics (sp, Plate 1) occur as pods and lenses contained within the intermediate pyroclastics discussed above. There are two main areas where these rocks crop out, Transverse Ridge and West Ridge (see Plate 1). The sericitic pyroclastics are buff to light gray in color, (weather reddish brown) and are generally fine grained with abundant relict feldspar phenocrysts. Scattered through the rocks are a minor amount (≤5%) of hornblende phenocrysts. In general these rocks are well foliated with all the phenocrysts aligned. In thin section sericite (60 - 70%) and quartz (20 - 30%) are dominant minerals with magnetite, biotite, chlorite, schorl, garnet and andalusite comprising the remainder of the rocks. About 30 - 40% of the rock is made up of broken to euhedral plagioclase crystals 1 - 3 mm in length that are pseudomorphed by massive sericite. About 1 - 5% of the rock is made up of hornblende crystals that are pseudomorphed by sericite and magnetite with minor biotite and chlorite. Occasionally a recrystallized quartz phenocryst may be present. The matrix is very fine grained (.03 - .1 mm) and consists predominantly of recrystallized quartz and sericite in equal proportions. Scattered through the matrix are grains of magnetite and schorl and porphyroblastic garnet and andalusite.

In general, the sericitic pyroclastics contain a better developed foliation and are more sericitic than the intermediate pyroclastics. This is probably due to the fact that the sericitic pyroclastics are somewhat more felsic than the intermediate pyroclastics and are probably dacitic to rhyodacitic in composition.

Exhalative Horizons

Surface mapping indicates two exhalative zones west of the North and Central shafts and south of the Piute decline (Figure 1). Rocks in these zones are expressed by 10 to 200 foot wide zones of chert and chert magnetite breccia with barite and dispersed sulphides. The strike of the two units varies from N 20° - 30° W to N 20° E. The dip, as indicated from drill holes and surface exposures, is about 70° E in the south, flattening to 35° - 40° E in the north. The easternmost horizon is the main Walker Mine ore zone and indications from both drill and underground intersections are that it is continuous but pinches down in two dimensions to very narrow widths. The back interval, or footwall zone, just recognized, appears thin (10 - 30 feet) but is anomalous in copper and gold. The two exhalative horizons are separated by highly altered intermediate pyroclastic rocks that will be discussed in the alteration section of this report.

Within the main Walker Mine ore zone a crude zonation of the exhalative may be present, as seen in the Piute Orebody (the only Orebody examined underground to date). Along the footwall of the exhalative is a thin zone (2 - 15 feet) of chert-magnetite breccia. This zone is marked by angular fragments of chert that are cemented by magnetite and minor pyrite, pyrrhotite and chalcopyrite. Overlying the chert-magnetite breccia is a massive zone of chert that ranges in thickness from 10 to 200 feet. Interpersed through the chert are pods and bands of magnetite, barite, pyrite, pyrrhotite and chalcopyrite.

Locally the sulphide minerals may form thin (1 - 2 foot-thick) pods of massive sulphide ore in a banded chert-magnetite host. Occasionally the massive chert becomes fragmental with chert fragments cemented by barite. Within the exhalative, magnetite is the most abundant mineral (5 - 30%) present, and barite (5 - 10%) exceeds pyrite which exceeds pyrrhotite which exceeds chalcopyrite. Other sulphide minerals reported to be present are tetrahedrite and cubanite (Hursh, 1977). Within 30 - 50 feet of the surface, the exhalative exhibits supergene enrichment with chalcocite as veins and coatings on pyrite and chalcopyrite grains. Barite may also zone across the exhalative horizon, it appears to be more abundant (10 - 15%) in the exhalative next to the hangingwall contact in the large glory hole at Line 4/S x 300 E.

Hangingwall Sequence

The hangingwall sequence of rocks consists predominantly of intermediate pyroclastics similar to those in the footwall with interbedded zones of felsic fragmental, arkosic wacke and sericitic pyroclastics (see Plate 1).

Immediately east of the exhalative horizon along lines 10, 12, 14 and 16, south and from 100 to 300 W is a lense of arkosic wacke (S, Plate 1). The arkosic wacke obtains a maximum thickness of 30 - 40 feet and laterally pinches out over a distance of about 500 feet. The arkosic wacke is a crudely layered rock with thin alternating biotite rich bands that are distinct from sericite rich bands. Abundant angular quartz grains and plagioclase grains that are pseudomorphed by sericite are present throughout. Small lithic fragments and scattered amphibole clasts comprise the remainder of the coarse fraction of the rock. The coarse material is set in a fine grained matrix of dominantly quartz and sericite with lessor amounts of magnetite, garnet, chlorite, apatite and tourmaline. Porphyroblastic andalusite is abundant throughout these rocks and locally comprises as much as 25 percent of the rock.

Occurring west of the baseline (21/S - 29/S x 300W) on the crest of Transverse Ridge is a zone of felsic fragmental (ff, Plate 1). This fragmental unit attains a maximum thickness of about 150 feet along line 26/S and pinches out 500 feet north and 300 feet south of this point. Within this thickest portion, the average fragment size is 10 cm with fragments to 30 cm. Both north and south, the average fragment size decreases to 5 cm with fragments to 15 cm. The fragments are a fine grained, foliated, sericite rich volcanic that is thought to be rhyolitic in composition. Barite as veins and clasts occurs throughout the fragmental unit. The felsic fragmental unit is believed to represent a period of explosive rhyolitic volcanism which accompanied mineralization.

East of the above, a large lense-like mass of sericitic pyroclastics (sp, Plate 1) crops out. These sericitic pyroclastics are identical to those described in the footwall section and are probably dacitic to rhyodacitic in composition. This lense-like mass reaches a maximum thickness of 300 feet along line 22/S.

The arkosic wacke, felsic fragmental and sericitic pyroclastics are interbedded in intermediate pyroclastics identical to those in the footwall. These rocks contain abundant plagioclase and hornblende crystals and lithic fragments and probably represent renewed andesitic volcanism from the same source as that of the footwall rocks.

Intrusive Rocks

Intruding both the hangingwall and footwall sequences are a series of dikes and sills of dacite porphyry (dp, Plate 1). The main intrusive mass is a large sill-like body occurring east of the baseline between lines 10/S and 52/S that is roughly parallel to the foliation of the volcanics that it intrudes. This sill has a few dikes that project away from the main mass into the volcanics. Scattered through the footwall rocks along West Ridge are a series of small dikes of dacite porphyry. In the field the dacite porphyry is medium to dark gray in color, contains abundant millimeter sized phenocrysts of white albite and clots and fracture coatings of epidote. About 40% of the rock consists of albitized plagioclase phenocrysts and glomeroporphyritic clusters of albite phenocrysts up to 5 mm across. An additional 20% consists of microlitic fine grained albite in the matrix. Primary phenocrystic hornblende or pyroxene constitutes 5 to 10% of the rock and is pseudomorphed by epidote, chlorite, biotite and actinolite. The feldspar and mafic phenocrysts are set in a very fine grained matrix of actinolite, biotite and magnetite. The dacite porphyry has undergone the same degree of thermal metamorphism as the pyroclastic rocks it intrudes and is believed to be part of the same period of volcanism that formed these pyroclastic rocks.

Intruding all of the above rocks is a large body of augite-hornblende-biotite quartz diorite that is part of the Sierran Batholithic Complex. The intrusive rocks occur south of the main Walker Mine area (Plate 1) where they intrude the South Orebody and are covered by Tertiary volcanic rocks. It is believed that the batholithic rocks are the causitive agent for the strong thermal metamorphism in the Walker area.

Tertiary Volcanic Rocks

The pre-Tertiary volcanic rocks that host the Walker Mine Mineralization are exposed in a semicircular window in Tertiary volcanic rocks (Tv, Plate 1). The Tertiary volcanics were not differentiated during field mapping but two separate units were noted. The first of these is a sequence of andesitic laharic breccia with intercalated flows of basalt, andesite and dacite. This unit forms the majority of the volcanic cover in the Walker area. The second unit is an olivine basalt flow with well developed columnar jointing that crops out on the south side of Dollie Creek by the old Walker Townsite. McMath (1952) believes that these two units are the Bonta Formation of Miocene age and the Warner Basalt of Piocene age respectively.

Structure of the Main Walker Area

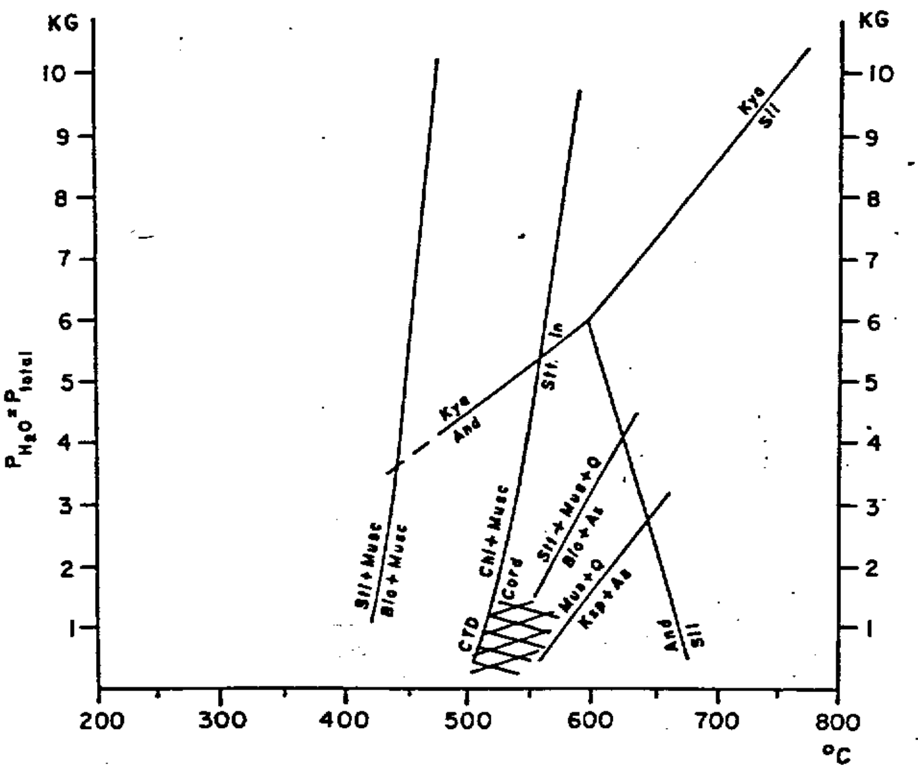
The structure present in the Main Walker Mine Area consists of foliation in the pyroclastic rocks, shearing, and minor faulting. The foliation consistantly strikes from N 20° W to N 40° W and dips from 60° to 80° E. The foliation consists of aligned and stretched phenocrysts and mafic fragments in the pyroclastics. Two small faults are present by the Central Orebody. The first of these is a N 50° E striking structure that offsets the main exhalative 100 feet in an apparent left lateral sense. The second fault is a N 20° W striking structure that may down drop the Tertiary volcanic rocks against the pre-Tertiary volcanics. A third fault, N 60° W, may be present between the 712 and Piute Orebodies. This fault would account for the linear stream drainage in the area and also the change of dip between the 712 (65° E) and the Piute (35 - 45° E) Orebodies. Along Transverse Ridge and by the North Orebody (Plate 2) is an abundance of small shear zones with a bleached sericitic halo around them. These shear zones can be grouped into two main groupings, N 20° - 40° W with a steep NE dip and N 20° - 40° E with steep NW or SE dips. These shears are thought to represent fractures that fluids moved through at the time of ore deposition.

Metamorphism

The Jurassic rocks in the Walker Mine area (Plate 1) have all undergone a medium grade thermal metamorphism that is probably related to the emplacement of the Sierran Batholith. This metamorphic event is marked by a temperature range of $500^{\circ} - 550^{\circ}$ and a pressure range of 1 - 2 kilobars (Figure 3). These P-T conditions give rise to two different metamorphic assemblages that are controlled by pre-metamorphic lithology.

The pyroclastic rocks (ip, sp, ff, Plate 1) and the arkosic wacke (s, Plate 1) give rise to a typical pelitic metamorphic assemblage. These rocks belong to the cordierite - almandine zone of the lower amphibolite facies (Figure 4). This is shown by the presence of a cordierite, almandine, andalusite, biotite and muscovite assemblage. These minerals generally occur as a blastoporphyritic assemblage that mimicks the relict pre-metamorphic volcanic textures. In general, the metamorphic minerals pseudomorph the relict volcanic minerals, feldspar and hornblende. Garnet, cordierite and andalusite are the only porphyoblastic minerals present. The andalusite is of particular interest because it shows "bow tie" radiating clusters indicative of low confining pressures during crystallization. Whenever quartz is present, it is always recrystallized into polygonal mosaics that intersect at triple points.

The dacite porphyry dikes show a similar metamorphic grade but a totally different metamorphic assemblage. These rocks belong to the albite/oligoclase-hornblende-biotite zone of the Amphibolite Facies (Figure 5). The dacite porphyry consists predominantly of albite, hornblende, clinozoisite and biotite with lesser amounts of sphene, quartz, sericite, magnetite and



Sti— Stilphomelane
Musc— Muscovite/Sericite
Bio— Biotite
Kya— Kyanite
And— Andalusite
Stt— Staurolite
CTD—Chloritoid
Chl— Chlorite
Cord— Cordierite
Q— Quartz
As— Alumnosilicate
Ksp— K feldspar
Sil— Sillimanite

Figure 3 Metamorphic reactions in pelitic rocks. Cross hatched area shows approximate P-T relationships of the metamorphism present at Walker Mine. After Winkler, 1976.

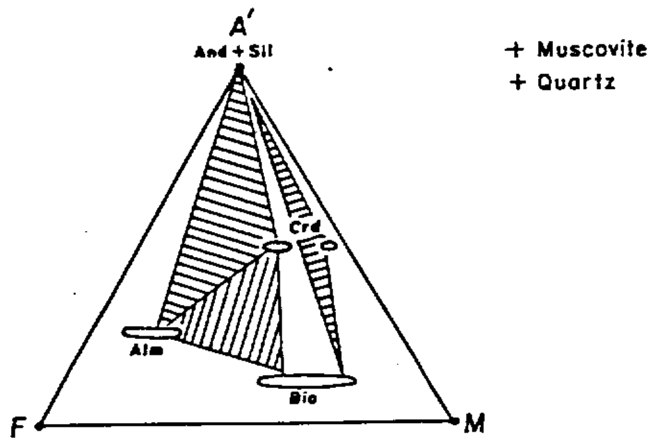


Figure 4 Mineral associations in the Cordierite — Almandine zone of the Medium Amphibolite Facies. After Winkler, 1976.

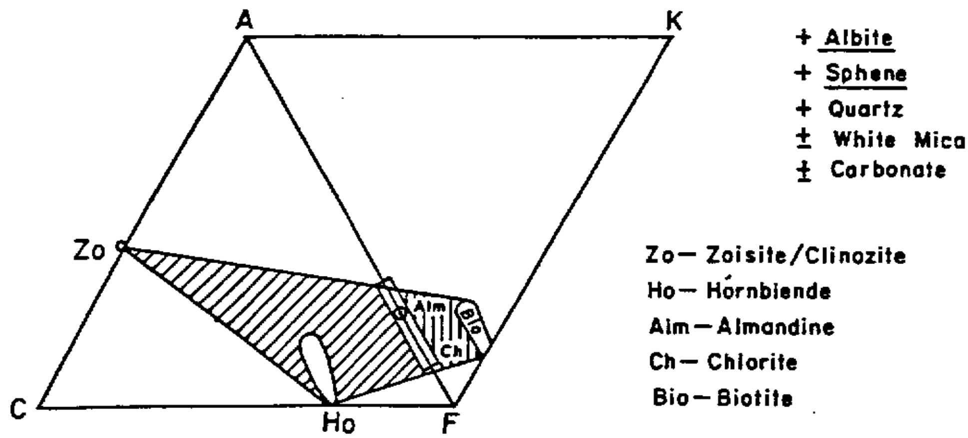


Figure 5. The albite/oligoclase-hornblende-biotite zone of the low grade, high temperature part of the Amphibolite Facies. After Winkler, 1976.

and carbonate. Blastoporphyritic textures where the original volcanic textures are mimicked by the metamorphic, minerals are abundant throughout. The plagioclase has been converted to albite, clinozoisite and carbonate and the amphibole/pyroxene phenocrysts are metamorphosed to hornblende, biotite, clinozoisite, sphene and magnetite. The matrix of these rocks is a fine grained mixture of hornblende, biotite, clinozoisite, quartz, magnetite and sericite.

Alteration

The host rocks for the Walker Mine mineralization show a well developed zonation of metamorphic minerals that directly reflects the original alteration mineralogy. The zonation was determined by examination of 275 thin sections and plotting and contouring of the percentage of constituent minerals present. Thin sections from the dacite porphyry were not used in the alteration zonation study because they are believed to postdate mineralization. The original alteration mineralogy was masked by the amphibolite grade metamorphism, but it can be determined by working backward through the metamorphic reactions.

Magnetite is ubiquitous throughout the hangingwall, footwall and exhalative horizons in the Walker area. Several areas (Plate 3) where the magnetite content exceeds 10 percent are present and appear to be related to alteration. These areas are along West Ridge, Transverse Ridge, by the Central Orebody and by the 712 Orebody. The magnetite is thought to represent an area of Fe metasomatism.

Biotite (Plate 4) has roughly the same general zonation pattern as magnetite. The biotite follows the exhalative horizons very well and is concentrated in both hangingwall and footwall as well as between the horizons. Biotite occurs along West Ridge in increased quantity and as a zone trending roughly N 60° - 80° W that starts at the Central Orebody and heads for the western end of Transverse Ridge. The biotite probably formed by the addition of K^+ to chlorite through K^+ metasomatism.

Cordierite (Plate 5) follows biotite and magnetite and occurs along West and Transverse Ridges in addition to the Central and North Orebody areas. Due to x-ray diffraction and whole rock chemistry in the Transverse Ridge area, it is thought that the cordierite is an iron rich variety. In order to form cordierite, iron and aluminum in the presence of excess quartz is needed. The formation of cordierite can be expressed by the following reaction: 4 Quartz + 1 Kaolinite + 1 Chlorite → 2 Cordierite.

Garnet (Plate 6) closely mimicks magnetite, biotite and cordierite in its zonal pattern. It is believed that the garnet is almandine in composition and therefore, needs excess iron and aluminum to form. A distinct N 30° - 40° E striking zone of garnet occurs along the northeast portion of West Ridge and closely follows similar zones of cordierite, biotite and magnetite. Garnet forms a broad (700 - 1100 feet) zone that occurs in both hangingwall and footwall rocks along the exhalative horizons from the Central to the Piute Orebodies.

Andalusite (Plate 7) occurs along Transverse Ridge, West Ridge, the exhalative horizons and as a N 70° - 80° W striking zone from the Central Orebody towards Transverse Ridge. Andalusite probably formed from a two step process in which plagioclase was altered to kaolinite, the latter then metamorphosed to andalusite by the following reactions:

4 plagioclase + 24 H_2O → 3 kaolinite + 8 quartz + 12 H_2O + 4 NA^+ + 4 Ca++ and 1 kaolinite → 1 andalusite + 1 quartz

These reactions start with a plagioclase of about An 50 which is that of a typical andesitic volcanic.

Sericite (Plate 8) shows an antithetic relationship to all of the above minerals. The sericite occurs as a halo around Transverse Ridge and the exhalative horizons. Sericite forms from the alteration of plagioclase by the following reaction:

$$2 \text{ plagioclase} + 2K^{+} + 4\, H_2O \rightarrow 1 \text{ sericite} + 4 \text{ quartz} + 2\, Na^{+} + 2Ca^{++} + 2\, H_2O$$

The sericite is stable through the metamorphism with only recrystallization to a coarser grain size.

Quartz (Plate 9) seems to follow sericite to some extent and also shows an antithetic relationship to cordierite, biotite, andalusite, garnet and magnetite. The zones of the highest quartz concentration occur as a halo around Transverse Ridge and to the west of the exhalite horizons. The reason for quartz and sericite going together is explained by the alteration of plagioclase to sericite releasing quartz as shown by the reaction described above.

The Mafic:Felsic Ratio (Plate 10)is a method of summing up the various metamorphic products of the original alteration mineralogy. This was done by taking the total percent mafic minerals and dividing by the total percent felsic minerals and then multiplying by 100 to obtain a whole number. In areas where the Mafic:Felsic ratio is greater than 100, at least 50 percent or more of the rock is mafic components and in areas where it is less than 25, then 20 percent or less of the rock is mafic minerals. The areas along Transverse and West Ridges and along the exhalite horizons and the N 70° - 80° W zone by the Central Orebody contain a marked increase of mafic minerals.

The sericitized shear zones (Plate 2) discussed under the "Structure" section show a close relationship to the altered zones discussed above. There is an abundance of these shears on Transverse and West Ridges and along the exhalite horizon by the North Orebody.

All of the zonal patterns of the metamorphic equivalents of the alteration products can be related to the deposition of the Walker Mine volcanogenic mineralization. A central pipe-like zone along Transverse Ridge represents peripheral alteration above a feeder zone. The metamorphic equivalent of the central "pipe" alteration is magnetite, biotite, cordierite, garnet and andalusite. This assemblage represents the presence of high iron, aluminum and possibly potassium. The andesitic pyroclastics were kaolinized and chloritized prior to metamorphism. The potassium needed to form biotite during metamorphism may have come from the primary hornblende or as a metasomatic product during alteration. This type of alteration also occurs along the exhalative horizons north and south of Transverse Ridge. In the area of West Ridge and west of the Central Orebody, are lenticular areas of alteration identical to those along Transverse Ridge. These areas were probably fault or fracture zones through which mineralizing solutions passed and may have actually been vents for mineralization. The zone by the Central Orebody was probably a feeder for the South and Central Orebodies and the altered zone along West Ridge represents a feeder for the North Piute area. These orebodies are proximal to their feeder source but distal to Transverse Ridge which was probably the main vent area for the pyroclastics. The North and 712 Orebodies were probably formed on the side of this main vent and are proximal orebodies with respect to Transverse Ridge.

Surrounding the Fe-Al-K alteration zones are areas where sericitization was prominant. The sericitized zones have a low mafic content and may actually represent areas where iron and magnesium was leached.

The apparent lack of a classic magnesium chlorite "pipe" can be explained by the lithology of the wall rocks. The fluids that passed upward through the vent were probably enriched in magnesium but found no receptive rocks to alter. The wall rocks were all andesitic-dacitic in composition and relatively high in MgO and were probably in equilibrium with the fluids in respect to MgO, so no Mg alteration developed.

There are no Na or Ca bearing minerals present in any thin sections examined from the Walker Mine property. This suggests that there was strong alkali leaching accompanying the alteration and mineralization.

<u>Soil Geochemistry</u>

Approximately 900 soil samples were collected over a grid on a 200 foot by 200 foot pattern and analyzed for Cu, Pb, and Zn. All soil samples were collected from the "B" horizon and where soil samples could not be taken, rock chip samples were collected.

No anomalous lead was detected in any of the soil samples. A nearly continuous band of high zinc values occurs in a semi-circular band around the main Walker Mine Zone (Plate 12) that correlates with the first outcrops of the overlying Tertiary volcanic rocks. There appears to be a zinc anomaly over the exhalative horizons by the Central and North Orebodies. This anomaly is not continuous through to the 712 and Piute area. There are some scattered anomalies in the West Ridge area that are not well understood at this time. These anomalies may be related to the presence of a zinc bearing spinel or to zinc incorporated into the lattice of magnetite.

Four prominent copper anomalies are present with values ranging from 710 ppm to 0.69%. All four of these anomalies correspond to outcropping exhalative horizons (Plate 13).

Mine Clean-Up

In August, 1978, Mr. Tex Tate of Ponderosa Mining and Development, was hired to re-open and clean-up the Walker Mine. This operation consisted of re-timbering the adit and mucking through a caved-in area. After many delays, the main haulage level was finally opened in late November. At this time, Mr. Tate took his equipment and left for the winter.

Mr. Jan Donato, a Portola contractor, has been doing general mine clean-up since fall of 1978. This work consisted of construction of a settling pond, building a storage shed over the portal, reconditioning the flume system and a minor amount of underground work. The underground work consisted of re-timbering areas where timbers have broken since Mr. Tate finished his work and re-building portions of the flume inside the mine. The flume system is set up to handle a very large flow of water and hopefully will help control the heavy spring run-off.

Environmental Program

The Walker Mine has the unfortunate problem of having an acid mine discharge that exceeds the California pollution standards for Cu, Zn, Fe and Al. A sampling program was established to monitor the pollution in the mine effluent and its effect on Dollie, Little Grizzly and Indian Creeks.

Water samples were collected monthly from May through November. The sample sites ranged from above the mine influence on Dollie and Little Grizzly Creeks to 20 miles downstream from the mine on Indian Creek. A more detailed sampling program involving stream sediment sampling, filtration of water samples in the field, and experimentation designed to remove Cu and Zn from the mine water were conducted in June by Dawn Kaback, an environmental geochemist from Ponco City. For more detailed information about the environmental program, the writer refers you to an interoffice communication from Dawn Kaback to Gordon Pine dated September 18, 1978 entitle "Environmental Program at Walker Mine".

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