CONTROLS OF OXIDE COPPER MINERALIZATION,

MACARTHUR PROPERTY, LYON COUNTY, NEVADA

by

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Abstract

The MacArthur deposit is an outcropping, oxidized porphyry copper occurrence located approximately 5 miles north of Anaconda's Yerington mine, Lyon County, Nevada. A significant mineral reserve was developed on the property in 1971-72.

The Jurassic quartz monzonite host rock of the deposit is intruded by two varieties of quartz monzonite porphyry and a rhyolite, also Jurassic in age. Tertiary hornblende andesites constitute the youngest rocks in the deposit. All of the intrusive rocks, except the older quartz monzonite, occur as northwest-trending dikes which dip moderately to the north.

Sulfide copper mineralization accompanied the intrusion of the older quartz monzonite porphyry. The alteration pattern associated with the Jurassic quartz monzonite porphyry was strongly influenced by the northwest fracture pattern and generally consists of a phyllic zone to the north and west, a very weakly potassic central zone, and a strong albite zone to the east.

Oxide copper values occur in three distinct mineral assemblages: (1) green copper oxides, (2) black copper wad, and (3) dark-brown limonites. Copper and iron are crudely zoned in the oxide mineralogy with a high iron to copper ratio in the north and west parts of the orebody and low iron to copper oxide assemblage to the east.

Higher grade oxide copper zones on the MacArthur property are erratic and difficult to project. Although poorly defined, several geologic features appear to control the grade distribution:

Major Controls

1. Primary grade distribution—higher grade oxide zones occur where the original sulfide grade was higher.
2. Exotic copper or oxide enrichment—supergene copper from the peripheral phyllic zone has moved laterally to enrich the low-grade porphyry copper center.

Minor Controls

1. Superleach zone—copper values leached from the present bedrock surface are redeposited several feet below.
2. Andesite dikes—unpyritized andesite dikes absorb exotic copper.
3. Fracture pattern—strong northwest-trending fracture pattern imparts similar trends to the grade zones.
4. Oxidized enrichment—deep zone of oxide mineralization immediately above the top of sulfide may represent an oxidized enrichment blanket.

Introduction

The MacArthur deposit is located in northwestern Nevada about 50 miles southeast of Reno, near the towns of Yerington and Weed Heights. The deposit is situated about five miles north of The Anaconda's Company's Yerington mine (Fig. 1). A mineral reserve was developed on the property by Anaconda geologists during the period 1971-72 as part of a district exploration program to find oxide ore that could be treated by the Yerington Mines oxide plant.

Mining claims were staked on the MacArthur property during the 1930s by local pros-

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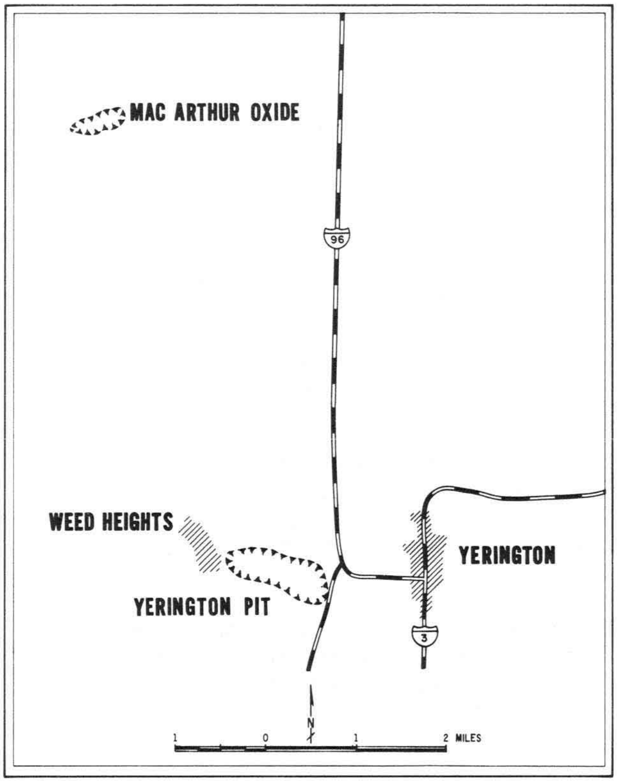

Fig. 1. Location map, MacArthur oxide deposit

pectors and several small shipments of hand-cobbed, high-grade oxide ore were made during this period. In 1950, the U.S. Bureau of Mines dug a series of trenches on green copper oxide occurrences and drilled eight diamond drill holes. During the period 1954 to 1971 the property was optioned by at least four major mining companies, including Anaconda. Over 60 holes were drilled on the property during this period; and approximately half of these drill holes are located within the known MacArthur orebody.

Recent Exploration

A mineral reserve was developed on the property in 1971-72 by a combination of detailed geologic mapping, systematic trenching, and improved drilling technology. The initial exploration work consisted of geologic mapping at the scale 1" = 200' and a compilation of existing data on the property. The preliminary geologic mapping delimited a broad zone of "glass or beer-bottle" limonite, which is known to represent oxidized chalcopyrite mineralization in the Yerington district's leached cappings. ("Glass-limonite" is a term used to describe resinous, dark-brown goethite.) The limonite mapping proved to be a very effective exploration tool; Figure 2 illustrates the zone of glass limonite as defined by the initial mapping and the outline of the pit which was designed to mine the Macarthur oxide mineralization.

The glass limonite zone was subsequently trenched and assayed. The trenching program delimited an outcropping area approximately 1000 x 2500 feet that assayed approximately 0.25% copper and contained erratic zones of higher grade. Both the grade zones and the geology projected into shallow covered areas to the north and east of the outcrops.

It was recognized early in the MacArthur evaluation that because of the nature of the oxide mineral occurrences (90% on fractures) that a large part of the copper values would be ground up and lost by conventional drilling techniques due to pulverization and dissemination by the drilling fluid. Screen analysis of drill cuttings showed that 40 percent of the copper values were contained in the - 50 mesh portion of the sample, which represented 28 percent of the weight of the samples. It was obvious that the loss of fine material resulted in a disproportionate loss of copper values. In order to obtain an accurate sample, Anaconda's Mining Research Department designed a sample collection system that collects 100 percent of the discharge from the percussion drill.

Over 280 vertical and angle holes, to an average depth of 200 feet, were drilled on the property. Both percussion and rotary drilling rigs were employed. The drilling and surface sampling defined approximately 13 million tons of +0.4% Cu mineralization.

Rock Types and Alteration

The host rock for the MacArthur oxide deposit is a quartz monzonite of Jurassic age (161 m.y., K-Ar). The quartz monzonite is intruded by northwest-trending dikes of quartz monzonite porphyry (Fig. 3). The older of these porphyries has prominent biotite phenocrysts and disseminated chalcopyrite. The younger porphyry has prominent hornblende phenocrysts and does not appear to influence copper grade patterns. A northwest-trending dike of rhyolite cuts the hornblende-rich quartz monzonite porphyry. Although the porphyries at the MacArthur property have not been dated, similar porphyries elsewhere in the Yerington district have yielded Jurassic dates (141 m.y., K-Ar).

Numerous northwest-trending dikes of hornblende andesite cut across the older intrusive rocks. Similar andesites elsewhere in the Yerington district have been mapped intruding Tertiary rocks.

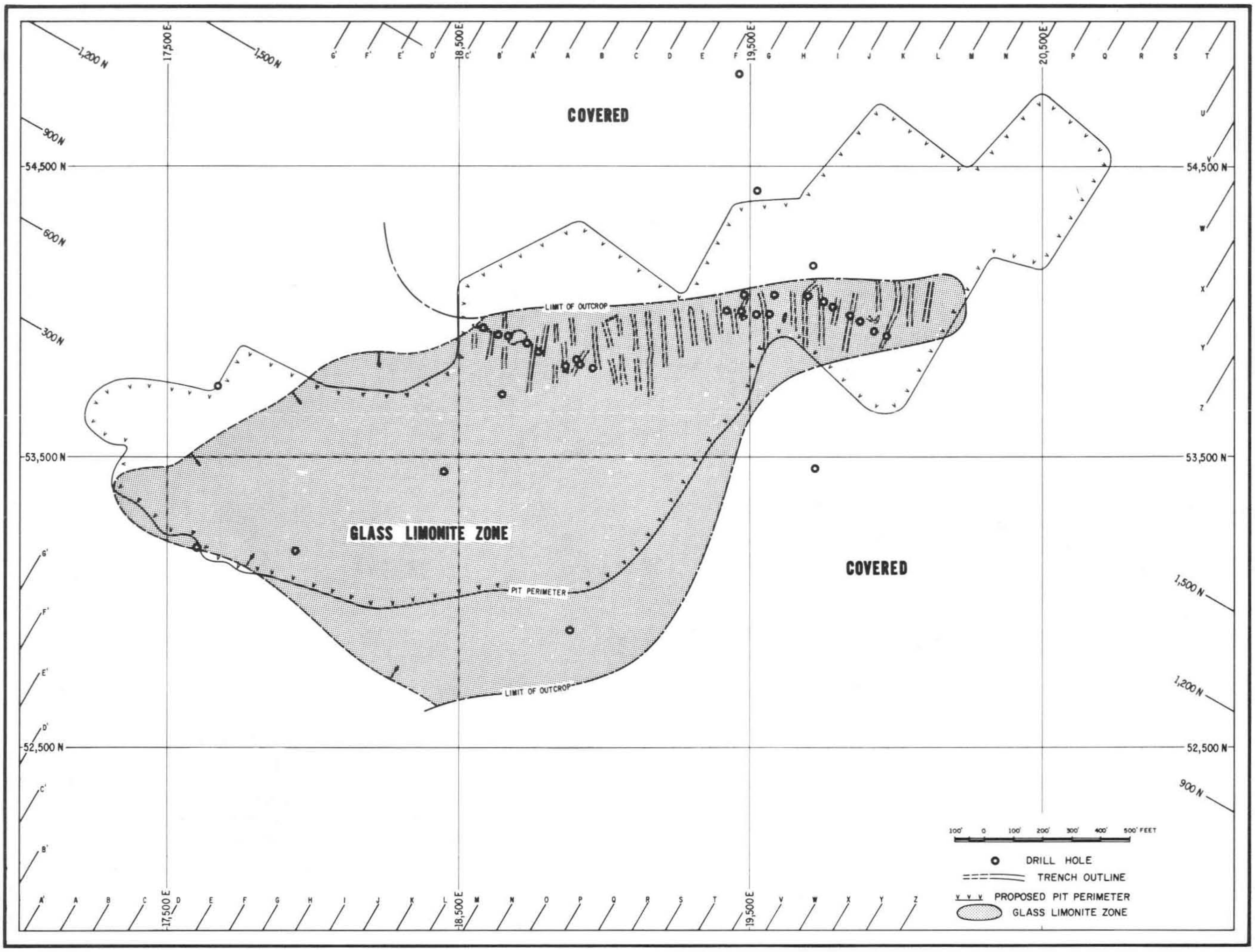

Fig. 2. Surface map of glass limonite zone and proposed pit outline, MacArthur oxide deposit

The following is a brief description of the rock types, listed in order of relative age (oldest to youngest).

Quartz monzonite is a medium to coarsely crystalline, equigranular rock with hornblende as the dominant mafic.

Biotite quartz monzonite porphyry is characterized by abundant quartz eyes, K-feldspar phenocrysts, and biotite phenocrysts in an aphanitic matrix. The northwest-trending dikes of biotite quartz monzonite dip 30°-40° N.

Hornblende quartz monzonite porphyry is texturally similar to biotite-rich quartz monzonite porphyry, but it has only rare quartz eyes, no K-feldspar phenocrysts and hornblende is the dominant mafic mineral. The northwest-trending dikes of hornblende quartz monzonite dip approximately 60° N.

Rhyolite is similar in composition to hornblende quartz monzonite porphyry except that it contains only rare phenocrysts. The dikes of rhyolite, which vary in dip from 75° N. to vertical, show sharp contacts with the hornblende quartz monzonite porphyry.

Pyritic hornblende andesite is a porphyritic andesite with prominent hornblende phenocrysts and 1-2% disseminated pyrite. The pyritic andesite dikes generally dip steeply northward.

Andesite dikes are usually porphyritic and occur both with and without hornblende phenocrysts. These dikes show little evidence of primary sulfide mineralization. The dips vary from steep to horizontal.

The alteration pattern at the MacArthur is very stripy, apparently strongly influenced by the northwest fracture pattern. The alteration zoning is as follows:

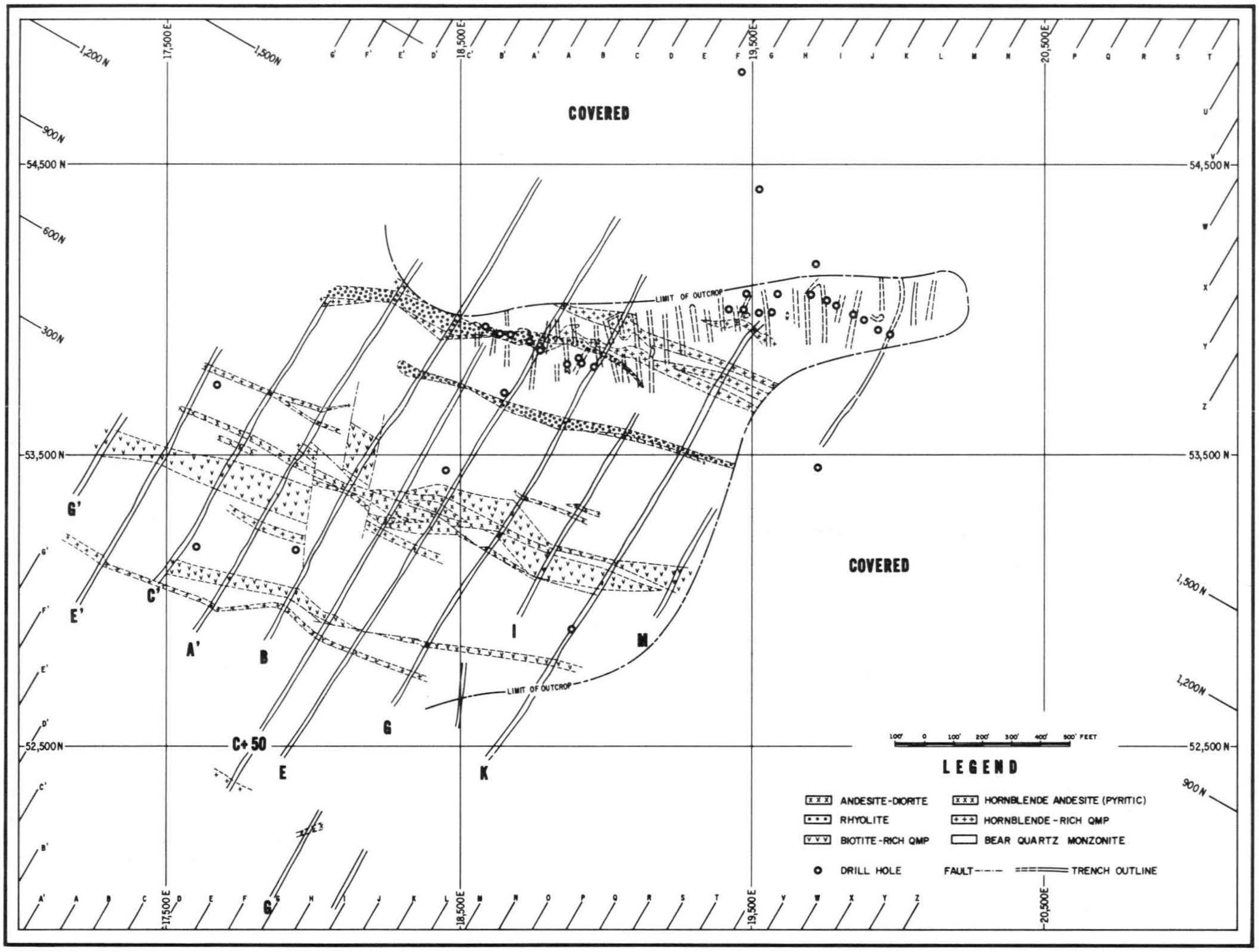

Fig. 3. Surface geology, MacArthur oxide deposit

1. The western phyllic zone is defined by stripy feldspar destructive alteration where plagioclase is partially altered to sericite, K-feldspar is fresh to partially altered to sericite and the mafic minerals are completely altered to sericite and clay. Based on the mapping of the drill cuttings, the phyllic alteration zone extends to the east along the northern edge of the oxide ore zone (Fig. 7).

2. The central zone is unaltered except for minor potassic alteration in the form of local biotization of hornblende.

3. The eastern albitic zone is characterized by the stripy albitization of both plagioclase and K-feldspar. The albitization is more pervasive to the east.

Copper Oxide Mineralogy and Distribution

Oxide copper values occur in three distinct mineral assemblages:

1. Green copper oxides—dominantly blue and green chrysocolla with minor amounts of malachite, azurite, and other unidentified green oxides.

2. Black copper wad—a sectile, amorphous mixture of copper-iron-manganese oxides and silica, which frequently is coated with scales of blue copper minerals.

3. Dark-brown iron oxides—dominantly goethite, rock mineralized with only brown limonite can contain up to 0.3% Cu. The dark-brown limonites contain copper only if they occur in rocks with fresh feldspar; similar limonites in altered rocks do not contain significant copper values.

The distribution of copper and iron in the oxide mineralogy shows a crude zoning with the high iron oxides, goethite and wad, more

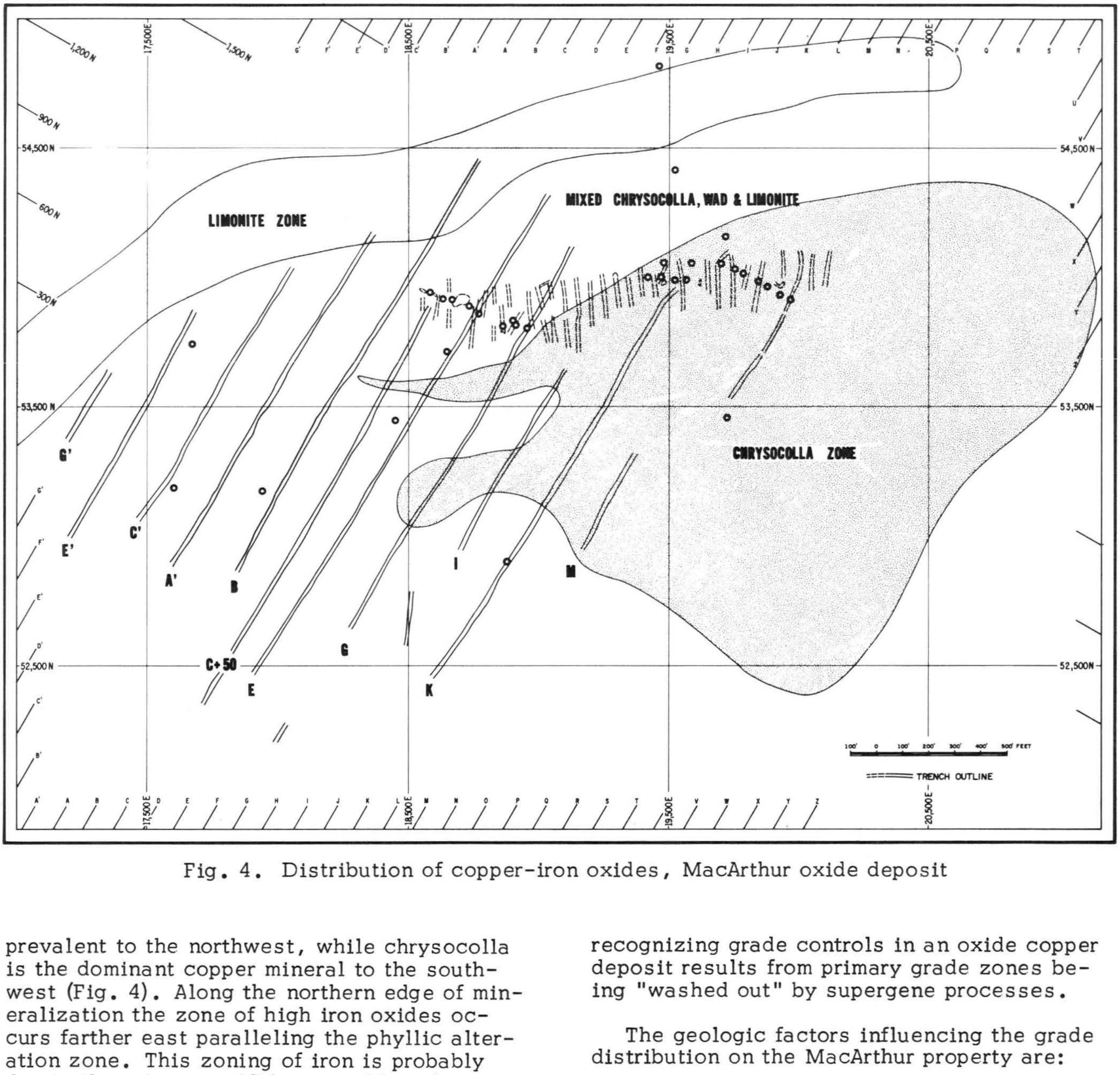

Fig. 4. Distribution of copper-iron oxides, MacArthur oxide deposit

prevalent to the northwest, while chrysocolla is the dominant copper mineral to the southwest (Fig. 4). Along the northern edge of mineralization the zone of high iron oxides occurs farther east paralleling the phyllic alteration zone. This zoning of iron is probably due to the primary sulfide assemblage because the western part of the area was originally high in pyrite. The chrysocolla zone is coincident with the glass limonite zone and probably represents the oxidation of a chalcopyrite-rich primary sulfide assemblage.

Controls of Oxide Copper Mineralization

Zones containing +0.4% Cu on the MacArthur property are erratic and difficult to project for any distance. Although poorly defined, several geologic features that apparently control the grade distribution were used successfully to project grade zones. The difficulty of recognizing grade controls in an oxide copper deposit results from primary grade zones being "washed out" by supergene processes.

The geologic factors influencing the grade distribution on the MacArthur property are:

Major controls—(1) primary grade distribution, and (2) exotic copper or oxide enrichment.

Minor controls—(1) superleach zone, (2) andesite dikes, (3) fracture pattern, and (4) oxidized enrichment.

Figures 5 and 6 illustrate the effect of the primary grade pattern. The gentle north dip of the +0.5% Cu zone parallels the dip of a biotite quartz monzonite porphyry dike. The higher grade oxide copper apparently is due to chalcopyrite mineralization, which accompanied the biotite quartz monzonite porphyry.

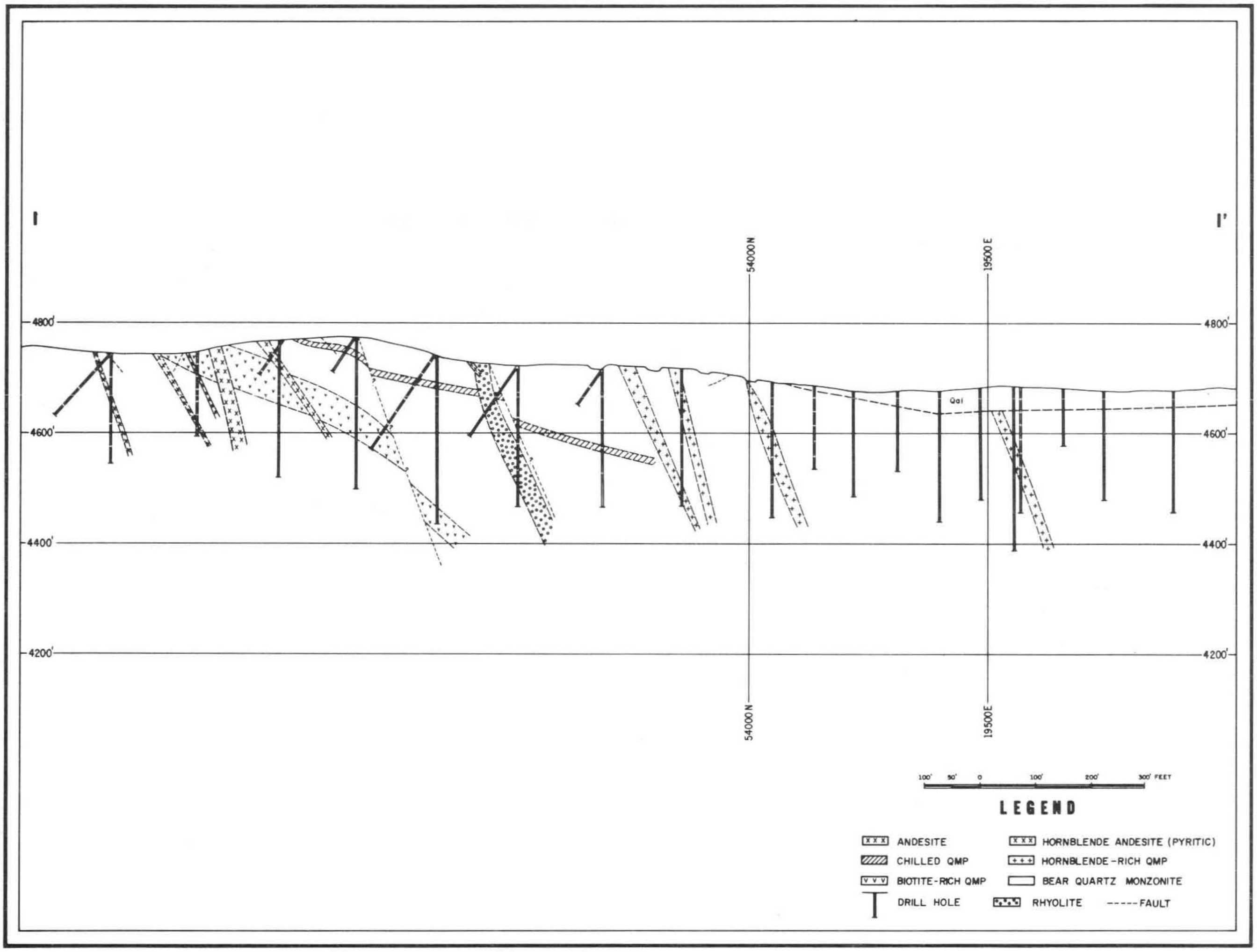

Fig. 5. Geologic cross section I-I', MacArthur oxide deposit

Areas containing +0.4% Cu form a crude east-northeast band across the well-defined northwest structural grain of the area. Figure 7 shows the +0.4% Cu grade blocks in relation to the southeast limit of the phyllic alteration zone. The individual grade blocks trend northwest and occur immediately east of the phyllic alteration zone. This alteration-grade relationship is interpreted to indicate that low-grade primary copper in the phyllic zone was dissolved by supergene solutions, transported and deposited as a copper oxide when it encountered the more reactive rocks with fresh feldspar. The addition of this exotic copper enriched the low-grade oxidized primary values to produce the areas of +0.4% Cu.

A leached zone immediately below the present bedrock surface was noted early in the trenching program. This zone ranges from zero to 10 feet in thickness and averages 1 or 2 feet. Within this superleach zone, no oxide copper values can be found. Drilling frequently penetrated a band of higher grade mineralization parallel to the bedrock surface as illustrated in Figure 8. This zone is interpreted to represent copper leached from the present bedrock surface and redeposited several feet below.

Andesite dikes with a high percentage of fresh calcic feldspar tend to "soak up" exotic copper. The dikes frequently contain over 1.0% Cu and are treated as veins in the ore-reserve calculations.

In several locations an area of higher copper grade was noted immediately above the top of sulfide (Fig. 8). A possible explanation for this higher grade would be oxidized chalcocite enrichment.

In summary, the MacArthur is an oxidized low-grade porphyry copper deposit which has been locally enriched by exotic copper. The probable source of the exotic copper was pri-

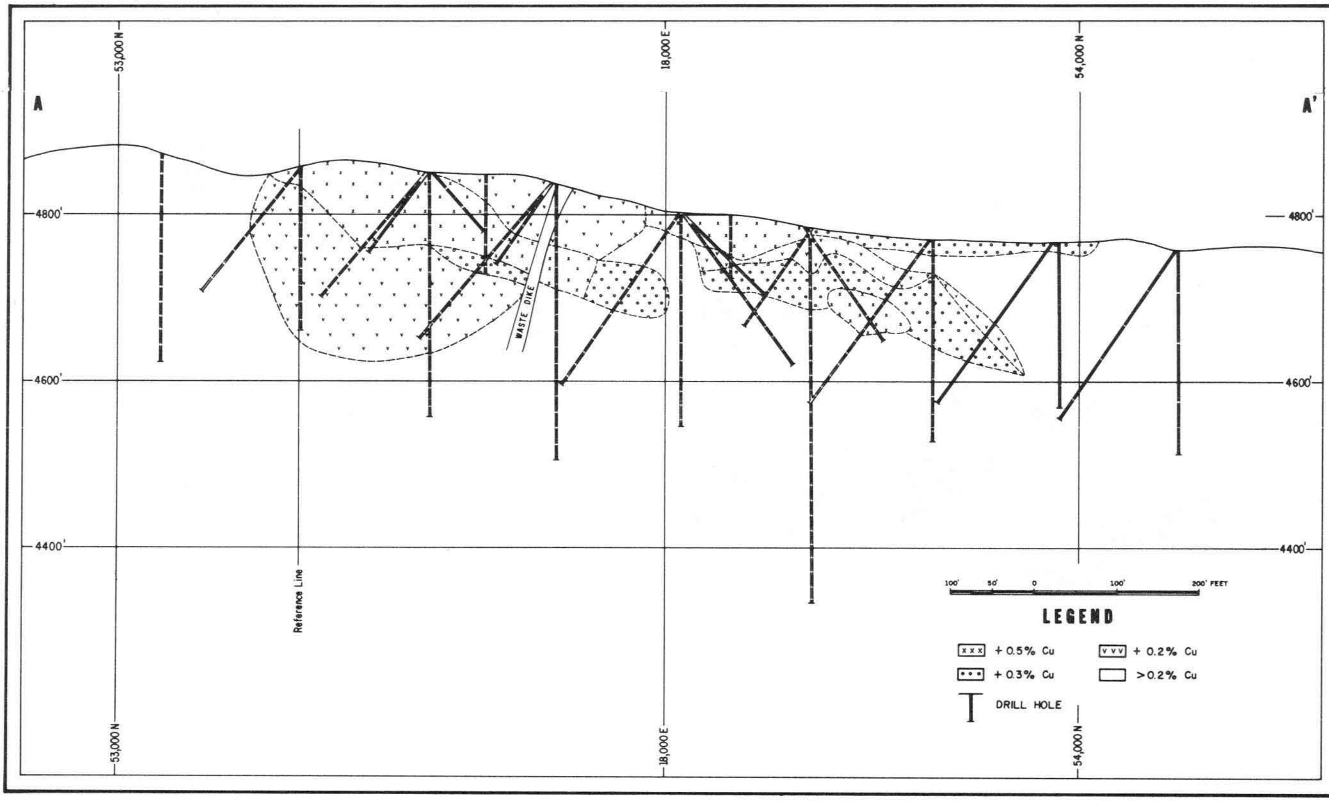

Fig. 6. Assay section A-A', MacArthur oxide deposit

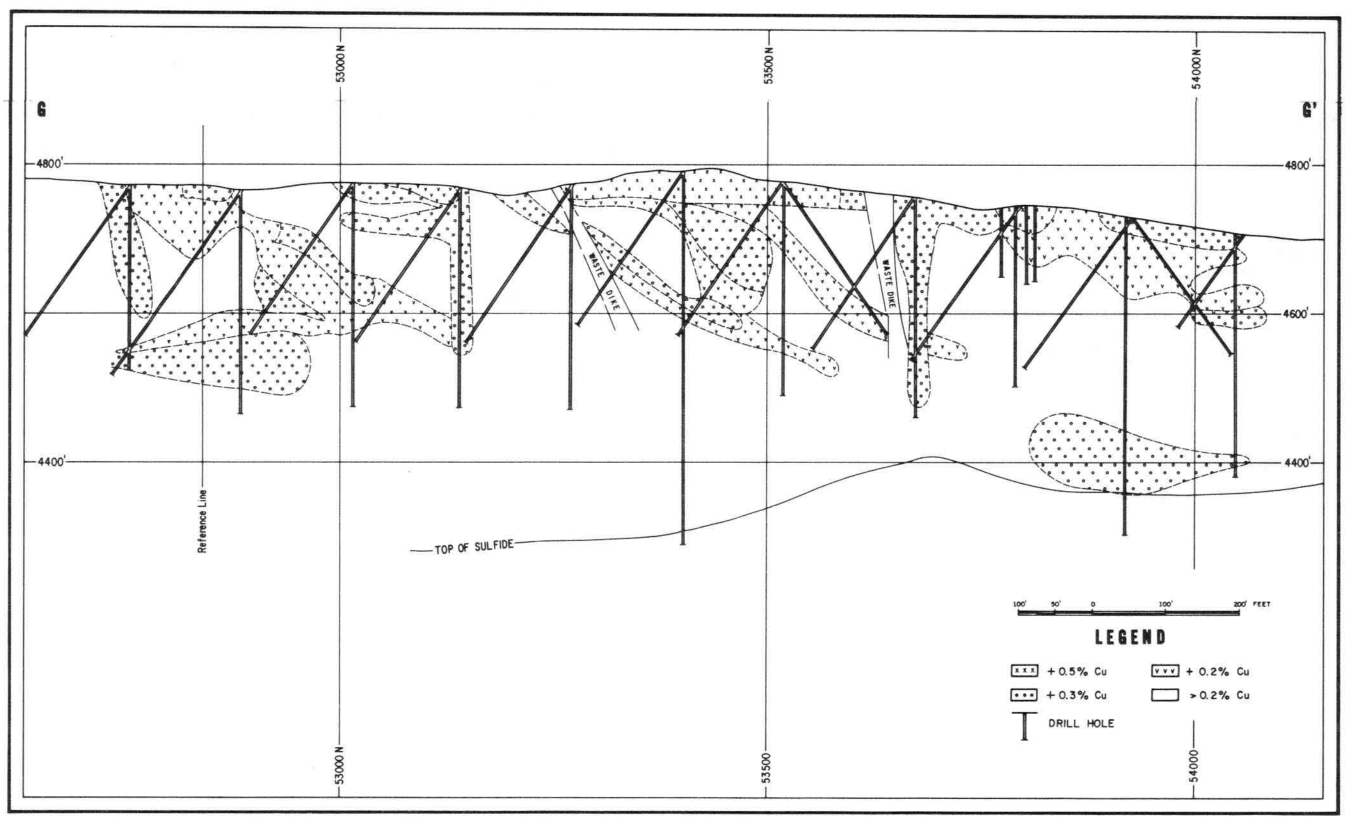

Fig. 7. Surface projection +0.4 percent copper grade, MacArthur oxide deposit

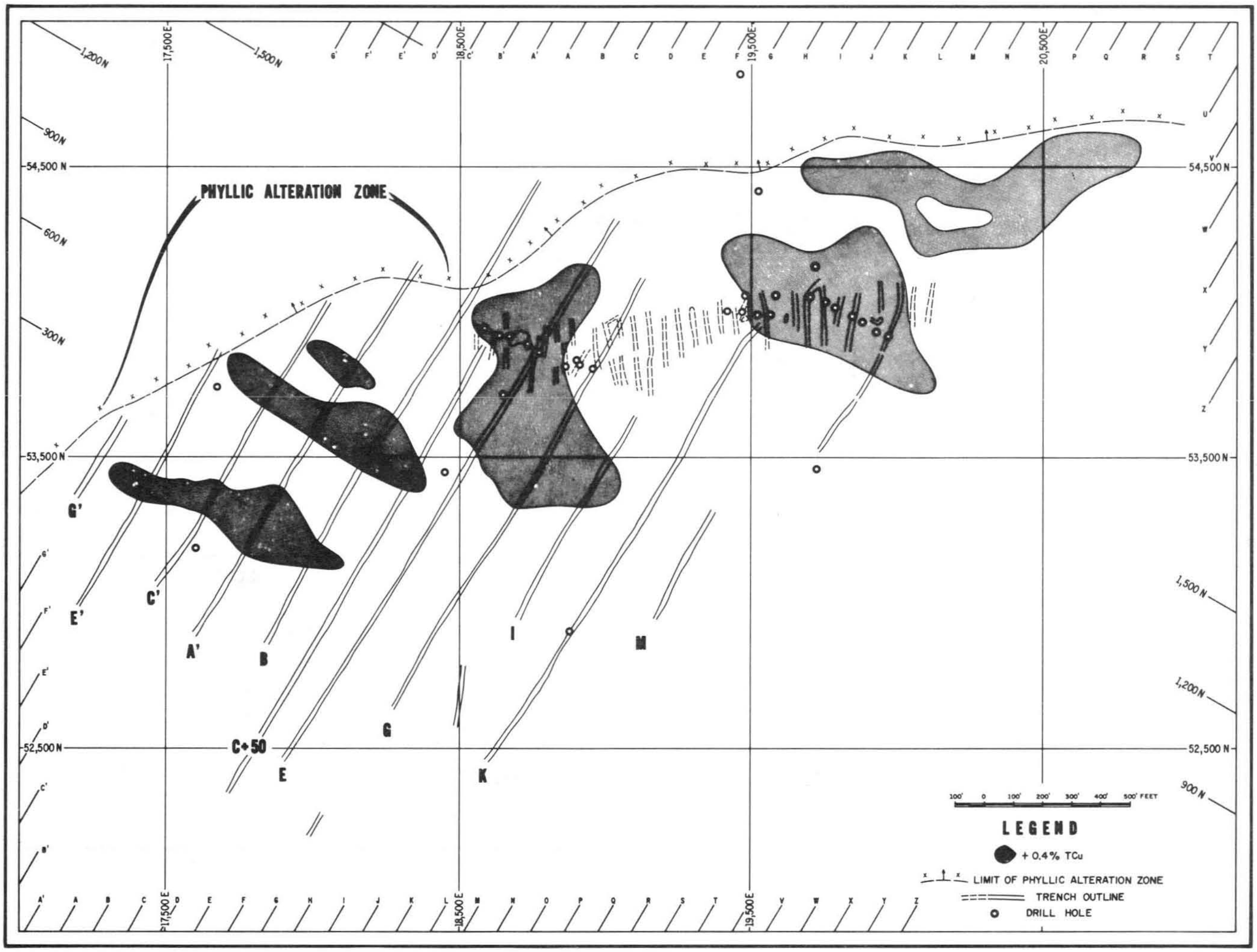

Fig. 8. Assay section G-G'

mary sulfide mineralization peripheral to the porphyry center.

Acknowledgments

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