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REPORT ON THE GEOLOGY AND EXPLORATION OF THE ZONIA PROPERTY; YAVAPAI COUNTY, ARIZONA.

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TABLE OF CONTENTS

PAGE

REPORT ON THE ZONIA PROPERTY EXPLORATION

SUMMARY

The Zonia property is located in T11N, R4W, Yavapai County, Arizona, about seven miles south of Kirkland Junction. Fairly widespread copper, in oxide form, was known to exist in outcrop. Occasional attempts to develop and mine the deposits had been made since about 1900. During 1956 options were secured by Miami Copper Company on five groups of claims, and the ground was explored for the purpose of blocking out a mineable tonnage of oxidized ore and determining the existence and extent of a possible enriched sulfide body at depth. This work consisted of geologic mapping, churn drilling, and rotary drilling. The program was concluded in December, 1956. Only about 2,500,000 tons of oxidized ore were developed which might be mined and processed at an operating profit. A zone of slight enrichment was found about 500 feet beneath the surface, but it was not of commercial interest. The property was abandoned late in 1956.

INTRODUCTION

LOCATION AND OWNERSHIP

The Zonia mineralized area is situated in the Walnut Grove Mining District, in Yavapai County, Arizona, in the east central portion of T11N, R4W, unsurveyed. The ground held under lease and option during 1956 by Miami Copper Company consisted of five groups of claims, each owned by different parties. These claim groups are tabulated below:

1. Mills Group: Owner, H.F. Mills and wife, Prescott, Arizona. This was the northernmost group and consisted of eleven unpatented claims. The option term began on April 13, 1956, with a down payment of $1000. The agreement provided for payments of $1000 after the first year, $2000 after the second year, and the balance of $46,000 after the third year. The agreement was terminated by the company on December 22, 1956.

2. Gillingham Group: Owner, James L. Gillingham and wife, Alameda, California. This group consisted of fourteen patented claims and adjoined the south end of the Mills Group. It was also known as the Zonia Group. The option was for three years beginning on April 10, 1956. The total purchase price was $120,000. A down payment of $5000 was made. Additional payments of $5000 after the first year and $5000 after the second year were provided for. The agreement was terminated by the Company on January 14, 1957.

3. Young-Whitehead Group: Owner, William Young and wife and R.H. Whitehead and wife, Kirkland, Arizona. This group, also known as the Georgia Group, consisted of ten patented claims adjoining the Gillingham and McMahan claims. Eight of these claims lay to the southeast of the mineralized area. The other two were fractions occupying a gap in the Gillingham Group. The option was signed on

March 14, 1956, for a period of three years with a total purchase price of $50,000. Payments of $5000 after the first year and $10,000 after the second year were provided for. The agreement was terminated on January 14, 1957.

4. McMahan Group: Owner, R.O. McMahan, et al, Downey, California. This group consisted of five unpatented claims and covers the best area of copper mineralization. It adjoins the south end of the Gillingham Group. An option was signed on March 8, 1956, to run to March 1, 1957. The total price was $120,000, with payments of $1000 after the first year and $250 per month during the third year; the balance being due at the end of the third year. The agreement was terminated on January 14, 1957.

5. Victory Group: Owner, Charles H. Brown, et al, Prescott, Arizona. This group of eleven unpatented claims adjoins the south end of the McMahan Group. One other unpatented claim under option from the same owners was west of the mineralized zone and adjoined the west side of the Gillingham Group. The option agreement, signed on February 18, 1956, was to run until March 1, 1959, and called for a down payment of $5000, $5000 after the first year, $5000 after the second year, and the balance at the end of the third year, for a total of $125,000. The agreement was terminated on January 14, 1957.

In addition, 22 claims were staked by the Company in order to protect possible mineralized ground on the southward extension of the strike, and 10 claims were staked to cover gaps between optioned claims and groups of claims.

The total area held under location or lease and option measured about 21,000 feet in a northeast-southwest direction and varied from 1500 to 4000 feet in width.

ACCESSIBILITY

The area of major interest centered in the McMahan Group of claims. These claims were already accessible when exploration started, from Kirkland Junction, a settlement 22 miles southwest of Prescott on State Highway 89. From Kirkland Junction a well-maintained county road goes south to Wagoner. A fair road turns right off the Wagoner road at a point 3.3 miles from the highway and goes another 3.7 miles to the McMahan shaft. Part of this road was widened and improved at the start of exploration. During the course of drilling approximately six miles of new road was constructed to the various drill sites, providing access to much of the area covered by the McMahan, Gillingham, and Victory claims.

Prescott, with a population of about 11,000, is the county seat and principal center for supplies in Yavapai County. Prescott is served by several major truck lines and by the Santa Fe railroad. The shipping point nearest the property is at Kirkland, on the Santa Fe line, four miles from Kirkland Junction.

Sufficient water for exploratory drilling was found in an old shaft in French Gulch, on the Richmond claim of the Young-Whitehead Group. This indicates a very good permanent subsurface flow for this intermittent stream. Presumably, sufficient water could be developed on or near the property for mining and milling.

The nearest power line is on Highway 89, about four miles from the property.

HISTORY

The deposits were known and exploited as long ago as the 1880's, at which time an attempt was made to smelt the high grade ores from the Sunflower and Copperopolis workings. The remains of the smelter and slag heap are present in French Gulch, a little downstream from the old Zonia camp.

In 1910 and 1911 the Shannon Copper Company, of Clifton, Arizona, drilled six churn drill holes on the property. There are conflicting reports as to the locations of these holes. However, five of them were rediscovered in 1956. Two were on the Cuprite claim, one on the Copperopolis, one on the Fairplay, and one on the Arrastra claim near the old smelter.

According to a Bureau of Mines Report, January, 1951, (1)* a syndicate held the property from 1916 to 1920. During that time the McMahan shaft was sunk to a depth of 874 feet and development work was done on five levels.

The Zonia Copper Company, incorporated in 1921, held 75 claims and did some underground exploration. The company was dissolved after a few months. This company was formed by Anaconda Copper Mining Company and Inspiration Consolidated Copper Company for the purpose of exploring this property.

In 1926 the Hammon Copper Company, of San Francisco, acquired the property. Extensive surface trenching and some development work on the 210- and 335- foot levels of the McMahan shaft was done. The Copperopolis shaft was deepened from about 200 to at least 330 feet and some drifting was done from the deeper level. A site was leveled for a leach plant and underground development of the McMahan ore body was scheduled which would provide 600 tons of ore per day. The property was abandoned in 1930 without starting production.

In 1942 the U.S. Bureau of Mines explored the McMahan property for the purpose of quickly developing some copper for the war effort. Work began in October, 1942, on surface trenching and sampling. Contract diamond drilling began on November 7, 1942, and was completed January 29, 1943. Eleven holes totaling 2960 feet were drilled at approximately 100 foot intervals along the strike of the ore body. These holes were all inclined to the southeast at shallow angles. Seven new trenches were excavated for a total length of 1795 feet and two old trenches were lengthened a total of 140 feet. Some check sampling was done in the McMahan workings. The final report gave a total of 350,000 tons of indicated ore averaging over 1% copper.

In 1947 and 1948, a Mr. Gottbehut of Los Angeles leased the McMahan property. The McMahan shaft was retimbered to the 210 foot level. Eleven carloads of 4 to 5% copper ore were shipped. Operations ceased after returns were received on this shipment.

(1)* Kumke, C.A.; "Zonia Copper Mine Yavaipai County, Arizona" USBM Rl 4023, March, 1947.

TOPOGRAPHY AND VEGETATION

The area lies just north of the east end of the Weaver Mountains. The elevation varies from about 4200 feet in French Gulch to over 5000 feet on the basalt cap on the south end. It is an area of high ridges with steep slopes, minutely dissected by steep canyons. Drainage is to French Gulch and thence to Hassayampa Creek. The form results from erosion of a fairly high mesa after destruction of the basalt cap.

The ground is fairly well covered with scrub oak, pinon, and catclaw. On some slopes, large areas are densely covered with oak and manzanita thickets.

GEOLOGY

AREAL GEOLOGY

The Walnut Grove mining district is situated along a belt of Precambrian schistose intrusive rocks about one mile wide and at least three miles long cutting across an extensive area of Precambrian granite. Conforming with the normal Precambrian structure of the region the schistose band strikes about N45°E and generally dips steeply west; planes of schistosity parallel this same trend. The extent of the granite on either flank of the schistose rocks was not determined; however, it is seemingly the rock type of the region. As discussed below, the schistose band may persist over a much greater distance than the above mentioned three miles. This schist band will be referred to as the Zonia schist band.

Much of the area north and east of the Zonia schist band is covered by Late Tertiary (?) gravels and conglomerates which probably are roughly correlative with the Whipple conglomerate near Prescott, Arizona. Remnants of this formation occur on and just south of the Zonia prospect area. To the southwest the schist band is overlapped by a thick volcanic series which make up the bulk of the southern Weaver Mountains. The volcanics appear to be younger than the Late Tertiary gravels; at any rate, similar gravels are overlain in several places by thick basalt flows and pyroclastics.

Rock types noted in the band of schistose intrusive rocks include diorite, diabase, and quartz diorite. The diorite and diabase and their metamorphic derivatives of the greenschist facies have been collectively mapped and termed as the "basic complex". Much of the quartz diorite has been sheared and altered to a quartz-mica schist.

Almost all of the significant copper mineralization in the Walnut Grove mining district occurs in the schistose rocks and is generally associated spatially with the quartz diorite and quartz diorite schist. Numerous small gold and silver deposits occur in the basic complex. Copper deposits of various sizes occur at irregular intervals along the exposed length of the schistose band.

Rocks similar to those in the Zonia schist band are described several miles to the northeast and southwest in the Hassayampa and Octave mining districts (Lindgren-1926, Wilson-1934). To the northeast the schist band may be traced with a fair degree of certainty into the Hassayampa district 10 miles distant; however, between the southwesternmost exposure of the Zonia schist band and Octave, 12 miles southwest, the band, if existent, is covered by the thick volcanic series of the Weaver Mountains for a distance of about 5 miles thus making any correlation to the southwest open to question.

Relations between the schist band and the surrounding granite were not determined. At first thought it would seem that the schist band represents a zone of weakness cutting the granite that has been subjected to recurrent shearing and intrusion. On the other hand the schist band may be a remnant septum of rock which was intruded by the granite. Just such a condition exists on the eastern flank of the Bradshaw Mountains about 15 miles east-southeast of Walnut Grove district. Jagger and Palache (Jagger-1905) map two schist septa in the Bradshaw granite. The westernmost, in which the Copperopolis, Crown King, and Alexandra mining districts occur, trends about N30°E, is from 1 mile to 3 miles wide, and is at least 19 miles long. The easternmost septum, 8 miles east of Crown King, follows roughly the course of Black Canyon trending about N5°W, is from 1 mile to 2 miles wide, and is at least 20 miles long. In support of the latter hypothesis, Anderson states (Anderson-1951) that in the Bagdad area, about 40 miles west-northwest of the Walnut Grove district, the most widespread igneous rock is a porphyritic granite clearly proven to be younger than the other intrusives cutting the Yavapai schist including gabbro, diorite, and quartz diorite.

ROCKS

Rocks of the Zonia schist band include diorite, diabase, and quartz diorite metamorphosed to greenschist, greenstone, and quartz mica schist. Granite forms the walls of the schist band and is probably the dominant rock type of the region. Degree of metamorphism and correlation with rocks in surrounding areas indicate a Precambrian age for the schistose rocks and the granite.

The above intrusive igneous and metamorphic rocks are overlain by a thin veneer of surficial deposits, mainly conglomerate and lava. The depositional hiatus between the two rock groups is extreme if any intervening rock deposition and subsequent erosion is discounted.

GRANITE. The granite flanking the schist band was not closely studied. It is typical of the Precambrian granites elsewhere in the region having a medium to coarse grained, holocrystalline texture with little tendency to form a porphyritic facies. From place to place the granite is strongly gneissic.

Much of the granite is more nearly a granodiorite; however, too little work was done outside the schist band to permit anywhere near an accurate designation of rock type for any given area in the "granite". Thus all the granitic rock flanking the schist band is collectively termed granite.

Little is known of the distribution of the granite; very probably it is the dominant rock type for several miles on either side of the schist band. There can be little doubt that the granite is Precambrian in age and is very probably a correlative of the Bradshaw granite.

DIORITE AND DIABASE. Diorite and diabase and rocks of the greenschist facies derived from them through metamorphism are the oldest and most abundant rocks of the Zonia schist band. Diorite is more abundant than diabase.

In thin section, a specimen of diorite from the northwest corner of the Black Prince claim is seen to be a hornblende diorite porphyry composed essentially of andesine, hornblende, augite, and a trace of quartz. Phenocrysts approximately equal the groundmass in volume and range in size up to about 10mm across.

The rock has been little affected by alteration; the feldspars show very weak to moderate alteration to sericite and clay. The specimen was selected for its "freshness"; the diorite generally is strongly altered to clay and chlorite.

Only a few exposures of diabase were noted. It is generally medium to fine-grained and possesses the typical ophitic texture.

Low grade metamorphism of the diorite and diabase has resulted in the formation of greenstone and greenschist. Metamorphic hornblende and massiveness characterize the greenstone; whereas, chlorite is seemingly the dominant mineral of the strongly sheared greenschist facies.

Almost all of the rocks of the basic complex show some degree of metamorphism. The grade of metamorphism and intensity of shearing varies across any given interval in the basic complex. Within 40 feet or 50 feet there may be a complete gradation from "fresh" diorite through greenstone and greenschist.

The basic complex makes up the bulk of the rock in the schist band. Where quartz diorite (or quartz-mica schist) occurs, it generally occuppies a more or less central position within the basic complex.

QUARTZ DIORITE. Quartz diorite intrudes the basic complex seemingly along zones of shearing. Though ranging in size from a few feet to a mile or so in length, the quartz diorite intrusives are generally similar in shape, almost all of them being irregular lens-like bodies whose borders parallel the foliation of the enclosing basic complex.

Seemingly, much of the shearing in the basic complex antedates the quartz diorite intrusions. This is indicated by the presence of unsheared dikes of quartz diorite which cut the schistose basic complex transverse to its foliation and the abrupt change from massive quartz diorite to schistose basic complex at some contacts which parallel foliation.

The quartz diorite is a medium grained porphyry consisting essentially of plagioclase (andesine ?), quartz, augite, and accessory (?) garnet. All specimens are more or less metamorphosed which complicates recognition of the original magmatic minerals and textures. The groundmass of the porphyry, about equal to the phenocrysts in volume, is composed of a fine grained mosaic of quartz grains. All phenocrysts, including secondary chlorite derived from augite, are corroded and replaced by the groundmass to varying degrees.

Much of the quartz diorite has been sheared and altered into a quartz-mica schist. The schistose zones are generally well defined and are easily traced along their strike, usually for considerable distances. Often the transition from massive quartz diorite to quartz-mica schist, measured perpendicular to the foiliation planes, is abrupt occurring with 10 feet or so; however, usually it is much more gradual and any "contact" between massive rock and schist is arbitrary. In plan the unsheared bodies of quartz diorite appear as giant horses between braided zones of shearing. Actually, all quartz diorite seen has been deformed; even the massive rock possesses a distinct gneissic structure. The mineralogical and micro-structural effects of shearing and metamorphism in the quartz diorite are discussed more fully under METAMORPHISM.

A few narrow, irregular dikes of diorite porphyry cut the quartz diorite at various places. Several of these minor intrusives

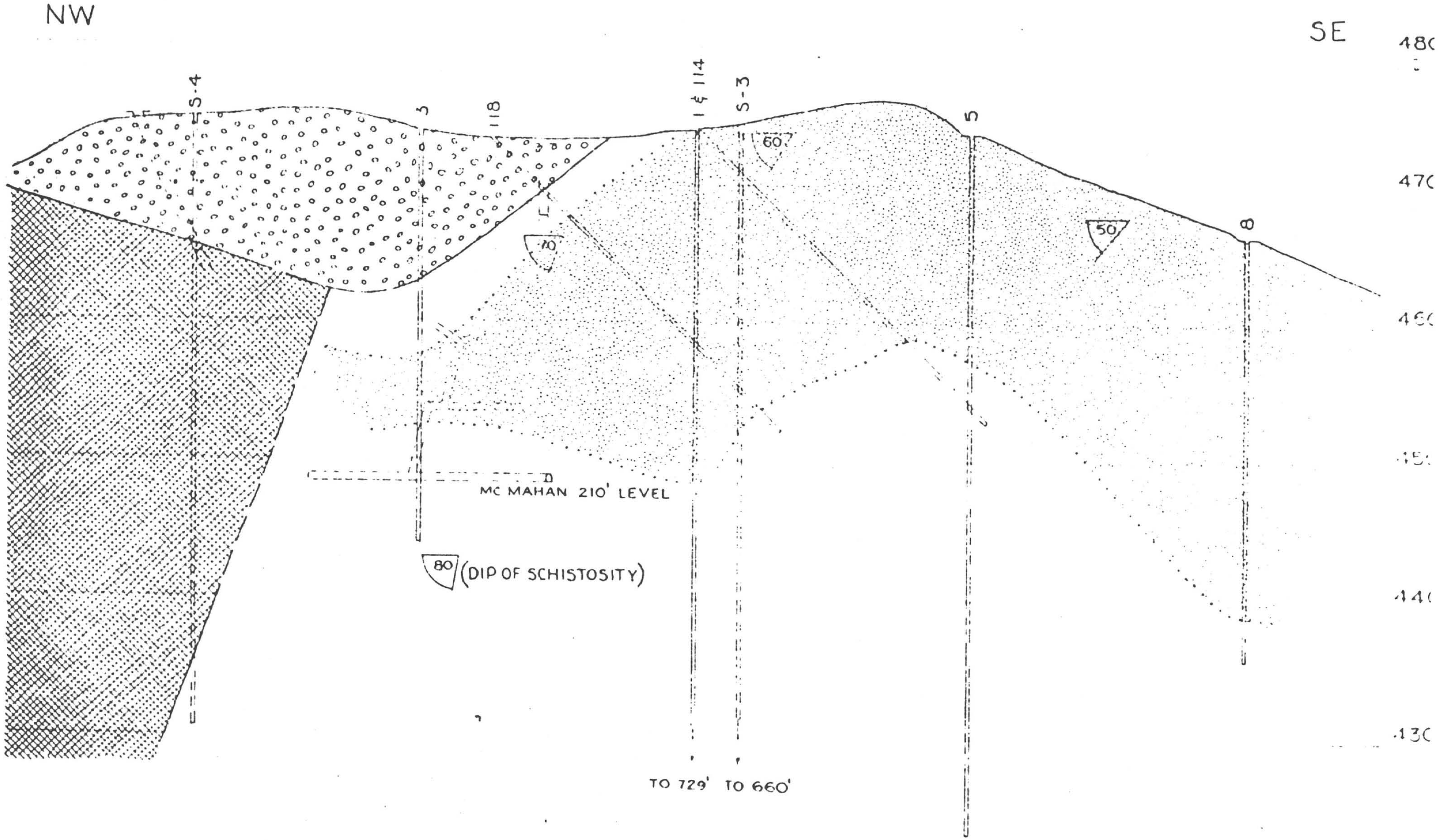

FIGURE 1. ZONIA PROSPECT

S 600 SECTION ACROSS CENTRAL MINERALIZED ZONE - LOOKING NORTHEAST

JUNE, 1957

SCALE : 1" = 100'

J.W. ALLAN

GREENSTONE LEACHED SCHIST OXIDE COPPER IN SCHIST GRAVEL

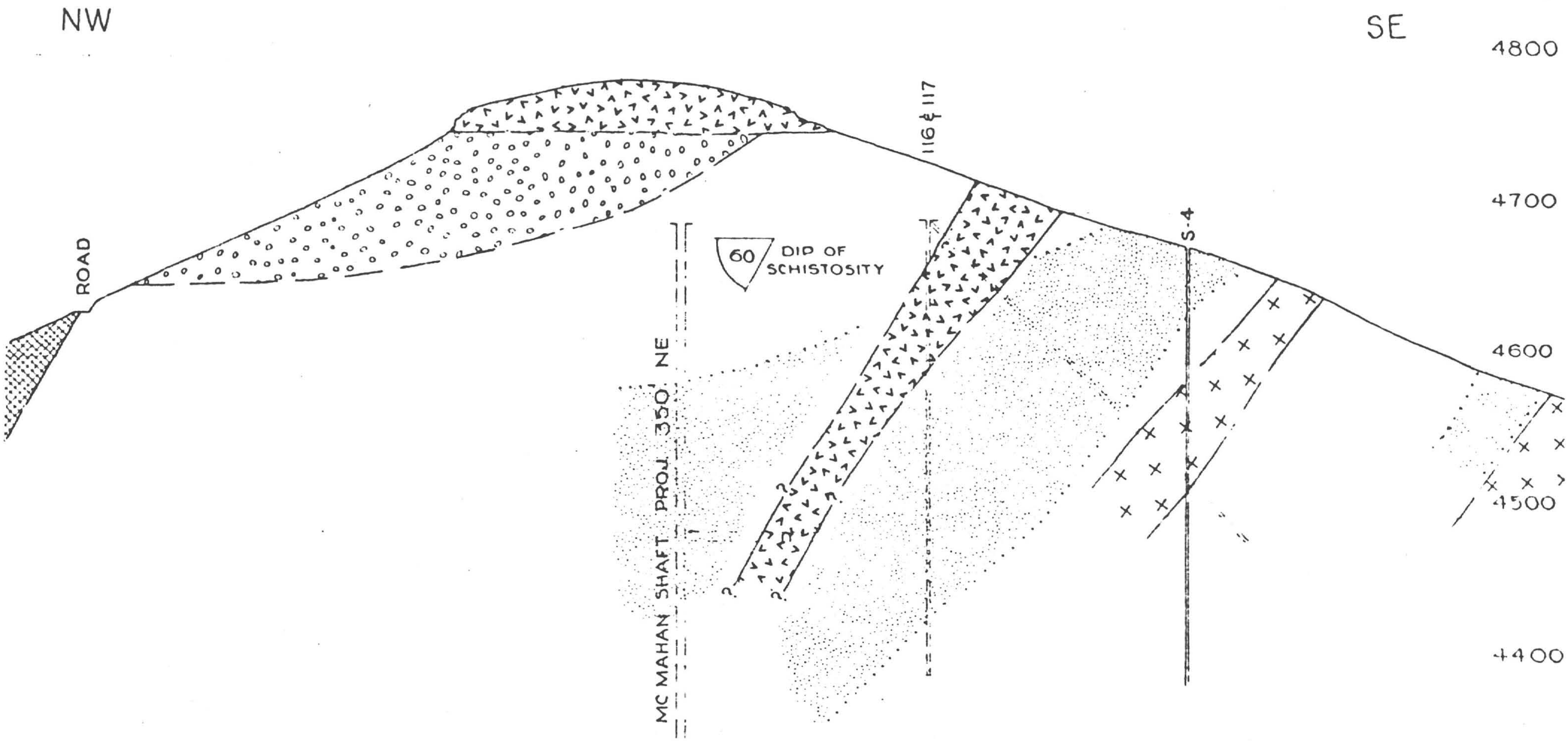

FIGURE 2. ZONIA PROSPECT

CROSS SECTION THRU BASALT PLUG - LOOKING NORTHEAST

JUNE, 1957 SCALE: 1" = 100' J.W. ALLAN

BASALT	UNSHEARED QTZ DIORITE	OXIDE COPPER
GRAVEL	LEACHED SCHIST	GREENSTONE

are well exposed along the road leading up the gulch in which the Sunflower shaft is located.

Very probably, the quartz diorite is Precambrian in age. The only direct indication of this is the degree of metamorphism exhibited by the rock. Such a criterion is valid for most of Arizona.

The quartz diorite and quartz-mica schist are the only important hosts of copper mineralization at the Zonia prospect.

OLDER GRAVELS. Several remnant patches of Late-Tertiary (?) gravel lie on the deeply eroded surface of the granite-schist complex. The gravel occurrences seem to be remnants of what was a much more extensive gravel cover now almost completely removed by erosion. In the prospect area the gravel occurs only as sub-horizontal wedges and prisms occuppying old stream channels or other depressions carved in the pre-gravel surface of the Precambrian rocks. All the occurrences are at or near the tops of the higher hills suggesting that the present hilltops coincide roughly with the pre-gravel surface. Subsurface knowledge of one of the gravel occurrences suggest that the pre-gravel topography was moderately rough, comparable to that now seen on the prospect southeast of the McMahan shaft.(See Figures 1 & 2).

The gravel is characteristically coarse, poorly sorted, and loosely cemented. It is composed mainly of angular fragments of granite with far lesser amounts of schist, quartz diorite and greenstone. Even where it directly overlies rocks of the schist band, the gravel is composed mainly of granite fragments.

Very little is known of the original thickness of the gravel. Southwest of the McMahan shaft the largest mapped gravel exposure is about 120 feet thick as revealed by mine openings and drill holes (Figure 1). The other smaller occurrences are probably much thinner. About two miles north and east of the prospect area, the gravel is much more extensive horizontally and is very probably much thicker.

VOLCANICS. Overlying and possibly interbedded with the Late Tertiary (?) gravel are a series of basalt flows, agglomerates, and tuffaceous sandstones. These rocks make up the bulk of the Weaver Mountains south of the Zonia property; however, in the prospect area these rocks occur only as small, isolated remnants capping the higher hills.

One such remnant caps the sharp peak just north of the McMahan shaft. A small feeder plug of basalt is exposed at the surface. 200 feet east of the basalt cap. What is probably the same plug is exposed on the 210 foot level of the McMahan shaft about 360 feet northeast of the shaft (See Figure 2).

No significant thickness of volcanic rocks remains on the prospect area probably having been stripped off during recent erosion cycles including the present. To the south; however, the volcanics are much thicker, increasing in thickness from about 100 feet at the extreme southwest end of the property to at least 1000 feet in the Weaver Mountains.

RECENT ALLUVIUM. Very little of the prospect area is covered by recent alluvium. Where it occurs it is thin and of limited areal extent.

METAMORPHISM

Regional low grade dynamic metamorphism has affected all of the Precambrian rocks exposed on the Zonia property. The "basic complex" has been altered to rocks of the greenschist facies derived from the quartz poor diorites and diabase; the quartz diorite has yielded a quartz-mica schist of the phyllonite facies. Too little work was done on the metamorphic problems of the area to provide for a detailed discussion on this phase of the district geology. The two main divisions of metamorphic rock types on the Zonia property are briefly discussed below.

GREENSCHIST FACIES. Chlorite schist, of the greenschist facies, is derived from the sheared diorite and diabase (?) of the "basic complex". Chlorite is the dominant metamorphic mineral in the schist; very little uralitic hornblende was noted in the sections studied. The relic feldspar grains are strongly fractured and deformed and show some replacement by sericite and clay.

In places rocks of the "basic complex" have yielded massive greenstone. Uralitic hornblende is the dominant metamorphic mineral of the greenstone. Actually, the greenstone should probably be classed in the amphibolite facies, a slightly higher metamorphic grade than the greenschist facies.

PHYLLONITE FACIES. The phyllonite facies is equivalent in metamorphic grade to the greenschist facies, the difference being in the original composition of the deformed rock. The term refers to a rock which shows both weak quartz-sericite schist (phyllite) development and strong cataclastic deformation (mylonite).

Quartz and feldspar porphyroclasts in even the apparently massive quartz diorite are strongly fractured, deformed, and corroded by later minerals. All the feldspar grains are partially replaced and traversed along microfractures by sericite. Augite and hornblende have yielded minor amounts of chlorite, fibrous amphibole, and iron ore. The groundmass is a fine grained mosaic of quartz grains which show some strain; however, not nearly so much as the original quartz phenocrysts of the rock.

DISTRIBUTION. Distribution of the "unsheared" quartz diorite and the quartz diorite schist are shown on the Geologic map. Most contacts between the two are transitional.

The distribution of the greenschist, greenstone, and relic basic rocks from which they are derived was not studied. The impression was gained that the schist bands in the "basic complex" are similar in shape and attitude but more extensive than those in the quartz diorite.

MINERAL DEPOSITS

INTRODUCTION

The copper deposits at Zonia are seemingly of the mesothermal pyritic replacement type as defined by Lindgren. No significant amount of the massive sulfides generally exhibited by the type have been found on the Zonia prospect; however, mineralogy, structure, mode of emplacement, and associated rock types suggest that the Zonia deposits are a weakly mineralized representative of the type.

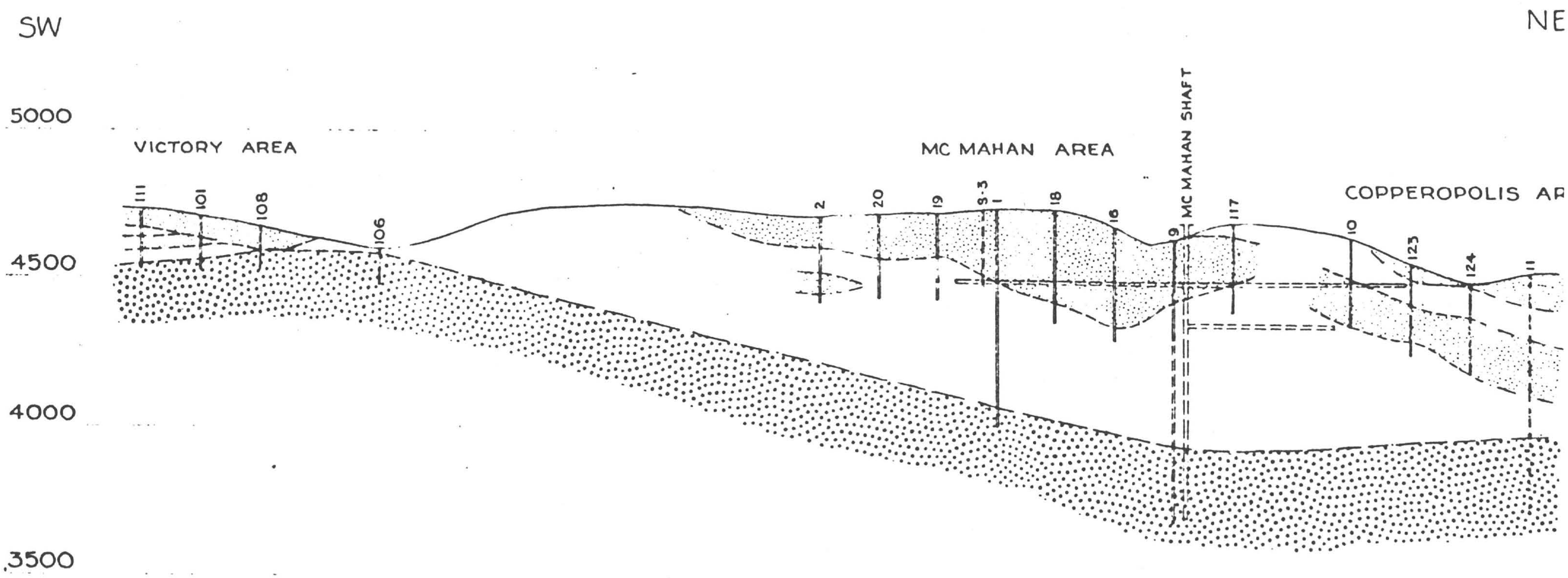

FIGURE 3. ZONIA PROSPECT

LONGITUDINAL SECTION THRU • CENTRAL MINERALIZED ZONE - LOOKING NORTHWEST

JUNE, 1957 SCALE : 1" = 500' J.W. ALLAN

COPPER OXIDES

HYPOGENE SULFIDES

LEACHED WASTE

Major deposits of the mesothermal pyritic replacement type are known at Jerome, Arizona; Rio Tinto, Spain; and Mt. Lyell, Tasmania. The copper deposits at Mr. Lyell, as described by Lindgren (Lindgren-1933), are strikingly similar to those at Zonia.

Little sulfide ore has been found on the Zonia prospect. The hypogene sulfide mineralization is far too low in grade to constitute ore and an ancient zone of supergene sulfides of higher grade has been almost completely destroyed by oxidation and erosion. Several million tons of submarginal-grade oxide copper mineralization derived from the old supergene sulfides constitutes the only realistic hope of the Zonia deposits ever becoming a significant copper producer.

Three main areas of mineralization occur on the Zonia property; (1) the McMahan (Cuprite) area (2) the Copperopolis area, and (3) the Victory area. Of these the McMahan area shows the strongest and most widespread mineralization and has been more intensely prospected than any other area on the property. The mineralized areas are shown on the Geologic map.

The areas showing valuable mineralization may be briefly described as follows:

MC MAHAN (CUPRITE) AREA. The important mineralization in the McMahan area is exposed at the surface mainly on the Cuprite claim and underground on various workings from the McMahan (Cuprite) shaft. The mineralization is dominantly oxide, probably the oxidized remnant of an ancient zone of supergene sulfide enrichment. The oxide zone is underlain by a leached waste zone and deeper low-grade hypogene mineralization. (See Figure 3).

COPPEROPOLIS AREA. Mineralization exposed in the Copperopolis area occurs around and to the southwest of the Copperopolis shaft. Here also oxide mineralization is underlain by a barren leached zone and low-grade hypogene sulfides. (See Figure 3).

VICTORY AREA. The only significant mineralization exposed in the Victory area occurs in the vicinity of Miami Copper Company drill hole No.101. A thin zone of oxide copper mineralization overlies barren hypogene sulfides at comparatively shallow depth. (See Figure 3).

OTHER AREAS. Other less important areas of mineralization may be listed as follows: (1) Sunflower area located on the Sunflower and Malachite claims about 5000 feet northeast of the McMahan shaft, (2) Copper Glance area located on the Copper Glance and Tourmaline claims about 1500 feet east of the McMahan shaft, and (3) Sunrise area located on the Sunrise No.4 and Sunset claims about 1800 feet southeast of the McMahan shaft. Mineralization in these areas is similar in most respects to that in the three larger, better mineralized areas.

MINERALOGY

TYPE AND AGE. The mineralogy of the Zonia deposits is relatively simple. Seemingly the copper deposits are of Lindgren's mesothermal pyritic replacement type which are characterized by simple hypogene mineralogy. Quartz, calcium-magnesium-iron carbonate, pyrite, and chalcopyrite are essentially the only hypogene minerals that normally occur in this type deposit. Several lead-silver veins occur in the Walnut Grove mining district; however, none were seen in the copper-bearing band of quartz-mica schist on the Zonia property. Small gold-bearing quartz veins are scattered over the district occurring usually in rocks of the basic complex.

It is assumed the Zonia deposits are Precambrian in age. The only basis for this assumption is the marked similarity between these deposits and several others in the region which are believed to be Precambrian in age. The ore deposits at Jerome, the Shylock and Yeager mines and the Binghamption-Copper Queen mine may be cited as examples (Lindgren-1926).

Effects of oxidation and supergene enrichment have not greatly complicated the mineralogy of the Zonia deposits. A now almost completely destroyed supergene chalcocite zone has yielded the normally expected oxides, carbonates, and silicate of copper. Remnant hypogene mineralization, mainly pyrite with subordinate chalcopyrite, which persisted into the zone of oxidation has yielded abundant oxides and sulfates of iron and scarce oxide copper minerals. Although a small amount of partially oxidized chalcocite ore has been mined on the property, any future the Zonia deposits may have probably lies in the low-grade oxide mineralization.

Minerals identified in the Zonia deposits are tabulated below.

Hypogene	Supergene
quartz	chalcocite
pyrite	cuprite
chalcopyrite	chrysocolla
ankerite	malachite
calcite	azurite
specularite	tenorite
*molybdenite	libethenite (?)
	"limonite"
	chalcedony

*Hershey (Hershey-1930) reports the occurrence of molybdenite.

HYPOGENE MINERALS. A brief description of the hypogene minerals noted in the Zonia deposits is as follows:

QUARTZ

Quartz, both crystalline and massive, is the dominant vein mineral of the deposits. It occurs mainly as thin veinlets pervading the rock along the countless shears or foliation planes which characterize the more strongly mineralized lenses. Only two or three massive quartz veins more than a foot or so wide were seen on the property. Well formed crystals up to about an inch in length are fairly common along the wider quartz veinlets, especially those occuppying fractures transverse to the schistosity of the enclosing rock. Carbonate and sulfide mineral casts are commonly preserved in many of the narrow, massive quartz veinlets.

A barren quartz-tourmaline vein one foot to three feet wide occurs in quartz diorite on the Copper Glance claim about 1330 feet southeast of the McMahan shaft.

PYRITE

Pyrite is the dominant hypogene sulfide. It occurs with quartz and chalcopyrite along the innumerable minor shears which collectively form a mineralized zone or lens. In areas of stronger mineralization pyrite grains are abundantly disseminated in the rock between veinlet-filled shears.

At the southwest end of the prospect on the Victory claim group, pyrite was noted at the surface in strongly silicified schist; whereas, in the central and northeast portions of the property around the McMahan, Copperopolis, and Sunflower shafts pyrite has been oxidized and thoroughly leached to depths of about 500 feet.

CHALCOPYRITE

Chalcopyrite is the only hypogene copper mineral recognized in the Zonia deposits. It was not seen in place and is known only from drill cuttings, dumps of the deeper shafts, and previous mention in earlier reports written when the deeper underground workings were accessible.

In hand specimens chalcopyrite, always accompanied by and subordinate in amount to pyrite, occurs both as disseminated grains in the rock and along narrow quartz-pyrite veinlets. It replaces pyrite along micro-fractures and grain boundaries. To the unaided eye, the pyrite appears barren.

ANKERITE

An iron-bearing carbonate, probably either ankerite or siderite, was noted in several specimens from the dump of the McMahan shaft. Elsewhere on the property carbonate casts in quartz are fairly common.

CALCITE

Calcite and aragonite occur sparingly in the "copper zone". These minerals are more abundant in the small lead-zinc-silver veins which generally flank the central band of quartz diorite.

SPECULARITE

Small amounts of specularite occur at various places on the property. Some of the specularite may be supergene. Lindgren (Lindgren-1926) notes veinlets of specularite cutting chrysocolla in an occurrence in the Bradshaw Mountains.

SUPERGENE MINERALS. A brief description of the supergene minerals noted in the Zonia deposits is as follows:

CHALCOCITE

Chalcocite is widespread though not abundant in the Zonia deposits. Where seen it occurs as remnant grains in oxide copper minerals, mainly malachite and cuprite. On the 210 foot level of the McMahan shaft chalcocite reportedly was abundant enough to provide a small amount of sulfide ore. Elsewhere on the property chalcocite occurs sparingly at the surface on the Sunrise No.4 claim and traces of the mineral were noted in several of Miami Copper Company's drill holes on and near the Cuprite claim and in the company's drill hole No.25 on the Sunset claim.

In polished section the chalcocite is seen to replace chalcopyrite and pyrite centripetally from the surfaces of small grains and along microscopic fractures. Chalcopyrite was preferentially replaced during the early stages of replacement; however, in specimens showing more advanced stages of enrichment, pyrite is also replaced.

CUPRITE

The occurrence of cuprite parallels closely that of chalcocite. The cuprite is seemingly derived directly from the "in place" oxidation of chalcocite.

CHRYSOCOLLA

Chrysocolla is seemingly the most abundant oxide copper mineral of the Zonia deposits. In general its pattern of occurrence coincides with that of the hypogene copper mineralization. Although the chrysocolla is not generally intimately associated with malachite, the two minerals occur in the same general zones in different ratios of relative abundance.

Sulfuric acid leaching tests made on the oxide ores indicate that the oxide copper minerals are more insoluble than is normal for chrysocolla or malachite. A possible explanation is that part of the chrysocolla is intimately associated with and thus protected by insoluble amorphous silica or chalcedony.

MALACHITE

Malachite runs a close second to chrysocolla in abundance in the Zonia deposits. Malachite shows no definite affinity for any particular rock, structure, or mineralization type; however, most of the malachite seemingly is derived from chalcocite and is more or less indigenous. A closer study of the distribution of the malachite and chrysocolla might reveal a preference of one mineral or the other for certain different geologic environments.

AZURITE

Azurite though much less abundant is closely associated with malachite.

TENORITE

Tenorite of the melaconite of "copper pitch" variety is widespread in the oxidized zone of the Zonia deposits. It is generally closely associated with chrysocolla.

LIBETHENITE (?)

An unidentified oxide copper mineral, possibly libethenite was noted on the Sunset claim near Miami Copper Company drill hole No.25.

"LIMONITE"

"Limonite" including mainly hematite, goethite, and jarosite is widespread in the oxidized zone of the Zonia deposits.

CHALCEDONY

Chalcedony occurs throughout the deposits; however, it is not an abundant mineral. It occurs mainly as miniature crustifications lining voids in the oxidized zone.

STRUCTURE

Structures which have controlled mineralization in the Zonia copper deposits are, in decreasing order of importance, (1) foliation planes in the schistose quartz diorite, (2) stockwork fracturing in some of the more massive rock lenses between schist bands, and (3) minor tensional fractures transverse to schistosity trends. Each structural type is described below.

FOLIATION PLANES. Most of the mineralization in the Zonia copper deposits clearly follows the foliation of the enclosing schist. With the exception of a few minor cross fractures no singular, well-defined mineralized structure was seen. The mineralized shoots are irregular lenses of widely ranging sizes and shapes; however, their greatest dimension consistently parallels the general direction of the foliation planes in the enclosing rocks. Mineralization occurs both in veinlets and disseminated through the rock between veinlets. As each of the countless foliation planes of the schist was a potential veinlet, the bulk of the mineralization probably occurs as veinlet filling.

In the prospect area schistosity trends about N45°E and generally dips steeply west. Slight differences in strike along the mineralized schist band cause a gentle S-shaped flexure of the band (See Geologic Map). At the southwest end of the property on the Victory claims the schistosity strikes about N40°E; to the northeast, at the northeast end of the Black Prince claim the strike swings to about N50°E; the Cuprite or McMahan mineralized zone follows this general trend. In the vicinity of the McMahan shaft the schistosity swings back to the N40°E trend; the Copperopolis mineralized zone occurs in this segment. What effect, if any, this flexure had on the structural control of mineralization is not known.

The dip of the schistosity also changes from place to place on the property. Along the strike of the schist band the dip increases from about 60° west in the vicinity of the Copperopolis shaft to about 70° west on the Victory claims at the southwest end of the property. Changes of dip across the schistosity are more striking. In the segment of the schist band between the Victory claims and the McMahan shaft the dip steepens from about 55° west along the west boundary of the segment to 90° or vertical in the vicinity of a line through the Victory No.2, Shamrock, and Defiance claims. East of this line for an unknown distance of at least 1000 feet the dip is 75°-80° east. In the segment of the schist band northeast of the McMahan shaft, the dip of the schistosity along the west boundary of the segment is about 55° west. However, across the schistosity to the southeast the dip decreases to about 45° west. This anomaly in the areal dip pattern was apparently caused by a northwest striking tear fault exposed 175 feet southwest of Miami Copper Company drill hole No.25.

Little was learned of the subsurface attitude of the hypogene mineralization. In plan the separate shoots are lenticular and range is size from inches in length and width to a maximum of about 1500 feet in length and 300 feet or so in width in the Cuprite (McMahan) zone. If the strong mineralization in the vicinity of Miami Copper Company drill hole No.1 may be correlated with that cut by the McMahan shaft at about the 400 foot level, the shoot has a northeast plunge of about 40°. However, the picture is complicated by supergene enrichment and the "plunge" may simply be the dip of a now oxidized chalcocite "blanket".

Not all the strongly schistose rock within the prospect area is mineralized. Mineralization walls do not generally coincide with shear zone walls; rather the shoots occur within shear zones and exhibit transitional or "assay" walls. No distinction could be made between the type or degree of shearing in the barren and in the well mineralized schist; however, in general it may be said that the best copper mineralization is all in strongly schistose quartz diorite; whereas, the massive, gneissose quartz diorite is essentially barren of copper mineralization.

STOCKWORKS. Three areas of stockwork fracturing in the quartz diorite containing copper mineralization were mapped. The largest and best-mineralized stockwork area, about 1000 feet long by 250 feet wide, is about 700 feet southeast of the McMahan shaft. The smaller areas are 500 feet northwest and 500 feet southeast of the Copperopolis shaft.

In plan the stockwork areas are lenticular with their long dimension parallel to the schistosity of the nearby schistose rocks. Each of the three lenses are bounded on either side by shear zones and probably represent rock which was deformed by breccia-type fracturing at the same time the surrounding rock was being deformed along rather uniform, close-spaced shear planes.

The individual rock fragments in the stockworks, most ranging in size from 1 inch to 6 inches across, are not schistose. The stockworks appear to be rather permeable and it is surprising that they do not host any of the stronger mineralization on the property.

TENSIONAL CROSS-FRACTURES. Many narrow, impersistent fractures closely resembling joints, cut the schistose quartz diorite at high angles to the foliation planes. These fractures were apparently formed after the rock was sheared and compressed into its present schistose and gneissose structure; none of the fractures seen show evidence of having been offset along the planes of schistosity.

Many of the fractures contain quartz-pyrite-chalcopyrite veinlets. Most range from a fraction of an inch up to 2 inches or so in width. The largest mineralized cross-fracture seen is on the Cuprite claim about 75 feet south of Miami Copper Company drill hole No.1. The vein is about 4 inches wide and strikes about N70°W It is exposed along its strike for 20 feet or so. The contribution of these veinlet-filled fractures to the total Zonia mineralization is small.

TIMING-STRUCTURE vs MINERALIZATION. The timing of the structural deformation, here almost exclusively of the shear type, and the hypogene mineralization is difficult to determine closely. Certainly most of the shearing preceded the mineralization. There are several indications that no significant amount of shearing has affected the mineralized rocks since the epigenetic minerals of the Zonia deposits were introduced. The indications are as follows:
(1) Tensional fractures (joints?) cut the schistose rocks at high angles to the planes of schistosity. Many of these fractures, some up to about 2 inches in width, contain quartz-pyrite- chalcopyrite mineralization. None of these fractures or veinlets are offset along the planes of schistosity.

(2) Well-formed pyrite and quartz crystals occurring along and near the foliation planes in the schist are not megascopically shattered or otherwise deformed. Many of the veinlet minerals show microscopic fracturing.

(3) Where the rock is more or less silicified, thin sections show the individual grains in the silicification mosaic are not fractured or deformed. In contrast, the adjacent remnant rock minerals, mainly quartz and feldspar, are severely shattered and deformed.

HYDROTHERMAL ALTERATION

Very little work was done on the problems of hydrothermal alteration at Zonia. Due to the pervasiveness of quartz-mica metamorphism in the mineralized rock, it is extremely difficult to differentiate between the metamorphic minerals and similar minerals which result from hydrothermal alteration.

There definitely are zones in the mineralized quartz diorite schist which are strongly silicified. The silicification is evidently later than the shearing and metamorphism which impressed the schistosity on the quartz diorite. However, not all well mineralized schist is strongly silicified.

Feldspars are commonly altered to clay and sericite but this alteration may be dominantly a result of regional metamorphism. Similarly, the chloritization of biotite and hornblende may be the result of either or both hydrothermal alteration and regional metamorphism.

GEOLOGIC HISTORY OF MINERALIZATION

HYPOGENE. Hypogene mineralization in the Zonia deposits was introduced probably in Precambrian time following the intrusion of the quartz diorite into the "basic complex". As previously mentioned the mineralization seemingly post dates the strong shearing in the quartz diorite. Too little work was done on the hypogene mineralization to permit a discussion of the detailed history or mineral paragenesis.

OXIDATION AND SUPERGENE ENRICHMENT. The hypogene sulfides of the Zonia deposits were exposed to oxidation and enrichment sometime between Precambrian and Late Tertiary times. Two or more surfaces of division between oxide and sulfide zones are present. The upper and older surface is a "ghost" and is indicated by the top of an older zone of supergene sulfides now to a large degree destroyed by oxidation and erosion. It is this oxidized remnant that contains the mineralization recently explored on the Zonia property. The present bottom of oxidation is from 500 feet to 700 feet below the above, older surface except at the southwest end of the property on the Victory claims where hypogene sulfides occur at depths as shallow as 20 feet beneath the present outcrop (See Figure 3). A very weak, thin zone of supergene sulfide enrichment occurs at places just below the present bottom of oxidation.

No definite dating of the above cycles of oxidation and enrichment can be made due to the extreme hiatus between the mineralized Precambrian host rock and the overlying Late Tertiary gravel and basalt. The few data collected seem to indicate that the enriched sulfide bodies were leached and oxidized almost to their present condition prior to the basalt eruption although there has clearly been some post-basalt leaching of the oxide mineralization. Data suggestive of the post-oxidation age of the basalt are scant; however, there are no indications that post-basalt erosion is responsible for the oxidation and enrichment in the Zonia deposits. The development of a mature erosion surface, which coincides roughly with the present surface over much of the mineralized area, immediately above the sulfide bodies should have caused oxidation to a considerable depth depending on the rate of erosion and depth of the water table.

EXPLORATION

EXAMINATION AND ACQUISITION

The McMahan and Victory groups of claims were examined by J.E. Fowells in March, 1949. At that time he remarked on the good capping found on both properties, and conjectured that a larger body of oxide ore might be found on the Victory claims than that developed on the McMahan property.

The area was again examined on June 21 and 22, 1955, by J.W. Allan. At that time it was recommended that the property be acquired under lease and option and that a minimum program of exploration be initiated. Negotiations with the various property owners were started in the fall of 1955, and all option agreements were signed during February, March, and April of 1956. Ten fractions were staked by the company between December, 1955, and the following March in order to protect open ground between the optioned claims. In April, 1956, 22 claims were staked in order to take in a possible extension of mineralized ground under gravel and basalt cover on the south end of the property.

MAPPING

Geologic mapping of the property began in January, 1956. An area approximately 6,000 feet long in the direction of strike and about 2,000 feet wide was mapped on a scale of 1"=200', with plane table and telescopic alidade. This covered the zones of best mineralization from the edge of the gravel cover on the Victory claims on the southwest to the Copperopolis workings on the northeast. This work was started by J.W. Allan and J.J. Spencer. In May, Reed Phillips replaced Spencer on the instrument. The plane table mapping was completed in June.

Reconnaissance geologic mapping of a larger area surrounding the mineralized zones was carried on intermittently during the same period as the plane table work. This reconnaissance work was also done by Allan and was completed in July. Mapping was done directly on aerial photographs on a scale of approximately 1"=660'. The area included varied from 2,000 to 3,500 feet in width and covered a strike length of about 17,000 feet.

Fairchild Aerial Surveys, Incorporated, of Los Angeles, photographed the property in April, 1956, for the purpose of making a topographic map. Excellent contact prints were delivered in black and white of an area seven miles long and two miles wide on a scale of 1:20,000. Color transparencies were also made of the same area on a scale of 1:10,000. The completed maps were on a scale of 1"=200', with a 10 foot contour interval.

A geologic photoanalysis of the area was made at the company's request by Donald J. Belcher & Associates, Incorporated, Ithaca, N.Y. This work was done using photos furnished by the Soil Conservation Service, without benefit of ground checking. The results were disappointing. The Belcher Company furnished an overlay and a report in which they attempted to map the rock types, areas of alteration, and likely prospect areas. In general, they failed to correctly identify the rock types except for the basalts and some areas of conglomerate. These types are usually inherently easy to identify. The prospect areas delineated by Belcher were found to show no signs of alteration or mineralization when checked in the field. The Zonia mineralized zone was not recognized by Belcher and was mapped as agglomerate. A detailed criticism of the Belcher Report was made by J.W. Allan, and is on file.

DRILLING

A total of 50 holes were drilled on the property, beginning on April 30, 1956, and ending on December 15, 1956. Of these, 26 were drilled with churn drills and 24 with a rotary drill.

CHURN DRILLING. Three churn drills were moved to the property. Two of these were gasoline powered, crawler mounted, Bucyrus Erie 22T's belonging to the company. The third machine belonged to the contractor, the J.T. Dungan Drilling Company, and was a trailer mounted Bucyrus Erie 24L. Drilling was done on a 10-hour day shift basis. Two rigs were kept in operation for the duration of the project, the third rig being kept for standby. All holes were collared with a 10-inch bit. Casing was resorted to when necessitated by caving, and was only used in three holes. 8 and 6 inch casing in 20 foot joints was used. The contract price for churn drilling was $4.00 per foot from the surface to 500 feet and $5.00 per foot below 500 feet. Casing, fishing, and company down time was paid for at the rate of $10.00 per hour. In addition, the company furnished drill rope and fishing tools.

ROTARY DRILLING. Angle air rotary drilling, although a relatively untried technique, was conceived of as a method almost ideally suited for the conditions at Zonia. These favorable conditions were the softness of the rock, low water table, and shallow depths desired on most of the holes. The only company which submitted a bid on the job was Minerals Engineering Company, Grand Junction, Colorado. They agreed to drill on a straight shift rate of $70 per 8 hour shift plus the cost of the bits used. Rotary drilling started on July 21 and was concluded on November 3, 1956. Holes were drilled to an average depth of about 300 feet, the deepest being 355 feet. Of the 24 holes drilled, 3 were vertical, the rest were inclined at an angle of 45° on a S45°E bearing. All holes were collared with a $6\frac{1}{4}$ inch bit to a depth of about 6 feet. Casing was then set and the hole was finished with a $4\frac{1}{4}$ inch bit. All drilling was done with tri-cone rock bits. Bits were charged at $55 each and most were retipped at a price of $12 each. Retipping approximately doubled the life of the bit.

The machine used for rotary drilling was a Joy 22HD diamond drill mounted on a 4x4 truck. A separate 600 cfm compressor furnished air. An auxiliary mast and block were rigged for pulling rod at 45° and 60° angles.

SAMPLING

All sampling was done by men on company payroll, one for each operating rig. All samples for assay were shipped from Prescott to Miami via Greyhound bus.

All drill hole sampling was done in five foot intervals. In the case of the churn drills, all the sludge from a five foot run was run through a three deck splitter. The resulting one eighth split was then further split by hand in a Jones splitter to about one or one and a half gallons. The sample was then dried, rolled, and split in a smaller splitter to fit a one quart ice cream carton. A character and a panning sample were made from the reject of the last wet split from each run and were dried and sacked. After logging, these samples were retained in four-dram plastic vials.

The rotary samples were also cut at the end of each five foot run. In this case, the dry cuttings, carried up the hole by the air blast, entered a box at the collar of the hole and were diverted through a rubber hose to a Ducon dust collector. The entire sample for each run was split by hand through a Jones splitter, usually to 1/32nd, and put in a one quart paper carton for shipment. A character sample from the reject was washed and dried.

An air jet, at right angles to the direction of the hole and in line with the rubber hose was used to divert the air stream to the dust collector. However, it was found that the jet was not necessary and only increased the dust loss from the collector. The use of the jet was discontinued. Loss of dust around the drill rods, which ran through a tight rubber gasket, was negligible.

LAYOUT OF HOLES

Three separate areas were known to contain copper mineralization of good grade. These were on the Victory No.2 claim belonging to C.H. Brown, the Cuprite claim of the McMahan group, and around the old Copperopolis workings on Gillingham's ground. The mineralization follows the strike of the schistosity, at about N45°E. A grid was established with the zero line running N45°E through the center of the McMahan zone. Cross lines were established at 600 foot intervals along the zero line. These lines were designated by their distance north or south of the McMahan shaft. The first holes were laid out at 200 foot intervals along these cross lines. The first churn drill holes were drilled on the S00, S600, and S1200 points on the zero line in order to delineate the McMahan zone. A little later, drilling was started on the Copperopolis zone on lines N600 and N1200. The first rotary holes were drilled at 200 foot intervals on the S2700 and S3300 lines on Victory ground.

After it was found that the low grade mineralization outside of the previously known areas did not carry enough copper to add materially to the tonnage, the remainder of the drilling was devoted to deep testing of the primary mineralization and a possible second zone of enrichment, and to blocking out the higher grade oxide on 200 foot intervals. Six deep holes were drilled, two on the McMahan zone, one each on the Copperopolis and Victory zones, one on an area of capping east of the main schist belt, and one on the Sun-Flower claim as required by the lease.

CONCLUSIONS

RESULTS OF DRILLING

A minimum of 27,000,000 tons of 0.4% copper amenable to heap leaching had been set as a goal in exploring the Zonia property. This figure was arrived at by assuming reasonable open pit mining costs, calculating the cost of recovery from data on Castle Dome and Miami mine leaching, and amortizing a $4,000,000 capital investment.

With three areas to work on, there seemed to be a reasonable chance of reaching this goal. Avenues for extension of known ore grade mineralization in these three areas were the following:

1. Victory Area: The zone of altered schist, with some included areas of less schistose quartz diorite, is approximately 1,000 feet in length and about the same in width. The schist in this zone has the appearance of being the most intensely altered rock on the property. Prospect trenches on the best mineralized portions of this zone showed values from 0.6% to 3.26% over varying widths. The presence of enough low grade copper in the rest of the zone could make possible the mining of a fairly large tonnage. There was also the possibility of extension of the mineralization under the gravel cover at the south end, and its extension, under gravel, to a connection with the McMahan mineralization 1,500 to 2,000 feet north.

2. McMahan Area: In this area there was a possibility of extension of the known mineralization west under gravel, south toward the Victory, and north toward the Copperopolis. The best possibility for greatly expanding the area of known ore lay in prospecting the silicified quartz diorite immediately to the east to see if the stockwork and copper mineralization existing on surface was of mineable grade.

3. Copperopolis Area: The same conditions prevailed in the Copperopolis area as in the McMahan, except that the high grade copper appeared to cover a smaller area. However, scattered shows of copper and mineralized quartz diorite adjoining offered the hope of developing some tonnage.

In addition to the above, enough holes were planned to check all likely areas at depth.

The drilling program thoroughly explored all the possibilities enumerated above.

The most disappointing area was on the Victory claims. The first five rotary holes, on the S3300 line, showed that the high grade ore extended to only a shallow depth and that the ground between the better grade schist zones contained only a few hundredths of a percent of copper. Two holes drilled on the S2700 line showed a very narrow zone of good grade on the north end. Six more holes were drilled 200 feet north and south of the first three holes to check out the extent of the eastern zone. The area was then abandoned.

Exploration of the McMahan area showed that the main zone of higher grade copper narrowed to uneconomic widths at both the north and south ends. Good grade copper was found in holes along the zero line over a strike length of 1,000 feet, from N200 to S800. Two churn drill holes and three inclined rotary holes checked out the west limit of the zone and revealed an unexpected very steep westerly dipping contact between the schist and the gravel. Drilling on the E200 and E400 lines showed only low grade copper in the eastern part of the schist zone. Holes in the non-schistose quartz diorite further east showed a copper content on the order of 0.1 to 0.2%. Furthermore, it was found that, while two-thirds to three-quarters of the copper in the central part of the zone was readily acid soluble, less than half of the copper in the east side was acid soluble. Drill logs showed a greater percentage of carbonates in the central part, and more silicates in the eastern part. This was confirmed by leach tests performed by the experimental laboratory. Tests run on ore from the McMahan shaft area before drilling started showed recovery of a large percentage of the total copper. Later tests on rock from trenches west of holes nos. 16 and 18 showed much poorer recovery.

The Copperopolis area showed little beside the main high grade zone at the Copperopolis shaft, which apparently bottomed at a rather shallow depth.

Deep drilling, to a maximum of 952 feet, did not disclose either high grade primary mineralization or sufficient enrichment to be of economic interest. Hole No.11 in the Copperopolis area and Hole No.21 on the Sunflower claim gave the most clear cut picture of the leaching and enrichment cycle. In each case the high grade oxide at the surface, probably derived from an ancient chalcocite zone, was underlain by a leached zone averaging about 0.1% copper. At about 400 to 600 feet depth, a second zone of slight enrichment was noted, with a little chalcocite and some native copper at the top of the zone. The enriched zone in Hole No.11 consisted of 180 feet averaging 0.301% total copper and 0.028% oxide copper. In Hole No.21, the zone was 140 feet thick and averaged 0.322% total copper and 0.030% oxide copper. The protore in the favorable zones apparently averaged about 0.2%.

TONNAGE AND GRADE CALCULATIONS

After it became apparent, from the drilling results, that the McMahan area was the only one which could possible be mined profitably, assay plans and sections of this area were prepared. A new cost estimate was made and cut off grade was calculated by J.H. Gray. Cost of plant, mining equipment, and dump preparation was estimated at $3,000,000. A mineable ore body of 10,000,000 tons was assumed to bear amortization of the capital cost. Other factors were a 23¢ per ton mining cost, 22.06¢ per pound processing cost (including 1¢ per pound profit), and 67½% recovery of the oxide copper. A future market price of 45¢ per pound was assumed. The resulting cut-off grade was 0.17% oxide copper. Minimum grades were then calculated for various waste to ore ratios.

A pit layout was then made by J.B. Fletcher in order to determine the tonnage and grade of mineable material. Pit limits were established to calculate minimum grades. A total of 2,631,120 tons of ore at 0.444% oxide copper was measured on five levels. Mining this would entail the moving of 2,016,000 tons of waste. As this tonnage was far below the amount estimated as necessary to amortize the capital investment, it was recommended that the lease and option be terminated.

SUMMARY OF COSTS

X-26A Engineering & Surveying:

Labor	5,378.26	Surveying 51 old claims
Supplies	77.91	and staking & surveying
Expenses	2,295.26	22 new claims, plus
Automotive Depreciation	98.34	miscellaneous surveying
Fairchild, contact prints		work, $107.53 per claim
(includes Que Paso)	1,740.00	(excluding cost of Fair-
Fairchild Topographic maps	6,525.00	child mapping).
Sub Total	16,114.77	

X-26B Geological Mapping:

Labor	5,345.25	Field work by 2 geologists
Misc. Supplies	136.84	for approximately 5
8 rope ladders	256.00	months; about $940 per
Expenses	3,210.27	man per month. (excluding
Automotive depreciation	422.91	cost of Belcher mapping).
Photo-mapping by Belcher & Associates	1,600.00	
Sub Total	10,971.27	

X-26C Location & Assessment:

Labor	566.60	Location & assessment
Supplies	10.02	holes contracted @ $125.
Expenses	494.64	Monument building contract-
Automotive deprecation	143.57	ed @ $2.00.
Morris & Malott	284.63	
Location work and fencing off shafts, on contract	4,359.16	
Sub Total	5,858.62	

X-26D Roads & Drill Sites:

Labor (Engineering and Supervision)	1,562.72	Direct cost of bulldozer
Supplies	2.61	work: 57 drill sites,
Expenses	227.28	$3,048.00, or $53.47 ave.
Automotive depreciation	79.55	Improvement of 6,860 feet
Dozer work on contract	9,815.58	of old road, $420.00, or
Sub Total	11,687.74	6.12¢/foot. Construction
		of 30,736 feet of new road
		$5,340.00, or 17.37¢/foot.
		Total cost of company
		Engineering and supervision
		was 19.07% added to
		contract cost.

X-26E Drilling:		
Labor (Engineering & Supervision)	2,662.57	Churn drilling 10,763 feet, $5.85/foot.
Expenses	709.37	Rotary drilling 6,973 feet, $2.66/foot. (including engineering and supervision).
Contract cost of moving equipment to property	901.50	
Misc. supplies & parts	4,001.12	
Casing	3,449.83	
Drill rope	1,957.21	
Loading pump	118.49	
Deep well pump	315.13	
Total Supplies	9,841.78	
Direct cost of contract drilling	68,020.81	
Sub Total	82,136.03	
X-26F Sampling & Assaying:		
Labor	18,361.05	Sampling and assaying 10,763 feet of churn drill hole, $1.86/foot.
Expenses	2,942.50	
Cost of moving equipmbnt to property	180.00	
Misc. supplies	875.74	Sampling and assaying 6,973 feet of rotary hole, $0.86/foot. (including supervision and logging).
100 sample cans	333.00	
3 drying stoves	344.04	
Total Supplies	1,552.78	
Laboratory expense	3,794.79	
Sub Total	26,831.12	
X-26G Option Payments:		
	11,000.00	
X-26H Miscellaneous:		
Taxes on claims	173.30	
Expenses	9.30	
Sub Total	182.60	
TOTAL	164,782.15	
X-15 Distribution	17,372.42	
GRAND TOTAL	$182,154.57	

REFERENCES

Anderson, C.A.; "Older Precambrian Structure in Arizona"; Bull. Geol. Soc. Amer., Vol.62, 1951.

Hershey, O.H.; Private report to Hammon Copper Co., 1930.

Jagger, T.A. and C. Palache; "Bradshaw Mountains Folio, Ariz."; USGS Geol. Folio 126, 1905.

Lindgren, W.; "Mineral Deposits"; McGraw-Hill, 1933.

Lindgren, W.; "Ore Deposits of the Jerome and Bradshaw Mountains Quadrangles, Ariz."; USGS Bull.782, 1926.

Wilson, E.D.; Cunningham, J.B.; and G.M. Butler; "Arizona Lode Gold Mines and Gold Mining"; Ariz. Bur. Mines, Bull.137, 1934.