



Geological Notes on the Miami-Inspiration Mine

E. F. Reed and W. W. Simmons

1962, pp. 153-157. <https://doi.org/10.56577/FFC-13.153>

in:

Mogollon Rim Region (East-Central Arizona), Weber, R. H.; Peirce, H. W.; [eds.], New Mexico Geological Society 13th Annual Fall Field Conference Guidebook, 175 p. <https://doi.org/10.56577/FFC-13>

This is one of many related papers that were included in the 1962 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual [Fall Field Conference](#) that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

This page is intentionally left blank to maintain order of facing pages.

GEOLOGICAL NOTES ON THE MIAMI-INSPIRATION MINE

E. F. REED

Inspiration Consolidated Copper Company

and

W. W. SIMMONS

Miami Copper Company, Division Tennessee Corporation

INTRODUCTION

History

The story of the Miami-Inspiration ore body has many chapters. It has been the scene of many innovations in mining and metallurgy and its stories are well covered in Parsons' *The Porphyry Coppers*.

Miami Copper Company was incorporated in 1908, and made its first production in 1911. Inspiration Consolidated Copper Company was incorporated in 1911 to consolidate the properties of the Inspiration Copper Company and the Live Oak Development Company. Production began in 1915.

Production at Miami has been entirely from underground mining and in-place leaching. During the period 1911-1925, production amounted to 24,400,000 tons averaging about 2% copper. From 1925 to 1959, production was from the low-grade ore bodies. Total production was 159,000,000 tons, which yielded in excess of 2,300,000,000 pounds of copper. Production since 1959 has been from in-place leaching at the rate of about 1,500,000 pounds of copper per month. In June, 1960, Miami Copper Company was liquidated. Since that date, the property has been operated as the Miami Copper Company, Division Tennessee Corporation.

As stated, Inspiration began production in 1915. Until 1948, all production was from underground mining. From 1948 to 1954, production was from both underground and open-pit operations. Since 1954, all production has been from open-pit operations. Inspiration was the first of the porphyry coppers to use only a flotation mill for recovery. This mill continued in operation until 1932. In 1926 an acid ferric-sulphate plant, unique in the industry, was put into operation for the recovery of copper from mixed oxide and sulphide ore. In 1956, the re-equipped concentrator was placed in operation, and copper is now recovered by a dual process of leaching followed by flotation. Production up to January 1, 1962, totaled 175,374,531 tons which yielded 3,322,124,665 pounds of copper.

GENERAL GEOLOGY

As shown on the accompanying map and section (Fig. 1), the Miami-Inspiration ore body has a strike length of slightly over 12,000 feet. Its width ranges from 1000 to 2500 feet and averages nearly 2000 feet. The thickness or height ranges from 40 to 700 feet. Although mined as separate entities and severed by faults, it is essentially one zone of mineralization, and thus is one of the great ore bodies of the world.

The general trend of its strike is east-northeast. It lies along the northern contact of a prominent bulge of intrusive igneous rock. Ore-grade mineralization is in schist, granite, and granite porphyry. In general, the schist-intrusive contact dips steeply to the south.

In the east end of the orebody, mineralization tends to follow the northeast trend of the schistosity. Farther west, the sulphide veinlets tend to cut across the schist-

osity and dip southerly toward the intrusive. In general, the more massive schist beds are the better mineralized. There is no constant system of orientation of veinlets in the intrusives.

In common with most of the other porphyry copper deposits, there is a three-fold vertical division in the orebody. A leached zone overlies a zone of supergene enrichment. The latter zone averages about 300 feet in thickness. Below it is the protore, which in general is too low in grade to be mineable.

ROCK DESCRIPTIONS

Precambrian Rocks

Pinal Schist. This unit consists of a series of metamorphosed sedimentary and volcanic rocks of early Precambrian age.

The general strike of the schistosity is about N50°E, and the dip is usually steeply southeast. There are many variations, however. The series is composed of a coarse-grained quartz-muscovite schist, and a fine-grained quartz-sericite-chlorite variety with some fine-grained amphibole schist. The units are not usually mapped separately.

Pioneer Formation. The Pioneer formation was originally called the Pioneer shale by Ransome (1919). It is part of the Apache group of Precambrian age, but is younger than the Pinal schist. The basal part is a pebbly arkose 15-20 feet thick. This grades into hard, fine-grained reddish-brown arkosic sandstone which, in some localities, grades into fine-grained sandstone and arenaceous shale.

Tertiary Rocks

Diabase. The age of the diabase shown on the map (Fig. 1) is not definitely established; however, some is believed to be of Tertiary age. It is dark gray or dark greenish gray, and ranges in texture from aphanitic to coarse grained. The composition ranges from augite diabase to hornblende diabase.

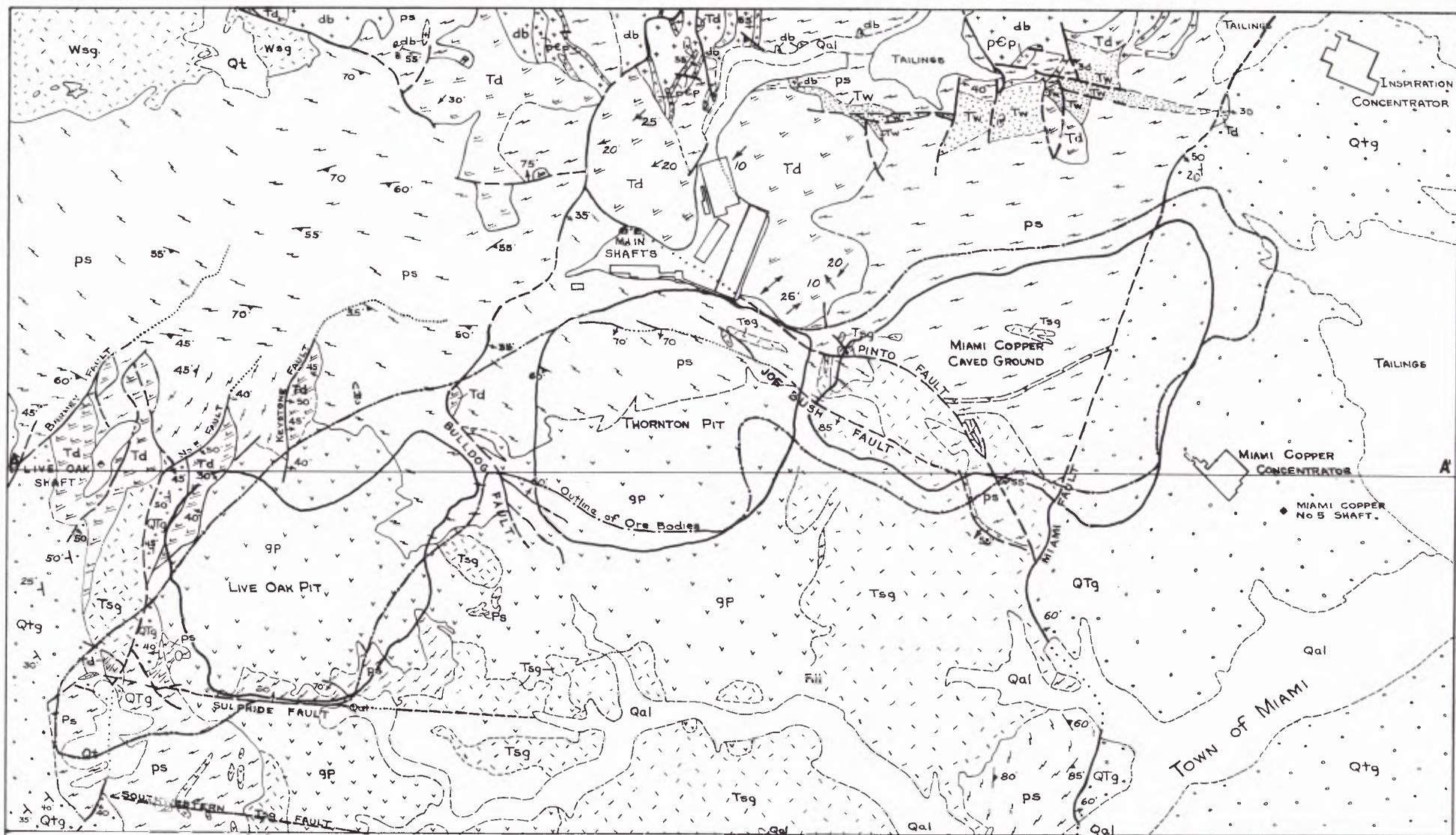
Willow Springs Granite. This granite is gray and finer grained than the usual granite. It consists of abundant quartz and microcline, with oligoclase, muscovite and biotite. Accessory minerals are apatite and tourmaline, but they are not abundant.

Schultze Granite. This granite is more correctly designated as a porphyritic quartz monzonite. Large orthoclase phenocrysts 1 to 4 inches long are set in a coarse matrix composed of quartz, oligoclase, orthoclase and biotite. Accessory minerals, magnetite, apatite and sphene, are sparse. It weathers to a pale yellow.

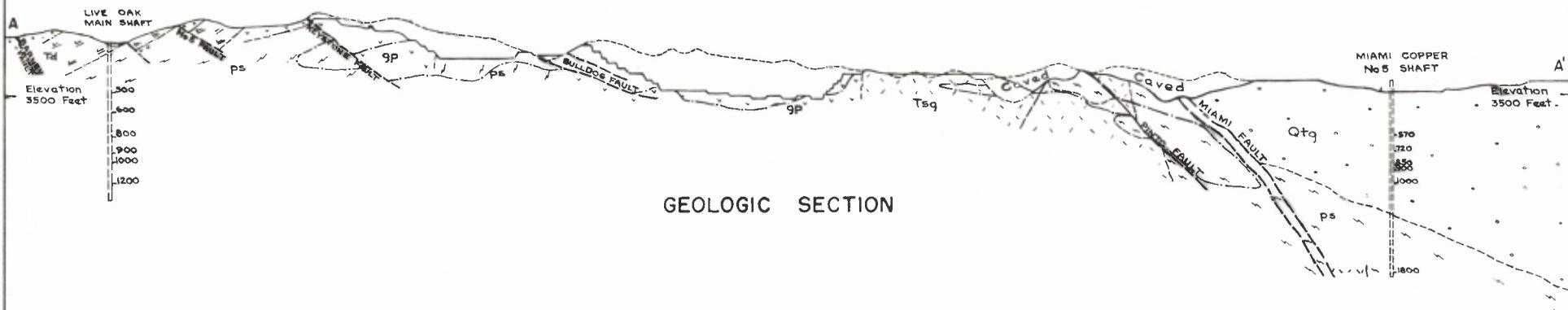
Granite Porphyry. This is considered to be a phase of the Schultze granite, but it is distinctly later intrusion. It is porphyritic with a nearly aphanitic groundmass, conspicuous quartz phenocrysts, and biotite, oligoclase, and orthoclase constituting the remainder of the phenocryst fraction. It generally weathers light gray.

Whitetail Conglomerate. The Whitetail conglomerate consists of detrital components of considerable variety. In general, it does not occupy large areas of outcrop.

Dacite. The dacite has an aphanitic or glassy



GEOLOGIC PLAN



GEOLOGIC SECTION

LEGEND

Quaternary		Talus and Alluvium		35° Strike and dip of beds
		Gila Conglomerate		60° Strike and dip of foliation
Tertiary		Dacite		20° Bearing and plunge of lineation
		Whitetail Conglomerate		Horizontal lineation
		Granite Porphyry		Shaft
		Schultze Granite		Outline of ore bodies
Pre-Cambrian ?		Willow Spring Granite		Outline of pits and caved ground
		Diabase		Faults
		Pioneer Formation		
		Pinal Schist		

Figure 1.-
GEOLOGIC PLAN and SECTION
MIAMI and INSPIRATION MINES
GILA COUNTY, ARIZONA



DWJ

groundmass, with phenocrysts of plagioclase, sanidine, quartz and biotite. It contains many fragments of older rocks. It is underlain in most places by a tuff layer from 10 to 100 feet thick, near the top of which there is commonly a black vitrophyre.

Quaternary Rocks

Gila Conglomerate. This name is a catch-all term for all of the sediments deposited in the area after the dacite eruptions and before the last period of deformation. The composition changes laterally depending on the source of the constituents. It thus contains fragments of all of the older rocks, but schist and dacite fragments are most prevalent.

STRUCTURE

Structure in the Globe-Miami area is to some extent related to the general structure of the Precambrian schist, which trends northeasterly and dips southeast. This structure is distorted in the vicinity of the intrusives, and was to a considerable extent obliterated near the contacts and in the mineralized zones. The lack of schistose structure in the mineralized zones may be due to the presence there of more massive beds of schist in which fractures were more readily developed that favored mineralization and enrichment.

The structural control of intrusion of the porphyritic phase of the Schultze granite, with which the ore bodies are associated, is shown by some of the existing structures. One of these, the Miami fault, strikes N25°E, and dips about 50°E dropping the Gila conglomerate east of the ore bodies downward 2,000 to 3,000 feet. This fault may have had some pre-porphyry movement, as indicated by the porphyry-schist contact extending along the general fault strike beyond where the present Miami fault swings into the trend of the Pinto fault for some distance. This relationship, as well as general relationships between the various faults, is shown on the geologic plan of Figure 1. East of the mining areas, the ore bodies appear to be cut off by the Miami fault, although some sections show that the ore did not reach the fault zone, or that there is a leached zone near the fault. Some ore has been found in diabase at considerable depth east of the Miami fault, and supergene-enriched sulphides were found in one drill hole below low-grade hypogene material near a branch of the Miami fault.

The Sulphide fault is also a pre-porphyry structure. It has an east-west trend, and dips steeply and irregularly to the north. The contact between schist and porphyry is in the fault plane for some distance, but the ore bodies do not appear to be displaced. The Sulphide fault cannot be traced in the porphyry for any distance, and passes under conglomerate to the west. This fault is paralleled by the Southwestern fault about 1,000 feet farther south. The Southwestern fault may be a younger structure, as it can be traced in the porphyry and appears to displace the ore zone.

The Pinto fault strikes northwest and dips about 45°-NE. It cuts through the mining areas in both the Miami Copper and Inspiration workings. At the junction of the Pinto with the Miami fault, the Miami swings to follow the trend of the Pinto for more than 1,000 feet. The Pinto fault is irregular, with a broad crush zone and some clay gouge. Drag fragments of mineralized material are present in the fault zone, and indications of post-fault mineralization have been noted. Although the ore bodies appear to be downthrown east of the fault, there also

appears to be a zone of higher grade hypogene material in the footwall of the fault in the Inspiration workings that was probably controlled by a pre-mineral structure. Also, the Miami Copper ore bodies are best developed in the acute angle near the junction of the Miami and Pinto faults, which suggests pre-mineral fault movement, but there is no clear indication that the faults were channels for mineralizing solutions.

Other faults in the Miami Copper workings appear to have minor displacement. However, where a crosscut from the No. 5 Shaft, which started in conglomerate, encountered the conglomerate-schist contact east of the Miami fault, there was considerable clay developed at the contact, which might indicate appreciable movement.

The Joe Bush fault is more or less parallel to the Pinto fault, but dips steeply to the southwest or is almost vertical. It passes south of the Miami Copper workings, but is well exposed by the workings on the Inspiration 600 Level. On this level there is an apparent horizontal displacement of the schist-porphyry contact of more than 1,000 feet. This large movement is not shown on the surface, and may in part be due to a pre-porphyry structure that controlled emplacement of the porphyry.

The Bulldog, Keystone, Number Five, and Barney faults are north- to northeast-trending faults, dipping flatly to steeply to the east. The movement on these faults is normal, with the eastern blocks downthrown. The amount of movement on some faults is shown by the displacement of the post-mineral dacite beds.

The Bulldog fault is roughly parallel to the Miami fault, and dips 35-40°E. This may also be a pre-porphyry structure with some post-porphyry movement, inasmuch as a dike of porphyry intruded the fault zone and the fault cannot be traced far into the porphyry or granite. The fault branches to the south, and there are a number of steeper hanging-wall splits that have about 100-foot displacements. Some post-supergene enrichment movement on these faults is shown by the downward displacement of the ore bodies to the east.

The Keystone fault trends northeasterly and dips about 45°SE. As shown on the geologic plan of Figure 1, it probably swings to join the Bulldog fault north of where it is exposed at the surface. There is a displacement of about 300 feet on this fault, but its location has never been well established in underground workings.

West of the Keystone there are the Number Five fault, the Barney fault, with about 600 feet displacement, and other smaller structures. These have a general northeasterly trend, and dip to the southeast. Some rotational movement on these structures is shown by tilting of the bedding of the conglomerate, and by the slope of the dacite beds and the pre-conglomerate land surface. The Sulphide fault, which guided emplacement of the porphyry, would have had a southerly dip before tilting took place, and continued movement on that fault may have caused some anomalous structural conditions, such as schist overlying dacite in drill holes in the area south of the projection of the Sulphide fault.

From underground mapping and drill-hole information, the ore bodies appear to be cut off on the west by the Porphyry fault, which trends about N15°E, and dips 20°E, although there is a considerable decrease in size of the ore zone before it reaches the fault. This fault is either cut off by the Barney fault or there is considerable steepening of dip towards the surface, and the Barney fault

represents the outcrop portion of the same structure. Exploration west of these structures has encountered mineralized schist, but no ore bodies.

MINERALIZATION

In the Miami-Inspiration Mines, hypogene mineralization appears to be closely associated with the intrusion of the porphyritic phases of the Schultze granite. The porphyritic phases of the granite are probably part of the main intrusive, but represent later surges of magma after the parent body had solidified to some extent. In some places the porphyritic character could be the result of later alteration.

The source and mode of emplacement of the mineralizing solutions is not known. In some portions of the porphyry, veins containing quartz and pyrite with minor chalcopryite have alteration bands of sericite near the veinlet, and clay minerals developed farther out, similar to those described by Sales and Meyer (1948) at Butte, Montana. In other portions, there is a large amount of orthoclase present that may or may not be related to the ore-bearing solutions. Chalcopryite commonly appears to be later than the quartz-pyrite assemblage, and molybdenite is usually associated with veinlets of a glassy variety of quartz that cuts all other veins.

Hypogene mineralization was not strong in these mines, and most of the ore bodies are the result of supergene enrichment. In one drill hole, which had penetrated fairly deeply into the porphyry from the lower levels of the Miami Copper workings, veinlets were noted that consisted of sericite bands containing very small blebs of chalcopryite. These resembled minute drops of sulphide which had been moved along a fracture.

In some of the higher grade hypogene zones in schist in the Inspiration Mine, diamond-drill cores contained veinlets of chalcopryite up to one-eighth of an inch thick, unaccompanied by either quartz or pyrite. Inasmuch as the rock is sericitic schist, no zones of alteration could be observed.

In general, the mineralization in both the Miami and Inspiration Mines is confined to a belt on either side of the schist-porphyry contact. This generalization may be misleading because the ore bodies extend some distance away from the contact along the Miami fault to the east, and along the Sulphide fault to the west, and some of the other fault zones may have affected the distribution of hypogene mineralization and the movement of supergene solutions. Irregular dikes and sills of porphyry may also have had an influence on the location of hypogene mineralization.

On the Miami Copper 1000 Level, very little hypogene copper mineralization was noted, but a plan showing the distribution of copper values indicated bands of higher grade near the Miami and Pinto fault zones. Zones of higher hypogene copper content were discovered by drilling near the Joe Bush fault, and between that fault and the Bulldog fault. Drilling in these zones has not been extensive, as the grade of material was not high enough to support underground mining under present conditions.

At the west end of the Inspiration Live Oak Mine, the ore bodies plunge to the southwest. Geologic maps and drill-hole data indicate that the copper values were mostly supergene even to the bottom levels. No porphyry was

encountered in any of the levels below the 600, and the drill holes show no porphyry near the ore bodies. Although some primary chalcopryite was found, mainly in the crushed zone near the Sulphide fault, there is very little information on the hypogene mineralization in that area. Some of the highest grade ore of the Live Oak section of the Inspiration Mine came from the bottom level. The deepest zone of ore was in the southwest corner, where there was some ore on the 1200 Level. The extent of this ore below the level was not determined, nor is there any information available regarding the ore minerals. There is no indication of high-grade hypogene mineralization in the Live Oak workings on the 1200 Level.

Although most of the ore in the Miami and Inspiration Mines was formed by supergene enrichment, there are indications that in the schist the strongest hypogene mineralization occurred in the more massive beds. Supergene chalcocite was deposited mainly on pyrite, hence ore bodies are localized in zones of hypogene mineralization regardless of the amount of copper originally present. Some pyritic halos outside of the ore zones are not enriched. In general, ore bodies in schist occur in granular beds in which schistose structure is poorly developed. Quartz and pyrite occur as veinlets, and pyrite is disseminated throughout the schist. Chalcocite replaced the pyrite completely or occurs as films on the surface.

Mineralization in the porphyry was similar, with pyrite and quartz filling fractures to form veinlets, and pyrite disseminated throughout the rock, in many places replacing biotite. The quartz and pyrite stages of mineralization did not always coincide, and numerous veinlets are filled exclusively with one or the other. In general, chalcopryite appears to have been introduced later, and molybdenite with glassy quartz was introduced at a still later stage.

The oxidized ores are the result of the oxidation of supergene-enriched ore. Chrysocolla is the principal ore mineral, with some malachite and azurite. Lindgrenite and libethenite are rareties, and some native copper and cuprite occur near fault zones.

The leached capping of this type of deposit usually contains considerable relief limonite derived from chalcopryite, but boxwork from chalcopryite is not common here due to the general low tenor of the hypogene ores. The usual limonite colors were developed, but the amount of ore below depends upon the amount of enrichment more than the amount of copper indicated by the character of the capping.

REFERENCES

- Parsons, A. B., 1932, The porphyry coppers: *Am. Inst. Min. Met. Engrs. Rocky Mtn. Fund Ser.*, N. Y., 581 p.
 -----, 1957, The porphyry coppers in 1956: *Am. Inst. Min. Met. Engrs. Rocky Mtn. Fund Ser.*, N. Y., 270 p.
 Peterson, N. P., Gilbert, C. M., and Quick, G. L., 1951, Geology and ore deposits of the Castle Dome area, Gila County, Arizona: *U. S. Geol. Survey Bull.* 971.
 Peterson, N. P., 1954, Geology of the Globe quadrangle, Arizona: *U. S. Geol. Survey Geol. Quad. map GQ-41.*
 Ransome, F. L., 1919, The copper deposits of Ray and Miami, Arizona: *U. S. Geol. Survey Prof. Paper* 115.
 Sales, R. H., and Meyer, Charles, 1948, Wall-rock alteration at Butte, Montana: *Am. Inst. Min. Met. Engrs. Trans.*, v 178, p. 9-35.
 Stephens, E. C., 1950, Geology of the Miami-Inspiration and Castle Dome deposits, Gila County, Arizona: unpublished private report.
 Annual reports: Inspiration Consolidated Copper Co.
 Annual reports: Miami Copper Co.
 Annual reports: Tennessee Corp.