MADERA - ELLWOOD

GILA CO

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MIAMI DISTRICT, ARIZONA

GEOLOGICAL REPORT FOR 1948

JULY 1, 1948

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MIAMI DISTRICT, ARIZONA
GEOLOGICAL REPORT FOR 1948

FOREWORD

The following report has to do with the geological investigation conducted between October, 1947, and July, 1948, for Miami Copper Company. Most of the field mapping was carried on in the so-called Madera-Ellwood area on the north flank of the Pinal Range above and southwest of the town of Miami. Considerable time was also spent in the office reviewing churn drill exploration in the Copper Cities area, and much of this ground was rapidly covered in the field to check the geology.

Besides these two major projects, a number of areas were examined by reconnaissance.

All of these matters are considered in this report, which is subdivided into several parts in order to segregate the various subjects.

In addition to a discussion of the exploration projects investigated by the writer, some comment is included about the Amico exploration campaign. A brief account is also given concerning the experimental investigation started (but not finished) with the Geiger-Mueller counter.

And finally, recommendations are made for continuing the geological study by the Company's resident geologist.

During the past eight months, several memoranda have been submitted covering special subjects of current interest. These were:

(1) Two accounts of zircon examinations of Amico churn drill sludge. (Letters dated February 23, and April 15, 1948).

(2) A discussion of the geology of the Powers Gulch area. (Dated June 2, 1948).

(3) My comments on the Ajo property of Mr. Hoval A. Smith. (Dated June 9, 1948).

The writer wishes to express his thanks to the Company's resident geologist, Mr. Joseph E. Fowells, for his capable assistance in the field and in the office.

MIAMI DISTRICT, ARIZONA

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SUMMARY

In the Madera-Ellwood area it is believed that the results of the two churn drill holes recently put down in the Ellwood zone on the west fully condemn that zone. The one hole drilled in the Madera zone on the east is similarly disappointing, but a decision on this ground must be deferred until another hole has been drilled. It is now apparent that the Madera-Ellwood area possesses several inferior qualities. Primary mineralization is very weak and erratic, not enough cycles of enrichment have taken place, and rapid erosion of weakly fractured rock may have dispersed some copper.

There is little likelihood that substantial additions will be found to the Copper Cities open cut ore body. However, there are possibilities for finding worthwhile primary mineralization at depth well below the zone of secondary sulphide enrichment. Four deep churn drill holes have been recommended to test these possibilities. No further exploration is proposed in the tracts just west of the Copper Cities ore body

MIAMI DISTRICT, ARIZONA

GEOLOGICAL REPORT FOR 1948

PART I

GEOLOGY OF THE MADERA-ELLWOOD AREA

INTRODUCTION

The so-called Madera-Ellwood area lies on the north flank of the Pinal Range just west of La Madera Peak fire lookout tower. It is immediately north of and adjacent to the head of Pinto Creek and occupies a tract about 3 miles long in an east-west direction by 2 miles wide. The ground may be reached by a narrow road leading south from near the Castle Dome highway turnout; by a road leaving Bloody Tanks Wash and going south through the Schultze ranch; and by a high-level road approaching the fire lookout tower via Russell Gulch and the Pinal Peak road.

The area of interest is a block of rugged ground occupying the divides that separate the drainage between Mineral Creek, Pinto Creek, and Bloody Tanks Wash. Elevations range between 4500 and 6000 feet for the most part. During much of the year the drainage lines are dry, except for a brief period of run-off after rain or snow falls.

Considerable stretches of the area exhibit light metallization by copper and iron sulphides. Miami Copper Company became interested in the mineral possibilities of the ground in midyear 1947 and in July and August staked the Madera group of 72 claims. In July, 1947, the Ellwood claims, lying toward the northwest, were taken under option. These, when amended, amounted to 38 claims. At about the same time, the Santa Anna group, in the north-central section was also taken under option, and comprised some 12 claims. Thus committed to an interest in the area, it was necessary for the Company to acquire, as a matter of protection, various prior locations that were excluded from the Madera group because of overlap or that were adjacent to the Madera group. Option arrangements were then made in early 1948 for ground controlled by Carrow, Ellis, Ellis and Greathouse, and Storey. Five additional Madera claims (75 and 79) were also staked.

The geological study of the ground was begun by the writer on October 19, 1947, and Mr. Fowells joined the work in December. The examination proceeded slowly because of the extent and ruggedness of the ground, inclement weather, and the necessity to give some attention to other areas.

It was apparent during the early course of the examination that we were dealing with two large zones of very light metallization in the Madera-Ellwood area. Their extent and character were such that there was some speculative chance for a large tonnage of low commercial tenor. With the Company's interest already engaged in the area, the geological problem was to locate a few scout churn drill holes in ground of good quality for the property and to carefully search the extensive holdings for other promising zones that at first might not have been readily apparent. With the known activity of copper-bearing solutions over such a wide area, the latter was a particularly important task.

This report is accompanied by a claim map on a scale of 1 inch equals 400 feet on which the geological details are shown. A photostatic enlargement of the U. S. Geological Survey preliminary contour map on a scale of 1 inch equals 1000 feet is also included. To this have been added the mining claims and the geology to give a compact view of the area.

GENERAL GEOLOGY

The Madera-Ellwood area is principally composed of a large and irregular block of Pinal schist bordered on the south by Madera diorite and flanked on the north by Schultze granite and quartz porphyry.

The Pinal schist for the most part is an average type for the district. It is mostly a quartz-sericite schist with a very fine grained sandy texture. On the one hand it grades into a very fine textured quartzite; on the other, to an argillaceous schist or phyllite. Chiastolite schist, schist with coarse flakes of muscovite, and biotite schist are varities of more restricted distribution. Irregular bands and pods of pegmatitic quartz have been injected into the Pinal schist both along and across the foliation. This quartz, in places intergrown with a little feldspar, is older than the quartz associated with the copper mineralization, and is tentatively considered to be pre-Cambrian in age.

The Pinal schist commonly exhibits a fine lamination made apparent on the surface by gray or buff color banding. The planes of schistosity (foliation) are considered to be in general parallel to the stratification of the ancient sedimentary layers. In one place, however, (in the Cherokee No. 8 claim) bedding and schistosity are clearly divergent.

The Madera diorite intrudes the Pinal schist on the south, the contact being in the general vicinity of Pinto Creek. This diorite shows no foliation and holds included fragments of Pinal schist in random orientation. There is no evidence here to support the contention that the Madera diorite is pre-Cambrian in age. In any event this dioritic intrusive is younger than the development of foliation in the Pinal schist.

The Madera diorite near the head of Pinto Creek is a quartz-mica-diorite of medium grain. It is even-granular (free from phenocrysts) and a medium gray in color due to rather abaundant black mica. Quartz and plagioclase feldspar are prominent constituents. Streaks and veinlets of epidote are common.

Quartz porphyry intrudes and is younger than the Madera diorite near Dr. Little's ranch. Ransome shows diabase and diorite porphyry invading the diorite toward the south, near Mineral Creek. The age relation between Madera diorite and Schultze granite could not be determined.

The Schultze granite that intrudes the Pinal schist on the north is an average type for the district. It is a pronouncedly porphyritic rock with prominent white orthoclase phenocrysts set in a groundmass of quartz, oligoclase, and a fairly abundant scattering of small, shiny black mica flakes. Its dead white color is commonly imparted to the hillsides which it forms.

A fair sized body of aplite is found at the margin of the quartz porphyry east of triangulation station N-23, beyond Santa Anna's camp. This is a fine-textured rock apparently made up of quartz and feldspar carrying abundant small phenocrysts of muscovite. Aplite is known to be younger in age and cut the Schultze granite. Its relation to the quartz porphyry is still uncertain, but it seems likely that the quartz porphyry is younger.

A prominent elongated body of quartz porphyry is found associated with the Schultze granite along the road leading to the Santa Anna claims (near triangulation stationsN-1, N-17, N-5, and N-23), and a number of smaller bodies are scattered about nearby to the south and west. This quartz porphyry is similar to that found at Castle Dome and Copper Cities, but appears to have a generally stronger development of quartz phenocrysts. (At the latter localities it was designated as "granite porphyry" by the U. S. Geological Survey).

The quartz porphyry on the north in the Madera-Ellwood area (here termed the "Ellwood type") generally displays prominent phenocrysts of pink orhoclase possessing clearly bounded crystal faces accompanied by abundant smaller quartz phenocrysts displaying stubby euhedral outlines and well-formed bipyramidal terminations. These are associated with a sprinkling of tiny thin flakes of black mica in variable abundance, and all are set in a rather dense groundmass of greenish-gray color. Where very lightly mineralized, the quartz porphyry weathers to a light buff tone.

Where the two rocks are typically developed, there is little difficulty in distinguishing between Schultze granite and the Ellwood type of quartz porphyry. However, where joint plane faces of Schultze granite are plastered over by quartz-muscovite veinlets, quartz grains in the granite show through with phenocrystic outlines and the two rock types are readily confused. Also, where the two types are lightly mineralized and stained by iron, confusion is easy.

A dense phase of quartz porphyry forms part of the borders of the irregular dike-like body south of Dr. Little's ranch. This is a light-colored rock whose only phenocrysts in some places are shining flakes of brown mica.

The Ellwood type of quartz porphyry intrudes the Schultze granite and is definitely younger in age. (It is not simply a chilled border phase, as some might contend). The evidence for the younger age relation is unequivocally displayed on Fairview No. 6 claim where sharply bounded inclusions of Schultze granite are contained in quartz porphyry.

The quartz porphyry is also younger than the zone of faulting and brecciation that cuts the Pinal schist between triangulation stations N-19 and N-14. Along this zone, quartz porphyry has invaded the breccia to cement its schist fragments. The Schultze granite behaves similarly, and both intrusions are without doubt younger than this zone of faulting. In turn, the copper and iron mineralization and the fracturing with which it is associated cut through the breccia fragments and the intrusives.

Only a few small bodies of diabase were noted, and these were seen to invade the Pinal schist. Very likely a number of similar bodies of diabase remain hidden under the extensive mantle of soil and slide rock so widely distributed in the area.

A small dike provisionally classified as latite was mapped in the Ora No. 1 claim. It is suspected that this is related to the younger volcanic rocks of the district.

The geologic structure of the Madera-Ellwood area is relatively simple. The Pinal schist intervening between the Madera diorite on the south and the more acidic intrusives on the north strikes northeasterly and generally dips steeply toward the north. Northwesterly strikes appear in the terrane north and east of Dr. Little's ranch. Due to the mantle of debris covering bedrock, it could not be determined whether this deviation is due to folding, faulting, or the intrusion of Madera diorite. It is not uncommon to find the dip of the schistosity reversed to the south. This is probably caused by bedding being overturned past the vertical rather than to simple folding with the development of flat anticlinal crests or synclinal troughs.

Only a few important faults were mapped in the Madera-Ellwood area, but with better exposure of bedrock there is little doubt that other faults would be revealed.

A zone that is probably related to the west branch of Jewel Hill fault has been traced to within a few thousand feet of the area. Its extension farther south may be marked by the northwest-southeast stretch of diroite contact near Dr. Little's ranch.

The faulting and brecciation connecting triangulation stations N-19 and N-14 have already been mentioned. This zone is believed to branch and die out toward the south. It has not been traced to the north but it may join onto a southerly extension of some member of the Jewel Hill fault system.

The quartz porphyry dikes on the southeast (near Dr. Little's ranch) appear to be faulted and offset. However, exposures were not clear enough to tell whether the observed arrangement is due to pre-porphyry or post-porphyry faulting.

All of the fault structures mentioned above strike a little west of north, and this is apparently the prevailing trend of major breaks in this area.

A close study of fracture trends in the Pinal schist was not attempted, because of poor exposures and lack of available time. This schist is not evenly and thoroughly fractured, but there are occasional sporadic zones displaying small fractures running in several directions. Sets of fractures and small faults strike (1) northeast; (2) northwest; (3) a little east of north; (4) a little west of north; (5) and north-south. A given outcrop commonly shows two or more sets of fractures.

The Schultze granite is cut by northeast joints dipping steeply south. This feature is strikingly displayed throughout much of the Schultze granite terrane. These fractures are commonly coated by quartz and muscovite.

The Madera diorite is not prominently jointed or fractured, but there are zones of northeast jointing, some members of which carry pegmatitic quartz and mineralization.

MINERALIZATION

Mineralization in the Madera-Ellwood area is best displayed in the Pinal schist. Locally in this formation thin fractures seen at the surface carry quartz and the oxidation products after pyrite, chalcopyrite, and chalcocite. Primary mineralization formed little veinlets of drusy quartz and pyrite associated with sporadic chalcopyrite. In some veinlets, the quartz is low in amount or is absent. Secondary enrichment precipitated some chalcocite above the elevations of the main gulches and this has been partly exposed to erosion, leaching and some re-solution of its copper. In general, primary metallization by copper has been sparse and erratic, and enrichment has not progressed much beyond one cycle (about like Castle Dome and Copper Cities where primary copper values were a little more than doubled by secondary enrichment).

So far as can be determined from the outcrops, most of the mineralization follows thin fractures cutting the schist at various angles. There is little evidence that sulphides were deposited along planes of schistosity, but final decision regarding this point should be based on a microscopic examination.

A few localities display some oxidized copper minerals fixed in the leached zone. These have either formed by the oxidation of chalcocite or covellite in the absence of much pyrite, or by the rapid precipitation of copper-bearing secondary solutions by reactive gangue or groundwater.

There are many veinlets that contain psuedomorphs of limonite preserving the crystalline outlines of pyrite. These apparently formed by the very rapid neutralizing of secondary solutions, and it is significant that they are so infrequently accompanied in the outcrop by oxidized copper minerals similarly precipitated. This is interpreted as evidence that only a small and erratic amount of primary copper accompanied the pyrite and that the general tenor of primary mineralization is disappointingly low.

Two extensive zones of this very light mineralization are shown on the geologic map. The "Madera mineralized zone" on the east is in Pinal schist but closely borders the Madera diorite contact. This zone is about 7,000 feet long and from 2,800 feet wide on the west to 1,200 on the east. Beyond to the north it fades out gradually. On the south it generally ends abruptly at the diorite, except for a few small areas where iron staining penetrates the intrusive.

The "Ellwood mineralized zone" is in the central and southeastern part of the area studied. It is about 8,000 feet long and from 3,500 to 1,000 feet wide. It also follows the margin of the diorite but is less closely confined thereto. In fact, in the central part of the map it practically reaches across to the Schultze granite and quartz porphyry. On the southwest it narrows toward the Henderson ground and appears to fade out. Mineralization in the flanking diorite is confined to a few thin veins and small iron-stained areas.

For several hundred feet beyond the northwest edge of the Ellwood zone, as portrayed on the map, there is a border several hundred feet wide in which there are a number of small veins and scattered mineral showings in what appears to be relatively unaltered schist. This erratically mineralized border has been placed outside of the margin of the Ellwood zone because of the scattered distribution of the showings, and the segregated nature of the mineralization in contrast to the more "disseminated" character of the Ellwood zone proper. Within this border zone, however, there has been considerable prospecting in the past by means of small shafts and tunnels following narrow veins in the search for pockets. It is obvious that the little piles of high grade near some of these workings do not advertise the average tenor of the ground, but rather do they testify to the skill of the prospector in finding small showings in a generally lean terrane.

On the map the Madera and Ellwood Zones are shown joined together near the north end-line of Madera 28A claim. However, outcrops are few and mineralization is sparse in this area, and the connection may not be valid.

In outlining the zones and evaluating the mineralization, one feature of the ground has proved to be particularly troublesome. This is the surprisingly heavy mantle of soil, subsoil, and slide rock on the steep slopes. It is rudely estimated that only about 15% of the bedrock of the mineralized zones is exposed at the surface. Those portions revealed are naturally composed of the harder rock and these are commonly mineralized by quartz veinlets and silicification with evidence of accompanying iron and copper minerals. It is of particular importance to determine the quality of mineralization beneath the masking detritus. Some information is furnished by the holes dug for location requirements, these pits being cannily located where the digging was easiest, and by the access roads recently constructed. These exposures exhibit a predominance of very lightly mineralized schist and detract severely from the quality of the ground.

The so-called Pinal tunnel has its portal on King No. 6 claim and pierces the steep hillside for a distance of over 500 feet to explore near the eastern end of the Madera zone. Its dump contains a fair amount of schist with fairly abundant chalcocite. Inasmuch as this attractive ore was obtained from beneath outcrops of average quality for the zone as a whole, it might be argued that similar mineralization might be found coextensive with the zone and hence amount to a great tonnage of outstanding value. However, examination of the tunnel reveals that it followed a veinlike fracture zone for most of its length and that the better material on the dump is by no means representative of the flanking ground as a whole. Secondly, sampling by the mine engineering department determined that the best stretch along the fracture zone, a distance of 295 feet, only averaged 0.69% total copper, of which 0.48% was in the oxidized state. A length of about 85 feet of tunnel diverging into the hanging wall of the fracture zone returned 0.40% total copper, of which 0.28% was in the oxidized state at a depth of about 125 feet below the surface. These samples from out in the hanging wall might be subject to a somewhat favorable interpretation provided it could be demonstrated that the average cropping for the zone was better in quality than that overlying these hanging wall samples. Everything considered, this is very difficult to ascertain, but the possibility warrants a churn drill hole for a test.

From an examination of the ground, it appears very likely that little or no secondary enrichment extends much below the elevation of the nearby main gulches. In many places, these exhibit fresh sulphides at very shallow depth, and occasional occurrences of moderately coarse pyrite untarnished by secondary chalcocite are revealed by prospectors' tunnels and shafts. Zones of secondary enrichment if present, would be expected to underlie the ridges and hillsides and to wedge out toward the gulches.

Many of the surface slopes are very steep and it might be argued that rapid erosion would dissipate rather than enrich the copper leached from the oxidized zone. This is problematical. The generally light fracturing of the bedrock would support this view as would the presence of iron oxide deposited by evaporation from solutions that coursed down the hillside on the Lonesome Pine No. 1 claim. Here also some copper has been deposited on twigs intermingled with the detritus. On the other hand, the extensive mantle of soil, subsoil, and slide rock should retard run-off and assist solutions to enter bedrock.

The Schultze granite on the north exhibits a very little scattered metallization by copper and iron sulphides. There are sizeable zones just north of the schist where the granite is intricately cut by veinlets of quartz, and well out toward the north the northeast-trending joint planes so prominently displayed in the granite carry thin coatings of muscovite and quartz. It has not been determined whether this quartz and sericite is of the same age and origin as that associated with the copper metallization.

There are a few limited areas where the Schultze granite carries a light and erratic scattering of thin films of chrysocolla in some places associated with a little malachite and azurite. In these situations the copper does not appear to be indigenous, and is not associated with any evidence of the former presence of sulphides. Rather does it appear to have been transported to its final resting place from nearby mineralized areas and to have been precipitated by neutralizing or drying out of the transporting solutions. A little migratory copper of this type may be seen in prospect workings near the trail leading southerly up the gulch from Santa Anna's camp.

The quartz porphyry contains a very minor amount of pyrite and chalcopyrite here and there, as evidenced by various oxidation products. In some places, it is cut by veinlets of quartz and muscovite. A small showing of the manganese tungstate, hubnerite, is exposed on the Lonesome Pine No. 5 claim, where it is intergrown with quartz cutting quartz porphyry.

As previously mentioned, the Madera diorite exhibits only a little mineralization. It is apparently cut by a number of small veins of pegmatitic quartz. There are a few small and irregular zones of iron staining apparently due to the oxidation of pyrite. Some fresh pyrite was noted on a tunnel dump. Specimens of chalcopyrite intergrown with epidote are piled around the collar of a boarded-over water well south of Poplar No. 8 claim.

EXPLORATION

At this date the Ellwood zone has been tested by two churn drill holes recently completed. The Madera zone has been explored by one hole and another will be started very soon.

The location of these holes and their results are next discussed.

As judged by surface outcrops, the Ellwood zone of mineralization contains a somewhat better section of copper showings that covers parts of Talequah Nos. 6 and 8 claims as well as parts of Madera No. 79 and Black Copper No. 1 claims. This is outlined on the maps by a red dotted line around a rudely elliptical area about 1500 feet across. Inasmuch as this area exhibits the strongest copper mineralization in the zone, it was contended that failure to find attractive copper values here would condemn the entire Ellwood zone without the necessity of further exploration in its remaining larger but weaker portion. Conversely, if attractive values were encountered it would be necessary to follow these out into ground of more average quality by drilling additional holes.

Two churn drill holes about 1,000 feet apart, were drilled in this supposedly better portion of the Ellwood zone, and their results were exceedingly disappointing.

Hole No. 301 was located on Talequah No. 8 claim (Coordinates: S20,800; E2,800.) A summary of its log is as follows:

Depth	650 feet
Bottom of tan sludge (color due to oxidized iron minerals)	125 feet

Bottom of oxidized copper minerals ...... 150 feet
(below this depth oxidized Cu is
less than 0.02%)

Water level .... 235 feet

Copper Assays:

0 - 65 ...	65'	@ 0.02 total 0.01 oxide 0.01 sulphide	
65 - 85 ...	20'	@ 0.28 total 0.24 oxide 0.04 sulphide	
85 - 110 ...	25'	@ 0.12 total 0.09 oxide 0.03 sulphide	
110 - 120 ...	10'	@ 0.72 total 0.49 oxide 0.23 sulphide	
120 - 155 ...	35'	@ 0.45 total 0.09 oxide 0.36 sulphide	
155 - 240 ...	85'	@ 0.13 total 0.01 oxide 0.12 sulphide	
240 - 325 ...	85'	@ 0.17 total 0.01 oxide 0.16 sulphide	
325 - 345 ...	20'	@ 0.45 total 0.01 oxide 0.44 sulphide	
345 - 455 ...	110'	@ 0.17 total 0.01 oxide 0.16 sulphide	
455 - 555 ...	100'	@ 0.09 (sulphide)	
555 - 650 ...	95'	@ 0.10 (sulphide)	

Hole No. 302 was located on Talequah No. 6 claim (Coordinates: S21,750; E2,400). A summary of its log is as follows:

Depth	415 feet
Bottom of tan sludge	155 feet
Bottom of oxidized copper minerals	175 feet
Water level	200 feet

<u>Copper Assays:</u>

0 - 150 .... 150'	@	0.04 total 0.01 oxide 0.03 sulphide
150 - 180 .... 30'	@	0.28 total 0.12 oxide 0.16 sulphide
180 - 415 .... 235'	@	0.04 (sulphide)

From the above, it will be seen that in Hole No. 301 the zone of better secondary enrichment probably runs from 65 to 155 feet, but is badly fouled by oxidation. This 90 feet averages 0.35% in total copper and is followed by a poorer enriched zone averaging 0.15% in total copper down to a depth of about 200 feet with 20 feet at 0.45% Cu between 325 and 345. Primary copper values below the zone of secondary enrichment are about 0.10% copper as chalcopyrite.

Hole No. 302 exhibits only 30 feet of noticeable enrichment of low tenor (0.28% total copper). Primary copper mineralization only averages 0.04% copper throughout the lowermost 235 feet of the hole.

The results of these holes in the Ellwood zone show that primary mineralization is very low, 0.04 to 0.10% copper, in contrast to that at Copper Cities and Castle Dome (0.30% copper). It would take far more cycles of enrichment to bring this up to ore grade than has occurred anywhere in the district.

Hole No. 301 lying to the north gave far better results than did Hole No. 302 but we still must recognize the mediocre quality of the ground cut by No. 301. There is no reasonable expectation that by moving on to the north we would find continued improvement. On the contrary, copper values will probably decrease at a distance of about 500 or 1,000 feet farther north of Hole No. 301.

To date only one hole has been drilled in the Madera zone, although it is expected that another will be started in a few days. Hole No. 303 is located in Madera No. 19 claim near the center of the Madera zone but toward its north edge where the outcrops appear more attractive than the average. (Coordinates: S23,200: E9,100.) A summary of its log is as follows:

Depth	340 feet
Bottom of tan sludge	65 feet
Bottom of oxidized copper minerals	50 feet
Water Level	95 feet

<u>Copper Assays</u>

0 - 50	50' .... @	0.08	total
		0.06	oxide
		0.02	sulphide

50 - 150	100'	@ 0.09	(sulphide)
150 - 250	100'	@ 0.10	(sulphide)
250 - 320	70'	@ 0.11	(sulphide)
320 - 335	15'	@ 0.21	(sulphide)
335 - 340	5'	@ 0.11	(sulphide)

This hole shows practically no enrichment and a low primary copper value of about 0.10%.

It is proposed to drill Hole No. 304 about 200 feet west of the Pinal tunnel in order to check the tenor of mineralization in the hanging wall of the fracture zone followed by that tunnel. As previously explained there is some possibility of finding better average copper values here than in the other holes drilled. In view of the results of the three holes already put down, these hopes are not bright.

CONCLUSIONS

It is the writer's opinion that the two holes (Nos. 301 and 302) fully condemn the Ellwood zone and that the expectations for finding a large body of copper ore of commercial value are far too small to warrant additional expenditures.

Hole No. 303, in the Madera zone, is similarly disappointing, but a decision on the ground must be deferred until Hole No. 304 has been drilled. If the results from this hole are poor, then it is recommended that all options on ground in the Madera-Ellwood area be dropped and that the Madera group of claims be abandoned. If results from this hole are encouraging, then the drilling of several additional holes will be called for before a decision can be made.

It is now apparent that the Madera-Ellwood area possesses several inferior qualities. The primary mineralization is generally very weak with its better portions erratically and widely spaced. Not enough cycles of enrichment have taken place to convert very weak primary mineralization into worthwhile secondarily enriched ore. Rapid erosion of weakly fractured, impervious rock may have dispersed some copper and made enrichment less effective.

In view of these unpromising features, exploration in the Madera and Ellwood zones should be confined to a very few drill holes.

As a result of the field examinations, no other zones warranting exploration were found in the area examined.

PART II

REVIEW OF COPPER CITIES AREA

INTRODUCTION

Since the writer's report covering this area was written in 1944, some 89 churn drill holes have been put down. Most of these are in the ore body zone proper (Tract A), or in Tract B where it was thought that an irregular extension of the ore body might reach. Nine exploratory holes were put down toward the west in mineralized blocks detached from the ore body area. Of these, four were drilled in Tract C, four in Tract D, and one in Tract E.

It is now necessary to review the results of this drilling under three headings, namely:

(1) Exploration of the relatively shallow zone suitable to open cut mining in the ore body area; (2) possibility for deep ore in the ore body area; and (3) exploration well to the west of the ore body area in Tracts C, D, and E. (Refer to maps accompanying the 1944 report.) In addition, several corrections in the geologic mapping will be noted as a result of further study of the area, particularly as regards the position and attitude of the Coronado fault.

The two sets of cross-sections illustrating the Copper Cities ore body were brought up to date by the writer in March, 1948, and are on file in the General Office at Miami. Drilling of the ore body was completed in June, 1948, and these sections will be further revised by Mr. Fowells in the very near future. Several copies of the corrected geologic plan are on file at Miami showing the adjusted position of the Coronado fault.

EXPLORATION OF THE SHALLOW ORE BODY

Drilling results in the Copper Cities ore zone emphasize that the ore body partly surrounds a quartz porphyry plug as an irregular, partial collar; that it is confined between and below the Coronado and Drummond faults; and that it fades out abruptly to the south where the faults flare apart.

Results of drilling and restudy of the ground indicate that the Coronado fault dips to the west at about 48 degrees and thus permits a moderate extension of ore out under the fault toward the west. This allows room for more ore than was formerly thought to exist when the theory of an easterly dip to the fault was favored.

Furthermore, the Coronado fault strikes about due north from near Hole No. 274 and does not swing around to the northeast under masking gravel as was formerly thought. This permits part of the ore body to extend on north nearly up to the Sleeping Beauty fault. The northeasterly fault segment passing through the Little Chief claim has been designated the Little Chief fault and is known to have a steep northerly dip with ore in its footwall. Striking westerly, the Little Chief fault is cut off by the Pardee fault and is presumably offset an unknown distance to the north under the gravels. This offset segment apparently does not appear south of the Sleeping Beauty fault. It is this structural arrangement that assists the ore to continue on north and closely approach the Sleeping Beauty fault. The so-called Pardee fault strikes about parallel the Drummond and dips about 50 degrees northeasterly with ore in its footwall.

Drilling has determined that commercial ore does not extend southerly into that irregular part of Tract B found in Good Luck, Half Moon, and Oro No. 3 claims.

The tonnage assigned to the Copper Cities ore body naturally depends upon the design of the open cut most economically suited to its extraction. Recent calculations by Mr. Coil give 29 million tons at a grade of 0.69% copper to be extracted from an open pit bottoming on the 3600-foot horizon. It now appears unlikely that any substantial addition will be found to this ore body.

Recent recalculations indicate that the average tenor of primary mineralization in granite below the enriched ore body is about 0.304% copper and in quartz porphyry is about 0.163% copper.

POSSIBILITIES FOR DEEP ORE

The above figure for primary mineralization in granite is the average amount. A number of the deeper holes in the ore body area show an increase in assay value toward their bottoms. Sludge samples from the lower 50 feet of six of these holes were made into brioquettes and examined microscopically. It was determined that 80% or more of the copper in these sludges was contained in primary chalcopyrite. For these holes this indicates a primary tenor of a little over 0.40% copper thus proving a small but definite and consistent increase in primary value above the average down to depths of 500 to 700 feet.

The most favorable places to attempt to follow this increase in primary copper down into a worthwhile ore body appear to be defined by one or more features. These are; namely, (1) nearby but outside the margin of the quartz porphyry plug, (2) beneath the Coronado fault at depth, (3) beneath the Drummond fault at depth, and (4) along the immediate hanging wall of the Sleeping Beauty fault where the mineralized zone approaches it at depth.

This latter arrangement is shown by a composite section accompanying this report. A view of the ore zone dipping down beneath the Drummond fault is also portrayed on another section accompanying this report. The relation of ore to the Coronado fault is similar to this and is shown on Section N2250 on file at the Miami general office. The relation of deep mineralization to the southerly margin of the quartz porphyry plug is well illustrated on Section W3000 and W3250, also on file at the Miami office.

It has been proposed that a churn drill hole be put down in each of these situations to a depth of 1,500 or 2,000 feet to test the possibility of finding a primary ore body at considerable depth on the assumption that the primary value will continue to increase as we follow it on down.

The hole to explore near the south margin of the quartz porphyry (No. 291) has already been started and has reached a depth of about 550 feet. Recent progress on this hole has been extremely slow. Drill holes proposed to pierce the Drummond and Coronado faults at considerable depth have been approved, and the drilling sites have been prepared. It remains only to discuss briefly the geologic situation near the Sleeping Beauty fault.

As previously mentioned, these relations are illustrated on an accompanying section. Here it can be seen that the ore body turns down sharply between a shoulder of quartz porphyry and the Sleeping Beauty fault. The mineralization appears to turn down beside the fault as though the fault were pre-mineral in age. However, when we consider that the ore body is shown on a 0.40% copper cut-off and the zone close to the fault is not adequately drilled, this pre-mineral appearance may be exaggerated.

Nevertheless, it is proposed that a deep hole scraping the Sleeping Beauty fault be drilled halfway between holes Nos. 281 and 290 (N4125; W2875). The dip of the Sleeping Beauty fault is not known precisely and the above location is based on an assumption that it is 80 degrees in a southerly direction. Should this hole encounter encouraging mineralization, then a second location should be collared about 250 feet southerly in an attempt to pierce the quartz porphyry which here may have a sill-like wing with ore below.

EXPLORATION RESULTS TO THE WEST

Four churn drill holes were put down to explore Tract C, following the writer's recommendations of 1944. These found very little secondary enrichment and extremely lean primary copper at depth. The outcrops that were observed did not indicate such poor ground, and the area was recently checked in search of an explanation in order to prevent future errors of a similar kind.

In this area slopes are very steep and outcrops are not too plentiful. When the ground was originally mapped, there was some doubt whether to classify the bedrock of Tract C as granite or granite porphyry, but granite was finally decided upon. Recent observations in the newly constructed road cuts give a better view of the rock and show it to be a dense variety more nearly resembling the granite porphyry. Its denseness and tightness are noteworthy, and it can readily be seen that secondary solutions would find it very difficult of access. That this is so is evidenced by the rather common appearance of pyrite occasionally accompanied by a little chalcocite here and there near the base of the road cuts.

Some of the outcrops still appear attractive, although the amount of ground covered by loose rock and subsoil masks much of the area and prevents a good view of the ground as a whole.

The churn drill holes showed very shallow oxidation with pyrite appearing at depths of only 5 to 10 feet. It is evident that oxidizing solutions could not penetrate the bedrock sufficiently to cause enrichment even were the primary mineralization rich enough to furnish a more adequate supply of copper for that purpose.

The steep slopes caused a very rapid run-off of precipitation and the tightness of the bedrock permitted secondary solutions to enter it for only a few feet. In effect these solutions cascaded down the steep hillsides virtually at the base of the subsoil. They apparently developed a thin shell of secondary enrichment, but much of the copper and iron content of the solution was apparently dissipated to the south. It is the outcrops of this thin shell that give the area a favorable aspect.

The reason that Tract C is not ore bearing is now clear; namely because, (1) primary mineralization is too lean (0.05 to 0.10% copper), (2) primary copper mineralization does not increase in value at depth as it does in the Copper Cities ore body area, and (3) slopes are too steep and the bedrock is too tight to permit secondary solutions to enter and effect widespread secondary enrichment to moderate depths.

Tract C has been adequately drilled and no further exploration is proposed here.

The writer has suggested that Mr. Fowells devote a short period of time to this area to again study the distribution of granite and granite porphyry in the now improved exposures.

Four exploratory churn drill holes were also put down in Tract D. It was early recognized that copper mineralization was lean in this tract, but due to the activity of copper-bearing solutions over such a wide area, it was recommended by the writer that four scout holes be drilled. This was done and no encouraging mineralization was revealed. Primary mineralization was determined to be exceedingly lean and secondary enrichment very scanty.

One hole was drilled in Tract E under similar conditions and with similar results.

No further exploration is proposed for Tracts D and E.

CONCLUSIONS

There is little likelihood that substantial additions will be found to the Copper Cities open cut ore body. However, there are possibilities for finding worthwhile primary mineralization at depth well below the zone of secondary sulphide enrichment. Four deep churn drill holes have been recommended to test these possibilities.

Test drilling to the west of the Copper Cities ore body failed to find ore, and no further exploration is proposed here.

PART III

REMARKS CONCERNING MISCELLANEOUS AREAS

GIBSON MINE AREA

The Gibson mine area near the old settlement of Bellevue was briefly looked over in company with Mr. Fowells. This ground lies about two miles west of the southwest corner of the Madera claim group, and may be viewed as an en echelon extension of the Madera and Ellwood zones.

Near Bellevue and on west for a mile or two, there are at least seven veins, three of which belong to the Gibson mine area proper. These veins are approximately along the steep foliation (which in turn is generally parallel to the original bedding) of the Pinal schist east of its contact against the Schultze granite. They really appear to follow steep bedding faults that occasionally transgress twisted foliation at a sharp angle.

These veins carry quartz, calcite, specularite and chalcopyrite. They are accompanied by little alteration of the wall rock, and the flanking schist appears to be essentially unaffected. There is no indication of zones of worthwhile low-grade copper mineralization between or bordering the veins.

The Gibson mine area contains the Summit vein on the southeast, the Pasquale vein on the northwest, and the less important Intermediate vein in between. In general the veins range between one and five feet in width with a strike of about N25E.

The property is described in some detail in the Mines Handbook for 1916 where it is noted that the gross value of the ore produced by the Gibson Copper Company between 1906 and 1909 amounted to $1,250.000. The ore came from narrow lenticular shoots in the veins with some sections assaying 20 - 30% copper. Development was carried to a depth of about 575 feet. For additional details, reference should be made to the Mines Handbook.

Considering the amount of exploration and development carried out and the large waste dumps now on the surface, it is doubtful if the property made an overall profit. It is best operated in a small way by leasers, who stand to profit from finding small, rich ore shoots.

The property is virtually abandoned and most of the workings are now inacessible. Some mining is going on at present in the Summit area toward the south by means of a tunnel. This is either being done by a leaser or by some one who has acquired title to one or more of the old claims.

It is not recommended that this property be acquired. However, it would be worthwhile at some future date to map these and other nearby veins and trace the broad, generalized zone southwesterly toward Ray.

PHILADELPHIA AREA

This limited area lies near the southwesterly end of the Copper Cities zone just north of Tract E.

Most of the ground on Philadelphia and Philadelphia No. 2 claims is covered by dacite, and it is likely that the ground was originally staked in order to acquire dacite tuff in the hopes of having another Black Warrior mine.

The theory has been advanced that in this area the Sleeping Beauty fault may have swung back to the north and that there is a block of favorable ground in its hanging wall that is covered by dacite. Nearby brecciated quartz porphyry iron-stained and yielding low assays of copper at the surface, is pointed to as an attractive indication.

The above structural theory was once entertained by the writer and might be correct. However, indications of copper mineralization are light and our previous experience in this general zone has been disappointing. If the ground were owned by Copper Cities Mining Company a speculative drill hole might be warranted because of easy access to the area.

However, the possibilities do not appear to warrant optioning the ground.

When convenient, a few days' geological mapping by Mr. Fowells would be useful in order to clear up several points of interest.

GOLDEN EAGLE AREA

The Golden Eagle area is found about two miles north of the Miami mine and just west of the Miami fault. Both the Golden Eagle and nearby Van Winkle claims have yielded some gold ore. An old shaft at the Cowboy mine on the Van Winkle claim is stated to be 600 feet deep and another shaft on the Golden Eagle claim is supposed to be about 300 feet deep. Other exploration was carried on by means of several tunnels, but practically all of the stoped sections now appear to be inaccessible.

Only a very brief examination was made of the ground. It was noted that mineralization occurs in or near the crushed zones of prominent northeast-trending faults. These cut metamorphosed and recrystallized Pinal schist with dikes or sills of diabase nearby in one wall. The schist also contains irregular northwest striking zones of pegmatitic material. Whether the latter influenced the location of ore shoots in the faults could not be determined.

Mineralization seems to be marked by zones of iron staining in the crushed material of the faults, and apparently pockets and small shoots of rich gold ore have been found in the past. Whether sulphides were encountered in the deeper workings is not known.

Three fault-veins were observed on the ground with a strike length of about 1,000 feet. The outermost veins were about 1,000 feet apart at the surface. On the east, they strike into and are apparently cut off by the Miami fault.

The pockety nature of the veins offers little inducement to Company operation. Only if the ground between the veins were favorably mineralized so as to give a large tonnage of minable ore would the property be of any interest. This is a matter that can be quickly checked by the taking of 20 or 30 samples on the surface. Sampling should be preceded by some geologic mapping in order to properly locate the positions of faults, cross-fractures, and other features influencing mineralization.

SELBY VEIN, CASTLE DOME AREA

The so-called Selby vein is the contact, supposedly a fault, between the Martin limestone and the Dripping Spring quartzite on the south slope of Jewel Hill in the Castle Dome area. Its strike length is about 1,300 feet directly across the rock slice bounded by the two branches of the Jewel Hill fault. In its footwall, about 150 feet to the south, is a large body of diabase. The Selby fault is directly along the northeast extension of the Castle Dome ore body, but is separated from this ore-bearing block by an intervening stretch of diabase about 800 feet across.

In the Castle Dome area, the Troy quartzite and the Mescal limestone are absent, apparently as a consequence of erosion prior to the deposition of the Martin limestone. Therefore, the so-called Selby fault could simply be the disconformable depositional contact between the Martin limestone and the Dripping Spring quartzite.

Surface outcrops of the zone show mineralization up to ten feet wide with silica replacing limestone and accompanied by sporadic showings of oxidized copper minerals. The dip of the zone is uncertain and it is not clear whether the mineralization dips moderately to the north with the bedding of the limestone or the slope of a disconformity or whether it goes down steeply along a fault fissure. However, evidence seems to favor the moderate northerly dip.

Copper mineralization is a little stronger near the two ends of the zone, and on the west it has been followed down a short distance by an inclined shaft.

On the surface the Selby mineralized zone does not look to be particularly promising. However, it does represent the northeastern extension of the Castle Dome trend. In the Castle Dome mine diabase is well mineralized, and if at depth diabase comes in and forms a wall of the Selby zone, mineralization might improve. Or, if the Selby is a steep fissure, then a buried, favorable horizon in the Martin limestone might be well mineralized and lead out to the north.

These possibilities offer a speculative chance to find ore in this area, and they should be investigated while the Castle Dome mine is in operation and while churn drill crews are available.

With this in mind, it is proposed that two churn drill holes be put down north of the Selby outcrop on the west. The first should be located about 100 feet north of the outcrop to determine the correct dip of the mineralization. Once this has been determined, and providing it is not too steep, the second hole should be located so as to cut the zone at a depth of 400 or 500 feet.

POWERS GULCH AREA

The Powers Gulch area was discussed in the writer's memorandum dated June 2, 1948, to which reference is made for a preliminary description of the ground. At this point it is only necessary to repeat the conclusions stated therein to the effect that "it is believed that the (Powers Gulch) ground has sufficient merit to warrant careful geological mapping and study by Mr. Fowells, provided a satisfactory arrangement can be made"------concerning the ground. "Considering the unsatisfactory results obtained by United Verde, the property owner is in no position to demand payment for the privilege of restudying the ground-----."

SCHULTZE RANCH AND INSPIRATION NEEDLES AREAS

These two property groups constitute a block that covers possible westerly extensions of the Inspiration mineralized zone.

There is some possibility that the Inspiration ore body is cut off on the west by complex post-enrichment thrust faulting and that an extension may be buried in the Inspiration Needles ground.

This possibility is attractive enough to warrant considerable study of the problem by mapping in close detail a wide area northwest, west, and southwest of the west end of the Inspiration zone.

THE AMICO PROJECT

The writer has participated to only a small extent in considering problems affecting the exploration program of the Amico Mining Corporation. For this reason, no extended discussion of this project will be entered into here. The formidable mechanical feat of drilling through a great thickness of Gila conglomerate will not be discussed, and only a summary description of the geological features contributing to the problem will be noted.

In brief, the Amico project seeks to pierce two thousand feet or more of Gila conglomerate and hit a body of ore attractive enough to mine at that considerable depth. The area in which this search is conducted is a part of the down-faulted basin of Gila conglomerate between the west end of the Old Dominion zone and the east end of the Inspiration-Miami zone. If ore of the Old Dominion type is expected, then a vein-like target from a few tens to a few hundreds of feet in width must be hit. If disseminated ore of the Miami type is expected, then the target is much broader. Inasmuch as the first two holes went into Pinal schist, it would seem that there is more likelihood of finding the disseminated type of ore in schist than the rich, aggregated type.

The sites of Amico exploratory holes must be located by projecting mineralized structures into the conglomerate basin, and across any faults hidden in the basin. In a practical way this is accomplished by projecting the Old Dominion vein system southwesterly for three or four miles toward the New York and Chicago claims, following the preference of Shoemaker. This is a rather clean-cut projection along the general trend of the Old Dominion zone and the dominant northeast trend of the district.

However, when we attempt to project the trend of the Miami ore zone the problem is not so easy. West of the Miami fault, where the ore body is well known it has a northwest-southeast trend if we consider the southerly, higher grade section generally illustrated on the older maps. On the other hand, the northerly mining margin of lower grade material presents the usual northeast trend, and this would carry it across the valley toward the Irene vein. A faulted segment of the Miami zone was found east of the Miami fault, and the problem is whether to project it southeasterly to an intersection (supposedly favorable) with the projection of the Old Dominion or whether to project it along the usual northeasterly trend under the conglomerate-filled trough toward the Irene. The correct answer to this question is of fundamental importance.

Trends of disseminated mineralized zones in the Miami-Inspiration district are largely controlled by the trend of the mineralized fractures locally dominant. This is best illustrated in the Castle Dome mine where one set prevails. Other areas, however, display two sets of mineralized fractures--one trending northwest and one running northeast. If one set is locally dominant, then its strike controls the trend of the zone, but this control may not persist for an indefinite distance.

It is entirely possible for a given zone to zig-zag from one trend to another along an unpredictable course in masked terrane.

The first two Amico holes were located along the southwesterly extension of the Old Dominion trend and possibly somewhat west of the Miami zone projected on a southeast course to intersect the Old Dominion trend. These two holes eventually reached unmineralized Pinal schist and were abandoned.

The third and fourth Amico drilling sites were located on the southeasterly projection of the Miami ore zone trend, near the northerly edge of the property and somewhat to the north of the Old Dominion zone projected. These two holes are now being drilled. Should these holes not find ore, then the Amico project would be very discouraging for a number of reasons. However, the possibilities for finding ore beneath the conglomerate filling the valley would not necessarily be exhausted as a consequence.

Projections of the Miami zone on a northeasterly trend under the conglomerate have never been prospected, and the southwesterly projection of the Old Dominion zone through ground now owned by Miami Copper Company has not been fully covered on the east side of the valley. Although these possibilities for finding ore still exist, the problem of effectively exploring the ground beneath a great thickness of Gila conglomerate is formidable.

PART IV

EXPERIMENTS WITH THE GEIGER-MUELLER COUNTER

The publication of Dr. N. P. Peterson's paper in the "American Mineralogist" describing the association of the radioactive mineral metatorbernite with certain sections of the Castle Dome ore body led to the purchase of a Geiger-Mueller counter by Miami Copper Company for research purposes. A good many observations were made with this instrument, but the experimental program desired was not carried to completion because of the time required and the urgency to complete other tasks.

This work was initiated by making "background counts" on a considerable number of the formations exposed in the Miami district. It showed that the count obtained with the instrument set up on each formation was distinctive of that formation, the count ranging between 30 "clicks" per minute for Naco limestone to 76 for the Willow Spring granodiorite. As might be expected in a district containing so many different formations, several gave identical counts.

Counts were also made with the Geiger tube shielded by a lead screen of 1/2-inch thickness. By this procedure from 12 to 45% of the rays were screened out, and probably most of those absorbed emanated from the formation. Preliminary work indicated that from 55 to 72% of the "formation count" was absorbed by the lead screen, but not enough experiments were conducted to determine whether this "absorption coefficient" is reliably distinctive for each formation.

Specimens of Castle Dome metatorbernite were placed within a few inches of the counter tube for one experiment and were found to raise the count only 17 clicks per minute. This either indicates a low number of emanations from the metatorbernite or that the tube employed is one with low sensitivity. The 1/2-inch lead shield screened out all of the metatorbernite emanations.

Experiments did not reach the stage of testing various types of alluvium and subsoil over calibrated formations, but it is believed that alluvium and subsoil will yield a count controlled by the kind of rock particles from which it is made up, and that a few feet overburden may mask counts emanating from buried formations. However, these points need to be checked by additional experimental work. It is clear that the Geiger-Mueller counter will not be effective in indicating what is below a sheet of dacite lava.

In conclusion, this instrument appears to have a very limited field of usefulness in this district, but some additional experimental work should be continued as time permits. The formation calibration should be concluded and several lines run across the Castle Dome and Copper Cities ore bodies. It would appear that a more sensitive counter is desirable, but this would necessitate an expensive automatic counting device.

PART V

SUGGESTIONS FOR FUTURE GEOLOGICAL INVESTIGATIONS

The following are suggestions for continuing the geological investigations in the Miami district by the Company's resident geologist:

1 - Of immediate importance is the revision of the Copper Cities ore body sections based on the results of recently drilled holes completing the exploration campaign in this area. One or two weeks should also be spent in the field here in order to clear up various odds and ends, and, as previously mentioned, check and possibly revise the distribution of granite and granite porphyry on the western portion of the map.

2 - The next project is the careful geological study of the Miami mine for the purpose of outlining any clean-up exploration necessary before the final exhaustion of reserves. Although only relatively few levels are now open for examination, they should be studied in considerable detail. With such information at hand, geological interpretation of the data available on abandoned levels can be better done. It will be particularly helpful to determine the trends of the fracture sets carrying primary mineralization in order to assist in properly projecting the ore body to the east.

3 - Geological mapping of the Powers Gulch area has been proposed for the coming winter, providing permission to do so can be obtained from the owners.

4 - The Inspiration Needles and Schultze ranch areas, just west of the present termination of the Inspiration zone, are worth studying in close detail. It is possible that there exists a western, offset extension of the zone, but it will take particularly good work to solve the faulting in an area like this with considerable Schultze granite and Gila conglomerate.

5 - Suggestions have been made for studying the broad area southwest of the Gibson mine. However, this project can be deferred for some time in favor of more promising examinations.

Various other suggestions regarding the investigation of several less important matters were mentioned in the body of this report.

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