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SAFFORD PROJECT

SNIVELY REPORT

Safford, Arizona
June 28, 1950

Mr. John Hope, Jr., Chief Geologist
Consolidated Coppermines Corporation
Safford, Arizona

Dear Sir:

The following report presents the results of my work in the Safford area during the past six weeks. The study was undertaken with the expectation that a rough geologic map extending eastward from ground already mapped in the Lone Star mining district would aid in further planning the drilling program beginning in the eastern area.

SUMMARY

A search for faults has revealed no breaks which complicate the geologic setting, or which influence the location of the mineralized body of rock. However, the delineation of the boundary between the capping of basalt flows and the underlying old erosion surface has reduced considerably the area within which there is hope of finding ore.

METHOD OF MAPPING

Formation boundaries were located upon aerial photographs of the area, and the map accompanying the report was then constructed from these, using transit triangulation points and compass bearings to eliminate most of the distortion inherent in the photographs. Elevations were obtained from adjusted, closed traverses with an aneroid barometer. The map is adequate to illustrate the general geology of the area, but should not be used as a base for more exact or detailed work.

REGIONAL GEOLOGY

The dominant feature of the areal geology is the capping of nearly horizontal flows of basic volcanics which occupy the hills and the upper portions of the valleys. Similarity to volcanic formations described at Miami, Aravaipa, and Morenci suggests that these flows are approximately Miocene in age.

Tentative correlation with adjacent areas indicates that the flows were extruded upon a surface eroded during Eocene or Oligocene time. In this area, the pre-volcanics surface was irregular in detail, but shows little relief in excess of two-hundred feet. On a larger scale, the old surface slopes gently eastward about three-hundred feet to the mile. It has been suggested at Aravaipa that the early Tertiary surface approximated that of today, with the present major topographic features already developed.

So small a portion of the old erosion surface is exposed within the limited area studied here that the relationships between the older geologic formations are not evident. Previous detailed study of the area lying west of the basalt flows indicates the presence of diorite intruded by quartz porphyry. Within the area of the present map, and for at least three miles further north and northeast, the only formations exposed beneath the Tertiary flows are intensely folded, acidic volcanic flows, tuffs, and agglomerates. Although critical contacts are not exposed, it is believed that the folded, acid volcanics are much older than the diorite and quartz porphyry, and have been intruded by them.

Similar volcanic formations are not described at Miami, Aravaipa, or Morenci. The intensity of folding in the older volcanics suggests that they may be older than the Paleozoic formations which usually appear in broad, open folds or in fault blocks in the areas surrounding Miami, Aravaipa, and Morenci. Yet the formation is certainly less metamorphosed than the pre-Cambrian Pinal schist. It is suggested that the older volcanics exposed here are younger pre-Cambrian, roughly correlative with the Unkar and Chuar sediments of the Grand Canyon series (Prof. Paper 115, Plate XIII) or, more probably, with the greenstone complex described by Schmitt (Ore Deposits of the Western States, pp. 318-319).

DESCRIPTION OF FORMATIONS

Older volcanics. Within the map area, this formation is composed principally of rhyolitic flows and tuffs; to the north beyond the map, a coarse, rhyolitic agglomerate predominates.

The rhyolites and tuffs are characteristically thin-bedded or thin-banded, with layers ranging from 1/16 inch to six inches wide. They are markedly fine-grained, and a predominant type is composed of cherty, cryptocrystalline quartz surrounding sparse flakes of biotite about 1/16 inch in diameter. A few beds have developed a nodular or pisolitic texture. Anything resembling a scoriaceous or vesicular texture is very rare.

Most of the flows and tuff beds are blue-gray on the fresh surface; rare layers may be black, and others are pale maroon and pink. The agglomerates, as well as most of the

coarser crystalline flows are pale gray to cream colored. Regardless of the color of the fresh rock, the formation all weathers pale gray to pale buff and cream.

Although the members of the formation vary considerably in detail, as a group they possess characteristics which clearly distinguish them from the younger volcanics.

Older	Younger
Acidic composition.	Basic composition.
Usually light colored, especially when weathered.	Nearly all black or hematite red.
Cherty, cryptocrystalline, or very fine-grained.	Moderately fine-grained, locally porphyritic.
Nearly all textures are dense and compact.	Nearly all vesicular or scoriaceous textures.
Thin-bedded, thin-banded.	Thick flows.
Steep dips and variable strikes.	Essentially horizontal attitude.

Diorite. This intrusive is so typical of the diorite type that it needs little description. Two varieties are common: one possesses a normal massive structure, and the other is an auto-breccia with sub-angular fragments enclosed in a matrix which appears to have the same composition as the fragments. The feldspars vary from fresh to strongly kaolinized; even in the fresher specimens epidote is a common and characteristic component. The diorite resembles some members of the basalt flows, except for the fact that it lacks the vesicular texture so common in the flows.

Quartz porphyry. The quartz porphyry is extremely variable in appearance and composition due to its having been the locus of various intensities of hydrothermal alteration. But there is little danger of confusing it with other formations of the area, regardless of the degree of its silicification, kaolinization, sericitization, or brecciation. Several separate intrusives may be present, but are not differentiated here. The quartz porphyry is the site of sulfide mineralization.

Basalt flows. Nearly a thousand feet of these volcanics are exposed in the area, and greater thicknesses are present nearby. The various members are all basic, apparently varying from andesite to basalt, and they are characteristically thick-bedded and vesicular.

These younger volcanics lie as a capping which blankets the older formations. The structure within the monotonous group of flows can be observed by reference to a bed of agglomerate and tuff usually lying somewhere between one-hundred and three-hundred feet above the base of the flows. This member is relatively soft, and hence often is concealed beneath basalt float. But its character is so consistent, and it is so readily identified that it serves as an excellent marker bed. Its color ranges from buff to reddish brown, which serves to distinguish it from local beds of dark red, agglomeritic scoria which are present a little higher in the series. The agglomerate is composed of angular fragments, of variable sizes up to one foot, poorly sorted and rudely stratified, enclosed in a matrix of glassy shards. In a few localities, the base of the basalt series is marked by five to twenty feet of coarse, white and maroon arkose. This member seems to be best developed in areas overlying the quartz porphyry, and probably represents a sediment of local derivation. There is some possibility that the agglomerate has been confused with the basal arkose at the eastern edge of the map, because nowhere else is the agglomerate observed to lie upon the old surface. However, just south of the map, one-thousand feet south of point C, the basal arkose is separated from the tuffaceous agglomerate by only a few feet of basalt.

GEOLOGIC STRUCTURE

At the beginning of this study it was suspected that faulting, such as that in the San Manuel deposit, for example, might account for the limited and irregular exposures of quartz porphyry near the SD-6 drill hole. That is, the absence of quartz porphyry to the east of SD-6, at elevations where it might reasonably be expected, could be due to a down-faulted block. The small fault at the southwest corner of the map, north of triangulation point C, would encourage such a hypothesis. Since most of the area is covered by a monotonous series of basalt flows, it was necessary to map the tuffaceous agglomerate member in order to decipher the structure. Although the agglomerate lies at variable elevations, and is exposed only in a discontinuous manner, the changes in elevation are so regular and gradual that no major fault can be discerned. At coordinate E 56,000, about six-hundred feet north of SD-6, there is an unusually abrupt slope along the agglomerate member. However, exposures at this point are exceptionally good, and no fault is indicated.

The essential continuity and consistency of elevation displayed by the agglomeritic member of the basalt series indicate that no fault has cut these flows except in the vicinity of point C.

The boundary between the steeply-dipping rhyolitic volcanics and the flat-lying basaltic flows obviously is an unconformable contact. At coordinates N 54,000 E 63,500,

the basalt-rhyolite contact meets the basalt-diorite contact without offset or change in elevation. This indicates that the basalt-rhyolite contact is the locus of the same old erosion surface as that represented by the basalt-diorite contact. Also, as illustrated in the accompanying cross-sections, the basalt-rhyolite contact forms part of a smoothly sloping surface continuous with the contact between the basalt and the quartz porphyry. The slope of this surface is verified or reflected by the slope of the basalt flows themselves, as shown by the slope of the agglomeritic member. This feature, too, suggests that the older, rhyolitic volcanics were exposed on the old erosion surface upon which the younger basalt flows were deposited.

Therefore, it is evident that the quartz porphyry is absent in the valleys northeast of SD-6, not because it is concealed beneath the capping of younger basalt flows, but because it was not exposed upon the old pre-basalt surface in that locality.

CONCLUSIONS

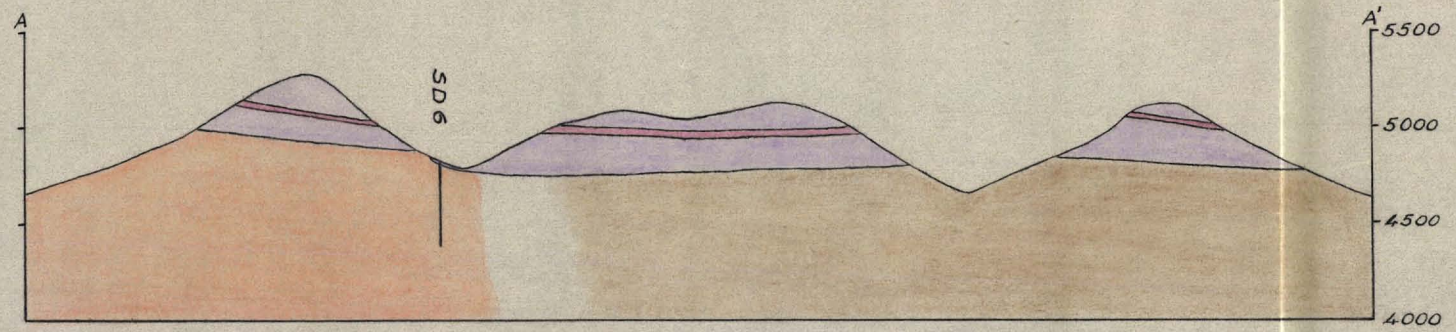
The trend and location of the contact between the quartz porphyry and the older volcanics are not revealed at the present surface, but are concealed beneath the basalt flows. The contact lies somewhere between SD-6 and the first rhyolite exposures 1100 feet down the valley to the east. Since it is thought that the quartz porphyry intruded the rhyolite, it is possible that the porphyry lies beneath some areas where only rhyolite is exposed. But, to drill into the older volcanics in the hope of encountering quartz porphyry would be a very long gamble.

If the results of drilling in SD-6 are encouraging enough to warrant further drilling in the vicinity, the holes probably will have to be located somewhere along the same valley as the present hole, in order to avoid drilling through a great thickness of barren basalt capping. As noted above, extensions of the quartz porphyry in the downstream direction cannot be expected beyond 1100 feet. The probability of staying within the quartz porphyry seems to be greater in the upstream (northwest) direction from SD-6. But drilling there will necessitate passing through increasing thicknesses of basalt as distance from SD-6 increases.

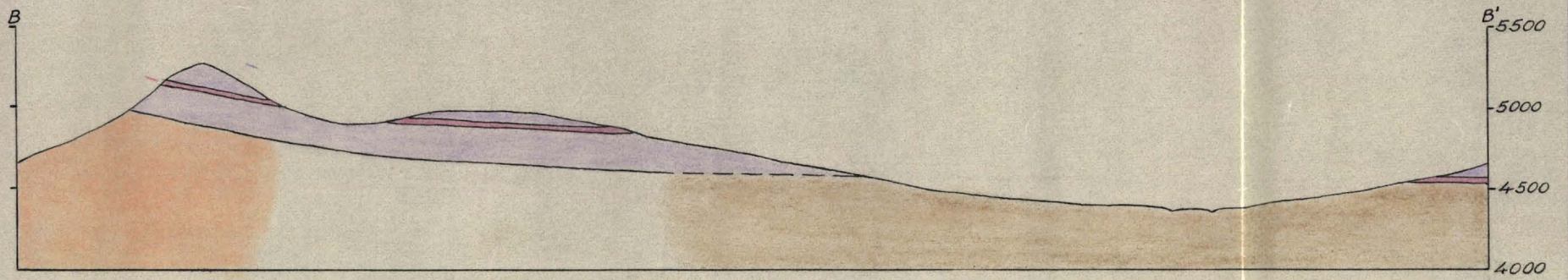
The two drill sites already prepared in the vicinity of SD-6 appear to be located at the best possible positions in accord with the above considerations.

Respectfully submitted,

Norman Swiley



SECTION AA'



SECTION BB'

CONSOLIDATED COPPERMINES CORPORATION

SAFFORD PROJECT
RECONNAISSANCE GEOLOGY MAP

Scale: 1" = 1000'

June, 1950 — N. Snively

N 58000

N 56000

N 54000

N 52000

E 54000

E 56000

E 58000

E 60000

E 62000

5000

4500

A

A'

B

B'

ΔH

ΔE

ΔI

ΔF

ΔD6

ΔG

ΔD

ΔC

S-1

35

LEGEND

- Basalt flows and agglomerate member
- Quartz porphyry
- Diorite
- Older volcanics
- Fault

REVIEW OF
SAFFORD, ARIZONA, PROJECT
BY

E. N. PENNEBAKER

MARCH 25, 1950

E. N. PENNEBAKER
CONSULTING GEOLOGIST

E. N. PENNEBAKER
GLOBE, ARIZONA

COPY

March 25, 1950

Mr. Chester D. Tripp
Hotel de la Cite
Carcassonne
France

Dear Chester:

The following comprehensive review of the Safford project was prepared in anticipation of John Payne's visit to this area on March 21, 1950, and a preliminary draft was given to him at that time. The conclusion reached is that more drilling is warranted near Safford, and in part this is derived from a consideration of recently acquired evidence.

In general Mr. Payne appeared to agree with my recommendations. However, he is not too keen on additional drilling on the southwest, and as a consequence I have reduced my proposal here to only one hole. He did express considerable interest concerning favorable possibilities farther on to the northeast in and near Star No. 22 claim and is agreeable to our continuing the project here by some 2500 feet additional drilling as proposed in my review. It is my impression that he might favor the Metal Company going it alone on this prospect if Coppermines did not desire to continue.

Activities at Safford have been temporarily stopped while we await a decision on these proposals. The diamond drill will remain on the ground on a standby basis of $7.00 per day rental until we advise the contractor of our future plans. We shall not go ahead until definitely authorized to do so, and naturally an early decision will be to the advantage of all concerned.

With very kindest regards and the hope that you are enjoying a splendid holiday.

Yours sincerely,

cc: Mr. A. J. O'Connor
Mr. John Hope, Jr.

March 26, 1950

Mr. Thomas G. Moore
Mining Department
The American Metal Company, Limited
61 Broadway
New York 6, New York

Dear Tom:

Enclosed is a copy of my report covering the Safford project, about which John Payne no doubt has already written you.

I am also sending a copy of this by air mail to Mr. Tripp who will be at Hotel de la Cite, Carcassonne, France, from April 3 until April 5. Thereafter, he will be at Hotel Meurice, Paris, France, from April 8 until April 13. On the 14th he returns to New York by TWA.

Activities at Safford have been temporarily stopped while we await the decision on these proposals. The diamond drill will remain on the ground on a standby basis of $7.00 per day rental until we advise the contractor of our future plans. We shall not go ahead until definitely authorized by Mr. Tripp to do so, and naturally an early decision will be to the advantage of all concerned.

We are looking forward to seeing you out in the West this coming summer. With very kindest regards.

Yours sincerely,

cc: Mr. Charles L. Steegar
Mr. Arthur J. O'Connor
Mr. John Hope, Jr.

REVIEW OF THE

SAFFORD, ARIZONA, PROJECT

FOR

CONSOLIDATED COPPERMINES CORPORATION

BY

E. N. PENNEBAKER

MARCH 25, 1950

COPY NO. 4 OF SEVEN COPIES

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COPY NO. 6 TO JOHN HOPE, JR.
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SUMMARY

From a consideration of information recently gained by geological study, drilling results and location work on the Safford project, a comprehensive review of the situation leads to the conclusion that the possibilities for finding an ore body in this area have not yet been exhausted. This is based largely upon evidence (1) that more copper has been abstracted from the capping than has been deposited as secondary enrichment in the area explored to date; (2) that the enriching solutions probably were guided by a broad fracture system and flowed away to the northeast to deposit this excess copper and form an ore body; and (3) that we now have sound evidence that the favorably mineralized quartz porphyry breccia capping continues on to the northeast under the young volcanic cover. These and other points are briefly stated in the section headed "Conclusions", pages 20 to 23, in the report that follows.

As a result of this analysis it is proposed that an access road be constructed leading around to the north side beyond the summit to near the exposures of mineralized capping on Star No. 22 claim. From sites to be constructed near here, it is recommended that two or three diamond drill holes be put down to test this very promising prospect on the northeast. While this road construction is going on it is further proposed that one hole be drilled from a site on the presently established road to clean up the subordinate possibility that an ore body lies in quartz porphyry breccia along the southwesterly contact of that formation against the diorite. This entire additional program of road building and drilling is estimated to cost approximately $40,000.

In the event that these recommendations are not accepted, an alternative proposal is brought forward in which is is advocated that the mining claims acquired

by location be held for several years in the hope that the U. S. Bureau of Mines might be prevailed upon to do some drilling. However, it is urged that we go ahead and do our own drilling on sites of our own selection.

It is finally pointed out that it will not be easy to find another district with exploration possibilities equal to those still remaining near Safford and that we should continue here by following out this additional program.

REVIEW OF THE
SAFFORD, ARIZONA, PROJECT
FOR
CONSOLIDATED COPPERMINES CORPORATION

INTRODUCTION

A review of the Safford exploration project is appropriate at this time. We have been active in this area for about a year, and there remains approximately another six months before substantial property payments become due. During the past year we have optioned 5 claim groups and have located 21 claims of our own, giving us control of a fairly compact area about 2 miles long in an east-west direction and about one mile wide with an additional irregular extension toward the west. Besides this, careful property surveys have been made, detailed geological mapping has been accomplished, and a geophysical examination of a part of the area by the self-potential method was completed.

Exploration by means of 4 bore holes has been effected. The first two were put down by churn drill under contract. This type of exploration was found to be very slow, and as an experiment one of these holes was deepened by diamond drilling. This was successful and contract diamond drilling was then undertaken. Two holes have now been drilled by this method with satisfactory rate of progress at fair cost for this type of ground.

These exploratory bore holes have found zones secondarily

enriched by the copper-bearing mineral, chalcocite. However, there is not yet an indication of a commercial ore body, and we must now decide whether (1) to continue active drilling; (2) to entirely abandon the project; or (3) to retain only our mining claims acquired by location, hoping that when we have released our options and retired from active exploration that the U. S. Bureau of Mines will carry on with some drilling at an indefinite future date.

We have now determined that the better mineral possibilities may be in the higher ground on the north where the cost of preparing access roads is a major item of expense when additional drilling is contemplated. We have spent to date about $56,000 on this campaign, although we should bear in mind that had we not entered into the Safford project we would have paid out during the year about $30,000 in the continuing search for a promising area.

Our present problem is to decide whether or not an additional expenditure is warranted in this district, keeping in mind that it may be difficult to find a new project in another district whose possibilities are greater than those still remaining at Safford.

REVIEW OF GEOLOGY

The area of interest north of Safford is along the southerly face of the Gila Range near its easterly end. The upper margin of the conglomerate-floored basin of the Gila River is eroded to reveal intermittent exposures of diorite (or andesite

porphyry) as the base of the range is closely approached. On the higher slopes above this is a broad band of quartz porphyry breccia covered near the crest by thick volcanic flows and breccias of basic and intermediate composition.

The diorite and quartz porphyry breccia are cut by numerous quartz porphyry dikes of pronounced northeasterly trend, and these are clearly the youngest rocks of the pre-volcanic igneous group. On the other hand, the age relations between the diorite and the quartz porphyry breccia are more difficult to discern. It is believed that they are both intrusive rocks, and it was formerly suspected that the quartz porphyry is the younger. However, results from recent drilling indicate that some bodies of diorite may be younger intrusives, and this question of age relations is not yet settled.

The attitude of the young volcanic cap indicates that the Gila Range has been uplifted as a fault block and tilted down to the northeast at an angle of about 20 degrees. Thus the present southwesterly face is an erosional modification of the fault scarp where the older rocks were exposed, and the less precipitous surface to the northeast beyond the summit line is the moderately dissected back-slope upon which the younger volcanics are displayed.

The diorite and quartz porphyry breccia are cut by a pronounced system of steep joints and fractures that strike northeast. A second system striking northwest is much less perfectly developed. As previously mentioned, a strong pattern of

quartz porphyry dikes also follows the dominant northeasterly trend. This direction points directly toward the important copper-producing district of Morenci, some 15 miles distant to the northeast.

CHARACTER OF MINERALIZATION

Widespread metallization over about a mile square is displayed in diorite, quartz porphyry, and quartz porphyry breccia by iron-staining and green copper minerals. Hydrothermal alteration is expressed by bleaching with the development of sericite and some quartz in the diorite and by silicification and subordinate sericite in the quartz porphyry breccia. Shallow workings and drill holes make it evident that some of the iron oxide is derived from the oxidation of pyrite but that a second type is formed by the oxidation of the copper sulphide, chalcocite.

Mineralization has been guided by the northeast fracturing. Sulphide grains have been deposited along these planes, although there is also a fair proportion disseminated between them. Bleached zones in the diorite are strongly controlled by this direction of jointing and fracturing.

Green copper staining is most abundant in the diorite that has undergone less bleaching, and its presence at the surface has in the past lead to a fair amount of generally futile exploration by shafts and pits. The bleached diorite, on the other hand, being a "less reactive gangue", has precipitated less copper in the outcrop, and its metallization is chiefly evidenced by iron staining. Much of this has been derived from pyrite, but there

are limited zones where a significant amount of iron oxide has been precipitated in the bleached diorite as a result of the oxidation of chalcocite.

Nevertheless, the quartz porphyry breccia on the higher slopes emerging from beneath the volcanic cap presents the best evidence of copper mineralization. There is here an exposed area of quartz porphyry breccia about a mile long in a northwest-southeast direction and about 1000 feet wide before it disappears under the volcanic cap to the northeast. Most of this area shows evidence that chalcocite has been leached from the rocks exposed at the surface. Within it there is a portion about 3000 feet long and up to 1000 feet wide where the evidence of copper mineralization, as judged by the interpretation of the leached outcrops, is somewhat more abundant, and this area constitutes the better showing. Although exposures do not give decisive information, there appears to be a "core" in the northwesterly part of this area that consists of poorly metallized diorite.

The favorability of the area mentioned above is based upon a diagnosis of the type of iron oxide left in the outcrop. In most exposures two kinds can be found; one is the "relief limonite" that is formed as a result of the oxidation of chalcocite, and the other is limonite derived from pyrite. An identical type of relief limonite is found in the croppings above the disseminated copper ore bodies at Ray, Inspiration, Miami, and Morenci. The particular croppings at the Safford project are leaner than those observed at Ray and Inspiration and more nearly resemble

those above the low-grade disseminated ore body recently developed at Silverbell, Arizona, by the A. S. & R. Company.

We, of course, are on a sounder basis if it can be proved for each project that the type of limonite there believed to be diagnostic of the former presence of a copper sulphide can actually be demonstrated to have such derivation. In this respect we are particularly fortunate at Safford, because the Clara tunnel has revealed a fracture zone that actually contains stringers of chalcocite locally preserved at very shallow depth. On strike these can be seen to change over to a "relief limonite" that replaces the chalcocite, and it is this type of limonite that has been considered diagnostic of the former presence of chalcocite in rocks now exposed at the surface on the Safford project.

Southwest of the southwest margin of the quartz porphyry breccia, various exploratory workings disclose sulphides at rather shallow depth. The fact that there was deep oxidation in some of the workings appurtenant to the Clara shaft on the north lead to the belief that the base of oxidation would be deep and give a thick zone of leaching in the favorable area with the consequent opportunity for secondary solutions to collect copper from an adequate "gathering ground".

Furthermore, it was believed that copper mineralization was somewhat more abundant toward the northeast and that there was a hint of favorable zoning in this direction.

Study of the ground clearly demonstrated that both primary mineralization and secondary enrichment of copper were

earlier than the formation of the volcanic cap and that there was a sound possibility that the enriched zone would extend northeasterly under the volcanics. Particularly good evidence was obtained toward the north where a knob of leached capping protruded through a thin place in the volcanics on Star No. 22 claim. The capping exhibited by this knob is of rather mediocre quality, but some 300 feet to the south the location hole for this claim passed through 5 feet of lava and into mineralized quartz porphyry breccia capping of excellent quality. This is a most encouraging recent development and proves that favorable mineralization extends northeasterly for 1500 feet under the young volcanics. It has strongly focussed our attention upon ore possibilities in this area.

Although it was evident that the average quality of the capping was definitely lean, we nevertheless could point to ore bodies beneath capping of similar and inferior grades in other districts where geological conditions were favorable. With these various points in mind the project was judged to be worth a few drill holes to search for secondarily enriched copper ore deposited from solutions that had gathered copper from chalcocite formerly contained in the now oxidized and leached capping. It was our intention to limit exploration to a rather moderate expenditure unless preliminary drilling gave information that would change our conclusions regarding the worth of this project.

As will be noted in the section that follows, some of the information yielded by the drills was surprising and has made it necessary to modify our ideas from time to time. It should be

pointed out that this is not an unusual situation in mining exploration, because not always can we be so sure of the geological relations that one or two preliminary holes "make or break" a property. In some places this is the case, but under other conditions we must use the information gained from preliminary exploration to reorient our plans and step by step approach our objective. It was my opinion a short time ago that if SD-4 and SD-4-A did not return a good column of ore we might well consider abandoning the Safford project. However, a full examination of all the data, including some very recently obtained, now leads to a different and more encouraging conclusion.

DRILLING RESULTS

Due to our desire to keep expenditures at a minimum, the problem of road construction was a considered factor in selecting sites for bore-holes.

Churn drill hole S-1 was located in the southeasterly portion of the better mineralized quartz porphyry breccia. This hole was drilled vertically to a depth of 615 feet in quartz porphyry and quartz porphyry breccia, where it was stopped. Oxidation persisted to a depth of 450 feet, beyond which point chalcocite and pyrite appeared. From 450 to 545 feet sludge samples averaged 0.52% copper for 95 feet; from 545 feet to the bottom of the hole at 615 feet, sludge samples averaged 0.16% copper for 70 feet. The lowermost samples still exhibited a little chalcocite so it is obvious that the primary tenor was quite low, say 0.10% copper or less, this copper being apparently carried by chalcopyrite.

The rig was then moved about 500 feet to the northwest and churn drill hole S-2 was collared. This was drilled vertically to a depth of 912 feet in quartz porphyry and quartz porphyry breccia. A surprisingly thick column of oxidized and leached capping was cut, and the sulphide zone did not appear until a depth of 845 feet had been reached. Below this point there was 35 feet averaging 0.73% copper between 845 and 880 feet with most of the copper contained in chalcocite. From 880 to 912 feet, churn drill sludge samples averaged 0.23% copper. This hole was then deepened by diamond drilling and thereafter designated as hole SD-2. It entered quartz diorite at a depth of 1044 feet and continued in that rock to 1134 feet, where the hole was abandoned. From 912 to 1044 feet the core averaged 0.27% copper in quartz porphyry breccia for 132 feet. Copper mineralization in the quartz diorite was generally low with an average of 0.15% copper for the 90 feet from 1044 to 1134 feet.

The deep oxidation revealed in hole S-2 was judged to be a feature of considerable promise. The slope of the base of oxidation between holes S-1 and S-2 was determined to be about 40 degrees, and it was believed that this might indicate a lateral movement to secondary solutions that had gained considerable copper from the great thickness of overlying leached ground and had deposited this copper on the northwest. To check this possibility it was proposed that a third hole, designated SD-4, be located about 1200 northwest of S-2, and the necessary access road to this site was constructed.

Diamond drill hole SD-4 was drilled vertically to a depth of 587 feet, where it was stopped. Thoroughly oxidized quartz porphyry breccia was cut to a depth of 341.5 feet. From 341.5 to 383.1 feet the core was partially oxidized and showed a mixture of pyrite, chalcocite and iron oxide. Beyond this interval there was no oxidation and the core was low in copper. From 351.5 to 383.1 feet the average assay value was 1.93% total copper for 31.6 feet. Oxide copper for this interval returned an average assay value of 0.38% copper. Core recovery was 82%. From 383.1 feet to the bottom at 587 feet the average assay value was 0.09% copper for 203.9 feet, again testifying to a low primary tenor. Diamond drill hole SD-4 cut quartz porphyry breccia, except for the interval 505.0 to 538.5 where quartz diorite appeared.

Diamond drill hole SD-4 returned much useful information. Most importantly it demonstrated that worthwhile enrichment did occur where geologic conditions were right. Also, the core samples gave a better view of the rock than did the sludge samples from the diamond drill holes and revealed the tightness of the quartz porphyry breccia below the zone of abundant chalcocite replacement. Although some enrichment took place by deposition of chalcocite within fractures in this deeper section, there was little or no replacement of the pyrite grains in the tight rock between these fractures. Results from this hole also made it clear that the base of oxidation did not slope down uniformly to the northwest. On the contrary it rose again to demonstrate that the condition of very deep oxidation observed in hole S-2 was probably exceptional.

This information demanded a review of the situation with the conclusion that secondary enriching solutions must have migrated laterally with the trend of the major fracturing and jointing. This runs about N 70 E, and the solutions must have flowed either northeast or southwest. Had it been to the southwest, better values should have been found in the vicinity of the old Elsie shaft, although their apparent absence here does not entirely eliminate such a possibility. It seems more likely that secondary solutions, prior to the outpouring of the volcanics and their subsequent tilting with the mountain block, flowed northeasterly toward what is now the Bonita Creek basin.

With the above possibility in mind, diamond drill hole SD-4-A was drilled from approximately the same site as SD-4, but it was pointed N 35 E and inclined down at 55 degrees. This hole cut quartz porphyry breccia to a depth of 313.8 feet, where it entered diorite (or andesite porphyry). It remained in this rock to the bottom at 892 feet, except for the interval 665.3 feet to 697.7 feet which cut quartz porphyry breccia. Oxidation persisted for an inclined distance of 524 feet, beyond which the dioritic rock carried pyrite and a very little chalcocite. The short interval of quartz porphyry breccia from 665.3 feet to 697.7 feet was mostly oxidized but showed some sulphides and assayed a few tenths of one percent. Evidently the dioritic plug mentioned in a foregoing section plunged down to the northwest and was intersected by diamond drill hole SD-4-A. Apparently secondary solutions did not penetrate the tighter diorite, and this hole did not give a

fair test of the possibilities toward the northeast.

None of the drill holes described above pierced the water table. It seems reasonable to believe that the zone of secondary enrichment discovered was deposited at or near an ancient water level. Evidently the faulting and tilting of the Gila Range lifted the chalcocite zone well above the level of the present water table where part of it underwent some oxidation. Inasmuch as the tilted base of oxidation slopes northeasterly, somewhere in this direction it should meet the groundwater zone.

FACTORS INFLUENCING FURTHER EXPLORATION

Examination of the leached capping exposed on the surface and that cut in the drill holes when compared with the amount of secondary chalcocite enrichment revealed by drilling leads to the conclusion that more copper has been abstracted from the quartz porphyry breccia capping than has been deposited in the secondary chalcocite zone. For example, in my judgment the leached capping now to be observed probably represents material that for the most part averaged 0.5% copper in the form of chalcocite as a result of several earlier cycles of enrichment before it was oxidized and the copper removed. If, to be conservative, we reduce this to 0.3% copper and multiply the latter percentage by 400 feet, the indicated approximate thickness of the oxidized zone, we obtain a figure of 120 "grade feet", Assuming 0.08% copper as the tenor of primary mineralization in the area drilled and subtracting this amount from the assay results of hole S-1 we obtain 47.6 grade feet, which represents the copper added by to the sulphide zone

which gives a measure of the copper obtained from the capping by oxidation and leaching.

enrichment. For hole S-2 (and SD-2) this figure is 59.6 grade feet; for SD-4, about 62 grade feet; and for SD-4-A it is apparently still lower. It is thus evident that much more copper has probably been leached from the oxidized zone than has been deposited in the zone of secondary sulphide enrichment where our drill holes have pierced the latter.

We must now try to determine what has become of this copper that has apparently disappeared. Has it been concentrated and deposited to form a worthwhile ore body, or has it been dissipated and lost for all practical purposes? It would seem that there has been a lateral migration of the secondary solutions carrying this copper, and, in part, our problem is one concerning the direction of movement of groundwater. From information gained by surface mapping and drilling, it is believed that groundwater circulation was controlled by the dominant northeast fracturing. It is further indicated that the direction of flow just prior to the volcanic episode was probably toward the northeast, but the possibility of circulation toward the southwest is not absolutely ruled out.

For the copper to be deposited from these solutions and concentrated into an ore body, they must be impounded against a barrier or their flow concentrated through a fracture zone where they will be in contact with pre-existent sulphides for a time sufficient to cause the precipitation of their contained copper.

Some 500 feet southwest of our drill holes the quartz porphyry breccia makes contact with the main body of diorite on

the surface, and this could have served as such a favorable barrier. If this had caused the precipitation of an important amount of copper, it would seem that early exploration work here where the sulphide zone is tilted up to shallower depth would have detected its occurrence. This was not the case, but, as indicated above, this possibility is not yet entirely ruled out.

That these solutions moved toward the northeast now seems most likely. We have no sure proof of this, and such a conclusion is reached largely by a process of elimination based upon the results of holes recently drilled. Whether or not a barrier exists to the north is problematical because of the extensive covering of late volcanics. However, from the occurrences on Star No. 22 claim we are assured that the favorably mineralized quartz porphyry breccia continues on north under the volcanics.

We now have evidence of more than three cycles of supergene activity. After the tilting of the range, the youngest and most recent of these events is revealed by the partial oxidation of the zone of chalcocite enrichment on the southwest (as indicated by the results of hole SD-4). By this the enriched zone was partially destroyed and some copper was dissipated. Inasmuch as the enriched zone tilts down to the northeast, this destructive effect should disappear in that direction, particularly near where it slopes down to meet the water table.

The cycle immediately preceding the above saw the deep leaching of a still earlier-formed zone of enrichment. It is the deposition of the copper taken into solution during this cycle

with which we are now principally concerned. Apparently there was a rapid movement of the groundwater carrying this copper through the zone we have explored to date, and it seems evident that within this zone only a part of the copper was deposited. There should have been an accumulation of these copper-bearing solutions in the direction of flow and better opportunities for precipitation in this direction.

A third cycle is represented by the indications of chalcocite formerly present in what is now a deep zone of capping. At the time of deposition of this chalcocite conditions were such that a thick blanket of enrichment (of low tenor) could be formed, whereas in the succeeding cycle we so far have evidence only of the development of a relatively thin zone. This is important, because it indicates that the rock was not too impervious for enrichment providing other conditions were favorable.

The above cycles were of course preceded by several others with the result that the originally very low-grade primary mineralization was converted to secondary chalcocite, whose relicts may now be observed in the capping on the present erosion surface, as noted above.

Regardless of the problem of relative ages, the area we have already drilled presents the risk of containing irregular bodies of diorite within the quartz porphyry breccia. This diorite appears less favorably mineralized and less susceptible to secondary enrichment except near its edges. It represents a hazard that might be lessened by exploring farther to the northeast.

During the past year we have had little or no competition in this district, and we have been able to gain control of a good-sized block of ground at reasonable expense. Our activities have recently attracted the attention of others, and it now appears that A. S. & R. Company geologists are starting an intensive examination of this general area.

PROPERTY CONSIDERATIONS

The Consolidated Metals group of 30 unpatented mining claims lies mostly to the south and west of the mineralized quartz porphyry breccia. Our investigation to date indicates that it is chiefly valuable because of a very few claims that jut into or near the mineralized quartz porphyry breccia, for rights-of-way along the principal access road, and for millsite and tailings disposal space. None of our drill holes cut this ground, but these claims have benefited from road work that we have performed. In our present view the only remaining mineral possibilities might be where a few claims come in near the southerly contact of quartz porphyry breccia against diorite, in which zone secondary solutions, if they have moved southwesterly, might have deposited secondary ore. An initial payment of $12,000 will fall due on November 1, 1950, if we decide to exercise our option on this group. The full purchase price is $60,000, spread over 5 years with the final payment falling due on November 1, 1954.

The Red Mountain group of 3 unpatented mining claims lies in the westerly portion of the mineralized quartz porphyry breccia

where it is exposed immediately southwest of the volcanics. Our drill holes SD-4 and SD-4-A have pierced this ground with the results noted in a foregoing section, and this claim group has also been benefited by road construction. Further mineral possibilities might be along the southerly margin of the quartz porphyry breccia, as explained in the preceding paragraph. An initial payment of $4,000 will fall due on November 1, 1950, if we decide to exercise our option. The full purchase price is $20,000, spread over 5 years, with the final payment falling due on November 1, 1954.

The Crown Point group of 4 unpatented mining claims lies on the northwesterly extension of the mineralized quartz porphyry breccia. We have not mapped this area geologically, but the ground is known to contain outcrops of mineralized quartz porphyry breccia of rather mediocre quality. Its ore-bearing possibilities do not appear too promising, but there has been no exploration to really determine the worth of this ground. We have made no improvements directly on these claims, but they are linked by a recently located claim to the Star group where work has been done that our attorneys believe can be applied to the benefit of the Crown Point group. An initial payment of $4,000 will fall due on November 1, 1950, if we decide to exercise our option. The full purchase price is $20,000 spread over 5 years with the final payment falling due on November 1, 1954.

The Iron Cap group of 3 unpatented mining claims lies at the southeast extension of the zone of mineralized quartz porphyry breccia. Their remaining mineral possibilities are

similar to other claims near the southerly contact of the quartz porphyry breccia, and they have been benefited by recently-constructed roads. An initial payment of $1,200 falls due on November 1, 1950, if we decide to exercise our option. The full purchase price is $6,000 spread over 5 years with the final payment falling due on November 1, 1954.

The Lone Wolf group of 3 unpatented mining claims joins the Iron Cap group on the southeast. No work has been done on this ground. The bedrock here appears to be diorite with very limited mineral possibilities. An initial payment of $1,200 falls due on November 1, 1950, if we decide to exercise our option. The full purchase price is $6,000 spread over 5 years with the final payment falling due on November 1, 1954.

The C. C. C. group of 6 unpatented mining claims was acquired by location prior to June 30, 1949. These flank the Red Mountain group on the north and east, with an additional claim on the south. Five of them cover mineralized quartz porphyry breccia or nearby volcanics. Churn drill holes S-1 and S-2 were put down in this group, and they were further benefited by road construction. They still contain mineral possibilities on the north.

The Star group of 15 unpatented mining claims was acquired by location in December, 1949 and March, 1950. They surround the C.C.C. group on the east, north, and west. No work, other than the location holes, has been done on these claims. Well-mineralized capping was found beneath the volcanics in the bottom

of the location shaft on Star No. 22, as previously mentioned. The mineral possibilities for most claims of this group are problematical because much of their surface is concealed by the younger lavas. However, that the favorable quartz porphyry breccia continues on north under the volcanics is indicated on Star No. 22 by the knob that protrudes through them and by the quartz porphyry breccia found in the bottom of the location hole. Furthermore they lie on the direct extension of the broad mineralized fracture zone that strikes N 70 E. As will be emphasized farther along, the general conclusion is that they contain favorable ground.

In summary it should be noted that the remaining possibilities for this general area to contain copper ore are believed to be in two situations. The most promising one is on the northeast where we control most of the attractive ground by means of claims held by location, and we can continue to retain these by merely fulfilling the annual requirements for assessment work. The other is on the southwest near where mineralized quartz porphyry breccia comes in contact with diorite. If the enriching solutions have migrated southwesterly along the fracture zone, then the precipitation of secondary chalcocite may have been favored here. From some evidence we have at hand, this does not appear to have been the case, but our evidence is not sufficient to rule out this possibility. The Iron Cap group, the Red Mountain group, and a few claims of the Consolidated Metals group cover this situation. The possibility that this zone contains ore could

be checked by one or two inclined diamond drill holes pointed south from the road already constructed. If this test was unsuccessful, then all of these options could be dropped before any property payments come due. However, by so doing we might be cramped for elbow room, rights of way, tailings disposal sites, etc. After cleaning up this possibility on the southwest we could then proceed to drill the more promising northerly section where we have already acquired ownership by location.

CONCLUSIONS

The above discussion of property groups more or less anticipates the conclusions reached in this report. Stated briefly, my views are based on the following points and are the result of progressive changes in ideas because more and more information has become available as drilling and geological investigations have progressed. Stated in summary fashion, these points are as follows:

1. On the Safford project we are dealing with a major display of rock alteration and metallization, and both are kinds commonly associated with porphyry copper mineralization.

2. The dominant northeasterly fracture zone controlling the distribution of mineralization points toward Morenci, some 15 miles distant, and suggests that these districts might be manifestations of the same major trend.

3. More copper has been removed from the capping by secondary processes than has been precipitated in the zone of chalcocite enrichment where we have cut it by our drills. Hence it appears reasonable to believe that a substantial fraction of the copper leached from the capping has escaped by lateral migration. Our drilling results disclose a thick overlying zone of oxidized and leached capping

and a much thinner zone of secondary enrichment. With lateral migration of secondary solutions, the stage is set for worthwhile concentration and precipitation of copper, provided that they are impounded against a barrier or their flow is concentrated through a well-fractured zone where they are in contact with pre-existent sulphides.

4. By a process of elimination we believe this direction of flow to be to the northeast. However, the possibility of circulation to the southwest has not been entirely eliminated by exploration to date.

5. The diorite contact on the southwest may have served as a barrier, and there remains a band just north of this and about 400 feet or more wide that has not yet been explored throughout a strike length of over a mile.

6. Although our opportunities appear more promising on the northeast, we cannot determine whether any barriers exist there because geologic relations are obscured by the covering of late volcanic rocks. Nevertheless if secondary solutions flowed to the northeast, then there should have been an accumulation of copper-bearing solutions in this direction with consequent opportunities for worthwhile deposition.

7. That mineralized capping of good quality extends back under the volcanics for at least an additional 1500 feet to the northeast is proved by the location work recently performed on Star No. 22 claim.

8. There may be less hazard on the northeast of cutting stray bodies of unfavorable diorite.

9. There is probably less destructive oxidation of the enriched zone on the northeast.

10. Although the exposure in the Star No. 22 location hole is admittedly very limited, rock alteration appears more attractive here with the development of more sericite.

11. A most desirable area to explore would be one where the primary tenor was higher than that encountered on the southwest, thereby requiring less enrichment to develop a worthwhile deposit. Although we have no assurance that such a condition exists on the northeast, this is the only direction we can go in search of it.

12 - The deep oxidation and what we can learn of the pre-volcanic topography makes it appear doubtful that copper was dissipated by supergene solutions cascading over precipitous

Thus the gamble to be assumed by continued exploration is if and where substantial enrichment has taken place. I believe this remaining gamble is a good one and worth taking. The evidence indicates that our best chances are probably to the northeast, although a little clean-up work is warranted on the southwest. I also believe that our drilling to date has not been wasted by being located in between where we now think our remaining chances exist. On the other hand, these holes give us much-needed information by means of which we can locate the decisive holes.

Features believed to be favorable are cited above. We must also recognize that several discouraging aspects have been disclosed by our drilling, and these are brought forward in the following summation:

1. The capping is generally lean in appearance except in restricted exposures and in the location hole on the northeast in Star No. 22 claim.

2. Primary mineralization was very low in tenor, necessitating repeated cycles of favorable enrichment to boost the grade to a worthwhile amount of copper.

3. The zone of enrichment is apparently relatively thin in the area drilled with tighter rock below.

4. Where tilted up on the southwest and exposed by shallow workings, copper mineralization is poor. However, this is in diorite, and the quartz porphyry farther northeast is believed to contain a more promising zone.

5. We have no certain knowledge that a favorable barrier exists on the northeast.

6. Drilling results to date have yielded erratic and discouraging results.

The final conclusion, in my opinion, is that the good points outweigh the bad and that we should continue with the project and carry it to a logical conclusion by more drilling. By so doing we would be exploring with the reasonable hopes of finding a relatively thin ore body of good tenor. In this situation we would be setting our sights on trying to discover a 5-10 million ton deposit of 2-3% copper content.

I believe there are two final points that should be kept in mind concerning the Safford project. One is that we may be flirting with the low-grade edge of a mineralized district just sticking out from beneath the younger volcanic cover. This is a situation analagous to that at San Manuel and the very geological relations we have been seeking to find and explore. With this in mind, I believe we should continue with the project. The second point can be expressed in two ways. One is to venture the assertation that if we encountered another district displaying the possibilities remaining at Safford, we would take it up with considerable alacrity. The other way is to point out that it will very probably be costly and time-consuming to find a new prospect whose merits are equal to those still remaining at Safford.

There is, of course, no guarantee that continued drilling will find an ore body nearby in this area. Nevertheless the gamble is a good one, and I cannot do otherwise but recommend that the venture be carried on.

PROPOSED FUTURE PROCEDURE AT SAFFORD

Based upon the foregoing discussion, I make the following firm recommendations concerning our future procedure on the Safford project.

I propose that a road be constructed to Star No. 22 claim so that the northeasterly extension can be explored by two or three diamond drill holes. Some cleaning off with the bull-dozer can be done here to determine other spots where the volcanic cover is very thin or lacking in expectation of developing two drilling sites some 500 feet or more apart. In the absence of detailed road location surveys, the cost of this added phase of the project is difficult to estimate, but it probably would be about $12,000-$15,000 for the road. While this road construction is going on, I believe it advisable to drill one diamond drill hole inclined southerly from a site along the present road to test mineralization in front of the southwesterly barrier. By so doing we shall be making use of the contractor's drill and thus obviate a standby fee. This hole should dispose of the mineral possibilities on the southwest; and, if it gives no encouragement, then we can abandon or renegotiate our options before the initial payments come due. This hole would probably cost about $7,000. Then I propose that two or three diamond drill holes (for an aggregate of 2,500 feet) be drilled on the northeast in or near Star No. 22 claim to seek for copper ore on the northeast under the volcanics. This drilling is estimated to cost about $20,000.

I believe that the above recommendations form a sound program for continuing the Safford project. The proposal for drilling on the northeast is, of course, the most promising phase and the one that should receive the most attention. The single drill hole suggested on the southwest calls for only a subordinate part of the proposed budget. Nevertheless, it will give much valuable information that will help us in the proper disposal of our property options besides preventing our competitors from later finding ore in a zone where there now remains substantial promise. I favor including this one hole in our program, but I do not wish its consideration to detract from the greater possibilities on the northeast.

The continuation of the Safford project thus calls for an expenditure of about $40,000 for drilling and road construction. A somewhat closer estimate can be made after road location surveys have been made and our diamond drilling contract has been renegotiated on the basis of a minimum footage guarantee.

If the above recommendation for an active continuation of the Safford project does not meet with approval, then I propose that we abandon the optioned ground but that we retain and perform the necessary assessment work to hold our 21 located claims for a period of several years. This is because representatives of the U. S. Bureau of Mines have intimated that they might do some drilling if we retired from active exploration and relinquished our options. They seemed interested in following out the low-grade zone cut in churn drill hole S-1, but only if

we were apparently out of the exploration picture. There is thus the possibility that they might do some drilling if we made proper application and submitted all of our available information; but we could not expect this to be done for perhaps several years, and I doubt very much if they would undertake the expensive road construction to get into the northeastern extension.

I personally believe we are warranted in continuing the drilling ourselves, as recommended above. The second proposal is admittedly a device to retain an interest in a very promising district and prevent complete abandonment until some more exploration has been done. I do not believe that we should defer our own drilling in the doubtful anticipation that the Bureau might carry on.

E. N. Pennebaker

E. N. PENNEBAKER

MARCH 25, 1950

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REVIEW OF
SAFFORD, ARIZONA, PROJECT

BY

E. N. PENNEBAKER

MARCH 25, 1950

E. N. PENNEBAKER
CONSULTING GEOLOGIST

REVIEW OF THE

SAFFORD, ARIZONA, PROJECT

FOR

CONSOLIDATED COPPERMINES CORPORATION

BY

E. N. PENNEBAKER

MARCH 25, 1950

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SUMMARY

From a consideration of information recently gained by geological study, drilling results and location work on the Safford project, a comprehensive review of the situation leads to the conclusion that the possibilities for finding an ore body in this area have not yet been exhausted. This is based largely upon evidence (1) that more copper has been abstracted from the capping than has been deposited as secondary enrichment in the area explored to date; (2) that the enriching solutions probably were guided by a broad fracture system and flowed away to the northeast to deposit this excess copper and form an ore body; and (3) that we now have sound evidence that the favorably mineralized quartz porphyry breccia capping continues on to the northeast under the young volcanic cover. These and other points are briefly stated in the section headed "Conclusions", pages 20 to 23, in the report that follows.

As a result of this analysis it is proposed that an access road be constructed leading around to the north side beyond the summit to near the exposures of mineralized capping on Star No. 22 claim. From sites to be constructed near here, it is recommended that two or three diamond drill holes be put down to test this very promising prospect on the northeast. While this road construction is going on it is further proposed that one hole be drilled from a site on the presently established road to clean up the subordinate possibility that an ore body lies in quartz porphyry breccia along the southwesterly contact of that formation against the diorite. This entire additional program of road building and drilling is estimated to cost approximately $40,000.

In the event that these recommendations are not accepted, an alternative proposal is brought forward in which is is advocated that the mining claims acquired

by location be held for several years in the hope that the U. S. Bureau of Mines might be prevailed upon to do some drilling. However, it is urged that we go ahead and do our own drilling on sites of our own selection.

It is finally pointed out that it will not be easy to find another district with exploration possibilities equal to those still remaining near Safford and that we should continue here by following out this additional program.

REVIEW OF THE

SAFFORD, ARIZONA, PROJECT

FOR

CONSOLIDATED COPPERMINES CORPORATION

INTRODUCTION

A review of the Safford exploration project is appropriate at this time. We have been active in this area for about a year, and there remains approximately another six months before substantial property payments become due. During the past year we have optioned 5 claim groups and have located 21 claims of our own, giving us control of a fairly compact area about 2 miles long in an east-west direction and about one mile wide with an additional irregular extension toward the west. Besides this, careful property surveys have been made, detailed geological mapping has been accomplished, and a geophysical examination of a part of the area by the self-potential method was completed.

Exploration by means of 4 bore holes has been effected. The first two were put down by churn drill under contract. This type of exploration was found to be very slow, and as an experiment one of these holes was deepened by diamond drilling. This was successful and contract diamond drilling was then undertaken. Two holes have now been drilled by this method with satisfactory rate of progress at fair cost for this type of ground.

These exploratory bore holes have found zones secondarily

enriched by the copper-bearing mineral, chalcocite. However, there is not yet an indication of a commercial ore body, and we must now decide whether (1) to continue active drilling; (2) to entirely abandon the project; or (3) to retain only our mining claims acquired by location, hoping that when we have released our options and retired from active exploration that the U. S. Bureau of Mines will carry on with some drilling at an indefinite future date.

We have now determined that the better mineral possibilities may be in the higher ground on the north where the cost of preparing access roads is a major item of expense when additional drilling is contemplated. We have spent to date about $56,000 on this campaign, although we should bear in mind that had we not entered into the Safford project we would have paid out during the year about $30,000 in the continuing search for a promising area.

Our present problem is to decide whether or not an additional expenditure is warranted in this district, keeping in mind that it may be difficult to find a new project in another district whose possibilities are greater than those still remaining at Safford.

REVIEW OF GEOLOGY

The area of interest north of Safford is along the southerly face of the Gila Range near its easterly end. The upper margin of the conglomerate-floored basin of the Gila River is eroded to reveal intermittent exposures of diorite (or andesite

porphyry) as the base of the range is closely approached. On the higher slopes above this is a broad band of quartz porphyry breccia covered near the crest by thick volcanic flows and breccias of basic and intermediate composition.

The diorite and quartz porphyry breccia are cut by numerous quartz porphyry dikes of pronounced northeasterly trend, and these are clearly the youngest rocks of the pre-volcanic igneous group. On the other hand, the age relations between the diorite and the quartz porphyry breccia are more difficult to discern. It is believed that they are both intrusive rocks, and it was formerly suspected that the quartz porphyry is the younger. However, results from recent drilling indicate that some bodies of diorite may be younger intrusives, and this question of age relations is not yet settled.

The attitude of the young volcanic cap indicates that the Gila Range has been uplifted as a fault block and tilted down to the northeast at an angle of about 20 degrees. Thus the present southwesterly face is an erosional modification of the fault scarp where the older rocks were exposed, and the less precipitous surface to the northeast beyond the summit line is the moderately dissected back-slope upon which the younger volcanics are displayed.

The diorite and quartz porphyry breccia are cut by a pronounced system of steep joints and fractures that strike northeast. A second system striking northwest is much less perfectly developed. As previously mentioned, a strong pattern of

quartz porphyry dikes also follows the dominant northeasterly trend. This direction points directly toward the important copper-producing district of Morenci, some 15 miles distant to the northeast.

CHARACTER OF MINERALIZATION

Widespread metallization over about a mile square is displayed in diorite, quartz porphyry, and quartz porphyry breccia by iron-staining and green copper minerals. Hydrothermal alteration is expressed by bleaching with the development of sericite and some quartz in the diorite and by silicification and subordinate sericite in the quartz porphyry breccia. Shallow workings and drill holes make it evident that some of the iron oxide is derived from the oxidation of pyrite but that a second type is formed by the oxidation of the copper sulphide, chalcocite.

Mineralization has been guided by the northeast fracturing. Sulphide grains have been deposited along these planes, although there is also a fair proportion disseminated between them. Bleached zones in the diorite are strongly controlled by this direction of jointing and fracturing.

Green copper staining is most abundant in the diorite that has undergone less bleaching, and its presence at the surface has in the past lead to a fair amount of generally futile exploration by shafts and pits. The bleached diorite, on the other hand, being a "less reactive gangue", has precipitated less copper in the outcrop, and its metallization is chiefly evidenced by iron staining. Much of this has been derived from pyrite, but there

are limited zones where a significant amount of iron oxide has been precipitated in the bleached diorite as a result of the oxidation of chalcocite.

Nevertheless, the quartz porphyry breccia on the higher slopes emerging from beneath the volcanic cap presents the best evidence of copper mineralization. There is here an exposed area of quartz porphyry breccia about a mile long in a northwest-southeast direction and about 1000 feet wide before it disappears under the volcanic cap to the northeast. Most of this area shows evidence that chalcocite has been leached from the rocks exposed at the surface. Within it there is a portion about 3000 feet long and up to 1000 feet wide where the evidence of copper mineralization, as judged by the interpretation of the leached outcrops, is somewhat more abundant, and this area constitutes the better showing. Although exposures do not give decisive information, there appears to be a "core" in the northwesterly part of this area that consists of poorly metallized diorite.

The favorability of the area mentioned above is based upon a diagnosis of the type of iron oxide left in the outcrop. In most exposures two kinds can be found; one is the "relief limonite" that is formed as a result of the oxidation of chalcocite, and the other is limonite derived from pyrite. An identical type of relief limonite is found in the croppings above the disseminated copper ore bodies at Ray, Inspiration, Miami, and Morenci. The particular croppings at the Safford project are leaner than those observed at Ray and Inspiration and more nearly resemble

those above the low-grade disseminated ore body recently developed at Silverbell, Arizona, by the A. S. & R. Company.

We, of course, are on a sounder basis if it can be proved for each project that the type of limonite there believed to be diagnostic of the former presence of a copper sulphide can actually be demonstrated to have such derivation. In this respect we are particularly fortunate at Safford, because the Clara tunnel has revealed a fracture zone that actually contains stringers of chalcocite locally preserved at very shallow depth. On strike these can be seen to change over to a "relief limonite" that replaces the chalcocite, and it is this type of limonite that has been considered diagnostic of the former presence of chalcocite in rocks now exposed at the surface on the Safford project.

Southwest of the southwest margin of the quartz porphyry breccia, various exploratory workings disclose sulphides at rather shallow depth. The fact that there was deep oxidation in some of the workings appurtenant to the Clara shaft on the north lead to the belief that the base of oxidation would be deep and give a thick zone of leaching in the favorable area with the consequent opportunity for secondary solutions to collect copper from an adequate "gathering ground".

Furthermore, it was believed that copper mineralization was somewhat more abundant toward the northeast and that there was a hint of favorable zoning in this direction.

Study of the ground clearly demonstrated that both primary mineralization and secondary enrichment of copper were

earlier than the formation of the volcanic cap and that there was a sound possibility that the enriched zone would extend northeasterly under the volcanics. Particularly good evidence was obtained toward the north where a knob of leached capping protruded through a thin place in the volcanics on Star No. 22 claim. The capping exhibited by this knob is of rather mediocre quality, but some 300 feet to the south the location hole for this claim passed through 5 feet of lava and into mineralized quartz porphyry breccia capping of excellent quality. This is a most encouraging recent development and proves that favorable mineralization extends northeasterly for 1500 feet under the young volcanics. It has strongly focussed our attention upon ore possibilities in this area.

Although it was evident that the average quality of the capping was definitely lean, we nevertheless could point to ore bodies beneath capping of similar and inferior grades in other districts where geological conditions were favorable. With these various points in mind the project was judged to be worth a few drill holes to search for secondarily enriched copper ore deposited from solutions that had gathered copper from chalcocite formerly contained in the now oxidized and leached capping. It was our intention to limit exploration to a rather moderate expenditure unless preliminary drilling gave information that would change our conclusions regarding the worth of this project.

As will be noted in the section that follows, some of the information yielded by the drills was surprising and has made it necessary to modify our ideas from time to time. It should be

pointed out that this is not an unusual situation in mining exploration, because not always can we be so sure of the geological relations that one or two preliminary holes "make or break" a property. In some places this is the case, but under other conditions we must use the information gained from preliminary exploration to reorient our plans and step by step approach our objective. It was my opinion a short time ago that if SD-4 and SD-4-A did not return a good column of ore we might well consider abandoning the Safford project. However, a full examination of all the data, including some very recently obtained, now leads to a different and more encouraging conclusion.

DRILLING RESULTS

Due to our desire to keep expenditures at a minimum, the problem of road construction was a considered factor in selecting sites for bore-holes.

Churn drill hole S-1 was located in the southeasterly portion of the better mineralized quartz porphyry breccia. This hole was drilled vertically to a depth of 615 feet in quartz porphyry and quartz porphyry breccia, where it was stopped. Oxidation persisted to a depth of 450 feet, beyond which point chalcocite and pyrite appeared. From 450 to 545 feet sludge samples averaged 0.52% copper for 95 feet; from 545 feet to the bottom of the hole at 615 feet, sludge samples averaged 0.16% copper for 70 feet. The lowermost samples still exhibited a little chalcocite so it is obvious that the primary tenor was quite low, say 0.10% copper or less, this copper being apparently carried by chalcopyrite.

The rig was then moved about 500 feet to the northwest and churn drill hole S-2 was collared. This was drilled vertically to a depth of 912 feet in quartz porphyry and quartz porphyry breccia. A surprisingly thick column of oxidized and leached capping was cut, and the sulphide zone did not appear until a depth of 845 feet had been reached. Below this point there was 35 feet averaging 0.73% copper between 845 and 880 feet with most of the copper contained in chalcocite. From 880 to 912 feet, churn drill sludge samples averaged 0.23% copper. This hole was then deepened by diamond drilling and thereafter designated as hole SD-2. It entered quartz diorite at a depth of 1044 feet and continued in that rock to 1134 feet, where the hole was abandoned. From 912 to 1044 feet the core averaged 0.27% copper in quartz porphyry breccia for 132 feet. Copper mineralization in the quartz diorite was generally low with an average of 0.15% copper for the 90 feet from 1044 to 1134 feet.

The deep oxidation revealed in hole S-2 was judged to be a feature of considerable promise. The slope of the base of oxidation between holes S-1 and S-2 was determined to be about 40 degrees, and it was believed that this might indicate a lateral movement to secondary solutions that had gained considerable copper from the great thickness of overlying leached ground and had deposited this copper on the northwest. To check this possibility it was proposed that a third hole, designated SD-4, be located about 1200 northwest of S-2, and the necessary access road to this site was constructed.

Diamond drill hole SD-4 was drilled vertically to a depth of 587 feet, where it was stopped. Thoroughly oxidized quartz porphyry breccia was cut to a depth of 341.5 feet. From 341.5 to 383.1 feet the core was partially oxidized and showed a mixture of pyrite, chalcocite and iron oxide. Beyond this interval there was no oxidation and the core was low in copper. From 351.5 to 383.1 feet the average assay value was 1.93% total copper for 31.6 feet. Oxide copper for this interval returned an average assay value of 0.38% copper. Core recovery was 82%. From 383.1 feet to the bottom at 587 feet the average assay value was 0.09% copper for 203.9 feet, again testifying to a low primary tenor. Diamond drill hole SD-4 cut quartz porphyry breccia, except for the interval 505.0 to 538.5 where quartz diorite appeared.

Diamond drill hole SD-4 returned much useful information. Most importantly it demonstrated that worthwhile enrichment did occur where geologic conditions were right. Also, the core samples gave a better view of the rock than did the sludge samples from the diamond drill holes and revealed the tightness of the quartz porphyry breccia below the zone of abundant chalcocite replacement. Although some enrichment took place by deposition of chalcocite within fractures in this deeper section, there was little or no replacement of the pyrite grains in the tight rock between these fractures. Results from this hole also made it clear that the base of oxidation did not slope down uniformly to the northwest. On the contrary it rose again to demonstrate that the condition of very deep oxidation observed in hole S-2 was probably exceptional.

This information demanded a review of the situation with the conclusion that secondary enriching solutions must have migrated laterally with the trend of the major fracturing and jointing. This runs about N 70 E, and the solutions must have flowed either northeast or southwest. Had it been to the southwest, better values should have been found in the vicinity of the old Elsie shaft, although their apparent absence here does not entirely eliminate such a possibility. It seems more likely that secondary solutions, prior to the outpouring of the volcanics and their subsequent tilting with the mountain block, flowed northeasterly toward what is now the Bonita Creek basin.

With the above possibility in mind, diamond drill hole SD-4-A was drilled from approximately the same site as SD-4, but it was pointed N 35 E and inclined down at 55 degrees. This hole cut quartz porphyry breccia to a depth of 313.8 feet, where it entered diorite (or andesite porphyry). It remained in this rock to the bottom at 892 feet, except for the interval 665.3 feet to 697.7 feet which cut quartz porphyry breccia. Oxidation persisted for an inclined distance of 524 feet, beyond which the dioritic rock carried pyrite and a very little chalcocite. The short interval of quartz porphyry breccia from 665.3 feet to 697.7 feet was mostly oxidized but showed some sulphides and assayed a few tenths of one percent. Evidently the dioritic plug mentioned in a foregoing section plunged down to the northwest and was intersected by diamond drill hole SD-4-A. Apparently secondary solutions did not penetrate the tighter diorite, and this hole did not give a

fair test of the possibilities toward the northeast.

None of the drill holes described above pierced the water table. It seems reasonable to believe that the zone of secondary enrichment discovered was deposited at or near an ancient water level. Evidently the faulting and tilting of the Gila Range lifted the chalcocite zone well above the level of the present water table where part of it underwent some oxidation. Inasmuch as the tilted base of oxidation slopes northeasterly, somewhere in this direction it should meet the groundwater zone.

FACTORS INFLUENCING FURTHER EXPLORATION

Examination of the leached capping exposed on the surface and that cut in the drill holes when compared with the amount of secondary chalcocite enrichment revealed by drilling leads to the conclusion that more copper has been abstracted from the quartz porphyry breccia capping than has been deposited in the secondary chalcocite zone. For example, in my judgment the leached capping now to be observed probably represents material that for the most part averaged 0.5% copper in the form of chalcocite as a result of several earlier cycles of enrichment before it was oxidized and the copper removed. If, to be conservative, we reduce this to 0.3% copper and multiply the latter percentage by 400 feet, the indicated approximate thickness of the oxidized zone, we obtain a figure of 120 "grade feet". Assuming 0.08% copper as the tenor of primary mineralization in the area drilled and subtracting this amount from the assay results of hole S-1 we obtain 47.6 grade feet, which represents the copper added by

enrichment. For hole S-2 (and SD-2) this figure is 59.6 grade feet; for SD-4, about 62 grade feet; and for SD-4-A it is apparently still lower. It is thus evident that much more copper has probably been leached from the oxidized zone than has been deposited in the zone of secondary sulphide enrichment where our drill holes have pierced the latter.

We must now try to determine what has become of this copper that has apparently disappeared. Has it been concentrated and deposited to form a worthwhile ore body, or has it been dissipated and lost for all practical purposes? It would seem that there has been a lateral migration of the secondary solutions carrying this copper, and, in part, our problem is one concerning the direction of movement of groundwater. From information gained by surface mapping and drilling, it is believed that groundwater circulation was controlled by the dominant northeast fracturing. It is further indicated that the direction of flow just prior to the volcanic episode was probably toward the northeast, but the possibility of circulation toward the southwest is not absolutely ruled out.

For the copper to be deposited from these solutions and concentrated into an ore body, they must be impounded against a barrier or their flow concentrated through a fracture zone where they will be in contact with pre-existent sulphides for a time sufficient to cause the precipitation of their contained copper.

Some 500 feet southwest of our drill holes the quartz porphyry breccia makes contact with the main body of diorite on

the surface, and this could have served as such a favorable barrier. If this had caused the precipitation of an important amount of copper, it would seem that early exploration work here where the sulphide zone is tilted up to shallower depth would have detected its occurrence. This was not the case, but, as indicated above, this possibility is not yet entirely ruled out.

That these solutions moved toward the northeast now seems most likely. We have no sure proof of this, and such a conclusion is reached largely by a process of elimination based upon the results of holes recently drilled. Whether or not a barrier exists to the north is problematical because of the extensive covering of late volcanics. However, from the occurrences on Star No. 22 claim we are assured that the favorably mineralized quartz porphyry breccia continues on north under the volcanics.

We now have evidence of more than three cycles of supergene activity. After the tilting of the range, the youngest and most recent of these events is revealed by the partial oxidation of the zone of chalcocite enrichment on the southwest (as indicated by the results of hole SD-4). By this the enriched zone was partially destroyed and some copper was dissipated. Inasmuch as the enriched zone tilts down to the northeast, this destructive effect should disappear in that direction, particularly near where it slopes down to meet the water table.

The cycle immediately preceding the above saw the deep leaching of a still earlier-formed zone of enrichment. It is the deposition of the copper taken into solution during this cycle

with which we are now principally concerned. Apparently there was a rapid movement of the groundwater carrying this copper through the zone we have explored to date, and it seems evident that within this zone only a part of the copper was deposited. There should have been an accumulation of these copper-bearing solutions in the direction of flow and better opportunities for precipitation in this direction.

A third cycle is represented by the indications of chalcocite formerly present in what is now a deep zone of capping. At the time of deposition of this chalcocite conditions were such that a thick blanket of enrichment (of low tenor) could be formed, whereas in the succeeding cycle we so far have evidence only of the development of a relatively thin zone. This is important, because it indicates that the rock was not too impervious for enrichment providing other conditions were favorable.

The above cycles were of course preceded by several others with the result that the originally very low-grade primary mineralization was converted to secondary chalcocite, whose relicts may now be observed in the capping on the present erosion surface, as noted above.

Regardless of the problem of relative ages, the area we have already drilled presents the risk of containing irregular bodies of diorite within the quartz porphyry breccia. This diorite appears less favorably mineralized and less susceptible to secondary enrichment except near its edges. It represents a hazard that might be lessened by exploring farther to the northeast.

During the past year we have had little or no competition in this district, and we have been able to gain control of a good-sized block of ground at reasonable expense. Our activities have recently attracted the attention of others, and it now appears that A. S. & R. Company geologists are starting an intensive examination of this general area.

PROPERTY CONSIDERATIONS

The Consolidated Metals group of 30 unpatented mining claims lies mostly to the south and west of the mineralized quartz porphyry breccia. Our investigation to date indicates that it is chiefly valuable because of a very few claims that jut into or near the mineralized quartz porphyry breccia, for rights-of-way along the principal access road, and for millsite and tailings disposal space. None of our drill holes cut this ground, but these claims have benefited from road work that we have performed. In our present view the only remaining mineral possibilities might be where a few claims come in near the southerly contact of quartz porphyry breccia against diorite, in which zone secondary solutions, if they have moved southwesterly, might have deposited secondary ore. An initial payment of $12,000 will fall due on November 1, 1950, if we decide to exercise our option on this group. The full purchase price is $60,000, spread over 5 years with the final payment falling due on November 1, 1954.

The Red Mountain group of 3 unpatented mining claims lies in the westerly portion of the mineralized quartz porphyry breccia

where it is exposed immediately southwest of the volcanics. Our drill holes SD-4 and SD-4-A have pierced this ground with the results noted in a foregoing section, and this claim group has also been benefited by road construction. Further mineral possibilities might be along the southerly margin of the quartz porphyry breccia, as explained in the preceding paragraph. An initial payment of $4,000 will fall due on November 1, 1950, if we decide to exercise our option. The full purchase price is $20,000, spread over 5 years, with the final payment falling due on November 1, 1954.

The Crown Point group of 4 unpatented mining claims lies on the northwesterly extension of the mineralized quartz porphyry breccia. We have not mapped this area geologically, but the ground is known to contain outcrops of mineralized quartz porphyry breccia of rather mediocre quality. Its ore-bearing possibilities do not appear too promising, but there has been no exploration to really determine the worth of this ground. We have made no improvements directly on these claims, but they are linked by a recently located claim to the Star group where work has been done that our attorneys believe can be applied to the benefit of the Crown Point group. An initial payment of $4,000 will fall due on November 1, 1950, if we decide to exercise our option. The full purchase price is $20,000 spread over 5 years with the final payment falling due on November 1, 1954.

The Iron Cap group of 3 unpatented mining claims lies at the southeast extension of the zone of mineralized quartz porphyry breccia. Their remaining mineral possibilities are

similar to other claims near the southerly contact of the quartz porphyry breccia, and they have been benefited by recently-constructed roads. An initial payment of $1,200 falls due on November 1, 1950, if we decide to exercise our option. The full purchase price is $6,000 spread over 5 years with the final payment falling due on November 1, 1954.

The Lone Wolf group of 3 unpatented mining claims joins the Iron Cap group on the southeast. No work has been done on this ground. The bedrock here appears to be diorite with very limited mineral possibilities. An initial payment of $1,200 falls due on November 1, 1950, if we decide to exercise our option. The full purchase price is $6,000 spread over 5 years with the final payment falling due on November 1, 1954.

The C. C. C. group of 6 unpatented mining claims was acquired by location prior to June 30, 1949. These flank the Red Mountain group on the north and east, with an additional claim on the south. Five of them cover mineralized quartz porphyry breccia or nearby volcanics. Churn drill holes S-1 and S-2 were put down in this group, and they were further benefited by road construction. They still contain mineral possibilities on the north.

The Star group of 15 unpatented mining claims was acquired by location in December, 1949 and March, 1950. They surround the C.C.C. group on the east, north, and west. No work, other than the location holes, has been done on these claims. Well-mineralized capping was found beneath the volcanics in the bottom

of the location shaft on Star No. 22, as previously mentioned. The mineral possibilities for most claims of this group are problematical because much of their surface is concealed by the younger lavas. However, that the favorable quartz porphyry breccia continues on north under the volcanics is indicated on Star No. 22 by the knob that protrudes through them and by the quartz porphyry breccia found in the bottom of the location hole. Furthermore they lie on the direct extension of the broad mineralized fracture zone that strikes N 70 E. As will be emphasized farther along, the general conclusion is that they contain favorable ground.

In summary it should be noted that the remaining possibilities for this general area to contain copper ore are believed to be in two situations. The most promising one is on the northeast where we control most of the attractive ground by means of claims held by location, and we can continue to retain these by merely fulfilling the annual requirements for assessment work. The other is on the southwest near where mineralized quartz porphyry breccia comes in contact with diorite. If the enriching solutions have migrated southwesterly along the fracture zone, then the precipitation of secondary chalcocite may have been favored here. From some evidence we have at hand, this does not appear to have been the case, but our evidence is not sufficient to rule out this possibility. The Iron Cap group, the Red Mountain group, and a few claims of the Consolidated Metals group cover this situation. The possibility that this zone contains ore could

be checked by one or two inclined diamond drill holes pointed south from the road already constructed. If this test was unsuccessful, then all of these options could be dropped before any property payments come due. However, by so doing we might be cramped for elbow room, rights of way, tailings disposal sites, etc. After cleaning up this possibility on the southwest we could then proceed to drill the more promising northerly section where we have already acquired ownership by location.

CONCLUSIONS

The above discussion of property groups more or less anticipates the conclusions reached in this report. Stated briefly, my views are based on the following points and are the result of progressive changes in ideas because more and more information has become available as drilling and geological investigations have progressed. Stated in summary fashion, these points are as follows:

1. On the Safford project we are dealing with a major display of rock alteration and metallization, and both are kinds commonly associated with porphyry copper mineralization.

2. The dominant northeasterly fracture zone controlling the distribution of mineralization points toward Morenci, some 15 miles distant, and suggests that these districts might be manifestations of the same major trend.

3. More copper has been removed from the capping by secondary processes than has been precipitated in the zone of chalcocite enrichment where we have cut it by our drills. Hence it appears reasonable to believe that a substantial fraction of the copper leached from the capping has escaped by lateral migration. Our drilling results disclose a thick overlying zone of oxidized and leached capping

and a much thinner zone of secondary enrichment. With lateral migration of secondary solutions, the stage is set for worthwhile concentration and precipitation of copper, provided that they are impounded against a barrier or their flow is concentrated through a well-fractured zone where they are in contact with pre-existent sulphides.

4. By a process of elimination we believe this direction of flow to be to the northeast. However, the possibility of circulation to the southwest has not been entirely eliminated by exploration to date.

5. The diorite contact on the southwest may have served as a barrier, and there remains a band just north of this and about 400 feet or more wide that has not yet been explored throughout a strike length of over a mile.

6. Although our opportunities appear more promising on the northeast, we cannot determine whether any barriers exist there because geologic relations are obscured by the covering of late volcanic rocks. Nevertheless if secondary solutions flowed to the northeast, then there should have been an accumulation of copper-bearing solutions in this direction with consequent opportunities for worthwhile deposition.

7. That mineralized capping of good quality extends back under the volcanics for at least an additional 1500 feet to the northeast is proved by the location work recently performed on Star No. 22 claim.

8. There may be less hazard on the northeast of cutting stray bodies of unfavorable diorite.

9. There is probably less destructive oxidation of the enriched zone on the northeast.

10. Although the exposure in the Star No. 22 location hole is admittedly very limited, rock alteration appears more attractive here with the development of more sericite.

11. A most desirable area to explore would be one where the primary tenor was higher than that encountered on the southwest, thereby requiring less enrichment to develop a worthwhile deposit. Although we have no assurance that such a condition exists on the northeast, this is the only direction we can go in search of it.

Thus the gamble to be assumed by continued exploration is if and where substantial enrichment has taken place. I believe this remaining gamble is a good one and worth taking. The evidence indicates that our best chances are probably to the northeast, although a little clean-up work is warranted on the southwest. I also believe that our drilling to date has not been wasted by being located in between where we now think our remaining chances exist. On the other hand, these holes give us much-needed information by means of which we can locate the decisive holes.

Features believed to be favorable are cited above. We must also recognize that several discouraging aspects have been disclosed by our drilling, and these are brought forward in the following summation:

1. The capping is generally lean in appearance except in restricted exposures and in the location hole on the northeast in Star No. 22 claim.

2. Primary mineralization was very low in tenor, necessitating repeated cycles of favorable enrichment to boost the grade to a worthwhile amount of copper.

3. The zone of enrichment is apparently relatively thin in the area drilled with tighter rock below.

4. Where tilted up on the southwest and exposed by shallow workings, copper mineralization is poor. However, this is in diorite, and the quartz porphyry farther northeast is believed to contain a more promising zone.

5. We have no certain knowledge that a favorable barrier exists on the northeast.

6. Drilling results to date have yielded erratic and discouraging results.

The final conclusion, in my opinion, is that the good points outweigh the bad and that we should continue with the project and carry it to a logical conclusion by more drilling. By so doing we would be exploring with the reasonable hopes of finding a relatively thin ore body of good tenor. In this situation we would be setting our sights on trying to discover a 5-10 million ton deposit of 2-3% copper content.

I believe there are two final points that should be kept in mind concerning the Safford project. One is that we may be flirting with the low-grade edge of a mineralized district just sticking out from beneath the younger volcanic cover. This is a situation analagous to that at San Manuel and the very geological relations we have been seeking to find and explore. With this in mind, I believe we should continue with the project. The second point can be expressed in two ways. One is to venture the assertation that if we encountered another district displaying the possibilities remaining at Safford, we would take it up with considerable alacrity. The other way is to point out that it will very probably be costly and time-consuming to find a new prospect whose merits are equal to those still remaining at Safford.

There is, of course, no guarantee that continued drilling will find an ore body nearby in this area. Nevertheless the gamble is a good one, and I cannot do otherwise but recommend that the venture be carried on.

PROPOSED FUTURE PROCEDURE AT SAFFORD

Based upon the foregoing discussion, I make the following firm recommendations concerning our future procedure on the Safford project.

I propose that a road be constructed to Star No. 22 claim so that the northeasterly extension can be explored by two or three diamond drill holes. Some cleaning off with the bulldozer can be done here to determine other spots where the volcanic cover is very thin or lacking in expectation of developing two drilling sites some 500 feet or more apart. In the absence of detailed road location surveys, the cost of this added phase of the project is difficult to estimate, but it probably would be about $12,000-$15,000 for the road. While this road construction is going on, I believe it advisable to drill one diamond drill hole inclined southerly from a site along the present road to test mineralization in front of the southwesterly barrier. By so doing we shall be making use of the contractor's drill and thus obviate a standby fee. This hole should dispose of the mineral possibilities on the southwest; and, if it gives no encouragement, then we can abandon or renegotiate our options before the initial payments come due. This hole would probably cost about $7,000. Then I propose that two or three diamond drill holes (for an aggregate of 2,500 feet) be drilled on the northeast in or near Star No. 22 claim to seek for copper ore on the northeast under the volcanics. This drilling is estimated to cost about $20,000.

I believe that the above recommendations form a sound program for continuing the Safford project. The proposal for drilling on the northeast is, of course, the most promising phase and the one that should receive the most attention. The single drill hole suggested on the southwest calls for only a subordinate part of the proposed budget. Nevertheless, it will give much valuable information that will help us in the proper disposal of our property options besides preventing our competitors from later finding ore in a zone where there now remains substantial promise. I favor including this one hole in our program, but I do not wish its consideration to detract from the greater possibilities on the northeast.

The continuation of the Safford project thus calls for an expenditure of about $40,000 for drilling and road construction. A somewhat closer estimate can be made after road location surveys have been made and our diamond drilling contract has been renegotiated on the basis of a minimum footage guarantee.

If the above recommendation for an active continuation of the Safford project does not meet with approval, then I propose that we abandon the optioned ground but that we retain and perform the necessary assessment work to hold our 21 located claims for a period of several years. This is because representatives of the U. S. Bureau of Mines have intimated that they might do some drilling if we retired from active exploration and relinquished our options. They seemed interested in following out the low-grade zone cut in churn drill hole S-1, but only if

we were apparently out of the exploration picture. There is thus the possibility that they might do some drilling if we made proper application and submitted all of our available information; but we could not expect this to be done for perhaps several years, and I doubt very much if they would undertake the expensive road construction to get into the northeastern extension.

I personally believe we are warranted in continuing the drilling ourselves, as recommended above. The second proposal is admittedly a device to retain an interest in a very promising district and prevent complete abandonment until some more exploration has been done. I do not believe that we should defer our own drilling in the doubtful anticipation that the Bureau might carry on.

E. N. Pennebaker

E. N. PENNEBAKER

MARCH 25, 1950

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REVIEW OF
SAFFORD, ARIZONA, PROJECT
BY

E. N. PENNEBAKER
MARCH 25, 1950

E. N. PENNEBAKER
CONSULTING GEOLOGIST

REVIEW OF THE

SAFFORD, ARIZONA, PROJECT

FOR

CONSOLIDATED COPPERMINES CORPORATION

BY

E. N. PENNEBAKER

MARCH 25, 1950

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SUMMARY

From a consideration of information recently gained by geological study, drilling results and location work on the Safford project, a comprehensive review of the situation leads to the conclusion that the possibilities for finding an ore body in this area have not yet been exhausted. This is based largely upon evidence (1) that more copper has been abstracted from the capping than has been deposited as secondary enrichment in the area explored to date; (2) that the enriching solutions probably were guided by a broad fracture system and flowed away to the northeast to deposit this excess copper and form an ore body; and (3) that we now have sound evidence that the favorably mineralized quartz porphyry breccia capping continues on to the northeast under the young volcanic cover. These and other points are briefly stated in the section headed "Conclusions", pages 20 to 23, in the report that follows.

As a result of this analysis it is proposed that an access road be constructed leading around to the north side beyond the summit to near the exposures of mineralized capping on Star No. 22 claim. From sites to be constructed near here, it is recommended that two or three diamond drill holes be put down to test this very promising prospect on the northeast. While this road construction is going on it is further proposed that one hole be drilled from a site on the presently established road to clean up the subordinate possibility that an ore body lies in quartz porphyry breccia along the southwesterly contact of that formation against the diorite. This entire additional program of road building and drilling is estimated to cost approximately $40,000.

In the event that these recommendations are not accepted, an alternative proposal is brought forward in which is is advocated that the mining claims acquired

by location be held for several years in the hope that the U. S. Bureau of Mines might be prevailed upon to do some drilling. However, it is urged that we go ahead and do our own drilling on sites of our own selection.

It is finally pointed out that it will not be easy to find another district with exploration possibilities equal to those still remaining near Safford and that we should continue here by following out this additional program.

REVIEW OF THE
SAFFORD, ARIZONA, PROJECT
FOR
CONSOLIDATED COPPERMINES CORPORATION

INTRODUCTION

A review of the Safford exploration project is appropriate at this time. We have been active in this area for about a year, and there remains approximately another six months before substantial property payments become due. During the past year we have optioned 5 claim groups and have located 21 claims of our own, giving us control of a fairly compact area about 2 miles long in an east-west direction and about one mile wide with an additional irregular extension toward the west. Besides this, careful property surveys have been made, detailed geological mapping has been accomplished, and a geophysical examination of a part of the area by the self-potential method was completed.

Exploration by means of 4 bore holes has been effected. The first two were put down by churn drill under contract. This type of exploration was found to be very slow, and as an experiment one of these holes was deepened by diamond drilling. This was successful and contract diamond drilling was then undertaken. Two holes have now been drilled by this method with satisfactory rate of progress at fair cost for this type of ground.

These exploratory bore holes have found zones secondarily

enriched by the copper-bearing mineral, chalcocite. However, there is not yet an indication of a commercial ore body, and we must now decide whether (1) to continue active drilling; (2) to entirely abandon the project; or (3) to retain only our mining claims acquired by location, hoping that when we have released our options and retired from active exploration that the U. S. Bureau of Mines will carry on with some drilling at an indefinite future date.

We have now determined that the better mineral possibilities may be in the higher ground on the north where the cost of preparing access roads is a major item of expense when additional drilling is contemplated. We have spent to date about $56,000 on this campaign, although we should bear in mind that had we not entered into the Safford project we would have paid out during the year about $30,000 in the continuing search for a promising area.

Our present problem is to decide whether or not an additional expenditure is warranted in this district, keeping in mind that it may be difficult to find a new project in another district whose possibilities are greater than those still remaining at Safford.

REVIEW OF GEOLOGY

The area of interest north of Safford is along the southerly face of the Gila Range near its easterly end. The upper margin of the conglomerate-floored basin of the Gila River is eroded to reveal intermittent exposures of diorite (or andesite

porphyry) as the base of the range is closely approached. On the higher slopes above this is a broad band of quartz porphyry breccia covered near the crest by thick volcanic flows and breccias of basic and intermediate composition.

The diorite and quartz porphyry breccia are cut by numerous quartz porphyry dikes of pronounced northeasterly trend, and these are clearly the youngest rocks of the pre-volcanic igneous group. On the other hand, the age relations between the diorite and the quartz porphyry breccia are more difficult to discern. It is believed that they are both intrusive rocks, and it was formerly suspected that the quartz porphyry is the younger. However, results from recent drilling indicate that some bodies of diorite may be younger intrusives, and this question of age relations is not yet settled.

The attitude of the young volcanic cap indicates that the Gila Range has been uplifted as a fault block and tilted down to the northeast at an angle of about 20 degrees. Thus the present southwesterly face is an erosional modification of the fault scarp where the older rocks were exposed, and the less precipitous surface to the northeast beyond the summit line is the moderately dissected back-slope upon which the younger volcanics are displayed.

The diorite and quartz porphyry breccia are cut by a pronounced system of steep joints and fractures that strike northeast. A second system striking northwest is much less perfectly developed. As previously mentioned, a strong pattern of

quartz porphyry dikes also follows the dominant northeasterly trend. This direction points directly toward the important copper-producing district of Morenci, some 15 miles distant to the northeast.

CHARACTER OF MINERALIZATION

Widespread metallization over about a mile square is displayed in diorite, quartz porphyry, and quartz porphyry breccia by iron-staining and green copper minerals. Hydrothermal alteration is expressed by bleaching with the development of sericite and some quartz in the diorite and by silicification and subordinate sericite in the quartz porphyry breccia. Shallow workings and drill holes make it evident that some of the iron oxide is derived from the oxidation of pyrite but that a second type is formed by the oxidation of the copper sulphide, chalcocite.

Mineralization has been guided by the northeast fracturing. Sulphide grains have been deposited along these planes, although there is also a fair proportion disseminated between them. Bleached zones in the diorite are strongly controlled by this direction of jointing and fracturing.

Green copper staining is most abundant in the diorite that has undergone less bleaching, and its presence at the surface has in the past lead to a fair amount of generally futile exploration by shafts and pits. The bleached diorite, on the other hand, being a "less reactive gangue", has precipitated less copper in the outcrop, and its metallization is chiefly evidenced by iron staining. Much of this has been derived from pyrite, but there

are limited zones where a significant amount of iron oxide has been precipitated in the bleached diorite as a result of the oxidation of chalcocite.

Nevertheless, the quartz porphyry breccia on the higher slopes emerging from beneath the volcanic cap presents the best evidence of copper mineralization. There is here an exposed area of quartz porphyry breccia about a mile long in a northwest-southeast direction and about 1000 feet wide before it disappears under the volcanic cap to the northeast. Most of this area shows evidence that chalcocite has been leached from the rocks exposed at the surface. Within it there is a portion about 3000 feet long and up to 1000 feet wide where the evidence of copper mineralization, as judged by the interpretation of the leached outcrops, is somewhat more abundant, and this area constitutes the better showing. Although exposures do not give decisive information, there appears to be a "core" in the northwesterly part of this area that consists of poorly metallized diorite.

The favorability of the area mentioned above is based upon a diagnosis of the type of iron oxide left in the outcrop. In most exposures two kinds can be found; one is the "relief limonite" that is formed as a result of the oxidation of chalcocite, and the other is limonite derived from pyrite. An identical type of relief limonite is found in the croppings above the disseminated copper ore bodies at Ray, Inspiration, Miami, and Morenci. The particular croppings at the Safford project are leaner than those observed at Ray and Inspiration and more nearly resemble

those above the low-grade disseminated ore body recently developed at Silverbell, Arizona, by the A. S. & R. Company.

We, of course, are on a sounder basis if it can be proved for each project that the type of limonite there believed to be diagnostic of the former presence of a copper sulphide can actually be demonstrated to have such derivation. In this respect we are particularly fortunate at Safford, because the Clara tunnel has revealed a fracture zone that actually contains stringers of chalcocite locally preserved at very shallow depth. On strike these can be seen to change over to a "relief limonite" that replaces the chalcocite, and it is this type of limonite that has been considered diagnostic of the former presence of chalcocite in rocks now exposed at the surface on the Safford project.

Southwest of the southwest margin of the quarts porphyry breccia, various exploratory workings disclose sulphides at rather shallow depth. The fact that there was deep oxidation in some of the workings appurtenant to the Clara shaft on the north lead to the belief that the base of oxidation would be deep and give a thick zone of leaching in the favorable area with the consequent opportunity for secondary solutions to collect copper from an adequate "gathering ground".

Furthermore, it was believed that copper mineralization was somewhat more abundant toward the northeast and that there was a hint of favorable zoning in this direction.

Study of the ground clearly demonstrated that both primary mineralization and secondary enrichment of copper were

earlier than the formation of the volcanic cap and that there was a sound possibility that the enriched zone would extend northeasterly under the volcanics. Particularly good evidence was obtained toward the north where a knob of leached capping protruded through a thin place in the volcanics on Star No. 22 claim. The capping exhibited by this knob is of rather mediocre quality, but some 300 feet to the south the location hole for this claim passed through 5 feet of lava and into mineralized quartz porphyry breccia capping of excellent quality. This is a most encouraging recent development and proves that favorable mineralization extends northeasterly for 1500 feet under the young volcanics. It has strongly focussed our attention upon ore possibilities in this area.

Although it was evident that the average quality of the capping was definitely lean, we nevertheless could point to ore bodies beneath capping of similar and inferior grades in other districts where geological conditions were favorable. With these various points in mind the project was judged to be worth a few drill holes to search for secondarily enriched copper ore deposited from solutions that had gathered copper from chalcocite formerly contained in the now oxidized and leached capping. It was our intention to limit exploration to a rather moderate expenditure unless preliminary drilling gave information that would change our conclusions regarding the worth of this project.

As will be noted in the section that follows, some of the information yielded by the drills was surprising and has made it necessary to modify our ideas from time to time. It should be

pointed out that this is not an unusual situation in mining exploration, because not always can we be so sure of the geological relations that one or two preliminary holes "make or break" a property. In some places this is the case, but under other conditions we must use the information gained from preliminary exploration to re-orient our plans and step by step approach our objective. It was my opinion a short time ago that if SD-4 and SD-4-A did not return a good column of ore we might well consider abandoning the Safford project. However, a full examination of all the data, including some very recently obtained, now leads to a different and more encouraging conclusion.

DRILLING RESULTS

Due to our desire to keep expenditures at a minimum, the problem of road construction was a considered factor in selecting sites for bore-holes.

Churn drill hole S-1 was located in the southeasterly portion of the better mineralized quartz porphyry breccia. This hole was drilled vertically to a depth of 615 feet in quartz porphyry and quartz porphyry breccia, where it was stopped. Oxidation persisted to a depth of 450 feet, beyond which point chalcocite and pyrite appeared. From 450 to 545 feet sludge samples averaged 0.52% copper for 95 feet; from 545 feet to the bottom of the hole at 615 feet, sludge samples averaged 0.16% copper for 70 feet. The lowermost samples still exhibited a little chalcocite so it is obvious that the primary tenor was quite low, say 0.10% copper or less, this copper being apparently carried by chalcopyrite.

The rig was then moved about 500 feet to the northwest and churn drill hole S-2 was collared. This was drilled vertically to a depth of 912 feet in quartz porphyry and quartz porphyry breccia. A surprisingly thick column of oxidized and leached capping was cut, and the sulphide zone did not appear until a depth of 845 feet had been reached. Below this point there was 35 feet averaging 0.73% copper between 845 and 880 feet with most of the copper contained in chalcocite. From 880 to 912 feet, churn drill sludge samples averaged 0.23% copper. This hole was then deepened by diamond drilling and thereafter designated as hole SD-2. It entered quartz diorite at a depth of 1044 feet and continued in that rock to 1134 feet, where the hole was abandoned. From 912 to 1044 feet the core averaged 0.27% copper in quartz porphyry breccia for 132 feet. Copper mineralization in the quartz diorite was generally low with an average of 0.15% copper for the 90 feet from 1044 to 1134 feet.

The deep oxidation revealed in hole S-2 was judged to be a feature of considerable promise. The slope of the base of oxidation between holes S-1 and S-2 was determined to be about 40 degrees, and it was believed that this might indicate a lateral movement to secondary solutions that had gained considerable copper from the great thickness of overlying leached ground and had deposited this copper on the northwest. To check this possibility it was proposed that a third hole, designated SD-4, be located about 1200 northwest of S-2, and the necessary access road to this site was constructed.

Diamond drill hole SD-4 was drilled vertically to a depth of 587 feet, where it was stopped. Thoroughly oxidized quartz porphyry breccia was cut to a depth of 341.5 feet. From 341.5 to 383.1 feet the core was partially oxidized and showed a mixture of pyrite, chalcocite and iron oxide. Beyond this interval there was no oxidation and the core was low in copper. From 351.5 to 383.1 feet the average assay value was 1.93% total copper for 31.6 feet. Oxide copper for this interval returned an average assay value of 0.38% copper. Core recovery was 82%. From 383.1 feet to the bottom at 587 feet the average assay value was 0.09% copper for 203.9 feet, again testifying to a low primary tenor. Diamond drill hole SD-4 cut quartz porphyry breccia, except for the interval 505.0 to 538.5 where quartz diorite appeared.

Diamond drill hole SD-4 returned much useful information. Most importantly it demonstrated that worthwhile enrichment did occur where geologic conditions were right. Also, the core samples gave a better view of the rock than did the sludge samples from the diamond drill holes and revealed the tightness of the quartz porphyry breccia below the zone of abundant chalcocite replacement. Although some enrichment took place by deposition of chalcocite within fractures in this deeper section, there was little or no replacement of the pyrite grains in the tight rock between these fractures. Results from this hole also made it clear that the base of oxidation did not slope down uniformly to the northwest. On the contrary it rose again to demonstrate that the condition of very deep oxidation observed in hole S-2 was probably exceptional.

This information demanded a review of the situation with the conclusion that secondary enriching solutions must have migrated laterally with the trend of the major fracturing and jointing. This runs about N 70 E, and the solutions must have flowed either northeast or southwest. Had it been to the southwest, better values should have been found in the vicinity of the old Elsie shaft, although their apparent absence here does not entirely eliminate such a possibility. It seems more likely that secondary solutions, prior to the outpouring of the volcanics and their subsequent tilting with the mountain block, flowed northeasterly toward what is now the Bonita Creek basin.

With the above possibility in mind, diamond drill hole SD-4-A was drilled from approximately the same site as SD-4, but it was pointed N 35 E and inclined down at 55 degrees. This hole cut quartz porphyry breccia to a depth of 313.8 feet, where it entered diorite (or andesite porphyry). It remained in this rock to the bottom at 892 feet, except for the interval 665.3 feet to 697.7 feet which cut quartz porphyry breccia. Oxidation persisted for an inclined distance of 524 feet, beyond which the dioritic rock carried pyrite and a very little chalcocite. The short interval of quartz porphyry breccia from 665.3 feet to 697.7 feet was mostly oxidized but showed some sulphides and assayed a few tenths of one percent. Evidently the dioritic plug mentioned in a foregoing section plunged down to the northwest and was intersected by diamond drill hole SD-4-A. Apparently secondary solutions did not penetrate the tighter diorite, and this hole did not give a

fair test of the possibilities toward the northeast.

None of the drill holes described above pierced the water table. It seems reasonable to believe that the zone of secondary enrichment discovered was deposited at or near an ancient water level. Evidently the faulting and tilting of the Gila Range lifted the chalcocite zone well above the level of the present water table where part of it underwent some oxidation. Inasmuch as the tilted base of oxidation slopes northeasterly, somewhere in this direction it should meet the groundwater zone.

FACTORS INFLUENCING FURTHER EXPLORATION

Examination of the leached capping exposed on the surface and that cut in the drill holes when compared with the amount of secondary chalcocite enrichment revealed by drilling leads to the conclusion that more copper has been abstracted from the quartz porphyry breccia capping than has been deposited in the secondary chalcocite zone. For example, in my judgment the leached capping now to be observed probably represents material that for the most part averaged 0.5% copper in the form of chalcocite as a result of several earlier cycles of enrichment before it was oxidized and the copper removed. If, to be conservative, we reduce this to 0.3% copper and multiply the latter percentage by 400 feet, the indicated approximate thickness of the oxidized zone, we obtain a figure of 120 "grade feet". Assuming 0.08% copper as the tenor of primary mineralization in the area drilled and subtracting this amount from the assay results of hole S-1 we obtain 47.6 grade feet, which represents the copper added by

enrichment. For hole S-2 (and SD-2) this figure is 59.6 grade feet; for SD-4, about 62 grade feet; and for SD-4-A it is apparently still lower. It is thus evident that much more copper has probably been leached from the oxidized zone than has been deposited in the zone of secondary sulphide enrichment where our drill holes have pierced the latter.

We must now try to determine what has become of this copper that has apparently disappeared. Has it been concentrated and deposited to form a worthwhile ore body, or has it been dissipated and lost for all practical purposes? It would seem that there has been a lateral migration of the secondary solutions carrying this copper, and, in part, our problem is one concerning the direction of movement of groundwater. From information gained by surface mapping and drilling, it is believed that groundwater circulation was controlled by the dominant northeast fracturing. It is further indicated that the direction of flow just prior to the volcanic episode was probably toward the northeast, but the possibility of circulation toward the southwest is not absolutely ruled out.

For the copper to be deposited from these solutions and concentrated into an ore body, they must be impounded against a barrier or their flow concentrated through a fracture zone where they will be in contact with pre-existent sulphides for a time sufficient to cause the precipitation of their contained copper.

Some 500 feet southwest of our drill holes the quartz porphyry breccia makes contact with the main body of diorite on

the surface, and this could have served as such a favorable barrier. If this had caused the precipitation of an important amount of copper, it would seem that early exploration work here where the sulphide zone is tilted up to shallower depth would have detected its occurrence. This was not the case, but,as indicated above, this possibility is not yet entirely ruled out.

That these solutions moved toward the northeast now seems most likely. We have no sure proof of this, and such a conclusion is reached largely by a process of elimination based upon the results of holes recently drilled. Whether or not a barrier exists to the north is problematical because of the extensive covering of late volcanics. However, from the occurrences on Star No. 22 claim we are assured that the favorably mineralized quartz porphyry breccia continues on north under the volcanics.

We now have evidence of more than three cycles of supergene activity. After the tilting of the range, the youngest and most recent of these events is revealed by the partial oxidation of the zone of chalcocite enrichment on the southwest (as indicated by the results of hole SD-4). By this the enriched zone was partially destroyed and some copper was dissipated. Inasmuch as the enriched zone tilts down to the northeast, this destructive effect should disappear in that direction, particularly near where it slopes down to meet the water table.

The cycle immediately preceding the above saw the deep leaching of a still earlier-formed zone of enrichment. It is the deposition of the copper taken into solution during this cycle

with which we are now principally concerned. Apparently there was a rapid movement of the groundwater carrying this copper through the zone we have explored to date, and it seems evident that within this zone only a part of the copper was deposited. There should have been an accumulation of these copper-bearing solutions in the direction of flow and better opportunities for precipitation in this direction.

A third cycle is represented by the indications of chalcocite formerly present in what is now a deep zone of capping. At the time of deposition of this chalcocite conditions were such that a thick blanket of enrichment (of low tenor) could be formed, whereas in the succeeding cycle we so far have evidence only of the development of a relatively thin zone. This is important, because it indicates that the rock was not too impervious for enrichment providing other conditions were favorable.

The above cycles were of course preceded by several others with the result that the originally very low-grade primary mineralization was converted to secondary chalcocite, whose relicts may now be observed in the capping on the present erosion surface, as noted above.

Regardless of the problem of relative ages, the area we have already drilled presents the risk of containing irregular bodies of diorite within the quartz porphyry breccia. This diorite appears less favorably mineralized and less susceptible to secondary enrichment except near its edges. It represents a hazard that might be lessened by exploring farther to the northeast.

During the past year we have had little or no competition in this district, and we have been able to gain control of a good-sized block of ground at reasonable expense. Our activities have recently attracted the attention of others, and it now appears that A. S. & R. Company geologists are starting an intensive examination of this general area.

PROPERTY CONSIDERATIONS

The Consolidated Metals group of 30 unpatented mining claims lies mostly to the south and west of the mineralized quartz porphyry breccia. Our investigation to date indicates that it is chiefly valuable because of a very few claims that jut into or near the mineralized quartz porphyry breccia, for rights-of-way along the principal access road, and for millsite and tailings disposal space. None of our drill holes cut this ground, but these claims have benefited from road work that we have performed. In our present view the only remaining mineral possibilities might be where a few claims come in near the southerly contact of quartz porphyry breccia against diorite, in which zone secondary solutions, if they have moved southwesterly, might have deposited secondary ore. An initial payment of $12,000 will fall due on November 1, 1950, if we decide to exercise our option on this group. The full purchase price is $60,000, spread over 5 years with the final payment falling due on November 1, 1954.

The Red Mountain group of 3 unpatented mining claims lies in the westerly portion of the mineralized quartz porphyry breccia

where it is exposed immediately southwest of the volcanics. Our drill holes SD-4 and SD-4-A have pierced this ground with the results noted in a foregoing section, and this claim group has also been benefited by road construction. Further mineral possibilities might be along the southerly margin of the quartz porphyry breccia, as explained in the preceding paragraph. An initial payment of $4,000 will fall due on November 1, 1950, if we decide to exercise our option. The full purchase price is $20,000, spread over 5 years, with the final payment falling due on November 1, 1954.

The Crown Point group of 4 unpatented mining claims lies on the northwesterly extension of the mineralized quartz porphyry breccia. We have not mapped this area geologically, but the ground is known to contain outcrops of mineralized quartz porphyry breccia of rather mediocre quality. Its ore-bearing possibilities do not appear too promising, but there has been no exploration to really determine the worth of this ground. We have made no improvements directly on these claims, but they are linked by a recently located claim to the Star group where work has been done that our attorneys believe can be applied to the benefit of the Crown Point group. An initial payment of $4,000 will fall due on November 1, 1950, if we decide to exercise our option. The full purchase price is $20,000 spread over 5 years with the final payment falling due on November 1, 1954.

The Iron Cap group of 3 unpatented mining claims lies at the southeast extension of the zone of mineralized quartz porphyry breccia. Their remaining mineral possibilities are

similar to other claims near the southerly contact of the quartz porphyry breccia, and they have been benefited by recently-constructed roads. An initial payment of $1,200 falls due on November 1, 1950, if we decide to exercise our option. The full purchase price is $6,000 spread over 5 years with the final payment falling due on November 1, 1954.

The Lone Wolf group of 3 unpatented mining claims joins the Iron Cap group on the southeast. No work has been done on this ground. The bedrock here appears to be diorite with very limited mineral possibilities. An initial payment of $1,200 falls due on November 1, 1950, if we decide to exercise our option. The full purchase price is $6,000 spread over 5 years with the final payment falling due on November 1, 1954.

The C. C. C. group of 6 unpatented mining claims was acquired by location prior to June 30, 1949. These flank the Red Mountain group on the north and east, with an additional claim on the south. Five of them cover mineralized quartz porphyry breccia or nearby volcanics. Churn drill holes S-1 and S-2 were put down in this group, and they were further benefited by road construction. They still contain mineral possibilities on the north.

The Star group of 15 unpatented mining claims was acquired by location in December, 1949 and March, 1950. They surround the C.C.C. group on the east, north, and west. No work, other than the location holes, has been done on these claims. Well-mineralized capping was found beneath the volcanics in the bottom

of the location shaft on Star No. 22, as previously mentioned. The mineral possibilities for most claims of this group are problematical because much of their surface is concealed by the younger lavas. However, that the favorable quartz porphyry breccia continues on north under the volcanics is indicated on Star No. 22 by the knob that protrudes through them and by the quartz porphyry breccia found in the bottom of the location hole. Furthermore they lie on the direct extension of the broad mineralized fracture zone that strikes N 70 E. As will be emphasized farther along, the general conclusion is that they contain favorable ground.

In summary it should be noted that the remaining possibilities for this general area to contain copper ore are believed to be in two situations. The most promising one is on the northeast where we control most of the attractive ground by means of claims held by location, and we can continue to retain these by merely fulfilling the annual requirements for assessment work. The other is on the southwest near where mineralized quartz porphyry breccia comes in contact with diorite. If the enriching solutions have migrated southwesterly along the fracture zone, then the precipitation of secondary chalcocite may have been favored here. From some evidence we have at hand, this does not appear to have been the case, but our evidence is not sufficient to rule out this possibility. The Iron Cap group, the Red Mountain group, and a few claims of the Consolidated Metals group cover this situation. The possibility that this zone contains ore could

be checked by one or two inclined diamond drill holes pointed south from the road already constructed. If this test was unsuccessful, then all of these options could be dropped before any property payments come due. However, by so doing we might be cramped for elbow room, rights of way, tailings disposal sites, etc. After cleaning up this possibility on the southwest we could then proceed to drill the more promising northerly section where we have already acquired ownership by location.

CONCLUSIONS

The above discussion of property groups more or less anticipates the conclusions reached in this report. Stated briefly, my views are based on the following points and are the result of progressive changes in ideas because more and more information has become available as drilling and geological investigations have progressed. Stated in summary fashion, these points are as follows:

1. On the Safford project we are dealing with a major display of rock alteration and metallization, and both are kinds commonly associated with porphyry copper mineralization.

2. The dominant northeasterly fracture zone controlling the distribution of mineralization points toward Morenci, some 15 miles distant, and suggests that these districts might be manifestations of the same major trend.

3. More copper has been removed from the capping by secondary processes than has been precipitated in the zone of chalcocite enrichment where we have cut it by our drills. Hence it appears reasonable to believe that a substantial fraction of the copper leached from the capping has escaped by lateral migration. Our drilling results disclose a thick overlying zone of oxidized and leached capping

and a much thinner zone of secondary enrichment. With lateral migration of secondary solutions, the stage is set for worthwhile concentration and precipitation of copper, provided that they are impounded against a barrier or their flow is concentrated through a well-fractured zone where they are in contact with pre-existent sulphides.

4. By a process of elimination we believe this direction of flow to be to the northeast. However, the possibility of circulation to the southwest has not been entirely eliminated by exploration to date.

5. The diorite contact on the southwest may have served as a barrier, and there remains a band just north of this and about 400 feet or more wide that has not yet been explored throughout a strike length of over a mile.

6. Although our opportunities appear more promising on the northeast, we cannot determine whether any barriers exist there because geologic relations are obscured by the covering of late volcanic rocks. Nevertheless if secondary solutions flowed to the northeast, then there should have been an accumulation of copper-bearing solutions in this direction with consequent opportunities for worthwhile deposition.

7. That mineralized capping of good quality extends back under the volcanics for at least an additional 1500 feet to the northeast is proved by the location work recently performed on Star No. 22 claim.

8. There may be less hazard on the northeast of cutting strey bodies of unfaverable diorite.

9. There is probably less destructive oxidation of the enriched zone on the northeast.

10. Although the exposure in the Star No. 22 location hole is admittedly very limited, rock alteration appears more attractive here with the development of more sericite.

11. A most desirable area to explore would be one where the primary tenor was higher than that encountered on the southwest, thereby requiring less enrichment to develop a worthwhile deposit. Although we have no assurance that such a condition exists on the northeast, this is the only direction we can go in search of it.

Thus the gamble to be assumed by continued exploration is if and where substantial enrichment has taken place. I believe this remaining gamble is a good one and worth taking. The evidence indicates that our best chances are probably to the northeast, although a little clean-up work is warranted on the southwest. I also believe that our drilling to date has not been wasted by being located in between where we now think our remaining chances exist. On the other hand, these holes give us much-needed information by means of which we can locate the decisive holes.

Features believed to be favorable are cited above. We must also recognize that several discouraging aspects have been disclosed by our drilling, and these are brought forward in the following summation:

1. The capping is generally lean in appearance except in restricted exposures and in the location hole on the northeast in Star No. 22 claim.

2. Primary mineralization was very low in tenor, necessitating repeated cycles of favorable enrichment to boost the grade to a worthwhile amount of copper.

3. The zone of enrichment is apparently relatively thin in the area drilled with tighter rock below.

4. Where tilted up on the southwest and exposed by shallow workings, copper mineralization is poor. However, this is in diorite, and the quartz porphyry farther northeast is believed to contain a more promising zone.

5. We have no certain knowledge that a favorable barrier exists on the northeast.

6. Drilling results to date have yielded erratic and discouraging results.

The final conclusion, in my opinion, is that the good points outweigh the bad and that we should continue with the project and carry it to a logical conclusion by more drilling. By so doing we would be exploring with the reasonable hopes of finding a relatively thin ore body of good tenor. In this situation we would be setting our sights on trying to discover a 5-10 million ton deposit of 2-3% copper content.

I believe there are two final points that should be kept in mind concerning the Safford project. One is that we may be flirting with the low-grade edge of a mineralized district just sticking out from beneath the younger volcanic cover. This is a situation analagous to that at San Manuel and the very geological relations we have been seeking to find and explore. With this in mind, I believe we should continue with the project. The second point can be expressed in two ways. One is to venture the assertation that if we encountered another district displaying the possibilities remaining at Safford, we would take it up with considerable alacrity. The other way is to point out that it will very probably be costly and time-consuming to find a new prospect whose merits are equal to those still remaining at Safford.

There is, of course, no guarantee that continued drilling will find an ore body nearby in this area. Nevertheless the gamble is a good one, and I cannot do otherwise but recommend that the venture be carried on.

PROPOSED FUTURE PROCEDURE AT SAFFORD

Based upon the foregoing discussion, I make the following firm recommendations concerning our future procedure on the Safford project.

I propose that a road be constructed to Star No. 22 claim so that the northeasterly extension can be explored by two or three diamond drill holes. Some cleaning off with the bull-dozer can be done here to determine other spots where the volcanic cover is very thin or lacking in expectation of developing two drilling sites some 500 feet or more apart. In the absence of detailed road location surveys, the cost of this added phase of the project is difficult to estimate, but it probably would be about $12,000-$15,000 for the road. While this road construction is going on, I believe it advisable to drill one diamond drill hole inclined southerly from a site along the present road to test mineralization in front of the southwesterly barrier. By so doing we shall be making use of the contractor's drill and thus obviate a standby fee. This hole should dispose of the mineral possibilities on the southwest; and, if it gives no encouragement, then we can abandon or renegotiate our options before the initial payments come due. This hole would probably cost about $7,000. Then I propose that two or three diamond drill holes (for an aggregate of 2,500 feet) be drilled on the northeast in or near Star No. 22 claim to seek for copper ore on the northeast under the volcanics. This drilling is estimated to cost about $20,000.

I believe that the above recommendations form a sound program for continuing the Safford project. The proposal for drilling on the northeast is, of course, the most promising phase and the one that should receive the most attention. The single drill hole suggested on the southwest calls for only a subordinate part of the proposed budget. Nevertheless, it will give much valuable information that will help us in the proper disposal of our property options besides preventing our competitors from later finding ore in a zone where there now remains substantial promise. I favor including this one hole in our program, but I do not wish its consideration to detract from the greater possibilities on the northeast.

The continuation of the Safford project thus calls for an expenditure of about $40,000 for drilling and road construction. A somewhat closer estimate can be made after road location surveys have been made and our diamond drilling contract has been renegotiated on the basis of a minimum footage guarantee.

If the above recommendation for an active continuation of the Safford project does not meet with approval, then I propose that we abandon the optioned ground but that we retain and perform the necessary assessment work to hold our 21 located claims for a period of several years. This is because representatives of the U. S. Bureau of Mines have intimated that they might do some drilling if we retired from active exploration and relinquished our options. They seemed interested in following out the low-grade zone cut in churn drill hole S-1, but only if

we were apparently out of the exploration picture. There is thus the possibility that they might do some drilling if we made proper application and submitted all of our available information; but we could not expect this to be done for perhaps several years, and I doubt very much if they would undertake the expensive road construction to get into the northeastern extension.

I personally believe we are warranted in continuing the drilling ourselves, as recommended above. The second proposal is admittedly a device to retain an interest in a very promising district and prevent complete abandonment until some more exploration has been done. I do not believe that we should defer our own drilling in the doubtful anticipation that the Bureau might carry on.

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MARCH 25, 1950

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