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E. N. Pennebaker

CALCULATION OF PIT LIMITS AND ORE RESERVES, COPPER CITIES MINING COMPANY

BY J. H. Gray and W. W. Simmons

INTRODUCTION

Copper Cities Mining Company operates an open pit mine in a disseminated copper deposit which is located in the Globe-Miami district, Gila County, Arizona.

Some attention was given the deposit early in the history of the district, but the first major exploration was begun in 1917 by the Louis d'Or Mining and Milling Company. This work, consisting of a shaft 360 feet deep and 12 drill holes, totaling nearly 9000 feet, was completed in 1922. Further exploratory drilling was done in 1929 and 1930. These efforts showed the presence of disseminated copper minerals, but the grade was too low to be considered ore at that time.

Miami Copper Company purchased the property in 1940 and organized a wholly-owned subsidiary, Copper Cities Mining Company, to operate the property. This paper is chiefly concerned with exploration by this company.

Systematic exploration by churn drilling was started in 1943 and completed in 1948 with the blocking out of 33,800,000 tons of low grade ore amenable to open-pit operations. Stripping was begun in November, 1950, and mill production was started in August, 1954.

ACKNOWLEDGEMENTS

The writers are indebted to many people for help of various kinds. We are particularly indebted to Dr. N. P. Peterson and Mr. E. N. Pennebaker. Their excellent work, Dr. Peterson's published paper

and Mr. Pennebaker's private reports on the Copper Cities ore body are the basis for much of the geological thought in the present work.

GENERAL GEOLOGY

Figure 1 is a generalized geologic map of the Copper Cities pit and the immediate area around it. The Lost Gulch quartz monzonite is the predominant rock in the pit. The other important rock in relationship to the ore is granite porphyry. In general, the quartz monzonite is the better grade material. A small amount of diabase is included within the pit limits.

STRUCTURE

The most important structures in relationship to the ore body are the Coronado and Drummond fault zones. The Coronado which lies near the west side of the pit, strikes north and dips steeply west. The Drummond, near the eastern pit limit, strikes northwest and dips about 60° northeast. Along the northern edge of the pit is the Sleeping Beauty fault which strikes northeast; its dip is unknown. The area bounded by these faults has been raised relative to the adjacent blocks. The ore body itself is intricately dissected by many minor fractures with no dominant pattern.

MINERALOGY

The principal hypogene minerals in the deposit are quartz, pyrite, chalcopyrite and molybdenite. Chalcocite is the predominant supergene sulfide mineral, and malachite, azurite and turquoise are the principal acid-soluble copper minerals in the ore body.

CHURN DRILLING

The base pattern for churn drilling was a 250 foot grid. From previous experience in the district, this was thought to be sufficiently close for accuracy of grade and tonnage calculations, but as a measure of insurance, some holes were drilled at intermediate points. Drilling at intermediate points was also used to more precisely define the pit limits on some sections. The base grid was oriented to make the sections at right angles to the supposed elongation of the ore body. As finally developed by the drilling, the right angle relationship did not hold exactly, but no serious error was introduced by this fact.

The churn drill holes were sampled at 5 foot intervals using the conventional Jones splitter. Each 5-foot sample was assayed for total copper and oxidized copper. Composite samples of each 50 feet were assayed for gold, silver and molybdenum. All samples were logged for rock type and other geological features.

Preceding and concurrent with the drilling, a geological map of the surface was made as a guide for the exploration. At the completion of the drilling, a map was prepared showing surface geology, topography and drill hole collars.

COMPILATION OF DATA FROM EXPLORATION PROGRAM

Using the plan map as a base, cross sections and longitudinal sections were made showing the assay data of drill holes. By inspection, it was obvious that correlation between drill holes on assay data alone did not show a coherent nor probably true relationship. By plotting rock types and other

geology on the sections, more reasonable ore outlines could be drawn.

On the basis of previous district experience, it was decided that a 45 foot bench height would give the best mining operations. By inspection and cut and try, the elevation of the bottom level of the pit was set at 3600 feet. Factors which influenced this selection were maximum ore production, working room, pit drainage, haulage and others, but to some extent the final figure was arbitrary and depended on the judgment of the planners. Using this base, the upper bench elevations were drawn on the sections and the average grade of the holes through each bench was plotted along the hole. These sections were the work sheets for the determination of the ultimate pit limits.

DETERMINATION OF ULTIMATE PIT LIMITS

The exploration indicated an ore body of small tonnage and low grade. It was improbable that mining would disclose enough additional ore, or that market conditions would change sufficiently, to justify enlarging the initially set pit limits. For these reasons, it was of prime importance that the pit as initially planned be the best economically for the life of the operation. This meant that the pit limits must be extended to the theoretical slope lines which would just meet a set of conditions to give an acceptable minimum profit.

From the exploration, it was known that the waste to be stripped was a relatively uniform cover. It was also evident that the copper mineralization was largely gradational which meant that the pit limits would be assay boundaries rather than some other geologic feature. For these reasons, it was believed that the pit limits could

be set by consideration of a line rather than by calculating a three-dimensional tonnage figure. This concept materially reduced the required calculations.

To locate the theoretical slope lines certain assumptions were necessary. These were grouped as the cost to concentrate one ton of ore, the costs per pound of copper, and the per cent copper extraction.

The cost to concentrate one ton of ore includes:

a. Cost per ton mined.
b. Cost per ton milled.
c. Miscellaneous costs per ton.

The costs per pound of copper include:

a. Smelting cost per pound of copper.
b. Miscellaneous costs per pound copper.
c. Minimum acceptable profit per pound of copper.

The gross value per pound of copper can be defined as the market value minus the costs per pound of copper.

The mine grade which will just satisfy the assumed costs per ton of ore and per pound of copper can be calculated by the following formulae.

A. $\dfrac{\text{Total cost to concentrate 1 ton ore}}{\text{Gross value/lb. Cu}}$ = Net lbs. Cu/ton ore required to give minimum acceptable profit.

B. $\dfrac{\text{Net lbs. Cu/ton ore}}{\text{\% Extraction}}$ = Gross lbs. Cu/ton ore required to give minimum acceptable profit.

C. $\dfrac{\text{Gross lbs. Cu/ton ore}}{2000}$ = \% Cu required in mill heads to give minimum acceptable profit.

To illustrate the use of the above formulae, certain figures, not necessarily those used at Copper Cities, are shown as follows:

Cost to concentrate 1 ton of ore: $0.94

Cost/lb. Cu: $0.0575 = Cost/lb. Cu to put 1 lb. Cu in concentrate into a market product.

Market price/lb. Cu	$0.18000
Minus cost/lb. Cu	0.05751

$0.12249 = Gross value/lb. Cu at mimimum acceptable profit.

$\frac{\$0.94 \text{ (cost to concentrate 1 ton)}}{0.12249 \text{ (Gross value/lb. Cu)}} = 7.674$ = Net lb. Cu per ton of ore required to give minimum acceptable profit.

$\frac{7.674 \text{ (Net lbs. Cu/ton ore}}{.87511 \text{ (\% extraction)}} = 8.769$ = Gross lbs. Cu/ton ore required to give minimum acceptable grade.

$\frac{8.769 \text{ (Gross lbs. Cu/ton)}}{2000} = .438\%$ Mine grade necessary to satisfy above assumptions.

The mine grade of ore necessary to meet the above conditions plus the mining of 1 ton of waste is calculated by the same basic formula, but must include the additional cost of mining 1 ton of material, i. e.,

$$\frac{\frac{\$0.94 + \$0.20}{.12249}}{\frac{.87511}{2000}} = 10.635 \text{ lbs. Cu ton} = 0.532\% \text{ mine grade.}$$

The grade necessary to give the minimum acceptable profit with a different tonnage of waste removal is calculated similarly.

A table of waste to ore ratios for which a corresponding mine grade of ore will meet the assumed conditions including profit is presented in Table 1.

With the aid of this table, the determination of theoretical slope lines which fix the ultimate pit limit can more easily be made.

At Copper Cities, it was decided that a 45° backslope could be safely maintained. The initial step in locating a backslope line on any section was to arbitrarily draw a 45° line on the section.

This initial line was, of course, located near one extremity of the ore body and as near the correct position as judgment based on quick visual inspection permitted.

In the investigation of the slope lines, it was assumed that ore grade in any prospect drill hole could be projected to the mid point between 2 adjoining holes. This assumption was subject to modification by geological conditions. The investigation consisted of several steps. First the total length of the backslope line from the bottom of the lowest ore bench to point where the line intersected the surface was measured. Next, the integral lengths of lines along the slope through each ore bench was measured, and each length multiplied by its related grade of ore. The summation of these "Grade Lengths" divided by the summation of the integral length of slope line through the ore benches is the average grade along this section of the backslope line. The total length of backslope line minus the length in ore is the measured length of slope line in waste.

By reference to Table 1, a waste to ore ratio corresponding to the average grade as computed can be found. By multiplying this waste figure by the length of ore line, a theoretical length of waste line is obtained. If this theoretical length of waste line is greater than the length of line actually measured, the ultimate slope line lies in the direction away from the center of the pit. Conversely, if the theoretical length of waste line is less than the measured waste line, the ore along this slope will not pay for the waste and the ultimate pit limit lies in a direction toward the pit center. By sufficient trial and error, a slope line can be located along which the measured waste will just equal the theoretical waste that can be carried by the ore under the assumed conditions.

Figure 2 is a section of Copper Cities. On line A, the total length of the backslope line from pit bottom to intersection with surface is 545 feet. The summation of the integral length of line through each ore bench multiplied by its related grade of ore divided by the total length of line in ore is .674%, which is the average grade of that portion of the slope line in ore. The length of the slope line in waste is 290.40 feet. By reference to Table 1, the waste ore ratio corresponding to .674% is 2.5. By multiplying the waste figure by 254.60, the length of line in ore, we see that the slope line can be moved outward. By similar calculations on Line B, the waste-ore ratio was found to be 1:1, and the waste figure multiplied by the ore length exceeded the measured waste length and the slope line must be moved inward. On Line C, the theoretical waste line was 323.33 feet and the measured waste was 329.05 feet. It was felt that this was as close as the accuracy of the original data and assumptions permitted, and this line was used. The detailed calculations of the lines are given below as illustrative of the method.

CALCULATIONS: INVESTIGATION OF SLOPE LINES

LINE A

Measured line		Slope Line Thru Ore			Grade
Designation	Length Feet	Bench	Length	Grade	Length Units
Ore	255.0	3645	45.40	.55	25.02
Waste	290.40	3645	18.15	.47	8.53
	545.40	3690	63.65	.70	44.56
		3735	63.65	.58	36.92
		3825	63.65	.89	56.65
			254.60	.674	171.68

From Table 1: .674% ore grade will carry 2.5:1 waste to ore
∴ 254.6 (ft. ore) x 2.5 = 636.50 ft. of waste which 254.6 ft. of .674% ore will carry. Since this is greater than the 290.4 ft. of waste actually measured along this slope (A), line B was tried.

LINE B

Designation	Measured line Length Feet	Bench	Slope Line Thru Ore Length	Grade	Grade Length Units
Ore	88.65	3645	63.65	.47	29.92
Waste	456.35	3690	25.00	.70	17.50
	545.00		88.65	.535%	47.42

From Table 1: .535% ore grade will carry 1:1 waste to ore .'. 88.65 ft. x 1.0 = 88.65 ft. of waste which 88.65 ft. of .535% ore will carry. Since this is less than the 456.35 ft. of waste measured along this slope line B, line C was tried.

LINE C

Designation	Measured line Length Feet	Bench	Slope Line Thru Ore Length	Grade	Grade Length Units
Ore	230.95	3645	63.65	.47	29.92
Waste	329.05	3690	63.65	.70	44.56
	560.00	3735	63.65	.58	36.92
		3825	40.00	* .50	20.00
			230.95	.569	131.40

* Assume .5% grade from midpoint to fault.

From Table 1: .569% ore grade will carry 1.4:1 waste to ore. .'. 230.95 ft. of .569% ore will carry 323.33 ft. of waste. The slope line thru waste actually measures 329.05 ft. As this is as close as the accuracy of data, this line was used as theoretical slope line.

The back slope lines on all sections were calculated by a similar process.

The portion of the line near the Drummond fault illustrates a modification of the basic method based on geological conditions. Ore was figured to the fault rather than to the midpoint between holes.

After completion of the sections, the data was transferred to plan maps. The initial step was to pick a key level near the midpoint of the ore column. A composite plan map was constructed by mechanical development from the key level up slope to surface, and down slope to the pit bottom. Individual bench maps were then made by transfer of theoretical bench outlines from the composite map and plotting of prospect holes with average grade and geology as derived from the sections.

Polygonal areas of grade influence modified by the geology were constructed around each hole. By planimeter, the area of influence of each hole was determined. From this data, the average grade and the tonnage of ore and waste on each bench was computed. The total tonnage of ore and waste in the pit was obtained by addition of individual bench tonnages and average mine grade by the bench average grade weighted by bench tonnage.

Based on these calculations, the Copper Cities pit contains 33,800,000 tons of ore. The waste to be removed at the start of mining totaled 34,700,000 tons which is a 1.03 to 1 waste to ore ratio.

TABLE 1

ORE-WASTE RATIO AND ITS REQUIRED MINE GRADE

Ratio Waste to Ore	Mine Grade Ore	Ratio Waste to Ore	Mine Grade Ore	Ratio Waste to Ore	Mine Grade Ore
0.0:1	.438%	1.7:1	.597%	3.4:1	.756%
0.1:1	.447	1.8:1	.606	3.5:1	.765
0.2:1	.457	1.9:1	.616	3.6:1	.774
0.3:1	.466	2.0:1	.625	3.7:1	.784
0.4:1	.475	2.1:1	.634	3.8:1	.793
0.5:1	.485	2.2:1	.644	3.9:1	.803
0.6:1	.494	2.3:1	.653	4.0:1	.812
0.7:1	.504	2.4:1	.662	4.1:1	.821
0.8:1	.513	2.5:1	.672	4.2:1	.831
0.9:1	.522	2.6:1	.681	4.3:1	.840
1.0:1	.532	2.7:1	.690	4.4:1	.849
1.1:1	.541	2.8:1	.699	4.5:1	.858
1.2:1	.551	2.9:1	.709	4.6:1	.868
1.3:1	.560	3.0:1	.718	4.7:1	.877
1.4:1	.569	3.1:1	.727	4.8:1	.886
1.5:1	.578	3.2:1	.737	4.9:1	.896
1.6:1	.588	3.3:1	.746	5.0:1	.905

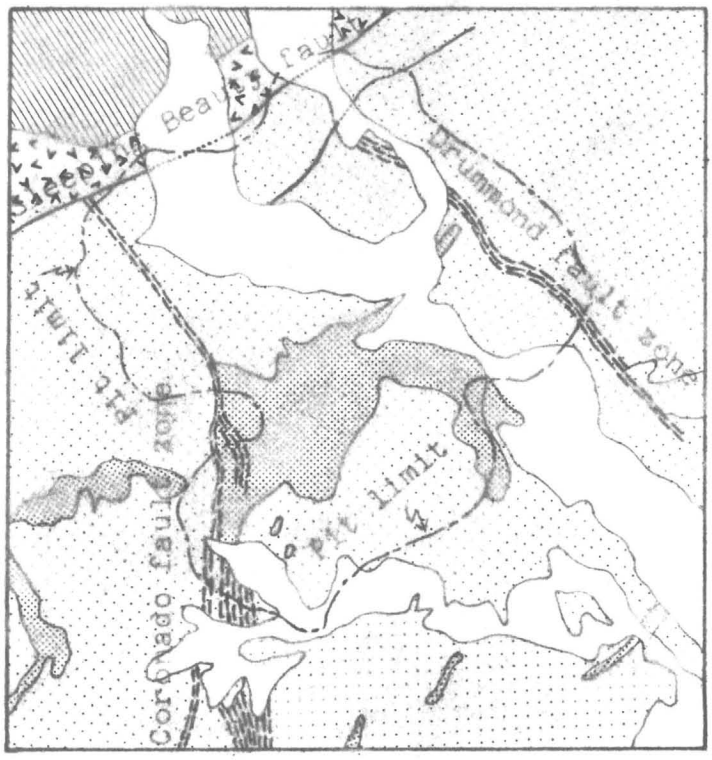


Fig. 1 Geologic map of the copper-bearing area
(After: N. P. Peterson)

EXPLANATION

Alluvium

Paleozoic limestones and Apache group

Granite porphyry

Diabase

Lost Gulch quartz monzonite

Fault

Contact

Scale
1 inch = 1000 feet

N

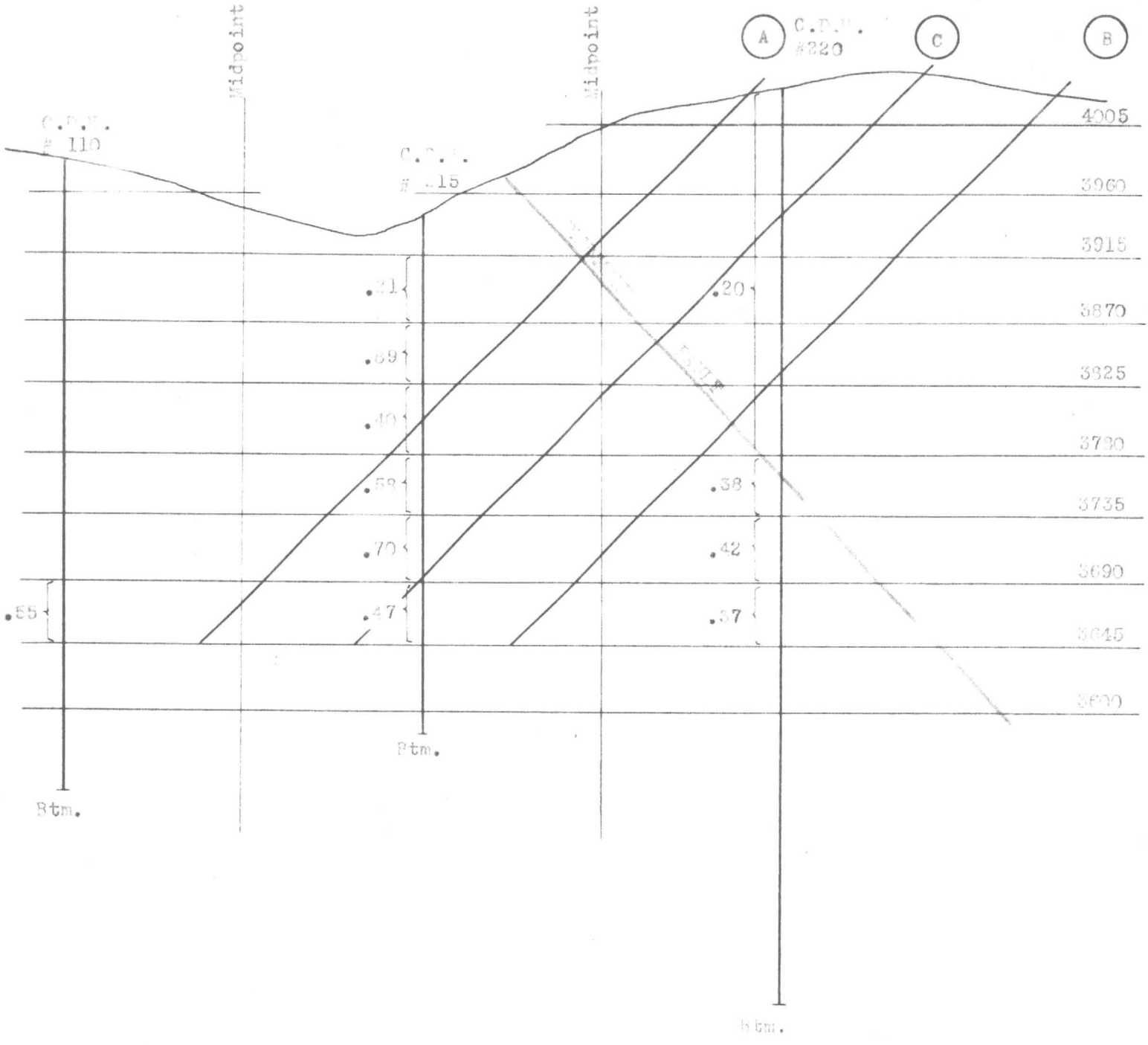


Fig 2. Portion of section N 3500 illustrating investigation of slope line.

THE AMERICAN METAL COMPANY, LIMITED
61 BROADWAY
NEW YORK 6, N.Y.

TELEPHONE BOWLING GREEN 9-1800
CABLE ADDRESS: EFFLUX, NEW YORK

December 20, 1956

Mr. E. N. Pennebaker
Box 817
Scottsdale, Arizona

Gila Co.

Re: Miami-Inspiration District, Arizona

Dear Penny:

Recently two separate sources have called to our attention the Inspiration-Needles, Bluebird and Schultz properties located generally between the Inspiration Pit and Castle Dome in the above district. Some 130 claims are involved and we understand that the Tovrea Land & Cattle Co. of Phoenix has an option on these properties. Tovrea is evidently trying to shop the properties through anyone who might have a contract.

I think that Don McMillan asked for your views on these properties and you expressed a rather negative opinion as to their possibilities.

We are fully aware that there will not be anything obvious in such a well known and carefully studied district, and to judge whether or not these properties have any merit will require a thorough knowledge of the geology of the district.

Would you be kind enough to give us a report expressing your views as to the possibilities, if any, of these properties and whether or not we should pursue the matter any further. I assume this will involve no conflict of interest in respect of your former association with Miami Copper, but naturally if there should be such a conflict I know you will advise us. We would appreciate your report as soon as possible because this situation is active, and if we are going to make any move we must do so without delay.

Best Wishes for a Merry Christmas and a Happy New Year,

Sincerely,

John Payne, Jr.

JP/art
cc- Mr. Chas. C. Towle
Mr. Don McMillan

December 22, 1956

Mr. John Payne, Jr.
Vice President
The American Metal Co., Ltd.
61 Broadway
New York 6, N. Y.

Dear John:

RE: Miami-Inspiration District, Arizona.

I have letters from you and David Moore concerning the Inspiration-Needles and adjacent claim groups, both under date of December 20, 1956.

I think my participation in discussions should involve no conflict of interest with Miami Copper, inasmuch as I have not been associated with Miami for over six years and they never showed any interest in this property whatever when I briefly considered it about nine years ago.

I shall review available information on this area and write a short report. We are attending a New Year's Eve party at Inspiration, so I shall go up there a day early and look over the area to refresh my memory. I know the ground pretty well and shall not need any of the vendors to tag along. I expect to be at the Silver Spur Motel in Globe on December 31, January 1, and possibly part of the morning of January 2.

A list of the 132 claims involved would be helpful, as I am not sure just what is included in the so-called Henderson group.

Frankly, I am not at all hopeful of this Inspiration-Needles package, but it does warrant a further review.

With best Holiday wishes,

Yours sincerely

E. N. Pennebaker

ENP:mc
cc - Mr. C. C. Towle
Mr. D. T. McMillan
Mr. David L. Moore

THE AMERICAN METAL COMPANY, LIMITED
61 BROADWAY
NEW YORK 6, N.Y.

TELEPHONE BOWLING GREEN 9-1800
CABLE ADDRESS: EFFLUX, NEW YORK

PLEASE ADDRESS REPLY TO

SUBJECT:

DLM/ms
December 20, 1956

Mr. E. N. Pennebaker
P. O. Box 817
Scottsdale, Arizona

Dear Penny:

Re: Tovrea Holdings near Miami, Arizona

You will remember that Gene Turley last summer discussed with Tom Moore, who then checked with you, the Inspiration Needles Copper Company property and various adjoining claims which have been put together by Phil Tovrea of the Tovrea Land and Cattle Company. Since that time, Turley brought the same property to the attention of Don McMillan, at which time Don called you and discussed the area with you. Now the property has been brought to us again by another geologist - promoter.

In view of your intimate knowledge of this district, we would like you to write a report on the Tovrea ground before you leave for Idaho.

We do not have an accurate map of the Tovrea holdings but Ned Eisenbrey, who visited the property in the company of Turley and Tovrea, has made a tracing of the relative boundaries of the Tovrea claims as he believes them to be. The principal claim group names are Inspiration Needles, the Schultz-Carrow, Bluebird, and I believe the Henderson Group. There are a few other minor holdings. The total area consists of about 132 claims.

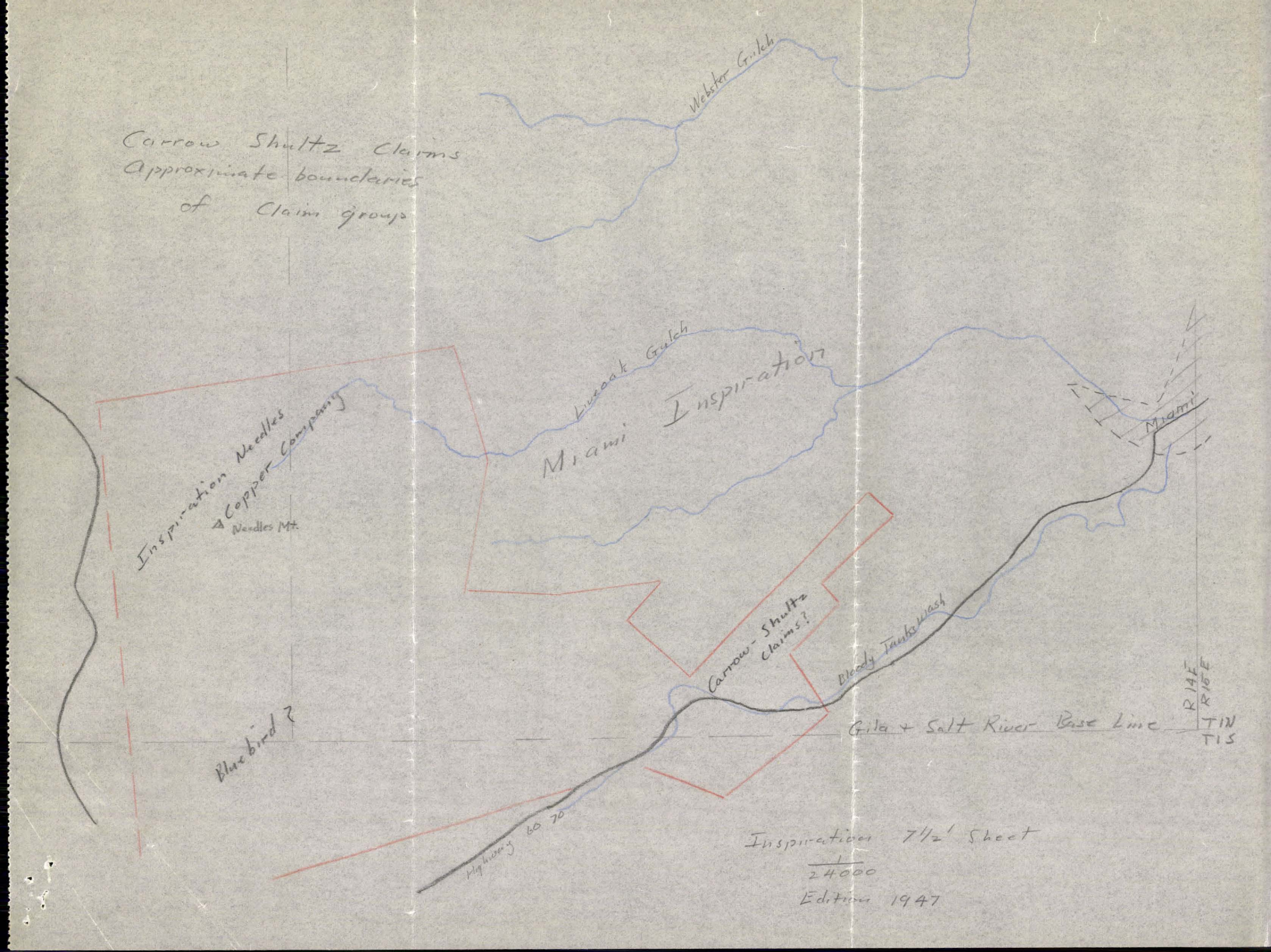
I don't know whether this report will require a trip to the area or simply a review of your notes of previous visits. Whatever the circumstance may be, we would like to have your appraisal of the ore potential of the Tovrea ground so that we may decide whether or not we want to undertake an exploration program here.

We all wish you a Merry Christmas and a Happy New Year.

Sincerely,

David L. Moore

David L. Moore


Carrow Shultz Claims
Approximate boundaries
of Claim groups
Webster Gulch
Lizzak Gulch
Miami Inspiration
Miami
Inspiration Needles
Copper Company
Needles Mt.
Carrow-Shultz
Claims?
Bloody Tanks Wash
Bluebird ?
Gila + Salt River Base Line
R14E
R15E
T1N
T1S
Highway 60 70
Inspiration 7½' Sheet
1/24000
Edition 1947

THE AMERICAN METAL COMPANY, LIMITED
61 BROADWAY
NEW YORK 6, N.Y.

TELEPHONE BOWLING GREEN 9-1800
CABLE ADDRESS: EFFLUX, NEW YORK

PLEASE ADDRESS REPLY TO

SUBJECT: Miami-Inspiration District
Arizona

DLM/ms
January 3, 1957

Mr. E. N. Pennebaker
P. O. Box 817
Scottsdale, Arizona

Dear Penny:

We do not have a complete list of the properties concerned in the Tovrea holdings near Inspiration. The only other further clue that might lead to the Henderson Group is that I believe there is a tunnel called the Henderson Tunnel. Perhaps you may have run across it in your examination. In any case, I am asking Don McMillan to send you a list of the claim groups if he has such list.

Hope you have a pleasant trip to Idaho.

Sincerely,

David L. Moore

David L. Moore

cc: Denver
Tucson

TOVREA HOLDINGS
NEAR MIAMI, ARIZONA

E. N. PENNEBAKER

January 8, 1957

E. N. PENNEBAKER
CONSULTING GEOLOGIST
SCOTTSDALE, ARIZONA

January 9, 1957

Mr. John Payne, Jr.
Vice President
The American Metal Co., Ltd.
61 Broadway
New York 6, N. Y.

Dear John:

Following your request of December 20, 1956, I herewith submit my report on the Tovrea holdings near Miami, Arizona. I am enclosing three copies for such distribution as you wish to make.

Unfortunately I have not been able to see the reports and drill logs submitted with the presentation of the property, and consequently I do not have all the background I would prefer upon which to base my conclusion, which is unfavorable. If these data again become available, I shall be glad to review the situation.

Catharine and I are leaving for Idaho on Sunday, January 13. Mail will reach me c/o Sunshine Mining Company, P.O. Box 1080, Kellogg, Idaho.

With best regards,

Sincerely

E. N. Pennebaker

ENP:mc
encls.

TOVREA HOLDINGS
NEAR
MIAMI, ARIZONA

SUMMARY

The 132 mining claims controlled by Tovrea Land and Cattle Company cover the westerly projection of the Miami-Inspiration copper-bearing zone. Possible exploration falls in two major categories: One is where mineralized bedrock crops out and can be followed down by sinking or drilling; the other is where various projections of the ore zone are masked by a thick covering of younger conglomerate and lava.

Exposed copper showings occur in a supposedly favorable contact zone of granite against schist. Although this green copper is widely distributed, it is erratically localized in spots with much fresh bedrock in between. Thus it is not associated with great zones of all-pervasive hydrothermal alteration that are characteristic features of the commercially important copper deposits at Miami, Inspiration, Copper Cities, and Castle Dome. Old drilling of which we have a record did not give encouraging results. More recent drilling by Tovrea is claimed to have found 1% ore, but inspection of the ground makes it evident that a major ore body containing commercial ore of even tenor probably does not exist in the areas drilled. Furthermore, the reported method of sampling is subject to

serious criticism.

The southwesterly projection of the Miami-Inspiration zone toward the Cactus copper deposit is mostly covered by Gila conglomerate. Much of this trend is protected by Inspiration property, but where it passes through Tovrea ground fresh and lightly altered schists at the margins of the conglomerate give no hopeful indications.

The northwesterly projection toward Castle Dome does not follow a recognized trend of mineralization in this district, and bedrock is buried by a thick cover of Gila conglomerate and lava and possibly also by Whitetail conglomerate. Drilling would be deep and expensive, and the covered area here, as elsewhere, would not have received the full value of secondary enrichment. This is not a promising prospect.

Possibilities of finding ore south of the west end of the Inspiration ore body may be somewhat more attractive, but the extent of favorable ground appears to be limited.

There is some speculative possibility that detailed geological study might reveal a legitimate prospect, but substantial monthly property payments and the considerable uncertainty of success make this a poor gamble.

On the basis of my present information, I do not recommend further exploration of the Tovrea holdings.

INTRODUCTION

On December 31, 1956, and January 1, 1957, I briefly examined part of the ground making up the Inspiration-Needles and associated claim groups in the western part of the Globe-Miami district, Gila County, Arizona. I am advised that some 132 mining claims have been brought together and optioned by Tovrea Land and Cattle Company and that these have been offered to Amco, but we have not been furnished with a map showing where all of these claims are located. It is my understanding that one or two recently written reports and logs of recently drilled holes were loaned to Amco, but these have been returned and are no longer available. Consequently it will be appreciated that some of the following remarks may need modification if and when I have the opportunity to inspect these data.

I have been familiar with the area under consideration for the last 10 years, and believe that I know the position of much of the ground involved. It should be noted that this has been on Inspiration's (Anaconda's) doorstep for nearly 40 years without their having purchased it; on the other hand, the same people did not acquire Castle Dome.

A generalized map at the back of this report portrays the geologic relations involved. Various publications of the U.S.G.S. and the Copper Handbook should be consulted for further details.

CLAIM GROUPS

The Inspiration-Needles group of 31 patented lode mining claims lies immediately south of Inspiration's Barney group and wraps around its west end (please refer to map).

The Schultz and Blue Bird groups are to the south, covering localities "E", "F", "G", and "T" on the map.

This leaves some 60 or 70 other claims to be accounted for. Presumably most of these lie on the west, or possibly around locality "H" north of the Barney group. Some (the Carrow claims) are toward the east, around locality "J".

In summary, the ground in question wraps around the west end of the Miami-Inspiration ore zone and covers possible extensions in this direction.

MINERAL TRENDS

Mineralization in the Globe-Miami district exhibits a pronounced trend running northeasterly. This feature was discussed both by myself and Nels Peterson at the A.I.M.E. meeting in New York during February, 1954. (A copy of my paper is in Amco's files.) This trend is defined by the strikes of Precambrian bedding, the elongation of Tertiary intrusives, certain major faults and contacts, fractures (both barren and mineralized), veins, zones of disseminated sulphides, and zones of hydrothermal alteration.

The alignment of the Copper Cities and Castle Dome zones (CC' - DD') is striking. On the accompanying map, the Copper

Cities ore body (also known as Porphyry Reserve, Sleeping Beauty, or Louis d'Or) is at locality "O"; the Castle Dome occurrence is at "P" and "Q". Both Copper Cities and Castle Dome occur in mineralized monzonite associated with northeast fracturing. The intervening ground is masked by younger dacite and Gila conglomerate. This has been tested by drilling, which pierced about 700 feet of dacite and 1000 feet of underlying Whitetail conglomerate without reaching the pre-mineral basement.

The control of the Miami-Inspiration zone is somewhat less easy to define. Its northerly edge runs northeasterly, conforming to the prevailing fracture trend. The southerly edge is curved, concave to the south, and is located along the contact of a porphyritic phase of the Schultze granite against the Pinal schist. Disseminated ore occurs in both porphyry and schist, but most of it is in the schist.

On the accompanying map, the Miami ore body is shown at locality "L"; the Inspiration ore body is at "K". A possible projection to the southwest is toward the Cactus ore body at locality "M". This small deposit occurs in Pinal schist and falls along the regional northeasterly trend, noted as lines AA' and BB' on the accompanying map. However, these lines cut diagonally across local intrusive trends south of Castle Dome, and the trend AA' and BB' may not be valid. There is the suggestion that the Inspiration zone may diverge from "K" through "F", "G" and "T" along a broad zone of N50E fracturing (UU', VV', WW'), either as a spur or the main zone dying out, leaving the

Cactus ore body as an en echelon or a detached occurrence. On the other hand, if we consider the Pinal schist-Schultze granite contact to be the important control, then the southwesterly extension of the ore zone would be sought at "F" and "G". It is therefore apparent that there can be a difference of opinion regarding where to search for a southwesterly extension of the Miami-Inspiration copper-bearing zone.

HYDROTHERMAL ALTERATION

The disseminated copper deposits at Miami, Inspiration, Copper Cities, Castle Dome, and Cactus are surrounded by extensive zones of hydrothermal alteration. In these mineralized areas the bedrock has undergone pyritization, sericitization, silicification, and argillic alteration, the details of which have been described by Peterson et al for Castle Dome. Consequently the copper-bearing portion is part of a mineralization pattern.

Extensive and severe alteration of this type is generally absent or is only weakly and sporadically displayed in the areas with which we are here concerned ("E", "F", "G", and "T").

AGE OF FAULTING

There has been a long history of fault movement, both of pre- and post-mineral age, in the Globe-Miami district, and certain faults have undergone continuing movement both before and after primary mineralization and during and after secondary enrichment. Consequently where the Inspiration ore body ends

at the fault near locality "K", we can speculate that this fault may have served either as a pre-mineral cross-wall in the basement or as a post-Gila, post-mineral fault cutting and displacing the ore zone, or both. Thus the problem of seeking an extension becomes very complicated.

SECONDARY SULFIDE ENRICHMENT

The Copper Cities and Castle Dome ore deposits occur in monzonite where a primary tenor about 0.20 to 0.45% copper has been about doubled by secondary sulfide enrichment. On the other hand, the Miami, Inspiration, and Cactus ore bodies occur for the most part in Pinal schist, where a somewhat lower average primary tenor has been about quadrupled. In certain particularly favorable environments, the amount of enrichment has been even greater.

Ransome (1919) maintains that most of the enrichment took place before the outpouring of the dacite and that later enrichment was of little importance. Consequently, he implies that just as good ore may be concealed beneath dacite and Gila conglomerate as where these younger formations have been stripped off and the ore zone exposed.

Nevertheless, there were actually three continuing periods of secondary sulfide enrichment, as follows:

1 - Pre-dacite (and pre-Whitetail conglomerate).

2 - Post-dacite and pre-Gila, when the dacite was eroded off parts of the ore zone and before the Gila was laid down.

3 - Post-Gila, after parts of the ore zone were exhumed again.

Although much of the secondary enrichment may have taken place during the first period of enrichment, my study of the Miami ore body demonstrated that an appreciable and desirable "sweetening" did take place in post-Gila times. Consequently, where an ore body is sought under deep cover in or near the Miami-Inspiration zone, the general expectation is that it will be of somewhat lower tenor than the general average of ore mined from the chalcocite-bearing ground at Miami and Inspiration. In other words, a reasonable expectation would be a tenor in the enriched zone of 0.6 to 0.8% copper.

PAST EXPLORATION IN AND NEAR INSPIRATION NEEDLES AND ASSOCIATED CLAIM GROUPS

There was a fair amount of churn drill exploration in the old days about which we have only a little information and no assurance whatever that the sampling and logging were reliable. Thus it is reported by Ransome (1919(that considerable prospecting has been done on the Barney group (now belonging to Inspiration), "but the drill holes have not yet shown the presence of ore in commercial quantities". He adds that "Similar statements might be made with reference to the Montezuma group, southwest of the Live Oak group, which has been prospected by the Southwestern Miami Development Company (later acquired by Inspiration); to the Schultze group, still farther southwest, explored by the South Live Oak Development Co.; and to the Needles group----------".

The Copper Handbook (1918) reports two unsuccessful holes drilled on the Barney ground by the General Development Co. It also states that the Barney Co. claimed to have put down two holes, one of which passed through 20 feet of ore with about 1.2% copper, before being lost. Later it was reported that a 495-foot shaft passed through 65 feet of carbonate ore and 21 feet of chalcocite.

Southwestern Miami Development Co. is reported in the same volume to have drilled 18 holes and developed about four million tons @ 1.2% copper. This was acquired by Inspiration, as previously noted.

South Live Oak Development Co. drilled 8 holes on the Schultze claims with the following results, as reported in the Copper Handbook for 1912-1913:

Hole No.	Depth	Ore	Remarks
1	825'	60' A "commercial ore"	
2	755	No ore	All in granite
3	815	65' @ 2%	(Elsewhere reported at 75' @ 1.71% Cu.)
4	850	Small amount of carbonates	
5	917	90' A 2% plus	(Elsewhere reported as 100' A 2.21% Cu)
6	950		Nothing of importance
7	965		No ore cut
8	250		No ore cut

Holes 3 to 8 were drilled near locality "F" where there are widespread showings of green copper in schist. I have

plotted these holes on a plan, and the spottiness of this mineralization is in accord with the observed pattern of surface mineralization. Holes 1 and 2 are in area "T", which carries streaks of copper in essentially fresh granite.

On the Inspiration-Needles ground, two holes were drilled in 1916, in Pinal schist, according to the Copper Handbook for 1926. These were near locality "E". One was 1000 feet deep and the other 551 feet deep. In the shallower hole, 100 feet was of leached material with small amounts of native copper reported.

It should again be emphasized that we have no assurance that the logging and sampling of the above-described drilling was properly done.

It is my understanding that Tovrea Land and Cattle Company has recently drilled a number of holes on the Inspiration-Needles, Schultze, and Bluebird groups and claim to have found considerable 1% copper ore. As previously stated, I have not seen the logs, assays, or plan of these holes and consequently cannot say too much about what they have found. It is my understanding from discussion with others that the results were not impressive, and one company has turned down the property partly on the basis of these results. I am also informed that the sampling of these holes was a miserably conducted affair.

From my inspection of the ground it was evident that much of the drilling was done in area "T", and the construction of access roads has provided many fine exposures of bedrock. Most of this consists of generally fresh, white Schultze granite cut by prominent northeasterly fractures. Some of the fractures

and fracture zones show green copper staining from a few feet to a few tens of feet across. Such showings are localized here and there, but most of the terrane is composed of the intervening, essentially fresh granite carrying unaltered biotite. Only a little iron oxide is evident, and relief limonite after chalcocite is a rarity. The generally fresh bedrock is strikingly different from the extensive zones of hydrothermal alteration associated with the district's commercially important ore bodies.

Area "F" also displays new access roads and has apparently been drilled by Tovrea. Here the Pinal schist displays a rather extensive occurrence of scattered chrysocolla in and near the Needle claim. However, the copper staining is in a generally gray Pinal schist that is fresh or only weakly altered. It shows no characteristic network of fractures, very little quartz, very minor iron stains, and little or no sericite of the type accompanying the mineralization of the productive zones. The better copper showings are from a few feet to a very few tens of feet across and are discontinuous and erratic. The old drill results were reported on a foregoing page (holes 3 to 8 drilled by the South Live Oak Development Co. on the Schultze group), and they confirmed the erratic nature of the occurrence. I doubt if the recent Tovrea drilling has improved the picture.

EXPLORATION POSSIBILITIES

There are three exploration possibilities in the ground under consideration, listed as follows:

1. To explore exposed showings that outcrop in schist or granite, which are mostly on or near the granite-schist contact that extends southwesterly from Inspiration.

2. To explore the Miami-Inspiration-Cactus trend under the Gila conglomerate.

3. To explore beneath the Gila conglomerate between the Inspiration ore body and Castle Dome (near locality "H").

4. To consider the possibilities near locality "J".

5. To consider the possibilities of a deeper block masked by an overlying fault slice which displays weak mineralization.

These possibilities will be briefly considered on the following pages.

1 - Exposed showings occur in the supposedly favorable granite-schist contact zone near locality "F". As previously noted, old drilling here did not give commercial ore in worthwhile amounts, and it is doubtful if the more recent Tovrea drilling made the ground more attractive. Copper showings in area "T" are discontinuous and erratic and give little promise of leading to a large tonnage of commercial copper ore. This area has also been drilled by Tovrea with dubious results.

2. As regards the projection of the Miami-Inspiration zone southwesterly toward the Cactus ore body, a glance at the map will show the extent to which this is protected by Inspiration's Barney and Southwest Miami Development claim groups. If an extension escapes to the south of the Barney group, it should be advertised by alteration and metallization in the schist occurring at "E" and "R". My recent inspection of these localities, as well as the schist at "S", found no promising indications.

3. If there is an ore-bearing trend connecting Inspiration and Castle Dome, then it must violate the general structural

arrangement of the district. Although this is possible, it is not very likely. Furthermore, the Gila conglomerate in area "H" is thick, it is underlain by dacite and probably also by Whitetail conglomerate, and the full value of secondary enrichment would not be expected in such a covered area. Consequently exploration here would be very speculative, slow, and expensive.

4. I do not have much information about the possibilities near locality "J". Apparently some of the Carrow claims tied up by Tovrea are located here. I am told that Inspiration wanted some of the Carrow ground for dump room and drilled a few holes to test it for Carrow. It is rumored that better than 0.5% rock was found and Carrow wanted a higher price from Inspiration, which was not granted. Part of this area is covered by the Garnet claim belonging to Miami Copper (see map), and I believe that Miami also owns another claim nearby. To me the promising part of the available area seems rather limited in size to offer the hope of containing worthwhile ore.

5. Ransome speculates on the possibility of the fault near "K" being a thrust that has shoved Gila conglomerate up and over the westerly extension of the ore zone, and there is also the speculative possibility that other slices of weakly mineralized bedrock lie above deeper blocks that are better mineralized. The analysis of such theoretical possibilities would require very careful and detailed geological study over a considerable period of time. For an organization already established and operating in the district, this is a worthwhile project because it could be accomplished without tying up any

property; but for an outside company to take over Tovrea's options and make the monthly payments that Mr. McMillan advises me will soon come due, this is too costly in the face of the very considerable odds against success.

CONCLUSION

From what information I have on the subject, my conclusion is that further exploration of the so-called Tovrea ground is not warranted unless there is some very favorable information available about which I am unaware. The reasons for this conclusion are set forth in the foregoing report, and they are summarized at its beginning.

E. N. Pennebaker

E. N. PENNEBAKER

Scottsdale, Arizona
December 9, 1957

LEGLND

GILA CONGLOMERATE

DACITE

SCHULTZE GRANITE

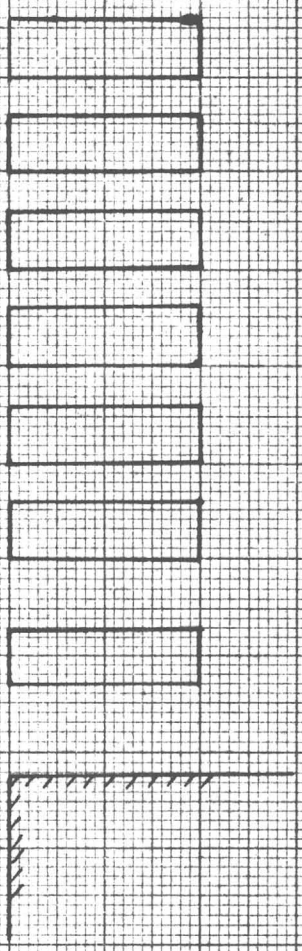
PINAL SCHIST

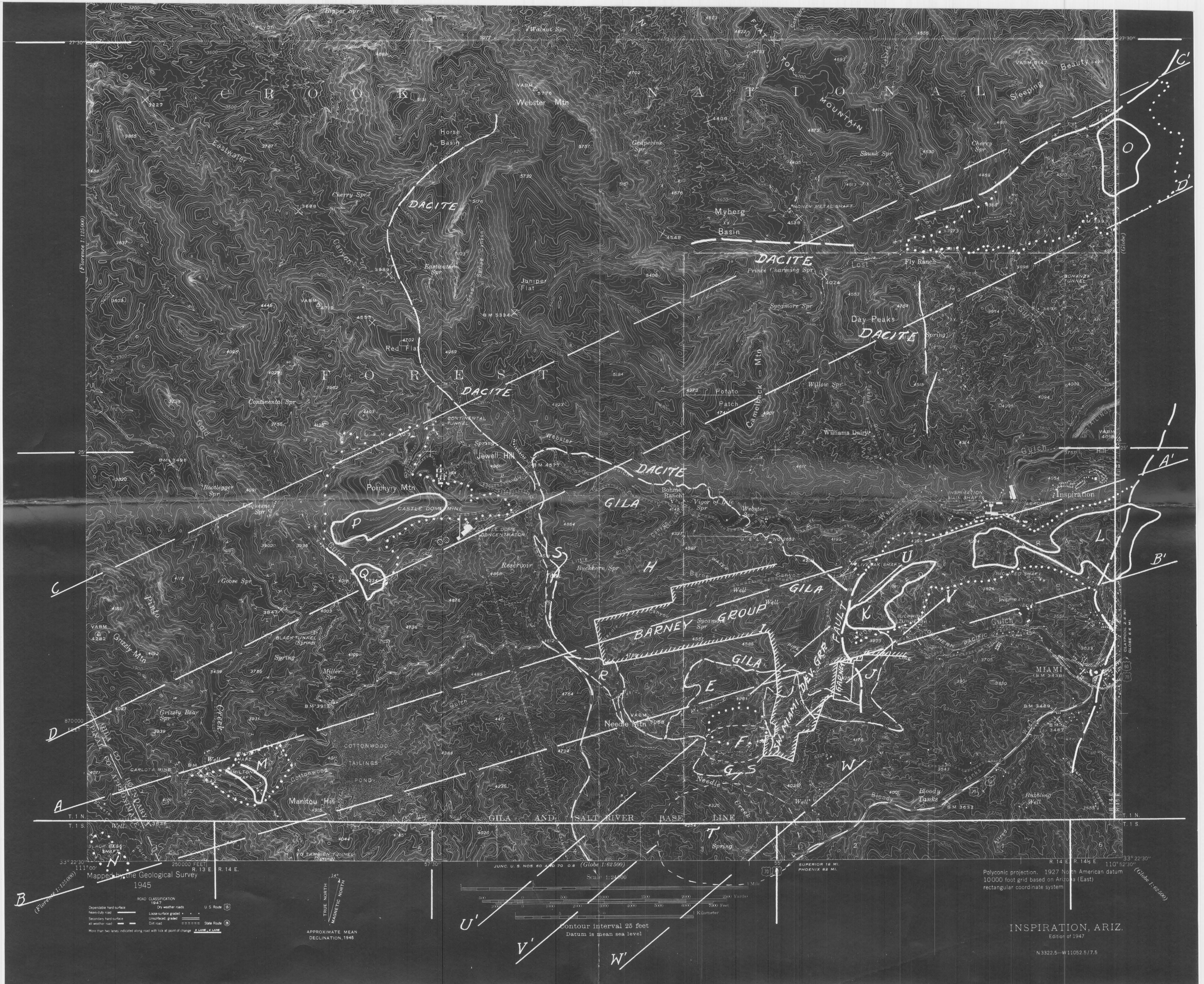
ORE BODIES

ALTERATION ZONES

AREAS WITH SCATTERED COPPER SHOWINGS

INSPIRATION PROPERTY LINE





DACITE
DACITE
DACITE
DACITE
DACITE
GILA
GILA
GILA
BARNEY GROUP
MIAMI
DEV. GRP. FAULT
Webster Mtn
Horse Basin
Myberg Basin
Day Peaks
Red Flat
Juniper Flat
Porphyry Mtn
Jewell Hill
Castle Dome Mine
Continental Spr
Goose Spr
Grizzly Mtn
Needle Mtn
Manitou Hill
Cottonwood Tailings Pond
Carlota Mine
Inspiration
Miami
Bloody Tanks
Bohme Ranch
Fly Ranch
Potato Patch
Camelback Mtn
Williams Dairy
Prince Charming Spr
Sycamore Spr
Cherry Spr
Sleeping Beauty
Bootlegger Spr
Buckhorn Spr
Bubbling Well
Gila and Salt River Base Line
A
A'
B
B'
C
C'
D
D'
U'
V'
W'
Mapped by the Geological Survey 1945
Contour interval 25 feet
Datum is mean sea level
Scale 1:24000
Polyconic projection. 1927 North American datum
10000 foot grid based on Arizona (East) rectangular coordinate system
APPROXIMATE MEAN DECLINATION, 1945
INSPIRATION, ARIZ.
Edition of 1947
N 3322.5—W 11052.5/7.5

LEGLND

GILA CONGLOMERATE

DACITE

SCHULTZE GRANITE

PINAL SCHIST

ORE BODIES

ALTERATION ZONES

AREAS WITH SCATTERED COPPER SHOWINGS

INSPIRATION PROPERTY LINE

TRIM TO HERE

INSPIRATION, ARIZ.

Edition of 1947

N 3322.5—W 11052.5/7.5

Mapped by the Geological Survey
1945

Polyconic projection. 1927 North American datum
10000 foot grid based on Arizona (East)
rectangular coordinate system

ROAD CLASSIFICATION
1947

Dependable hard surface
heavy-duty road
Secondary hard-surface
all weather road
Dry weather roads
Loose-surface graded
Unsurfaced, graded
Dirt road
U. S. Route
State Route
More than two lanes indicated along road with tick at point of change 3 LANE 4 LANE

APPROXIMATE MEAN DECLINATION, 1946

TRUE NORTH
MAGNETIC NORTH
14°

Scale 1:24000
1 Mile
2500 Yards
7000 Feet
1 Kilometer

Contour interval 25 feet
Datum is mean sea level

JUNC. U. S. NOS. 60 AND 70 0.8 (Globe 1:62500)
SUPERIOR 18 MI.
PHOENIX 82 MI.

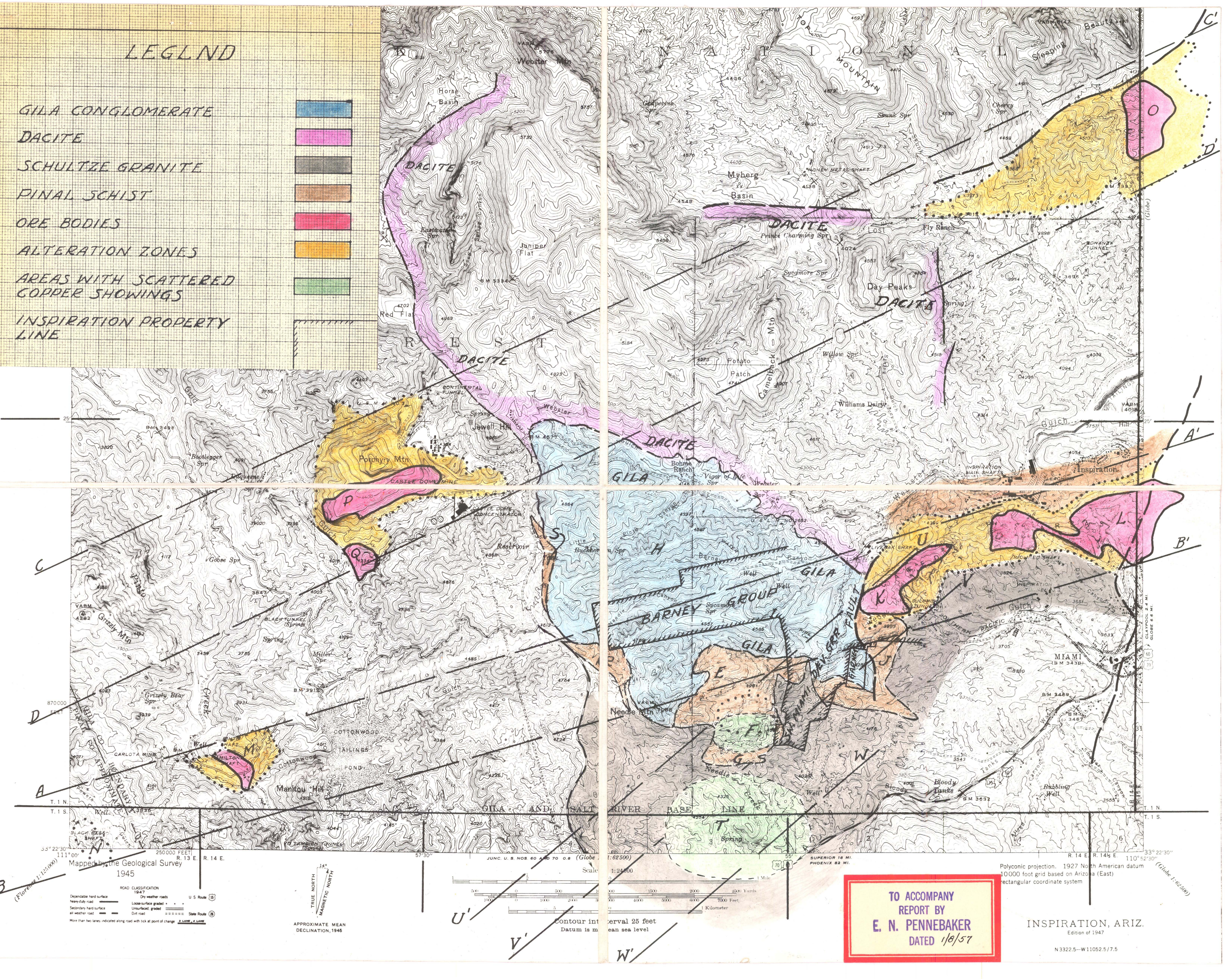
(Florence 1:125000)
(Globe 1:62500)

GILA AND SALT RIVER BASE LINE

T. 1 N.
T. 1 S.
R. 13 E.
R. 14 E.
R. 14½ E.

870000 FEET
250000 FEET
33° 22′30″
111° 00′
110° 52′30″
57′30″
55′
27′30″
25′
31

CLAYPOOL 2.4 MI.
GLOBE 66 MI.


LEGEND
GILA CONGLOMERATE
DACITE
SCHULTZE GRANITE
PINAL SCHIST
ORE BODIES
ALTERATION ZONES
AREAS WITH SCATTERED COPPER SHOWINGS
INSPIRATION PROPERTY LINE
DACITE
GILA
BARNEY GROUP
DAISY GR. FAULT
GILA AND SALT RIVER BASE LINE
Porphyry Mtn
Castle Dome Mine
Inspiration
Miami
Manitou Hill
Needle Mtn
Webster Mtn
Myberg Basin
Day Peaks
Camelback Mtn
Jewell Hill
Mapped by the Geological Survey 1945
Polyconic projection. 1927 North American datum
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E. N. PENNEBAKER
DATED
1/8/57