CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
520-770-3500
http://www.azgs.az.gov
inquiries@azgs.az.gov

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James Doyle Sell Mining Collection

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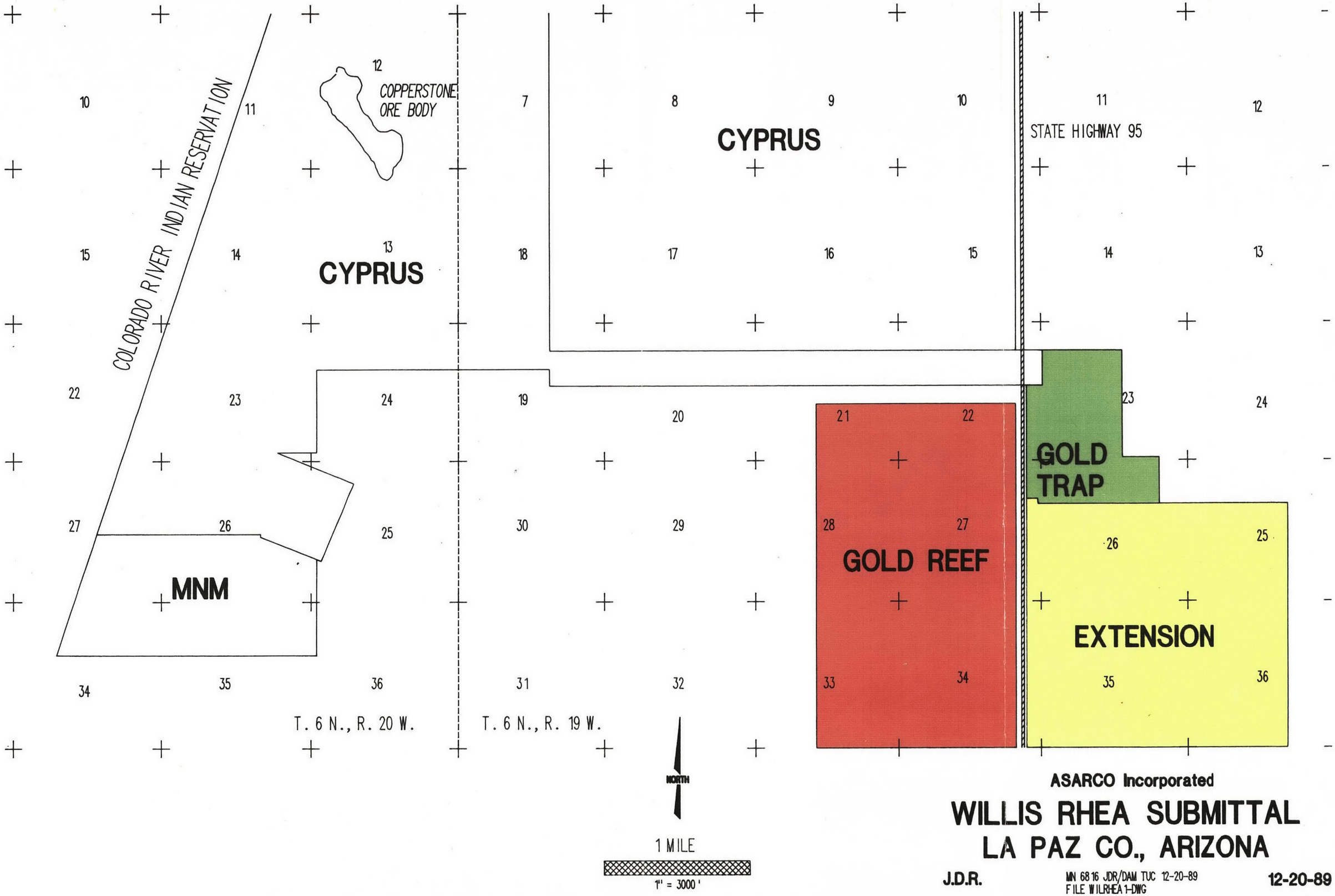
COLORADO RIVER INDIAN RESERVATION
COPPERSTONE ORE BODY
CYPRUS
CYPRUS
STATE HIGHWAY 95
MNM
GOLD REEF
GOLD TRAP
EXTENSION
T. 6 N., R. 20 W.
T. 6 N., R. 19 W.
NORTH
1 MILE
1" = 3000'
ASARCO Incorporated
WILLIS RHEA SUBMITTAL
LA PAZ CO., ARIZONA
J.D.R.
MN 6816 JDR/DAM TUC 12-20-89
FILE WILRHEA1-DWG
12-20-89

Authorized Walter Heinrichs to complete review of May data ≠ £2000. 3-14-90
has completed matching all the pieces ≠ £200 & can see some things that need commenting on, death to bedrock, faults.

JH

JDS

ASARCO

Southwestern Exploration Division

April 10, 1990

J.D. Sell

Interpretation of Magnetic Data
Willis Rhea Property
La Paz County, Arizona

on file

After reviewing Mr. Walter Heinrichs' report on the magnetic data supplied by Willis Rhea, I have mixed sentiments about the property. The verification of the northwest-southeast trending structures which are subparallel with the "producing" structure in the Copperstone Mine is encouraging. However, the "depth to bedrock" estimates of 700 to 2000 feet would eliminate any open pit potential, if accurate. The quality of the data and the assumptions made by Mr. Heinrichs to correct the obvious compilation errors will have an affect on the estimate of depth and structure character.

Given the shadow that deep alluvial cover casts on the property, I would like to wait until the airborne EM data is collected and evaluated before any action is taken on this submittal. During the hiatus it may be valuable to search the University of Arizona Gravity Data Base for measurements that may be available in the area. The gravity data will be a better "depth to bedrock" measurement than the magnetics.

Jim

JDR:mek

James D. Rasmussen

yes, placed on hold till HEM results are available

JDS

TELEX:364412 INTR-ID894
FAX:602/326-4019

HEINRICHS GEOEXPLORATION COMPANY

P. O. BOX 5964. TUCSON. ARIZONA 85703. 806 WEST GRANT ROAD. PHONE: (602) 623-0578

ASARCO Incorporated
MAR 26 1990
SW Exploration

23 March 1990

Mr. James D. Sell,
Regional Exploration Manager
ASARCO Incorporated
P. O. Box 5747
Tucson, AZ 85703

Re.: Rhea's and Mack's magnetic data, La Paz County, Az
Our#1904-AZ-90.

Dear Jim:

In order to minimize confusion, it is necessary, regrettably, to call your attention some errors as follows:

1. In the letter report, first paragraph under PROCEDURES, the original plan maps are at a scale of 1000' per inch, not 100' per inch.

2. Second paragraph under CONCLUSIONS talks about northerly dip component. On at least the southernmost anomaly there could also be a southerly dip component as well, especially on the extreme easterly portion. and, it would not be surprising to find similar effects elsewhere.

3. Under PROCEDURES first paragraph again, the smallest line interval is 200' not 300', (Lines 1-A and 1-W).

4. Third paragraph under CONCLUSIONS mentions: "Section B-B'. This section was used in some of the depth estimates but does not show on the map. It represents a line which crosses the middle magnetic high half way between "X" and Z and extends from the bottom of the North Arrow all the way to the southwestern part of the map.

I hope that is all! But, no! One more thing: I had enough trouble copying scale changes a bar scale should be on the map. Please use the one enclosed.

Our statement is enclosed.

Sincerely,

Walt

GRAPHIC SCALE: 0 500' 1000'

CO Incorporated

MAR 2 6 1990

SW Exploration

TELEX:364412 INTR-ID894

FAX:602/326-4019

HEINRICHS GEOEXPLORATION COMPANY

P. O. BOX 5964, TUCSON, ARIZONA 85703, 806 WEST GRANT ROAD, PHONE: (602) 623-0578

22 March 1990

STATEMENT

ASARCO Incorporated
P. O. Box5747
Tucson, AZ 85703

Attn.: Mr James D. Sell,
Regional Exploration Manager

Re.: Reinterpretation of magnetic data, portions of T. 5&6 N., R. 19 W., La Paz County, AZ.
Our #1904-AZ-90

Professional Services:

Walter E. Heinrichs, Jr., Geological Engineer-Geophysicist
P. E. and C. P. G. Recompile and reinterpret data,
prepare and submit contour map and report,
Time: 5 March thru 22 March 1990 - - - - - - - - - - - - -$2100.00

Expenses: Copying, materials, supplies and
reproductions - - - - - - - - - - - - - - - - - - 245.41

Total due: - - - - - - $2345.41

APPROVED FOR PAYMENT

By:_____
(Signature)

NOTE: Professional statements are customarily due upon presentstion. Amounts unpaid after thirty (30) days from above date, will incur late payment charges computed at the rate of 1½% per month from the above date..

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

New York, April 11, 1990

Mr. J. D. Sell
Tucson Office

Plomosas Plain Project
Arizona

Dear Mr. Sell:

I attach hereto a copy of Form 302-M and the request for the above-captioned project. Please note that this form has been processed by the Controllers Department and by Mr. T. C. Osborne.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

FTG:mc
Att.

cc: E. J. Franko (w/att.)
W. L. Schoonmaker (w/att.)

ASARCO Incorporated
APR 16 1990
SW Exploration

ASARCO Incorporated 180 Maiden Lane New York, N.Y. 10038 (212) 510-2000
Telex:RCA 232378 Cable: MINEDEPART Fax: (212) 510-1978

New York, N.Y., March 26, 1990

To: T. C. Osborne

AEM Requests

The attached table summarizes authorization requests for 11 separate AEM flight blocks totalling 4,451 line miles; 8 are supplemental and 3 are new project areas. The 8 supplementals cover existing claim groups and occasionally large areas of adjacent ground. Asarco holds no ground in areas of the 3 new projects, although Weaver is an extension of the Yarnell project area. Land record searches indicate the new survey areas cover mostly open Federal ground.

Four of the requests exceed $50,000. All attach a location map, a survey flight block map and various other maps as seemed necessary. Some of the flight blocks have somewhat revised geometries from the original proposal, although I have attached some of the original proposals if they were otherwise useful. Total funds requested are $560,000; all areas and funds are in Mr. Brown's budget, and there is an additional $100,000 remaining in the AEM planning for initial follow-up.

Note that the request for each project is for the estimated full amount of each AEM survey even though most of the existing projects have some remaining funds. These remaining funds will be used either for AEM follow-up or assessment work (AEM is not applicable for assessment work commitments) in an additional authorization where required.

Our consultant has advised all geologists how to review data quality in the field before data are sent to Dighem in Toronto for reduction and has reviewed all flight blocks for efficient flying format. Several flight blocks include certain areas for flying 1/8 to 1/16 mile spacing over known mineralization to assist with interpretation. Nominal reconnaissance line spacing will be 1/4 mile.

Additional AEM requests will be forthcoming from the Spokane Office. The machine is already in Nevada. Clipped separately are the 11 authorization requests for your review.

F. T. Graybeal

F. T. Graybeal

RECEIVED

FTG:mc
Att.

AEM SUMMARY

Area	Line Miles	Contract Cost[1)]	Total Cost[2)]
Pine Valley, Nev.	247	25,935	30,000
Cooper Peak, Nev.	663	69,615	80,000
Lincoln Hgwy, Nev.	261	27,405	33,000
Gilbert E., Nev.	566	59,430	70,000
Paradise, Nev.	1,165	122,325	140,000
Ochre Spring, Utah	314	32,970	38,000
Garfield, Utah	177	18,585	27,000
Yellow Jacket, Utah	176	18,480	25,000
Weaver, Ariz.	356	37,380	45,000
BVO, Ariz.	70	7,350	12,000
Plomosas, Ariz.	456	47,880	60,000
Total	4,451		$560,000

1) $105/line mile except Paradise which is billed at $96/line mile.

2) Includes data interpretation, mobilization, set up charges for navigation, standby for staking crews; does not include actual staking or other follow-up.

T.C.

New York, N.Y., March 26, 1990

To: T. C. Osborne

Exploration Authorization
Plomosas Plain Project
Arizona

This is a high pediment region in western Arizona which includes the Copperstone mine with numerous small mineral occurrences on the flanks of the adjacent mountains. The pediment is underlain by numerous flat-structures, generally termed detachment faults. Copperstone is a high angle structure related to the detachment fault, and the Tucson Offie recommends an AEM survey over the pediment to search for other high angle structures under shallow cover which might be tested with shallow drill holes.

In additional to the Plomosas Plain, the flat structures may extend over much of this part of Arizona and if AEM can locate these steep structures, AEM may become an important exploration tool in detachment fault environments. Our consultant, Mr. Windels, notes that as far as he knows no one has yet applied AEM in this region.

Cost of the proposed 456 line mile program is estimated at $60,000 for contract flying, interpretation of data, and standby for staking crews. If you agree with this proposal, please obtain the necessary approvals and return the attached form to the Exploration Department.

F. T. Graybeal

F. T. Graybeal

FTG:mc
Att.

cc: C.L. Snow (w/att. Form 302-M)
(4/17/90)

PRINTED IN U.S.A. 1/73

FORM 302-M

New York No. 0485-00

APPLICATION FOR EXPLORATION APPROPRIATION

March 26 19.90 Originating Office T. Tucson

DESCRIPTION: Plomosas Plain Prospect

LOCATION OF PROSPECT/PROJECT:

PARTNERS:

Partner's Per Cent .....

COMPANY: ☒ ASARCO

☐ Subsidiary. Specify .....

WORK CONTEMPLATED:

Contract AEM flying including navigation set-up and mobilization
Data interpretation
Stand-by staking crews

Total estimated cost (FORM 302-MA ATTACHED) $. 60,000

Reviewed by ..... Acct. Mgr. or Chief Acct.

Approved by J. T. Graybeal ~~Vice President~~

Recommended by ..... Supervisor

Approved by R. J. O'KEEFE Comptroller

Account Chargeable to EXPLORATION EXPENSE

To be designated by Comptroller

Approved by Advisory Committee ..... 19 ...

Approved by Board of Directors ..... 19 .....

J. C. O. ..... Secretary

ASARCO

Southwestern Exploration Division

March 5, 1990

FILE MEMO

Willis Rhea Submittal
Plomosa Mining District
La Paz County, Arizona

Attached are copies of all reports received from Willis Rhea.

1. Report Titled: Ground Magnetic Survey, Bill Rhea Claim Block, Plomosa Mining District, La Paz County, Arizona, Sections 26 & 27, T6N, R19W.

2 Report Titled: Supplementary Geophysical Report, Ground Magnetic Survey, Bill Rhea Extension Claim Block, Plomosa Mining District, La Paz County, Arizona.

3. Report Titled: Supplementary Report II, Ground Magnetic Survey by Bill Rhea, Extension Claim Block, Plomosa Mining District, La Paz County, Arizona.

4. Report Titled: Ground Magnetic Survey, Gold Trap Lode Mining Claims, Plomosa Mining District, La Paz County, Arizona, Sections 22, 23, 26 & 27, T6N, R19W.

5. Report Titled: Supplementary Report - Phase II, Ground Magnetic Survey, Gold Trap Lode Mining Claims, Plomosa Mining District, La Paz County, Arizona. (Missing profiles of Line 7 and Line 8.)

6. Letter: To Bill from Frank, July 22, 1988, Re: transmittal of Gold Trap magnetic report.

7. Report Titled: Potential Ground Magnetically Indicated Copperstone Type of Structures Extension - Gold Trap - Jack Pot Claim Block - La Paz County, Arizona (with cover letter).

8. Profile: Line 5W Looking South.

James D. Rasmussen

JDR:mek
Atts.

James D. Rasmussen

cc: J.D. Sell

JDS

ASARCO

Southwestern Exploration Division

January 10, 1990

W.L. Kurtz

Willis Rhea Properties
Plomosa Mining District
La Paz County, Arizona

Attached is Mr. J.D. Rasmussen's report on the area southeast of the Copperstone gold deposit of Cyprus Minerals.

As geophysics/drilling are the two best ways of getting at a new Copperstone type under gravel cover, I believe that the Rhea/Mack ground magnetic data should be reviewed. Walt Heinrich or Bob West are two that come to mind, to confirm that the signatures found are probably from a bedrock reflected source rather than the possibility of being from magnetic sand layers in the nearer surface gravel tongues shedding from the mountain ranges.

James D. Sell

James D. Sell

JDS:mek

cc: R.L. Brown/F.T. Graybeal
J.D. Rasmussen

JDS

October 16, 1989

J.D. Sell

Willis Rhea Properties
Plomosa Mining District
La Paz County, Arizona

Summary & Conclusions

Mr. Willis Rhea and associates control or have interest in 215 claims about 6 miles east, southeast of Cyprus Mining Company's Copperstone Mine.

Mr. Rhea and Mr. Franklin Mack have conducted over 7 line miles of ground proton magnetometer measurements on the claim group. These surveys have identified suspected faulting similar to that hosting the mineralization at the Copperstone Mine.

No outcrop is present on the claim block. The surface is pediment gravel from the Plomosa Mountains to the east.

The terms offered for a lease are reasonable, beginning with a no or low cost ($5,000 total) ninety day option with minimal work commitment followed by a one year period with a low cost lease payment. A 4% NSR is the requested royalty.

I recommend that the claims be leased and an exploration program initially limited to geophysical surveys (gravity, high resolution seismic, IP and additional magnetic) be conducted. These surveys should identify high quality drill targets.

Introduction

Willis Rhea and associates control 215 unpatented mining claims located about 6 miles east, southeast of the Copperstone Mine (Cyprus Minerals Company). The claims and mine lay on the La Posa Plain in the Plomosa Mining District, La Paz County, Arizona (see location map).

The La Posa plain is a broad pediment surface covered by gravel and sand derived from the Plomosa Mountains to the east. The plain dips generally westward toward the Colorado River. No outcrop has been located on the claim block.

Mr. Rhea and Frank Mack, a claimant on an associated claim block, have collected magnetometer measurements on several east-west lines across the claim blocks and have identified fault structures similar to those

hosting mineralization at the Copperstone Mine. Mr. Mack is a former employee of AMOCO Minerals, the predecessor to Cyprus at Copperstone, and has experience applying ground magnetics about the initial discovery.

Copperstone Deposit Geology

The Copperstone deposit is located with a "detachment" splay fault off of the main Moon Mountain detachment fault as described in the FIELDNOTES report (Attachment A).

A number of sites are available to host mineral deposits in the tectonic setting of "detachment" faults (Attachment B). A cross-section (Attachment C) shows the Copperston Mine area zone off of the main Moon Mountain fault exposed in the Copper Peak area of the Dome Rock Mountains.

Ground Magnetic Surveys

Mr. Rhea and Mr. Mack have run over 74 line miles of ground megnetic survey using a Geometric Proton Magnetometer. The survey lines were all east-west along claim boundaries at about 1200' line spacing. Readings were taken at twenty foot intervals and corrected for diurnal variations.

Mr. Mack's interpretation of the magnetic data identified fault-like signature on many of the lines. These faults are similar to those hosting mineralization at the Copperstone Mine. A large broad magnetic trough bisects the Gold Trap and Extension Claim block from northwest to southeast. This trough may be a graben in the bedrock or an altered band of rock associated with mineralization. Several profiles indicate the depression is bounded by faults on the east and west. Copies of the reports and profiles prepared by Mr. Mack are available for examination at the Tucson Office.

Terms and Principals

The following terms were discussed by Mr. Rhea for a lease on the two claim blocks he controls or holds an interest. The claim blocks are located on Figure 2.

Extension Claims (84 claims) - Willis Rhea 100% owner.

Ninety-day (free) option period with a $25,000 work commitment, then $10,000 payment and $150,000 work commitment for one year. Fifty

thousand dollar minimum annual royalty for each additional year against a 4% NSR royalty.

Gold Reef Claims (105 claims) - Willis Rhea 50% & Don Patch 50%.

Ninety-day option and 1000 feet of drilling as work commitment; then $2,000 per month for the next twelve months. No work commitment was discussed for this period of time. Following the twelve month period a $50,000 annual minimum royalty against a 4% NSR for the term of the lease.

Gold Trap Claims (26 claims) - Franklin Mack 50% & Dane Clive 50%.

Neither Mr. Mack nor Mr. Clive have been contacted directly at this time, but Mr. Rhea stated that they have told him they will accept terms in proportion to what he is receiving from his larger interest.

Addresses and phone numbers of the principals are:

Willis Rhea Brenda Route, Box 244 Salome, Arizona 85348 (602) 927-6304	Don Patch 6850 N 86th St. Scottsdale, Arizona 85253 (602) 483-8365
Dave Clive 297 E 6400 S Murray, Utah 84107 (801) 262-7365	Franklin Mack 8655 East Phillips Ave. Englewood, Colorado 80112 (303) 799-6620

Mr. Rhea has also identified an area adjacent to the southeast of the Extension Claims that has not as yet been staked. He indicates that about 100 claims would be needed to cover this ground. Mr.Rhea has requested that he retain a 1% NSR royalty for identifying this area.

Conclusions and Recommendations

The Copperstone Mine produces from 60,000 to 100,000 ounces of gold per year. The location of these claims, along strike from this mine, make them a good bet for a continuation of the mineralization. However, the lack of outcrop and pediment cover of unknown depth lend a degree of uncertainty to the potential of the claim block. This uncertainty is offset by the very reasonable terms the claimant has offered Asarco.

I would recommend that the claims be leased and that Asarco begin an evaluation program. The program will initially be limited to the geophysical tools because of the lack of outcrop.

The application of gravity, high resolution seismic, and IP surveys supplementing the magnetic surveys should identify quality drill targets within a short time.

Copperstone has essentially mined out its open pittable portion of the mineralization. They started a decline under the open-pit to take a look at their drill indicated reserves, mineable by underground methods. However, they have recently announced the closing of the underground development due to "heavy ground" problems.

Thus, the exploration on Mr. Rhea's block would be aimed at the open-pit potential.

James Rasmussen

James D. Rasmussen

JDR:mek
Atts.

cc: W.L. Kurtz

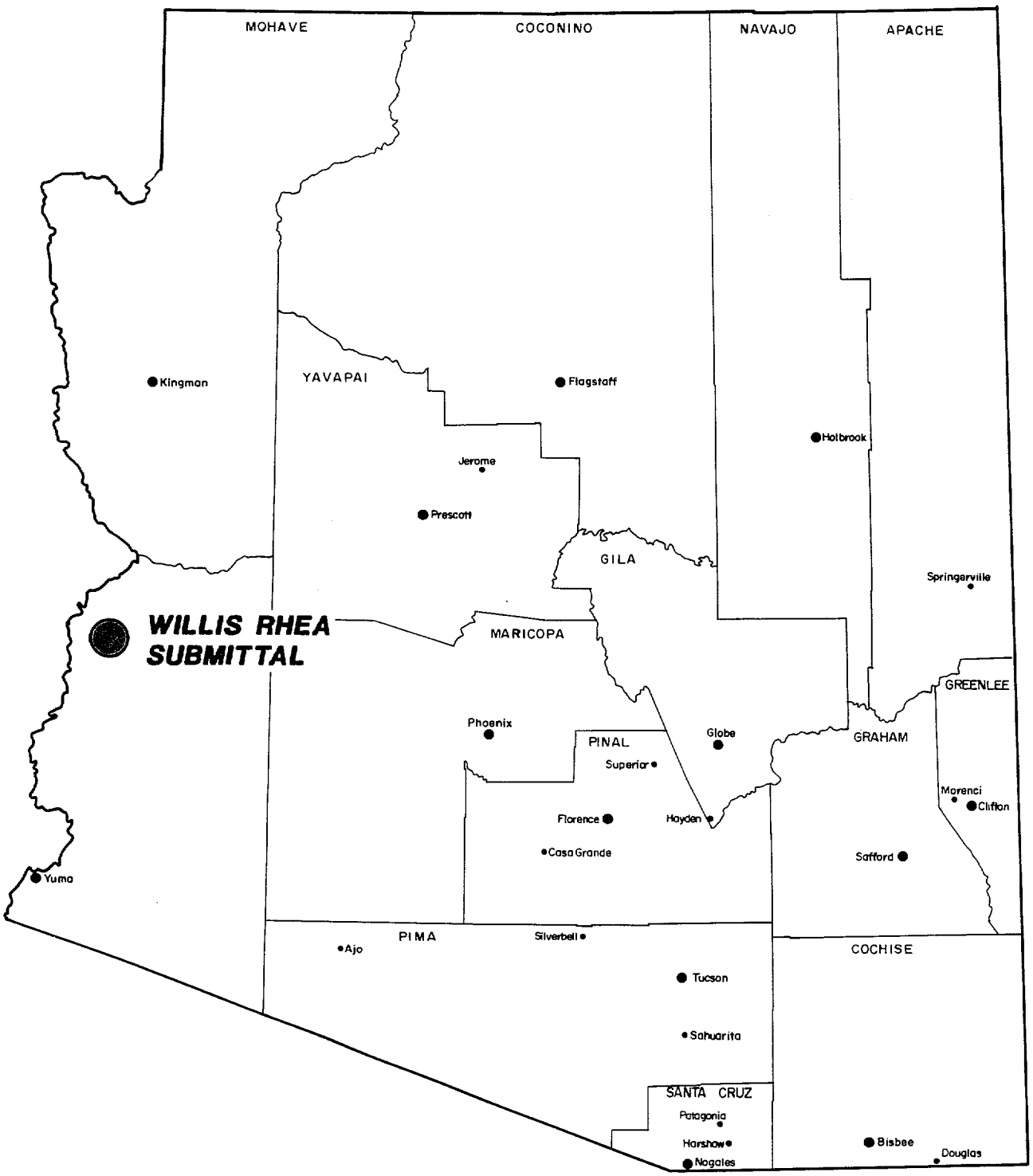

FIGURE 1
WILLIS RHEA SUBMITTAL
LA PAZ COUNTY, ARIZONA

mn6815 JDR/dam tuc 12-19-89

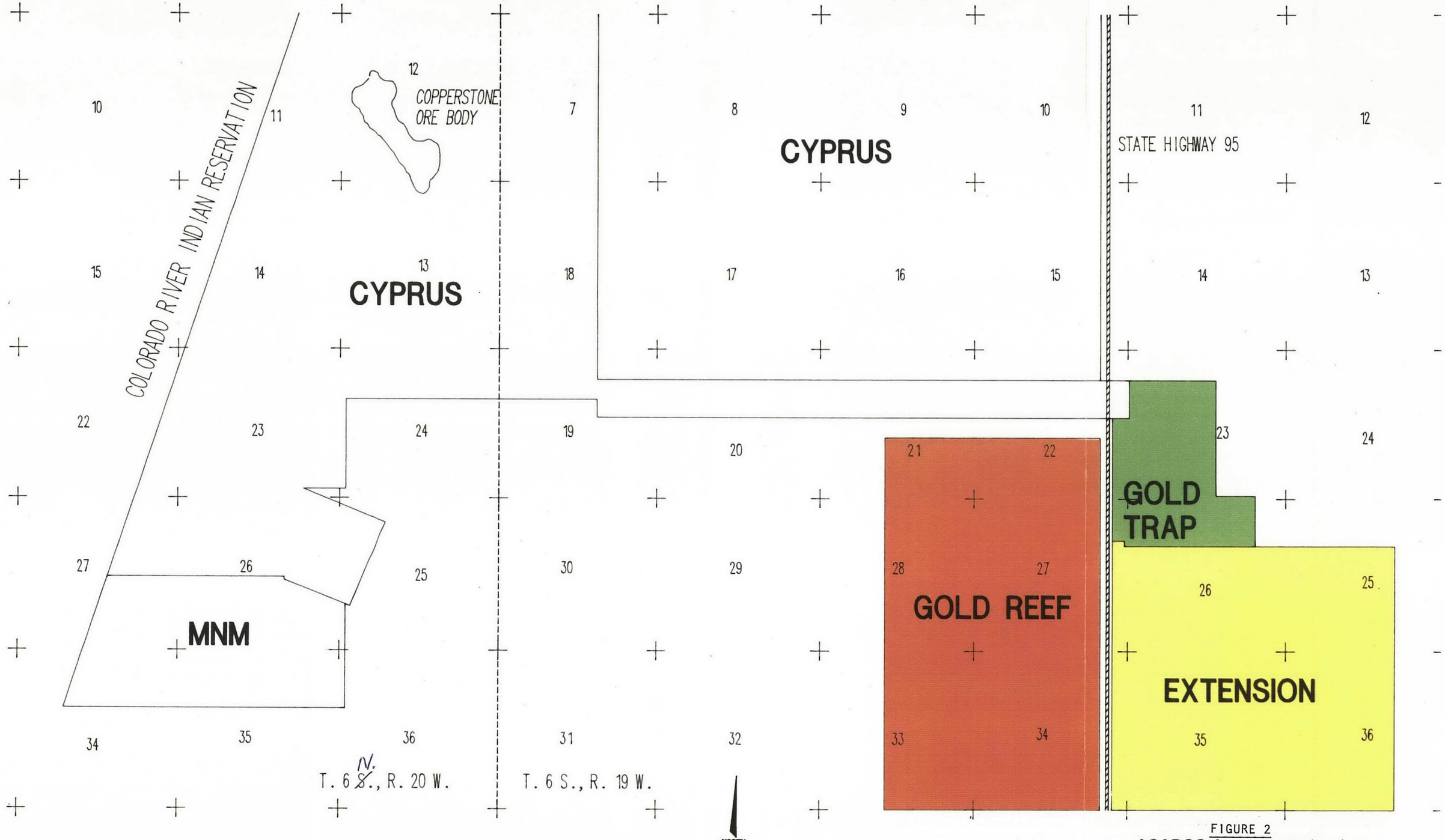

FIGURE 2

ASARCO Incorporated

WILLIS RHEA SUBMITTAL
LA PAZ CO., ARIZONA

J.D.R.

MN 6816 JDR/DAM TUC 12-20-89
FILE WILRHEA1-DWG

12-20-89

ATTACHMENT A

Arizona Bureau of Geology and Mineral Technology
FIELDNOTES
Vol. 18, No. 2 Summer 1988

RECEIVED
JUN 29 1988
EXPLORATION DEPARTMENT

The Copperstone Mine: Arizona's New Gold Producer

by Jon E. Spencer and John T. Duncan
Arizona Geological Survey

and William D. Burton
Cyprus Minerals Company
P.O. Box 3299
Englewood, CO 80155

Arizona's annual gold output will almost double in 1988 as a result of production from Cyprus Minerals Company's Copperstone gold deposit in La Paz County, west-central Arizona. During 6 years of expected mine life, the deposit is predicted to yield approximately 510,000 troy ounces of gold worth $230 million, based on a value of $450 per ounce. Unlike many recent gold discoveries in the Southwest, Copperstone is a new discovery in an area not previously identified as a mineral district. In this article, the geology and regional setting of the Copperstone deposit are described. Although the deposit is still not completely understood, enough is known to warrant reassessment of estimates of mineral-resource potential in west-central Arizona.

Regional Geologic Setting

West-central Arizona and adjacent areas of California and southern Nevada contain some of the most spectacularly exposed detachment faults in the world. The term "detachment fault" is commonly applied to large-displacement, gently dipping (inclined) normal faults. In this region, hanging-wall rocks, or rocks overlying the detachment faults, were displaced northeastward relative to footwall rocks, rocks that underlie the faults. The faults originally dipped to the northeast, but are now rotated and warped to form undulating surfaces that are nearly horizontal over large areas.

The north- to northeast-dipping Moon Mountains detachment fault, exposed at the northern tip of the eastern Moon Mountains, separates two large, geologically distinct areas: to the northeast lie numerous detachment faults, such as those in the Buckskin, Rawhide, and northern Plomosa Mountains; to the south, in the Dome Rock, southern Plomosa, and most of the Moon Mountains, detachment faults are absent. The Copperstone gold deposit lies within the hanging wall of the Moon Mountains detachment fault and flanks the area of pervasive faulting.

Miocene (5- to 24-million-year [m.y.]-old) detachment faults in west-central Arizona are associated with numerous copper, iron, and gold deposits, especially in the Buckskin and Rawhide Mountains, that have yielded metals worth many millions of dollars (Figure 1; Table 1; Wilkins and Heidrick, 1982; Spencer and Welty, 1986). Copper-gold deposits associated with detachment faults typically lie along or within a few tens of meters of the faults; a few, however, are hundreds of meters above the faults. Detachment-fault deposits contain fractures and thick, irregular zones that are commonly filled with the minerals specular hematite, chrysocolla, quartz, barite, fluorite, calcite, and manganese oxides. Pyrite and chalcopyrite, which are commonly oxidized, are also present in many deposits.

The northeastern tip of the Moon Mountains is primarily composed of Mesozoic (63- to 240-m.y.-old) granitic rocks that form the footwall of the Moon Mountains detachment fault. Hanging-wall rocks are mostly metamorphosed Jurassic (138- to 205-m.y.-old) volcanic rocks. Older (Paleozoic; 240- to 570-m.y.-old) metamorphosed sedimentary rocks that are brecciated (composed of

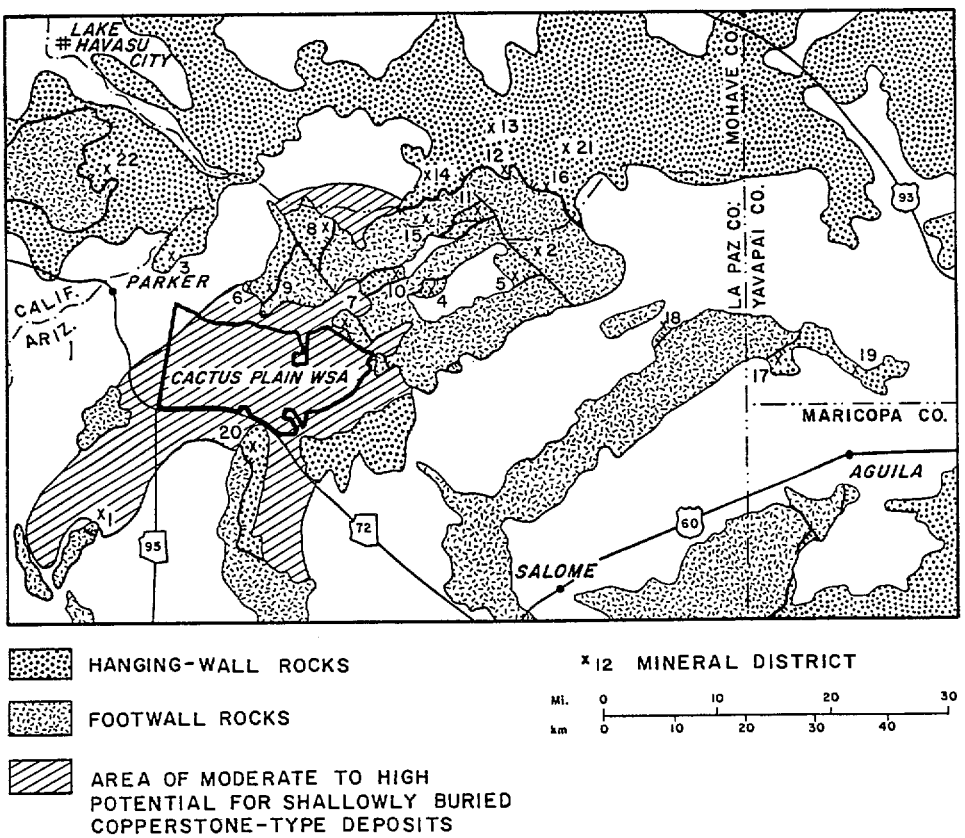

Figure 1. Map of part of west-central Arizona showing mineral districts where mineral deposits are known or suspected to be related to detachment faults. Middle Tertiary and older rocks are divided into hanging wall and footwall rocks, which lie above and below, respectively, regionally northeast-dipping detachment faults. Also shown is the outline of the Cactus Plain and Cactus Plain East Wilderness Study Areas. Numbers refer to mineral districts listed in Table 1.

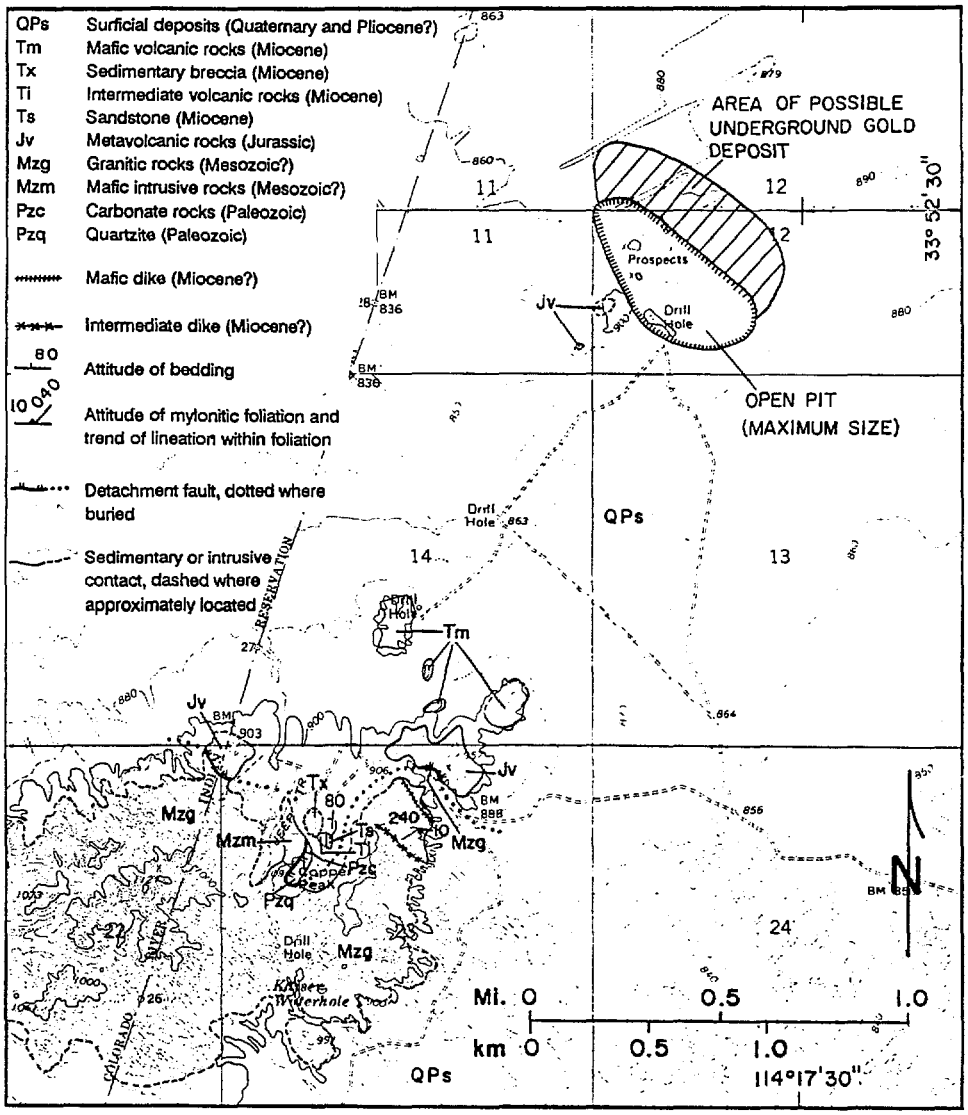

Figure 2. Geologic map of northeastern Moon Mountains showing location of Copperstone mine.

broken rock fragments) underlie Copper Peak; steeply dipping, younger (Miocene) volcanic and sedimentary rocks, including sedimentary breccias derived from the Jurassic volcanic rocks, are also present adjacent to Copper Peak (Figure 2). The copper-iron mineralization that characterizes detachment-fault deposits elsewhere in west-central Arizona is also evident in brecciated rocks along the Moon Mountains detachment fault at Copper Peak and at the edge of the Colorado River Indian Reservation.

Geology

The Copperstone mine is approximately 1½ miles northeast of exposed bedrock in the northeastern Moon Mountains (Figure 2). Bedrock exposures in several very small hills surrounded by alluvium contain evidence of gold mineralization and led to the discovery of the Copperstone deposit. Mineral deposits are present above and along a gently dipping contact that is probably a fault; the contact separates Jurassic metamorphosed volcanic rocks and overlying sedimentary breccias derived from them. The mineralized contact zone dips approximately 30° to the northeast, extends horizontally for 3,000 feet and at least 1,000 feet down dip, and is generally several tens of feet thick. The sedimentary breccia and a volcanic rock that contains vesicles (relict gas bubbles) are almost certainly Miocene in age and are mineralized, indicating that mineralization is Miocene or younger.

Drill-core samples reveal that some brecciation occurred after quartz veins were formed; however, numerous northwest-trending quartz-amethyst veins exposed in the mine pit are not brecciated. Steeply dipping, northwest-striking fractures and narrow shear zones exposed in the mine pit locally cut quartz-amethyst veins and contain subhorizontal slickenside lineations, which are smooth and polished striations that result from friction along a fault plane.

Gold is present where quartz and specular hematite are abundant in the breccia zone and locally within veins in the metamorphosed volcanic rocks. Chrysocolla, barite, earthy red hematite, and malachite are also common in the gold-mineralized zone. Fluorite, adularia, magnetite, calcite, chalcopyrite, pyrite, and manganese oxides are present in smaller quantities. Gold, however, is rarely visible. The presence of quartz, hematite, and chrysocolla is a good indicator of gold mineralization.

Fluid-Inclusion Characteristics

Fluid inclusions are bubbles of liquid and gas that are commonly trapped inside minerals during mineral formation. The composition of fluid inclusions in mineral deposits reflects the composition of the aqueous fluids that formed the deposits. One can determine the salinity of the inclusions by determining the freezing temperature of the fluid within them. The minimum temperature of the fluid at the time it was trapped can be determined by heating the sample until the two phases (liquid and gas) in the inclusion become one. Fluid inclusions in quartz-amethyst from the Copperstone mine contain between 16 and 22 percent sodium-chloride equivalent (by weight) and were trapped at minimum temperatures between 200° and 260° C. These characteristics are similar to those of other mineral deposits along Miocene detachment faults in west-central Arizona, but are substantially different from those of most other types of deposits, such as epithermal-vein gold deposits (Figure 3; Wilkins and others, 1986).

Origin

The following characteristics of the Copperstone deposit suggest that it originated from the same processes that formed mineral deposits along numerous other Miocene detachment faults: (1) fluid-inclusion salinities and temperatures of entrapment; (2) abundant specular hematite with less abundant copper minerals such as chrysocolla, malachite, and chalcopyrite; (3) geographic proximity to a detachment fault; and (4) probable Miocene age. Two characteristics of the Copperstone deposit, however, differ from those of other detachment-fault deposits: abundance of quartz-amethyst veins and abundance of gold. These authors believe that most evidence at the Copperstone deposit supports a relationship between mineralization and detachment faulting.

A working model for the origin of the Copperstone deposit is as follows: hot, saline, aqueous fluids containing dissolved gold, copper, iron, and other elements moved up-dip along the north- to northeast-dipping Moon Mountain detachment fault. These fluids encountered highly porous and permeable sedimentary breccias in the hanging wall of the detachment fault and began ascending through the breccia zone. As a result of cooling or mixing with more oxygen-rich, shallow-level ground water, largely within the sedimentary breccias, gold and

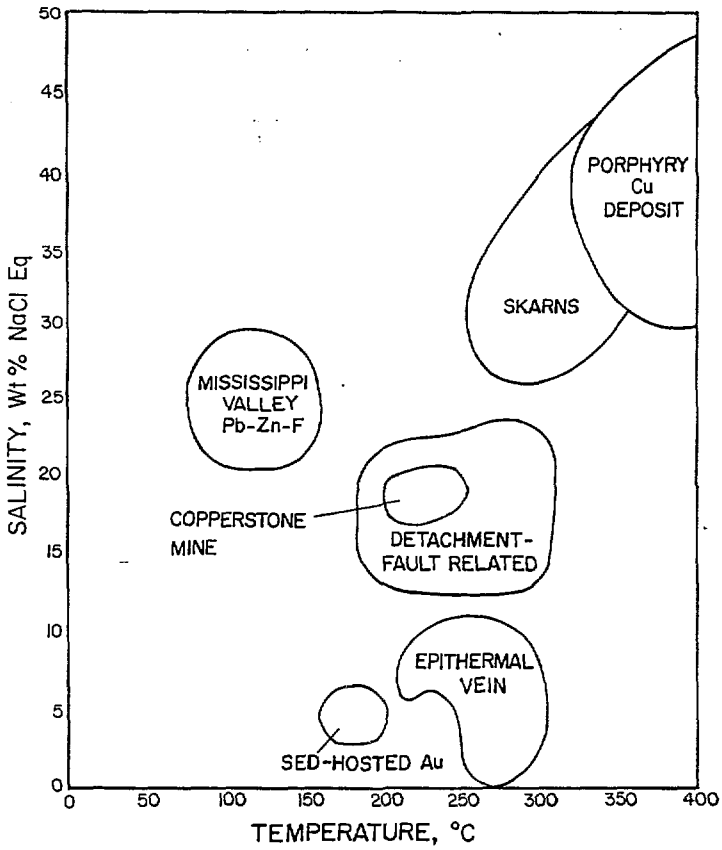

Figure 3. Diagram of salinity and homogenization temperature fields for fluid inclusions from several major mineral deposits, including those associated with detachment faults. Fluid inclusions from the Copperstone deposit clearly fall within the field of other detachment-fault-related deposits. Many geologists suspected that the Copperstone deposit was an epithermal-vein deposit, as are many other gold deposits in the Southwest; fluid-inclusion data, however, strongly suggest otherwise. Modified from Wilkins and others (1986), with additional data from the Copperstone mine.

Table 1. Value of production for commodities from mineral districts in west-central Arizona that are known or suspected to be related to detachment faults. Manganese mineral deposits, although not clearly understood, are suspected to be related to detachment faults. District locations are shown on Figure 1.

District	Commodities*	1986 Value**
1. Copperstone	Au (reserves)	$189,306,900
2. Alamo	Cu, Pb, Ag, Au	72,303
3. Cienega	Cu, Ag, Au	5,571,167
4. Clara	Cu, Ag, Au	3,066,661
5. Lincoln Ranch	Mn	18,960,000
6. Mammon	Cu, Ag, Au	93,913
7. Midway	Cu, Ag, Au	43,743
8. Planet	Cu, Ag, Au	12,771,828
9. Pride	Cu, Ag, Au	37,679
10. Swansea	Cu, Ag, Au	17,471,085
11. Black Burro	Mn	261,490
12. Cleopatra	Cu, Pb, Ag, Au	1,118,459
13. Lead Pill	Cu, Pb, Ag, Au	303,365
14. Mesa	Mn	47,400
15. Owen	Cu, Pb, Zn, Ag	107,561
16. Rawhide	Cu, Pb, Zn, Ag	116,573
17. Bullard	Cu, Ag, Au	1,763,481
18. Burnt Well	(unknown)	(minor)
19. Harris	Mn	79,395
20. Northern Plomosa	Cu, Pb, Ag, Au	2,123,413
21. Artillery	Mn	75,135,320
22. Whipple	Cu, Pb, Zn, Ag, Au	683,550
TOTAL		$329,135,287

* Ag = silver; Au = gold; Cu = copper; Mn = manganese; Pb = lead; Zn = zinc.
** Values do not add to total because of rounding.

other elements precipitated from the fluids to form the Copperstone deposit.

Implications for Land-Use Planning and Management

The presence of the Copperstone gold deposit in a geologic setting that is characteristic of large areas of west-central Arizona indicates that the mineral-resource potential of this area in the State is greater than previously suspected.

The Copperstone deposit was probably not discovered until recently because it was almost entirely concealed by young surficial deposits. Undiscovered mineral deposits similar to Copperstone may also be concealed beneath other surficial deposits, such as those covering nearby Cactus Plain (Figure 1). Application of more sophisticated geophysical techniques may eventually result in discovery of such deposits. Many areas in west-central Arizona, such as the Cactus Plain and Cactus Plain East Wilderness Study Areas, are presently under consideration for Federal wilderness-area status. If designated to be managed as wilderness, these areas would no longer be open to mineral exploration or mining activity.

Mineral deposits associated with detachment faults have only been recognized as a distinct deposit type during the past 10 years. The recent discovery of the Copperstone deposit and recognition of its association with a detachment fault are generating renewed interest in detachment-fault-related deposits and in areas where such deposits might be located. Future improvements in our understanding of Arizona geology and future mineral-deposit discoveries will undoubtedly lead to renewed interest in areas that presently receive little attention from research or exploration geologists.

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Wilkins, Joe, Jr., Beane, R.E., and Heidrick, T.L., 1986, Mineralization related to detachment faults; a model, *in* Beatty, Barbara, and Wilkinson, P.A.K., eds., Frontiers in geology and ore deposits of Arizona and the Southwest: Arizona Geological Society Digest, v. 16, p. 108-117.

Wilkins, Joe, Jr., and Heidrick, T.L., 1982, Base and precious metal mineralization related to low-angle tectonic features in the Whipple Mountains, California and Buckskin Mountains, Arizona, *in* Frost, E.G., and Martin, D.L., eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River region, California, Arizona, and Nevada: San Diego, Cordilleran Publishers, p. 182-203.

GSA Centennial Field Guides

The Geological Society of America (GSA) has published two Centennial Field Guides that include areas in Arizona: the Cordilleran Section and the Rocky Mountain Section (volumes 1 and 2, respectively). The first volume contains field-guide articles and maps to 100 outstanding geologic locations in Alaska, British Columbia, California, Hawaii, Nevada, Oregon, and Washington, as well as Arizona. The second volume contains 100 guides for Alberta, Arizona, Colorado, Idaho, Montana, New Mexico, South Dakota, Utah, and Wyoming. These two volumes are part of the 71-item GSA publishing project, the Decade of North American Geology (DNAG). To obtain copies, send $43.50 for each volume to The Geological Society of America, Publication Sales, P.O. Box 9140, Boulder, CO 80301; tel: (800) 472-1988.

ATTACHMENT B

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CONTROL OF MINERALIZATION BY MESOZOIC AND CENOZOIC LOW-ANGLE STRUCTURES IN WEST-CENTRAL ARIZONA

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S. J. Reynolds

J. W. Welty

Arizona Geological Survey
Tucson, Arizona

For presentation at the SME Annual Meeting
Phoenix, Arizona - January 25-28, 1988

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CONTROL OF MINERALIZATION BY MESOZOIC AND CENOZOIC LOW-ANGLE STRUCTURES IN WEST-CENTRAL ARIZONA

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845 N. Park Ave.
Tucson, Arizona 85719

ABSTRACT

Mesozoic and Tertiary mineral deposits in west-central Arizona are commonly associated with Mesozoic thrust faults and Tertiary detachment faults, respectively. Quartz-kyanite rocks and pyritic quartz-sericite schists with local anomalous gold are the product of probable Jurassic argillic alteration of Jurassic volcanic, sedimentary, and plutonic rocks followed by Cretaceous thrust burial and associated metamorphism. Slivers and sheets of Paleozoic carbonates along Mesozoic thrust faults were locally sites of syn- and post-thrust mineralization. Widespread brecciation along Tertiary detachment faults resulted in increased permeability along fault zones. Elevated thermal gradients also resulted from detachment faulting and apparently caused convective aqueous-fluid circulation along detachment faults and associated Fe+Cu±Au mineralization.

INTRODUCTION

Quartz-kyanite-pyrophyllite mineral assemblages with locally occurring pyrite and anomalous gold have recently been recognized within Mesozoic metasedimentary and metavolcanic rocks of west-central Arizona and southeasternmost California. These deposits are most common in the wall rocks of Jurassic plutons and below thrust sheets of crystalline rocks (Reynolds et al., in press). Thrust faulting and tectonic burial are not considered to be responsible for the genesis of the deposits, but are thought to be responsible for their preservation and, in part, their metamorphism. Major gold deposits are associated with similar aluminous mineral deposits in the southern Appalachian Mountains, raising the possibility that significant gold deposits of similar origin are present in the Southwest as well.

Detachment-fault-related mineral deposits of mid-Tertiary age are numerous in west-central Arizona and southeastern California. Virtually all of these deposits have the same mineral assemblage: massive or fracture-filling specular hematite with younger, fracture-filling chrysocolla and malachite or brochantite. Some deposits contain early-formed copper and iron sulfides that are now largely oxidized. The larger deposits form replacements in upper-plate rocks directly above the detachment fault. Numerous smaller replacement and fracture-filling deposits are present along detachment faults or are within a few tens to perhaps a hundred meters above or below the faults. Consistent mineralogy, structural style, and association with Tertiary detachment faults indicate that these deposits are genetically related to faults (Reynolds, 1980; Wilkins and Heidrick, 1982; Spencer and Welty, 1986). Copper has been the primary commodity produced from these deposits, with additional production of minor gold, silver, lead, and zinc.

MESOZOIC ALUMINOUS METASOMATIC DEPOSITS

Mesozoic metavolcanic, metasedimentary, and plutonic rocks in west-central Arizona and southeasternmost California host aluminous metasomatic rocks that are locally associated with anomalous gold. The most striking of the aluminous metasomatic rocks are those composed almost entirely of quartz and kyanite; other common combinations are quartz-muscovite and quartz-pyrophyllite. Minor associated minerals are andalusite, sillimanite, pyrite, tourmaline, rutile, ilmenite, biotite, lazulite (hydrous Mg-Fe aluminophosphate), apatite, dumortierite, staurolite, K-feldspar, and magnetite. The most common assemblage comprises quartz, an aluminosilicate, a Ti-bearing mineral, and a P-bearing mineral (Reynolds et al., in press).

Aluminous metasomatic rocks are most common in schistose metavolcanic and metasedimentary rocks, especially near Mesozoic thrust faults (Granite Wash Mountains) or near the intrusive margins of Jurassic plutons (Dome Rock Mountains). They have also been recognized as pods within granitic rocks (Fig. 1). Schistose fabrics and evidence of greenschist-grade metamorphism are common in host rocks, especially near thrust faults and plutons. Virtually all of the Mesozoic supracrustal rocks in west-central Arizona and southeasternmost California underwent Cretaceous thrust burial and associated prograde metamorphism and fabric development. The coarse aluminous minerals in the aluminous meta-

COPPERSTONE
GEOLOGIC SUMMARY

The Copperstone gold deposit is located in an area of flat, dry, sandy terrain with several small knolls about 40 feet high and prominent longitudinal sand dunes. Only 17 outcrops with a total surface area of approximately one acre are exposed. At the southern end of the Copperstone claim block and beyond is exposed an igneous and metamorphic outlier of the Dome Rock Mountains. These rocks include granite, gneiss, schist, quartzite and amphibolite of uncertain age - Precambrian to Jurassic. A low angle fault (detachment?) separates these rocks from an upper plate consisting of a thick sequence of Jurassic age quartz latite welded tuffs (qlt). The upper plate sequence has been affected by weak green schist facics metamorphism in Cretaceous time. This fault probably extends beneath the Copperstone gold deposit, but drilling failed to confirm its presence.

No early prospect pits, shafts or adits were found at Copperstone. Prospecting began in 1968 with bulldozer trenching by a prospector to better expose weak copper mineralization. The property was submitted to Cyprus in 1980, and a lease was signed after initial field evaluation and sampling indicated 0.02 to 0.09 ounce per ton gold in a few small breccia outcrops. During 1981 through 1983 conventional percussion drilling in a 140 foot grid by Cyprus (Amoco Mineral Company) tested the limits of the Copperstone mineralization. Extensive induced polarization and ground magnetic surveys were run. Anomalous frequency effects outlined the gold deposit with considerable accuracy. Drilling from 1984 through 1986 further defined the deposit.

The Copperstone gold deposit is hosted by a thick sequence of foliated to massive and brecciated quartz latite tuffs. These rocks are correlated regionally with the Jurassic volcanics exposed in the Dome Rock Mountains to the south and throughout west-central Arizona. In the deposit area the quartz latite tuffs are at least 900 feet thick based on drilling formation. The tuffs are characterized by variable degrees of foliation defined by segregated bands of quartz - feldspar and sericite, probably developed along original primary laminations in the tuff. The foliations exposed in surface outcrops in the deposit area all dip 30-50° to the southwest. The indurated breccia dike that hosts the main gold zone within the deposit strikes approximately N45W and dips on an average of 30° to the northeast. These breccias continue along strike at least 2,500 feet and down-dip 1,500 feet. The breccias range in thickness from 50 to 200 feet and contain variably altered fragments of quartz latite in a hematite matrix. The main ore zone within the deposit generally occurs along the basal contact of these breccias with the underlying foliated quartz latite tuff. This mineralized zone is defined by an extensive multi-stage hydrothermal breccia zone. Fragments of quartz vein material, quartz latite tuff and earlier developed breccia are contained within a hematite - specularite matrix. Gold mineralization occurs primarily within this hydrothermal breccia zone and in quartz - amethyst veins cutting through the adjacent latite tuffs. Specular hematite, chrysocolla, minor malachite, and barite are the most common accessory minerals with lesser amounts of calcite, siderite, manganese oxide, flourite, adularia, magnetite,

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chalcopyrite and pyrite. Multiple episodes of mineralizing hydrothermal events and brecciation occurred at Copperstone.

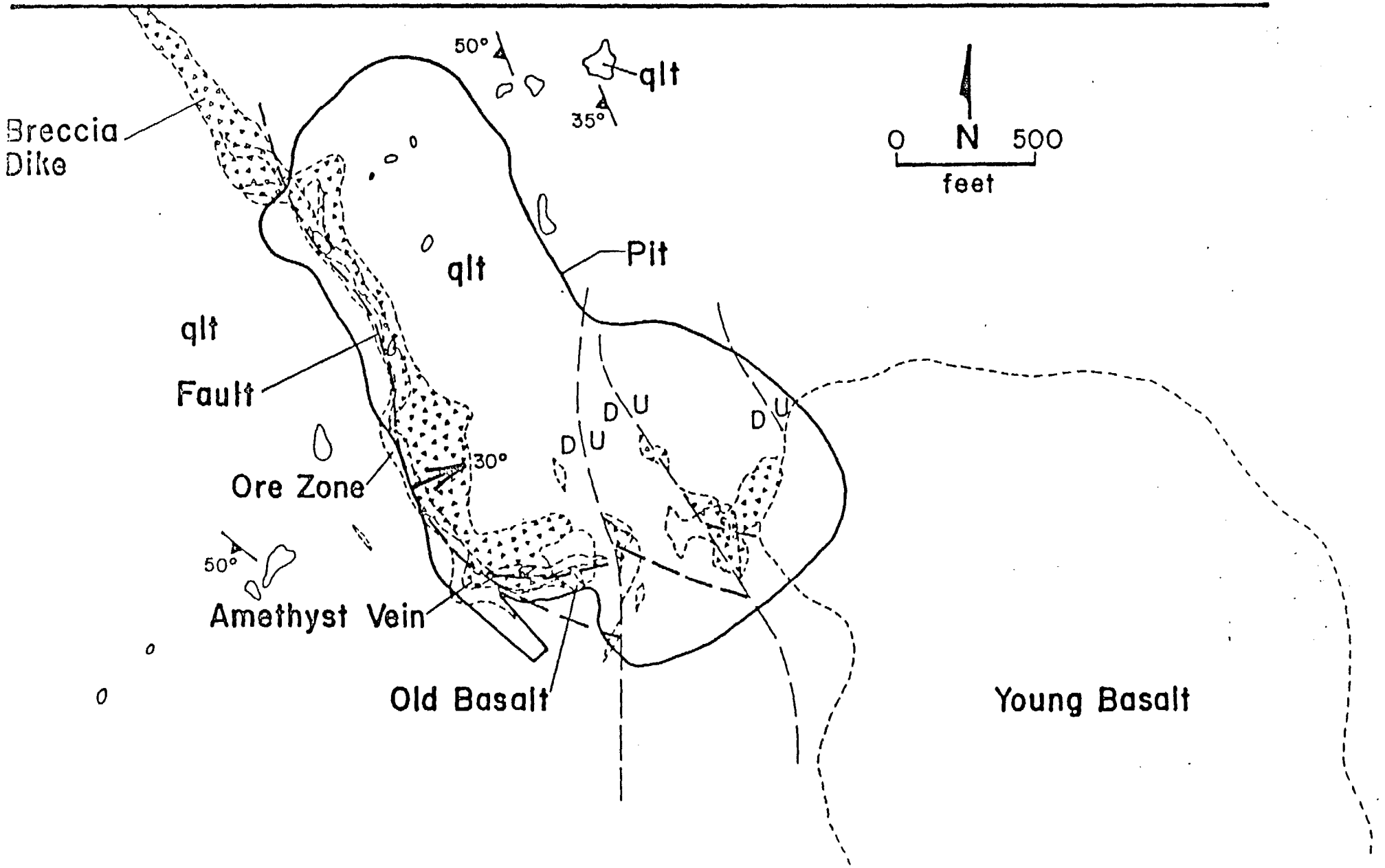
Mineralizing solutions also formed local zones of alteration in and near the ore zones. Bleaching effects are caused by argillization and sericitization. Local secondary gray-green chlorite as wispy veining and minor chalcedonic silicification with small patches of chalcopyrite, pyrite and native gold have been seen. Microscopic examination of a gravity concentrate was made from a floatation concentrate of the ore. About 80 percent of the gold occurs in small flakes ranging between 4 and 40 microns. Coarse gold plates range from 50 to 150 microns. Most gold is free, but a small amount is locked within quartz and iron hydroxides.

The few mineralized outcrops at Copperstone contain highly anomalous gold, silver and copper. Initial sampling found subore and ore grade gold values that led directly to drilling. Several early core holes and a large suite of surface samples were analyzed for a broad spectrum of trace elements in an effort to characterize the deposit.

Copperstone is characterized by high barium, manganese, uranium and low arsenic, antimony, thallium and mercury. Barite and flourite are most abundant in the extreme southeastern end of the deposit where they occur in massive 4-5 foot veins.

Generally, gold mineralization is sharply defined within the mineralized breccia zone. It markedly decreases over a few tens of feet into hanging wall and footwall rocks where often no gold is detected by atomic absorption analysis. In higher gold grade zones within the deposit, silver values are higher and may provide some recoverable value. Copper ranges up to several percent within the gold zone, mostly as chrysocolla.

SUBSURFACE GEOLOGY



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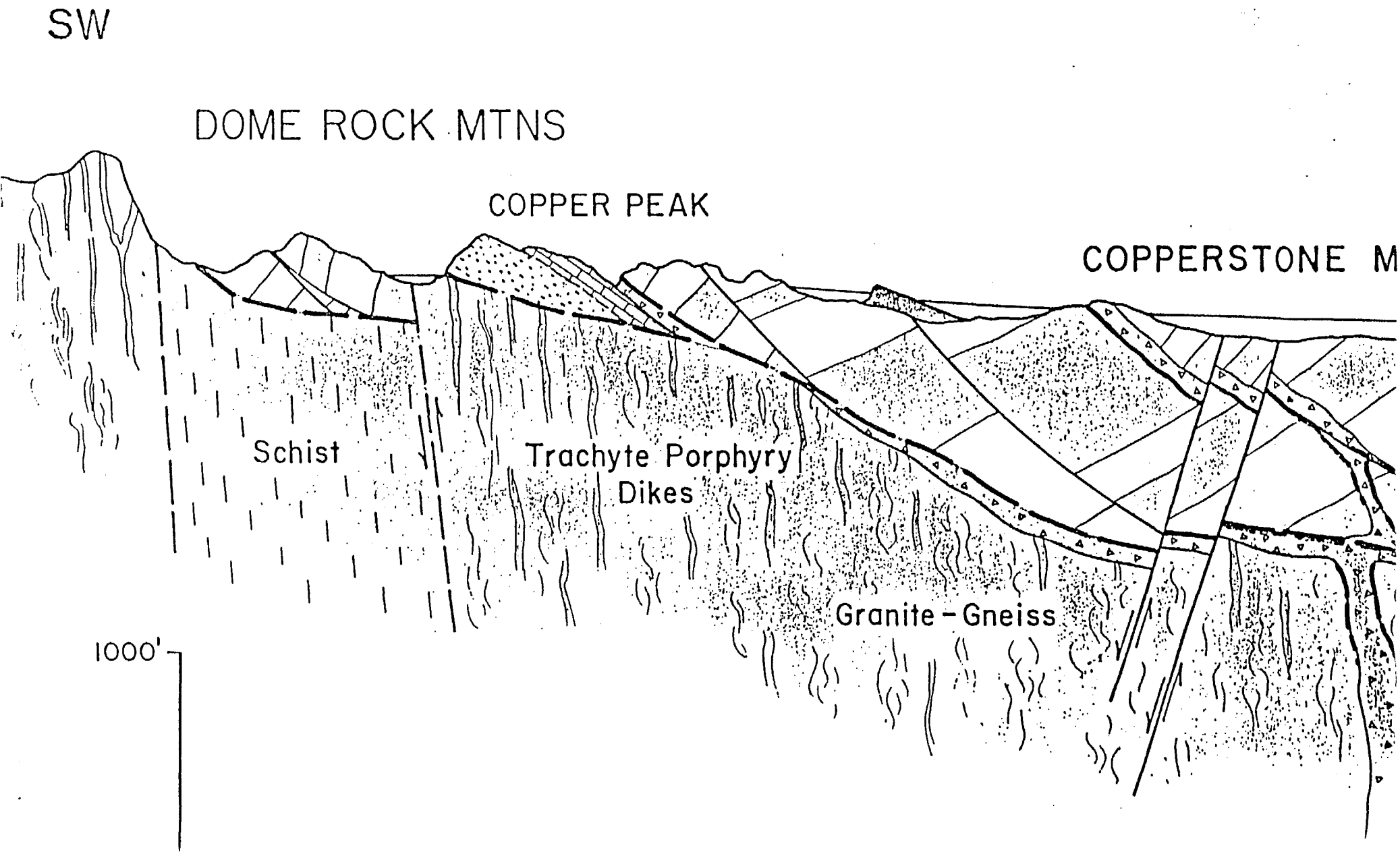

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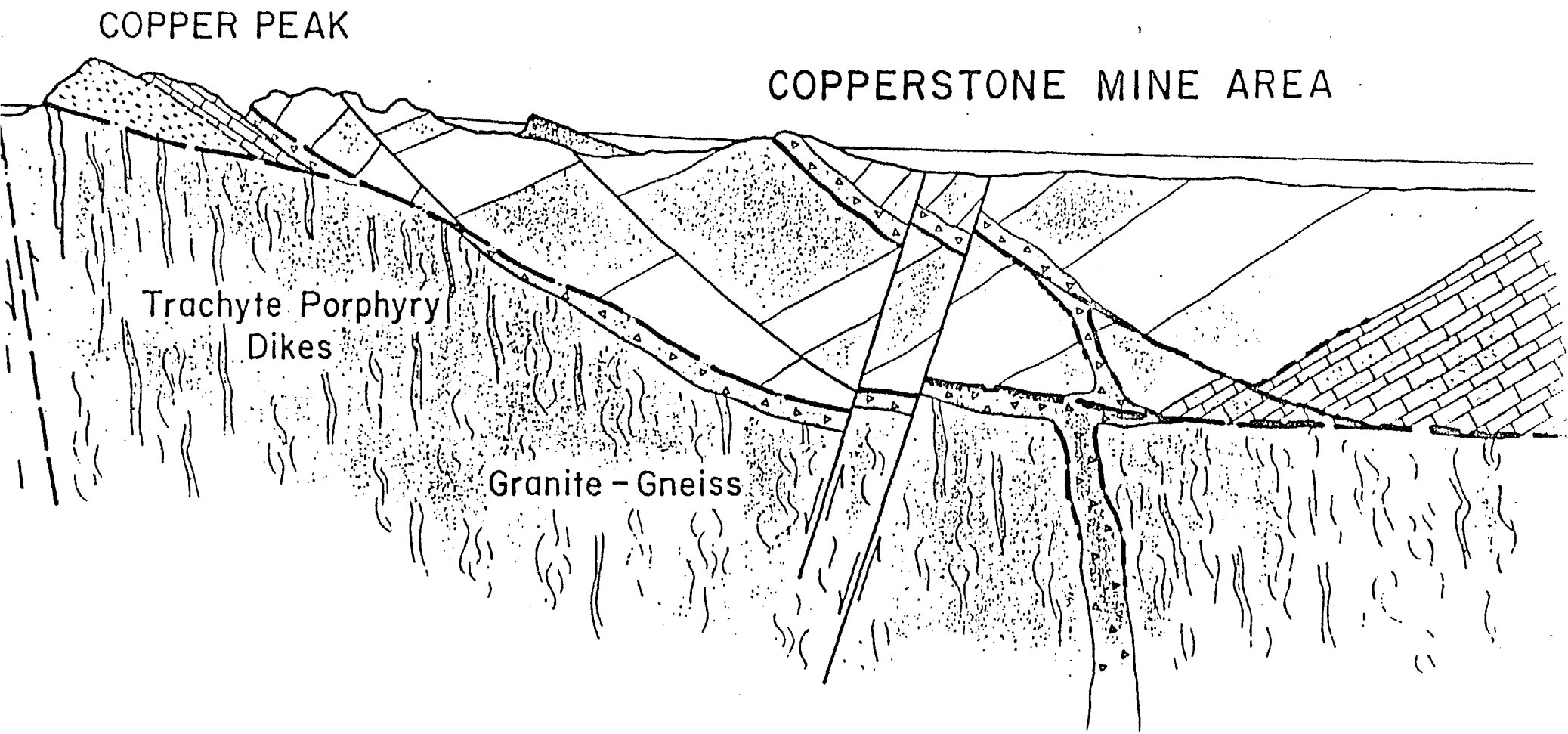


ASARCO Southwestern Exploration Division

JDS

January 12, 1990

W.L. Kurtz

Willis Rhea Properties
Plomosa Mining District
La Paz County, Arizona

The location on the map attached to J.D. Rasmussen's report on the Willis Rhea Properties, dated October 16, 1989, should be T6N rather than T6S. This report was attached to my memorandum of January 10, 1990.

James D. Sell

JDS:mek

James D. Sell

cc: R.L. Brown/F.T. Graybeal
J.D. Rasmussen
D.A. Melhado

ASARCO

Southwestern Exploration Division

JDS

January 17, 1990

FILE NOTE

Corrected Map
Willis Rhea Properties
Plomosa Mining District
La Paz County, Arizona

Please replace your "Willis Rhea Submittal, La Paz County, Arizona" map MN 68 16 with the corrected map attached.

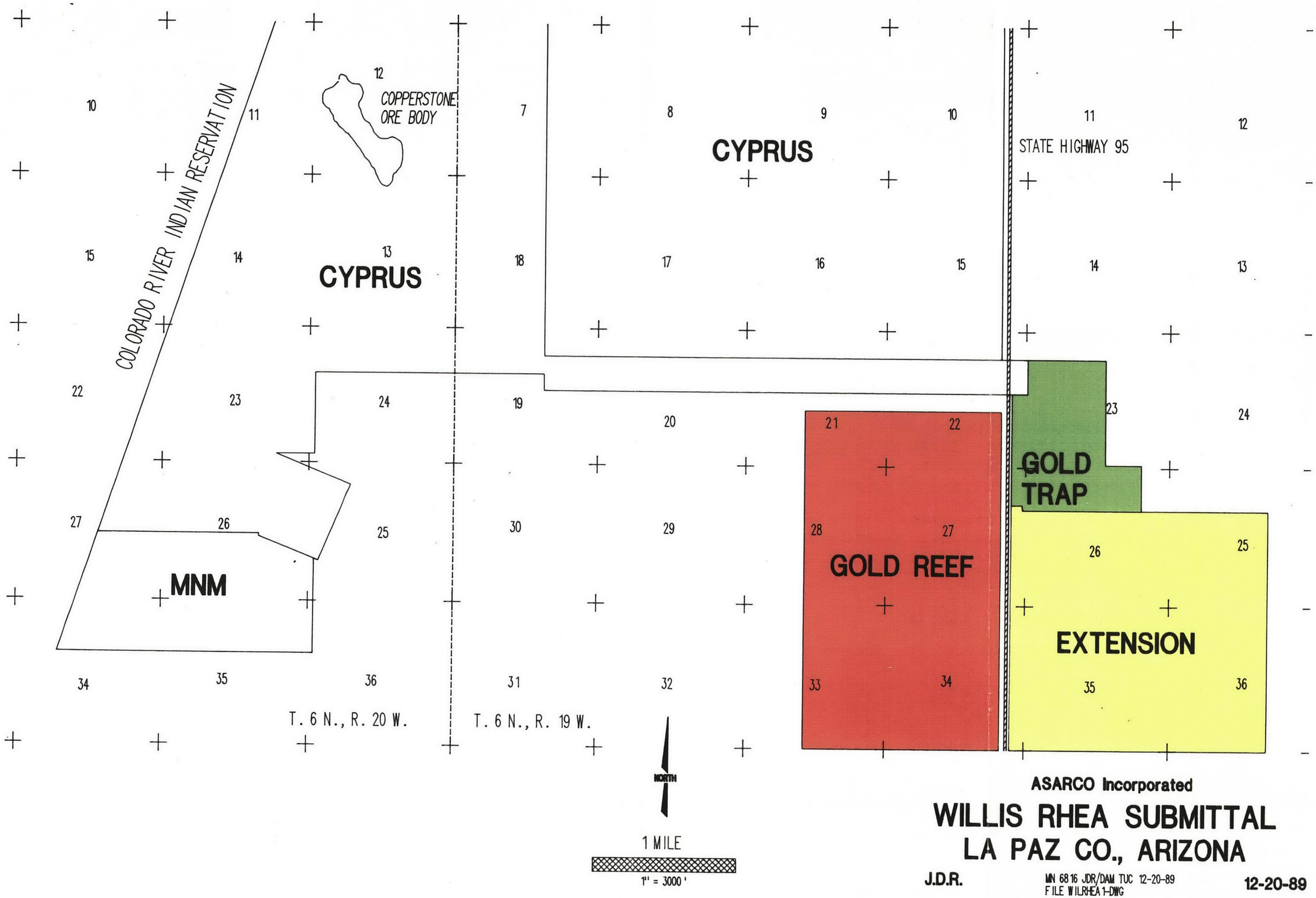
The original report by J.D. Rasmussen was dated October 16, 1989 with my cover letter of January 10, 1990. A note on the corrected T6N notation was made on January 12, 1990.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: R.L. Brown/F.T. Graybeal
W.L. Kurtz
J.D. Rasmussen



ASARCO Incorporated

WILLIS RHEA SUBMITTAL
LA PAZ CO., ARIZONA

J.D.R.

MN 6816 JDR/DAM TUC 12-20-89
FILE WILRHEA1-DWG

12-20-89

JDS FILE

LaPaz Co
General

February 21, 1989
8655 East Phillips Avenue
Englewood, CO 80112

Mr. James D. Sell
Manager, Exploration Dept.
ASARCO Incorporated
P. O. Box 5747
Tucson, AZ 85703

Dear Jim:

Re: Extension-Gold Trap-Jack Pot
Mining Claims-Copperstone Area-AZ

Please find enclosed for your information and possible interest a brief summary of a ground magnetic geophysically indicated Copperstone type of gold prospect.

Due to a complete lack of rock exposures, preliminary work to date has been by means of ground magnetic surveys which have indicated possible near surface fault structures.

If you wish more data or general information regarding this interesting property or an on site tour please contact:

Bill Rhea at (602)927-6304
or
Frank Mack at (303)799-6620

Very truly yours,

Frank Mack

FEB 23 1989

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POTENTIAL GROUND MAGNETICALLY INDICATED COPPERSTONE TYPE OF STRUCTURES

EXTENSION-GOLD TRAP-JACK POT CLAIM BLOCK-LA PAZ COUNTY, ARIZONA

INTRODUCTION

Ground magnetic surveys have been conducted over an area covered by 124 unpatented lode mining claims located about six miles easterly of the Cyprus Minerals Company Copperstone gold mine now in commercial production(60,000-100,000 ounces of gold per year).

This particular area of the La Posa Plain has a good untested exploration potential for a Copperstone type orebody. Although open pit mining methods would be preferable, consideration for deep ore zones below surface mining methods should not be discounted, especially in light of the newly discovered below open pit mining level ore zones at Copperstone which are soon going to be mined.

The initial exploration drilling at Copperstone depended heavily on the use of ground magnetic surveys to locate potentially gold hosted breccia structures(normal listric faults). Not all of the anomalous breccia zones were gold bearing but most were.

GEOLOGIC MODEL OF COPPERSTONE

The Copperstone gold deposit is hosted in brecciated epizonally metamorphosed Jurassic quartz latite porphyry. The detachment related mineralization is in normal thrust structures in upper plate volcanic rocks. The detachment surface and lower plate rocks were not reached during the exploration drilling phase. Deeper ore zones below the open pit mining methods will be exploited by underground mining methods. Working levels will extend several thousand feet below the surface. The access decline is currently being driven with the first production level planned for about the one thousand foot depth.

POTENTIAL OF EXTENSION-GOLD TRAP-JACK POT CLAIM GROUP

The surface of the above mentioned claims have no ourcropping rock exposures. Some very near surface rocks may be present however their actual existence has not been physically proven.

The widespread E-W magnetic profiles performed to date over the Extension and Gold Trap claims most certainly indicate that the magnetic source anomalies, potentially fault structures, are relatively shallow (within several hundred feet of the surface). By means of aligning similar anomalous signatures, it appears that the strike of the possible structures is NW-SE.

GEOLOGIC HOST ROCKS EXPECTED BELOW ALLUVIUM

Lower and upper plate rocks are exposed to the west of the claims in the Dome Rock Mountains and east of the claims in the Plomosa Mountains. It is expected that detached blocks of of Upper Mesozoic and Tertiary sediments and volcanics moved westward from the metamorphic core complex of the Plomosa Mountains to the area below the claim block. The lower plate or foot wall rocks would presumably be composed of lower Mesozoic gneissic lithology.

Mineralization would be localized in the normal listric faults and at further depth along the detachment surface.

RECOMMENDED EXPLORATION

If prior to drill testing additional exploration geophysical work is considered, gravity and I. P. surveys would be the most practical.

The Copperstone orebody was closely outlined by means of anomalous frequency effects.

Some fill-in ground magnetic surveying would narrow down areas of interest for further I.P. and gravity surveys.

FRANKLIN MACK

CONSULTING GEOLOGIST