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12/14/90

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES FILE DATA

PRIMARY NAME: SOCORRO MINE

ALTERNATE NAMES:

LA PAZ COUNTY MILS NUMBER: 89

LOCATION: TOWNSHIP 5 N RANGE 12 W SECTION 25 QUARTER SW
LATITUDE: N 33DEG 44MIN 41SEC LONGITUDE: W 113DEG 28MIN 12SEC
TOPO MAP NAME: LONE MOUNTAIN - 15 MIN

CURRENT STATUS: PAST PRODUCER

COMMODITY:

GOLD LODE
SILVER
LEAD

BIBLIOGRAPHY:

KEITH, S.B., 1978, AZBM BULL. 192, P. 154
ADMMR SOCORRO MINE FILE
AGS 1988 SPRING FIELD TRIP

Folder
3 of 5

GOLD DEPOSITS IN THE SALOME REGION,

YUMA COUNTY, ARIZONA:

A POTENTIALLY NEW

DISSEMINATED GOLD PROVINCE

by

Stanley B. Keith

Geologic Consultant
Tucson, Arizona

Jack Bright - Geologist

December 8, 1982

for

Socorro Mining Corporation

Brooklyn, New York

Scan note
Set E-1-63
Set F-1-74

Large Reports & mapping too big to mail

FIGURE 3

COMPLETED and [illegible] DRILL HOLES SHOWING GENERALIZED GEOLOGY

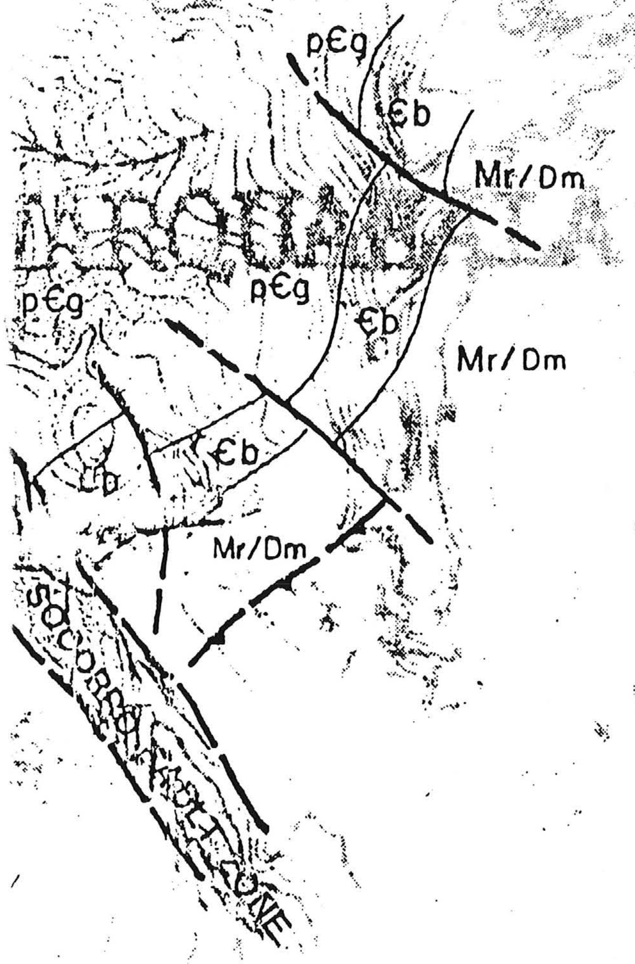
Socorro Reef Property

LA PAZ COUNTY, ARIZONA

PROJECT 08050

500 0 500

N



PHASE I

Rotary Drill Holes Completed

PHASE II

~~Proposed~~ Completed Rotary Drill Holes

all 17 are completed

LITHOLOGY

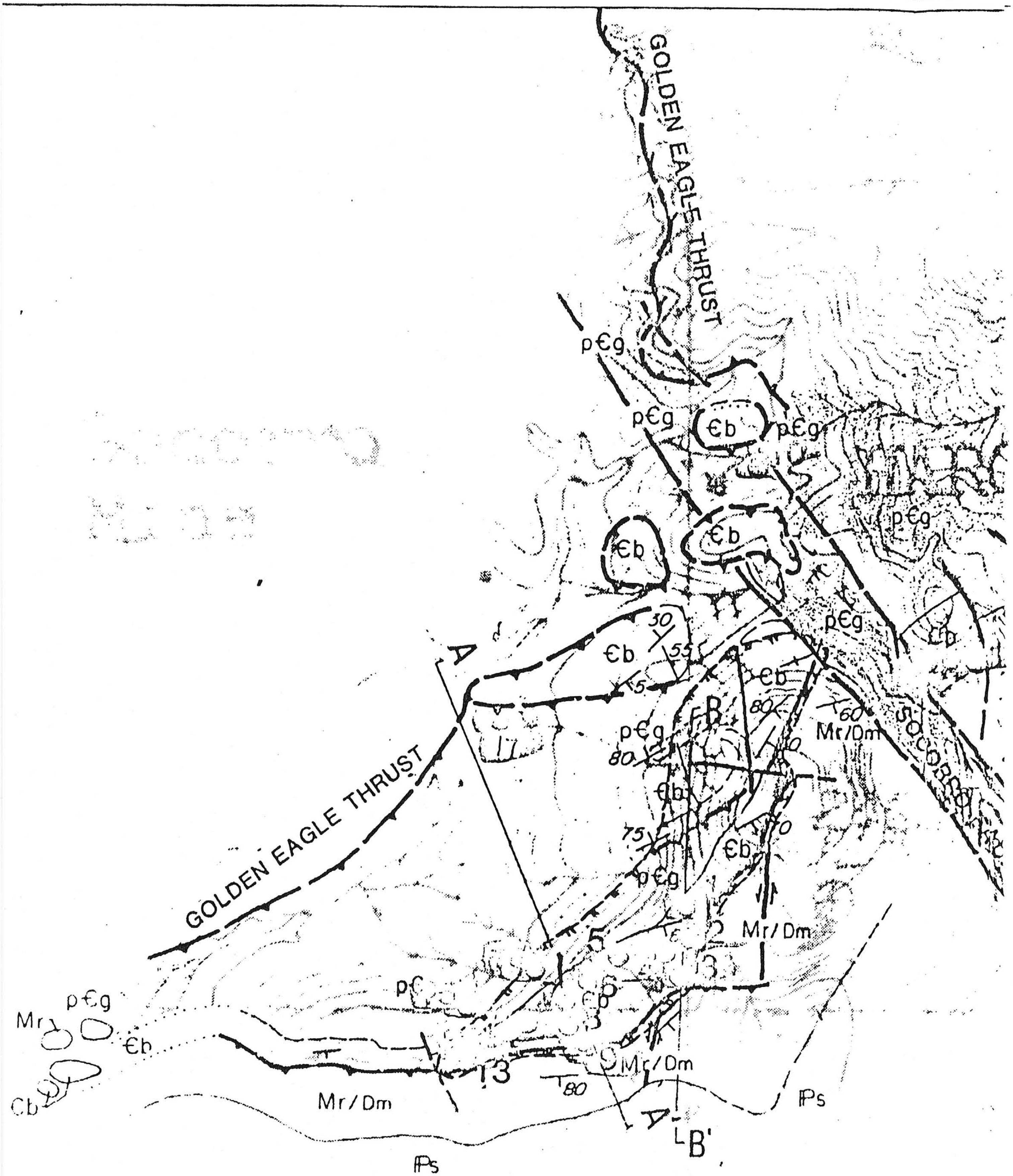
(PPs) SUPAI FM.

(Mr/Dm) REDWALL FM./ MARTIN FM. UNDIVIDED

(Єb) BOLSA QUARTZITE

(pЄg) PRECAMBRIAN GRANITE UNDIVIDED

OUTLINE OF SURFACE GEOCHEM ANOMALY


GOLDEN EAGLE THRUST
GOLDEN EAGLE THRUST
SOCORRO
p€g
€b
Mr/Dm
A
A'
B
B'
IPs

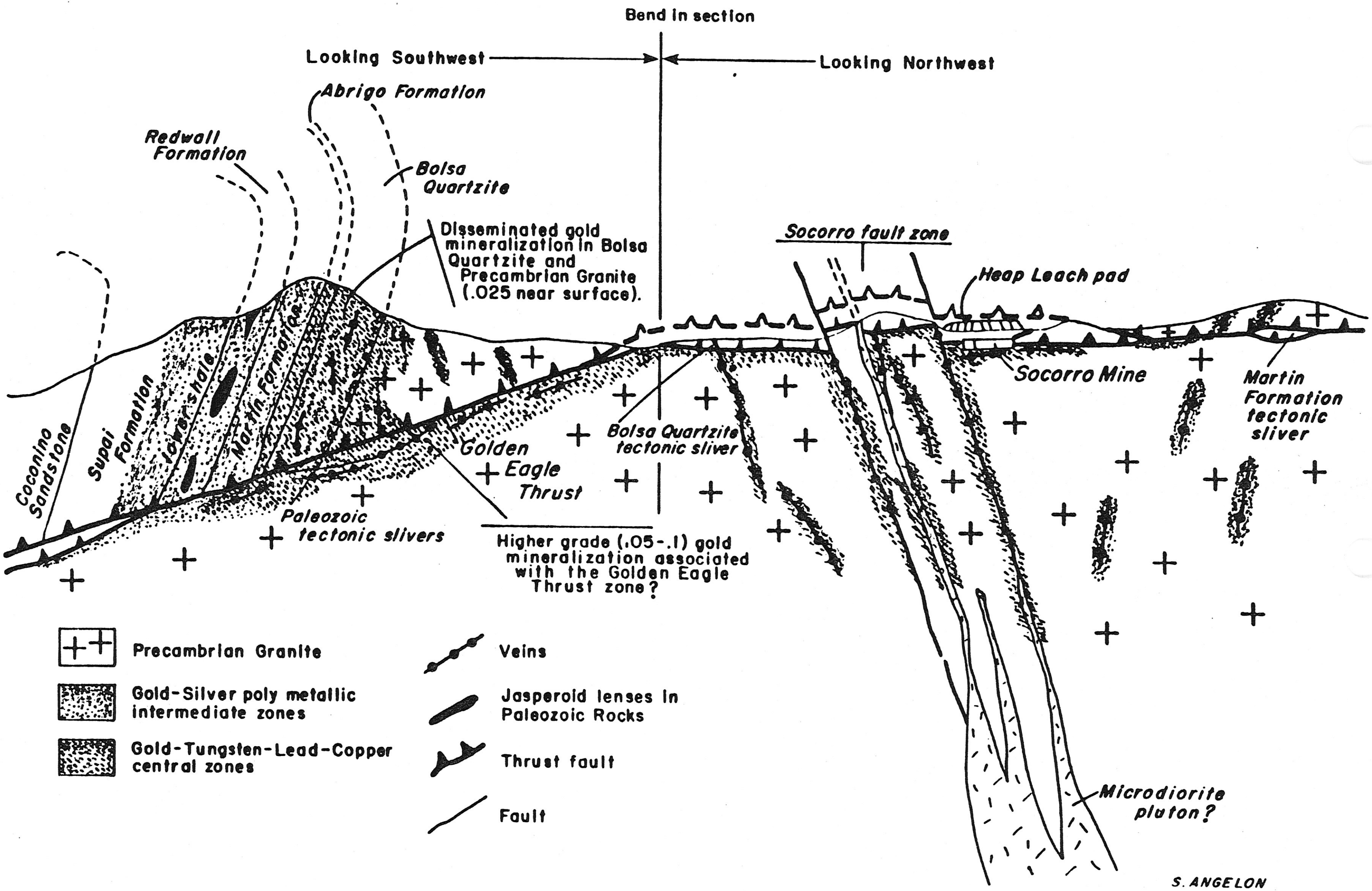


Figure 25. Cross section illustrating exploration model for inferred disseminated gold deposit beneath the Socorro Reef gold anomaly.

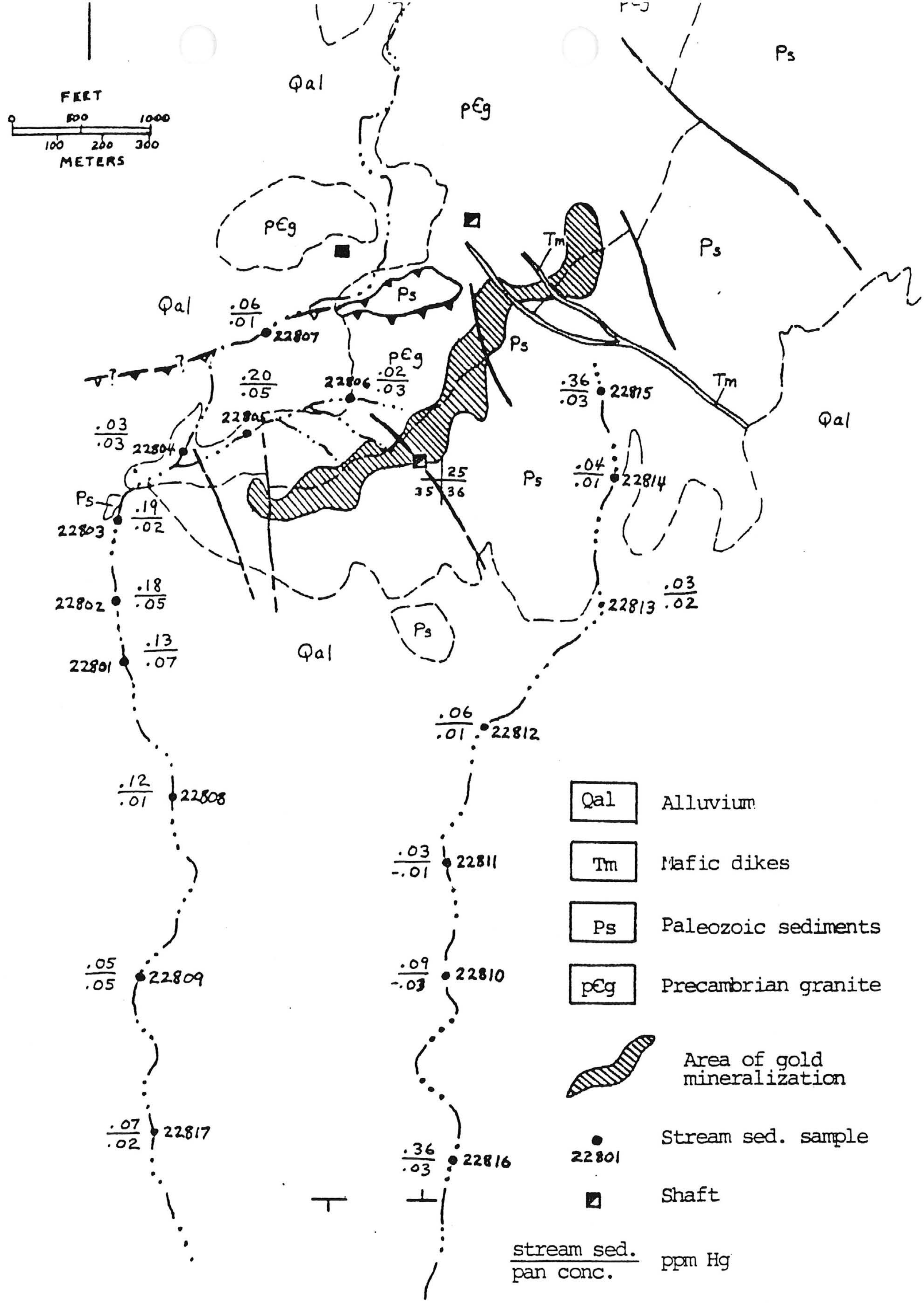
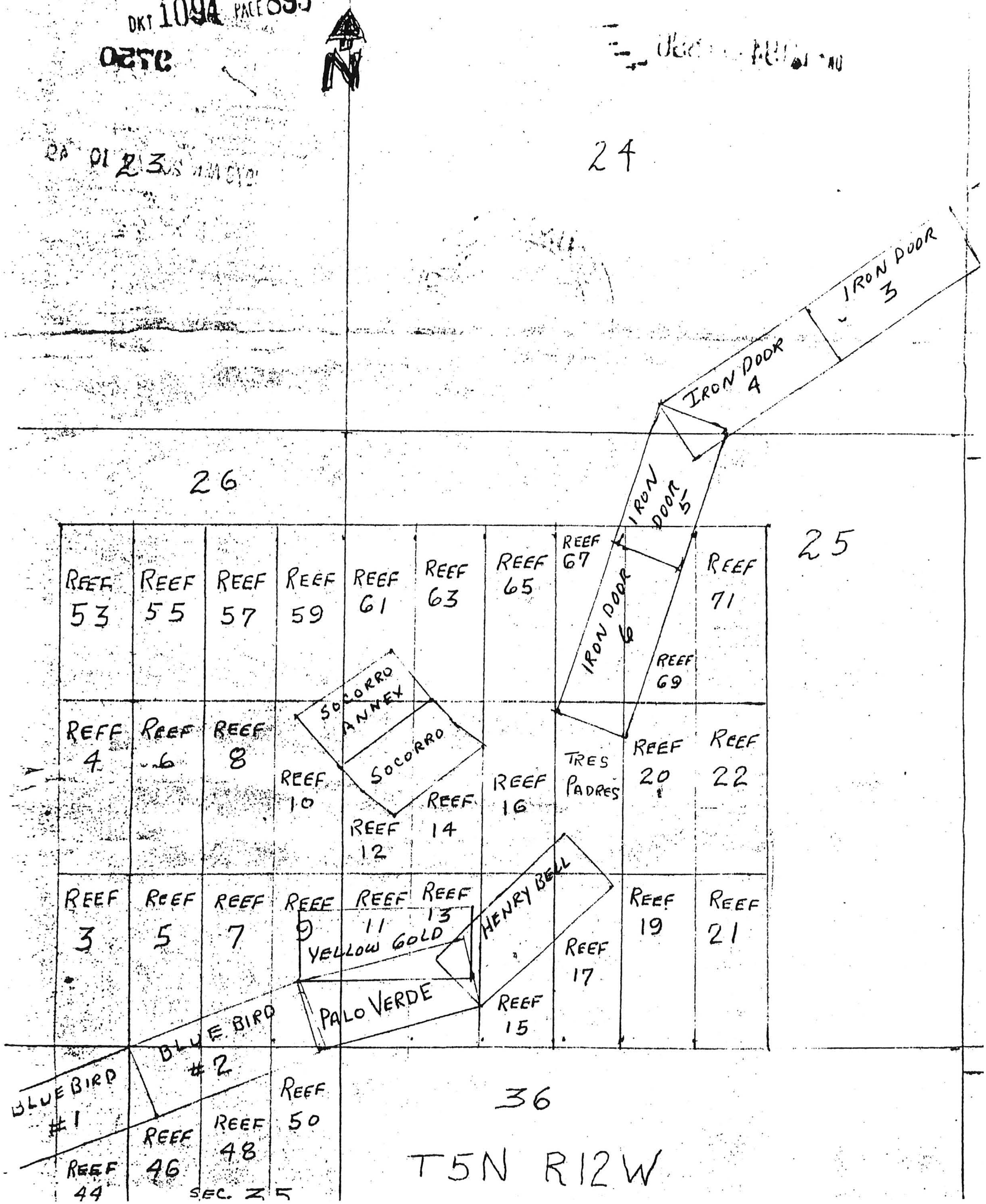


FIGURE 4

Socorro Peak Gold Prospect, Arizona
Mercury in Stream Sediments

George W Campbell Jr. Box 302 Salome, Az. 85348

DKT 1094 PAGE 895



Socorro Mine Site viewed from west.

SUMMARY

An interesting altered area containing high gold values, herein named the Socorro Reef gold deposit, was discovered in April of 1982 on the Palo Verde and Bluebird mining claims during a property examination for Socorro Mining Corporation on its claims in the Socorro Peak area of Yuma County, Arizona (Figure A). Subsequent geological, geochemical, and geophysical studies by myself and 10 major mining companies have defined a gold-rich area 3300 feet long, 250 feet wide, and about 350 feet deep (Figure B). Continuity of the Socorro Reef gold deposit on the surface has now been rigorously confirmed by detailed geologic mapping at a scale of 1 inch = 500 feet, by a time-domain, induced polarization and resistivity, geophysical survey, and by over 350 samples that contain more than 0.005 oz gold/ton.

From optimistic, but geologically reasonable, modeling this ground contains a possible 35.6 million tons of rock containing 760,000 ounces of gold that, at a gold price of $450/oz, represents a value of $342,000,000. Under present economic conditions about 10 million tons of the above material is commercial pending drilling verification of gold grades with depth. The estimated value of gold in the 10 million ton block is about $150,000,000. If economic conditions improve slightly, that is, if the price of gold increases to and remains over $500/oz, then another 11 million tons of gold-bearing material would be commercial and would increase the total estimated value of the Socorro Reef gold deposit to about $293,000,000.

Socorro Mining Corporation controls much of the ground in and immediately adjacent to the gold-bearing area. In addition, Socorro Mining Corporation currently has a 20-year lease, signed May 15, 1981, on the remaining ground in and near the gold-bearing area from the Campbell family and associates, who reside mostly in Salome, Arizona, about 10 miles from the property.

The Socorro Peak area is located in the Desert Province of western Arizona within the southwestern United States (Figure A). The topography within the gold-bearing area is favorable for exploitation of the gold deposit by low cost open-cut mining techniques with mining costs estimated to be between $4-$9/ton. The temperate climate makes year around extraction of gold by heap leach techniques possible. This is a major advantage over similar gold deposits further north in Nevada and Utah, where cold winter temperatures freeze the cyanide leach solutions.

Geological, geophysical, and geochemical studies of the Socorro Reef gold deposit and surrounding areas strongly suggest that the Socorro Reef disseminated gold deposit may be only one of several such deposits throughout the Salome region. Part I of this report develops a detailed geologic model for disseminated gold deposits that might occur in the region. Application of this model to the Salome region suggests five areas might contain disseminated gold deposits. Preliminary analysis of mineral rights in these areas suggests that two of the areas contain a considerable amount of unclaimed ground. Acquisition of this ground by Socorro Mining is strongly recommended. If, for example, these areas

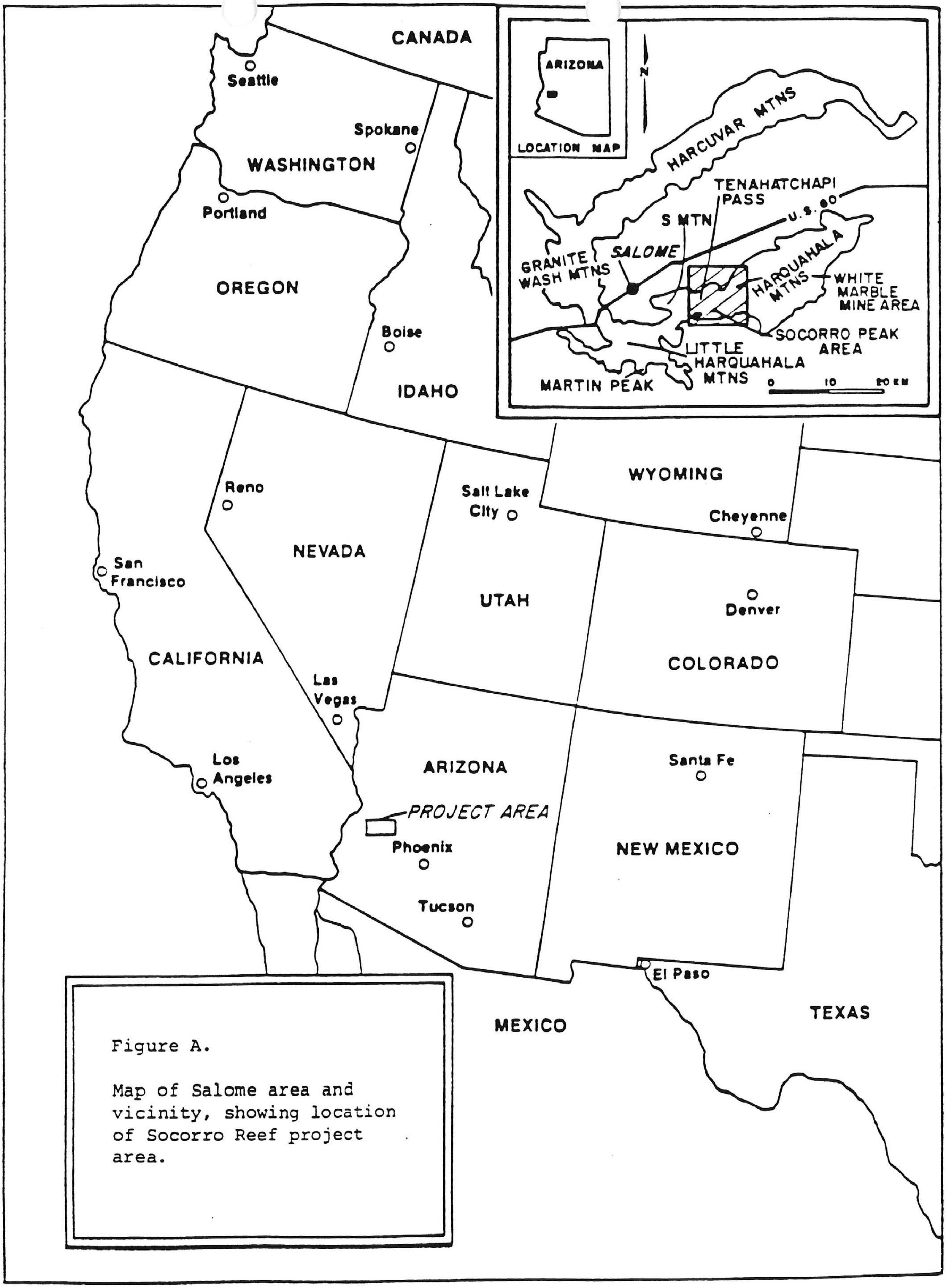


Figure A.

Map of Salome area and vicinity, showing location of Socorro Reef project area.

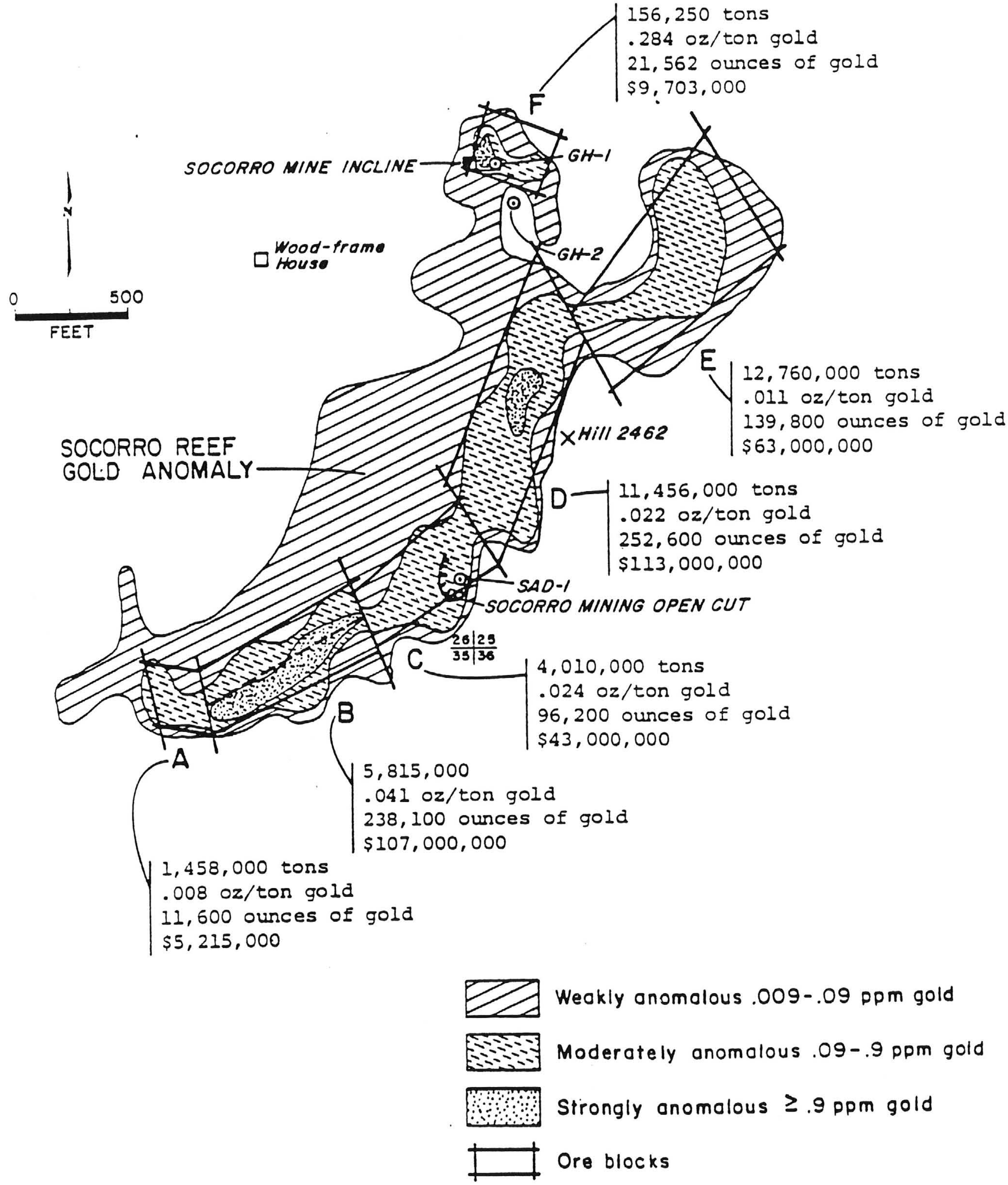


Figure B. Map of Socorro Reef gold anomaly showing drill hole locations and grade-tonnage blocks discussed in text.

contained two more disseminated gold deposits the size of the Socorro Reef deposit, total worth of Socorro Mining Corporations holdings in the Salome region could increase to about $1,000,000,000.

. Part II develops a detailed geologic exploration model for the Socorro Reef gold deposit based on the abundant surface information that has been accumulated from April to December 1982. Inferred tonnages, gold grades, amounts of gold, and dollar value of contained gold within the various blocks are shown on Figure B and utilize the optimistic, but geologically reasonable assumptions that are discussed in detail in Part II. From the grade tonnage data on Figure B it is clear that drilling confirmation should be conducted first within Blocks B and C.

The high gold values and attractive geologic and topographic situation at the Socorro Reef gold deposit have led to continuing interest in the property by all of the major mining companies that have visited the ground or have been shown the data. The activities of the various major mining companies are summarized in detail in Part II. On September 29, 1982, Noranda Exploration, Inc., initiated discussions with Socorro Mining Corporation personnel about a 25-year mining exploration and development lease on the property. In early October 1982, Socorro Mining Corporation received a formal lease agreement offer from Noranda. Negotiations regarding this lease are still ongoing. In addition, Gulf Minerals personnel have recently reviewed Socorro Mining Corporation data and are very impressed with the surface documentation of the Socorro Reef gold deposit. I strongly suspect that they will seriously compete with the Noranda offer very soon.

Respectfully submitted,

Stanley B. Keith
Consulting Geologist
Tucson, Arizona

December 8, 1982

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INTRODUCTION

The Salome gold deposit region is located in northern Yuma County in west-central Arizona in the southwestern United States (Figure 1). The Salome area has been a consistent producer of gold since 1888 when a major gold discovery went into production at the Harquahala Mine 10 miles southwest of Salome. Since 1888 the Salome region has produced over 150,000 ounces of gold, about 100,000 ounces of silver, and minor amounts of copper and lead from about 176,000 tons of ore. This amounts to $60,000,000 of gold at the present gold price of $400/oz. Table 1 summarizes this production by districts, whose locations are shown on Figure 2. All of the reported production on Table 1 since 1888 has come from high-grade gold ore shoots in fractures and veins.

The recent surge in world gold prices since 1970 has led to the search throughout the western U.S. for larger tonnage, lower grade gold deposits that might be amenable to open cut mining techniques. Geologic work by this author in the Socorro Peak area 10 miles southeast of Salome has led to the recognition of a large gold anomaly at the old Socorro Mine that might harbor a major, disseminated gold deposit. Geologic mapping, thousands of geochemical analyses for numerous trace metals, and geophysical work in the Socorro Mine area by this author and by several major mining companies since March 1982, has led to the development of a predictive, disseminated gold model that has immediate application to other gold occurrences throughout the Salome region.

This report is divided into two major parts. Part I derives a regional model of disseminated gold deposits for the Salome region based on the abundant data from gold occurrences in the Socorro Peak area. This disseminated gold model is then applied to other gold districts in the Salome region to derive potential exploration targets for open-cut, disseminated gold deposits. Part II develops a site specific model of disseminated gold deposits that specifically applies to the potential gold orebody that is inferred to lie beneath the gold anomaly at the old Socorro Mine.

Table 1. Summary of cumulative reported production for mine districts within the Salome Region, Yuma County, Arizona

District	Tons	Au(oz)	Ag(oz)	Cu(lbs)	Pb(lbs)	Au:Ag	Years
Cunningham Pass	8,885	4,110	2,637	1,558,302	7,393	1.56	1901-03, 1905-13, 1915-20, 1922-30, 1933, 1935-44, 1947-49, 1952-54, 1956-60
Harcuvar	282	156	50	26,086	-	3.12	1910-12, 1915-19, 1937-38, 1942, 1956
Harquahala	7,616	2,450	7,043	32,171	1,446	.348	1905-06, 1908, 1911-14, 1916-19, 1930-35, 1937-44, 1948, 1950-56, 1959, 1961, 1965-67
Little Harquahala	159,146	143,406	90,093	50,378	156,009		1888, 1890-91, 1893-9, 1901, 1904, 1907-08, 1913-14, 1916, 1918, 1922-26, 1928-39, 1941-43, 1947-52, 1963
TOTALS	175,929	150,000	100,000	1,666,937	170,848	1.5	

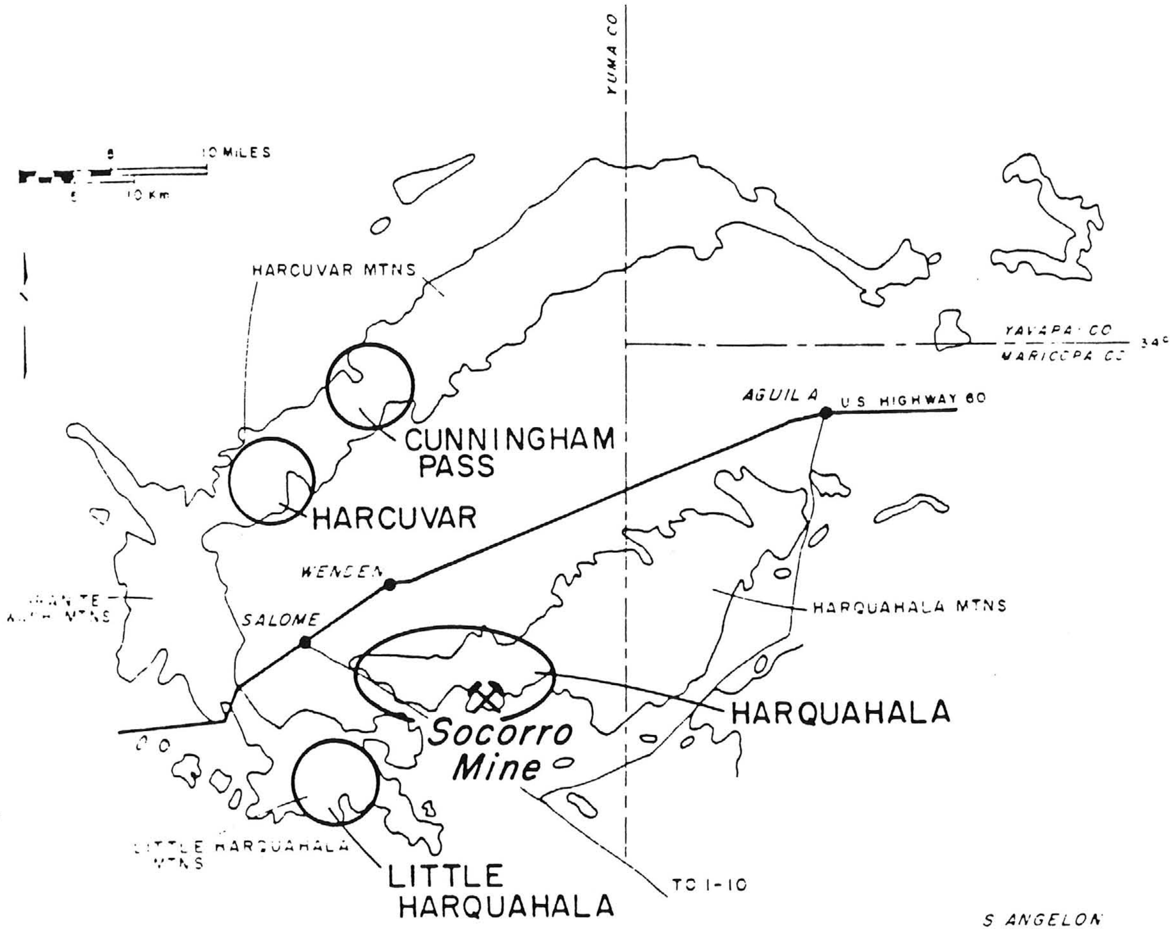


Figure 2. Gold districts in the Salome region that are discussed in text.

PART I. REGIONAL EVALUATION OF DISSEMINATED GOLD DEPOSIT POTENTIAL IN SALOME REGION

Introduction

The Socorro Peak area is located in the western part of the Harquahala Mountains about 10 miles southeast of Salome, Arizona (Figure 1). The topography of the area is dominated by Socorro Peak. The area around Socorro Peak was initially mapped, sampled and evaluated for gold potential by myself in late March and early April, 1982, at the request of Mr. Jake Jacobsen of Socorro Mining Corporation (formerly Socorro Reef Associates). At that time particular attention was devoted to the Iron Door claim group and the Tres Padres claim within the Socorro Reef Property Position (See Plate 1).

Following the initial property evaluation (See report dated May 3, 1982), I entered into negotiations with major mining companies to obtain additional surface information on a gold anomaly on the Palo Verde and Bluebird claims in the southwestern part of the claim group controlled by Socorro Mining Corp. Subsequent visits to this ground by myself and numerous major mining companies has led to the acquisition of abundant surface data that strongly suggest the presence of a major, low-grade, large-tonnage, disseminated gold deposit. Confirmation of commercial value remains to be tested by drilling, but the information obtained so far allows the development of a model of disseminated gold deposits that has immediate application to other districts in the Salome region.

The Socorro Peak area is part of the Harquahala Mining District of Keith (1978). Total production of mines within the area is unknown, but reported cumulative production for several properties in the Socorro Peak area is summarized in Table 2. The known gold producers are situated in a complex structural environment that involves faults of several kinds, many of which have had a history of pre-mineralization and post-mineralization movements. To better understand the geologic history as it relates to gold mineralization and the structural controls for that gold mineralization, detailed mapping was undertaken at a scale of one inch equals 1,000 feet. A multi-metal, rock chip geochemical survey was conducted simultaneously with the mapping to evaluate metal distribution values. Samples collected during this survey were reanalyzed by U.S. Borax during August, September, and October, 1982, to verify existing data and obtain additional information regarding trace metal zoning patterns in the Socorro Peak area. Initial field work in late March and early April occupied about five days. About two additional days were spent deciphering the surface geology on the Palo Verde-Bluebird claims and mapping at a scale of one inch equals 500 feet to better understand the geologic controls on the underlying gold anomaly.

Table 2. Summary of cumulative reported production for mines within the Socorro Peak area.*

	Tons	Au(oz)	Ag(oz)	Cu(lbs)	Pb(lbs)	Au:Ag	Years
Gold Leaf	135	136	43	531	-	3.16	1930-32, 1934, 1941
Hidden Treasure	964	914	5147	596	-	0.1776	1932, 1935, 1940, 1951-56, 1959, 1961, 1966-67
Mars and Mescal (Iron Door 1 & 2)	109	16	56	23,857	-	0.2857	1916-18
San Marcos	93	104	33	428	-	3.15	
Silver Queen	1	-	4	143	114		1948
Socorro	4786	683	471		50	1.45	1905-06, 1911, 1913-14, 1934-35
Why Not (Iron Door 3 & 4)	395	233	689	1612	-	0.3382	1932-35, 1939
Total:	6483	2086	6443	27,166	164	0.3238	

* Data from Keith (1978) and Bureau of Geology and Mineral Technology files.

Previous Work and Acknowledgements

Prior to 1976, the area around Socorro Peak had only been investigated in a reconnaissance fashion by Wilson (1960), who noted the presence of large thrusts in the area. Varga (1976, 1977, see Appendix I) was the first to provide a more detailed geologic account of Socorro Peak itself. A more detailed account of the regional thrusting in the Harquahala and Little Harquahala Mountains was presented by Reynolds and others (1980, see Appendix I). Keith and others (1981) presented detailed documentation of the thrusting in the White Marble Mine area 3.5 miles northeast of Socorro Peak, and the results of their mapping are incorporated into the geologic map for this report (Plate 2). The larger thrusts were named by Keith and others (1981), and that nomenclature is carried on Plate 2. Recently, Richard (1982, see Appendix I) has presented an excellent refinement of the Precambrian, Paleozoic and Mesozoic stratigraphy in the Little Harquahala Mountains that, along with stratigraphy from Varga (1976), provides the basis for map units shown on Plate 2. Keith (1978) has tabulated a summary of mines within the Socorro Peak area and their past reported production and Reynolds (1982) has recently published an account of the regional geology around Salome.

The geologic map (Plate 2) and geologic cross-section (Plate 3) are the cumulative products of several years of mapping. The White Marble Mine area was mapped in late 1979 and early 1980 by myself and Stephen J. Reynolds, currently with the State of Arizona Bureau of Geology and Mineral Technology in Tucson, Arizona. The area around the Silver Queen Mine was mapped by myself and Stephen R. Richard, a graduate student at the University of Arizona, during a very hot October in 1980. The area around Socorro Peak, originally mapped by Varga (1976), was largely remapped for the Socorro Peak project in April 1982 by myself with assistance by Frank Springer, Jr. of Elmwood, Wisconsin; the Socorro Mine area was mapped in detail by myself during the summer of 1982. As one can see from Plate 2, much of the area is still unmapped and remains a continuing project. Conversations with George Campbell of Salome, Arizona greatly improved my knowledge of the mining history and location of the various mining properties within the Socorro Peak area.

Geology

Regional geologic patterns in the Salome region are shown on Figure 3; the detailed geology of the Socorro Peak area is presented on Plate 2. Most of the past production, with the exception of the San Marcos mine area, has come from several mines in and near the Paleozoic section (see Table 2). These mines are highlighted on Plate 1, along with the Socorro Mining Corporation's property position as of April, 1982.

ROCKS

Rock units shown on Plate 2 follow the stratigraphy of Varga (1976) in the Socorro Peak area and that of Richard (1982) in the Little

Harquahala Mountains. Richard (1982) has provided a convenient summary of the stratigraphic section that is reproduced here as Figure 4. Rocks in the Little Harquahala section that are present at Socorro Peak and vicinity include a Precambrian quartz monzonite; the Bolsa Quartzite, Abrigo Formation, Martin Formation, Redwall Limestone, Supai Formation, Coconino Sandstone, Kaibab Limestone, all of Paleozoic age; and lithofeldspathic sandstone of early Cretaceous (?) age. The Cambrian Bolsa Quartzite at the bottom of the Paleozoic section (Figures 5A and 5B) is of special interest because it hosts disseminated gold mineralization at the Socorro Mine.

Comparison of stratigraphy mapped by Varga (1976) with that mapped for this project reveals significant differences. Varga claimed that Cambrian Abrigo and Devonian Martin units were not present in the Socorro Peak area. Presence of these units <u>within</u> the Socorro Peak area was confirmed during this project, and the position of these units is shown on Plate 2. In addition, Varga claimed that the coarse-grained granite widely exposed over several square miles northwest of Socorro Peak was a biotite, muscovite granite that intruded the Paleozoic Bolsa Quartzite. He assigned this granitoid body a post-middle Triassic (?) age. Work during this project showed conclusively that the granite is unconformably overlain in several places (especially in the SW 1/4, SW 1/4, NE 1/4 of Section 25, T. 5 N., R. 12 W., .33 miles N60E of the Socorro Mine) by the Cambrian Bolsa Quartzite. Hence, the granite is unquestionably of Precambrian age. Also, the granite is commonly a porphyritic, biotite granite with coarse phenocrysts of rapakivi-textured potassium feldspars. This lithology strongly suggests correlation with the 1400 m.y. old granitoid assemblage that is widespread throughout southwestern Arizona. No outcrops of two-mica granite have yet been seen in the area by myself. Also, the unit assigned by Varga to the Moenkopi Formation of mid-Triassic age lithogically resembles the lithofeldspathic sandstone unit that Richard (1982) mapped in the Little Harquahala Mountains. That unit overlies a volcanic section of probable middle Jurrasic age. If this correlation is valid, the unit mapped as 'Ms' for this report is late Mesozoic (and probably Cretaceous) rather than early Mesozoic in age. However, more work is needed before the above tentative correlation can be rigorously affirmed.

A sequence of Tertiary igneous rocks is present at Socorro Peak and consists of volcanic extrusive rocks and northwest- to west-northwest-trending dike swarms. The volcanic rocks are present in two small outcrops (S 1/2 of Sec. 29, T. 5 N., R. 11 W. and at the corner of Sec. 26, 27, 34, and 35, T. 5 N., R. 12 W., unmapped). They consist of southward dipping andesite flows and rhyolitic air-fall tuffs.

The dike swarms are of two major types, both of which are near known gold mineralization. By far the most common type of dike is composed of hornblende microdiorite that locally contains accessory biotite. These dikes intrude the thrust fault pile (see Structure section) and the northwest-striking high-angle faults. Most of the known gold occurrences are within short distances of and in the same structures as the microdiorite dikes. The dikes are chloritically altered near areas of gold mineralization. Keith and Reynolds (1980) presented chemistry for one of the dikes that shows an affinity with the calc-alkalic magma series (see Table 3 and Figure 6). Dike rocks of similar magma chemistry

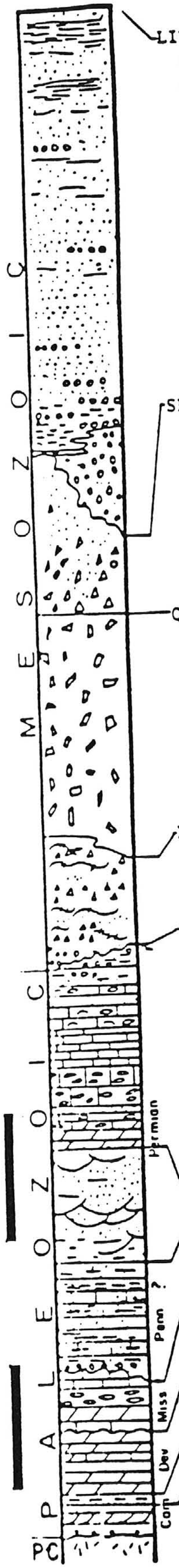
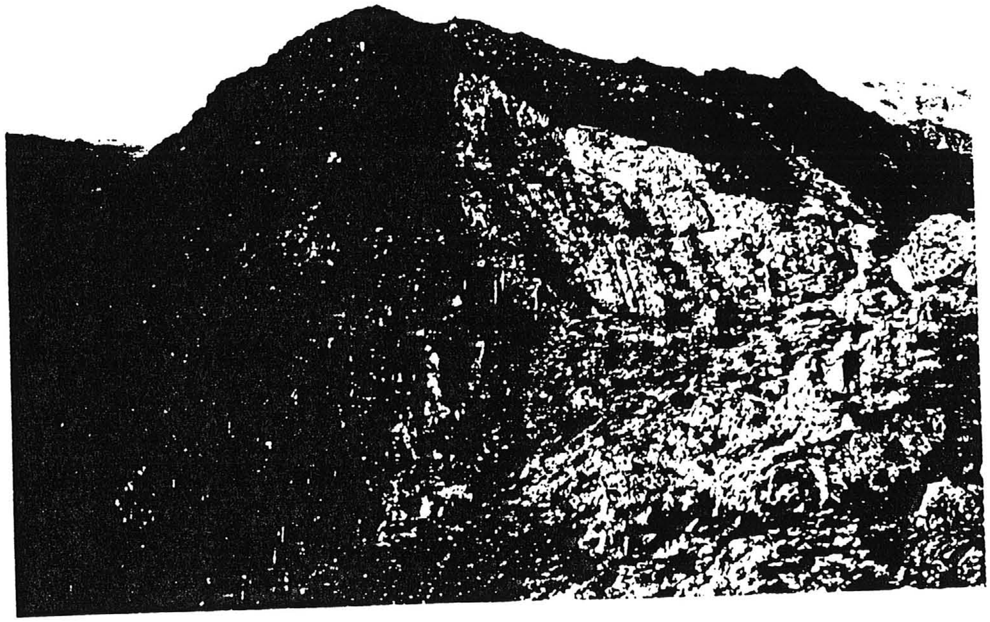
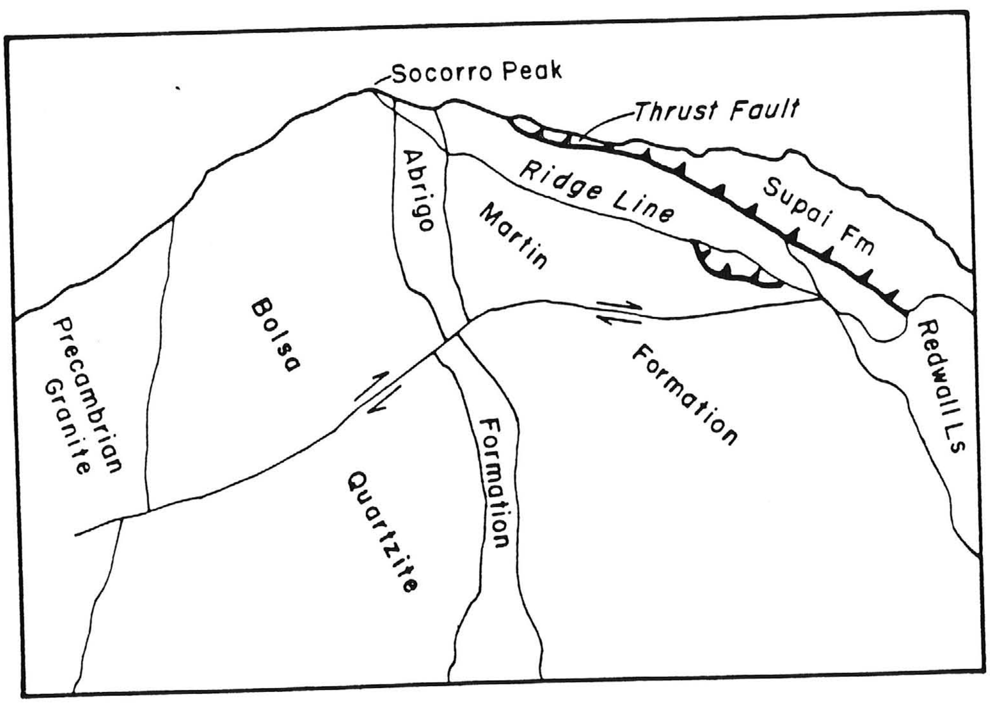


Figure 4. Stratigraphic column for Little Harquahala and a portion of the western Harquahala Mountains (from Richard, 1982). Scale to left of stratigraphic column is calibrated in meters.



ure 5A. Photograph of Lower Paleozoic stratigraphy southwest of Socorro Peak on Iron Door No. 3 claim. View is towards northeast.



re 5B. Diagram of Figure 5A showing formational boundaries of Lower Paleozoic stratigraphy. Bolsa-Abrigo formations to left of center are the principal gold-bearing host rock on the Socorro Reef claims.

Table 3. Major element chemistry for a microdiorite dike, Harquahala Mountains, Yuma County, Arizona.

Sample Number	79-12-17-6*
SiO_2	54.8%
Al_2O_3	16.0
Fe_2O_3**	8.36
CaO	7.32
MgO	4.48
K_2O	1.58
Na_2O	4.38
MnO	0.12
TiO_2	1.44
P_2O_5	0.79
L.O.I.***	0.85
Total	100.01

* Sample collected from float in Sunset Canyon northeastern Harquahala Mountains, Yuma County, Arizona

** Total iron reported as Fe_2O_3.

***L.O.I. = volatiles (mostly water) lost on ignition.

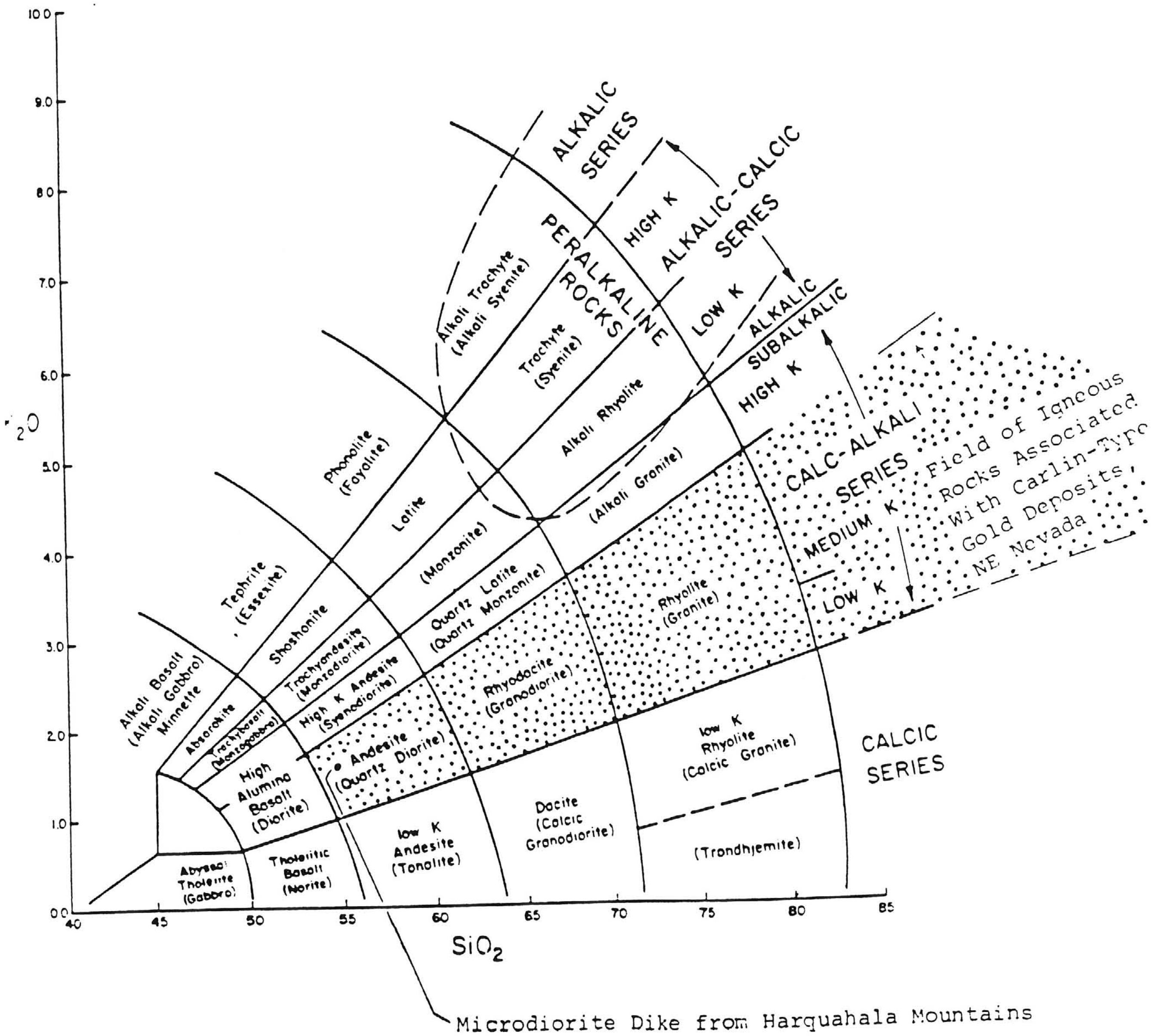


Figure 6. K_2O-SiO_2 variation diagram for average world-wide metaluminous rock series showing position of Harquahala microdiorite dike sample and calc-alkalic igneous rock series that are spatially associated with Carlin-type gold occurrences in northeast Nevada.

are consistently associated with Carlin-type, open-cut gold mineralization in northwest Nevada. Hornblende and biotite that were separated from one of the microdiorite dikes occurring a few miles west of the Socorro Peak area yielded K-Ar ages of 28.6 m. y. +/- 1.9 m. y. and 22.1 +/- 1.3 m. y., respectively. The close spatial relationship of these dikes with gold mineralization suggests a genetic link. If so, the gold mineralization would also be about 25 m. y. old or late Oligocene-early Miocene in age. Tungsten mineralization may also be related to emplacement of the microdiorite dikes, especially where they traverse relatively pure carbonate strata. For example, Campbell (personal communication, April 1982) reports scheelite mineralization in marbles of the Martin Formation that are adjacent to microdiorite sills on the Treasure Hill claim group (NW 1/4, NW 1/4, NE 1/4 Sec. 20, T. 5 N., R. 11 W.) about 1.9 miles east northeast of Socorro Peak. He also reports veins of scheelite in the microdiorite from the same area and indicates that tungsten shows are present near some of the gold mineralization.

A suite of medium- to coarse-grained granodiorite dikes intrude the same structure as the microdiorite dikes, but the granodiorite is much less abundant than the microdiorite. One of these dikes intrudes the Hidden Treasure fault at the eastern end of the Iron Door Claim Group in Sec. 19, T. 5 N., R. 11 W. and carries anomalous gold values.

STRUCTURE

The structural geology of the Socorro Peak area (especially that between the Silver Queen and White Marble Mines east of Socorro Peak) is one of the most complicated structural geology problems known in Arizona. For example, the area east of the Socorro Reef Claim groups contains a large tract of completely inverted Paleozoic rocks. This constitutes one of the largest areas of upside down rocks in Arizona and southern California (See Plates 2 and 3). The complex structural geology is the result of multiple events of folding, low angle faulting, and high angle faulting which are described below.

Folds

Three generations of folds are present in the Socorro Peak area: an early generation of nappe dimension, southeast-directed, recumbant folds (F_1); a second generation of small-scale, northeast-directed, 'S' and 'Z' type folds that are closely associated with north- to north-northeast-directed thrust faults (F_2); and a third generation of upright, northeast-trending anticlines and synclines (F_3) that warp pre-existing, thrust-fault surfaces.

<u>F_1 Folds (Southeast-Directed).</u> The F_1 folds comprise by far the most impressive fold set in the Socorro Peak area and are part of a regional, southeast-directed fold system that extends from the western Harquahala Mountains southwestward into the Little Harquahala Mountains. Geometry of these folds has been mapped and described at Socorro Peak by Varga (1976), at the White Marble Mine by Keith and others (1981), and in the Little Harquahala Mountains by Richard (1982) (reproduced in Appendix I). One of the most spectacular examples of these folds is present in the

north half of Sec. 30, T. 5 N., R. 12 W. (Figure 7). The axis of this fold may be traced more or less continuously through several fault offsets to the White Marble Mine 4 miles northeast of Socorro Peak. As the fold is traced to the northeast, exposures of the overturned limb are more widespread so that in the vicinity of the Silver Queen Mine the Paleozoic section is entirely upside down over an area of at least one square mile and the length of the overturned limb is at least 0.7 mile (See Plates 2 and 3)! Identification of the overturned fold in this area is very difficult because the various limbs have been severed and transported in various directions and distances by the subsequent low-angle thrust event(s). In the Socorro Peak area all of the productive gold properties are located in the lower, right-side-up limb of this structure.

F_2 Folds (Northeast-Directed). A second set of smaller-scale folds that generally have north to north-northeast overturning is consistently associated with thrust faults that cut and offset the axes of the large, recumbant, F_1 folds that were discussed in the last section. Keith and others (1981) have provided orientation data and descriptions of folds such as these that occur at the White Marble and Harquahala thrust in the White Marble Mine area (see Appendix 1). These folds are important because they provide kinematic constraints for the direction and sense of tectonic transport for at least some of the younger thrusts. One of the best exposures of these fold-thrust relationships is present at the Iron Door 3 and 4 claims where Supai Formation has been carried northward over Redwall and Martin Formation (Figures 8A and 8B). The thrust structure grades to the south into northward overturned folds that deform the Redwall-Supai contact and, in turn, probably give way to decollement or detachment zones within the basal Supai Formation in the phyllitic shale unit. The thrust portion of this structure is important because it controls the location of auriferous quartz veins on the Iron Door 3 and 4 claims.

F_3 Folds (Broad Warps). The F_3 folds are among the youngest geologic structures in the area and warp both the low-angle thrust faults and the F_1 folds around upright to steeply inclined, axial surfaces. The most graphic example of this folding may be seen in the canyon west of the Silver Queen Mine, where the upside-down limb of the earlier (F_1) southeast-vergent nappe has been sharply refolded around northeast-trending, anticlinal and synclinal axes near the corner of Sections 16, 17, 20, and 21 T. 5 N., R. 11 W. Generally these folds form broad warps that are responsible for the present-day northeast trend of the Harquahala Mountains, McMullen Valley, and Harcuvar Mountains. The relationship of F_3 folds to the northwest-trending faults is unclear but they may have formed at the same time that right slip occurred on the northwest-trending faults. Regional relationships suggest to myself that this deformation occurred in western Arizona between about 13 and 8 m. y. ago.

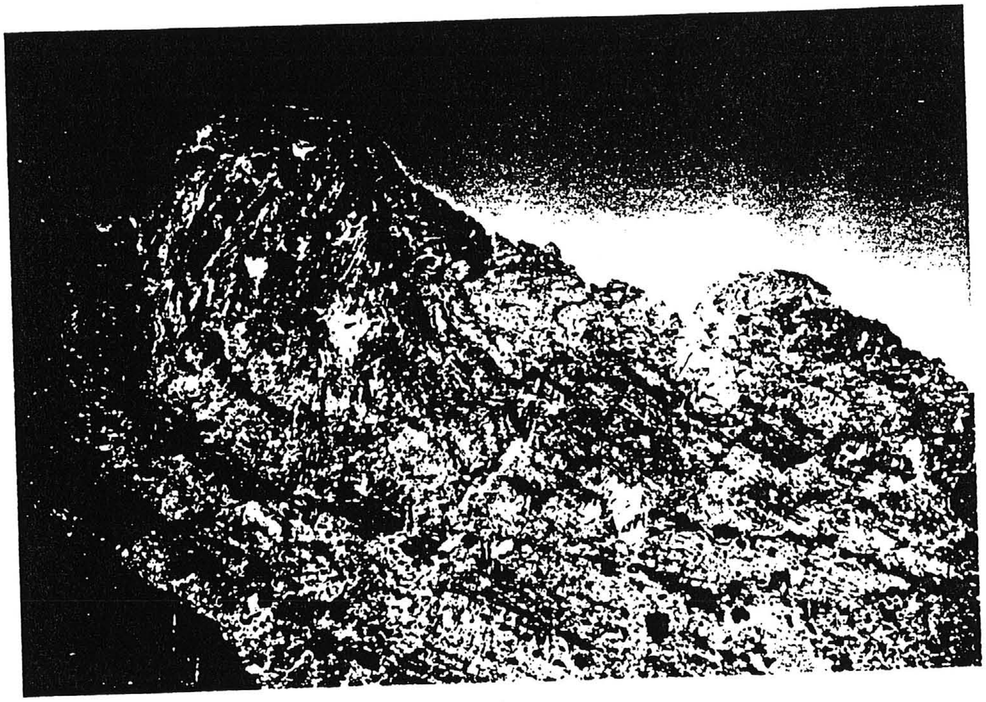


Figure 7. Photograph of large southeast overturned recumbant F_1 fold one mile south of Socorro Peak, western Harquahala Mountains. View is towards northeast.

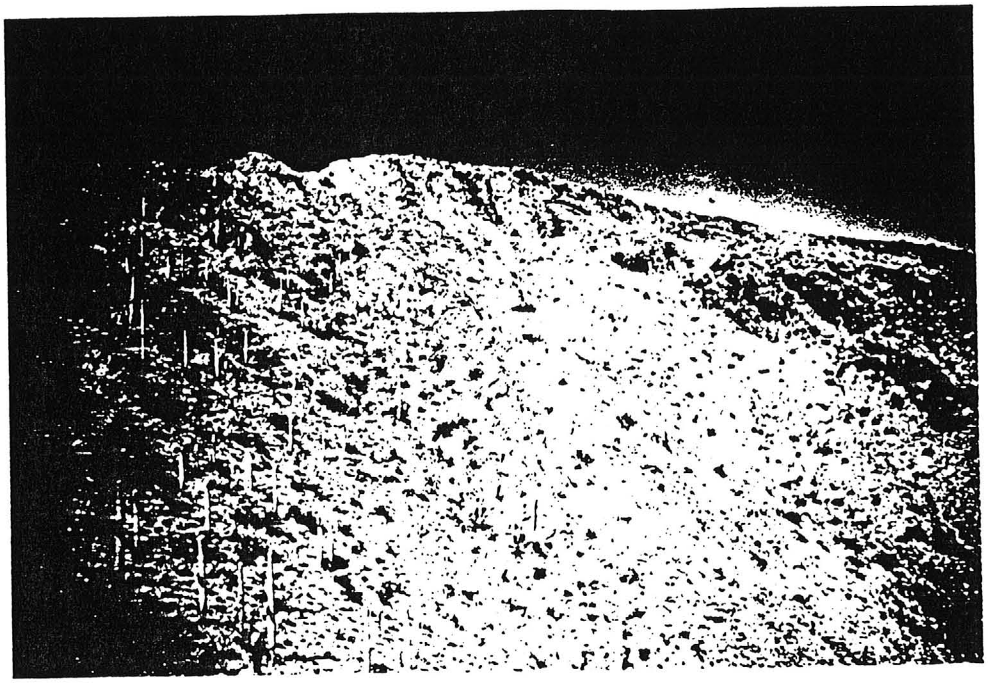


Figure 8A. Photograph of small north-vergent thrust along main ridge one mile southwest of Socorro Peak. Pennsylvanian-Permain Supai formation in upper plate has been carried northward over Devonian Martin and Mississippian Redwall Formations. Note folds along Redwall-Supai contact at right of picture. Gold mineralization occurs in quartz gash veins within Supai Formation just above thrust fault in upper left of picture. View is towards northeast.

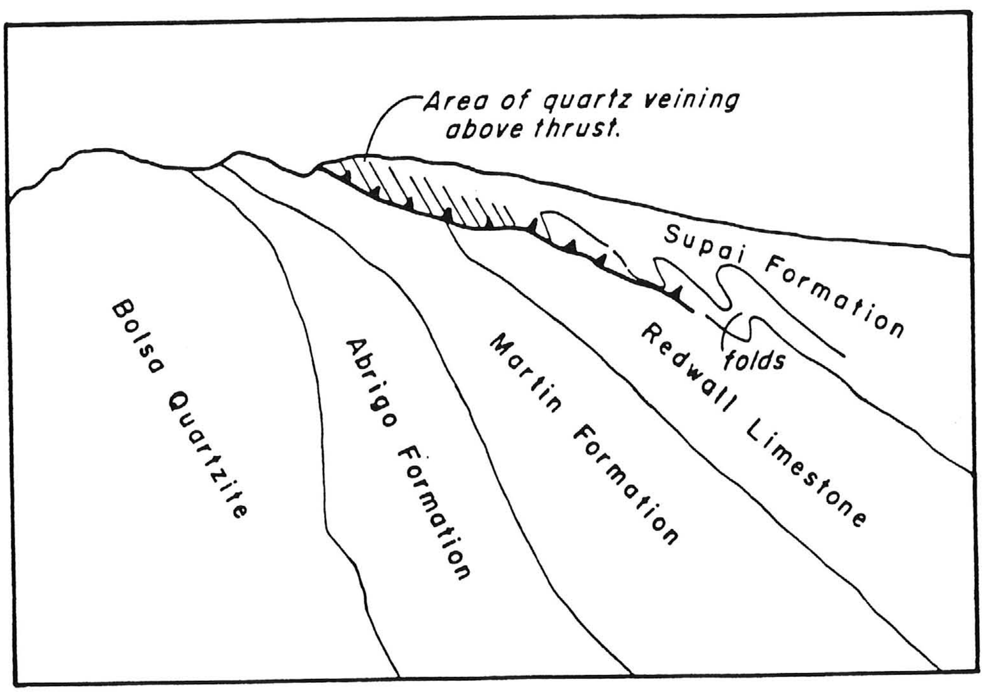


Figure 8B. Geologic interpretation of Figure 8A.

FAULTS

Two major styles of faults are present in the Socorro Reef area -- low-angle thrust faults and high-angle, northwest-striking faults with reverse and right separation. The low-angle thrust faults are older and are described first.

Thrust Faults. The Socorro Peak study area is part of a regional thrust fault sandwich that was first noted by Wilson (1960) and was regionally documented by Reynolds and others (1980), Keith and others (1981), and Reynolds (1982). (Refer to those references in Appendix I for more detail). The Socorro Peak area occurs within the upper portion of the thrust fault sandwich. Major thrusts present in the Socorro Peak study area, in order of increasingly higher structural level, include the Golden Eagle thrust, White Marble thrust, and Harquahala thrust. One of the best areas to view and become familiar with these structures is at the White Marble Mine, where Keith and others (1981) have written a self-guiding geologic tour (Location A-E, Plate 2; text is in Appendix I). This tour is highly recommended for those not familiar with the geology of the region.

The thrust fault sandwich may be a composite of two regional thrusting events, each with different timing, direction, sense and amount of tectonic transport. Both are probably present in the Socorro Peak area, although this fact has yet to be rigorously proved. The significant age relationship between thrust faults in the Socorro Peak area is that thrusts of higher structural level consistently truncate thrusts of lower structural level; thus the Harquahala thrust is the youngest thrust in the area (See Plate 2).

The Harquahala and White Marble thrusts and several, unnamed thrust slices that cut the underlying, metamorphosed Paleozoic section are probably part of the younger thrusting event. The direction and sense of movement for this event is north to northeastward and is provided by numerous north- to northeast- overturned F_2 interfolial folds that are closely associated in space with the thrusts. The time of the younger thrusting is between 85 to 50 m. y. and most probably from 85 m. y. to 70 m. y., as established from regional mapping and dating by Reynolds and others (1980), Keith and others (1981), and Reynolds (1982) (see Appendix I).

The age and tectonic transport of the older major thrusts that are lower in the structural sandwich (Golden Eagle and Hercules thrusts) are more difficult to establish, but some constraints are available. Reconnaissance mapping by Reynolds in the Granite Wash Mountains 15 miles northwest of the Socorro Peak study area suggests that a thrust fault that is possibly correlative to the Hercules thrust is intruded by the 85 m. y. old Tank Pass Granite. This thrust cuts clastic metasedimentary rocks of lower Cretaceous (?) age, as does the Hercules thrust. Limited fold data at 'S' Mountain 5 miles west-northwest of the Socorro Peak area indicate an eastward direction of tectonic transport for the Hercules thrust. A similar sense of tectonic transport is provided for the Golden Eagle thrust in the Socorro Peak area by map data generated during the Socorro Reef Project. If it is assumed that the exotic Paleozoic rocks that are in tectonic lenses within the Golden Eagle thrust zone north of the Socorro Mine (see Plate 2) were once part of the Paleozoic sedimentary package in the upper plate, then that plate has moved eastward or south-eastward relative to the exotic tectonic slivers in the Golden Eagle thrust zone. The sense of eastward or southeastward tectonic transport is kinematically consistent with that of F_1 folds that are overturned to the southeast. Thus, the Hercules and Golden Eagle thrusts might have formed as a late phase of the tectonic event that generated the southeast-directed, F_1 folds.

Recent mapping (early November 1982) by S.J. Reynolds, S. Richard and J. Spencer in the Little Harquahala Mountains, 8 miles southwest of the Socorro Peak area, has established that the Hercules thrust is cut by the 70 m.y. old granite of Granite Wash Pass (S. Reynolds, pers. comm., November 1982). Hence, the lowermost thrust in the Salome region is at least 70 m.y. old.

High-Angle Faults. The thrust fault sandwich is cut by numerous high-angle faults that occur at fairly regularly spaced intervals throughout the mapped area. From northeast to southwest, these faults are the Cougar fault, White Eagle fault, Treasure Hill fault, Hidden Treasure fault, Jennie fault, and the Socorro fault. All of the above faults dip northeast, display right and reverse separation (with the exception of the Jennie fault), and contain both dip-slip and oblique-slip slickensides, although the strike-slip component is dominant. The low-plunging, oblique-slip slickensides are the most common type of slickensides. Nevertheless, the presence of two slickenside directions and consistently right and reverse separation suggest at least two periods of movement on the faults, one dominantly right slip and one dominantly reverse slip. The preponderance of strike-slip slickensides suggests that the right-slip event is the younger of the two movements. Both movements probably occurred after the intrusion of the microdiorite dikes and the movements may both post-date the gold mineralization episode, although this is suggested with less certainty. Faults trending west-northwest to east-west that have much less displacement occur in the fault blocks between the northwest-striking faults. These faults generally display left separation with near-vertical dips.

GEOLOGIC HISTORY

After Lower Cretaceous time, the Harquahala district has been repeatedly affected by numerous tectonic events with each younger event "masking" those that preceded it. Based on current data, the major tectonic events are listed below from oldest to youngest:

1. 110 to 85 m. y. ago: Major southeast-overturned folding (F_1). Major inversions of the Paleozoic section accompanied this event.

2. 110 to 85 m. y. ago: Major east- to southeast-directed thrust-faulting (Hercules and Golden Eagle thrusts).

3. 85 m. y. ago: Intrusion of 85 m. y. old Tank Pass Granite in the Granite Wash Mountains.

4. 85 to 70 m. y. ago: North- to northeast-directed thrusting (White Marble and Harquahala thrusts) and folding (F_2).

5. 70 m. y. ago: Intrusion of the granite of Granite Wash Pass in the Granite Wash Mountains.

6. 60 to 45 m. y. ago: Major southwest-directed thrusting, mylonitization, regional metamorphism, and intrusion of two-mica granites to the northeast of Socorro Peak area (metamorphism in the Socorro Peak area may be a reflection of this event).

7. 28 to 25 m. y. ago: Intrusion of calc-alkalic microdiorite dike swarms and related granodiorite dikes into east-west to northwest-striking fractures. These fractures probably developed slightly before the intrusion the the dike swarms. Similar fractures with more north-south to northeast orientations developed in the Little Harquahala Mountains before and during some of the thrust-fault episodes mentioned earlier (Richard, 1982, see Appendix I). However, no evidence has been found to date in the western Harquahala Mountains to suggest the east-west to northwest trending fractures have any history of movement before or during thrusting.

8. Approximately 25 m. y. ago. Emplacement of district-wide gold mineralization during or slightly after the calc-alkalic microdiorite dike event.

9. 25 to 15 m. y. ago: Regional warping around northwest-trending fold axes; alkalic magmatism; development of regional, low-angle, normal, detachment faults; and tilting of overlying (upper plate) rocks above the detachment faults. The detachment faulting and tilting probably developed as a denudational response to regional warping with the volcanic cover rocks moving down dip away from anticlinal structural highs. During this event most of the volcanic cover was

removed from the Socorro Peak area.

10. 15 to 12.5 m. y. ago: Reverse movement that was southwest-directed on the northwest-trending fractures within the Socorro Peak area. Timing for this event is provided by analogy with the northwest-trending Lincoln Ranch fault system that probably trends across the Harquahala Mountains in Sunset Canyon 6 miles northeast of the Socorro Peak study area. In the Buckskin Mountains 25 miles north of the Socorro Peak study area the Lincoln Ranch fault system offsets the Buckskin-Rawhide detachment surface (Shackelford, 1981) on which movement terminated about 15 m. y. ago. Folding related to the Lincoln Ranch fault system is overlapped by flat-lying, 9 m. y. old basalts on Manganese Mesa in the Artillery Mountains north of Alamo Lake (Laskey and Weber, 1949; Shafiqullah and others, 1981; Shackelford, 1981).

11. 12.5 to approximately 5 m. y. ago: Right slip on the northwest-trending fractures and upright folding (F_3) along northeast-trending axes. Formation of the northeast-trending Harquahala Mountains, McMullen Valley, and Harcuvar Mountains probably occurred at this time. These movements include right slip on the Hidden Treasure and Socorro faults within the Socorro Peak Study area.

Alteration and Mineralization

Alteration and mineralization in the Socorro Peak area is of two major types: (1) regional, amphibolite grade metamorphism; and (2) hydrothermal alteration and gold mineralization. As outlined in the geologic history section, the gold mineralization is of probable mid-Tertiary age and is superimposed on the regional metamorphism. The mid-Tertiary, hydrothermal gold mineralization exhibits several types of alteration: (1) supergene hematite-clay alteration and hypogene quartz-sericite-pyrite alteration in the Bolsa Quartzite; (2) epidote-chlorite alteration in the microdiorite dikes; (3) quartz filling of gash veins in the Supai Formation and Coconino Sandstone; (4) quartz veining and moderate sericitization of the porphyritic Precambrian granite ("p€g"); and (5) jasperoid alteration and silicification of the Martin Formation and Redwall Limestone. Rock type thus exerts a strong control on the type of alteration that is associated with the mid-Tertiary gold mineralization.

REGIONAL DYNAMIC METAMORPHISM

Regional dynamic metamorphism of amphibolite-grade affects virtually all rock types in the Socorro Peak area. The amphibolite-grade metamorphism increases in grade and intensity from southwest to northeast, and is especially noticeable in the Paleozoic section. Carbonate strata (especially Martin and Redwall Formations) have been converted to white marble or dolomitic marble and have been exploited for marble at the White Marble Mine three miles northeast of Socorro Peak. Clastic-carbonate sections (portions of the Martin and Supai Formations) have been converted to calc-silicate, wollastonite-stable assemblages.

Excellent specimens of wollastonite may be collected at a small prospect pit in metamorphosed Martin Formation (NE 1/4, NE 1/4, Section 23, T. 5 N., R. 12 W.). Shale sections (Abrigo Formation and portions of the Supai Formation, especially the basal shale unit) have been converted to purple phyllite. Quartzite sections are essentially unchanged.

The Paleozoic section in the Little Harquahala Mountains is much less metamorphosed than the equivalent section in the western Harquahala Mountains. For example, the Martin Formation at Martin Peak in the Little Harquahala Mountains still retains hydrocarbon material, as evidenced by fetid odors emitted by the darker dolomite units when broken. Northeast of Socorro Peak in the western Harquahala Mountains, however, all of the Martin Formation has been converted to an aphanitic white dolomitic marble and is mined for such at the White Marble Mine. Upper Paleozoic units contain considerable wollastonite 6 miles farther east in the Arrastre Canyon area of the eastern Harquahala Mountains.

An important geochemical feature of the amphibolite-grade rocks in the western Harquahala Mountains is their total impoverishment in background contents of base and precious metals relative to unmetamorphosed counterparts in southeastern Arizona (see Table 3 in geochemical section). Apparently, the base and precious metal contents of these rocks have been completely scavenged during the amphibolite-grade regional metamorphism. Because this event is of probable late Laramide age, the gold mineralization was emplaced into wall rocks that were totally barren with respect to their base and precious metal contents. This fact further strengthens the interpretation that microdiorite dikes are cogenetic with the gold mineralization and, like the gold mineralization, have been introduced into the hostrocks from a deeper source. Significantly, the microdiorite dikes contain normal lead, copper, and zinc backgrounds for a rock of calc-alkalic magma series chemistry and differentiation level.

GOLD MINERALIZATION

Several kinds of alteration accompanied the gold metallogenic episode in mid-Tertiary time; these alteration types are strongly affected by rock type.

The most economically significant alteration types are supergene hematite-goethite-jarosite-clay alteration along fractures in Bolsa Quartzite and quartz veining and sericitization of the Precambrian-aged, porphyritic biotite granite that is stratigraphically beneath the Cambrian Bolsa Quartzite. Hematite occurs as the earthy red-colored variety. Highest gold values seem to correlate with the reddest hematite. Such alteration is widespread at the two most productive mines in the Harquahala region to date: the Harquahala-Golden Eagle mining complex in the Little Harquahala Mountains (158,761 tons that yielded 143,308 oz of gold) and the Socorro Mine (4786 tons with a yield of 683 oz of gold) in the western Harquahala Mountains. The largest area of such alteration at the Socorro Mine is contained in Bolsa Quartzite outcrops on the Palo Verde-Bluebird claim group, with similar but less widespread mineralization at the old Socorro Mine site, 1/4 mile north-northeast of the Palo Verde claims. Also, quartz veining and sericitization of the Precambrian granite, along with moderate supergene hematite-goethite coatings on fractures, was observed to be moderately widespread in and above the Golden Eagle thrust in the NE 1/4 of section 23, T. 5 N., R. 12 W. Samples from this area have locally yielded anomalous gold values.

Hematite-goethite-jarosite-clay altered areas are supergene expressions of a hypogene, quartz-sericite-pyrite, phyllic alteration assemblage that originally accompanied the gold mineralization. Phyllic alteration has sericitized feldspars and has added pyrite and silica to the quartzite along fractures of various scales within the Bolsa Quartzite; the phyllic alteration has also replaced plagioclase feldspars and biotite with sericite in areas of fractured Precambrian granite. Pyritization is expressed by euhedral cubes (1/32 to 1/8" long on an edge) of pyrite (now replaced by goethite) along and near fractures in the quartzite. The quartzite in and adjacent to the pyrite cubes is severely bleached. Pyritization and bleaching was noted at three locations: within the hematite-clay altered Bolsa Quartzite on the Palo Verde and Bluebird claims, along a northeast-striking fracture in Bolsa Quartzite on Socorro Peak, and in fractured Supai clastics on the Iron Door No. 5 claim. Samples containing pyrite cubes or goethitic supergene replacements of pyrite consistently gave moderate to strongly anomalous gold values.

Where microdiorite dikes traverse areas of anomalous gold concentration in the northwest-striking fracture set, the dikes are affected by pervasive chloritization and minor epidotization of the mafic minerals (biotite and especially hornblende) within the dike. In such areas, fractures within the microdiorite dikes contain moderate to strong goethite coatings and locally moderate, earthy red-colored hematite coatings. Chloritization of microdiorite dikes is especially well developed along dikes in and near the Socorro fault southeast of the old Socorro Mine site. Chloritization of microdiorite dikes is also locally developed in dikes in the northwest 1/4 of Section 23, T. 5 N., R 12 W.

Quartz gash veins in the Supai Formation and Coconino Sandstone locally carry anomalous gold values. Such veins are best developed near the small thrust plate of Supai Formation on the Iron Door Nos. 5 and 4 claims. Here quartz-filled gash veins are particularly numerous just above the thrust fault that has placed Supai Formation over Martin Formation and Redwall Limestone. Similar quartz veins occur near thrusts (for example in the NW 1/4, NW 1/4 of Section 20, T. 5 N., R. 11 W.) but samples from these veins did not carry anomalous gold. Care must be taken to distinguish gold-bearing quartz veins from barren gash veins that occur in the same host rocks and exhibit similar morphology. Gold-bearing veins seem to be best developed in close proximity to low-angle thrust faults. Thirty similar veins sampled away from thrust faults yielded no anomalous gold values except for one sample in Supai Formation near the Socorro Fault. The barren quartz-filled gash veins probably formed when quartz was remobilized into tensional site via a pressure solution process during the Cretaceous F_1 folding event. Such veins thus predate the Tertiary and gold metallization by about 75 million years.

Jasperoid replacement and silicification of Paleozoic carbonate rocks are commonly auriferous. The best developed showing of jasperoid replacement bodies occurs on the Iron Door Nos. 1 and 2 claim where hematitic, manganiferous, and cupriferous silica lenses replace bedding in the Redwall Limestone adjacent to north- and northwest-trending faults. More subtle silicification occurs in brecciated Martin Formation and Redwall Limestone on the Henry Bell claim near the Socorro fault and is associated with silver-dominated metal assemblages (see geochemistry section).

PHYSICAL ORE CONTROLS

In order of importance, the physical ore controls on gold mineralization are: (1) high-angle, northwest-striking faults; (2) low-angle thrust faults; and (3) favorable units in the Paleozoic section. Coincidence of any or all of the above features tends to increase the possibility of a gold occurrence. The most important ore control is the northwest fracture set that probably provided a "feeder" structure for ascending microdiorite dikes and probably related gold mineralization. All reported production from the Socorro Peak area (all mines in Table 2) has come from gold-rich zones within or adjacent to the northwest-trending fractures. The most consistently mineralized, northwest-trending structure within the Socorro Reef project area appears to be the Socorro fault, followed closely by the Hidden Treasure fault system.

Gold mineralization also occurs in areas near thrust faults especially where they intersect the northwest-striking fracture set (for example, the NE 1/4, Section 23, T. 5 N., R 12 W. and the Palo Verde-Bluebird claim area). Favorable units in the Paleozoic section also contain mineralization where they intersect the northwest-striking faults. In ascending stratigraphic order these favorable units are Cambrian Bolsa Quartzite, Devonian Martin Formation, and Mississippian Redwall Limestone (especially the upper cherty limestone member). By far the most important stratigraphic control seems to be the Cambrian-age Bolsa Quartzite. It hosts much of the mineralization at the Socorro Mine within the study area and at the Harquahala-Golden Eagle mine groups in the Little Harquahala Mountains. The proximity of Bolsa strata to major, north- to northwest-striking faults and to low-angle faults at the above-mentioned properties has augmented the favorability for a large bulk gold occurrence. Although other gold occurrences are in favorable Paleozoic strata (such as the Iron Door Nos. 1 and 2, Tres Padres area, Henry Bell claim) and are near northwest-trending fractures, they are not near one of the major thrust faults. This may help explain their comparatively lower production and their limited extent of alteration. Similarly, gold-bearing quartz veins on the Iron Door 4 and 5 claims, while occurring near a thrust fault, are not near one of the northwest-trending feeder fractures.

The only area within the Socorro Peak area that meets all three of the above conditions is the Socorro Mine area, which has the largest reported historic production and is in the largest altered and mineralized area.

Geochemistry

PROCEDURES AND METHODOLOGY

In order to provide quantitative information about the amounts and distribution patterns of gold mineralization, a rock chip, fracture geochemical sampling program was carried out concurrently with geologic mapping. Sample locations are shown on Plate 4. The raw analytical results were compiled on frequency histograms by rock type (Plate 4). An unexpected result was the complete impoverishment of base and precious metals in all pre-Cenozoic rock types. Normally, rock type exerts a considerable control below 100 ppm (compare Harquahala data with data for similar but unmetamorphosed southeastern Arizona rocks in Table 4). However, true modal background for any pre-Cenzoic rock type was not determinable because metal values were consistently below the detection limit (less than 5 ppm for copper, lead, and zinc; 0.1 ppm for silver, and 0.002 ppm for gold)!!! The most reasonable interpretation of this data is that the base and precious metal content (as well as the uranium content from data in Keith and Reynolds, 1980) was scavenged from the pre-Cenozoic rocks during the probable late Laramide age, regional, amphibolite-grade metamorphism. In any case, rock type exerts no control on the background metal content or weakly anomalous base and precious metal categories (inspect Plate 4). Hence, geochemical interpretation of low-level metal anomalies is considerably simplified for areas in the Harquahala region that were affected by the regional metamorphic event. Parts per million boundaries for weakly, moderately, and strongly anomalous categories were picked by inspection of population clusters on the frequency histograms in Plate 4, and are summarized in Table 4.

From the data in Plate 4 and Table 4, contour maps were prepared for gold, silver, copper, zinc, lead, and copper to lead plus zinc ratios (Plates 5, 6, 7, 8, and 9, respectively) to evaluate metal contents and zoning. Individual analytical data by sample and metal are listed in Appendix IV. Analyses for all of the above listed metals were performed by Skyline Laboratories in Tucson, Arizona. Gold was determined on a graphite furnaces and silver, copper, lead, and zinc were determined by atomic absorption. Whereas statistical treatment with histograms determined the values of the metal anomaly contours, contours themselves were positioned according to sample locality and geological and alteration context of the sample.

Initial interpretation of the geochemical data (see report dated May 3, 1982) established the probable presence of metallogenic zoning in the Socorro Peak area. To provide further clarification and verification of the metallogenic zoning, the Socorro Mining samples were submitted to U.S. Borax for reanalysis of gold, silver, copper, lead, and zinc and for new analyses of mercury, antimony, arsenic, tungsten, uranium, and molybdenum (Plates 10, 11, 12, 13, 14, and 15, respectively).

Table 4. Background data in ppm for amphibolite-grade meta-sedimentary rocks in the western Harquahala Mountains compared with background data for similar unmetamorphosed rocks in southeast Arizona.

	Carbonates					"Dirty Clastics" (Shales, Siltstones, Arkoses, etc.)					Cherts and Quartzites[1]				
	Au	Ag	Cu	Pb	Zn	Au	Ag	Cu	Pb	Zn	Au	Ag	Cu	Pb	Zn
Western Harquqhala Mountains amphibolite-grade metasedimentary rocks															
Number of Samples[2]	12	16	15	22	13	14	16	15	9	10	-	-	-	-	-
Modal Background[3]	<.002(5)	<.2(10)	5(8)	<5(12)	5(6)	<.002(9)	<.2(8)	5(6)	<5(8)	5(6)	-	-	-	-	-
Range Background[4]	<.002-.008	<.2-.95	5-80	<5-70	<5-70	<.002-.009	<.2-.7	<5-60	<5-5	<5-70	-	-	-	-	-
Mean Background[5]	<.0037	<.0225	<16	<15.9	<17.7	<.0034	<.25	<15.7	<5	<14.5	-	-	-	-	-
Southeast Arizona unmetamorphosed rocks[6]															
Number of Samples	32	32	32	32	32	22	22	22	22	22	11	11	11	11	11
Modal Background	<.02(25)	8(7)	5(24)	60(12)	25(7)	<.02(16)	<1(20)	15(10)	30-35(5)	30(4)	<.02(7)	<1(8)	5(6)	35(3)	10,15&20(2)
Range Background	<.02-.04	1-11	<5-15	35-70	10-55	<.02-.04	<1-4	5-30	15-50	15-50	<.02-.04	<1	5-20	10-55	5-35
Mean Background	<.0125	<6.1	5.5	57.3	26.6	<.04	<.49	13.2	31.4	41.9	<.021	<1	10	36.4	14.4

1. Quartzite lithology rocks from the Harquahala Mountains are geochemically indistinguishable from and combined with dirty clastic rocks.
2. For calculation of average values, only the number of samples within the background range were used.
3. The number in parentheses next to the modal value is the number of samples in the mode.
4. Range Background: the highest and lowest class interval for a given population of occurrences.
5. Mean Background: total ppm value for a given population of occurrences divided by the number of samples within that population.
6. Data for SE Arizona rocks is from an unpublished report by S. B. Keith for a Paleozoic-Cretaceous section in the Dragoon Mountains, Cochise County.

RESULTS

Gold

Anomalous amounts of gold occurred more frequently than anomalous concentrations of any of the other elements analyzed for. Details establishing these statistics are given in Table 5. Fifty-six percent of the samples collected contained anomalous gold. Significantly, 43.4% of the samples analyzed for tungsten were anomalous and surprisingly, 33.5% of the samples analyzed for mercury were anomalous. Silver was anomalous in 16% of the samples, whereas arsenic was anomalous in 12.8% of the samples analyzed for arsenic. Lead, zinc, and copper were anomalous in 11.7%, 10.9%, and 9.2% respectively and molybdenum, uranium, and antimony in 8.6%, 8.1%, and 5.8% respectively. Obviously, the Socorro Peak area has a distinct gold-tungsten bias.

Because more samples contained anomalous gold than any other metal, areas of anomalous gold are more numerous and more widespread. The largest area of weakly anomalous or more anomalous gold-bearing samples is near the Socorro Mine (Plate 5). Here, an irregularly shaped gold anomaly is defined by northwest-trending faults and by hematite-silica-clay alteration in outcrops of Bolsa Quartzite. This anomaly is herein named the Socorro Reef gold anomaly and will be discussed in great detail in Part II. The second largest area enclosed by the weakly anomalous gold contour is on the Iron Door No. 4 and 5 claims: its location is controlled by the position of the small thrust fault discussed in preceding sections. Several other weakly anomalous areas are scattered over the map area (Refer to Plate 5). The most interesting of these is probably in the NE 1/4 of Sec. 23, and the NW 1/4 of Sec. 24, T.5N., R.12W., where several anomalies that are poorly defined because of sample density occur where high-angle fractures cross the Golden Eagle thrust zone. Follow up sampling and mapping in this area is highly recommmended because of its similarity to the regional, disseminated gold model that will be derived in subsequent sections.

Numerous highly anomalous gold values or "hot spots" may be observed on Plate 4. The jasperoid replacement mineralization at Iron Door No. 1 and 2 claims carries the highest average gold values (2.1 ppm or .06 oz Au/ton) of any area sampled. However, the exclusive limitation of these grades to comparatively narrow replacement lenses severely limits the size of any ore body that might be mined; the lenses typically are 5 feet wide by 30 feet long in surface exposures. Highly anomalous gold values also were obtained within the weakly anomalous anomaly on the Iron Door No. 4 and 5 claims, and at several other locations. However, the fact that these anomalies do not occur within a sizable area of moderate gold intensity discourages the possibility of a bulk gold occurrence because the samples were collected from obviously mineralized bodies. Wallrocks in between those bodies are not likely to contain anomalous gold values. This fact is particularly true for the gold anomaly at the Iron Door Nos. 4 and 5 claims, where two samples of Supai Formation in between auriferous quartz gash veins did not contain anomalous gold. Numerous "hot spots" occur within the Socorro Reef gold anomaly and will be discussed in more detail in Part II.

Table 5: Summary of Anomalous Metal Contents in Analyzed Samples

Element	Number of Samples Analyzed	Number of Anomalous Samples	Percent of Anomalous Samples
Gold	865	482 (.009)	55.7
Tungsten	221	95 (5)	43.4
Mercury	221	74 (.5)	33.5
Silver	842	135 (1.0)	16.0
Arsenic	399	51 (8	12.8
Zinc	221	26 (80	11.7
Lead	402	44 (80)	10.9
Copper	402	37 (90)	9.2
Molybdenum	221	19 (10)	8.6
Uranium	221	18 (6)	8.1
Antimony	221	13 (5)	5.8

At many of the mines in the Socorro Peak area gold exhibits a positive correlation with silver (Figure 9). An excellent correlation between gold and silver is developed within the Socorro Reef gold anomaly, on the Tres Padres claim, and at the Henry Bell claim. At all three localities increasing gold values correlate positively with increasing silver values. Also, the field enclosing the Socorro Reef gold-silver values is completely offset fromm the field of Henry Bell gold-silver values with the Socorro Reef field offset toward higher gold values. The Tres Padres field mostly overlaps with the Henry Bell field. The partitioning of gold-silver values into separate fields on the gold-silver variation diagram is suggestive of metallogenic zoning within the Socorro Peak area. This concept will be developed in much greater detail in subsequent sections.

Also gold-silver values from the gold-bearing jasperoid lenses on the Iron Door No. 1 and 2 claims do not appear to exhibit a gold-silver correlation. However, the analyses from the Iron Door claims cluster into a field that largely overlaps with the upper end of the field of the Socorro Reef gold anomaly. Hence, the gold-bearing jasperoids as a class contain the highest amount of precious metal in the Socorro Peak area.

Tungsten

Anomalous tungsten values are widespread throughout the Socorro Peak area with 43% of the samples containing more than 5 ppm tungsten. Within the Socorro Reef gold anomaly all but 5 out of 50 samples contained anomalous tungsten with 21 samples containing more than 10 ppm tungsten. Hence, anomalous gold values within the Socorro Reef anomaly correspond with significantly elevated tungsten contents. Elsewhere in the Socorro Peak area the highest values of tungsten came from the gold-bearing jasperoid lenses in Paleozoic rocks on the Iron Door No. 1 and 2 claims (See Figure 10). Locally anomalous tungsten values were also obtained from quartz veins on the Tres Padres and Iron Door No. 3 and 4 claims and from quartz veins that have been prospected in Sec. 23, T.5N., R.12W., one mile north of the Socorro Mining claim block.

Many tungsten samples contain anomalous gold values, but tungsten exhibits a positive correlation with gold only in the area of the Socorro Reef gold anomaly (Figure 10). All samples from the gold-bearing jasperoids on the Iron Door No. 1 and 2 claims contained at least 15 ppm tungsten, but exhibit no correlation with gold.

Mercury

A surprising number of samples (at least 74 out of 221) contain greater than 5 ppm mercury. In particular, large, continuous mercury anomalies exist in Paleozoic rocks between the Socorro fault on the southwest and the Hidden Treasure fault to the northeast. Mercury "hot spots" are present at the Iron Door No. 1 and 2 claims where mercury ranges to as high as 7.2 ppm in the gold-bearing jasperoid lenses and on the Tres Padres claim where 1.65 ppm mercury exists in a sample from a bull quartz vein. No values above .5 ppm were obtained in 58 Phillips samples taken from the Socorro Reef gold anomaly.

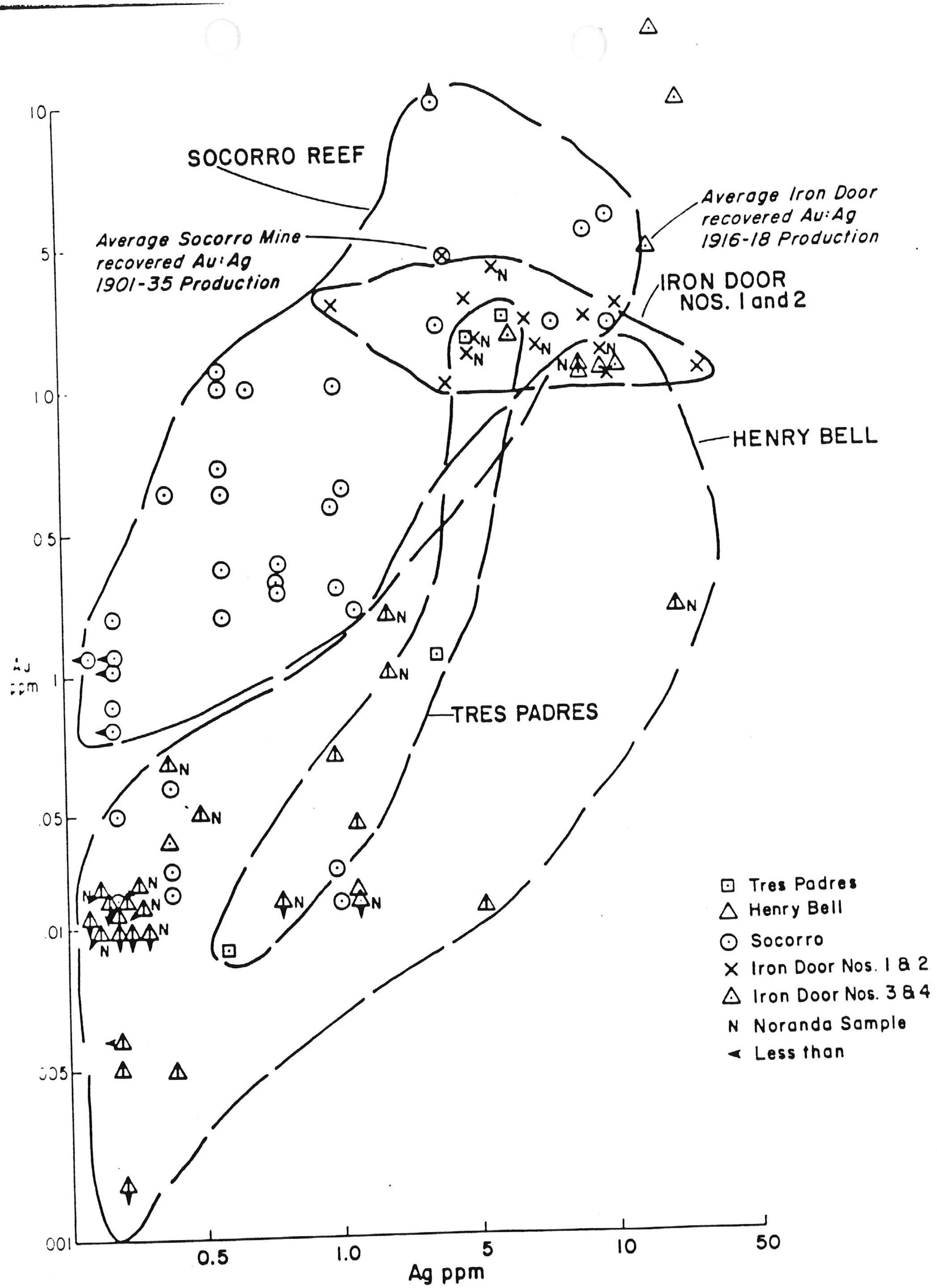


Figure 9. Gold:Silver variation diagram for geochemical samples from mines within the Socorro Peak area of the Harquahala district.

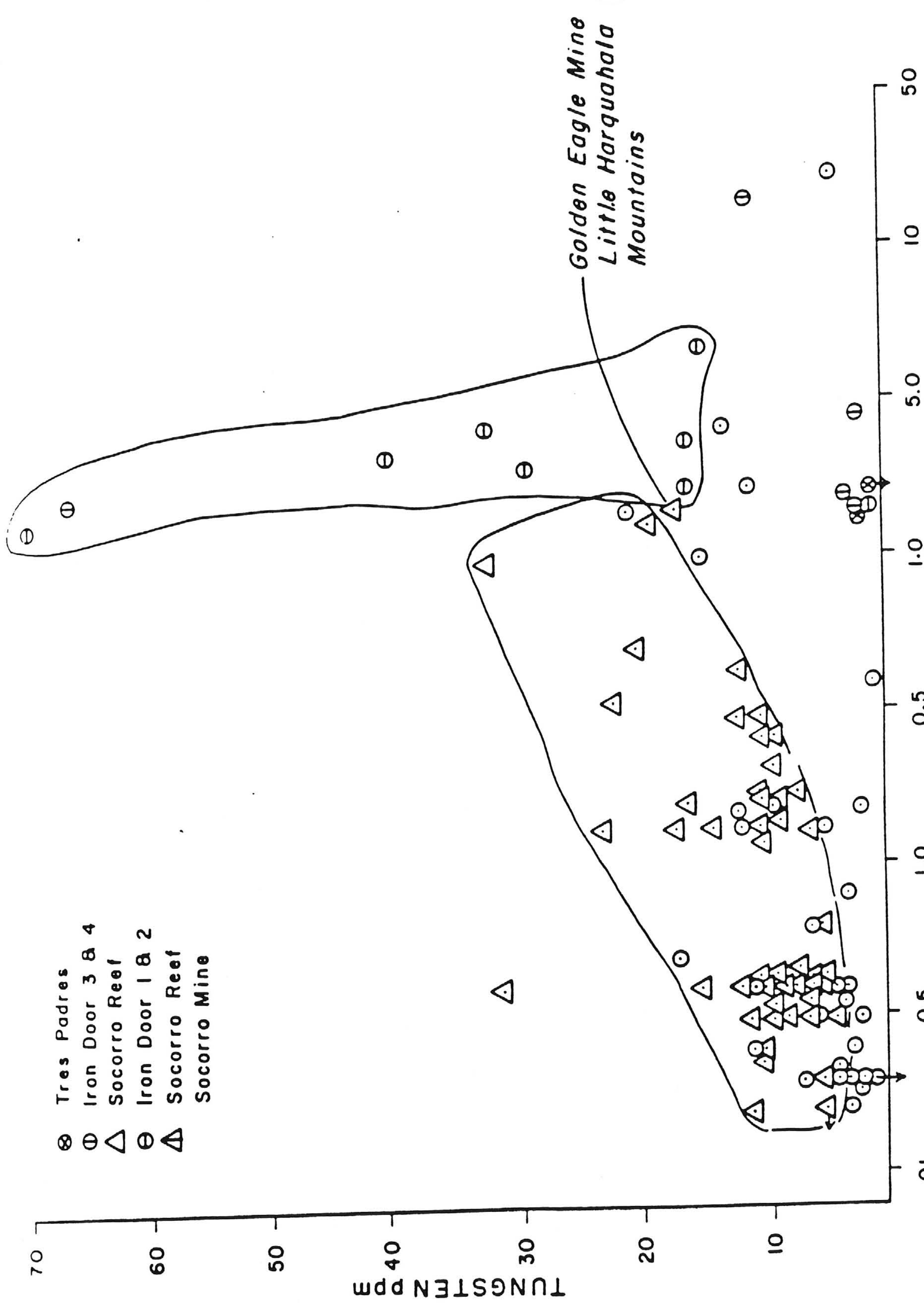


Figure 10. Tungsten:Gold variation diagram for geochemical samples with greater than 5 ppm tungsten in the Socorro Peak area of the Harquahala district and from the Golden Eagle mine in the Little Harquahala Mountains.

Silver

Anomalous silver values occurred much less frequently than gold. Only 16% of 842 samples analyzed for silver contained more than 1 ppm silver. Silver anomalies were generally restricted to areas of high gold values. The most anomalous silver values were obtained from the Henry Bell claim where silver values in one sample exceeded 350 ppm or about 10 ounces per ton.

Arsenic

The highest arsenic contents were obtained from the gold-bearing jasperoid lenses in the cherty marble member of the Redwall Limestone, especially on the Iron Door No. 1 and 2 claims and in some small jasperoid lenses immediately south of the west end of the Socorro Reef gold anomaly. On Iron Door No. 1 and 2 claims arsenic values for 7 samples from the main uppermost working ranged from 151 ppm to 345 ppm. Values of 240 ppm arsenic were obtained from the jasperoid replacement lense south of the Socorro Reef gold anomaly. Within the Socorro Reef gold anomaly only 3 out of about 135 samples contained greater than 50 ppm arsenic. Arsenic values ranging from 10 to 50 ppm occurred erratically in the quartz vein samples on the Tres Padres, Iron Door No. 3 and 4 and Sec. 23 prospects. No anomalous arsenic was found in 18 Noranda samples from the Henry Bell claim.

Zinc, Lead, Copper

Base metal anomalies, just as silver anomalies, occur less frequently and over a much more limited aerial extent than gold. Like silver, base metal anomalies are restricted to areas that contain anomalous gold. The highest copper values were obtained from the gold-bearing jasperoids on the Iron Door No. 1 and 2 claims where copper ranged to a high of 18.9% with most values between 1440 ppm and 7060 ppm (Borax analyses). Copper and lead consistently gave anomalous returns for samples from within the Socorro Reef gold anomaly. Significantly, no anomalous zinc values were reported within the Socorro Reef gold anomaly. Highly anomalous zinc and lead values (greater than 220 ppm), however, are common in the gold-bearing jasperoids, in quartz veins on the Tres Padres and Iron Door No. 3 and 4 claims, and in silicified and fractured Martin Formation on the Henry Bell claim.

Molybdenum

Virtually all samples with greater than 10 ppm molybdenum were restricted to the gold-bearing jasperoid lenses on the Iron Door No. 1 and 2 claims, although one sample with 44 ppm came from a mineralized shear zone in the Cambrian Bolsa Quartzite on the Tres Padres claim and five anomalous samples came from quartz veins in the Sec. 23 prospects. Only one out of 48 Phillips samples from the Socorro Reef gold anomaly contained more than 10 ppm molybdenum.

Uranium

As with molybdenum, anomalous uranium values are restricted to the gold-bearing jasperoid lenses on the Iron Door No. 1 and 2 claims and quartz veins in the Sec. 23 prospects. One sample out of 48 Phillips samples from the Socorro Reef gold anomaly contained 7 ppm uranium.

Antimony

Of the samples analyzed for antimony, 5.8% contained more than 5 ppm antimony. These values are mostly restricted to the gold-bearing jasperoids on the Iron Door No. 1 and 2 claims. Two out of 48 Phillips samples from the Socorro Reef gold anomaly contained anomalous antimony.

Summary

From the above data it is apparent that elevated values of various trace metals form discrete assemblages that are dependent on the geologic setting of the sample. High gold contents in the Socorro Reef gold anomaly correspond with consistently anomalous tungsten values, with frequently anomalous lead values, and with less frequently anomalous copper values. The gold-bearing jasperoid lenses are metallogenic "supermarkets" with consistently elevated values of gold, tungsten, mercury, silver, arsenic, zinc, lead, copper, molybdenum, uranium, and antimony; that is, they contain anomalous amounts of all of the elements analyzed for. Indeed, the highest values of each metal analyzed for consistently occurred in the jasperoid lenses. Gold-bearing quartz veins in various host rocks consistently contain elevated gold, silver, and tungsten values with minor but consistent zinc, lead, and copper values and spotty uranium, antimony, arsenic, and molybdenum values. Anomalous mercury is generally present. In silicified fracture zones within Paleozoic carbonate rocks, silver is commonly highly anomalous with locally anomalous gold and consistently anomalous lead, zinc, and copper. Manganiferous material is commonly present and mercury is consistently anomalous.

METAL RATIO STUDIES

In order to obtain more precise information about metal zoning patterns and about the extent to which gold rich areas are geographically partitioned from areas with other metal emphasis, a gold:silver ratio map (Plate 16), a copper:lead plus zinc ratio map (Plate 17), and several variation diagrams comparing various trace metals with gold:silver ratios were prepared. The results of these studies show that the geographic distribution of the trace metal assemblages is systematically rewlated to the gold:silver ratio of a given sample.

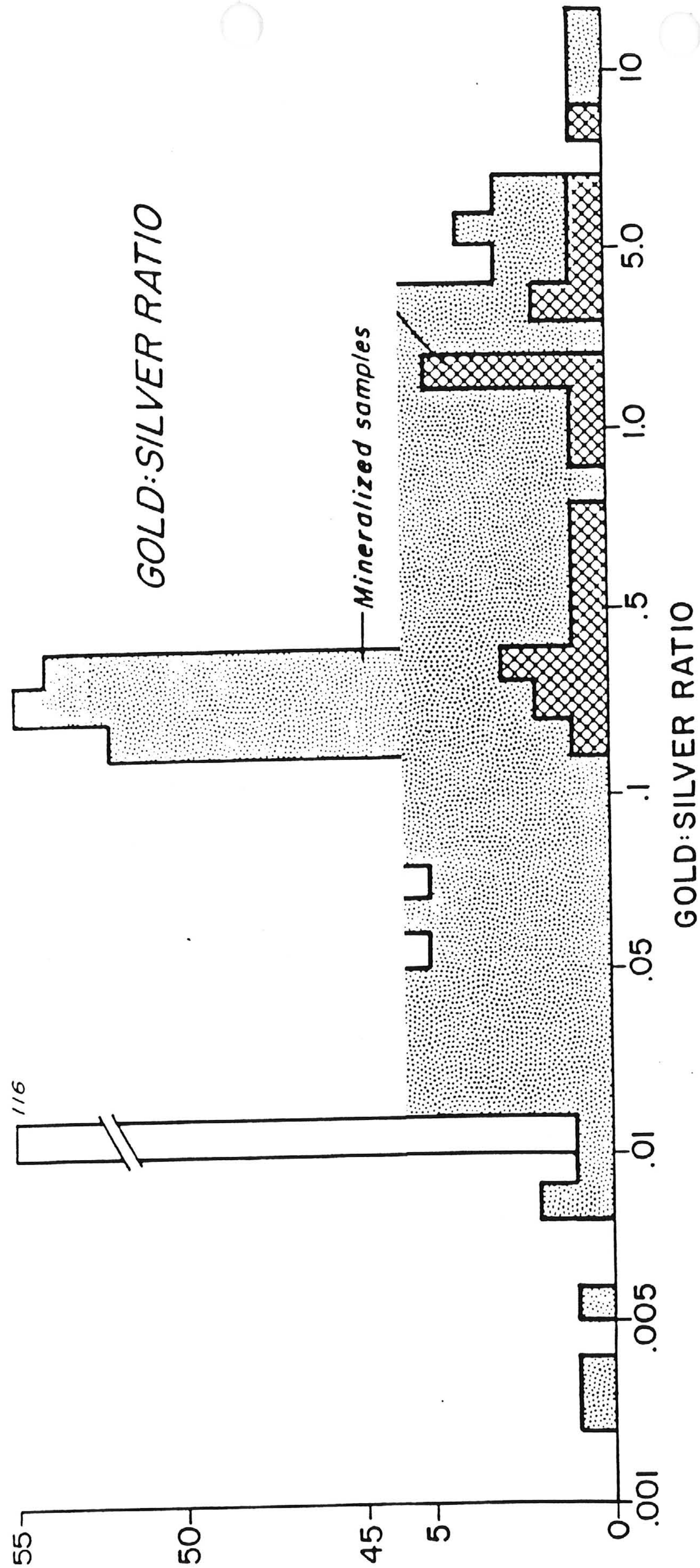
Analysis of Gold:Silver Ratios

Analysis of gold:silver ratios in the Socorro Peak area was done by analyzing their frequency distribution, which was graphically presented in the form of frequency histograms. These diagrams were constructed in the following way. First gold:silver ratios were determined for all analyzed samples to determine the total range of values. In the case of gold:silver ratios the range of values was from .002 to 10.0. Because of the large range of values (4 orders of magnitude) a modified log scale was used to present the data on the x-axis of the diagram. The modified log scale is divided into equal parts called class intervals with each order of magnitude divided into 10 equal parts. The frequency of occurrence is found by assigning individual values to their appropriate class interval for the entire population of samples (in this case gold:silver ratios). Hence, the frequency distribution of a given gold:silver ratio is represented by the number of samples (shown on the y-axis) that occur within a given class interval.

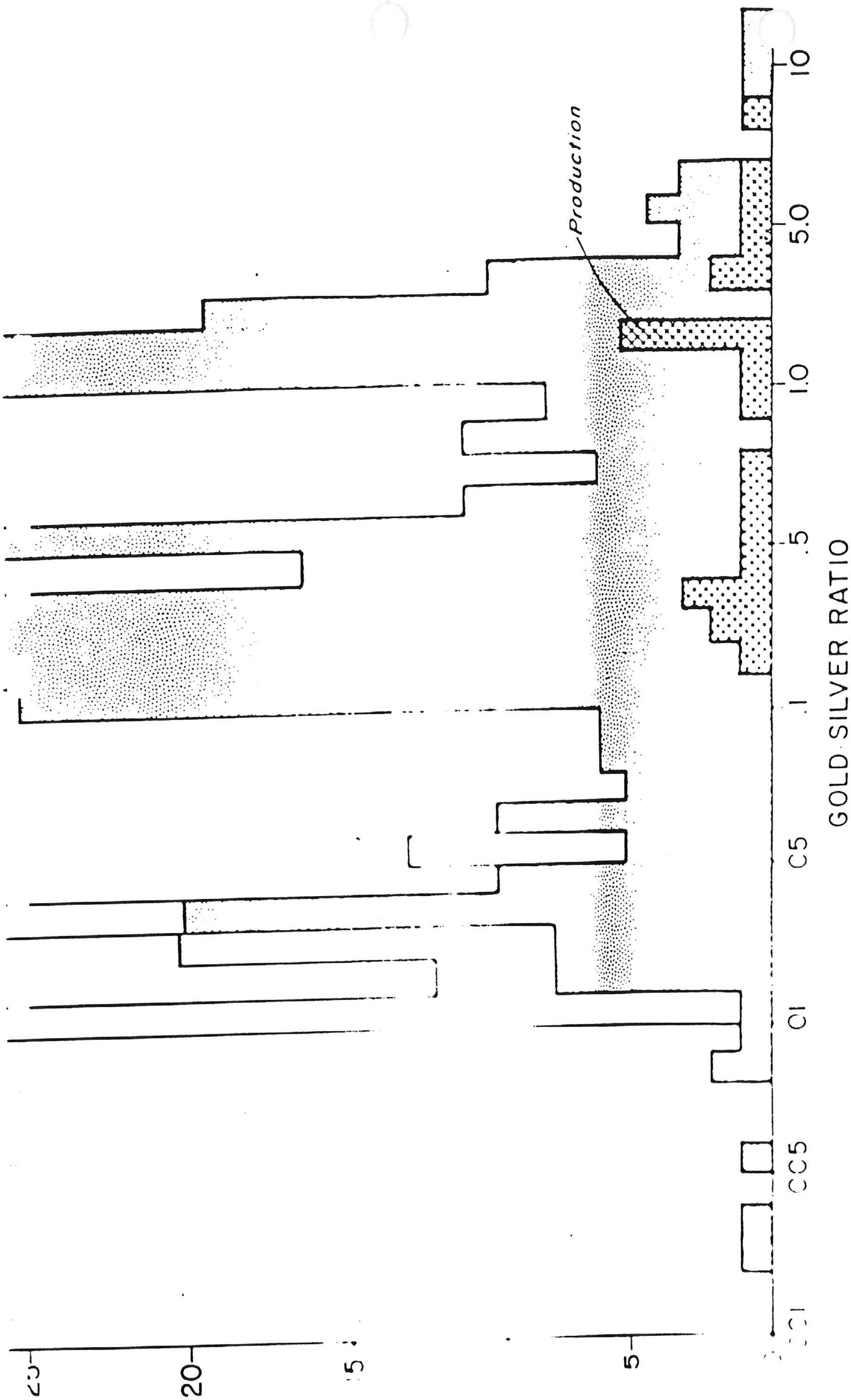
The first part of the analysis examined to what extent gold:silver ratios in the Socorro Peak area have a tendency to cluster into discrete populations. To determine this, mineralized samples containing anomalous gold (where gold is greater than or equal to .009 ppm) and/or silver (where silver is greater than or equal to 1 ppm) were compared with non-mineralized samples (Figure 11).

From Figure 11 three major populations of gold:silver ratios for mineralized samples are evident. In order of increasing gold:silver ratio these populations are represented by a silver-dominant cluster with a mode at .035, a gold-silver cluster with a mode at .025, and a gold-dominant cluster with a mode at 1.05. The largest population of samples is the gold-silver group, followed closely by the gold-dominant group, which in turn is followed by the silver-dominant group which contains a fairly low population of samples. Gold:silver ratios for historic producing mines are also shown on Figure 11. Significantly, all of the reported production coincides with the gold-silver and gold-dominant populations. Also, the principal modes of the production data closely correspond with the modes for the geochemical data. Very importantly, 99.4% of the gold production in the Salome region is associated with the gold-dominant population of gold:silver ratios, although only 56.5% of the mines in the region have gold-dominant gold:silver ratios. No precious metal production has come from prospects with silver-dominant gold-silver ratios.

On a mine by mine basis gold:silver ratios are significantly different from mine to mine (Figure 12). Three major types of deposits may be delineated on the basis of gold:silver ratios. The first type is gold dominated and is bimodal with strong modes at 1.05-1.5 and .35. The Socorro Reef gold anomaly is the best documented example of this type. A second type is gold:silver deposits which are unimodal in character with a mode at .15-.25. The gold-bearing jasperoid lenses on the Iron Door No. 1 and 2 claims and the gold:silver quartz veins on the Iron Door No. 3 and 4 claims are examples of this second type. A third class is silver



11. Frequency histogram comparing Gold:Silver ratios of mineralized samples, reported mine production, and background values in rocks of Harquahala region.



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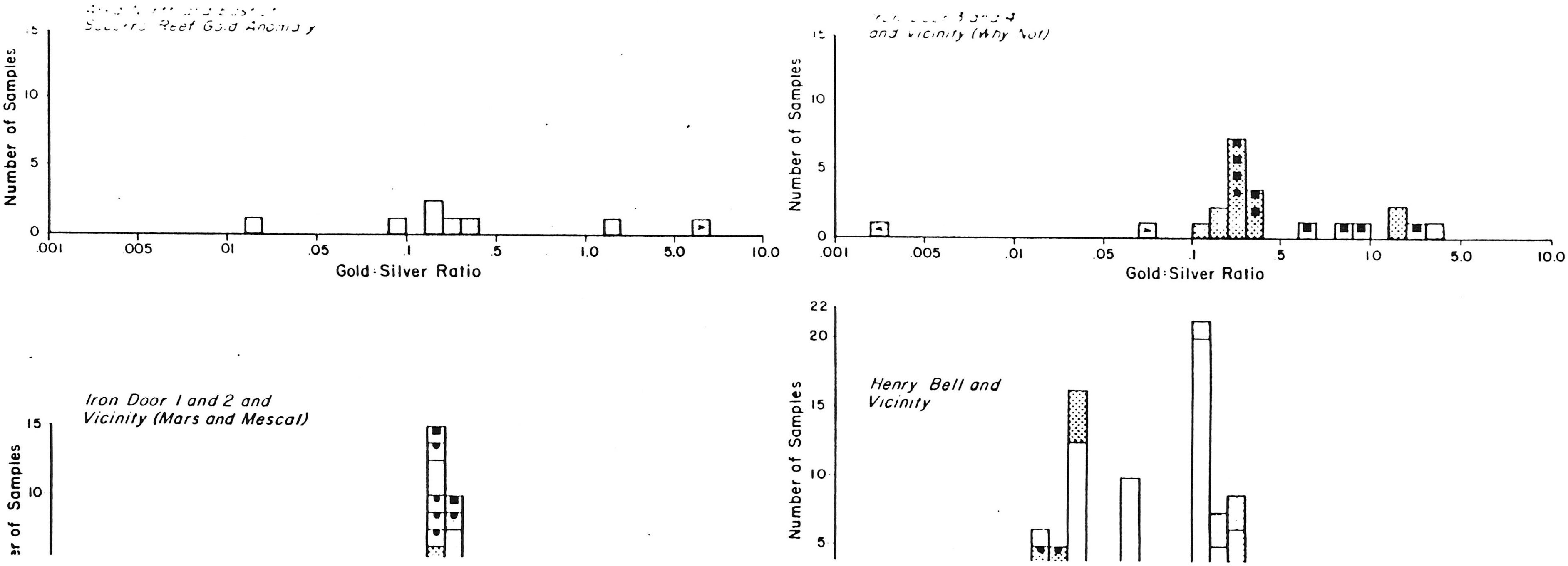
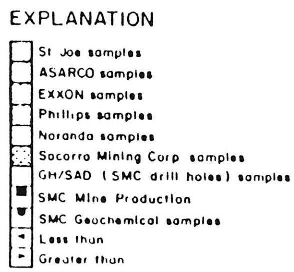
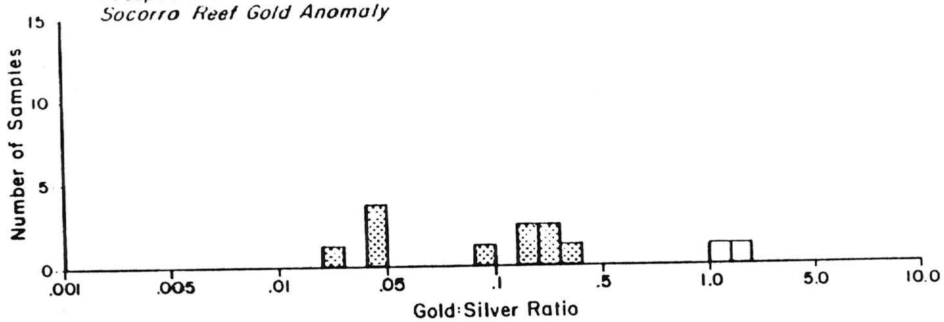




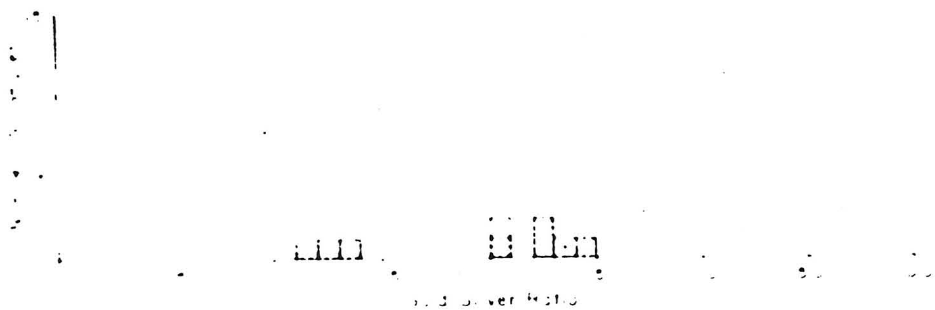
FREQUENCY HISTOGRAMS OF GOLD:SILVER RATIOS FROM MINES IN THE SOCORRO PEAK AREA OF THE HARQUAHALA DISTRICT

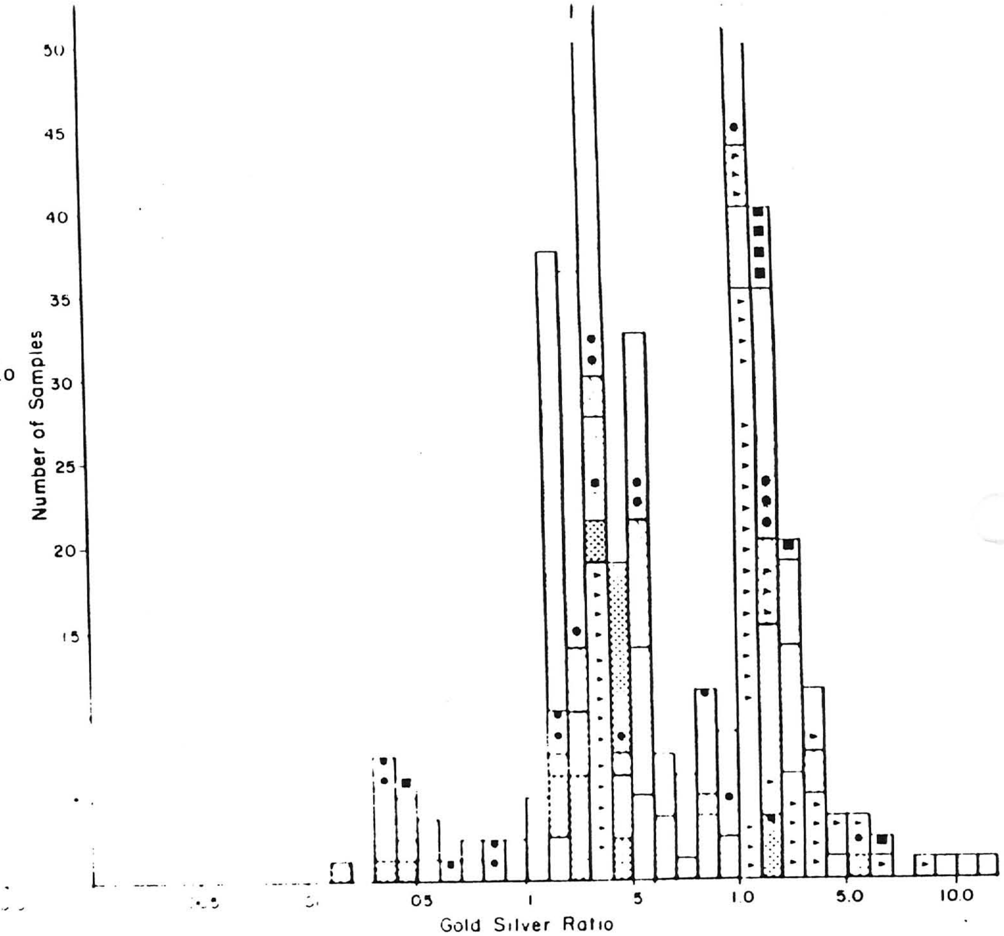
FIGURE 12

Prospects one mile North and East of Socorro Reef Gold Anomaly



Tres Padres





dominated with a bimodal character with modes at .105 and .15-.35. The Henry Bell claim is an example of the silver-dominant class.

Comparison of other metals with gold:silver ratio

In order to evaluate to what extent other trace metals correspond with specific populations of gold:silver ratios, anomalous samples of arsenic (greater than 10 ppm), antimony (greater than 5 ppm), molybdenum (greater than 10 ppm), and uranium (greater than 6 ppm) were compared with the gold:silver ratio for each sample that contained one of the above anomalous elements (Figure 13). It is clear from Figure 13 that uranium, molybdenum, antimony, and arsenic anomalies consistently correspond with the gold:silver population of gold:silver ratios (i.e. the population of gold:silver ratios with a principal mode at .15 to correspond with the gold:silver and gold-dominant populations. The lack of anomalous mercury in the Socorro Reef gold anomaly strongly suggest that mercury will correspond with the silver-dominant and gold-silver populations of gold:silver ratios. Lead and copper anomalies are associated with all three gold:silver ratio populations, whereas zinc is associated with the silver-dominant and gold:silver populations.

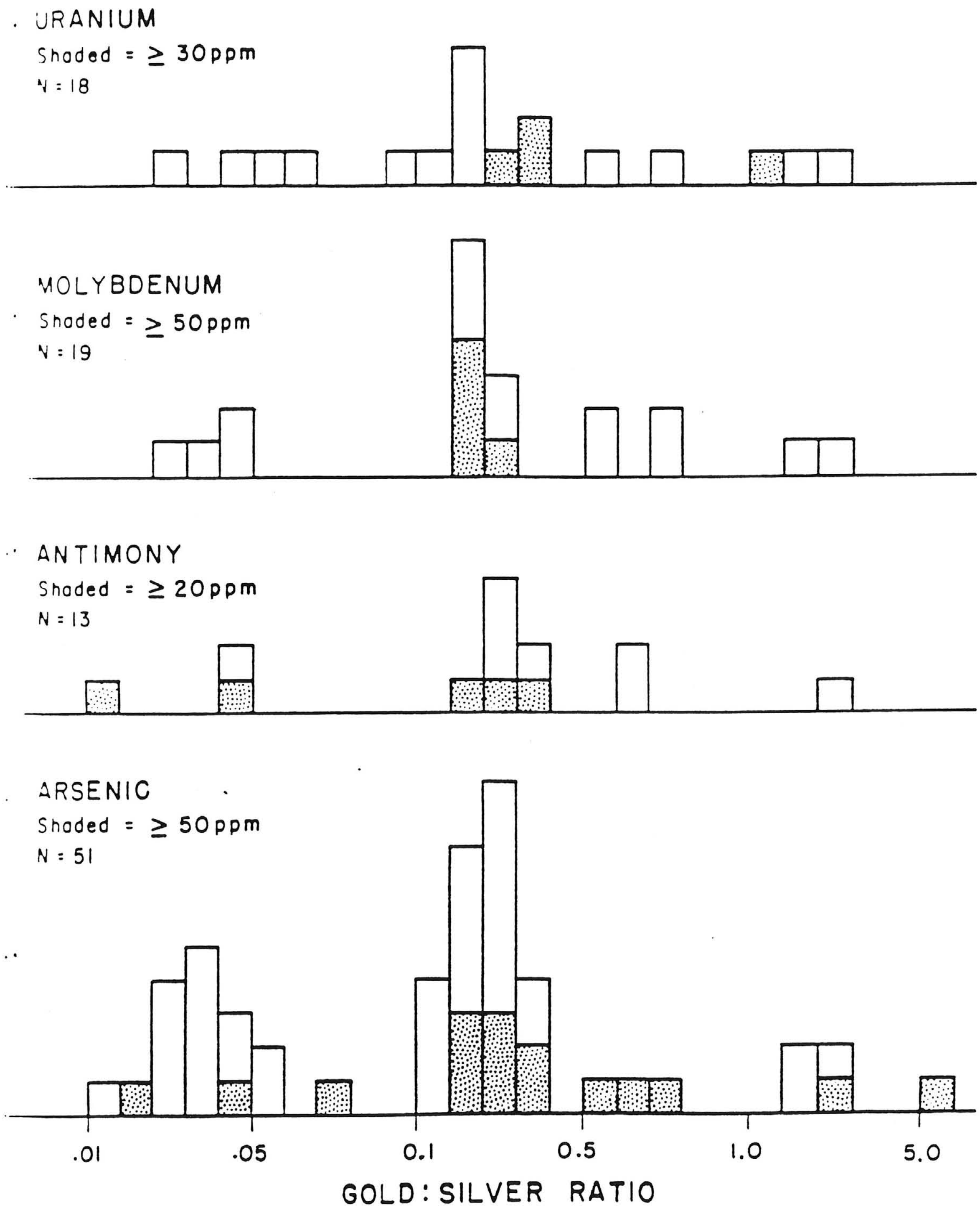
Metallogenic Zoning within Socorro Peak area

The foregoing sections have established that there are three distinctive mineral deposit types, each with a distinctive assemblage of metallogenic components, gold-silver ratios, mineralogy, and structural habit. Furthermore, each assemblage may be interpreted as a component of a larger single zoned metallogenic system with a central zone that grades outward into an intermediate zone which, in turn, grades outward into a peripheral zone.

These zones will be described from the center outward and are as follows: 1) a central, gold-dominant, tungsten-lead-copper zone; 2) an intermediate, gold-silver, polymetallic zone; and 3) an outer, silver-dominant, base metal-manganese-mercury zone. Each of these is described in more detail below.

CENTRAL, GOLD-DOMINANT, TUNGSTEN-LEAD-COPPER ZONE

The Socorro Peak gold anomaly is an excellent example of the metallogenic center of a calc-alkalic, low-grade, disseminated gold sulfide system. It has many similarities to the more familiar disseminated gold systems in Nevada, namely the presence somewhere in the sulfide system of anomalous mercury, antimony, arsenic, and tungsten. Unlike Carlin, at Socorro Peak the antimony, arsenic, and mercury are zoned away from the main disseminated gold center. Like Carlin, tungsten with minor lead and lesser amounts of copper and even lesser silver are present within the main disseminated gold deposit. Like Carlin, the Socorro Reef gold anomaly contains a pyritic alteration expressed by disseminated, euhedral cubes of pyrite scattered throughout the central



13. Frequency histogram comparing samples with anomalous Arsenic (greater than 10 ppm), Antimony (greater than 5 ppm), Molybdenum (greater than 10 ppm), and Uranium (greater than 6 ppm) with Gold:Silver ratio.

zone. Also, the pyritization is accompanied by quartz-sericite alteration of feldspars and ferromagnesian minerals in the associated wall rocks. Like Carlin, the Socorro Reef gold anomaly is structurally controlled by the intersection of high-angle structures with low-angle structures (in this case the intersection of the northwest-striking, high-angle Socorro fault with the low-angle, late Cretaceous aged Golden Eagle thrust fault).

INTERMEDIATE, GOLD-SILVER-TUNGSTEN, POLYMETALLIC ZONE

The Socorro Reef gold anomaly is flanked outward by a distinctive gold-silver-tungsten, polymetallic assemblage that is physically expressed in two ways: as gold-bearing jasperoid lenses and as quartz veins. The gold-bearing, polymetallic jasperoid lenses are strongly controlled by stratigraphy. All lenses so far mapped occur exclusively in the cherty carbonate member of the Mississippian Redwall Limestone and are spatially near north- to northwest-trending faults. The gold-bearing jasperoid lenses are metallogenic "supermarkets" with highly anomalous values of all eleven metals that were analyzed. Within the jasperoid lenses, molybdenum probably exhibits a positive correlation with tungsten. This correlation may indicate the presence of powellite. The high values of arsenic, antimony, and copper are consistent with the presence of the tetrahedrite-tennantite series. The marked affinity of uranium for the jasproid lenses suggests that the uranium at Socorro Peak is not exotic, but rather is associated in some low-level way with the calc-alkalic gold system.

In a more erratic way the gold-silver-tungsten bearing quartz veins are also polymetallic. The quartz veins appear to be structurally controlled by their proximity to thrust faults (for example, Figure 8A and 8B). A strong correlation with northwest-trending fractures is not apparent; this is consistent with their inferred peripheral position with respect to the gold-dominated, central zone. The disseminated pyrite cubes which were a diagnostic feature of the central zone occur only sparingly in the gold-silver polymetallic zone. Only one small area of fracture-controlled, pyritic alteration was noted on the Iron Door No. 3 and 4 claims and one small pyritic patch was observed in Bolsa Quartzite outcrops at the summit of Socorro Peak.

The highest concentrations of tungsten within the Socorro Peak area came from polymetallic jasperoid lenses and quartz veins of the intermediate zone where high tungsten values are consistently correlated with the gold-silver population cluster (Figure 11). Indeed, tungsten production associated with the mid-Tertiary calc-alkalic dikes throughout the Salome region comes from mines with gold:silver ratios in reported production between .11 and .7. The best example of the gold-silver-tungsten association is the Blue Eagle or Bunker Hill property about six miles west-northwest of Socorro Peak which produced 1100 short ton units (stu) of tungsten in the 1950's, 172 ounces of gold, and 258 ounces of silver from flat quartz veins and scheelite disseminations in a mylonite zone in Precambrian crystalline rocks about 50 m above the Hercules thrust.

PERIPHERAL, SILVER-DOMINANT, BASE METAL-MANGANESE ZONE

The Henry Bell claim appears to be a good example of silver-dominated outer zoning. The Hidden Treasure mine, two miles southeast of Socorro Peak, and the Tres Padres claim are also probably examples of the silver-dominated outer zone. Mineralization in these areas is expressed by silicification and quartz veining within Paleozoic carbonate rocks. No examples of this type are known from the Precambrian crystalline rocks that are widespread throughout the Salome region. Base metals (copper, lead, and zinc) are present in locally anomalous amounts with no clear dominance of one over the other. The silicic alteration is commonly manganiferous and consistently carries anomalous mercury. Indeed, many apparently unmineralized rocks in the outer zone contain anomalous mercury (See Plate 7). Barite and wulfenite occurs sporadically in these deposits. None of the silver-dominant outer zone deposits occur in close proximity to thrust faults and at the Tres Padres no clear structural control for the quartz pods is apparent. Hence, structural control appears to be most important in the case of centrally zoned, gold-dominant deposits; moderately important for intermediate zoned, gold-silver, polymetallic deposits; and least important for the outer zoned, silver-dominant deposits. However, the Henry Bell and the Hidden Treasure, which are silver-dominant deposits, do occur in or near the intersection of northwest-striking, high-angle faults with Paleozoic carbonate wall rocks, so structural control is not entirely absent.

Disseminated Gold Deposit Model for the Salome Region

Synthesis of geological and geochemical information presented in previous sections suggest that any disseminated gold occurrence in the Harquahala region should have as many as possible of the following characteristics.

1. Proximity to late Oligocene, calc-alkalic, microdiorite dikes.

2. Proximity to high-angle, north- to northwest-striking fractures.

3. Proximity to regional, low-angle thrust faults.

4. Proximity to favorable units in the Paleozoic section, especially the Bolsa Quartzite - Abrigo section.

5. Presence of widespread, supergene, hematite-goethite-jarosite-clay alteration and hypogene, quartz-sericite-pyrite alteration.

6. Presence of a favorable gold:silver ratio, especially a significant number of ratios greater than 1.0.

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7. Consistent presence of anomalous lead and copper values and a lack of anomalous zinc values.

8. Presence of greater than .009 ppm gold.

9. Consistently anomalous tungsten with a positive correlation to gold.

10. Lack of polymetallic characteristics (general lack of anomalous antimony, arsenic, uranium, zinc, and molybdenum).

11. Lack of strong mercury contents (less than .5 ppm mercury).

Each of the above criteria alone may be viewed as a necessary condition for the occurrence of a disseminated gold deposit. A coincidence of all ten would highly augment the possibility of a commercially viable system. Obviously, the ultimate sufficient condition are the grade-tonnage parameter and the price of gold.

Figure 14 is a schematic diagram illustrating the model outlined above. In this model gold mineralization occurred throughout the Salome region about 25 m.y. ago in association with calc-alkalic magmatism. The calc-alkalic nature of this magmatism determined the overall metallogenic content of hydrothermal fluids that would be expelled from the calc-alkalic plutonic bodies upon their final consolidation.

The gold-tungsten bearing solutions, following the microdiorite dikes, ascended through a high-angle, generally northwest-striking fracture system. Where these fluids encountered zones of increased permeability at the intersection of the high-angle, northwest-striking feeder fractures with low-angle, pre-mineral faults, deposition of disseminated gold mineralization took place. In the Salome region gold deposition took place at the intersection of the high-angle fracture system with the low-angle, thrust-fault sandwich of Late Cretaceous-early Tertiary age. At these structural intersections increased permeability probably induced pressure quenching and boiling of the ascending hydrothermal fluids. This resulted in deposition of the gold-tungsten-lead-copper pyritic assemblage in the central zone.

As fluids moved laterally outward and upward away from the central zone into the carbonate section, the gold-silver-tungsten polymetallic assemblage was deposited as jasperoid lenses in favorable Paleozoic carbonate rocks near northwest-trending faults and as quartz veins near low-angle thrust faults in Paleozoic and Precambrian crystalline rocks. Continued outward migration and cooling of the hydrothermal fluids resulted in the deposition of the silver-dominated, base metal-manganese-mercury mineralization in outer zones where Paleozoic carbonate wall rocks were present. The absence of the silver-dominated assemblage in the Precambrian crystalline rocks may reflect the fact that the carbonate lithology of the Paleozoic rocks induced deposition of the silver-bearing

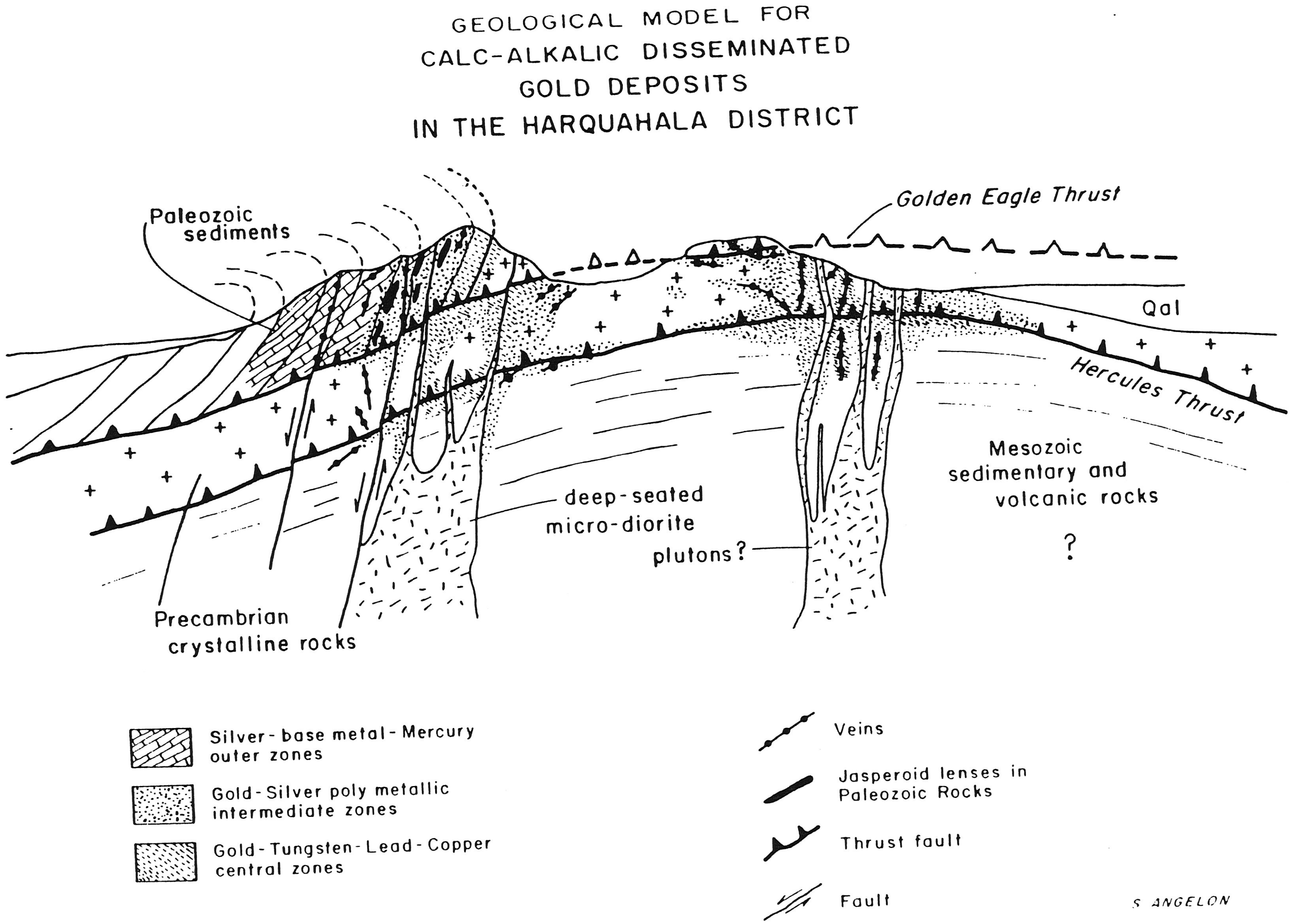


Figure 14. Diagrammatic cross section showing model for disseminated gold deposits in the Salome region.

assemblage by neutralization of the through-going hydrothermal fluids. The presence of a widespread mercury anomaly in the Paleozoic section suggests that the late Oligocene hydrothermal systems were very large and thoroughly penetrated wall rocks away from the northwest-striking feeder structures for some distance.

Figure 14 also speculates that two styles of disseminated gold systems might be present within the Salome region. The first type has already been documented in the Socorro Peak area and represents a disseminated gold system deposited at a structural intersection between high and low angle structures where a significant Paleozoic section is present nearby. In these systems a well-developed, gold-silver bearing, polymetallic halo is present in Paleozoic rocks adjacent to the central zone and gold-bearing jasperoid lenses are developed in favorable Paleozoic stratigraphy. Also, a consistent silver-dominated outer zone assemblage is deposited in carbonate host rocks within the Paleozoic section, as is mercury. Plate 18 is a specific application of this model to the Socorro Peak area. An intriguing aspect of this map is that the mercury anomalies in the Paleozoic section between the Socorro and Hidden Treasure faults might represent a high level mercury halo in the outer zone above a disseminated gold deposit associated with the Golden Eagle thrust at depth (about 2500 feet) beneath the Paleozoic section. It also might represent lateral zoning away from the disseminated gold deposit beneath the Socorro Reef gold anomaly.

A second kind of disseminated gold deposit in the Salome region, which is yet to be documented in any kind of detail, would occur entirely within Precambrian crystalline rocks in the various thrust plates. In such terrains the gold-silver polymetallic halo would be diffusely present as scattered quartz veins in pods near the thrusts. These veins would grade inward into central zones where gold:silver ratios of high-grade veins would be greater than one. The area between the Hercules Mine and the San Marcos - Gold Leaf properties three to five miles north and northwest of the Socorro Mine might be an example of such an occurrence.

Application of the Disseminated Gold Model to the Salome Region and Proposed Exploration Strategies

Certain aspects of the disseminated gold model developed in the preceding sections have immediate application to existing gold deposits and to exploration for new disseminated gold deposits throughout the Salome region. In particular, the last sections have shown that disseminated gold systems, like that beneath the Socorro Reef gold anomaly, have a strong population of gold-dominant gold:silver ratios, where the gold:silver ratio is greater than or equal to 1.0. To test this observation 23 mines with reported production in the Salome region were arranged in order of decreasing tons of gold production (Table 6). It is clear from Table 6 that all of the mines in the region with greater than 2,000 tons of production have recovered gold:silver ratios of near 1 or greater than 1. This in turn suggest that smaller producers with recovered gold ratios of 1.0 or greater might be "sleepers" and could be high grade pockets near or within a larger disseminated gold center. In

Table 6: Precious Metal Production parameters for mines in Salome region.

Mining District	Mine	Tons	Au:Ag	Au(oz)	Au opt	Ag opt	Net Worth @ 400 Au
Little Harquahala	Harquahala	150,000	1.6	127,500	.85	.53	51,000,000
Harquahala	Socorro	4,786	1.45	683	.143	.098	273,200
Cunningham Pass	Critic	4,600	3.0	2,760	.6	.2	1,104,000
Harquahala	Hercules	2,670	.93	667.5	.25	.27	267,000
Cunningham Pass	Bullard	2,000	1.0	600	.3	.3	240,000
Harquahala	Hidden Treasure	964	.1776	91.4	.95	.1776	36,560
Cunningham Pass	Bonanza	713	1.1	156.9	.22	.2	62,744
Cunningham Pass	Little Giant	500	.4	100	.2	.5	40,000
Cunningham Pass	Cuprite	430	4.61	279.5	.65	.3	111,800
Harquahala	Blue Eagle (Bunker Hill)	430	.67	172	.4	.6	68,800
Harquahala	Gold Leaf	400	3.0	240	.6	.2	96,000
Harquahala	Why Not (Iron Door 3 & 4)	395	.33	233	.59	1.74	93,220
Little Harquahala	Rio del Monte	350	.33	80.5	.23	.7	32,200
Harquahala	San Marcos	300	6.67	600	2	.3	240,000
Cunningham Pass	Golden Star	270	1.55	167.4	.62	.4	66,960
Harcuvar	True Blue	200	1.17	140	.7	.6	56,000
Harcuvar	Bell Crown	170	8.0	136	.8	.1	54,400
Cunningham Pass	Davis & Fleming	120	.33	36	.3	1.0	14,400
Cunningham Pass	Wenden	120	.75	36	.3	.4	14,400
Harquahala	Mars & Mescal (Iron Door 1&2)	109	.2857	16	.15	.51	6,400
Cunningham Pass	Wenden King	100	5.0	100	1.0	.2	40,000
Harcuvar	Sheba	100	.5	20	.2	.4	8,000
Harquahala	Silver Queen	1	.25	-	.4	4	-

order to obtain an idea of how many disseminated gold centers might exist in the Salome region, gold:silver ratios for the mines listed on Table 6 were plotted on a map (Figure 15) and interpreted according to the regional disseminated gold model (Figure 16). It is apparent from Figure 16 that at least 5 and possibly 7 disseminated gold centers might be present in the Salome region. Favorability of individual mines in or near these centers is evaluated by comparison with the regional disseminated gold model in Tables 7, 8, 9, 10, and 11. Several of the more intriguing potential disseminated gold centers are summarized and discussed below.

HARCUVAR MOUNTAINS

Cunningham Pass Area

The Cunningham Pass area contains high-grade gold veins associated with closely spaced, northwest-striking fractures and microdiorite dikes that cut Precambrian gneissic rocks which have been intruded by the 85 m.y. old Tank Pass Granite. A pre-mineral mylonitic fabric has been imposed on the wall rocks. Proximity to one of the major thrust faults is not clearly evident, but it is possible that the Hercules thrust fault projects beneath the area. It is also possible that the northwest-striking fracture system in Cunningham Pass is intense enough to provide the necessary permeability requirements for a low-grade, disseminated gold system. From the gold:silver ratios of reported production this system would potentially lie between the Centroid Mine Group to the southeast and the Wenden Mine Group to the northwest. The system might be centered in the area of the Critic, Cuprite, Davis and Fleming, and Little Giant Mine Groups, which all occur in close proximity to one another about midway between the Wenden and Centroid Mine Groups. About one week of mapping and sampling would confirm the presence of such a target. However, land positions in the area are largely static because of the established mining history and entry into the area by Socorro Mining would have to be through fairly involved negotiations with numerous property owners. The geologic work would, if nothing else, contribute valuable information towards further refinement and quantification of the regional gold model.

LITTLE HARQUAHALA MOUNTAINS

Harquahala-Golden Eagle Mine Area

It is obvious from Table 9 that the Harquahala-Golden Eagle Mine Group in the Little Harquahala Mountains has many attributes in common with the Socorro Reef gold anomaly and is obviously a candidate for disseminated gold mineralization. This is especially true for a pyritic-quartz-sericite alteration area in the coarse-grained, Precambrian granite between the Harquahala Mine on the southwest and the Golden Eagle

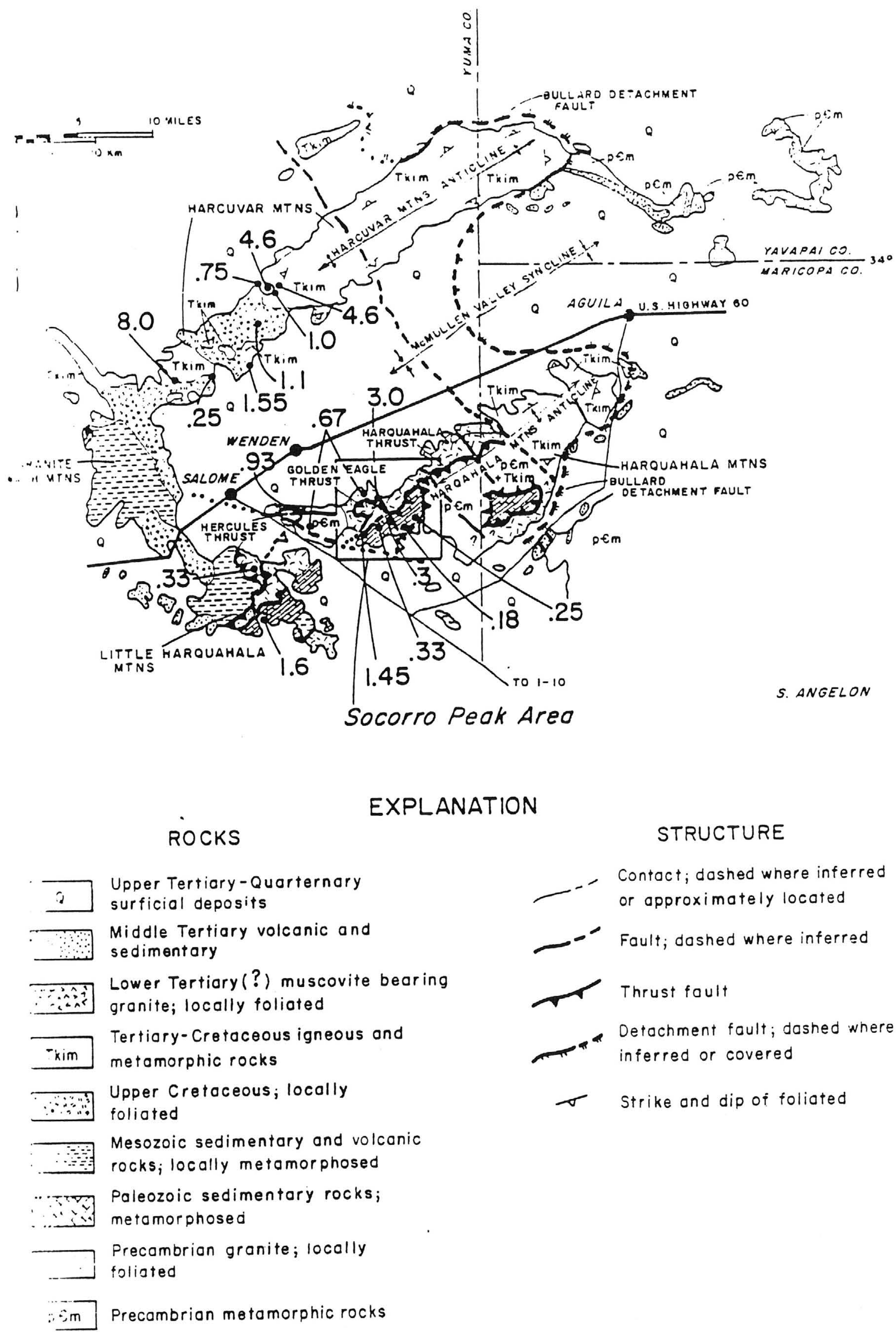
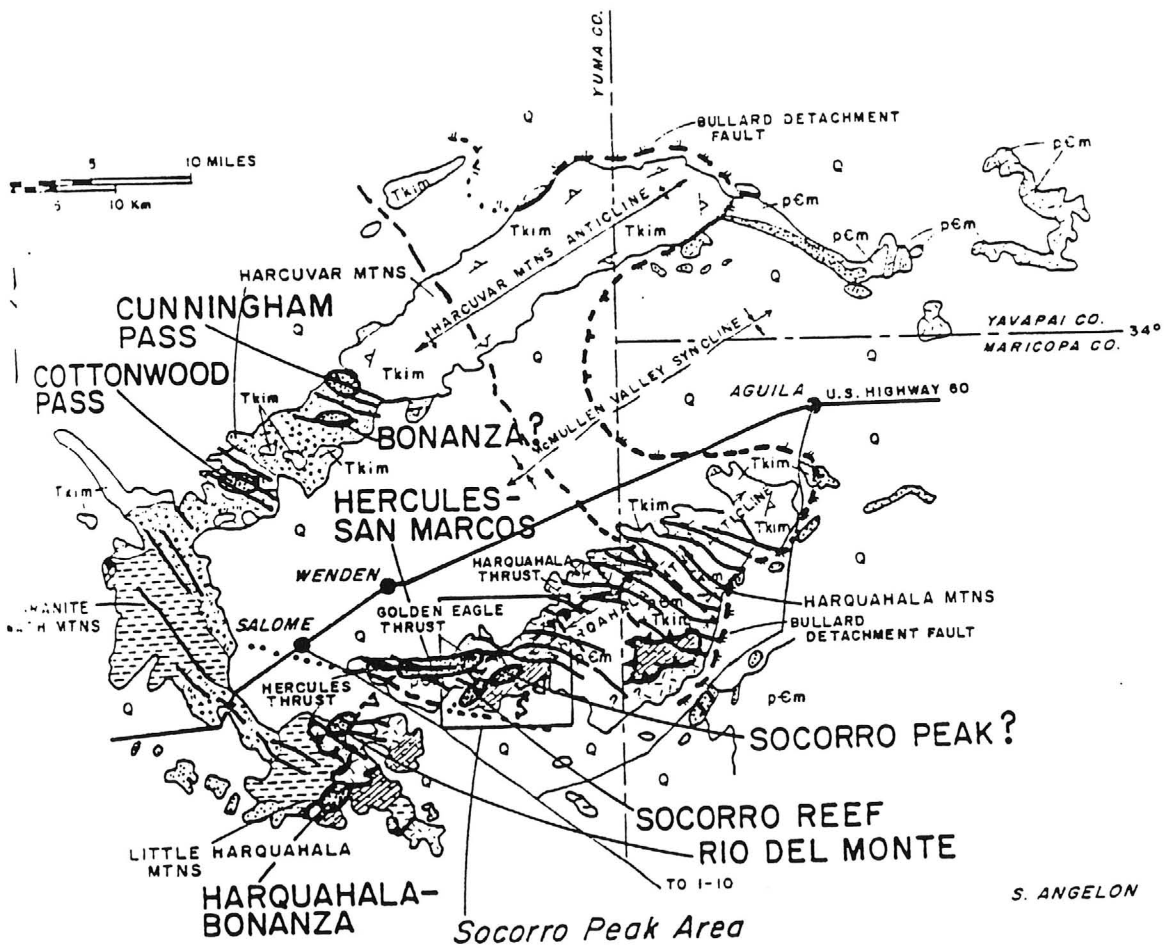


Figure 15. Map of Gold:Silver ratios from mines with reported production in Salome region.



EXPLANATION

ROCKS

- Q — Upper Tertiary-Quarternary surficial deposits
- Middle Tertiary volcanic and sedimentary
- Lower Tertiary(?) muscovite bearing granite; locally foliated
- Tkim — Tertiary-Cretaceous igneous and metamorphic rocks
- Upper Cretaceous; locally foliated
- Mesozoic sedimentary and volcanic rocks; locally metamorphosed
- Paleozoic sedimentary rocks; metamorphosed
- Precambrian granite; locally foliated
- p€m — Precambrian metamorphic rocks

STRUCTURE

- Contact; dashed where inferred or approximately located
- Fault; dashed where inferred
- Thrust fault
- Detachment fault; dashed where inferred or covered
- Strike and dip of foliated

Figure 16. Geologic map of Salome region showing potential centers of disseminated gold mineralization based on Gold:Silver ratios and metal zoning and location of calc-alkalic dike swarms.

Table 7: Comparison of Tertiary gold occurrences in the Socorro Peak area with Tertiary, disseminated gold deposit model for Salome region.

	SOCORRO PEAK AREA					
	Socorro Reef GoldAnomaly	Henry Bell	Tres Padres	Iron Door Nos. 4 & 5	Iron Door Nos. 1 & 2	Hidden Treasure - Suzy Q
...ICAL AND MINEROLOGICAL ...ACTERISTICS						
...esence of tertiary calc-...alic microdiorite dikes	Yes, along Socorro fault	Yes, along Socorro fault	No	No	One small dike to west	Probably No
...esence of high-angle NW ...riking fractures	Yes, also north and west-northwest fractures	Yes, proximal to Socorro fault	No	No	Small faults locally	Yes
...esence of major ...w-angle thrusts	Golden Eagle fault projects about 200-300 feet beneath area and directly controls mineralization of the Socorro mine	No	No	Yes	No	No, but minor thrust are exposed to N and E
...esence of favorable ...leozoic section	Yes, Bolsa Quartzite	Yes, Martin Formation	Yes, Redwall Limestone	No	Yes, Redwall Limestone	No
...esence of hematite-...ay alteration ...upergene) and quartz-...ericite-pyrite alter-...ation (hypogene)	Yes, locally strong; Quartzite averages .5 - .75 weight percent introduced pyrite	No	No	No, but minor pyritic zones	No, mostly polymetallic Au-bearing jasperoid lenses	No, mostly silicification
...E...CHEMICAL CHARACTERISTICS						
...esence of favorable ...:Ag ratio (>.9)	Yes, includes areas of strongly dominant gold with many Au:Ag ratios greater than 1.0	No, strong Ag bias; main Au:Ag modes at .105 & .035	Yes	No, main Au:Ag mode is .35	No, strong Au:Ag mode at .25	No
...esence of copper and lead ...minant base metal ratios ...ack of Zn)	Yes	No, strong Zn anomaly	No, mostly Pb	No, Pb-Zn	No, Zn is significant along with strong Cu	No, minor Cu, Pb,Zn,Mn production. One sample ran 27% Pb
...esence of greater than	Yes, largest Socorro Peak area	Only locally	Yes	Yes	Yes	Yes
...omalous Tungsten with ...ositive correlation to ...old	Yes, good positive correlation	No data	Weak W & no correlation with Au	Locally anomalous W	Strong W but no correlation with Au	Not determined
...ack of polymetallic ...aracteristics (lack of ...omalous Sb-As-Hg-U-Zn-Mo)	Yes, strong lack of polymetallic character	No data	Yes, but some Sb, As, W	Generally Yes	No, anomalous presence of As,Sb,Mo,U, Hg,Zn,Pb	Not determined
...ack of strong Hg ...(.5 ppm Hg)	Yes, all analyzed samples less than .5 ppm Hg	No data	No, strong Hg anomaly	No, 6 out of 8 samples >.5 ppm Hg	Very strong Hg; all samples >.8 ppm -7.2 ppm Hg	Not determined
...ESULTS OF COMPARISON	Very High Favorability	Very Favorable	Very Favorable	Unfavorable	Unfavorable	Very Favorable

Table 8: Comparison of Tertiary gold occurrences in the San Marcos-Hercules Area with Tertiary, disseminated gold deposit model for Salome region

	SAN MARCOS-HERCULES AREA				
	Prospects in Section 23	Gold Leaf	San Marcos	Hercules	Bunker Hill (Blue Eagle)
PHYSICAL AND MINERALOGICAL CHARACTERISTICS					
Presence of tertiary calc-alkalic microdiroite dikes	Several dikes in area	Not determined	Yes	Yes	Probably
Presence of high-angle NW striking fractures	Yes	Probably	Yes	Yes, mostly WNW to EW trending	Yes
Presence of major low-angle thrusts	Yes, Golden Eagle Thrust	Yes, Golden Eagle Thrust	Yes, Golden Eagle Thrust is nearby	Yes, Hercules thrust is nearby	Yes, mine is in a low-angle zone about 150-300 feet above Hercules thrust
Presence of favorable Paleozoic section	No	No	No	No	No
Presence of hematite-clay alteration (supergene) and quartz-sericite-pyrite alteration (hypogene)	Yes, Locally	Probably	Probably	Yes, large areas of goethite-jarosite alteration E of Hercules mine	No, mostly flat-lying quartz veins
GEOCHEMICAL CHARACTERISTICS					
Presence of favorable Au:Ag ratio (>.9)	Yes, locally not enough samples to determine ratio character	Yes	Yes	Yes	No
Presence of copper and lead dominant base metal ratios (lack of Zn)	Yes, locally but also significant Zn locally	Probably	Probably	Yes	Not determined
Presence of greater than .009 ppm Au	Yes	Yes	Yes	Yes	Yes
Anomalous Tungsten with positive correlation to Gold	Anomalous W but no correlation with Au	Not determined	Not determined	Not determined	1100 stu W production, but W-Au correlation is not determined
Lack of polymetallic characteristics (lack of anomalous Sb-As-Hg-U-Zn-Mo)	Yes, local presence of anomalous Mo, W,Cu,Pb,Zn,U, and As with local threshold Hg and Sb	Not determined	Not determined	Not determined	Not determined
Lack of strong Hg (<.5 ppm Hg)	Hg generally lack except for 2 samples between .4 - .5 ppm Hg	Not determined	Not determined	Not determined	Not determined
RESULTS OF COMPARISON	Generally Unfavorable but may be a polymetallic southerly fringe of Hercules-San MarcosAu anomaly	Probably Favorable	Probably Favorable	Probably Favorable	Not determined weakly favorable; especially if the density of Quartz veining (which contains virtually all the Au) is high enough to permit open-cut mining). Property is similar to Iron Door 3 & 4 claims in terms style & metal contents, but not hostrocks

Table 9: Comparison of Tertiary gold occurrences in the Little Harquahala Mountains with Tertiary, disseminated gold deposit model for Salome region

	LITTLE HARQUAHALA MOUNTAINS		
	Harquahala (Bonanza) and Golden Eagle Mine Group	Gold Dyke	San Marcos
PHYSICAL AND MINERALOGICAL CHARACTERISTICS			
Presence of tertiary calc-alkalic microdiorite dikes	Yes, but not in close proximity to mine group as presently mapped	Yes	Yes
Presence of high-angle NW striking fractures	Yes, also N-S fracturing present	Probably	No, mostly E-W
Presence of major low-angle thrusts	Yes, possibly Golden Eagle thrust at Golden Eagle mine and numerous low-angle faults in Paleozoic section	Probably no	Hercules Thrust is nearby
Presence of favorable Paleozoic section	Yes, Bolsa Quartzite	No	No
Presence of hematite-clay alteration (supergene) and quartz-sericite-pyrite alteration (hypogene)	Yes, strong in Bolsa Quartzite and moderate intensity quartz-sericite-pyrite alteration in underlying granite	Probably no, Au-W mineralization mostly in discontinous quartz veins	Minor, Au is mostly in quartz veins
GEOCHEMICAL CHARACTERISTICS			
Presence of favorable Au:Ag ratio (>.9)	Yes	No	No
Presence of copper and lead dominant base metal ratios (lack of Zn)	Yes, minor lead (154,785 lbs) and Cu (12,479 lbs) production from Harquahala mine. One sample from Golden Eagle mine contained anomalous Zn	Not determined	Minor Cu production but Zn content not determined
Presence of greater than .009 ppm Au	Yes	Yes	Yes
Anomalous Tungsten with positive correlation to Gold	Anomalous W at Golden Eagle, but W-Au correlation not determined	100 stu of W produced, but W-Au correlation is not determined	Not determined
Lack of polymetallic characteristics (lack of anomalous Sb-As-Hg-U-Zn-Mo)	Anomalous Mo,Pb,Zn,W,Sb,Hg with threshold As and U from one sample from Golden Eagle mine	Not determined	Not determined
Lack of strong Hg (<.5 ppm Hg)	Not determined. One sample from Golden Eagle mine contained .528 ppm Hg	Not determined	Not determined
RESULTS OF COMPARISON	Very favorable, Golden Eagle mine might be on polymetallic fringe but much more sampling is needed	Unfavorable; similar to Bunker Hill & Iron Door 3 & 4 properties in Harquahala district	Unfavorable; similar to Iron Door 3 & 4 ?

Table 10: Comparison of Tertiary gold occurrences in the Cunningham Pass area with Tertiary gold deposit model for Salome region

	CUNNINGHAM PASS AREA			
	Bonanza	Bullard-Critic-Cuprite-Little Giant	Centroid	Wenden-Wenden-King
PHYSICAL AND MINERALOGICAL CHARACTERISTICS				
Presence of calc-alkalic microdiorite dikes	Yes	Yes	Yes	Yes
Presence of high-angle NW striking fractures	Yes, but moderate dipping	Yes	Yes	Yes
Presence of major low-angle thrusts	Not determined	Not determined	Not determined	Not determined
Presence of favorable Paleozoic section	No	No	No	No
Presence of hematite-clay alteration (supergene) and quartz-sericite-pyrite alteration (hypogene)	Probably but most mineralization is in the vein	Probably	Probably also, specular hematite at cuprite	Probably
GEOCHEMICAL CHARACTERISTICS				
Presence of favorable Au:Ag ratio (>.9)	Yes	Yes	Yes	No
Presence of copper and lead dominant base metal ratios (lack of Zn)	Probably? Minor copper production weak U reported	Yes. Significant by-product Cu production; minor Pb production from Centroid	Probably significant by-product copper production	Probably significant by-product Cu production
Presence of greater than .009 ppm Au	Yes	Yes	Yes	Yes
Anomalous Tungsten with positive correlation to Gold	Not determined	Not determined	Not determined	Not determined
Lack of polymetallic characteristics (lack of anomalous Sb-As-Hg-U-Zn-Mo)	Not determined	Not determined	Not determined	Not determined
Lack of strong Hg (<.5 ppm Hg)	Not determined	Not determined	Not determined	Not determined
RESULTS OF COMPARISON	Probably favorable	Favorable	Favorable	Probably Unfavorable

Table 11: Comparison of Tertiary gold occurrences in the Cottonwood Pass area with Tertiary gold deposit model for Salome region

	COTTONWOOD PASS AREA	
	Bell Crown	Sheba
PHYSICAL AND MINERALOGICAL CHARACTERISTICS		
Presence of tertiary calc-alkalic microdiorite dikes	Yes	Yes
Presence of high-angle NW striking fracture	Yes	Yes
Presence of major low-angle thrusts	Hercules thrust??	Hercules thrust??
Presence of favorable Paleozoic section	No	No
Presence of hematite-clay alteration (supergene) and quartz-sericite-pyrite alteration (hypogene)	Probably	No
GEOCHEMICAL CHARACTERISTICS		
Presence of favorable Au:Ag ratio (>.9)	Yes	No
Presence of copper and lead dominant base metal ratios (lack of Zn)	Probably; significant by-product copper production	Possibly, by-product Cu production
Presence of greater than .009 ppm Au	Yes	Yes
Anomalous Tungsten with positive correlation to Gold	Not determined	Not determined
Lack of polymetallic characteristics (lack of anomalous Sb-As-Hg-U-Zn-Mn)	Not determined	Not determined
Lack of strong Hg (<.5 ppm Hg)	Not determined	Not determined
RESULTS OF COMPARISON	Probably favorable	Probably Unfavorable

Mine on the northeast.

The principal production in the Harquahala-Golden Eagle mine area has come from rich, pockety shoots of gold with minor silver from shattered Bolsa Quartzite at the Harquahala mine. Much of the mineralization in the Bolsa Quartzite was mined by open-cut techniques and one notable pocket of bonanza ore (the "Castle Garden" stope) was encountered in the Bolsa Quartzite during early mining. Veins in the quartzite are composed of two sets: one flat dipping and one steeply dipping and northwest- to north-trending. The north- to northwest-striking fractures are mineralized and extend to depth into the Precambrian granite beneath the quartzite. At least 50% of the production (Table 6) came from fracture veins in the granite where, similarly to Socorro Reef, gold values were associated mainly with auriferous pyrite with minor copper (as chalopyrite-bornite) and lead (as galena). The Precambrian granite beneath the quartzite is highly fractured and pervasively altered by the quartz-sericite-pyrite phyllic alteration assemblage.,

Unfortunately, the land status in this area is static, especially since a recent major entry into the area in 1980 by Goldfields Mining Corp., who staked at least 400 claims. Hence, virtually all available ground is under claim by various claimants with the presence of Goldfields greatly increasing any entry price for Socorro Mining. However, detailed geologic mapping and geochemical sampling of this ground would, if nothing else, provide important geologic information towards quantifying the disseminated gold model.

Rio del Monte Area

Production ratios for the Rio del Monte Mine indicate the Rio del Monte and immediately adjacent ground are not of interest. However, the Rio del Monte Mine is far enough removed from any of the other areas that it might be zoned away from a potential "sleeper" gold system. A good place to look for such a wildcat target would be to the east of the Rio del Monte where a probable extension of the Golden Eagle thrust was mapped by S. Reynolds, S. Richard and J. Spencer (S. Reynolds, personal communication, November 1982). The thrust zone is also the locus of a fairly pervasive, supergene, limonitic alteration.

Because of the poor gold production record in this area, ground northeast of this area (SE 1/4, T.5S., R.13W., and NE 1/4, T.4S., R.13W.) is probably lightly held and should be relatively open (Figure 17). I recommend a detailed initial property search and immediate acquisition of the ground if any open ground is available. The land search should be conducted concurrently with the one recommended for the Hercules-San Marcos-Gold Leaf area (see below).

HARQUAHALA MOUNTAINS

Socorro Peak Area

The recent U.S. Borax analyses of Socorro Mining Corp. samples have conferred a new perspective to the Socorro Peak area. Although the mineral deposits on the Iron Door No. 1 and 2 (Mars and Mescal), Iron Door No. 4 and 5 (Why Not), and Hidden Treasure claims have the wrong geologic and geochemical parameters and are not large enough to be of commercial interest as disseminated gold deposits (see Table 7 and Keith report of Socorro Mining dated May 3, 1982), their metal contents suggest they are zoned either vertically above or laterally away from a significant, gold-dominated, disseminated gold system. This idea is strongly reaffirmed by the presence of a widespread mercury anomaly in the area (Plate 7). The question is whether the Iron Door-Hidden Treasure area is zoned laterally away from the Socorro Reef gold anomaly or if it is zoned vertically above a separate disseminated gold system associated with the Golden Eagle thrust at depth. If the Iron Door-Hidden Treasure area is zoned vertically above a separate disseminated gold system, the system would be inferred to lie beneath the Iron Door No. 1 - 4 claims at an inferred structural intersection between the Golden Eagle thrust and the high-angle, northwest-striking, Hidden Treasure fault system. Target depths are poorly constrained at this point in time because the exact position of the Golden Eagle thrust north of the Iron Door claim block is yet to be firmly mapped. However, extrapolation of existing map data would suggest that a disseminated gold deposit target might lie 500 to 1500 feet beneath the Iron Door claims. Additional geochemical sampling and mapping would be needed in the Hidden Treasure mine area and in the granite terrain north of the Iron Door claim block between the Iron Door claim block and the Gold Leaf property. This program would tie down the position of the Golden Eagle thrust and clarify zoning relationships in the Socorro Peak area.

Socorro Mining Corporation already controls much of the ground in the area. In addition, Jerry Sira, Socorro Mining Corporation's watchman, controls much of the ground in Sections 30 and 29 over the southern extension of the mercury anomaly (the Suzy Q claims). Also George W. Campbell controls the White Eagle Group in the northeast 1/4 of Section 19, over the eastern extension of the mercury anomaly. There is much open ground in Sections 24 and 23 which should probably be obtained and negotiations with George Campbell, Jr. for rights to the White Eagle claims should be initiated if the results of further mapping and geochemical sampling are encouraging. In the interim, Socorro Mining Corporation should take Jerry Sira up on his offer to assign his claims to Socorro Mining Corporation. Mapping and geochemical sampling of this area would cost about $8,000.00.

Socorro Reef Area

Individual properties in the Socorro Reef area are reviewed for their favorability in Table 7. Obviously, the Socorro Reef gold anomaly is highly favorable. The geology, geochemistry, and economic aspects of the Socorro Reef gold anomaly will be described in great detail in Part II. The Tres Padres and Henry Bell properties are interpreted to be laterally zoned away from the disseminated gold center beneath the Socorro Reef gold anomaly and thus are considered unfavorable for a major gold system (see Table 7 for details).

Socorro Mining already controls all the ground it needs to explore and potentially develop the Socorro Reef gold anomaly. A program for the exploration and development of the Socorro Reef gold anomaly will be presented in Part II.

Hercules-San Marcos Area

Application of the disseminated gold deposit model to the Salome region revealed a very intriguing gold:silver ratio pattern for reported mine production between the San Marcos-Gold Leaf mines on the east and the Hercules mine on the west. This anomaly is mostly contained in Section 7 - 18, T.5N., R.12W. The geology of the area is dominated by Precambrian crystalline rocks within the Hercules plate of the regional, Late Cretaceous-Early Tertiary, thrust fault sandwich. The Precambrian rocks have been strongly broken by high-angle, west-northwest striking to east-west striking fractures, which have been intruded by numerous microdiorite dikes. During reconnaissance mapping in Sections 18 and 19, T.5N., R.12W., I observed large areas of limonite-jarosite alteration of the Precambrian rocks and numerous microdiorite dikes within the east-west striking fracture zones. There is a good possiblilty that one or several disseminated gold anomalies with commercial potential might exist in this zone. This idea is reinforced further by geochemical sample results for mineralization in Section 23, T.5N., R.12W. These samples indicate that the mineralization here is in a possible, diffuse gold-silver, polymetallic halo south of the inferred San Marcos-Gold Leaf-Hercules gold center.

The mineral rights as of March 17, 1982, in the area are locally tied up by several claimants, especially in Sections 10 - 12 and 14 - 19. However, ground is moderately held in Sections 7, 8, and 18. Also, at least 113 out of 208 claims in the densely held sections are not current according to Bureau of Land Management records dated March 17, 1982. Hence, a substantial amount of ground may be open. I recommend that a detailed land search be conducted of this area and that any available ground be acquired as soon as possible (Figure 17). This could amount to as many as 250 claims. Following acquisition of this ground, detailed mapping and geochemical sampling should be done to zero in on any potential gold targets. If such a program leads to encouraging results, Socorro Mining would have a highly attractive new gold prospect package to add to the one it already has at Socorro Reef. Acquisition of the above ground and preliminary geologic mapping and sampling would amount to $35,000 to $40,000. Because the ground could be acquired in the early part of 1983 assessment year, Socorro Mining would have about 1 year and 9 months to obtain the necessary geologic information. Also this information could be used for assessment purposes in the 1984 assessment year. Thus, Socorro Mining Co. could tie the ground up until September 1, 1985. This real estate could provide an attractive new package that would greatly enhance interest in the total Socorro Mining package by any

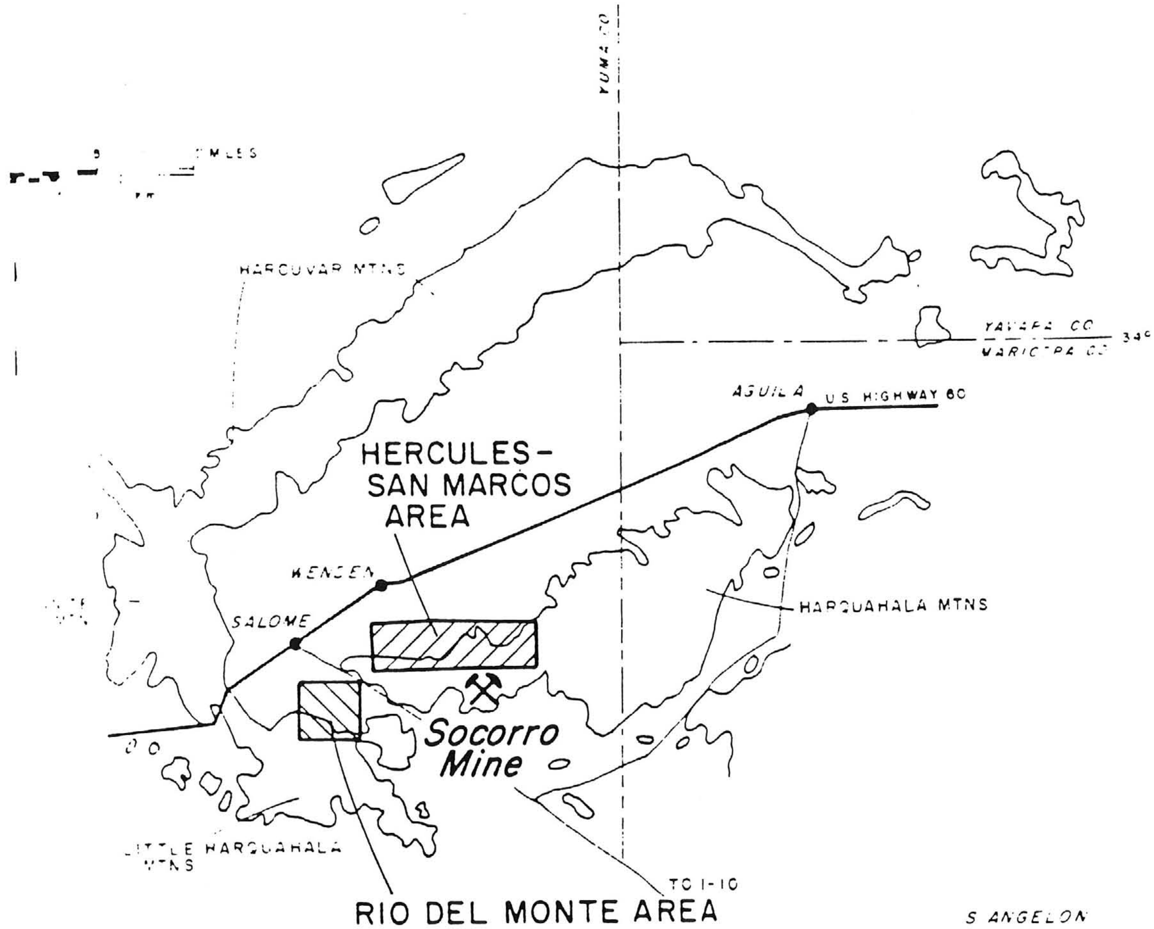
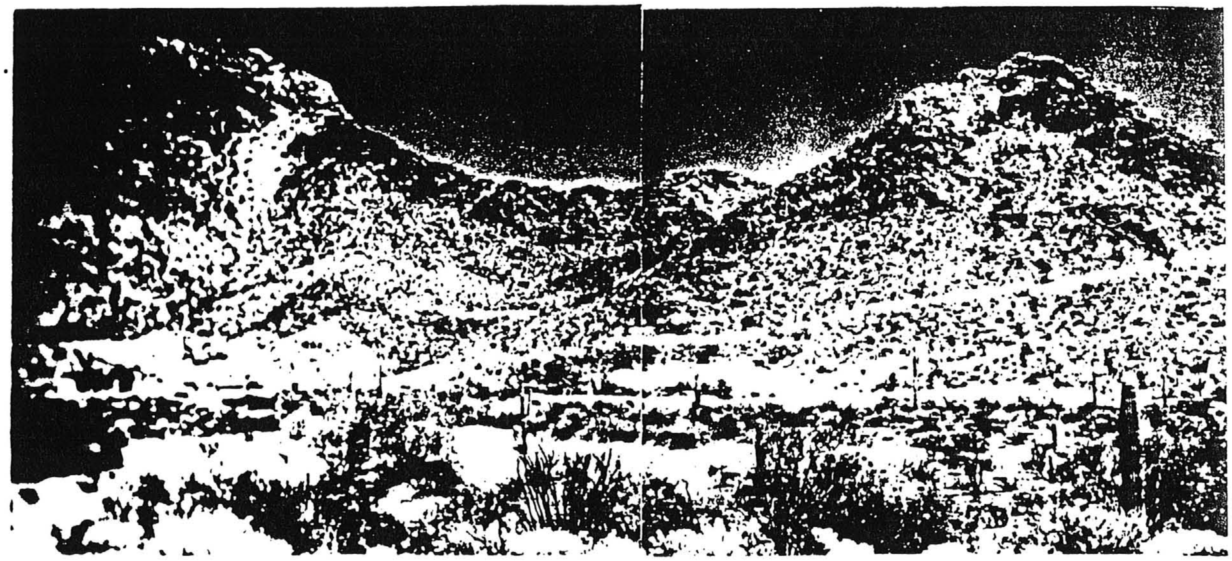


Figure 17. Recommended property acquisition in Tenahatchapi Pass area.



Photographic panorama of Socorro Reef gold anomaly. The Socorro Mine and mill site at the northeast end of the anomaly is at the left of the panorama.

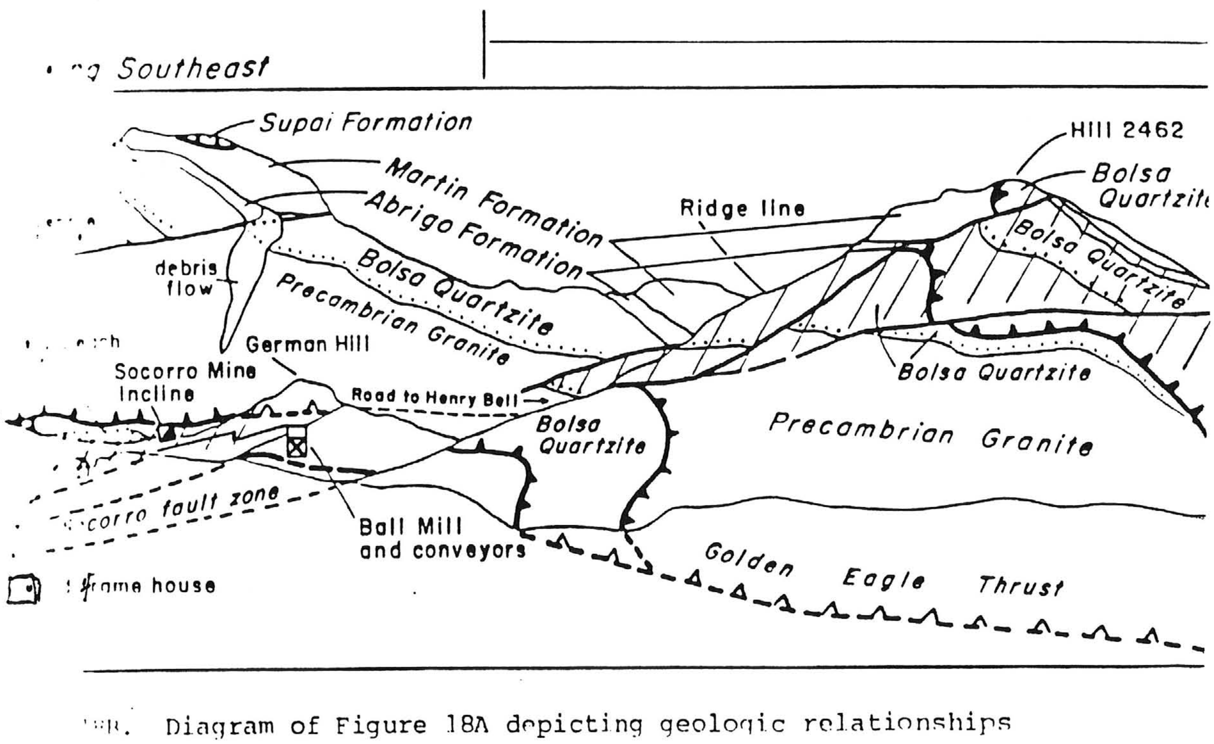
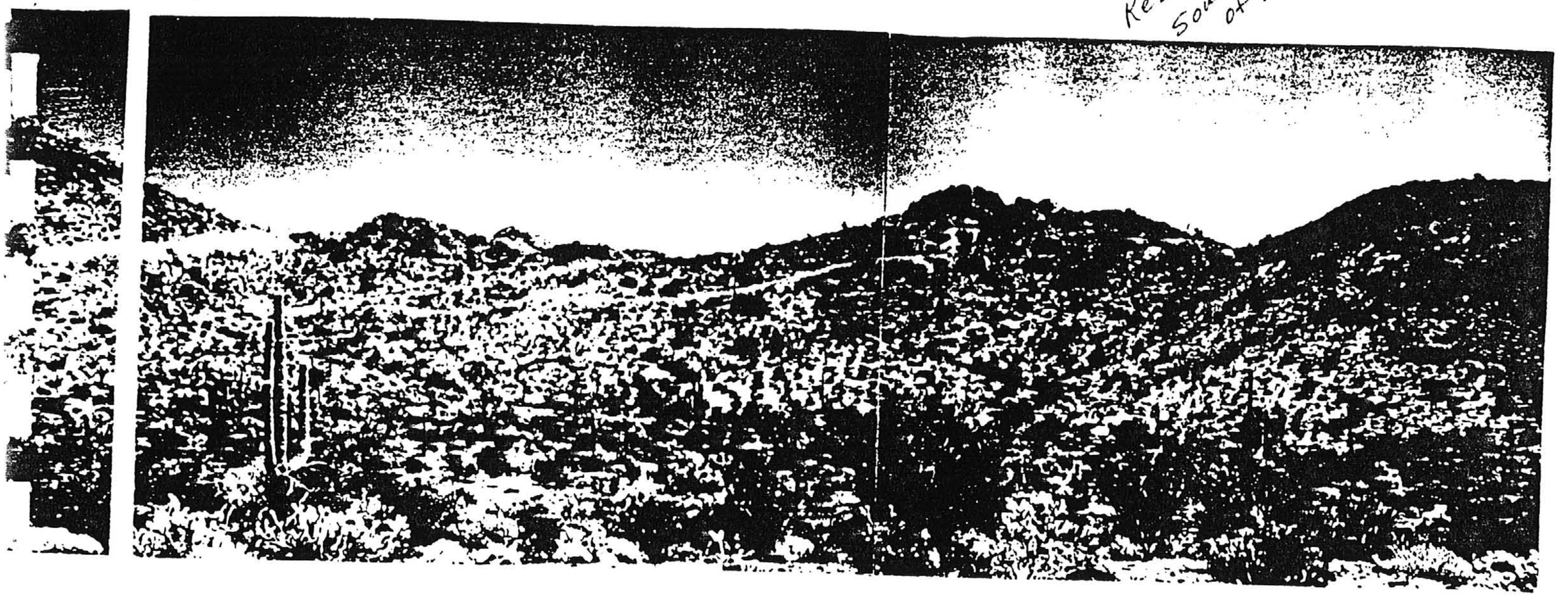
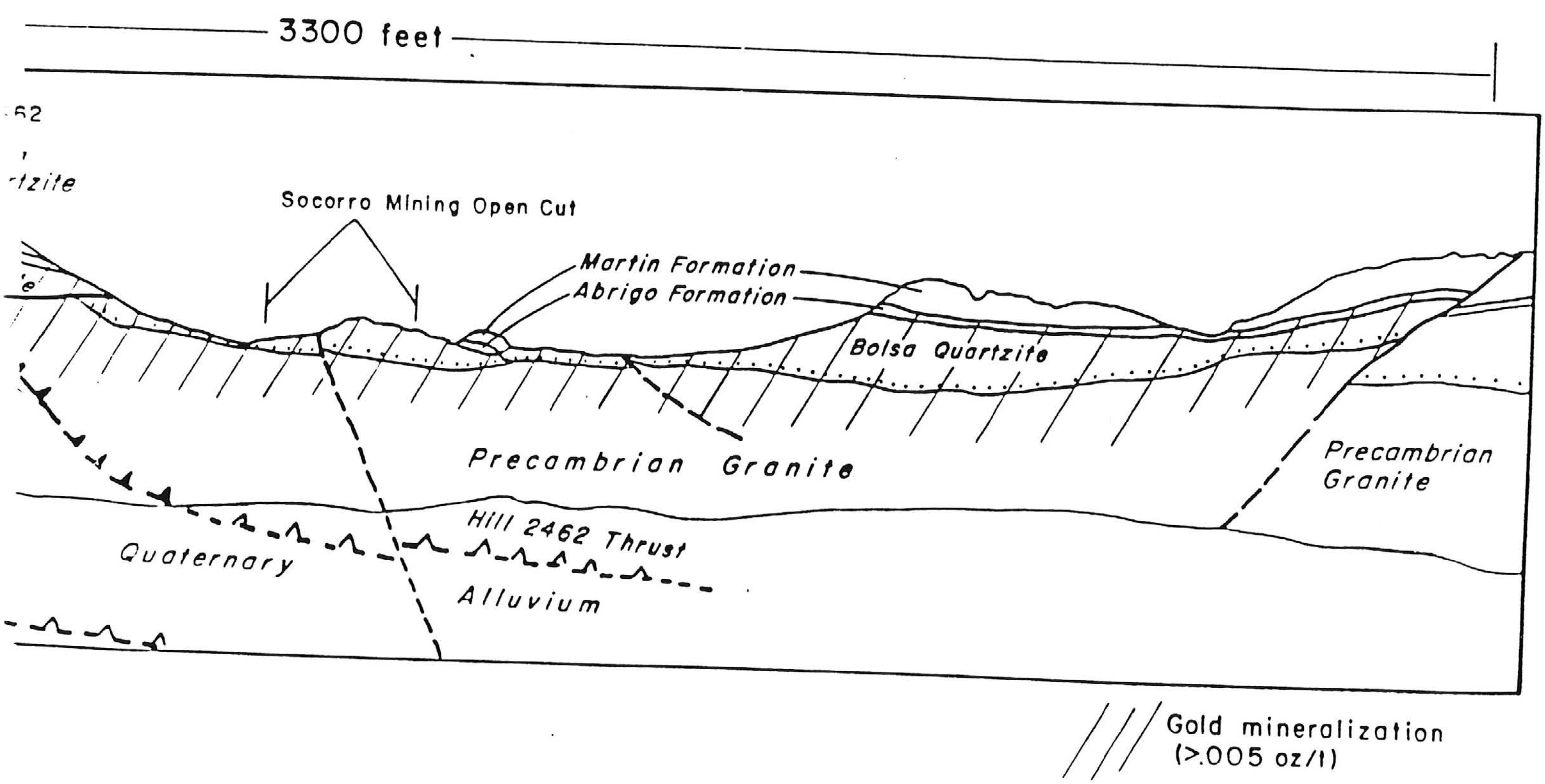


Diagram of Figure 18A depicting geologic relationships within the Socorro Reef gold anomaly.

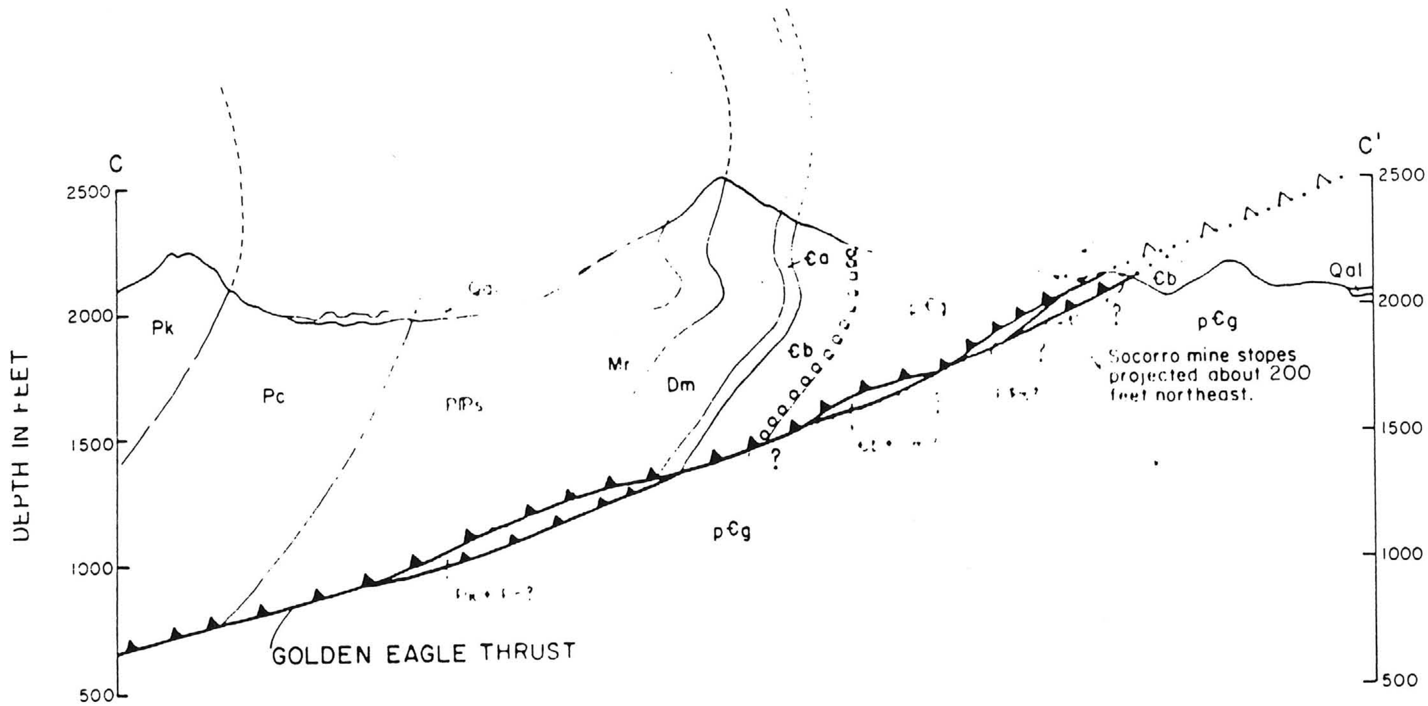
Red Hills South of RD





59-60

CROSS SECTION C-C'
Looking Southwest



EXPLANATION

ROCKS

Qal / Ql	Qal-surface alluviums, Ql- [illegible] debris flow materials
Tm	microdiorite dikes
Pk	Kaibab Formation
Pc	Coconino Formation
PIPs	Supai Formation
Mr	Redwall Formation
Dm	Martin Formation
€a	Abrigo Formation
€b	Bolsa [illegible] conglomerate
p€g	porph[illegible], 1.4 b.y. old), locally conta[illegible]

[illegible]

----- litho[illegible] where approximate

thrust [illegible] where approximate

? gold [illegible]

CR[illegible]

SOCORR[illegible]

YUM[illegible]

500 [illegible] feet

Scale [illegible]

STANLEY B [illegible]

potential joint venture partner. Consequently, I strongly recommend that Socorro Mining authorize and initiate a land search and acquisition program for the area, if the land search reveals any significant open ground at all.

Summary and Conclusions

The preceding sections have outlined the geologic dimensions of a disseminated gold model based primarily on data from the Socorro Peak area. Application of this model to the Salome region reveals that there are at least five and possibly eight areas that might harbor disseminated gold deposits that are amenable to open cut mining. Of these eight, three may have open ground that could be tied up at a reasonable cost by Socorro Mining Corporation. Within these three areas I believe there is a good chance that one viable exploration target in the size range of the Socorro Reef gold anomaly might be discovered. This would potentially double the dollar yield of Socorro Mining Corporation properties in the Salome region. Based on reserve calculations utilizing optimistic but reasonable assumptions for the Socorro Reef gold anomaly (detailed calculations are in Part II), such a target could potentially add another 760,000 ounces of gold or about $340,000,000 to the Socorro Mining Corporation portfolio for an initial investment of about $50,000.

PART II: DETAILED GEOLOGICAL AND GEOCHEMICAL INVESTIGATIONS OF THE SOCORRO REEF GOLD ANOMALY

Introduction

During geologic mapping and geochemical sampling on the Socorro Mining Corporation property in early April 1982 an intriguing alteration anomaly in the Bolsa Quartzite on the Palo Verde and Bluebird claims was encountered (See panorama in Figure 18A and 18B). The general geographic position of the Socorro Reef gold anomaly is shown on Plate 5. Eleven geochemical samples from the alteration anomaly all yielded weakly anomalous to strongly anomalous gold values (.016 to 6.0 ppm). Following my initial recommendation for further work on the gold anomaly unpublished report dated May 3, 1982), at Socorro Mining Corporation's request I began negotiations with major mining companies in May, 1982 to obtain additional surface information on the gold anomaly which has been named the Socorro Reef gold anomaly. Subsequent visits to this ground by myself and numerous major mining companies have led to the acquisition of abundant surface data that strongly suggests the presence of a major, low-grade, large-tonnage, disseminated gold deposit with an indicated gold value of over 340 million dollars (at $450/oz) in over 35 million tons. Part I developed a regional disseminated gold model that was applied to the Salome region in general; this regional model was derived from data at the Socorro Reef gold anomaly and surrounding mineral deposits. Part II develops a detailed, site-specific, geochemical and geometric model for the disseminated gold deposit that is inferred to lie beneath the Socorro Reef gold anomaly.

Exploration and Development History

The history and development of the Socorro Peak area is strongly tied to the discovery of bonanza gold ores in 1888 at the Harquahala (Bonanza) Mine in the Little Harquahala Mountains 10 miles to the southwest (See Table 1 in Part I). By 1905 gold mineralization had been discovered and was being developed at the old Socorro Mine in the Socorro Peak area. The exploration and development of mineral deposits in the Socorro Peak area can be divided historically into four periods - before 1969, 1969-1979, 1979-April 1982, and April 1982-December 1982.

EARLY DEVELOPMENTS (BEFORE 1969)

The yearly reported production from mines in the Socorro Peak area is listed in Table 12. Three mines (the Socorro Mine, Mars and Mescal Mine, and Why Not Mine) operated discontinuously from 1905 to 1938. The exploration and development history for each of these mines is summarized below.

Table 12: Reported Production by year for mines within the Socorro Mining Corporation Property Position

:orro

Operators: Death Valley, R.A. Salisbury, Gilbert and Schmidt, Socorro Gold Co., Socorro Mines, Inc.

Year	Ore Treated (Short Tons)	Gold	Silver	Lead	Au:Ag
1905	2200	230	145	-	1.59
1906	1461	207	122	-	1.69
1911	570	134	62	-	2.16
1913	59	59	37	-	1.59
1914	25	31	5	-	6.2
1934	60	18	12	-	1.5
1935	411	4	88	50	.045
Totals	4786	683	471	50	1.45

:.n Door 1 & 2 (..rs & Mescal)

Operators: Jerome Wenden Co., Nuevo Mundo

Year	Ore Treated (Short Tons)	Gold	Silver	Copper	Au:Ag
1916	56	15	18	15,234	.83
1917	21	1	8	6,746	.125
1918	32	0	30	1,876	-
Totals	109	16	56	28,856	.286

..:n Door 3 & 4 (Why Not)

Bell Henry Now

Operators: Kuisto & Smith, A.E. Lang & Gilbert, A.E. Lang, T.F. Johnson

Year	Ore Treated (Short Tons)	Gold	Silver	Copper	Au:Ag
1932	41	37	40	0	.925
1933	142	112	134	960	.836
1934	65	16	75	0	.213
1935	30	25	90	338	.278
1936	8	2	1	0	2.0
1937	24	6	10	46	.60
1938	85	35	139	268	.252
Totals	395	233	689	1,612	.338

Socorro and Henry Bell Mines

The majority of the reported production in the Socorro Peak area was in 1905 and 1906 when the Socorro Mine produced 3461 tons of ore that yielded 437 ounces of gold and 267 ounces of silver. In 1901 the Socorro Gold Mining Company acquired the mine and within four years sank a 375-foot inclined shaft and developed 2300 feet of drifts away from the shaft. A 20-stamp mill equipped for amalgamation, concentration, and cyanidation was built in 1904. Intermittent operations from 1905 to 1914 yielded about $20,000 in gold bullion from at least 661 ounces of gold extracted from over 4000 tons of ore. In 1934 the Socorro Mine produced 60 tons of ore that yielded 18 ounces of gold.

The 1935 production listed under the Socorro Mine label may not actually have come from the Socorro Mine, but rather could have come from the Henry Bell property .3 mile southeast of the Socorro Mine site. The 1935 production listed from the Socorro Mine is predominantly silver production. The gold:silver ratio of the 1935 production is .045, which is very similar to geochemical results from recent drilling and sampling on the Henry Bell claim by Socorro Mining Corporation and Noranda in 1982 (Figure 12). The grades of the Socorro Mine production are plotted sequentially by year on Figure 9. All of the grades fall within the Socorro Reef gold anomaly field except the 1935 production, which plots in the Henry Bell field. In addition, George Campbell, Sr. has informed me that he worked as a miner at the Henry Bell property in 1934-1936 when the property was being developed by an adit. At that time the adit was connected by an aerial tramway to a millsite near the bottom of an unnamed canyon 500 feet southwest of what is now called the Henry Bell tunnel. Only the foundation for this mill remains today and no remains of the former tramway were noted during my mapping. According to George Campbell the mill did process some ore, which could well have been the 1935 production reported under the Socorro Mine label. The Henry Bell property was offered to ASARCO in 1936 and the results of their 1936 sampling are included with the ASARCO data in Appendix IX.

Why Not Mine

During my field work in 1982 claim notices were found in the NW 1/4 of Sec. 36, T.5N., R.12W. for the Jessie Allard claim located by W.J. Stoke on June 8, 1916. These claims were at least partially relocated under the Why Not Gold label on April 30, 1930 by Thomas F. Johnson and A.E. Linnell. It is probable that at least 16 Why Not Gold claims were located at this time. These claims are most likely related to the production in 1932-1938 from the Why Not Mine (Table 12). Most of this production probably came from numerous pits and adits in the NE 1/4 of Sec. 25 and the SE 1/4 of Sec. 24, T.5N., R12W. Geochemical values of samples from these locations closely approximate the recorded production (Figure 12).

Mars and Mescal Mine

During World War I the Mars and Mescal property produced 109 tons of copper ore from 1916 to 1918. The copper production most likely came from adits and inclined shafts in gold-bearing jasperoid lenses in the SE 1/4 of the NW 1/4 of Sec. 19, T.5N., R11W. Geochemical values of samples taken by Socorro Mine Corporation and by Noranda at this location closely approximate the reported production from the Mars and Mescal property (See Figure 12).

Other Activity

Reports for the Campbell family by Thomas C. King Engineering in 1973 indicate that during 1927 and 1928 a company named the El Tigre Mining Company of old Mexico evaluated much of the Socorro Peak area. King reportedly had information that the El Tigre Mining Company took possibly 5000 samples and assays during two separate channel campaigns. Various sample cuts were reportedly found by King on the Henry Bell and Tres Padres claims. In addition, King claims the El Tigre Mining Company concluded that there was an indicated 16,000,000 tons assaying .179 troy ounces of gold per ton in the Socorro Peak area between the Henry Bell claim and the Iron Door claim. No sample or assay results substantiating this gold grade have been conveyed to me. However, independent mapping and sampling by myself and Noranda fail to find anything even close to the reported El Tigre numbers.

Since 1935 there has been no reported production from mines in the Socorro Peak area and little is known of any verifiable exploration or production activity, except for claim staking in February of 1958, when George W., Sr., Henrietta, and John S. Campbell located the Henry Bell claim. There are reports that high grade pockets of gold ore were encountered in the Socorro Peak area (See King Engineering report of 11/24/72 in Appendix II), but none of these reports has been substantiated to date. Apparently the material that was taken out was processed by arrastre milling in Harrisburg, where the remains of numerous arrastres are reported to still exist.

DEVELOPMENT 1969 - 1979

On March 8, 1969, George Campbell, Jr., Robert K. Barritt, and Frank Sayre located the Tres Padres claim .3 miles northeast of the Socorro Reef gold anomaly. Thus began a new period of exploration and development in the Socorro Peak area. In June and July of 1969 George W. Campbell, Sr., located the Yellow Gold No. 1 claim, the Palo Verde No. 1 claim, and the Bluebird claims over what is now the center of the Socorro Reef gold anomaly. In May of 1973 Thomas C. King, George Campbell, Jr., and Hayden S. Brown located the Iron Door claims over what formerly had been the Mars and Mescal and the Why Not properties of earlier years. Also, Carl F. Ludwig located the Socorro claim on May 27, 1972, and the Socorro Annex claim in September of 1973. In June 1974 the Campbell family, in association with nine other parties (the Socorro Reef

Association) located the Reef Group of claims. (See Plate 1 for specific locations of all of the aforementioned claims). Between 1974 and 1978 the Socorro Reef Association leased the above mentioned claims to B and B Mining Co., now a member of the Noranda group. From conversations with George Campbell, Jr., B and B Mining sampled the Henry Bell claim, put in most of the open cuts, and stockpiled some of the mineralized material taken from the open cut. Following these operations they terminated their lease. I have not seen any assays or reports relating to the B and B Mining Co. work, although George Campbell, Jr., indicated that he has copies of material relating to this activity.

After the B and B Mining Company involvement and probably in early 1978, Campbell and associates leased the property to Jordan Industries Inc., a Utah-based company. Jordan Industries attempted to mine the block of ground beneath the old Henry Bell adit on the Henry Bell claim by open-cut techniques. They added an additional bench, installed a milling facility with a stated 1000 ton/day crushing capacity, and reportedly stockpiled at least several thousand tons of Henry Bell material on the old Socorro Mine dump. Mr. Joe Behunin was the principal representative for Jordan Industries during this time (early 1978 to early 1979). So far as is known no production was ever realized from these operations. Various reports and assay results for the 1969 to 1979 period are presented chronologically in Appendix II.

DEVELOPMENT 1979 - APRIL 1982

In 1978 and 1979 Jordan Industries experienced financial difficulties in raising capital to develop the Henry Bell claim and initiated bankruptcy proceedings. On April 23, 1979, the leases with Jordan Industries (i.e., Behunin and others) expired and the Campbell family locked the gate and had an injunction issued against Behunin to keep him off the property. My understanding is that in the spring of 1979 Mr. James M. Jacobson, Sr., and Simon Srybnik of Brooklyn, New York were shown the property by Mr. Behunin; they were favorably impressed and formed Socorro Reef Mining Company to infuse new capital into the Jordan Industries operation to get the property into production. After several reports (in chronological order in Appendix III) had been prepared by several different consultants who reached mostly favorable conclusions, Socorro Reef Mining Company entered into a joint venture with Jordan Industries to continue developing the property. However, sampling of the Henry Bell claim by Socorro Reef Mining Company personnel (Jake Jacobson, Jr., personal communication, May 1982) failed to substantiate the high gold values of the earlier reports. (See assay certificate dated October 17, 1980, Appendix III). Consequently, Jake Jacobson, Jr., sampled an area in the Bolsa Quartzite in a saddle where Behunin had formerly drilled several shallow percussion holes about 1/2 mile west of the Henry Bell adit. He obtained encouraging results that averaged .0153 ounces per ton of gold (See assay certificate dated November 20, 1980, Appendix III). These data are from the center of what would later become known as the Socorro Reef gold anomaly. On the basis of the assay results dated November 20, 1980, Socorro Reef Associates decided to develop a small open pit in the quartzite and to heap leach material taken from the pit. Socorro Reef Mining Company then commissioned Duane Grey to design and operate the heap leach pad. By late February 1981 precious metal-bearing solutions were being recovered from a leach pad from approximately 30,000 tons of material that had been placed above the Henry Bell material on the old Socorro Mine dump. Resampling of material from within the pit yielded discouraging results, but 37.7 troy ounces of metal (in six pieces that contained 66% gold) were recovered from leach solutions before recovery problems set in at the leach pad (Jake Jacobson, personal communication, May 1982). Much of the equipment currently on the property (see Appendix XII) relates to this period of activity.

On May 15, 1981, a new lease was signed between Socorro Reef Mining Company (Socorro Reef Associates) and the underlying property owners (the Campbell family and associates) to bring the property into full production within one year. After the lease was signed $10,000 of drilling totalling 600 feet was done from June 1, 1981 to June 4, 1981 by Arizona Drilling Services Company to explore for possible gold ore on the Palo Verde, Socorro, and Henry Bell claims. This drilling was done under the direction of Duane Grey, the heap leach operator, and Bob Rose, an accountant in Scottsdale, Arizona. The analytical results of this drilling are presented in Appendix X.

DEVELOPMENT APRIL 1982 - DECEMBER 1982

As part of the lease dated May 15, 1981, Socorro Reef Associates (now Socorro Mining Corporation) had to geologically assess gold deposits on the Iron Door and Tres Padres claims and, if geologic studies indicated the gold occurrences were economically feasible, Socorro Reef Associates was required to develop the area by roadwork and drilling. Initially Jake Jacobson of Socorro Reef Associates contacted Noranda Exploration Inc. in Tucson, Arizona, about examining this area. After an initial visit to the property in early 1982, Noranda conducted follow up sampling in mid-March 1982. However, it became apparent that Noranda would not be able to make a detailed geologic assessment of this ground available to Socorro Reef Associates by May 15, 1982, the expiration date of the 1981 lease. Hence, Socorro Reef Associates contacted me, at the suggestion of Noranda, about examining the Socorro Reef property position with special emphasis on the Iron Door and Tres Padres claims. My report dated May 3, 1982, identified an interesting gold anomaly on the Palo Verde and Bluebird claims and recommended further exploratory work. At the request of Socorro Reef Associates (now Socorro Mining Corporation) I initiated discussions with major mining companies to obtain additional surface geologic assessment of the Socorro Reef gold anomaly. What follows is a summary of my activity and that of various major mining companies between May 1982 and December 1982. The sequence of company summaries is arranged chronologically in the order of initial contact with these mining companies. Analytical data and correspondence relating to the various activities is contained in Appendices IV - X. A briefly summarized description of surface work commitment performed by the various major mining companies is presented in Table 13 along with its approximate dollar value.

Table 13: Dollar value of work commitments by major mining companies, 1982

Company	Type of Work	Approximate Dollar Amount
Noranda	Geochemical Sampling during March, June, and September	6,300
	Geochemical Induced Polarization Survey in June	4,500
Phillips	Geochemical Sampling in June	3,000
U.S. Borax	Analytical Geochemical Work on Socorro Mining and Phillips samples	7,000
St. Joe	Detailed surface geochemical sampling in August and September	4,800
Exxon	Confirmatory geochemical sampling	800
ASARCO	Confirmatory geochemical sampling	1,200
		27,600.00

Noranda Activity

Because Noranda Exploration, Inc. had already performed recent sampling, I contacted them first in mid May. During these initial discussions it became apparent that Noranda had independently identified the Socorro Reef gold anomaly and was interested in follow up studies. However, their budget was tight so that their timing for such work was indefinite. In late May I contacted Phillips about sampling the Socorro Reef gold anomaly. When Noranda learned about these contacts, they indicated they would conduct a detailed surface geochemical sampling and geophysical survey during mid-June. (See letter dated June 8, 1982 in Appendix V). Data relating to this work were transmitted to Socorro Mining Corporation on July 13, 1982. Noranda considered the results encouraging, but not encouraging enough to immediately acquire the ground. Subsequently, I initiated discussions with other major mining companies (see below) and kept Noranda informed of these activities. On September 29, 1982, I visited the property with Noranda personnel to further acquaint them with the property in view of what was currently known. At this time Noranda took additional samples from an adit. (See analytical report dated October 13, 1982). The next day Jeff Snow, President of Noranda Exploration in charge of U.S. exploration, visited the property, was favorably impressed, and authorized lease negotiations with Socorro Mining that evening in Phoenix, Arizona. The initial offer called for $30,000 of initial work commitment by Noranda over an initial period of three months in 1982. If results are favorable, Noranda proposes to escalate its work commitment to $100,000 a year for the next several years. Negotiations with Noranda are still ongoing.

Phillips Activity

After my initial contact with Phillips, I visited the Socorro Reef gold anomaly on June 1, 1982 with Robert D. Enz, Minerals Geology Supervisor for the Minerals Group of Phillips Petroleum Co. Enz was favorably impressed and indicated that Phillips would do follow up sampling in the Socorro Reef gold anomaly later in June. On June 21-23 Phillips collected 61 samples within the Socorro Reef gold anomaly. However, Phillips announced that week that they were terminating their Strategic Minerals Division as of September 1, 1982. Hence, Phillips was not able to obtain analyses for the samples, but did send me on July 15, 1982 sample descriptions, location data, and the samples they had collected.

U.S. Borax Activity

In late July I contacted Dick Ahern, a consultant for U.S. Borax about analyzing the Phillips samples. In return for monitor rights and receipt of existing Socorro Mining Corporation data regarding the Socorro Reef gold anomaly, U.S. Borax has analyzed the Phillips samples for copper, molybdenum, lead, zinc, gold, silver, arsenic, antimony, tungsten, mercury, and uranium. In addition, U.S. Borax has reanalyzed the Socorro Mining Corporation samples collected by myself in April 1982 for gold, silver, lead, zinc, and copper and has furnished additional analyses on the Socorro Mining Corporation samples for molybdenum, tungsten, uranium, antimony, arsenic, and mercury. These data have now been received in several lots from October 11, 1982 to the present. Numbers S-109 through S-143 remain outstanding and should be received shortly. U.S. Borax continues to monitor competitor activities at Socorro Reef, although it does not appear that they will compete with the Noranda offer.

Exxon Minerals Activity

In early August 1982 I contacted personnel in the Tucson office of Exxon Minerals Company about the Socorro Reef property. Following an initial examination of the property on August 31, 1982, Richard Chuchla of Exxon Minerals was favorably impressed and recommended follow up sampling. Exxon spent two addditional days performing confirmatory sampling at Socorro Reef in September of 1982 and the results of that sampling were transmitted to me by phone on October 8, 1982 (Appendix VII). The Tucson office has recommended that Exxon obtain Socorro Reef for drilling evaluation, but have yet to make a formal offer to Socorro Mining Corporation. Whether they will compete with the Noranda offer at this point in time is somewhat doubtful.

St. Joe American Activity

In late July of 1982 I contacted geologists for St. Joe American Corporation about the Socorro Reef property and on August 3, 1982 I presented the property to Tom Chapin of St. Joe in the field. He was favorably impressed and recommended a detailed sampling program which St. Joe conducted September 9-13, 1982. The results of this program were encouraging and St. Joe geologists have recommended to their district manager that St. Joe acquire the ground for drilling evaluation. On December 2, 1982 Joe Rankin, the southwestern U.S, exploration manager for St. Joe out of Tucson, visited the property with Noel Cousins, the St. Joe supervisor for St. Joe's exploration at the Socorro Reef property to date. Rankin was favorably impressed with the surface geology, but when he observed several air-track drill holes on the ridge west of Socorro Mining Corporation's open cut, he became more skeptical. His impression was the the ground may already have been evaluated by these air-track holes (probably former Jordan Industry work by Behunin). Cousins indicated to me by phone on December 3, 1982 that St. Joe would proceed no further until Socorro Mining determines the status of information relating to these holes and conveys it to St. Joe.

ASARCO Activity

During my initial mapping and sampling activities in April 1982 a representative of ASARCO, Inc. also visited the Socorro Reef property. Following that evaluation ASARCO remained inactive until I contacted them on September 9, 1982 and showed them the Noranda and Socorro Reef data. After examining this data ASARCO reevaluated its position and contacted me with a verbal work commitment offer for $20,000 of air-hammer drilling and supportive assay work. They made this offer contingent upon favorable results from additional surface sampling by their acting regional manager, Bill Kurtz. This work was conducted on September 23, 1982 and the results of that work, together with analytical data for the April 1982 sampling and for 1936 sampling of the Henry Bell adit workings, are presented in Appendix IX. ASARCO has been informed of the Noranda offer and, while they were favorably impressed with the ground, I do not believe they will compete with the Noranda offer.

Newmont Activity

On September 9, 1982 I made an office presentation to geologists for Newmont Mining Corporation using the Noranda and Socorro Mining data. Their geologists were favorably impressed and indicated that they would contact me about visiting the Socorro Reef property in the field. They have yet to make this contact. My feeling is that Newmont prefers to "let the traffic clear" before initiating any work.

Hecla Activity

On September 13, 1982 I received a call from Dick Nielsen, a consultant for Hecla Mining Corp., who had heard about the Socorro Reef property "on the grapevine". After further contact with Hecla I visited the Socorro Reef property on September 24, 1982 with Lou Knight, the regional exploration manager from the Denver office of Hecla. He was favorably impressed with the ground, but has since indicated to me that Hecla is not interested in any "bidding wars". They also believe that the available data indicate the Socorro Reef deposit is slightly too low grade to warrant a major entry by Hecla into Socorro Reef at this time. However, if Socorro Mining has not entered into an exploration lease with a major mining company by the first of 1983, Dr. Knight has instructed me to make additional contact with him regarding the Socorro Reef property because he expects that his 1983 budget will be much more flexible in terms of acquiring new drilling projects.

Utah International Activity

On October 18, 1982 I received a phone call from Alex Ascencios, district manager of Utah International exploration office in Tucson. Mr. Ascencios had heard about Socorro Reef "on the grapevine" and was interested in looking at the Socorro Reef data. That day I made an office presentation to Utah International and they indicated they were interested and would contact me later about a subsequent field examination of the property. At the time I talked with them I informed them that several other companies were interested and that Noranda had made a formal offer.

When St. Joe geologists were visiting the Socorro Reef property on December 2, 1982, they encountered one geologist (Miles Shaw) and an assistant who were collecting numerous geochemical samples. In a telephone conversation with Alex Ascencios on December 3, 1982 he related that he and Shaw had visited Socorro Reef in mid-November and had decided to follow up their first visit with a detailed sampling program for 3 days in early December. They were scheduled to complete this sampling by December 3, 1982. Ascencios indicated that Utah International was taking 50 to 75 samples which would be analyzed for gold, silver, mercury, arsenic, lead, zinc, thallium, and at my suggestion, tungsten. From our conversation it appeared that Utah was interested in sampling the granite to increase the potential minable tonnages. They indicated interest in all of the data Socorro Mining Corporation has accumulated since my contact with Utah in October and that perhaps they would be ready to "swap" data by mid December. I informed them that Socorro Mining was very close to cutting a deal with Noranda and Ascencios indicated Utah would proceed accordingly.

Gulf Minerals Activity

In early November of 1982 Monte Swan, a consultant with Gulf Mineral Resources Company, a division of Gulf Oil, contacted me about the Socorro Reef package. I showed him the data on November 8, 1982 and later that week he recommended the property to Tom Heidrick, the regional manager for western U.S. exploration in Denver. On November 16, 1982 I transmitted Socorro Reef data to geologists in the Tucson office of Gulf Mineral Resources Co. for inclusion in their 1983 budget meetings in Denver on the 17th and 18th of November. Tom Heidrick has since informed me by phone on November 22, 1982 that he is seriously considering putting Socorro Reef into his 1983 budget if the financial terms are right. I indicated that I believed a minimum of $50,000 in drilling would be needed to fairly test the Socorro Reef gold anomaly. (See my letter dated May 20, 1982 in Appendix X). Heidrick indicated that they could spend at least $50,000 in an initial work commitment. Thus, I strongly believe that Gulf Mineral Resources Co. will seriously complete with the Noranda offer. I am scheduled to give an office presentation to Gulf Mineral Resources Co. geologists including Tom Hedrick on December 7, 1982. Following this presentation I expect that Gulf geologists will visit the Socorro Reef property later in the week.

Keith Activity

In addition to all of my activities with the major mining companies between May and December, of 1982, I have conducted detailed geologic mapping in the area of the Socorro Reef gold anomaly, acquired additional protection ground immediately south of the Socorro Reef gold anomaly, obtained and evaluated the June 1981 Socorro Reef drill hole information for inclusion in the Socorro Reef data base, and conducted discussions and negotiations with the Campbell family who own part of underlying property.

After receipt of the Noranda data in July 1982 it became apparent that some of the gold mineralization might extend south of the Socorro Reef property position as of July 1982. Also, it was apparent that any open pit mining would include a small part of the ground in the NW 1/4 of Sec. 36, T.5N., R.12W. in which the mineral rights were owned by the State of Arizona. After approval from Socorro Mining Corporation 16 Reef Annex claims were located on August 16 and 25, 1982. After September 1, 1982 the Reef Annex group was repapered on October 13, 1982 and recorded at the Yuma County Courthouse on October 19, 1982. The repapering was done so that Socorro Mining would have an additional assessment year to evaluate the ground. The repapering in effect saves Socorro Mining Corporation $1600 of 1983 assessment and ties the ground up until September 1, 1984. The location and recording notices for the Reef Annex group are contained in Appendix XI along with ownership information for the Reef, Iron Door, Palo Verde, Bluebird, and Tres Padres claims.

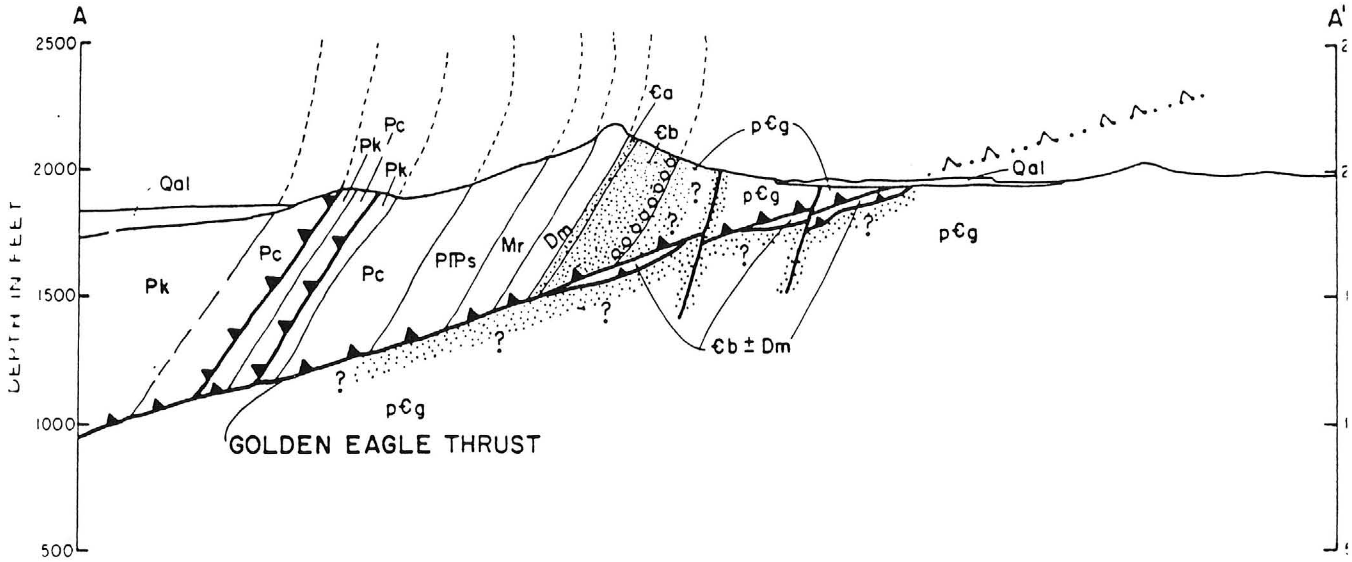
During my various trips to the Socorro Reef property in August and September of 1982, I conducted about 2 days of detailed geologic mapping at a scale of 1 inch = 500 feet to obtain more precise geologic information about the occurrence of gold within the Socorro Reef gold anomaly and also to obtain tighter sample control for all of the various major mining company geochemical sampling. During discussions with Noranda geologists in Tucson it was learned that Arizona Drilling Services had done drilling at the Socorro Reef property in mid 1981. I was previously unaware of this information. After phone calls with James L. Witt of Arizona Drilling Services and Bob Rose, Socorro Mining Corporations accountant in Scottsdale, Arizona, I obtained over the telephone the drill hole names and locations and the analytical results for gold and silver in 120 five-foot composite samples collected during the reverse-circulation drilling. Notes bearing these data are contained in Appendix X.

On September 29, 1982, I visited with the Campbell family in Salome, Arizona. At this time I discussed my new geologic interpretations and the economic implications of those interpretations with the Campbells. I also transmitted to the Campbells a copy of my May 10, 1982 report. The main intent of these discussions was to convince the Campbells of the poor commercial potential for deposits on the Iron Door claims and to stress the high commercial potential of the Socorro Reef gold anomaly. This was done to allow the Campbells to more realistically reassess ore deposits on their claims and to convince them that the Socorro Reef property is not yet a mine and that much exploration remains to be done before a mine could be brought into production. My overall purpose in this regard was to explain to the Campbells that terms in the May 15, 1981 lease agreement pertaining to mine production and royalty payments were unrealistic considering the incompleteness of geologic data regarding the Socorro Reef property as of May 1981. My recommendation to the Campbell's was to replace the mine production requirements with new requirements pertaining to efficient exploration of the Socorro Reef property.

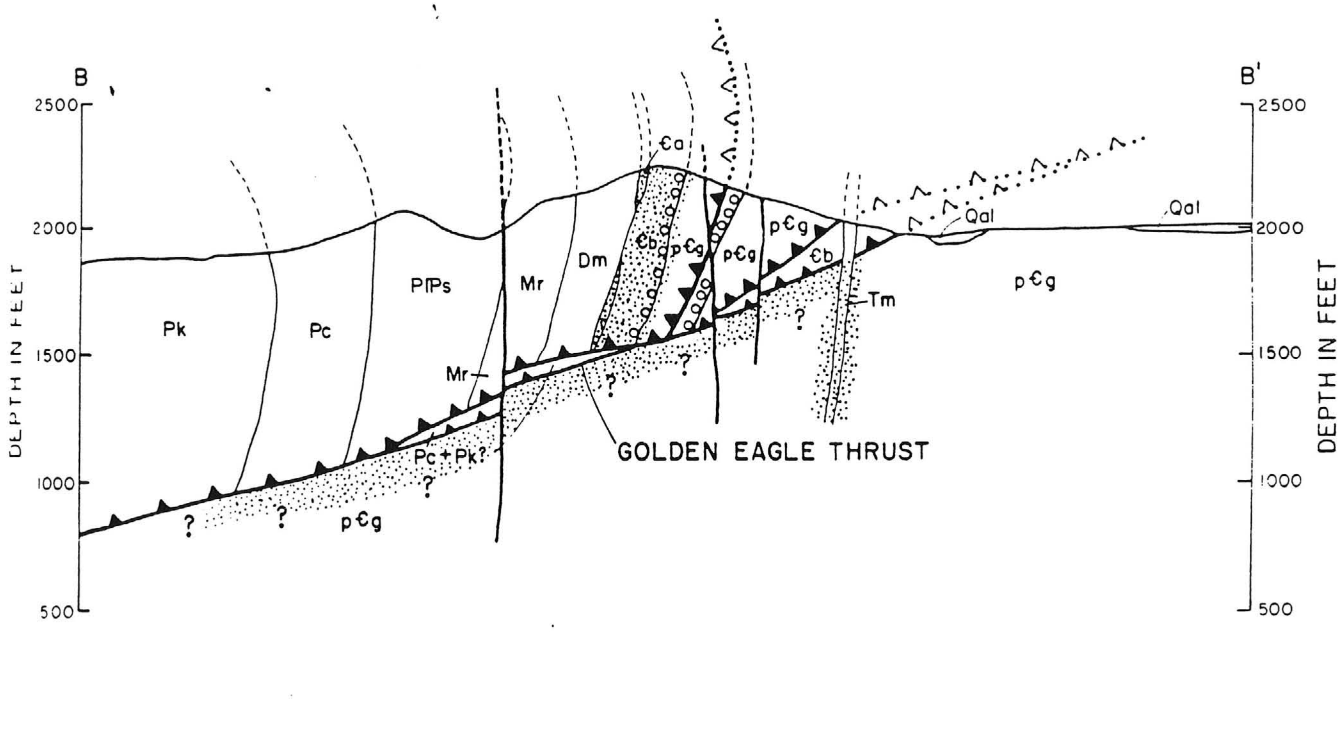
Geology

The regional geology of the Socorro Reef gold anomaly is shown on Plate 2. During August and September of 1982 two days were spent revising the geologic map of the Socorro Reef gold anomaly and vicinity at a scale of one inch equals 500 feet (Plate 19). Three cross sections were drawn through the Socorro Reef gold anomaly and are presented in Figure 19.

CROSS SECTION A-A'
Looking Southwest



CROSS SECTION B-B'
Looking Southwest



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ROCKS

The regional stratigraphy in the Socorro Peak area was summarized in Part I. Rock units specifically present in or near the Socorro Reef gold anomaly include the Precambrian (probably 1.4 b.y. old) porphyritic biotite granite, the depositionally overlying Middle to Upper Cambrian Bolsa Quartzite and Abrigo Formation, the Upper Devonian Martin Formation, the Mississippian Redwall Formation, and the Pennsylvanian-Permian Supai Formation. For lithologic descriptions of these units see Figure 4 in Part I. The highly anomalous to moderately anomalous portion of the Socorro Reef gold anomaly is contained entirely within the Bolsa Quartzite and Abrigo Formations. In addition, weak to moderate gold values are present in the Precambrian porphyritic granite beneath the Bolsa Quartzite.

Significantly, gold values drop to background in the Paleozoic carbonate section immediately south and southeast of the Bolsa-Abrigo contact. Thus, the contact between the Bolsa-Abrigo formations and the Martin Formation represents a firm assay wall and abrupt geologic boundary for the southern boundary of the Socorro Reef gold anomaly. Thus the southern boundary of the Socorro Reef gold anomaly is strongly controlled stratigraphically by the basal Martin contact. Conversely, on the basis of present geochemical data, no firm assay wall exists in the Precambrian porphyritic granite beneath the Bolsa Quartzite.

Paleozoic carbonate strata also exert a strong stratigraphic control on peripheral mineralization south of the Socorro Reef gold anomaly. Erratic gold-bearing jasperoid lenses exclusively occur in the upper cherty carbonate member of the Mississippian Redwall Limestone (for example at several prospects south of the Socorro Reef gold anomaly in the NE 1/4 of the NE 1/4 of Sec. 35, T.5N., R.12W.).

A sequence of northwest-trending, calc-alkalic, microdiorite dikes is present along the Socorro fault zone at and south of the Socorro Mine for about 1/2 mile along the fault. Three such dikes were mapped; a fourth microdiorite dike was mapped 500 feet southwest of the Socorro fault zone about 1000 feet south of the Socorro Mine. The microdiorite dike swarm along the Socorro fault mostly occurs within the northeast end of the Socorro Reef gold anomaly and is chloritically altered, especially where the dikes traverse the gold anomaly.

STRUCTURE

Structural geology in the region around the Socorro Mine has already been outlined in Part I. The main elements of the structural geology locally present at Socorro Reef are shown in cross sections A-A', B-B', and C-C' on Figure 19. The locations for these section lines are on Plate 19.

Low-angle Thrust Faults

The main structure at the Socorro Mine and vicinity is the Golden Eagle thrust, one of the middle thrusts in the regional thrust fault sandwich that is present throughout the Salome region. As can be seen in the cross sections, the Golden Eagle thrust divides the area into two major plates. The lowermost plate is composed mostly of Precambrian porphyritic granite with minor metasedimentary inclusions. Several exotic lenses of Paleozoic rocks occur along the thrust fault (See Plate 19 for the map position of these lenses). The largest of these lenses is composed of Bolsa Quartzite. The northeast end of this lense, which actually is composed of several lenses, begins about 500 feet northeast of the Socorro Mine within the Golden Eagle thrust zone. The lense reaches its maximum thickness about 200 feet southwest of the Socorro Mine where the quartzite is about 150 feet thick. The quartzite lense progressively attenuates to the southwest and is no longer present about 1000 feet southwest of the Socorro Mine. Other tectonic lenses of Paleozoic strata within the Golden Eagle thrust zone include a small, one-hundred-foot long lense of Martin Formation about 1000 feet northwest of the Socorro Mine and a 500-foot long sliver of Supai Formation beginning about 200 feet southwest of the collar of the Socorro Mine incline.

The upper plate of the Golden Eagle thrust is composed of Precambrian, coarse-grained, porphyritic biotite granite, which is depositionally overlain by a steeply south- to southeast-dipping Paleozoic section that contains a normal Paleozoic stratigraphic sequence from basal, Middle Cambrian Bolsa Quartzite to Permian Kaibab Limestone. Porphyritic granite rests tectonically on the Paleozoic tectonic lenses in the Golden Eagle thrust zone. This older over younger juxtaposition of rock units demonstrates the fundamental thrust nature of the Golden Eagle thrust. The steep south and southeastward dip of the Paleozoic section and westward attenuation was probably imposed during regional, F_1 southeast-directed folding in mid-Cretaceous time. The Socorro Mine area and the Socorro Reef gold anomaly are within the lower, right-side-up limb of a major F_1 fold. The hinge of this fold is exposed one mile east of the mine area (Figure 7). A few F_1 minor folds are present in the Pennsylvanian-Permian Supai section southeast of the Socorro Mine. Fold hinges for these folds are shown in Plate 19.

The Golden Eagle thrust throughout the Socorro Mine area consistently dips either south or southeast. The south or southeast dip is post-thrust in age and is probably related to F_3 folding (Event No. 11, Geologic History Section, Part I). Hence, the Socorro Mine area is inferred to be in the south limb of a broad northeast-trending anticline whose axis is about one mile north of the Socorro Mine (See Plate 2).

High-angle Faults

The thrust plates in the Socorro Mine area are broken by numerous members of the high-angle, northwest- to west-northwest-striking fault set. The principal fault of this set in the Socorro Mine area is the Socorro fault. The Socorro fault dips about 60 degrees to the northeast and displaces the Paleozoic slivers in the Golden Eagle thrust zone northeast of the Socorro fault up and to the southeast. Hence, there is about 250 feet of right separation and about 200 feet of reverse separation through the Socorro fault zone. Southwest of the Socorro fault numerous high-angle, north-northwest-striking to west-northwest-striking faults offset the Paleozoic section between the Socorro fault and the Bluebird fault (See Plate 19). Separation on the northwest- to west-northwest-trending faults is sinistral, whereas separation of the more northerly trending faults is generally dextral. Sinistral or left separation on the west-northwest-striking faults is only about one-third that of the dextral separation on more northerly faults. However, the Bolsa-granite contact west of Hill 2462 has been offset repeatedly (6 inches to 3 feet) in a sinistral way by numerous northwest- to west-northwest-striking faults that were too small to map.

The geology about 1000 feet south of the Socorro incline has been complicated by the presence of an additional thrust (now tilted) that trends directly through Hill 2462 (See Figure 18B). As shown on cross section B-B' (Figure 19) Bolsa Quartzite is repeated three times on now-tilted thrust faults. The Hill 2462 thrust probably formed just before the F_1 folding event and was tilted during the F_1 folding event.

Inspection of Plate 19 reveals that the generally northeast-striking, southeast-dipping Paleozoic section which occurs northeast of the Socorro fault bends into an east-west, steeply south-dipping orientation southwest of the Socorro fault near the edge of outcrop (especially in the NE 1/4, Sec. 35, T.5N., R.12W.). This bending may be due to drag along a major west-northwest-striking fault concealed just beneath the alluvium in the NE 1/4, Sec. 35. This fault could be an extension of or a sliver of the high-angle, northwest- to west-northwest-striking Centennial Wash fault zone, which trends up Centennial Wash west of the Socorro Peak area (See Figure 3). Movement on this fault and the associated right drag of the Paleozoic section in the Socorro Mine area might reflect regional right shear along the northwest-trending fracture system about 12.5 to 5 m.y. ago (Event No. 11, Geologic History Section, Part I). If this interpretation is correct, east-west bending of the Paleozoic section would be post-mineral in age.

ALTERATION AND MINERALIZATION

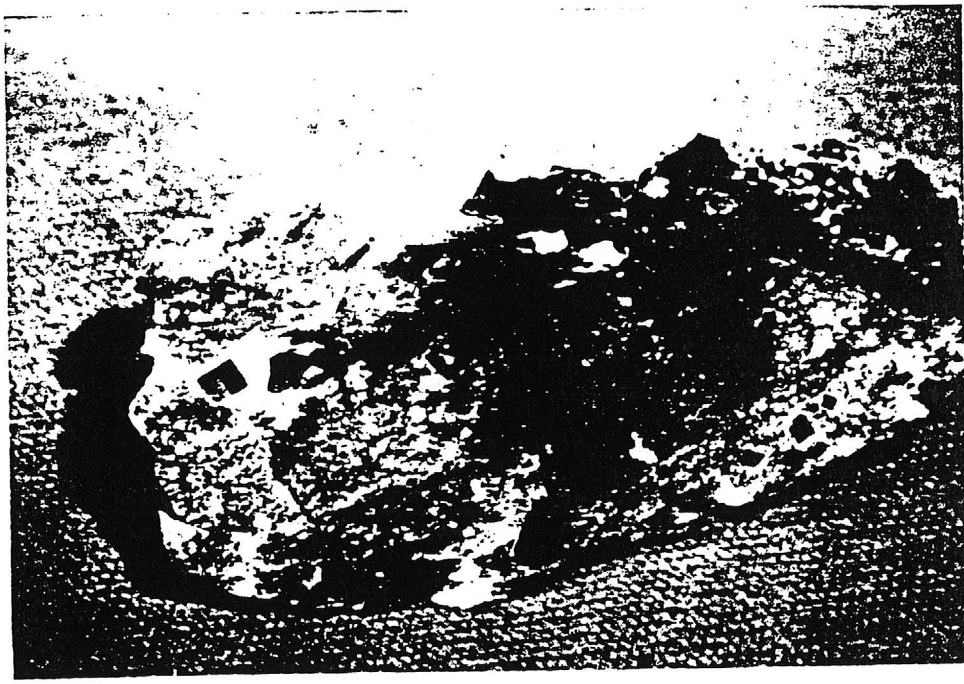
The geographic position of the Socorro Reef gold anomaly (Plate 5, Part I) essentially coincides with the alteration and mineralization. Alteration and mineralization is expressed in several different ways within the Socorro Reef gold anomaly: 1) supergene hematite-clay alteration and hypogene quartz-sericite-pyrite phyllic alteration in the Bolsa Quartzite; 2) quartz-veining and moderate phyllic alteration and chloritization of the Precambrian porphyritic granite; and 3) epidote-chlorite alteration in the calc-alkalic microdiorite dikes.

Within the Bolsa Quartzite gold mineralization is specifically related to areas of pervasive phyllic alteration. Supergene expressions of this alteration feature a hematite-goethite-jarosite-clay alteration assemblage, which is commonly associated with replacements of euhedral pyrite by goethite. Hematite occurs as the earthy red variety and the highest gold values are associated with rock that contains red, pulverulent hematite and limonite and/or goethitic replacements of euhedral pyrite cubes. Locally, weak, copper oxide staining (malachite and/or chrysocolla) occurs in areas of strong hematite-goethite coatings and/or goethite replacements of pyrite cubes. Areas where a visual copper association was noted also commonly carried highly anomalous gold values.

Hypogene expressions of phyllic alteration in the Bolsa-Arigo section are manifested by sericitic replacements of detrital feldspar within the more arkosic lithologies and by pyritic cubes disseminated throughout the rock near closely spaced, quartz-filled microfractures and quartz-filled stockworks and microfracture networks. Locally the pyrite cubes are numerous enough so that the alteration may be termed pyritic. These areas consistently yield strongly anomalous (>.9 ppm gold) gold values. Figure 20A and 20B are photographs of some of the better pyritic alteration. Within the Socorro Reef gold anomaly phyllic alteration within the Bolsa Quartzite-Abrigo section is developed between a north-northwest-trending, unnamed fault about 600 feet northeast of the Socorro fault and an unnamed north-northwest-trending fault east of the Bluebird fault (See Plate 19). This area of altered Cambrian clastic rocks is about 3300 feet long and about 200 feet wide. In the structurally complicated area on Hill 2462 the southernmost band of Bolsa Quartzite is the best mineralized section. Phyllic alteration within the Bolsa Quartzite-Abrigo Formation section is terminated abruptly to the south at the contact with the Devonian Martin Formation.

Phyllic alteration does extend, however, into the Precambrian porphyritic granite north of the Bolsa Quartzite. Here the phyllic alteration is more specifically limited to macroscopic fractures which are lined with quartz-sericite-pyrite or its supergene equivalents, quartz-clay-hematite-goethite. Ferromagnesian minerals in the porphyritic biotite granite between phyllically altered fractures are generally chloritized. Precambrian granite further north of the Bolsa Quartzite-granite depositional contact is less phyllically altered but it does contain moderate propylitic alteration in the form of chloritization and minor epidotization of the biotite and plagioclase feldspars within the granite. Areas of propylitically altered granite north of the Bolsa Quartzite generally contain weakly anomalous gold values, whereas more phyllically altered granite closer to the Quartzite generally contains weakly to moderately anomalous gold values. The precise geographic extent of the altered granite north of the Bolsa Quartzite is yet to be quantitatively determined. On a preliminary basis phyllic or porphyritic alteration in the granite probably extends from 100 to 400 feet north of the phyllically altered Bolsa Quartzite-Abrigo Formation block.

As was previously mentioned several microdiorite dikes occur along the Socorro fault zone southeast of the Socorro Mine. Where these dikes cross the Socorro Reef gold anomaly they commonly exhibit moderate to strong chloritization and epidotization of the ferromagnesian minerals. Also the dikes contain moderate to strong hematite and goethite along fractures and locally contain small goethitic replacements of former pyrite cubes.



X pyrite cubes

Figure 20A. Photograph of Bolsa Quartzite specimen from Socorro Reef Gold Anomaly exhibiting pyritic alteration. Euhedral pyrite cubes in this specimen have been replaced by goethite.

Figure 20B. Close-up photograph of goethite replaced pyrite cubes.

Peripheral alteration outside of the Socorro Reef gold anomaly is less common, less pervasive where it occurs, and is limited to discrete fractures or stratigraphy. North of the Socorro Reef gold anomaly alteration is expressed as quartz veins with minor sericitic envelopes within fractures in the Precambrian granite below the Golden Eagle thrust. East of the Socorro Reef gold anomaly similar quartz veins occur in the Precambrian granite; irregular, flat-lying quartz lenses occur in the Redwall Limestone on the Tres Padres claims; and minor silicification with moderate goethite occurs along northeast-trending fractures in the Bolsa Quartzite. Southeast of the Socorro Reef gold anomaly moderate silicification is locally accompanied by barite, manganese oxides and iron oxides and occurs along fractures and stockworks in the Martin-Redwall section on the Henry Bell claim northeast of the Socorro fault. South of the Socorro Reef gold anomaly siliceous, gold-bearing jasperoid lenses occur in the upper cherty carbonate member of the Redwall Limestone and black calcite with local goethite occurs along faults and locally along small-scale fractures in the Martin Formation.

PHYSICAL CONTROLS OF GOLD MINERALIZATION

The cross sections in Figure 19 show the physical distribution of gold mineralization with respect to the structural geology outlined previously. Gold mineralization at the Socorro Mine occurred within the lower part of the Golden Eagle thrust zone below the Bolsa Quartzite sliver (See cross section C-C', Figure 19). Gold mineralization at the Socorro Mine is inferred to extend down the dip of the Golden Eagle thrust and in cross sections A-A' and B-B' gold mineralization is shown penetrating into the plate above the Golden Eagle thrust where it mineralized highly fractured, Cambrian Bolsa-Abrigo strata. The cross sections also show how the mineralization is abruptly truncated at the contact with the overlying Paleozoic carbonate strata. This structural interpretation is strongly reinforced by geophysical data that will be discussed in a subsequent section.

At the Socorro Mine and in prospects 500 feet south of the Socorro Mine gold mineralization is controlled by the high-angle, northwest-striking fracture system. In these fractures gold-bearing quartz pods are common. Also, several high-grade (greater than 1 ppm) samples came from northwest- to west-northwest-striking fractures in the Bolsa Quartzite-Abrigo section about 300 feet west-northwest of the common corner of Sec. 26, 25, 35, and 36, T.5N., R.12W. The Bolsa Quartzite in this general area also contains moderately common, northeast-trending, gold-bearing quartz lenses along high-angle fractures. Indeed, bedding planes within the Cambrian clastic strata and northeast-trending fractures within the underlying Precambrian granite have exerted a subtle secondary fracture control on gold mineralization within the Socorro Reef gold anomaly. Offsets on fractures of this orientation have not been mapped and no significant faults of this orientation exist within the gold anomaly.

Geochemistry

The Socorro Reef gold anomaly is now one of the best documented, though yet undrilled, surface gold anomalies that I am aware of anywhere in the southwestern U.S. Since March 1982, 745 samples yielding 4806 analyses for various metals have been collected and analyzed by seven mining companies. About 360 of these samples were collected from within the Socorro Reef gold anomaly. The geochemical sampling programs of the various companies are summarized in Table 14 and sample locations for this work are shown in Plates 20 and 21. As a result of this work the geographic position of the gold anomaly is now firmly known and has been rigorously confirmed. Geological implications of the geochemical data are discussed below. Economic implications of the geochemical data are discussed in the section entitled Economic Evaluation.

RESULTS

Gold

Gold contents and locations of all samples collected by Socorro Mining Corporation, Noranda, and Phillips in the Socorro Mine area are presented in Plate 22. Gold contents and locations of all samples collected by St. Joe, ASARCO, and Exxon in the Socorro Mine area are shown on Plate 23. A composite gold anomaly map for all samples collected is presented as Plate 24.

The main components of the Socorro Reef gold anomaly are the moderately intense gold zones (0.09 to 0.9 ppm gold) that coincides with highly fractured, phyllically altered, and locally pyritized Bolsa Quartzite. The strongest and most continuous of these moderately intense gold zones begins at the Socorro fault where it intersects the southerly Bolsa Quartzite unit southwest of the fault (See Plate 19); it extends for about 2500 feet to the southwest along the Bolsa Quartzite outcrops to its termination by a north-northwest-trending fault that is 300 feet east of the Bluebird fault. This anomaly is about 250 feet wide. A second area of moderately intense gold values occurs in the Bolsa Quartzite northeast of the Socorro fault and extends indefinitely into the underlying Precambrian granite. A third area enclosed by the moderately intense gold contour is at the old Socorro Mine site where high-grade quartz lenses in the Golden Eagle thrust zone were mined in the early 1900's.

Several "hot spots" of strongly anomalous gold values occur within the moderately intense contour. The strongest and most continuous of these strongly anomalous areas is a zone about 600 feet long that begins in the Bolsa Quartzite about 400 feet west of the NE corner of Sec. 35, T.5N., R.12W. This zone is about 100 feet wide and has been extensively prospected by means of several adits and shafts. A second "hot spot"

Table 14: Summary of Geochemical Sampling Programs by Various Companies in the Socorro Peak Area June, 1981 to October, 1982

Company	Date(s) Collected	Lab	Au	Ag	Pb	Zn	Cu	Mo	W	U	As	Sb	Hg	# of samples analyzed	x	# of elements per sample	=	Number of Analyses
			Elements analyzed for															
Socorro Mining Corp Rotary Drill-hole Samples	early June 1981	Arizona Testing Labs - Phoenix	x	x	-	-	-	-	-	-	-	-	-	120	x	2	=	240
Socorro Mining Corp.	March 30- April 4, 1982	Skyline - Tucson	x	x	x	x	x	-	-	-	-	-	-	162	x	5	=	810
Reanalysis of Socorro samples by U.S. Borax	August - October 1982	Borax - Anaheim	x	x	x	x	x	x	x	x	x	x	x	162	x	11	=	1,782
Noranda	March, 1982	Skyline - Tucson	x	x	-	-	-	-	-	-	x	-	-	88	x	3	=	264
Noranda	June, 1982	Skyline - Tucson	x	x	-	-	-	-	-	-	x	-	-	64	x	3	=	192
Noranda '108' Adit Samples	September 1982	Skyline - Tucson	x	x	-	-	-	-	-	-	x	-	-	12	x	3	=	36
Phillips	June, 1982	Borax - Anaheim	x	x	x	x	x	x	x	x	x	x	x	59	x	11	=	649
Exxon	August 1982	Exxon - Tucson	x	-	-	-	-	-	-	-	-	-	-	23	x	1	=	23
St. Joe	August 1982	Skyline - Tucson	x	x	x	-	x	-	-	-	x	-	-	14	x	5	=	70
St. Joe	September 1982	Skyline - Tucson	x	x	x	-	x	-	-	-	-	-	-	167	x	4	=	668
ASARCO	April, 1982	Skyline - Tucson	x	x	-	-	-	-	-	-	-	-	-	25	x	2	=	50
ASARCO	September 1982	Skyline - Tucson	x	x	-	-	-	-	-	-	-	-	-	11	x	2	=	22
Totals														745				4,806

exists in the Bolsa Quartzite and Precambrian granite about 200 feet west of Hill 2462. A third "hot spot" of high-grade gold was mined at the old Socorro Mine.

The moderately anomalous zones of gold occur within a larger, more diffuse, weakly anomalous field that constitutes the overall area of the Socorro Reef gold anomaly. The southern contact of the weakly anomalous contour is essentially the contact between the Abrigo Formation and Martin Formation. North of the Bolsa Quartzite, however, a large area of Precambrian granite is apparently weakly anomalous and the northwestern boundary of the Socorro Reef gold anomaly is indefinite in several areas (See Plate 24).

The Socorro Reef gold anomaly is flanked outward by several, smaller discontinuous anomalies. These discontinuous anomalies are associated with tungsten-bearing quartz veins in the Precambrian granite north of the Socorro Reef gold anomaly, with siliceous, northeast-trending fracture zones in the Bolsa Quartzite, and with irregular quartz lenses in the Redwall Limestone northeast of the Socorro Reef gold anomaly. Scattered, moderately anomalous gold values are associated with silicified fractures in the Martin Formation at the Henry Bell property southeast and south of the Socorro Reef gold anomaly on the Henry Bell and Palo Verde claims; the moderately anomalous values are also associated with jasperoid lenses in the upper cherty member of the Redwall Limestone south of the Socorro Reef gold anomaly on the Reef No. 50 claim.

Silver

Silver contents of samples collected by Socorro Mining Corporation, Phillips, and Noranda are shown on Plate 25 and silver contents of samples collected by Exxon, ASARCO, and St. Joe are shown on Plate 26. A composite silver anomaly map for all the samples collected is presented as Plate 27. As shown on Plate 27, anomalous silver values in the Socorro Mine area occur much less frequently and are much more erratically distributed than anomalous values of gold. The moderate to strongly anomalous values of silver that do occur are in the outlying prospects mentioned in the gold section north and east of the Socorro Reef gold anomaly. Also, anomalous silver values occur in the Paleozoic carbonate section that is immediately south of the Socorro Reef gold anomaly and also occur within the Socorro Reef gold anomaly at its westernmost end. Hence, high silver values appear to be arranged concentrically around the Socorro Reef gold anomaly.

Gold:Silver Ratios

Gold:silver ratios of samples collected by Socorro Mining Corporation, Phillips, and Noranda are depicted on Plate 28 and gold:silver ratios of rock chip and rock channel samples collected by Exxon, ASARCO, and St. Joe are shown on Plate 29. A synoptic gold:silver ratio map for the entire Socorro Mine area is presented as Plate 30. This map strongly emphasizes the theme developed in previous sections, namely that gold-dominant areas within the Bolsa Quartzite are flanked outward by peripheral prospects with gold-silver and silver-dominant ratios. Virtually all of the gold-dominant ratios are restricted to the Bolsa Quartzite-Abrigo sections that are northeast of and southwest of the Socorro fault; a smaller gold-dominant area occurs in the Golden Eagle thrust zone at the old Socorro Mine. Interestingly, the part of the Socorro fault zone that occurs between the Socorro Mine and the Bolsa Quartzite outcrops to the southeast appears to have a silver-dominant character. The gold:silver ratio map (Plate 30) strongly highlights the gold-dominant character of the Bolsa Quartzite that crops out in an arcuate area southwest of the Socorro fault. Here, an arcuate-shaped outcrop area exists that contains numerous samples with gold:silver ratios that are gold-dominant. This zone is about 2500 feet long and 250 feet wide. It is, by far, the most interesting disseminated gold target within the Socorro Reef gold anomaly.

Other Metals

The distribution of other metals in the Socorro Reef gold system has already been discussed in Part I and is only summarized here. As developed in Part I, gold-dominant portions of the Socorro Reef gold anomaly carry high concentrations of tungsten, which are positively correlated with gold content. Lead and minor copper base metal anomalies occur locally within the gold-dominant area. The gold-dominant area is also characterized by a distinct lack of silver, zinc, molybdenum, arsenic, antimony, and mercury. Conversely, zinc, silver, molybdenum, arsenic, antimony, and mercury are frequently anomalous in outlying prospects. Tungsten is locally strongly anomalous in outlying prospects, especially in a tungsten-bearing silver vein in Precambrian granite 500 feet northwest of the wood frame house that is west of the Socorro Mine (George Campbell, Jr., personal communication, summer 1982). Mercury is consistently anomalous in Paleozoic rocks east of the Socorro Reef gold anomaly.

Metal Zoning at Socorro Reef

Plate 31 shows the inferred zonal relationships of the Socorro Reef gold system. In this plate the Socorro Reef gold anomaly represents the gold-tungsten-lead-copper-rich central zone of a disseminated gold system. The gold-tungsten-dominated central zone is flanked outward by a surrounding, gold-silver-polymetallic zone and by a silver-dominant peripheral area at the Henry Bell Mine. More complete descriptions and implications of this metal zoning for other calc-alkalic gold districts of mid-Tertiary age in the Salome region were discussed in Part I.

Geophysics

In order to obtain preliminary information about three-dimensional aspects of the Socorro Reef gold anomaly, Mining Geophysical Surveys Inc. conducted a time-domain, induced polarization and resistivity survey (IP) for Noranda Exploration Inc. in June of 1982. Two north-south IP lines (Lines 1 & 3) were run through the Socorro Reef gold anomaly and one north-south IP line (Line 2) was run through non-mineralized Bolsa Quartzite 500 feet west of the Socorro Reef gold anomaly. The locations for these lines are shown in Figure 21 and the time-domain, induced polarization and resistivity profiles are reproduced in Figures 22 (Line 1), Figure 23 (Line 2), and Figure 24 (Line 3).

The IP survey yielded intriguing results; namely, the presence of a weak to moderate, southward-inclined, apparent polarization response in the Bolsa Quartzite that terminates approximately 300 to 400 feet below the surface. The bottom of this anomaly could be structural and could reflect the presence of the Golden Eagle thrust beneath the southward-dipping Paleozoic sedimentary section. By analogy with surface exposures to the northeast in Sec. 17, T.5N., R.11W. (See Plate 2), the Golden Eagle thrust probably truncates the southward-inclined Paleozoic section; it would, therefore, represent the geologic bottom of the gold mineralization in the Bolsa Quartzite. The termination of the southward-inclined IP anomaly is consistent with this interpretation. The consistency of the moderate intensity IP anomaly suggests that the Bolsa Quartzite and underlying granite are well enough fractured and contain enough pyrite (probably about 2/3 wt. %) and intervening intergranular fluids to continously conduct current. Consequently, the shape of the IP anomaly effectively outlines the downdip projection of surface alteration and gold mineralization in the Bolsa Quartzite and underlying Precambrian granite.

The southward-inclined, moderate intensity IP anomaly, which is well developed in Lines 1 and 3, is absent from Line 2. In Line 2, however, there is a noticeable polarization contrast between the granite and the Paleozoic section to the south where the contact is crossed between stations C-5 and C-6 on Line 2. The granite north of the contact is more conductive with apparent polarization values ranging between 10 and 15 millivolt-seconds/volt whereas the Paleozoic section south of the contact is clearly more resistant with apparent polarization values ranging between 1 and 6 millivolt-seconds/volt. The polarization contrast in Line 2 appears to have a near vertical dip to about 400 feet. This dip is consistent with the vertical dip of the contact at the surface.

Implications of the time-domain, induced polarization data for the gold mineralization at Socorro Reef were taken into consideration during the construction of the geologic cross sections (Figure 19). In cross sections A-A' and B-B' gold mineralization is shown within the Bolsa Quartzite and Precambrian granite as a tabular mineralized body that parallels the strike and dip of the Bolsa Quartzite. The mineralization is shown to extend into the granite and terminate somewhere in the granite because of the IP data in Lines 1 and 3. Mineralization is then shown to dip southward into the Golden Eagle thrust where it is terminated by the thrust. Mineralization is also shown within the Golden Eagle thrust zone beneath the Paleozoic section. Although the IP data did not verify this idea, it is reasonable based on an analogy with the gold mineralization that was mined at the old Socorro Mine.

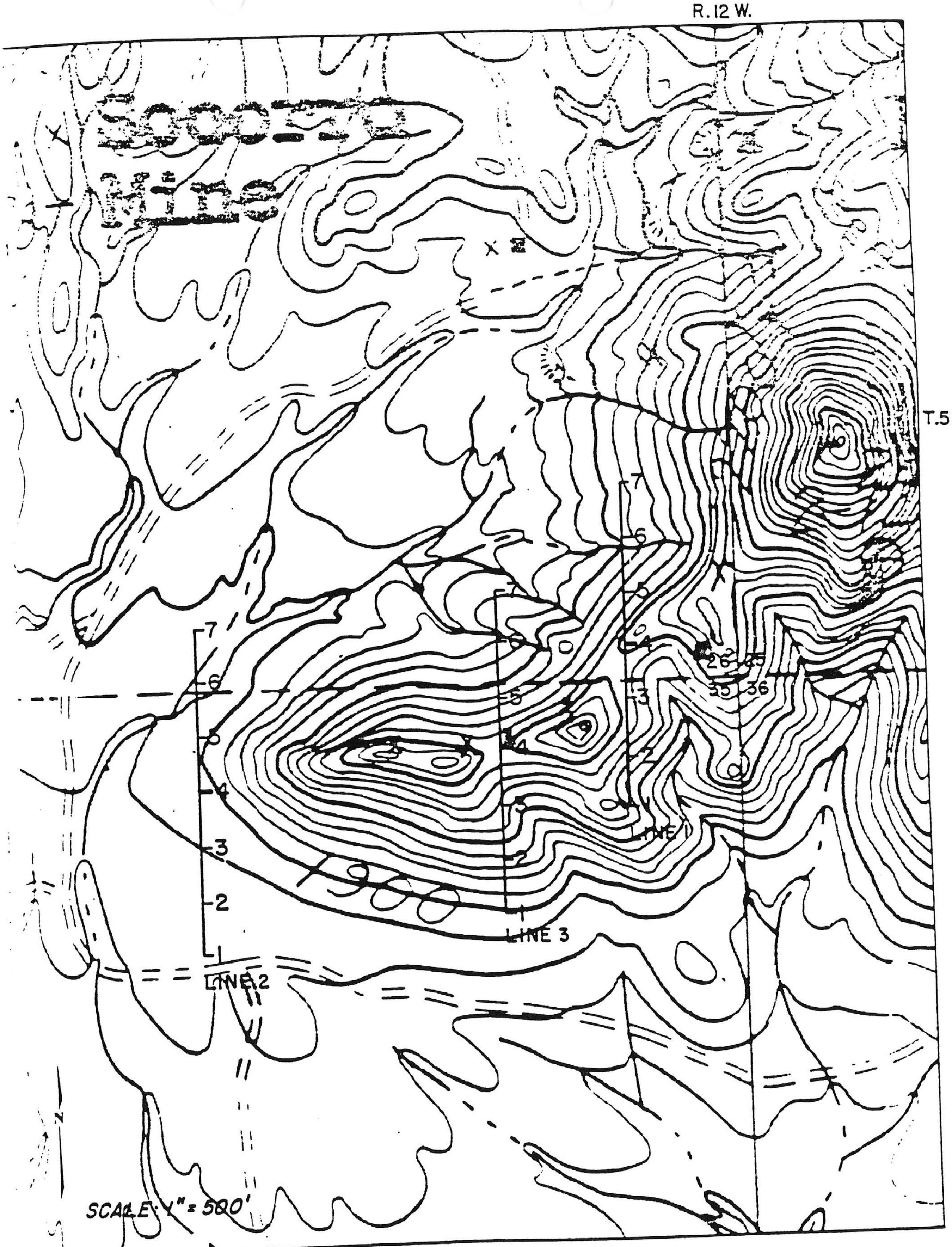


Figure 21. Location map for induced polarization lines from geophysical survey for Noranda Exploration, Inc.

Geologic Model for Socorro Reef Disseminated Gold Deposit

Figure 25 is a geometric model for gold mineralization beneath the Socorro Reef gold anomaly and is based on data discussed in previous sections. In this model gold mineralization ascended the Socorro fault zone following the emplacement of microdiorite dikes about 25 m.y. ago. When the gold-bearing hydrothermal fluids encountered the pre-mineral Golden Eagle thrust zone, the increased premeability induced deposition of the gold-tungsten-lead-copper assemblage in the central zone. This mineralization was deposited along the thrust and in the upper plate of the Golden Eagle thrust in permeable Precambrian granite and the overlying, south- and southeast-dipping, Bolsa Quartzite-Abrigo section. Lateral migration of fluids along the thrusts to the north and to the south of its intersection with Bolsa Quartzite led to deposition of the peripheral gold-silver-polymetallic assemblage. Also, cooling hydrothermal fluids laterally and vertically migrated into the upper plate Paleozoic section where deposition of the gold-silver-polymetallic assemblage and the silver-base metal-mercury-manganesse assemblage occurred peripheral to the gold-tungsten-lead-copper-rich central assemblage in the Bolsa Quartzite. Consequently, one should not expect the gold-dominant assemblage to occur directly beneath silver-dominant deposits, such as those on the Henry Bell ground, because of their predicted lateral position away from the gold-dominated central core. That is, the gold-dominated central core is inferred to have near-vertical walls with perhaps minor lateral extensions near the Golden Eagle thrust (See Figure 25). The entire Socorro Reef gold system has subsequently been tilted south and southeastward by post-mineral tilting around northeast-trending fold axes. For a more general discussion of the disseminated gold deposit model as it applies to gold districts in the Salome region and the geologic history of the Salome region, the reader is referred to Part I.

Economic Evaluation of the Socorro Reef Gold Anomaly

CONFIRMATION AND DOCUMENTATION

Following the initial identification of the Socorro Reef gold anomaly by Socorro Mining Corporation and Noranda in March and April 1982, follow up field studies were conducted by Noranda, Phillips, Exxon, St. Joe, and ASARCO from June through September 1982. Most recently, follow up studies have just been completed on December 3 by Utah International. The results of these studies have confirmed and documented the existence of the Socorro Reef gold anomaly in an impressive way. From what is presently known, the moderate-intensity portion of the Socorro Reef gold anomaly in the Bolsa Quartzite is over 3300 feet long and averages about 250 feet wide (See Figure 26) and is inferred to be about 350 feet deep. This constitutes about 35.5 million tons of gold-rich material.

The Phillips sampling in June 1982 was designed to confirm the existence of the auriferous quartzite block to the west of the open cut in the saddle southwest of Hill 2462 and to sample the granite north of the quartzite in order to add additional tonnage. Noranda work during the same period was designed to confirm the known block of anomalous quartzite and to determine how far northeast and west of the Socorro Mining Corporation open cut the anomalous quartzite persisted. Noranda also obtained geophysical information to estimate the depth extent of the surface anomaly. Results of these studies defined the west limit of the anomaly about 500 feet west of the Bluebird fault (See Plate 19) and extended the anomaly for at least 900 feet to the northeast of the Socorro Mining open cut.

In August and September of 1982 Exxon Minerals and ASARCO took 48 samples to confirm the existence of the anomalous quartzite as established by the Noranda and Socorro Mining work. Exxon took more samples in the Paleozoic carbonate section south of the quartzite section to confirm that the carbonate section did not carry anomalous gold. The objectives of the Exxon and ASARCO work were met. The work by Exxon firmly established that the carbonate section south of the Socorro Reef gold anomaly contains very little gold.

In August and September of 1982 St. Joe conducted extensive sampling of the Socorro Reef gold anomaly to confirm the preexisting geochemical data and to determine how much gold was contained in Bolsa Quartzite exposures northeast of the known auriferous quartzite and how far gold mineralization extended to the northeast of the Socorro Mine along the Golden Eagle thrust zone. Also, the method of sampling by St. Joe within the known anomalous quartzite was by continous rock channel sampling rather than by point rock chip sampling, as the previous sampling programs had been. Again, St. Joe rock channel sampling within the known quartzite gold anomaly confirmed the existence of the gold anomaly and suggested that this anomaly was very continuous because of the sampling method employed. Also, St. Joe established that the quartzite block northeast of the Socorro fault was weakly to moderately auriferous for about another 875 feet. St. Joe sampling northeast of the Socorro Mine failed to uncover any continuous gold mineralization within or below the Golden Eagle thrust zone. St. Joe sampling also established that granite and quartzite exposures between Hill 2462 and the Socorro Mine were weakly anomalous. Hence, as of the St. Joe sampling, the Socorro Mine, which had constituted a separate anomaly on previous maps, is now known to be physically continuous with the moderate to strong intensity gold anomaly in the quartzite to the south.

In October and November of 1982 Borax analyses of the June Phillips sampling became available. These analyses again reaffirmed the existence of moderately to strongly anomalous quartzite west of the Socorro Mining open cut. The Borax analyses of granite samples, which were taken at the Bolsa-granite contact and for about 100 feet north into the granite, showed that the granite also was weakly to moderately anomalous. These results added another 50 to 75 feet of width to the moderate intensity portion of the Socorro Reef gold anomaly west of the Socorro Mining open cut in the saddle southwest of Hill 2462.

Accumulated data from all studies to date allows the inference that much of the Precambrian granite north of the quartzite-granite, moderate intensity anomaly is at least weakly anomalous with spotty gold values of moderate intensity. More sampling would be needed to discover any large areas of moderately intense gold values, but the granite block does represent a potential addition of large tonnages to existing tonnages (perhaps as much as 40,000,000 Tons). However, alteration patterns in this granite do not look promising enough to directly allow inference of these tonnages at the surface and much of this area would have to be evaluated by drilling for a blind, thrust-related target. Such drilling at this time is considered a wildcat venture, especially in light of the more essential drilling that would confirm mineable ground beneath the moderately intense gold anomaly in the Bolsa Quartzite and immediately underlying granite.

GOLD AND SILVER GRADES

Gold Grades

Average Gold Grades. Figure 27 is a frequency histogram for all 368 samples analyzed for gold within the Socorro Reef gold anomaly. Average yearly gold values for seven years of reported production data from the Socorro Mine are also shown for comparison (also refer to Table 12). Samples within the moderately intense gold anomaly exhibit a bimodal frequency distribution with one mode between 0.11 and 0.4 ppm and another mode at 1.15 ppm. Samples from the weakly to moderately anomalous Precambrian granite (which is north of the moderately intense portion of the Socorro Reef gold anomaly) are weakly anomalous (mode at 0.065) to moderately anomalous (mode at 0.015).

Excluding the 1904-1934 production data, gold values for all 368 samples collected by surface sampling and drilling within the Socorro Reef gold anomaly average 1.02 ppm (0.03 oz/T). Excluding high grade samples (greater than 9 ppm) and low-grade samples (less than 0.02 ppm), 334 samples averaged 0.5172 ppm (0.0152 oz/T). Of these, 100 samples fell within the weakly anomalous interval (0.11 to 0.09 ppm) and averaged 0.053 ppm gold; 193 occurred in the moderately anomalous interval (0.09 to 0.9 ppm) and averaged 0.319 ppm; and 48 samples occurred in the strongly anomalous category (0.9 to 9 ppm) and averaged 2.59 ppm.

Gold Content by Rock Type. During the sampling it became apparent that both the Bolsa Quartzite section and the Precambrian granite north of the Bolsa Quartzite contained gold mineralization. To evaluate the distribution of gold values within these two rock types, a frequency histogram was prepared for samples collected within the quartzite and another for those from the granite. Inspection of Figure 28 reveals that the Bolsa Quartzite carries systematically higher values of gold. 158 samples known to have been collected from the Bolsa Quartzite-Abrigo section contained an average of 0.485 ppm gold, whereas 49 samples known to have been taken from the Precambrian porphyritic granite contained an

1/202

average of 0.213 ppm gold. Both groups of samples are bimodal and in both groups the principal modes are at 0.065 ppm gold and 0.15 ppm gold. However, the principal mode for the Precambrian granite is 0.065 ppm gold, whereas the principal mode for the Cambrian Bolsa Quartzite-Abrigo section is 0.15 ppm gold. In summary, Figure 28 clearly shows the preference of higher grade gold values for the Bolsa Quartzite-Abrigo section. Thus, rock type exerts a considerable control on the distribution of gold grades. Nevertheless, samples of the Precambrian granite, especially where it occurs directly below the Bolsa Quartzite, are anomalous and do add to the overall tonnage amounts at Socorro Reef.

<u>Presence of Coarse Gold</u>. The bimodal character of samples enclosed by the contour around the moderately intense anomaly within the Socorro Reef gold anomaly suggests that coarse gold might be present. That is, there could be two or more populations of sizes of gold particles within the auriferous quartzite. The coarse gold fraction would produce fewer particles per given volume of rock. This would introduce a sampling problem in that sampling would mainly sample the fine gold fraction and would irregularly sample or miss the coarse gold fraction.

To evaluate to what extent there might be coarse gold present, Exxon analyzed two sample splits from the same samples in the anomalous Bolsa Quartzite-Abrigo section by the same analytical technique (atomic absorption). They found significantly increased gold contents in one out of seven samples that contained anomalous gold. These data suggest that some coarse gold is present within the moderate intensity portions of the Socorro Reef gold anomaly; they also support the idea that the bimodal aspects of the Socorro Reef gold anomaly are, at least in part, possibly due to size differences between fine gold and coarse gold. Thus, when a particle of coarse gold enters into an analytical split, it will significantly increase the gold contents to one ppm or more from a background, fine-gold population that would range between 0.3 and 0.5 ppm. Enough samples have been collected so that the average figures quoted in the preceding paragraphs on gold grades probably represent realistic average values for gold at the ground surface within the Socorro Reef gold anomaly and would include a representative sample of the coarse gold fraction.

Silver Grades

Figure 29 is a frequency histogram for 267 samples that were analyzed for silver within the Socorro Reef gold anomaly. As can be seen from Figure 29 silver is not an important ingredient in the Socorro Reef gold system. Average silver values for the 267 samples was much, much less than 1.23 ppm because most of the samples within the Socorro Reef gold anomaly contained less than detectable silver at the 0.2 ppm level. The probable silver content can be estimated by assuming that the gold:silver ratio for the 1904-1934 Socorro Mine production applies to the Socorro Reef gold anomaly in general. Thus, if one divides 0.5172 ppm (the average gold content of the Socorro Reef gold anomaly without the high and low grade samples) by 1.77 (the gold:silver ratio for the 1904-1934 Socorro Mine production), a value of 0.29 ppm silver is obtained. This number is probably a realistic number for silver values within the Socorro Reef gold system.

Possible Variations in Gold Content with Depth

Figure 30 is a gold-silver variation diagram for all samples analyzed for gold and silver within the Socorro Reef gold anomaly. As is Figure 9 in Part I, gold exhibits a good positive correlation with silver values over the domain of the Socorro Reef gold anomaly. A minor exception to this correlation is silver data analyzed by Borax on Phillips samples, which yielded systematically higher values of silver for samples below the 2 ppm level. This discrepancy is probably a function of the different analytical techniques for silver used by the two laboratories.

Figure 30 also shows the production data for the Socorro Mine from 1904 to 1934. The significant point about the Socorro Mine production and geochemical sampling within the Socorro Mine portion of the Socorro Reef gold anomaly is that this mineralization was deposited at a lower structural level; that is, the gold mineralization at the Socorro Mine was deposited along the Golden Eagle thrust rather than structurally higher in the upper plate quartzite. If it is assumed that the Golden Eagle thrust directly beneath the anomalous Bolsa Quartzite is mineralized with gold grades similar to those encountered in the Socorro Mine, then there is a good possibility that gold contents obtained from surface samples of Bolsa Quartzite might systematically increase downward towards the Golden Eagle thrust. Sampling to date within the Socorro Mine portion of the Socorro Reef gold anomaly (Block F on Figure 26) averages 0.138 oz/Ton based on 23 samples. This grade is slightly less than the 0.155 oz/Ton average grade for the 1904-1934 Socorro Mine production. This grade is about three and a half times higher than average values for gold on the surface within the quartzite portion of the Socorro Reef gold anomaly.

Some information is available about what happens to gold values in the quartzite portion of the Socorro Reef gold anomaly with depth. In June of 1981 Arizona Drilling Services drilled one 200-foot, reverse-circulation, rotary hole in the floor of the Socorro Mining open cut southwest of Hill 2462. The location for this hole, named SAD-1, is shown on Figure 26. Cuttings were collected and composited for every 5-foot interval in the drill hole. The first 50-foot interval averaged 0.0105 oz/Ton, the interval from 50-100 feet averaged 0.0135 oz/Ton, the interval from 100-150 feet averaged 0.016 oz/Ton, and the interval from 150-200 feet averaged 0.015 oz/Ton. Thus, in the SAD-1 drill hole, there is a slight increase in grade with depth, although the grade level is not as high as one would like. Appendix X contains analytical data for the SAD-1 drill hole, for two holes (designated GH-1 and GH-2) drilled in and near the Socorro Mine portion of the Socorro Reef gold anomaly, and for two holes designated CAM-1 and CAM-2 drilled on the Henry Bell claim. Locations for these holes are shown on Figure 26.

TIME DOMAIN INDUCED POLARIZATION

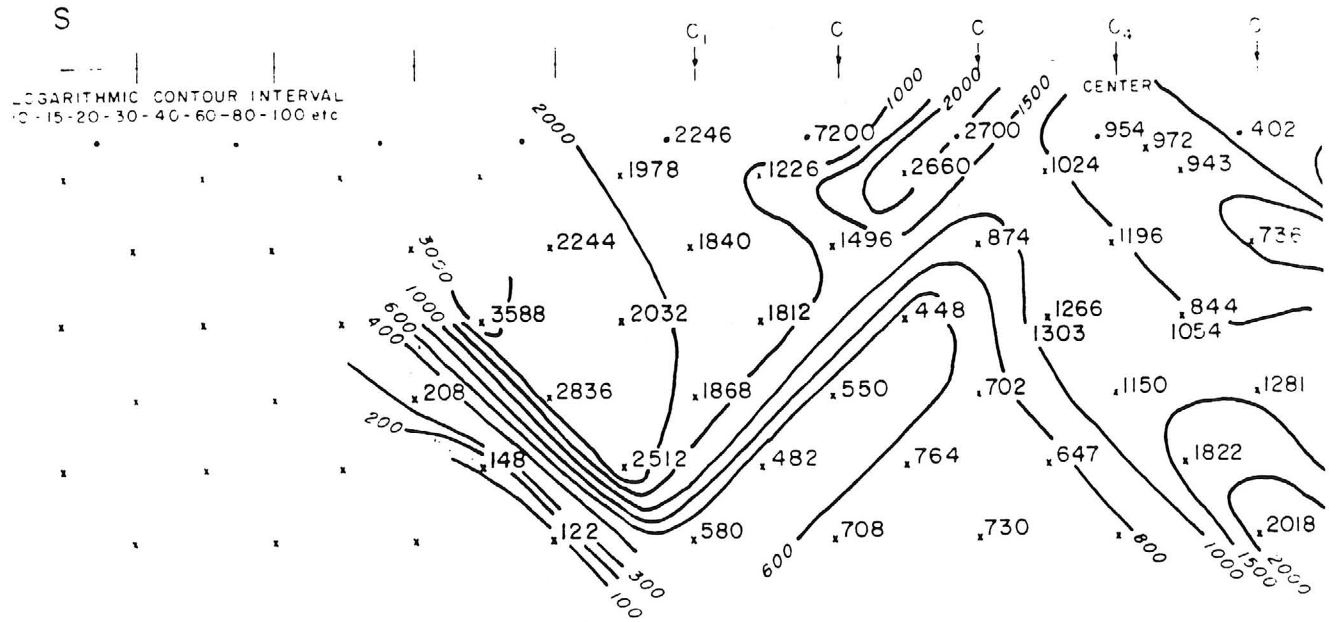
SOCORRO REEF PROJECT – YUMA

for

Noranda Exploration, Ir

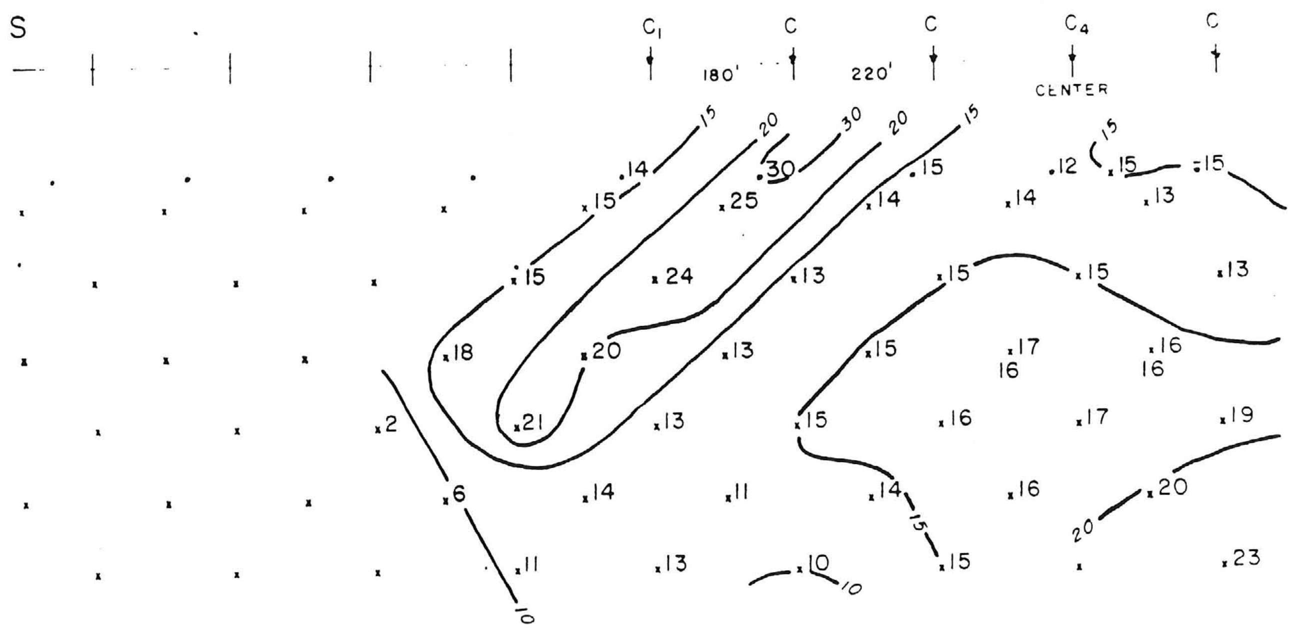
APPARENT RESISTIVI

ohm meters

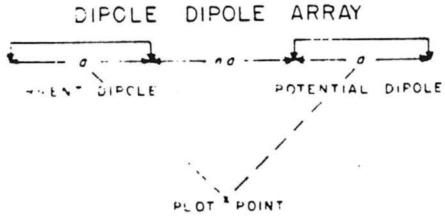


APPARENT POLARIZA

millivolt seconds/volt



DIPOLE DIPOLE ARRAY



LINE 1

LOOKING WEST

DIPOLE LENGTH 200'

DATE 6/15/82

POLARIZATION AND RESISTIVITY SURVEY

PROJECT - YUMA COUNTY, ARIZONA

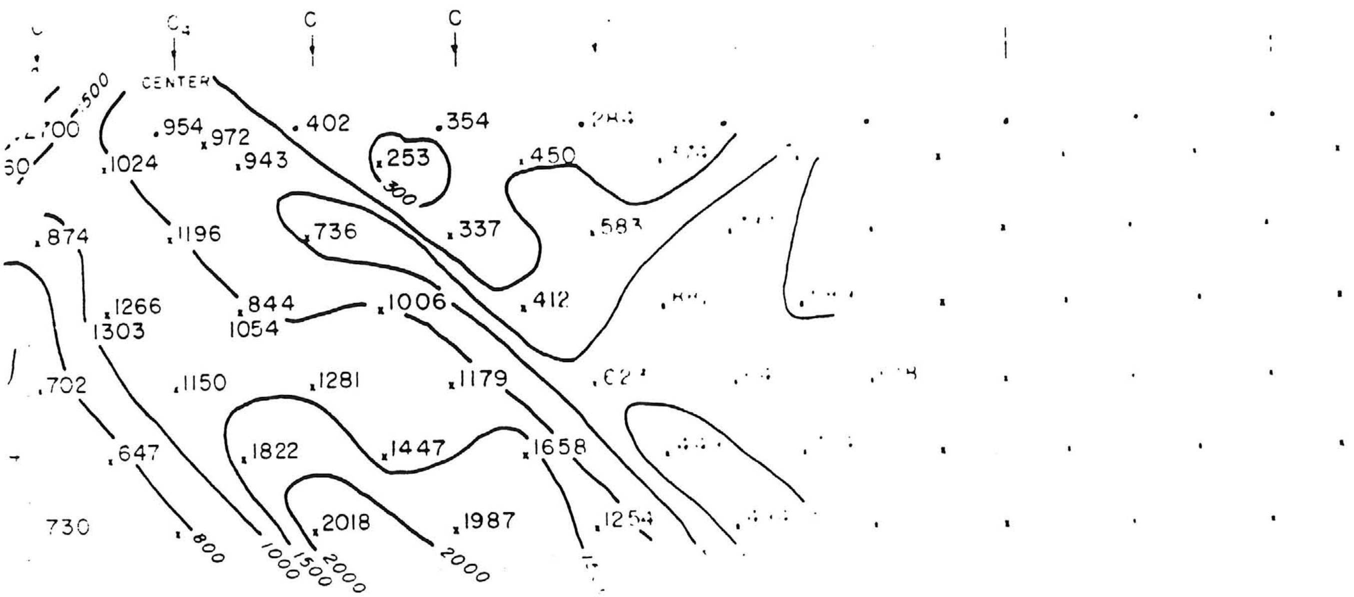
for

Noranda Exploration, Inc.

APPARENT RESISTIVITY

ohm meters

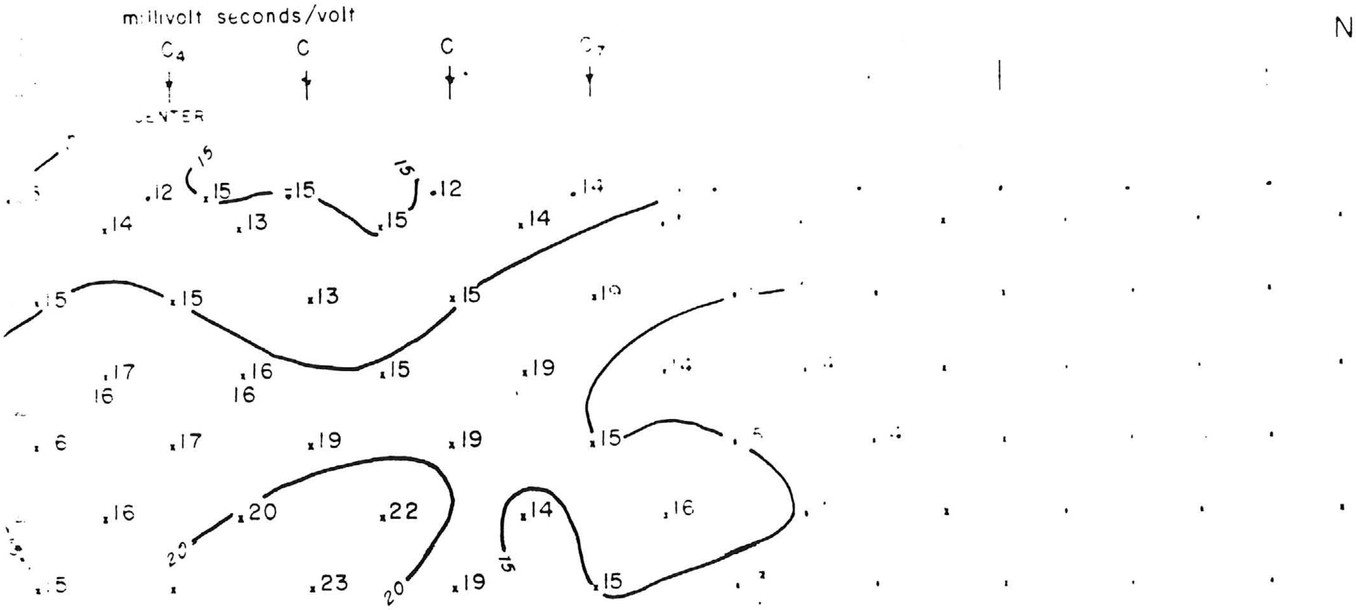
N



APPARENT POLARIZATION

millivolt seconds/volt

N



LEGEND

FENCE X

PIPELINE .... ϕ

POWERLINE ...... T

ROAD, R.R. == ###

5/82

FIGURE 22

TIME DOMAIN INDUCED POLARIZATION

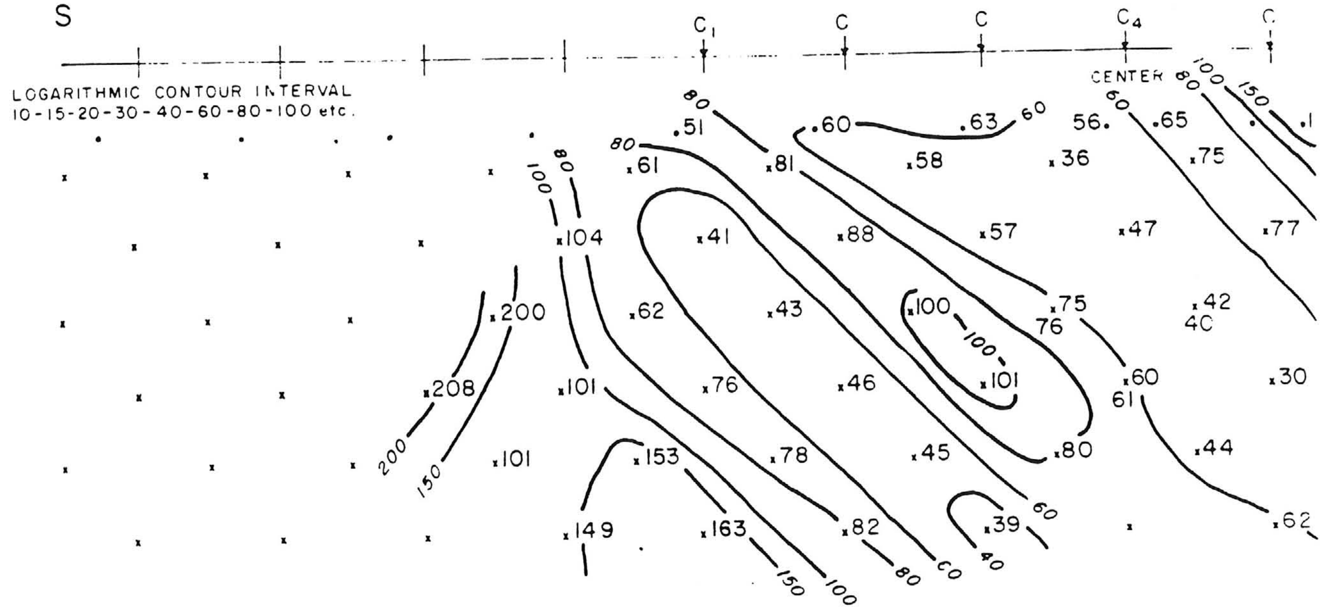
SOCORRO REEF PROJECT - YUMA

for

Noranda Exploration,

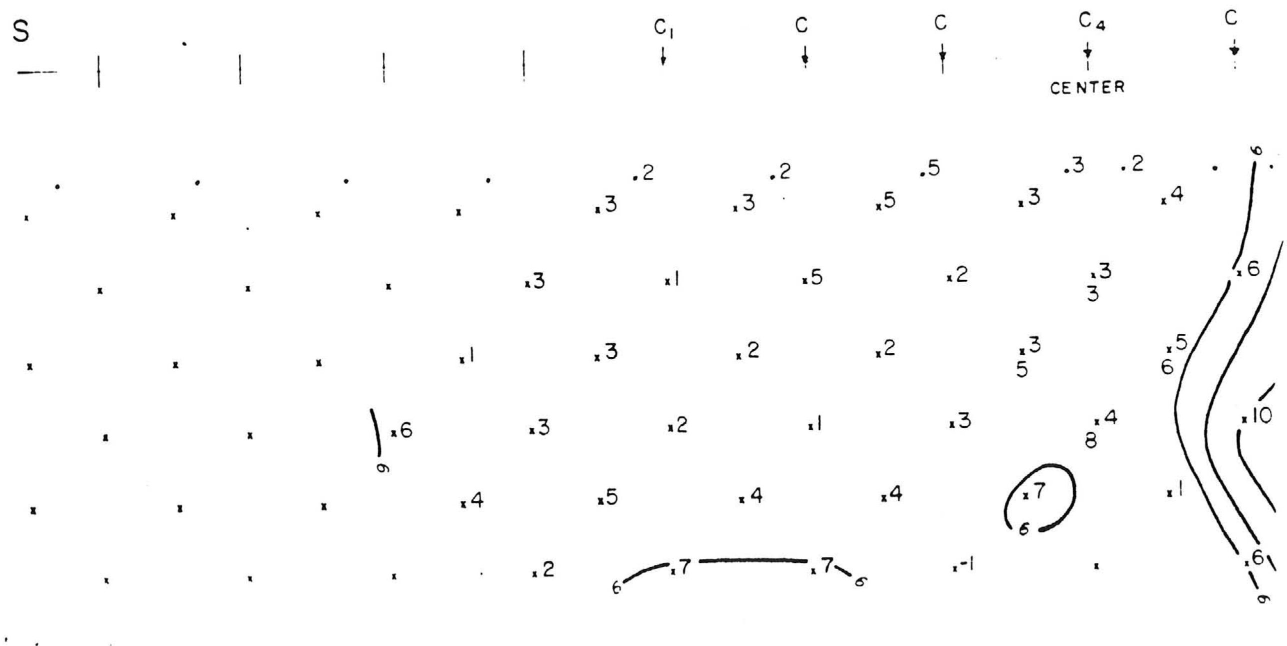
APPARENT RESISTIV

ohm meters

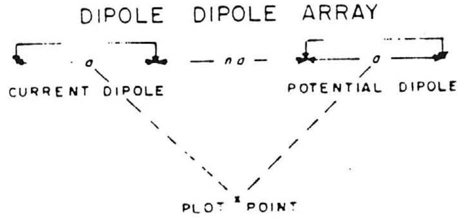


APPARENT POLARIZ

millivolt seconds/vo



DIPOLE DIPOLE ARRAY



LINE 2

LOOKING WEST

DIPOLE LENGTH 200'

DATE 6/16/82

POLARIZATION AND RESISTIVITY SURVEY

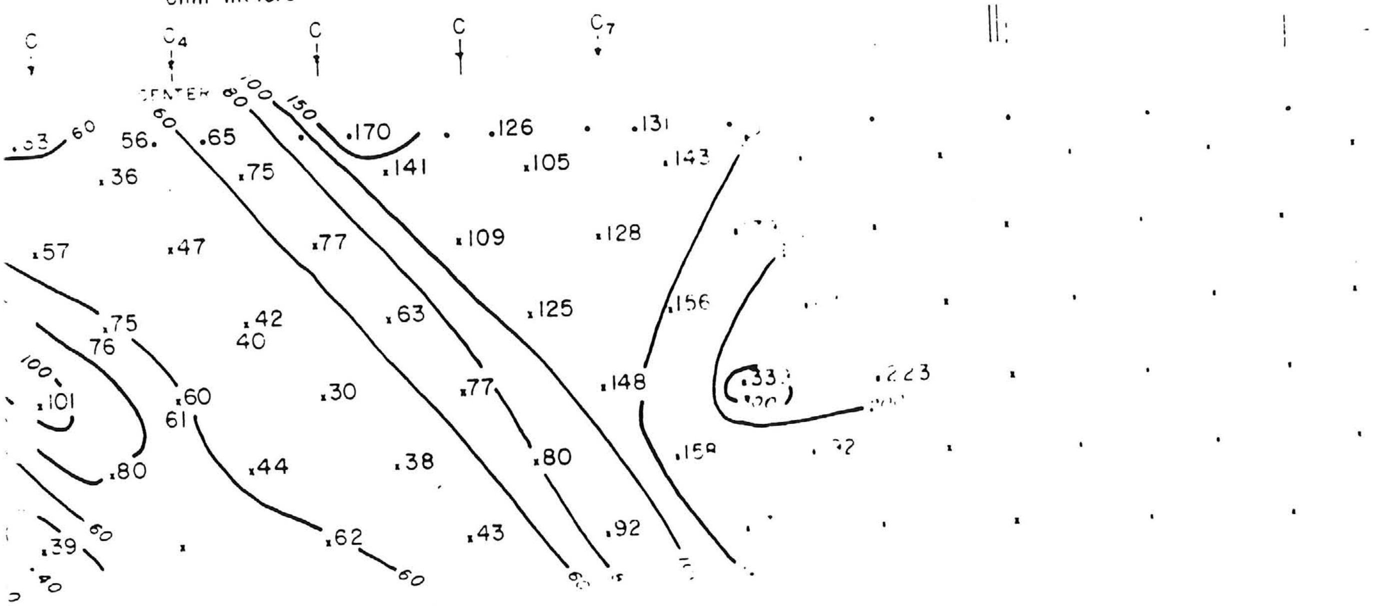
PROJECT – YUMA COUNTY, ARIZONA

for

Noranda Exploration, Inc.

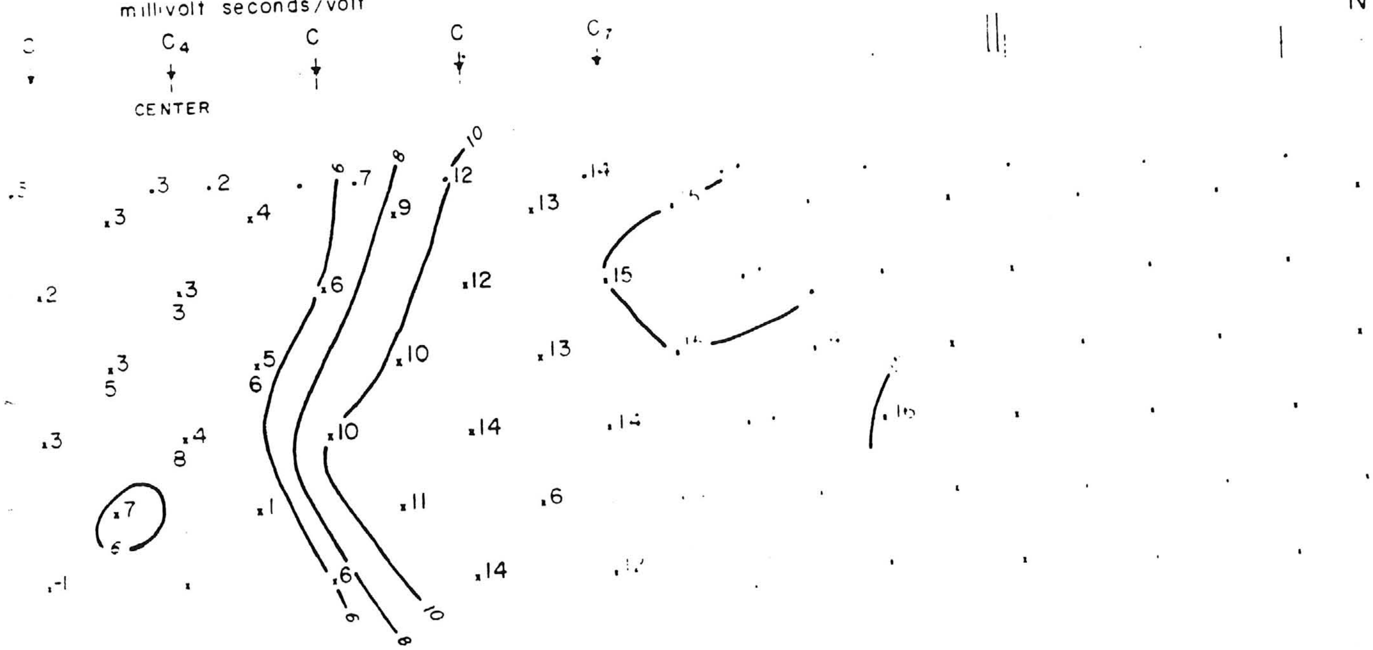
APPARENT RESISTIVITY

ohm meters



APPARENT POLARIZATION

millivolt seconds/volt



LEGEND

FENCE.......... ✗

PIPELINE....... ϕ

POWERLINE...... T

ROAD, R.R. ═ ╪╪

FIGURE 23

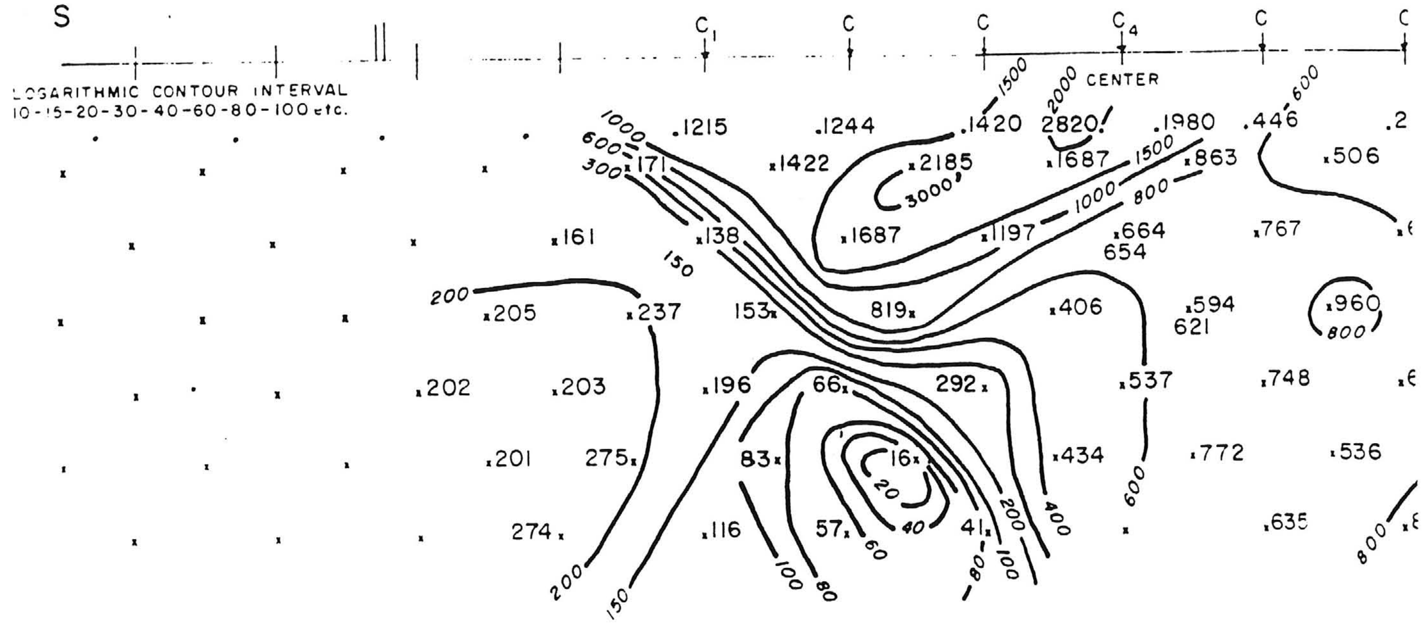
TIME DOMAIN INDUCED POLARIZATION ANC

SOCORRO REEF PROJECT – YUMA COU

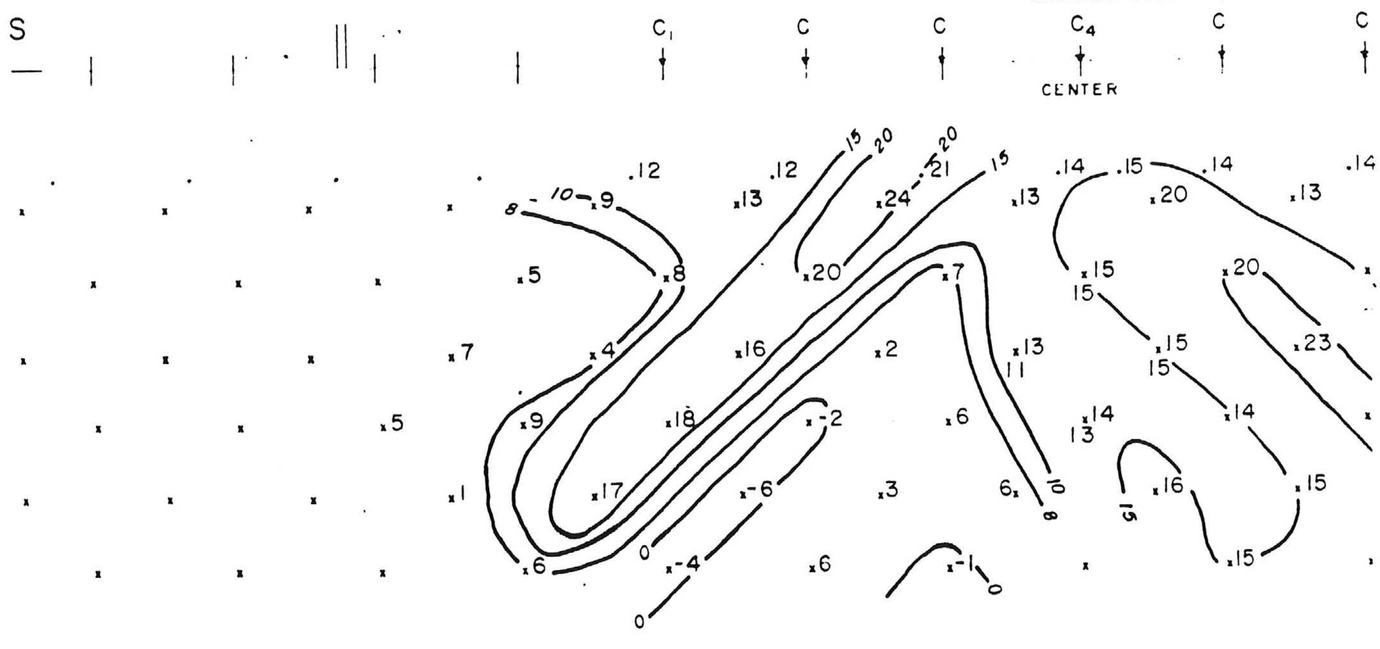
for

Noranda Exploration, Inc.

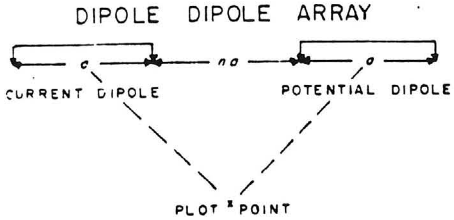
APPARENT RESISTIVITY
ohm meters



APPARENT POLARIZATION
millivolt seconds/volt



DIPOLE DIPOLE ARRAY



S Angelon

LINE 3

LOOKING WEST

DIPOLE LENGTH 200'

DATE 6/18/82

LEGEN

FENCE . . . .

PIPELINE . . . .

POWERLINE . .

ROAD, R.R. ══

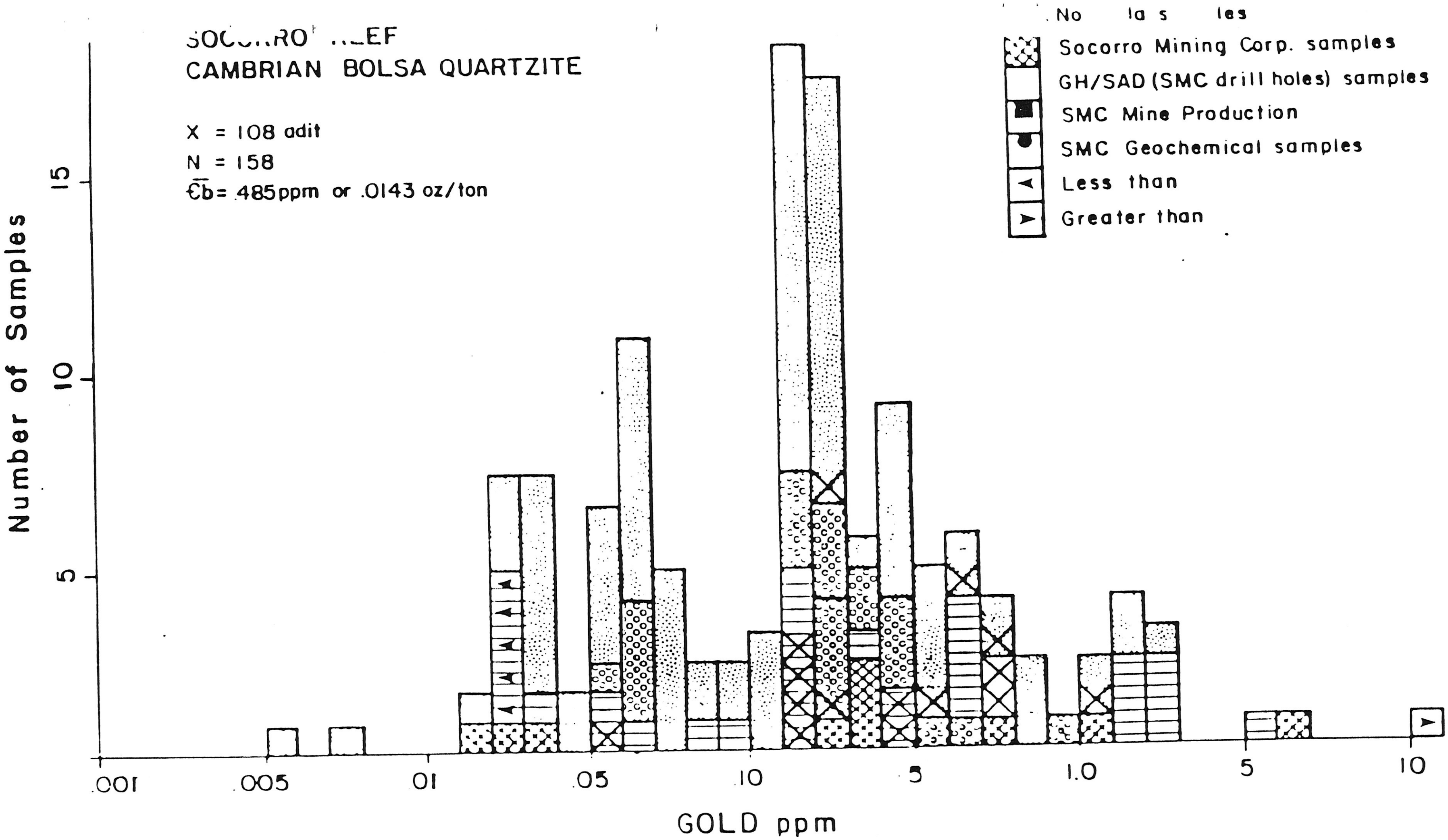
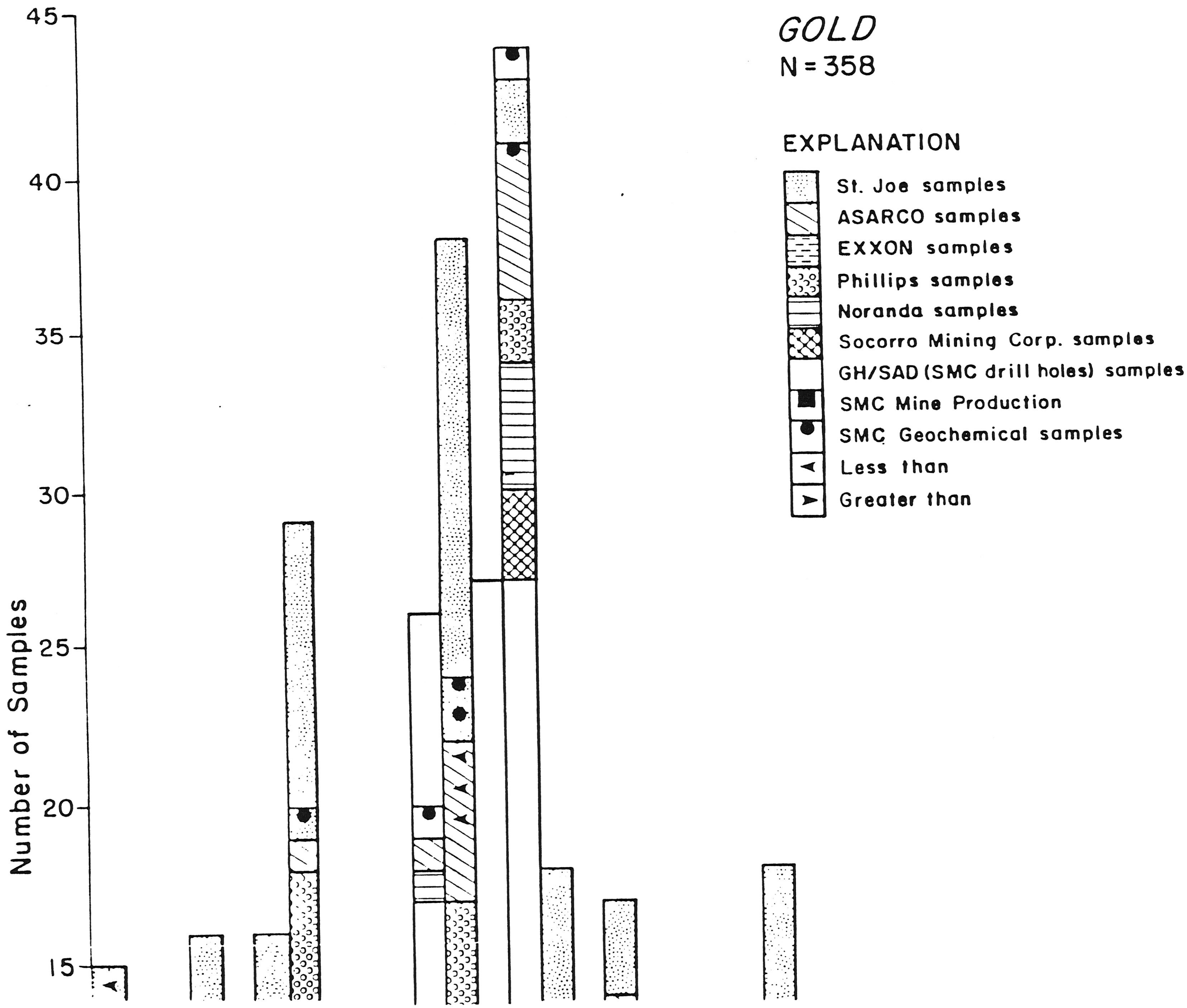


Figure 28B. Frequency histogram of gold contents in samples from Bolsa Quartzite within the Socorro Reef anomaly.

FIGURE 28A-B


GOLD
N = 358
EXPLANATION
St. Joe samples
ASARCO samples
EXXON samples
Phillips samples
Noranda samples
Socorro Mining Corp. samples
GH/SAD (SMC drill holes) samples
SMC Mine Production
SMC Geochemical samples
Less than
Greater than
Number of Samples
45
40
35
30
25
20
15

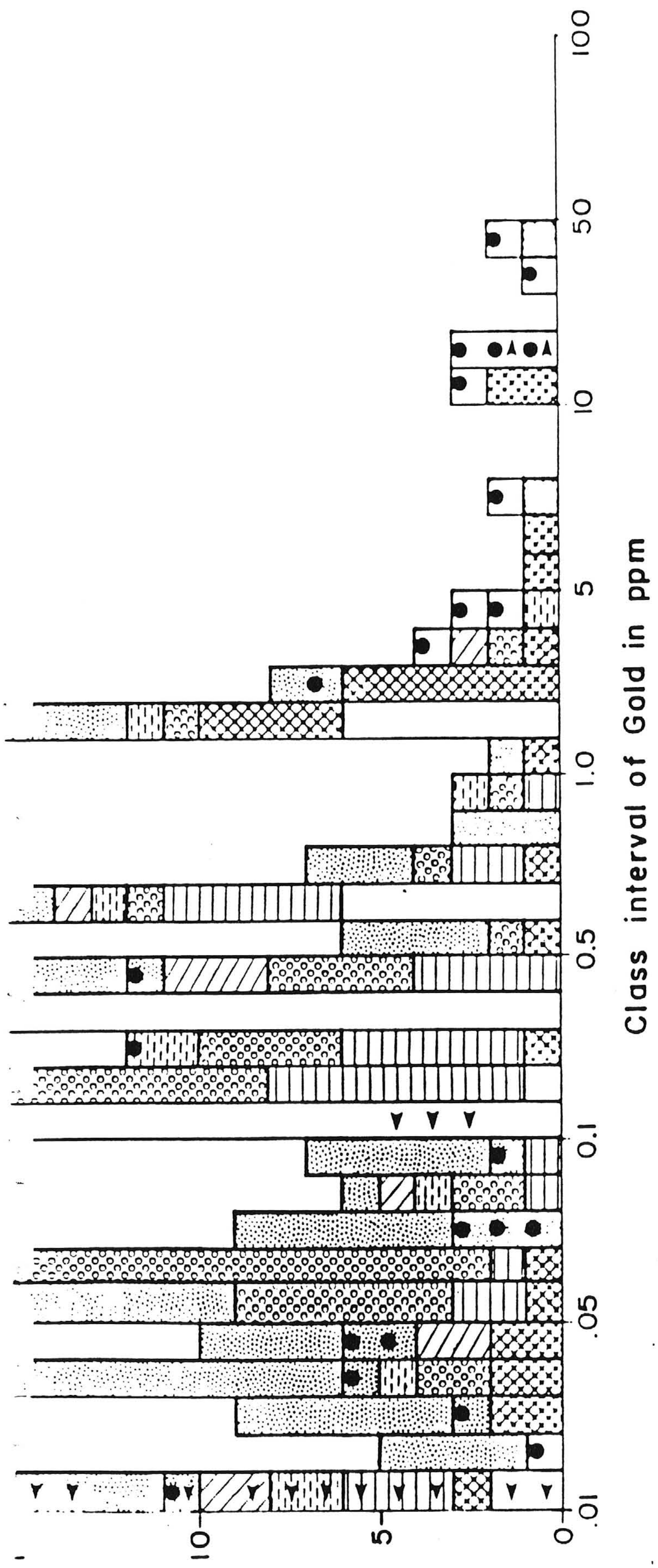


Figure 27. Frequency histogram for Gold values in samples from the Socorro Reef Gold anomaly.

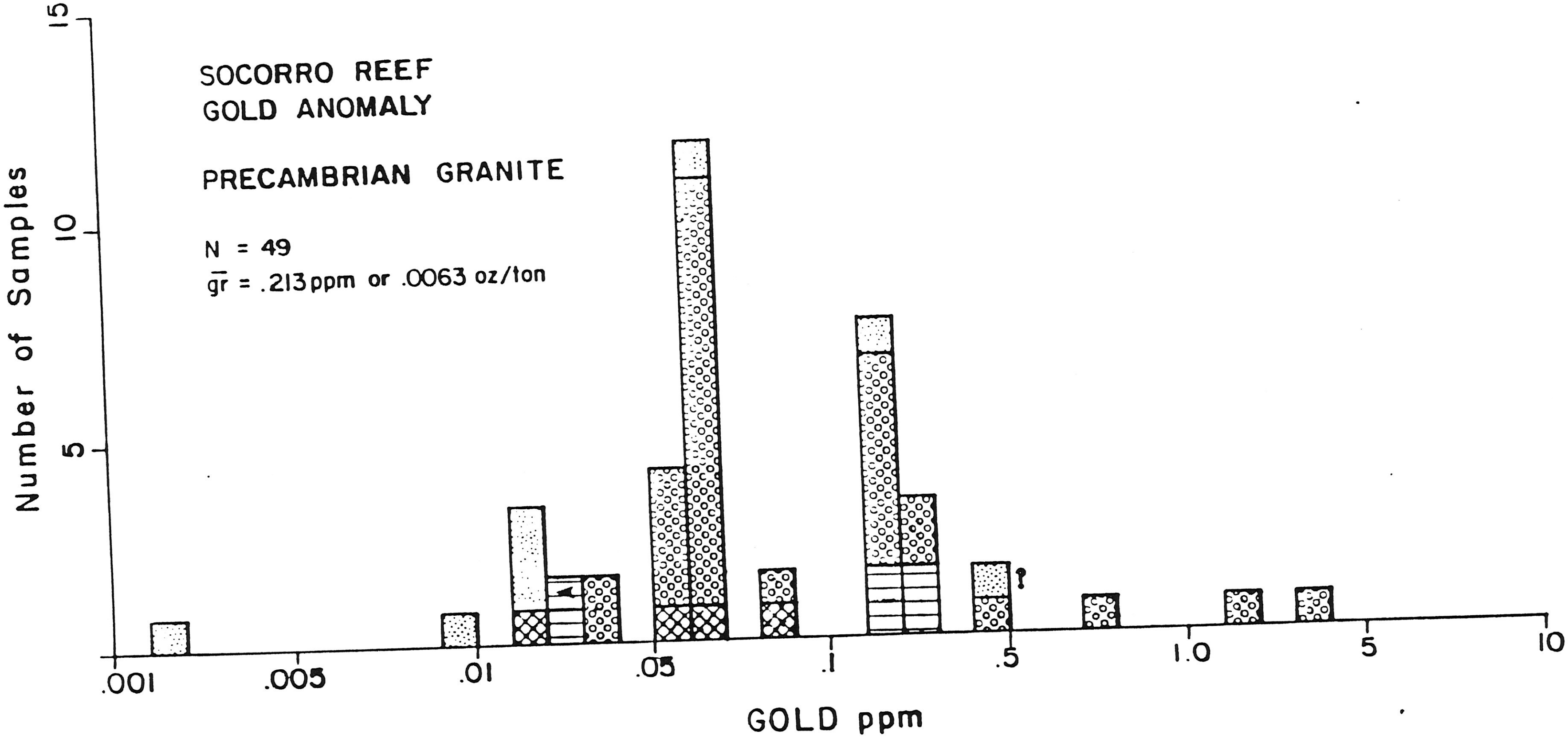
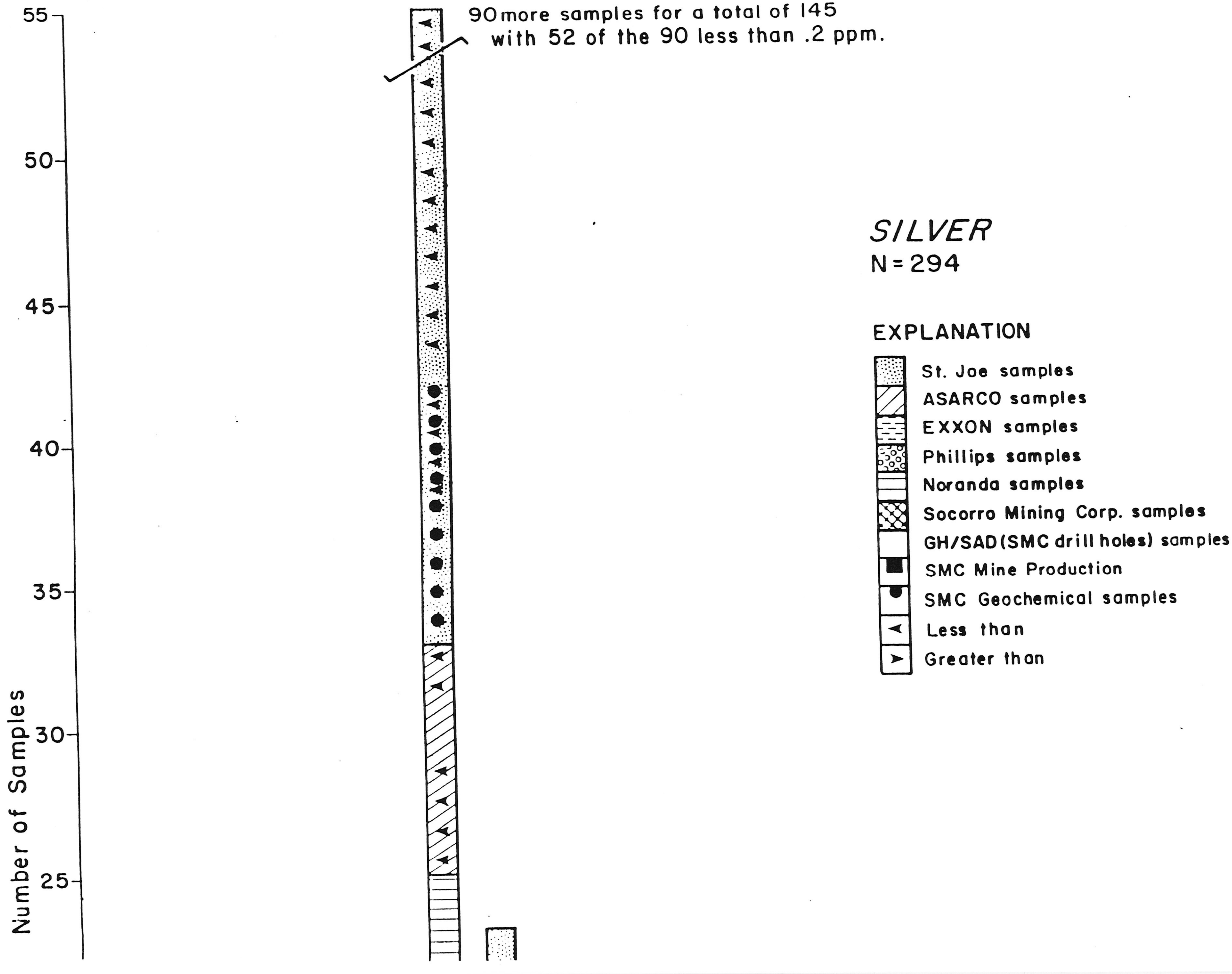


Figure 28A. Frequency histogram of gold contents in samples from Precambrian granite within the Socorro Reef anomaly.



90 more samples for a total of 145
with 52 of the 90 less than .2 ppm.
55
50
45
40
35
30
25
Number of Samples
SILVER
N=294
EXPLANATION
St. Joe samples
ASARCO samples
EXXON samples
Phillips samples
Noranda samples
Socorro Mining Corp. samples
GH/SAD (SMC drill holes) samples
SMC Mine Production
SMC Geochemical samples
Less than
Greater than

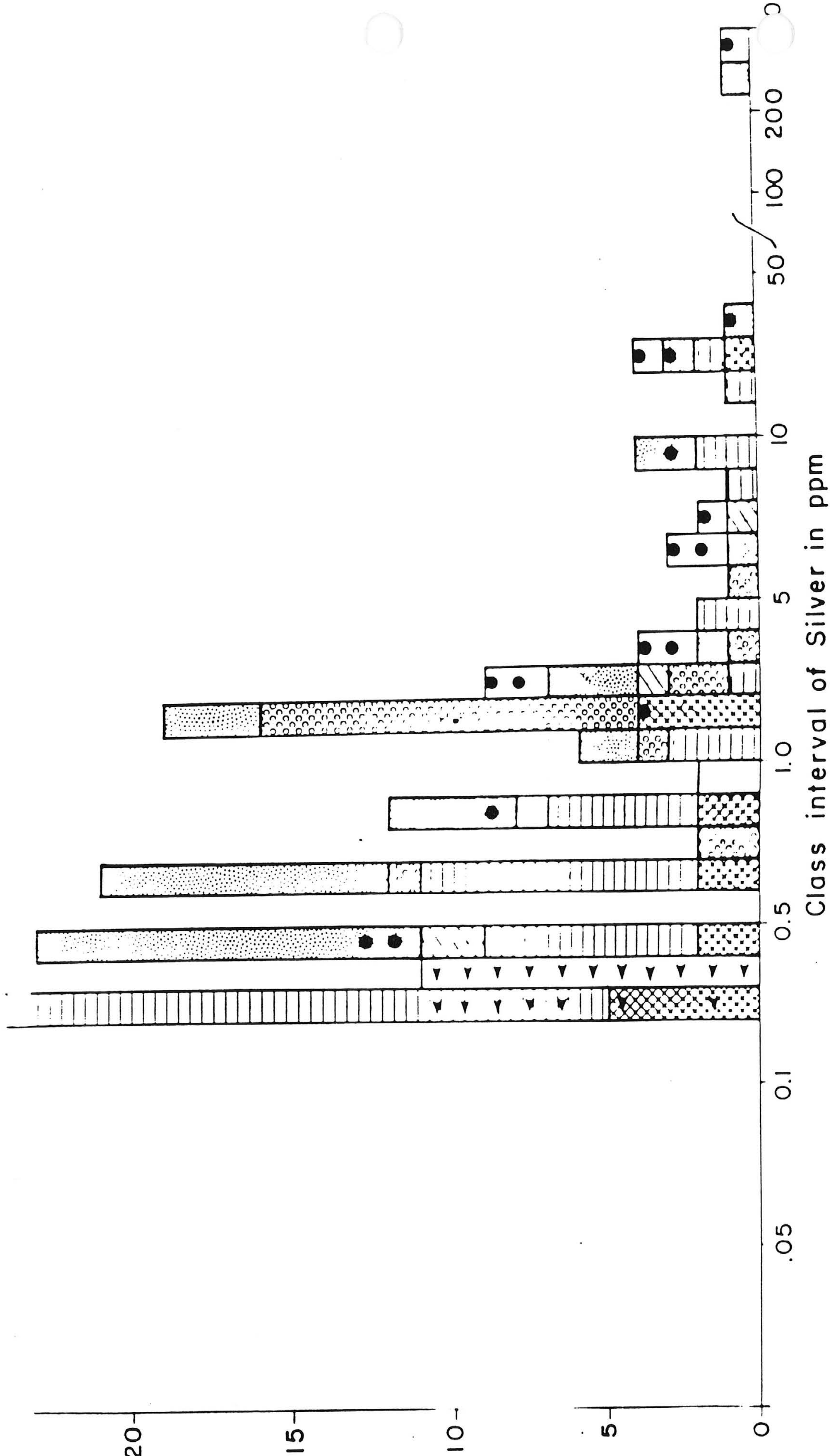


Figure 29. Frequency histogram for Silver value in samples from the Socorro Reef gold anomaly.

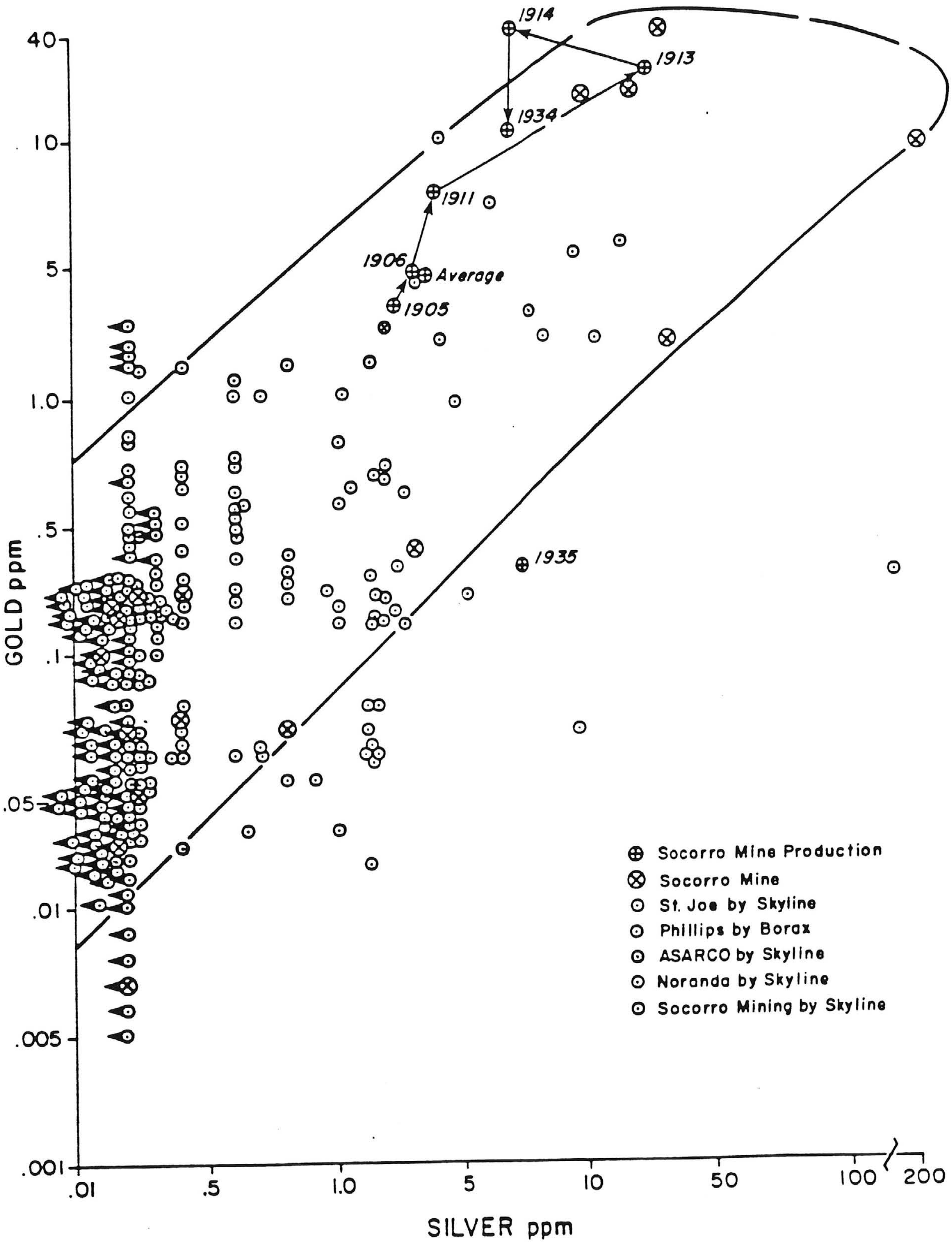


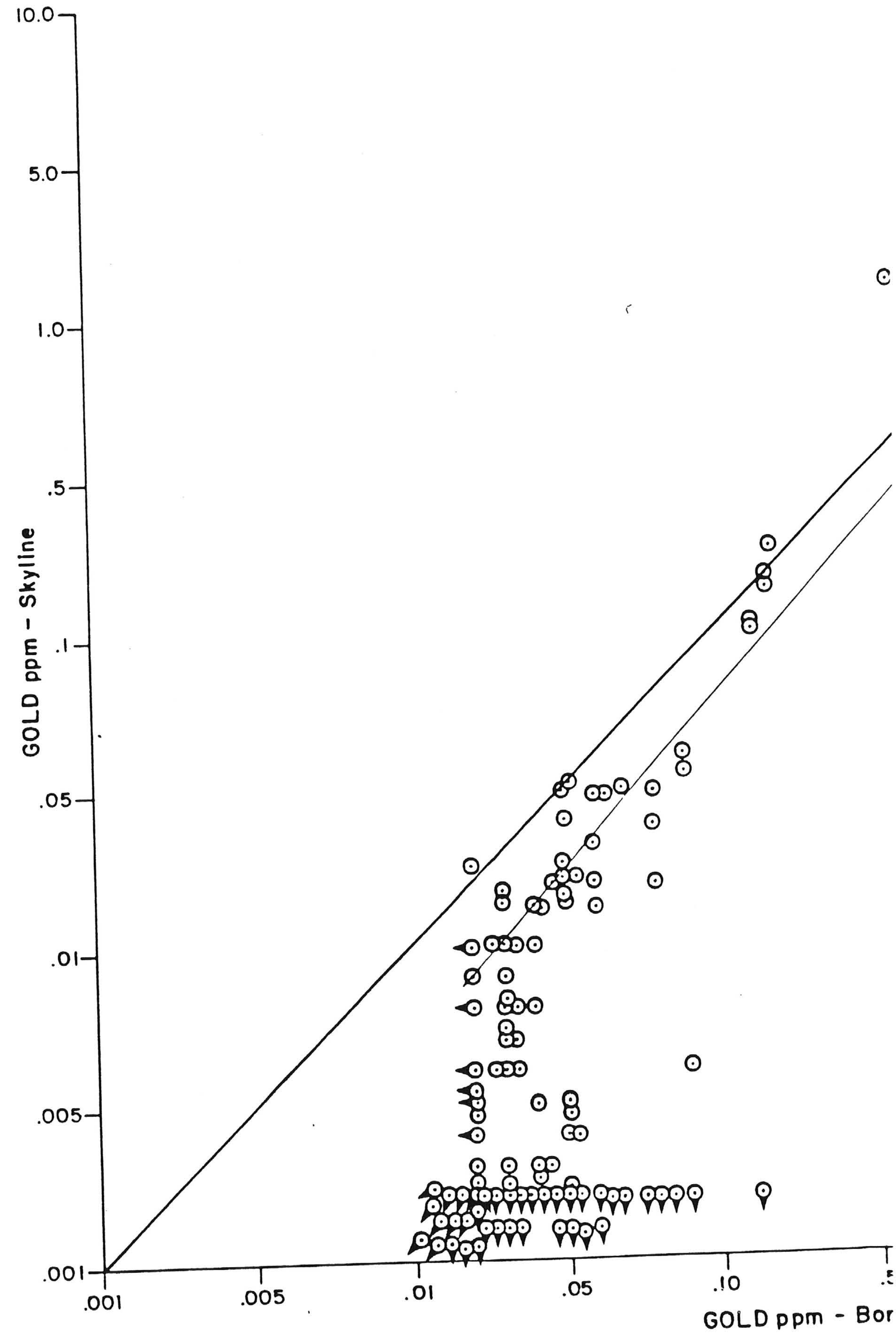
Figure 30. Gold:Silver variation diagram for samples within the Socorro Reef Gold anomaly.

Based on all the data currently at hand it is reasonable to suggest that grades near the surface in the quartzite portion of the Socorro Reef gold anomaly might double with depth towards the Golden Eagle thrust. One could, of course, assume that grades might be as much as 3.5 times higher from the foregoing discussion, but a factor of 2 is more reasonable given the possible tonnages involved. The influence of depth on dollar values for gold within the Socorro Reef gold anomaly will be discussed in a subsequent section.

Verification of Gold Grades

Gold grades in the preceding section are almost entirely based on atomic absorption analyses performed by Skyline Laboratory in Tucson, Arizona. Although atomic absorption techniques are reliable for establishing the presence of anomalous gold, they lack resolution in identifying quantitatively the exact concentration of gold in anomalous samples. Typically, atomic absorption underestimates the amount of gold in an anomalous samples where gold is greater than 0.1 ppm. Hence, the Socorro Mining Corporation samples were resubmitted to U.S. Borax for reanalysis by a fire assay data with an atomic absorption finish technique. St. Joe also obtained fire assay data for many of their samples where gold exceeded 1.2 ppm.

Figure 31 compares gold values determined by Skyline Laboratory by atomic absorption with gold values determined by Borax-Anaheim Laboratory by fire assay methods with atomic absorption finish for the same samples. The diagonal line through the diagram represents a line of perfect correlation between laboratories. Samples that appear above and to the left of this line indicate that Skyline analysis is high relative to the Borax analysis of the same sample. The opposite is the case for samples that plot below and to the right of the line; these samples indicate the Borax analysis is high relative to Skyline analysis of the same sample. It can be seen on the diagram that Borax analyses are systematically higher than Skyline analyses for the same sample. It is also apparent from Figure 31 that above 0.1 ppm Borax samples exhibit a good correlation with Skyline samples. The slope for this correlation falls below the line of perfect correlation indicating a bias towards higher gold values for the Borax samples. Below 0.1 ppm and especially below 0.05 ppm a significant number of Borax analyses have no correlation at all with Skyline analyses. Thus, in samples with less than 0.1 ppm gold, it is impossible to tell whether or not gold contents based on Borax analytical data alone are weakly anomalous. However, one can evaluate whether or not Borax data is weakly anomalous for gold by comparing Borax data with Skyline data for the same sample. From the diagram it is apparent that weakly anomalous Skyline samples above 0.009 ppm gold correlate positively with Borax data. A line fit through this data corresponds closely with a line fit through Borax and Skyline data in samples above 0.1 ppm gold. Thus, the Borax analyses that do correlate positively with Skyline data in the weakly anomalous gold category are probably real. It is also apparent that the line which fits all weakly through strongly anomalous Borax and Skyline analytical pairs is systematically steeper than the line of perfect correlation. Thus, Borax samples with low gold values (below 0.1 ppm gold) are


10.0
5.0
1.0
.5
.1
.05
.01
.005
.001
GOLD ppm - Skyline
.001
.005
.01
.05
.10
GOLD ppm - Bor

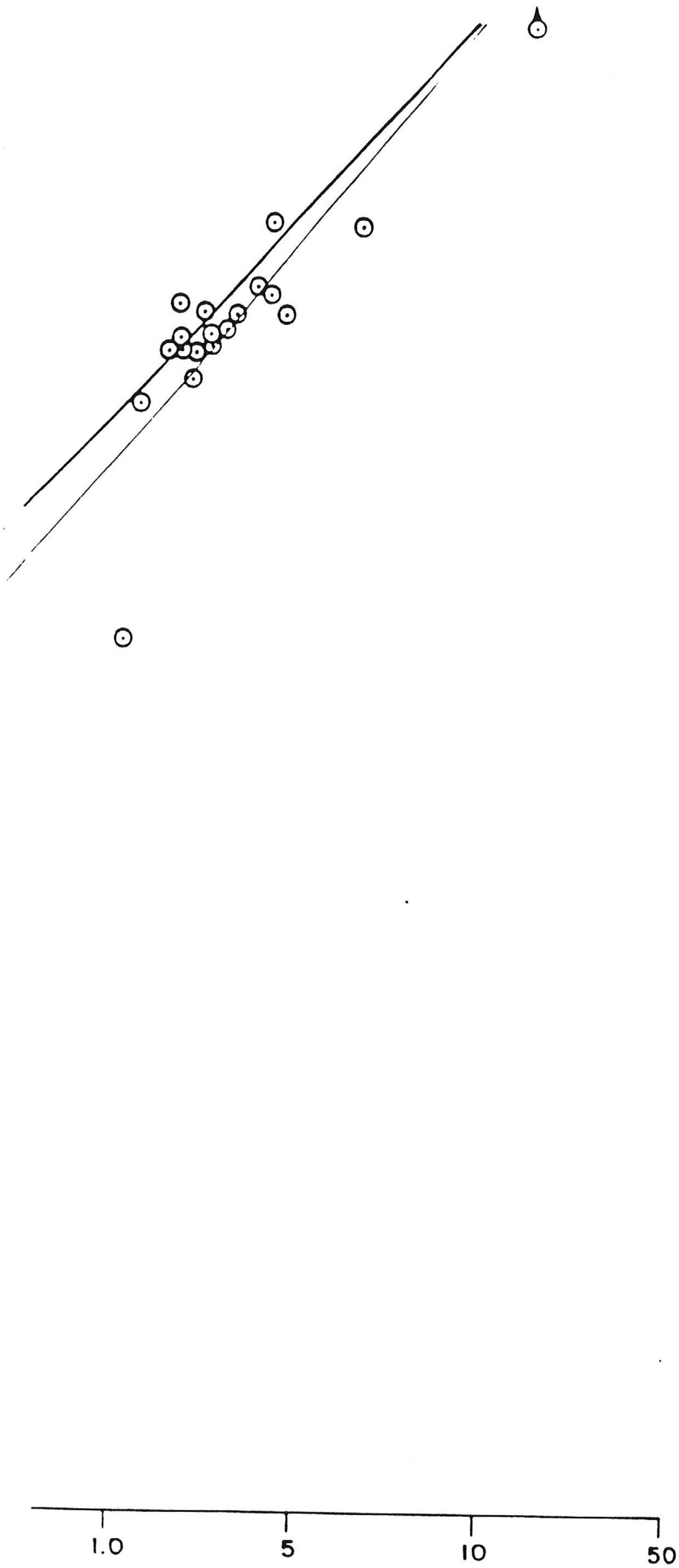


Figure 31. [illegible] of U.S. Borax analyses and [illegible] analyses for gold in Socorro [illegible] rock chip geochemical

systematically much higher than Skyline analyses. At higher gold values Borax numbers are systematically higher than Skyline analyses but to a much less extent.

The degree to which Borax analyses were systematically higher than Skyline analyses for the same sample is shown on Figure 32 and was determined in the following manner. First, all samples where the Skyline analysis contained less than 0.009 ppm gold were ignored, because of the complete lack of correlation with Borax analyses. Secondly, the Borax analysis of a given sample was divided by the Skyline analysis for that sample. In 44 out of 53 cases the Borax analysis was higher than the Skyline analysis. In the 9 cases where the Skyline analysis was greater than the Borax analysis, the Skyline analysis was divided by the Borax analysis. The results of these calculations are presented in Figure 32. On the diagram the factor by which a Skyline or Borax analysis is greater than the other is plotted with reference to gold contents in the Skyline samples. The variation diagram shows that, for samples above 0.09 ppm gold, Borax analyses, on the average, are about 1.3 times greater than the Skyline samples. For samples below 0.09 ppm gold, Borax data are much higher than Skyline analyses by a factor of 1.3 to 3.5 times. Consequently, based on this exercise, average gold values for a given portion of the Socorro Reef gold anomaly may be increased by a factor of about 1.3 where stated gold ✓ contents exceed 0.09 ppm gold. For example, the average gold content determined for the entire Socorro Reef gold anomaly on the basis of atomic absorption data was stated in the gold grade section to be about 0.0152 oz/Ton. If this number is multiplied by 1.3, a value of 0.0198 oz/Ton is obtained. This amounts to an increase of about 0.01 oz/Ton gold for gold grades between about 0.02 and 0.04 ppm. As will be seen in the next section, this factor will significantly increase the gold yields in both ounces and dollars.

DETERMINATION OF POTENTIAL ORE RESERVES AND DOLLAR VALUE

Data in the foregoing sections now allows the construstion of economic models of the Socorro Reef gold deposit. Based on geology and average gold contents, the moderately intense portions of the Socorro Reef gold anomaly were divided into six blocks denoted A - E on Figure 26. Average gold grades within each block were calculated by averaging the gold contents for all samples within each block, including subsurface data where available. Tonnages (in short tons) were calculated by determining the volume of each block in cubic feet and dividing that volume by a tonnage factor of 12, which is the number of cubic feet of granite and/or quartzite per ton. The map dimensions of each block were obtained from the 1 inch = 500 foot scale map of the Socorro Reef gold anomaly (Plate 24). These blocks are also outlined on Figure 26. The vertical dimension or depth of Blocks A, B, C, and E was estimated to be about 350 feet based on geophysical data and structural modeling discussed in previous sections. The depth of Block D, which contains

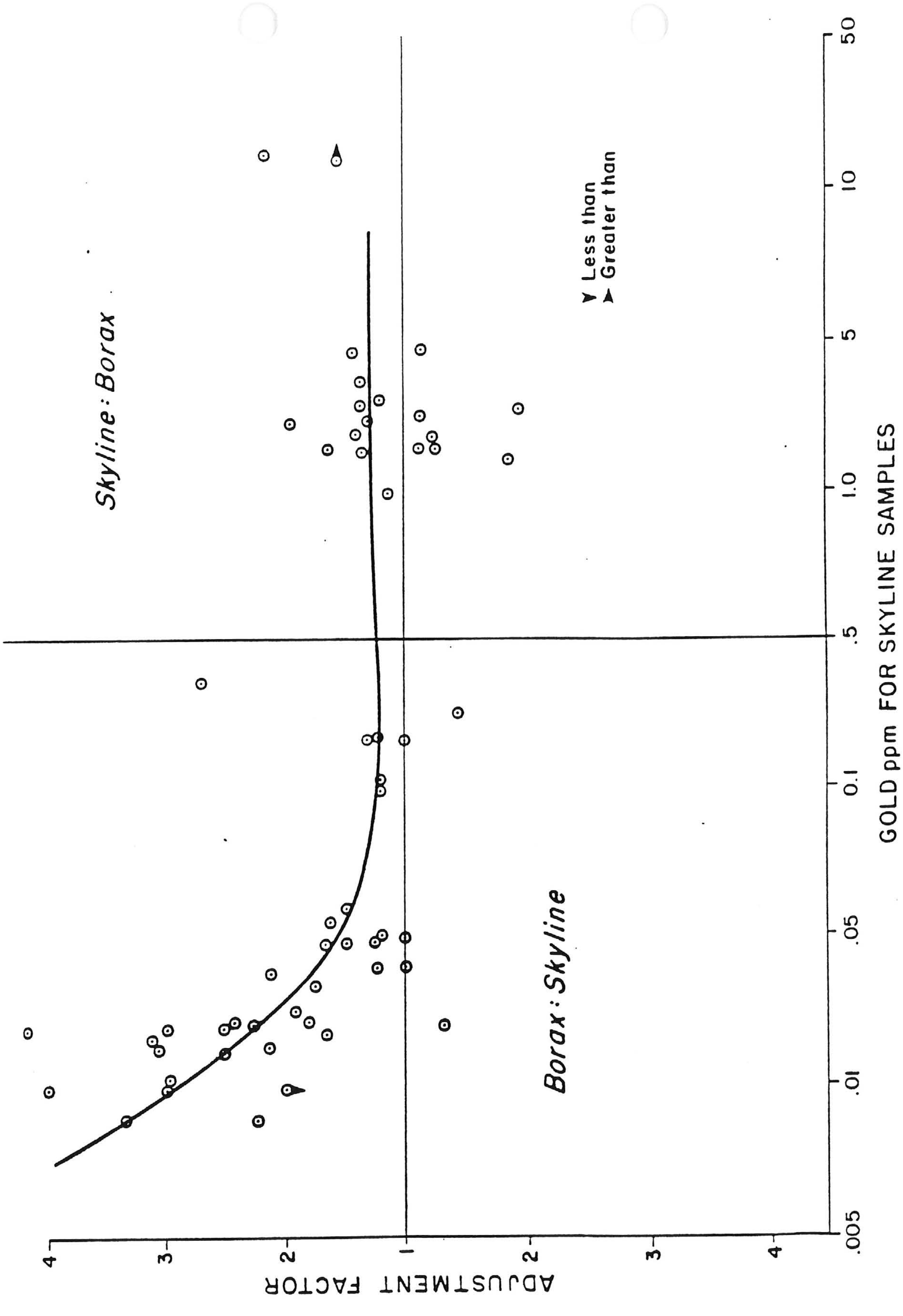


Figure 32. Variation diagram showing factors to adjust Skyline Laboratory atomic absorption data to U.S. Borax Laboratory fire assay data.

Hill 2462, was taken as 450 feet with the additional 100 feet added because of higher elevations in the hill. Plan dimensions of Block F were taken from the maps and the vertical dimension of 20 feet was taken from intercepts in the GH-1 drill hole and from estimated heights of stopes within the old Socorro Mine workings. All of the above information is summarized in Table 15.

Total gold content, gold grade, and dollar value of gold within each block was calculated according to three models (Table 15). The first calculation (Model 1) assumed a conservative model where average gold values derived from Skyline Laboratory's analytical data were assumed to represent true surface values and do not increase with depth. The second model (Model 2) assumed that the Skyline Laboratory analytical data is systematically low by a factor of 1.3 (See section on Verification of Gold Grade), and that there was no increase in grade with depth. The third and most optimistic model (Model 3) assumed the average gold values from Skyline Laboratory were low by a factor of 1.3 and therefore had to be adjusted upward as in Model 2 and also assumed the gold grades increased with depth by a factor of 2 (See section on Possible Variations of Gold Content with Depth).

Dollar values for all models in Table 15 were calculated at a gold price of $450/oz. Gold contents and dollar values at various gold prices for various combinations of blocks and economic models are shown in Table 16. From present data the silver content within the Socorro Reef gold anomaly is too low to be of economic interest (Table 17). The total indicated silver value for all blocks within the Socorro Reef gold anomaly is only $2,300,000; this is 79 times less than the dollar value of gold. The above numbers for silver assumed a gold:silver ratio of 1.77 over the Socorro Reef gold anomaly and a gold:silver price ratio of 45:1.

Model 1 is clearly the most conservative of the three models and probably is too conservative because of the analytical technique used to obtain the gold values. Model 2 is perhaps the most realistic of the three models given what is currently known about the Socorro Reef gold anomaly. If it is assumed (and this is a sizeable assumption) that the SAD-1 drill hole represents a fair test of gold grades with depth, then a significant increase in depth from surface values is not predicted. The SAD-1 drill hole data is reinforced with the induced polarization (IP) data, which suggests the sulfide-bearing material is fairly evenly distributed throughout the quartzite portion of the Socorro Reef gold anomaly and does not increase with depth.

However, there are substantial reasons to question the Model 2 assumptions. First, one drill hole is probably not representative. Second, as outlined in the previous section on Variations in Gold Content with Depth, gold grades within the SAD-1 drill hole do increase slightly with depth. The lower 100 feet of the hole averaged 0.0155 oz gold/Ton based on 40 5-foot composite samples of drill cuttings, whereas surface samples within Block [illegible] average [illegible] oz gold/Ton based on [illegible] samples; This latter number is very close to the average grade (0.012 oz gold/Ton) for 40 composite samples from the upper 100 feet of the SAD-1 drill hole.

Table 15: Gold Grade and tonnage information for various gold-bearing blocks within the Socorro Reef gold anomaly

OMIC PARAMETERS	BLOCK A	B	B high grade	C	D	E	F
Top Dimensions (feet)	250 x 200	725 x 275	725 x 130	550 x 250	940 x 325	875 x 500	250 x 375
Depth extension (feet)	350	350	350	350	450	350	20
Number of surface samples	14	64 (.023)	37 (.035)	44 (.0123)	41	23	9 (.0144)
Number of subsurface Samples	-	16 (.012) (from adit)	16 (.012) (from adit)	40 (.0138) (from SAD-1)	-	-	11 (.23)
Number of surface and subsurface samples	14	80	53	84	41	23	23
Average gold grade from subsurface and surface data (oz/ton)	.0041	.021	.028	.013	.0113	.0056	.138
Standard deviation (oz/ton)	.006	.0415	.0491	.0166	.0156	.0114	.284
Tonnage (short tons)	1,458,000	5,815,000	2,749,000	4,010,000	11,456,250	12,760,000	156,250
Total gold content (oz)	5,978	122,115	76,972	52,130	129,453	71.456	21,562
Dollar value (@ $450/oz)	2,690,000 * (1.84)	54,952,000 (9.45)	34,637,000 (12.60)	23,458,000 (5.85)	58,354,000 (5.09)	32,155,000 (2.52)	9,703,000 (62.20)
CALCULATION OF ABOVE ASSUMING GOLD GRADE ADJUSTMENT FROM BORAX DATA (Model 2)							
Average gold grade of all data (oz/ton)	.0053	.0273	.0363	.016	.0147	.0073	.179
Total gold content (oz)	7,727	158,750	99,789	64,160	168,403	73,148	27,969
Dollar value (@ $450/oz)	3,477,150 * (2.38)	71,437,000 (12.28)	44,905,000 (16.34)	28,872,000 (7.20)	75,781,000 (6.61)	41,917,000 (3.28)	12,586,000 (80.68)
ALCULATION OF ABOVE SUMING INCREASE IN D GRADE WITH DEPTH del 3)							
erage gold grade of ower 1/2 of block oz/ton)	.0106	.0546	.0726	.032	.0294	.0146	
nage of lower /2 of block	729,000	2,907,500	1,374,500	2,005,000	5,728,125	6,380,000	
d content of lower /2 of block	7,700	150,700	99,800	64,200	168,400	93,200	
erage gold grade of pper 1/2 of block oz/ton)	.0041	.021	.028	.013	.0113	.0056	
nage of upper 2 of block	729,000	2,907,000	1,374,500	2,005,000	5,728,125	6,380,000	
rage gold grade of ntire block (oz/ton)	.008	.0409	.0543	.024	.022	.011	
d content of upper 2 of block ounces)	3,900	79,400	49,500	32,100	84,200	46,600	
al gold content of lock (ounces)	11,600	238,100	149,300	96,200	252,600	139,800	
ar Value (@ $450/oz)	5,215,000 * (3.57)	107,000,000 (18.40)	67,000,000 (24.37)	43,000,000 (10.72)	113,000,000 (9.86)	63,000,000 (4.94)	

* Number in parenthesis is gold value in dollars per ton.

Table 16: Gold content and Dollar value combinations of various blocks

MIC PARAMETERS	B + C Model 1	B + C Model 2	B + C Model 3	B + C + D Model 1	B + C + D Model 2	B + C + D Model 3
age (millions short tons)	9.825	9.825	9.825	21.281	21.281	21.281
Grade (oz/ton)	.018	.023	.034	.0143	.0184	.0276
Content (oz)	174,245	222,910	334,300	303,698	391,313	586,900
lar Value						
400/oz	70,000,000 * (7.12)	89,000,000 (9.06)	134,000,000 (13.64)	121,000,000 (5.71)	157,000,000 (7.40)	235,000,000 (11.08)
450/oz	78,000,000 * (7.94)	100,000,000 (10.18)	150,000,000 (15.27)	137,000,000 (6.46)	176,000,000 (8.30)	264,000,000 (12.45)
500/oz	87,000,000 * (8.85)	111,000,000 (11.30)	167,000,000 (16.99)	152,000,000 (7.17)	195,000,000 (9.20)	293,000,000 (13.82)
600/oz	105,000,000 * (10.69)	134,000,000 (13.64)	201,000,000 (20.46)	182,000,000 (8.58)	235,000,000 (11.08)	352,000,000 (16.60)

MIC PARAMETERS	B+C+D+F Model 1	B+C+D+F Model 2	B+C+D+F Model 3	A+B+C+D+E+F Model 1	A+B+C+D+E+F Model 2	A+B+C+D+E+F Model 3
age (millions short tons)	21.437	21.437	21.437	35.655	35.655	35.655
Grade (oz/ton)	.0152	.0192	.0284	.0113	.0144	.0213
content (oz)	325,260	412,875	608,462	402,694	513,750	759,862
lar Value						
400/oz	130,000,000 * (6.06)	165,000,000 (7.69)	243,000,000 (11.33)	161,000,000 (4.51)	205,500,000 (5.76)	304,000,000 (8.61)
450/oz	146,000,000 * (6.81)	185,000,000 (8.63)	273,000,000 (12.73)	181,000,000 (5.08)	231,000,000 (6.48)	342,000,000 (9.59)
500/oz	162,000,000 * (7.56)	206,000,000 (9.61)	304,000,000 (14.18)	201,000,000 (5.64)	257,000,000 (7.21)	380,000,000 (10.66)
600/oz	195,000,000 * (9.10)	247,000,000 (11.52)	365,000,000 (17.03)	242,000,000 (6.79)	308,000,000 (8.64)	456,000,000 (12.79)

*Number in parenthesis is gold value in dollars per ton.

Table 17: Economic data for silver within the Socorro Reef Gold Anomaly

ECONOMIC PARAMETERS	Block						
	A	B	B high grade	C	D	E	F
Gold grade (oz/Ton)	.0041	.021	.028	.013	.0113	.0056	.138
Silver grade (oz/Ton)*	.0023	.012	.016	.0073	.0064	.0032	.078
Tonnage (short ton)	1,458,000	5,815,000	2,749,000	4,010,000	11,456,000	12,760,000	156,250
Total Silver (oz)	3,353	69,780	43,984	29,273	73,139	40,370	12,182
Dollar Value (@ 10./oz)	33,534	697,800	439,840	292,730	731,390	403,700	121,820

Total Silver in dollars
$2,291,000

* Calculated assuming a gold:silver ratio of 1.77 (based on 1904-1934 Socorro Mine production)

Third, the induced polarization (IP) data discussed in the geophysics section is not resolved enough to identify small tonnage zones (about 200,000 tons or less) that contain higher sulfide-bearing zones which are presumably more gold rich, even though the method does generally identify a zone of moderately intense, apparent polarization within the quartzite-granite blocks. Fourth, Model 2 assumes that no high-grade, bonanza pockets are present within Blocks A-E. Even one bonanza pocket, like the one encountered in the 'Castle Garden' stope within the Bolsa Quartzite at the Harquahala Mine in the Little Harquahala Mountains, would substantially increase the overall gold content of the Socorro Reef gold deposit. As outlined in the previous section on Variation in Gold Content with Depth, there are substantial geologic reasons (by analogy with the high-grade material within the Golden Eagle thrust at the old Socorro Mine) to expect an increase in gold content with depth towards the Golden Eagle thrust. The presence of high-grade bonanza pockets, the presence of intermediate-tonnage, moderate-grade gold zones (0.08 to 0.12 oz/ton), and the overall increase in grade with depth are all taken into consideration in Model 3. Because the removal of the large tonnages that are involved would considerably dilute the effect of bonanza pockets and moderate-tonnage, higher grade zones, the overall factor by which the grade can be reasonably expected to increase above surface grades is taken to be a factor of two or double the known surface grades. This increase is projected for the lower one half or the lower 175 feet of Blocks A-E. Economic aspects of Models 1, 2, and 3 are shown in Tables 15 and 16.

The summation of all data for Blocks A-F (Table 16) reveals that in the moderately anomalous portion of the Socorro Reef gold anomaly there is an indicated tonnage of 35.6 million tons with an average grade (using Model 3 assumptions) of 0.0213 oz gold/Ton. At $450/oz, and using Model 3 assumptions, this amounts to a total of $342,000,000 of gold with a gold value of $9.59/Ton. It is clear from Tables 15 and 16, however, that the average gold grade quoted above is not evenly distributed over all blocks; within the moderately anomalous granite and quartzite blocks, Blocks B, C, D, and F have substantially higher grades and constitute an attractive gold target with an indicated 21.4 million tons of potential gold ore. Of these, Blocks B and C are the most economically attractive.

From the existing data the Blocks with the most potential for mining are Blocks B, C, and F and a 'high-grade' subblock within Block B containing an indicated 2.75 million tons comprises the most attractive possibility. With Model 2 assumptions, the indicated surface grade for this subblock is 0.036 oz gold/Ton, which is comparable to gold grades of cyanide heap leach properties in Nevada that were operating in 1979 (See Table 18). With Model 3 assumptions for this higher grade subblock of Block B, the average indicated gold grade for this ground increases to 0.054 oz gold/ton, which is very close to the grade of most of the properties listed in Table 18. Obviously, Block B should be given the highest priority for confirmation drilling. Several larger tonnage targets within the Socorro Reef gold anomaly are also attractive, particularly a 9.8 million ton block that comprises Blocks B and C. This block of ground contains $100,000,000 of gold (using Model 2 assumptions) or $150,000,000 of gold (using Model 3 assumptions) (See Table 16). The 0.034 oz/Ton grade of this block (using Model 3 assumptions) is similar to the grades of producing properties at Windfall, Cortez, and Gold Acres

Table 18: Comparison of Socorro Reef with other disseminated, low-grade gold deposits in the western United States

Deposit	Tons (short)	Gold Grade (oz/ton)	Gold Content Dollars/ton (@ $450./oz)	Mining Costs Dollars/ton (pre-tax)	Recovery Method	Reference
Ortiz, New Mexico	6,841,000	.053	23.85	9.84 (mid-1981 total mining, processing and administrative cost)	Cyanide Heap-Leach	Hickson (1981)
Carlin, Nevada	9,370,000 (1965-77 Production)	.32	144.07	37.20 (Nov. 1981)	Milling	Mining Record (Nov. 1981)
Bootstrap, Nevada		.063 #1 heap .028 #2 heap		1.67 direct (1979) costs	Cyanide Heap-Leach	McQuiston & Shoemaker (1980)
Cortez, Nevada	422,000 tons/year	.036	16.20	1.22 (1979)	Cyanide Heap-Leach	McQuiston & Shoemaker (1980)
Gold Acres, Nevada	907,000 tons/year	.036	16.20	1.22 (1979)	Cyanide Heap-Leach	McQuiston & Shoemaker (1980)
...nd Mtn, Nevada		.06	27.00	5.32 (1979 direct and administrative)	Cyanide Heap-Leach	McQuiston & Shoemaker (1980)
Windfall, Nevada	220,000 tons/year	.028	12.60	3.93 (1980 mining and processing costs)	Cyanide Heap-Leach	McQuiston & Shoemaker (1980)
Socorro Reef, AZ						
B-C+D+F Model 3	21,437,000	.0284	12.73			
B-C+D+F Model 2	21,437,000	.0192	8.63			
B-C Model 3	9,825,000	.034	15.27			
B-C Model 2	9,825,000	.023	10.18			

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