Trip 6:

Globe-Miami and Superior Districts: Thornton, Live Oak, Pinto Valley, Old Dominion-Magma, Carlota

October, 1994

Bootprints Along the Cordillera

Porphyry Copper Deposits from Alaska to Chile

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Dear Field Trip Participants:

On behalf of the **Arizona Geological Society, Society for Mining, Metallurgy and Exploration Inc., and the U. S. Geological Survey**, we bid you welcome to the Bootprints Along the Cordillera field trip program. We have assembled a collection of field trips that portray the geologic and mineralogic diversity that exists along the cordillera of North and South America.

We wish to thank all of the field trip leaders who volunteered their time, effort, and expertise to organize their individual trips. We also want to thank collectively, all of the mining companies and staff who graciously allowed us to visit their properties. Without their cooperation, this program would not have occurred. A special thanks goes to Kathie Harrigan of Asarco for her help in the compilation of the field trip guides. We also want to thank Tucson Blueprint who underwrote the complete reproduction cost of the guides.

Mark Miller and Jim Briscoe
Field Trip Co-Chairmen
October 2, 1994

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Field Trip No. 6

Globe-Miami and Superior Districts

Dear Participant,

We welcome you to the Superior-Globe-Miami area of Arizona. This country is rich in copper mineralization and mining lore.

We will observe various styles of porphyry copper mineralization. **Pinto Valley** is a low-grade porphyry copper deposit with broad alteration zones in intrusive rocks. **Miami-Inspiration** has low-grade porphyry mineralization in schist and intrusives as well as abundant supergene copper minerals forming secondary enrichment and exotic deposits. **Carlota** has exotic supergene copper and secondary enrichment in structurally controlled schist and schist breccia. **Superior** has high-grade hypogene copper in veins and bedded replacement deposits. So many styles with so little time! Unfortunately, we will only be able to observe a few key features.

Feel free to enter into discussions with our tour leaders, hosts and other participants. The tour leaders and hosts are dedicated geologists who have invested many years in the study of mineral deposits. Many years in one area may cause near sightedness, and we may not see the forest for the trees. Your perspectives are welcome.

We would like to thank the management and geologists of Carlota Copper Company, Cyprus Miami Copper Corporation and Magma Copper Company for allowing us access to their properties. Thanks to all who will host various parts of the tour or participate in the poster sessions and discussions.

Have a very rewarding trip.

Sincerely,

Brent Bingham
Gary Lenzi

PROPOSED SCHEDULE

GLOBE-MIAMI AND SUPERIOR DISTRICTS: THORNTON - LIVE OAK, PINTO VALLEY, OLD DOMINION, MAGMA SUPERIOR
OCTOBER 3 AND 4, 1994
(Limited to 82 participants)

MONDAY, OCTOBER 3, 1994

6:30 AM	Meet at Tucson point of departure, Gary Parkison will lead tour to Superior
7:00	Depart Tucson
7:00-9:00	Drive to Superior
9:15-11:30	Magma, **Superior Mine** overview of district and Superior vein and manto deposits: poster session, rock samples, maps. Underground access not available unless limited to less than 15 (Hosts: Alex Paul and Matt Knight)
11:30-12:30 PM	Lunch in Superior
12:30-2:00	Walk stratigraphy and compare with examples of bedded replacement, discuss distal precious metal deposits
2:00-2:30	Drive to Carlota property passing site of ASARCO's deep prospect
2:30-4:15	Observe **Carlota** exotic copper deposit, Cactus breccia, and Cactus thrust
4:15-5:00	Drive to Globe: Passing mostly exotic copper in Cyprus Miami Ox Hide mine, and Bluebird area; and Magma's tailings that are being reclaimed in Miami.
5:00-5:15	Drive to motel
5:15	Arrive at motel
7:30-8:30 PM	Talks or poster session on Pinto Valley, Inspiration, Carlota-Cactus, Superior mineral deposits?

TUESDAY, OCTOBER 4, 1994

7:15 AM	Depart motel
7:15-7:45	Drive to Pinto Valley
8:00-10:45	Tour **Pinto Valley**: alteration zoning and primary sulfide mineralization (Host: Gary Lenzi)
10:45-11:00	Drive to Miami
11:00-11:45	Lunch in Miami
11:45-12:00	Drive to Cyprus Miami's **Live Oak** pit
12:00-1:30 PM	Tour Live Oak and/or Ox Hide pits (Hosts: Jim Clark and Zean Moore)
1:30-4:30	Drive to Tucson
4:30	Arrive **Tucson**, end of trip

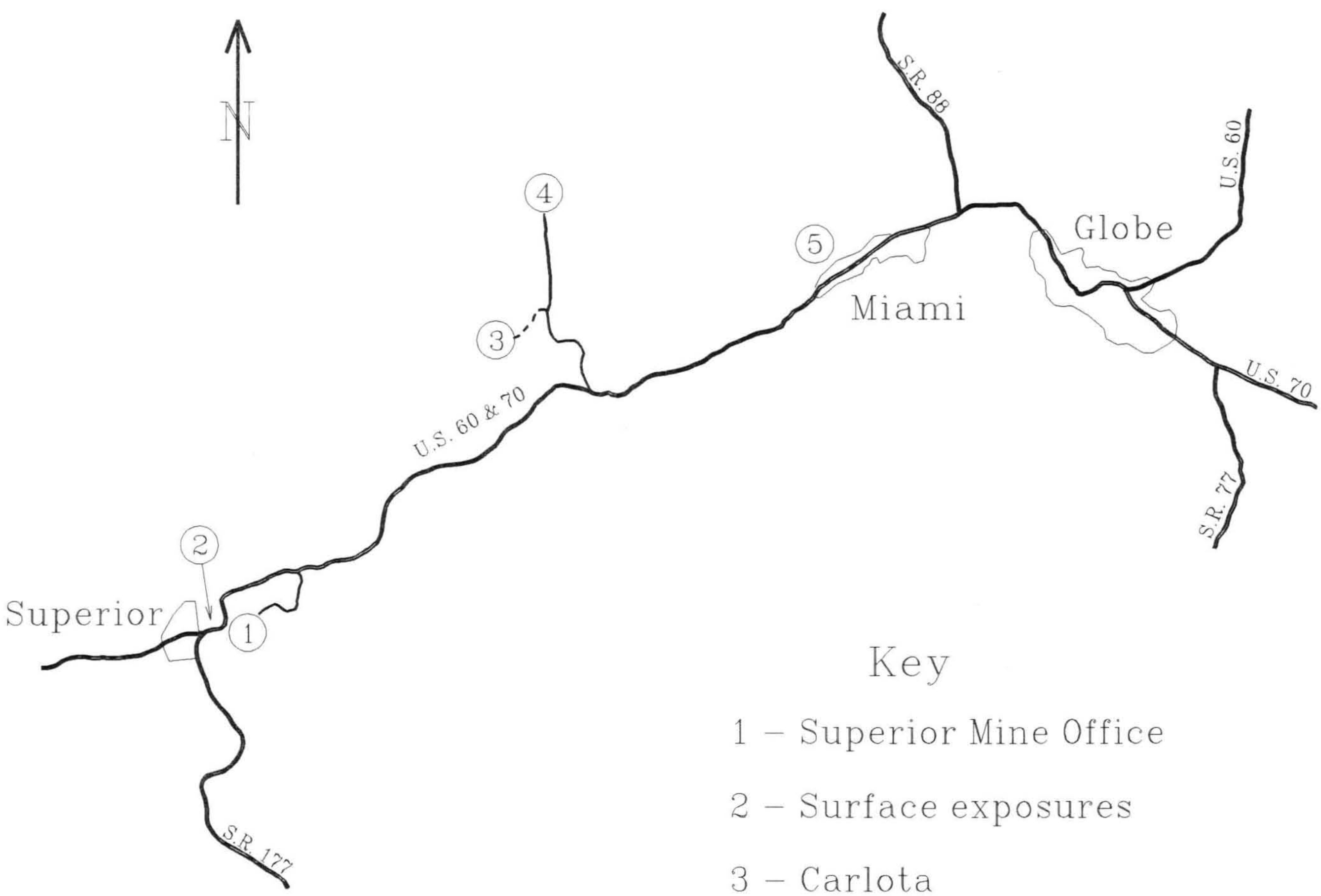
Suggested equipment:

Hard hat, safety glasses, sturdy boots, long pants

Bootprints Along the Cordillera

Field Trip No. 6

Globe–Miami and Superior Districts



Key

1 – Superior Mine Office

2 – Surface exposures

3 – Carlota

4 – Pinto Valley

5 – Live Oak

Oct. 3 & 4, 1994
Not to Scale
Trip Leaders: Brent Bingham & Gary Lenzi

Figure 1. Index map of Arizona showing location of Magma Mine (SUPERIOR).

Figure 2. Generalized stratigraphic column of limestone units in the Magma Mine showing position and relative thickness of favorable ore hosts, A, B, C, D and E Beds.

Figure 3. Generalized east-west cross section through East Replacement orebodies (looking north). Shows relative position of ore hosts and variations in replacement thickness. Mine levels are shown in feet below the collar of No. 1 shaft.

Figure 4. Plan map of Superior area showing principal structures, extent of massive limestone replacement, and position of No. 9 mine shaft.

Figure 5. Horizontal slices through East Replacement C-Bed orebody showing distribution of replacement mineral types. Waste refers to unreplaced carbonate pods within orebody. Coordinate lines are Magma Mine survey system.

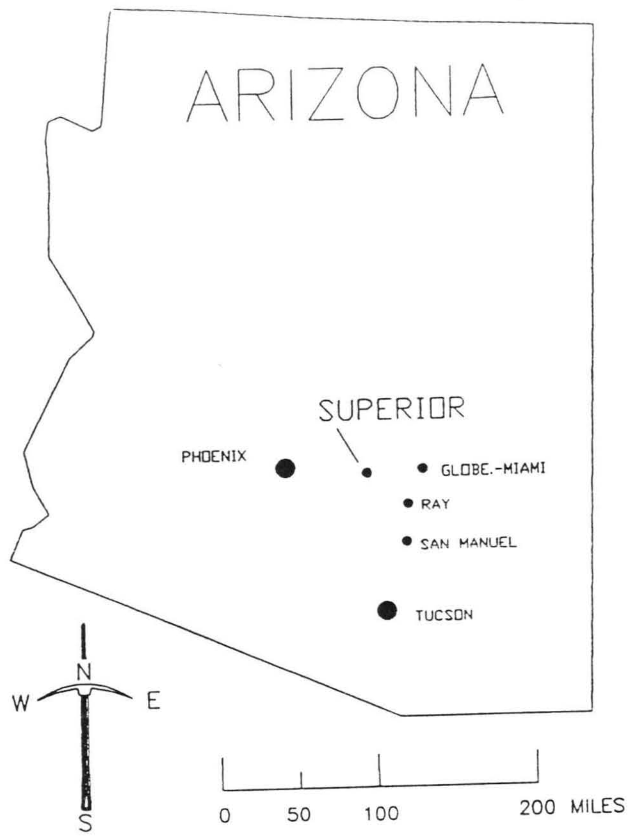
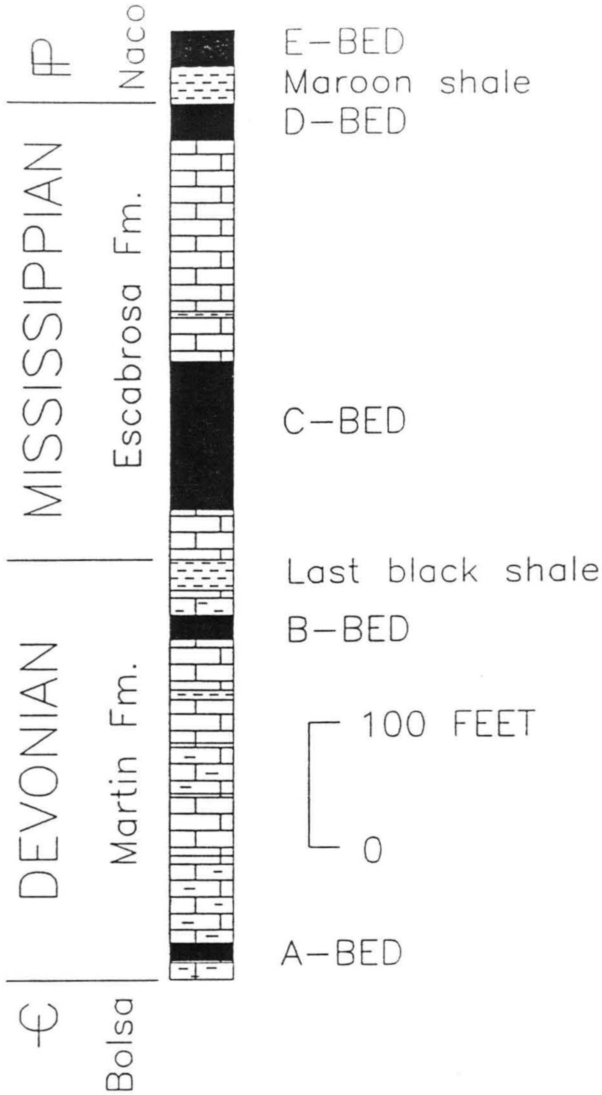

ARIZONA
SUPERIOR
PHOENIX
GLOBE.-MIAMI
RAY
SAN MANUEL
TUCSON
N
W
E
S
0
50
100
200 MILES

Fig. 1



P
Naco
MISSISSIPPIAN
Escabrosa Fm.
DEVONIAN
Martin Fm.
Bolsa
E–BED
Maroon shale
D–BED
C–BED
Last black shale
B–BED
100 FEET
0
A–BED

Fig. 2

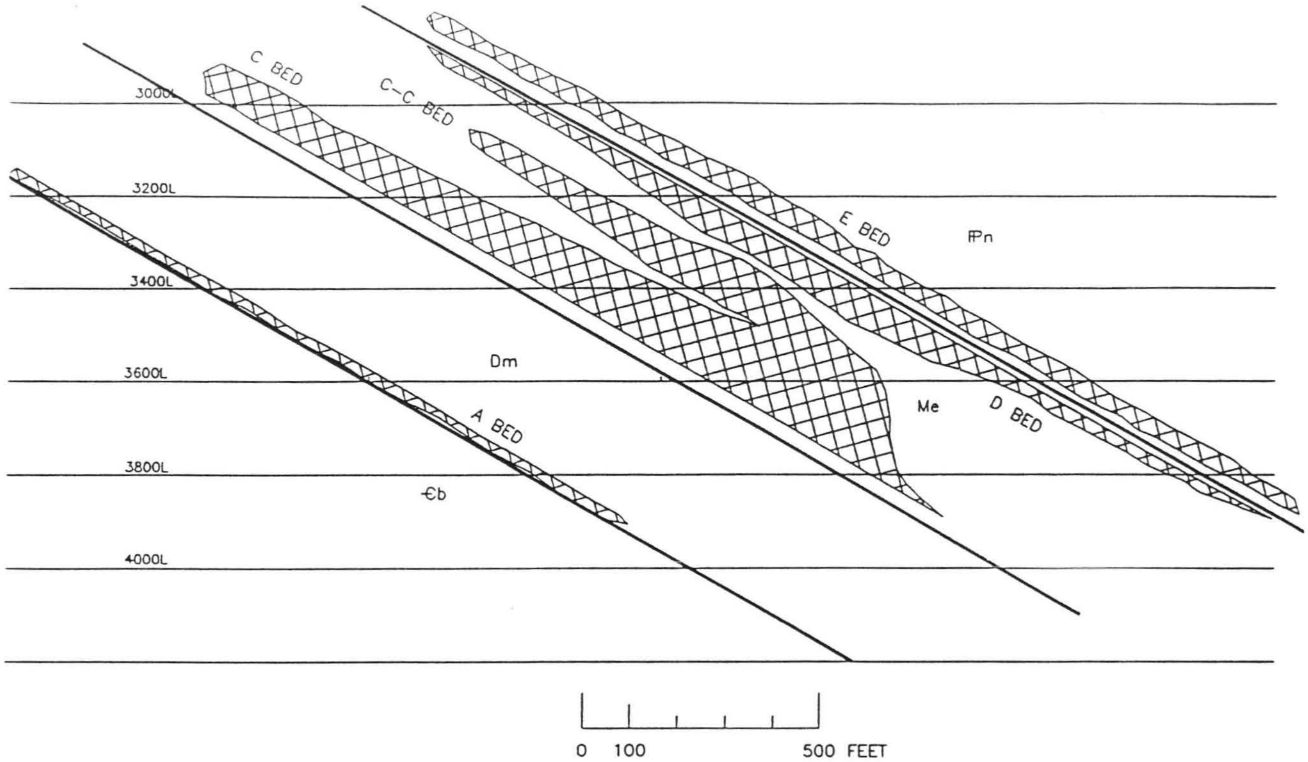

C BED
C-C BED
E BED
ΡPn
3000L
3200L
3400L
3600L
3800L
4000L
Dm
Me
D BED
A BED
Єb
0 100
500 FEET

Fig. 3

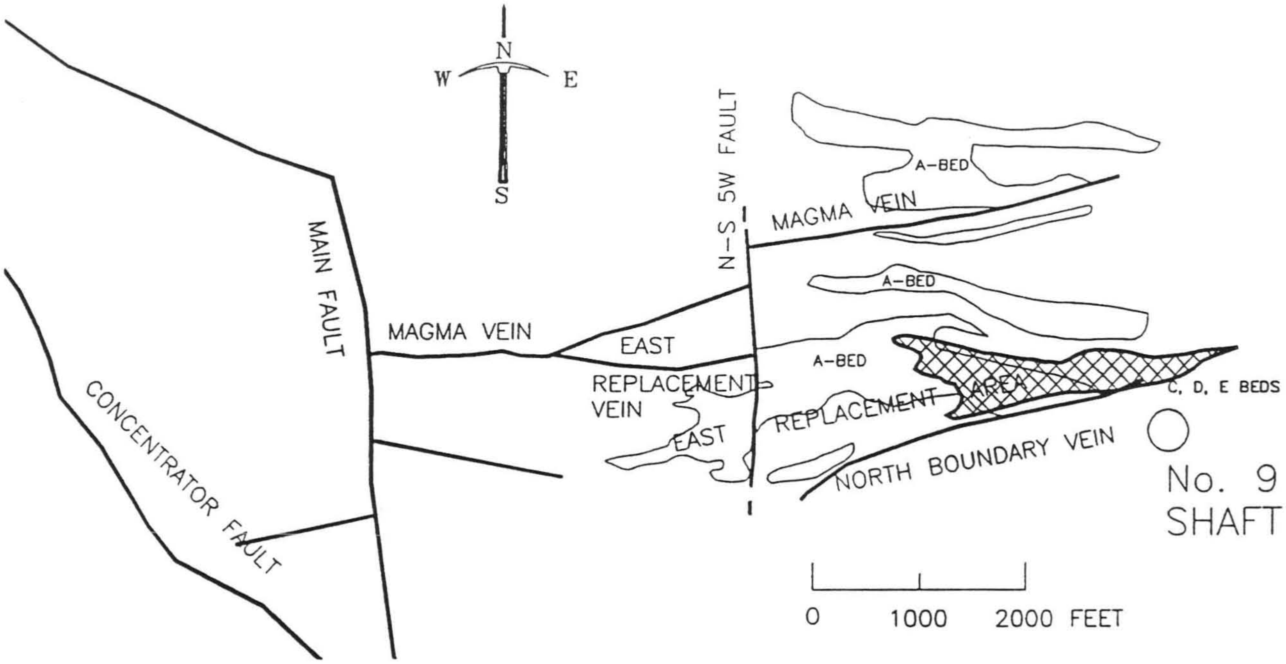
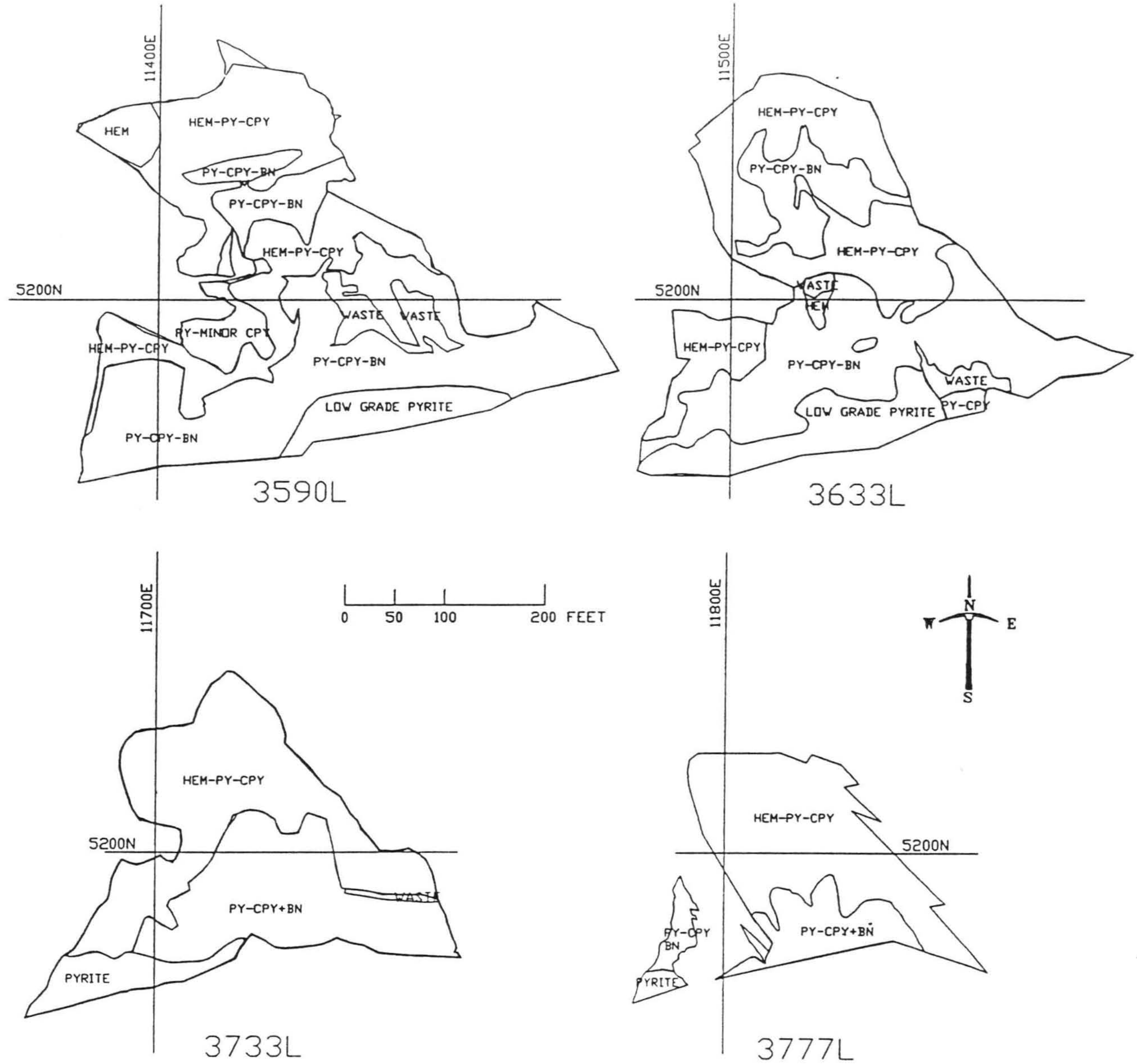

N
W
E
S
MAIN FAULT
CONCENTRATOR FAULT
MAGMA VEIN
EAST
REPLACEMENT
VEIN
N-S 5W FAULT
MAGMA VEIN
A-BED
A-BED
A-BED
EAST
REPLACEMENT
AREA
C, D, E BEDS
NORTH BOUNDARY VEIN
No. 9
SHAFT
0
1000
2000 FEET

Fig. 4



11400E
5200N
HEM
HEM-PY-CPY
PY-CPY-BN
PY-CPY-BN
HEM-PY-CPY
PY-MINOR CPY
HEM-PY-CPY
WASTE
WASTE
PY-CPY-BN
LOW GRADE PYRITE
PY-CPY-BN
3590L
11500E
5200N
HEM-PY-CPY
PY-CPY-BN
HEM-PY-CPY
WASTE
HEM
HEM-PY-CPY
PY-CPY-BN
WASTE
LOW GRADE PYRITE
PY-CPY
3633L
11700E
0
50
100
200 FEET
5200N
HEM-PY-CPY
PY-CPY+BN
WASTE
PYRITE
3733L
11800E
N
W
E
S
HEM-PY-CPY
5200N
PY-CPY
BN
PYRITE
PY-CPY+BN
3777L

Fig 5

GENETIC MODEL
for
MAGMA ORE DEPOSITION

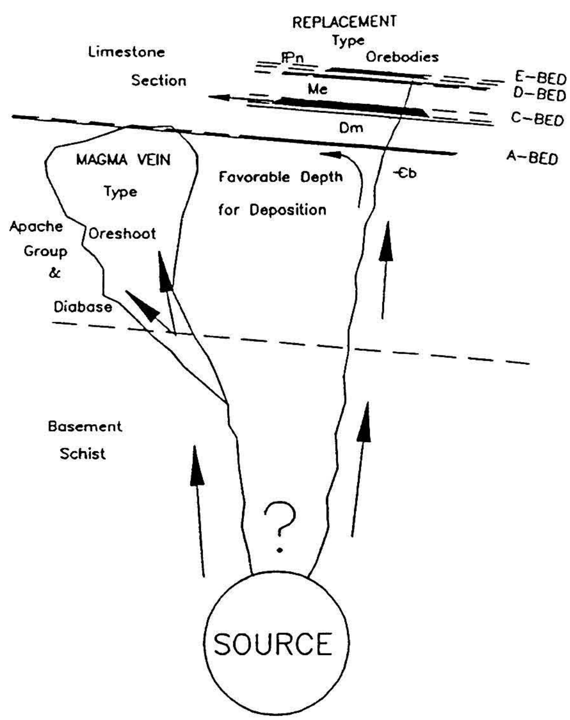


Figure 6

CARLOTA COPPER PROJECT
FACT SHEET

Location:

Head Office
Carlota Copper Company
8101 East Prentice Ave., Suite 800
Englewood, CO. 80111
(303) 694-4936
Fax (303) 773-0733
Contact: Jock McGregor, President

Field Office
Carlota Copper Company
1306 Live Oak Street
P.O. Box 1009
Miami, Arizona 85539
(602) 473-3518 / 473-3519
Fax (602) 473-3216
Contact: Bob Walish, General Manager

Mine Site: Just west of Magma's Pinto Valley Operation in the Globe/Miami Mining District in Gila and Pinal Counties.

Project Details:	Ore Reserve:		106,000,000 tons @ 0.45% Cu
	Project Life:		18 years
	Mine: Open Pit		24,000,000 tons/year
	Processing:	Heap Leach	7,000,000 tons/year
		Solvent Extraction	6,000 gpm
		Electrowinning	33,000 Cu/yr tons.
	Total Employees:		280-300
Economic Impact:	Invested to date		$14,000,000
	Capital investment		$99,000,000 preproduction
			$133,000,000 life of mine

Direct Annual Contribution to Arizona Economy:

Income of employees	$10,000,000
Arizona purchases	$28,000,000
State and local fees & taxes	$3,900,000

Estimated Total Annual Contribution
(direct and indirect) to Arizona's Enconomy $122,000,000*

Regulatory Agencies Involved in Permitting the Project:

- USDA Forest Service
- US Army Corps of Engineers
- US Fish and Wildlife Service
- Environmental Protection Agency
- Arizona Department of Environmental Quality
- Arizona Department of Water Resources
- Arizona Game and Fish Department

Expected Schedule:	Draft EIS	September 1994
	Record of Decision	January 1995
	Start of construction	March 1995
	First copper production	October 1995

*Western Economic Analysis Center June 1992

June 1994

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3.0 GEOLOGY AND MINERALIZATION

The Globe-Miami District is one of the largest in Arizona in terms of mineral production and has enjoyed a long and colorful history. Most of the Globe-Miami Mining District, including the area encompassing the Carlota Project, has been described by N.P. Peterson in U.S. Geological Survey Professional Paper 342, 1962. For this study, Peterson geologically mapped approximately 125 square miles, covering the entire district, and described most of the significant mineral deposits, including the Carlota, Cactus, and Eder deposits. Other significant studies authored or co-authored by Peterson within the region include a study of the Castle Dome Mine area (U.S. Geological Survey Bulletin 971, 1951) and the geology of the Pinal Ranch quadrangle (U.S. Geological Survey Bulletin 1141-H, 1963). Other important studies of the area include those of F.L. Ransome, namely, U.S. Geological Survey Professional Papers 12 and 115. These studies have done an excellent job of describing the geology and mineralization of the area on a regional basis. They have also provided the framework for more detailed mapping within the more immediate project area. In most cases, the mapping of Peterson (1962) was found to be quite accurate, however, owing to the published scale of this mapping (1"=2000'), much detail was necessarily left out. To provide a sound basis to better evaluate the geology and mineral potential of the Carlota Project area, the entire area was geologically mapped at scales of 1"=200' or 1"=500' by Dale Armstrong, a Tucson-based consulting geologist familiar with the geology of Central Arizona.

3.1 Regional Geology and Mineralization

Extensive exposures of Precambrian rocks (primarily Proterozoic-age Pinal schist, Lost Gulch Quartz Monzonite, and diabase) underlie the entire district. Isolated exposures of Paleozoic sedimentary rocks are found predominately north of a generally east-west trending linear zone, which has appeared to localize most of the significant copper deposits in the district. Various phases of the Laramide-age Schultze Granite are found generally to the south of this linear zone. Along this mineralized zone, border phases of the Schultze Granite predominate, and copper mineralization is found both within the altered mineralizing intrusive as well as adjacent wallrock, which is predominantly Pinal Schist. Extensive areas of Miocene Apache Leap Tuff (20 Ma) and Gila Conglomerate (3-10 Ma) cover much of the older rocks and could potentially conceal additional mineralized areas.

Copper mineralization is similar to other porphyry copper deposits in the Southwest and is typically disseminated in nature and originally consisted of chalcopyrite and pyrite. Two periods of weathering and related supergene enrichment have oxidized the pyrite and chalcopyrite, leached out the copper values, and deposited the copper as an enriched blanket with chalcocite as the predominant copper-bearing mineral. Open-pit operations have often mined through the approximately 150- to 200-foot thick enrichment blanket, and mining is now frequently within the unenriched lower-grade primary or hypogene ores.

3.2 Project Geology and Mineralization

3.2.1 Description of Rock Types

Significant rock types in the area of the Carlota-Cactus-Eder deposits range from Precambrian to Recent in age and include (from oldest to youngest): Pinal Schist, Lost Gulch Quartz Monzonite, clastic rocks of the Apache Group and diabase all of Proterozoic age, Paleozoic calcareous rocks, early Tertiary or Laramide (60 Ma) Schultze Granite, Mid-Tertiary Whitetail Conglomerate (30 Ma), an informally defined unit referred to as Cactus Breccia (the primary host for mineralization at the Carlota/Cactus deposits), Apache Leap Tuff of Early Miocene age (17-20 Ma), Gila Conglomerate (3-10 Ma), and Recent unconsolidated alluvial deposits (Figures 3-1 and 3-2, Drawing 3-1).

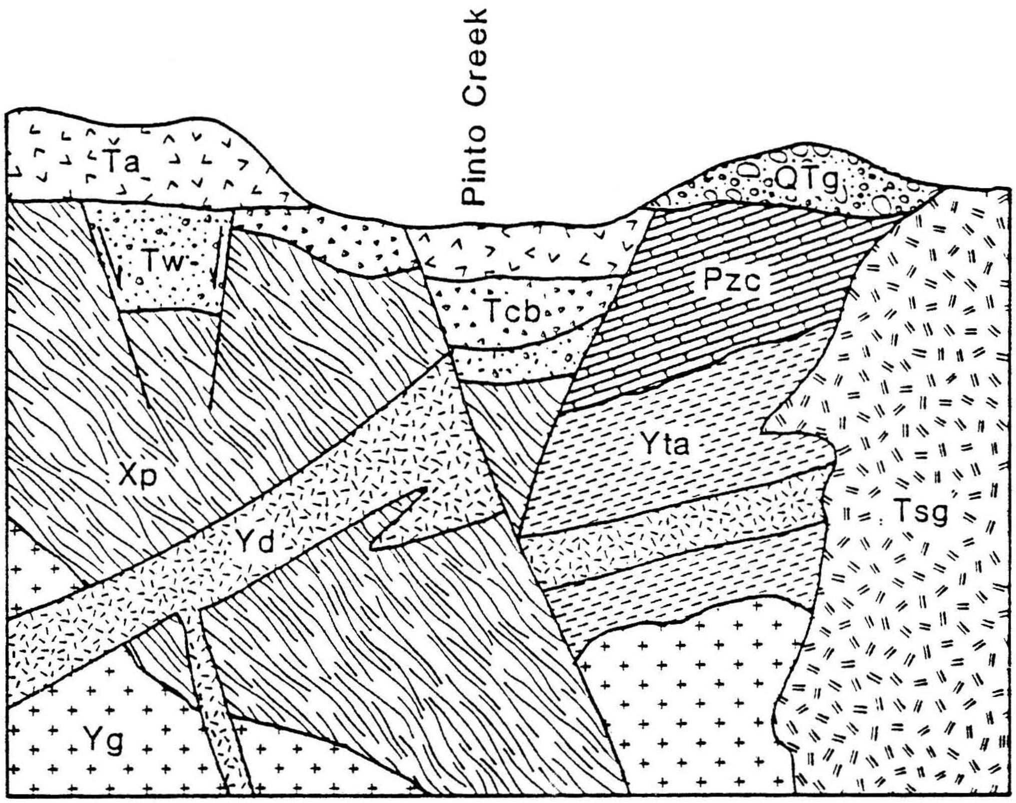
The Pinal Schist is a variable unit but consists primarily of a quartz-sericite or quartz-muscovite schist. The amount of mafic minerals varies quite a bit, as does the texture, ranging from the predominant schist to coarsely granular gneiss. Where altered, the schist is often little affected except for a "bleached" appearance. The schist is the main host rock for mineralization at the Eder South deposit. The schist has been locally intruded by the Lost Gulch Quartz Monzonite, the primary host rock for the Pinto Valley deposit, and massive brown-to-black diabase, which appears as sill-like intrusives. Scattered exposures of Paleozoic carbonate rocks are preserved north of the Kelly Fault. Exposures of Schultze Granite in the Carlota area are generally lacking but are noted at the Pinto Valley deposit and at the south end of the Eder claims. The Schultze Granite is the "mineralizer" in the Globe-Miami District and hosts ore in many of the deposits near Miami. It does not appear to have any direct genetic significance, however, to the copper mineralization within the Carlota Project area.

Remnants of the basin and/or channel-filling Whitetail Conglomerate are preserved locally in the Carlota Project area. The Whitetail is up to several hundred or more feet thick in the area and is comprised predominantly of poorly stratified sand-to-cobble-sized diabase and limestone fragments. A thick volcanic ash unit near the top of the unit has been dated at approximately 30 Ma. The Whitetail does not appear to be mineralized in the project area.

At least locally, the Cactus Breccia was deposited directly on top of the Whitetail Conglomerate. Like the Whitetail, the informally defined Cactus Breccia was deposited in small, evolving basins or filling channels incised into older units. The unit is named after exposures of breccia at the Cactus deposit, which Peterson (1962) mistakenly mapped as brecciated Pinal Schist.

The Cactus Breccia is composed primarily of variably altered quartz-muscovite schist clasts derived from the Pinal Schist. Other clasts are thought to be derived from altered Lost Gulch Quartz Monzonite, Shultze Granite, and quartzite units of the Apache Group. The breccia is clearly of sedimentary origin and likely represents megabreccia or subaerial landslide deposits not unlike similar units in Arizona deposited during this time (20-30 Ma). Limonite coating on clasts and limonite disseminated within clay matrix impart a characteristic red color to the

Carlota Copper Company
Carlota Project



Schematic Geologic Section

Quaternary
- Qtg — Gila Conglomerate

Tertiary
- Ta — Apache Leap Tuff
- Tcb — Cactus Breccia
- Tw — Whitetail Conglomerate
- Tsg — Schultze Granite

Paleozoic
- Pzc — Sedimentary (Carbonate) Rocks, Undiff.

Middle Proterozoic
- Yd — Diabase
- Yta — Troy Quartzite, Apache Group
- Yg — Granitic Rocks, Undiff.

Early Proterozoic
- Xp — Pinal Schist

Figure 3-1

breccia. Clast sizes are variable and range from house-size boulders down to sand-size fragments. The breccia is typically chaotic and unsorted, with clasts generally quite angular. Based on the relative proportion of clay/sand matrix to clasts, the breccia has locally been subdivided into matrix-rich and matrix-poor varieties. Elongated clasts and vague bedding layers showing specific clast lithologies, as well as internal shearing, suggest a crude layering in the deposit dipping moderately to the northeast. Preserved thickness of the breccia exceeds 600 feet.

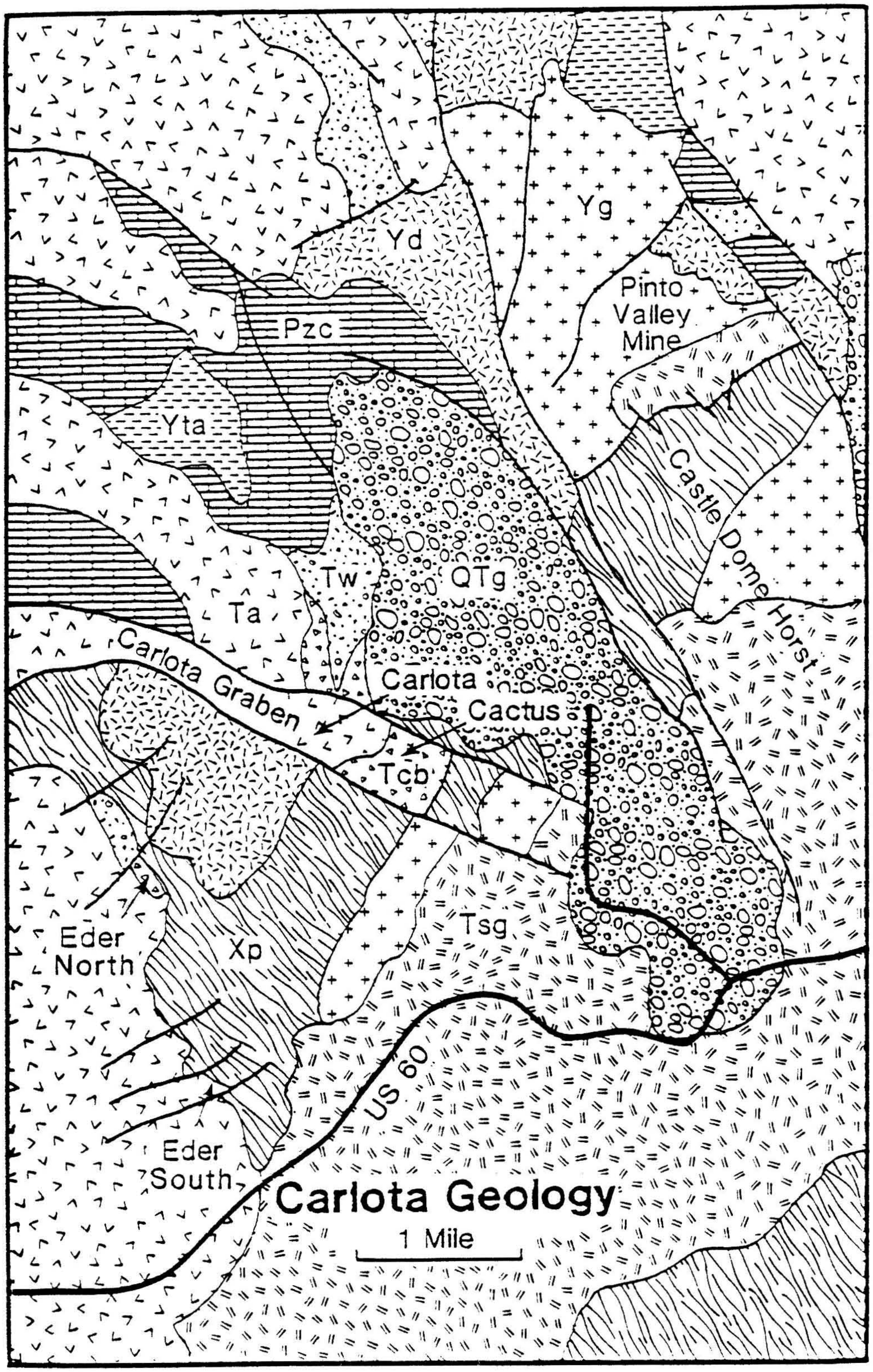
Depositionally overlying the Cactus Breccia is the Apache Leap Tuff. The tuff is generally dacitic in composition and brown in color, often exhibiting crude generally subhorizontal layering. The tuff is generally welded and often is relatively fresh in appearance. An approximately 10-foot-thick black vitrophyric zone is often present near the base of the tuff. A thin ash layer is also present locally near the base of the tuff. The tuff is a significant ore host in the Carlota area. The Gila Conglomerate is present in the northeastern part of the area and locally appears to be weakly mineralized. These poorly-sorted alluvial fan deposits record a period of erosion deposition and uplift predating the current period of tectonic activity.

3.2.2 Structure

The structure of the Carlota area is largely a record of Tertiary extensional tectonics. The north-trending Castle Dome Horst, hosting the Pinto Valley Mine, and the northwest-trending Carlota Graben are the two most significant structural features which, in concert, led to the localization of the Carlota/Cactus deposit (Figure 3-2).

Uplift of the Castle Dome Horst was accommodated by at least several thousand feet of vertical movement along the boundary fault which defines the east and west limits of the Pinto Valley deposit. Uplift was most likely initiated in the mid-Tertiary, probably after deposition of the Whitetail Conglomerate, and continued intermittently through the Tertiary. Erosion and mass wasting from the uplifted block led to the deposition of the Cactus Breccia, which was deposited in local, probably subsiding, basins peripheral to the horst. Movement along the Cactus Fault, a low-angle feature which underlies the entire Cactus Breccia unit within the area of the Carlota Graben and separates it from the underlying Precambrian rocks, was initiated during and shortly after deposition of the breccia. The Cactus Fault is marked by a zone of crushed and "gougy" rock, 4- to 10-feet thick. Within the graben, the breccia appears to have been rotated moderately to the northeast. The eastern limit of the Cactus deposit is defined by the outcrop of the Cactus Fault within this graben.

Movement along the Kelly Fault zone, the south-bounding fault of the Carlota Graben, was likely initiated after the emplacement of the breccia in this area. Movement of at least several thousand feet of combined oblique slip is based largely upon the absence of both breccia and dacite to the south of the fault. There appears to be lesser movement on a parallel fault (North Fault) defining the graben to the north. Cactus Breccia and the contact with overlying dacite have been preserved in the graben, whereas these features have been largely eroded away outside the graben. The Carlota Graben is typically 1,200- to 1,500-feet wide and can be traced for over



Carlota Copper Company
Carlota Project

Figure 3-2

7,500 feet along the length of the Kelly Fault. Westward tilting of some 15- to 25-degrees of the regional tectonic block west of the Carlota Dome Horst is suggested by the westward dip of the Apache Leap-Pinal Schist contact in the Eder area.

3.2.3 Mineralization

Based on the visual examination of surface exposures, drill core and cuttings, and associated petrographic work, copper mineralization at the Carlota-Cactus-Eder deposits is exotic in origin, supergene in nature, and broadly similar in aspect between the deposits. While chrysocolla is the dominant ore mineral in all the deposits, significant amounts of chalcocite and malachite are present at Cactus. The fracture-filling nature of the copper minerals results in excellent metallurgical characteristics.

The Cactus Breccia is the primary host rock for mineralization at the Carlota/Cactus and Eder North deposits. At Carlota, mineralization in the dacite overlying the Cactus Breccia is important, as is mineralization along approximately 3,300 feet of the Kelly Fault, which bounds the Cactus and Carlota deposits to the south. Kelly Fault mineralization is hosted in brecciated diabase (northwest segment) and Pinal Schist (southeast segment). Mineralization at the Eder South deposit is hosted within fractured and brecciated Pinal Schist.

Chrysocolla, which can vary between the more typical blue color and a black, manganiferous and iron-oxide variety, is generally present filling and lining fractures within brecciated rocks of the Kelly Fault, Pinal Schist, and Apache Leap dacite, as well as larger clasts in the Cactus Breccia. Within the Cactus Breccia, chrysocolla can also be found rimming clasts, filling vugs and open spaces, and locally replacing clay matrix. In the dacite, chrysocolla can also be found filling or lining vugs or crystal cavities and replacing altered feldspar phenocrysts. Occasionally associated with chrysocolla and generally sharing the same habits are black copper pitch and/or neotocite (Cu-, Mg-, Fe-oxide). Malachite is locally abundant in the eastern portion of the Cactus deposit and sporadically along the Kelly Fault. In the Cactus deposit, malachite appears to be related to oxidized chalcocite mineralization, is generally found as veinlets within breccia clasts along with iron oxides and pyrite, and is typically present within a local transition zone between underlying chalcocite mineralization and overlying chrysocolla mineralization. Within the Cactus Breccia, copper-bearing clays and copper-bearing iron oxides (hematite) can locally contain significant amounts of copper. The only significant copper sulfide mineral identified is chalcocite, where it is restricted to the lower parts of the Cactus deposit. The chalcocite is commonly found rimming or partially to totally actively replacing pyrite, which is often found as veinlets or individual grains within breccia clasts.

Paragentic relationships among the various copper oxide minerals have been elucidated based on petrographic examinations. At least three probably closely-spaced periods of chrysocolla deposition have been noted with and without intervening periods of authigeonic montmorillonite-type clay deposition. Where noted, malachite usually precedes chrysocolla deposition, and occasionally chrysocolla has been noted replacing earlier formed malachite. Chalcocite is generally never seen in contact with chrysocolla, whereas malachite altering from and replacing chalcocite is fairly common at the Cactus deposit.

3.3 Form of Deposits

The form or distribution of significant copper mineralization at the Carlota Project is for the most part determined by results from drilling. As such, the following discussion will rely heavily on drill-generated information which has been used to generate a number of geologic and assay sections through each of the deposits as well as other graphic products. Drill holes and sections for the deposit areas are shown in Drawing 3-2, while representative sections for each deposit area are presented as Drawings 3-3 through 3-7.

3.3.1 Carlota/Cactus Area

The Carlota and Cactus deposits will be discussed together because they are not only adjacent to each other, but share many common attributes and are intimately related. For this discussion, the Cactus deposit is defined as being east of Pinto Creek with Carlota lying to the west of Pinto Creek.

Outcropping mineralization at Carlota is restricted to local exposures along the Kelly Fault. The distribution of the more significant mineralization hosted in the lower part of the dacite and within the Cactus Breccia is known only through drilling. Mineralization at Cactus does outcrop and is predominantly hosted within the Cactus Breccia, within the Kelly Fault, and locally within the dacite. Only oxide-type mineralization is found in outcrops while the sulfide-rich mineralization at Cactus is known only from drilling.

The Kelly Fault defines the southern limit of mineralization at both the Carlota and Cactus deposits and contains exclusively oxide mineralization over widths of from 10 to 70 feet with typical grades of 0.6- to 1.0-percent copper. Mineralization at both deposits is generally floored by the low-angle Cactus Fault which separates overlying, potentially mineralized Cactus Breccia from underlying, generally barren Pinal Schist. Mineralization at both deposits appears to be strongest (>0.50 percent total copper) adjacent to or in closer proximity to the Kelly Fault with diminishing intensity farther away from the fault. However, significant mineralization may be present up to 1,000 feet or more from the fault. Proximity to the eastern, up-dip limit of the Cactus Fault also appears favorable for better grade mineralization. At the Carlota property, mineralization and the favorable breccia both thin out going to the west. Relatively lean mineralization is present (> 0.10- to 0.35-percent total copper) in a central area between the two deposits. Along the length of the two deposits, significant mineralization is noted for roughly 3,600 feet. The form of the Carlota/Cactus deposit is well illustrated in Figure 3-3, a contoured grade x thickness product map derived from drill-hole intercepts (100 feet thickness at 1 percent copper=100).

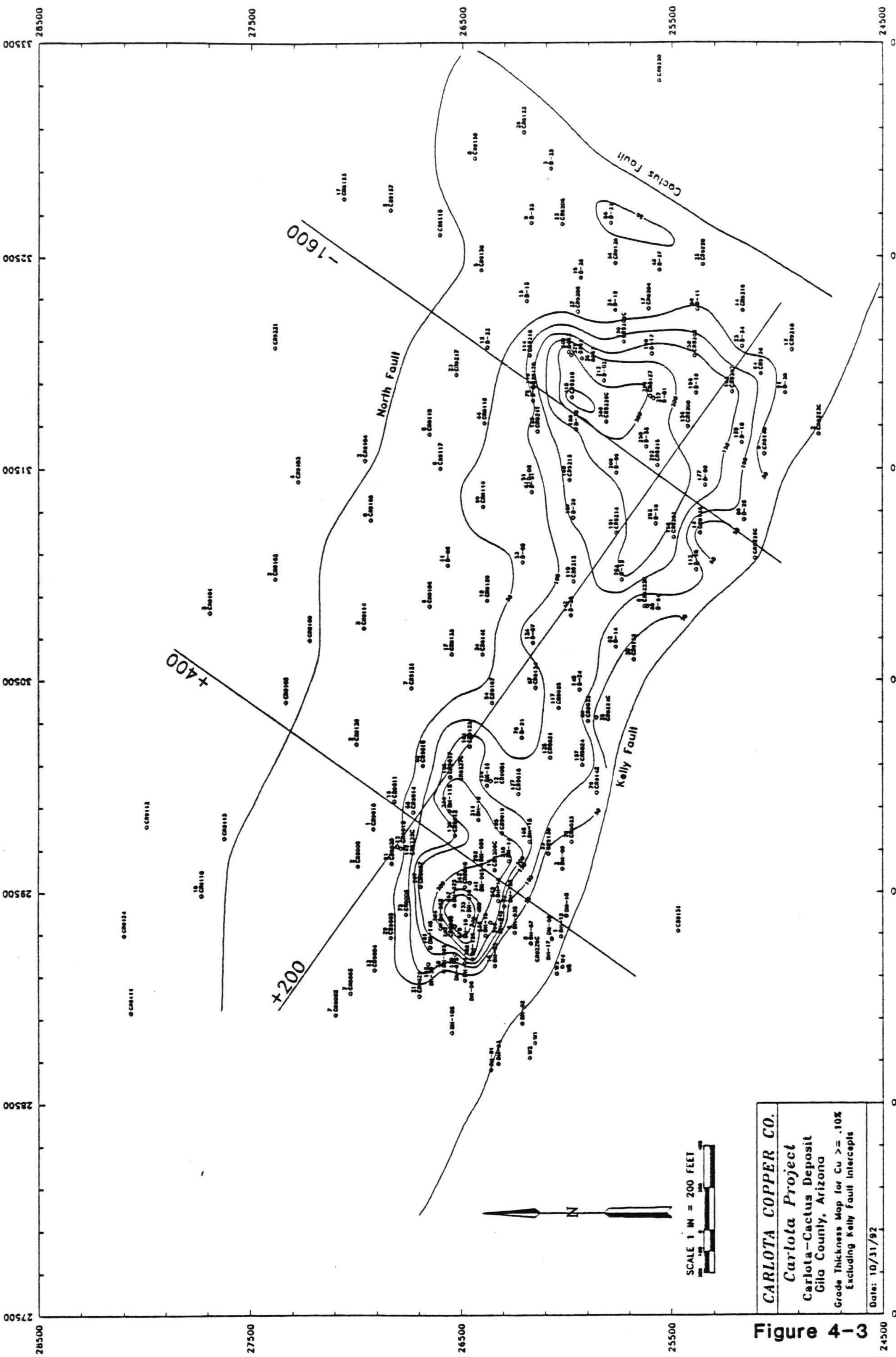

CARLOTA COPPER CO.
Carlota Project
Carlota-Cactus Deposit
Gila County, Arizona
Grade Thickness Map for Cu >= .10%
Excluding Kelly Fault Intercepts
Date: 10/31/92
SCALE 1 IN = 200 FEET
N
North Fault
Kelly Fault
Cactus Fault
-1600
+400
+200

Figure 4-3

The envelope of significant mineralization at the Carlota and Cactus deposits can be up to 600-feet and 400-feet thick, respectively, near the Kelly Fault where the preserved thickness of the breccia is greatest, but generally diminishes as the breccia thins going to the north away from this fault. At Carlota, the top of the mineralized zone is generally within the lower part of the dacite, is relatively flat, and is apparently related to the present groundwater table. Mineralization is most often persistent and highest in grade along the dacite-Cactus Breccia contact. Within the breccia, higher-grade mineralization is also often noted near the Cactus Fault contact. Dacite-hosted mineralization at Cactus is relatively minor, due in part to its small areal distribution and location above the present ground water table.

Mineralization at Carlota is entirely of oxide-type, with the oxide-sulfide interface generally rising in elevation to the east on the Cactus property. Over much of the Cactus deposit, the oxide-sulfide boundary (n.s. copper %/total copper % <50%) mimics the current groundwater table and is as close as 50 feet to the surface. Sulfide mineralization (chalcocite) is generally quite uniform and consistent in tenor, often grading about 0.70-percent copper but with multipercent grades often present immediately below the oxide-sulfide boundary. Oxide mineralization at Cactus is more erratic in distribution and grade, commonly with a relatively thin mineralized zone (<100 feet) near the surface and separated by a relatively barren zone from a deeper mixed-oxide-sulfide or sulfide-mineralized zone. Surface mineralization at Cactus is generally present as chrysocolla which appears to have formed after preexisting malachite. Malachite is the most common oxide mineral from immediately below the surface to the oxide-sulfide boundary and locally below.

Typical cross sections through the Carlota deposit (+400) and Cactus deposit (-1600) are presented in Drawings 3-3 and 3-4, respectively. A longitudinal section (+200) through both deposits is shown as Drawing 3-5.

3.3.2 Eder North and South Areas

Mineralization at Eder South is present mainly as chrysocolla along fractures within the Pinal Schist. No sulfide mineralization, including pyrite, has been found at Eder South; the rocks appear to be thoroughly oxidized. Extensive faulting, generally along northeast trends, has created sufficient fracturing and brecciation in the Pinal Schist so as to localize the deposit. Significant (>.15 percent) near-surface copper mineralization at Eder South is present over an area measuring roughly 2,400 feet (north-south) by at least 1,000 feet (east-west). Mineralization often extends from the surface to depths of roughly 200 to 300 feet with the bottom of mineralization at approximately the 4,200-foot elevation. The western portion of the deposit is overlain by essentially barren Apache Leap Dacite. The eastern edge of mineralization is defined by erosion. Mineralization is known to extend at least 1,000 feet west of the outcropping zone under the dacite "cap," but an economic limit is imposed by topography rising steeply in this direction. Mineralization to the north and south appears to diminish gradually, perhaps related to a lack of faulting and ground preparation. Near the south end of the deposit, mineralization appears to increase along the east-west trending structural/intrusive boundary of

Schultze Granite and then diminishes within the granite farther to the south. Figure 3-4 is a grade x thickness map of the Eder South deposit illustrating the northeast-southwest trending control to the mineralization. Drawing 3-6 is a representative cross section through the deposit.

At the Eder North deposit, mineralization is hosted within Cactus Breccia, which apparently infills a northeast-southwest trending channel carved into underlying Pinal Schist and Whitetail Conglomerate. The north and south limits of the deposit are poorly defined, but the deposit is known to extend for roughly 1,000 feet, across the channel trend with the breccia appearing to thin, and the grade diminishing away from the axis of the channel. The eastern limit is defined by erosion, while the western limit is also poorly defined, but is known to extend for over 1,300 feet down-dip from the outcrop and under the overlying essentially barren Apache Leap Dacite. An economic limit, however, is imposed in this direction, owing to the westwardly dip (20 to 30 degrees) of the breccia into the steep dacite ridge. Significant mineralization appears to be generally in the more basal part of the breccia and can be over 200-feet thick. A grade x thickness map of the Eder North is presented in Figure 3-4. Drawing 3-7 is a representative cross section through the deposit.

3.4 Origin of the Deposits

The genesis of the Carlota/Cactus and Eder copper deposits is thought to be a result of the following significant events: 1) Local intrusions of Laramide-age (60 Ma) Schultze Granite altered and mineralized Pinal Schist and Lost Gulch Quartz Monzonite wall rocks and deposited concentric zones of hypogene sulfide mineralization at depth in the Pinto Valley area; 2) Relatively stable conditions persisted until deposition of the Whitetail Conglomerate (30 Ma); 3) Following this, significant mid-Tertiary tectonic activity with related uplift and block faulting affected the area, and a portion of the altered and weakly mineralized schist overlying the Pinto Valley deposit was shed as landslide or megabreccia deposits (Cactus Breccia) into adjacent basins; 4) Low-angle faulting (Cactus Fault) and continued graben development largely preserved the Cactus Breccia within the Carlota Graben from subsequent erosion; 5) The emplacement of the welded ash flow sheet of the Apache Leap Tuff (20 Ma) then covered most of the region from Superior to Globe; 6) Continued tectonic movement led to uplift of the Castle Dome Horst containing the Pinto Valley deposit, with related movement along the Kelly Fault. Copper was leached by surface water and groundwater from the uplifted Pinto Valley deposit and copper-rich solutions moved downgradient into the adjacent Carlota Graben; 7) Downward and lateral flow of copper-bearing solutions along the Kelly Fault and Cactus Fault was important and mineralized the Cactus Breccia and dacite as well as the Kelly Fault. Where pre-existing sulfides (pyrite) in breccia clasts were oxidized prior to the introduction of the copper-bearing solutions (Carlota deposit), only oxide-copper minerals, principally chrysocolla, were formed. Where residual sulfides were still present (Cactus deposit) chalcocite was formed as a replacement of pyrite; 8) Deposition of the Gila Conglomerate (3-10 Ma) and subsequent rejuvenation of the topography along with moderate warping and westward tilting complete the history of the Carlota area. Erosion, oxidation, and redistribution of copper minerals related to the latest tectonic movements continue, both above and below the present water table.

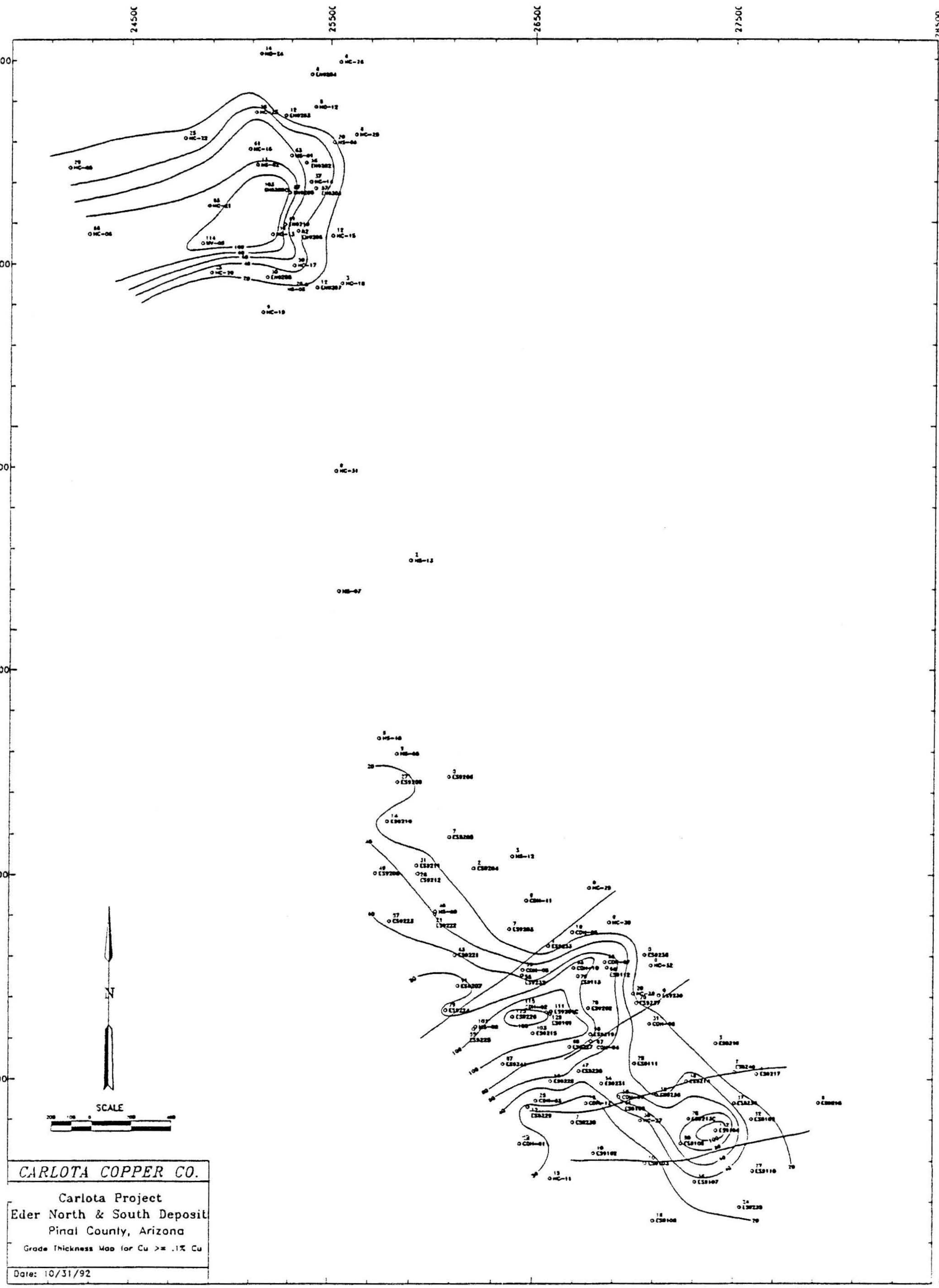

CARLOTA COPPER CO.
Carlota Project
Eder North & South Deposit
Pinal County, Arizona
Grade Thickness Map for Cu >= .1% Cu
Date: 10/31/92
SCALE
N

Figure 3-4

MEMO

To: Duane Bollig and Bob Walish
From: Herb Welhener
Date: June 1, 1994
Regarding: Tonnages by Pits and Dumps

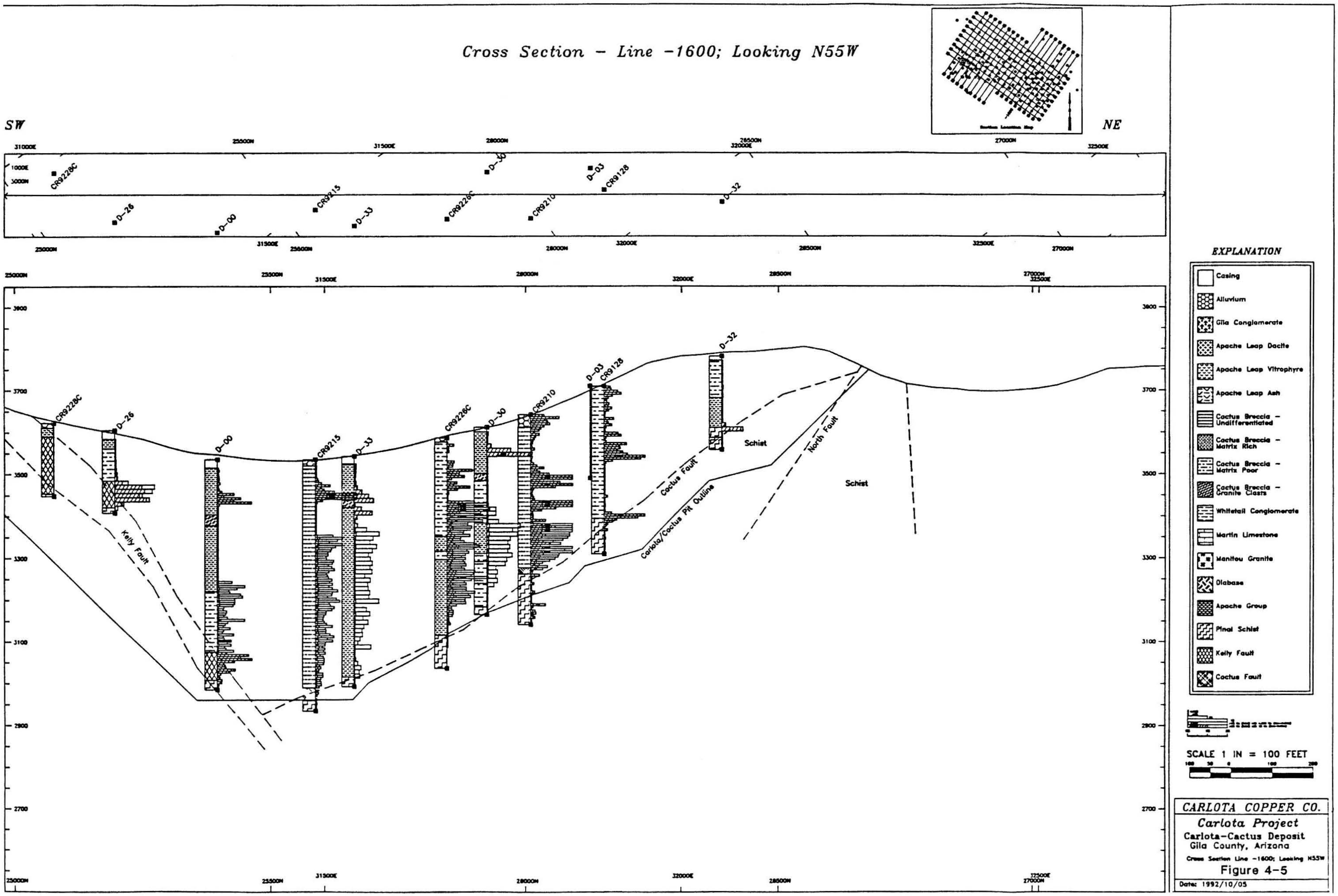
The table below summarizes the material within the current pit designs and the capacities of the various dumps. I took the latest schedule assuming that all of the 33,000 tons of copper to the pad by the end of year 1 comes from Carlota/Cactus Phase 1 and scheduled tonnages to the dumps. You can see that we are tight for dump capacity and I would like to propose that the Cactus Southwest dump be made about 2 million tons larger at some point in the future. I believe this can be done by extending it to the west slightly with the Eder access road incorporated into the toe of the dump and the top elevation of the dump would not have to be raised. Things have gotten tight because of the small pit changes and dump changes that have occurred over the past few months and all of them have not been taken into the waste schedule until now. I assume that nothing will be changed at this moment, but I would suggest that it be addressed shortly. Let me know what you think.

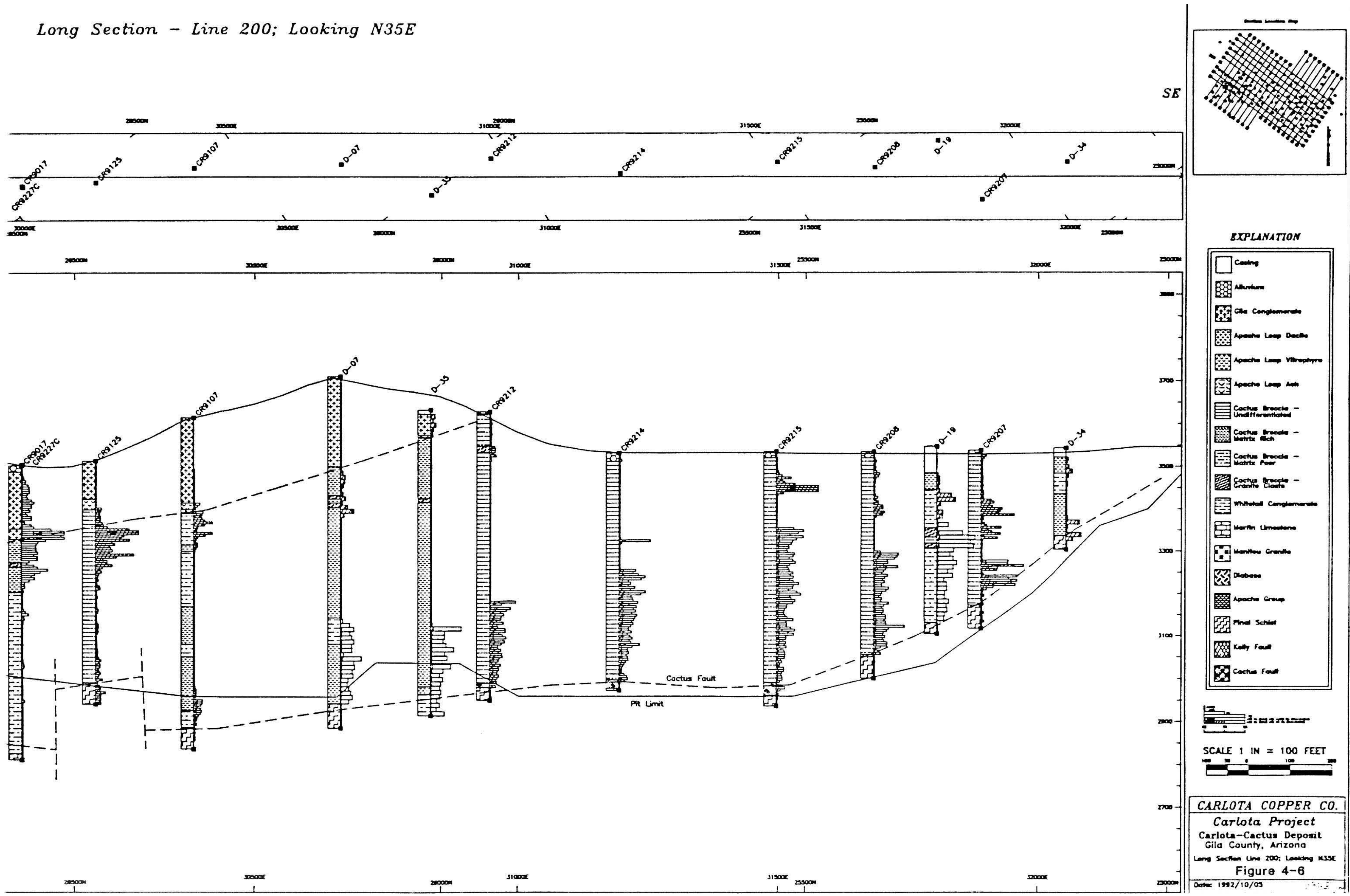
Pit Tonnage:	Ore		Waste	Total
Carlota/Cactus	86,890	.473	191,754	278,644
Eder South (including NW)	16,360	.295	8,234	24,594
Eder North	2,405	.320	3,670	6,075
Total Reserve	105,655	.442	203,658	309,313

Waste Dump Tonnages:

Carlota/Cactus	Main Rock Dump and Road Fill:	110,878
	Cactus Southwest Dump:	27,239
	Carlota/Cactus Pit Backfill:	52,459
		190,576
Eder	Main Eder Dump (Maximum)	8,940
	Eder North Backfill from dump	-1,032
	Remaining Eder Dump	7,908
	Eder South Pit Backfill (placed during mining)	2,964
	Total Eder Waste	11,904

INDEPENDENT
MINING CONSULTANTS, INC.


Cross Section - Line -1600; Looking N55W
SW
NE
CR9228C
D-26
D-00
CR9215
D-33
CR9226C
D-30
CR9210
D-03
CR9128
D-32
Kelly Fault
Cactus Fault
Carlota/Cactus Pit Outline
North Fault
Schist
3900
3700
3500
3300
3100
2900
2700
EXPLANATION
Casing
Alluvium
Gila Conglomerate
Apache Leap Dacite
Apache Leap Vitrophyre
Apache Leap Ash
Cactus Breccia - Undifferentiated
Cactus Breccia - Matrix Rich
Cactus Breccia - Matrix Poor
Cactus Breccia - Granite Clasts
Whitetail Conglomerate
Martin Limestone
Manitou Granite
Diabase
Apache Group
Pinal Schist
Kelly Fault
Cactus Fault
SCALE 1 IN = 100 FEET
CARLOTA COPPER CO.
Carlota Project
Carlota-Cactus Deposit
Gila County, Arizona
Cross Section Line -1600; Looking N55W
Figure 4-5
Date: 1992/10/05


Long Section - Line 200; Looking N35E
SE
CR9017
CR9227C
CR9125
CR9107
D-07
D-35
CR9212
CR9214
CR9215
CR9208
D-19
CR9207
D-34
Cactus Fault
Pit Limit
3700
3500
3300
3100
2900
2700
EXPLANATION
Casing
Alluvium
Gila Conglomerate
Apache Leap Dacite
Apache Leap Vitrophyre
Apache Leap Ash
Cactus Breccia - Undifferentiated
Cactus Breccia - Matrix Rich
Cactus Breccia - Matrix Poor
Cactus Breccia - Granite Clasts
Whitetail Conglomerate
Martin Limestone
Manitou Granite
Diabase
Apache Group
Pinal Schist
Kelly Fault
Cactus Fault
SCALE 1 IN = 100 FEET
CARLOTA COPPER CO.
Carlota Project
Carlota-Cactus Deposit
Gila County, Arizona
Long Section Line 200; Looking N35E
Figure 4-6
Date: 1992/10/05

Pinto Valley Copper Deposit

by

Gary W. Lenzi
Pinto Valley Division, Magma Copper Company
P. O. Box 100
Miami, Arizona 85532

Richard A. Breitrick
Magma Nevada Mining Company
Ely, Nevada

PURPOSE

This tour shows the principal features of the Pinto Valley porphyry copper deposit (Figures 1 and 2) with emphasis on hydrothermal alteration and accompanied sulfide mineralization. Examples of vein-controlled and pervasive alteration will be seen. The deposit shows the effects of Laramide intrusions and alteration on Precambrian quartz monzonite host rocks.

GEOLOGIC SUMMARY

Pinto Valley is a hypogene orebody with chalcopyrite, pyrite, and minor molybdenite as the only significant primary sulfide minerals. It is the underlying protore of the chalcocite-enriched Castle Dome deposit (Peterson et al., 1951). A chalcocite-enriched zone was mined from 1943 through 1953 (Castle Dome mine) and produced 41 million tons of ore having an average grade of 0.62% copper. Pinto Valley ore reserves as of January 1994 were 184 million tons averaging 0.389% copper. Total ore mined from the beginning of production in July 1974 through December 1993 was 330 million tons. The average molybdenum content of the ore for the 7-year period from 1975 through 1981 was 0.01% Mo.

The Pinto Valley porphyry copper deposit formed within Precambrian Lost Gulch Quartz Monzonite, which is equivalent to the Ruin Granite. Copper-bearing mineralization was associated with small stocks and dikes of granite porphyry and granodiorite, whose ages are about 61.2 Ma.(Creasey, 1980). Copper mineralization has been dated at 59.1 Ma. (Creasey, 1980). There is evidence to suggest that the original configuration of the copper zone was that of a distorted inverted bowl with its long axis striking approximately N.80°E. with an ore shell surrounding a low-grade core. As presently defined, the deposit is bounded by post-mineral faults. On the south is the South Hill fault, on the east is the Jewel Hill fault, and on the west is the Gold Gulch fault (Figure 3). Minor postmineral normal displacement has taken place on the Dome fault, a premineral structure that strikes northeasterly across the north limb of the deposit.

Primary sulfide mineralization consists of pyrite, chalcopyrite, and minor molybdenite that occur in veins and microfractures, and less abundantly as disseminated grains predominantly at biotite sites. The ore zone grades outward into a pyritic zone with higher total sulfide content and grades inward toward the low-grade core having lower total sulfides. Molybdenum distribution generally reflects copper distribution, with higher molybdenum values usually found in the high-grade copper zones.

The Pinto Valley deposit has all of the major alteration features associated with most porphyry copper systems hosted by a monzonitic intrusion. The most prominent is a selectively pervasive argillic hydrothermal alteration which permeated the mineral deposit and is characterized by the alteration of plagioclase to montmorillonite. Phyllic alteration is vein controlled, occurring as sericitic selvages along quartz-sulfide veins, and is most strongly developed in the pyritic halo outside and above the ore zone. Potassic alteration grades from early, narrow zones of texture-destructive alteration into a broader zone of hydrothermal biotite. Narrow zones of texture-destructive sodic-potassic alteration, characterized by the replacement of both original orthoclase and oligoclase by fine granular K-feldspar and albite, are restricted to the low-grade core. This earliest alteration type evolved into widespread potassic hydrothermal biotite alteration characterized by the introduction of biotite along joints and microfractures and the recrystallization of original biotite to fine-grained "felty" biotite (the aggregate biotite of Peterson and others, 1951).

STOP 1 - SQUAW HILL

Squaw Hill is on the outer edge of propylitic alteration and is about 1300 feet northwest of exposures of good vein-controlled phyllic alteration and about 1600 feet north of the northern limit of 0.3% copper mineralization. Porphyritic quartz monzonite occurs north of the saddle, and quartz monzonite porphyry lies to the south. Both are intruded by Precambrian aplite.

Propylitic alteration is fracture controlled and has produced an array of associated veins and microveins that differ mineralogically with respect to both vein filling and alteration selvage mineralogy. Prominent among the minerals produced during propylitic alteration as vein fillings and alteration products are clinozoisite, epidote, quartz, adularia, pennite, and primary chlorite. Anhydrite, pyrite, and chalcopyrite occur in trace amounts. Propylitic veins that carry trace amounts of sulfides were accompanied by weak sericite alteration in the adjacent oligoclase phenocrysts. Propylitic alteration was most strongly developed as an outer halo to the deposit; however, propylitic microveins also extend sparingly into the copper zone.

Chlorite-altered hydrothermal biotite microveins are present in the 6-foot by 10-foot vertical face on the west edge of the outcrop. This is the only occurrence of hydrothermal biotite alteration in the outcrop and is the furthest known occurrence of hydrothermal biotite north of the mine. No biotite has been found in any of the propylitic veins or any of their alteration selvages. However, sparse microveins containing both biotite and epidote have been found in a single drill hole located closer to the mine, providing evidence that potassic (biotite) alteration and propylitic alteration were at least partially synchronous.

The microvein density is very low. Epidote and K-feldspar + chlorite microveins are common and locally abundant. The pale pink planar faces on many of the boulders and in the outcropare open are open fractures coated with pink to white euhedral adularia, quartz, chlorite, and sparse oxidized pyrite cubes. Some also contain minor epidote and (or) clinozoisite.

Weak to incipient pervasive argillic alteration of the plagioclase is also present. Most of the plagioclase phenocrysts are a cloudy white to buff color, but unaltered glassy, clear phenocrysts are present, usually in clusters.

GEOLOGIC HIGHLIGHTS EN ROUTE TO STOP 2

The route will proceed south within the pyrite-rich upper levels of the mineral deposit. The prominent vein set is composed of phyllic veins. These pyrite-rich veins have strong sericite selvages, which replace the main minerals except quartz. They form a set that strikes east-northeast and dips to the southeast. Integrated fractures density on upper levels is less that 0.13 cm-1. Isolated areas of chalcocite enrichment can be seen.

The Paleozoic limestone cliffs to the east form Jewel Hill. At the base of the hill, the West Jewel Hill fault has displaced the east end of the orebody. The limestones have only a few thin replacement beds of garnet skarn and an oxidized "magnetite" skarn. Copper mineralization did not extend into the limestone.

Precambrian diabase is the dark-gray rock exposed south of the Dome fault. It has been intruded by a small stock of granite porphyry. Both rock types contain pyrite and very little chalcopyrite.

STOP 2 - ROAD CUT

This stop is a walk-through along the east side of the road. The exposures are within the weathered and oxidized pyrite-bearing phyllic zone and about 300' above the top of the primary orebody (see cross section C-C', Figure 4). The reddish-brown limonite is characteristic of oxidized chalcocite, which has been a diagnostic tool used in exploration for porphyry copper deposits. Chalcocite enrichment is preserved within the gray exposures near the bottom of the face. Pervasive argillic alteration and phyllic alteration, seen as abundant quartz-pyrite veins with sericite selvages, are present. From south to north the rock types are granite porphyry, quartz monzonite porphyry, rhyolite intruding quartz monzonite porphyry, quartz monzonite, small dikes of aplite, alaskite porphyry, and diabase. The quartz monzonite, quartz monzonite porphyry, aplite, and alaskite porphyry are all phases of the Lost Gulch Quartz Monzonite and are dated at 1415 Ma. (Creasey, 1980). The diabase has an age of 1079 Ma. Rhyolite is related to granite porphyry.

Granite porphyry is a late phase of the Schultze Granite. It is distinguished by clear, euhedral quartz eyes, altered plagioclase, pink orthoclase phenocrysts, and fine-grained biotite in a microcrystalline groundmass. The phenocrysts of biotite and pink orthoclase are fewer than those of plagioclase and quartz. Orthoclase phenocrysts are generally much larger than the others. Its contact with quartz monzonite porphyry is sharp and several veins can be seen cutting the contact. In several drill holes, the ore boundary is found at granite porphyry-quartz monzonite porphyry contacts with ore in the quartz monzonite porphyry. Beginning 300 feet below the surface the quartz monzonite porphyry averages 0.453% copper, whereas the adjacent granite porphyry only averages 0.128%. Granite porphyry is associated with economic mineralization at Copper Cities, the Old Dominion vein area, and the Cactus breccia as well as at Pinto Valley. Very similar rocks are exposed at porphyry copper deposits at Safford (Lone Star), and Tyrone.

The quartz monzonite porphyry contains phenocrysts of oligoclase (altered to clay), quartz, and biotite that are much larger than phenocrysts in the granite porphyry. It also contains pink to reddish-brown orthoclase phenocrysts that range from 1 to 3 inches in size. The finer grained groundmass is composed of quartz and orthoclase in varying amounts and crystal sizes.

The principal alteration within the orebody is argillic, or as Peterson and others (1951) described it, clay alteration. The main feature of this alteration is the selective pervasive replacement of oligoclase phenocrysts by a slightly yellowish to greenish clay that Peterson and others identified as beidellite. The clay formed from a reaction with hydrothermal alteration and is not a supergene effect as has been suggested by some to account for the type of alteration at other porphyry copper deposits. At Pinto Valley, the clay alteration of plagioclase is ubiquitous and is seen from the deepest drilling in the low-grade core to the propylitic zone near Squaw Hill.

Near the top of the road cut, a one-foot thick aphanitic diabase dike intruded the quartz monzonite porphyry.

Rhyolite is the white aphanitic rock with rare, small quartz phenocrysts. It has both normal and faulted contacts. Other exposures of rhyolite show that it is an aphanitic phase of granite porphyry.

The contact between quartz monzonite porphyry and quartz monzonite is occupied by a thin aplite dike. Quartz monzonite looks like quartz monzonite porphyry except that groundmass is absent. Plagioclase, quartz, and biotite occur in a nearly equigranular texture with larger orthoclase phenocrysts.

Within the quartz monzonite is a small dike of alaskite porphyry. It has the same mineral composition and texture as aplite with a few phenocrysts of quartz, oligoclase, biotite, and rare orthoclase.

GEOLOGIC HIGHLIGHTS EN ROUTE TO STOP 3

On the way to stop 3, we pass outcrops of granodiorite, which is believed to be cogenetic but slightly older than granite porphyry. This area is within the central low-grade core of the deposit.

The hill to the south is composed of unmineralized Precambrian Pinal Schist. The South Hill fault separates mineralized granodiorite and quartz monzonite from unmineralized schist, and has removed about one-third of the original deposit (>0.3% copper). A low-angle fault has displaced schist to the north at the nose near the road. This fault block overrode the South Hill fault and can be seen in the road cut here gray schist over-lies tan granodiorite.

STOP 3 - RED HILL PIT

The Red Hill area contains ore-grade copper mineralization in quartz monzonite with an average grade of about 0.5% copper. Chalcopyrite and lesser amounts of pyrite occur as veinlets and disseminated in biotite sites. Alteration is potassic and is noted by secondary biotite (felty or shredded biotite) and additional biotite as veins. Intense zones of hydrothermal biotite veining form biotite breccias, which are common at this location in quartz monzonite. Plagioclase is altered to clay as at other locations in the mine.

Formation of the deposit began with sodic-potassic alteration starting with the introduction of K-feldspar and albite, which evolved into hydrothermal biotite alteration. The transition from the early phase to the later phase was gradational. In the early phase orthoclase phenocrysts were replaced by granular K-feldspar and minor albite, and oligoclase phenocrysts were altered to albite and partially replaced by granular K-feldspar. During the hydrothermal biotite phase, orthoclase was stable, igneous biotite was recrystallized to clots of fine-grained "felty" biotite, and hydrothermal biotite was introduced along joints and microfractures. Locally hydrothermal biotite was also finely disseminated in the oligoclase phenocrysts, which continued to be altered to albite during the early stage of hydrothermal biotite alteration. The early sodic-potassic alteration was restricted to the low-grade core, and its occurrence at present levels of exposure and in the drill-hole intercepts is limited to relative narrow linear zones. Hydrothermal biotite alteration was much more extensive and was described by Peterson and others (1951) in the Castle Dome deposit.

Following potassic alteration, granodiorite was intruded at about the same time that barren quartz veins were formed in the host rock. Granite porphyry was then emplaced with accompanying igneous intrusive breccias during early stages of granite porphyry emplacement. Various sulfide-bearing veins followed the intrusions of granodiorite, granite porphyry, and igneous breccias.

STOP 4 - SADDLE AREA

The saddle area is located between the existing North pit and the Red Hill pit. The eastern portion of the saddle area is the low-grade core while the western portion is ore. Potassic alteration is seen as "felty" biotite and biotite veinlets and breccias. The density of barren quartz veins increases toward the east which is the low-grade core.

Some of the sulfide veins, particularly the more pyrite-rich veins, have sericite selvages. These phyllic veins cut earlier chalcopyrite-bearing veins and are less abundant here than they are on the upper levels. Peterson and others (1951) give evidence that at least some of the sericite may be older than the clay alteration. Because clay alteration is selectively pervasive and not vein controlled, crosscutting relationships between the argillic alteration and phyllic veins cannot be established.

Attempts were made to establish the age of copper versus molybdenum mineralization. Both occur in veins that cut one another. Generally there are more chalcopyrite-bearing veins cut by molybdenite-bearing veins than vice versa. Mineralization may have formed from repeated pulses of fluids that began as copper precipitating and evolved into molybdenum precipitating.

The last sulfide veins are rare sphalerite-galena-chalcopyrite-pyrite veins.

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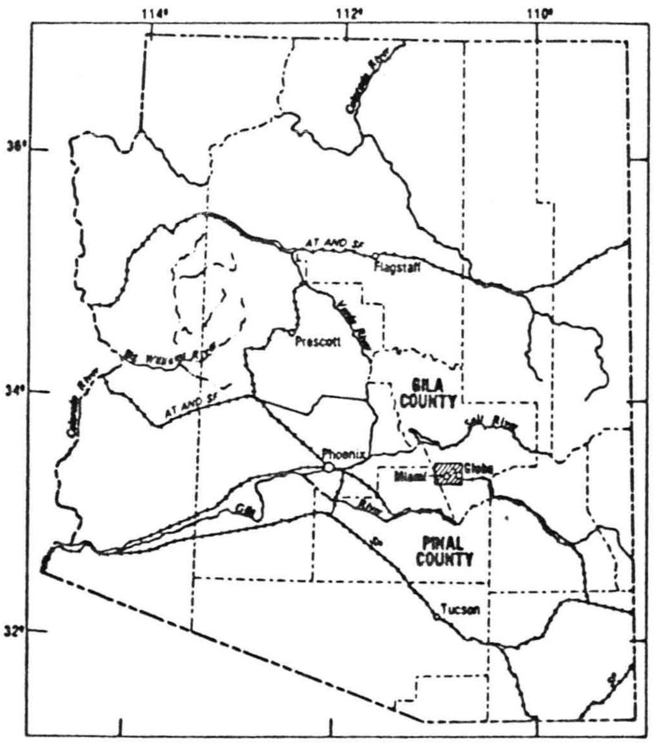


Figure 1. Location of the Globe-Miami district, Arizona (Creasey, 1980).

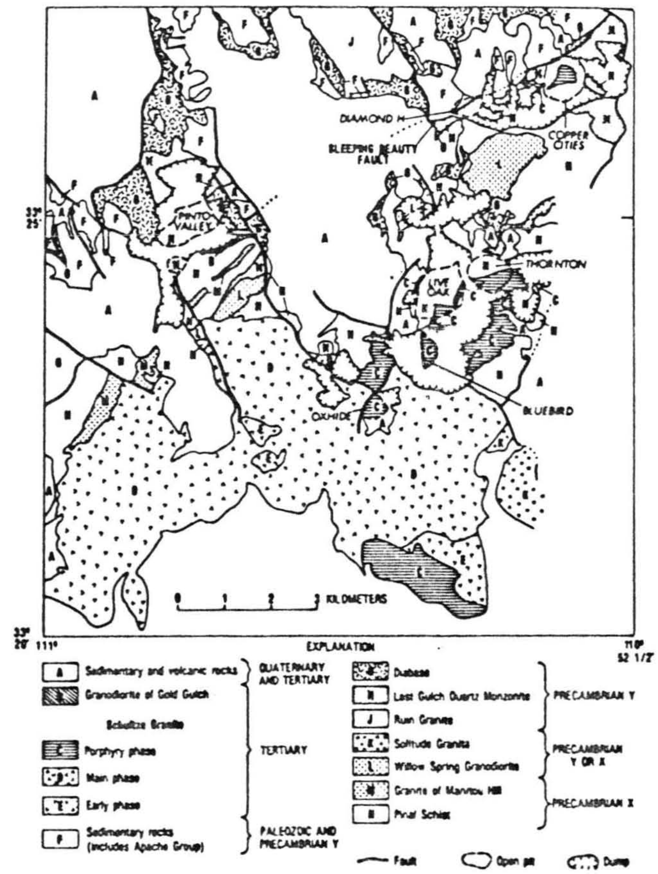


Figure 2. Generalized geology of the western part of the Globe-Miami district, Arizona (Creasey, 1980).

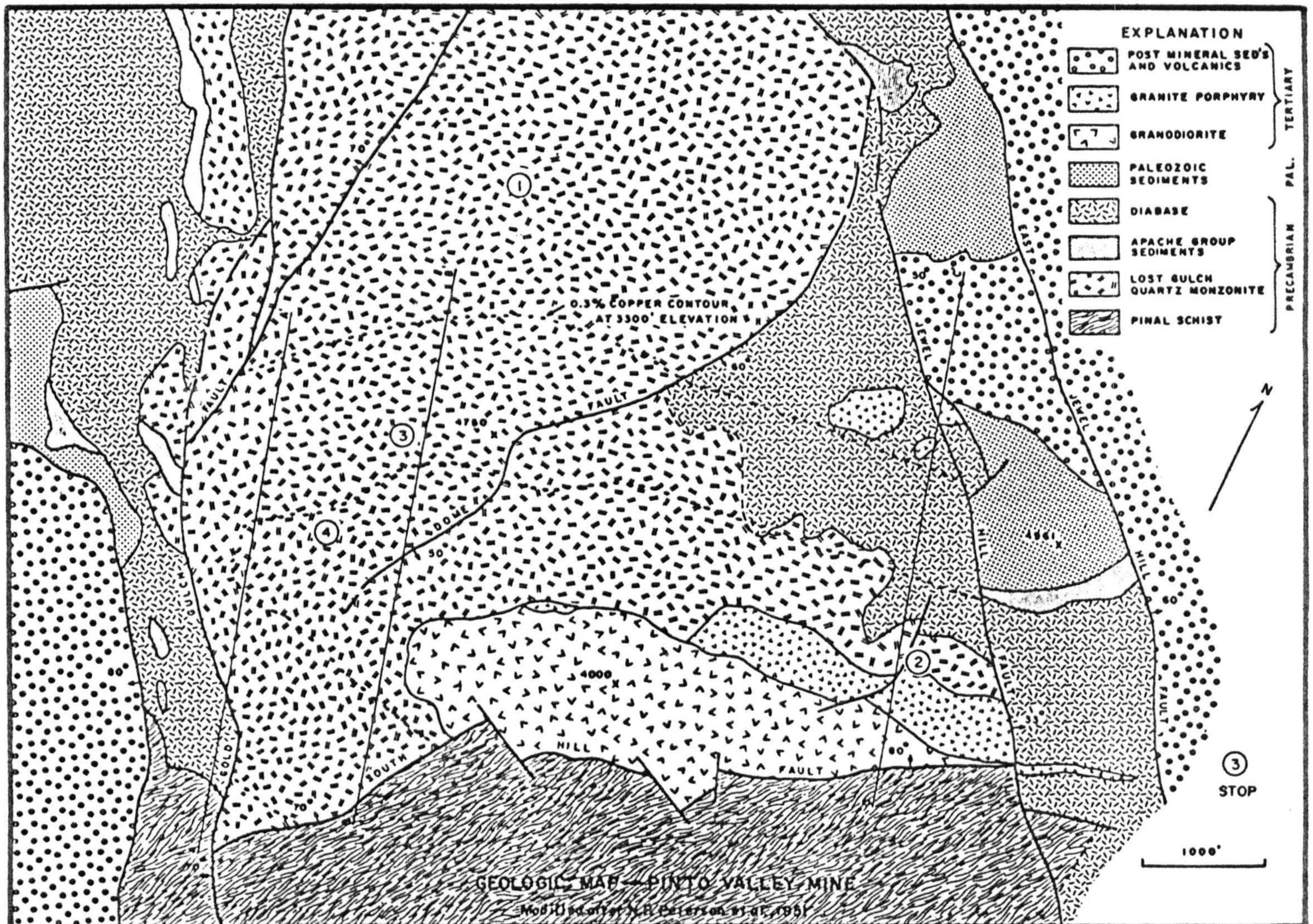


Figure 3. Geologic map of Pinto Valley Mine.

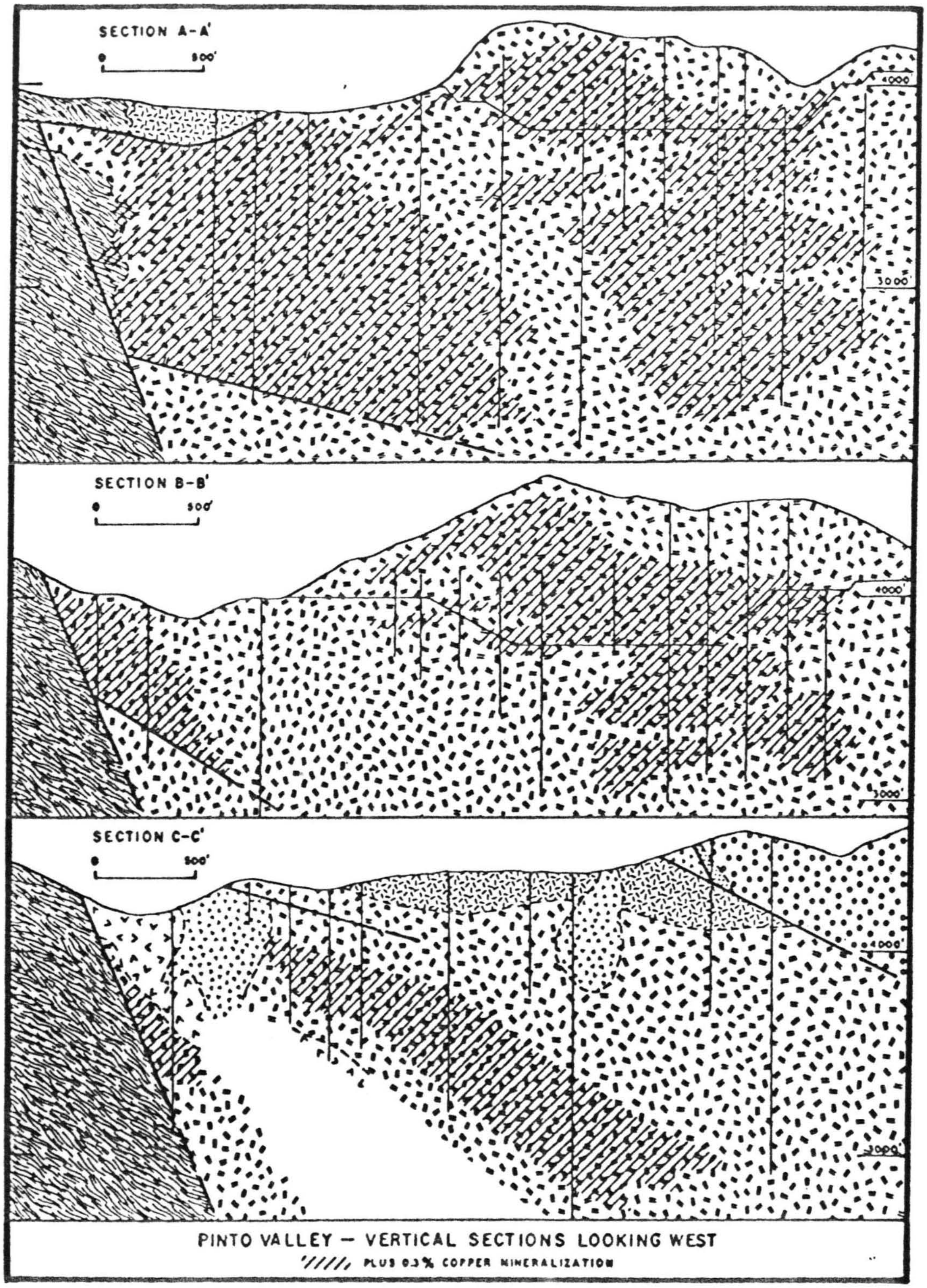


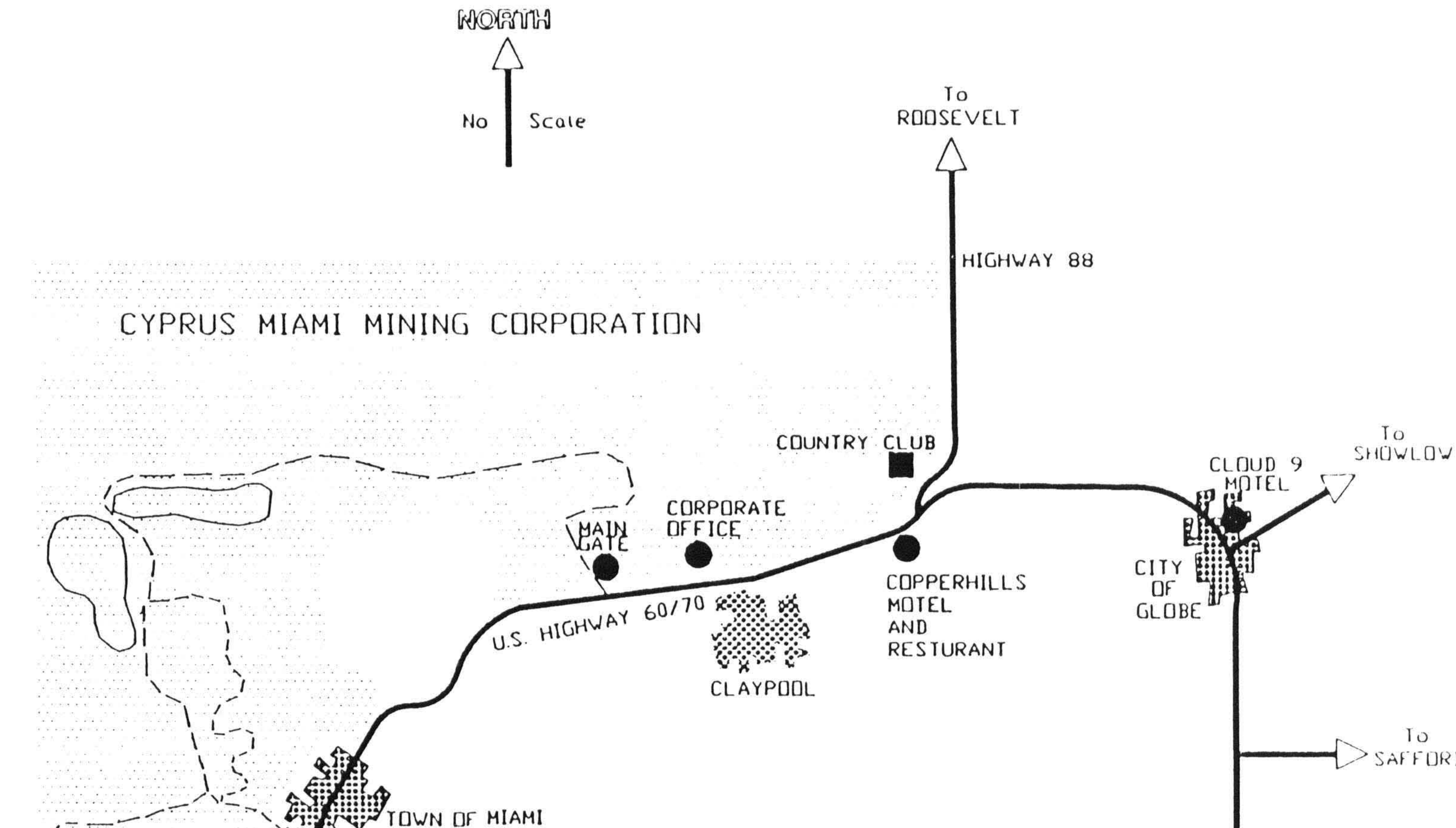
Figure 4. Pinto Valley vertical cross sections looking west.

Geology of Cyprus Miami Orebody

By

Cyprus Miami Geology Staff

August 2, 1994



VICINITY MAP OF CYPRUS MIAMI MINING CORPORATION CLAYPOOL, ARIZONA

February, 1994

Mine Engr. Dept./ND

The Cyprus Miami (Inspiration)-Magma (Miami Copper) ore deposit has had a long productive history and in terms of production, it ranks among the large orebodies of the world. As presently developed (including the Ox Hide and the Bluebird pits), it has a strike length of over 27,000 feet with widths ranging up to 4,000 feet and thickness up to 900 feet. Although severed by faults and mined as separate orebodies, it is essentially one zone of mineralization. This mineralized zone occurs along the contact between Precambrian schist and Tertiary porphyritic intrusive rocks, which trend generally to the east and to the southwest.

Geology and geotechnical problems are very important to the economics of the Cyprus Miami mining operations. Much work and credit goes to those who have spent time sorting out the features that provide benefits and challenges to mine this orebody. Dr. James P. Savely was one who deserves credit for guiding and improving the emphasis of geology at this mine. His work framed the fabric of how geology can be used to take geology to a higher level. His coworkers and friends will forever be better geologists and engineers to have worked with such a man.

ROCK UNITS WITHIN THE MINE AREA

Rocks represented in the general area within and surrounding the orebody include only those of Precambrian and Tertiary ages. Paleozoic sediments are absent, but are exposed elsewhere in the district in association with other mineral deposits indicating that a thick section of covering material existed during the time of the intrusions of the granitic rocks and the formation of the ore deposit.

Pinal Schist

Lower Precambrian in age, the Pinal schist is the basement formation in southern Arizona and is composed of metmorphosed sediments and volcanics. The age of this rock is uncertain but age dating of the Willow Springs Granite which intrudes the schist was age dated at 1870 m.y. In the mine area, it is predominately a quartz-sericite schist with varying minor amounts of biotite and chlorite. Texturally it ranges from a micaceous quartzite to well foliated and/or well crenulated schist to poorly foliated gneiss. Free quartz in the schist is found in lenses and augens ranging from 1/8 inch to four inches thick. Foliation has a regional northeast trend with a dip of 45 degrees to the southeast.

Pioneer Formation

This unit comprises the lower part of the younger Precambrian Apache Series. The upper portions of this formation are fine grained, thin-bedded sandstones, whereas the basal part is a pebbly arkose 15 to 20 feet thick. In places, the lower part grades into hard, fine grained, reddish-brown sandstones, and in some localities interfingers with fine grained gray sandstones and arenaceous shales. Pre-Whitetail erosion has removed much of the

Pioneer Formation from the area containing the mineralized deposit, but it is mineralized where found within the limits of the orebody. Pre-Tertiary Whitetail erosion has removed much of the Pioneer Formation from the area containing the mineralized deposit, but it mineralized where found within the limits of the orebody.

Diabase

Upper Precambrian in age, diabase is found as sills and dikes within the Pinal schist. Age dating of the diabase based on select samples is approximately 1140-1150 m.y. It clearly intrudes the Pinal schist and younger Precambrian Apache Series, but contacts with the later Precambrian Troy quartzite and Paleozoic sediments are generally fault contacts. It usually has been intensely altered to chlorite, biotite, and hematite although in places it retains a diabasic texture. In its altered state it formed planes of weakness that control some of the later faulting. Large bodies of diabase occur near and immediately north of the TJ mine area.

Schultze Granite and Granite Porphyry

The Schultze granite (actually a porphyritic quartz monzonite) was intruded in the area during early Tertiary. It forms a large elongate pluton, extending southwest-northeast, paralleling a common Precambrian plane of weakness. The Cyprus Miami mine is located on the north side of the northeast lobe. The intrusion was multistage with the main mass being intruded 61.2 million years ago and the porphyry phase with which mineralization is associated has an age of approximately 59.5 m.y. The main mass is composed of large phenocrysts of orthoclase in a equigranular groundmass of plagioclase, orthoclase, quartz and biotite. There are at least three facies of porphyry composed of orthoclase and quartz phenocrysts in a finer grained phaneritic to aphanitic groundmass of quartz, orthoclase, plagioclase, and biotite. Chemically the rock is a sodium-rich granite, but mineralogically it is a quartz monzonite. Differences in porphyries are based on phenocryst size and composition, groundmass grain size and composition and biotite content.

The relationship of the Schultze granite to the orebody is obscure, but it is generally believed to be part of the parent magma from which the porphyritic intrusives and associated hypogene mineralization were derived. Although both the Bluebird and OxHide deposits rest on Schultze granite, both are fault contacts and only very weak pyrite disseminations are noted in the immediate footwall at the locations. It is important to note that although the exact relationship of the Schultze granite to the ore genesis is unclear it is a fact that first it is the only apparent pluton in the area and secondly mineral occurrences fall generally on the perimeter of the intrusion.

Whitetail Conglomerate

This formation represents the continuation of the conglomerate depositional cycle as well as being the start of the enrichment of the Miami-Inspiration orebody. It is typified by subangular to angular clasts, usually of the formation immediately below, in an hematite-limonite rich sandy clay to clay matrix. It varies in thickness from non-existent to 50 feet in the mine area.

Apache Leap Welded Tuff (Dacite)

The Apache Leap welded tuff or locally referred to as dacite occurs in the district. Also Tertiary in age (20 m.y.), this formation represents a break in the conglomerate depositional cycle. It is a welded volcanic tuff from a nuee ardente type eruption which covered the Globe-Miami district. Within the mine area there remnants up to 700 feet thick on the north and west. It can be broken into three units. The basal tuff is a poorly welded devitrified tuff, usually pink in color, but with a definite igneous type texture and varies from two to five feet in thickness. Above it is vitrophyre, a bed of black glass. It ranges from thin stringers to 15 feet in thickness. The main body of the dacite is composed of plagioclase, potassium feldspar, quartz and brown and/or black biotite. This unit generally trends northwest-southeast and dips to the southwest at 5-20 degrees.

Gila Conglomerate

This formation represents the continuation of the conglomerate cycle and is Tertiary and Quaternary in age. It is composed of rounded to subrounded pebble to boulder size clasts in a sandy clay matrix. Clast composition varies with the locale; in the mine area clasts of granite and schist are most common. The formation represents interfingering of alluvial fans derived from surrounding highlands. Some sorting is evident and across bedding and ancient stream channels are visible in road cuts. Thick sections of Gila Conglomerate cover the mineralized zone to the west of the Barney Fault and to the east and southeast along the hanging wall side of the Miami Fault. With these area, fragments of schist and the various intrusive rocks are the prevailing rock constituents with schist being dominant toward the bottom. Cementing material consists generally of clay and calcareous minerals. This conglomerate generally overlie a post-dacite erosion surface with the bedding trending northwest-southeast and dipping 30-50 degrees southwest. The contacts with the dacite or other erosional surfaces generally trend northwest-southeast and dip southwest at 10 to 25 degrees.

STRUCTURE

Pre-porhyry and pre-mineral controls within the area are to some extent related to the schistosity of the Precambrian schist which trends to the southwest, and to other fault structures and fault veins which strike east-west to northeast-southwest, generally paralleling the schist-porphyry contact. Structures of this type include the Warrior, Sulphide, and other paralleling faults and faults veins located further to the south. All of these have some post-mineral movement, but apparently these trends had some expression before the emplacement of the porphyry and the formation of the ore deposit.

MINERALIZATION

The ore deposit result from late stage magmatic activity associated with the emplacement of the porphyry facies of the Schultze granite during Early Tertiary. The original orebody consisted of pyrite and chalcopyrite with a copper grade of 0.30 to 0.40 percent total copper. Oxidation of the upper part of the orebody took place before and during the deposition of the Whitetail conglomerate. Supergene enrichment of the orebody also formed an upper zone of leached capping about 400 feet thick grading into a copper oxide zone 200 to 400 feet thick. The bottom of the oxide zone represents the water table at the time of supergene enrichment. Below the water table, copper in solution was precipitated on chalcopyrite and pyrite forming a chalcocite blanket with thicknesses up to 200 feet and an average grade of approximately 1.5 percent total copper. Below the chalcocite blanket are found remnants of the protore. The deposit was then buried and preserved until recent times when the area was uplifted, the overburden eroded off , and more enrichment occurred. Post-mineral fault movement has cut the orebody into sections giving the chalcocite blanket a southwesterly dip and stepped appearance to the northeast.

Mineralogy is typical of a supergene enriched orebody. The leached capping consists of pervasive hematite and limonite with spotty remnants of chrysocolla. The copper oxide zone usually grades into the chalcocite blanket with a "dual" zone of oxide and chalcocite of up to 200 feet thick. The blanket consists of chalcocite, covellite, and digenite replacing chalcopyrite and pyrite; degree of replacement decreases rapidly with depth. Finely disseminated native copper is found with chalcocite in some places usually associated with more basic schist facies or chloritzed diabase.

Below the chalcocite blanket, the hypogene mineralization consists of pyrite, chalcopyrite, and molybdenite, with occurrences of bornite, sphalerite, and galena. Bornite and chalcopyrite sometimes tarnish pyrite and chalcopyrite immediately below the chalcocite blanket which is an unusual occurrence. the higher grade primary copper mineralization is found parallel to the granite porphyry-schist contact extending up to 700 feet into the schist side and 200-300 feet into the porphyry side. A higher grade molybdenite zone is found nestled inside the primary copper zone extending not quite as far into schist but further into the porphyry.

<u>Alteration</u>

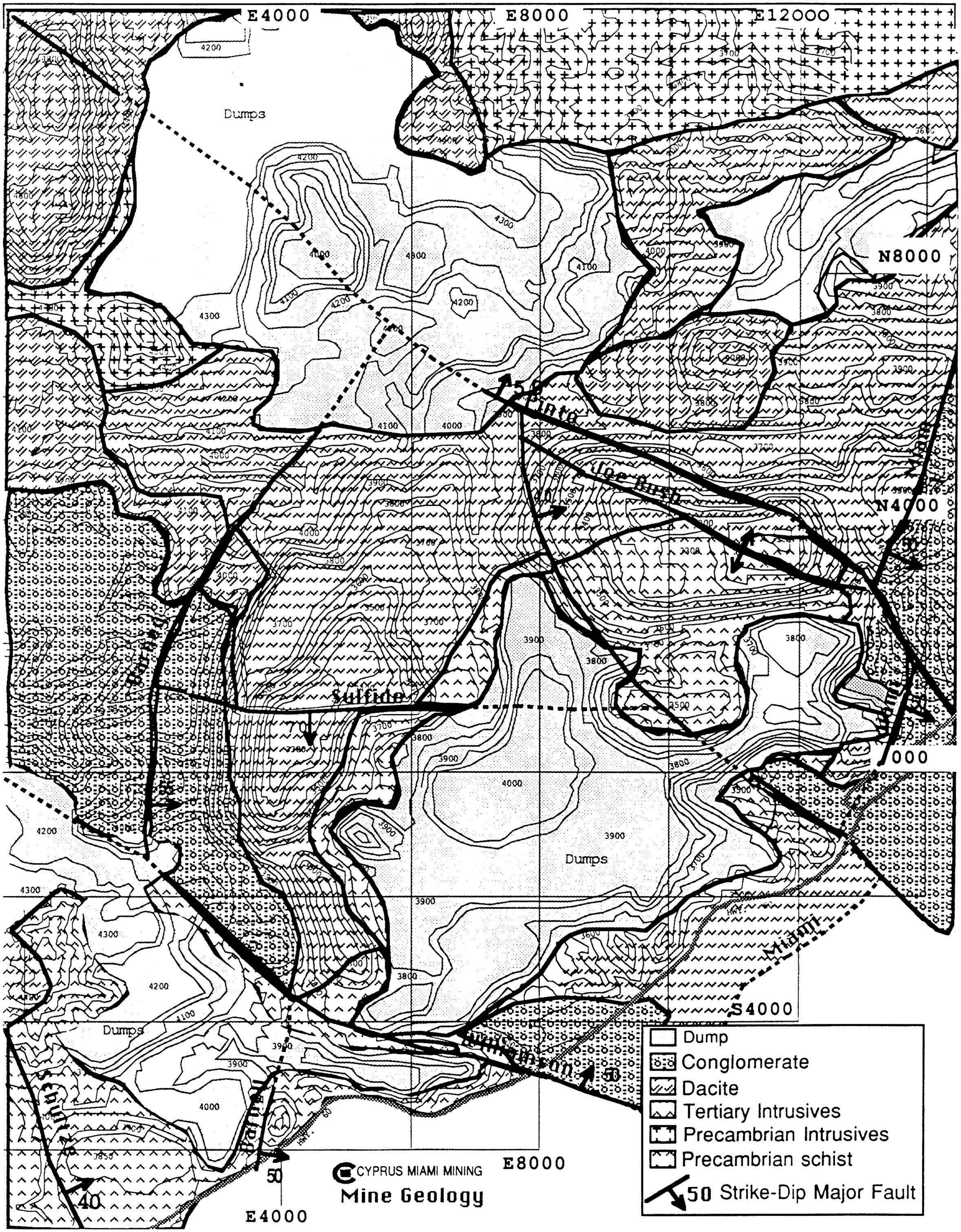
Alteration within the orebody has been little understood in the past. Being a supergene enriched orebody, a lot of the hydrothermal alteration has been eradicated within the leach capping and oxide portion. Faulting and block caving have further jumbled the zones. Some progress has been made in defining alteration zones by means of percentage and type of sulfides compared with zones from other porphyry copper deposits and will improve as more material is mined.

Alteration zones appear to parallel the granite porphyry-schist contact, as is to be expected. The barren potassic core is within the granite porphyry in the Thornton-Joe Bush pit, but extends into the schist in the Bluebird-Live Oak pit. The potassic core is characterized by potassium feldspar-quartz veining, with some vein wall rock alteration in the granite porphyry to potassium feldspar. Sulfide content is usually less than 0.30 percent total sulfides with little to no chalcopyrite.

Outside the potassic core is the biotite-orthoclase zone which extends northward for about 400 feet and in part straddles the granite porhyry-schist contact. This zone also has potassium feldspar-quartz veining, but wall rock alteration in schist is to biotite. Sulfide content is generally greater than one percent about half of which is chalcopyrite. This is the high grade primary copper zone.

The next zone outward is the quartz-sericite-pyrite zone, extending another 800-1,000 feet northward. This zone contains quartz veining with sericitic wall rock alteration. Sulfide content is also greater than one percent, but there is very little chalcopyrite.

The last zone on the fringes of the mine is the propylitic zone. Again, quartz veining is present, but not as prevalent as it is closer to the granite porphyry contact. There is no wall rock alteration and sulfide content is low, usually less than 0.20 percent and decreases away from the orebody.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