



CONTACT INFORMATION  
Mining Records Curator  
Arizona Geological Survey  
416 W. Congress St., Suite 100  
Tucson, Arizona 85701  
602-771-1601  
<http://www.azgs.az.gov>  
[inquiries@azgs.az.gov](mailto:inquiries@azgs.az.gov)

The following file is part of the Grover Heinrichs Mining Collection

#### **ACCESS STATEMENT**

These digitized collections are accessible for purposes of education and research. We have indicated what we know about copyright and rights of privacy, publicity, or trademark. Due to the nature of archival collections, we are not always able to identify this information. We are eager to hear from any rights owners, so that we may obtain accurate information. Upon request, we will remove material from public view while we address a rights issue.

#### **CONSTRAINTS STATEMENT**

The Arizona Geological Survey does not claim to control all rights for all materials in its collection. These rights include, but are not limited to: copyright, privacy rights, and cultural protection rights. The User hereby assumes all responsibility for obtaining any rights to use the material in excess of "fair use."

The Survey makes no intellectual property claims to the products created by individual authors in the manuscript collections, except when the author deeded those rights to the Survey or when those authors were employed by the State of Arizona and created intellectual products as a function of their official duties. The Survey does maintain property rights to the physical and digital representations of the works.

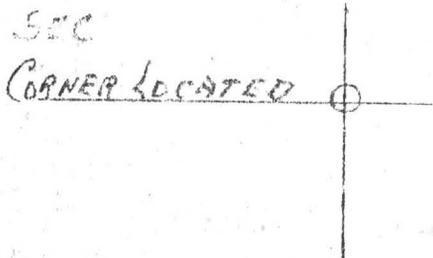
#### **QUALITY STATEMENT**

The Arizona Geological Survey is not responsible for the accuracy of the records, information, or opinions that may be contained in the files. The Survey collects, catalogs, and archives data on mineral properties regardless of its views of the veracity or accuracy of those data.

SEPT. 1ST, 1972

DON EVANS MINING CLAIMS HEREBY KNOWN AS LA JARA  
CLAIMS NO. ONE THROUGH AND INC. NO THIRTY ONE.

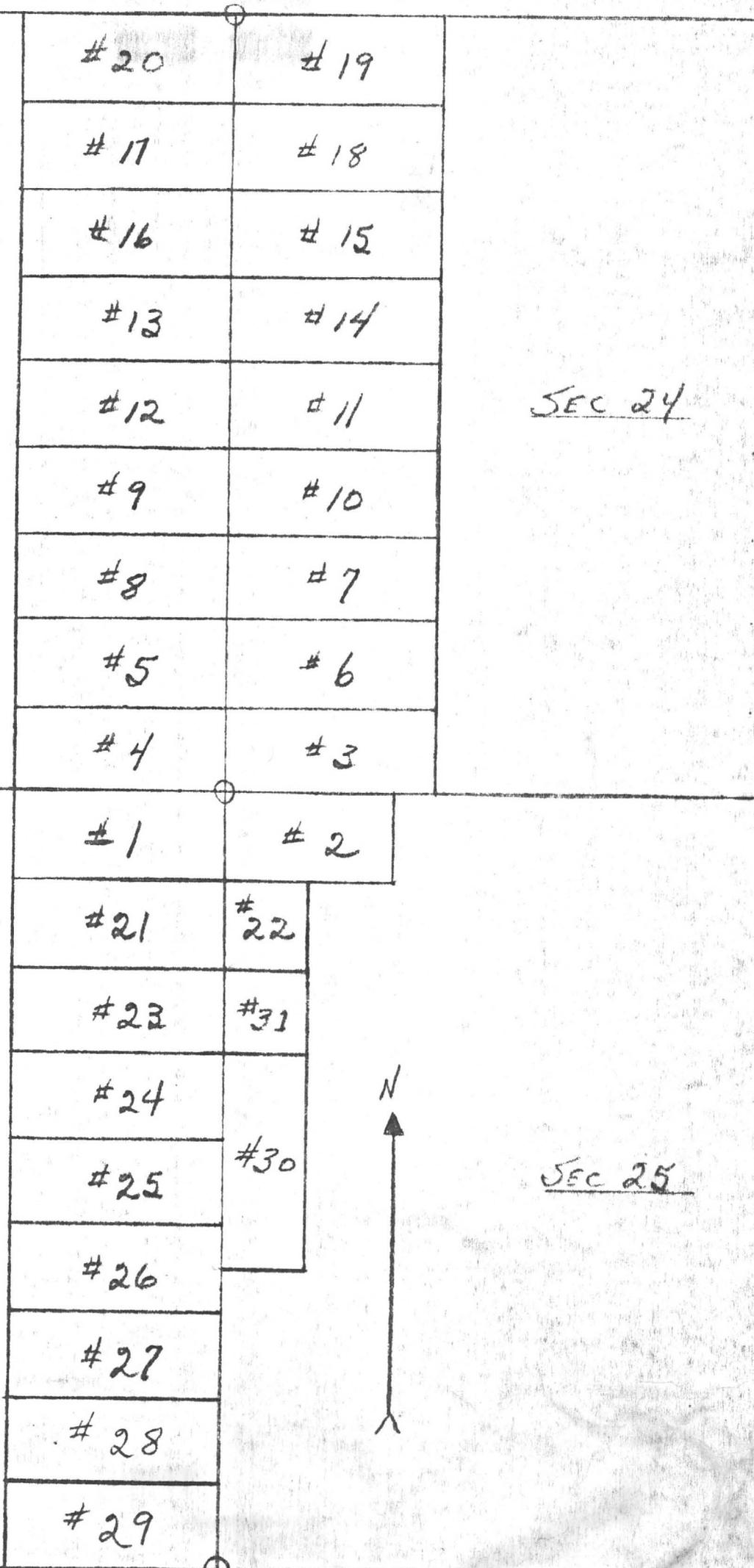
LOCATED IN SECS. 23-24-25-26 T 22 N = R 1 W



SEC 23

SEC 24

DON EVANS  
 2059 W. Ajo  
 Tucson, 85713  
 ph. 883 2507  
 Tucson address  
 New Mexico address  
 P.O. Box 33  
 Regina, N. Mexico



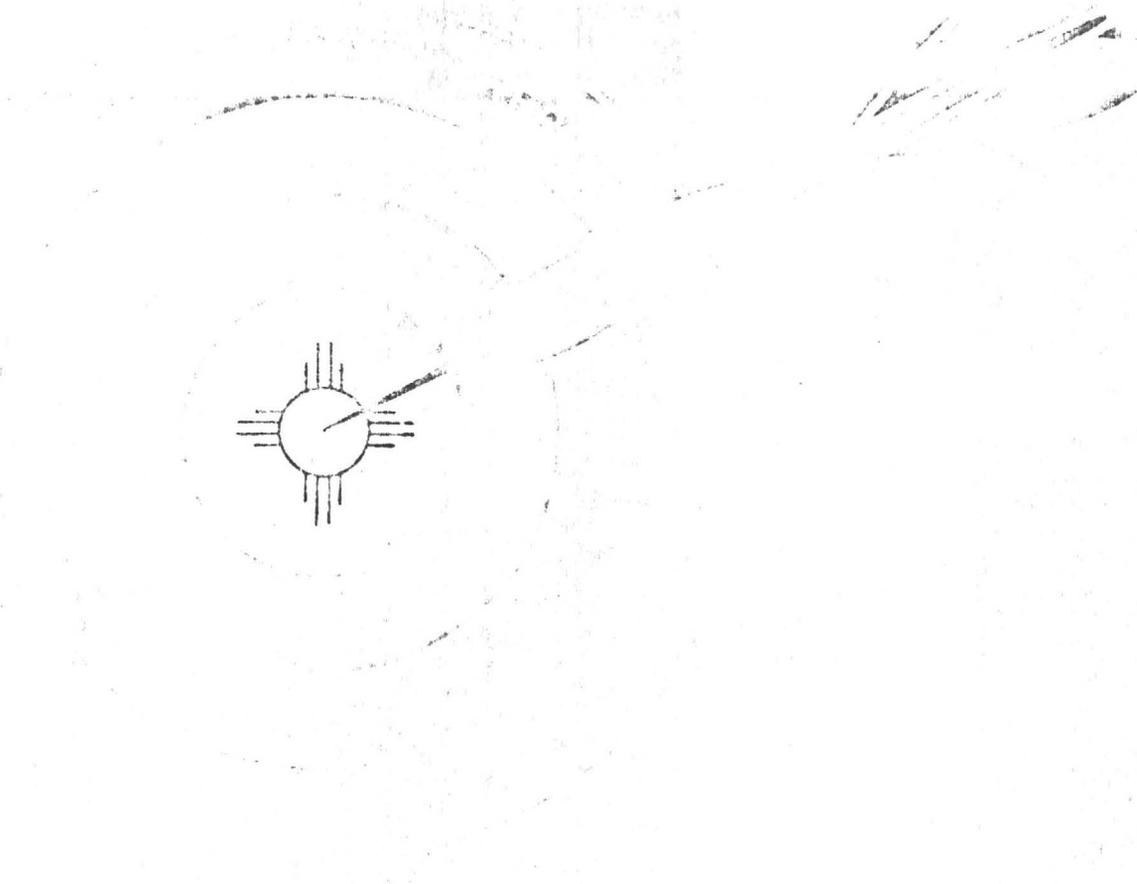
SEC 26

SEC 25



200.00/claim/year  
 until production  
 & 2% gross  
 buy out open to negotiation?

E-1



100

091  
-28 70

Stratiform Copper Mineralization  
In The Nacimiento Region  
New Mexico

New Mexico State Bureau of Mines and Mineral Resources

---

Target Exploration Report E-1

---

STRATIFORM COPPER MINERALIZATION  
IN THE NACIMIENTO REGION  
NEW MEXICO

by *William H. Kaufman, Otto L. Schumacher, and  
Lee A. Woodward*

Department of Geology, University of New Mexico

*The main purpose of this series is the immediate release of significant new exploratory information which otherwise would have to await release at a much later date as part of a comprehensive and formal document. These data are preliminary in scope, therefore, subject to revision and correction.*

Socorro, Jan. 1972



## SUMMARY

In the region of the Nacimientto uplift there is widespread copper mineralization in sedimentary rocks ranging from the Pennsylvanian Madera Formation to the Agua Zarca Member of the Chinle Formation of Triassic age. Copper-bearing sulfides are closely associated with carbonaceous fossil plant material and are surrounded by halos of malachite, chrysocolla, and azurite in the interstices of the clastic host rocks.

Commercial amounts of ore apparently occur at fossil logjams within paleochannels. Primary sedimentary structures in the paleochannels can be used to project trends for exploration. Major faults post-date deposition of the ore and, therefore, can be expected to offset some of the ore bodies.

## INTRODUCTION

The region covered by this report produced over 7,500,000 pounds of copper and about 75,000 ounces of silver between 1881 and 1960 (Elston, 1967, p. 25-26). Most of the production came from the San Miguel mine (fig. 1, location 1) prior to 1900 (Lindgren and others, 1910, p. 147). From about 1900 until the middle 1960's production was sporadic, the Eureka and San Miguel mines being the main producers (Elston, 1967, p. 26).

In the late 1960's Earth Resources Company began an extensive exploration program that centered around Eureka Mesa (fig. 1, localities 2, 3, 4, 5); in 1971 their Nacimientto mine (fig. 1, locality 3) went into production. The Nacimientto mine is an open pit that includes what was formerly known as the Copper Glance mine (Lindgren and others, 1910). Earth Resources Company has not released information concerning grade and tonnage of reserves; however, their large capital outlay for exploration and development suggests fairly extensive reserves. (Albuquerque Tribune, 31 January 1970, indicated the reserves are 10 million tons of copper ore to a depth of 400 feet).

In addition to the three major mines noted above (localities 1, 2, 3) at least 17 other mineralized prospects are located in the area of this report. The mineralized localities are indicated by number on fig. 1 on page 2.

Previous reports on this area were based on reconnaissance work and did not include all the mineralized areas reported here. The earliest mention of the mineral deposits in this area was by Newberry (1876). Lindgren and others (1910) published a report dealing with the major deposits noted above. Many of the smaller prospects were noted by Soulé (1956). Elston (1967) summarized some of the mineral resources of this region in a report that included the southern part of the Nacimientto uplift.

This report is based mainly on mapping at a scale of 1:24,000 as part of theses by Kaufman (1971) and Schumacher (1972) under the supervision of Woodward, as well as a mapping project sponsored by the New Mexico State Bureau of Mines and Mineral Resources. Four 7½-minute quadrangles (Cuba, La Ventana NW, La Ventana NE, and La Ventana SW) are currently being published in connection with this project. Geologic details of many of the mines and prospects are shown on these maps.

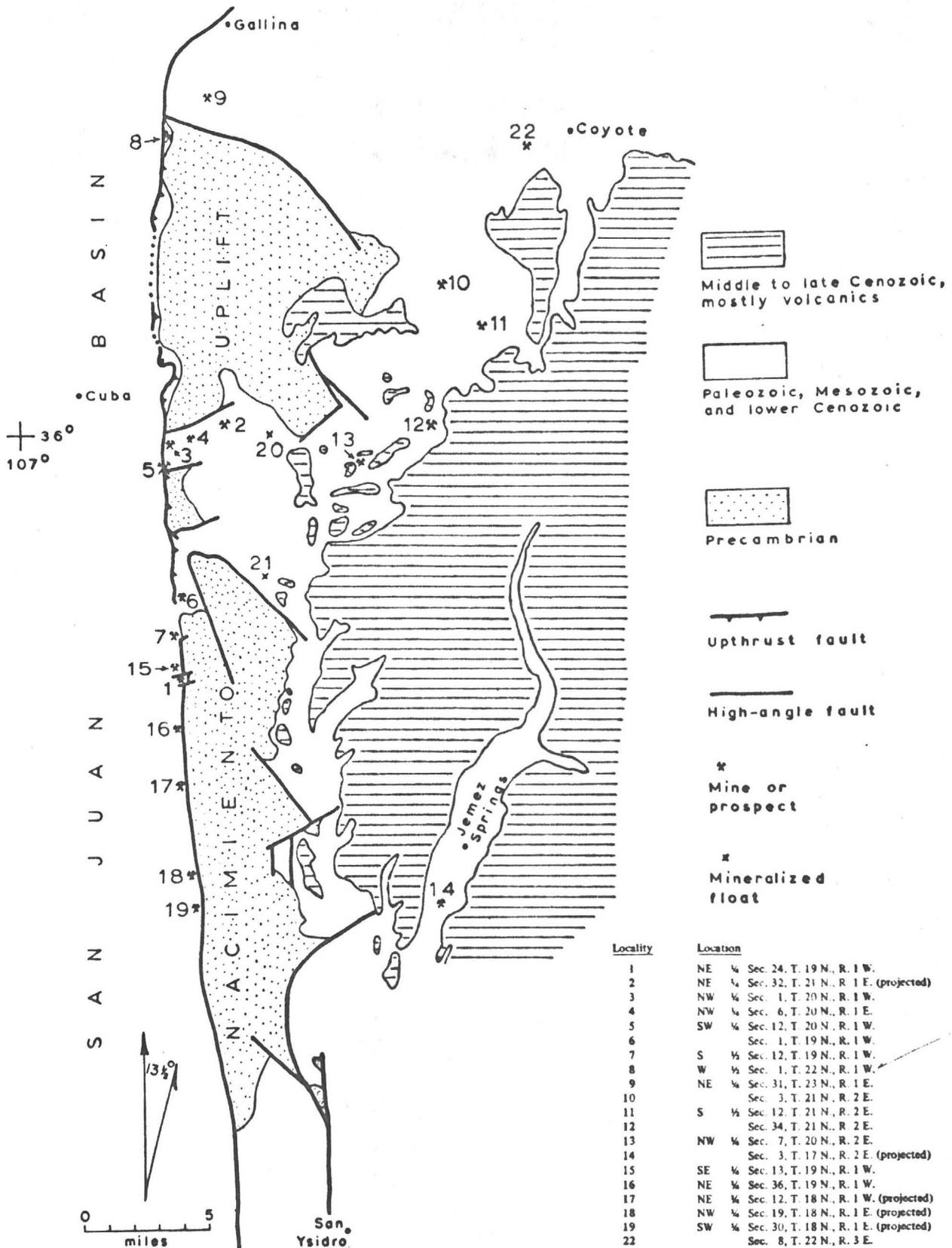


Figure 1. Geologic sketch map showing mineralized localities.

## GEOLOGIC SETTING

### Stratigraphy

Precambrian crystalline rocks are unconformably overlain by Mississippian, Pennsylvanian, and Permian strata which onlap toward the center of the uplift. The Arroyo Peñasco Formation (Mississippian) (Armstrong and Holcomb, 1967) and the Sandia Formation (Pennsylvanian) have not been observed to be mineralized and, therefore, are not discussed further although shown in the columnar section (fig. 2) on page 3.

The Madera Formation (Pennsylvanian) consists of up to 750 feet of limestone, reddish to gray shale, pink arkose, and locally sandstone. The overlying Abo Formation (Permian) is composed of 150 to 800(?) feet of reddish mudstone with lenticular arkose and sandstone interbeds. Minor limestone and conglomerate are locally present.

PC — Above the Abo is the Yeso Formation which consists of orange-tan, evenly-bedded, well-sorted sandstone. This unit is up to 600 feet thick and is locally missing north of Eureka Mesa because of pre-Chinle erosion. Previous workers have mapped the Abo and Yeso intervals in the northern part of the uplift as the Cutler Formation (Wood and Northrop, 1946).

The Glorieta Sandstone (Permian) and the Bernal Formation (Permian), thin northward and cannot be distinguished north of the San Miguel mine (locality 1). The Glorieta consists of up to 100 feet of white, thick-bedded sandstone; the overlying Bernal is up to 65 feet thick and is composed of very thin-bedded, fine-grained, reddish-brown sandstone.

The overlying Chinle Formation (Triassic) is divided into four members. The lower is the Agua Zarca Member which is composed of 20 to 210 feet of buff to white sandstone, conglomeratic sandstone, conglomerate, and minor shale. This member is overlain by the Salitral Shale Member that consists of about 300 feet of reddish-maroon shale. The next highest member is the Poleo Sandstone Member; it consists of up to 135 feet of greenish, micaceous sandstone with minor shale and clastic limestone. This unit pinches out southward and is absent near the San Miguel mine (locality 1). The Upper Shale Member forms the top of the Chinle and consists mostly of reddish shale with minor fine-grained sandstone and clastic limestone. It is 450 to 600 feet thick.

### Structure

The north-trending Nacimiento uplift is about 50 miles long and 6 to 10 miles wide. The uplift has been tilted eastward and is bounded on the west by a belt of steeply-dipping and complexly-faulted beds. The uplift consists of several segments that have undergone different amounts of vertical movement. Along the western margin of the uplift is commonly an anticlinal bend in addition to the range-marginal fault zone.

A synclinal bend marks the eastern edge of the San Juan basin. At least 10,000 feet of structural relief is between the highest part of the uplift and the adjacent basin.

The eastern margin of the uplift is poorly defined and is unconformably covered by volcanic rocks derived from the Jemez volcanic center to the east (Smith and others, 1970).

Precambrian crystalline rocks are exposed in the core of the uplift, and Paleozoic and Mesozoic strata are present near the margins. Sedimentary rock units in the lower part of the section have been tectonically cut out at many places along the complex fault zone on the west side of the uplift. At some localities Precambrian rocks are juxtaposed with Mesozoic strata.

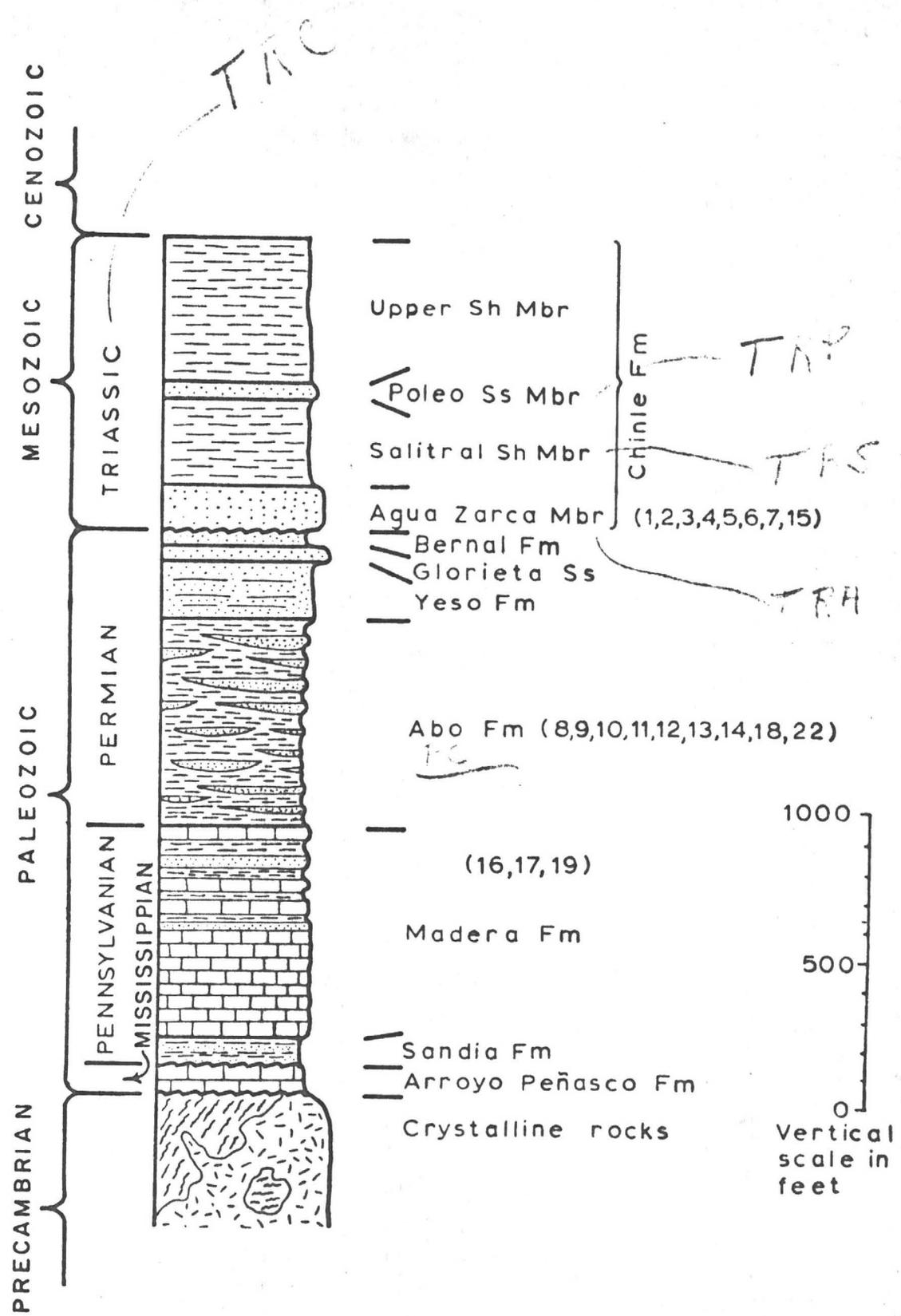


Figure 2. Diagrammatic columnar section of Precambrian through Triassic rocks of Nacimiento region. Numbers in parentheses show mineralized horizons and are keyed to localities on Figure 1 and in text.

Uplift began during the early Tertiary and continued into the middle Tertiary. Major faults are younger than the deposition of the ore; this relationship is clearly seen at the Blue Bird prospect (locality 5).

## MINERALIZATION

All the mines and prospects in this report are red-bed or sandstone type deposits. The known ore bodies are confined to certain stratigraphic horizons discussed below. Copper and copper-iron sulfides occur as replacements of, or are closely adjacent to, carbonaceous fossil plant material. Malachite, azurite, and chrysocolla occur in irregular halos in the interstices of the clastic host rocks and along joint and fault surfaces near the organic material as well as within the organic material itself. Minor silver is associated with the sulfides.

The principal ore minerals are chalcocite, bornite, covellite, and malachite, and locally considerable quantities of azurite and chrysocolla. Pyrite and minor chalcopyrite are present in the ore at the Nacimiento mine (locality 3) and were probably present at other mineralized localities as well, but have been oxidized and leached. Polished sections of a fossil log from the Eureka mine (locality 2) show that chalcocite is the most abundant sulfide mineral within the log, although considerable amounts of bornite and covellite are present. These sulfides and siliceous gangue minerals have replaced most of the wood, preserving the cellular structure. Minor malachite and azurite coat the sulfides and are disseminated through the remaining carbonaceous material. Assays show that the log contains 38.9 percent copper and 6.42 oz/ton silver.

Samples of the clastic host rocks containing interstitial copper carbonates and silicate that were collected from the Eureka and Nacimiento mines (localities 2, 3) were assayed and show a maximum of 4.78 percent copper and 0.088 oz/ton silver.

The host rocks are not really red beds, but are white to tan or buff sandstone, arkoses, and conglomerates. The following descriptions of the mineralized areas are discussed in stratigraphic order from oldest to youngest.

### Madera Formation

CIA  
CAH  
CMH

Mineralization in the Madera Formation occurs in siltstones and in coarsely-clastic arkoses and consists of minor disseminated malachite (localities 16, 17, 19). The observed areas of mineralization are not of commercial value, but are important in showing the geographic distribution of copper mineralization. These locations suggest that favorable horizons in younger stratigraphic units in the same general area were probably mineralized also.

### Abo Formation

FC

Seven prospects (localities 8, 9, 10, 11, 12, 13, 14, 18, 22) and two areas of mineralized float (localities 20, 21) were observed in the Abo. Most of the mineralized beds consist of tan, coarse-grained arkose or feldspathic sandstone, or rarely conglomerate.

The exposed mineralized areas at most of these localities consist of stratigraphically-thin zones that are laterally discontinuous. Carbonaceous material and sulfides are sparse; malachite,

azurite, and chrysocolla are by far the most abundant cupriferous minerals, and they are present in interstices of the host rocks.

The larger deposits include the prospect near Gallina (locality 9) and the Spanish Queen mine (locality 14). The latter produced about 19,200 pounds of copper between 1928 and 1937 (Elston, 1967, p. 24). The prospect near Gallina is somewhat different than the other Abo localities insofar as the mineralized horizon is conglomeratic, with quartzite pebbles and cobbles exposed in lenticular channels traced for several hundred feet along strike.

### Agua Zarca Member

The Agua Zarca Member contains the largest of the known copper deposits. In view of the importance of primary sedimentary characteristics in the localization of ore deposition, a review of the lithologic character of this member follows.

The Agua Zarca consists of white to light buff, very thick-bedded, medium- to coarse-grained, angular, friable, quartzose sandstone and is locally conglomeratic, micaceous, and arkosic. Interbedded gray clay zones up to 1.0 foot thick, gray sandy shale, and opalized zones occur locally. Lenticular channels of crossbedded conglomerate and crossbedded conglomeratic sandstone are abundant throughout. These channels are characterized by light- to dark-gray metaquartzite cobbles up to 13.0 centimeters in diameter, fossil wood, and clay galls.

The mines and prospects in the Agua Zarca near Eureka Mesa (localities 2, 3, 4, 5) are east of the range-marginal fault and are within the uplift. These localities have been called the Copper Cities group by Soulé (1956) and include the Eureka mine (locality 2), the Nacimiento mine (locality 3), the Blue Bird prospect (locality 5), and the Cliff prospect (locality 4). Triassic and older rocks are exposed near Eureka and Blue Bird Mesas, and as a result of uplift, the Agua Zarca is folded and faulted, with the attitudes of bedding ranging from flat-lying to very steeply dipping.

The *Eureka mine* (locality 2) is 2.5 miles northeast of Earth Resources plant site (locality 3) on the south side of Eureka Mesa. Here, the Agua Zarca is approximately 140 feet thick and dips gently to the southwest. The mine is in the base of the Agua Zarca and the ore has been mined by means of quarrying and underground workings. Lindgren and others (1910) reported a 500-foot north-trending tunnel extending through Eureka Mesa, but this tunnel has collapsed. A detailed map of the mine is in Kaufman's thesis (1971).

Ore mineralization is confined principally to a lenticular channel, approximately 280 feet wide and a maximum of 40 feet thick, composed of intercalated, crossbedded, quartz-pebble conglomerate and crossbedded, quartzose sandstone. High-angle, festoon and planar crossbed sets up to 5 feet thick, and fossil wood fragments up to 1 foot in diameter and 5 feet long are numerous within the channel. The conglomerate contains more carbonaceous material and is also more porous and permeable than the adjacent sandstone, which is usually barren. Clay galls are common throughout the channel, and clay beds up to 2 feet thick are present as overbank deposits in the north part of the mine.

Elston (1967) reported that crossbedding shows the current direction to be northeast to southwest -- a detailed paleocurrent study confirms this trend (Kaufman, 1971). The Eureka mine appears to be the most promising deposit of the Copper Cities group. Future exploration should be done in the directions indicated by paleocurrent studies.

The *Nacimiento mine* (locality 3) is on the west side of Eureka Mesa, 0.5 mile north of N. M. Highway 126. The ore mineralization is within the Agua Zarca which dips from 20 to 50° W. and has a maximum thickness of 100 feet. Mineralization is exposed along strike in a north-trending zone approximately 2,400 feet long and 350 feet wide. Several small adits and pits were

located along the ore zone prior to Earth Resources' development of their open pit Nacimiento mine.

Mineralization is principally restricted to fine- to medium-grained, crossbedded, quartzose sandstone which contains thin films of sulfides and carbonaceous material along bedding planes. Several conglomeratic paleochannels are exposed in, and adjacent to, the ore zone along present eroded valleys. Most of the channels lack carbonaceous material and are barren; therefore, the ore content of the host varies laterally and vertically within the mineralized zone.

Crossbedding shows that the current direction was to the southwest. The ore appears to continue down dip along the paleocurrent trend into the subsurface. Downdip mining of the steeply-dipping host rock by open pit methods will require removing large amounts of overburden.

The *Blue Bird prospect* (locality 5) is 0.5 mile south of Earth Resources' plant site along the range-marginal fault. Tectonic slices of mineralized Agua Zarca up to 5 feet in diameter are within the fault zone. No underground workings are present, but a 300-square yard area has been bulldozed and drilled in search for more ore.

At this location the range-marginal fault separates the Abo Formation on the east from the Upper Shale Member of the Chinle Formation on the west. Mineralization is restricted to the tectonic slices of Agua Zarca which contain carbonaceous material. No apparent hydrothermal alteration was noticed along the fault and the fault gouge is not mineralized. Therefore, the mineralization of these blocks must have occurred prior to the time of the range-marginal fault. The economic value of the Blue Bird prospect appears to be submarginal due to insufficient reserves.

The *Cliff prospect* (locality 4) consists of a small collapsed adit in the base of the Agua Zarca. A small channel contains minor mineralization.

The *San Miguel mine* (locality 1) occurs west of the range-marginal fault which is nearly vertical here. Thus, the mine is within the San Juan Basin, not the uplift. Two west-trending faults about 800 feet apart apparently bound most of the mineralized area. The ore body has been offset by both of these faults. Mineralized Agua Zarca is present a few feet north of the northern fault which has left-lateral separation. The fault to the south is mostly covered by pediment gravel that obscures the structural relations. The strata bounded by these three faults form a structural terrace, with most of the present workings in the gently-dipping part. Details of the structure are given by Schumacher (1972).

The Agua Zarca as mapped in this area (Woodward and Schumacher, 1972) may include some of the Glorieta Sandstone. The unconformity at the base of the Agua Zarca cuts down-section to the north; and where the Bernal Formation (fig. 2) is absent the Agua Zarca and Glorieta cannot be mapped separately. Soulé (1956) reported that the mineralization occurred in the Poleo Sandstone Member. The Poleo, however, is not present here and the mineralized horizon is actually the Agua Zarca. TRP

Lindgren and others (1910) reported that five or six drifts, ranging from 300 to 800 feet long, were driven along strike. These drifts are all inaccessible and no underground maps are available.

Bulldozing and dumps developed during the 1950's and 1960's have obscured most of the older workings.

Meager crossbed data and other primary sedimentary structures suggest that the current direction was nearly due west. A paleochannel complex is present, but is not as obvious as that at the Eureka mine. One paleochannel is well exposed in cross section along a north-south face of an open cut. Most of the other faces are east-west and paleochannels are not particularly obvious; this may be due to the fact that the cuts are parallel to the channels and they are not seen in cross section.

Chalcocite in close association with carbonaceous material was apparently the most abundant primary sulfide. Malachite, azurite, and chrysocolla(?) are present in the interstices of the host

