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NACIMIENTO PIT, A TRIASSIC STRATA-BOUND COPPER DEPOSIT

by

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INTRODUCTION

The Nacimiento Mine-Mill open pit is owned and operated by Earth Resources Company, Inc., a diversified natural resources company. The ore deposit is typical of the so-called "red bed" copper deposits of the southwest. The mine is located about 5 miles east of the village of Cuba, New Mexico, on state road 126 (see road log, first day, this Guidebook).

HISTORY

Natives of the area say that copper was first mined and smelted by the Conquistadores, who used Indian slaves to extract ore and coal locally. The Nacimiento Pit covers the Copper Glance-Cuprite Claims, patented in 1929, which, according to Lindgren (1910), were worked in the 1880s. W. S. Greathouse (1972, personal communication) describes Señorito as a thriving mining camp in 1917, producing coal to smelt oxide ore of the Copper Glance-Cuprite Claims as well as ore from the Eureka Mine, while high-grade sulfide ore was shipped by wagon, then rail, to the smelters at Durango, Colorado and El Paso, Texas. Interest in the district faded to a passive sporadic state after the end of World War I in 1918. The old workings consisted of a few small diggings in the outcropping oxide portion of the ore deposit, mainly drifts along sulfide-replaced logs.

During the 1960s limited drilling was done by two companies who judged the deposit too small and too high in oxide. Then the property was acquired by Vitro Minerals Corporation, which was merged into Earth Resources Company in 1968. Applying the theories of uranium ore habits to this property, a vigorous exploration program was culminated by the mill start-up in June, 1971 at 3,000 TPD.

REGIONAL GEOLOGY

Figure 1 places the Nacimiento Mine in perspective with the dominant regional geologic feature of the Four Corners Area of the Colorado Plateau. The mine is located on the western edge of the Nacimiento uplift, a part of the western chain of uplifts of the eastern Rockies.

STRATIGRAPHY

The ore body is contained within the Agua Zarca Sandstone Member of the Chinle Formation of Triassic age, which lies unconformably on Permian rocks (Fig. 2). The upper Permian Yeso Formation which forms the foot-wall of the mine is a reddish-orange muddy siltstone with occasional thin, discontinuous sandstone channels. The Yeso here is marked by worm burrows, rain prints, and ripple marks. The basal conglomerate of the Agua Zarca often overlies mud-cracked beds of the Yeso (Fig. 3).

The ore host, Agua Zarca Sandstone Member of the Chinle Formation, is a white, kaolinized, poorly cemented, quartzose,

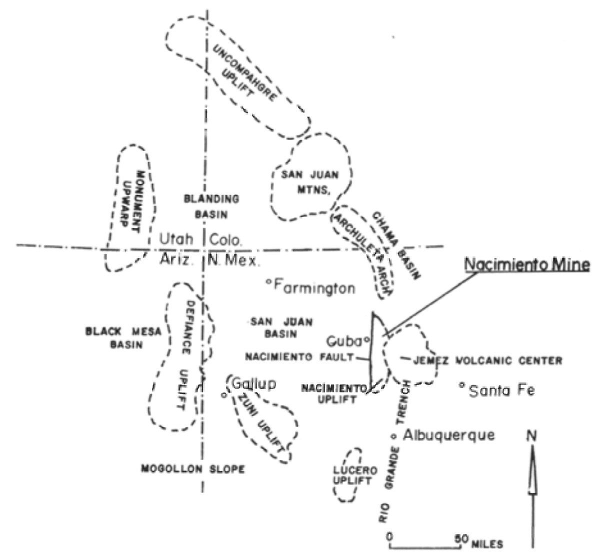

Figure 1. Regional geologic features of northwestern New Mexico and the four-corners area. (After Kelley, 1955, p. 23)

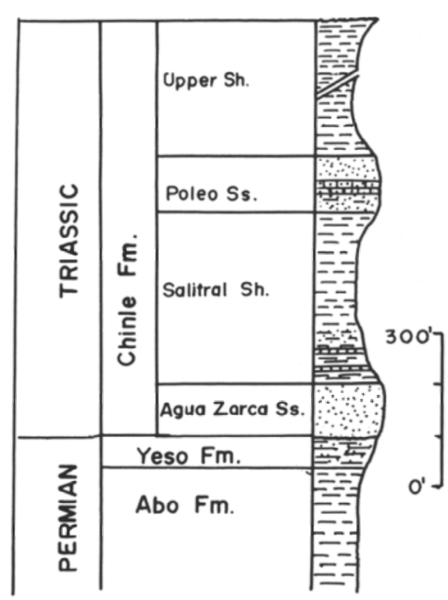

Figure 2. Stratigraphy of the Nacimiento Mine.

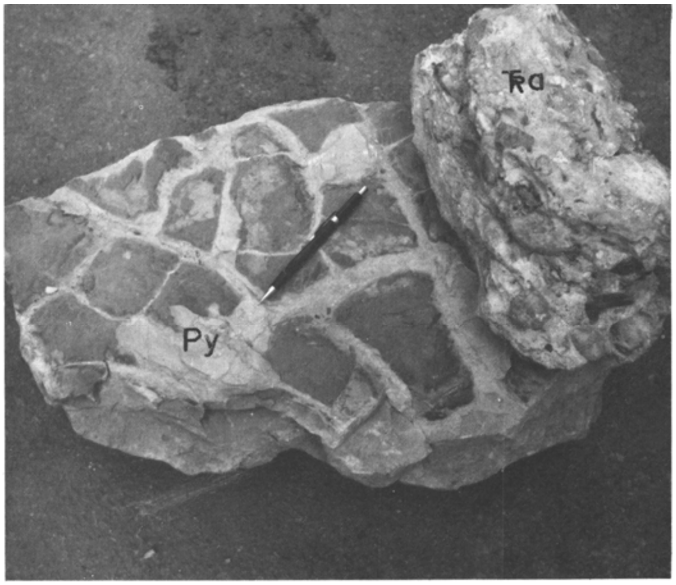

Figure 3. Agua Zarca Sandstone (Triassic) resting on mud-cracked bedding surface of the Yeso Formation (Permian).

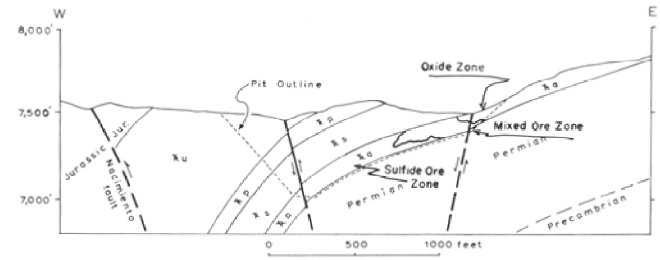

Figure 4. East-west cross section through Nacimiento open pit showing geology prior to excavation. Symbols for members of Chinle Formation are Ŧa: Agua Zarca Sandstone Member; Ŧs: Salitral Shale Member; Ŧp: Poleo Sandstone Member; Ŧu: Upper Shale Member.

fine-grained to conglomeratic sandstone, probably once an arkose, containing abundant carbon trash which varies from logs to films. It is 75 to 100 feet thick, striking N. 18° W. and dipping 34° to 29° W. A few laterally discontinuous layers and lenses of mudstonc are also present. Quartz grain overgrowths give an angular appearance to the sand grains but do not effectively cement the friable sandstone.

The Salitral Shale Member of the Chinle Formation conformably overlies the Agua Zarca. This variegated maroon, green and gray shale contains a few small channels filled with dense sandy-limestone pebbles. Carbonaceous fragments are distributed through the shale. The Salitral is easily distinguished by its calcite-filled concretions.

The buff to gray, well-rounded, well-sorted, fine-grained, micaceous Polco Sandstone Member rests on the Salitral Shale. This hard, ridge-forming unit contains a large amount of carbon pieces and considerable pyrite.

The Chinle Formation's uppermost unit is the Upper Shale Member, a light red shale with minor green streaks, silty zones, and isolated, thin channel fills of fine- to very fine-grained, well-rounded, gray-green sandstone.

STRUCTURE

The Nacimiento Mine lies on a monoclinal fold at the western edge of the sediment-draped, Precambrian-cored Nacimiento uplift. The orebody lies on the upthrown side of the Nacimiento fault, a major north-south structure which separates the Nacimiento uplift and the San Juan Basin to the west. Structure of the area is discussed by Woodward and others (1972).

Locally the orebody lies in a graben formed by the El Cajete fault on the north and the Blue Bird Fault on the south. Both are east-west faults cutting the uplift. The resistant Agua Zarca Sandstone caps the mesa-forming east flank of the monocline. Structural and stratigraphic relationships, as well as the orebody and pit outline, are depicted on Figure 4.

Detailed structural features which are seen in the pit walls include bedding-plane shearing, plastic flowage of the Salitral Shale, overthrusting resulting from compression, reverse and antithetic faulting from tension, and normal faulting. Jointing and shearing arc intense. Some pre-Triassic structure can be seen.

SEDIMENTATION OF ORE HOST

The base of the Agua Zarca, the ore host, is marked by conglomerate with cobbles and boulders of quartzite. Flow direction mean is S. 58° W. while the mean direction of the long axis of contained fossil wood is N. 31° W. with a standard deviation of 25°.

Laminated, fine-grained sandstone beds containing a few discontinuous, thin mudstone layers are truncated by broad, shallow, cut-and-fill channels of poorly sorted and poorly graded, coarse- to fine-grained sandstone containing quartzite pebbles. These characteristics are indicative of a shallow, quiet flow system depositing fine-grained sand and thin layers of mud, interrupted by cyclic, high energy, cloud burst-type overbank torrents with high bed and suspended loads which ripped up and quickly buried sediments and carbonaceous material.

MINERALIZATION

Ore mineralization is principally chalcocite as discrete anhedral mineral grains adhering to quartz grains and as replacement of organic matter. Pyrite is the only accessory sulfide mineral and is a minor constituent, while minor native silver occurs on fracture faces in chalcocite at the water table. Principle associated minerals are malachite, with minor chryscolla, azurite, cuprite, and native copper as rare and poor specimens. One minor occurrence of antlerite and spangolite has been found (Hauff and others, 1974). Spectacular logs up to tens of feet long are chalcocite. These logs show mineral replacement of the less dense vascular systems of the wood, as cell structures are often distinguishable. Mineralization is bimodal, consisting of the "disseminated ore" and the "high grade ore" of mineralized fossil logs. Average grade is 0.67% with reserves in excess of 11,000,000 tons.

ORE GENESIS

Unlike many sedimentary copper deposits, the carbonaceous shales here are not mineralized. At the Nacimiento mine, mineralization appears to be a function of permeability and is restricted to the Agua Zarca Sandstone. There is no apparent permeability optimum, as zones of very low to very high permeability may or may not be mineralized with little consistency. Certainly the lack of mineralization in carbonaceous shales and in the Poleo Sandstone Member is difficult to explain. Woodward and others (1974) discuss area mineralization and genesis theory.

Not all carbon trash is replaced in the ore body, the range of carbon replacement being from 0 to 100%. Pyrite is not necessarily associated with mineralization or carbon trash. Thin and polished sections suggest that massive chalcocite has been remobilized after structural deformation while preserved cell structure is evidence of carbon replacement at an early date. The question of ore genesis is not yet resolved.

The second theory of ore genesis concerns detrital grains deposited and mobilized by telethermal (ground-water) solutions to enrich ore grades. This theory explains some questions such as the lack of mineralization in the Poleo Sandstone, the preference of sand and exclusion of shale mineralization, mineralization along bedding planes, etc. Vine and Tourtelot (1 97 0) suggested that atmospheric chemistry could have made detrital sulfide minerals very stable during Triassic time. This theory is perhaps the most popular, but it too leaves many unanswered questions.

MINING AND MILLING

The mining was first a ripper-scraper operation using Caterpillar D-9 rippers and Caterpillar 30-yard, twin-engine, high-speed scrapers with two D-9 pushers for loading. The equipment was later replaced by 50-ton trucks and 10-yard loaders. Waste is drilled and blasted, while ore is ripped and selectively dozed, then loaded as directed by ore control personnel.

Production began at a rate of 3,000 TPD mill feed but within a few months was raised to 4,000 TPD with a modest revamping and expansion of the mill.

Milling is by conventional methods of flotation for sulfide minerals, with recovery about 90%. Earth Resources' metallurgical staff has developed a method for the flotation of oxide ore and improved recovery of sulfide minerals. This process is now patented and is probably the most outstanding achievement at the Nacimiento mine and is a significant contribution to the mining industry.

Vegetation and reclamation of spoil areas is now in progress, with considerable testing of plantings and soil conditioning. Environmental awareness and responsibility are a part of the company policy.

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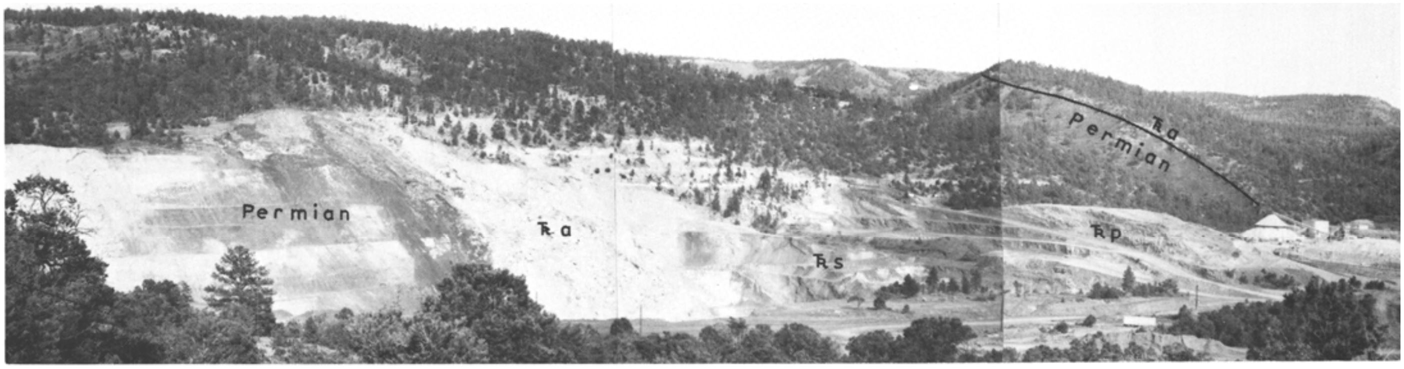

View east and southeast of Nacimiento mine. Mill and mine buildings are at the far right. Beds dip moderately to the west (toward the viewer). Symbols are TRa: Agua Zarca Sandstone Member of Chinle Formation; TRs: Salitral Shale Member; TRp; Poleo Sandstone Member. Ore is mined from the Agua Zarca.