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GEOLOGY AND COPPER DEPOSITS OF THE TYRONE DISTRICT

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GEOLOGIC SETTING

The Tyrone copper deposit is located in the Burro Mountains mining district in Grant County, New Mexico, 10 miles southwest of Silver City at an elevation of about 6000 feet. The district is divided into two distinct areas known as the Little Burro Mountains and the Big Burro Mountains, separated by the Mangas valley which contains Gila Conglomerate of Pliocene and Pleistocene age and Recent sands and gravels.

The Little Burro Mountains are located on the northeast side of the valley, north and east of the Tyrone mine site. These mountains trend northwest along a tilted fault block that has been elevated on its west side by the northwest-trending Mangas fault; the Mangas fault forms a scarp northwest of the Tyrone copper deposit in the Little Burro Mountains. The Little Burro Range consists of Precambrian granite and Cretaceous sediments intruded by andesite and rhyolitic rocks and overlain by Tertiary volcanic flows.

The Big Burro Mountains are located southwest of the Mangas valley and consist of Precambrian granite intruded by many dikes of diverse composition and age and contain a laccolith of quartz monzonite porphyry of Laramide age. The northeast sector of the quartz monzonite mass is covered by Quaternary gravel; the exposed part of the laccolith is elliptical in shape, 6 miles long and 4 miles wide.

The Tyrone copper deposit is confined to a wedge-shaped area bounded on the northwest by the Burro Chief fault, on the south by a fault system extending eastward from the Copper Mountain claim area, and on the northeast by gravel (Fig. 1). The deposit is located in a horst which is bounded on the northwest by the Austin-Amazon fault and on the southeast by the Sprouse-Copeland fault. Three fault blocks, the White Signal graben, Tyrone horst, and the Willow Creek graben are the resulting structures. The northern part of the Tyrone laccolith is almost bisected by the Burro Chief hinge fault which parallels the Sprouse-Copeland and Austin-Amazon faults and tilts the Tyrone copper deposit to the northeast.

DESCRIPTION OF ORE BODY

The Tyrone ore body occurs within the Tyrone quartz monzonite laccolith and the underlying Precambrian granite (Fig. 2). The ore body consists of a supergene blanket of erratic chalcocite mineralization which may vary from a few feet to over 300 feet in thickness. The ore body slopes to the northeast and tilts northwesterly toward the Burro Chief fault. The surface of the enrichment blanket is very irregular, with streaks of ore sporadically penetrating well into the capping.

Ultimately the pit may reach a depth of 1300 feet with lateral dimension of approximately 1$_3$A. miles along its north south axis and about 11/4 miles along its east-west axis.

Although the ore body is low-grade (the tenor of the ore being comparable to the average grade of the porphyry coppers of the southwest), within the mine area are at least 20 partially mined-out high-grade areas of chalcocite concentration averaging 2 to 3 percent copper. These areas were the principal underground mining areas at the time the underground operations closed down in 1921, and they trend roughly northeasterly along larger fractures, most of which parallel the Burro Chief fault. Aside from minute amounts of gold and silver recovered from the ore, copper is the only product resulting from the mining.

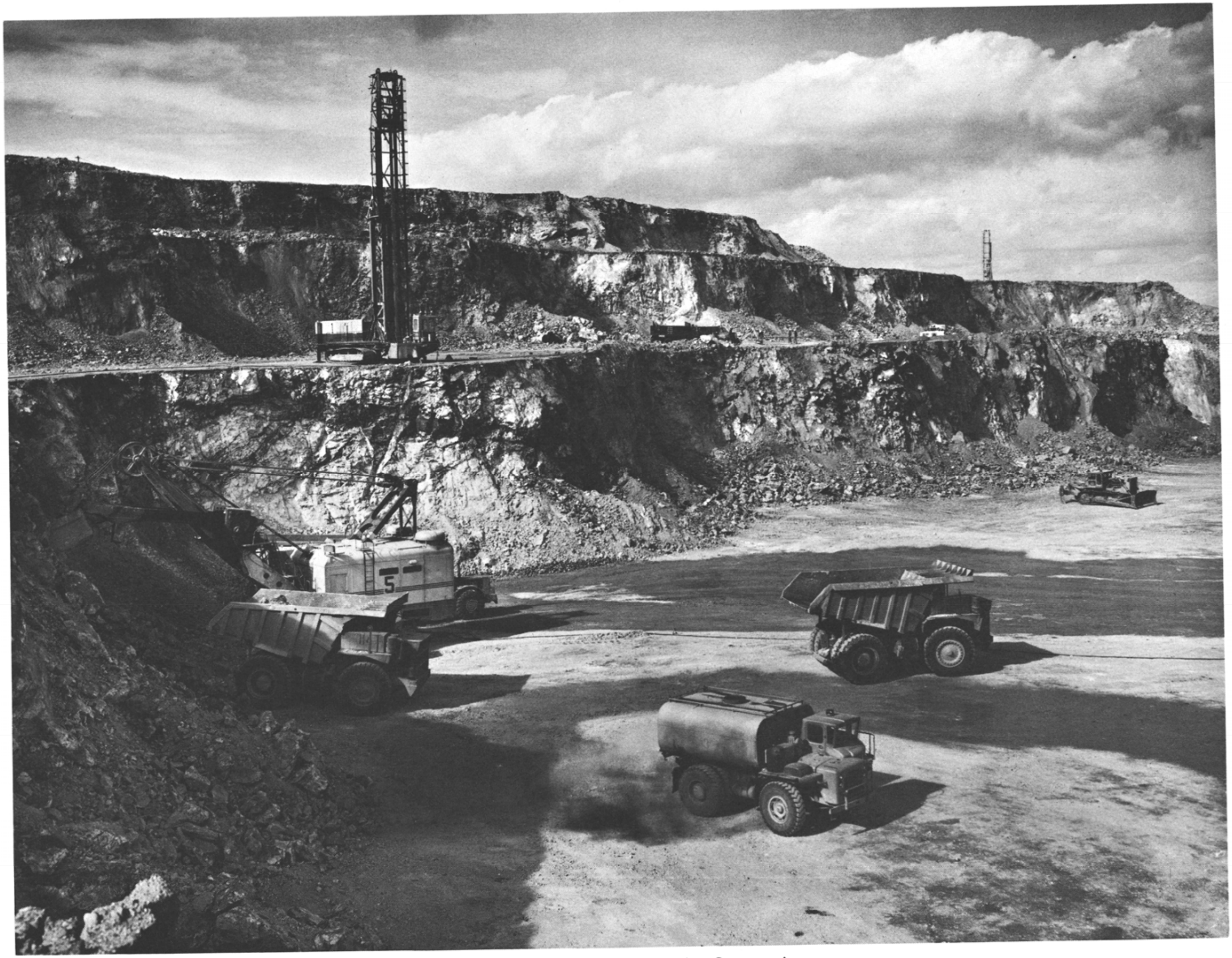
The top of the sulfide zone, or old water table level, differs sharply from the present water level. The ore can be found above the present water table in the Racket area and below the present water table from the 5700 level down in the northern part of the mine area. However, the surface of the ore body, in a very generalized fashion, corresponds reasonably with the present topographic surface.

The bottom of the ore body is also irregular, grading into protore averaging approximately 0.10 percent copper. Ore occurs within a few feet of the surface in the St. Louis or Leopold area and in the northeast corner of the mine site (slightly north of the gravel-granite contact) the top of the sulfides is 500 to 600 feet below the surface.

IGNEOUS ROCKS

Precambrian granite is the oldest exposed rock in the vicinity and within the Tyrone mine area. The granites, of which there are at least four varieties in the region, are medium- to coarse-grained rocks containing quartz, plagioclase, orthoclase, some biotite, and hornblende. Accessory minerals are sphene, zircon, tourmaline, apatite, magnetite, rutile, and ilmenite. Within the mine area the granite is intensely altered. The feldspars are kaolinized and in many areas sericitization is prevalent. Dikes of varying composition intrude the Precambrian granite. Diabase dikes occur in the mine site area and many have been intersected in drill holes, but surface exposures are rare. Rhyolite dikes are found within and south of the Tyrone copper deposit. These dikes, cut by quartz monzonite porphyry dikes, are older than the quartz monzonite Tyrone laccolith. Most of these dikes are altered, and many are mineralized.

The Tyrone laccolith, composed of quartz monzonite porphyry and monzonite porphyry is exposed northeast of the Big Burro Mountains. Most of the laccolith in the Tyrone mine area is a porphyritic quartz monzonite with



Tyrone operation of Phelps Dodge Corporation

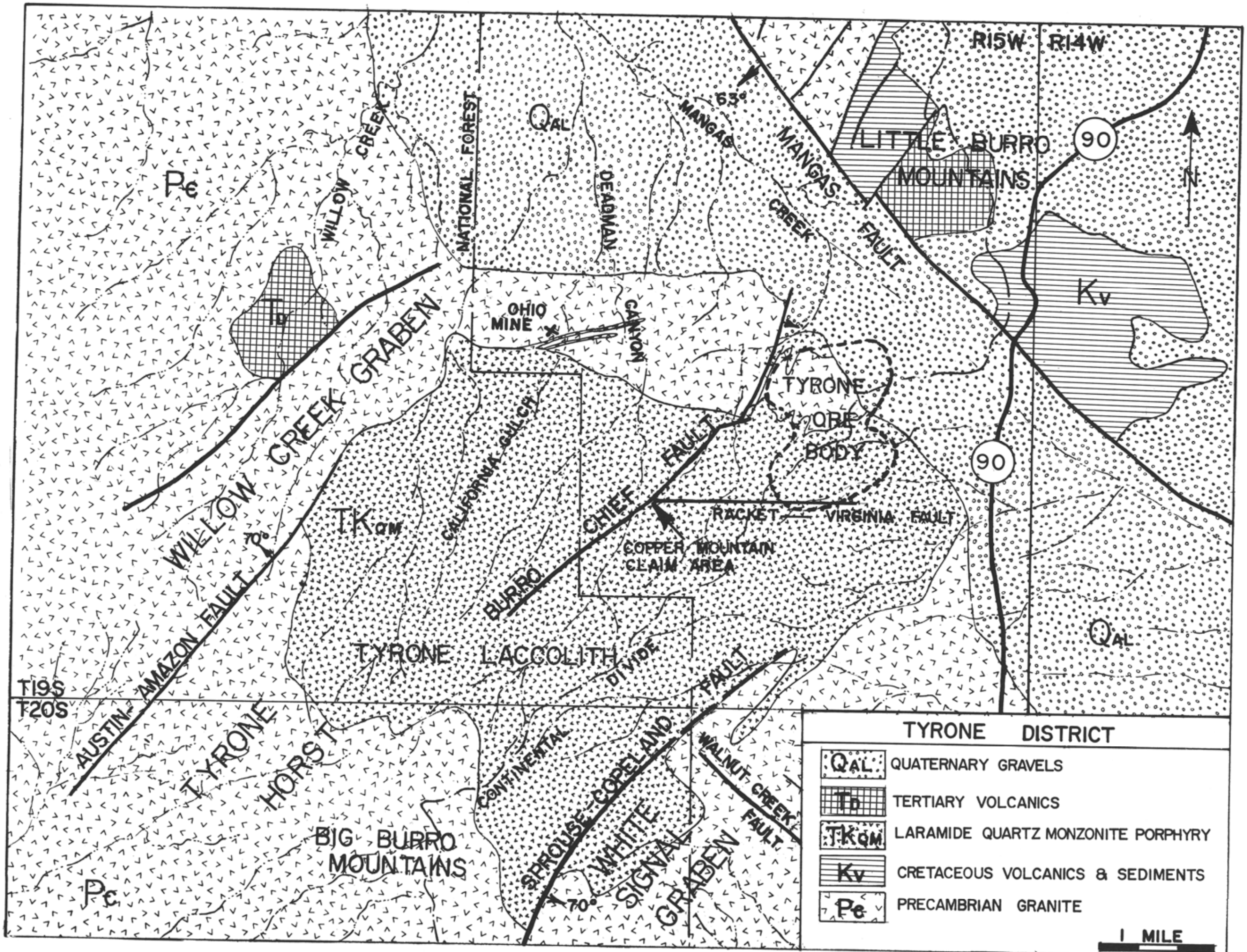

R15W R14W
T19S
T20S
N
90
LITTLE BURRO MOUNTAINS
MANGAS FAULT
MANGAS CREEK
63°
DEADMAN
NATIONAL FOREST
WILLOW CREEK
WILLOW CREEK GRABEN
OHIO MINE
CANYON
TYRONE ORE BODY
RACKET - VIRGINIA FAULT
COPPER MOUNTAIN CLAIM AREA
BURRO CHIEF FAULT
CALIFORNIA GULCH
TYRONE LACCOLITH
AUSTIN - AMAZON FAULT
70°
TYRONE HORST
BIG BURRO MOUNTAINS
CONTINENTAL DIVIDE
SPROUSE - COPELAND FAULT
WHITE SIGNAL GRABEN
WALNUT CREEK FAULT
TYRONE DISTRICT
QAL QUATERNARY GRAVELS
TV TERTIARY VOLCANICS
TKQM LARAMIDE QUARTZ MONZONITE PORPHYRY
KV CRETACEOUS VOLCANICS & SEDIMENTS
P€ PRECAMBRIAN GRANITE
1 MILE

FIGURE 1.

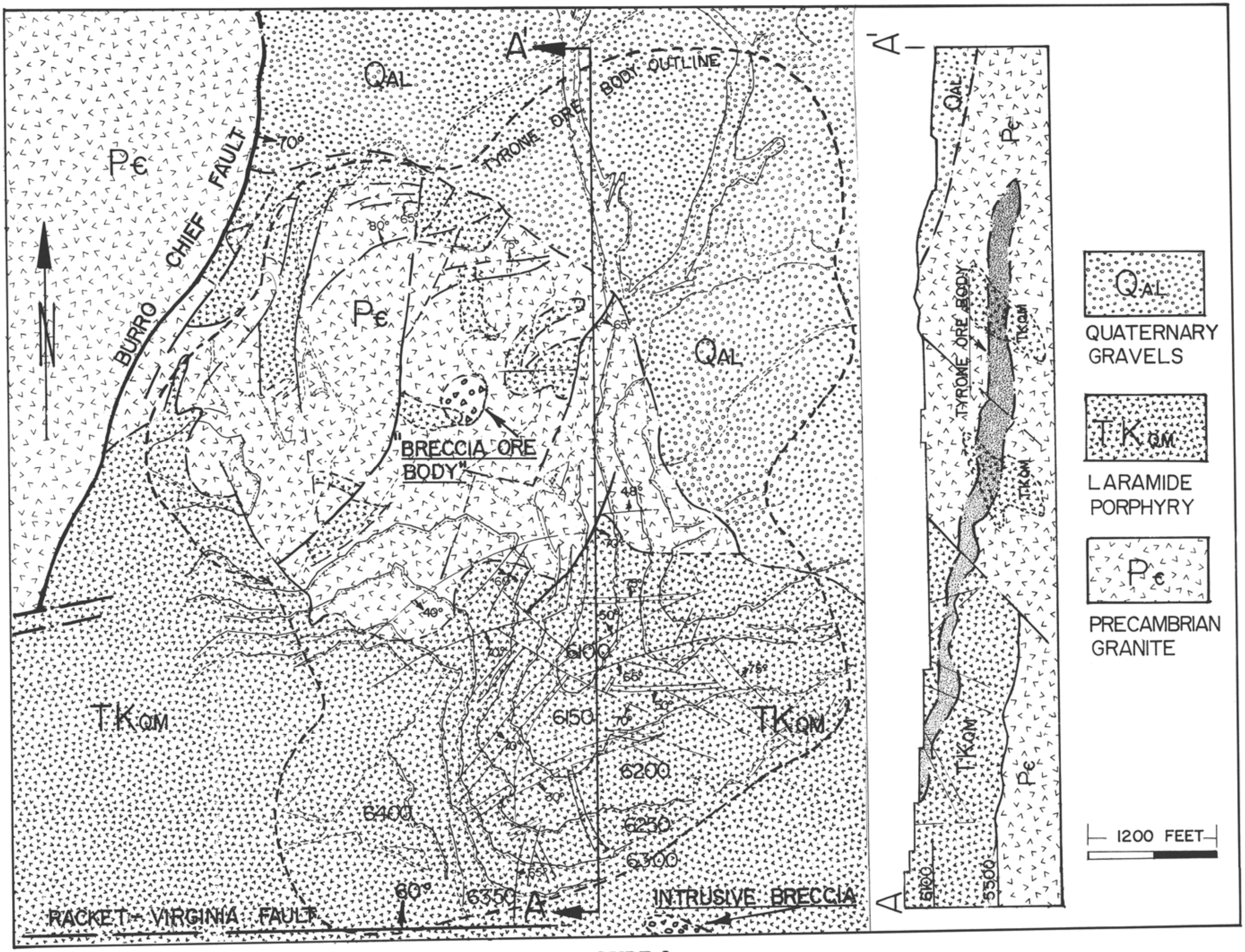


FIGURE 2.
Tyrone ore body.

abundant quartz, oligoclase, orthoclase, and sporadic occurrences of chloritized biotite. Rarely, the quartz monzonite contains euhedral poikilitic orthoclase phcnocrysts, some measuring three inches long and containing inclusions of quartz, oligoclase, biotite, magnetite, apatite, and sphene. The poikilitic orthoclase phenocrysts occur as Carlsbad twins and as single crystals.

Dikes of fine-grained quartz monzonite intrude the laccolith and the surrounding granite.

INTRUSIVE BRECCIA

Paige (1922), in U.S.G.S. Professional Paper 122, described a mineralized breccia known as No. 2 stope or the "breccia ore body" above the 5669 level at the Burro Mountain Copper Company workings east of No. 2 shaft in Niagara Canyon. Unfortunately, the area is not accessible today, but his paper, printed in 1922, does present an excellent description of an intrusive breccia long before nomenclature of this type existed. The breccia could not be associated with any known fault system, and some of the fragments were rounded and consisted of granite and quartz monzonite porphyry. The rnartix of the breccia was finer grained breccia. The breccia was in turn fractured. The bottom of the breccia was not traced and will not be known until excavation provides the necessary exposure.

Near the summit of a hill southwest of the old Gettysburg mine an outcrop of intrusive breccia has been viewed by many visiting geologists. The fragments are porphyry and granite, and the feldspars have undergone argillic alteration. Fragments within the exposure display supergene hematite staining on the surfaces. Some silicification is noted but capping does not indicate intense mineralization. This breccia is approximately 1000 feet long, 400 feet wide, strikes northwesterly, and dips northeasterly. The country rock surrounding the breccia is considerably shattered and fractured.

VOLCANIC ROCKS

Volcanic rocks are confined for the most part to the Little Burro Mountains, where Cretaceous andesites and dacites are overlain by Tertiary rhyolites and andesites.

SEDIMENTARY ROCKS

The areal extent of sedimentary rocks is limited in and around the Tyrone deposit. North of the Tyrone mine area the Beartooth Quartzite of Cretaceous age caps a northeasterly tilted block in secs. 27 and 34. In the immediate vicinity of the mine area the only sedimentary formations are the Gila Conglomerate of late Tertiary and early Quaternary age and Quaternary unconsolidated gravel.

FAULTS

The Mangas fault, dipping southwest at 63°, forms a prominent scarp with the Little Burro Mountains; the Gila Conglomerate and unconsolidated gravels were dis placed along this fault and brought against the older rocks of the Little Burro Mountains.

The Burro Chief fault, striking northeast and bisecting the northern sector of the horst, also displaces Quaternary gravels and appears to form the western limit of the Tyrone copper deposit.

A hinge type movement is postulated for the entire block southeast of the fault; the hinge line could possibly be projected northwest from the Walnut Creek fault. The latest movement on this fault tilted the ore deposit 5-8° to the northeast.

Several occurrences of copper oxides are found west of the Burro Chief fault, the most prominent of these is the copper oxide mineralization near the Ohio mine adjacent to a dike of Laramide quartz monzonite porphyry that strikes northeasterly through California gulch and Deadman canyon in secs. 16 and 17 and is emplaced in Precambrian granite.

The Racket-Virginia fault zone extends eastward from the Burro Chief fault near the Copper Mountain claim and can be traced for almost two miles. Some copper mineralization is found south of this zone, but generally most of the Tyrone deposit is situated north of this fault. Copper mineralization occurs south of the Racket-Virginia zone in the east half of sec. 27. This could possibly be an erosional remnant, as granite outcrops in the quartz monzonite laccolith can be found east and west of this area, and the outcrops are topographically higher than the mineralized area.

LEACHED OUTCROPS AND CAPPING

Hematite occurs in the capping as the predominant derivative filling of cavities vacated by the sulfides. An earthy and porous form of hematite forms veinlets throughout the capping, imparting a maroon color to the host rock. Limonite occurs chiefly as staining in halos and some botryoidal varieties are observed.

In the northwest area of the mine site the fissure outcrops contain considerable hematite and chalcedony stained deep red with hematite. In the Racket-Virginia area, fissure outcrops consist of limonite and granular quartz with chrysocolla scattered irregularly through the surface portions of the rocks. At the Copper Mountain claim in Deadman canyon, chrysocolla is preponderant. Tenorite and melaconite staining of outcrops is also quite common. There is a possibility that the Copper Mountain claim area in the southwest corner or wedge of the deposit represents a sector faulted above any known water table, forming an area where oxidation of the enriched sulfides is almost complete.

In the contact zone between the quartz monzonite laccolith and the granite, vein quartz and silicification prevail. The silicification is irregular, as in some areas both granite and quartz monzonite porphyry are intensely silicified, whereas in other areas the silicification is confined to the quartz monzonite porphyry. Apparently this high silica content represents a pre-mineralization "chill" zone. Along the granite-quartz monzonite contact, the sulfide mineralization was less intense.

Veins of alunite, ranging from several millimeters to 8 inches in thickness can be found in the geographic center of the mine area near the granite-quartz monzonite contact.

MINERALIZATION

In the oxidized zone, chrysocolla, the most abundant copper mineral, occurs erratically. Malachite, azurite, cuprite, tenorite, native copper, turquoise, minor torbernite, and autunite have been observed in kaolinized areas.

Chalcocite and minor covellite occur in the supergene zone, chalcocite being the most important ore mineral. Chalcocite and covellite replace pyrite, chalcopyrite, and sphalcrite.

The primary minerals are pyrite, chalcopyrite, and sphalerite, with traces of molybdenite and bornite. Pyrite is the most abundant sulfide mineral and commonly is partially replaced by chalcocite at its margins or along shatter-like veinlets. It contains small inclusions of quartz and chalcopyrite and some grains are partially replaced by primary sphalerite. This current ratio of pyrite to chalcocite is approximately 4:1.

Chalcopyrite is generally observed as particles in quartz. It is also present as small inclusions in pyrite and sphalerite. Sphalerite is commonly attached to pyrite and has replaced it in part. It commonly contains minute blebs of chalcopyrite, the visible inclusions constituting 5-10 percent of the sphalerite.

Molybdenite occurs as curved shreds or folic that are mostly free from other sulfide minerals. It commonly is found with quartz in the granitic area of the deposit and as a thin coating on joints in the porphyry, but it is not of economic importance at this time. Bornite, of minor significance, has been observed as sparse remnants of crystals largely replaced by chalcocite.

The ore minerals occur in fractures and also as disseminations in the country rock adjacent to the fractures. Most of these fractures are a fraction of an inch wide, but can range up to one foot in width.

Two major periods of primary mineralization are noted: the copper, iron, zinc, and molybdenum during Laramide time; and a late Tertiary period depositing fluorite, uranium, lead, and precious metals.

ALTERATION

Sericite is the most abundant hydrothermal alteration product. Intensive kaolinization appears to have obliterated hypogene clay minerals in the higher levels of the ore body. Below the enriched zone there is a preponderance of yellow-brown clay resembling montmorillonite. Chloritization of biotite is widespread, and propylitic alteration has been observed at the periphery of the copper deposit in the Gettysburg area. Argillization occurs in the southeast corner of the Racket area, but appears to be localized.

Silicification, as mentioned earlier, is prevalent in the granite-quartz monzonite contact zone, but at least one fault contains siliceous outcrops above an area of higher grade ore.

GEOLOGIC HISTORY

Prior to the intrusion of the Tyrone laccolith, the area southwest of the present mine site was probably overlain by Cretaceous volcanics and sediments. During Laramide time, the Tyrone laccolith intruded the area north of the Big Burro range. Primary mineralization followed. After intrusion, the horst-graben structure defined by Gillerman (1964) developed. Uplift in the Big Burro Mountain Range began in late Laramide to early Tertiary time, tilting the entire area north of the Big Burro Mountains to the northeast. Rapid erosion during this time stripped the Cretaceous cover over the laccolith, exposing the porphyry. During middle Tertiary time, the Burro Chief fault dropped the Tyrone copper deposit. Several movements along this structure occurred, the last during Pleistocene time, tilting the deposit into its present position.

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