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Geology, mines, and prospects of the Tyrone stock and vicinity, Grant County, New Mexico

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ABSTRACT

This preliminary study emphasizes the geochronology of intrusion, faulting, and mineralization in the Tyrone area of the Big and Little Burro Mountains of southwestern New Mexico. Geologic and aeromagnetic mapping, geochemical study, and K-Ar and fission-track age determinations have elucidated the intrusive history of the Tyrone stock.

The Tyrone stock is a multiphase pluton that consists of both porphyritic and equigranular intrusives of dominantly quartz monzodioritic composition. The porphyritic rocks probably represent the hood zone of the pluton that has been preserved from erosion by northeast tilting of at least 10 degrees during the Pliocene. The Tyrone stock is a Paleocene (56 Ma) subvolcanic intrusion with steep outward-dipping walls, but the parent magmas may have mushroomed outward to form sill-like intrusives in the overlying Upper Cretaceous sedimentary strata. At the time of intrusion at least 1,000 ft of Late Cretaceous strata covered the Precambrian basement rocks, but these sedimentary strata have been eroded and are only preserved in the Little Burro Mountains. If the propylitized andesite flows of the Little Burro Mountains are correlative with the andesite flows (fission track 58 m.y.) of the Saddle Rock Canyon Formation, it is then probable that the emplacement of the Tyrone stock was accompanied by the extrusion of coeval lava flows and even some ash flows (e.g. ash-flow tuffs of the White Signal district). Inadequate age determinations of these older volcanic rocks have prevented a direct correlation of eruption with the emplacement of the Tyrone stock.

During the late stages of quartz monzodiorite crystallization, numerous dikes were intruded along east-northeast-striking fractures and faults. Some of the quartz monzodiorite porphyry dikes cut the Tyrone stock, and the dike in the vicinity of the Ohio mine is sericitized suggesting some pre-mineral quartz monzodiorite dike development in this area. At a still later stage of crystallization, about 50 Ma, rhyolitic magmatism prevailed and the numerous rhyolite dikes and coeval plugs and sills that surround the Tyrone stock were intruded into east-northeast-striking fault and fracture systems. The numerous rhyolite dike swarms are coeval with the rhyolite plugs of Three Sisters, the Shrine mine, and the rhyolite sill(?) of Saddle Mountain. Some of the dike swarms west and east of Saddle Mountain are curvilinear with a radius of about 6.5 mi from the center of the Tyrone stock; this is suggestive of a weakly developed ring fracture system about the stock. The episode of rhyolitic magmatism probably occurred 40-50 Ma as based on fission track ages of 41.9±3.0 m.y. and 49.5±2.8 m.y. for the rhyolite dikes (W. N. Sharp, oral commun., 1983). Some, if not most, of the uranium-bearing, precious- and base-metal veins of the White Signal district were synchronous with this rhyolitic magmatic episode.

The porphyry copper deposit of Tyrone is within the quartz monzodiorite porphyry hood zone of the stock. The numerous small faults and fractures within the area of porphyry copper deposits are probably related to "crackling" effects produced by hydrothermal fluid pressures within this hood zone. The Tyrone deposit has an estimated reserve of 400 million tons of ore averaging 0.7 percent copper.

After the U.S. Geological Survey completed geologic mapping in the Silver City $1^{o}x2^{o}$ quadrangle in the late 1970's, it became apparent that there was a zonation of ore minerals about the Tyrone stock. Quartz-molybdenite veins are concentrated along the northwest margin of the stock near Sugarloaf Mountain and along the Beaumont fault. Precious-metal and base-metal veins

occupy the next outer zone and locally contain anomalous amounts of bismuth and antimony. Silver-bearing veins containing barite and manganese oxides are along the outermost zone. Fluorite veins are late, post-sulfide, breccia-filling vein deposits. An area of uranium veins in the White Signal district is probably related to the numerous rhyolite dikes and plugs that were intruded during a period of silicic magmatism that is slightly younger than the calc-alkaline monzonitic rocks of the Tyrone stock.

INTRODUCTION

The Tyrone stock is within the Big Burro Mountains and is located about 10 mi southwest of Silver City, New Mexico. The stock is quartz monzodiorite and is the dominant intrusion in a region of numerous silicic plugs, dikes, and sills. The stock has an oval-shaped outcrop, measures about 6 mi long and 4 mi wide--an area of about 16-17 mi^2, and consists mostly of two intrusive phases. The dominant type is a holocrystalline quartz monzodiorite; this type is associated with a quartz monzodiorite to quartz monzonite porphyry that may represent an erosional remnant of a hood zone. The geologists of Phelps Dodge Corporation have mapped at least five types of porphyry of which the finest textured is the oldest and the most intensively mineralized (Kolessar, 1982, p. 330). The porphyries are highly fractured and locally altered, showing extreme sericitization and argillization along fault and fracture systems.

A zone of supergene enrichment is relatively thin, generally less than 300 ft, and shows a patchy distribution; the contact with hypogene ores is highly uneven. This zone of supergene enrichment developed during several periods of uplift and subsequent weathering on the tilted Burro Mountain fault block. Some of the copper deposits occur within the Precambrian granite country rock, and Kolessar (1982) states that more copper ore occurs in the granite than in the porphyry.

Open-pit copper production at Tyrone started in 1969; however, prior to this many high-grade copper mines were developed by underground workings by the Burro Mountain, Chemung, and Savannah Copper companies, and by the Mangas Development Company. These mines evolved into the large-volume, low-grade, open-pit copper operation when the Phelps Dodge Corporation consolidated the earlier holdings and invested an estimated 118 million dollars in mill and other facilities in 1969. In the 1950's an estimated 400 million tons of ore averaging 0.7 percent copper had been blocked-out by the Phelps Dodge Corporation.

The Big Burro and the associated Little Burro Mountains are within the Basin and Range province in New Mexico. This region of the province is dominated by northwest-trending fault blocks that are separated by elongate basins containing as much as 1,000 ft of basin-fill. The altitudes range from 8,635 ft on the granite outcrops on Burro Peak to 6,200-7,100 ft within the oval-shaped basin that is developed on the Tyrone stock. The quartz monzodiorite of the stock weathers into a subdued, highly forested basin that is open to the northeast; the surrounding granitic rocks are more resistant to weathering. In contrast to this basin, the Tertiary rhyolitic and silicic intrusions that intrude the granite in the peripheral areas to the stock form conspicuous topographic highs, such as that seen along Three Sisters, at Saddle Mountain, Tullock Peak, and at the plug near the Shrine mine.

The Tyrone stock is present within parts of the Wind Mountain, Tyrone, Burro Peak, and White Signal 7.5-minute quadrangles (pl. 1) which were mapped as a part of the Silver City $1^{o}x2^{o}$ CUSMAP project from 1978 through 1980.

This current study emphasizes the geologic setting of the Tyrone porphyry copper deposit and the geochronology of intrusion, faulting, and mineral deposition. The geologic map of the stock (pl. 1) has a composite base formed from the pertinent parts of the four cited quadrangles.

Regionally, the Tyrone stock is located along the "New Mexico mineral belt," a major northeast trend for porphyry copper deposits (fig. 1). This trend extends from the Lordsburg stock at the southwest, through the Tyrone stock, the Santa Rita and Fierro stocks, northeastward to the Copper Flat stock at Hillsboro. Most of these intrusions, calc-alkaline in composition, are along a northeast-striking fault and fracture system that probably developed during Late Cretaceous through Eocene time. The criteria for establishing this age is based primarily on the displacement of radiometrically dated plutons and volcanic rocks, the fission-track dating of rhyolite dike swarms that are coextensive with the northeast-striking faults, and the displacement of upper Cretaceous sedimentary strata--such as in the Little Burro Mountains.

Acknowledgments

This study incorporates and acknowledges data from numerous sources including that from D. P. Klein, W. N. Sharp, and R. F. Marvin of the U.S. Geological Survey; Joseph Kolessar of Phelps Dodge Corporation; Victor E. Kral, consultant, Sparks, Nevada; T. L. Heidrick who allowed the use of a preliminary thesis map of the Tyrone stock; R. F. Breitrick, Cities Service Minerals Corporation, who allowed the examination of drill core from the Sugarloaf Mountain area; and B. Donegan of Leonard Resources Co. who allowed the examination of drill logs from the Oak Grove Project. In addition, some of the most significant analytical data in table 5 is from published information by A. J. O'Neill and D. S. Thiede for the National Uranium Resource Evaluation of the Silver City quadrangle, 1982. This open-file report has benefited from reviews by W. N. Sharp and A. L. Bush, both of the U.S. Geological Survey.

GEOLOGY

The Big Burro and Little Burro Mountains comprise a large area of dominantly Precambrian rocks that are intruded by numerous Laramide to mid-Tertiary stocks, plugs, sills, and dikes. The Laramide, quartz monzodiorite Tyrone stock, dated at 56 Ma, is the principal intrusion and occupies an outcrop area of about 16-17 mi^2. The stock is mineralized and contains porphyry copper deposits at its eastern end. The stock and surrounding Precambrian rocks have been tilted as much as 10 degrees eastward by late Oligocene and Miocene-Pliocene faulting, thus preserving the mineralized porphyritic hood zone of the intrusion downdip. Other intrusions, of rhyolitic to rhyodacitic composition, range in age from 40 to 50 m.y. (Eocene) and commonly are synchronous with precious- and base-metal fissure veins outside of the Tyrone stock. Late Cretaceous sedimentary strata, present in terranes to the east and west, have largely been eroded from the Big Burro Mountains in the Tyrone area but are still preserved along the dip-slope of the Little Burro Mountains. Volcanic rocks of both Late Cretaceous and early Tertiary age (Paleocene and Oligocene) also once mantled the Big Burro Mountains but are preserved now only along the Little Burro Mountains and along the Knight Peak half-graben to the southwest (pl. 1).

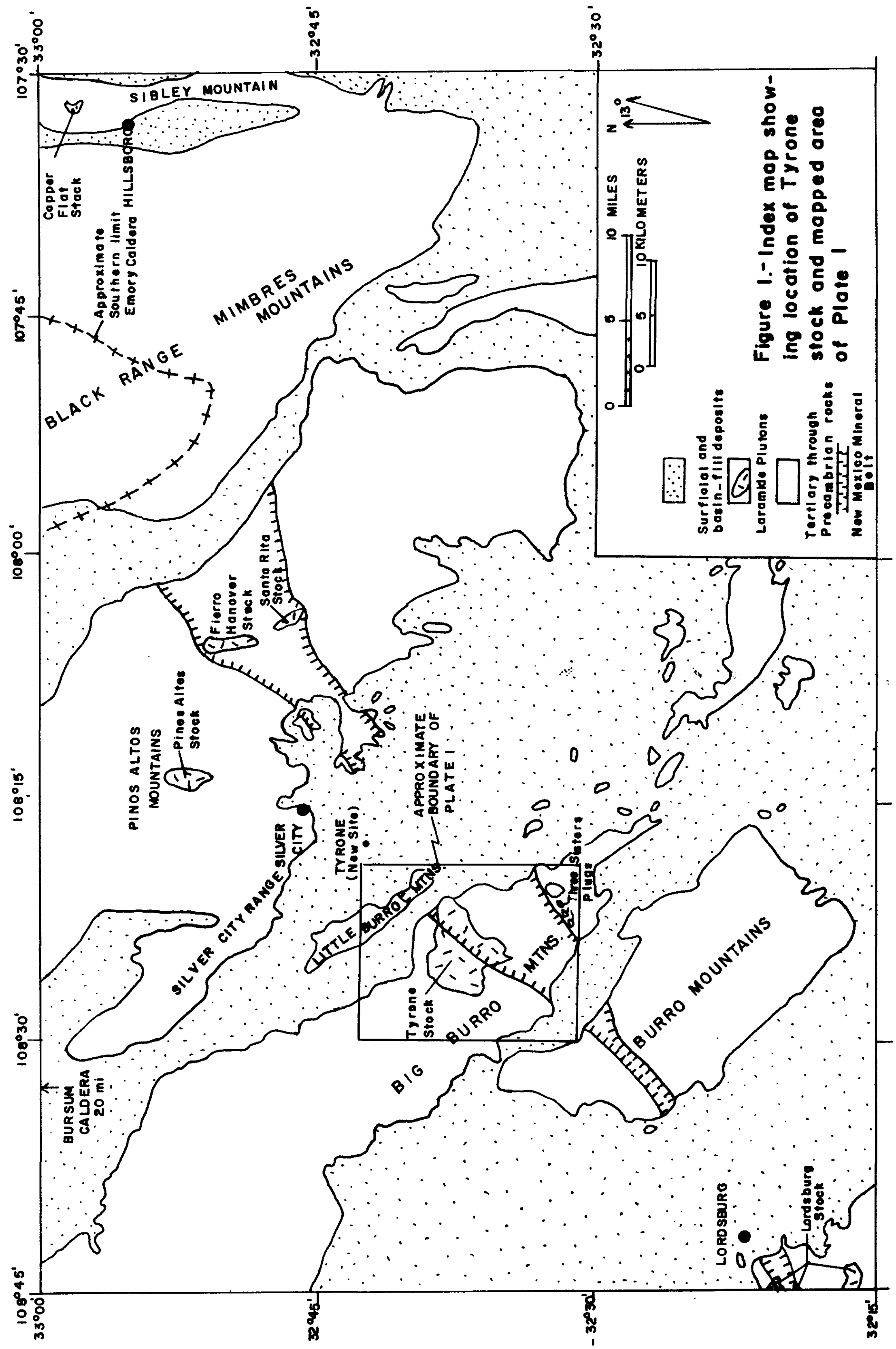

Figure 1.- Index map showing location of Tyrone stock and mapped area of Plate 1

Precambrian rocks

The Precambrian rocks of the area are dominated by the Burro Mountain granite batholith and the metasedimentary rocks of the Bullard Peak Series (table 1). The Middle Proterozoic schist and gneiss of the Bullard Peak Series are chiefly metapelitic rocks that were deposited in a geosynclinal basin about 1,650 to 1,550 Ma. These pelitic sediments were regionally metamorphosed to sillimanitic upper amphibolite-facies schists and gneisses about 1,450 Ma when granitic magmas of the Burro Mountain batholith were intruded into the thick sedimentary rocks. Contact zones of the granite with hornblendic schists within the Bullard Peak Series locally contain scheelite which formed in Precambrian skarns. The granite of the Burro Mountain batholith is principally a two-feldspar granite with local variations in biotite and hornblende. In places the granite is intruded by epizonal stocks of Precambrian rapakivi granite and trondhjemite. Diabase dikes of probable late Precambrian age cut all Middle Proterozoic rocks and follow strong north-northwest-striking fractures. Diabase dikes have been an important factor in localizing secondary urano-phosphate minerals in the White Signal district.

Paleozoic and Mesozoic rocks

Paleozoic strata are largely absent from the Burro Mountains and Mesozoic rocks are only present in the Little Burro Mountains. The strata that are present include both shallow and deep marine sedimentary rocks. It is most probable that the Burro Mountain area was covered by shallow marine seas during much of the Paleozoic. Lower Paleozoic strata of average thicknesses crop out along the margins of the Burro Mountain Uplift, e.g. in the Werney Hill quadrangle, and the remainder of the Paleozoic section is covered by basin-fill. From the late Permian and through Triassic, Jurassic, and early Cretaceous time, there was a long period of erosion during which the Paleozoic strata were largely removed from the Burro Mountain Uplift. A Late Cretaceous subsidence resulted in the deposition of pro-deltaic sediments which were deposited on a surface of low relief. The clean, well-sorted sandstones of the Beartooth Quartzite are representative of this pro-deltaic environment. This early subsidence in the Late Cretaceous was followed by a deepening of the basin and deposition of marine shales and thin silty limestone beds of the Colorado Formation.

Volcanism during Laramide time

During the Late Cretaceous and into the Paleocene, volcanism commenced with an outpouring of thick andesite flows and the eruption of thin ash-flow tuff units. The propylitized andesite flows (TKa, pl. 1) are still preserved in the Little Burro Mountains, and some of the older ash-flow tuff units (Trt, pl. 1) are present in the White Signal district. The source area for these remnant Laramide volcanics is largely unknown but may be related to the Tyrone subvolcanic intrusion.

Following this early volcanic episode the composite phases of the Tyrone stock (table 2) and satellitic plugs were intruded. The stock was probably forcibly emplaced at the juncture of Laramide northeast-striking faults and rejuvenated north-northwest-striking Precambrian faults. Room for the Tyrone stock was probably made by upward displacement of the Tyrone horst along the Sprouse-Copeland and Austin-Amazon faults. At the time of intrusion

Table 1.--Chemical analyses of early Tertiary intrusions and diverse Precambrian rocks from the Burro Mountain-Tyrone area, New Mexico

[Rapid rock analyses by H. Smith, J. Reid, and L. Artis, U.S. Geological Survey, 1979. Samples listed in order of increasing age; rhyolite and quartz monzodiorite are Tertiary, others are Precambrian]

Laboratory No.--	W-202220	W-20217	W-207543	W-207544	W-203844	W-202219	D-174682W	W-202222
Rock unit-------	Rhyolite of the Shrine mine	Quartz monzo-diorite	Quartz monzo-diorite[1]	Rhyodacite porphyry sill[1]	Granite of Burro Mountain	Granite of Burro Mountain	Granite of Burro Mountain	Biotite schist of Bullard Peak Series
Powder density--	2.61	2.52	n.d.	n.d.	2.56	2.62	2.62	2.70
SiO_2------------	76.5	67.5	69.0	67.9	74.0	71.3	76.1	68.8
Al_2O_3-----------	13.0	16.2	16.2	15.3	13.8	13.5	12.5	17.1
Fe_2O_3-----------	.99	1.7	1.5	1.5	.63	1.1	.27	1.9
FeO-------------	1.2	1.0	.42	.10	1.0	.92	.96	2.4
MgO-------------	.32	1.1	.47	.68	.35	.72	.22	.85
CaO-------------	.29	2.6	1.9	2.1	1.5	1.5	1.5	.89
Na_2O------------	.17	5.0	5.3	4.2	3.2	2.8	2.9	1.4
K_2O-------------	5.3	3.3	3.0	3.3	4.8	5.8	4.2	4.3
TiO_2------------	.10	.41	.25	.24	.23	.45	.16	.61
P_2O_5------------	.07	.24	.11	.08	.10	.18	.06	.14
MnO-------------	.15	.03	.01	.02	.02	.04	.02	.07
CO_2-------------	.02	.06	.01	.40	.10	.08	.02	.01
H_2O^+------------	1.8	1.6	.68	1.7	.50	.77	.43	1.8
H_2O^-------------	.25	.34	.24	1.9	.18	.17	.11	.28
Sum-----------	100	101	99	99	100	99	99	101

[1]Analyses S-111 and S-112 from W. N. Sharp (written commun., 1983).

DESCRIPTION AND LOCATIONS OF ROCK SAMPLES

Sample No.	Lab No.	Location	Description
WM-1-78	W-202220	NE, NE, SW 13 T. 19 S., R. 16 W.	Very light gray, weakly porphyritic rhyolite plug. Rhyolite contains about 10 percent sanidine and bipyramidal quartz phenocrysts in a patchy, felted and recrystallized groundmass.
BP-271-78	W-20217	NE, NE, NE 32 T. 19 S., R. 15 W.	Light-gray, medium-grained, hypidiomorphic-granular quartz monzodiorite stock of Tyrone. Rock contains 65 percent zoned oligoclase (An_{24-26}), 10 to 12 percent orthoclase, 15 to 18 percent quartz, 4 percent biotite, and accessory iron oxides, sphene, and apatite.
S-111 (W. N. Sharp)	W-207543	SW, NW, NE 20 T. 19 S., R. 16 W.	Light-gray, medium-grained, quartz monzodiorite stock of Tyrone.
S-112 (W. N. Sharp)	W-207544	NW, NW, NW 18 T. 19 S., R. 14 W.	Rhyodacite porphyry sill of Little Burro Mountains.
GH-149A-78	W-203844	SE, SW, SE 24 T. 21 S., R. 16 W. (Hoodoo Springs)	Grayish-pink, medium-grained, hypidiomorphic-granular granite. Rock consists of 35 to 38 percent oligoclase (An_{23-27}), 25 to 28 percent microcline, 25 to 37 percent quartz, and 2 to 3 percent biotite. Accessory minerals are epidote, white mica chlorite, iron oxides, and zircon.
NDI-3-78	W-202219	NW, NW, NW 24 T. 19 S., R. 16 W.	Composite samples from diamond drill hole core #3 (Cities Service Co.). Light-gray to pinkish-gray, medium-grained granite contains 20 to 30 percent calcic oligoclase (An_{25-27}), 40 to 50 percent microcline, 26 to 30 percent quartz, and accessory epidote, chlorite, biotite, and muscovite.
GH-145-T5	D-174682W	NW, NE, SE 29 T. 21 S., R. 16 W.	Very light gray, medium-grained allotriomorphic-granite contains 35 percent oligoclase (An_{24-26}), 28 percent microcline, 28 percent quartz, and 6 to 7 percent biotite. Accessory minerals are chiefly zircon and sphene.
R-24-78	W-202222	NE, NE, NE 14 T. 18 S., R. 18 W.	Biotite-sillimanite, porphyroblastic biotite schist of Bullard Peak Series. Abundant clots of fibrolitic sillimanite. Rock consists of about 60 percent quartz and feldspar granules, 15 to 20 percent biotite, 8 to 10 percent muscovite, and 10 percent sillimanite.

Table 2.--Modal analyses of rocks from the Tyrone stock

Number	BP-357-76	BP-296-76	BP-355-A-76	BP-271-78	WS-6-76	WS-7-76	WS-12-76	WS-3-76	WM-256-77	WM-259-A-77	T-1-73
Rock type	Quartz monzo-diorite	Quartz monzo-diorite	Chilled margin-quartz monzo-diorite porphyry	Quartz monzo-diorite	Quartz monzo-diorite	Quartz monzo-diorite	Quartz monzo-diorite	Quartz monzodiorite porphyry	Quartz monzodiorite porphyry	Quartz monzodiorite porphyry	Quartz monzodiorite porphyry
Location	NE,NE,SW 4 T20S, R15W	SE,NE,SW 4 T20S, R15W	SE,SE,SE 4 T20S, R15W	NE,NE,NE 32 T19S, R15W	NE,SE,NE 34 T19S, R15W	NW,NW,NW 35 T19S, R15W	SE,SE,SW 26 T19S, R15W	NW,NW,NE 33 T19S, R15W	NE,SW,SE 21 T19S, R15W	SE,NW,NE 27 T19S, R15W	NW,NW,NE 27 T19S, R15W
Groundmass	0	0	78	0	0	0	0	54	68	62	72
K-feldspar	16	14	5	10	13	9	14	5	0	3	6
Plagioclase	55	65	11	66	72	76	64	38	27	31	18
Quartz	23	16	6	19	10	13	19	0.5	3	1	0
Biotite	4	4	0.2	4	5	2	2	2	1	2	0.3
Hornblende	0	0	0	0	0.4	0	Tr	0.7	0	0.5	0
Muscovite	Tr	0	0	0	0	0	0	0	0	Tr	Tr
Apatite	0.6	0.2	0	0	0	0	0	0	0	Tr	0
Opaques	0.4	1	0	0.6	0	Tr	0.3	0.4	0	Tr	1.5
Calcite	1	0	0	0	0	0	0	0	0	0	0
Sphene	0	0	Tr	Tr	Tr	0	Tr	0.3	0	0	0
Epidote	0	0	0	0	0	0	0.3	Tr	0	0	0
Totals	100	100	100	100	100	100	100	100	99	99	98

sedimentary strata of the Beartooth Quartzite and Colorado Formation probably covered the Precambrian rocks, and porphyritic sills of the hood zone of the Tyrone stock probably were emplaced into the Cretaceous strata. Closely following the intrusion of the stock (56 Ma) there was an intrusion of rhyolite dike swarms along pre-existing east-northeast faults. Some of the dikes expanded into rhyolite plugs (table 3), e.g. Three Sisters and at the Shrine mine (89)[1], and others acted as feeder dikes to rhyolite sills, e.g. Saddle Mountain. Some of the dike swarms west and east of Saddle Mountain are curvilinear with a radius of about 6.5 mi from the center of the Tyrone stock; this is suggestive of a weakly developed ring fracture system about the stock (pl. 1). This episode of rhyolitic magmatism probably occurred 40-50 Ma as based on fission-track ages of 41.9±3.0 m.y. and 49.5±2.8 m.y. for rhyolite dikes (W. N. Sharp, oral commun., 1983). Some, if not most, of the uranium-bearing, precious- and base-metal veins in the White Signal district were synchronous with this rhyolitic magmatic episode.

A rhyodacite porphyry sill and (or) stock (table 3) intrudes older andesite (TKa, pl. 1) at the south end of the Little Burro Mountains. This intrusion has been dated by K-Ar methods on biotite as 50 Ma (R. F. Marvin, written commun., 1983). The rhyodacite porphyry is highly faulted, altered, and mineralized in the vicinity of the Boston (3) and Tullock group (4) of mines which suggests a post-50 m.y. age for the fissure veins in this area.

Post-Laramide erosion

A lull in igneous activity occurred from 45 to 35 Ma when most of the Laramide flows, tuffs, and Late Cretaceous sedimentary rocks were stripped from the Burro Mountain Uplift. This period of erosion resulted in the unroofing of the Tyrone stock and marked the beginning of supergene enrichment in the mineralized parts of the stock.

Oligocene and late Tertiary volcanism

Volcanism of an explosive eruptive type occurred in the Oligocene and extended into the early Miocene. There was a widespread accumulation of ash-flow and air-fall tuffs from such calderas as the Emory and Bursum cauldrons, as well as contributions from the Schoolhouse Mountain volcanic center (fig. 1). The volcanic rocks of this episode are largely preserved along the Knight Peak half-graben and along the dip-slope of the Little Burro Mountains.

Basin-and-range faulting and late Tertiary deposits

A period of extensive faulting followed the Oligocene-early Miocene volcanism, and numerous northwest-trending fault blocks, horsts, and grabens formed in late Oligocene-early Miocene time (26-20 Ma). Erosion during this extensional tectonic activity resulted in the formation of thick basin-fill deposits of the Gila Conglomerate. The earliest formed deposits of the Gila Conglomerate in the Tyrone area are represented by ferruginous sedimentary breccias (QTgb, pl. 1) in the NW1/4 sec. 25, and in secs. 12 and 13, T. 19 S., R. 15 W. These breccias probably pre-date the earliest movement on the Mangas

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[1]Numbers refer to localities described in table 5.

Table 3.--Modal analyses of plug, dike, and stock satellitic to Tyrone pluton

Number	WM-246-77	WS-11-76	T-317-77	T-2-83
Rock type	Quartz porphyry plug	Quartz monzodiorite porphyry dike	Rhyodacite porphyry stock	Rhyodacite porphyry stock
Location	SE,SW,NE 15 T19S, R15W	SW,SW,SW 25 T19S, R15W	SW,SW,SE 12 T19S, R15W	NE,NE,NE 13 T19S, R15W
Groundmass	63	67	63	62
K-feldspar	0	0	4	0
Plagioclase	36	27	27	32
Quartz	1	5	2	2
Biotite	0	1	3	3
Hornblende	0	0.2	1	0
Muscovite	Tr	0	Tr	0
Apatite	0	0	Tr	Tr
Opaques	0	0.7	2	Tr
Calcite	0	0	0	0
Sphene	0	0	0	Tr
Epidote	0	0	0	0
Totals	100	100	100	99

fault, and the limited outcrops of the channel-fill type of occurrences on both sides of the fault preclude any positive determinations of the amount of subsequent Pliocene or Holocene displacement. In the late Oligocene or early Miocene, iron-rich ground waters flowed northeast from the tilted and weathered copper deposits of the Tyrone stock and the iron was precipitated as limonite, and in some cases as Cu-Mn-Fe oxides, in the porous gravels and sedimentary breccias that accumulated along the dip-slope of the tilted fault block. Such deposits suggest that the supergene enrichment at Tyrone probably pre-dates the most recent Pliocene displacement on the Mangas fault. Movement on the Mangas fault and other northwest-striking faults, such as the Knight Peak fault, began in the late Miocene but continued after much of the Gila Conglomerate had accumulated.

Volcanic flows locally cap the Gila Conglomerate along the western foothills of the Little Burro Mountains. These basaltic flows of probable Pliocene age represent fissure eruptions that came up along the Mangas fault.

Structure

Faults

In the Tyrone area the major northeast-striking faults are the Sprouse-Copeland and Austin-Amazon faults which delimit the Tyrone horst. These faults are splayed and branched and show evidence for several periods of movement. At places these faults are intruded by rhyolite and quartz monzodiorite porphyry dikes. Subsequent movement along the faults has caused brecciation of the dikes. The amount of displacement along the Sprouse-Copeland fault is unknown, but it is at least 500 ft if based on the high relief between surfaces on similar rocks on opposite sides of the fault and on the deep dissection by stream action on the upthrown north block. Similarly the amount of offset on the Austin-Amazon fault is unknown but is probably not as much as on the Sprouse-Copeland fault. Branch faults along the splayed Austin-Amazon fault are intruded by quartz monzodiorite porphyry dikes.

Other important northeast-striking Laramide faults are the Osmer, Bismuth-Foster, Spar Hill, Beaumont, Burro Chief, Niagara, Bison-Thistle, Copper-Gulf, Gettysburg, and the Blue Jay. Many of these features are associated with zones of closely spaced northeast-striking fractures, some of which are highly silicified, and others highly ferruginous. The numerous small faults and fractures within the area of porphyry copper mineral deposits are probably related to "crackling" effects produced by hydrothermal fluid pressures within the hood zone of the Tyrone stock. The Burro Chief fault bisects the stock displacing the southeast part of the porphyry hood zone downward to the southeast, further preserving the porphyritic intrusive phase from erosion. This fault also is locally intensively silicified and sericitized, as along the east side of Deadman Canyon, and in places is highly brecciated and mineral filled, as in the Burro Chief fluorspar mine (16). Similar fluorite deposits, late-stage and post sulfide-ore, are observed along parts of the Spar Hill fault and along the Sprouse-Copeland fault near the Neglected mine (116). A characteristic feature of many of the northeast-striking faults is recurrent displacement.

The Southern Star fault displaces the Gila Conglomerate downward against Precambrian granite at the north end of the Tyrone horst. In the vicinity of the Southern Star mine (25), sediments of the basal Gila Conglomerate also are impregnated with Cu-Mn-Fe oxides. The displacement on the Southern Star fault at this locality is probably as much as 800 ft and must be appreciable as shown by aeromagnetic surveys (D. P. Klein, written commun., 1984). This fault is part of the Basin-and-range fault system and could be part of the Beaumont fault only if recurrent movement had taken place.

Basin-and-range type, tilted fault blocks occur throughout the Burro Mountain-Silver City region. The faults that bound the fault blocks strike northwest, can be traced for tens of kilometers, and are chiefly of Miocene-Pliocene age, although displacements as recent as the Holocene have also occurred. In the Tyrone area these faults are represented by the Mangas and Knight Peak faults which have displacements of about 1,200 and 6,000-8,000 ft, respectively (see secs. C-C′, Wind Mountain quadrangle, Hedlund, 1978a, and sec. A-A′, Burro Peak quadrangle, Hedlund, 1978d). In the Mangas Valley the thickness of basin fill provides some indication of fault displacement. As much as 1,100-1,200 ft of basin fill has been penetrated by drilling (Trauger, 1972). The amount of displacement along the Knight Peak fault is more uncertain and is estimated on the assumption that the fault flattens with depth. Both the Mangas and Knight Peak faults have the northeast blocks upthrown, and the amount of tilting to the northeast is as much as 20 to 25 degrees on the Little Burro Mountain block, 5 to 8 degrees on the Burro Mountain block, and as much as 60 to 65 degrees to the northeast on volcanic rocks within the Knight Peak half-graben.

Other northwest-striking faults of lesser magnitude are present along both sides of Walnut Creek and in the White Signal district. These faults commonly displace older northeast faults, such as the Blue Jay, but they lack continuity and are locally intruded by rhyolite dikes. It is probable that these small northwest-striking faults have a 40-45 Ma Eocene age rather than a Miocene-Pliocene age. Moreover, some of the west-northwest and northwest-striking faults are mineralized, e.g. the Uncle Sam deposit to the southeast outside of the mapped area and the Apache Trail mine (69) to the north of the White Signal district.

It is possible that some of the northwest-striking faults may be rejuvenated faults of late Precambrian age, but this is difficult to prove. The only evidence is that of diabase dike orientation and the presence of subparallel rhyolite dikes that also strike northwest, e.g. just northwest of the Shrine intrusion.

Jointing

Numerous joint readings (128) on rocks in the Tyrone stock indicate a strong N. 50°-70° E. orientation and a minor N. 5° W. orientation (pl. 1). These joint readings are supplemented by numerous readings from joints in the nearby Precambrian country rocks where a discernible N. 60°-80° E. orientation is present. All of these joint readings coupled with dike swarm orientations (N. 60°-80° E.) indicate an operative stress field during the emplacement, crystallization, and cooling history of the Tyrone stock. This stress component, oriented N. 50°-80° E. had an extension component oriented N. 10°-30° W. which facilitated the intrusion of numerous dikes. The principal period through which the stress component was in effect ranged from 56 to 40 Ma.

MINERALIZATION, ALTERATION, AND GEOCHEMISTRY

Introduction

Detailed descriptions of the diverse mineral deposits of the Big Burro and Little Burro Mountains have been published by Gillerman (1964, 1967, 1970), Paige (1911, 1916, 1922), Kolessar (1970, 1982), Somers (1915), Granger and Bauer (1950, 1952), Rothrock and others (1946), and O'Neill and Thiede (1982). Generally these studies have been of specific types of hydrothermal deposits including (1) porphyry copper; (2) precious- and base-metal fissure veins; (3) quartz-molybdenite veins; (4) uranium-bearing veins; and (5) fluorite veins. Some of these vein types have been subdivided into sub-groups. For example, Gillerman (1964, 1967) grouped the uranium-bearing veins into four categories: quartz-pyrite, quartz-specularite, high-silver and lead-silver, and turquoise. O'Neill and Thiede (1982) observed secondary uranium occurrences with these four vein types but noted that most uranium is associated with quartz-pyrite veins.

Comprehensive geochemical surveys in the Burro Mountain-White Signal areas have not yet been made. In the past, most analyzed samples were from inactive mine workings and little effort was made to analyze soil, spring waters, or stream-sediment concentrates. However, a geochemical survey for molybdenum was conducted by the Cities Service Co. in 1978 in the vicinity of Sugarloaf Mountain along the northwest margin of the Tyrone stock. The results of this study were released to the U.S. Geological Survey in 1979 after the Cities Service Co. released their claims in this area of Sugarloaf Mountain.

After the U.S. Geological Survey completed geologic mapping in the Silver City $1^{o}x2^{o}$ quadrangle in the late 1970's, it became apparent that there was a zonation of ore minerals about the Tyrone stock. Quartz-molybdenite veins are concentrated along the northwest margin of the stock near Sugarloaf Mountain and along the Beaumont fault. Precious metal- and base-metal veins occupy the next outer (intermediate) zone and locally contain anomalous amounts of bismuth and antimony. Silver-bearing veins containing barite are along the outermost zone. Fluorite veins are late, post-sulfide, breccia-filling vein deposits. An area of uranium veins in the White Signal district is probably related to the numerous rhyolite dikes and plugs that were intruded during a period of silicic magmatism that is slightly younger than the calc-alkaline monzonitic rocks of the Tyrone stock.

Porphyry copper deposits of the Tyrone stock

At least three intrusive phases can be recognized for the Tyrone pluton (table 2): (1) an equigranular phase of quartz monzodiorite (Tqm, pl. 1) largely represented in the central and southwestern parts of the stock, (2) a porphyritic phase (Tqmp) that is present in the northeastern part of the intrusion and probably represents the upper hood zone of the stock, and (3) an intrusive quartz porphyry (Tqp) phase that forms a satellitic plug in sec. 15, T. 19 S., R. 15 W. In addition, there are breccia pipes (Tqmb) both within the quartz monzodiorite porphyry and within the Precambrian granite country rock.

The hypogene ore minerals of the Tyrone stock are pyrite, chalcopyrite, sphalerite, galena, and traces of molybdenite and bornite. Most of the ore minerals occur as fracture fillings and disseminations in the quartz monzodiorite porphyry and to a limited extent in the granite country rock. Some ore minerals occur as a partial matrix to the fragments within the breccia pipes. The sulfide mineralogy of the hypogene ore minerals is relatively simple and the two major sulfides, pyrite and chalcopyrite, are present in a ratio of 6:1.

The supergene blanket is irregular, discontinuous, has an uneven lower surface, and is generally less than 300 ft thick. Chalcocite is the most common secondary sulfide and mantles and replaces pyrite and chalcopyrite. The secondary ore minerals in the supergene zone are more complex than the hypogene sulfides and include tenorite, cuprite, native copper, malachite, chalcanthite, brochantite, and turquoise.

Only three samples of the mineralized quartz monzodiorite porphyry were spectrographically analyzed (table 4), and therefore the trace element assemblage is not well known. Tentative results indicate as much as 15 ppm Ag, 20 ppm Mo, 10 ppm Ni, 30 ppm Co, and 150 ppm V in parts of the mineralized porphyry.

The mineralized part of the quartz monzodiorite porphyry is characterized by pronounced potassic metasomatism, with sericitic alteration most common. Locally chlorite replaces biotite, clay minerals replace sericite, and alunite veins up to 8 in. in thickness cut the porphyry (Kolessar, 1970, p. 131). A limited number of analyses indicate that the Na_2O/K_2O ratio in the unaltered rock is 1.5, whereas in the altered rock the ratio is 0.10 to 0.23 (tables 3 and 4). The spectrographic data also indicate a significant depletion of barium and especially strontium in the altered quartz monzodiorite porphyry. There is as much as 1,500 ppm Sr and 1,000 ppm Ba in the fresh quartz monzodiorite of the stock but only 200 to 300 ppm Sr and 500 to 700 ppm Ba in the two samples of the mineralized rock within the stock (table 4).

Data on the Tyrone open pit (1) is presented in table 5, which follows the list of selected references.

Precious- and base-metal veins exclusive of the quartz-pyrite veins of the White Signal district

Most commonly the Laramide faults that strike east-northeast to northeast are the chief sites of precious-metal and base-metal vein deposits. The vein mineralogy is highly variable, but generally mineral assemblages can lead to a classification scheme. For example, some veins are simple quartz-pyrite-gold or quartz-molybdenite assemblages; others are more complex and contain varying amounts of magnetite, specularite, pyrite, sphalerite, chalcopyrite, covellite, bornite, galena, cerargyrite, native silver, bismuthinite, native bismuth, an antimony sulfosalt, and uraninite. The mineralization can be divided into three stages: an early stage of quartz veining, silicification of the wall rocks and formation of magnetite, specularite, and molybdenite; a second stage of sulfide mineralization and a slightly later substage formation of Ag-Bi-Sb sulfosalts; and a third, post-sulfide stage with the formation of fluorite deposits. The early silicification stage is locally very pervasive, e.g. in Sugarloaf Mountain and surrounding areas where a quartz stockwork is locally present.

Many of these veins have siliceous and ferruginous cappings owing to extensive oxidation during weathering. However, exceptions occur; for example, at the Neglected (116), Sprouse (75), Copeland (76), Austin-Amazon (105), Alexander-Jacobs Promise (90), Bolton (92), and Beaumont (88) mines, the veins are relatively unoxidized and occur in areas where erosional

Table 4.--Semiquantitative spectrographic analyses of mineralized samples

[Analyses by L. A. Bradley, M. J. Malcolm, and J. C. Hamilton. Values reported in parts per million to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.1, and so forth. Number below element is lower limit of determination. Elements determined but not reported here are: Fe, Mg, Ca, Cr, Ga, Sc, Yb, and Zr. L, detected but below limit of determination; N, not detected; G, greater than 10 percent]

Lab No.	Mine	Ag (0.5)	Au (10)	As (200)	Ba (20)	Be (1)	B (10)	Bi (10)	Cd (20)	Co (5)	Cu (5)	La (50)	Mn (10)	Mo (5)	Ni (5)	Pb (10)	Sb (100)	Sr (65)	Sn (10)	V (10)	W (50)	Y (5)	Zn (200)	K	Na
D-189617	Tyrone[1]	15	N	N	500	N	N	N	N	7	5,000	L	300	20	10	150	N	200	N	70	N	15	1,500	3.0%	0.7%
D-225894	Tyrone[1]	1	1	N	700	1.5	1	N	N	30	15,000	30	N	5	10	300	N	300	15	150	N	20	300	3.0%	.3%
D-221182	Tyrone[1,2]	N	N	N	1,000	N	N	N	N	5	150	N	200	N	L	20	N	1,500	N	70	N	10	300	3.0%	3.0%
D-186326	Austin-Amazon	30	N	N	700	N	N	L	N	7	10,000	N	20,000	7,000	N	1,000	N	150	30	15	N	30	1,500	N	N
D-186328	Foster-Zinc	15	N	N	100	N	N	50	700	70	2,000	100	700	15	15	700	N	N	10	10	N	50	70,000	N	N
D-186327	Silver Dollar	200	N	N	70	N	N	30	N	N	300	N	150	20	N	1,000	N	N	N	7	N	N	3,000	N	N
D-186325	Spar No. 2	N	N	N	50	N	N	N	N	N	70	100	30	N	N	15	N	150	N	N	N	150	N	N	N
D-189618	Shrine	5	N	N	100	1.5	N	N	N	N	15	L	70	300	L	N	N	20	N	15	N	70	N	N	N
D-168329	Neglected	100	N	N	30	N	N	N	N	N	10,000	N	20	N	5	2,000	N	10	N	7	N	N	300	N	N
D-195636	Osmer Gold	5	N	N	700	1.5	L	N	N	L	15	N	1,500	3	7	500	N	50	N	7	N	15	N	N	N
D-189615	Alexander	.7	N	N	300	2	N	L	N	N	100	L	70	70	N	50	N	70	N	30	N	15	N	N	N
D-189616	Jersey Lilly	150	N	N	G	N	L	15	N	L	1,500	N	500	N	L	150	N	5,000	N	7	N	15	700	N	N
D-189620	Contact No. 1	70	N	N	150	1.5	L	N	50	5	3,000	N	300	N	L	700	N	5	N	15	N	30	10,000	N	N
D-189621	Contact No. 2	30	N	N	100	3	L	L	50	L	300	N	G	N	L	2,000	N	15	N	7	N	20	10,000	N	N
D-195637	Blue Jay	1	N	N	300	7	N	N	N	7	300	200	700	N	15	30	N	150	15	150	L	150	N	N	N
D-193211	---	N	N	N	700	2	L	N	N	L	10	70	150	N	L	20	N	500	N	N	N	50	N	N	N

[1]All Tyrone samples are from within the stock.

[2]Fresh quartz monzodiorite porphyry.

processes have been relatively rapid. In addition to the limonitic-jarosite cappings, some of the weathered veins contain chrysocolla, malachite, turquoise, azurite, bismutite as yellowish efflorescences, and small amounts of torbernite, metatorbernite, autunite, and bassettite at the contact with diabase dikes (O'Neill and Thiede, 1982). Some of the silver-bearing veins in the Little Burro Mountains contain abundant manganese oxides and barite. Semiquantitative spectrographic analyses of mineralized samples are given in table 4.

Quartz-molybdenite veins

Molybdenite is common in areas of intense silicification along the northwest margin of the Tyrone stock, for example along and adjacent to the Beaumont and Austin-Amazon faults and along the contact of the quartz monzodiorite with granite. These silicified zones contain as much as 800-900 ppm Mo. Other sulfides are locally present, mostly pyrite and chalcopyrite, in areas of argillic alteration that locally accompany the quartz "flooding." The molybdenite tends to occur as veinlets rather than as disseminations along this northwest margin.

Quartz-specularite veins

The quartz-specularite veins are commonly present along the east side of the Tyrone stock along the Apache Trail fault where the veins are as much as 8 ft wide. Other occurrences of specularite occur at the Merry Widow (130) and Chapman (145) mines, and anastomosing quartz-specularite veinlets also occur within the rhyolite plugs of the Three Sisters. Magnetite is also locally abundant at the Apache Trail mine (69) as well as pyrite, gold, an unidentified bismuth mineral, copper carbonates, galena, torbernite, and fluorite. Granger and Bauer (1952) reported as much as 0.041 percent eU_3O_8 along parts of the Apache Trail fault. As in most other vein occurrences of this type the specularite and magnetite are early in the paragenetic sequence, e.g. pyrite commonly has numerous inclusions of magnetite and specularite.

Quartz-pyrite veins, including the White Signal district

The quartz-pyrite veins are commonly gold bearing, and many of these veins are also radioactive in the White Signal district. Numerous analyses (table 5) presented by O'Neill and Thiede (1982) show as much as 3,100 ppb Au in veins of the Calamity mine (155) and 15,300 ppb Au in veins of the Paddy Ford mine (158). Other veins in this area commonly contain 250 to 380 ppb Au. All of the veins contain minor amounts of chalcopyrite, sphalerite, galena, bismuthinite, and an unidentified antimony sulfosalt.

Uraninite has been identified only at the Blue Jay mine (139), but secondary uranophosphate minerals are ubiquitous where the quartz-pyrite veins cut diabase dikes. The prevailing view (O'Neill and Thiede, 1982, p. 9) for the origin of these secondary uranium deposits is as follows: ". . . during the Tertiary, uranium-bearing hydrothermal solutions were generated by a concealed intrusive body and entered an existing pervasive system of east-northeast- to east- and northwest-trending faults and shear zones. As the solutions moved through the fault system, fissure-filling veins were formed in fractures and brecciated zones cutting Precambrian granite and dikes ranging in age from Precambrian to Tertiary. The veins contained uranium, probably as uraninite, and variable amounts of base and precious metals. After deposition of the veins, a deep-weathering profile developed, which progressively oxidized the primary ore minerals of the veins. Within the oxidation zone, uranium became mobile and started to be dispersed from the near-surface portion of the veins. Where the veins had intersected, or were located adjacent to high phosphate mafic dikes, uranium was precipitated as secondary concentrations of uranyl phosphate minerals." The White Signal district was especially favorable for uranium deposition since there are numerous north-northwest-striking diabase dikes in this region that are cut by quartz-pyrite veins.

Anomalously high values (350 ppm) for rare-earth elements are reported from the Blue Jay mine (139) and probably are components in the uraninite (thorian uraninite) from this vein system. The thorium contents are highly variable but as much as 547 ppm equivalent thorium--radiometrically determined, has been reported from the Banner vein (136), 582 ppm eTh from the Tunnel Site No. 1 (141), and 702 ppm eTh from the Tullock shaft (142) (O'Neill and Thiede, 1982).

Silver-lead-manganese oxide veins

Fissure veins that contain appreciable silver (table 5) are as follows: Silver Dollar mine (104) (200 ppm Ag), Jersey Lilly (13, 14) (150 ppm Ag), Neglected (116) (100 ppm Ag), Contact group (8) (30 and 70 ppm Ag), Austin-Amazon (105) (30 ppm Ag), and just outside of the mapped area, the Uncle Sam mine (97 ppm Ag). Generally these veins have high lead contents (1,000-2,000 ppm Pb), although some Pb values are as low as 150 ppm, e.g. Jersey Lilly group, and others have as much as 12,900 ppm Pb, e.g. Uncle Sam mines (O'Neill and Thiede, 1982). Abundant manganese oxides are characteristic of some silver veins, e.g. the Contact mine (8), and in others barite is a common gangue mineral, e.g. the Jersey Lilly (13, 14) and Snowflake deposits (12). Some of the silver-lead veins contain anomalous fluorine, e.g. the Uncle Sam vein (2,177 ppm F).

Turquoise veins

Fissure veins containing turquoise are the Red Hill Turquoise mine (71), the Chapman occurrence (145), the Azure (18), New Azure (17), Parker (19), and Porterfield mines (20). Generally the turquoise occurs in pockets and seams along faults or fractures in which the wall rock is variably argillized, sericitized, and iron stained. Residual pyrite and chalcopyrite may be present and copper carbonates are locally abundant. The Chapman deposit is weakly radioactive and contains as much as 63 ppm U_3O_8 (O'Neill and Thiede, 1982).

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Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico

[Leaders (---) indicate no data. Analytical data are chiefly semiquantitative and quantitative spectrographic determinations from sources identified by footnotes: the U.S. Geological Survey (1/), the U.S. Department of Energy (2/), and private industry (*). All values in parentheses are in parts per million, except for those for gold which are in parts per billion (ppb). cU_3O_8 - chemically determined U_3O_8; eU - equivalent uranium; eU_3O_8 - equivalent uranium oxide. Map numbers refer to plate 1]

Map No.	Name	Description	Analytical data	Development	References
1	Tyrone open pit	Disseminations and fracture-fillings of chalcopyrite, chalcocite, sphalerite, galena, and pyrite in highly faulted quartz monzonite. Chalcocite in supergene blanket deposits is not an important source of copper. Average ore grade 0.7 percent Cu.	(1) Cu (15,000), Pb (300), Zn (300), Ag (0.7), Mo (5) 1/. (2) Cu (5,000), Pb (150), Zn (1,500), Ag (15), Mo (20), 1/	In the 1950's Phelps Dodge conducted a 10-year drilling program to develop the Tyrone porphyry copper ore deposit. The Tyrone open pit has been in operation since 1969. Former high-grade vein deposits that are now a part of the pit include the Niagara, Thistle, B-shaft, No. 3 shaft, Sampson, St. Louis, Racket, and Copper Gulf.	Paige, 1916, 24 p. Gillerman, 1964, p. 44-48. Kolessar, 1970, p. 127-132. Kolessar, 1982, p. 327-333. Sommers, 1915, p. 604-656. This report, table 4.
2	Montezuma Group	Thin copper-bearing veins in rhyodacite porphyry.	---	Numerous adits, shafts, and prospect pits. Now largely concealed by rock waste.	Gillerman, 1964, p. 105.
3	Boston Group	Small copper deposits along N. 60-70° E.-striking veins in sericitized rhyodacite porphyry.	---	Shaft, adit, and prospect pits. Past production unknown.	Gillerman, 1964, p. 105.
4	Tullock Group	Small copper deposits along N. 70° E.-striking veins in sericitized rhyodacite porphyry.	---	Several shafts. Past production unknown but probably small.	Gillerman, 1964, p. 105.
5	Silver King-Mystery Group	Gold and silver-bearing base metal veins in propylitized andesite.	---	Shaft and adit. Past production averaged 5.8 oz gold/short ton (181 g/ton).	Gillerman, 1964, p. 106 Paige, 1922.
6	Virtue mine	Silver-bearing base metal veins along silicified and highly altered fault that strikes N. 60° E.	---	Shaft and tunnel with extensive underground workings.	Gillerman, 1964, p. 109. Paige, 1922.
7	Afternoon shaft	Silver-bearing base metal veins strike N. 35° E. in andesite. Abundant calcite gangue.	---	Ore averages 0.6 oz silver/ton.	Gillerman, 1964, p. 106, 108.
8	Contact mines	Silver-bearing base metal veins along faulted contact of granite and andesite. Abundant manganese oxides.	(1) Cu (3,000), Pb (700), Zn (10,000), Ag (70) 1/. (2) Cu (300), Pb (2,000), Zn (10,000), Ag (30) 1/.	At least 140 short tons of manganese ore averaging 20 percent manganese. Silver values vary from 30 to 70 ppm.	Gillerman, 1964, p. 110. This report, table 4.
9	Wyman mine	Silver-bearing base metal vein 3-5 ft wide.	---	Numerous prospect pits and shafts along vein over a distance of 480 ft.	Gillerman, 1964, p. 110.
10	Casino mines	Silver-bearing base metal vein along a highly brecciated and silicified fault.	---	Numerous prospect pits and several shafts. Ore values were greatest in the brecciated vein with some ores containing as much as 20 oz silver/ton and 0.25 oz gold/ton.	Gillerman, 1964, p. 110.
11	Full Moon mine	Silver-bearing base metal veins along N. 40° E. and N. 10-15° E.-striking faults.	---	About 525 short tons of ore shipped averaging 10 oz silver/short ton.	Gillerman, 1964, p. 110.
12	Snowflake mine	Silver-bearing base metal vein in granite and along a fault that strikes N. 65-70° E. Cerargyrites bearing ores were high grade, as much as 350 oz Ag/ton.	---	In 1907 about $25,000 of silver ore was shipped. Developed by shaft and prospect pit.	Gillerman, 1964, p. 111.
13	Jersey Lilly No. 1 mine	Silver-bearing base metal deposit along fissure veins that strike N. 15° E.	Cu (1,500), Pb (150), Zn (700), Ag (150) 1/	Three adits in granite about 70 ft below contact with Beartooth Quartzite. Value of silver shipped in 1907 was between $10,000 and $15,000. In 1930, 60 short tons of ore shipped.	Gillerman, 1964, p. 111. This report, table 4.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
14	Jersey Lilly No. 2 mine	Silver-bearing base metal deposit along fissure vein that strikes N. 45° E.	---	Adit	Gillerman, 1964, p. 111.
15	No. 2 shaft	Fissure veins strike N. 40° E. in granite	---	Workings are now part of the Tyrone open pit mine.	Paige, 1922, p. 41, 42.
16	Burro Chief mine	Fluorite veins as much as 5 ft wide along brecciated fault that strikes N. 15-25° E. Some azurite and malachite in dump material.	---	Past production about 28,500 short tons of fluorspar.	Gillerman, 1964, p. 53, 54. Johnston, 1928, p. 109-110. Rothrock and others, 1946, p. 69-71.
17	New Azure mine	Turquoise along vein at contact of quartz monzodiorite porphyry and granite.	---	Developed by open cut.	Gillerman, 1964, p. 48.
18	Azure mine	Turquoise in pockets along vein that strikes N. 65-70° E.	---	Formerly a high-grade deposit with large production of turquoise.	Gillerman, 1964, p. 49, 50.
19	Parker mine	Turquoise along vein that strikes N. 65-70° E.	---	Two large open cuts.	Gillerman, 1964, p. 51.
20	Porter-field mine	Turquoise in seams along fractures that strike N. 65° E. Kaolinized, silicified, and sericitized granite host.	---	Two shafts and tunnel about 170 ft long.	Gillerman, 1964, p. 51, 52.
21	Copper King mine	Chrysocolla and copper carbonates along a sheeted fracture zone that strikes N. 55° E.	---	Developed by shaft reported to be at least 410 ft deep.	Gillerman, 1964, p. 51.
22	___	Silicified fault strikes N. 60° E. Minor amounts of malachite and azurite along fault.	---	Two shafts.	Unpublished U.S. Geological Survey data.
23	---	Minor amounts of copper carbonate along margins of quartz monzodiorite porphyry dike.	---	Two shafts	Unpublished U.S. Geological Survey data.
24	Two-Best-in-Three mine	Ore shoot in granite at intersection of N. 75° E. and N. 25° W.-striking faults. N. 75° E.-striking shear is locally marginal to quartz monzodiorite porphyry dike. Oxidized high-grade ore shoot averaged 7.5 percent copper.	---	Developed by adit driven eastward 375 ft. As much as 2,000 short tons of ore mined in 1890's contained 15 percent copper.	Gillerman, 1964, p. 61-62.
25	Southern Star mine	Copper-bearing conglomerate (Gila Conglomerate) with boulders and cobbles of quartz monzodiorite cemented by crednerite and chrysocolla.	---	Three adits and open cut.	Gillerman, 1964 p. 59, 60.
26	California Gulch mine	Fluorite-quartz veins up to 3 ft thick along brecciated faults that strike ENE and NW in granite.	---	Numerous prospects, adits, and shallow shafts. Past production probably about 20 short tons.	Gillerman, 1964, p. 58, 59.
27	Little Rock mine	Copper-bearing vein is locally marginal to quartz monzodiorite porphyry dike. Vein strikes due east to N. 70° E.	---	Shaft inclined due south.	Gillerman, 1964, p. 61.
28	Ohio mine and Copper Leach pit	Copper-bearing vein strikes N. 20-30° E. and N. 70° E. Abundant copper carbonates at the surface. Minor fluorite present.	---	Developed by shaft 340 ft deep and by open cut in 1969-1970(?) by U.S. Natural Resources and by Copper Mountain. Copper oxide leach operations were carried out along south half of sec. 17.	Gillerman, 1964, p. 60, 61.
29	Nellie Bly mine	Copper-bearing vein about 0.5 ft thick strikes due east.	---	Developed by adit inclined 35° S.	Gillerman, 1964, p. 61.
30	Copper Mountain mine	Secondary copper oxides along the silicified Burro Chief fault. Chrysocolla is abundant for about 500 ft along the strike of the fault.	---	Shaft, trenches, and prospect pits.	Gillerman, 1964, p. 54, 55.
31	---	Secondary copper oxides along the silicified Burro Chief fault.	---	---	---

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
32	Liberty Bell mine	Numerous veinlets of copper carbonates along a fault that strikes N. 50-55° E. Some chalcocite is reported at depth. The workings are along a subsidiary fault of the Burro Chief fault.	---	Deposit developed by an adit about 98 ft long and extensive underground workings.	Gillerman, 1964, p. 53, 54.
33	---	Secondary copper oxides along silicified fault.	---	Series of trenches along hillside.	Unpublished U.S. Geological Survey data.
34	---	Hematite-stained fault with traces of secondary copper oxides at intersection of two northeast-striking faults. Vein is radioactive, about 2 times background.	---	Shaft.	Unpublished U.S. Geological Survey data.
34-A	---	Hematite-stained fault strikes N. 65° E. Radioactive, about 5 times background.	eU(673), eTh(46) 2/	---	O'Neill and Thiede, 1982.
35	---	Hematite-stained fault with minor secondary copper oxides.	---	---	Unpublished U.S. Geological Survey data.
36	---	Hematite-stained fault with minor secondary copper oxides.	---	Prospect pit.	Unpublished U.S. Geological Survey data.
37	---	Hematite-stained N. 20° E. fault is slightly mineralized, especially at intersection with N. 85° W.-striking fault. Slightly radioactive.	Cu (83), Pb (346), Mo (12), F (216), eU (230), eTh (21) 2/	---	O'Neill and Thiede, 1982.
38	---	Secondary copper oxides along sheeted fractures in quartz monzonite. Fault strikes N. 80° E.	---	Prospect pits.	Unpublished U.S. Geological Survey data.
39	---	Fracture-fillings of copper oxides and abundant limonite at fault intersection.	Cu (362), Mo (32), Sb (267), Sn (19), P (341), eU (44), eTh (3), cU_3O_8 (200) 2/	Prospect pit.	O'Neill and Thiede, 1982.
40	---	Fracture-fillings of copper oxides and abundant limonite.	---	Prospect pit.	Unpublished U.S. Geological Survey data.
41	---	Fracture-fillings of copper oxides. Radioactivity 2 times background along N. 80-85° E. fault.	Cu (117), Mo (69), Sb (273), eU (506), eTh (3), F (1321) 2/	Prospect pit.	O'Neill and Thiede, 1982.
41-A	---	Fault intersection in quartz monzonite. Abundant ferric oxides. Radioactive.	eU (1000), eTh (85) 2/	---	O'Neill and Thiede, 1982.
42	---	Sparse pyrite; no visible copper oxides.	Cu (210), Pb (190), Zn (170)*	Prospect pit.	Unpublished U.S. Geological Survey data.
43	---	Abundant quartz along N. 30° E.-striking fault.	Cu (2000), Pb (720), Zn (1900)*	---	Hedlund, 1978d.
44	---	Quartz vein along N. 80° E.-striking fault.	Cu (380), Pb (30), Zn (90)*	Prospect pit.	Unpublished U.S. Geological Survey data.
45	---	Secondary copper oxides along fault.	Cu (455), Pb (60), Zn (350)*	Shaft.	Unpublished U.S. Geological Survey data.
46	---	Abundant hematite along N. 15° E.-striking fault. Minor secondary copper minerals.	Cu (140), Pb (1500), Zn (365)*	Two prospect pits.	Unpublished U.S. Geological Survey data.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
47	---	Abundant quartz along N. 40-50° W.-striking fault. Minor secondary copper minerals.	Cu (1200), Pb (30), Zn (200)*	Prospect pit.	Hedlund, 1978d.
48	---	Quartz vein along N. 80° E.-striking fault. Some secondary copper carbonates.	Cu (845), Pb (220), Zn (110)*	Prospect pit.	Unpublished U.S. Geological Survey data.
49	---	Abundant quartz along vein.	Cu (175), Pb (20), Zn (60)*	Two prospect pits.	Unpublished U.S. Geological Survey data.
50	---	Minor quartz veinlets; some pyrite.	Cu (200), Pb (40), Zn (75)*	Prospect pit.	Unpublished U.S. Geological Survey data.
51	Racket shaft	Numerous fissure veins along the Rocket Virginia fault contain chalcocite.	---	Shaft; now concealed by rock waste.	Unpublished U.S. Geological Survey data.
52	Gettysburg shaft	Fissure veins along the Gettysburg fault contain chalcocite.	---	Shaft; now concealed by rock waste.	Unpublished U.S. Geological Survey data.
53	---	Occurrence of crednerite in small outcrop of Gila Conglomerate. Shaft to southwest is along a N. 85° W.-striking shatter zone in granite.	---	Shaft and prospect pit.	Unpublished U.S. Geological Survey data.
54	---	Abundant secondary copper oxides in quartz vein that strikes N. 85° W.	---	Three prospect pits.	Unpublished U.S. Geological Survey data.
55	---	Abundant quartz veins in quartz monzodiorite porphyry dike.	Cu (35), Pb (190), Zn (115)*	Prospect pit.	Unpublished U.S. Geological Survey data.
56	---	Copper oxides along N. 85° W.-striking fault.	---	Two prospect pits.	Unpublished U.S. Geological Survey data.
57	---	Secondary copper minerals along N. 45° E.-striking fault.	---	Prospect pit.	Unpublished U.S. Geological Survey data.
58	---	Abundant limonite along contact of rhyolite dike and granite.	(1) Cu (310), Pb (2100), Zn (135)*, (2) Cu (525), Pb (660), Zn (170)*	Prospect pits.	Unpublished U.S. Geological Survey data.
59	---	Intensive silicification of granite.	Cu (90), Pb (20), Zn (30)*	Prospect pit.	Unpublished U.S. Geological Survey data.
60	---	Abundant limonite along N. 55° E.-striking fault.	---	---	Unpublished U.S. Geological Survey data.
61	---	Anastomosing veinlets of ferric oxides in rhyolite at contact with N. 55° E.-striking fault.	Cu (140), Pb (1000), Zn (170)*	Prospect pit.	Unpublished U.S. Geological Survey data.
62	---	Abundant pyrite and magnetite along N. 75° W. fault. Vein is about 6 ft wide.	Cu (205), Pb (40), Zn (160)*	Shaft.	Unpublished U.S. Geological Survey data.
63	---	Abundant pyrite along fault that strikes N. 75° W.	Cu (425), Pb (20), Zn (20)*	Prospect pit.	Unpublished U.S. Geological Survey data.
64	---	Limonitic fault that strikes N. 75° W.	Cu (80), Pb (20), Zn (30)*	Prospect pit.	Unpublished U.S. Geological Survey data.
65	---	Iron oxides along N. 85° W.-striking Apache Trail fault.	Cu (5100), Pb (1300), Zn (2600)*	---	Unpublished U.S. Geological Survey data.
66	---	Abundant specularite and earthy hematite along the Apache Trail fault.	Cu (230), Pb (40), Zn (1300)*	---	Unpublished U.S. Geological Survey data.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
67	---	Abundant earthy hematite and specularite along Apache Trail fault.	Cu (505), Pb (130), Zn (620)*	Numerous prospect pits.	Unpublished U.S. Geological Survey data.
68	---	Abundant earthy hematite in seam 4 ft thick. Also specularite along Apache Trail fault.	Cu (405), Pb (80), Zn (950)*	Numerous prospect pits.	Unpublished U.S. Geological Survey data.
69	Apache Trail mine	Abundant earthy hematite, specularite, chrysocolla, and azurite along the Apache Trail fault. Traces of fluorite. Slightly radioactive.	Cu (1700), Pb (660), Zn (1500).* (Average of 6 analyses)2/ eU_3O_8 (ranges from 0.012 and 0.041 percent).	Several shafts and numerous prospect pits along fault.	Gillerman, 1964, p. 87, 88, 89. Lovering, 1956, p. 341-344. O'Neill and Thiede, 1982. Unpublished U.S. Geological Survey data.
70	---	Trace of molybdenite in rhyolite dike.	---	---	Unpublished U.S. Geological Survey data.
71	Red Hill Turqoise mine	Turquoise along N. 30° W.-striking fractures in quartz-biotite schist xenolith within granite. Radioactivity 2 times background.	Cu (546), Mo (100), Sn (28), P (2220), eU (125), eTh (18), cU_3O_8 (63) 2/	Three prospect pits, open cut and adit.	Gillerman, 1964, p. 102, 103. O'Neill and Thiede, 1982.
72	---	Sparse copper oxides along small N. 70° E.-striking fault.	Cu (35), Pb (10), Zn (5)*	Two prospect pits.	Unpublished U.S. Geological Survey data.
73	---	Minor hematite along sheeted fractures in granite.	Cu (55), Pb (10), Zn (20)*	---	Unpublished U.S. Geological Survey data.
74	---	Soil sample from wash contains sparse copper oxides and quartz.	Cu (70), Pb (40), Zn (80)*	---	Unpublished U.S. Geological Survey data.
75	Sprouse mine	Highly shattered and faulted granite contains fissure-vein deposits of chalcopyrite, pyrite, galena, sphalerite, malachite, azurite, and molybdenite.	---	Shaft and open cuts.	Gillerman, 1964, p. 73, 74.
76	Copeland mine	Mineralized fault contact of quartz monzodiorite and granite. The ore is concentrated in lenses arranged en echelon within the fault zone. Ore minerals are chalcopyrite, pyrite, galena, sphalerite, molybdenite, and tenorite. Assays show small amounts of bismuth, gold, and silver.	---	Shaft and open cuts.	Gillerman, 1964, p. 73-76.
77	---	Quartz vein along branch of Sprouse-Copeland fault that strikes N. 45° E. Some pyrite and chalcopyrite present.	Cu (3700), Pb (360), Zn (2800)*	Dozer scrapes about 100 ft by 60 ft.	Unpublished U.S. Geological Survey data.
78	Indian Hill Shaft	Dump of abandoned workings on west side of Indian Hill. Some secondary copper oxides, pyrite, and chalcopyrite present.	Cu (895), Pb (40), Zn (205)*	Prospect pits and shallow shaft.	Unpublished U.S. Geological Survey data.
79	---	Quartz vein along N. 35-45° E.-striking fault is locally capped by a gossan. Abundant copper carbonates along fractures.	(1) Cu (115), Pb (70), Zn (40)* (2) Cu (1200), Pb (220), Zn (385)* (3) Cu (115), Pb (30), Zn (60)*	Series of dozer cuts and prospect pits along fault.	Unpublished U.S. Geological Survey data.
80	---	Soil sample contains quartz and minor amounts of hematite.	Cu (45), Pb (20), Zn (65)*	---	Unpublished U.S. Geological Survey data.
81	---	Quartz vein material on dump of filled prospect.	Cu (50), Pb (40), Zn (110)*	---	Unpublished U.S. Geological Survey data.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
82	---	Geochemical molybdenum anomaly (300 ppm) in vicinity of Sugarloaf Mountain in an area of "quartz flooding".	---	---	Unpublished U.S. Geological Survey data.
83	National Copper Mine	Copper carbonates along quartz vein that strikes N. 40° E. Vein follows shear zone as much as 50 ft wide.	---	Shaft and adit. Some samples showed 2.0 percent copper, 0.10 oz of gold and a trace of silver.	Gillerman, 1964, p. 57, 58.
84	---	Molybdenum anomaly established by geochemical studies. Most values indicate a maximum of 7000 ppm molybdenum.	---	Area of drill core analyses by Cities Service Minerals Corp., 1976, and some geochemical prospecting.	Unpublished U.S. Geological Survey data.
85	National mine	Chiefly copper carbonates in zone of oxidation. Some chalcocite and pyrite at lower levels along N. 70° E. fractures.	---	Shaft about 180 ft deep.	Gillerman, 1964, p. 57.
86	Beaseley mine	Pyrite, chalcopyrite, and copper carbonates in vein along the Beaumont fault.	---	Shaft, about 50 ft deep, open cut, and numerous prospect pits.	Gillerman, 1964, p. 56, 57.
87	Mayflower shaft	Pyrite, chalcopyrite, and copper carbonates along vein that strikes N. 70° E. This vein is along the continuation of the Beaumont fault.	---	Two shafts, one of which is 112 ft deep.	Gillerman, 1964, p. 57.
88	Beaumont mines	Pyrite, argentite, native silver, galena, and molybdenite veins along the Beaumont fault. Molybdenite especially abundant in quartz vein within deeper parts of the mine.	---	Shaft about 350 ft deep.	Gillerman, 1964, p. 68, 69.
89	Shrine mine	Abundant fluorite along N. 65° W. fault. Vein is as much as 6 ft wide.	Cu (15), Pb (N), Zn (N), Ag (5), Mo (300) 1/	Discovered in 1936 and mined intermittently until 1952. Inclined shaft about 425 ft deep. Total production about 71,700 short tons. Fluorspar deposits chiefly mined during World War II.	Gillerman, 1964, p. 69. Hedlund, 1978a. This report, table 4.
90	Alexander-Jacobs Promise	Quartz, pyrite, molybdenite veins along ENE-striking fractures and along the margins of a quartz monzonite dike that strikes N. 70-80° W.	Cu (100), Pb (50), Zn (N), Ag (0.7), Mo (70) 1/	Shaft and adit.	Hedlund, 1978a. This report, table 4.
91	---	Quartz-pyrite veins along N. 70-80° E.-striking fault and in zone of rhyolite dikes. Visible molybdenite and some analyses indicate as much as 195 ppm Mo.	---	Shaft and two prospect pits; near diamond drill hole site NDI-1 (T.D.=1718 ft). Cities Service Minerals Corp.	Unpublished U.S. Geological Survey data.
92	Bolton mine	Pyrite, chalcopyrite, chalcocite, and molybdenite-bearing veins along NE faults and fractures.	---	Shallow shafts and prospect pits. Ore shipped in 1920's was mostly chalcopyrite.	Gillerman, 1964, p. 69.
93	---	Ferruginous veins along branch of Austin-Amazon fault. Some copper carbonates.	---	Shaft and adit.	Unpublished U.S. Geological Survey data.
94	---	Ferruginous quartz-pyrite veins along branch of Austin-Amazon fault. Highly sheared granite.	---	Adit and prospect pits.	Unpublished U.S. Geological Survey data.
95	Shamrock group--(Osmer gold)	Quartz veins along margin of rhyolite dike and coextensive with Osmer fault. Minor amounts of pyrite and chalcopyrite.	---	Shaft and prospect pits.	Unpublished U.S. Geological Survey data.
96	Osmer gold mine	Quartz veins extend for about 7500 ft along the Osmer fault. Veins are parallel to numerous silicic dikes. Small amounts of pyrite, hematite, bismutite, and copper are associated with the gold.	Cu (15), Pb (500), Zn (N), Ag (5) 1/	Shaft. In 1912 17 short tons of ore averaged 9 oz gold per ton.	Gillerman, 1964, p. 69, 70, 71. This report, table 4.
97	Shamrock group	Quartz veins along margin of quartz monzonite porphyry dike. Abundant limonite.	---	Shaft.	Unpublished U.S. Geological Survey data.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
98	Foster zinc mine (Badger mine)	Chiefly sphalerite, pyrite, chalcopyrite, and native copper as veins along faulted dikes of andesite porphyry and rhyolite. Zinc content of ore shipments ranged from 4-6 percent.	Cu (2000), Pb (700), Zn (70,000), Ag (15) 1/	Shaft 78 ft deep; drifts as much as 100 ft long; two drill hole sites on property.	Gillerman, 1964, p. 67, 68. This report, table 4.
99	Bismuthinite Lode	Vein is coincident with Bismuth-Foster fault that is locally intruded by rhyolite. Ore minerals are chiefly pyrite, native bismuth, bismuthinite, and chalcopyrite.	---	Mine chiefly operated as a silver deposit. Shaft about 70 ft deep; numerous prospect pits.	Gillerman, 1964, p. 66, 67.
100	Bismuthinite Lode extension	Bismuth minerals along the silicified Bismuth-Foster fault. Vein as much as 2 ft wide. Yellow crystals of bismutite occur as fracture-fillings.	---	Prospect pits.	Unpublished U.S. Geological Survey data.
101	Spar Hill mine	Fluorite veins along margins of rhyolite dike that shows varying degrees of brecciation. Vein can be traced for about 2400 ft to the southwest, although fluorspar veins are not continuous over this interval.	---	Open cuts and trenches. Past production about 800 short tons.	Gillerman, 1964, p. 66. Rothrock and others, 1946, p. 74, 75.
102	---	Quartz-pyrite vein along Bismuth-Foster fault. Abundant limonite along fault. Some yellowish fracture-fillings suggest the presence of bismuth minerals.	---	Shaft and prospect pit.	Hedlund, 1978d.
103	Spar Hill No. 2 mine	Anastomosing fluorite veins along N. 55° E.-striking fractures within granite.	---	Dozer cuts.	Hedlund, 1978d.
104	Silver Dollar mine	Silicified Spar Hill fault strikes N. 55-60° E. and contains traces of pyrite, argentiferous galena, and specular hematite.	Cu (300), Pb (1000), Zn (3000), Ag (200) 1/	Shaft about 160 ft deep. Mine chiefly operated for its silver production.	Gillerman, 1964, p. 65, 66. This report, table 4.
105	Austin-Amazon mines	Strong branching fault system strikes N. 50-55° E. Fissure vein deposit contains pyrite, chalcopyrite, bornite, chalcocite, and molybdenite.	Cu (10,000), Pb (1000), Zn (1500), Ag (30) 1/	Numerous prospect pits, open cuts, and shafts. Past production 3000+ tons of copper ore averaging more than 5 percent copper.	Gillerman, 1964, p. 63, 64.
106	High Point Extension	Extension of the Austin-Amazon fault to the south. Ore minerals are chiefly chalcopyrite, pyrite, bornite, native copper and some torbernite.	---	Open cut.	Unpublished U.S. Geological Survey data.
107	John Malone mine	Strong fractures in granite strike N. 55° E. and are weakly mineralized. Pyrite and chalcopyrite observed in mine dump.	---	Shaft and prospect pits.	Gillerman, 1964, p. 80, 81.
108	---	Fracture-fillings of ferruginous oxides along N. 60-70° E.-striking fault. Radioactivity 2 to 3 times background.	Au (23 ppb), eU (85), eTh (40), cU_3O_8 (207) P (257) 2/	Road cut; no development.	Hedlund, 1978d. O'Neill and Thiede, 1982.
109	Gold Gulch placers	Gold placers in terrace and alluvium deposits extend for about 1 mi in secs. 21 and 22, T. 20 S., R. 16 W.	---	Operations in the early 1930's, late 1940's, and early 1950's.	Gillerman, 1964, p. 80.
110	Vertical shaft	Fracture zones that strike N. 45° E. contain azurite, malachite, tenorite, and specular hematite.	---	Shaft.	Gillerman, 1964, p. 79.
111	Summit No. 1 and 2 (Wes Williams)	Highly silicified fault strikes N. 60° E. and surface outcrops indicate the presence of chalcopyrite, galena, pyrite, and some chrysocolla. Vein is slightly radioactive.	Au (400 ppb), U (356), Th (7), cU_3O_8 (262) 2/	Shafts and prospect pits.	Gillerman, 1964, p. 79. O'Neill and Thiede, 1982.
112	Russell Gold Mine	Vein along contact of rhyolite dike and granite.	---	Shaft, adit and several prospect pits. A short ton of ore shipped in 1915-1916 contained 27 oz of gold.	Gillerman, 1964, p. 79.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
113	Uncle Jimmy Thwaits Mine	Quartz vein with a few high grade veinlets of gold.	---	Adit about 40 ft long.	Gillerman, 1964, p. 79.
114	Barnett Mine	Quartz vein along south side of a rhyolite dike contains minor amounts of gold. A part of the Neglected vein.	---	Shaft.	Gillerman, 1964, p. 79.
115	Wild Irishman Mine	Quartz vein along an extension of the Neglected vein contains gold and silver, copper oxides and torbernite.	---	Two shafts. A short ton of ore shipped from the property contained 9 oz of gold and 0.75 oz of silver per ton.	Gillerman, 1964, p. 79.
116	Neglected mine	Veins along faulted margins of rhyolite dike contain chalcopyrite, bornite, covellite, galena, sphalerite, and pyrite. Quartz vein along south margin of dike is as much as 5 ft thick. Some barite gangue.	Cu (10,000), Pb (2000), Zn (300), Ag (100) 1/	Two shafts, an adit, and numerous prospect pits along the Sprouse-Copeland fault.	Gillerman, 1964, p. 77, 78. Hedlund, 1978d. This report, table 4.
117	Moneymaker mine, also PAHA No. 3	Dominantly green fluorite along silicified and brecciated Sprouse-Copeland fault. Vein strikes N. 80-85° E. and is as much as 8 ft wide and 800 ft long.	---	Largely developed by trenches along south margin of rhyolite dike at contact with granite. Past production about 300-400 short tons.	Gillerman, 1964, p. 76, 77. Rothrock, and others, 1946, p. 74.
118	Hop Williams mine	Quartz vein about 2 ft wide adjacent to rhyolite dike strikes N. 75° E. Only oxidized copper minerals remain on dump. Previous assays show 0.5 percent Cu, 1.5 percent Pb, and traces of gold and silver.	---	Shaft about 100 ft deep.	Gillerman, 1964, p. 76.
119	Paymaster mine	Quartz-pyrite vein strikes N. 85° E. along the north contact of a rhyolite dike with granite. Another vein strikes N. 80° E. and is along the south margin of a quartz monzodiorite porphyry dike.	---	Two shafts and prospect pits. Both veins were mined for gold and silver.	Gillerman, 1964, p. 76.
120	---	Quartz vein strikes N. 75-85° W. and contains abundant limonite. Slightly radioactive at contact with diabase.	---	Two prospect pits.	Unpublished U.S. Geological Survey data.
121	---	Quartz vein strikes N. 85° W. and contains abundant limonite. Radioactivity 1.5 times background at projection of fault with diabase dike to west.	---	Shaft and prospect pit.	Unpublished U.S. Geological Survey data.
122	Bisbee mine	Quartz-pyrite vein that strikes N. 65-85° E. is gold-bearing and radioactive.	---	Two shafts, adit, and numerous prospect pits. Ores reported to have high gold values.	Gillerman, 1964, p. 97.
123	Edmonds mine	Abundant manganese oxides along vein that strikes N. 75-85° W. The vein is offset by a N. 35° E. fault. Vein was originally exploited for silver; some radioactivity is also reported.	---	Shaft.	Gillerman, 1964 p. 97.
124	---	Highly oxidized quartz-pyrite veins along margins of rhyolite dikes. Manganese oxides common, and traces of chrysocolla locally present.	---	Four prospect pits.	Unpublished U.S. Geological Survey data.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
125	---	Oxidized quartz-pyrite vein along margin of rhyolite dike adjacent to N. 10-15° W.-striking fault and diabase dike.	(1) Cu (191), Pb (542), Mo (40), Sb (292), Sn (94), P (1490) 2/ (2) Cu (134), Mo (23), Sb (944), Sn (62), W (250), P (911) 2/ (3) Au (14 ppb) Cu (376), Mo (16), Sb (413), Sn (116) 2/	Two prospect pits.	O'Neill and Thiede, 1982.
125-A	---	Oxidized quartz-pyrite vein along N. 15° W.-striking fault.	(1) Cu (664), Mo (30), P (6870), Sb (1360) 2/ (2) Cu (343), Mo (11) 2/ (3) Cu (205) 2/ cU_3O_8 (26, 210, 356) 2/	Prospect pit.	O'Neill and Thiede, 1982.
126	---	Oxidized quartz-pyrite vein along margin of rhyolite dike.	---	Three prospect pits.	Unpublished U.S. Geological Survey data.
127	Alhambra-Blue Bell mine	Diabase dike strikes N. 20° W. and is highly shattered by later fault movement. Torbernite is present as fracture-fillings in the diabase. Radioactivity can be traced for about 390 ft along the dike.	Au (39 ppb), Cu (663), Mo (30), Sb (360), Sn (108), W (508), P (6870), eU (312, 314, 14) eTh (0, 7) 2/	Prospect pit and trench.	Gillerman, 1964, p. 95. O'Neill and Thiede (1982), 87 p.
128	Floyd Collins mine	Radioactivity along diabase dike 10-15 ft thick. Dike has faulted margin. Radioactivity 2 times background.	Cu (134, 191), Pb (542), Zn (N), Mo (23, 30), Sb (292, 944), W (280), eU (64, 79, 889) eTh (24) 2/	Two shallow shafts, 40 and 80 ft deep. Two carloads of ore averaging 0.1-0.2 percent U_3O_8 have been shipped.	Gillerman, 1964, p. 91-93 O'Neill and Thiede, 1982, 87 p.
129	---	Oxidized quartz-pyrite vein at intersection of rhyolite dike and diabase.	---	Two shafts.	Unpublished U.S. Geological Survey data.
130	Merry Widow mine	An east-trending fault cuts and displaces 2 diabase dikes. Fracture-fillings of autunite and torbernite in the diabase. An east-trending vein that is contiguous with the fault contains chalcopyrite, pyrite, hematite, magnetite, bismuthinite, and gold. Minor quartz-specularite veins. Maximum U_3O_8 content is about 0.2 percent.	---	Shaft; uranium was first identified at the Merry Widow mine in 1920. Renewed activity in the White Signal district occurred between 1948 and 1955.	Granger and Bauer, 1950, 1952. Gillerman, 1964, p. 94, 95. Lovering, 1956, p. 329-341. O'Neill and Thiede, 1982, 87 p.
131	Acme mine	A diabase dike about 10 ft thick is radioactive across its entire width and especially at the contact with granite where torbernite is present. A strong north-northwest-striking fault is locally concordant with the diabase-granite contact.	---	Shaft.	Gillerman, 1964 p. 86.
132	---	Vein along N. 5° W.-striking fault.	---	Prospect pit.	Unpublished U.S. Geological Survey data.
133	---	Oxidized quartz-pyrite vein along N. 80° W.-striking fault.	---	Prospect pit.	Unpublished U.S. Geological Survey data.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
134	California mine	Radioactive zone that is coextensive with a diabase dike that extends to the Acme mine to the northwest. Fracture-fillings in the diabase contain secondary uranium minerals.	---	Shaft	Gillerman, 1964, p. 85, 86.
135	---	Oxidized quartz-pyrite vein along N. 85° W.-striking fault.	---	Prospect pit.	Unpublished U.S. Geological Survey data.
136	Banner mine	Quartz-pyrite vein along the Blue Jay fault is radioactive, about 1.5 times background.	(1) Au (257 ppb), Cu (1540), Pb (384), Zn (2630), Mo (33), Bi (92), Sn (100), W (198), eU (814), eTh (23) 2/	Shaft and several prospect pits.	Gillerman, 1964, p. 91. O'Neill and Thiede, 1982.
137	Red Bird mine	Quartz-pyrite vein adjacent to rhyolite dike strikes N. 75-85° W. Ocherous vein material on dump is radioactive.	---	Shaft reported about 200 ft deep.	Gillerman, 1964, p. 97.
138	Shamrock	Two diabase dikes that strike N. 40° W. are cut by several northeast-trending quartz-pyrite veins that contain trace amounts of gold. Secondary uranium minerals occur as fracture-fillings within the diabase.	---	Two shafts and prospect pits.	Gillerman, 1964, p. 95.
139	Blue Jay mine	Radioactive faulted margins of rhyolite dikes. Uraninite present in trace amounts. Radioactivity 10 times background at fault contact with diabase. Rare earths are relatively abundant, 340 ppm.	Cu (200), Pb (30), Zn (N), Ag (1) 1/ Au (377 ppb), Cu (574, 1040), Pb (357), Zn (239), Mo (79), Bi (99), Sb (776), Sn (176), W (460), P (3400), eU (1200), eTh (220), cU_3O_8 (0.541% maximum value) (0.2-0.3% median value) 2/	Open cuts. At least 3 inclined diamond drill holes by the Cities Service Co., in this area.	Gillerman, 1964, p. 88-91. Lovering, 1956, p. 344-347. O'Neill and Thiede, 1982. This report, table 4.
140	Eugenie	Quartz-pyrite vein strikes N. 55° E. in proximity to a diabase dike which is about 35 ft southwest of the shaft. The dike strikes N. 45° W. and fracture fillings within the dike contain secondary uranium minerals.	(1) Au (387 ppb), Cu (1520), Pb (226), Zn (347), Ag (30), Mo (25), Bi (231), Sn (65), W (355) 2/ (2) Mo (36), W (960), Y (80), Zn (493) 2/	Shaft. Mine was principally operated for gold and copper ore. Also radioactive; 500 lbs of torbernite-bearing ore has been extracted.	Gillerman, 1964, p. 95. O'Neill and Thiede, 1982.
141	Tunnel Site No. 1	Argillized granite near rhyolite dike is slightly radioactive and contains about 0.018 percent equivalent uranium. Oxidized quartz-pyrite veins are several centimeters thick and strike N. 75° E.	Au (57, 186 ppb), Cu (906), Ag (15), W (486), P (2770), eU (45), eTh (582), cU_3O_8 (19) 2/	Discovery shaft about 10 ft deep and adit about 250 ft long.	Lovering, 1956 p. 348, 349. O'Neill and Thiede, 1982.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
142	Tullock shaft	Quartz pyrite vein strikes N. 70° W. and cuts an older more radioactive vein which strikes N. 45° W. Azurite-pyrite-chalcopyrite-torbernite ore. Vein probably cuts diabase at depth.	Au (24 ppb), Cu (1630), Zn (858) 2/	Shaft. At least 25 short tons of gold-bearing ores have been shipped.	Gillerman, 1964, p. 99, 100.
143	---	Oxidized quartz-pyrite vein along N. 40-45° W.-striking fault.	Au (19 ppb), Cu (1990), cU (4450) 2/	Prospect pit.	Unpublished U.S. Geological Survey data. O'Neill and Thiede, 1982.
144	---	Oxidized quartz-pyrite vein strikes N. 10° W.	---	Shaft.	Unpublished U.S. Geological Survey data.
145	Chapman mine	Quartz-pyrite-turquoise and quartz specularite veins in faulted rhyolite near contact with Precambrian granite. Radioactivity 1.5 times background.	Cu (440), P (1040), eU (58), eTh (19), cU_3O_8 (63) 2/	Originally operated as a high grade turquoise mine. Pockets of turquoise along N. 5-10° W.-striking fault.	Gillerman, 1964, p. 102. O'Neill and Thiede, 1982.
146	---	Quartz-pyrite vein strikes N. 10° W. Radioactivity 2 times background.	eU (39), eTh (41) 2/	Prospect pit.	O'Neill and Thiede, 1982.
147	---	Quartz-pyrite vein strikes N. 70° E. Radioactivity 5 times background.	Cu (619), Mo (25), Bi (110), eU (33), eTh (8) 2/	Prospect pit.	O'Neill and Thiede, 1982.
148	---	Quartz-pyrite vein strikes N. 70° E.	Au (940, 177 ppb), Cu (758), W (460), Ag (21), P (2010), eU (138), eTh (11) 2/	Prospect pit.	O'Neill and Thiede, 1982.
149	---	Quartz-pyrite vein at intersection of N. 80° E. and N. 15° W.-striking faults. Abundant limonite. Radioactivity 2 times background near thin diabase dike.	Au (214 ppb), Cu (2170), Pb (N), Zn (718), Mo (51), Bi (79), Sn (225), P (2940) 2/	Shaft.	O'Neill and Thiede, 1982.
150	Hummer mine (Good Luck)	Quartz-pyrite vein adjacent to rhyolite dike strikes N. 70° E. Deposit mined for gold but is also radioactive.	---	Adit.	Gillerman, 1964, p. 98.
151	Inez mine	Quartz-pyrite vein strikes N. 75° E. and cuts NW.-trending diabase dike. Numerous small cross faults displace the diabase. Torbernite occurs as fracture-fillings.	Cu (1590), Au (26 ppb), Cu (955), Pb (N), Zn (N), Ag (15), Mo (48), Bi (70), Sn (131), eU (2988, 52), eTh (42, 64) 2/	Considerable trenching about 150 ft long. Two carloads of ore averaging 0.2 percent U_3O_8 have been shipped.	Gillerman, 1964, p. 93, 94, 98. O'Neill and Thiede, 1982.
152	Bouncing Bet mine	Quartz-pyrite veins and adjacent rhyolite dikes strike N. 30-35° E. The ferruginous veins show some alteration to malachite and are slightly radioactive.	---	Two shafts and numerous prospect pits.	Gillerman, 1964, p. 101.
153	---	Oxidized quartz-pyrite vein at intersection of N. 70° E. and N. 30° W.-striking faults.	---	Shaft.	Unpublished U.S. Geological Survey data.
154	---	Oxidized quartz-pyrite vein along N. 5-10° E.-striking fault. Adjacent diabase dike radioactive.	Au (57 ppb), Cu (416), Mo (31), eU_3O_8 (3430). For diabase. 2/	Prospect pit.	Unpublished U.S. Geological Survey data. O'Neill and Thiede, 1982.

Table 5.--Mines, prospects, and mineral occurrences in the Tyrone subdistrict, Grant County, New Mexico--Continued

Map No.	Name	Description	Analytical data	Development	References
155	Calamity mine	Quartz-pyrite vein strikes W. 75° E. and cuts older diabase dike. The vein was previously mined for gold but is also radioactive. Radioactivity 2 times background.	Au (3100 ppb), Cu (7230), Pb (314), Zn (690), Mo (83), Bi (1250), Sn (113), W (394), eU (166), eTh (28) 2/	Shaft and prospect pits.	Gillerman, 1964, p. 96. O'Neill and Thiede, 1982.
156	---	Oxidized quartz-pyrite vein strikes N. 65° E. Radioactivity 2 times background.	---	Shaft and three prospect pits.	Unpublished U.S. Geological Survey data.
157	---	Oxidized quartz-pyrite vein strikes N. 50-55° E. Radioactivity 1.5 times background.	---	Three prospect pits.	Unpublished U.S. Geological Survey data.
158	Paddy Ford mine	Quartz-pyrite vein strikes N. 85° E. About 100 ft north of shaft a faulted diabase dike is radioactive. The quartz-pyrite ore was previously mined for gold and silver.	Au (15300 ppb) Cu (1190), Pb (804), Ag (33, 54), Mo (75), Bi (1400), Sn (79) 2/	Shaft about 118 ft deep.	Gillerman, 1964, p. 95, 96. O'Neill and Thiede, 1982.
159	Copper Glance mine	Quartz vein as much as 3 ft wide, strikes N. 45° E. and contains pyrite, chalcopyrite, and chalcocite.	---	Shaft.	Gillerman, 1964, p. 98, 99.
160	---	Oxidized quartz-pyrite veins strike N. 45° E.	---	Two shafts and numerous prospect pits.	Unpublished U.S. Geological Survey data.
161	---	Quartz-pyrite vein strikes N. 10-15° W.	---	Shaft and prospect pits.	Unpublished U.S. Geological Survey data.
162	Red Dodson mine	East-trending quartz-pyrite vein that is radioactive. Ore minerals within the vein are pyrite, cerargyrite, argentiferous galena, and bismuthinite.	---	Adit and shaft. Vein was originally mined for silver and as much as 30 short tons of high grade ore averaged $200-300 per ton.	Gillerman, 1964, p. 100.
163	---	Oxidized quartz-pyrite vein at fault contact with rhyolite dike. Vein strikes due east.	---	---	Unpublished U.S. Geological Survey data.
164	Golden Eagle mine	Workings localized at intersection of N. 70° E. and N. 10-15° W. faults. The quartz-pyrite vein was first mined for gold. The vein is also radioactive, especially along the N. 10-15° W.-striking fault.	---	Shaft 80 to 90 ft deep. Operated in 1905 for gold and copper.	Gillerman, 1964, p. 99.