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CONTENTS

Hydrogeology of the Irrigation Study Basin, Oldman River Drainage, Alberta, Canada .... Grant L. Nielsen 3

Crossbedding of the Tanglewood Limestone Member of the Lexington Limestone (Ordovician) of the Blue Grass Region of Kentucky .... S. V. Hrabar, E. R. Cressman, and Paul Edwin Potter 99

Geology and Mineralogy of the Trump Fissure-Fault Ore Body, Trixie Mine, East Tintic District, Utah .... Lance W. Pape 115

Petrology and Geochemistry of Shoal Water Carbonates of the Virgin Limestone Member, Triassic Moenkopi Formation Clark County, Nevada .... Dennis W. Belnap 147

Publications and maps of the Geology Department 185

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Geology and Mineralogy of the Trump Fissure-Fault Ore Body, Trixie Mine, East Tintic District, Utah*

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ABSTRACT.—The Trump fissure-fault ore body is a siliceous copper-gold-silver fissure-filling deposit in the Trixie mine, East Tintic district, Utah. Ore is confined to the breccia zone of the Trump fissure-fault which is part of a larger fissure zone characterized by north-northeast-trending monzonite and pebble dikes, breccia zones, and hydrothermal alteration.

Several stages of hydrothermal alteration in the Trump fissure-fault zone have prepared the Tintic Quartzite host for ore emplacement. Fissure-filling and replacement ores occur as a complex assemblage of primary and secondary sulfides, sulfosalts, carbonates, and sulfates. Paragenesis and zoning of the ore body are difficult to identify due to telescoping of minerals and variation of ore tenor. Favorable guides for exploration of Trump-type ore bodies are north-northeast-trending fissures, which have been hydrothermally-altered and contain monzonite and pebble dikes.

CONTENTS

Text ... page
Introduction ... 116
  Location and Accessibility ... 116
  Previous Work ... 117
  Present Work ... 118
  Acknowledgments ... 118
General Geology of the East Tintic District ... 119
  Lithology ... 119
  Structure ... 119
  Ore Deposits ... 119
Geology of the Trump Fissure-Fault Ore Body ... 121
  History of Exploration-Trixie Area ... 121
  Trump Ore Body Development ... 122
  Tintic Quartzite ... 123
    Distribution ... 123
    Lithology ... 123
    Structural Habit ... 124
    Chemistry ... 124
  Hydrothermal Alteration ... 124
    Early Barren Stage ... 124
    Mid-Barren Stage ... 127
    Late Barren Stage ... 127
    Early Productive Stage ... 130
    Productive Stage ... 130
Structure of the Trump Fissure-Fault ... 130
  Characteristics of the Trump Fissure-Fault ... 130
  Displacement of the Trump Fissure-Fault ... 133
  Relation to East Tintic Anticline ... 133
  Relation to Local Faults ... 133
  Host Preparation ... 134
Economic Geology ... 135
  Ore Body Characteristics ... 135
    Mineralogy ... 135
    Chemistry ... 135
    Economics ... 135
    Mining Methods ... 135
  Characteristics of Primary Ore ... 135
    Fissure-Filling Ore ... 135
    Replacement Ore ... 140
  Mineralogy ... 140
    Primary Minerals ... 140
    Enrichment and Oxidation Minerals ... 141
  Replacement Textures ... 141
  Paragenesis ... 142
  Zoning ... 142
  Classification ... 143
  Ore Guides ... 143
  Structural Guides ... 143
  Mineralogical Guides ... 144
  Drilling ... 144
Summary ... 144
References cited ... 144

ILLUSTRATIONS

Text-figures ... page
1. Index Map ... 117
2. Faults of the East Tintic District ... 120

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3. 750 foot Level of the Trixie Mine 122
4. Paragenesis of the Trump Ore Body 143

Plates page
1. Photomicrographs of Tintic Quartzite 125
2. Photomicrographs of Tintic Quartzite 126
3. Photomicrographs of Monzonite Dike 128
4. Photomicrographs of Jasperoid Alteration 129
5. Photomicrographs of Pyrite in Tintic Quartzite 131
6. Photomicrograph of Trump Ore and photograph of Barite 132
7. Photomicrographs of Trump Ore 136
8. Photomicrographs of Trump Ore 137
9. Photomicrographs of Trump Ore 138
10. Photomicrographs of Trump Ore 139

Tables page
1. Summary of Drill Holes-Trump Ore Body 123
2. Primary Minerals 141
3. Secondary Minerals 142

INTRODUCTION

Recent exploration and geology studies in the East Tintic mining district have been directed toward the Burgin-Tintic Standard type lead-zinc-silver limestone replacement ore bodies which have accounted for approximately 75 percent of the total production for the district. The bulk of the remaining production has come from north-northeast fissure-filling, siliceous copper-gold-silver ores of the Apex Standard, Eureka Standard, and Eureka Lily mines.

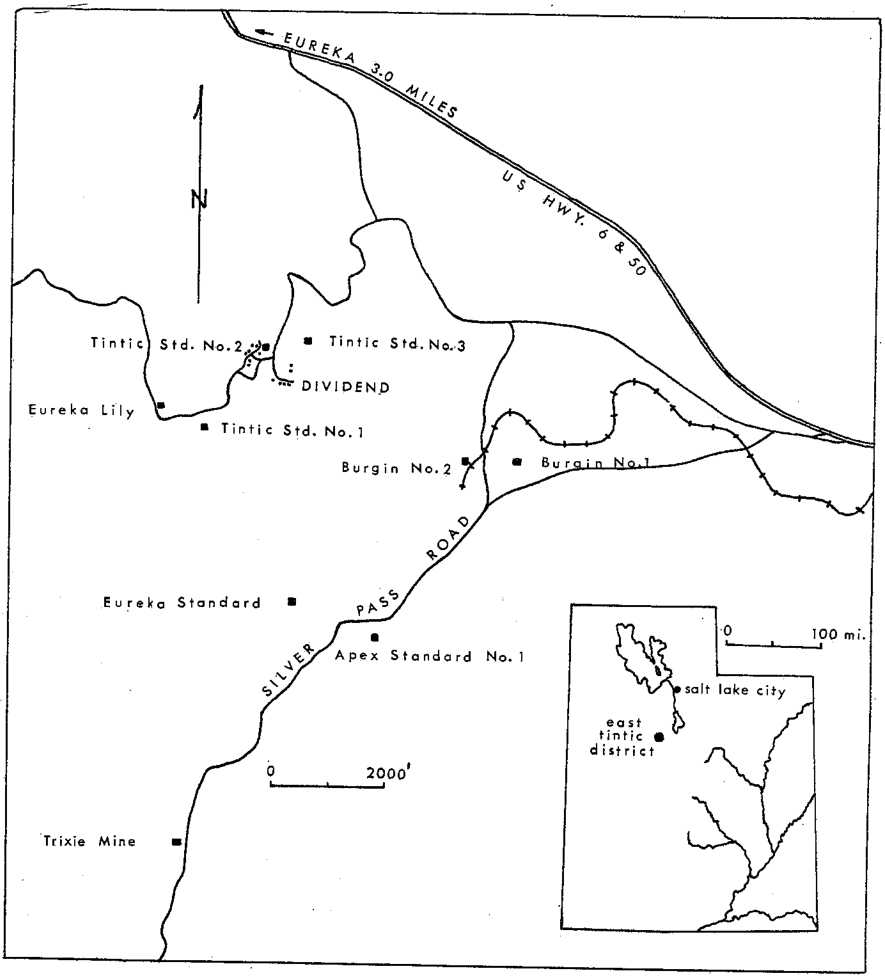
Two mines are presently operating in the East Tintic district, the Burgin and the Trixie mines. Both properties are operated by the Tintic Division of Kennecott Copper Corporation. The Burgin mine and the Trixie fault ore body of the Trixie mine are limestone replacement lead-zinc-silver ore bodies, whereas the Trump fault ore body in the Trixie mine is a fissure-filling, siliceous copper-gold-silver ore body.

The purposes of this study are to a) describe the geology and structure of the siliceous copper-gold-silver ore body of the Trump fissure-fault, b) differentiate stages of hydrothermal alteration, ore deposition, and oxidation of the ore, c) identify minerals present and determine the paragenesis of the ore body, and d) determine exploration guides to Trump fissure-fault type ore bodies in the district. The Trump ore body was chosen for this purpose because it is the only siliceous, fissure-type ore body currently in production in the East Tintic district.

Location and Accessibility

The Trump fissure-fault ore body of the Trixie mine is located in the East Tintic Mountains of central Utah, near the eastern margin of the Great Basin, about sixty miles south-southwest of Salt Lake City (Text-fig. 1). The mine is accessible by the Silver Pass Road, which connects the mining town of Mammoth in the Tintic mining district to U.S. Highways 6 and 50 and the Burgin mine of the East Tintic district. The Burgin mine, a Kennecott Copper Corporation property which is producing from lead-zinc-silver replacement ore bodies, is 1.7 miles northeast of the Trixie mine.

Eureka, which has a population of approximately 1,200, is 3 air-miles northwest of the Trixie mine and is accessible via the Silver Pass Road and U.S. Highways 6 and 50. The Tintic Branch of the Denver and Rio Grande Railroad enters the East Tintic Mountains from the east and extends to the Burgin mine.



TEXT-FIGURE 1.—Index map of the East Tintic district, Utah.

Previous Work

There have been no published studies on the Trump fissure-fault ore body to date. However, several company and U.S. Geological Survey reports have been prepared which deal with preliminary stages of exploration and development of the Trixie project. Among these reports are a U.S. Geological Survey open file report by Morris, *et al.* (1956); an appraisal of the Trixie target area by Billingsley (1957); and a Trixie area progress report by Gilbert (1959). Gilbert has compiled geochemical and surface drill hole data of the Trixie area, and evaluated the potential of the Trixie project, but has made no attempt to identify or relate this data to the Trump fissure-fault. In fact, ore mineralization was not identified in the Trump fault unil underground drilling began in July 1969, and drill hole No. T-1 penetrated the ore body on the 750-foot level of the mine.

Although there are no published reports on the ores of the Trixie mine, the author has benefited greatly from several district reports which have helped to evaluate the Trump ore body. Lovering's report (1949) on rock alteration in the East Tintic district identified five stages of hydrothermal alteration which are developed in or around the Trump fissure-fault. Kildale (1938) discussed the pattern and occurrence of pebble dikes and north-northeast-trending mineralized fissures of the Trump fissure-fault type, and related structure and lithology with control of fissure ore bodies. Utah Geological Society Guidebook Number 12 (Cook, ed., 1957), included a district report on the geology, structure, alteration, and production of the mines and prospects of the East Tintic district. A recent AIME publication on the geology and ore deposits of the East Tintic district by Shepard and others (1968) outlined the geology of the Burgin mine and included a summary on lithology, structure, and alteration guides to ore exploration in the East Tintic district.

Present Work

Sampling of drift workings and logging of underground cores by the author began in October 1969, when the first cuts were made into the Trump fissure-fault. The writer had the advantage of observing and sampling the ore body from its first exposure in November 1969, and has examined material from all areas of the ore body. The 750-foot level drift, which follows the strike of the Trump fault, three vertical production raises, and eight drill holes which penetrate the ore body have been sampled at eighty-eight locations and materials prepared for study by atomic absorption, X-ray diffraction, infrared, ore microscope, and microprobe methods. Nine thin-sections and twenty hand samples of the Tintic Quartzite host rock were examined using binocular and petrographic microscopes to identify stages of hydrothermal alteration, ore deposition characteristics and textures, and the effects of regional metamorphism on the quartzite host. Seventy-one polished sections were examind by ore microscope and microprobe methods to determine the mineralogy, textures, and paragenesis of primary, enriched, and oxidized minerals. In addition, twenty samples were studied by infrared analysis, X-ray diffraction, or atomic absorption analysis where ore microscope or microprobe analysis proved impractical or unnecessary.

Acknowledgments

The author would like to express appreciation to many individuals who aided in this study, particularly Dr. Kenneth C. Bullock and Dr. Wm. Revell Phillips for their advice, encouragement, and continual interest in this work and review of the manuscript. Appreciation is also extended to many people at the Tintic Division and Salt Lake City Research Center of Kennecott Copper Corporation; especially to Paul Mogensen, Samuel Smith, J. D. Stephens, and Pat Clinger, whose advice and criticism gave direction to this study. In addition, the author wishes to thank Dana Griffen for his assistance in X-ray diffraction analyses and thin-section preparation. Special thanks is due to my wife, Judy, for her constant encouragement and support during this study.

This thesis has been supported in part by the Tintic Division of Kennecott Copper Corporation. The Division permitted the author to make a study

of the Trump ore body and assisted in microprobe, atomic absorption, and infrared analysis work.

GEOLOGY OF THE EAST TINTIC DISTRICT

Lithology

Rocks in the East Tintic mining district include a wide variety of consolidated sedimentary rocks, intrusive and extrusive igneous rocks, and semiconsolidated to unconsolidated Eocene to Recent deposits. Consolidated sedimentary rocks range in age from Late Precambrian to Permian and exceed 12,000 feet in total thickness (Morris, 1964). Limestone and dolomite constitute the majority of rocks, with lesser amounts of quartzite, sandstone, and shale.

The sedimentary rocks, which were folded, faulted, and deeply eroded prior to volcanic activity, are overlain by a series of porphyritic lava flows, vitrophyres, and quartz latite tuffs, the Packard Quartz Latite and the Laguna Springs Latite, of Middle Eocene age (Morris, *et al.,* 1956). The extrusive volcanics and buried Paleozoic rocks are cut by quartz monzonite and monzonite stocks, dikes, and plugs, and injection breccia dikes termed "pebble dikes", that contain abrasion-rounded fragments of quartzite with a few disc-shaped pieces of limestone, shale, and igneous rocks (Kildale, 1938).

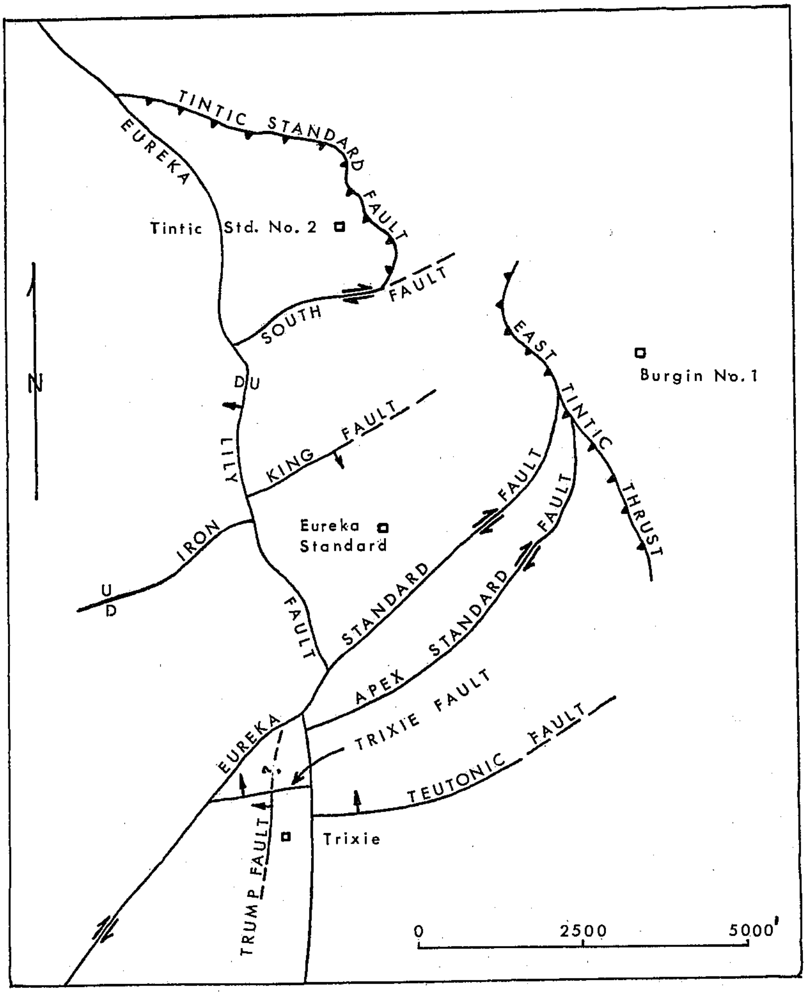
Structure

The East Tintic anticline is the main north-trending compressional fold of the East Tintic mining district. Where it is best exposed in the central part of the East Tintic district, the East Tintic anticline is an undulating anticlinal dome that plunges gently to the north and south from a point a few hundred feet east of the Tintic Standard mine (Shepard, 1968). The crest and the moderately dipping west limb of the fold are crenulated by several small asymmetric folds of diverse trends and broken by many faults of small displacement.

The folded strata are cut by many thrust and strike-slip faults created by the same compressive forces that produced the north-trending folds (Morris, 1957). At least three sets of high-angle strike-slip faults have developed: a) northeast and northwest-trending shear developed during east-west compressive forces that produced the folds, b) major east-trending, north-dipping normal faults developed after folding but prior to volcanic activity, and c) mineralized fissure-faults of minor displacement formed after volcanic activity, such as the Trump fissure-fault (Morris, 1957). These north-northeast-trending fissure zones have been intruded by pebble dikes and monzonite intrusives, and are commonly marked at the surface by linear zones of hydrothermally-altered volcanics and geochemical anomalies. The origin of these north-northeast-trending fissure zones is not understood but field relations suggest that the fissures were originally formed in response to weak tectonic forces acting on preexisting folds. Once formed, they were further ruptured and enlarged by forces related to intrusion of monzonite stocks and dikes (Morris, 1957).

Ore Deposits

Ore bodies of the district may be divided into two main categories: a) massive limestone replacement ore bodies of the Tintic Standard, Burgin, and North Lily mines, rich in lead, zinc, silver, and manganese, and b) siliceous



TEXT-FIGURE 2.—Faults of the East Tintic district.

fissure ores of the Eureka Standard, Apex Standard, and Eureka Lily mines valued for copper, gold, and silver. The Trump fissure-fault ore body is the most recently discovered example of the latter.

Most of the replacement ore bodies have been produced from calcareous beds in the Ophir Formation, especially where it is in juxtaposition by thrusting or normal faulting with Tintic Quartzite. Structural control for these ore bodies is apparent for many of the East Tintic deposits and appears to have greater influence on ore emplacement than lithology (Shepard, 1968). Replacement deposits are chiefly localized where zones of north-northeast-trending fissures intersect large normal or thrust faults which provide necessary brecciation, porosity and permeability for transport and precipitation of ore (Bush, 1957).

North-northeast-trending fissures and faults of post-volcanic, Late Eocene, age represents conduits for mineralizing fluids of many replacement ore bodies (Morris, 1964) and are important structural traps for siliceous copper-gold-silver ore deposits in the East Tintic district. These fractures have great linear extent, trend within 10° or 15° of N. 30° E., dip steeply to the west, and have displacements of from a few feet to 30 feet (Shepard, 1968). Where Upper Tintic Quartzite has been "prepared" by strong brecciation, hydrothermal alteration, or open fissuring, high grade filling and vein replacement, siliceous copper-gold-silver ore bodies of the Trump fissure-fault type may occur.

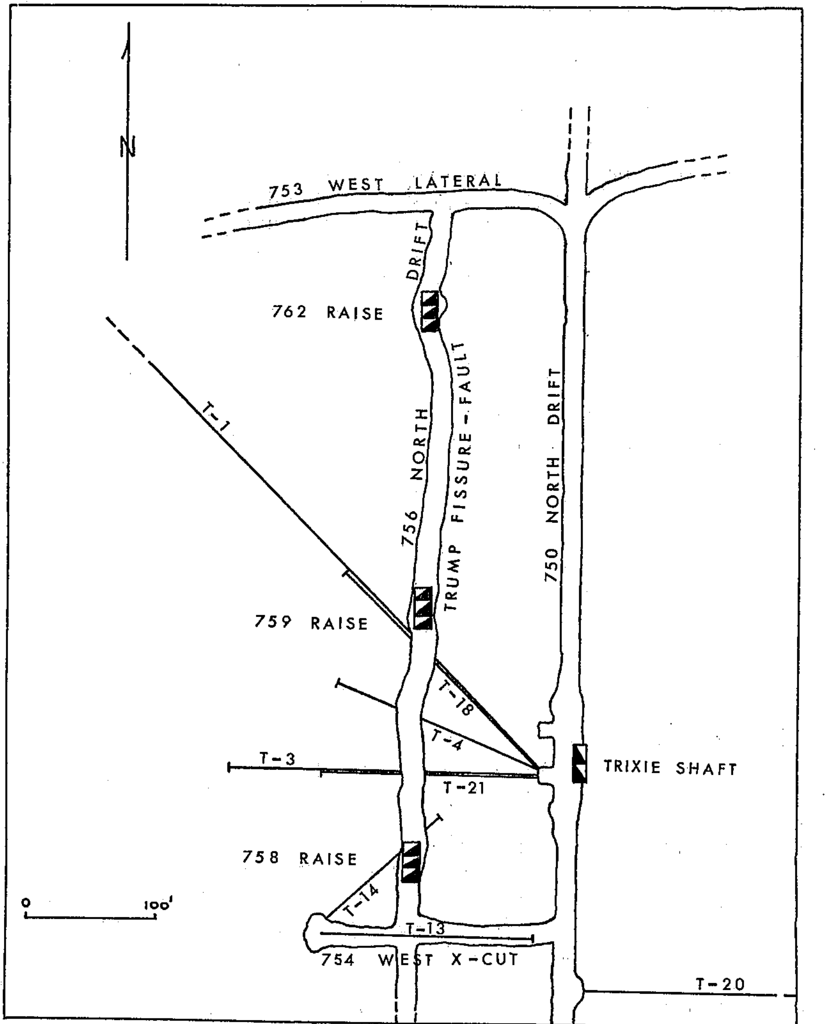
GEOLOGY OF THE TRUMP FISSURE-FAULT ORE BODY

History of Exploration-Trixie Area

During the summer months of 1954 and 1955, the U.S. Geological Survey drilled nine exploratory drill holes near the Trixie target area. This work was part of an extensive program of stratigraphic, structural, alteration, geochemical, and geothermal investigations to develop prospecting techniques for concealed ore bodies in the East Tintic district (Morris, *et al.,* 1956). The Trixie area was selected since it was believed to include the intersection of north-northeast-trending silicified, hydrothermally-altered pebble dikes and fissures with geochemical anomalies in copper, lead, and zinc, and a major high-angle easterly-trending fault, the Trixie fault (Morris, 1956). In addition, the presence of a large surface zone of alteration in the overlying volcanics indicated hydrothermal alteration and possible mineralization with favorable host rocks at depth (Gilbert, 1959, and Morris, *et al.,* 1956). Encouraged by the results of the U.S. Geological Survey drilling program and after preliminary investigations by company personnel, Bear Creek Mining Company initiated a surface exploration drilling program in the Trixie and Burgin areas. After a limited amount of surface drilling, a shaft was started in January 1957, in the Burgin area, and resulted in discovery of the Burgin limestone replacement ore bodies (Bush, *et al.,* 1960). It was not until the Burgin mine had been in production for five years that work on the Trixie shaft began.

Sinking of the shaft began in 1968 in the Trixie area at the site of the old Trump prospect shaft (refer to index map). It penetrated a thin cap of Packard rhyolite and basal volcanic rubble of 30 feet, a nearly complete 384-foot section of Ophir shale, and 386 feet of Tintic quartzite which conformably underlies the Ophir Formation. The shaft collared at 6,065 feet elevation and was sunk to a depth of 862 feet. A shaft station was cut 750 feet below the collar. Drifting began on this level to intersect and explore the Trixie related faults 500 feet to the north and evaluate mineralization discovered by surface drilling.

A drill station was cut at the shaft to test the Tintic quartzite to the west. Drill holes T-1, T-3, and T-4 were drilled from the station at 0° inclination with bearings N. 42° W., due west, and N. 67 W., respectively (refer to 750-foot level map, Text-fig. 3). Drill hole T-1 was the longest of the three holes and intersected the Trixie fault 674 feet from the collar. Assays for these holes indicated a mineralized zone 7 to 20 feet wide, trending N. 10° E., with values of lead, copper, gold, silver, and zinc (see Table 1). To check this mineralized structure, a cross-cut was made from the south end of the 750-foot drift (Text-fig. 3) which intersected the above-mentioned structure 138 feet from the drift. This structure has subsequently been named the Trump fissure-fault.



TEXT-FIGURE 3.—Map of the 750-foot level of the Trixie Mine.

Trump Ore Body Development

In late October of 1969, a slusher trench was cut along strike of the Trump fissure-fault to test mineralization encountered in drill holes T-1, T-3, and T-4. After the tenor of mineralization was deemed "ore grade' 'and structure proved to be persistent, the slusher trench was abandoned and a permanent drift (756 drift) was cut along strike of the Trump fissure-fault. Subsequent work on the level extended the 756 drift 573′ N. 5° E. to intersect with the 753 west lateral drift and 102′ south along the 756 south extension slusher cut. Three vertical production raises, 758, 759, and 762, have been raised

TABLE 1
SUMMARY OF DRILL HOLES—TRUMP ORE BODY

DDH T-1	
0-15'	Tintic Quartzite, quartzite
15-47'	shale
47-64'	quartzite
64-92'	shale
92-503'	quartzite
503-534'	shale
354-674'	quartzite
675-784'	Trixie fault zone
DDH T-3	
0-16'	Tintic Quartzite, quartzite
16-46'	shale
46-62'	quartzite
62-80'	siliceous shale
80-215'	quartzite
DDH T-4	
0-17'	Tintic Quartzite, quartzite
17-32'	shale
32-54'	quartzite
54-61'	shale
61-182'	quartzite
DDH T-13	
0-112'	Tintic Quartzite
(65-70'	fracturing plus minor sulfide mineralization)
DDH T-14	
0-198'	Tintic Quartzite
DDH T-17	
0-70'	Tintic Quartzite
70-81'	Intrusive porphry
81-173'	Tintic Quartzite
DDH T-18	
0-18'	Tintic Quartzite shale
18-287'	quartzite
287-305'	Mineralized quartzite breccia
305-347'	Tintic Quartzite
DDH T-20	
0-60'	Tintic Quartzite shale and quartzite
60-212'	quartzite
212-340'	Interbedded shale and quartzite
(224-230'	flat pebble conglomerate)
340-357'	Pebble dike
357-720'	Tintic Quartzite

132′, 132′, and 48′ respectively, as of July 1970, with sublevel connections between the 758 and 759 raises on the 10th and 20th levels. Additional production sublevels have been cut north of the 759 raise and south of the 758 raise. As of July 1970, a sublevel drift is being cut 80′ north of the 758 raise on the 20th sublevel to connect with the mainshaft 134′ away. All drifts, raises, and cuts are confined to the Tintic Quartzite, except for the 756 south extension cut which terminates in an altered monzonite dike .

Tintic Quartzite

Distribution.—Underground workings and diamond drill holes in the mineralized zone of the Trump fissure-fault have exposed a 307-foot section of Lower-Middle Cambrian Tintic Quartzite host rock. The conformable contact between the lower Ophir Shale and the upper Tintic Quartzite is exposed in the main shaft, 334 feet above the 750-foot level of the mine. Consequently, all of the Trump ore body workings and below-level drill holes are confined to the upper 500 feet of Tintic Formation.

Lithology.—The Upper Tintic Quartzite is a vitreous, light gray to fleshy-pink, medium to coarse-grained quartzite (Plate 1). It is moderately to thoroughly recrystallized, granular to massive, and commonly shows relict bedding. The quartz grains, which constitute greater than 90 percent of the rock, are well rounded and moderately well sorted, clear to milky gray or pink, and very well cemented. Individual grains contain "dust trails" or minute vacuoles which Morris and Lovering (1961) indicated were, "lined with an isotropic dust of unknown identity, probably iron or alumium compounds." The original host rock appears to have very low porosity and permeability. A few decomposed feldspar grains have been identified which have altered to clay minerals or have been replaced by pyrite. Minor constitunts include zircon, apatite, sphene, pyrite, iron-titanium oxides, muscovite, biotite, and sericite.

The intergranular material of the quartzite prior to metamorphism probably consisted of partially decomposed feldspars, quartz silt, micas, and clays. Compaction and metamorphism have forced the migration of nonquartz constituents into interstitial pockets and clusters which appears as cloudy buff-colored spots in the quartzite. This material has since been kaolinized, sericitized, alunitized, silicified, and pyritized by metamorphism and hydrothermal alteration (Plate 2).

Many thin lenses of gray-green, micaceous to sandy shale are interlayered with the bedded quartzite. These shale lenses range from a fraction of an inch to beds 4 feet thick and constitute as much as 20 feet of a 100-foot section. They are not reliable marker beds as they pinch and swell abruptly over short distances. The shale is hard, micaceous to argillaceous, weakly fissile, and generally sheared, deformed, and bleached in the vicinity of the Trump fissure-fault.

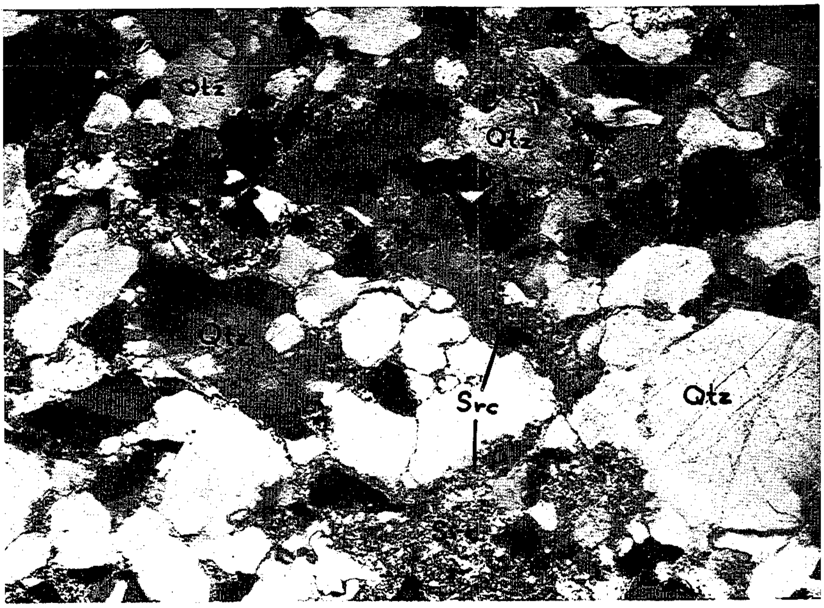
Structural habit.—Throughout the East Tintic district, the Tintic Quartzite acts as a ledge-forming, resistant unit above ground and a brittle, highly competent unit underground. It shatters well, requires little or no timbering, and will remain open indefinitely (Morris and Lovering, 1961). However, in the Trump fissure-fault zone, the Tintic Quartzite host is severely brecciated with abundant open fractures and fissures, and requires frequent timbering to keep the rock from sloughing off between the west hanging wall, slickenside surface and the brecciated east footwall. The problem of ground caving is intensified by intermittent shale beds within the quartzite. The hanging wall and footwall of the Trump fissure-fault are highly competent and localize the need for structural support to ground within the narrow 4′ to 20′ fissure-fault zone.

Chemistry.—According to Morris and Lovering (1961), much of the Tintic Quartzite contains at least 90 percent silica. Shales in the upper part of the fromation are high in K_2O and TiO_2, reflecting an abundance of coarse clastic mica, probably altered biotite. The proportion of Al_2O_3 and K_2O in the shale indicates the mineral composition is nearly 80 percent hydrous white mica and the remainder, silt-size quartz.

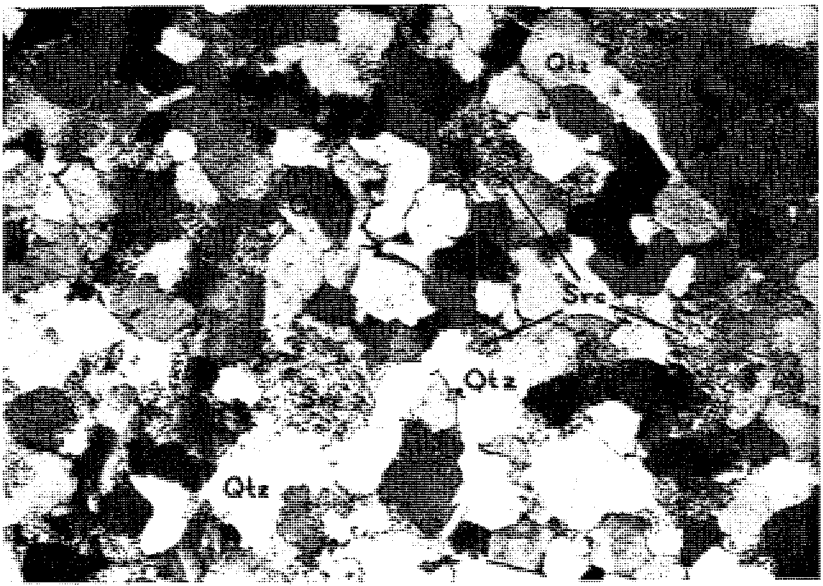
Hydrothermal Alteration

Tintic Quartzite in the Trump fissure-fault zone has been subjected to several stages of hydrothermal alteration. Lovering (1949), in an extensive study of alteration in the East Tintic district, has identified and described in considerable detail five separate stages of hydrothermal alteraton. These stages are 1) the early barren stage, typified by chloritic alteration in volcanics and dolomite alteration in limestones; 2) the midbarren stage, characterized by argillic alteration and acid leaching; 3) the late barren stage, characterized by the introduction of jasperoid, barite, and pyrite; 4) the early productive stage, marked by the introduction of clear quartz, sericite-hydromica, and pyrite; and 5) the productive stage, characterized by the precipitation of pyrite and ore sulfides .

Early Barren Stage—The early barren stage is not recognized in the Trump fissure-fault zone. Evidence for this stage exists in hydrothermally-dolomitized



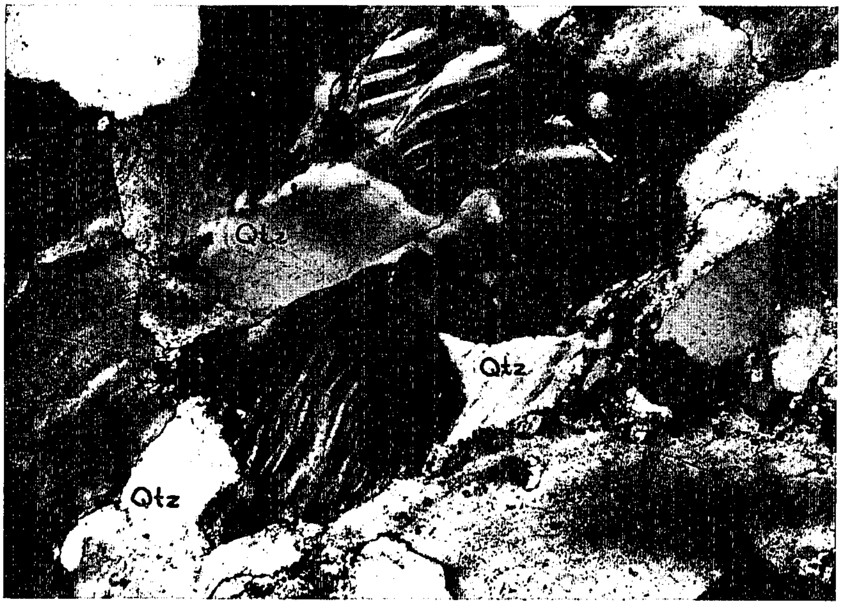
1



2

EXPLANATION OF PLATE 1
PHOTOMICROGRAPHS OF TINTIC QUARTZITE

FIG. 1.—Tintic Quartzite. X-Nicols, 88X.
FIG. 2.—Tintic Quartzite. X-Nicols, 88X.



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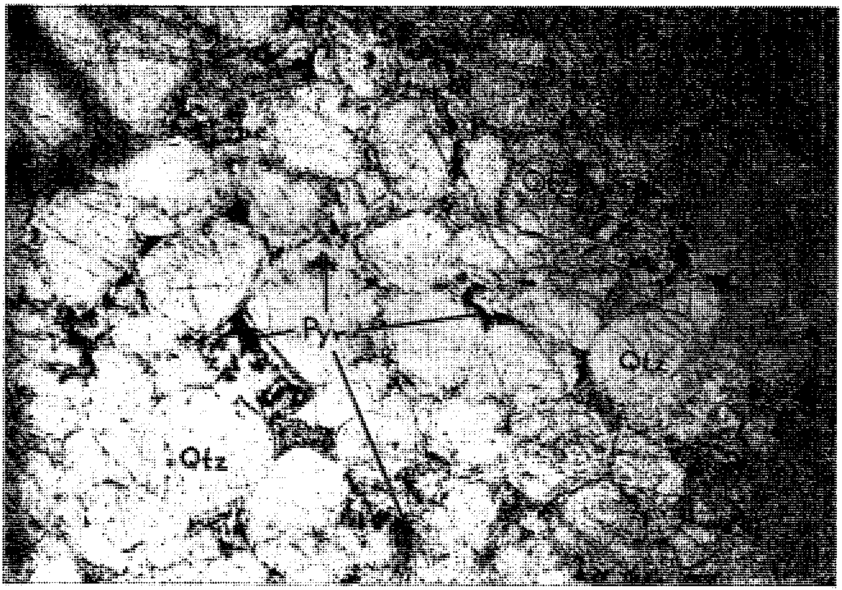


2

EXPLANATION OF PLATE 2
PHOTOMICROGRAPHS OF TINTIC QUARTZITE

FIG. 1.—Strained quartz grains. X-Nicols, 220X.
FIG. 2.—Quartz grains with interstitial pyrite. Plain light, 88X.

Cambrian limestones and chloritized basal units of Packard Quartz Latite and Laguna Springs Latite which overlie the Tintic Quartzite in the Trixie mine (Morris, *et al.*, 1956).

Mid-barren Stage.—The mid-barren stage is characterized by strong argillic alteration of carbonate and extrusive rocks, but also affects monzonite intrusives, quartzite, and shale (Lovering, 1949). A monzonite intrusive dike at the south terminus of the Trump ore body is moderately argillized with feldspar phenocrysts altered to kaolinite, dickite (?), hydromica and sericite, and ground mass weakly altered to clays, silica, and pyrite (Plate 3). Lovering (1949) proposed that the degree to which a monzonite dike has been altered can be correlated to the period of its intrusion. Accordingly, the monzonite dike injected along the Trump fissure-fault zone has been dated by the author as mid-to-late mid-barren stage. The evidence for this date is the apparent abundance of alteration minerals characteristic of this period, namely kaolinite, dickite (?), sericite, and hydromica.

Evidence of mid-barren stage argillic alteration in the matrix of brecciated quartzite is questionable. Interstital material between quartz grains has been altered to sericite, silica, minor clays, and pyrite. This type of alteration is characteristic of Lovering's late barren and early productive stages. If mid-barren alteration existed in the quartzite, there undoubtedly has been post-argillic alteration which modifies the effects of the mid-barren stage.

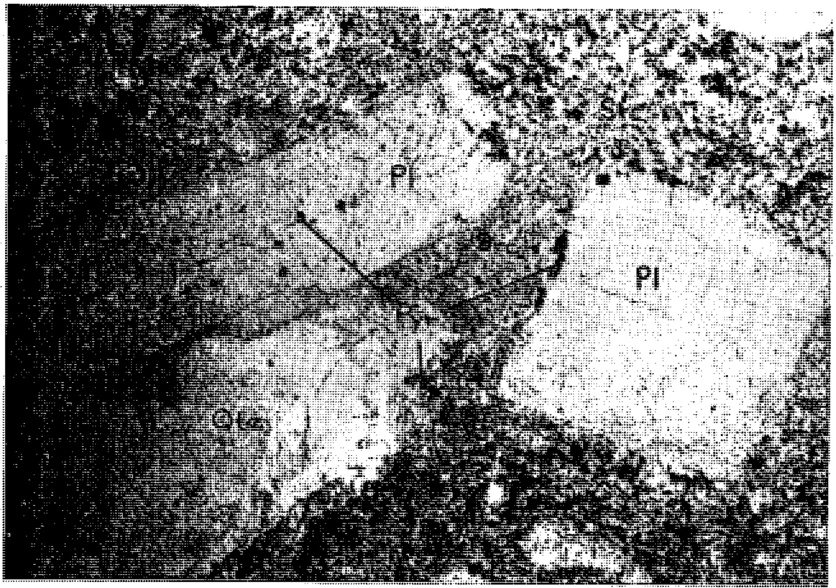
The most important evidence for mid-barren stage alteration is increased porosity of quartzite brought about by substantial leaching of acid solutions which accompanied argillic alteration. This is visible in samples of strongly etched quartzite from the 759 and 762 raises (Plate 4), which have been subsequently encrusted by barite and jasperoid of the late barren stage.

Late Barren Stage.—In the Trump area, late barren stage hydrothermal alteration is characterized by the introduction of jasperoid, barite, and pyrite. Sampling throughout the ore body shows jasperoid introduction is widespread in shale and quartzite, and weak to nonexistent in the monzonite dike. Fault gouge, intergranular clays and micas in quartzite, and silty shales are most easily attacked by jasperoid alteration which may be expressed as very fine-grained (<0.01 mm) cryptocrystalline jasperoid to coarser, microcrystalline quartz (Plate 4). Within the brecciated quartzite, silica of the late barren stage cements microbreccia and fragments of quartzite into hard, competent blocks.

Barite is deposited intermittently during the late barren stage and is both preceded and followed by silica deposition. Field evidence indicates that the barite not deposited contemporaneously with the silica. Samples of barite examined by the author consistently show barite covering or encrusting by quartz crystals, but not intergrown. According to Lovering (1949):

> The presence of several generations of barite, each one commonly showing corrosion before the enclosing quartz formed, suggests a delicate balance between precipitation and solution in the hydrothermal solutions. Fluctuations in pressure such as would accompany intramineralization faulting would immediately affect the amount of free CO_2 in solution and could cause precipitation of barite if the pressure was relieved, or resolution if the pressure increased.

Field evidence indicates this delicate balance between solution and precipitation of quartz and barite existed during late barren hydrothermal alteration in the Trump fissure-fault.



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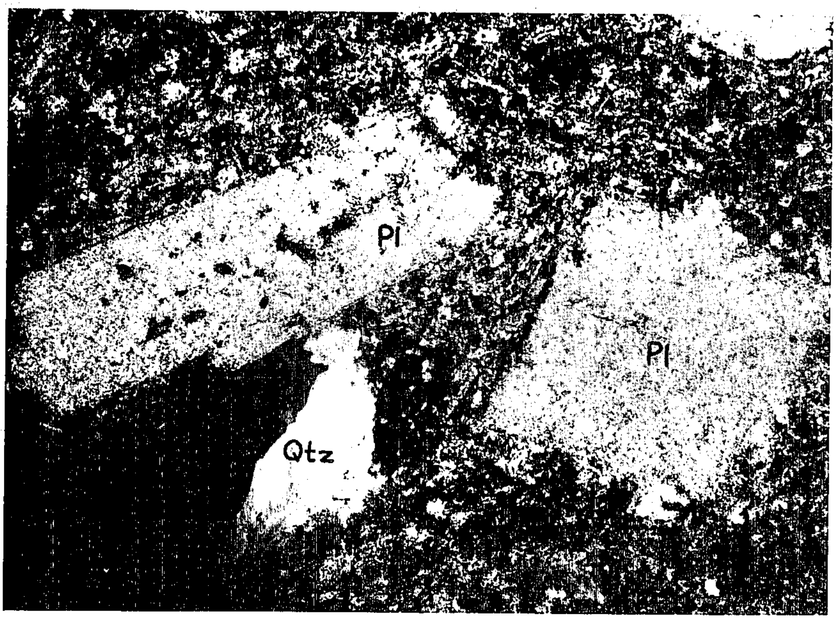

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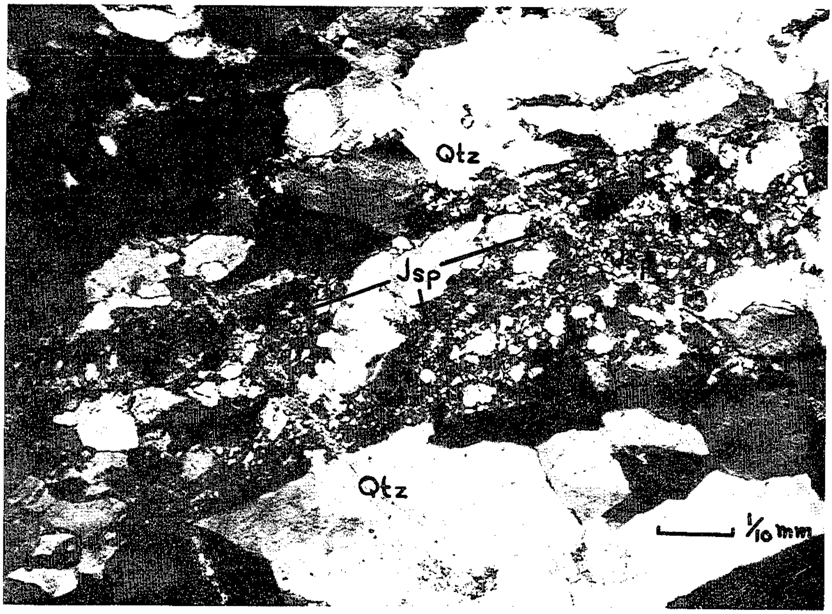
EXPLANATION OF PLATE 3

PHOTOMICROGRAPHS OF MONZONITE DIKE

FIG. 1.—Altered phenocrysts and groundmass. Plain light, 88X.
FIG. 2.—Altered phenocrysts and groundmass. X-Nicols, 88X.



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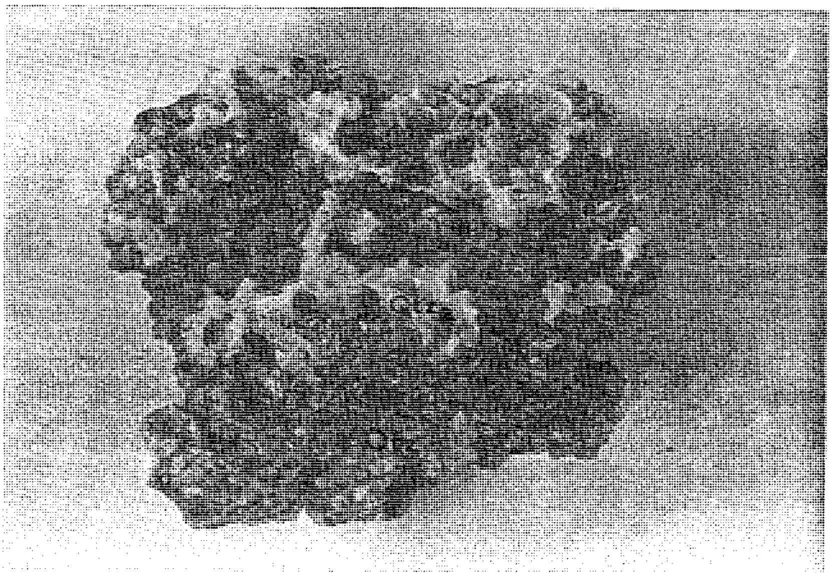

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Explanation of Plate 4

SECONDARY SILICA AND PHOTOMICROGRAPH OF JASPEROID ALTERATION

Fig. 1.—Jasperoid veinlet in Tintic Quartzite. X-Nicols, 88X.
Fig. 2.—Secondary silica on etched quartzite. Natural size.

Pyrite alteration of the late barren and early productive stages is characterized by fissure-filling and replacement veins of pyrite in quartzite, shale (Plate 5), and breccia, and by disseminated grains in altered quartzite and shale. In open-spaced cavity fillings in quartzite and quartzite breccia, pyrite occurs as an aggregate of interlocking crystals or as individual, well-formed euhedral pyritohedrons. Disseminated grains of pyrite generally occur as solitary fine crystalline euhedra replacing hydrothermal clays or sericitized, silicified material between quartz grains. Since pyrite replaces the argillization products of the mid-barren stage, coats barite crystals and jasperoid of the late barren stage, and is replaced by ore minerals of the productive stage, its age in the hydrothermal alteration sequence must be late barren to early productive.

Early Productive Stage.—The early productive alteration stage is evidenced throughout the Trump fissure-fault zone by the introduction of clear quartz, pyritohedral pyrite, and sericite-hydromica. This alteration appears confined to the immediate vicinity of the Trump fissure-fault. Quartzite on the hanging wall of the ore body is essentially barren of pyrite and sulfide mineralization in the foot-wall decreases to trace amounts within 15' to 20' of the zone of brecciation.

Pyrite and clear quartz were deposited in open cavities. Sericite and hydromica occur as veinlets in shale, quartzite, and altered microbreccia and have replaced clay minerals formed during argillic alteration of the mid-barren stage.

The monzonite dike in the south end of the Trump fissure-fault zone has been highly altered by solutions of the early productive stage. The intrusion contains abundant clear quartz veins and disseminated pyritohedral pyrite. An intrusive sample 70' from the collar of drill hole T-17 contains 35 percent modal count of disseminated and vein pyrite with strongly altered feldspar phenocrysts of sericite, hydromica, and quartz.

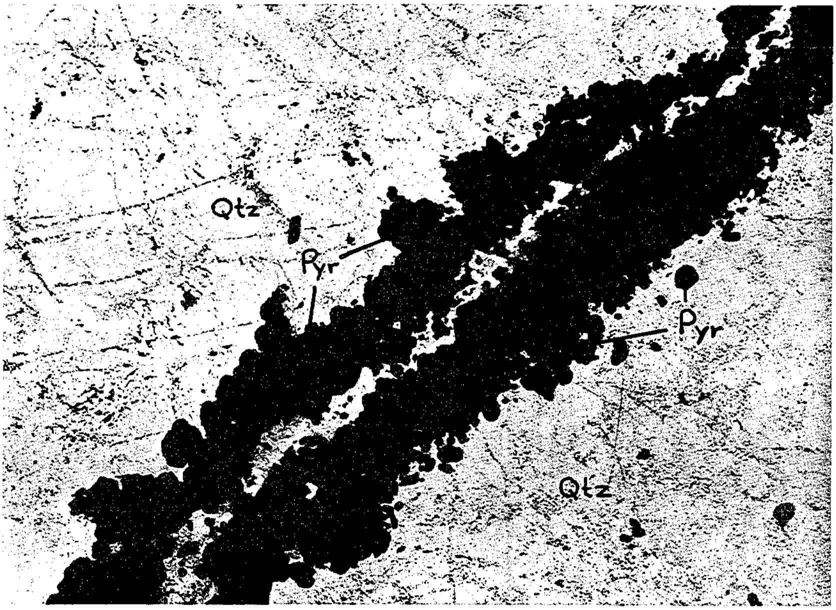
Productive Stage.—The final stage of alteration recognized by Lovering is the productive stage. This is distinguished by abundant precipitation of sulfides, sulfosalts, and native gold with minor amounts of barite and quartz. Most of the ore in the Trump fissure-fault is precipitated in open spaces of breccias and solution cavities or replaces pyrite. Minor amounts of ore directly replace the quartzite or shale.

STRUCTURE OF THE TRUMP FISSURE-FAULT

The Trump fissure-fault is one of a series of north-northeast-trending fissures in the Trixie area which postdate lavas, monzonite intrusives, and sediments. This fissure system is an aggregate of parallel fissures, pebble dikes, and porphry dikes (Billingsley, 1957) that trend about N. 25° E. and dip steeply to the west. The zone of fissuring is marked at the surface by a linear patch of pyritic and argillic-altered volcanics, and short monzonite and pebble dikes. This linear altered zone is 500 to 1,000 feet wide and has been traced by Morris (1956) nearly two miles southwestward.

Characteristics of the Trump Fissure-Fault

The Trump fissure-fault varies in strike from due north to N. 15° E. and has an average strike of N. 5° E. In one section of the 756 drift, the structure trends N. 20° W. for 42 feet but quickly returns to a N. 10° E. course. The



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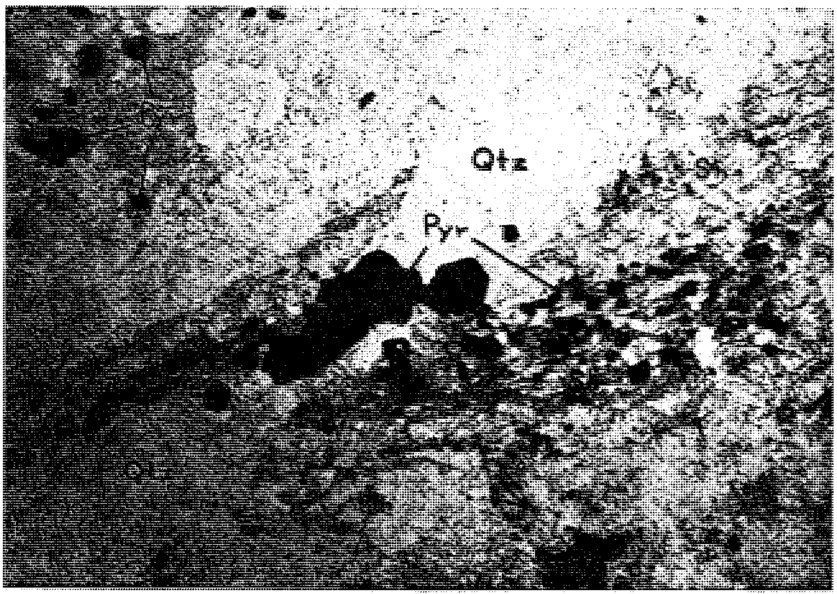

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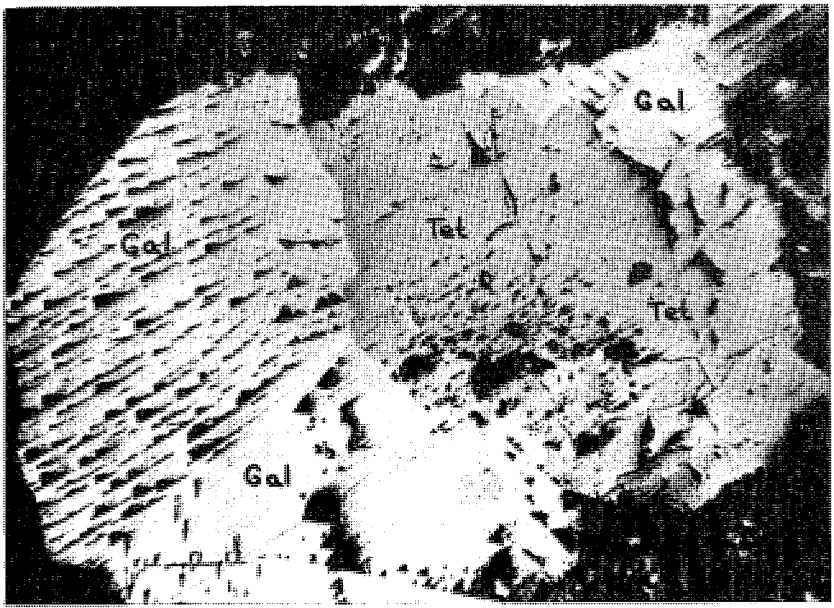
EXPLANATION OF PLATE 5

PHOTOMICROGRAPHS OF PYRITE IN TINTIC QUARTZITE

FIG. 1.—Pyrite replacement in quartzite. Plain light, 220X.

FIG. 2.—Pyrite replacement in shale. Plain light, 88X.



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EXPLANATION OF PLATE 6
PHOTOMICROGRAPH OF TRUMP ORE AND
PHOTOMICROGRAPH OF BARITE

FIG. 1.—Tetrahedrite and galena, 756 south cross-cut. 123X.

Abbreviations.—qtz-quartz, src-sericite-hydromica, jsp-jasperoid, qtz_2-secondary quartz, sh-shale, gal-galena, pyr-pyrite, cp-chalcopyrite, sph-sphalerite, tet-tetrahedrite, str-stromeyerite, dg-digenite, cv-covellite, bd-bindheimite.

FIG. 2.—Barite on quartzite, 759 raise. Natural size.

dip of the west hanging wall varies from 45° to slightly overturned and averages 73° W. There is no consistant variation in dip along the length of the 756 drift; however, strike trends more eastward approaching intersection with the Trixie fault. Width of the brecciated zone between the west hanging wall and the footwall ranges from 3 or 4 feet to about 20 feet. The brecciated zone narrows at the ends of the 756 drift but in the north this may be due to branching or horsetailing of the main fissure-fault zone as it approaches the Trixie fault. Sublevel drill holes and exposures in raises do not suggest any consistant vertical variation in the width of the brecciated zone.

The Trump fissure-fault has not been positively identified at the surface. Projection of the subsurface structure brings it to the surface along the approximate position and trend of Silver Pass creek. The topographic low of the creek may be due to easily eroded brecciated and altered country rock along the fissure-fault zone (Morris, communication, 1970).

Displacement of the Trump Fissure-Fault

Slickensides are well-developed in fault gouge and massive quartzite along the hanging wall of the Trump fissure-fault. Smith (personal communication, 1970) recognized drag folds with bedding slips and brecciation in the hanging wall along the 756 south drift and postulated normal dip-slip movement.

The direction of slickenslides confirms dip-slip movement but the magnitude of movement is uncertain. Much of the fault gouge has been hydrothermally altered to sericite, hydromica, and pyrite, which obscures the original structure of the gouge. There have been no marker beds observed in the quartzite which would indicate relative movement along the fissure fault. The only possible conclusion indicates minor dip-slip movement of uncertain magnitude. Observaton of the Tintic Quartzite-Ophir Shale contact or identification of a marker bed in the upper Tintic Quartzite may provide an answer to this problem.

Relation to East Tintic Anticline

The origin of this fissure zone, as previously mentioned, is thought by Morris (1957) to be response to weak tectonic forces acting on previous folds (i.e., the East Tintic anticline). This is plausible, for the fissure zone trends within 15° of the axial strike of the East Tintic anticline. The mechanism for fissuring along the crest of the anticline was probably east-west compressive forces that tightened the north-south folds. Intrusion of monzonite stocks and plugs to the southwest of the Trump may have been an important factor in producing secondary folding of the East Tintic anticline and enlarging preexisting fissures by forceful injection of monzonite dikes.

The East Tintic anticline in the vicinity of the Trump fissure-fault has a broad, flattened, undulating crest more than a mile wide (Gilbert, 1959). Underground field mapping by Kennecott personnel indicates beds east of the Trump fissure-fault gently dip to the east and northeast, and gradually increase in dip eastward (drill hole No. 20). The Trump fissure-fault strikes parallel to the East Tintic anticline and is on the eastern edge of the anticlinal axis.

Relation to Local Faults

The Trump fissure-fault trends N. 5° E. and is surrounded by high-angle, strike-slip faults (Text-fig. 2). On the west, the Eureka Standard fault strikes about N. 40° E. (Shepard, 1968) and diverges southward from the Trump fault. The intersection of these two structures to the north has not been observed at depth. The Eureka Standard fault has an average dip of 55° NW. It has a right lateral displacement of about 3,000 to 4,000 feet (Morris, 1964), and predates formation of the Trump fissure-fault. The intersection of north-northeast-trending fissures and the Eureka Standard fault is the locus of high-grade, fissure-filling, siliceous gold-copper-silver ores of the Eureka Standard mine.

The Trixie fault, which intersects the Eureka Standard fault to the west, strikes N. 82° E. This fault is possibly a displaced extension of the Teutonic fault which appears on the east side of the Eureka Lily fault (Morris, *et al.*, 1956), or a bifurcation of the Eureka Standard fault. Measured dip slip displacement of the Trixie fault is approximately 1,000 feet. The intersection of the Trump fissure-fault and the Trixie fault is about 50 feet north of the 756 drift and 753 west lateral intersection. Drilling along the Trixie fault indicates the Trump fissure-fault may control the westward extent of the Trixie ore body and postdate the Trixie fault. It is possible that the Trump fault continues north through the Trixie fault to intersect with the Eureka Standard fault.
On the 750-foot level, the Eureka Lily fault lies about 500 feet east of the Trixie shaft and strikes about N. 5° W. It dips 65° W. and has an inferred displacement (Gilbert, 1959) of 340 feet.

Drifting south on the Trump fissure-fault terminates at the contact of the intruded monzonite dike 102 feet south of the 754 west cross-cut. It is not known if the structure continues beyond this point to intersect the Sioux-Ajax fault, 800 feet to the south. Persistence of the surface pebble dike-fissure zone to the southwest of the Trixie area indicates the subsurface structure may continue beyond the monzonite dike contact. Drifting along the 751 south crosscut is presently underway to explore this possibility.

Host Preparation

Brecciation of Tintic Quartzite is fairly well confined to rock between the hanging wall on the west and the footwall on the east. Fracturing is intense near the hanging wall surface, with abundant fault gouge, breccia, and microbreccia, but rapidly loses intensity into the footwall. For this reason, the hanging wall contact is readily identified, but the footwall contact is uncertain. Some slickensides occur along the footwall contact but the best indication of the footwall is a noticeable decrease in brecciation and hydrothermal alteration as the contact is approached.

The mechanism for brecciation in the Trump fissure-fault is complex. Hanging wall and footwall fracturing and related parallel fractures are undoubtedly adjustments to tectonic forces described by Morris (1957) as producing north-northeast-trending fissures. The intrusion of the monzonite dike at the south terminus of the fissure-fault also affected fracturing of the host rock. The intrusion was probably emplaced by forceful injection.

Hydrothermal acid leaching, described in Lovering's mid-barren stage, and alteration and jasperoidization of the late barren stage played significant roles in opening up the quartzite in preparation for ore deposition. Alteration enlarged cavities and solution channelways created by original fracturing.

ECONOMIC GEOLOGY

Ore Body Characteristics

Mineralogy.—The mineral assemblage identified from underground exposures and drill cores indicate the present workings of the Trump body are restricted to the oxide zone of the ore body. Ores occur as hypogene and supergene sulfides and sulfosalts, and as oxidized carbonates, arsenates, sulfates and oxides. Primary hypogene ore minerals are chalcopyrite, tetrahedrite-tennanite, enargite and galena, with minor sphalerite and bornite. The important secondary ores are chalcocite-digenite, stromeyerite, azurite, malachite, and plumbojarosite.

Chemistry.—The ores undoubtedly were derived from residual magmatic solutions related to monzonite and quartz latite (Lovering, 1949) igneous rocks of the district. There is no source inherent in the Precambrian and Paleozoic sedimentary rocks of the Tintic mountains for ore elements. According to Lovering (1959), spectroscopic analysis of the quartz latite and the ore indicate both were derived from the same source.

Field evidence shows that only minor amounts of barite, quartz, and pyrite were deposited with ore minerals. The paucity of gangue minerals deposited during the productive stage and the formation of sulfides and sulfosalts indicates solutions were alkaline. In this chemical environment, there was probably intermittent solution and minor precipitation of quartz.

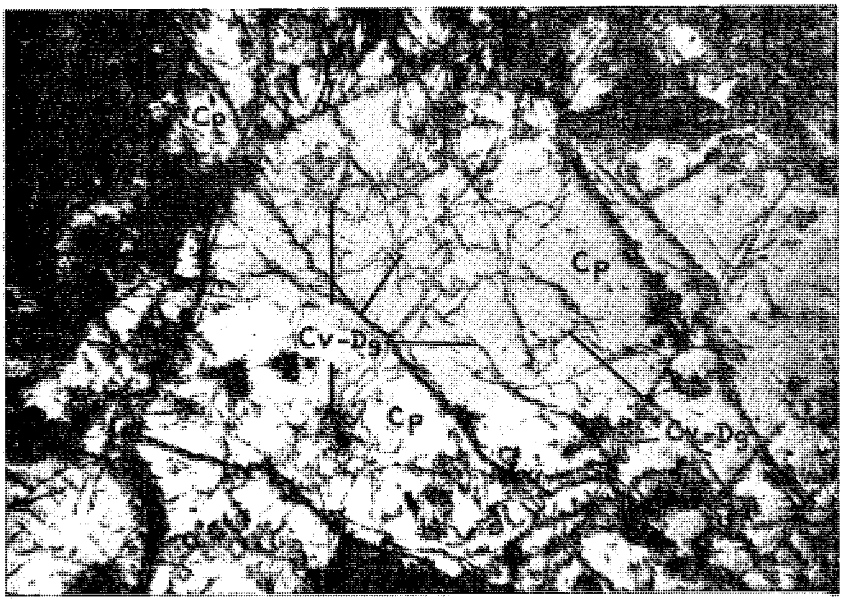
Economics.—The tenor of Trump ore varies greatly through the ore body. The ore carries metal values in lead, copper, silver, gold, a trace of zinc, and variable amounts of bismuth and antimony. Minor cadmium occurs with zinc in sphalerite.

Mining Methods.—The ore body is being mined by drifts, raises, and sublevel slusher cuts. Timbering has been limited to haulage tunnels and raises. Brecciation along the fissure-fault promotes caving of ore once a cut has been made, but rarely requires roof bolts or timbering to prevent extensive caving. The strength of the hanging wall and footwall results in caved rock forming an arch of brecciated blocks which supports itself against continued caving. The quartzite breccia is amenable to extraction. It is firm to drill and shatters well on blasting.

Characteristics of Primary Ore

Fissure-Filling Ore.—Primary sulfides and sulfosalts of the ore zone were deposited by open-space filling and replacement. Open-space filling in brecciated quartzite was brought about by fairly rapid pressure and temperature changes encountered when residual ore solutions ascended along the Trump fissure-fault. The main evidence for this is the paucity of primary and secondary ore minerals in abundant cavities and open channelways in the quartzite breccia, and the telescoping of a wide variation of hypogene minerals in the ore zone. Leaching of ore minerals and silica may account for absence of some ore but no evidence exists for supergene enrichment at depth. In addition, oxidation minerals such as azurite and malachite are minor in relation to the abundance of primary and enriched sulfides.

The lack of chemical reactivity of the host with ore solutions may account for the weak tenor of the ore body, yet throughout the East Tintic district, copper-gold-silver ores of the Trump fissure-fault type have a lithologic affinity for



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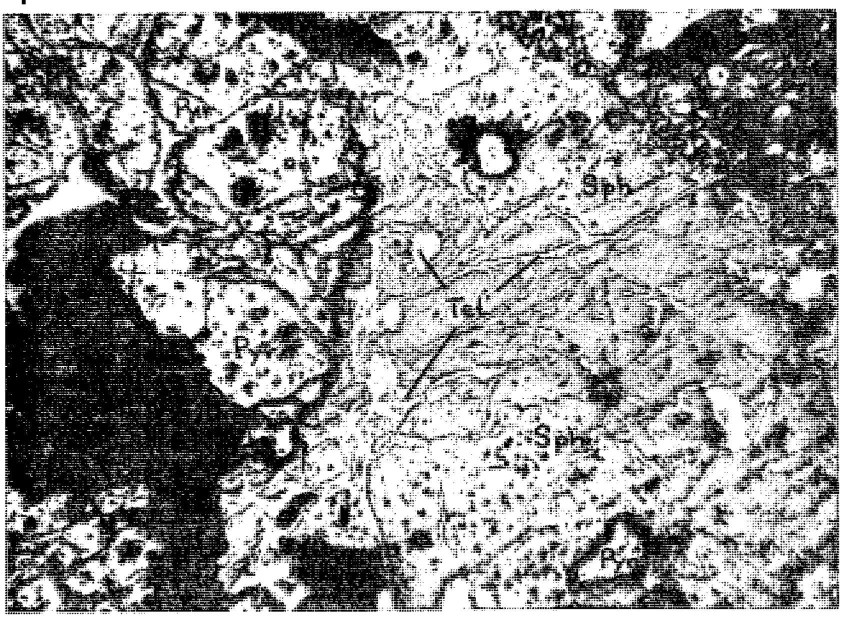

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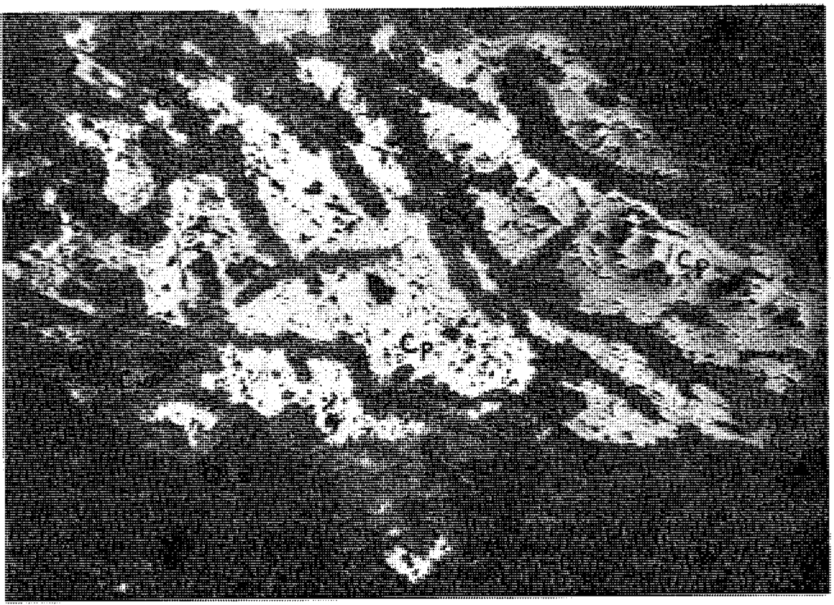
EXPLANATION OF PLATE 7

PHOTOMICROGRAPHS OF TRUMP ORE

FIG. 1.—Covellite-digenite after chalcopyrite, DDH-1. 123X.
FIG. 2.—Tetrahedrite after sphalerite, 756 drift. 123X.



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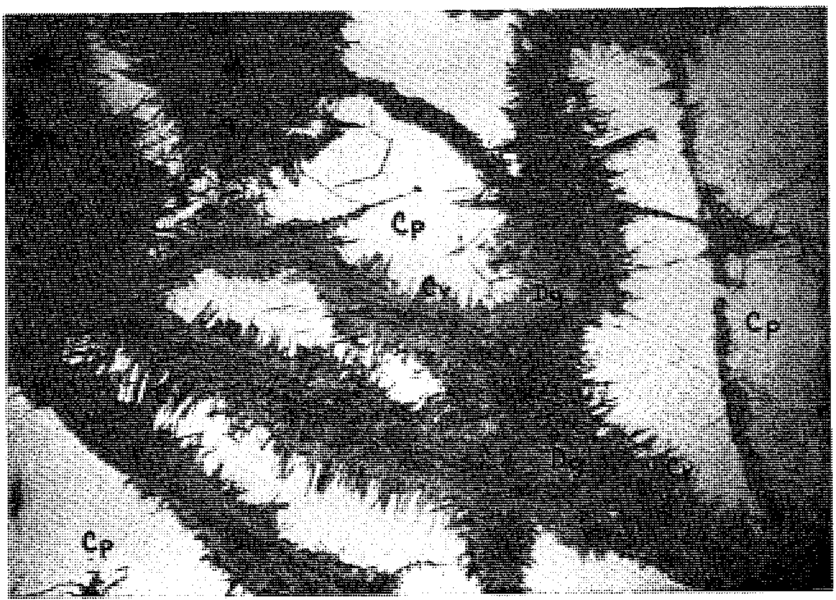

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EXPLANATION OF PLATE 8

PHOTOMICROGRAPHS OF TRUMP ORE

FIG. 1.—Covellite after chalcopyrite, DDH-1. 123X.

FIG. 2.—Covellite-digenite after chalcopyrite, 756 drift. 1400X.

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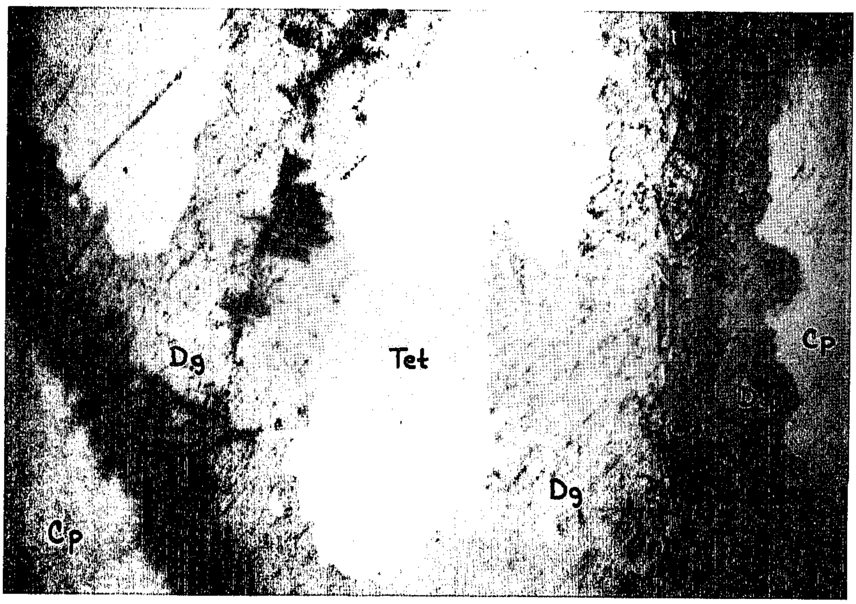

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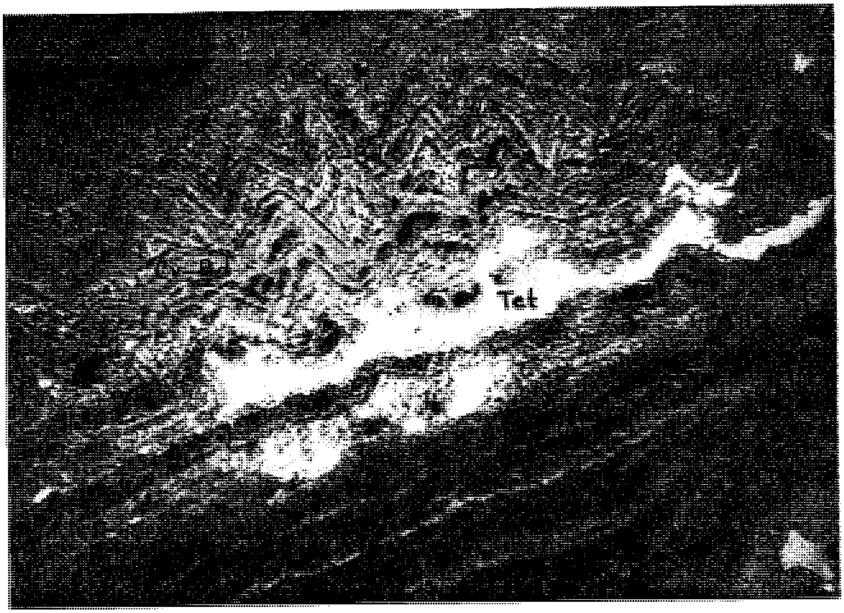
EXPLANATION OF PLATE 9

PHOTOMICROGRAPHS OF TRUMP ORE

FIG. 1.—Covellite-digenite after chalcopyrite, DDH-1.

FIG. 2.—Covellite and digenite after tetrahedrite and chalcopyrite, 756 drift. 400X.



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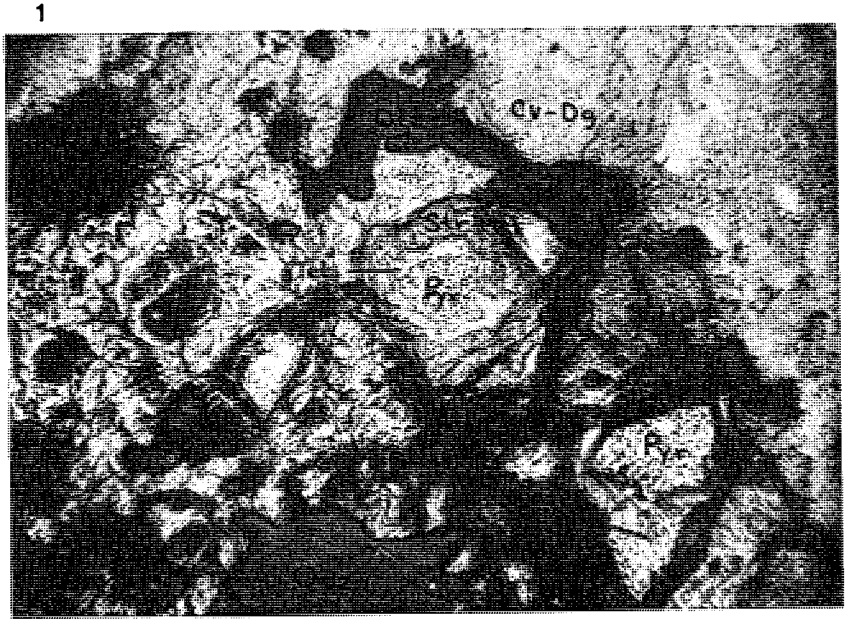

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EXPLANATION OF PLATE 10

PHOTOMICROGRAPHS OF TRUMP ORE

FIG. 1.—Covellite-bindheimite after tetrahedrite, 756 drift. 123X.

FIG. 2.—"Sea and Island" texture. Pyrite replaced by tetrahedrite, stromeyerite, and covellite-digenite, DDH-1. 123X.

quartzite (as opposed to lead-zinc limestone replacement ores.) This association is shown well in the Trump and Trixie ore bodies. Lead, zinc, silver, and minor copper were carried up rake and northward along the Trump fissure-fault to form the larger Trixie ore body, while copper, gold, silver, lead, and minor zinc were deposited in quartzite. Apparently, ore solutions moved rapidly through the Trump fissure-fault along open channelways and precipitated the bulk of their load along the Trixie fault.

Complex intergrowths of copper sulfide and sulfosalt minerals indicate rapid precipitation of hypogene ore. Most polished sections contain a minimum of four hypogene copper sulfides, chalcopyrite, bornite, enargite, and tetrahedrite, which are intimately associated in a patchwork of interlocking grains. Precipitation over an extended period would result in a less-chaotic, zoned sequence of ore minerals which show some paragenesis of deposition. This is generally not the case with Trump cavity filling deposits.

Pebble and monzonite dikes, surface alteration, and geochemical anomalies along the fissure zone indicate open channels extended to the surface during alteration and ore deposition.

Replacement ore.—The process of metasomatism or replacement is widespread in Trump ores. Direct quartz replacement by pyrite occurs but most pyrite replaces interstitial clays, micas, secondary silica, or fault gouge within brecciated quartzite. Metacrysts of pyrite are common in shales and the interstitial matrix of quartzite. Diffusion replacement and migration along microfractures and grain boundaries accounts for the occurrence of disseminated pyrite well beyond the limits of fracture surfaces.

Most of the ore sulfides and sulfosalts directly replace massive or disseminated pyrite. Some ore is formed by replacement of intergranular material and microbreccia in quartzite and shale. Apparently the amount of pyrite present during formation of ore minerals was sufficient to allow volume for volume replacement of ore sulfides until copper, silver, arsenic, and other ore elements were extracted from solution.

Mineralogy

An extensive group of ore and gangue minerals has been identified from the Trump fissure-fault. Most specimens were initially examined with a 10X hand lens and a 30X binocular microscope. Subsequent observations were made on polished sections, thin-sections, and powdered samples by ore and petrographic microscope examinations, infrared analysis, atomic absorption, and microprobe analysis. Ore microscope work involved etch reaction and microchemical tests, and textural studies. Seventy-one polished sections were prepared for this study. Infrared, microprobe, and atomic absorption analyses were done by the Research Division of Kennecott Copper Corporation.

Primary Minerals.—The primary minerals which have been identified in Trump fissure-fault ore are shown in Table 2.

In addition, freibergite [$Cu_{12}(As,Sb,Ag)_4S_{13}$], pyrargyrite ($Ag_3SbS_3$), polybasite [$(Ag,Cu)_{16}Sb_2S_{11}$], and pearceite ($Ag_{16}As_2S_{11}$) are suspected from etch reactions and microchemical tests but have not been confirmed by microprobe analysis.

The major copper ore mineral in the Trump ore body is tetrahedrite, followed in abundance by enargite. Generally, one or the other occurs in a given

TABLE 2
PRIMARY MINERALS

Metal	*Ore Mineral*	*Composition*	*Determined by*
Copper	Chalcopyrite	$CuFeS_2$	ore microscope
	Bornite	Cu_5FeS_4	ore microscope
	Enargite	Cu_4AsS_5	ore microscope
	var. Luzonite	Cu_4AsS_5	ore microscope
	Tennanite	$Cu_{12}As_4S_{13}$	microprobe
	Tetrahedrite	$Cu_{12}Sb_4S_{13}$	ore microscope
	Digenite	Cu_2S	ore microscope
Lead	Galena	PbS	ore microscope
Zinc	Sphalerite	ZnS	ore microscope
Silver	Stromeyerite	$(Ag,Cu)_2S$	microprobe
Gold	Native Gold	Au	microprobe
Iron	Pyrite	FeS_2	ore microscope
Marcasite		FeS_2	ore micropscope

area with enargite more commonly forming in open-spaced cavities. Silver-bearing tetrahedrite is far more abundant than stromeyerite and probably carries 80 to 90 percent of the silver in Trump ore.

In atomic absorption and microprobe analysis of primary ore minerals, certain chemical variations are noteworthy. Extensive solid solution and chemical substitution exist in the tetrahedrite-tennantite series with some assays indicating freibergite. The series also includes up to 1:1 substitution of bismuth for antimony, and minor values in lead, zinc, and gold. Enargite and galena also contain minor gold values. Native gold has been known to associate with enargite in ores from the Eureka Standard mine but has not been identified in samples examined by the author.

Enrichment and Oxidation Minerals.—The number of secondary minerals identified in the Trump ore body seems limited only by the ability of the author to separate and analyze individual minerals. Each visit underground produced a new mineral or a new physical form for one previously identified. The list includes secondary minerals which have been separated and identified by the methods listed (see Table 3).

In addition, conichalcite [$Ca,Cu(AsO_4)(OH)$], chenivixite [$Cu_2Fe_2(AsO_4)_2(OH)_4 \cdot H_2O$], and linarite [$(Pb,Cu)SO_4(OH)_2$] are suspected from microchemical tests but have not been confirmed by infrared analysis.

Gangue minerals not listed above include quartz, chalcedony, barite, muscovite, sericite, hydromica, chlorite, kaolinite, and altered feldspar.

Replacement Textures

The order of replacement in Trump ore is pyrite replacing quartz, clays, micas, jasperoid, and fault gouge; sulfide and sulfosalt ores replacing pyrite; secondary sulfides replacing primary sulfides and sulfosalts and; arsenates, carbonates, and sulfates replacing all others.

Many evidences for replacement exist in selected samples of Trump ore. Plates 7-10 show characteristic replacement features.

The most common replacement texture is veinlet replacement, as indicated by Plates 7-9. In each example, pyrite, chalcopyrite, sphalerite, or tetrahedrite is replaced by secondary copper sulfides along microfractures (Plate 7, fig. 1),

TABLE 3
SECONDARY MINERALS

Metal	*Ore Mineral*	*Composition*	*Determined by**
Copper	Chalcocite	Cu_2S	ore mi
	Covellite	CuS	ore mi
	Bournonite (?)	$PbCu_2Sb_2S_5$	mcrp.
	Azurite	$Cu_3(CO_3)_2(OH)_2$	visual
	Malachite	$Cu_2CO_3(OH)_2$	visual
	Aurichalcite	$(Zn,Cu)_5(CO_3)_2(OH)_6$	bin mi
	Olivenite	$Cu_2AsO_4(OH)$	bin mi
	Bayldonite (?)	$(Cu,Pb)_2(AsO_4)(OH)$	IR.
	Chrysocolla	$CuSiO_3 \cdot 2H_2O$	bin mi
Lead	Cerussite	$PbCO_3$	bin mi
	Plumbojarosite	$Pb_2Fe_6(SO_4)_4(OH)_{12}$	IR.
	Mimetite	$Pb_5(AsO_4)_3Cl$	bin mi
	Anglesite	$PbSO_4$	bin mi
Silver	Argentite	Ag_2S	mcrp.
	Argentojarosite	$Ag_2Fe_6(SO_4)_4(OH)_{12}$	IR.
Antimony	Bindheimite	$Pb_2Sb_2O_6(O,OH)$	ore mi
Iron	Jarosite	$K_2Fe_6(SO_4)_4(OH)_{12}$	IR.
	Hematite	Fe_2O_3	ore mi
	Scorodite	$FeAsO_4 \cdot 2H_2O$	X-ray

*Abbreviations. bin m.—binocular microscope, IR.—infrared, mcrp.—microprobe, ore m.—ore microscope.

cleavage planes (Plate 7, fig. 2), or crystallographic directions (Plate 9, fig. 1). Advanced development of this texture results in "sea and island" replacement (Plate 10, fig. 2) where pyrite islands remain after progressive replacement from pyrite to tetrahedrite to stromeyerite to digenite-covellite.

Plate 10, fig. 1 shows advanced pseudomorph replacement of bindheimite-digenite-covellite after tetrahedrite. The following pseudomorphs have been identified: a) enargite and chalcopyrite after pyrite, b) covellite after pyrite, c) stromeyerite after pyrite, d) tetrahedrite after galena, e) stromeyerite, covellite and digenite after galena, and f) covellite and bindheimite after tetrahedrite.

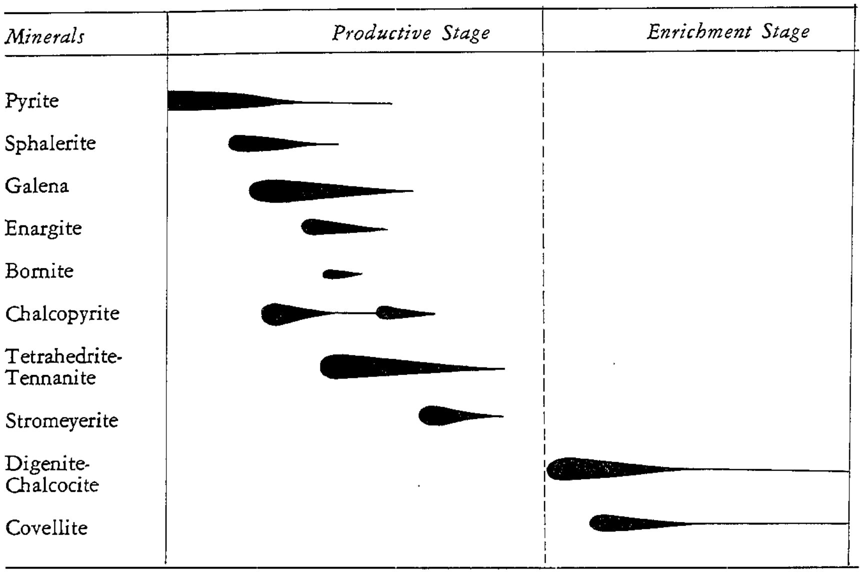
In addition to pseudomorphs, veinlet replacement, and "sea and island" textures, vermicular intergrowths and "cusp and caries" textures have been identified where digenite and covellite replace tetrahedrite or chalcopyrite.

Paragenesis

A sequence of deposition for hypogene and supergene minerals has been recognized in the Trump ore body. This sequence was established by studying textures of seventyone polished sections of ore from drill-hole cores and mine workings. Two periods of chalcopyrite deposition are shown. The first occurs as replacement ore around pyrite and is in turn replaced by tetrahedrite. The second is contemporaneous with tetrahedrite deposition.

Zoning

Changes in the character of mineralization in the Trump ore body indicate a subtle vertical zoning pattern. This zoning is difficult to identify in mine workings because of telescoping of hypogene and supergene ores. Assay values on ore shipments are the criteria used to establish a zone pattern of the ore body.



TEXT-FIGURE 4.—Paragenesis of the Trump Ore Body

Assay values on production raising and diamond drilling indicates vertical zoning of copper and perhaps silver· Good silver values were mined on the 750-foot level and assayed in diamond drill holes beneath the level. Silver values fluctuate in the 758 and 759 raises, and are considerably lower in the 762 north raise. Copper shows a slight increase in grade in diamond drill holes beneath the 750-foot level. Gold, lead, and zinc values show no consistent vertical variations.

Zoning from south to north along the strike of the Trump fissure-fault is even less apparent than vertical zoning. The grade of ore fluctuates greatly along the 756 drift, but for any 100-foot section, the average grade remains constant. This holds true to 100-feet north of the 759 raise where the Trump bifurcates or horsetails and tenor of ore decreases rapidly to about half of the average grade.

In conclusion, weak vertical zoning may exist in the ore body, but evidence is inconclusive. Lack of zoning, as well as telescoping and general low tenor of ore, are due to rapid deposition of ore minerals, brought about by steep temperature and pressure gradients at the time of ore emplacement.

Classification

On the basis of depth of emplacement, telescoping, and mineral assemblage, according to Lindgren's classification, the Trump ore body is low mesothermal.

Ore Guides

Structural guides.—The presence of north-northeast-trending tension fractures with intruded monzonite dikes and pebble dikes is a basic requirement for

Trump-type ore bodies. Tension fractures provide necessary brecciation for porosity and permeability, and open channelways for migration of ore solutions. These fractures are located at the crest or along the crenulated west limb of the East Tintic anticline and, intermittently, along trend on the east flank. The intersections of north-northeast fissure zones and east-west transcurrent faults where Tintic Quartzite and Ophir Shale are juxtaposed are excellent sites for Trump fissure-fault and Trixie replacement ore bodies.

Mineralogical Guides.—A crude mineralogical zoning pattern may be identified around Trump type ore bodies. Disseminated pyrite and sericite alteration of Lovering's early productive stage may be present as a halo around the ore body but its intensity is variable. Early productive stage alteration has been identified at the shaft station almost 140' from the ore body but is nonexistent a few feet west of the hanging wall contact. Minor occurrances of secondary copper sulfides and carbonates may indicate proximity to ore, but these minerals are usually within 10' or 15' of the main ore body. Hydrothermal alteration and geochemical anomalies of surface fissure zones give some indication of potential ore mineralization at depth.

Drilling.—Underground drilling of quartzite is a valuable exploration tool. Close attention to changes in structure and percentage of core recovery and assaying all occurrences of mineralization may indicate protore to ore values in weakly altered rock. The same close attention to minor fissure-fault structures should be observed when drifting in quartzite.

Summary

The Trump ore body should persist in tenor for several hundred feet in depth as long as the brecciated structure persists. An increase in the grade of copper, and minor supergene enrichment of copper and silver may exist at lower levels of the ore body. The possible extension of ore south beyond the monzonite intrusion and north beyond the Trixie fault intersection should be explored. It is anticipated the ore will decrease in grade as the Tintic Quartzite-Ophir Shale contact is approached and increase in grade at depth as the limestone-quartzite contact adjacent to the Trixie fault ore body is reached.

Elsewhere in the district, similar structures that acted as conduits for ore solutions of the Eureka Standard, Apex Standard No. 1, and Burgin mines are targets for exploration. It is likely that many north-northeast fissures have been cut by earlier workings in the district and have gone unnoticed. Variable tenor and brecciation make it possible to drift or drill through an ore body without recognizing it. One of three original drill holes which penetrated the Trump ore body went unnoticed until subsequent drilling indicated a mineralized zone had been penetrated. Close attention to mineralogical and structural guides to ore in future exploration and reevaluation of previous workings in upper Tintic Quartzite should lead to development of additional ore bodies of the Trump fissure-fault type. The tenor of ore from the Trump fissure-fault zone and similar fissure ores of the Eureka Standard mine makes this type of ore body a worthwhile exploration target.

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