GEOLOGY OF THE PAYMASTER MINE PIMA COUNTY, ARIZONA

By

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INTRODUCTION

The Paymaster mine is situated near the northwestern margin of the Pima mining district and on the eastern pediment of the Sierrita Mountains, approximately 30 miles south-southwest of Tucson. The Paymaster area is essentially flat, with relief generally less than 10 feet, and is characterized by low rises and rounded hills of andesite surrounded, in an island-and-sea pattern, by granitic alluvium washed down from higher elevations to the west.

The present discussion is a brief summary of certain facets of work done by the writer as geologist for the Sunrise Mining Company during 1959 and 1960. Preliminary mapping was done on aerial photographs at a scale of 1 inch = approximately 200 feet. Detailed surface and underground mapping, at scales of 1 inch = 40 feet and 1 inch = 20 feet, was done with Brunton and tape. The mine shafts and reference points on the surface were established by transit survey by E. J. McCullough, Jr.

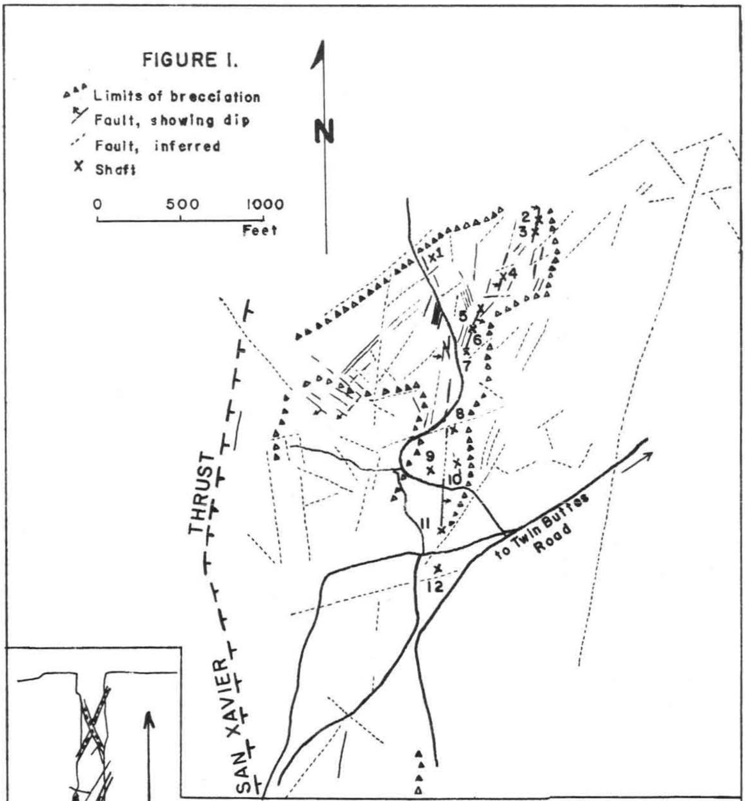
Others who have written on the area include Ransome (1922), Mayuga (1942), Lacy (1959), and Waller (1960). According to Ransome, approximately \$220,000 in lead-silver ore was shipped from the property in the latter part of the 19th and the early part of the 20th century. The property is currently controlled by the Sunrise Mining Company of Dallas, Texas.

Twelve shafts and a number of pits and trenches have explored portions of the property (Fig. 1). Apparently, successive operators believed in "getting a fresh start" on previously untouched leads in the vein system.

The author is indebted to Mr. G. W. Irvin, consulting engineer, and particularly to Dr. Willard C. Lacy, University of Arizona, for many stimulating discussions on the geology of the property. Thanks are also due the Sunrise Mining Company for permission to publish this paper.

IGNEOUS ROCKS

Andesite porphyry, consisting of phenocrysts of feldspar ranging from less than 1/8 to 1/2 inch in length in a medium to dark gray, aphanitic groundmass, is the only rock outcropping in the mine area. Over much of the area the rock is stained brown by iron oxides and bleached white along veins. In portions of the underground workings adjacent to the veins a silicified, bleached porphyry is exposed which has been interpreted as altered andesite porphyry, but it may represent a different rock type. Lacking evidence of an extrusive nature, the andesite has tentatively been considered to be intrusive. Both intrusive and extrusive andesites are known elsewhere in the district.



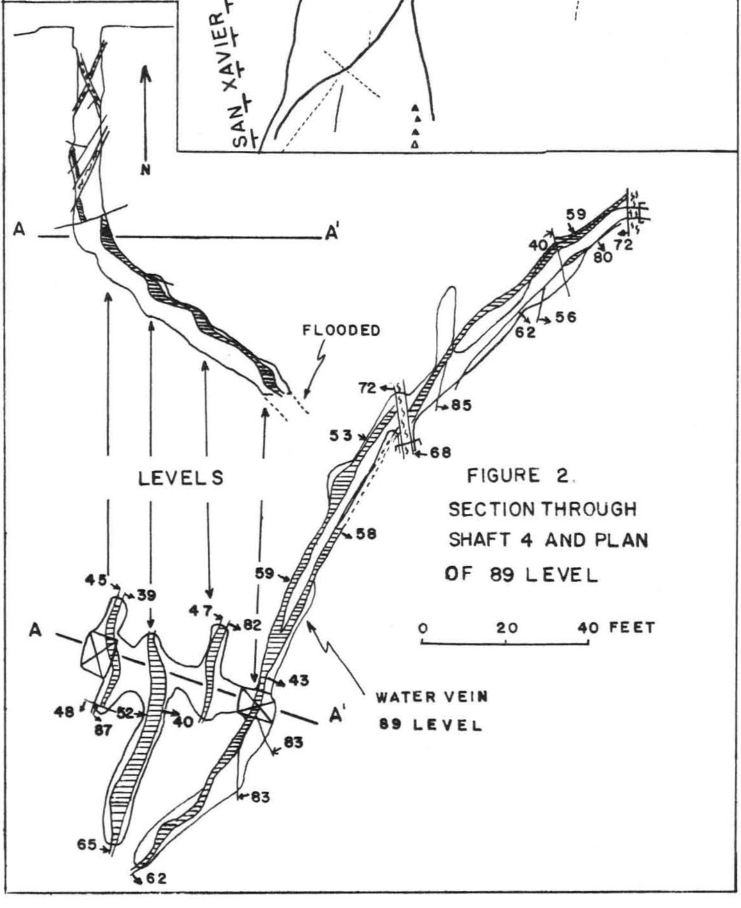


FIGURE 2.
SECTION THROUGH
SHAFT 4 AND PLAN
OF 89 LEVEL

STRUCTURE

Approximately 1,500 feet west of the mine area the San Xavier thrust fault is exposed, trending north and dipping eastward at angles of 10^{o} to 30^{o}. West of the thrust is a granitic complex of undetermined age.

East of the thrust is an irregular zone of brecciation which coincides with the surface limits of mineralization and alteration. The V-shape of the exposure may be partly misleading as the limits of brecciation are obscured by lack of outcrop in portions of the northwest and southern sectors. However, control of the V-shape is suggested by the intersecting northeast- and north-trending fracture zones shown in Figure 1. A second zone of brecciation and alteration parallels the San Xavier thrust on the east and has a width of approximately 300 feet except at the southern end (Fig. 1) where it widens to 1,000 feet or more.

Five distinct trends of faulting and/or fracturing are recognized: NNE, NE, ENE, NNW, and NW. Faults of the NNW and NW trends tend to dip southwest, those striking NE to ENE dip northwest, while the NNE faults dip east, at angles of 45^{o} to 90^{o}. Exceptions may be noted in all cases.

Veins, defined for this paper as sulfide-bearing zones of clay-sericite-quartz alteration, occupy faults of all five trends described above, within the zone of brecciation. Most of the ore has been mined from veins of the NNE set.

The intersection of the NE- and NNE-trending veins has formed a splinter area, accompanied by more intense brecciation and alteration. Away from this area the veins are resolved into fewer and more distinct structures. The veins tend to increase in width on the surface to as much as 20 feet, toward the south.

The fault planes of the NNE-trending set are irregular in plan and in section. Normal faulting along these irregular planes produced "open spaces" or shattered zones of steeper-dipping tension fractures. These zones are replaced by ore, forming high-grade shoots which plunge southward at angles of 10^{o} to 20^{o}. The shoots are discontinuous, but are repeated so that a rough prediction of the location of the next ore shoot can be made. Gash veins of 2 sets, one dipping steeply west and the other dipping east at low angles, join the NNE-trending veins. These are wide at their intersection and narrow away from these veins. The flat, east-dipping gash veins indicate pre-mineral reverse faulting along the NNE-trending faults (Fig. 3, sec. BB').

Cross faults, offsetting the major veins, show varying degrees of alteration. One cross fault contains a vein of uncrushed sulfides. Other cross faults contain crushed sulfide fragments. Thus, these faults are pre- or intra-mineral in age and have locally undergone renewed post-mineral movements.

In the raise south of the east crosscut in shaft 6 the China vein is seen to be offset by a flat, rolling fault (Fig. 3, sec. CC'). West of the bottom segment of the vein this fault is altered and contains rolled aggregates or "nodules" of ore minerals. East of the bottom segment the fault is unmineralized and essentially unaltered. The steep vein above the fault is only weakly mineralized and smaller than the bottom segment, suggesting that the two are different structures. Section CC' is interpreted as indicating offset of the China vein by renewed, post-mineral thrusting.

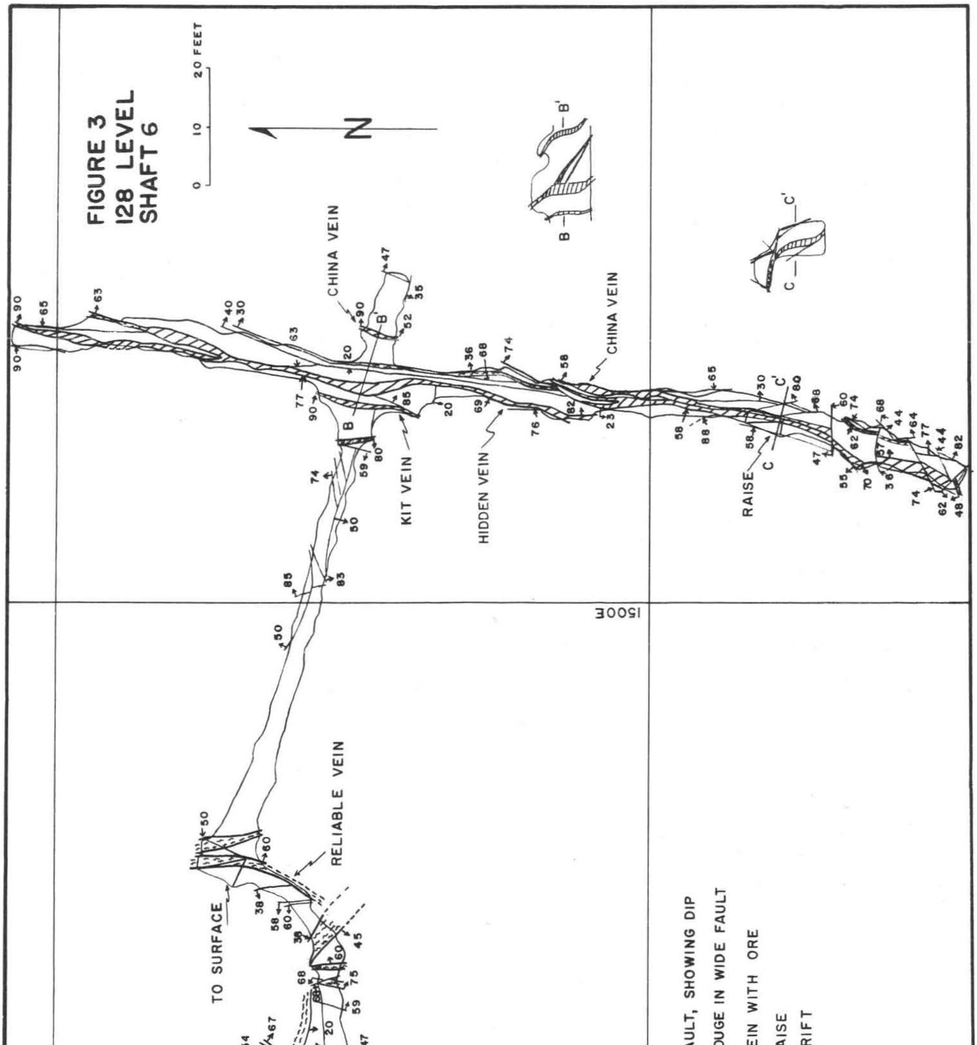


FIGURE 3
128 LEVEL
SHAFT 6

ALTERATION

Alteration appears to be Butte-type: Chlorite-clay changing to quartz-sericite, from the outer edge of wallrock alteration to the center of the vein. In places silicification has extended outward as much as 3 feet from the vein. Within the breccia zone outlined on the surface, the andesite is generally altered to chlorite-clay, with local sericitization and silicification. Veins generally stand out as bleached zones 3 inches to 20 feet wide consisting of clay-sericite with a few quartz stringers. However, the outcrop of the Hidden vein (Fig. 3) consisted of an inconspicuous brown-stained shear zone which went unnoticed until drilling showed it to be ore-bearing underground.

ORE DEPOSITS

Ore minerals consist of galena, sphalerite, chalcopyrite, and tetrahedrite. The ore is argentiferous, particularly where tetrahedrite is encountered. Pyrite and quartz are ubiquitous components of the veins, and are replaced by the ore minerals.

Oxidation and enrichment are limited, where observed, to within 30 feet of the present surface. Anglesite, chalcocite, and malachite ore fragments are sparingly present in the older workings above the 30-foot depth.

The Hidden-China vein system exhibits a crude zoning pattern, with pyrite-galena-sphalerite on the north giving way to chalcopyrite-galena-sphalerite south of the crosscut. Tetrahedrite is concentrated where the China vein is exposed in the drift south of the crosscut.

High-grade ore shoots are formed along the "steeps" of the NNE-trending veins as seen in cross-section, and along east-facing concavities of the veins as seen in plan, forming lense- to cigar-shaped ore bodies (Figs. 2, 3, and 4). Between the high-grade ore shoots mineralization has been sufficient in most cases to make low-grade ore. Gash veins of both steep and flat dips carry lesser amounts of ore which decreases rapidly away from the main veins.

In shaft 6 (Fig. 4) workings above the 128 level are old and partly inaccessible. Although the general form of the ore shoots is known, details are uncertain. In shaft 6 the NNE-trending veins aggregate into two vein systems, separated by a stretch of barren ground. Elsewhere in the mine area a similar pattern exists, of systems of parallel veins, rather than single structures separated by less-mineralized or barren ground.

At the end of the eastern crosscut in shaft 6 (Fig. 3, sec. BB') the Hidden, China, and Kit veins are concave toward the east and carry high-grade shoots. All 3 shoots pinch out laterally and vertically at approximately the same points, suggesting that their parallel localization is due to a common structural origin. Accordingly, parallel or *en echelon* ore shoots might be anticipated elsewhere along this vein system.

The discovery of the Hidden vein system in shaft 6 led to exploration which confirmed the presence of additional veins, unexposed on the surface as such, east of the China vein and west of the shaft. Obviously, not all the veins in the area topped out at the same level with respect to the present surface, and

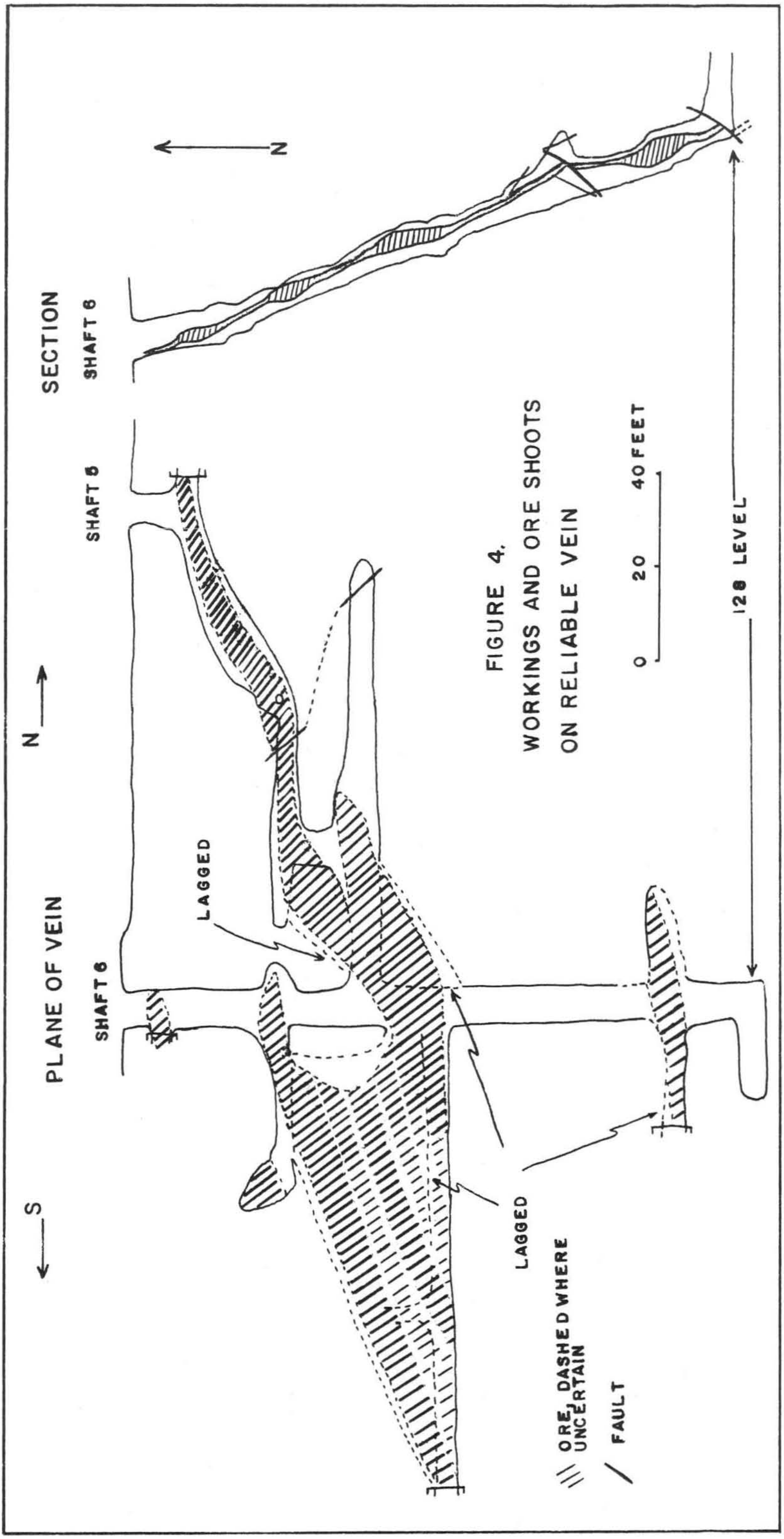


FIGURE 4.
WORKINGS AND ORE SHOOTS
ON RELIABLE VEIN

blind ore bodies can be expected.

DISCUSSION

Ore-bearing veins in the areas contiguous to the Paymaster mine may occur in any one of the fracture directions described above, but in the Paymaster area the mined structures strike N. 10°-20° E. for the most part, roughly paralleling the San Xavier thrust, and dip steeply east. A flattening of dip with depth is indicated in shaft 4 and elsewhere. The veins also show a tendency to become wider with depth. Northeast-striking faults in general dip north and offset the NNE-trending veins in apparent left-lateral fashion. East of the mine area, northeast-striking faults have been observed (Waller, 1960, p. 17) which show left-lateral offset.

It is suggested that the NNE-trending veins of the Paymaster mine are inbricate faults in the upper plate of the San Xavier thrust, and that these faults flatten with depth, joining the thrust toward the east; northeast-striking tear faulting north of the mine area has sprayed out into a splinter zone, splitting up the imbricate faults which are resolved into fewer structures southward, away from the tear zone. Reverse faulting on the NNE-trending veins is evidenced by the flat, east-dipping gash veins, and was followed by normal faulting which produced the "steeps" occupied by the high-grade ore shoots. Mineralization was post-thrusting; renewed post-mineral compression caused slight thrust and lateral offsets of the NNE-trending veins toward the west. Displacement of the veins by the northwest-trending faults is apparent right lateral, and may be due to normal faulting.

The structural pattern at the Paymaster mine indicates that thrusting along the San Xavier fault was toward the west. The NNE-trending imbricate faults, flat east-dipping veins, and NE- to ENE-trending faults showing left-lateral offset, are not readily explained by the thrusting to the north, noted in other parts of the district.

If, as suggested by W. C. Lacy, the Pima district has been subjected to a counterclockwise rotational stress, release of stress could be effected by thrusting both to the north and to the west: Upon encountering resistance to stress, in one direction, compensation of stress would be transferred to a different vector.

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