THE WEST SAN XAVIER MINE, KEYS TO A DISTRICT

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INTRODUCTION

A number of geologists have described and interpreted the geology of the San Xavier mine. Wilson (1960) presents the results of his studies, and he provides an excellent summary of the work of others. In general, these studies include the vicinity of the No. 6 shaft, which is also called the West San Xavier mine.

Our studies of the mine are preliminary, and our underground observations are limited to the three levels (100, 150, and 250) extending from the No. 6 shaft. They do not include extensions to the southeast on the 250 level into stopes that connect with deeper workings of the main San Xavier mine. Also, no data from drill holes were available to us.

We believe that the West San Xavier mine presents challenging geologic problems that have not been solved by studies to date. Fracture systems are complex, and marker beds are rare. Solution of some of the problems—or at least supplying the most probable answers to them—is likely to provide geologic keys that will be useful elsewhere in the Pima district.

FOUR PROPOSITIONS

No specific solutions are offered, but we shall enumerate certain propositions. Each one is considered to point toward likely answers but primarily suggest a direction of investigation. In spite of more extensive implications, the propositions are specifically intended for the West San Xavier mine.

Proposition 1

The contact between Cretaceous(?) arkose and Paleozoic limestone—including dolomite and shale—is primarily a sedimentary contact with angular unconformity. Faulting in the vicinity of the contact is rather intricate, and a given point of observation, such as that near the face of the south crosscut on the 150 level, is frequently a fault contact. However, the probability that a given point of observation will be a depositional contact is considerably greater.

The outcrop trace of the arkose-limestone contact trends easterly across the West San Xavier area, the arkose lying south of the contact. Lacy

(1959, fig. 44) and Cooper (1960, pl. 1) map this contact as a fault. However, Cooper does map the contacts around limestone outliers southeast of the main shaft as depositional. Also, Wilson (1960, p. 28, 31, pls. 1-20) designates the arkose-limestone contact to be a fault contact throughout his report, but he does recognize possible significant errors by stating that many of the fault contacts on his maps are probably sedimentary contacts (Wilson, 1960, p. 8).

Proposition 2

Silicated areas and later sulfide bodies are localized primarily because the arkose-limestone contact was exposed to the invasion of hydrothermal solutions by faulting. Chemically, the vicinity of the contact is an anomalous system.

The reactivity of interfaces between limestones and rocks of high silica and alumina content, when exposed to ore-forming fluids, is a fact of worldwide observation. Physically, the arkose-limestone contact tends to localize intensity of fracturing because of locally imposed differential stresses. This increases the degree of openness of ground, providing access for solutions and numerous surfaces for the advance of replacement activity. Wilson (1960, p. 44) notes that in addition to those on the contact, bodies of garnet and ore are localized by fault intersections at distances of 100 feet or more from the contact.

Wilson (1960, p. 43-45) recognizes the arkose-limestone contact as one of the ore controls, but he explains it physically. He considers that the arkose acted as a barrier to rising hydrothermal solutions, deflecting their movements. This deflection caused increases in concentration and time of reaction with the limestone. He states that portions of the contact which localize ore are shaped like inclined inverted troughs (Wilson, 1960, p. 43).

This explanation seems physically weak and difficult to accept. The fact of arkose-contact control of bodies of silicates and sulfides in limestone is more logically explained chemically.

Proposition 3

The large mass of garnet on Garnet Hill is explained by the fact that the southern slope of the hill is the approximate position and attitude of the arkose-limestone contact, the less resistant arkose that covered the slope having been removed recently by erosion.

The resistant garnet, which replaced limestone on the contact, remains on the hill, and the original form of the massive body of garnet (fig. 1) is only slightly altered by erosion. Faults, fault intersections, and areas of brecciation on Garnet Hill are not sufficient in magnitude to account for the large body of garnet. However, the structures undoubtedly aided in its localization and in controlling the details of its form.

This proposition suggests that the southerly dip of the arkose-limestone contact is considerably less than Wilson's estimated range of 55^{o} to 80^{o} (Wilson, 1960, p. 31).

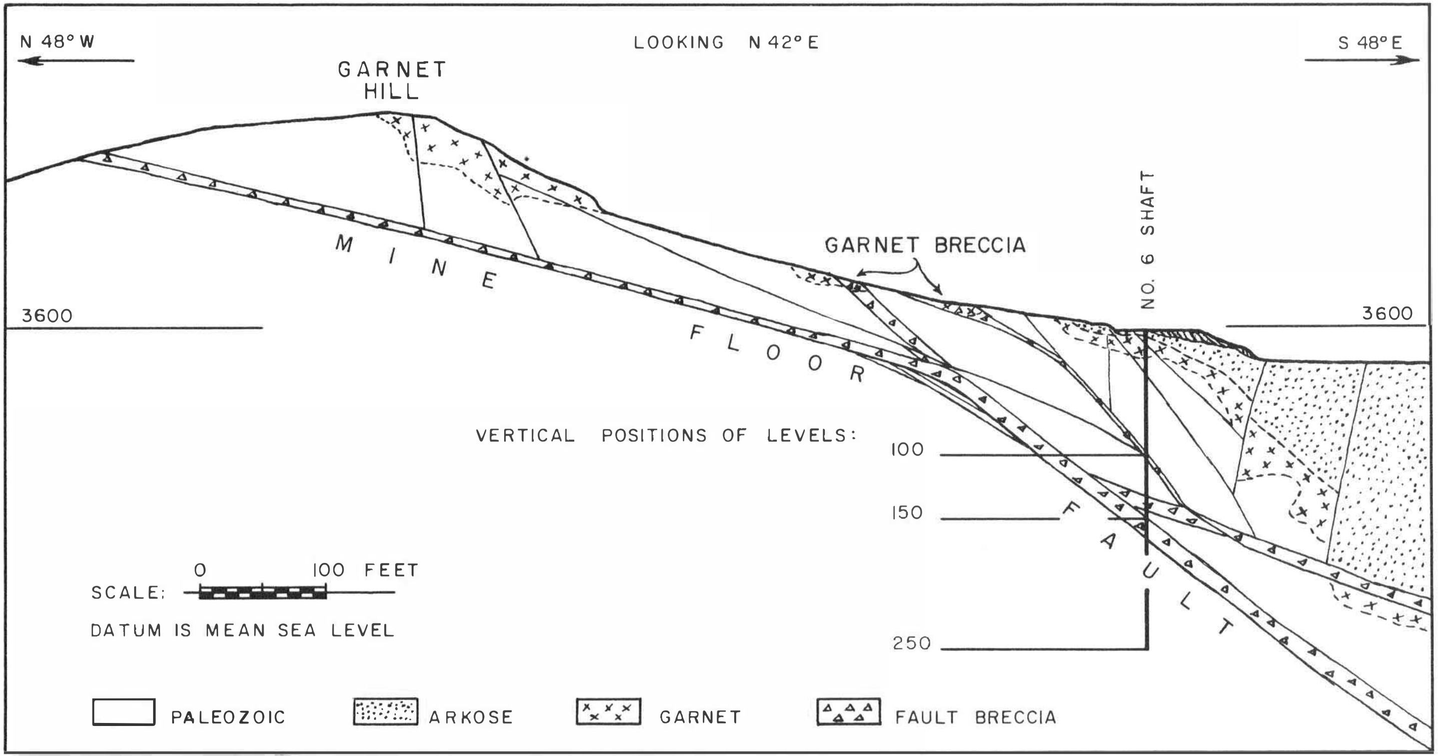

Figure 1. --Geologic cross section through Garnet Hill.

Proposition 4

The major Mine Floor fault and other related low-angle faults do, in fact, exist as interpreted on figure 1. The outcrop trace of the south-dipping Mine Floor fault apparently forms a broad V-shaped pattern on Garnet Hill, its apex being high on the north slope of the hill. The strike of the fault appears to average about N. 80° E. The dip is south, and it is interpreted to change from about 18° near the surface to about 38° with depth. The major movement (and probably the latest) defines the Mine Floor fault. This movement appears to change from one earlier fault to another, explaining the change in dip (fig. 1).

The fault literally appears to be the floor of the West San Xavier mine based on both surface and underground observations. The No. 6 shaft and crosscuts on two levels penetrate its footwall, which is essentially barren both as to silication and metalization.

The entire mineralized block of ground—essentially the West San Xavier property—appears to have been moved in from somewhere else; either this, or the bottom extension of the "mine" was shifted to another location. Little evidence is suggested as to the net direction of movement. A relatively large dip component would seem likely, but this cannot be assumed. Certainly, we would not call the Mine Floor fault a thrust fault simply because of the low angle of dip. An attempt to solve the problem of net movement on this fault, alone, would appear to be a challenging study.

Some of the characteristics of the low-angle fault system shown on figure 1 are strikingly similar to district observations by Lacy (1959). He states (Lacy, 1959, p. 188) that the earlier thrusting is pre-ore and generally steeper than the later thrusting, the later thrusting being post-ore. The Mine Floor fault appears to be sympathetic to the San Xavier thrust that Lacy (1959, fig. 44) describes.

An interesting outcrop of garnet (grossularite?) breccia is found at the assumed outcrop position of the steeper low-angle fault (fig. 1). This garnet breccia is considered to be more suggestive of downdip drag than of updip drag. Thus, a normal dip component of movement may be indicated. On the other hand, the exposed outcrop pattern of this garnet breccia is suggestive of a garnet breccia pipe.

Ore bodies are found on the hanging wall of the Mine Floor fault. It controls ore localization, and, thus, movements are both pre-ore and post-ore.

The 150-level station and drifts from it to the northeast and southwest are in a breccia composed of shale, mainly, and limestone. The breccia zone here has a normal thickness averaging at least 15 feet. Although quite undulating in detail, its hanging wall is almost flat, and its footwall is dipping about 38°.

The exposure of gouge and breccia on the 150 level is considered to be at about the intersection of the Mine Floor fault and its earlier flat branch (fig. 1). Detailed structures resembling bedding are observed in the gouge and breccia at a point about 75 feet northeast of the shaft. These features are interpreted as unusual sets of parallel shears in earlier gouge material. Each shear contains a very thin seam of clay, probably nontronite.

CONCLUSION

Characteristic of the Pima district, the geology of the West San Xavier mine is very complex. Solution of the complex problems, through detailed studies on this small property, will provide answers applicable to the district—will supply additional keys to help reconstruct the shredded pages of its history.

Four propositions are stated that are in need of testing. Also, during the course of elaboration, a number of related problems are suggested. Other problems could be listed, for example: The 250-level station and crosscuts leading from it are in a large mass of altered shale. Its plastic behavior in fault zones is striking, the gouge in these faults apparently containing abundant nontronite. Is the shale a member of the Earp Formation? What is the nature of its alteration? Is the nontronite an alteration mineral of the main body of shale or of the fault zone within it, or is it a primary or diagenetic rock-forming mineral? Is the rock shale? Is it tuff? Although very unlikely, is it an unusual alteration of limestone?

REFERENCES CITED

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