NOTES AND NEWS

THE FORMATION OF JAROSITE ON PYRITE ORNAMENTS

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In the course of archaeological investigations in Sinaloa, Mexico, Mr. Gordon Eckholm of the Department of Anthropology of The American Museum of Natural History, excavated a number of Indian skeletons which can be dated at approximately 1350 A.D. They were buried in an artificial, small dirt mound rising above the flood plain of the Sinaloa River, four miles south of Guasave, Sinaloa, Mexico. After the removal of the bones of one skeleton, which were in very poor condition, remnants of a necklace were found which, from its position, must have lain around the neck of the body.

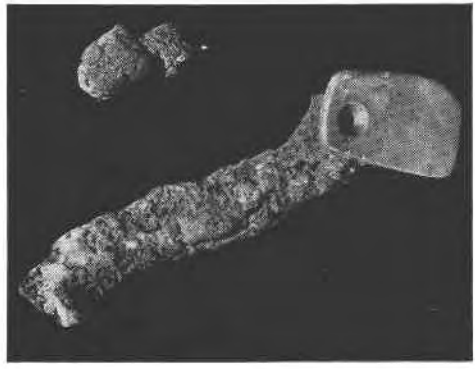

Fig. 1

The necklace (A.M.N.H., Dept. of Anthrop. #30. 2-5110) originally consisted of small cylindrical pyrite beads, with several turquoise pendants strung between them. Like the bones, the necklace has suffered from its burial and was collected in fragments. From a mineralogical standpoint, its present condition is most interesting.

The cylindrical pyrite beads seem to have been originally about 5 mm. in diameter and 2.5 to 4 mm. in length. The three turquoise pendants are approximately 15 by 10 by 2.5 mm. in size. The turquoise is crudely polished and each has a small hole drilled at one end. They obviously were strung between the pyrite beads and extended below them, much as in more modern, all turquoise, Indian necklaces to be seen today. The pyrite beads were, no doubt, equally well rounded, drilled and

finished, but they have not survived in the fresh, unaltered condition of the turquoise. The polishing and shaping of the turquoise is on a par with that obtained today by primitive methods. It does not seem to have suffered or been changed in any way by its burial. Its color is slightly muddy, though here and there small fissures extending through the turquoise are marked by a clearer fresh blue color along their margins. This relationship is quite the reverse of that which would be expected had the discoloration been introduced after the cutting and the burial; it seems likely that both the clearer places and the muddier tones were in the turquoise before it was cut.

The pyrite beads, on the other hand, have been strongly affected by the ground water which has penetrated the mound for six hundred years. The cord, of course, is long since gone, and the beads are now cemented together in a fragile jagged column. Here and there the brown crust has flaked away to reveal the inner core, which, wherever it can be seen, is fresh and shining pyrite. Rounded surfaces, with small, irregular etched elevations and depressions characterize the metallic mineral faces, none of the original polish noted on the turquoise is to be seen in these beads. The beads are all covered with a crust, which ranges from an almost paper thinness to 2 mm. thick, but very irregular in outline. This brownish crust of alteration contains two recognizable minerals and is the reason for this note.

First, and closest to the pyrite, are crusts and crystals of golden brown jarosite. Most of the crust is free from the pyrite, the jarosite masses being separated by a hair's breadth from the unaltered sulphide. Here and there however, a few isolated well-formed crystals of jarosite are growing on the pyrite itself. The pyrite beads have suffered badly from the alteration and are seamed and fissured so that no bead is intact, the altering solutions have worked in through the cracks and have produced jarosite which now cements the whole together, and which perhaps expanded the fissure as it formed.

The jarosite forms crystallized crusts up to half a millimeter in thickness, and grades down to single isolated crystals, perched upon the still brilliant pyrite surface. The free crystals show perfect combinations of *o* and *r*, and when viewed through the microscope, the combination of the upper and lower rhombohedral faces makes a golden six pointed star. The single crystals are exceedingly minute, some of the largest are but .025 mm. across and a little less in thickness. They are not isotropic in basal section, but show a typical abnormal segmental birefringence.

Outside of the jarosite there is a second compact crust composed of minute complex crystals of gypsum. Locally the crust is very solid and separated from the ochreous jarosite crust by a thin space into which

the gypsum needles project. Elsewhere the crust is directly attached to the inner layer, and here and there a microscopic gypsum flower curls upward from its base.

No other distinct mineral was recognizable in the crusts. There was considerable adhering dust, presumably the dirt in which the skeleton lay, and around the jarosite there is some very fine-grained ochreous material. Probably a great part of this is also jarosite, some of it may be limonite developed from the jarosite with the release of sulphur.

The grave is dated about six hundred years ago; from this we can see that under the circumstances of alteration, jarosite must form very slowly and the pyrite oxidize slowly, to form such comparatively thin crusts in this span. Potassium and calcium have been introduced, the surrounding earth is the likely source of both these elements. Other than the limonitic dust here and there on the crust, there is no indication that jarosite has been replaced or altered. The gypsum may have formed from the excess sulphur released by the pyrite, or it may have formed after the jarosite, as a second alteration product. The occurrence is of interest not only because we can see a zoning of alteration products around the pyrite, but also because we have here a crust of measurable thickness, formed under known conditions, in a fixed period of time.