

tion of the material in the cavities, and comparison of the clay in this and shell-tempered pottery would seem pertinent to the study.

ANNA O. SHEPARD  
Santa Fe, New Mexico

#### METALLOGRAPHIC STUDY OF COPPER ARTIFACTS

The clear exposition by Wilson and Sayre of the metallographic study of primitive copper work, *AMERICAN ANTIQUITY*, Vol. I, No. 2, pp. 109–112, must impress the archaeologist as presenting a precise and valuable means of extending our knowledge of this primitive industry. Although the archaeologist recognizes that the application of the method requires training in the microscopic study of opaque minerals, and that analyses should be undertaken by the specialist, he is none the less interested in the details of the technique and in the limits of its accuracy, in order that he may better judge the extent of its application to his problems. One would like to know, for example, more about the significance of twinning in copper. The following quotations suggest the need for further explanation:

“Twinning always shows that the copper has been mechanically worked and then annealed” (p. 111).

“This spearhead was hot-worked, at a bright red, about 800° C., and thoroughly annealed after being worked. The evidence for these conclusions is: large, equiaxed grains, showing good annealing; twinning, indicating mechanical working” (pp. 111–112).

“This arrow-point was hot-worked, the work ceasing at about 500° C., not followed by annealing. The evidence for this is the occasional twinning, the different sized grains, and the unequal axes of many of the grains” (p. 112).

“This axe was hot-worked, followed by good annealing, but at relatively low temperature, about 500° C. The evidence for this is the equiaxed grains, with some twinning, with uniform grain size throughout, but with all grains small” (p. 112).

“This nugget was heated, allowed to cool, and then cold-rolled. The grains are elongated, without twinning, proving that the metal was not annealed after having been worked” (p. 112).

The occasional twinning in a specimen that was hot-worked but not afterward annealed seems a contradiction of the general statement that twinning always shows that the copper has been mechanically worked and then annealed. But perhaps the effects of hot-working without subsequent annealing are comparable to cold-working followed by annealing. If so, how are the two methods of workmanship distinguished, by the shape of grains?

It would also be of particular interest to know how close is the correlation between size of grain and temperature of heating; if it is reported, for example, that an implement was “annealed at about 500° C.,” what are the limits above

and below this temperature implied by the word "about"; are they in the order of twenty-five, one hundred or more degrees? How is the time distinguished from the temperature factor; that is, how is the effect of long heating at a relatively low temperature differentiated from the effect of shorter heating at a higher temperature? Considerable variations are expected in primitive craftsmanship. We accept them as the indications of inexact methods. This fact, however, does not lessen our concern in the limits of quantitative accuracy of our analytical technique.

While the answers to these questions are doubtless obvious to the metallurgist, the general archaeologist, unfamiliar with the fundamentals of the investigation, must be eager for more information. The significance of the data afforded by the method would seem sufficient to insure its wide application in archaeological investigations.

ANNA O. SHEPARD  
Santa Fe, New Mexico

#### SURVEY METHODS

While not wishing to detract from Mr. Robbins' laudable idea of an acceptable method for the designation of archaeological sites through the use of the U. S. Topographical Survey sheets, as presented in the January issue of this journal, it seems only fair to call his attention to the fact that such a system, with the detail sheet giving the essentials of the site listed, and available specimens, was inaugurated by Mr. Harold Gladwin of the Gila Pueblo, Globe, Arizona, early in 1928. In November, 1928, Mr. Gladwin, then residing in Pasadena, California, published a small brochure entitled, *A Method for Designation of Ruins in The Southwest*, which was "Privately Printed for The Medallion, Pasadena, California."

In this item is described the method mentioned by Mr. Robbins. In subsequent publications which have been issued from time to time by the members of the staff of the Gila Pueblo, this method has been used and seemingly has proved very satisfactory. The detail sheets upon which the archaeologists of the Gila Pueblo keep their field records are of a necessity more varied than those which Mr. Robbins might keep in New England.

It is interesting to note that two men who have come into the archaeological field after browsing in other pastures, men who have probably not contacted each other, and who live on opposite sides of the country, have hit upon the identical method for making archaeological surveys. We need more such interested students.

ARTHUR WOODWARD  
University of California  
Berkeley, California