Journal of Archaeological Science 38 (2011) 3019–3028

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Hematite sources and archaeological ochres from Hohokam and O'odham sites in central Arizona: an experiment in type identification and characterization

B. Sunday Eiselt [a,*], Rachel S. Popelka-Filcoff [b], J. Andrew Darling [c], Michael D. Glascock [d]

[a] Department of Anthropology, Southern Methodist University, 3225 Heroy Hall, Dallas, TX 75205, USA
[b] School of Chemical and Physical Sciences, Flinders University, Australia
[c] Cultural Resource Management Program, Gila River Indian Community, USA
[d] Research Reactor, University of Missouri, USA

ARTICLE INFO

Article history:
Received 23 November 2010
Received in revised form
20 June 2011
Accepted 26 June 2011

Keywords:
Ochre
Pigments
INAA
Arizona
Phoenix Basin
Hohokam

ABSTRACT

The use of ochre is a defining characteristic of populations living in the Sonoran Desert of the American Southwest. Red pigments and paints were used for craft production, bodily adornment, rock art, and in mortuary contexts. Hematite and other iron-oxides are common components of this pigment that frequently appear in the archaeological record in a variety of forms and in various stages of production. Beyond this, very little is known about these materials. This paper describes the collection of potential geological sources of ochre in the Phoenix Basin and presents a methodology for the identification of processed paints. Geological sources samples are characterized using instrumental neutron activation analysis (INAA) and compared to raw materials recovered archaeologically from the Gila River Indian Community reservation. This preliminary study indicates that iron-oxide sources can be distinguished from each other and that artifacts can be matched to these sources, revealing local procurement along the Gila River by Hohokam and O'odham artisans and continuity in use of one source from the prehistoric period to the present.

1. Introduction

Iron-oxides and other associated minerals ("ochre") are among the most common pigments used by prehistoric North American populations, particularly in the Hohokam region of central Arizona where they were employed in mortuary rituals, as body paint, and to decorate pottery, basketry, arrows, and pictographs (Haury, 1976; Stafford et al., 2003). Red ochre has been found in securely dated contexts in the Tucson Basin, which are at least 2300 years old, and red paints and slips are hallmarks of Hohokam ceramic production (Mabry, 1998; Miksa and Tompkins, 1998). Potters began using iron-oxides to decorate vessels from the very beginning of the Hohokam sequence starting in AD 200, and the O'odham (Pima and Papago) continued this tradition during the historical era. Since Harold Gladwin's pioneering work at Snaketown in the 1930s, archaeologists likewise have defined historic and prehistoric slipped pottery in central Arizona based in part on the color and hue of polished iron-oxide slips and designs on red-on-buff vessels to reveal important shifts in the social, economic, and political organization of the Hohokam (Abbott, 2000; Haury, 1976).

Archaeologists typically refer to iron-oxides as "ochre" when describing earthy hematite or processed red or yellow pigment. Geologists and ethnographic populations, on the other hand, distinguish a wide variety of iron-oxide types – specular, rocky, or earthy – depending upon the composition, processing state, or intended functions of the material. The dominant iron-oxides in Arizona are hematite, magnetite, and iron-containing rocks having variable amounts of iron ranging from 3% to 70% of weight (Harrer, 1964).

Although the use of red pigments is a defining characteristic of populations living in the Sonoran Desert, researchers know relatively little about these materials, particularly along the middle Gila River, the core area of red-on-buff production during the Hohokam pre-Classic period (Abbott, 2008; Abbott et al., 2007). Did prehistoric and historic potters use the same sources and techniques for red paint manufacture? Can archaeologically recovered iron-oxides be characterized and related to source? The Gila River Indian Community Cultural Resource Management Program (GRIC-CRMP) has recovered hundreds of artifacts identified as "ochre", and ethnographic sources of paint have been identified and recorded within the boundaries of the reservation. A recent study of ochre sources in the Tucson Basin likewise reveals the utility of instrumental neutron activation analysis (INAA) for characterizing iron-

* Corresponding author. Tel.: +1 480 755 7825.
E-mail address: seiselt@smu.edu (B.S. Eiselt).

0305-4403/$ – see front matter
doi:10.1016/j.jas.2011.06.030

oxide from local sources on a regional scale (Popelka-Filcoff et al., 2008). This study demonstrated the feasibility of matching geological ochre samples to source locations and it identified different types of hematite (specular, rocky, and earthy) that occur in archaeological contexts. Up to now, hematite sources from the Phoenix Basin have not been characterized by INAA, and the feasibility of relating archaeological hematite to raw material sources has not been evaluated. Without this information, archaeologists cannot move beyond basic chronological descriptions of red-painted ceramics or other objects to investigate important underlying issues concerning iron-oxide technologies and exchange.

The goal of this article is to present initial findings that link hematite artifacts recovered from several sites on the Gila River Indian Community to geological sources in the Phoenix Basin. Research was designed to test two hypotheses: (1) that hematite sources in the Phoenix Basin have the variation necessary to proceed with artifact-based provenance studies, and (2) that the provenance of ochre artifacts of different types can be investigated using INAA. Chemical analysis demonstrates a local origin for archaeological hematite from contexts along the middle Gila River. Ethnographic data and experimental research with archaeological materials provides a methodology for distinguishing processed archaeological hematite according to type as a necessary first step in the formulation of geochemical source groups.

2. Background

2.1. Archaeological occurrences of hematite

Hematite, the main ingredient in red slips and paints, is an iron-oxide material that occurs as earthy deposits (ochre), as metallic masses (specular hematite), and as matrix or accessory minerals in a wide variety of sedimentary and granitic rocks (rocky hematite). At Archaic and Hohokam sites, it occurs in a variety of forms and processing states, from unmodified red rocks and earthy lumps, to abraded rocks, powdered specimens and processed billets or "cakes" (Miksa and Tompkins, 1998). Sites along the middle Gila River also have yielded numerous processing tools including bowl fragments with hematite residues, stained handstones, and cached jars containing abundant hematite stores (Haury, 1976:pp. 275–276; Loendorf and Woodson, 2008). Archaeological examples of hematite suggest that processing involved several steps including procurement, grinding, and possibly levigation, and that cleaning and grinding resulted in a denser and more pure form of prepared hematite cakes. Raw hematite is particularly abundant at sites believed to be centers of pottery or red paint manufacture, and powdered material occurs in approximately 15% of burial contexts, at least along the middle Gila River (GRIC-CRMP files, Teresa Rodrigues, personal communication).

2.2. Ethnographic sources, processing, and trade

Production of red pigments by the O'odham and Pee Posh (formerly Pima/Papago and Maricopa Indians) involved direct procurement of nearby and distant sources, indirect procurement through trade, a complex production sequence, and storage of raw and prepared materials for paint and pottery manufacture. Earthy hematite was first ground or crushed into smaller pieces and then placed in a water solution to soak for several hours. The resulting slurry was stirred and the heavy fraction was allowed to settle. The fine fraction was poured into a second container or it was strained through a cloth. The decanted liquid was allowed to evaporate into a paste (Fernald, 1995:p. 32; Spier, 1970:p. 109). Once dry, the paste was formed into a loaf or a billet for storage. Prepared clays were reconstituted by crushing and soaking (Fernald, 1995:p. 32). Russell also notes that Akimel O'odham potters ground "dark red shale" in water to obtain a red slip or slurry that was applied directly to pots (1908:p. 27). Tohono O'odham ground hematite rock but added mesquite gum as a binder. Raw and prepared clays were kept in covered ceramic jars buried up to the neck in household floors (Fontana et al., 1962).

Tohono O'odham potters traded prepared paints from southern Arizona to the Pee Posh and Akimel O'odham of central Arizona during the June harvest ceremonies during the late 19th and early 20th centuries. With the decline of this trade starting in the 1950s, Pee Posh potters have become reliant on a local source near Santa Cruz in the area known as *Komatkĭ Vuhtcho* (in the Pima language) on the Gila River reservation (Fontana et al., 1962; Fernald, 1995). The Akimel O'odham obtained red slip for pottery manufacture from earthy hematite sources at a second site called Crooked Red (*Veg Gakut*) on the southern slopes of the Santan Mountains until the 1950s (Rea, 1996; Russell, 1908:p. 161). However, as late as the 1960s, a second major red paint source was said to exist below Crooked Red in the alluvial terrace and cut bank of the Gila River at Granite Knob (Stanley Ellis, personal communication 2010).[1] Gila River populations also obtained red and specular hematite paint from their Yuman neighbors to the west during the historical era. The specular hematite paint adorned the faces of warriors before battle. Red paint was mixed with animal fat and applied as body decoration or for protection against the elements (Russell, 1908).

2.3. Geological occurrences and descriptions

Ethnographic and historical accounts demonstrate use of a wide variety of resources in a region that is rich in iron ores, most of them formed during the Yavapai orogeny (1700–1690 Ma.), a period of intense deformation and widespread granitoid emplacement across much of central and southern Arizona (Harris, 1994; Karlstrom, 1991). Iron-oxides are found in three types of geological formations within this broad region (Harrer, 1964) (Fig. 1). The first are in piedmont soils with strongly developed argillic horizons (Huckleberry, 1994). Soils forming just above bedrock of Proterozoic metamorphic rocks have enriched iron, on the order of 3%–20% of total volume in the B horizon. The ethnographic Santa Cruz source is represented by this type of material. Iron-oxide formations also occur as near-surface secondary mineralization resulting from the emplacement of the granite intrusives associated with the Yavapai orogeny. The intrusives vary greatly in size and shape and in many cases form the cores of mountain ranges and ridges (Harrer, 1964:p. 18). Iron-oxides occur as contact-metamorphic or pyrometasomatic replacements of the Proterozoic rocks at the margins of these ridges where they occur in dykes or as isolated finds (Ferguson and Skotnicki, 1996; Harris, 1994; Leighty et al., 1997). Specular hematite is a common occurrence in these locations and in its pure form consists of up to 70% iron by weight. The ethnographic Crooked Red source area exhibits units of this kind with iron-rich soils forming in the B Horizon above the bedrock. The third formation comprises metasedimentary deposits such as slates and mudstones with iron concentrations of 20%–40% of total weight. Extensive deposits of this kind are found in the Cave Creek area and in the mountains along the northern border of the Phoenix Basin. Finally, iron-rich alluvial

[1] This source is rumored to have been removed or covered by flooding of the Gila River some time during the 1960s. We did obtain a sample of the paint from Mr. Ellis subsequent to the current analysis but have been unable to locate the source.