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Residue analysis links sandstone abraders to shell fishhook production on San Nicolas Island, California

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ABSTRACT

Excavations at the upper component of the Tule Creek site (CA–SNI–25), dating between approximately 600–350 cal BP, yielded numerous well-preserved sandstone abraders referred to as saws. Many of these tools show heavy use-wear and abundant white residue still adhering to the surface. We used X-ray diffraction (XRD) analysis to characterize the residue from two of the abraders, which identified the mineral phases calcite and aragonite (both $CaCO_3$), albite ($NaAlSi_3O_8$), and quartz (SiO_2). A scanning electron microscope (SEM) equipped for Energy Dispersive X-Ray (EDS) analysis identified the elements C, Ca, S, Na, and Al in the samples, confirming the XRD results. Albite, quartz, and calcite in the scrapings are consistent with the mineralogy of sandstone, though the presence of calcium carbonate in the form of calcite and aragonite suggests marine shell is also present in the residue samples. XRD and SEM analysis of a modern red abalone (*Haliotis rufescens*) shell indicates that the inner-layer (nacre) consists mostly of aragonite phase calcium carbonate, whereas the outer layer (epidermis) is made up mostly of calcite phase. SEM images revealed that calcite and aragonite from the archaeological residues display similar morphologies as the material from a modern abalone sample, and a greater presence of aragonite over calcite suggests the abraders were primarily used to work the inner layer of the abalone shell. These results provide a functional linkage between sandstone saws and shell fishhook production at CA–SNI–25.

1. Introduction

Characterizing ancient residues on artifacts provides important data regarding the role and function of tools, weapons, containers, and other artifacts found in archaeological contexts across the globe (Brieur, 1976; Charters et al., 1993; Eerkens, 2007; Eerkens et al., 2012; Hardy and Garufi, 1998; Jahren et al., 1997). Improvements in analytical techniques and integrative methodological approaches have increased the accuracy and reliability of these studies (Barton et al., 1998; Haslam, 2004; Kooyman et al., 1992; Regert et al., 2001). Pottery vessels, ground stone implements, and chipped stone artifacts have been the subject of a variety of destructive and non-destructive characterization studies (Adams, 2002; Eerkens, 2002, 2005; Pearsall et al., 2004). Most of these studies focused on identifying organic material such as proteins (Brieur, 1976; Dier, 2011; Kooyman et al., 1992, 2001), alkaloids (Henderson et al., 2007), lipids (Charters et al., 1993; Dudd et al., 1999; Quigg et al., 2001), and starch grains (Pearsall et al., 2004; Piperno et al., 2004), characterizing residues on artifacts hypothesized to have been used for food or beverage processing and storage. Techniques used to characterize inorganic materials, on the other hand, are predominantly used to investigate residues associated with metalworking, to elucidate the uses of particular tools, or to yield insights into the technology used at a specific workshop (e.g. Rehren, 2003; Ježek, 2013).

Few studies have examined residues as a means of functionally linking different artifacts together to reconstruct manufacturing sequences and complete toolkits (Ache et al., 2012; Bertemes et al., 2000; Bertemes and Heyd, 2002). Yet, understanding how artifacts fit together to form discrete and cohesive toolkits designed to perform specific tasks is crucial to building technological profiles of archaeological sites. Archaeological sites are likely to contain the majority of tools used for local manufacturing of objects, at least if the preservation is good (Bortenschlager and Oeggl, 2000). Shell

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middens and calcareous soils in general tend to provide good preservation for bone and shell artifacts, making them ideal settings to examine such artifacts, investigate the organization and development of technology, and make behavioral inferences about past human activities based on their material remains. It is with this in mind that the following paper focuses on using transfer residues on sandstone abraders as a means to test hypotheses about the organization of shellfish hook production at a 15th to 16th century village site on the California Channel Islands.

2. Sandstone saws

Recent excavations of the Tule Creek site (CA–SNI–25) on San Nicolas Island, California, yielded abundant cortical flake abraders of local indurated sandstone. These tools were originally referred to as "sandstone saws" by Malcom J. Rogers (1930) who described them as numerous in his initial surveys and excavations at the site (Fig. 1). Kendig et al. (2010) used replicative studies, use-wear analysis, and examination of the spatial distributions of sandstone saws relative to other artifacts. A statistical correlation between sandstone saws and single piece shell fishhooks implied that sandstone saws were used to manufacture and refine shell fishhooks at this site (Fig. 2). The study tested replicated saws and their effectiveness, use wear, and residue placement patterns when set to a variety of tasks. The results showed that the replicated specimens were extremely effective during key stages of shell fishhook manufacture and that use-wear and residue placement patterns were most representative of archaeological specimens when the saws were set to this task (Kendig et al., 2010). Patterns of white residue formed along the distal cutting edge of the tools during these stages of shell fishhook production and became embedded in the exterior of the tool; a pattern well reflected in the archaeological assemblage (Kendig et al., 2010: 203–205). These data provided a foundation for the current study regarding the use of sandstone saws in shell fishhook production on San Nicolas Island.

3. San Nicolas Island

The most isolated of the Southern California Channel Islands, San Nicolas Island lies 98 km (68 mi.) from the nearest point on the mainland at the Palos Verdes peninsula (Kendig et al., 2010: 194) (Fig. 3). Geologically, uplifted sedimentary Eocene deposits of siltstones, conglomerates, and sandstones make up the majority of this landmass (Burnham et al., 1963; Schoenherr et al., 1999; Vedder and Norris, 1963). The semi-arid island is somewhat sparse in terrestrial resources and contains only a few perennial fresh water springs, low growing shrubs, and six terrestrial animals including the white footed deer mouse (*Peromyscus maniculatus*), side-blotch lizard (*Uta stansburiana*), island night lizard (*Xantusia riversiana*), southern alligator lizard (*Elgaria multicarinata*), island fox (*Urocyon littoralis*), and land snail (*Micrarionta* sp.) (Schoenherr et al., 1999). However, San Nicolas Island is surrounded by the most extensive kelp beds of any of the California Channel Islands and contained within this unique ecosystem thrives an abundance of marine life (Browne, 1994; Engle, 1994).

Fig. 1. Morphological variation of sandstone saws from CA–SNI–25. Distinct residue placement pattern indicated with white circle (adapted from Kendig et al., 2010).

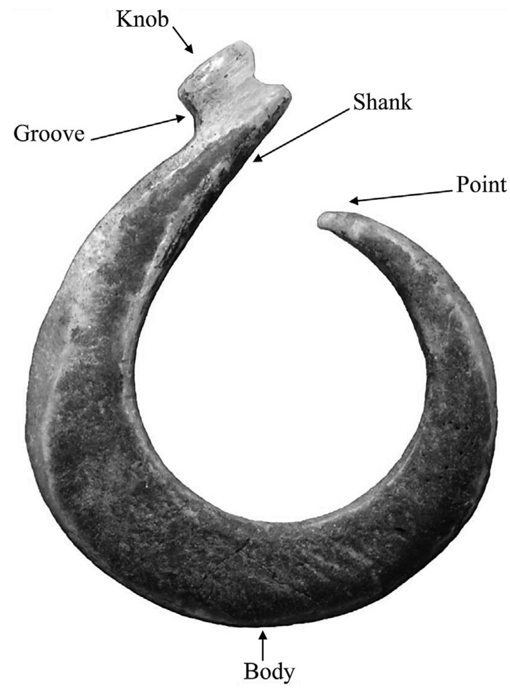

Fig. 2. Anatomy of a single piece shell fishhook from the Tule Creek Site (adapted from Cannon, 2006).

The earliest occupation on San Nicolas Island dates to the Terminal Pleistocene/Early Holocene as supported by the presence of lithic crescents, a flaked stone technology associated with this period (Davis et al., 2010). However the oldest radiocarbon dates associated with archaeological deposits date to around 6000 cal BP (Davis et al., 2010). Middle Holocene (6500–3500 YBP) occupation is well reflected within several extensive sites on the northwest coast of the island (Rick et al., 2005; Vellanoweth and Erlandson, 1999). The Late Holocene (3500 cal BP-European contact) reflects significant shifts in regional social complexity (Arnold, 2001; Gamble, 2008; Kennett, 2005), and on San Nicolas Island this period is characterized by the formation of large village sites, communal cemeteries, and increased evidence of trade (Martz, 1994: 18, 2005). This rising complexity may have been influenced by the advent of the single pieced shell fishhook, roughly 2500 cal BP (Rick et al., 2002), as well as the prevalent use of the seaworthy sewn plank canoe (Arnold, 2001; Gamble, 2002; Kennett, 2005: 215) in addition to many advanced fishing technologies still in use (Erlandson and Braje, 2008).