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Ground stones: a synthesis of the use-wear approach

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ABSTRACT

The use-wear approach is crucial to an understanding of the life-history of ground stone tools. This chapter outlines the current methodological framework for use-wear analysis, with an emphasis on the importance of multiple scales of magnification, beginning with the un-aided eye. Tribological theory offers a framework for understanding the development of wear patterns, and highlights the importance of a careful description of the raw material as a baseline for understanding the changes produced by subsequent use episodes. Use-wear analysis relies on an analytical framework created through the experimental reconstruction of a variety of processing tasks using replica ground stone tools. Actualistic experiments of this nature are presented in a growing body of literature, a summary of which is provided here. The experimental approach has made it clear that use-wear characteristics vary according to the materials and mechanics involved in a processing task. This has allowed for the creation of an analytical framework for low magnification studies. At high magnification, a growing number of studies has allowed for a better understanding of micropolish formation and variability on ground stone. It is underlined that use-wear characteristics other than micropolish can also been observed at this scale as well.

1. Introduction

The analysis of use-wear is a significant component of ground stone tool studies. Sorting and classifying ground stone tools largely relies on the identification of the traces related to use or manufacture, and their location on the implement. This is especially true for the expedient, non-manufactured, ground stone tools which were abundant in early prehistory.

As traditionally defined, the category of "ground stone tools" includes objects which were produced and/or used according to motions such as percussion, pounding, pecking, grinding, abrasion, polishing etc. The term 'macro-lithic tools' has also been used as a synonym for this category (Adams et al., 2009). The tool types commonly found in ground stone assemblages include hammerstones, abraders, grinding implements (e.g., grinding slabs/querns/metates used in conjunction with handstones/manos), as well as pounding (e.g., mortars and pestles) and cutting (axes and adzes) implements. Assemblage composition often varies substantially through time and according to geographic area, as illustrated by Wright (1992) in Southwest Asia, Adams (2002a) in the American southwest, and De Beaune (2000) in Europe.

Some have suggested that percussive technology (hammerstones and anvils) might have been inherited from a human–chimpanzee clade (e.g., Mercader et al., 2007). The hypothesis that percussive technology could be a precursor of more complex stone knapping is also the focus of recent studies (e.g., Carvalho et al., 2008; Haslam et al., 2009; McGrew, 2010; Bril et al., 2011). Tool types such as cupmarks, hammerstones and pounders are well represented in early prehistory (e.g., Leakey, 1971; Willoughby, 1987; Goren-Inbar et al., 2002; Mora and De la Torre, 2005), while grinding slabs, handstones (metate–mano) and other grinding implements make their earliest appearance in South Africa (e.g., McBrearty and Brook, 2000; Van Peer et al., 2003; Klein, 2009: 537; Henshilwood et al., 2011), early in the Middle Stone Age (dated approx. between 300 ka and 50 ka following Klein, 2009). Mortars and pestles emerged later, and some of the earliest manifestations are seen during the Upper Paleolithic period in Europe (43 ka–11 ka, following Klein, 2009: 666) and the Early Epipaleolithic (23.0–14.6 ka cal. BP, following Maher et al., 2011) in Southwest Asia (e.g., Semenov, 1964: 134; Bar-Yosef, 1980; Wright, 1992, 1994; de Beaune, 2004). However, ground stone assemblages (for instance at Natufian and Jomon sites) tend to become larger and more varied during the terminal Pleistocene–Early Holocene, a period which coincided with the development of semi-sedentary communities. Precursors of edge-ground tools, such as axes and adzes, often viewed as characteristic of the Neolithic period, can also be found in such contexts. Recent studies suggest that they

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appear even earlier in Australia (Geneste et al., 2012) and Japan (Takashi, 2012). The subsequent proto-historic and historic periods coincide with major developments in macro-lithic tool technologies, including those related to metallurgy, the stabilization of querns into a solid platform, the invention of the hopper mill and rotary quern, as well as presses for the extraction of oil (e.g., Curtis, 2001; Alonso Martinez, 2002; Treuil, 2002; Delgado and Risch, 2008).

Although ground stone tools have been less extensively studied than chipped stone implements or ceramics, research has shown how important they are in discussions addressing key anthropological questions, such as the evolution of technology and complex cognition, the evolution of plant exploitation and the transition from foraging to farming, the emergence of multi-level social organization, and the rise of symbolic behavior. In many of these studies, the function of the ground stone tools, the manner in which they were used, and the material(s) which was/were processed, are central to the discussion. This underlines the importance of the use-wear approach.

Use-wear descriptions can be found in early in-depth studies of archaeological ground stones (e.g., McGuire, 1891). Semenov's (1964) pioneering work on use-wear included an analysis of axes, adzes, mortars, pestles, and abraders. However, unlike chipped stone implements, studies aimed at exploring use-wear formation on ground stones only expanded in the decades following the publication of the English translation of Semenov's book. The aim of the present paper is to discuss the methodological framework currently employed to study use-wear on ground stones. A focus is placed on non-cutting types of ground stone tools. Parallels in the characteristics of use-wear formation can be found between non-cutting (e.g. hammerstones, abraders, polishers, grinding and pounding implements) and cutting (e.g. knifes, axes and adzes) ground stone tools, as they can be made of the same type of raw materials. However, their mode of operation differs significantly, which has a major impact on use-wear development. For similar reasons, use-wear formation on stone beads and pendants, which are sometimes included in the ground stone category, is not discussed in this paper.

The formation of use-wear on ground stones is examined here at various magnifications. The present paper does not discuss overall morphological changes associated with the utilization of the tool; to date, only a few experiments have focused on this aspect (e.g., Adams, 1993; Delgado-Raack and Risch, 2009; Stroulia and Dubreuil, 2013). Before examining the various frameworks currently used in use-wear analysis of non-cutting ground stone tools, our review first presents the experimental database which forms the basis of this framework.

2. The groundwork

2.1. Experiments

Our understanding of use-wear formation on ground stone tools depends heavily on experiments. Several types of experimental programs can be undertaken (e.g., Keeley, 1980; Plisson, 1991), including mechanized or manual, and exploratory or systematic approaches (when parameters which may affect use-wear formation are controlled as much as possible). Most experiments with ground stone tools involve manual approaches, which serve to assess the feasibility and efficiency of the action performed. A few mechanized experiments have been conducted as well, often with a focus on the analysis of material behavior using material science approaches (e.g., Procopiou et al., 1998; Procopiou, 2004; Delgado-Raack et al., 2009).

Experimental programs have explored use-wear formation on ad hoc implements as well as manufactured tools (Tables 1 and 2).

Table 1
List and references of experiments that include a functional analysis of grinding and pounding tools. Expanded from Adams et al. (2009).

Activity	Raw material of the active and/or passive tool(s)	References
Grinding, pounding (with upper and lower implements)		
Grinding maize	Medium-grained quartzite and granitic stones, vesicular basalt, sandstone	Wright, 1993; Kamp, 1995; Adams, 1999
Grinding cereals (e.g., wheat, spelt barley, millet)	Granetiferous mica schist, conglomerate, gabbro, wood (olive, oak, almond), metapsammite, basalt, compact sandstone, quartzitic sandstone, fine-grained sandstone	Procopiou et al., 1998; Menasanch et al., 2002; Risch, 2005; Dubreuil, 2002; Zurro et al., 2005; Hamon, 2007; Delgado, 2008; Verbaas and van Gijn, 2008; Hamon and Plisson, 2008; Bofill, 2012
Pounding cereals	Basalt	Dubreuil, in prep.
Grinding linseed	Quartzitic sandstone	Verbaas and Van Gijn, 2008
Grinding sunflower seeds	Medium-grained quartzite, granitic stone, sandstone, vesicular basalt	Adams, 1999
Grinding amaranth seeds	Medium-grained quartzite, granitic stone	Adams, 1999
	Medium-grained quartzite, sandstone	Adams, 1999
	Vesicular basalt	Adams, 1999
Grinding nuts	Basalt	Dubreuil, 2002
Grinding acorns	Basalt, quartzitic sandstone	Dubreuil, 2002; Hamon and Plisson, 2009
Pounding acorns	Basalt	Dubreuil, in prep.
Grinding mustard seeds	Basalt	Dubreuil, 2002
Grinding legumes (e.g., fenugreek, feva beans, lentils)	Basalt	Dubreuil, 2002
Pounding lentils	Basalt	Dubreuil, in prep.
Pounding rosemary	Basalt	Dubreuil, in prep.
Grinding meat	Basalt	Dubreuil, 2002
Pounding meat	Basalt, quartzitic sandstone, compact sandstone	Hamon and Plisson, 2009; Dubreuil, in prep.
Grinding fish	Basalt	Dubreuil, 2002
Crushing bone, cartilage and marrow	Compact altered sandstone, quartzitic sandstone, calcareous sandstone	Hamon and Plisson, 2009
Grinding pottery clay, pot sherds	Medium-grained quartzite, compact sandstone	Adams, 1989; Cunnar, 2007; Hamon, 2007
Temper grinding ("chamotte", cooked bone and flint)	Compact sandstone	Hamon, 2007
Grinding calcite	Compact sandstone, calcareous sandstone	Hamon and Plisson, 2009
Grinding ochre and processing pigment	Basalt, compact sandstone, medium-grained sandstone	Logan and Fratt, 1993; Dubreuil, 2002; Hamon, 2006; Verbaas and Van Gijn, 2008

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