ELSEVIER

Journal of Archaeological Science 35 (2008) 2153–2163

Journal of Archaeological SCIENCE

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

Oldowan reduction sequences: methodological considerations

David R. Braun [a,*], Joanne C. Tactikos [b], Joseph V. Ferraro [c], Shira L. Arnow [d], John W.K. Harris [d]

[a] *Department of Archaeology, University of Cape Town, Rondebosch 7701, South Africa*
[b] *Archaeological Consulting Services, 424 West Broadway Road, Tempe, AZ 85282, USA*
[c] *Department of Anthropology, Baylor University, One Bear Place #97173, Waco, TX 76798-7173, USA*
[d] *Department of Anthropology, Rutgers University, 131 George Street, New Brunswick, NJ 08901, USA*

Received 31 August 2007; received in revised form 7 January 2008; accepted 22 January 2008

Abstract

Transport of resources is a major feature of Oldowan hominin technological adaptations. Comparisons between different Oldowan localities often employ measures of transport that are based on artefact attributes as proxies for the intensity of raw material utilization. The Technological Flake Category system [Toth, N., 1985. Oldowan reassessed: a close look at early stone artifacts, Journal of Archaeological Science 12, pp. 101–120] has been used extensively to infer the relative intensity of lithic reduction within Oldowan assemblages. Here we use a large experimental sample to test the relationship between a flake's stage in a reduction sequence and various quantitative attributes. We demonstrate how many previously described attributes are affected by initial core size. We then develop a multiple linear regression model that incorporates several variables to predict the placement of a flake within a generalized reduction sequence. The model is then applied to Oldowan assemblages in the Koobi Fora Formation which explores the strengths and weaknesses of different methods of investigating reduction intensity on an assemblage level.

Keywords: Oldowan; Lithic analysis; Koobi Fora; Experimental archaeology

1. Introduction

Oldowan stone tools provide an important record of the technological adaptations of our earliest ancestors. Understanding the way in which Oldowan cores are reduced is important for an understanding of behaviour of Plio-Pleistocene hominins (Inizan et al., 1999). While initial studies of these Oldowan technologies were hampered by small assemblages (Harris, 1983), recent field and lab based research projects are providing the necessary data set to understand the variation in Oldowan stone tool production (Semaw et al., 1997; Semaw, 2000; Roche et al., 1999; Delagnes and Roche, 2005; de la Torre, 2004; Harris et al., 2002). Technological strategies of Plio-Pleistocene hominins are more complex than was previously thought (Semaw et al., 1997; Roche et al., 1999). A more technologically oriented approach to Oldowan stone tool production is necessary. Recent technological approaches to Oldowan tool production have outlined major obstacles in the comparison of Oldowan data sets (Delagnes and Roche, 2005; de la Torre, 2004).

To understand the behaviours associated with Oldowan stone tool production it is necessary to understand how stone tools are produced. The best way to do this is by literally observing the sequence of removals, which is possible with cores that have been refit (Delagnes and Roche, 2005; Kroll, 1997). In the absence of refit sets the techniques of stone tool manufacture must be inferred from the morphology of the flakes and cores in the assemblage (Roche, 1988, 2000, 2005; Toth, 1982, 1987, 1997). Inferring patterns of behaviour from these artefacts is difficult because of the absence of a referential framework. However, recent work is bridging the gap

* Corresponding author. Tel.: +27 21 650 2350; fax: +27 21 650 2352.
E-mail addresses: david.braun@uct.ac.za (D.R. Braun), jtactikos@acstempe.com (J.C. Tactikos), joseph_ferraro@baylor.edu (J.V. Ferraro), jwharris@rci.rutgers.edu (J.W.K. Harris).

0305-4403/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jas.2008.01.015

between behaviour and artefact morphology through ethnographic (Stout, 2002; Roux and Bril, 2005) and experimental (Toth, 1985, 1987, 1991; Sahnouni et al., 1997; Schick et al., 1999; Toth et al., 1993; Braun et al., 2005) studies. Through continued research on the Oldowan we are beginning to understand the system of the sequence of removals (reduction sequence) associated with this early technology (Hovers, 2007). This is particularly difficult because of the highly variable nature of the knapping systems in the Oldowan.

Calculating the intensity of artefact utilization through modelled reduction sequences allows an understanding of what Isaac (1984) referred to as the ‘‘flow of stone’’ across ancient landscapes (i.e. the use and discard patterns along linear lines of transport away from a stone source). By understanding the distribution of artefact manufacturing products it is possible to understand the manufacturing processes that took place at different localities. An understanding of reduction intensity at several localities across a landscape can begin to outline the dynamics of raw material economy in the Oldowan (Roche, 2005; Toth, 1987; Stout et al., 2005; Schick, 1987; Bunn et al., 1980) as has been done in younger time periods (Bamforth, 1990; Bamforth and Bleed, 1997; Kelly, 1995; Kuhn, 1995). The combination of an integrated stone resource transport model with an understanding of tool production could provide insights into decision processes in stone tool production strategies (Inizan et al., 1992).

Here we investigate existing methodologies of interpreting Oldowan lithic reduction sequences. We investigate the use of Technological Flake Categories that are widely used in studies of Oldowan technological strategies (Toth, 1985, 1987). We explore possible weaknesses in using this system to measure the intensity of reduction in Oldowan assemblages of differing initial core size. Using a large experimental sample, we employ a multiple linear regression technique that combines several variables to provide higher resolution information in the investigation of reduction sequences in the earliest stone tools. We test this experimental model on archaeological refit sequences and other experimental replicative assemblages. As a case study for the application of this technique, the multivariate model is applied to two assemblages from the Koobi Fora Formation. This application shows that a multivariate approach offers increased resolution in understanding raw material use in Oldowan contexts.

1.1. Flake types and reduction sequences

The Technological Flake Category system has been applied to interpret models of tool production at several Plio-Pleistocene sites (Toth, 1985, 1982). This system assigns whole flakes into a series of categories based on the presence or absence of cortex on the platform and dorsal surface (Fig. 1). The distribution of whole flakes within these categories can be used to infer the nature of core form reduction that occurred at archaeological localities in the past. A similar technique was developed by Villa (1978) to investigate flaked piece reduction at the Terra Amata Lower Paleolithic assemblage.

Toth (1982, 1987) used this methodology to determine various aspects of Oldowan technology, including inferences about

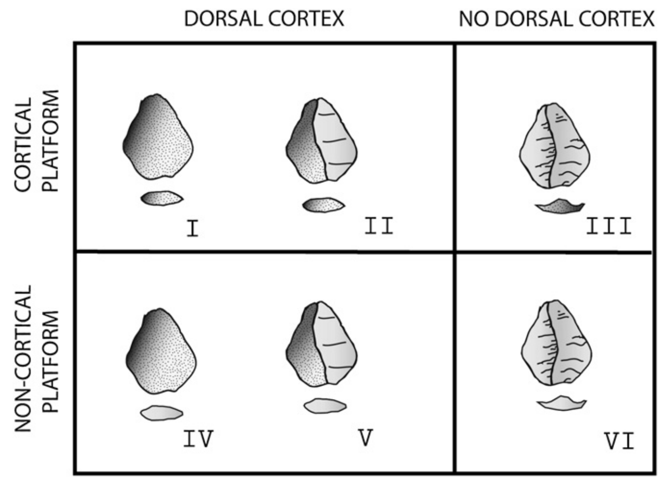

Fig. 1. Technological Flake Categories as described by Toth (1985).

the type of artefact manufacture that an assemblage of whole flakes represents (e.g. unifacial vs. bifacial). The simplicity of this model, and the ability to attribute different distributions of these six types to particular reduction strategies, makes it a powerful tool for the study of Plio-Pleistocene lithic technology. Toth (1985, 1982) has applied this system to describe technological differences between Oldowan sites (Schick, 1987). Subsequently the system has been used to assess intensity of reduction in Oldowan assemblages. When Technological Flake Categories are used to determine the intensity of reduction, the proportion of flakes in Categories I–III relative to Categories IV–VI is thought to reflect the degree of reduction on an assemblage level. A relatively high percentage of flakes in Technological Flake Categories I–III suggest primary flaking, whereas higher percentages of flakes in Technological Flake Categories IV–VI suggest a greater intensity of core reduction. This model has been applied to many Plio-Pleistocene assemblages (e.g. West Turkana: (Kibunjia, 1994); Gona: (Semaw, 1997); Olduvai: (Kimura, 1999, 2002); Peninj (de la Torre et al., 2003); Olorgesailie: (Noll, 2000)).

Technological Flake Categories have recently been used to analyze several large assemblages from Olduvai Gorge, Tanzania (Kimura, 1999, 2002). Results of this study suggest a trend through time from the Oldowan through the Developed Oldowan to the Acheulean marked by decreased percentages of flakes in the Type I through III categories. This was suggested to be the result of increased levels of transport behaviour in these later industries. Kimura (2002) proposed that this increase in the frequency of Technological Flake Categories was ultimately the product of large-scale ecological factors as well as biological changes in hominins themselves.

While Kimura’s (1999, 2002, 1997) conclusions may be correct (Rogers et al. (1994) detected similar behavioural patterns in the Koobi Fora Formation), a closer examination of the data suggests that the distributions of flakes within the Technological Flake Categories may be influenced by other factors. There is a significant relationship between mean core size in the Olduvai assemblages and the percentage of flakes in the I through III categories. Variation in the mean