Journal of Archaeological Science: Reports 2 (2015) 367–383

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: http://ees.elsevier.com/jasrep

Production and use of percussive stone tools in the Early Stone Age: Experimental approach to the lithic record of Olduvai Gorge, Tanzania

Policarpo Sánchez Yustos [a,*], Fernando Diez-Martín [a], Isabel M. Díaz [a], Javier Duque [a], Cristina Fraile [a], Manuel Domínguez [b]

[a] Department of Prehistory and Archaeology, University of Valladolid, Pza del Campus, s/n, 47011 Valladolid, Spain
[b] Department of Prehistory, Complutense University, Madrid, Spain

ARTICLE INFO

Article history:
Received 4 December 2014
Received in revised form 9 March 2015
Accepted 15 March 2015
Available online 4 April 2015

Keywords:
Early Stone Age
Olduvai Gorge
Percussive technology
Bipolar technique
Modified battered tool
Spheroid
Food pounding

ABSTRACT

The present work explores the production and functional relationships that may exist between bipolar cores and spheroids in Olduvai Gorge. Percussion experiments have been conducted to determine: if the bipolar technique is an adequate solution to split large and heavy quartz blocks into cuboid-shaped fragments, and in which percussion activities those bipolar fragments are modified from cuboid to spherical shape. In light of the results achieved, it can be concluded that: the bipolar technique is the most efficient technique to produce portable and manageable cuboid-shaped slab fragments, and bipolar cuboid-shaped fragments can be modified to subspherical shape through intensive percussive processes. The associations established between use patterns and functional parameters have allowed us to suggest that food pounding is the most plausible functional context for such shape modification.

1. Introduction

Growing evidence in both primatology and archaeology suggests the relevance of percussive activities in early human behaviour. Several percussive techniques have been recorded for vegetal processing among chimpanzees and capuchin monkeys (i.e. Boesch and Boesch-Achermann, 2000; Mercader et al., 2002; Whiten et al, 2009; Spagnoletti et al., 2011; Elisabetta et al., 2013). According to these findings, some scholars suggest that percussive technology could have been the precursor of flaking technology in the emergence of human technology (de Beaune, 2004; Marchant and McGrew, 2005; Carvalho et al., 2008; Haslam et al., 2009; McGrew, 2010; Bril et al., 2012).

Although flaking predominates in early archaeological sites, in some of them the evidence of percussive activities is quite relevant (Goren-Inbar et al., 2002; Chavaillon and Piperno, 2004; Mora and de la Torre, 2005; Diez-Martín et al., 2010). Olduvai Gorge, at present, provides the most exhaustive archaeological record to evaluate the significance of percussive activities in early human behaviour. Current studies have demonstrated that percussive tools are quite abundant in Bed I and Bed II (de la Torre and Mora, 2005; Diez-Martín et al., 2010). At the same time, some authors have tried to solve inconsistencies in the classification of percussion tools (de la Torre and Mora, 2005), while new interpretations as regards the functionality and way of producing some percussive tools have been developed through experimental research (Diez-Martín et al., 2011; de la Torre et al, 2013; this work). These studies have introduced new elements of discussion into the debate on non-flaked stone tools in the Early Stone Age (ESA), for a long time focused on the interpretation of the sub/spheroidal pieces (Leakey, 1971; Willoughby, 1987; Schick and Toth, 1994; Texier and Roche, 1995; Sahnouni et al., 1997).

The first element of discussion introduced in this debate was the “bipolar hypothesis” (Diez-Martín et al., 2009), supported experimentally (Diez-Martín et al., 2011). Another current element of discussion was introduced by Mora and de la Torre (2005), who proposed that quartz blocks were modified through intensive percussive battering, distinguishing different stages of transformation (from cuboid to spherical-shape). This hypothesis was not supported experimentally, and the experimental concerns of these authors have concentrated on the modification of the battered stone anvils (de la Torre et al., 2013). It is interesting to note that M. Leakey's term “Modified Battered Block” (MBB) would suggest that Leakey also considered that battered blocks could show different stages of transformation, as she noted that MBBs displayed no clear demarcation with regard to spheroids and subspheroids (Leakey 1971: 6). Among the lithic materials unearthed at the current archaeological excavations being conducted in Olduvai Beds I and II (Diez-Martín et al., 2009; Diez-Martín et al., 2010; Diez-Martín et al., 2014), we have also identified quartz blocks with

* Corresponding author. Tel.: +34 983343359.
E-mail address: policarpo.sy@gmail.com (P.S. Yustos).

http://dx.doi.org/10.1016/j.jasrep.2015.03.005
2352-409X/

intensive percussive battering on ridges and faces, and distinguished different degrees of transformation. We have also noted that a number of bipolar cores could be modified from cuboid-shaped to sub/spherical-shaped through intensive percussive battering, which would suggest that bipolar cores and spheroids could be part of the same operative sequence.

2. Experimental protocols

2.1. Objectives

An experimental protocol has been designed to provide a better understanding of the production and functionality of quartz blocks modified through percussion, referred to here under the name MBB irrespective of their degree of transformation. Regarding their production, our main goal is to test if bipolar cores and sub/spheroidal pieces could represent different stages of the same percussion sequence. In order to follow this line of inference, it is necessary to test if the bipolar technique is an adequate solution to split large quartz slabs into angular, portable and manageable fragments. In fact, it has been documented that Early Pleistocene hominins split large blocks into pieces to maximize the number of acute angles (Toth, 1997). The experiments focused on functionality aimed to describe the possible functional context in which a cuboid-shaped bipolar core is modified through percussion to a sub/spherical-shaped object. The development of our experimental programme may contribute to a methodological protocol that could be applied to the fields of Palaeolithic archaeology and primate archaeology.

2.2. Parameters and measurements

2.2.1. Design of experiments

The experiments analysed here are detailed in Tables 1 and 2. These included two experimental sets (production and use experiments) consisting of different activities in which a variable number of elements were processed (Fig. 1). The array of percussion activities replicated were documented in Olduvai, such as bipolar and hand-held knapping (e.g. Diez-Martín et al., 2009) and bone breaking (e.g. Domínguez-Rodrigo et al., 2014); or documented in the early archaeological record, such as nut-cracking (Goren-Inbar et al., 2002) and plant and underground storage organs (USOs) processing (Lemorini et al., 2014); or are likely to have occurred, such as meat-tenderizing (Carmody and Wrangham, 2009).

All lithic materials were collected in Olduvai. From 40 quartz slabs collected, 21 were used, and from 100 cobbles collected, 44 were used (Fig. 1.1). Participants were asked to select among the slabs and cobbles according to the individual conditions of the participants and the type of activity that they would perform. No further instructions were given. Only the percussion tools involved in the percussion experiments are included in the present work, while the rest of the materials are excluded (non-used cobbles and slabs, flaking cores, flakes and by-products).

The organic elements were sourced in different places: oldupai, acacia branches and goat bones were sourced in Olduvai; the palm nuts (*Hyphaene petersiana*) are from Lake Eyasi (Tanzania); and the cow bones and flesh and yam were sourced in Spain. Most of the experiments were conducted in Olduvai, with the exception of meat-tenderizing, USO-pounding and cow bone-breaking, conducted in the archaeological laboratory at the University of Valladolid (Spain), where a few lithics were shipped for this purpose. As in the case of the percussion activities replicated, the species chosen attempt to reflect the range of organic elements documented in the ESA record (e.g. Domínguez-Rodrigo et al., 2014; Lemorini et al., 2014; Barboni, 2014).

Table 2
Number of items processed, duration and participants in each percussive activity.

Activity	Number of items processed	Duration (min)	Participants
Bipolar knapping	21	126	2
Breakage	10	59	2
Shaping	11	67	2
Ground knapping	7	45	2
Hand-held knapping	10	48	2
Bone breaking	12	36	4
Nut cracking	10	78	4
Plant processing	4 (or 1 kg)	16	1
Yam processing	9 (or 2200 kg)	42	2
Meat tenderizing	1 (or 2500 kg)	63	2
Wood chopping	3	21	2

The design of our experiments bears similarities with the current lithic experiments conducted with materials from Olduvai Gorge, in terms of activities and technical actions (Diez-Martín et al., 2011; de la Torre et al, 2013; Gurtov and Eren, 2014). However it differs in its rationale: while the other experiments aim to recognize the morphotechnical attributes of the bipolar objects (Diez-Martín et al., 2011), explain why hominins used bipolar on quartz and avoided bipolar on non-quartz (Gurtov and Eren, 2014), or classify types of damage on passive percussion elements according to the percussive task performed (de la Torre et al, 2013), the present experimentation aims to describe percussion patterns on active percussion elements, link them to possible stone tool use, and explain the functional context in which bipolar technique is employed. The present study constitutes the first experimental replication exploring the production and functional relationships that may exist between bipolar cores and spheroids, the most controversial lithic elements in the archaeological record of Olduvai Gorge Bed I and II (Mora and de la Torre, 2005; Diez-Martín et al., 2009).

2.2.2. Raw materials

Quartz slabs and cobbles of three different raw materials (basalt, phonolite and quartz) were employed for this research. The cobbles were quarried by the authors in the present water courses of the Olduvai Gorge. Quartz slabs were quarried on the slopes of the Precambrian inselberg of Naibor Soit, where they can be found nowadays in abundance. In this orthogneiss outcrop, quartz originates in pegmatitic veins and dykes with its host rock, gneiss of granitic composition. Naibor Soit quartz is characterized by polycrystalline aggregates of centimetric size with contacts between lobulated grains. Large quartz crystals usually show an incipient shadowy extinction, demonstrating

Table 1
Count of percussive tool types sorted by raw materials and blanks.

Percussion tools		Raw materials			Blank			
	N	Basalt	Phonolite	Quartz	Cobble	Slab	Slab fragm.	Shaped fragm.
Anvil	6			6		2	4	
Direct active element	45	28	4	13	36	2	5	2
Indirect active element	8	2	3	3	5		1	2
Intermediate passive element	4			4			3	1
Multi percussion element	4	2	1	1	3		1	
Totals	67	32	8	25	44	4	14	5