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Experimental flaking in the Danjiangkou Reservoir Region (central China): A rare case of bipolar blanks in the Acheulean

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ABSTRACT

The exploration of techniques used to produce large flakes has long been a focus in Acheulean studies, especially from an experimental perspective. In this study we develop an experimental methodology to analyze Acheulean materials from the Danjiangkou Reservoir Region (DRR) in central China. The results show that large flakes experimentally produced with the bipolar technique can be easily distinguished from flakes produced by the other techniques due to the compression fracture unique to this method of flaking. These bipolar flakes show features consistent with those observed on a portion of the DRR archaeological handaxes. We suggest that the internal flaws and foliated structure found in quartz phyllite can actually assist in splitting cobbles, and consequently, they make bipolar flaking easier and effective. The anvil and throwing techniques have the next most successful ratio in detaching large flakes. The freehand technique is the least successful. Overall, the experimental study reported in this paper clearly demonstrates that raw materials influence the choice of flaking techniques, and the bipolar technique is a unique characteristic of the DRR Acheulean.

1. Introduction

The ability to detach large flakes (maximal size generally ≥10 cm) is widely accepted as distinguishing the Acheulean technocomplex from the earlier Oldowan technocomplex (e.g., Isaac, 1969; Semaw et al., 2009; Beyene et al., 2013). As a result, the exploration of technologies used to produce large flakes has long been a focus in Acheulean studies, especially from an experimental perspective, which can provide direct evidence to reconstruct the flaking strategies (Jansen, 1926; Goodwin, 1929, 1934; Corvinus, 1983; Schick and Toth, 1993; Texier and Roche, 1995; Toth, 2001; Madsen and Goren-Inbar, 2004; Sharon, 2007; Shipton et al., 2009; Mourre and Colonge, 2009–10).

Early experimental studies mainly focused on the physical actions involved in the techniques used to produce large flakes (see Inizan et al., 1999 [p.30]). The Chinese Palaeolithic specialist Pei Wenzhong (also known as W.C. Pei among western scholars) was a pioneer in this work. He systematically undertook experiments by using three techniques, namely, freehand, bipolar and anvil (also known as the block-on-block technique, or the anvil-chipping technique; Pei, 1936). After comparing experimental flakes produced with each technique, he summarized three characteristics for anvil products—namely, large platform size and angles (interior angles from 90° up to 170°), large bulbar scars, and strong force waves on the ventral face; and further argued that these features can be used to distinguish flakes produced by freehand versus anvil techniques (Pei, 1936; Pei and Jia, 1958). Based on Pei's work, Breuil and Lantier (1965) redefined the anvil technique and confirmed the results achieved by Pei. Importantly, they claimed that the anvil technique is more suitable and effective than freehand percussion for producing large sized flakes. They further thought that this technique was widely used in the European Clactonian and Abbevillian cultures, due to the large flake tools found at these two sites.

However, different opinions have arisen since François Bordes' (1968) replication experiments using anvil and freehand techniques. He concluded that the same features can be produced by either technique. Bordes' experimental study has been influential, and debate is ongoing on how to distinguish large flakes produced by different techniques accurately, or if it is even possible to do so (Wang, 1989; Schick and Toth, 1993; Shen and Wang, 2000; Clark and Kleindienst, 2001; Wang, 2004; Yang et al., 2016). Regardless of opinions held, we demonstrate that experimental study is a method essential to understanding the technological choices of Acheulean hominids.

Another aspect of experimental studies that attracts great interest is the concept of technological organization for the working of cores prior to the detachment of large flakes (i.e., the knapping methods as defined by Inizan et al., 1999). Currently, various flaking strategies are identified, with the term "Acheulean giant core technology" adopted to encompass all known strategies (Sharon, 2007). A well-known example is the

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experimental study of reduction methods in Gesher Benot Ya'aqov (GBY). The bifacial core method and the sliced slab method were identified through experimental reconstructions of core reduction, and clearly, different methods are flexible adaptations to the specific qualities and shapes of available raw materials in this region (Madsen and Goren-Inbar, 2004; Sharon, 2007). This example demonstrates well that experimental study is a key means for reconstructing the reduction strategies of giant cores in the Acheulean.

1.1. Large flake production in the Danjiangkou Reservoir Region (DRR)

Danjiangkou Reservoir Region (DRR) is a handaxe-bearing region in central China and is currently studied by the authors (Kuman et al., 2014; Li et al., 2014a, 2014b, 2014c). Handaxes are buried in the fine clay deposits of the third terraces of the Han River, which flows through and feeds the DRR (Fig. 1). Palaeomagnetic and ESR dating have placed the third terrace deposits to the earlier half of the Middle Pleistocene (Li et al., 2014c). To date, 105 handaxes are both surface-collected and excavated from 22 sites in DRR. Fig. 1 shows all the palaeolithic sites (with and without handaxes) currently discovered in DRR. According to Sharon's (2007) definition, the raw materials used in DRR were giant (>30 cm) to medium (from 10 to 30 cm) sized clasts collected from the nearby gravel layers of the Han River (Fig. 2). Random sampling to determine the proportions of different raw materials in DRR shows that 39.1% (N = 34/87) is quartz phyllite (see Fig. 2:b). In our archaeological samples, quartz phyllite is the predominant raw material used for DRR handaxes, with a proportion of 73.3% (N = 77/105). It is a metamorphic rock that belongs to the schist family. Thus, the foliated structure is very developed in most of these rocks (see Kuman et al., 2014 for a detailed description of this raw material).

In a detailed study of handaxes retrieved from recent investigations in this region, Li et al. (2014b) show that large flake blanks, which comprised 47.6% of the handaxe collection, were systematically used to make handaxes, along with cobbles and split cobbles as the other types of blank. Our analysis also shows that most of the handaxes were actually made on primary flakes, or cobble opening flakes. Specifically, nine out of 10 of those for which the striking platform can be identified have a cortical platform, and only one has a plain platform. The preservation of cortex on the dorsal face averages 23%, with some examples having up to 80% (Li et al., 2014b). This evidence shows that the cobble opening method was the main strategy chosen in the DRR for detaching large flakes. Fig. 3 presents archaeological examples of cobble opening flakes and handaxes made on these blanks. As commented by Sharon (2007), the cobble opening method for producing large flakes is less complicated than other well organized technologies. However, this does not mean it is not sophisticated; attention was paid to raw material size and shape, and to the systematic removal of a single, pre-planned primary flake (Sharon, 2007). Elsewhere, we also concluded that this method required an intentional selection of the original shape and size of the clasts to be used (Li et al., 2014b). Because the cobble opening method was used in producing large flakes, our research in this paper focuses on which physical actions or flaking techniques were used to detach large flakes from cobbles in the initial stage of reduction, and on the efficiency of different techniques in a comparative context.

We have also observed that large bipolar flakes were notably used as blanks to make handaxes in the DRR (Kuman et al., 2014; Li et al., 2014a, 2014b, 2014c). Among the 77 handaxes made of quartz phyllite, 46.8% (N = 36) were made on flakes, including 15.6% (N = 12) that were clearly made on bipolar flakes (see Supplemental Online Material [SOM] Table S1 for raw data). Although the proportion of the bipolar flakes is not high, this is a significant component in the DRR large flake production system. Large bipolar flakes are seldom reported from other Acheulean regions as blanks for handaxes. Therefore, if this conclusion can be further confirmed from an experimental perspective, it will contribute to our understanding of the technological flexibility and diversity during the Acheulean stage.

The experimental flaking in this study is goal-directed. We set out to address two questions: 1) to confirm the existence of bipolar technique in DRR large flake production; and 2) to compare the efficiency of four flaking techniques (freehand, bipolar, anvil and throwing) for quartz phyllite and determine which techniques were probably more frequently used by hominids. Both questions are closely related to the understanding of how the DRR hominids adapted their technology to the local raw materials.

2. Materials and methods

Both experimental and archaeological materials (see references above) were used in this study. For experimental materials, 80 flake production experiments were conducted (see SOM Table S2 for raw data). The experimental protocol included the initial stage of raw material procurement, with cobbles mainly collected in the region. Fig. 2 shows gravels that we accessed, which were exposed during the construction of roads, bridges or other facilities. Because of the predominance (73.3%) of quartz phyllite handaxes in the DRR, we focused on investigating the influence of quartz phyllite on the flaking techniques used in the replications. In selecting raw materials, flat and oval gravels were preferred, while those with a spheroidal shape were used less due to the lack of suitable angles for striking platforms. Both giant and

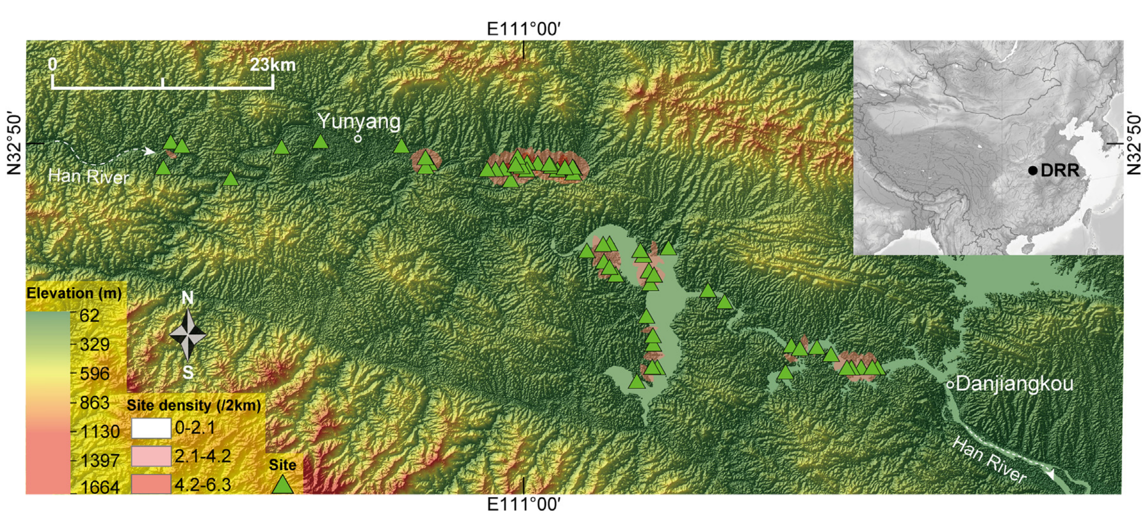

Fig. 1. Location of the Danjiangkou Reservoir Region (DRR) and distribution of the Palaeolithic sites in this area.