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Middle Palaeolithic raw material procurement and early stage reduction at Jubbah, Saudi Arabia

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ABSTRACT

Several hundred Middle Palaeolithic (MP) archaeological sites have now been identified in the Arabian Peninsula. However, the study of lithic raw material properties and related procurement behaviours is still in its infancy. Here we describe raw material procurement and early stage lithic reduction at MP sites in the Jubbah palaeolake basin, in the Nefud Desert, northern Saudi Arabia. We describe the sites identified during our surveys, and we use petrographic studies to demonstrate that MP assemblages were mostly produced from differing forms of ferruginous quartzite. These raw materials do not substantially vary in composition, although they are not identical in terms of factors such as grain size and the proportion of iron oxide. We then describe the lithic technology at these sites, with a particular focus on the largest assemblage identified, Jebel Katefeh-12 (JKF-12), which provides detailed information on lithic reduction at a quartzite source. Analyses from this site are then considered together with data from other MP sites in the Jubbah basin, where similar raw material was used. The results indicate that factors such as initial clast size/shape and reduction intensity play important roles in influencing aspects of morphological and technological variability. Our results suggest that incursions of MP populations into northern Arabia were probably temporally limited, as might be expected in a marginal and generally arid region. MP raw material procurement sites provide a highly visible signal of these ephemeral incursions, providing information on the ways that human populations adapted to the challenging conditions of the Saharo-Arabian arid belt.

1. Introduction

Archaeologists have paid considerable attention to lithic raw material procurement, stone tool reduction, and landscape behaviours (e.g. Andrefsky, 2005; Doronicheva et al., 2016; Ekshtain et al., 2016; Ferris, 2015; Garvey, 2015; Odell, 2000; Will and Mackay, 2016). Raw material availability and quality, as well as clast shape and size play important roles in the technological and organisational strategies of hunter-gatherer populations. Relatively little research on this topic has been conducted on Middle Palaeolithic (MP) sites in much of southwest Asia.

In part this reflects a focus on cave and rockshelter sites, which often preserve dateable Pleistocene sediments, but also reflects the influence of the notion of 'embedded procurement' (Binford, 1979), which suggests that raw material procurement was essentially subsumed within other subsistence activities (see also Brantingham, 2003). However, the idea of 'embedded procurement', was developed from the ethnographic study of sledge and metal tool using groups and therefore caution must be exercised when applying it to MP populations. Indeed, raw material procurement can be an energetically costly activity (e.g. Kuhn, 1995; Amick, 2007; Wilson, 2007) and the uneven distribution of raw material resources led hominins to develop specific provisioning systems (e.g. Kelly, 1988; Kuhn, 1995; Mackay et al., 2014; Wilson and Brown, 2014). Therefore, Binford's (1979, 259) argument that logical foragers would not make "express and exclusive" trips to raw material

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sources aside from exceptional circumstances, because there are "few or no direct costs" of procurement, must be evaluated in light of the evidence that raw material procurement can actually be extremely costly. Similarly, the record of areas such as Southwest France, where high quality chert is widely available, has led to the notion that MP hominins rarely transported lithic materials for long distances. Such conclusions are questioned by findings of regular long distance transport in areas such as East Africa (Negash et al., 2011) and the Caucasus (Doronicheva and Shackley, 2014).

Cave and rockshelter excavations in Southwest Asia have produced important behavioural findings, but offer only partial insights into spatially and technically fragmented and complex lithic reduction processes and mobility strategies. It has been argued, for instance, that many Levantine MP sites represent the provisioning of places (sensu Kuhn, 1995; e.g. Hovers, 2009; Hovers and Belfer-Cohen, 2013). Along with factors such as high levels of reduction intensity in many caves and rockshelters, it is clear that factors such as provisioning of places will have important consequences for the technological character of those assemblages. It is therefore necessary to understand behaviour at a landscape level, and particularly to integrate data from raw material procurement localities where the early stages of lithic reduction were conducted. Such sites may lack the stratigraphic integrity of caves and rockshelters, but provide a key and often overlooked element of lithic technology and human behaviour.

Sites in Egypt and Sudan show raw material extraction extending back to the Acheulean (Vermeersch and Paulissen, 1997). MP raw material extraction from pits is documented at sites such as Arkin 5 (Chmielewski, 1968), where a series of artificial pits, each around 3.5 m in diameter, are interpreted as evidence for 'mining' ferruginous quartzite/ferricrete sandstone. In one case it appears that a wall had been strengthened with slabs of stone. A number of other sites along the Nile demonstrate the quarrying of raw materials such as ferruginous quartzite (e.g. Marks, 1968). Several sites show hominin procurement of chert cobbles by often extensive ancient excavations (e.g. Otte et al., 2002). It is estimated that the total area exploited by MP hominins to access sub-surface raw materials at the Egyptian sites of Nazlet Safaha and Taramsa I is around 10,000 m^3, producing millions of chert cobbles (Van Peer, 1998). At Taramsa a series of occupations associated with raw material procurement cover >100,000 years (Van Peer et al., 2010). Phase IV (~60–55 thousand years ago [henceforth ka]) at Taramsa is characterised by an intensification of raw material procurement, perhaps reflecting population concentration close to the Nile in an otherwise arid region. The lithic technology is characterised by the 'Taramsan' core reduction method, the steeper lateral preparation of which allows more continuous, and therefore perhaps less wasteful, production compared to Levallois reduction. The Taramsan, which has been described as transitional to the Upper Palaeolithic (Van Peer et al., 2010, p. 234), demonstrates the interacting influences of demography, mobility strategies, technology, and raw material factors.

In the Levant the best understood localities are occupations in caves and rockshelters, in contrast to open-air procurement and early stage reduction sites. The chronology of the latter is currently problematic, but the presence of handaxes and Levallois technologies suggests that they date to the Acheulean and Middle Palaeolithic, as well as being used more recently (Finkel et al., 2016). In the case of Mt. Pua there are around 1500 tailing piles, some over fifteen meters across and three meters in height (Gopher and Barkai, 2014). In contrast to traditional views where hominins simply embedded raw material procurement within subsistence activities, and hence left the landscapes in which they lived almost unaltered, localities such as Mt. Pua and others such as Sede Ilan indicate a much more intensive approach to raw material procurement (see e.g. Barkai and Gopher, 2009; Barkai et al., 2006). Test excavations at these localities demonstrate that a variety of tools, such as basalt and limestone wedges, were imported to the sites from elsewhere as part of organised, long term quarrying activities, creating 'industrial areas' and extensive modification of the landscape. The tailing piles were deliberately positioned so as to not impede future extractions. For example, at Sede Ilan some of the highest quality chert in the landscape occurs in the bedrock. Here exhausted extraction fronts were backfilled, seemingly to stabilize the walls and allow continued and future extraction. Reduction to produce handaxes and Levallois flakes was conducted on top of the tailing piles. Piles of limestone, lacking the flint and basalt in the main activity zones, may even represent topographic/stratigraphic markers placed during an early phase of site use (Barkai et al., 2006), suggesting that the early hominins had a good understanding of the geology and landscape. The discovery of two lithic 'caches' has even been claimed to indicate symbolic behaviours associated with raw material procurement behaviours (see Barkai and Gopher, 2011 for details). Elsewhere in the Levant, studies of the cosmogenic beryllium isotope ^{10}Be have suggested that by the late Middle Pleistocene some raw material was being acquired from deeply buried sources (Boaretto et al., 2009).

The above data indicate that by the MP a variety of methods of extraction were being used, including energetically costly extraction of raw material from sediments and, to a lesser extent, from bedrock. Aside from offering insights into hominin behaviour (technology, forward planning, etc.), it can be argued that evidence for the intensity of raw material procurement and lithic reduction provide an approximate (relative) indicator of demography. This takes the form of both the number of lithics on a landscape (e.g. Foley and Lahr, 2015) and of energetically expensive procurement behaviours indicating pressure on resources. Given the importance of considering raw material procurement, an aim here is to examine the MP of Arabia, analysing how raw material was accessed and its implications concerning mobility strategies and technological variation. Here we will place particular attention on recent research conducted in the Jubbah Oasis, in the Nefud Desert of Saudi Arabia.

2. Background

2.1. Raw material procurement and the Middle Palaeolithic of Arabia

The majority of identified MP sites in Arabia are located directly on, or close to raw material sources (Fig. 1) (e.g. Groucutt and Petraglia, 2012; Delagnes et al., 2012; Usik et al., 2013). This, together with analyses of their technology, indicates that most of these sites can be described as raw material procurement localities where early stage lithic reduction was carried out. Consequently, understanding technological variation in Arabia is dependent on understanding the different characteristics of raw material sources, and how these relate to factors such as mobility strategies.

In Yemen, 94% of the raw material used at Shi'bat Dihya 1 (SD-1) consists of locally procured rhyolite that was abundantly available both on the surface and in alluvial deposits proximal to the site (Delagnes et al., 2012). The rhyolite was acquired in the form of cobbles of desirable morphologies, which consequently required little in the way of preparation of convexities to produce blades and pointed flakes. Clasts of these suitable morphologies were particularly abundant where steep tributaries joined the main wadi, in contrast to more rounded morphologies elsewhere. Delagnes et al. (2012) discuss the relationship between the limited preparation of striking platforms and the physical properties of rhyolite as a raw material. Their knapping experiments show that the rhyolite has reasonable properties of conchoidal fracture, but it needs to be struck very forcibly, which they suggest may explain the lack of faceting at SD-1. Likewise, the abundance of raw material may explain the short production sequences, with little evidence for the re-preparation of debitage surface convexity or platform surfaces. Perhaps at least in part as a result of these raw material factors, the site of SD-1 is unlike other known assemblages either in Arabia or in surrounding regions.

Further east, chert is abundant in many areas of Yemen and Oman. Crassard (2008), for instance, describes numerous sites associated

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