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Middle Palaeolithic toolstone procurement behaviors at Lusakert Cave 1, Hrazdan valley, Armenia

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ABSTRACT

Strategies employed by Middle Palaeolithic hominins to acquire lithic raw materials often play key roles in assessing their movements through the landscape, relationships with neighboring groups, and cognitive abilities. It has been argued that a dependence on local resources is a widespread characteristic of the Middle Palaeolithic, but how such behaviors were manifested on the landscape remains unclear. Does an abundance of local toolstone reflect frequent encounters with different outcrops while foraging, or was a particular outcrop favored and preferentially quarried? This study examines such behaviors at a finer geospatial scale than is usually possible, allowing us to investigate hominin movements through the landscape surrounding Lusakert Cave 1 in Armenia. Using our newly developed approach to obsidian magnetic characterization, we test a series of hypotheses regarding the locations where hominins procured toolstone from a volcanic complex adjacent to the site. Our goal is to establish whether the cave's occupants procured local obsidian from preferred outcrops or quarries, secondary deposits of obsidian nodules along a river, or a variety of exposures as encountered while moving through the river valley or across the wider volcanic landscape during the course of foraging activities. As we demonstrate here, it is not the case that one particular outcrop or deposit attracted the cave occupants during the studied time intervals. Nor did they acquire obsidian at random across the landscape. Instead, our analyses support the hypothesis that these hominins collected obsidian from outcrops and exposures throughout the adjacent river valley, reflecting the spatial scale of their day-to-day foraging activities. The coincidence of such behaviors within the resource-rich river valley suggests efficient exploitation of a diverse biome during a time interval immediately preceding the Middle to Upper Palaeolithic "transition," the nature and timing of which has yet to be determined for the region.

1. Introduction

The strategies employed by Middle Palaeolithic (MP) hominins to fulfill their toolstone needs, including the occurrence or absence of specialized procurement or quarrying locations, have previously been discussed in terms of their movements through the landscape, social relationships with neighboring groups, and cognitive abilities, such as foresight behind the use and production of stone tools (e.g., Marks, 1988; Roebroeks et al., 1988). Such appraisals have, in turn, been incorporated into debates considering whether MP hominins had fundamentally different behaviors or abilities than modern humans (e.g., Mithen, 1994, 1996a,b; Klein, 1995, 2000; Mellars, 1996a,b; Pettitt, 1997, 2000; Kolen, 1999; Tattersall, 1999), or whether their behaviors are essentially indistinguishable from modern humans once variations within social and ecological conditions are taken into account (e.g., Grayson and Delpech, 2003; Adler et al., 2006; Shea, 2011; Hopkinson et al., 2013). Many of these assessments remain primarily based on an extensive corpus of research on chert procurement in southwestern France (e.g., Larick, 1986, 1987; Geneste, 1988, 1989a,b, 1990; Turq,

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1988a, b, 1989, 1990, 1992; Geneste and Rigaud, 1989; Demars, 1990a, b). These foundational studies, in which cherts were macroscopically attributed to outcrops and deposits in the region, revealed the frequent predominance of local (<5 km) cherts among MP lithic assemblages. This finding has been interpreted as evidence for the spatial scale of day-to-day foraging (e.g., Geneste, 1985, 1989a) and for toolstone procurement "embedded" within economic and subsistence activities that took place near residential sites (e.g., Féblot-Augustins, 1997a,b, 2008). It remains largely uncertain, however, how such local behaviors were manifested. For example, does an abundance of local toolstone at a given site reflect frequent encounters with different outcrops while foraging, or was a particular outcrop favored for some reason and, thus, preferentially quarried? This study examines such behaviors at a finer scale than has so far been possible, allowing us to investigate hominin movements through the local landscape and the ways in which they structured their behaviors in light of their daily technological needs. Here, using a newly developed approach based on the spatial dependence of obsidian's magnetic properties, we test hypotheses regarding the locations where MP hominins procured toolstone from an extensive obsidian source adjacent to a cave. Our goal is to establish whether the cave's occupants procured obsidian from preferred outcrops or quarries, secondary deposits of obsidian nodules along a river, or a variety of exposures as encountered while moving through the river valley or across the wider volcanic landscape during the course of other subsistence activities.

Hominin provisioning behaviors offer unique insights into foraging patterns and landscape use that might otherwise remain obscured. While most archaeological materials recovered from a given site were brought there by its occupants, it is often impossible to know where on the landscape those resources — be they stones, bones, or plants — originated and were procured. Economically important animals and plants have specific environmental requirements, but they typically occupy ranges far larger than those used by hominins during a single foraging episode. While the archaeological remains of animals and plants serve as important proxies for the broader environmental setting, it is often impossible to pinpoint the precise area(s) where these resources were procured, thus limiting our ability to recognize land use patterns. This study seeks to rectify this problem by linking specific obsidian artifacts to specific parts of the landscape and, thus, tie those sources to broader patterns of mobility and land use. Analysis of the dynamic interplays between fixed toolstone sources and procurement behaviors is among the most productive ways to directly test hypotheses regarding hominin foraging patterns and ranges.

Archaeologists have previously used a variety of approaches to investigate the procurement of lithic raw materials, including lithic analysis at technologically specialized sites where extraction and initial working of toolstone may have occurred. However, recognizing specialized quarrying sites has been challenging. Such sites could be buried beneath subsequent deposits or might have been destroyed by later quarrying. The nature of activities at such sites must also be considered. If largely unworked blocks or cobbles were removed, there may be no remnants of the procurement activities (e.g., Ross et al., 2003). The short distances involved in local procurement suggest that minimal processing would occur at extraction or quarrying locations (Metcalfe and Barlow, 1992). Sites interpreted as quarrying locations have typically been characterized by the presence of tested and/or partially worked blocks or nodules with high proportions of cortical flakes and low proportions of tools (e.g., Turq, 1988a, 1989), but it has been argued that such sites reflect a mixture of activities rather than specialization (e.g., Geneste, 1989a). Quarrying complexes, provisionally dated to the MP, have been reported in the Levant (Barkai et al., 2006; Barkai and Gopher, 2009; Gopher and Barkai, 2014), but such sites have been largely elusive in most other parts of the world. Key challenges include how we can identify quarrying activities without finding a quarry and how we can rule out quarrying with an absence of evidence rather than evidence of absence.

Issues of toolstone procurement, use, and resupply have traditionally been investigated using lithic analysis (e.g., Hayden et al., 1996; Prentiss, 1998, 2001; Cowan, 1999; Andrefsky, 2005). Commonly such data are linked to procurement in terms of energy or cost, whereby toolstone procurement strategies "embedded" in foraging and other subsistence activities are low cost while any special-purpose excursions to procure toolstone are high cost (Bamforth, 2006). Consequently, archaeologists typically seek evidence for or against economizing behaviors. For example, Blades (2001) examined variables such as tool type, retouch intensity, cortex amount, and core and blank morphology in Aurignacian assemblages in France and argued that earlier, more mobile groups acquired toolstone from greater distances than was the case for later groups. His conclusion was based, in part, on greater intensity of tool retouch in earlier assemblages and greater intensity of core reduction in later ones. In contrast, Kuhn (1991) studied the Mousterian assemblages from two Italian sites: one situated on a coastal plain with immediate access to abundant chert cobbles, the other in a similar setting but without chert deposits. His findings were the opposite of those of Blades (2001): retouch intensity was greater at the site with abundant chert, whereas cores at the other site were maximized by making greater numbers of unretouched flakes. Thus, there are certainly links among the decisions made at toolstone procurement locations and variables such as material abundance and mobility (Kamp and Whittaker, 1986; Andrefsky, 1994a,b; Beck et al., 2002; Odell, 2003; Bamforth, 2006), but the toolstone procurement hypotheses that we consider here may not be resolvable with this type of analysis, at least not in isolation.

A relatively recent approach to toolstone procurement is the use of cosmogenic isotopes (e.g., ^{10}Be) to establish if chert was obtained at or near the surface (<2 m) or had been sheltered from cosmic radiation. Isotopic analyses of artifacts from Levantine sites (Tabun Cave, $n = 19$; Qesem Cave, $n = 49$) have been interpreted as evidence that cherts originated from meters-deep quarries rather than primary or secondary near-surface exposures (Verri et al., 2004, 2005; Boaretto et al., 2009). This approach to elucidating toolstone procurement has yet to see widespread application, perhaps due, at least in part, to its destructive sample preparation (i.e., crushing artifacts to yield a powder), effort (i.e., two or three spectrometric techniques are preceded by a series of chemical treatments), and cost (i.e., several hundred dollars per specimen or artifact). Another approach is that of Fernandes and colleagues (e.g., Fernandes et al., 2007; Thiry et al., 2014), who use scanning electron microscopy (SEM) to examine artifacts' cortical surfaces. The micromorphology of these surfaces, they argue, reveal a palimpsest of geological environments from which chert nodules were initially collected (e.g., surface, colluvium, alluvium, marine) and in which artifacts were eventually discarded. Applying their techniques at Payre and Sainte-Anne 1 in southeastern France suggested that nodules had complex depositional histories before their collection as toolstone.

Here we report on the first application of a new approach, based on a combination of portable X-ray fluorescence (pXRF) and rock magnetic characterization, to Lusakert Cave 1 (LKT1), a MP site along the Hrazdan River valley in central Armenia (Fig. 1a). The stratum on which we focus in this study is provisionally dated between MIS (marine isotope stage) 4 and MIS 3. The lithic assemblage is entirely obsidian, and the cave is adjacent to the Gutansar volcanic complex (GVC; Fig. 1b), one of the most important obsidian resources in the region. Geochemically indistinguishable obsidian, produced simultaneously by the GVC, occurs