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Hominin raw material procurement in the Oldowan-Acheulean transition at Olduvai Gorge

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ABSTRACT

The lithic assemblages at the Oldowan-Acheulean transition in Bed II of Olduvai Gorge, Tanzania, represent a wide variety of raw materials reflecting both the diversity of volcanic, metamorphic, and sedimentary source materials available in the Olduvai basin and surroundings and the preferences of the tool-makers. A geochemical and petrographic systematic analysis of lava-derived archaeological stone tools, combined with textural and mineralogical characterization of quartzite, chert, and other metamorphic and sedimentary raw materials from two Middle and Upper Bed II sites, has enabled us to produce a comprehensive dataset and characterization of the rocks employed by Olduvai hominins, which is used here to establish a referential framework for future studies on Early Stone Age raw material provenancing. The use of rounded blanks for most lava-derived artifacts demonstrates that hominins were accessing lava in local stream channels. Most quartzite artifacts appear to derive from angular blocks, likely acquired at the source (predominantly Naibor Soit hill), though some do appear to be manufactured from stream-transported quartzite blanks. Raw material composition of the EF-HR assemblage indicates that Acheulean hominins selected high-quality lavas for the production of Large Cutting Tools. On the other hand, the HWK EE lithic assemblage suggests that raw material selectivity was not entirely based on rock texture, and other factors, such as blank shape and availability of natural angles suitable for flaking, played a major role in Oldowan reduction sequences.

1. Introduction

The relative abundances and total mass of lithic artifacts made from different materials reflect both raw material availability and hominin preferences for specific materials. Potential raw material sources can be primary (e.g., in situ outcrops), secondary (e.g., cobbles from drainages derived from primary sources), or tertiary (e.g., hominin-made stone caches). This study will focus on primary and secondary sources at Olduvai Gorge. Hominins in the Olduvai Basin during Bed II times accessed and used a wide variety of raw materials from the local environment to manufacture stone tools. The Ngorongoro Volcanic Highlands to the east and south provide a variety of lava types, many of which would have been available to hominins in the Olduvai Basin as cobbles in stream channels draining the highlands (Leakey, 1971; Hay, 1976; Kyara, 1999). Precambrian metamorphic inselbergs (predominantly Naibor Soit and Naisiusiu) provide a local source for quartzite, and lacustrine chert nodules would have been intermittently exposed at the margins of the Olduvai paleolake (Hay, 1976).

Previous researchers have categorized Olduvai stone tools into general raw material groups (e.g., lavas, quartzite, and chert: Leakey, 1971; Kimura, 2002; or phonolite, basalt, trachyte, quartzite, and chert: Hay, 1976) and made inferences about raw material selection, availability, and transport based on the relative abundances of each, distance from source, and the proportion of flakes compared to cores (see also Kyara, 1999). Blumenschine et al. (2008, 2012) and Tactikos (2005) document changes in quartzite stone tool abundances with increasing distance from the presumed source (Naibor Soit), likely reflecting increased conservation of material with greater transport distances (distance-decay). In their studies, similar trends are not seen for lava-derived lithics, as flakeable stream cobbles would have been less geographically restricted. Other researchers (e.g., Stiles et al., 1974; Kimura, 1997) have focused on intervals in Bed II with exceptionally high abundances of chert artifacts, manufactured at a time when Olduvai

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lake-precipitated chert nodules would have been a readily available and desirable raw material source.

Four large Pliocene to Pleistocene volcanoes directly border the Olduvai Basin (Fig. 1), providing a potential primary source for lava raw materials for stone tool manufacture. To the south sits Lemagurut, a massive, heavily dissected volcano with basaltic to trachyandesitic lavas (2.40 ± 0.01 to 2.22 ± 0.10 Ma: Mollel et al., 2011), and to the southeast sits the older and more eroded Satiman, with its silica undersaturated phonolites and phono-tephrites (4.63 ± 0.05 to 4.02 ± 0.02 Ma: Mollel et al., 2011). To the east and southeast sits Ngorongoro, characterized by its rhyolitic tephra and ignimbrites (rarely if ever used as raw material for tools), along with lavas ranging from basalt to trachydacite (2.25 ± 0.02 to 2.01 ± 0.02 Ma: Mollel et al., 2008). Olmoti, to the east, has basaltic through trachytic lavas (2.01 ± 0.03 to 1.80 ± 0.01 Ma: Mollel et al., 2009). Engelosin, a small volcanic neck to the north of Olduvai, provides distinctively green and fine-grained phonolite (2.97 ± 0.02 Ma: Mollel, 2007). All of these volcanic centers were present and had ceased eruption of new materials before the deposition of Bed II sediments (Mollel and Swisher, 2012), and all are positioned such that paleo-drainages could have transported raw materials into the basin, making them locally available in stream channels during Bed II times. Such streams would have served as secondary sources for lava raw materials. Other Ngorongoro Volcanic Highlands (NVH) volcanoes are either too young or are blocked by the older volcanoes from supplying eroded lavas into the Olduvai basin. Mollel and Swisher (2012) provide a geochronological, geochemical, and petrological overview of likely NVH source volcanoes. Figure 2 provides a composite stratigraphic section for Olduvai Bed II, including previously published ages for some marker tephra.

Naibor Soit hill is a prominent metamorphic inselberg located just to the north of the Olduvai "junction" area (Fig. 3). Current exposures provide coarse grained quartzite, often weathering into angular slabs along planes with abundant muscovite mica. The hill is currently a major topographic high and would have been exposed

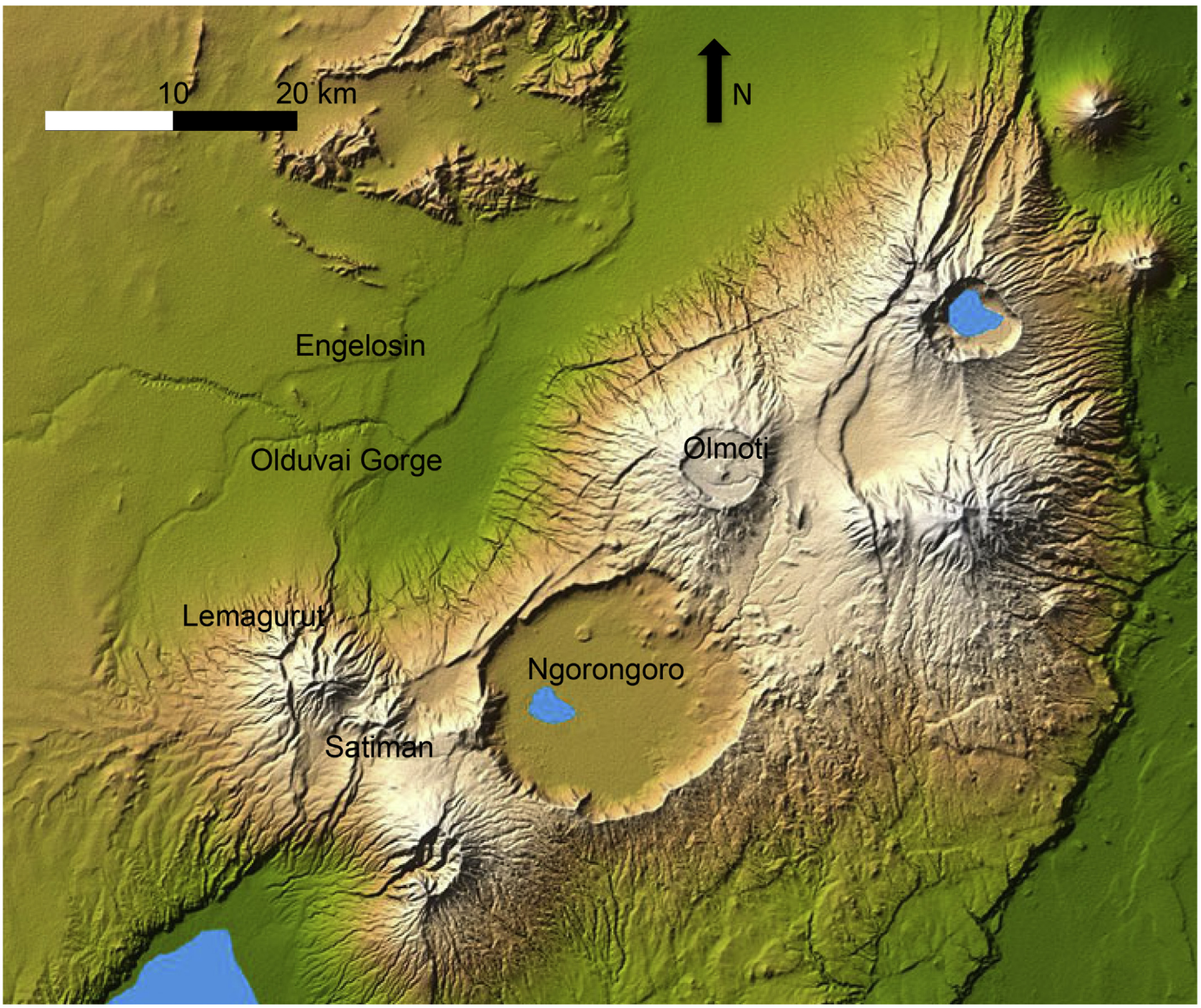

Figure 1. Map showing relative positions of Olduvai Gorge and the neighboring Ngorongoro Volcanic Highlands volcanoes. Base map from the Shuttle Radar Topography Mission, image credit NASA/JPL/NIMA. Lemagurut, Satiman, Ngorongoro, Olmoti, and Engelosin are all directly adjacent to the Olduvai basin and pre-date the deposition of Middle to Upper Bed II, making them potential primary sources for volcanic raw materials.

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