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Later Stone Age toolstone acquisition in the Central Rift Valley of Kenya: Portable XRF of Eburran obsidian artifacts from Leakey's excavations at Gamble's Cave II

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ABSTRACT

The complexities of Later Stone Age environmental and behavioral variability in East Africa remain poorly defined, and toolstone sourcing is essential to understand the scale of the social and natural landscapes encountered by earlier human populations. The Naivasha-Nakuru Basin in Kenya's Rift Valley is a region that is not only highly sensitive to climatic changes but also one of the world's most obsidian-rich landscapes. We used portable X-ray fluorescence (pXRF) analyses of obsidian artifacts and geological specimens to understand patterns of toolstone acquisition and consumption reflected in the early/middle Holocene strata (Phases 3–4 of the Eburran industry) at Gamble's Cave II. Our analyses represent the first geochemical source identifications of obsidian artifacts from the Eburran industry and indicate the persistent selection over time for high-quality obsidian from Mt. Eburru, ~20 km distant, despite changes in site occupation intensity that apparently correlate with changes in the local environment. This result may indicate resilience of Eburran foraging strategies during environmental shifts and, potentially, a cultural preference for a specific lithic material that overcame its accessibility changes. Testing such hypotheses requires a more extensive program of obsidian artifact sourcing. Our findings demonstrate the great potential for sourcing studies in the Rift Valley as well as underscore the amount of work that remains to be done.

1. Introduction

The complex dynamics of Holocene interglacial environmental and behavioral variability in East Africa remain poorly defined. Significant and often abrupt environmental changes include the return to near-glacial conditions during the Younger Dryas event (~12.9–11.7 ka), followed by the African Humid Period (AHP, ~11–6 ka), and a return to more arid conditions (~6–4 ka; e.g., Gasse, 2000; Tierney and deMenocal, 2013). Changes during the AHP are particularly striking, including the "Green Sahara" phase of northern Africa, with a number of East African lakes expanding in size and depth, coincident with the expansion of more forested ecotones (Butzer, 1972; Hamilton, 1982; Bergner et al., 2009; Trauth et al., 2010). Archaeologically, a number of regionally distinct artifact traditions are recognized, including the Kansyore fisher-foragers of the Lake Victoria basin (Dale and Ashley, 2010), fisher-forager communities who produced the "dotted-wavy line" pottery and barbed harpoons found throughout parts of the Sahara and the Sahel as far south as Lake Turkana (Wright et al., 2015; cf. Sutton, 1974; Holl, 2005), and the Eburran industry produced by foragers in the Central Kenyan Rift Valley (e.g., Ambrose, 1984; Wilshaw, 2016). Cattle, sheep, and goat spread southward from northern to eastern Africa by ~7 ka, resulting in a complex cultural and economic mosaic that was in place by 3 ka (di Lernia, 2013; Kusimba, 2003; Lane, 2013; Skoglund et al., 2017).

A number of unanswered questions remain about the archaeology of this timeframe. For example, do distinctive regional behavioral entities (e.g., archaeological industries like the Eburran) form because of adaptations to specific habitats, as a result of isolation from neighboring groups, or as a deliberate expression of what Wiessner (1983) referred to as emblemic style? Does the spread of pastoralism reflect the demic diffusion of groups along an expanding frontier or a series of local adaptations as stock is transferred along existing social networks among foraging groups (cf. Lane, 2004; Prendergast, 2010; Skoglund et al., 2017)? Answering these questions ultimately requires

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establishing the nature and strength of inter-group connections, which is not straightforward, particularly using archaeological data. Fortuitously, artifacts made of obsidian are common at many AHP sites in East Africa, particularly in Kenya, and identifying the geological sources of these artifacts can enhance our understanding of the extent to which different regions – and, in turn, the populations within them – were connected in the past.

There are > 80 geochemically distinct obsidian sources along an 800-km stretch of Kenya between Lake Turkana on the Ethiopian border and Lake Natron on the Tanzanian border (Brown et al., 2013). Of these, roughly two-thirds lie within Kenya's Naivasha-Nakuru Basin and its surroundings, and there is now a fairly robust geochemical database for source outcrops as well as Pleistocene-Holocene artifacts made by foragers and pastoralists from sites in Kenya and Tanzania (e.g., Merrick and Brown, 1984a, 1984b; Merrick et al., 1988, 1994; Mehlman, 1989; Coleman et al., 2008, 2009; Nash et al., 2011; Ndiema et al., 2011; Ambrose et al., 2012a, 2012b; Ferguson, 2012; Prendergast et al., 2013; Faith et al., 2015; Blegen, 2017; Blegen et al., 2017; Frahm et al., 2017). From the extant data, a few generalizations can be made. First, foragers and pastoralists in the Lake Turkana basin appear to have used locally available obsidian sources, which means there is no strong evidence in these data to support cultural connections between the Turkana region and the Naivasha-Nakuru Basin. Second, pastoralist groups relied extensively on sources within the Naivasha-Nakuru Basin, transporting large quantities of obsidian across long distances (often ≥100 km), particularly to the south. Third, there has been persistent movement of obsidian from the Naivasha-Nakuru Basin into the Lake Victoria basin. Connections between these regions date to at least the Late Pleistocene (Faith et al., 2015; Blegen et al., 2017) and persist throughout the Holocene, including portions of the AHP (Merrick and Brown, 1984a, 1984b; Frahm et al., 2017) that overlap in time with Kansyore sites in the Lake Victoria basin and assemblages attributed to the Eburran industry in the Naivasha-Nakuru Basin.

Apparent connections between foragers in the Lake Victoria basin (e.g., Kansyore groups) and groups in the Naivasha-Nakuru Basin (e.g., Eburran producers) are based entirely on obsidian sourcing data from sites in the Lake Victoria basin, that is, from sites ~200 km from the sources. As yet, there are no published geochemical data on obsidian artifacts found at Eburran industry sites. Such data can serve as a means to better understand the extent of connections between these two areas. To initiate this, we focus on collections from Gamble's Cave II (GC2; Kenya), the type-site for Phases 3, 4, and 5 of the Eburran industry. In particular, we focus on a collection of GC2 obsidian artifacts from L.S.B. Leakey's 1920s excavations housed at Harvard University's Peabody Museum of Archaeology and Ethnology. This subsample of the GC2 assemblage reflects what Leakey (1931) termed the "fourth occupation level" of GC2. He initially subdivided it into the Kenyan Aurignacian Phases *a* and *b*, which were subsequently designated as the type deposits for Phases 3 and 4 of the Eburran industry (see Ambrose et al., 1980; Ambrose, 1984; Wilshaw, 2016).

Using state-of-the-art portable X-ray fluorescence analysis (pXRF), we chemically identified the geological sources of 239 GC2 obsidian artifacts. pXRF instruments offer archaeologists several advantages over techniques traditionally used for obsidian sourcing. First, pXRF is nondestructive, meaning that artifacts do not need to be polished, powdered, dissolved, or discarded. Second, it can be conducted at a museum, in a field house, or even at an archaeological site. Third, it can be rapid, often needing just a minute or two to measure dozens of elements. The first two advantages were paramount in this study. Recent studies demonstrate that newer pXRF instruments have technical advances (e.g., large-area Si drift detectors with high spectral resolution, adaptive signal-processing electronics) that enable excellent accuracy, reproducibility, and sensitivity (e.g., Frahm, 2014; Milić, 2014; Frahm and Feinberg, 2015; Newlander et al., 2015; Le Bourdonnec et al., 2015; Campbell and Healey, 2016; Bonsall et al., 2017; Orange et al., 2017; cf. older instruments in Potts and West, 2008; Drake et al., 2009; and Liritzis and Zacharias, 2011). In this study, our pXRF measurements were directly calibrated and compared to the published data of Brown et al. (2013) in order to determine the artifacts' origins. We have previously documented that the XRF database of Brown et al. (2013) and our pXRF measurements are directly compatible (Frahm et al., 2017).

Our results for the Eburran Phases 3 and 4 at GC2 suggest that the site's occupation history or local environment had no discernable effect – at least in this sample – on the variety or range of obsidian sources used for tool manufacture. Previously unpublished data for the site's use indicate a higher occupation intensity during the more humid Eburran Phase 3, when the lake's shoreline was likely closer at GC2 than at present. As the lakeshore retreated and, with it, the site's position at an ecotone important to Eburran groups, the occupation intensity at GC2 decreased, as indicated by the lower frequency of retouched tools and artifact discard rates in the later deposits. In both phases, the closest source – Mt. Eburru at ~20 km distant – was consistently exploited to meet the demands for lithic material. This implies that demand for this toolstone outweighed ecologically linked changes in its accessibility to GC2 occupants. This result might also indicate the resilience of Eburran foraging strategies during the transition from an earlier, more humid interval and a later, drier one. Speculatively, these GC2 data might also mark the beginning of the widespread use of Mt. Eburru obsidian by foragers across Kenya and Tanzania. Testing such hypotheses requires a more extensive program of obsidian sourcing in the region, and our findings not only reveal the potential for such analyses but also underscore the amount of work that remains to be done.

2. Background

The GC2 rockshelter (0.55525° S, 36.08936° E, 1934 m) is an overhang cut into an interface between Quaternary lacustrine sediments and Pleistocene pyroclastics, where it formed during an early Holocene highstand of Lake Nakuru (Figs. 1–2; Washbourn-Kamau, 1971). Leakey excavated ~45 m^2 at GC2 to a depth of ~8.5 m in 1926–1929, and he recognized four "occupation levels" that include a number of early-to-late Holocene LSA obsidian blade-based lithic industries that span the transition to food production (i.e. pastoralism) and the local adoption of ceramics. These different occupation levels were only summarily described in his 1931 book *The Stone Age Cultures of Kenya Colony*. As Leakey (1971:iv) notes in a new introduction to the second printing of that book, "a very detailed report… on Gamble's Cave II, was sent to press in Paris, just before the outbreak of World War II, but the whole report and all the illustrations and diagrams were mislaid or destroyed during the German Occupation."

In 1964, Glynn Isaac and Ronald Clarke excavated a 1 × 2 m stratigraphic section at GC2 to collect material for radiocarbon dating. Ambrose (1984) provides a summary of lithic and faunal assemblages from the 1964 excavation. Materials from the Leakey and Isaac/Clarke excavations formed the basis for a major revision of the Holocene Later Stone Age (LSA) sequence in the Central Kenya Rift. The divisions are based on stratigraphy as well as changes in retouched tool type and, in particular, a size decline in blade and backed piece length over time. The early so-called "giant blade" Eburran Phases 1 and 2, which are not present at GC2, are dated to ~12 ka and 11.0–10.3 ka elsewhere in the Central Kenya Rift (Wilshaw, 2016). These are followed by Eburran Phase 3 and Phase 4, which are not very well dated at GC2. Reliable dates are restricted to a number of similarly aged radiocarbon determinations near the base of the Phase 3 deposits. Estimates from GC2 (based partially on inferred sedimentation rates) are generally consistent with those from other Eburran Phase 3 and Phase 4 assemblages, which suggest an age of ~8.5–8 ka for Phase 3 and ~7.8–6 ka for Phase 4 (Ambrose, 1984; Ambrose et al., 1980; Bower et al., 1977; Protsch, 1978; Wilshaw, 2016). These are, in turn, overlain by the 'small blade' Eburran Phase 5 (~4.5–1.8 ka) and by the Pastoral Neolithic Elmenteitan industries from ~3.2–1.4 ka (Goldstein and Munyiri, 2017).