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News and Views

2.6-Million-year-old stone tools and associated bones from OGS-6 and OGS-7, Gona, Afar, Ethiopia

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Introduction

Initial archaeological explorations of the early 1970s in the Kada Gona, Afar, Ethiopia indicated the presence of artifacts of great antiquity in the region (Roche and Tiercelin, 1977, 1980; Harris, 1983). The systematic archaeological excavations undertaken at East Gona between 1992–1994 have resulted in the discovery of the oldest known stone artifacts from EG-10 and EG-12 localities dated to ~2.6–2.5 million years (Myr) (Semaw, 1997, 2000, *in press*; Semaw et al., 1997). The recent systematic excavations of two new sites in the Ounda Gona South area, at OGS-6 and OGS-7, have produced stone artifacts and associated fragmentary fauna within fine-grained sediments. The artifact-bearing horizon is laterally extensive and these two sites are separated by only about 300 meters. A volcanic tuff located ~7 meters directly above locality OGS-7 was dated by $^{40}Ar/^{39}Ar$ to 2.53 ± 0.15 Myr, and the geomagnetic polarity transition traced immediately beneath the excavation was identified as the Gauss-Matuyama which is dated close

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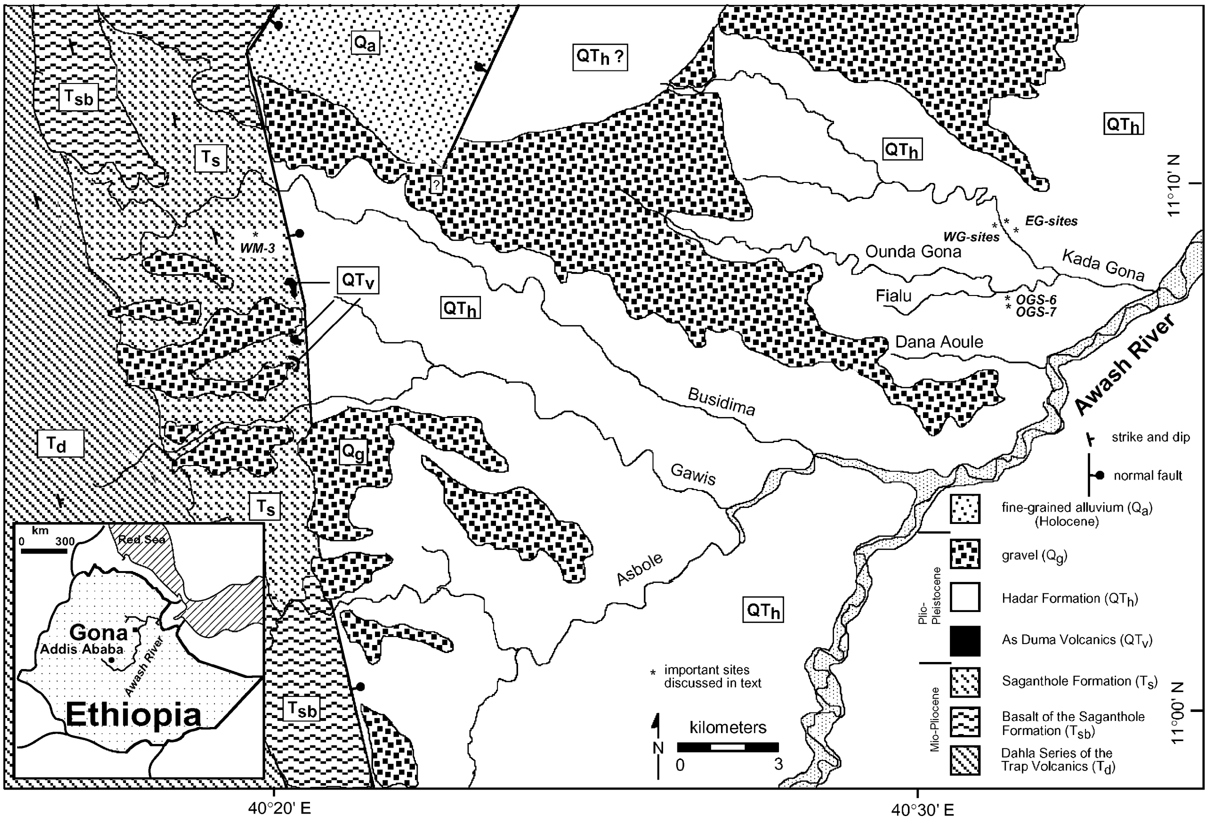


Fig. 1. A geological map showing the entire Gona study area. The OGS-6 and OGS-7 sites are located to the east near the intersection of the Kada and Ounda Gona Rivers.

to 2.6 Myr. The most informative artifacts and associated fauna including rib fragments, a humerus midshaft fragment and a bone flake with diagnostic platform and bulb of percussion were recovered *in situ* from OGS-7. The OGS-6 excavation yielded *in situ* artifacts but no associated bones. However, at OGS-6 a freshly eroded bone fragment with definite cutmarks was identified from surface occurrences. The 2.5 Myr site from Bouri in the Middle Awash, 90 Km to the south of Gona, has yielded fossilized bones with evidence of stone tool cut marks, but without associated artifacts (de Heinzelin et al., 1999). Thus, the new sites of OGS-6 and OGS-7 from Gona provide the oldest known archaeologically documented associations between artifacts and broken faunal elements. The current evidence from Gona combined with the well-preserved excavated cut-marked bones identified from Bouri provide complementary data showing that the first stone tools were used for processing animal carcasses for meat and bone marrow.

Stratigraphy and dating

The deposits exposed along the banks of the Ounda Gona, 3–5 km south-southwest of the previously known sites of the Kada Gona (Fig. 1), Afar, Ethiopia have been investigated recently (Semaw et al., 2002). In 1999, JQ noted the presence of surface eroded artifacts and fauna below a prominent tuff exposed near locality OGS-6 (40°31.158′E, 11°6.424′N). Extensive survey was carried out in 2000 and MJR discovered OGS-7 (40°31.758′E, 11°6.479′N) within the Fialu, a stream feeding into the Ounda Gona. Both sites were excavated in 2000 and yielded a high density of artifacts and associated fauna securely dated close to 2.6 Myr.

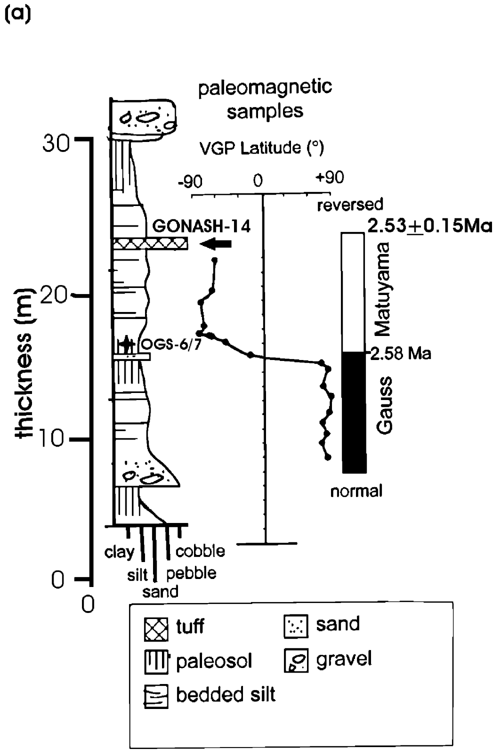
The most informative assemblages were recovered from OGS-7, and its geological context and the materials recovered from the excavations are described here in more detail. The steep-walled outcrops in the area provide superb exposures of OGS-7 and its relationship to the overlying tuffs and surrounding sediments. The site resides in the upper Kada Hadar Member time equivalent deposits at Gona. The deposits are divided from the lower portion by a sharp disconformity that separates lacustrine and deltaic deposits below from fluvial sediments associated with the ancestral Awash above. The age of the disconformity is constrained between 2.92 and 2.7 Myr, along the Kada Gona, and it is readily recognizable in the Fialu, ~23 meters below OGS-7. The fluvial deposits above the disconformity are composed of multiple fining upward sequences, generally 5–8 m in thickness. Conglomerates composed of well-rounded cobbles up to 25 cm in diameter form the base of the fining upward cycles, followed by rhyzolith-rich sands, bedded silts, and capping paleo-vertisols. The artifacts occur in the middle of the second cycle above the disconformity. They are confined to a <10 cm-thick interval of fine vertisol and rest flatly on a local contact between coarse sand below and bedded silt above (Fig. 2a). Twenty meters to the east of OGS-7 the sand laps onto a coarse conglomerate with clasts dominated by porphyryitic volcanics, nearly identical to the coarse bedload carried by the modern Awash. This suggests that the artifacts were dropped along the banks (or the margin) of the ancestral Awash.

The age of both OGS-6 and OGS-7 was determined by a combination of $^{40}Ar/^{39}Ar$ analysis of the continuous tuff (Gonash-14) located 7.6 m directly above the OGS-7 excavation and by magnetostratigraphy (Figs. 2a and 2b). The Gonash-14 tuff is exposed 67 m to the northeast, 76 m to the northwest, 73 m to the south-southeast and 51 m to the south-southwest of the OGS-6a site; and by interpolating the elevations of the southwest-dipping tuff, we estimate that the *in situ* archaeological horizon at OGS-6a is about 4.6 meters below the base of this tuff. The tuff is 50–80 cm thick and is composed of completely altered glass but with abundant, unaltered plagioclase phenocrysts along the base. Magnetostratigraphic samples collected in a 15-meter-thick stratigraphic section containing OGS-7 provide precise age control. The resulting 18 polarity determinations define a polarity zonation with nine normal-polarity sites below OGS-7 and nine reversed-polarity sites at or above this level (Fig. 2a). Based on the 2.53 ± 0.15 Myr age of the OGS-7 tuff (Fig. 2b) and the age of the disconformity below the site (~2.9 Myr) (Semaw et al., 1997), we can confidently identify the normal to reversed polarity boundary as the Gauss-Matuyama boundary of the geomagnetic polarity time scale (GPTS), the established date of which is 2.58 Myr (essentially 2.6 Myr) (McDougall et al., 1992).

Assemblage characteristics

Only a portion (2.6 m^2 [4 m × 0.65 m]) of OGS-7 has been excavated because of the steep exposures and the >25 meters of overburden. The materials consist of typical Oldowan artifacts with cores and *débitage* and associated fragmentary fauna. More than 200 surface and close to 500 excavated artifacts and bones were recovered. Several lines of evidence, including the very high density of the materials (at least 162 artifacts/m^2 and 13 bone fragments/m^2 piece-plotted only, Fig. 3a), the high percentage of *débitage* (~97%) with several refitting pieces, the fresh condition of the artifacts and the wide range in sizes (~5–85 mm in maximum dimension [MD]), the lack of preferred orientation and the vertically-restricted (<10 cm-thick, Fig. 3b) distribution of the materials in bedded silt undisturbed by bioturbation suggest that OGS-7 contains a primary archeological association.

The *in situ* artifacts from OGS-7 analyzed here (>2 cm) include 7 cores, 76 whole flakes and 182 flaking debris. Five side choppers and two end choppers, all made of rounded cobbles were excavated *in situ*. All the cores were bifacial and show evidence of multiple generations of flaking scars (Fig. 4). The cores were heavily reduced, the largest with MD of 70 mm (mean = 63 mm,



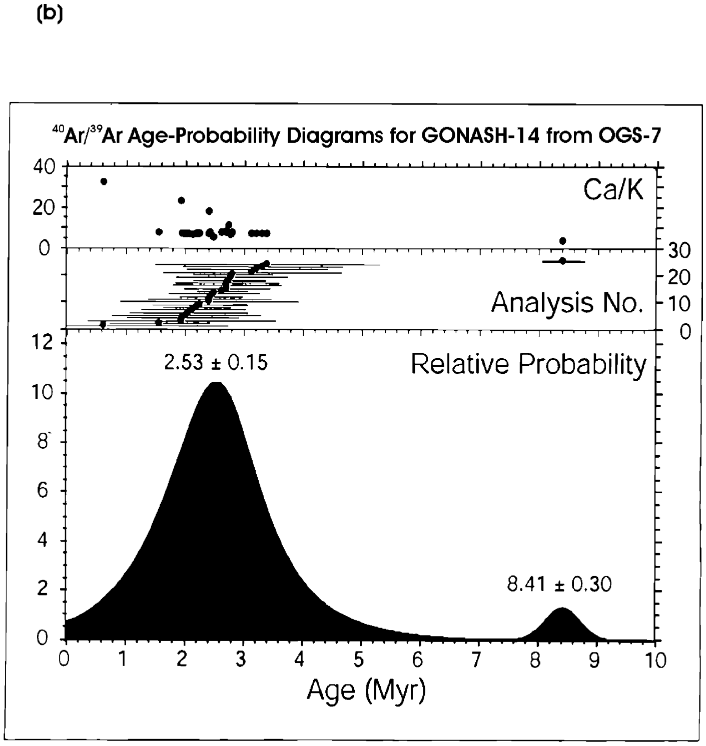


Fig. 2a. A stratigraphic column showing the lithology of OGS-7. The higher stratigraphic position of the 2.53 ± 0.15 Myr tuff (Gonash-14), in relation to the OGS-7 excavation, is shown by the arrow. The results of the magnetic polarity sampling are shown next to the stratigraphic column. Site-mean virtual geomagnetic pole (VGP) latitude is plotted against stratigraphic level; negative VGP latitude indicates reversed polarity, and positive VGP latitude shows normal polarity. The Gauss-Matuyama boundary of the geomagnetic polarity time scale (GPTS) dated at ~2.58 Myr (essentially 2.6 Myr) is located just below the OGS-7 excavation.

Fig. 2b. Age-Probability spectra for individual plagioclase crystals of tuff sample G-14 (Gonash-14) showing weighted mean age for the homogenous population (excluding 8.41 Myr xenocryst). Ca/K is determined from corrected ^{37}Ar/^{39}Ar ratios.

s.d. = 7.6 mm), compared to 105 mm (mean = 80 mm, s.d. = 10 mm) for EG-10 (n = 15), and 93 mm (mean = 74 mm, s.d.=11 mm) for EG-12 (n = 7). The whole flakes include pieces that measure up to 80 mm in MD (mean = 44 mm, s.d. = 15 mm), larger than the largest recovered core. The occasional technical "blades" made of chert and aphanitic lava indicate that the hominids were highly selective and made optimal use of fine-grained raw materials. By comparison, a majority of the EG10 and EG12 cores were unifacial and larger in MD (Semaw, 1997, 2000; Semaw et al., 1997). Most striking is the presence at OGS-7 of well-struck, knife-like flakes and deliberately retouched pieces, and a blade struck from a coarser, porphyritic trachyte (Fig. 4). Following the flake classification of Toth (1987), 40% were classified to Type 5 and close to 20% to Type 6, good indicators of intensive bifacial flaking and heavy core reduction.

Raw materials

The Oldowan sites at Gona, including OGS-7, are found in close proximity to cobble conglomerates deposited by the ancestral Awash. These types of conglomerates accumulate in point and transverse bars along the modern Awash, and in the ancestral Awash they would have been ready sources of raw materials during the non-rainy season(s). No other source of similarly-sized,

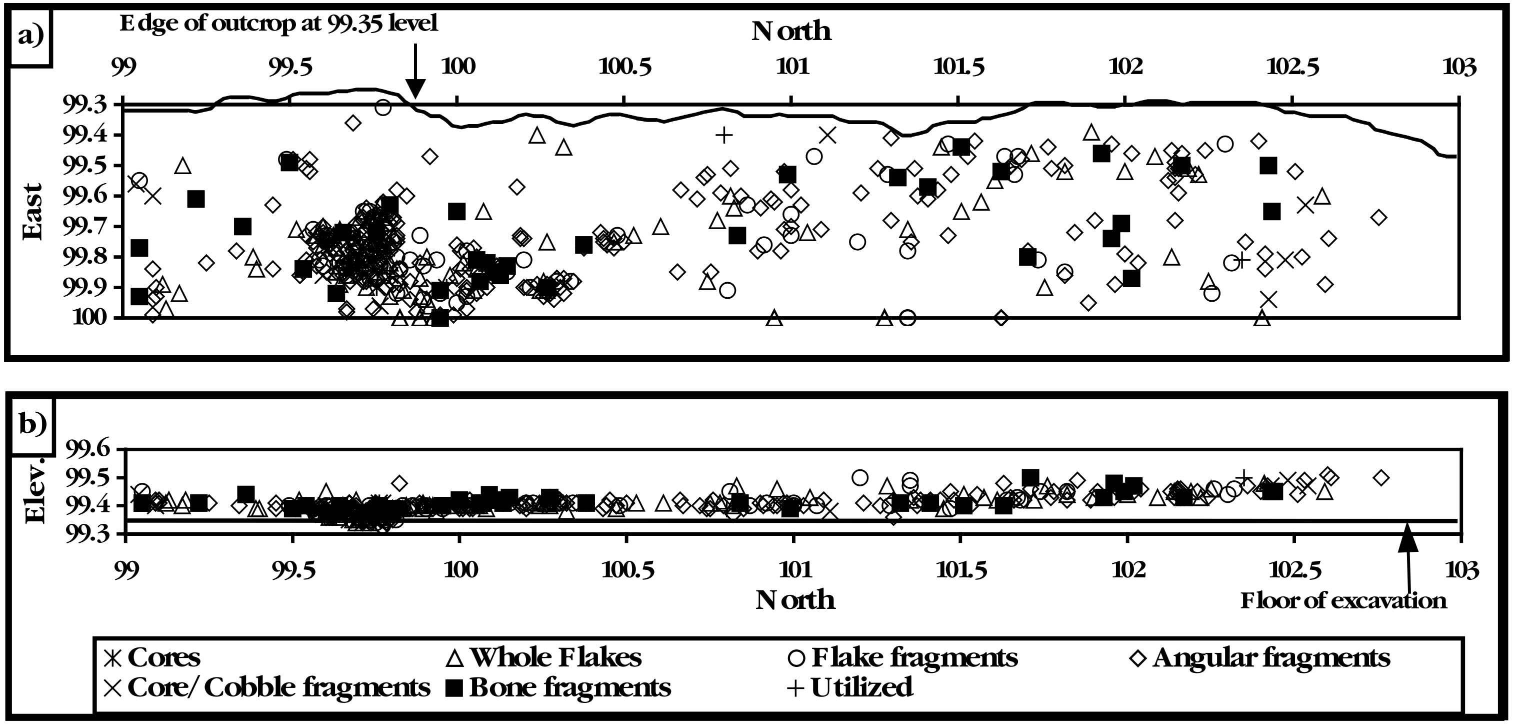


Fig. 3a. Piece plot of the OGS-7 excavated artifacts and bones showing horizontal distributions.

Fig. 3b. Piece plot of the OGS-7 excavated artifacts and bones showing vertical distributions. Note that the materials were tightly clustered within 10 cm.

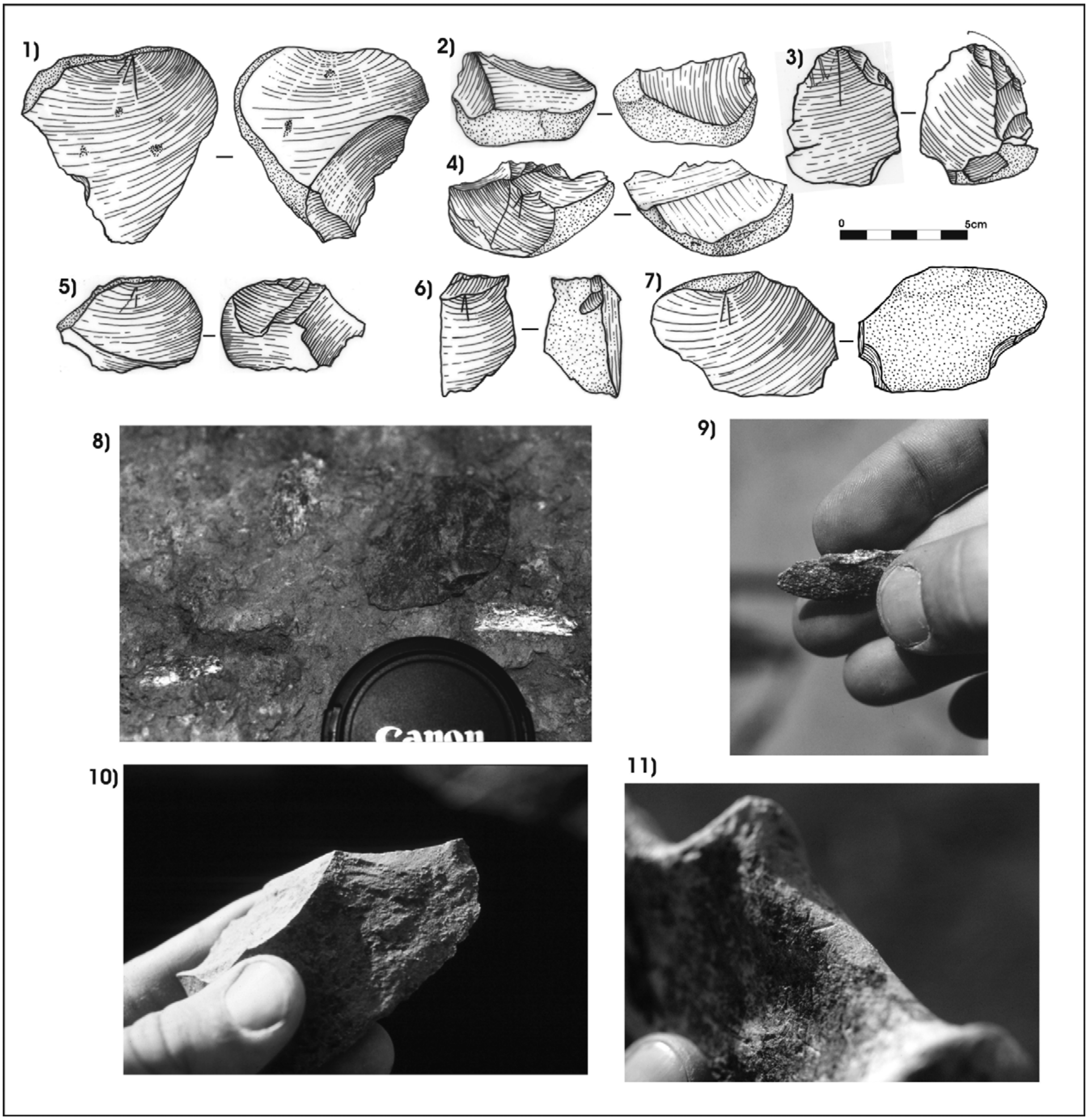


Fig. 4. Drawings of the OGS-7 excavated artifacts: sketches 1, 3, 5, 6 and 7 show whole flakes, and 2 and 4 are heavily reduced cores. Note that flake #3 may be intentionally retouched. Photos: 8, excavated artifacts and associated fragmentary fauna; 9, a bone flake; 10, a knife-like flake (all excavated from OGS-7), and 11, a calcaneum from OGS-6 showing definite cutmarks.

rounded cobbles such as those used at the Kada Gona and Ounda Gona are present anywhere else in the study area. To assess the raw material selectivity of these toolmakers we examined the raw materials in the paleo-Awash conglomerate exposed laterally and just below OGS-7 through a random outcrop sampling of 100 cobbles (>10 cm in MD), and a total collection of cobbles from a

1 m × 1 m excavation. Out of 116 excavated clasts, only one-fifth were >5 cm in MD (i.e. of a size suitable for knapping). Of these, 31% were identified as trachyte, 26% as rhyolite, 26% as latite, 11% as aphanitic lava and the remainder as indeterminate (6%). The random outcrop sample was similarly dominated by latite (41%) and rhyolite (34%), with a smaller percentage of basalt (18%) and trachyte (7%), but no chert clasts were recognized. Both these samples produced a high proportion of large-grained, porphyritic, vesicular, or otherwise flawed clasts. Samples from other conglomerates throughout the study area (unpublished data) also support this general characterization.

Sites undisturbed post-depositionally (e.g., Schick, 1997) often preserve a high percentage of *débitage* (~97% at OGS-7), and these may be used to investigate the raw material preferences and selectivity of the hominids. The raw material composition of the OGS-7 excavated *débitage* (29% latite, 20% trachyte, 14% rhyolite, 12% chert and 25% others, including aphanitics) contrasts strongly with the availability of materials in the conglomerate. In fact, there is no significant correlation between the frequency of raw material types in the 100 randomly collected cobbles and in the OGS-7 *débitage* (Pearson's 2-tailed $r = 0.443$, $p = 0.319$; Spearman's 2-tailed $\rho = 0.400$, $p = 0.374$). Particularly noteworthy is the heavy utilization of chert (12% of the *débitage* with almost every chert flake coming from a different original nodule), a material which is extremely rare in the conglomerates, and which was completely absent from the samples collected near OGS-7. The raw materials comprising the OGS-7 artifacts also differ generically from the conglomerate samples in being less porphyritic and displaying finer grained groundmass. Chert is absent from any of the 2.6–2.5 Myr sites at East Gona, and the high percentage utilized at OGS-7, and its rarity in the conglomerates, indicates a high degree of selectivity and hominid preference for fine-grained, high-quality raw materials. Our study shows that the OGS-7 conglomerate contains smaller-size cobbles compared to those found near EG10 and EG12. The comparison between the raw materials used for making the artifacts and those sampled from the conglomerate indicate that the OGS-7 hominids selected for large cobbles with good flaking qualities. Therefore, the lack of a single core made of chert from the OGS-7 excavation implies that chert may have been highly sought after, exhaustively reduced and probably transported across the landscape.

Modified bones

The OGS-7 bones are fragmented and too poorly preserved to show biostratinomic modifications on their surfaces. However, an equid calcaneum with definite cutmarks was found at OGS-6 (Fig. 4). The bone was recovered on the surface with a large number of freshly exposed artifacts that had recently eroded from the sediments exposed below the 2.53 ± 0.15 Myr tuff. At OGS-7 we piece-plotted 34 bone fragments from the 4 m × 0.65 m excavated area. The spatial distribution of the bone fragments shows a tight clustering (horizontally and vertically) with the excavated artifacts. In fact, no bone fragments were found in sediments that lacked artifacts (see Fig. 3). We identified two rib fragments and a humerus midshaft fragment belonging to a size 3 (wildebeest-sized) bovid. In addition, a small bone flake (with butt/platform and bulb of percussion) possibly broken from a limb bone shaft was recovered *in situ* (Fig. 4).

Discussion/Conclusion

Although the OGS-7 bones are fragmentary, well-documented stone tool cutmarked bones have been discovered at the contemporary site of Bouri, ~90 Km to the south of Gona (de Heinzelin et al., 1999). The Bouri excavated bones lack associated stone tools, but the evidence clearly shows that ancestral hominids by ~2.5 Myr ago definitely made sharp-edged cutting tools used for processing carcasses for meat. Despite the lack of direct evidence for the co-occurrence of *in situ* artifacts and bones with cutmarks for the earliest archaeology, the association between artifacts and broken animal bones at 2.6 Myr has been unequivocally established for the first time by the new evidence from OGS-6 and OGS-7. Earlier reported associations from Hadar are dated to 2.3 Myr (Kimbel et al., 1996). Furthermore, OGS-7 has provided remarkable insights for understanding the strategies involved in the raw material selection strategy of the first toolmakers.

Surveys of the deposits that are older than 2.6 Myr have failed to yield either flaked stones or bones with evidence of stone tool cut-marks. The period between 2.9 to 2.7 Myr appears to be partly to entirely missing in the sections exposed at Gona, thus, perhaps accounting for the apparently stratigraphically abrupt appearance of abundant and relatively advanced toolmaking such as that seen at OGS-7. The toolmakers have yet to be identified at Gona, but *Australopithecus garhi* known from Bouri seems the best candidate thus far for the hominid responsible for these early activities (Asfaw et al., 1999). The other hominid in East Africa at this time is *Australopithecus aethiopicus* (Walker et al., 1986; Suwa et al., 1996), and it is known thus far only in the Omo/Turkana basin. The evidence for early *Homo* in East Africa dates back to c. 2.4–2.3 Myr (Hill et al., 1992; Schrenk et al., 1993; Kimbel et al., 1996; Suwa et al., 1996; Deino and Hill, 2002) and by this time, the use of stone artifacts has been firmly documented (Chavaillon, 1976; Merrick, 1976; Merrick and Merrick, 1976; Howell et al., 1987; Kibunjia, 1994, 2002; Kibunjia et al., 1992). The age of the artifacts from Lokalalei 2C (LA2C) (Roche et al., 1999), appears to be uncertain and somewhat younger (see Brown and Gathogo, 2002). The archaeological evidence from Gona indicates that the need for cutting tools—as well as the knowledge of how to manufacture them—was firmly in place by 2.6 Myr, and has not been evidenced prior to this time. The sophisticated control and raw material selection shown at OGS-7 strongly suggests that stone tool use may have begun prior to 2.6 Myr, but not earlier than 2.9 Myr, and the search for older artifacts will continue at Gona.

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