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Background and the Early Acheulean Assemblages

Edited by
Yonas Beyene, Berhane Asfaw, Katsuhiro Sano, and Gen Suwa

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CHAPTER 4

Technological and Cognitive Advances Inferred from the Konso Acheulean Assemblages

Yonas Beyene[1], Katsuhiro Sano[2], Berhane Asfaw[3], Gen Suwa[4]

[1]Association for Conservation of Culture (A.C.C.) Awassa, P.O. Box 6686, Addis Ababa
and French Center for Ethiopian Studies, P.O. Box 5554, Addis Ababa, Ethiopia.
Email: yonasbeyene.gm@gmail.com
[2]The University Museum, The University of Tokyo, Hongo, Bunkyo-ku, Tokyo, 113-0033 Japan.
Email: sano@um.u-tokyo.ac.jp
[3]Rift Valley Research Service, P.O. Box 5717, Addis Ababa, Ethiopia
Email: ramideth@gmail.com
[4]The University Museum, The University of Tokyo, Hongo, Bunkyo-ku, Tokyo, 113-0033 Japan.
Email: gsuwa@um.u-tokyo.ac.jp

4.1 INTRODUCTION

The chronologic range of the over 30 archaeological occurrences of the Konso Formation (listed in Chapter 2) spans the ~1.9 Ma to ~0.85 Ma time period. The use of large flakes (larger than 10 cm following Kleindienst, 1962) as blanks for handaxes, cleavers, and picks is generally accepted as the hallmark of the Acheulean technology. Isaac (1969) considered the production of large flakes greater than 10 cm as indicative of the formulation of new techniques not seen in the earlier Oldowan technology. Field workers in Africa and elsewhere have further developed the notion that the production of large flake blanks and shaping large cutting tools from them are technologically and cognitively important distinctions from the Oldowan (e.g., Semaw et al., 2009; Sharon, 2009; Beyene et al., 2013).

We considered an assemblage to represent the early Acheulean technological complex based on the production of large flake blanks (>10 cm and frequently exceeding ~20 cm) and modification of these large blanks and similar-sized cobbles into handaxes, cleavers, and picks (Beyene et al., 2013). While assemblages without large cutting tools (LCTs) and/or picks were found from the ~1.9 Ma stratigraphic levels of the Konso Formation (at KGA4 and KGA11) and assigned to the Oldowan, the earliest Acheulean assemblage so far recognized at Konso occurs at KGA6-A1 and is dated at ~1.75 Ma. More typical early Acheulean large bifacial tools are known from KGA4-A2 at ~1.6 Ma. Subsequently, Acheulean assemblages are seen at many Konso localities, including those of KGA10-A11, KGA10-A6, KGA7-A1/A3, KGA7-A2 and KGA8-A1, and KGA12-A1. These well-preserved Acheulean assemblages range from ~1.45 Ma to ~1.25 Ma, and show variability in typology and raw material among sites. A large number of handaxes and cleavers were also collected from the younger ~0.85 Ma stratigraphic levels at KGA18-A1 and KGA20-A1/A2.

In this chapter, we analyze and interpret the significance of the suite of lithic characteristics outlined in the site by site analysis of Chapter 3. We do this in a comparative framework in terms of both chronology and inter-site variation when possible. The latter is predominantly restricted to the ~1.45 to ~1.25 Ma time-period which is represented by multiple assemblages within a relatively short time interval.

4.2 INTER-SITE COMPARISONS: TECHNO-MORPHOLOGY AND TEMPORAL TRENDS

Tool types and raw materials

Systematic field work at Konso has resulted in an abundant Acheulean lithic collection; a total of 1,860 lithic specimens were collected, comprising 711 LCTs, such as handaxes and cleavers or heavy duty tools (HDTs), 439 flakes, 211 chunks, nine retouched/modified angular fragments, 16 polyhedrons, 40 core/choppers, 117 cores, six split cobbles, 60 cobbles, and 251 unidentified weathered pieces (Appendix Table A2.1). The Konso Acheulean assemblages are characterized by the large numbers of handaxes (n=223, 31.4%), cleavers (n=133, 18.7%), and picks (n=144, 20.3%). Besides the three main Acheulean tool types, 19 knives (2.7%), 33 large scrapers (4.6%), 14 core axes (2.0%), 43 part bifaces (6.0%), 51 blanks/modified flakes (7.2%), and 51 broken LCTs/HDTs (7.2%) were recovered (Appendix Table A2.4).

Except at KGA7-A2, basalt is the most frequently used lithic raw material at all the KGA sites (Appendix Tables A2.2, A2.5). Next to basalt, a substantial number of artifacts are made on quartzite at KGA7-A2, KGA8-A1, and KGA12-A1, probably due to accessibility of quartzite outcrops at these western sites situated relatively closer to the Precambrian basin margin. A cluster of quartz artifacts was found at KGA10-A6, where a quartz outcrop is exposed nearby. At KGA10-A6 as well as at KGA10-A11, quartz is the second dominant raw material. Quartz veins occur near these sites today, and can be inferred to have been locally present in the past as well. The other raw materials used for making the Konso Acheulean tools are scarce (Fig. 4.1). Only limited numbers of rhyolite and ignimbrite were utilized. Lithic artifacts made on quartzite and quartz tend to exhibit a fresh condition, while most of the basalt artifacts are weathered or moderately weathered (Appendix Tables A2.3, A2.6).

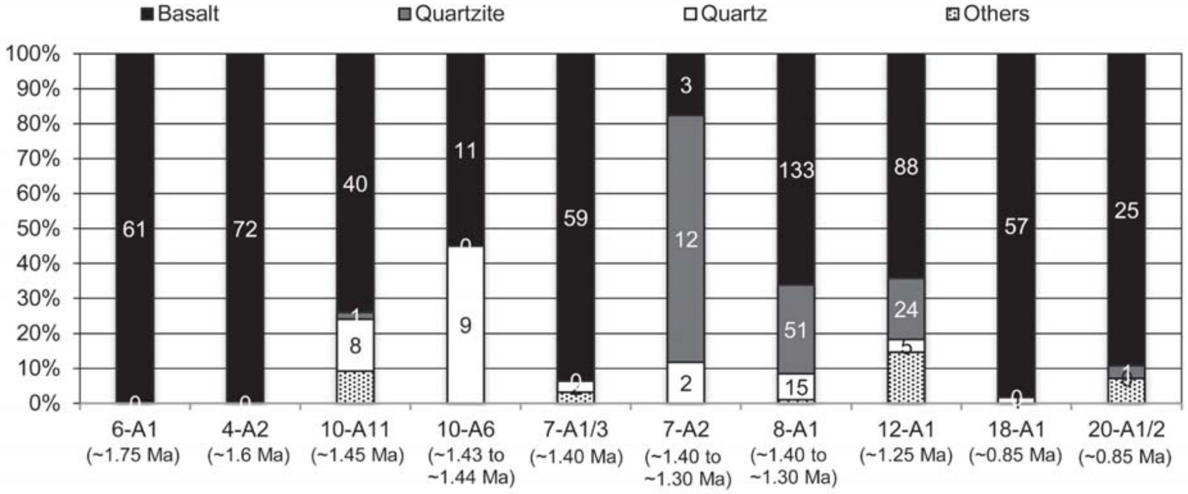

Fig. 4.1. Raw material component used for large cutting tools and picks.

At the ~1.75 Ma KGA6-A1 and ~1.6 Ma KGA4-A2 Konso Acheulean sites, the pick is the dominant tool type (Appendix Table A2.4; Fig. 4.2). Picks were made on thick flake blanks and were roughly shaped by abrupt flaking (Plates 4–8, 12–14). One of the lateral sides towards the tip was often concavely modified, sometimes accentuated into a notch-like form. In contrast, the butt was crudely modified or remained unworked and formed a rounded outline. These morphological features may indicate either functional and/or stylistic intent. The handaxes of these assemblages were made on flake blanks and roughly modified by crude and minimal flaking (Plates 1, 2, Plate 3: KGA6-A1 Loc C E11-13, Plate 9, Plate 10: KGA4-A2 29). Some of the handaxes are of intermediate morphology between handaxes and picks. The HDT-like rather than LCT-like morphology is representative of the Konso early Acheulean techno-morphological complex. However, in comparison with the KGA6-A1 homologues, at KGA4-A2 some refinement of handaxes is also seen, so as to give the impression of an increased occurrence of more “typical” handaxes.

At the ~1.45 Ma KGA10-A11 site, the number of handaxes is greater than that of picks. However, picks numerically dominate some of the even younger assemblages such as those of KGA10-A6 and KGA7-A1/A3. These are dated between 1.44 Ma and ~1.40 Ma. In these cases, specificity of raw material utilization, such as frequent quartz use at KGA10-A6 (Fig. 4.1) and the preferential use of basalt cobbles as blanks at KGA7-A1/A3 (Appendix Table A2.8), may be a possible reason for the larger number of picks (Fig. 4.2). However, at KGA7-A1/A3, a distinctive pick morphology represented by thick, rounded butts and narrow pointed tips, combined with use-wear-like traces on both ends (battering marks on the butt and flute-like scars on the tip) (Plate 26, Plate 27: KGA7-A1 9), imply specific functions. Hence, typological and technological variability among the ~1.45 Ma to ~1.40 Ma Konso assemblages might also reflect functional differences among sites.

After ~1.4–1.3 Ma, handaxes (at KGA8-A1, KGA12-A1, KGA18-A1, and KGA20-A1/A2) and cleavers (at KGA7-A2) were the most frequently produced tool types, and it appears that picks were less often produced. At Konso, it seems that demand for the LCTs increased after ~1.4–1.3 Ma, and picks became rare by ~0.85 Ma (KGA18-A1 and 20-A1/A2).

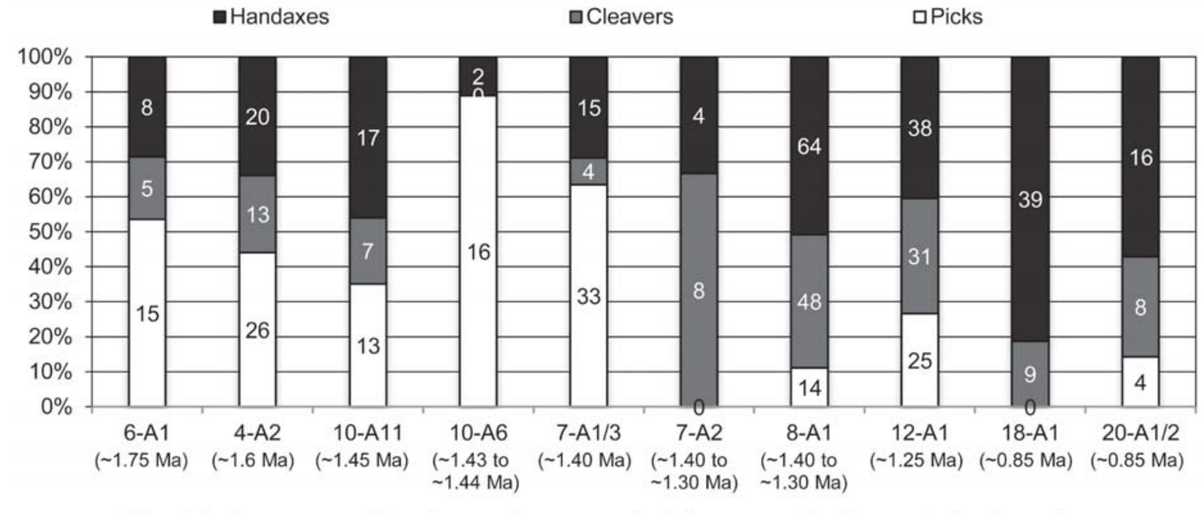

Fig. 4.2. Frequency of handaxes, cleavers, and picks among the Konso Acheulean sites.

Techno-morphological refinements

Temporal refinement of the Acheulean tools can be evaluated by a combination of attributes analyzed in Chapter 3. Blank modification flaking techniques exhibited in the artifacts show substantial temporal changes in Acheulean tool manufacture between ~1.75 Ma and ~0.85 Ma.

While most of the LCTs and picks from the KGA6-A1 site are unifacially worked, the number of partly or fully bifacial artifacts slightly increased at KGA4-A2. Thereafter, the ratio of bifacial tools tends to be higher with progression of age (Appendix Table A2.10). Since picks were more or less multi-facially prepared to produce thick pointed tips, and cleavers, in contrast, were often of unifacial form to keep an unretouched sharp edge, we compared the unifacial-bifaical ratio among handaxes alone (Fig. 4.3). It can be seen that the unifacial-bifacial ratio shows a progressive increase of bifacially flaked handaxes. It is especially remarkable that more than 80% of the handaxes from both of the two ~0.85 Ma sites (KGA18-A1 and KGA20-A1/A2) were mostly fully bifacial. Other than at these sites, the extremely high ratio of bifacial handaxes seen at only one of the other sites (the ~1.4 Ma KGA7-A1/A3) stems from a particular site-context. Multi-facially prepared picks numerically dominate this site, and handaxes at this site are also morphologically similar to picks, and hence tend to be multi-facially worked.

The above outlined temporal trend seen in the bifacial tool ratio is interrelated with frequency of cross-section type. At KGA6-A1, 74.5% of the Acheulean tools show either trapezoidal or triangular cross-section shapes (Appendix Table A2.12; Fig. 4.4). This ratio is similar to the unifacial to bifacial/trihedral ratio of LCTs/picks at this site. The frequencies of the other cross-section types increased from KGA4-A2 to the later sites. In particular, the double convex, plano-convex, and lenticular cross-section shapes reflect advanced bifacial tool manufacture skill (Shelley, 1990). The ratio of these cross-section types exceeds 40% at KGA12-A1, and reached 62.5% at KGA18-A1 and 85.7% at KGA20-A1/A2. The overall trend towards thin biconvex or semi-biconvex cross-section types represents technological refinement in the production of Acheulean tools.

An advanced flaking technology is needed for the production of comparatively straight working edges (Appendix Table A2.13; Fig. 4.5). The high ratios of straight edges at KGA6-A1 and KGA7-A2, however, result from a large number of unifacial tools and do not reflect refined technology in edge formation. In the other assemblages, while only low frequencies of LCTs/picks

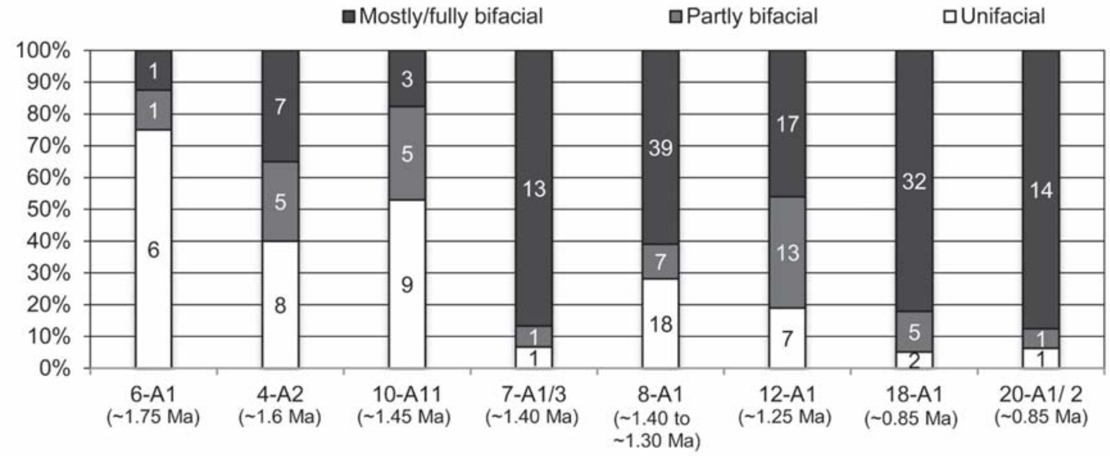

Fig. 4.3. Ratios of mostly/fully bifacial, partly bifacial, and unifacial handaxes. KGA10-A6 and KGA7-A2 handaxes are not ploted because of small sample sizes (less than five).

show straight edges prior to ~1.4 Ma (at KGA4-A2, KGA10-A11, KGA10-A6, and KGA7-A1/A3), numerous Acheulean tools exhibit comparatively straight edges after ~1.4 Ma (KGA8-A1, KGA12-A1, KGA18-A1, and KGA20-A1/A2) (Plates 35, 56, 57, 59-65). The increase in frequency of straight-edged tools relates to both LCT dominance (over picks) and to refinement of LCT shape.

Advanced workmanship of the LCTs was achieved not only by finer flaking, but also by more intensive edge flaking (Beyene et al., 2013). While the flake scar counts of the handaxes at KGA6-A1 and KGA4-A2 are generally lower than the overall median value, the handaxes from KGA18-A1 and KGA20-A1/A2 show greater counts (Fig. 4.6). Cleavers also show an increase of flake scar count at ~0.85 Ma. That many of the LCTs at KGA18-A1 and KGA20-A1/A2 do not allow determination of primary form and flake type (Appendix Tables A2.8 and A2.9) reflects the intensive, invasive flaking of the ventral surfaces.

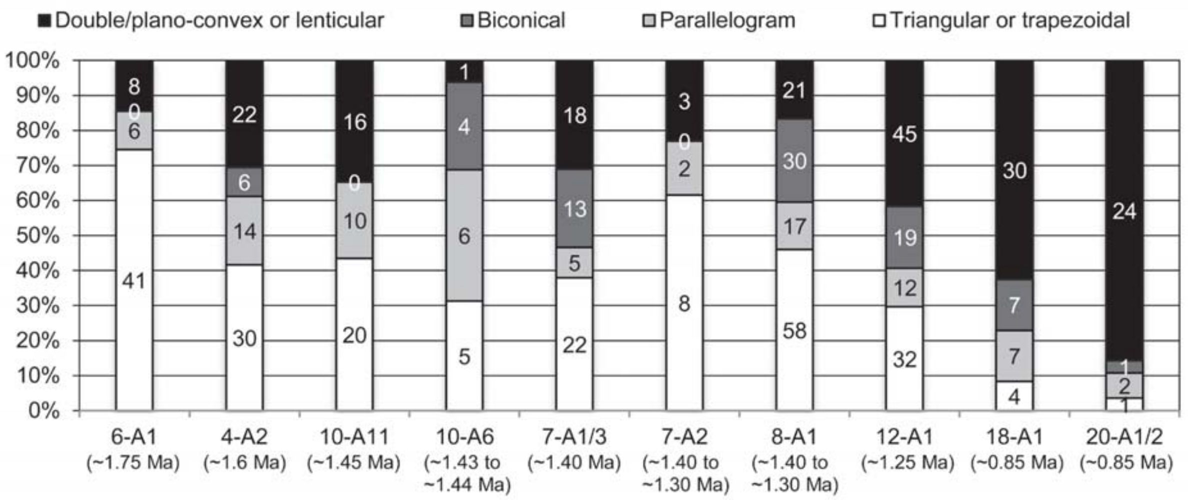

Fig. 4.4. Frequency of cross-section types among the Konso Acheulean sites.

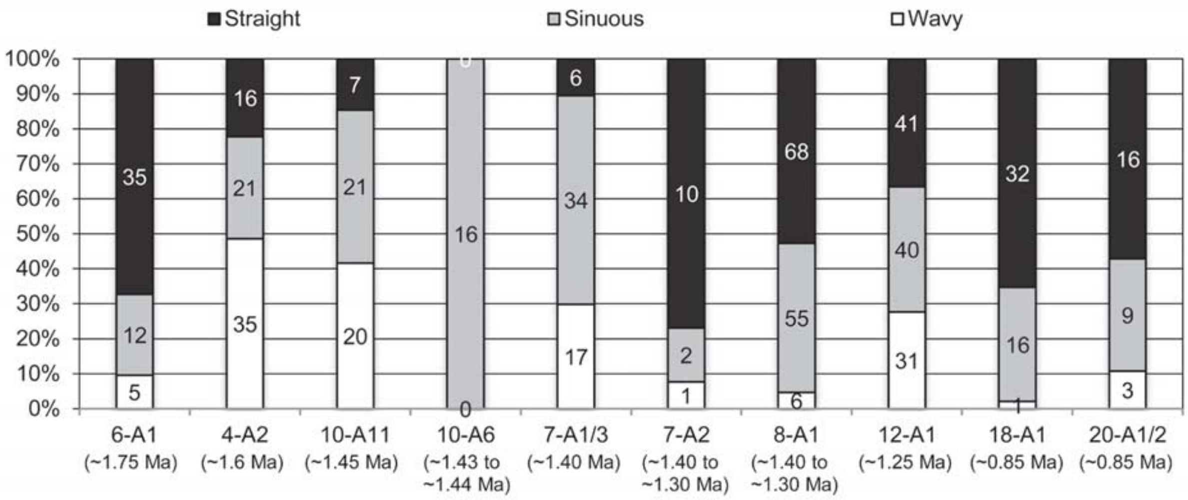

Fig. 4.5. Edge sinuosity of the Konso Acheulean tools.

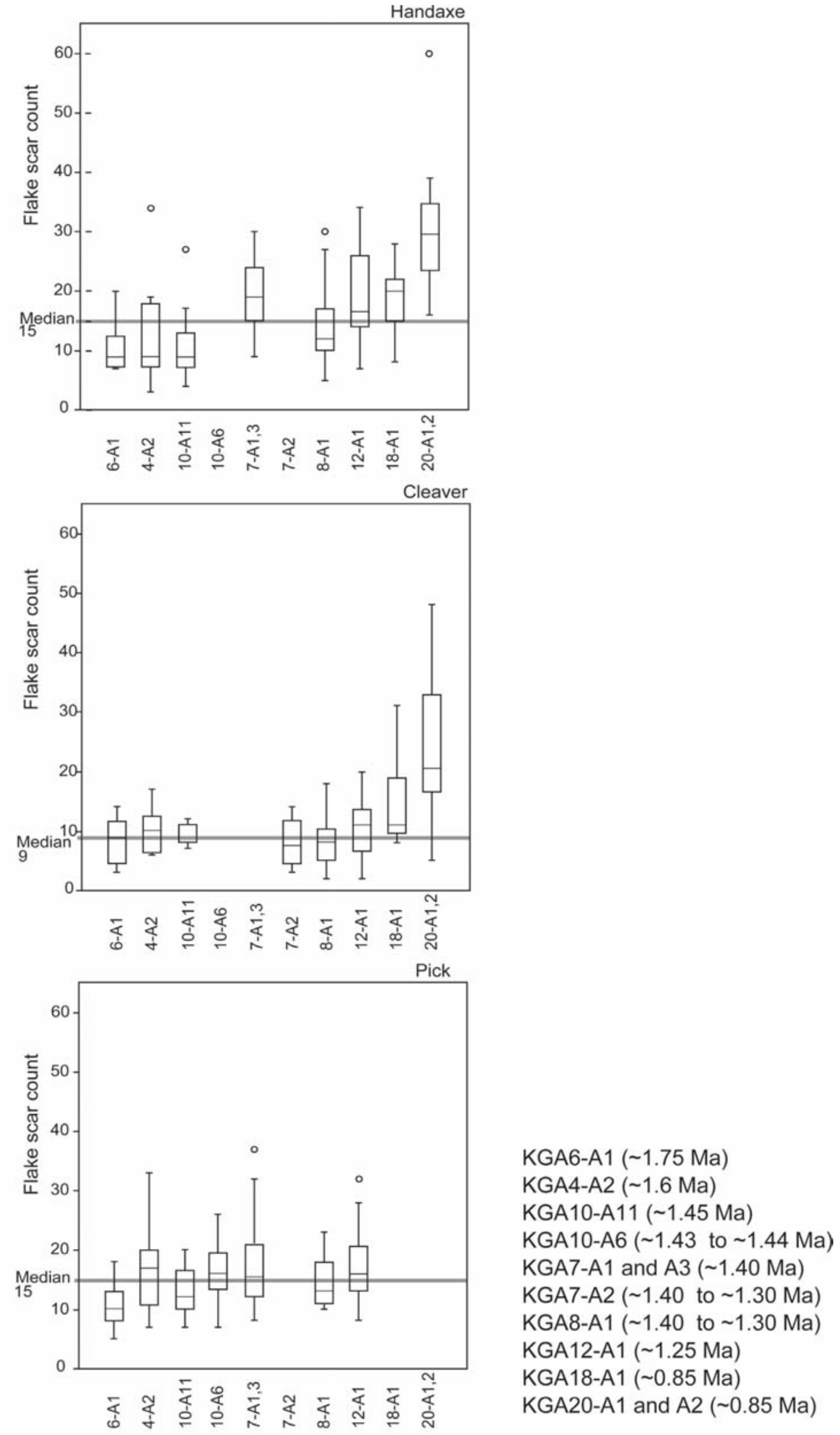

Fig. 4.6. Box plots of flake scar counts in hadaxes, cleavers, and picks. KGA10-A6 and KGA7-A2 handaxes, KGA10-A6 and KGA7-A1 and A3 cleavers, and KGA7-A2, KGA18-A1, and KGA20-A1 and A2 picks are not ploted because of small sample sizes (less than five). Gray lines show median of the total flake scar counts of handaxes, cleavers, and picks.

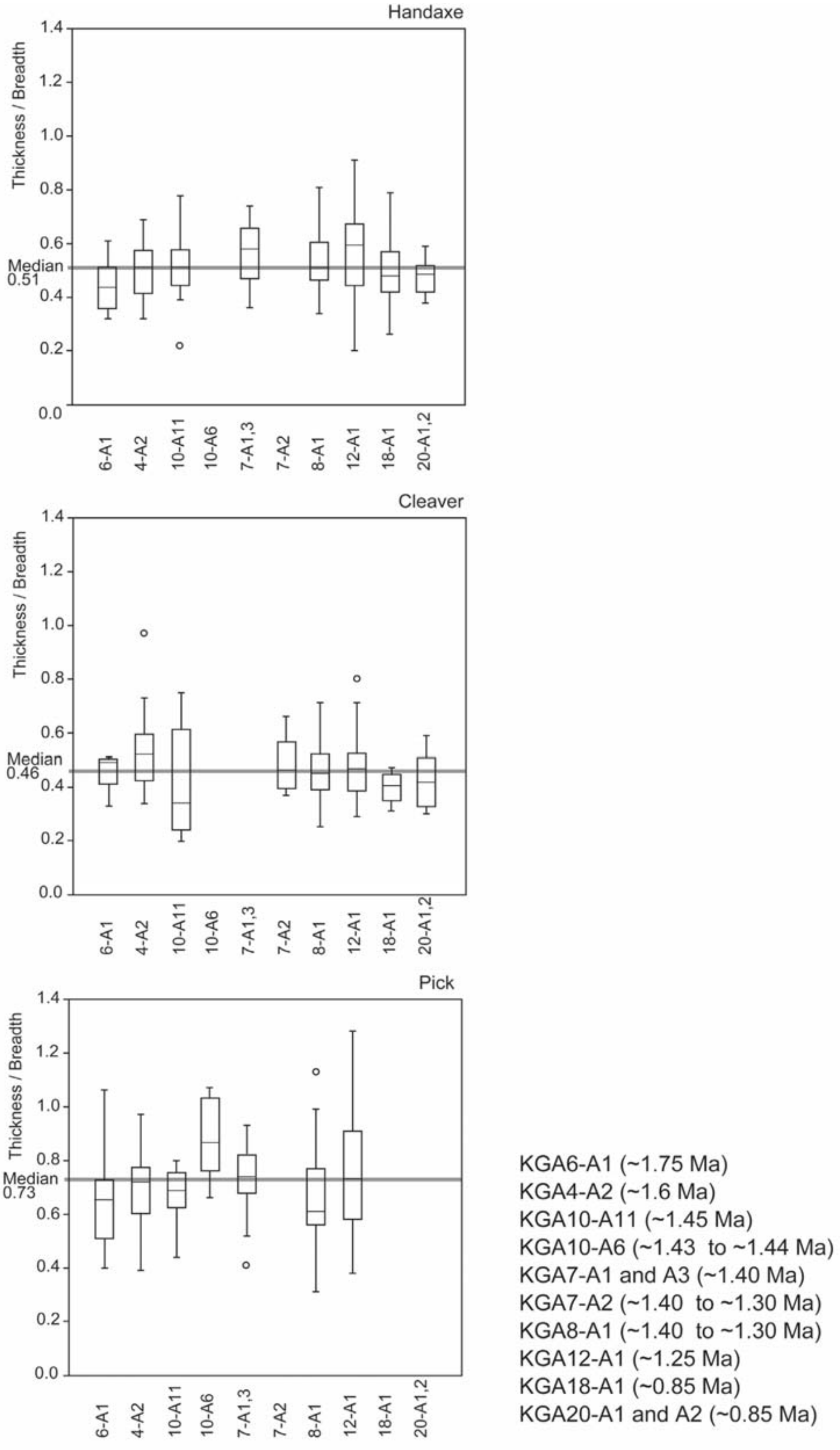

Fig. 4.7. Box plots of relative thickness (thickness/breadth) in hadaxes, cleavers, and picks. KGA10-A6 and KGA7-A2 handaxes, KGA10-A6 and KGA7-A1 and A3 cleavers, and KGA7-A2, KGA18-A1, and KGA20-A1 and A2 picks are not ploted because of small sample sizes (less than five). Gray lines show median of the total thickness/breadth values of handaxes, cleavers, and picks.

The thickness/breadth ratios of handaxes and cleavers at KGA18-A1 and KGA20-A1/A2 are lower than those of the chronologically older KGA sites (Fig. 4.7). The anomalously low value of relative thickness of the KGA6-A1 handaxes is due to the fact that unifacially produced handaxes dominate this small sample. Scatter plots of relative thickness against flake scar count (Fig. 4.8) show that, at Konso, intensive flaking of handaxes prior to 1.2 Ma did not result in a reduction of thickness. On the contrary, a slight increase of relative thickness accompanies intensive flaking. This tendency is caused by edge modification involving relatively steeper flaking that reduces tool breadth, but does not result in thinning. On the other hand, at ~0.85 Ma, the Konso LCTs were thinned by flaking. Unlike the >1.2 Ma handaxes repeated flaking did not result in thicker tools (Fig. 4.8). The ability to control LCT thicknesses during intensive modifications is a technological advance that involves shallow, invasive flaking, probably representing routine/intensive use of the soft hammer technique.

The tendency for thinner LCTs in the ~0.85 Ma Konso assemblages is clearly seen from the thickness values at KGA18-A1 and KGA20-A1/A2 (Appendix Table A2.11). The low thickness values of the KGA6-A1 and KGA7-A1/A3 handaxes are due to their overall smaller dimensions. Otherwise, it can be seen that the handaxe and cleaver mean thicknesses are much lower at KGA18-A1 than at the other sites. The KGA18-A1 LCTs are thin, even though their flake scar counts are low and comparable to the chronologically earlier KGA12-A1 counts (Table A2.17). This is because the thin KGA18-A1 LCTs were made on thinner flake blanks. Thus, the ~0.85 Ma knappers obtained better-shaped thin handaxes and cleavers by means of two advanced technological strategies: 1) shallower flaking and 2) production of thinner blanks.

Summary of temporal trends

The Konso Acheulean assemblages demonstrate obvious temporal advances in multiple aspects of techno-morphology. The picks are typologically most dominant at KGA6-A1 and KGA4-A2. They are crudely made and are massive in appearance. They often exhibit a characteristically notched tip. The morphological similarities between the older KGA6-A1 and the more abundant KGA4-A2 picks can be inferred as a functional and/or stylistic continuity of picks from ~1.75 Ma to ~1.6 Ma. On the other hand, the frequency of bifacially made picks and handaxes slightly increases at KGA4-A2, and the handaxes tend to be better shaped than at KGA6-A1.

Between ~1.6 Ma and ~1.25 Ma, while the Konso Acheulean assemblages are characteristically diverse, there is a clear increase of workmanship/skill manifested in the handaxes and cleavers, especially those from the ~1.4–1.3 Ma KGA8-A1 and the ~1.25 Ma KGA12-A1 sites. Not only do handaxes of these assemblages tend to be better-shaped, the LCTs (handaxes, cleavers and knives) numerically dominate over picks. A finer bifacial flaking technology resulted in increased frequencies of straight edges and biconvex or semi-biconvex cross-section types. Moreover, a greater number of LCTs exhibits symmetric plan outlines and thinner tips.

Finally, at ~0.85 Ma, the previously dominant heavy-duty type picks are not as abundant, and handaxe/cleaver frequency exceeds 80%. These handaxes and cleavers, at KGA18-A1 and KGA20-A1/A2, are more clearly refined in plan form, edge sinuosity, and cross-section shape. This refinement is based on the combination of an advanced flake-blank detaching technology for production of large thin blanks, and the common application of shallow, invasive flaking capacities. The better-made handaxes and cleavers of this time period tend to be standardized in morphology, exhibiting a substantially thin, 3-dimensionally symmetric form with fine straight edges.

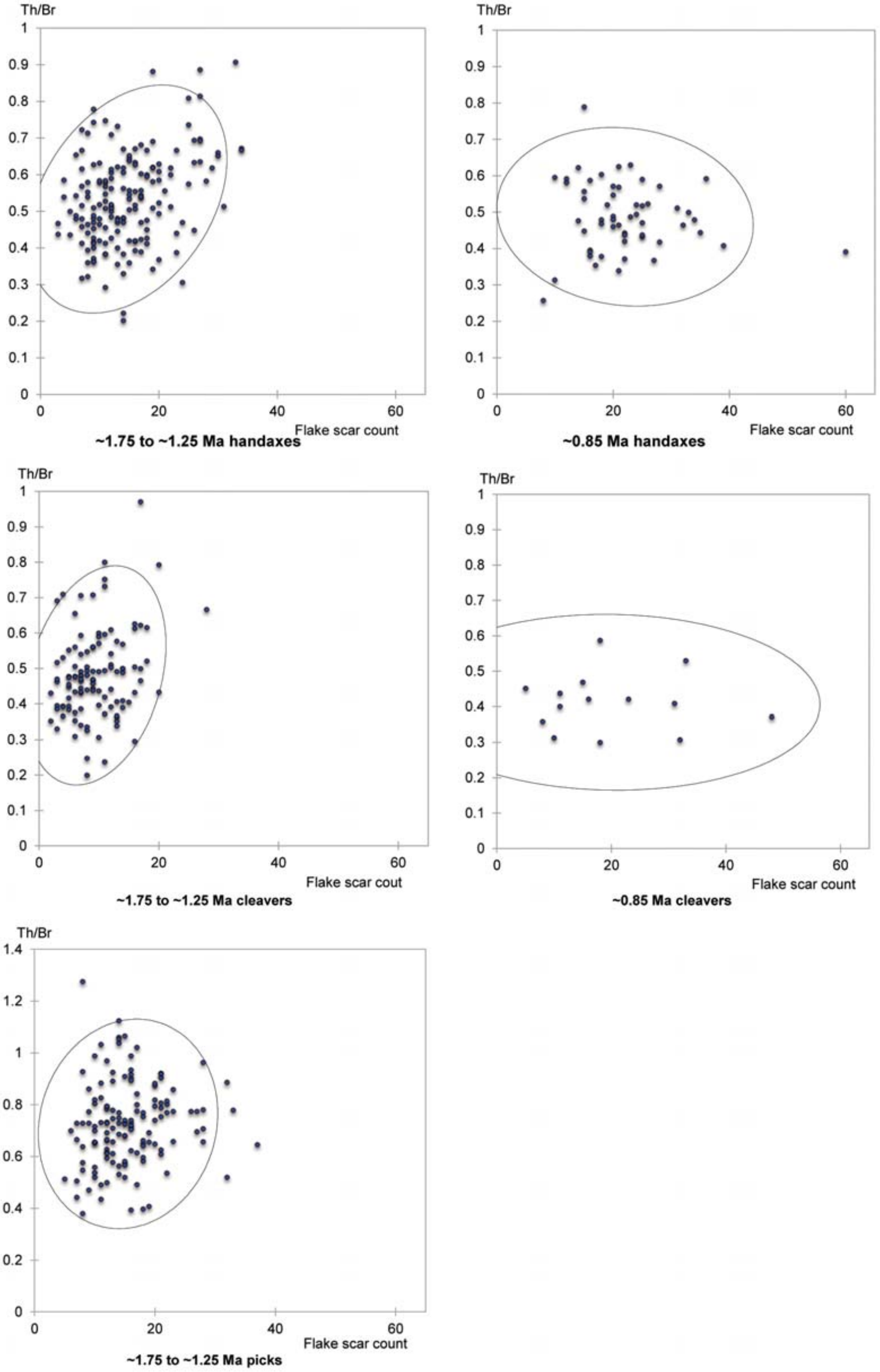

Fig. 4.8. Scatterplots of relative thickness vs. flake scar count. In the ~1.75 to ~1.25 Ma assemblages, relative thickness of handaxes and cleavers increases with flake scar counts: handaxes (n =168), r = 0.350, P < 0.001; cleavers (n = 113), r = 0.263, P = 0.005; picks (n = 140), r = 0.105, P = 0.218. In the ~0.85 Ma handaxes and cleavers, a positive correlation was not observed: hadaxes (n = 55), r = -0.096, P = 0.484; cleavers (n = 14), r = -0.027, P = 0.947.

4.3 BLANK PREDETERMINATION TECHNOLOGY

The Konso early Acheulean is characterized by a strong preference for utilizing large flake blanks, consistently from ~1.75 Ma through ~0.85 Ma. In the above section, we focused on the techno-morphological characteristics of the Konso assemblages as seen primarily from the attribute analysis. In this section, we outline some other more qualitative aspects of the advanced knapping capacities seen in the Konso early Acheulean technology.

Large Cores

The Konso LCTs are made on large flake blanks, often exceeding 20 cm maximum diameters. This forecasts the presence of giant cores. We observed such large cores at several localities as surface finds. Although no giant core was recovered from our limited excavations, the few surface occurrences of giant cores are undoubtedly associated with the Acheulean LCTs. This is clear from an example of *in situ* occurrence of a giant core that we observed in summer 2013 at KGA10 just northwest of the quartz-tool rich KGA10-A6 to KGA10-A8 area (Fig. 4.9).

This giant core is on a quartz slab, and was observed partially exposed in the near-vertical erosional section (of the silt/sand/small gravel section) at approximately the same stratigraphic level as inferred for the KGA10-1 *Homo erectus* mandible (at KGA10-A1) and the KGA10-A6 artifacts. Because of the much lower energy inferred for the encasing sediments (predominantly silt and sands), this giant core was probably moved to its location (by hominids) and knapped multi-directionally. Other giant and large cores (as defined by Sharon, 2009; see also Clark and Schick,

Fig. 4.9. Giant quartz core embedded in a section at KGA10 northwest of the KGA10-A6 to KGA10-A8 area (August 8, 2013, Berhane Asfaw pointing to the quartz core).

2000) made on quartz blocks were found on the surface at multiple locations of the south face of KGA10, mostly at or near the KGA10-A6 to A8 site areas (see Chapter 2 Fig. 2.4 for locations of KGA10-A6 and A8). These giant cores are either bi-directionally or multi-directionally flaked. Their occurrences at KGA10 coincide with occurrence of quartz vein outcrops in the general vicinity today and also probably at the time of deposition. Judging from the quartz-rich component of many of the KGA10 assemblages (e.g., KGA10-A6), but not at most other localities, a predominantly local procurement and use of raw materials is suggested broadly at the locality scale (<1 to at most several kilometers) (see Chapter 2 Fig. 2.3 for locality placements and sizes).

A large and heavy polyhedron made on quartz was collected as a surface find probably from the KGA10-A6 stratigraphic level (Plate 67). It measures 220 × 200 × 190 mm, and its circumference is 650 mm. It has a small portion of the cortex/talon preserved, which was used as a platform. At least five large flakes were removed from this platform, the largest three of these flake scars measure 125 × 93 mm, 102 × 82 mm, and 75 × 80 mm. Other medium-sized or small flake scars occur, totaling >28. This polyhedron was extensively used and shows strong battering on all its face, especially the ridges which were crushed and battered and became rounded. The size of the flake scars testifies that the polyhedron began as a core and then was used as a large and heavy hammer stone. This might have been used by the swing method (Semaw et al., 2009) to detach large flakes from big boulders or to crush and extract marrow from large mammal bones, or to perform both activities.

At KGA8 giant core quartzite slabs were found, similar to the quartz slabs of KGA10. Some of these show *éclat entame* (opening cortical flake) scars and subsequent flaking of a large single flake. A notable cluster of several of these examples was observed ~70 meters west of the KGA8-A1 collection site, albeit in secondary context (farmed outcrop). We simply note that KGA8-A1 is characterized by high frequencies of quartzite LCTs and that some of these exhibit possibly platforms indicative of slab cores (Plate 42). Of interest is to establish the original source or parental rock quarry of these giant cores, which are so far elusive. The KGA8 sediments are in fault contact with or overlie the Precambrian basement, which today forms the marginal hillslopes, the possible source of the quartzite cores. As with the KGA10 evidence, a predominantly local procurement and manufacture of the giant cores is suggested.

We collected two examples of giant cores, one near the KGA6-A1 site (1.75 Ma) (Plate 68), and another at KGA4-EE (~1.45 Ma) (Plate 69). The latter is an outcrop patch, east of the KGA4 collecting area, that was established during the follow-up survey of 2010. Here representative artifacts were collected without designating specific site names. Both of these giant cores are on basalt. The entire artifact assemblages at both localities are dominated by basalt. As was the case with the quartz and quartzite examples discussed above, these basalt giant cores were almost certainly locally collected and used. These cores were probably boulders that were brought to the site by the hominids, and the quarry site was probably close by. At KGA4-EE, a basalt hill occurs adjacent to the sediment patch, and large boulders were probably abundantly available at the time of deposition. At KGA6, the current Kayle River bed-load exhibits similar-sized basalt boulders that derive from nearby basalt outcrop sources. At the time of deposition, such outcrop sources must have also existed nearby.

The KGA6-2013-0 core (Plate 68) was discovered on the surface at KGA6 several tens of meters north of the KGA6-A1 excavation site. It is possible that it eroded out from stratigraphic levels equivalent to the KGA6-A1 archaeological horizon. The core is made on a basalt boulder and is multi-directionally flaked. A large, in part, denticulated edge is formed by the intersection of large flake scars made on both faces. The size of this core is 270 × 180 × 180 mm. Flake scars measure 150 × 99 mm, 135 × 105 mm, 105 × 105 mm, and 143 × 100 mm. The flake scar sizes are indicative of large blanks suitable for making LCTs.

KGA4-EE-A (Plate 69) is a large and heavy bi-directionally worked core on a basalt boulder with large flake scars. The core measures 310 × 250 × 245 mm. The detached flakes were large and could have been used as blanks for making LCTs. The length and breadth of the largest flake scar measures 204 × 182 mm and the second largest flake scar measures 178 × 164 mm. The source of the basalt boulders are inferred to have been nearby (see above). Together with the abundance of basalt LCTs that we observed at KGA4-EE, the giant core suggests local raw material use and on site making of the large cutting tools.

Radially flaked large cores

In addition to the giant or large cores used in the production of large flake blanks for making the LCTs and picks, we also discovered highly distinctive large–medium sized cores at a number of localities. Some of these exhibit features suggesting a preconceived sequence of core reduction. Two of these examples are illustrated in Plates 70 and 71, both collected at KGA4-EE. They are in the form of large discoidal cores >150 mm in maximum diameter. Another example was collected at KGA12 (Plate 72) from one gully west of the KGA12-A1 site. This is a large radially flaked bifacial centripetal core on basalt, measuring 206 × 156 × 118 mm. Large flakes were removed from both faces in a centripetal direction. There are 20 flake scars each on the dorsal and ventral faces. One large flake (138 × 78 mm) was ventrally removed with a blow from the proximal end. On the dorsal face, flake scars were also removed from the mid-ridge in a localized fashion towards both lateral sides. This core shows the application of a prepared core technique for the removal of a large flake, perhaps a cleaver.

The Kombewa core technique

The KGA7-A2 site is unique in the occurrence of large flake tools which are almost exclusively made on quartzite (12 out of a total of 17 pieces). This assemblage is dominated by large cutting tools made on flakes. Five of these LCTs (cleavers and knives) are made on Kombewa flakes, all of them on quartzite (Plates 29–32). One piece shows a thick platform from which both dorsal and ventral faces were detached, showing two bulbs and two positive surfaces (Plate 32: KGA7-A2 13). Others have two platforms (Plate 29: KGA7-A2 1 and Plate 31: KGA7-A2 18). The platforms are usually removed by flaking. The cleavers made on Kombewa flakes are either parallel sided with a straight cleaver bit at the distal end or are side cleavers. Some have been retouched with scraper-like flaking. Differentiating between side cleavers and knives is sometimes difficult, either typologically or technologically.

The KGA7-A2 Kombewa technique shows the ease with which these flake blanks were removed. Similar quartzite tools occur at KGA8-A1, >1 km from KGA7-A2. The assemblages from the two sites are possibly time equivalent (see Chapter 2). At KGA8-A1, as with the KGA7-A2 assemblage, Kombewa flakes were used to make LCTs. However, the Kombewa flakes at KGA8-A1 are less frequent, perhaps in part because of difficulty in identifying them due to the exhaustive flaking. Only two Kombewa flakes were identified with certainty, one made into a cleaver (Plate 37: KGA8-A1c 2) and another into a large scraper. The platforms are at the proximal end, and show modification (removal) by flaking. There are instances of considerable similarity of Kombewa flake-based LCTs, for example between two end struck Kombewa flakes, one from KGA7-A2 (Plate 32: KGA7-A2 13) and the other from KGA8-A1 (Plate 37: KGA8-A1c 2). The similarities are in workmanship and in the applied technique. This resulted in a thick proximal platform worked by large flake scars.

At KGA12-A1, a Kombewa flake tool was recovered. The Kombewa flake blank on quartzite was used to make a cleaver (KGA12-A1 12, not figured). This piece shows two blank flaking surfaces. Its ventral flaking surface is worked exhaustively. The platforms are removed by large, semi-abrupt and invasive flake scars.

Other prepared core techniques

At KGA8-A1 we found a number of LCTs which show prepared core techniques that are not either Levallois or Kombewa. The resulting LCTs are mostly cleavers and knives. A notable example is an LCT that exhibits successive flaking from a single large quartzite slab (Plate 42: KGA8-A1 23). In this technique, flakes were detached using the same platform and same detaching direction. In other words, the platform of the former blank negative and the platform of the present flake blank were continuous. This is indicative of a simple pattern applied in exploiting the same slab/core using the same platform.

Other pieces from KGA8-A1 show knapping of blanks with predefined forms (Plates 36–40). The technique applied involves the knocking off of a flake to determine the desired cleaver bit at the preparation stage of the core (before detaching the cleaver flake blank) and some more flakes shaping the lateral sides. The dorsal face of the resulting blank shows centripetal invasive and semi-abrupt flake scars. The platform is prepared with few blows and at last the LCT blank is detached with a decisive blow from the core. The proximal area of the blanks is usually thick and the blank gets progressively thinner towards the distal end. In most cases, the platform and the bulb are reduced by abrupt/semi-abrupt flaking. The mid-lateral to distal area shows an oblique cleaver/knife type of natural sharp cutting edge (either on one side or on both sides of the blank) which is left unmodified.

Although only one Kombewa flake was identified at KGA12-A1, a considerable number of artifacts attest to core preparation during LCT manufacture (Plates 51, 52). This is evident in both quartzite and basalt. The flaking technique on the dorsal face shows that centripetal flaking was applied from two to three sides before the blank was detached from the core. Two examples exhibit a large negative flake scar at the center of the dorsal face (Plates 49, 50). These pieces give an impression of a crude Levallois-like preparation of cores. However, because the frequency of such flake scars are minimal, and there appear to be no indication of standardization of such dorsal flakes, these were probably accidental products that mimic later prepared core standardized flaking.

Discussion

As noted in Sharon (2009) the purpose of the process of knocking off large flakes is to consistently acquire usable desired-shaped large flakes. Such large flakes were preconceived prior to their detachment via a "prepared core" thought process.

At Konso, it is possible that the earliest Acheulean at the ~1.75 Ma KGA6-A1 and ~1.6 Ma KGA4-A2 sites exhibit actual examples of production of desired-shaped blanks. This is seen in the cleavers (Plate 11: KGA4-A2 4) that exhibit flaking patterns that approximate "predetermined" formation of a cleaver working edge, and suggests that such advanced technology might extend back to the dawn of the Acheulean. An *in situ* cleaver from the excavation at KGA6-A1 (Plate 3: KGA6-A1-Loc.C O3) is another example, testifying to the complex technological template from the earliest Acheulean. However, since the number of such examples is still limited, these may also be from chance factor.

Higher in the Konso sequence, especially after ~1.4 Ma, a remarkably high frequency of a variety of core preparation techniques appear to have been applied prior to LCT blank detachment.

These include the Kombewa technology, successive flaking from single platforms of slab cores, centripetal core preparation, and platform preparation suggested from multifaceted platforms. The emergence of this suite of techniques appears to correspond in timing with the comparatively refined morphologies of the KGA8-A1 and KGA12-A1 handaxes. This indicates that, at this time, the entire LCT production operation was being refined with regards to both final shape-product and efficiency of manufacture.

4.4 SUMMARY AND CONCLUSIONS

The earliest Konso Acheulean occurs at ~1.75 Ma, which broadly coincides with the emergence of the oldest Acheulean lithic artifacts known at west of Lake Turkana (Lepre et al., 2011). The near-simultaneous appearance of the earliest Acheulean assemblages in both the Turkana and Konso basins indicates that this new technology was somewhat widespread by at least ~1.75 Ma (Beyene et al., 2013). The recently refined Turkana basin chronology shows that the earliest definite and well-provenanced *H. erectus* fossil, KNM-ER 3733, is best dated at 1.7–1.65 Ma (Suwa et al., 2007; Lepre and Kent, 2010; McDougall et al., 2012). Thus, the emergence of the earliest crude Acheulean technology must have broadly corresponded with, or closely preceded, the emergence of a *H. erectus*-like morphology within the early *Homo* lineage.

It is worth noting that most of the ~1.75 Ma KGA6-A1 Acheulean tools were made on large, thick flakes. The predominant use of large flake blanks than cobbles at KGA6-A1 and the other Konso sites almost certainly stems from easy access to basalt boulders. This allowed the hominids to detach large flakes and adopt a new lithic manufacture system characteristic of the Acheulean technology (Semaw et al., 2009; Sharon, 2008, 2009). Nonetheless, form modification was still by means of minimal and crude flaking, and mostly unifacial. Flake scar counts remained low. Almost one fourth of the LCTs/picks retained cortex on over 50% of their dorsal surface. Consequently, these ~1.75 Ma Acheulean tools exhibited thick pointed tips and roughly- or non-modified butts, and were consistently triangular or trapezoidal in cross-section form. The west Lake Turkana ~1.75 Ma Acheulean assemblages also seem to share these features (Roche, 2003; Texier et al., 2006; Leper et al., 2011).

While the earliest Acheulean tools made on large flake blanks imply advanced motor skill and cognition, the predominance of picks and an overall heavy duty-like morphology of the LCTs suggest that these were at an early stage of the Acheulean technology. These Acheulean tools might have needed substantial bulk and weight that was advantageous in their use. Despite the still crude workmanship of the ~1.75 Ma Acheulean tools, the new tool inventory of handaxes, cleavers, and picks might have allowed early *Homo erectus* to expand into new activities, or engage more effectively in activities already based on the Oldowan technology, such as wood-chopping, cutting and scraping, butchering, and perhaps extracting/processing of underground storage organs (Keeley and Toth, 1981; Lemorini et al., 2014).

Although the ~1.6 Ma KGA4-A2 assemblage exhibits techno-morphological similarities with the KGA6-A1 assemblage, some more typical Acheulean features are manifested. This is seen in the increase in handaxe and cleaver frequencies and their better-shaped morphologies. The KGA4-A2 Konso assemblages seem broadly analogous in workmanship with the early Acheulean of Olduvai Gorge middle Bed II (Leakey, 1971), such as represented at EF-HR (~1.6–1.5 Ma). At Konso, both handaxes and cleavers exhibit a clear trend towards gradual refinement and standardization of morphology through time. By 1.4–1.25 Ma, advanced workmanship is seen in cross-section form, edge sinuosity, tip thinning, and plan form symmetry, and these are especially enhanced at KGA8-A1 and KGA12-A1. In contrast, such functionally relevant refinement seems to be less conspicuous in picks. Although the picks from KGA7-A1/A3 exhibit a distinctive morphology which may have been caused by the use of cobles as a blank or some functional requirement, the general style of the Konso picks represented by a massive butt and a pointed narrow tip with steep-angled edges did not change much through time. This relatively consistent shape of picks suggests that pick functions were already fulfilled by the earlier ~1.75 Ma to ~1.6 Ma shapes and technologies.

Simultaneously with the increase of LCT workmanship, blank predetermination technologies seem to have taken on a diverse and sophisticated repertoire. This is amply documented at KGA7-A2, KGA8-A1, and KGA12-A1, and includes application of the Kombewa technique and the common use of centripetal core preparation, platform preparation, and planned sequential blank removal. Despite the limited samples, the presence of these advanced techniques, especially at the ~1.4–1.25 Ma levels of the Konso Acheulean sequence, suggests that production technology changed from the primary simple method centered on production of large thick flakes with little modification to methods that involve additional steps of predetermination aimed for efficiency. Thus, blank predetermination and blank shaping technologies both seem to have advanced through time, noticeably between ~1.6 Ma and ~1 Ma.

Sometime after ~1 Ma, either late *Homo erectus* or their descendent lineages attained additional levels of advanced flaking technology. These would be the techniques that enabled the detaching of thin blanks, as well as the routine use of soft hammer techniques in extensive and refined shaping of the blanks. The substantial reduction of LCT thickness seen in the ~0.85 Ma Konso assemblages was thus obtained by using thinner blanks and by shallower flaking of the blank surfaces.

The inclination for thinner LCTs was probably a response to enhanced functional requirements in cutting activities. This is also reflected in the high frequency of handaxes and cleavers and their increasingly straight edges. Experimental studies indicate that Acheulean handaxes usefully functioned in cutting skin and meat, and that bifacially flaked straight edges are more durable than unretouched flakes (Jones, 1980; Mitchell, 1995, 1997). The large early Acheulean handaxes with long edges and an enormous butt is advantageous in butchering, in efficiently removing skin, in cutting meat, and for expending energy in holding the handaxe (butt) especially in disjointing (Jones, 1980). Despite the limited examples of use-wear analysis of Acheulean handaxes (Mitchel, 1995, 1997), carcass processing was probably a prime task of the Acheulean handaxes. Their advanced morphological refinement and assumed functional enhancement suggest an increase in demand for meat procurement. This technologically supported change in diet probably resulted in enhanced energy budget capacities needed as a background for growing and evolving larger brains (Martin, 1996; Snodgrass et al., 2009).

Advanced flaking technologies enabled advanced LCT standardization, leading to substantially thinned and symmetric LCTs in both cross-section and outline that qualify as approaching "three-dimensional symmetry" (Wynn, 2002). Manufacture of 3-dimensionally symmetric tools is considered to require advanced mental imaging capacities. Such tools might have emerged in association with advanced spatial and navigational cognition, perhaps related to an enhanced mode of hunting adaptation.

At Konso, advanced-shaped LCTs occur at the ~0.85 uppermost stratigraphic levels. In Ethiopia, similarly advanced LCTs have been recovered from the Melka Kunture Gombore II site dated at ~0.8 Ma (Gallotti et al., 2010). However, the known ~0.95 Ma Acheulean assemblages of Bouri, Ethiopia (Clark, 2000) do not include comparably advanced 3-dimensionally symmetric Acheulean tools. At the ~0.7 to <1.0 Ma sites in Kenya, variable LCTs were reported with some presence of refined handaxes (Isaac, 1977; Gowlett, 1988, 2011; Roche et al., 1988; Potts et al., 1999). It would be of interest to pursue the spatio-temporal processes of this technological advance, as this may reflect cognitive evolution (Stout, 2011).

The long Acheulean sequence at Konso spanning ~1.75 to ~0.85 Ma importantly reveals new aspects of the emergence and development of the Acheulean technology. This in turn leads to a better understanding of the behavioral and biological evolution of the genus *Homo*.

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