How many handaxes make an Acheulean? A case study from the SHK-Annexe site, Olduvai Gorge, Tanzania

Ignacio de la Torre[1]* & Rafael Mora[2]

[1] Instituto de Historia, CSIC. Albasanz 26-28. 28037 Madrid, Spain

[2] Centre d'Estudis del Patrimoni Arqueologic de la Prehistoria, Facultat de Lletres, Universitat Autonoma de Barcelona, 08193 Bellaterra, Spain

* Corresponding author: ignacio.delatorre@csic.es

Introduction

For better or for worse, discussions on the transition between archaeological cultures still receive significant attention today. Despite the culture- history baggage implicit in enquiries of this nature, in a historical science such as Archaeology it is probably unavoidable that we continue interrogating ourselves about what elements characterise new archaeological techno-complexes and differentiate them from the earlier ones. Until we are able to figure out the dynamics that led to the emergence of the earliest human technology (Panger et al. 2002; Rogers and Semaw 2008; de la Torre 2010, 2011a; Tennie et al. 2017), it is fair to state that the first major archaeological transition –and one that has received much attention– is that from the Oldowan to the Acheulean.

Once Louis Leakey (1951) established that the Oldowan-Acheulean transition took place in East Africa, the seminal work by Mary Leakey (1971) at Olduvai Gorge built the paradigm for the chronological, technological and evolutionary grounds over which such transition took place (see reviews in de la Torre and Mora 2014; de la Torre 2016). In subsequent years, Leakey's (1971) model was the basis for most discussions on the Oldowan-Acheulean transition (e.g., Davis 1980; Stiles 1980), discussions in which the recipient of this festschrift played a pivotal role (e.g., Gowlett 1986, 1988).

In recent years, we have learned that older Acheulean sites exist elsewhere in East Africa (e.g., Lepre et al. 2011; Beyene et al. 2013), but the rich archaeological sequence excavated by Leakey (1971) at Olduvai has still been the focus of the greater part of the debate (e.g., de la Torre and Mora 2005, 2014; Semaw et al. 2009). The past decade has also witnessed the renewal of fieldwork in early Acheulean contexts at Olduvai (Diez-Martin et al. 2015; Dominguez-Rodrigo et al. 2014, 2017; de la Torre et al. 2018), which is contributing new data to the debate on the dynamics of the Oldowan-Acheulean transition.

This paper aims to contribute to such debate by presenting a first-hand re-study of the lithic assemblage excavated by Mary Leakey (1971) in SHK-Annexe. Leakey (1971) included SHK within the Developed Oldowan B, and therefore it is a relevant assemblage to characterize technological dynamics during the onset of the Acheulean at Olduvai Gorge.

The S. Howard Korongo (SHK) site was found during the 1935 expedition led by Louis Leakey, but first excavations took place in 1953, and then in 1955 and 1957 (Leakey 1971). Louis Leakey (1958) reported briefly on the fauna and a possible bone tool, Kleindienst (1959) studied the handaxes, and then Mary Leakey (1971) presented the excavations in SHK-Main and SHK-Annexe. Fieldwork at SHK-Main has resumed in recent years (Diez-Martin et al. 2014, 2017), but apart from a revision of the fossil assemblage (Egeland and Dominguez-Rodrigo 2008) and of the cores and handaxes from SHK-Main (de la Torre and Mora 2014), we are unaware of any other studies involving the Leakey SHK lithic collections. Thus, this paper introduces the first re-study of the SHK-Annexe stone tool assemblage since it was originally published by Mary Leakey (1971).

Materials and methods

The SHK outcrop is located in the Side Gorge of Olduvai (Figure 1). A clay unit can be traced from SHK-Annexe to SHK-Main, with archaeological material on top of the clay unit at SHK-Annexe, and mostly concentrated in a fluvial conglomerate eroding the clay at SHK-Main (Leakey 1971). Leakey (1971) emphasized the resemblance of the tuff overlaying the clay unit to Tuff IID, but she and then Hay (1976) positioned the site stratigraphically in the upper part of Middle Bed II. However, new tephro-geochemistry results indicate that the tuff capping the archaeological deposits is indeed Tuff IID, and therefore the site should be placed in Upper Bed II (McHenry et al. 2016), rather than Middle Bed II. Despite these recent results, renewed fieldwork at SHK has positioned the site below Tuff IIC (Diez-Martin et al. 2017), although they do not discuss why the tephro-chemistry analyses should be disregarded. Therefore, we will follow here the latest tephro-chronology model (McHenry et al. 2016), and consider the site as positioned in Upper Bed II, along with geographically close sites such as BK and SC (Figure 1).

The archaeological material at SHK-Annexe was clustered in an area of approximately 4.5 x 3 metres, and included stone tools and bone specimens. Sediments were not systematically screened, and part of the smaller sized remains were not retained (Leakey 1971). We analysed the SHK-Annexe assemblage in 2010, when the Leakey collection was still housed at the National Museums of Kenya in Nairobi, and before it was repatriated to Tanzania. Curation of the assemblage was excellent in the museum of Nairobi, where the material was organized in drawers and bags according to Mary Leakey’s classification, therefore enabling to contrast our identifications with hers.

The assemblage was studied macroscopically only. All artefacts were measured and weighed. The analysis of flaked and detached artefacts followed criteria established by de la Torre and Mora (2005), and updated by de la Torre (2011b) and de la Torre and Mora (2018a). The distinction between the chaînes opératoires of small debitage and Large Cutting Tool (LCT) production, and the technological categories in the latter, are based on the criteria discussed by de la Torre and Mora (2018b). The study of battered artefacts followed groups established by Mora and de la Torre (2005) and updated in de la Torre and Mora (2010), and Arroyo and de la Torre (2018).

Results

Assemblage composition

The collection studied totals 492 artefacts that weigh ~71 kg. Metamorphic rocks are the most abundant raw material (n = 439; 58.9 kg), followed by basalt/ trachyte-trachyandesite (T-Ta) and phonolite (see Table 1). Quantitatively, detached artefacts dominate the assemblage (n = 271; 55.1%), although flaked pieces also show high frequencies (35.6%). Whilst the number of pounded tools is comparatively insignificant (n = 46), they comprise 20 kg of used raw material and therefore are more relevant than detached pieces (13.8 kg) in terms of weight contribution, being only exceeded by flaked tools (37.4 kg).

The dominance of quartzite both in terms of number of artefacts and weight contribution is consistent in all technological categories (see Figure 2A), although Figure 2B indicates that the total weight of lava cores is considerably higher than in any other technological group. The Chi-square comparison of technological categories and raw material groups indicates the existence of significant differences (X^2 (6) = 13.15, $p < 0.0407$), and the Pearson's residues and Fisher's test link such differences to an overrepresentation of lava cores and quartzite retouched tools.

A minimum of 283 artefacts (57.5% of the assemblage) can be attributed to the chaîne opératoire of small debitage. Most of the debitage that shows no reduction sequence-defining features (and therefore are listed as indeterminable in Table 2) probably correspond to the small debitage chaîne opératoire as well. Therefore, the very low frequencies of artefacts attributable to the LCT production sequence (n = 14; 2.8%) is probably an accurate reflection of the actual technological pattern at the site (Figure 2C). Although in terms of weight contribution the LCT chaîne opératoire yields higher values (3.5 kg; 5%), Table 3 and Figure 2C show that the entire assemblage is still overwhelmingly dominated by the small debitage reduction sequence (39.4 kg; 55.3%).

Table 4 shows that 91% of the material for which roundness was analysed is fresh, with negligible frequencies of abraded artefacts. Quartzite artefacts are particularly fresh, often in mint conditions, and the few slightly abraded pieces are mostly in lava (Table 4), with statistically significant differences between the two raw materials (X^2 (2) = 49.10, $p < 0.0001$).

The chaîne opératoire of small debitage

<u>Detached artefacts</u>. Even if we added the indeterminable detached pieces from Table 2 to the small debitage chaîne opératoire, the overall number of shatter and flake fragments is comparatively small when compared to the combined sample of whole flakes (n = 120). Whole flakes show two morphological patterns: some are quadrangular, wide and short flakes, which are probably linked to the reduction of radially flaked cores. Other flakes have more elongated shapes, and suggest knapping from unidirectional cores.

Considering only the sample of flakes clearly attributable to the chaîne opératoire of small debitage (n = 111), average length is ~5 cm. Although length variability is significant (see Table 5), most flakes (71%) range between 40 and 59 mm (Table 6 and Figure 3C). No clear disparity is observed in length size per raw material (Table 5 and Figure 3A). More obvious differences could exist in terms of weight, as lava flakes are in average over a gram heavier than quartzite flakes (Table 5 and Figure 3B), but this disparity might be influenced by the much smaller sample available for lava flakes.

Flake striking platforms are predominantly cortex-free (92.5%), although prepared butts (i.e., bifaceted or multifaceted striking platforms) are rare (see values in Table 6). Thus, clear preponderance of unifaceted butts in lava (94.1%) and quartzite (84.4%) flakes (Figure 3D) suggest core knapping platforms that were cleared of cortex but which were not further prepared prior to flake removal. Dorsal patterns are predominantly non-cortical (72.2%), although some variability is observed between lava and quartzite flakes (Table 6), with cortex more abundant on the dorsal side of lava flakes. The proportion of Toth's (1982) types (Table 6 and Figure 3E) shows that fully cortical flakes (Type I) are negligible in the assemblage (1.9%), and most flakes were obtained from fully (Type VI: 65.4%) or considerably (Type V: 25%) decorticated cores.

Cores. The number of small debitage cores (n = 98) is substantial when compared to other technological categories (see Table 2) and, in terms of weight contribution (~32 kg), is the largest group within the assemblage (Table 3). In addition to complete cores, a considerable number of quartzite core fragments (n = 28) are documented. Some of these fragments correspond to cores of very small size that broke in half during flaking. A large number of cores (n = 37; 37.8%) bear battering marks (see details in Table 7), usually on natural/ cortical areas opposite the knapping surface. In several examples, this is interpreted as hammerstones that were then recycled as cores. In other instances, however, it was observed that battering was posterior to flaking, as shown by pitted areas that break through flaking scars.

Mean core length is ~7cm and ~330 g, with lava cores being in average large than quartzite cores (see values in Table 5). Figure 4A shows no clear breaks in quartzite core dimensions, whereas size of lava cores is clustered. Clustering of lava core length is better observed in Figure 4C, which shows most cores are in the 80-99 mm range (see also Table 7). Lava cores are substantially heavier in average than quartzite cores (Table 5 and Figure 4B), particularly in the 401-800 g range (Table 7 and Figure 4D). The Shapiro-Wilk test indicates the normal distribution of dimensions and weight of lava cores (alpha = 0.05; p-value = 0.52 [length], 0.67 [width], 0.83 [thickness], 0.93 [weight]), as opposed to quartzite cores, which do not follow a normal distribution (alpha = 0.05; p-value < 0.0001 in all variables). The Mann-Whitney test confirms that lava and quartzite core do not have the same size distribution (alpha = 0.05, p-value < 0.0001 [length, width, thickness], 0.0003 [weight]).

The wide variability of quartzite core sizes when compared to the lava sample is linked to the blanks used for flaking. As shown in Table 7, nearly all lava cores are on cobble blanks (see also Figure 4E). Conversely, blanks for quartzite cores range from small flakes to fragments, cobbles and blocks; some of the cores on small flakes and fragments weigh less than 50 g, whereas a number of cores on blocks have large dimensions and some weigh over 2 kg (see Figure 5 #1-2).

Table 7 shows that only 27.5% of cores preserve large quantities of cortex. A relatively higher reduction intensity can be inferred for quartzite, where 40.6% of cores preserve no cortex, as opposed to lavas, where 56.3% of cores contain predominantly cortical surfaces (see also Figure 4F). Cores have an average of 5.7 scars, although lava cores have a higher mean (6.7 scars) than metamorphic cores (5.5 scars). Considering the entire sample together, 79.5% of cores have four or more scars, with predominance of cores with 4-6 scars (see Table 7), which is generally consistent with cortex results and thus indicates moderate reduction of core blanks.

The bipolar technique is observed in 7.4% of cores (all of them in quartzite), while the rest (n = 88) are attributed to freehand flaking methods. Table 7 and Figure 6A show the predominance of unidirectional abrupt (particularly UAU1) and radial (BP and BHC) flaking schemes. Clear differences are observed by raw material, with most "chopper" cores (USP and BSP) made of lava (Figure 6B), despite overwhelming predominance of quartzite in the entire sample.

As with core size, flaking schemes seem to be conditioned, at least in part, by blank type. Thus, choppers are usually made on lava cobbles, which have natural shapes prone to produce core morphologies with unifacial or bifacial partially flaked edges opposite a cortical surface (e.g., Figure 5 #7). Likewise, most of UAU cores are on quartzite tabular blocks, in which knappers used natural planar surfaces to remove longitudinal flakes. Such unidirectional cores are not structured, and often show no more than one series of flake removals, despite the large size of core blanks and the potential for further reduction (see Figure 5 #1-2). Alongside substantially large cores such as that in Figure 5 #1-2, bipolar cores are small (often < 40 mm), although not necessarily heavily exploited; instead, their small dimensions are due to the reduced size of blanks (Figure 5 #4). Some radial cores are also small (see Figure 5 #5) and, in this case, it is uncertain to what extent size correlates with reduction intensity; most of radial cores correspond to BP schemes, where central volumes are not exploited and thus flaking sequences cannot be sustained for long. Similarly, BHC cores at SHK-Annexe did not undergo long reduction sequences and their small size may also be explained by blank selection, rather than flaking intensity.

<u>Retouched tools</u>. All but one of the 46 retouched pieces identified in SHK-Annexe are made of quartzite, and constitute an abundant category within the small debitage chaîne opératoire (Table 2). With an average length of ~40 mm and of ~22 g in weight (Table 5), the size distribution of retouched tools (Figure 7A) shows no clear clustering. Results of the Shapiro-Wilk test indicate that dimensions of retouched tools do not follow a normal distribution (alpha = 0.05, p-value =0.0036 [length], 0.0220 [width], <0.0001 [thickness, weight]).

Blanks used for retouched tools were flakes or flake fragments, but Table 5 shows that average dimensions of retouched pieces are consistently smaller than those of flakes (see also Figure 7B). The Mann-Whitney test (alpha = 0.05) confirms that the two groups do not share the same size distribution in all variables (p-value < 0.0001 for length and width, and 0.0490 for weight) apart from thickness (p-value = 0.7859). It is unclear, however, whether such differences are due to selection of smaller blanks for retouching, size reduction due to retouching intensity, or to the fact that some retouched pieces were made on flake fragments (instead of complete flakes).

As shown in Figure 8, there is no clear standardization of retouched shapes, although there is predominance of unifacial denticulates and notches, normally using the ventral face as striking platform to retouch the dorsal face (i.e., direct retouch). A number of these tools are retouched around their entire perimeter, which is interesting given the small size of some of the blanks.

The chaîne opératoire of Large Cutting Tool production

LCT production is attested in a very small sample of the SHK-Annexe assemblage (n = 14 and 3.5 kg; see Table 2 and Table 3). As shown in Table 8, small flakes associated to handaxe shaping (n = 5), and potential LCT blanks (n =5) are the best represented categories, while actual LCTs are very rare, with one complete specimen (Figure 9A) and two LCT fragments (e.g., Figure 9B). Interestingly, while both the complete LCT and all flakes are of quartzite, the two LCT fragments correspond to broken handaxes of lava.

The LCT in Figure 9A shows the usual features of knives from the early Acheulean of Olduvai Gorge (de la Torre and Mora, 2018b); a large blank (19 cm of length and over 1 kg of weight; see Table 8), probably a flake, was shaped unifacially on one edge, through denticulate retouch. This shaping is on the abrupt edge of the artefact (probably the butt of the flake), and is opposite a sharper, unmodified edge. The rest of the artefact remained mostly unmodified. Figure 9B shows a handaxe tip with bilateral and partially bifacial retouch, and thus shows more extensive shaping than the complete handaxe from Fig. 9A. Emphasis on the shaping of tips is also characteristic of most handaxe morphotypes in the Olduvai early Acheulean (de la Torre and Mora, 2018b).

Pounding tools

A minimum of 20 kg of raw materials were used in pounding tools (n = 46). Nonetheless, relevance of battering was probably higher, since many cores (n = 37) show also evidence of impact marks (Table 7). Admittedly, on occasions it is difficult to distinguish impact marks produced by missed blows on knapping platforms aimed at removing flakes, from battered areas produced during pounding. Nevertheless, at least in the case of those that show clustered battering on natural surfaces opposite a flaking surface (Figure 10 #3 and #4), it is clear that some cores were also involved in percussive activities.

Although we chose not to assign any of the pounding tools to either the small debitage or LCT production chaînes opératoires (see Table 2), Figure 7D shows that two of the knapping hammerstones are large (with one of them weighing over 1.7 kg; Table 8), and therefore may have been associated with production of LCT blanks.

Anvils (n = 5) amount to 4.4 kg (Table 1; see dimensions in Table 8), and show battering over planar surfaces of quartzite blocks and chipping of the edges (e.g., Fig. 10 #6). Nonetheless, their role also as active hammers cannot be excluded, as evidenced by the clustered battering in Fig. 10#6. Only one artefact was categorised as a spheroid, but many of the pounding tools classified here as hammerstones with fracture angles (n = 25; 7.5 kg) show various stages of shape rounding that is linked to blunting of edges through battering.

With an average weight of >400 g, many pounding tools do not seem fit to flake some of the tiny cores present in the SHK-Annexe collection. Thus, both the large size (Table 8 and Figure 7D) and weight (Figure 7C) of most pounding tools may be indicative of additional activities to knapping at the site.

Discussion

Comparing earlier and current classifications of the SHK-Annexe collection

Leakey (1971) reported that most SHK sediments were not sieved, and that only a sample of flakes was retained. Since Leakey did not state the exact number of flakes she curated from SHK-Annexe, attempts to consider the completeness of the collection for the present study have to be loosely based on the materials Leakey (1971: 171) listed as tools (n= 185). This figure is only slightly lower than the non-detached component of our study (n = 175 flaked and 46 pounded tools; Table 1), and hence it is inferred here that we accessed most, if not all, of the assemblage originally curated by Mary Leakey.

Under this premise, divergences between Leakey's and our own technological attributions concern inter-analyst variability on the identification of retouched tools, subspheroids/ spheroids, bifaces and core tools. Most of Leakey's core tools (e.g., choppers, heavy-duty scrapers) are here attributed to a range of core flaking schemes (e.g. USP, UAP). Conversely, some of the pieces classified by Leakey as discoids are seen here as small retouched tools or irregular fragments, rather than as centripetally- flaked and biconically- reduced cores.

Leakey (1971) identified a substantial number of artefacts as spheroids and subspheroids. We agree that intensity of battering at SHK-Annexe is high, although our analysis raises some uncertainties. For example, some of the pieces originally listed as spheroids/ subspheroids bear battering over cortical surfaces –cortex is conspicuous in river cobbles, and in SHK-Annexe it is not rare to document quartzites that are clearly fluvial, rather than derived from the primary source at Naibor Soit (see discussion in McHenry and de la Torre 2018). Thus, blank rounding is natural –rather than produced by battering– in many pieces, which therefore questions their attribution to spheroidal shaping (see discussion in de la Torre and Mora 2005). On the other hand, uncertainties on the analysis of Olduvai subspheroids/ spheroids should be acknowledged (see Arroyo and de la Torre 2018), and therefore our attribution of many of Leakey's subspheroids to hammerstones with fracture angles should also be considered with caution.

We generally agree with Leakey's identification of a substantial number of artefacts as retouched tools. However, we did not recognise any of the alleged burins as such, and several of them are Siret burins (i.e., split flakes), rather than intentional burins –see de la Torre and Mora (2005) for a discussion of this misidentification in other Olduvai sites. Some of the retouched tools are substantially modified (at least when compared to other Olduvai Beds I and II assemblages), but they can all be considered as denticulate side scrapers and notches, with no clearly standardized shapes apart from some possible 'pointed' tools (e.g., Figure 11B, #10).

The most relevant divergence in our techno-typological attribution refers to artefacts originally classified as bifaces. Apart from the three specimens retained in this paper as LCT or handaxe fragments, Leakey (1971) identified six further artefacts. However, we are unconvinced that they should be considered within that category, with some best qualifying as small retouched tools or cores (see Figure 11C), rather than as part of the LCT chaîne opératoire.

Interpreting assemblage composition in SHK-Annexe

Any consideration of the SHK-Annexe assemblage as a whole should take into account the deficit of debitage due to collection bias. Nonetheless, the material is fresh (Table 4) and Leakey (1971) considered the site as a living floor on a clay surface covered by tuff, so it can be assumed that, apart from the smaller pieces, the studied collection resembles the original configuration of the assemblage.

To overcome post-depositional and collection biases, we can use the proportion of larger artefacts to run inter-assemblage comparisons. In this line, ratios of relevant tools in the Olduvai post-Tuff IIB sequence (de la Torre and Mora, 2018b) shed interesting results as far as SHK-Annexe is concerned. Thus, SHK-Annexe has the highest core:LCT ratio (value=98) in all of the twenty-seven sites considered between Beds II and Masek (average ratio= 6.1). This means that SHK-Annexe contains proportionally (when compared to handaxes) the highest number of cores across the entire post-Tuff IIB sequence at Olduvai. Equally interesting is that, according to the calculations by de la Torre and Mora (2018b), SHK-Annexe also yields the lowest LCT:retouched tool ratio (value=0.02) of the entire Olduvai sequence (average ratio =1.9), which is again influenced by the near absence of handaxes at the site. It is only once LCTs are removed from comparisons that SHK stops being at one end of the sample; when, in addition to indices produced by de la Torre and Mora (2018b), we calculate a new ratio of retouched tools to cores (mean value =1.2), SHK-Annexe sits in a more intermediate position (ratio = 0.46).

Overall, the most salient features of the SHK-Annexe assemblage are the disproportionate abundance of cores, and the merely testimonial presence of handaxes. It is clear then that small debitage flaking was the most relevant technological activity at the site, while tasks involving production and/or use of handaxes were marginal, or else handaxes were removed from the site.

With over 20 kg of pounding tools, it is also evident that battering tasks played an important role at the site. SHK-Annexe not only includes knapping hammerstones, but also contains anvils and hammerstones with fracture edges (Figure 10) that were probably involved in other pounding tasks beyond flaking. A number of such tools are heavily battered, which suggests significant intensity of pounding activities. A recent comparison of pounded tool frequencies in Oldowan and Acheulean assemblages does not discern differences between the two periods (Arroyo and de la Torre 2018), but it is now manifest that percussive activities played an important role throughout the Olduvai sequence (Mora and de la Torre 2005). Although some have questioned the relevance of pounding tasks at Olduvai (Diez-Martin et al. 2009), they have subsequently acknowledged their abundance in the new excavations at SHK-Main (Sánchez-Yustos et al 2015). This is interesting given the geographic proximity between SHK-Main and SHK-Annexe and the pene-contemporaneity of the two sites (Leakey 1971: 166), and could indicate an emphasis on battering activities in some particular spots of the Olduvai paleo-landscape. Bones were founds spatially associated to stone tools at SHK-Annexe (Leakey 1971), but recent reassessments of the Leakey fossil collection (Egeland and Dominguez-Rodrigo 2008) do not provenance materials to either the SHK-Main or SHK-Annexe, and therefore it is unfeasible to link the zooarchaeological and technological data within the latter assemblage.

What is the technology of SHK-Annexe?

The SHK-Annexe assemblage contains elements from two clearly different chaînes opératoires. Figure 11A illustrates such difference by comparing flakes from the small debitage reduction sequence (#1-5) to potential blanks for LCT shaping (#6-8). This is even clearer in Figure 11D, where flakes attributed to the LCT reduction sequence (#14, #17) are 3-4 times larger than the sources of flakes (that is, cores: #15-16) in the small debitage chaîne opératoire. The target of the chaîne opératoire of small debitage is to produce 4-5 cm flakes such as those in Figure 11A #1-5, which in occasions are retouched (Figure 11B #9-10). In contrast, large flakes produced in the LCT sequence, such as those in Figure 11A #6-8 and Figure 11D #14, #17), are potential blanks to configure LCTs such as that in Figure 9A.

Despite the obvious differences between the two chaînes opératoires, it is also clear that LCT production is very poorly represented at the site, which contains isolated elements of a fragmented reduction sequence only evident in a few large blanks, broken handaxes and a single LCT. The absence of LCT cores is not particularly surprising, as this is a pattern shared by most early Acheulean sites at Olduvai (de la Torre and Mora 2018b). However, the remarkably rare presence of handaxes in the collection –with only one undisputable and complete specimen– pushes the limits of its attribution to the Acheulean techno-complex; is it meaningful to categorize SHK-Annexe as an Acheulean assemblage when most of the assemblage show no signs of handaxe production?

Most specialists will agree that it would be best not to return to the –now superseded– term of Developed Oldowan B (Leakey 1971). Apart from the culture-history connotations of the term (see review in de la Torre and Mora 2014), the alleged techno-typological features of the Developed Oldowan B at SHK-Annexe presents the same problems as we have previously reviewed for BK, TK and FC West (de la Torre and Mora 2005). This includes the dubious character of the so-called diminutive bifaces (see Figure 11C), the similarity of 'true' handaxes (Figure 9A) to those of undisputed Acheulean assemblages such as EF-HR, and the existence of other elements of the LCT chaîne opératoire that are invisible in typological recounts of normative tools (e.g., handaxe shaping flakes, LCT blanks; Table 2 and Table 3).

We subscribe Gowlett's (1986) reasoning that, if the Acheulean is characterised by the presence of handaxes, then one should be enough to consider an assemblage as such. And as mentioned in the paragraph above, SHK-Annexe contains other elements apart from handaxes per se to typify the site as Acheulean; for instance, the ability to produce large flakes has long been claimed to be a defining feature of the Acheulean (Isaac 1969), and such ability is well attested at SHK-Annexe.

Nonetheless, even if most present-day specialists will concur in including SHK-Annexe within the Acheulean –on the basis that the Acheulean does not solely convey the presence of handaxes but refers to a techno-complex with shared biological, cognitive, technological and subsistence affinities (de la Torre 2016)–, this still does not satisfactorily explain why we encounter such a substantial inter-assemblage variability at Olduvai (de la Torre and Mora 2014), and elsewhere in East Africa (de la Torre 2011b).

Here, consideration of another defining feature of the Acheulean might provide an important clue; and that is the fragmented character of reduction sequences during this period, which again is well documented both at Olduvai (de la Torre and Mora 2018b) and at other East African Acheulean sequences (Gowlett 1982; de la Torre et al 2014). For instance, raw material source distance is key to explain variability in Kilombe (Gowlett 1993) and Olorgesailie (Potts et al. 1999), and site function and their paleoecological context at Olduvai have also been used to decipher the Acheulean/ Developed Oldowan B dichotomy (Isaac 1971; Hay 1976). In principle, this may be seen as a truism, as we all expect technological strategies will correlate with transport distance and site function. However, such patterns are not so obvious during the Oldowan; indeed, transport-decay and reduction intensity patterns are observed to correlate with raw material distance in pre-Acheulean contexts (e.g., Blumenschine et al. 2008; Toth 1982), but Oldowan toolkit composition does not seem to vary substantially. In contrast, inter-assemblage variability in the East African Acheulean is significantly higher (e.g., Isaac 1977) and is linked to a massive fragmentation of the chaînes opératoires (Gowlett 1982), which in turn may respond to a much more structured use of the landscape (de la Torre and Mora 2005; de la Torre et al. 2014).

What if there were not handaxes?

In response to the question posed in the title of this paper, we hope that reflections in the previous section are persuasive to conclude that one handaxe should usually be enough to include a site within the Acheulean techno-complex. But how about when we do not even have the one? There is consensus that assemblages with few or no handaxes in < 1-million-year-old sequences such as the Hope Fountain Industry (Posnasky 1959), Developed Oldowan C (Leakey and Roe 1994) and the Clactonian (White 2000) should still be accounted for as part of the technological variability within the Acheulean (see summary in de la Torre and Mora 2014). However, it gets more complicated for sites without handaxes in the chronological boundary between the Oldowan and the Acheulean, and SHK-Annexe may prove to be an excellent case study to contribute to the debate.

Firstly, because of its sample size. The SHK-Annexe collection studied here contains around 500 artefacts, and the original number sample was larger, as we know of the debitage discarded by Leakey; however, despite this relatively large number of artefacts, only one complete handaxe was recovered. Some of the handaxe-free assemblages in the Oldowan-Acheulean boundary such as Peninj-Type Section (de la Torre and Mora 2004), Nyabusosi (Texier 1995) and Chesowanja (Gowlett et al. 1981), yield similar or even smaller absolute frequencies. From this perspective, there is a possibility that an increase in the collection size of those sequences eventually led to a documentation of handaxes, even if in a small percentage as in SHK-Annexe.

In the absence of handaxes, the presence of structured flaking methods of small debitage has been proposed as an additional technological proxy to track Acheulean innovations (de la Torre 2009, 2011b). Relatively structured small debitage methods in East African sites at the Oldowan/ Acheulean boundary have been reported in Peninj (de la Torre 2009), Melka Kunture (Gallotti 2013), Nyabusosi (Texier 1995), and in TK and BK at Olduvai (de la Torre and Mora 2005; Sánchez-Yustos et al. 2017; Santonja et al. 2014), thus supporting yet another prescient observation by Gowlett (1986, 1990), who linked the appearance of handaxes with the development of structured centripetal methods. While handaxe-rich assemblages such as EF-HR exhibit expedient small debitage flaking techniques, the SHK-Annexe collection contains examples of centripetal cores (de la Torre and Mora 2014), some of them considerably small (e.g., Figure 5 #5), and similar to those of TK and BK (de la Torre and Mora, 2005). Thus, even though flaking methods in SHK-Annexe are generally simple (see Figure 6), more structured small debitage schemes appear consistently, and separate the assemblage from the flaking patterns typical in the Oldowan sequence at Olduvai (Proffitt, 2018; de la Torre and Mora 2005, 2018a).

The average size of stone tools in SHK-Annexe is also clearly different from dimensional patterns in Oldowan assemblages. It is unfeasible to embark here in a quantitative assessment of the Olduvai archaeological sequence, but a superficial comparison between Table 5 and the metric datasets for pre-Tuff B sites available in de la Torre and Mora (2005) will show that small debitage technological categories in SHK-Annexe are consistently larger than in any of the Olduvai Oldowan assemblages. This pattern stands despite the huge intra-assemblage size variability observed within SHK-Annexe (see examples of such disparities in Figure 5), and clearly points to the overall larger dimension of *all* stone tools –i.e., not only those associated to LCT production but also those from small debitage chaînes opératoires– in the Acheulean when compared to the Oldowan.

Conclusions

The publication of Mary Leakey's (1971) seminal work on Olduvai Beds I and II was the starting point for the modern debate on the origins of the Acheulean in East Africa. Five decades on, the debate is still very much alive today, and John Gowlett's ideas have been pivotal in shaping it. He was a pioneer in advocating the need to understand cognitive and technical abilities behind the Oldowan and Acheulean stone tools (Gowlett 1982, 1986, 1990). When the debate was still typological, Gowlett (1982) was already stressing the fragmentation of chaînes opératoires in the Acheulean sequences. While discussions were still based on comparison of tool frequencies, he was proposing that the proportion of handaxes is irrelevant and that it is the mental templates involved what matters (Gowlett 1986). When, more recently, debates on handaxe variability have turned purely quantitative, he has reminded us that there is a set of technical parameters intrinsic to them all (Gowlett 2006).

SHK-Annexe highlights the interest of conducting first-hand assessments of Acheulean assemblages, and that such studies should include the entire collections. Direct inspection allows to better understanding analysts' decisions in artefact attribution, which in the case of the so-called diminutive handaxes bear relevant implications on the character of handaxes during the Developed Oldowan B. Also, the focus on entire assemblages instead of on particular categories enables us to identify additional elements attributable to the handaxe reduction sequence (e.g., LCT shaping flakes, LCT blanks), and finding alternative proxies to handaxes (e.g. features of small debitage systems) to refine the features of the Acheulean technology as a whole.

As reassessment of classic collections and data from new excavations accrue, Gowlett's views on the Oldowan -Acheulean gradient have proved visionary. Our restudy of the SHK-Annexe assemblage is no exception, and it only proves right arguments that Gowlett (1986) had already put forward thirty years ago; one handaxe is as important as forty as far as the mental templates required for handaxe manufacture are concerned. A handaxe is a techno-unit that requires a hierarchical construction through an interval of manufacture, and entails manipulation of a set of instructions in a tri-dimensional state (Gowlett 2002). Such instructions are "packaged" around a few concepts or "imperatives" that impose a heavy cognitive load (Gowlett 2006), and are those that truly define the Acheulean character of the assemblage.

Acknowledgements

We thank the National Museum of Nairobi for permits to study the Leakey collection from SHK. Funding by the NSF (BCS-0852292) and the European Research Council-Starting Grants (283366) is gratefully acknowledged. We thank the editors of this festschrift for inviting us to participate. Our special thanks go to John Gowlett, for being a constant source of inspiration to all of us interested in early stone tool technologies. IT also wishes to thank John for his support and friendship along the years.

References

Arroyo, A., de la Torre, I., 2018. Pounding tools in HWK EE and EF-HR (Olduvai Gorge, Tanzania): percussive activities in the Oldowan - Acheulean transition. Journal of Human Evolution 120, 402-421.

Beyene, Y., Katoh, S., WoldeGabriel, G., Hart, W.K., Uto, K., Sudo, M., Kondo, M., Hyodo, M., Renne, P.R., Suwa, G., Asfaw, B., 2013. The characteristics and chronology of the earliest Acheulean at Konso, Ethiopia. Proceedings of the National Academy of Sciences 110, 1584-1591.

Blumenschine, R.J., Masao, F.T., Tactikos, J.C., Ebert, J.I., 2008. Effects of distance from stone source on landscape-scale variation in Oldowan artifact assemblages in the Paleo-Olduvai Basin, Tanzania. Journal of Archaeological Science 35, 76-86.

Davis, D.D., 1980. Further Consideration of the Developed Oldowan at Olduvai Gorge. Current Anthropology 21, 840-843.

de la Torre, I., 2009. Technological Strategies in the Lower Pleistocene at Peninj (West of Lake Natron, Tanzania), in: Schick, K., Toth, N. (Eds.), The Cutting Edge: New Approaches to the Archaeology of Human Origins. Stone Age Institute Press, Bloomington, pp. 93-113.

de la Torre, I., 2010. Insights on the Technical Competence of the Early Oldowan, in: Nowell, A., Davidson, I. (Eds.), Stone Tools and the Evolution of Human Cognition. University Press of Colorado, Boulder, pp. 45-65.

de la Torre, I., 2011a. The origins of stone tool technology in Africa: a historical perspective. Phil. Trans. R. Soc. B 366, 1028-1037.

de la Torre, I., 2011b. The Early Stone Age lithic assemblages of Gadeb (Ethiopia) and the Developed Oldowan / early Acheulean in East Africa. Journal of Human Evolution 60, 768-812.

de la Torre, I., 2016. The origins of the Acheulean: past and present perspectives on a major transition in human evolution. Philosophical Transactions of the Royal Society of London B: Biological Sciences 371, 20150245.

de la Torre, I., McHenry, L.J., Njau, J. (Eds) 2018. From the Oldowan to the Acheulean at Olduvai Gorge (Tanzania). Journal of Human Evolution 120, 1-421.

de la Torre, I., Mora, R., 2004. El Olduvayense de la Sección Tipo de Peninj (Lago Natron, Tanzania). CEPAP, vol. 1, Barcelona.

de la Torre, I., Mora, R., 2005. Technological Strategies in the Lower Pleistocene at Olduvai Beds I & II. ERAUL 112, Liege.

de la Torre, I., Mora, R., 2010. A technological analysis of non-flaked stone tools in Olduvai Beds I & II. Stressing the relevance of percussion activities in the African Lower Pleistocene, in: Mourre, V., Jarry, M. (Eds.), Entre le marteau et l'enclume. La percussion directe au percuteur dur et la diversité de ses modalités d´application. Actes de la table ronde de Toulouse, 15-17 mars 2004, Paleo 2009-2010, numéro spécial, pp. 13-34.

de la Torre, I., Mora, R., 2014. The Transition to the Acheulean in East Africa: an Assessment of Paradigms and Evidence from Olduvai Gorge (Tanzania). Journal of Archaeological Method and Theory 21, 781–823.

de la Torre, I., Mora, R. 2018a. Oldowan technological behaviour at HWK EE (Olduvai Gorge, Tanzania). Journal of Human Evolution 120, 236-273.

de la Torre, I., Mora, R. 2018b. Technological behaviour in the early Acheulean of EF-HR (Olduvai Gorge, Tanzania). Journal of Human Evolution 120, 329-377.

de la Torre, I., Mora, R., Arroyo, A., Benito-Calvo, A., 2014. Acheulean technological behaviour in the Middle Pleistocene landscape of Mieso (East-Central Ethiopia). Journal of Human Evolution 76, 1-25.

Diez-Martín, F., Fraile, C., Uribelarrea, D., Sánchez-Yustos, P., Domínguez-Rodrigo, M., Duque, J., Díaz, I., De Francisco, S., Yravedra, J., Mabulla, A., Baquedano, E., 2017. SHK Extension: a new archaeological window in the SHK fluvial landscape of Middle Bed II (Olduvai Gorge, Tanzania). Boreas 46, 831-859.

Diez-Martín, F., Sánchez, P., Domínguez-Rodrigo, M., Mabulla, A., Barba, R., 2009. Were Olduvai Hominins making butchering tools or battering tools? Analysis of a recently excavated lithic assemblage from BK (Bed II, Olduvai Gorge, Tanzania). Journal of Anthropological Archaeology 28, 274-289.

Diez-Martín, F., Sánchez Yustos, P., Uribelarrea, D., Baquedano, E., Mark, D.F., Mabulla, A., Fraile, C., Duque, J., Díaz, I., Pérez-González, A., Yravedra, J., Egeland, C.P., Organista, E., Domínguez-Rodrigo, M., 2015. The Origin of The Acheulean: The 1.7 Million-Year-Old Site of FLK West, Olduvai Gorge (Tanzania). Scientific Reports 5, 17839.

Diez-Martín, F., Sánchez-Yustos, P., Uribelarrea, D., Domínguez-Rodrigo, M., Fraile-Márquez, C., Obregón, R.-A., Díaz-Muñoz, I., Mabulla, A., Baquedano, E., Pérez-González, A., Bunn, H.T., 2014. New archaeological and geological research at SHK main site (Bed II, Olduvai Gorge, Tanzania). Quaternary International 322–323, 107-128.

Domínguez-Rodrigo, M., Baquedano, E., Mabulla, A., Diez-Martín, F., Egeland, C.P. (Eds.) 2017. Oldowan and Acheulian archaeology of Olduvai Gorge. Boreas, 46: 605–936.

Domínguez-Rodrigo, M., Diez-Martín, F., Mabulla, A., Baquedano, E., Bunn, H.T., Musiba, C., (Eds.). 2014. The evolution of hominin behavior during the Oldowan–Acheulean transition: Recent evidence from Olduvai Gorge and Peninj (Tanzania). Quaternary International 322–323, 1-6.

Egeland, C.P., Dominguez-Rodrigo, M., 2008. Taphonomic perspectives on hominid site use and foraging strategies during Bed II times at Olduvai Gorge, Tanzania. Journal of Human Evolution 55, 1031–1052.

Gallotti, R., 2013. An older origin for the Acheulean at Melka Kunture (Upper Awash, Ethiopia): Techno-economic behaviours at Garba IVD. Journal of Human Evolution 65, 594-620.

Gowlett, J.A.J., 1982. Procedure and form in a Lower Palaeolithic industry: Stoneworking at Kilombe, Kenya. Studia Praehistoria Belgica 2, 101-109.

Gowlett, J.A.J., 1986. Culture and conceptualisation: the Oldowan-Acheulian gradient, in: Bailey, G.N., Callow, P. (Eds.), Stone Age Prehistory: studies in memory of Charles McBurney. Cambridge University Press, Cambridge, pp. 243-260.

Gowlett, J.A.J., 1988. A case of Developed Oldowan in the Acheulean? World Archaeology 20, 13-26.

Gowlett, J.A.J., 1990. Technology, skill and the psychosocial sector in the long term of human evolution. Archaeological Review from Cambridge 9, 82-103.

Gowlett, J.A.J., 1993. Le site Acheuléen de Kilombe: stratigraphie, géochronologie, habitat et industrie lithique. L´Anthropologie 97, 69-84.

Gowlett, J.A.J., 2002. Apes, hominids and technology, in: Harcourt, C.S., Sherwood, B.R. (Eds.), New Perspectives in Primate Evolution and Behaviour. Linnean Society, London, pp. 147-171.

Gowlett, J.A.J., 2006. The elements of design form in Acheulian bifaces: modes, modalities, rules and language, in: Goren-Inbar, N., Sharon, G. (Eds.), Axe Age. Acheulian Toolmaking from Quarry to Discard. Equinox, London, pp. 203-221.

Gowlett, J.A.J., Harris, J.W.K., Walton, D., Wood, B.A., 1981. Early archaeological sites, hominid remains and traces of fire from Chesowanja, Kenya. Nature 294, 125-129.

Hay, R.L., 1976. Geology of the Olduvai Gorge. University of California Press, Berkeley.

Isaac, G.L., 1969. Studies of early culture in East Africa. World Archaeology I, 1-28.

Isaac, G.L., 1971. The diet of early man: aspects of archaeological evidence from lower and middle Pleistocene sites in Africa. World Archaeology 2, 278-299.

Isaac, G.L., 1977. Olorgesailie. Archeological Studies of a Middle Pleistocene Lake Basin in Kenya. University of Chicago Press, Chicago.

Jorayev, G., Wehr, K., Benito-Calvo, A., Njau, J., De la Torre, I., 2016. Imaging and photogrammetry models of Olduvai Gorge (Tanzania) by Unmanned Aerial Vehicles: A high-resolution digital database for research and conservation of Early Stone Age sites. Journal of Archaeological Science 75, 40–56.

Kleindienst, M. R. 1959. Composition and significance of a Late Acheulian assemblage based on an analysis of East African occupation sites. Chicago: Unpublished PhD, University of Chicago.

Leakey, L.S.B., 1951. Olduvai Gorge. A Report On The Evolution Of The Hand-Axe Culture In Beds I-IV. Cambridge University Press, Cambridge.

Leakey, L.S.B., 1958. Recent Discoveries at Olduvai Gorge, Tanganyika. Nature 181, 1099-1103.

Leakey, M.D., 1971. Olduvai Gorge. Vol 3. Excavations in Beds I and II, 1960-1963. Cambridge University Press, Cambridge.

Leakey, M.D., Roe, D.A., 1994. Olduvai Gorge. Volume 5. Excavations in Beds III, IV and the Masek Beds, 1968-1971. Cambridge University Press, Cambridge.

Lepre, C.J., Roche, H., Kent, D.V., Harmand, S., Quinn, R.L., Brugal, J.-P., Texier, P.-J., Lenoble, A., Feibel, C.S., 2011. An earlier origin for the Acheulian. Nature 477, 82-85.

Proffitt, T. 2018. Is there a Developed Oldowan A at Olduvai Gorge? A diachronic analysis of the Oldowan in Bed I and Lower-Middle Bed II at Olduvai Gorge, Tanzania. Journal of Human Evolution 120, 92-113.

McHenry, L.J., Njau, J.K., de la Torre, I., Pante, M.C., 2016. Geochemical "fingerprints" for Olduvai Gorge Bed II tuffs and implications for the Oldowan–Acheulean transition. Quaternary Research 85, 147-158.

McHenry, L., de la Torre, I. 2018. Hominin raw material procurement in the Oldowan-Acheulean transition at Olduvai Gorge. Journal of Human Evolution 120, 378-401.

Mora, R., De la Torre, I., 2005. Percussion tools in Olduvai Beds I and II (Tanzania): Implications for early human activities. Journal of Anthropological Archaeology 24, 179-192.

Panger, M.A., Brooks, A.S., Richmond, B.G., Wood, B., 2002. Older Than the Oldowan? Rethinking the Emergence of Hominin Tool Use. Evolutionary Anthropology 11, 235-245.

Posnasky, M., 1959. A Hope Fountain Site at Olorgesailie, Kenya Colony. The South African Archaeological Bulletin XIV, 83-89.

Potts, R., Behrensmeyer, A.K., Ditchfield, P., 1999. Paleolandscape variation and Early Pleistocene hominid activities: Members 1 and 7, Olorgesailie Formation, Kenya. Journal of Human Evolution 37, 747-788.

Rogers, M.J., Semaw, S., 2009. From Nothing to Something: The Appearance and Context of the Earliest Archaeological Record, in: Camps, M., Chauhan, P. (Eds.), Sourcebook of Paleolithic Transitions. Methods, Theories, and Interpretations. Springer, New York, pp. 155-171.

Sánchez Yustos, P., Diez-Martín, F., Díaz, I.M., Duque, J., Fraile, C., Domínguez, M., 2015. Production and use of percussive stone tools in the Early Stone Age: Experimental approach to the lithic record of Olduvai Gorge, Tanzania. Journal of Archaeological Science: Reports 2, 367-383.

Sánchez-Yustos, P., Diez-Martín, F., Domínguez-Rodrigo, M., Duque, J., Fraile, C., Baquedano, E., Mabulla, A., 2017. Diversity and significance of core preparation in the Developed Oldowan technology: reconstructing the flaking processes at SHK and BK (Middle-Upper Bed II, Olduvai Gorge, Tanzania). Boreas 46, 874-893.

Santonja, M., Panera, J., Rubio-Jara, S., Pérez-González, A., Uribelarrea, D., Domínguez-Rodrigo, M., Mabulla, A.Z.P., Bunn, H.T., Baquedano, E., 2014. Technological strategies and the economy of raw materials in the TK (Thiongo Korongo) lower occupation, Bed II, Olduvai Gorge, Tanzania. Quaternary International 322–323, 181-208.

Semaw, S., Rogers, M.J., Stout, D., 2009. The Oldowan-Acheulian Transition: Is there a "Developed Oldowan" Artifact Tradition?, in: Camps, M., Chauhan, P. (Eds.), Sourcebook of Paleolithic Transitions. Methods, Theories, and Interpretations. Springer, New York, pp. 173-193.

Stiles, D., 1980. Industrial Taxonomy in the Early Stone Age of Africa. Anthropologie XVIII, 189-207.

Tennie, C., Premo, L.S., Braun, D.R., McPherron, S.P., 2017. Early Stone Tools and Cultural Transmission: Resetting the Null Hypothesis. Current Anthropology 58, 652-672.

Texier, P.-J., 1995. The Oldowan assemblage from NY 18 site at Nyabusosi (Toro-Uganda). C.R. Acad. Sc. Paris 320, 647-653.

Toth, N., 1982. The Stone Technologies of Early Hominids at Koobi Fora, Kenya; An Experimental Approach, Unpublished Ph. D., Berkeley, University of California.

White, M.J., 2000. The Clactonian Question: On the Interpretation of Core-and-Flake Assemblages in the British Lower Paleolithic. Journal of World Prehistory 14, 1-63.

Figures

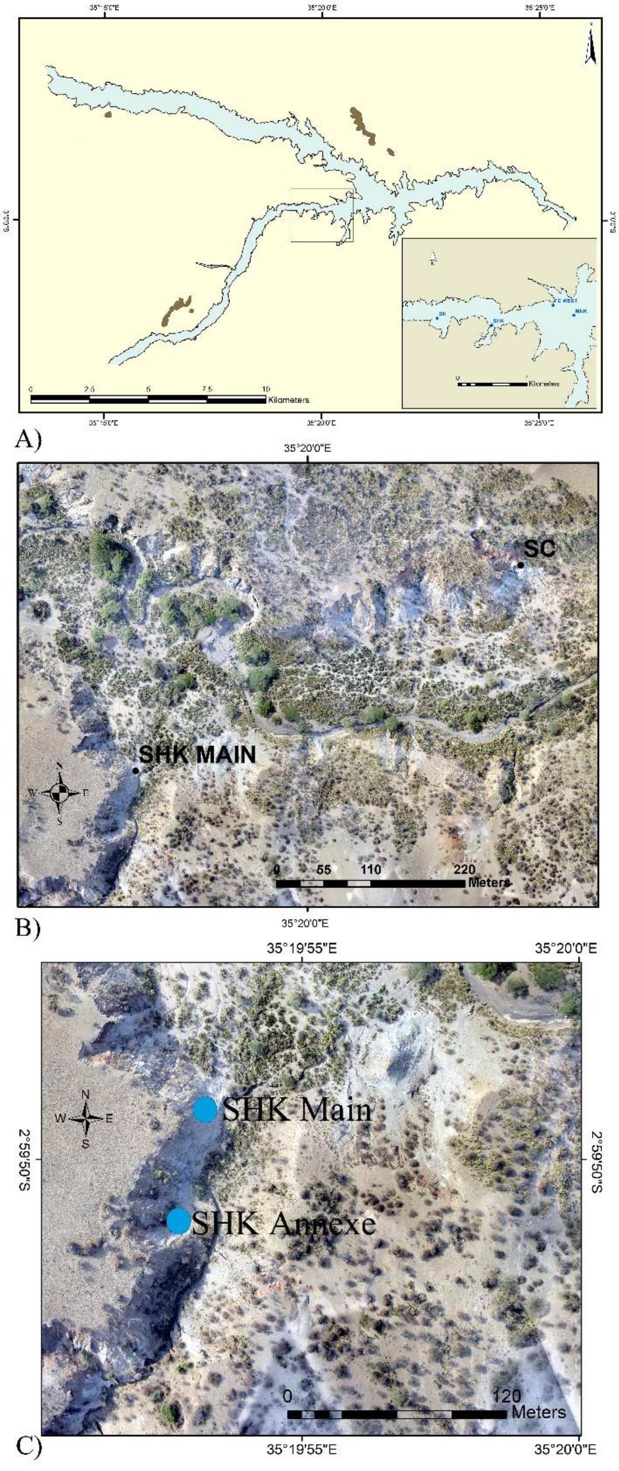

Figure 1. A) Map of the Olduvai Gorge with the position of SHK and nearby localities in the Side Gorge. B) Orthomosaic of the area of SHK and the nearby SC site. C) Location of SHK Main and SHK-Annexe –the position of SHK-Annexe is approximate, and based on Leakey's (1971: 165) account of the site being at around 91 metres from SHK Main. Olduvai Gorge outline, aerial pictures and orthomosaics after Jorayev et al. (2016).

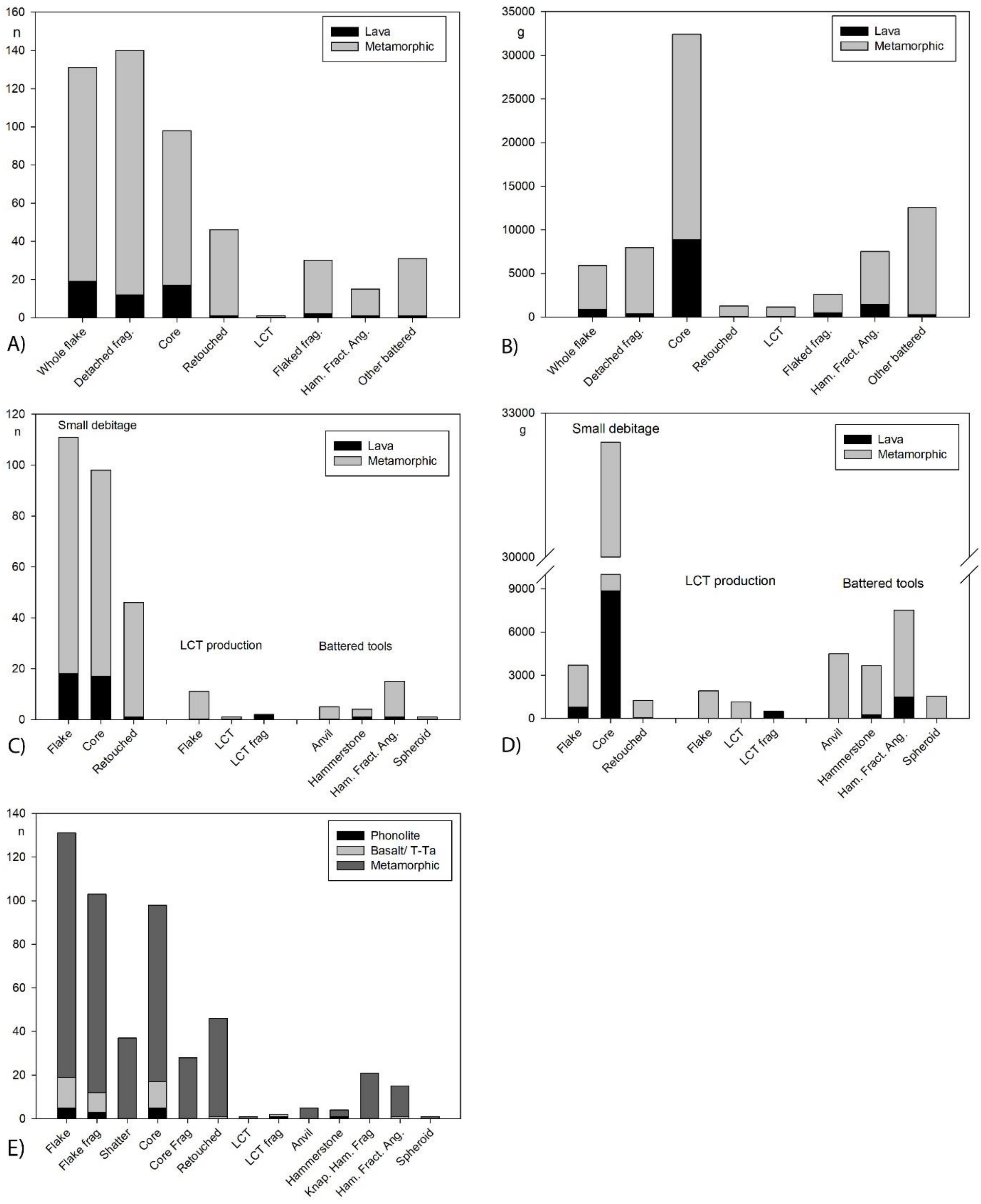

Figure 2. Technological categories in the SHK-Annexe lithic assemblage. A) Absolute frequencies per general raw material. B) Total weight of each technological category. C) Absolute frequencies of battered tools, and of the main categories in the chaînes opératoires of small debitage and LCT production. D) Total weight of battered tools, and of the categories in the chaînes opératoires of small debitage and LCT production. E) Absolute frequencies of all technological categories per rock type.

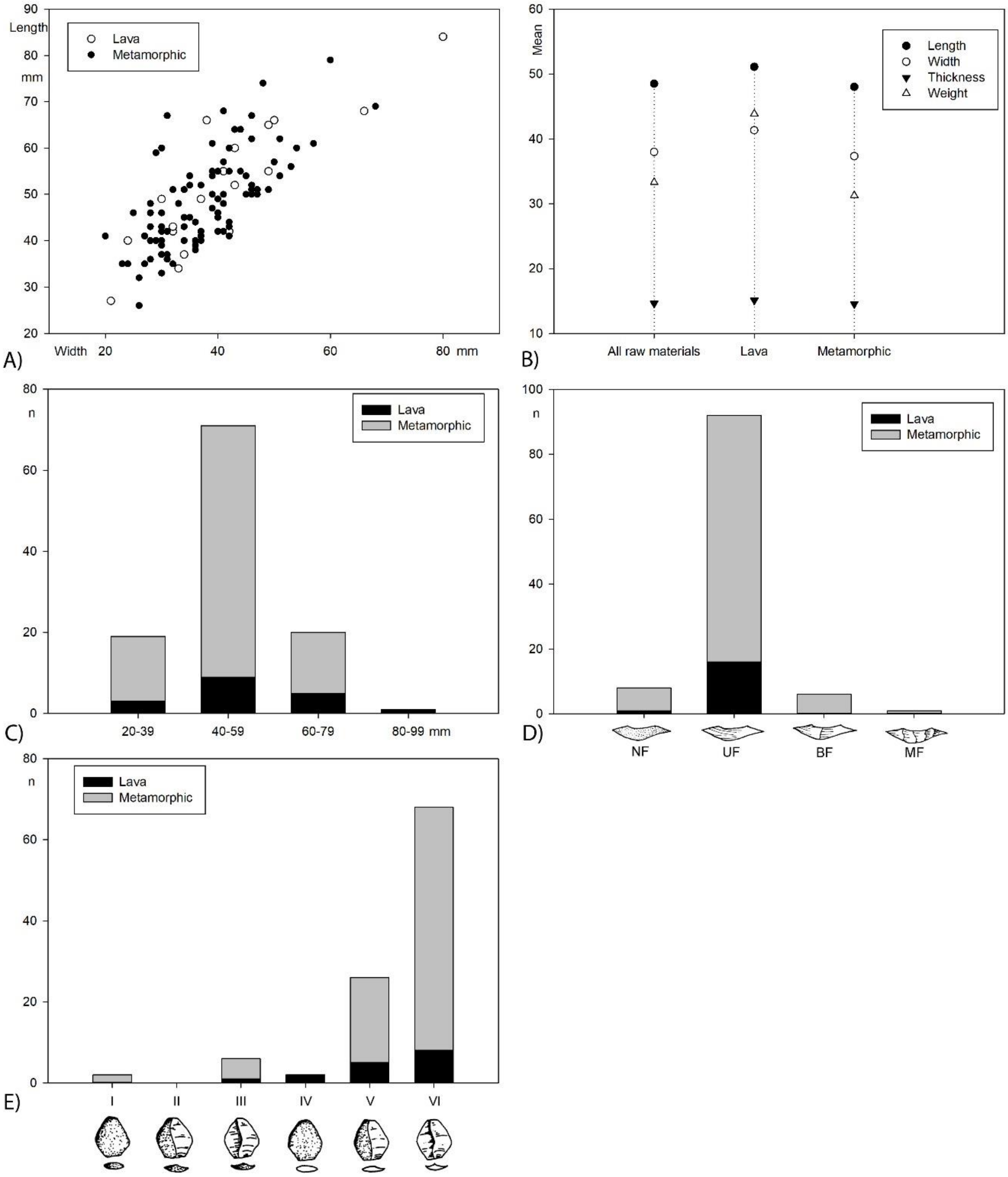

Figure 3. Attributes of flakes attributed to the chaîne opératoire of small debitage. A) Length and width distribution. B) Average dimensions (length, width, thickness and weight). C) Length ranges. D) Types of flake striking platforms. E) Flake cortex according to Toth's types.

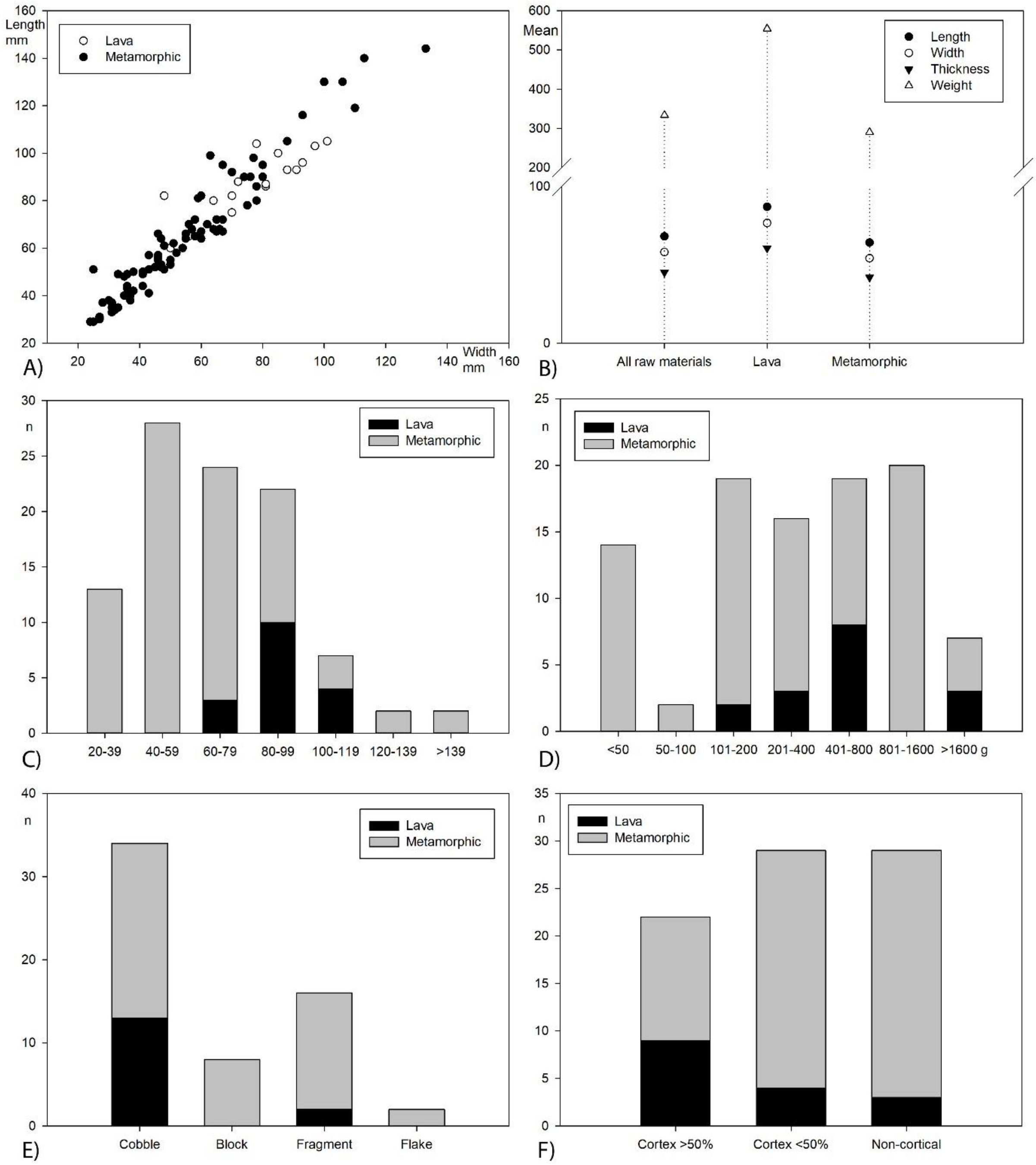

Figure 4. Attributes of small debitage cores. A) Length and width distribution. B) Average dimensions (length, width, thickness and weight). C) Length ranges. D) Weight ranges. E) Core blanks. F) Cortex percentage remaining in cores.

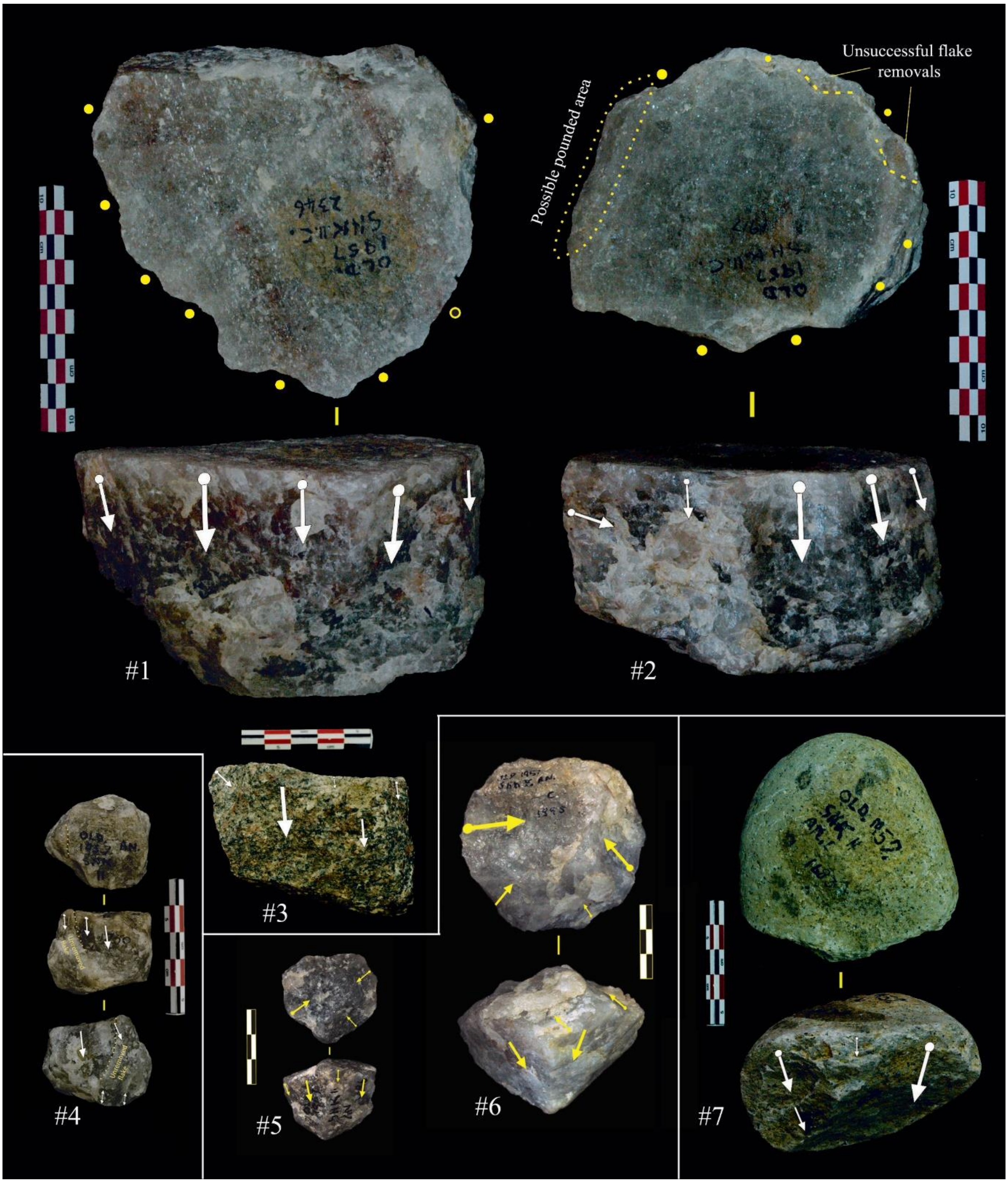

Figure 5. Small debitage cores in the SHK-Annexe collection. #1-3) Quartzite (#1-2) and gneiss UAU1 flaking schemes. #4) Quartzite bipolar core. #5-6) Quartzite BHC flaking schemes. #7) USP lava core.

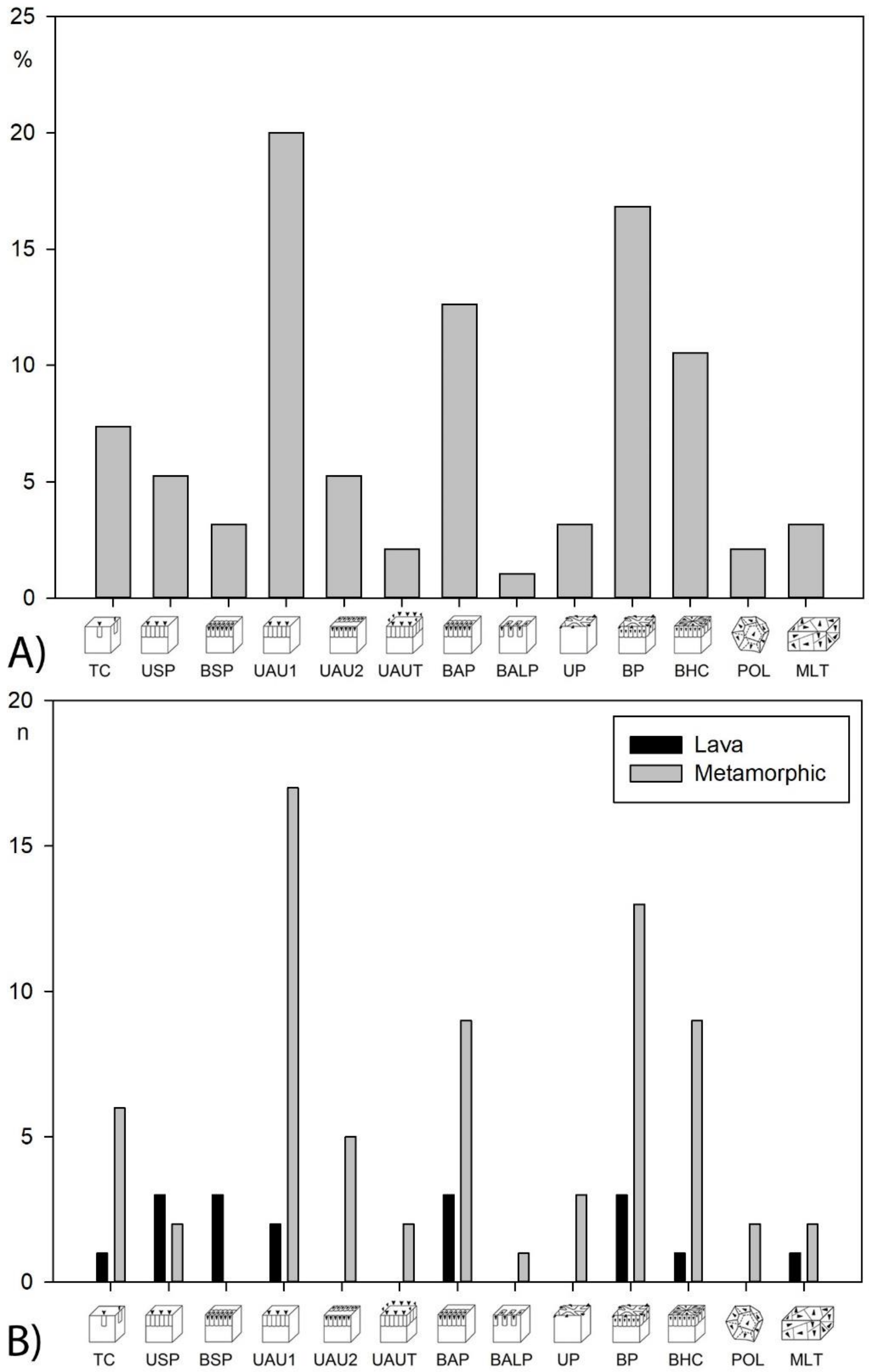

Figure 6. Freehand knapping schemes identified in the SHK-Annexe core assemblage. A) Entire freehand core assemblage. B) Freehand knapping schemes per raw materials. Abbreviations (extracted from de la Torre and Mora 2018b): TC: Test core. USP: Unifacial simple partial exploitation. USP2: Unifacial simple partial exploitation on two independent knapping surfaces. BSP: Bifacial simple partial. UAU1: Unidirectional abrupt unifacial exploitation on one knapping surface. UAU2: Unidirectional abrupt unifacial exploitation on two independent knapping surfaces. UAUT: Unifacial abrupt unidirectional total exploitation. UABI: Unifacial abrupt bidirectional. BAP: Bifacial abrupt partial. BALP: Bifacial alternating partial. BALT: Bifacial alternating total. UP: Unifacial peripheral. BP: Bifacial peripheral. UC: Unifacial centripetal. BHC: Bifacial hierarchical centripetal.

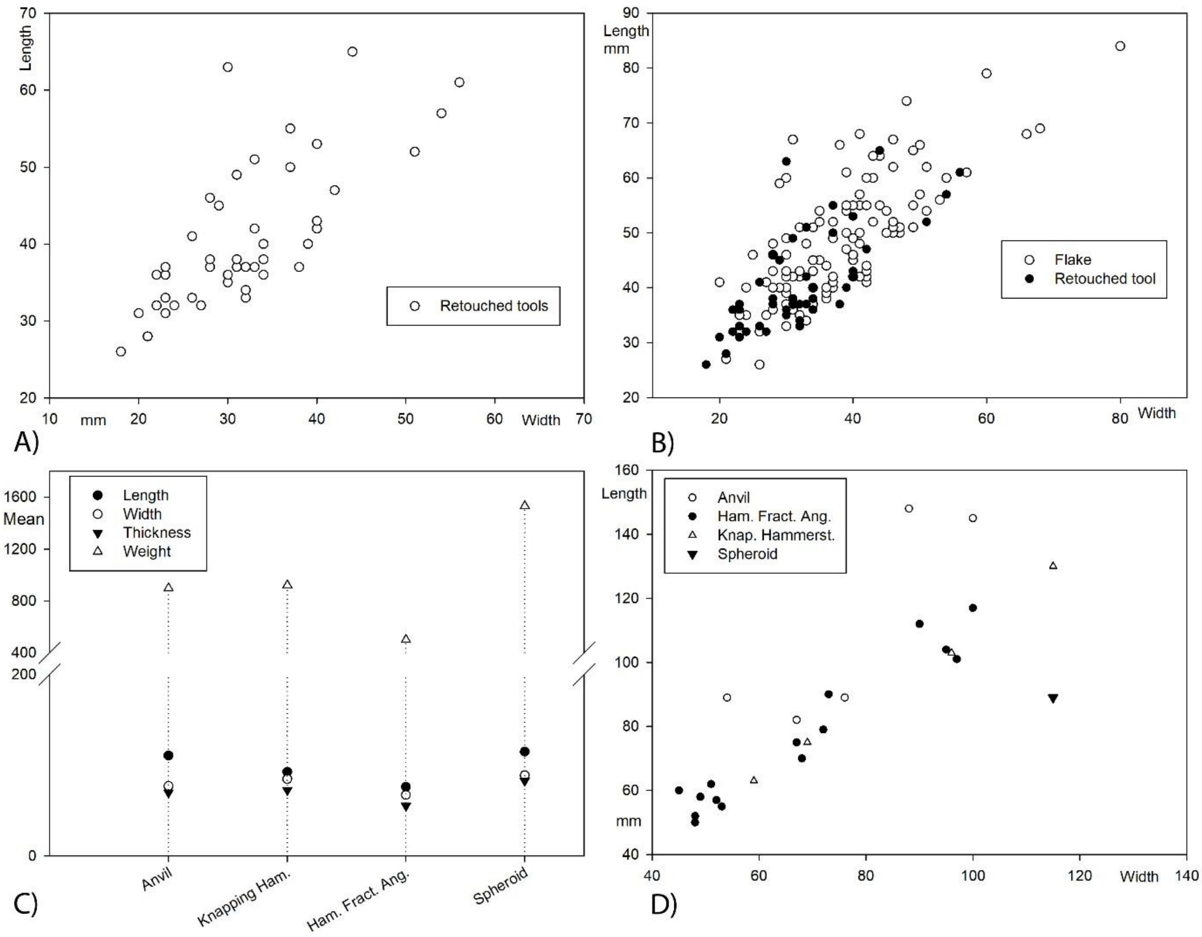

Figure 7. Dimensional features of relevant technological categories. A) Scatter plot of length and width of retouched tools attributed to the chaîne opératoire of small debitage. B) Length and width distribution of small debitage retouched pieces and whole flakes. C) Average dimensions of pounding categories. D) Length and width distribution of pounding categories.

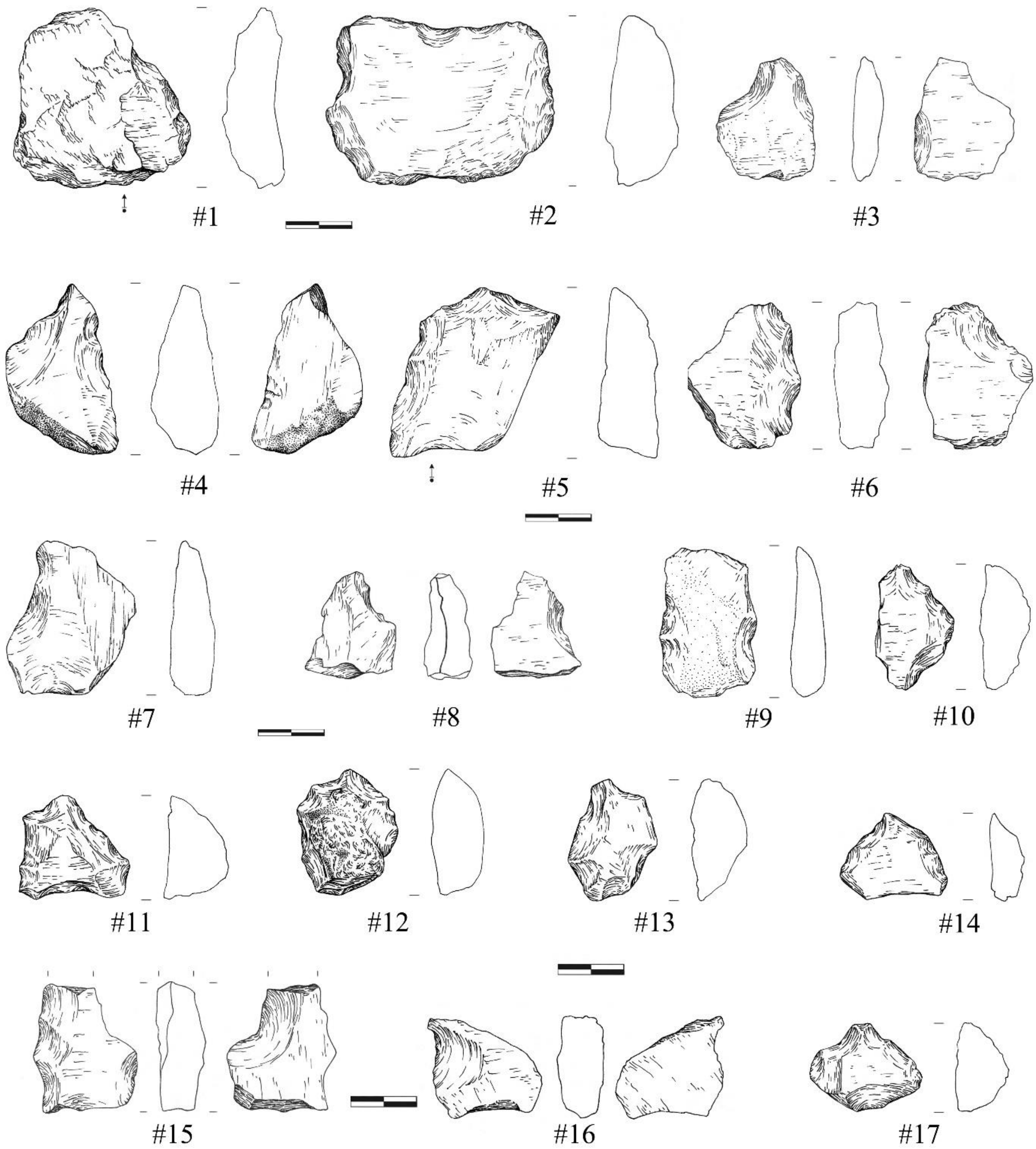

Figure 8. Retouched tools (denticulates and notches) of the small debitage chaîne opératoire at SHK-Annexe.

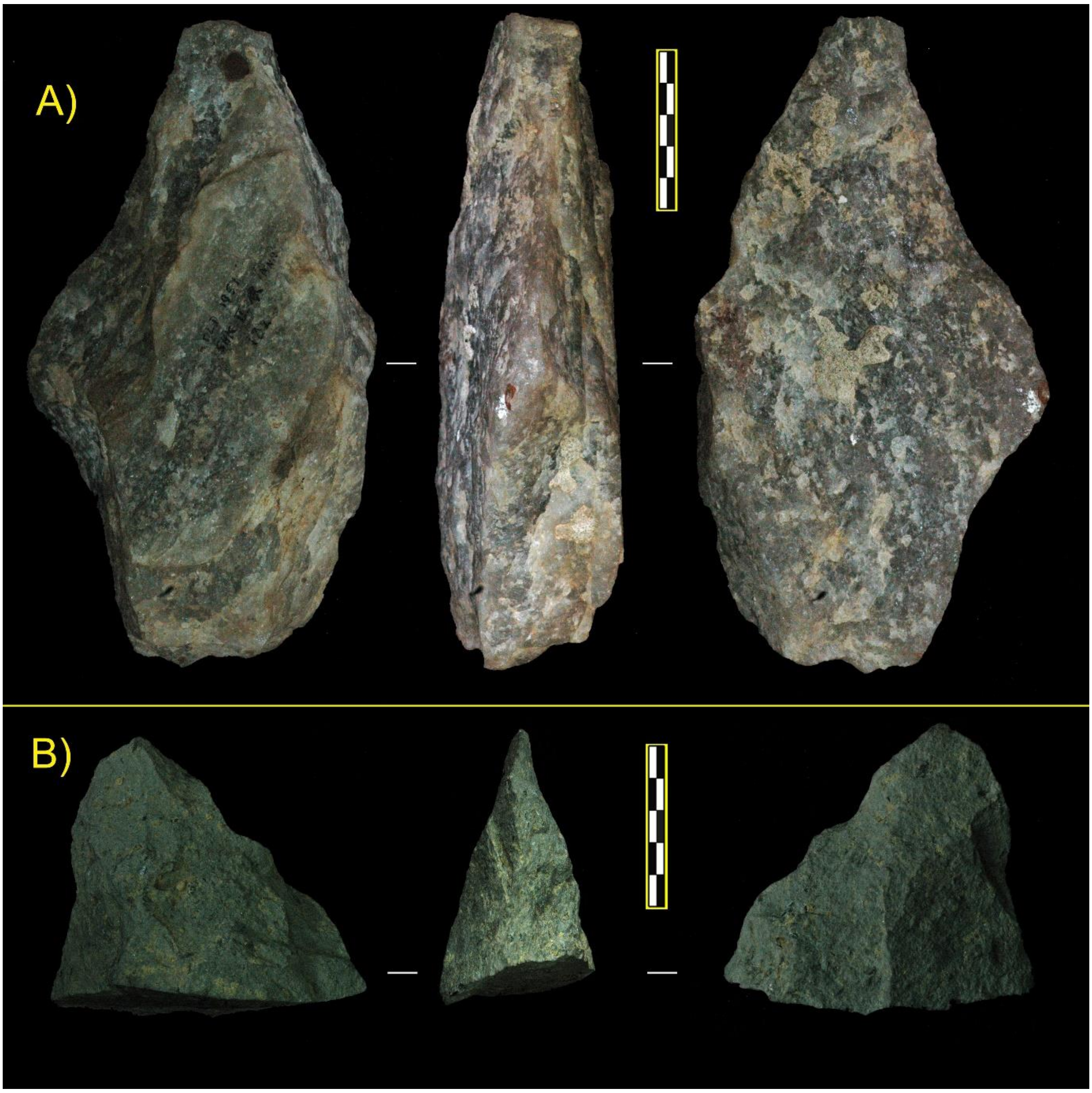

Figure 9. Handaxe evidence in SHK-Annexe. A) Complete quartzite knife. B) Tip of a broken LCT.

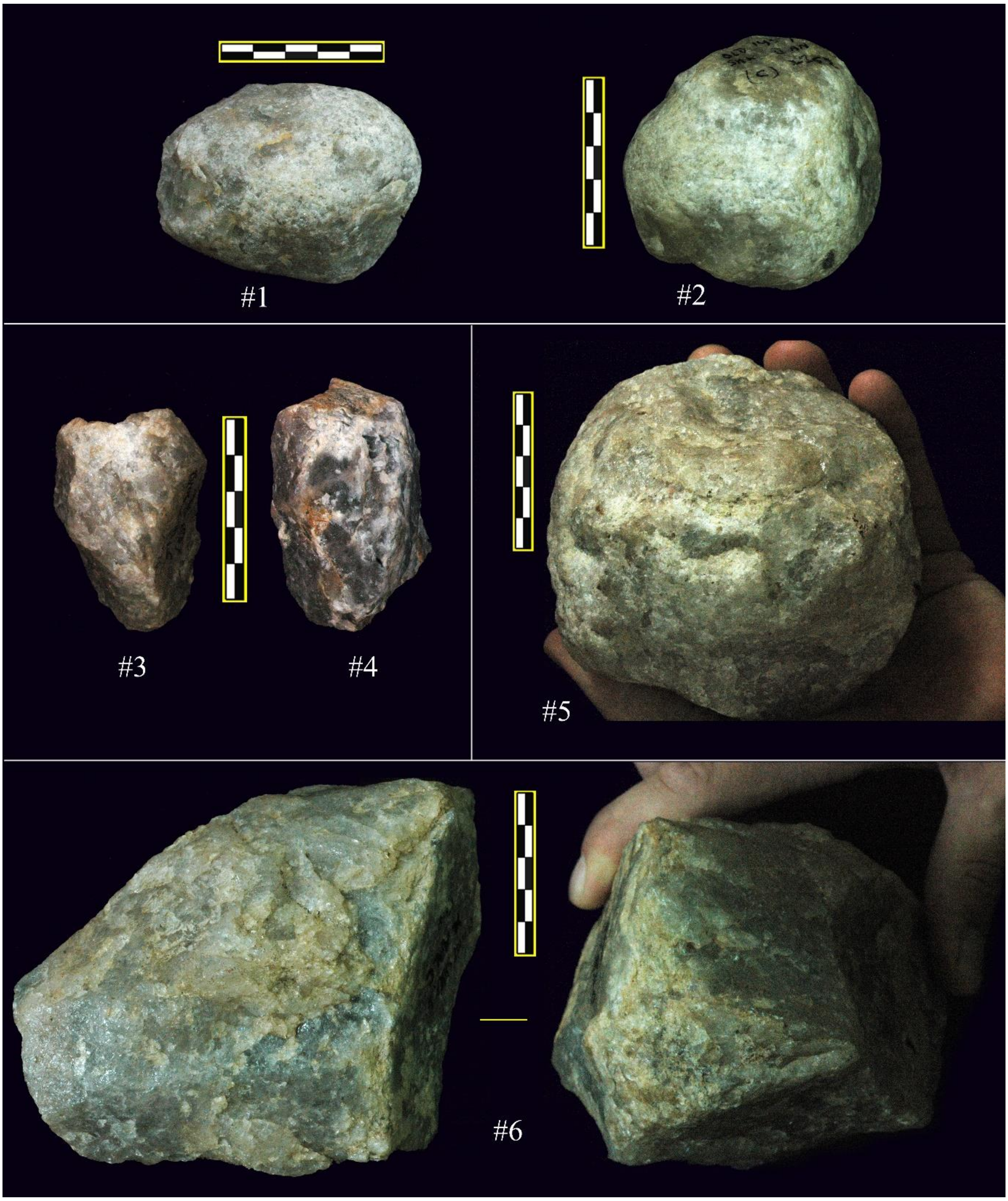

Figure 10: Battered quartzite tools at SHK-Annexe. #1-2: Regular hammerstones. #3-4: Battered surfaces in hammerstones recycled as cores. #5: Hammerstone with active edges. #6: Anvil with edge scarring (left) and clustered battering (right).

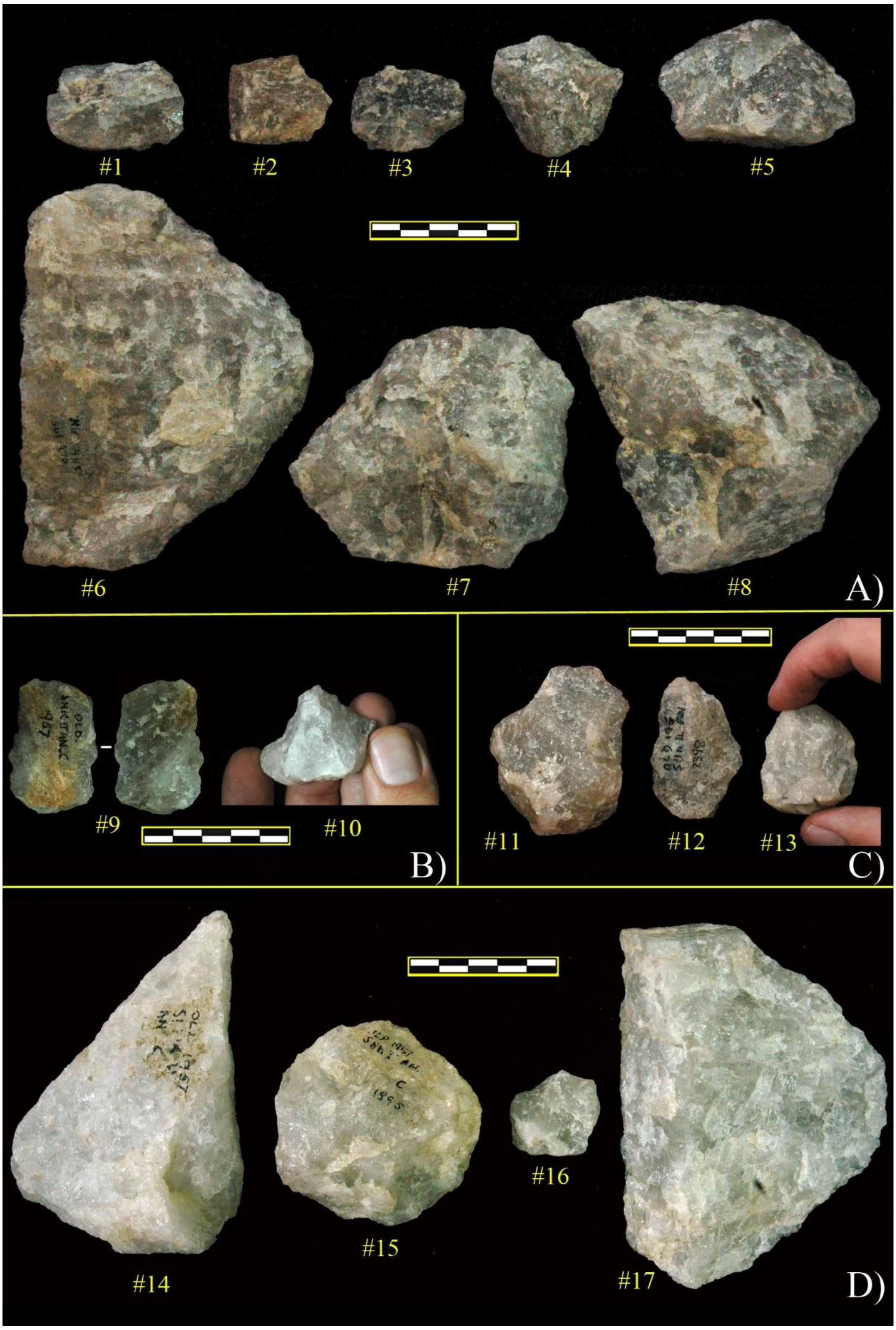

Figure 11. A) Quartzite flakes attributed to the reduction sequences of small debitage (#1-5) and of LCT production (#6-8). B) Small retouched tools of the small debitage chaîne opératoire. C) Examples of diminutive bifaces according to Leakey. D) LCT large flakes (#14, #17) compared to small debitage cores (#15, #16).

Tables

		Phonolite				Basalt/ T-Ta				Metamorphic*				Total			
		Frequency		Weight		Frequency		Weight		Frequency		Weight		Frequency		Weight	
		n	%	Sum	%	n	%	Sum	%	n	%	Sum	%	n	%	Sum	
Detached	Flake	5	62.5	249	87.0	14	60.9	605	63.0	112	46.7	5048	40.0	131	48.3	5902	42.6
	Flake frag	3	37.5	37	13.0	9	39.1	356	37.0	91	37.9	4824	38.2	103	38.0	5217	37.6
	Shatter		0.0				0.0			37	15.4	2750	21.8	37	13.7	2750	19.8
	Total Detached	8	3.0	286	2.1	23	8.5	961	6.9	240	88.6	12623	91.0	271	55.1	13869	19.4
Flaked	Core	5	83.3	1891	90.2	12	85.7	6976	95.1	81	52.3	23528	84.1	98	56.0	32395	86.6
	Core Frag		0.0				0.0			28	18.1	2094	7.5	28	16.0	2094	5.6
	Retouched tool		0.0			1	7.1	62	0.8	45	29.0	1195	4.3	46	26.3	1257	3.4
	LCT		0.0				0.0			1	0.6	1160	4.1	1	0.6	1160	3.1
	LCT frag	1	16.7	206	9.8	1	7.1	301	4.1		0.0		0.0	2	1.1	507	1.4
	Total Flaked	6	3.4	2097	5.6	14	8.0	7339	19.6	155	88.6	27977	74.8	175	35.6	37412	52.5
Pounded	Anvil		0.0				0.0			5	11.4	4494	24.5	5	10.9	4494	22.4
	Hammerstone	1	100.0	258	100.0		0.0			3	6.8	3426	18.7	4	8.7	3684	18.4
	Knap. Ham. Frag		0.0				0.0			21	47.7	2823	15.4	21	45.7	2823	14.1
	Ham. Fract. Angles		0.0			1	100.0	1469	100.0	14	31.8	6045	33.0	15	32.6	7514	37.5
	Spheroid		0.0				0.0			1	2.3	1532	8.4	1	2.2	1532	7.6
	Total Pounded	1	2.2	258	1.3	1	2.2	1469	7.3	44	95.7	18320	91.4	46	9.3	20047	28.1
	Grand Total	15	3.0	2641	3.7	38	7.7	9768	13.7	439	89.2	58919	82.6	492	100.0	71328	100.0

Table 1. General breakdown of technological categories in the SHK-Annexe assemblage. *All quartzite except two gneiss artefacts (one piece of shatter and a core).

	Small debitage						LCT production						Indeterminable*						Grand Total	
	Lava		Metamorphic		Total		Lava		Metamorphic		Total		Lava		Metamorphic		Total			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Flake	18	100.0	93	100.0	111	100.0		0.0	11	100.0	11	100.0	1	7.7	8	5.9	9	6.0	131	48.3
Flake frag		0.0		0.0		0.0		0.0		0.0		0.0	12	92.3	91	66.9	103	69.1	103	38.0
Shatter		0.0		0.0		0.0		0.0		0.0		0.0		0.0	37	27.2	37	24.8	37	13.7
Detached Total	18	6.6	93	34.3	111	41.0		0.0	11	4.1	11	4.1	13	4.8	136	50.2	149	55.0	271	100.0
Core	17	94.4	81	52.6	98	57.0		0.0		0.0		0.0		0.0		0.0		0.0	98	56.0
Core Frag		0.0	28	18.2	28	16.3		0.0		0.0		0.0		0.0		0.0		0.0	28	16.0
Retouched tool	1	5.6	45	29.2	46	26.7		0.0		0.0		0.0		0.0		0.0		0.0	46	26.3
LCT		0.0		0.0		0.0		0.0	1	100.0	1	33.3		0.0		0.0		0.0	1	0.6
LCT frag		0.0		0.0		0.0	2	100.0		0.0	2	66.7		0.0		0.0		0.0	2	1.1
Flaked Total	18	10.3	154	88.0	172	98.3	2	1.1	1	0.6	3	1.7		0.0		0.0		0.0	175	100.0
Anvil		0.0		0.0		0.0		0.0		0.0		0.0		0.0	5	11.4	5	10.9	5	10.9
Hammerstone		0.0		0.0		0.0		0.0		0.0		0.0	1	50.0	3	6.8	4	8.7	4	8.7
Knap. Ham. Frag		0.0		0.0		0.0		0.0		0.0		0.0		0.0	21	47.7	21	45.7	21	45.7
Ham. Fract. Angles		0.0		0.0		0.0		0.0		0.0		0.0	1	50.0	14	31.8	15	32.6	15	32.6
Spheroid		0.0		0.0		0.0		0.0		0.0		0.0		0.0	1	2.3	1	2.2	1	2.2
Pounded Total		0.0		0.0		0.0		0.0		0.0		0.0	2	4.3	44	95.7	46	100.0	46	100.0
Grand Total	**36**	**7.3**	**247**	**50.2**	**283**	**57.5**	**2**	**0.4**	**12**	**2.4**	**14**	**2.8**	**15**	**3.0**	**180**	**36.6**	**195**	**39.6**	**492**	**100.0**

Table 2. Frequencies of artefacts in the chaînes opératoires of small debitage and LCT production. *Stone tools that show no defining features attributable to the small debitage or LCT reduction sequences.

	Small debitage						LCT production						Indeterminable*						Grand Total	
	Lava		Metamorphic		Total		Lava		Metamorphic		Total		Lava		Metamorphic		Total			
	g	%	g	%	g	%	g	%	g	%	g	%	g	%	g	%	g	%	g	%
Flake	790	100.0	2908	100.0	3697	100.0		0.0	1922	100.0	1922	100.0	64	14.0	219	2.8	282	3.4	5902	42.6
Flake frag		0.0		0.0		0.0		0.0		0.0		0.0	393	86.0	4824	61.9	5217	63.2	5217	37.6
Shatter		0.0		0.0		0.0		0.0		0.0		0.0		0.0	2750	35.3	2750	33.3	2750	19.8
Detached Total	790	5.7	2908	21.0	3697	26.7		0.0	1922	13.9	1922	13.9	457	3.3	7793	56.2	8250	59.5	13869	100.0
Core	8867	99.3	23528	87.7	32395	90.6		0.0		0.0		0.0		0.0		0.0		0.0	32395	86.6
Core Frag		0.0	2094	7.8	2094	5.9		0.0		0.0		0.0		0.0		0.0		0.0	2094	5.6
Retouched tool	62	0.7	1195	4.5	1257	3.5		0.0		0.0		0.0		0.0		0.0		0.0	1257	3.4
LCT		0.0		0.0		0.0		0.0	1160	100.0	1160	69.6		0.0		0.0		0.0	1160	3.1
LCT frag		0.0		0.0		0.0	507	100.0		0.0	507	30.4		0.0		0.0		0.0	507	1.4
Flaked Total	8929	23.9	26817	71.7	35746	95.5	507	1.4	1160	3.1	1666	4.5		0.0		0.0		0.0	37412	100.0
Anvil		0.0		0.0		0.0		0.0		0.0		0.0		0.0	4494	24.5	4494	22.4	4494	22.4
Hammerstone		0.0		0.0		0.0		0.0		0.0		0.0	258	15.0	3426	18.7	3684	18.4	3684	18.4
Knap. Ham. Frag		0.0		0.0		0.0		0.0		0.0		0.0		0.0	2823	15.4	2823	14.1	2823	14.1
Ham. Fract. Angles		0.0		0.0		0.0		0.0		0.0		0.0	1469	85.0	6045	33.0	7514	37.5	7514	37.5
Spheroid		0.0		0.0		0.0		0.0		0.0		0.0		0.0	1532	8.4	1532	7.6	1532	7.6
Pounded Total		0.0		0.0		0.0		0.0		0.0		0.0	1727	8.6	18320	91.4	20047	100.0	20047	100.0
Grand Total	**9719**	**13.6**	**29725**	**41.7**	**39443**	**55.3**	**507**	**0.7**	**3082**	**4.3**	**3588**	**5.0**	**2184**	**3.1**	**26113**	**36.6**	**28297**	**39.7**	**71328**	**100.0**

Table 3. Weight contribution of artefacts in the chaînes opératoires of small debitage and LCT production. *Stone tools that show no defining features attributable to the small debitage or LCT reduction sequences.

	Lava						Metamorphic						Grand Total	
	Detached		Flaked		Lava Total		Detached		Flaked		Metamorphic Total			
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Fresh	12	63.2	9	56.3	21	60.0	106	99.1	74	93.7	180	96.8	201	91.0
Slight	6	31.6	7	43.8	13	37.1	1	0.9	5	6.3	6	3.2	19	8.6
Medium	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Severe	1	5.3		0.0	1	2.9		0.0		0.0		0.0	1	0.5
Grand Tota	19	8.6	16	7.2	35	15.8	107	48.4	79	35.7	186	84.2	221	100.0

Table 4. Edge abrasion in a sample of the SHK-Annexe assemblage.

			Minimum	Maximum	Mean	Std. Deviation
Small flake	Total (n=111)	Length	26.0	84.0	48.5	11.0
		Width	20.0	80.0	38.0	9.9
		Thickness	6.0	34.0	14.6	5.1
		Weight	5.4	160.3	33.3	27.3
	Lava (n=18)	Length	27.0	84.0	51.1	14.6
		Width	21.0	80.0	41.3	14.3
		Thickness	8.0	26.0	15.1	5.3
		Weight	5.4	160.3	43.9	43.8
	Metamorphic (n=93)	Length	26.0	79.0	48.0	10.2
		Width	20.0	68.0	37.3	8.8
		Thickness	6.0	34.0	14.6	5.1
		Weight	6.6	124.2	31.3	22.6
Core	Total (n=98)	Length	29.0	144.0	68.2	26.1
		Width	24.0	133.0	58.1	22.8
		Thickness	20.0	108.0	45.3	18.4
		Weight	15.3	2657.6	334.0	433.5
	Lava (n=17)	Length	60.0	105.0	87.0	13.0
		Width	48.0	101.0	76.7	15.7
		Thickness	35.0	83.0	60.7	13.4
		Weight	126.6	995.1	554.2	257.4
	Metamorphic (n=81)	Length	29.0	144.0	64.2	26.4
		Width	24.0	133.0	54.2	22.3
		Thickness	20.0	108.0	42.1	17.7
		Weight	15.3	2657.6	290.5	448.9
Retouched Tool	Total (n=46)	Length	26.0	65.0	40.6	9.5
		Width	18.0	56.0	31.6	8.7
		Thickness	7.0	37.0	15.4	5.4
		Weight	5.3	116.5	27.3	22.1
	Lava (n=1)	Length	57.0	57.0	57.0	.
		Width	54.0	54.0	54.0	.
		Thickness	17.0	17.0	17.0	.
		Weight	61.8	61.8	61.8	.
	Metamorphic (n=45)	Length	26.0	65.0	40.2	9.3
		Width	18.0	56.0	31.1	8.1
		Thickness	7.0	37.0	15.3	5.4
		Weight	5.3	116.5	26.6	21.7

Table 5. Dimensions (in mm) and weight (in grams) of the main categories in the chaîne opératoire of small debitage.

	Small debitage						LCT production		Indet						All flakes					
	Lava		Metamorphic		Total		Metamorphic		Lava		Metamorphic		Total		Lava		Metamorphic		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
20-39 mm	3	16.7	16	17.2	19	17.1		0.0		0.0	2	25.0	2	22.2	3	15.8	18	16.1	21	16.0
40-59 mm	9	50.0	62	66.7	71	64.0	1	9.1		0.0	5	62.5	5	55.6	9	47.4	68	60.7	77	58.8
60-79 mm	5	27.8	15	16.1	20	18.0	4	36.4	1	100.0	1	12.5	2	22.2	6	31.6	20	17.9	26	19.8
80-99 mm	1	5.6		0.0	1	0.9	3	27.3		0.0		0.0		0.0	1	5.3	3	2.7	4	3.1
100-119 mm		0.0		0.0		0.0	1	9.1		0.0		0.0		0.0	0	0.0	1	0.9	1	0.8
> 119 mm		0.0		0.0		0.0	2	18.2		0.0		0.0		0.0	0	0.0	2	1.8	2	1.5
Total	18	13.7	93	71.0	111	84.7	11	8.4	1	0.8	8	6.1	9	6.9	19	14.5	112	85.5	131	100.0
Non-faceted	1	5.9	7	7.8	8	7.5		0.0	1	100.0	1	33.3	2	50.0	2	11.1	8	7.7	10	8.2
Unifaceted	16	94.1	76	84.4	92	86.0	11	100.0		0.0	2	66.7	2	50.0	16	88.9	89	85.6	105	86.1
Bifaceted		0.0	6	6.7	6	5.6		0.0		0.0		0.0		0.0		0.0	6	5.8	6	4.9
Multifaceted		0.0	1	1.1	1	0.9		0.0		0.0		0.0		0.0		0.0	1	1.0	1	0.8
Total	17	13.9	90	73.8	107	87.7	11	9.0	1	0.8	3	2.5	4	3.3	18	14.8	104	85.2	122	100.0
Cortical	4	23.5	14	15.4	18	16.7	3	27.3		0.0		0.0		0.0	4	22.2	17	16.3	21	17.2
Cortex >50%	1	5.9	7	7.7	8	7.4		0.0		0.0	1	50.0	1	33.3	1	5.6	8	7.7	9	7.4
Cortex <50%	2	11.8	2	2.2	4	3.7		0.0		0.0		0.0		0.0	2	11.1	2	1.9	4	3.3
Non-cortical	10	58.8	68	74.7	78	72.2	8	72.7	1	100.0	1	50.0	2	66.7	11	61.1	77	74.0	88	72.1
Total	17	13.9	91	74.6	108	88.5	11	9.0	1	0.8	2	1.6	3	2.5	18	14.8	104	85.2	122	100.0
I		0.0	2	2.3	2	1.9		0.0		0.0		0.0		0.0	0	0.0	2	2.0	2	1.7
II		0.0		0.0		0.0		0.0		0.0		0.0		0.0	0	0.0	0	0.0		0.0
III	1	6.3	5	5.7	6	5.8		0.0	1	100.0	1	50.0	2	66.7	2	11.8	6	5.9	8	6.8
IV	2	12.5		0.0	2	1.9		0.0		0.0		0.0		0.0	2	11.8	0	0.0	2	1.7
V	5	31.3	21	23.9	26	25.0	3	27.3		0.0	1	50.0	1	33.3	5	29.4	25	24.8	30	25.4
VI	8	50.0	60	68.2	68	65.4	8	72.7		0.0		0.0		0.0	8	47.1	68	67.3	76	64.4
Total	16	13.6	88	74.6	104	88.1	11	9.3	1	0.8	2	1.7	3	2.5	17	14.4	101	85.6	118	100.0

Table 6. Main features of whole flakes attributed to the chaîne opératoire of small debitage.

		Lava		Metamorphic		Total	
		n	%	n	%	n	%
Length class	20-39 mm		0.0	13	16.0	13	13.3
	40-59 mm		0.0	28	34.6	28	28.6
	60-79 mm	3	17.6	21	25.9	24	24.5
	80-99 mm	10	58.8	12	14.8	22	22.4
	100-119 mm	4	23.5	3	3.7	7	7.1
	120-139 mm		0.0	2	2.5	2	2.0
	>139 mm		0.0	2	2.5	2	2.0
	Total	17	17.3	81	82.7	98	100.0
Weight class	<50 g		0.0	14	17.3	14	14.4
	50-100 g		0.0	2	2.5	2	2.1
	101-200 g	2	12.5	17	21.0	19	19.6
	201-400 g	3	18.8	13	16.0	16	16.5
	401-800 g	8	50.0	11	13.6	19	19.6
	801-1600 g		0.0	20	24.7	20	20.6
	> 1600 g	3	18.8	4	4.9	7	7.2
	Total	16	16.5	81	83.5	97	100.0
Cortex	Cortex >50%	9	56.3	13	20.3	22	27.5
	Cortex <50%	4	25.0	25	39.1	29	36.3
	Non-cortical	3	18.8	26	40.6	29	36.3
	Total	16	20.0	64	80.0	80	100.0
Blank	Cobble	13	86.7	21	46.7	34	56.7
	Block		0.0	8	17.8	8	13.3
	Fragment	2	13.3	14	31.1	16	26.7
	Flake		0.0	2	4.4	2	3.3
	Total	15	25.0	45	75.0	60	100.0
Battering	Esquillees		0.0	7	8.6	7	7.1
	Impacts	5	29.4	32	39.5	37	37.8
	Absent	12	70.6	42	51.9	54	55.1
	Total	17	17.3	81	82.7	98	100.0
Number of scars	1-3 scars	1	6.7	17	23.3	18	20.5
	4-6 scars	9	60.0	33	45.2	42	47.7
	7-9 scars	2	13.3	21	28.8	23	26.1
	> 9 scars	3	20.0	2	2.7	5	5.7
	Total	15	17.0	73	83.0	88	100.0
Flaking method	TC	1	5.9	6	7.7	7	7.4
	USP	3	17.6	2	2.6	5	5.3
	BSP	3	17.6		0.0	3	3.2
	UAU1	2	11.8	17	21.8	19	20.0
	UAU2		0.0	5	6.4	5	5.3
	UAUT		0.0	2	2.6	2	2.1
	BAP	3	17.6	9	11.5	12	12.6
	BALP		0.0	1	1.3	1	1.1
	UP		0.0	3	3.8	3	3.2
	BP	3	17.6	13	16.7	16	16.8
	BHC	1	5.9	9	11.5	10	10.5
	POL		0.0	2	2.6	2	2.1
	MLT	1	5.9	2	2.6	3	3.2
	BIPO		0.0	7	9.0	7	7.4
	Total	17	17.9	78	82.1	95	100.0

Table 7. Main attributes of small debitage cores.

			Minimum	Maximum	Mean	Std. Deviation
LCT production	Small flake (n= 5)	Length	58.0	74.0	66.6	7.1
		Width	42.0	58.0	52.4	6.5
		Thickness	11.0	25.0	19.0	5.6
		Weight	28.4	102.6	68.0	32.4
	Intermediate flake (n= 1)	Length	83.0	83.0	83.0	.
		Width	60.0	60.0	60.0	.
		Thickness	28.0	28.0	28.0	.
		Weight	158.9	158.9	158.9	.
	LCT blank (n= 5)	Length	92.0	130.0	109.0	17.6
		Width	50.0	120.0	89.8	25.9
		Thickness	25.0	41.0	34.0	6.0
		Weight	152.3	417.2	298.3	98.1
	LCT (n=1)	Length	190.0	190.0	190.0	.
		Width	117.0	117.0	117.0	.
		Thickness	56.0	56.0	56.0	.
		Weight	1159.6	1159.6	1159.6	.
Pounding tools	Anvil (n= 5)	Length	82.0	148.0	110.6	32.9
		Width	54.0	100.0	77.0	17.9
		Thickness	62.0	75.0	70.0	5.4
		Weight	426.5	1541.9	898.8	475.4
	Hammerstone (n= 4)	Length	63.0	130.0	92.8	30.0
		Width	59.0	115.0	84.8	25.5
		Thickness	50.0	106.0	72.8	24.4
		Weight	258.2	1766.0	921.0	697.1
	Ham. Fract. Angles (n= 15)	Length	50.0	117.0	76.1	23.1
		Width	45.0	100.0	67.2	19.9
		Thickness	12.0	95.0	55.5	21.7
		Weight	134.3	1468.8	500.9	446.1
	Spheroid (n=1)	Length	115.0	115.0	115.0	.
		Width	89.0	89.0	89.0	.
		Thickness	83.0	83.0	83.0	.
		Weight	1531.5	1531.5	1531.5	.

Table 8. Dimensions (in mm) and weight (in grams) of pounding tools and artefacts attributed to the chaîne opératoire of LCT production.