TECHNOLOGICAL STRATEGIES IN THE LOWER PLEISTOCENE AT OLDUVAI BEDS I & II

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INTRODUCTION

This book envisages an analysis of the lithic collections from several sites Mary Leakey excavated between 1960 and 1963 in Bed I and II at Olduvai (Tanzania), currently stored at the National Museum of Nairobi (Kenya) and previously published in a classic monograph (Leakey 1971). Nonetheless, we have conceived this study from a standpoint that relates more to aspects concerning technical production than to the typological issues that governed Leakey's approximation. Furthermore, the Olduvai collections will be contemplated from a contextual prism, bearing in mind a constant concern in reconstructing the processes that formed the archaeological record, aiming to understand the differences or similarities that appear between the different assemblages.

This monograph focuses on the analysis of lithic materials. We assume blood cannot be squeezed from stones, paraphrasing the title of one of the articles by Isaac (1977b). Yet, we can reconstruct part of the puzzle concerning human evolution by understanding the technological guidelines and technical patterns in use during the transformation processes, which are, in short, telling of the hominids´ behaviour. A meticulous analysis of the lithic objects can provide valuable information to comprehend their technical abilities, cognitive skills and economic concerns. Therefore, each lithic object will be studied analytically, attempting to integrate them in the corresponding stage of the *chaîne opératoire*.

It is essential to keep a distance from the last works that examined the Olduvai sequence (Ludwig 1999; Kimura 1997, 1999, 2002). Therein, artefact categories stand their own ground (in a classically typological conception), and are compared in isolation throughout a chronological sequence. In contrast, we consider that it is essential to analyse each lithic element in connection with others, and each site as a whole, since each assemblage is subjected to specific, exceptional circumstances. Only upon understanding each collection after comparing the different categories it comprises, it is possible to elaborate conclusions that can subsequently be extrapolated and compared to the facts documented in other sites.

This work contains constant references to the terms Oldowan and Acheulean. The Oldowan was defined precisely in Olduvai, therefore this location is the perfect setting for the justification of the term. In fact, the term Oldowan has well-defined chronological and cultural connotations, whilst Mode 1 defined by Grahame Clark (1969) has, over recent years, been used without enough precision. The same occurs with the Acheulean, which will predominate herein over the term Mode 2, and which also presents specific technological, chronological and cultural features. One of the key goals this work establishes is precisely to define the attributes that characterise the Oldowan and the Acheulean, and to attempt to understand the technological and cultural connotations this differentiation entails. Therefore it is essential that this dichotomy exists explicitly in our discourse.

In the first chapter we will expound some general notions on the historiography of the Olduvai expeditions, the stratigraphy, the radiometric and paleo-ecological framework, the archaeological sequence Leakey defined, and the methodology employed in our re-examination. By doing so, we aim to create a suitable contextual framework in which to develop the technological study. As regards all other matters, the index of this work respects a diachronic structure, starting with the oldest sites in Bed I and moving through the archaeological sequence to the top of Bed II, the chronological limit for our research. After presenting a systematic description of each site in its corresponding chapter, general conclusions that summarise and present a global interpretation of the Olduvai sequence appear at the end of the monograph.

Our goal is to combine a systematic study of the lithic reduction methods and *chaînes opératoires,* with a vaster vision that integrates these technical systems in the general framework of the land-use by hominids. We assume that the manufacturing of any stone tool is the result of a series of technical, economic, social and symbolic options that can be encompassed under the term strategies (Perlès 1992:225). From this general perspective, in this work we will attempt to understand the technological strategies used by the humans that lived in Olduvai during the Lower Pleistocene.

Works like these are always brought to fruition thanks to many other people. We would like to thank the staff at the Nairobi museum for their support during our stay at the centre. We thank the Governments of Kenya and Tanzania for authorising us to research the Olduvai collections. Most of the drawings of the lithic material were rendered by N. Morán. We acknowledge the comments on Jorge Martínez-Moreno on an earlier draft of this book. This work has been financed by the *Estades per a la Recerca a Fora de Catalunya* 2001 (BEAI400198) of the Generalitat de Catalunya, and the Projects BHA 2000-0405, BTE 2000-1309, PGC 2000-3342-E and BHA 2002-12145-E of the Spanish Ministerio de Educación y Ciencia. We also thank the Universidad Autónoma de Barcelona, M.J. Fonseca and M. Otte for their support towards having this book published. This is a publication of the Institute of Archaeology, University College London (Ignacio de la Torre) and the Universidad Autónoma de Barcelona (Rafael Mora). Obviously, any errors it could contain are our sole responsibility.

Chapter 1

THE CONTEXTUAL FRAMEWORK OF OLDUVAI

History of the research

En 1911, Kattwinkel found fossils of *Hipparion* in the Olduvai Gorge which he took to Berlin. These discoveries generated a great deal of interest in Germany, so in 1913, Reck studied the palaeontology and geology of the gorge (Reck 1914). He discovered a human skeleton (OH1), which he ascribed to what was then thought to be the Middle Pleistocene of Bed II. Later this skeleton was proved to be intrusive and much more recent (L. Leakey 1931).

The First World War prevented further work being undertaken, and it was Louis Leakey who resumed the expeditions in 1931; the discovery of a primitive lithic industry in Bed I was published for the first time in *Nature* in December of that year. Although the term Oldowan was not yet being employed, it seemed evident that some of the oldest evidence of human culture was being found in Olduvai.

A little later the Oldowan was clearly defined, and it was assumed that "*the Oldowan culture comprises a series of artefacts which are made either from worn pebbles or from lumps of rock. The piece of material to be made into a tool was then trimmed very roughly by striking off flakes in two directions so that the line of intersection of these flake scars gave a jagged cutting edge along one side of the pebble or lump of rock*" (L. Leakey 1936:40). Louis Leakey said that the Oldowan "typical site" was Bed I of what at the time was called Oldoway, where the supposedly alluvial deposits contained an association between that lithic industry and archaic fauna ascribed to the first part of the Middle Pleistocene.

Work in Olduvai was sporadic until 1959. The appearance of the *Zinjanthropus boisei* cranium that year was the first physical evidence of hominids outside South Africa, and in fact its discovery was considered so important that it enabled investigation to be started on a large scale. In 1960, Mary Leakey began a programme of systematic excavations in Beds I and II. The work ended in 1963, after more than 10 archaeological sites had been excavated, providing the material for a detailed monograph (Leakey 1971). Together with the discovery of *Zinjanthropus*, the monograph of the excavations in Beds I and II was the great landmark of African archaeology in these years (Isaac 1984). The publication of Volume 3 of the work in Olduvai implied the assumption of various unprecedented paradigms: the first was the documentation of lithic industries 1.8 my ago. Moreover, that industry appeared in dense concentrations close to bone remains. The first known lithic technology was characterised by cores and flakes, with a few retouched pieces. In addition, Acheulean industries were documented that coexisted with the so-called Developed Oldowan. In short, Leakey's monograph (1971) provided a prodigious compendium of empirical information, and served to structure the entire archaeological sequence of East Africa, comparing the other African sites with the cultural stratigraphy established in Olduvai Beds I and II.

From 1968 to 1971 Mary Leakey excavated in Beds III, IV and Masek Beds. The scientific impact of these excavations was not as great as that of Beds I and II: in the later sequence the fauna is poorly preserved, the remains of hominids are scarce and assemblages are usually found in a secondary position. Furthermore, the monographic publication of these excavations is considerably later (Leakey & Roe 1994), although it is as rigorous and detailed as that of Beds I and II (Leakey 1971).

Despite isolated works by Stiles *et al.* (1974) on Bed II and Kleindienst (1973) on Bed III, no further excavations were undertaken on Bed III until the 1980s. The first of these was directed by Johanson, and in 1986 a partial skeleton of *Homo habilis* was discovered (Johanson *et al.* 1987) just below Tuff IC. By 1974 forty-six human fossils had been found (Leakey 1978), and with OH-62, the total number of hominids discovered in Olduvai came to more than 60.

In 1988, Blumenschine and Masao (1991) began excavations, and these are still in progress. While Leakey's excavations (1971, 1994) concentrated on large areas with conspicuous concentrations, Blumenschine and Masao have approached the task from a landscape archaeology perspective, making pits in the basal part of Bed II. To date preliminary studies on their excavations have been published (Blumenschine & Masao 1991; Deocampo *et al.* 2002), the models generated (Blumenschine & Peters 1998; Peters & Blumenschine 1995), and new remains of *Homo habilis*, which bring the number of hominids recovered in Olduvai to 65 (Blumenschine *et al.* 2003).

Stratigraphical, chronological and paleoecological contexts of Beds I & II

The Olduvai basin was created 2 my ago by the lifting of volcanic highlands to the east and south. Today, the Olduvai gorge, which bisects the Serengeti Plain, begins in lakes Masek and Ndutu and flows eastwards into the Olbalbal Depression. To the south and east of the Olduvai valley are volcanic highlands, and to the north an area of metamorphic mountains. According to Hay (1976), the Olduvai sedimentary deposits are nearly 100 metres deep. This sequence was deposited in a basin 25 kilometres in diameter, and 7 different formations have been distinguished: Beds I, II, III, IV, Masek, Ndutu and Naisiusiu, which cover a time span of between 2.1 my and 15,000 BP.

Bed I, the oldest in the sequence, is no more than 60 metres thick. The oldest deposits, with an age of 2.1 – 2 my, are found only on the western side of the Gorge. In Bed I there are 6 main tuffs, which from bottom to top are referred to as Tuffs IA, IB, IC, ID, IE and IF. All the archaeological sites of Bed I are located in the Upper Member, above Tuff IA and below Tuff IF. According to Hay (1976), during the deposition of Bed I the Olduvai lake was shallow, and its area fluctuated seasonally a great deal. The lake-margin terrains were deposited at levels that were intermittently flooded by the lake, although fresh water flowed through the floodplain of the southeast of the basin, where most of the sites are located (Hay 1976). Deocampo *et al.* (2002) calculate that the lacustrine plain in which the sites in Bed I and the basal part of Bed II are found was some 3 kilometres wide from the shore of the perennial lake to the alluvial fan and that, given the lake's alkalinity and salinity, it would have been covered by open grassland tolerant to salt. The lava flows and alluvial fan deposits are located solely on the eastern margin of the paleolake, while the alluvial plain deposits have only been identified on the western side of the gorge (Hay 1976).

In its 20-30 metres thickness Bed II is extremely variable. Tuff IF, on which the entire sequence of Bed II rests, and Tuffs IIA, IIB, IIC and IID, the latter at the top of the formation, stand out as stratigraphic markers. These tuffs serve to divide Bed II into three different members, along which there are different archaeological remains. The Lower Member of Bed II is formed by sediments deposited between Tuff IF and IIA, the Middle Member by the deposits between Tuff IIA and IIC, and the Upper Member by the deposits between Tuff IIC and the sediments which make up the base of Bed III (Hay 1971, 1976). This author distinguished a greater variety of lithofacies than in Bed I, such as the alluvial fan, alluvial plain, the perennial lake, the lake margin, the aeolian deposits and the stream deposits, which are much more abundant than in Bed I. The basal part of Bed II, well studied in recent years (Deocampo *et al.* 2002; Ashley & Driese 2000; Ashley & Hay 2002), was very similar to that of the previous period: until the deposition of Tuff IIA, there was an alluvial plain and a river delta in the Olduvai basin on the western and northern margins of the lake, and an alluvial fan complex in the eastern and southern parts (Ashley & Hay 2002). In the period represented by Tuffs IIB and IID the Olduvai lake was constantly shrinking and the open and fluvial areas were extending; the deposits on the bottom of the lake were progressively contracting and its floodplain gradually covered a larger area.

Hay (1976) says that, of the 63 archaeological sites so far discovered in Beds I and II, 46 are located in the fluvio-lacustrine deposits on the eastern margin of the lake, while only 16 were on the western shore. Hay (1976) related the concentration of sites on the eastern shore of the lake with the greater abundance of fresh water in this area, associated with a permanent river flowing from the Crater Highlands. He concluded that all the archaeological sites were associated with constant sources of fresh water and vegetation, no evidence of human life being documented in the aeolian tuffs deposited on dry savannas or alluvial plains (Hay 1976:180). Recent studies support this conclusion, and in fact in the random trenches throughout the whole of the territory there would seem to be a correlation between the presence of fresh water and the appearance of artefacts (Deocampo *et al.* 2002).

The first radiometric evidence of Olduvai coincided with the need to establish a chronological framework for the remains of *Zinjanthropus* and *Homo habilis*, which appeared in 1959-1960. Various K-Ar dates were carried out in various tuffs of Bed I and these oscillated between 1.57 and 1.89 my, a date of 1.75 my being suggested for FLK Zinj (L. Leakey *et al.* 1961). When Leakey's monograph (1971) was published, a chronology for the Basal Member of Bed I of around 2-1.8 my was estimated, and Tuff IF was dated at 1.7 my (Hay 1971). The same author warned that there were no satisfactory dates for Bed II, calculating that its top would be between 1-0.7 my.

In recent years new radiometric dates have been obtained. Walter *et al.* (1991, 1992) have used the 40Ar/39Ar laser-fusion method: according to their studies, Tuff IB is between 1.859±0.007 and 1.798±0.004 my, and Tuff IC 1.761±0.028 my, Tuff ID (1,764±0,014 my), Tuff IE (1,75±0,020 my) and Tuff IF (1,749±0,007 my), the upper part of which closes Bed I. Manega (1993) calibrates the dates of Walter *et al.* (1991) and offers new 40Ar/39Ar dates for Beds II and III. Manega (1993) puts Tuff IB at 1.8±0.01 my, Tuff IC in 1,76±0,01 my, Tuff ID in 1,76±0,02 my, Tuff IE in 1,75±0,02 my and Tuff IF in 1,75±0,01ma. He also offers reliable dates for Bed II, situating Tuff IIA at 1.66±0.01 my and IID at 1.48±0.05 my, when it was thought that the top of Bed II would be about 1.2 my (Hay 1976). Manega (1993) dates Tuff IIIA (the bottom of Bed III) at 1.33±0.06 my, which reinforces the greater anti-

Bed	Tuff	Dates (my)
Naisiusiu	Loc. 45	0,04-0,013
Ndutu	Lower Ndutu	>0,40
Masek	-	>0,78**
IV	-	>0,78**
III	IIIA	1,33±0,06
II	IID	1,48±0,05
	IIA	1,66±0,01
I	IF	1,75±0,01
	IE	1,75±0,02
	ID	1,76±0,02
	IC	1,83±0,00*
	IB	1,84±0,00*
	Bed I Lavas	1,87±0,05
	IA	1,98±0,03
Pre-Bed I	Naabi Ignimbrite	2,03±0,01

Table 1.1. 40Ar/39Ar ages by Manega (1993:110). (*) 40Ar/39Ar dates by Blumenschine *et al.* (2003); (**) Paleomagnetism dates (Tamrat *et al.* 1995).

quity of the final part of Bed II. The most recent 40Ar/39Ar dates put Tuff IC of Bed I at 1.839±0.005 my and Tuff IB at 1.845±0.002 my (Blumenschine *et al.* 2003), so Tuff IF and the top of Bed I are probably over 1.75 my old (tabl. 1.1).

The general evolution of the paleoenvironments has been sketched out above, indicating the gradual process of desertification that affected the Olduvai lake. The isotopic study of the carbonates (Cerling & Hay 1986) indicates that during the sedimentation phase of Bed I and the basal part of Bed II, the average temperature of the Olduvai basin was 13°-16°. During the formation of the Lemuta Member, the basin would have been subject to drier and warmer conditions, with temperatures of 22°-25° and a substantial drop in rainfall, giving way later to periods with more humid conditions similar to those of Bed I. According to Cerling and Hay (1986), from the upper part of Bed II to the end of Bed IV conditions would have been stable, with a temperature of 15°-18°. According to Sikes's (1994, 1996) isotopic analyses the climate in the basal part of Bed II was similar to that of present-day lake Nakuru, with an average temperature of 18° and rainfall of 900 mm. Sikes's interpretations (1994, 1996), which assume the presence of gallery forests with which the archaeological sites would be associated, are complemented with the reconstruction by Deocampo *et al.* (2002) based on the geochemistry of the soils; these authors describe a great lacustrine floodplain of open vegetation in which the hominids would not have moved about much, restricting themselves to areas close to sources of fresh water.

Numerous paleoclimatic reconstructions through the fauna exist (for example Potts 1988; Kappelman 1984; Kappelman *et al.* 1997; Andrews 1983; Fernández-Jalvo *et al.* 1998; Plummer & Bishop 1994; Stewart 1994), pollen (Bonnefille 1984), soil analysis (Ashley & Hay 2002; Ashley & Driese 2000; Cerling & Hay 1986; Hay 1976; Deocampo *et al.* 2002; Sikes 1994, 1996) and landscape models (Blumenschine & Peters 1998; Peters & Blumenschine 1995). According to the general synthesis by Potts (1988), in the oldest sites of Bed I (those below Tuff IB) there was a period of humid savanna, with closed vegetation, meadows and pools and an average rainfall of 1000 mm. In the interval between Tuff IB and Tuff IC the vegetation became more open and the climate drier, with a mosaic of meadows, closed savannas and gallery forests. In the basal part of Bed II, Peters and Blumenschine (1996) propose that that there were seasonally exposed lacustrine plains around the perennial lake dominated by grasses that would sustain enormous herds of herbivores (in contradiction with Sikes 1994). Although there would have been some small clumps of trees in this floodplain (where sites such as DK or FLK Zinj were located in Bed I), trees would have been more abundant in the middle and higher part of the lacustrine plain (Peters & Blumenschine 1996). The climate would become progressively more arid and open, and the gradual increase of equids in the sites throughout Bed II would indicate that the hominids were adapting to savanna lands with less and less closed vegetation.

Archaeological sites in Beds I & II

The primary source for studying Olduvai Beds I and II is Leakey's monograph (1971). The historiographic importance of this work has already been mentioned, since it established the foundations on which subsequent archaeological research in East Africa was based. This monograph became the principal point of reference of all archaeological works in two respects, the empirical and also the methodological. Beginning with the latter, it has to be emphasised that until the publication of Leakey's monograph, there was no standardised terminology for discussing the most ancient archaeological assemblages of East Africa. Thanks to Leakey's work a detailed, orderly and comprehensible study appeared which situated different lithic artefacts in a stratigraphic sequence and made it possible to advocate typological evolution.

Since there were no other African assemblages that had been subjected to radiometric dating in the same way as the sites of Beds I and II, the establishment of a sequence of typological development in Olduvai was a key point of reference from which to structure an evolution of lithic artefacts. Thus, to a greater or lesser extent all the studies after Leakey's monograph (1971), particularly in the 1970s (for example Bower 1977; Chavaillon *et al.* 1979; Clark & Kleindienst 1974; Isaac 1976, 1977; Harris & Isaac 1976; Kurashina 1978) but also in the 1980s (Davis 1980; Roche 1980; Stiles 1980; Gowlett 1986; Harris *et al.* 1987; Potts 1988; Willoughby 1987; Toth 1982) and in recent years (Jones 1994; Isaac *et al.* 1997; Kyara 1999; Ludwig 1999; Kimura 1999, 2002; Schick & Toth 1993; de la Torre & Mora 2004) have adopted Leakey's typology to dispute or support her classifications.

The historiographic importance of Leakey's formal methodology and typology was accompanied by a prodigious empirical record: her monograph describes 13 sites that cover the whole of the first part of the early Pleistocene. In these sites Leakey (1971) observed a cultural evolution from the Oldowan typical of Bed I and the basal part of Bed II, up to the Acheulean which emerged after Tuff IIB (Middle Member of Bed II), together with a development of the Oldowan (which she called Developed Oldowan A and B). It was not just of typological, but also contextual, significance since Leakey (1971) underlined the excellent conditions of preservation of most of the sites. This author spoke of authentic living floors and butchering sites in different levels of DK, FLK NN, FLK I, FLK North, HWK, EF-HR, FC West, SHK and TK, and said that the assemblages in a secondary position were few and restricted (with the exception of BK) to not very significant strata.

The antiquity, quantity and quality of the record excavated by Leakey has led many archaeologists to examine the materials of Beds I and II. With regard to the scholars who have personally reviewed the lithic materials, it is curious to observe that those who studied artefacts in the 1970s were not interested in the analysis of complete sites but of specific artefacts, such as Dies and Dies (1980), Bower (1977) and Roche (1980), who studied examples of choppers in different parts of the sequence. This typological approach can still be seen in some studies conducted in the 1980s, such as those of Wynn (1981), Willoughby (1987) and Sahnouni (1991). The latter analysed certain specific artefacts – polyhedrons, subspheroids and spheroids – throughout the whole of the Oldowan sequence. Although they incorporate a great number of analytical variables, both Sahnouni (1991) and in particular Willoughby (1987) respect Leakey's original ascriptions (1971), only adding new attributes to a study that is still typological. Wynn (1981) also opted for interpreting some objects in isolation without analysing their relationships with other categories of tools within each site, but he adopted a more innovative approach, structuring his hypothesis on the craftsmen's spatial, geometric and mental skills.

There are also comprehensive reviews of the Oldowan lithic collections restricted to specific aspects. Of note is the contribution by Kroll (Kroll & Isaac 1984; Bunn & Kroll, 1986), who concentrates on the spatial analysis of FLK Zinj through the study of lithic refits. This work has never been systematically published and only preliminary information exists. Kyara's investigation (1999) also concentrates on a specific aspect of the lithic industry, with a monographic study of the raw materials of Bed II. One of our objections to this study is its rigid adherence to the categories created by Leakey, which, as we shall see in the following chapters, can be questioned. The major problem is the emphasis on a diachronic comparison of the different categories throughout the whole of the sequence, instead of a synchronic reconstruction of the contribution of raw materials in each site. By failing to do this, it is only possible to monitor the changing frequencies of different raw materials in each category of artefacts, when in fact the classification of the categories is in itself questionable.

The same problem, which we could call a "diachronic fixation" affects other supposedly technological modern reviews such as those of Ludwig (1999) and Kimura (1997, 1999, 2002). The merit of Ludwig (1999) is that he reviewed most of the lithic collections of Beds I and II. However, instead of analysing the relationships between the artefacts from each site, this author concentrates on comparing each category over half a million years. From this perspective, Ludwig (1999) never presents a reconstruction of each site's technology, but restricts himself to a formal comparison of attributes outside their contexts (cortex, length, number of scars, etc.) which provides little technological information. This is also the problem with Kimura (1997, 1999, 2002), who explicitly states her interest in what she calls "time trends" (Kimura 2002) or diachronic variations between Beds I and II. Like Ludwig (1999), Kimura concentrates on comparing analytical attributes without seeking a deeper understanding of the technical parameters they generate, and with no examination of knapping methods. However, the studies by Kimura (particularly 1997 and 1999) do explore the dynamics of importing and exporting artefacts in each site and the role of the availability of raw material so (despite the fact that her conclusions are sometimes at variance with those that will presented in the following chapters), her work has relevance.

The first complete review of the lithic collections of whole sites was that conducted by Stiles (1977), who analysed various assemblages from Bed II in order to demonstrate the typological similarities between the Developed Oldowan B and the Early Acheulean. The next complete study was that of Potts (1988), who reviewed various assemblages from Bed I from an innovative standpoint. The main problem is that Potts (1988) was faithful to Leakey's original classification (1971), only modifying the classifications in small details. Since Leakey's classification was basically typological, this prevented Potts (1988) making a technological reconstruction of the activities of each site, far less the knapping methods. Despite these objections, not just the study of the industry but in fact the whole of Potts' study (1988) benefits from an integrated conception of the sites, and from an interest in reconstructing the processes of formation and the paleoecological environment. In this way, Potts (1988) adopted a synchronic perspective in order to ask himself what strategies for obtaining raw materials would be adopted in each site, why certain raw materials were chosen and others were not, and what the dynamics of importing and exporting objects would have been. In short, despite the fact that it was a strictly typological study, the perspective adopted by Potts is fundamental for understanding the strategies adopted for managing lithic resources in Bed I.

Apart from the use-wear study of a few pieces carried out by Sussman (1987), we know of no other studies that involve a first-hand review of the Oldowan lithic materials. However, there are numerous contributions that had been based on the data contained in Leakey's original monograph. The most interesting are those of Jones (1979, 1980, 1981, 1994), who through the use of experimental replicas has proposed various explanations for the diversity and functionality of Acheulean bifaces. Also relevant at a methodological level are the works of Brantingham (1998) and McNabb (1998), who used the frequencies of objects in sites of Beds I and II to propose the hypotheses about mobility through the landscape and the dynamics of importing and exporting artefacts. However, at an empirical level, their conclusions are not very functional, since these authors base themselves directly on the same percentages as Leakey (1971) which, as we shall see in the following chapters, are questionable.

This is the problem with the studies on the differences between the Oldowan and Acheulean of Olduvai (Davis 1980; Stiles 1979, 1980; Callow 1994; Roe 1994, etc.). All these authors have based themselves on the data provided by Leakey (1971) and have used it for conducting statistical analyses. By not examining the artefacts themselves, these scholars have attributed cultural connotations to questionable objects, and based their interpretations on metrics and percentages that can be disproved. Although we shall expand on this problem in chapter 9, we would say here that we consider it dangerous to base models of behaviour on second-hand data, and that the artefacts should be examined personally in order to understand the technical dynamics implicit in their manufacture. This reflection leads us to set out which sites we shall be studying in the coming chapters and why they have been chosen.

The sites analysed in this study

From the assemblages excavated by Leakey (1971) in Beds I and II, seven sites have been chosen (fig. 1.1). A number of criteria were adopted in order to select the assemblages shown in table 1.2: the first and most important was to select collections that Leakey considered to be in primary position, since our major interest is the synchronic reconstruction of the technology and operational sequences employed in each site. For this reason FLK Zinj and the two levels of TK (Lower Floor and Upper Floor) were selected, classified by Leakey (1971) as living floors.

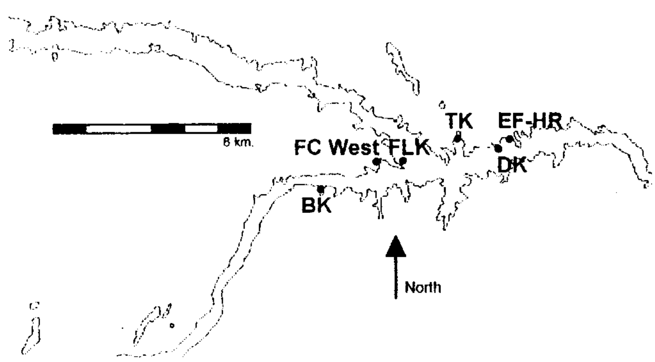


Figure 1.1. Olduvai Gorge with the sites analysed in this study.

Bed II	Upper	II D (1,48 my)	BK TK (Lower & Upper Floors)
		II C (~1,5 my)	
	Middle	II B (~1,6 my)	FC West EF-HR
		II A (1,66 my)	FLK North Sandy Conglomerate
	Lower		FLK North, *Deinotherium* Level
		I F (1,75 my)	
Bed I (Upper Member)	Upper		FLK North, Levels 6-1
		I D (1,76 my)	
	Middle		FLK *Zinjanthropus*
		I B (1,84 my)	
	Lower		DK

Table 1.2. Olduvai sites studied in this work.

Another of the selection criteria was our interest in the earliest technological strategies found in Olduvai, which led us to study DK, situated at the beginning of the archaeological sequence of Bed I. The contextual integrity of this site is not as well preserved as those already cited, but it does contain a numerous lithic collection that makes it possible to reconstruct knapping methods. Moreover, various authors (Gowlett 1986; Davidson 2002; Davidson & Noble 1993; de la Torre & Mora 2004) had referred to possible technical similarities between DK and the technological strategies documented in the Middle Palaeolithic on the basis of the Leakey's original publication (1971), but without having studied the lithic collection at first hand, so it was interesting to test this hypothesis. While DK was chosen for being the earliest Olduvai site, BK was studied for precisely the opposite reason, since it is the site of the most recent assemblages of Bed II, the limit of this study. Given that here, too, attention had been drawn to the similarities with the discoid cores of the Middle Palaeolithic, BK was included in this study, despite its serious contextual problems. Leakey (1971) warned of the secondary position of some of the levels of FLK North. Nevertheless, it was decided to carry out a study of nearly all its levels, in order to discern any possible diachronic differences in the use of the same point in the landscape. In addition, with the aim of understanding the differences proposed by Leakey (1971) between the Developed Oldowan and the Acheulean, FC West and EF-HR respectively were selected, both in primary position.

In short, the selection criteria have led us to study a representative sample of the archaeological evidence of Olduvai Beds I and II. In the following chapters we will attempt to present an orderly and coherent description of their technical features in order to reconstruct the knapping methods, operational sequences and, in general, the underlying technological strategies in each assemblage. The methodology of the lithic analysis will be described in the next section, and it should be emphasised that our classification will not be subordinated to the one proposed by Leakey (1971), arguing and justifying the disagreements that arise. This study will always be approached from a synchronic standpoint, that is, trying to discern the relationships between the different categories which make up an assemblage, and the behavioural response that these imply within specific contextual and temporal parameters. Then, once each assemblage has been characterised, we can go on to evaluate the synchronic and diachronic relationships between different settlements. We hope that the 885 kilograms of stones that have passed through our hands in the Museum of Nairobi will enable original and comprehensible conclusions to be

Leakey (1971)	Isaac *et al*. (1997)	De la Torre & Mora (2004)	This work
Tools	**Flaked pieces**		**Flaked pieces**
Choppers	Choppers	Choppers	Cores
Polyhedrons	Polyhedrons	Polyhedrons	
Discoids	Discoids, regular	Cores	
	Discoids partial		
Proto-bifaces	Discoids, elongate		
Heavy Duty scrapers	Scrapers, core		
Light Duty Scrapers	Scrapers, flake	Retouched flakes	Small retouched pieces
Burins	Other and misc.		
Awls			
Outils écaillés			
Laterally trimmed flakes			
Sundry tools			
Bifaces	Acheulean forms		Large Cutting Tools
Spheroids/ subspheroids	**Pounded pieces**		**Pounded pieces**
Modified battered			
Utilised materials			
Hammerstones	Hammerstones	Hammerstones	Knapping Hammerstones
Utilized cobbles	Battered cobbles		Hammerstones fract. angles
Utilised flakes			Spheroids / subspheroids
Anvils	Anvils		Anvils
Debitage	**Detached pieces**		**Detached pieces**
Flakes	Whole flakes	Whole flakes	Whole flakes
Others	Broken flake	Flake fragments	Flake fragments
	Angular fragments	Angular fragments	Angular fragments
		Chips	Chips
	Core fragments		
Manuports	**Unmodified**	**Manuports**	**Unmodified material**

Table. 1.3. Different classifications of the lithic collections in the East African Lower Pleistocene.

offered on the technological strategies of the Olduvai sequence, which even today remains a fundamental point of reference for studying the hominids of the Early Pleistocene in East Africa.

Methodology for describing the industry

Isaac's desire to simplify (1984, 1986), by trying to synthesise the variety of categories defined by Leakey (1971), has also been our aim in this and previous studies (de la Torre & Mora 2004). However, given that the number of sites and chronological range are very much greater than those we studied previously in Peninj, the number of categories identified has been considerably increased (tabl. 1.3).

Precisely because of this broad temporal and contextual range, describing in this section the different types of objects would not be very elucidating; in Olduvai, many of the classes of artefacts require a contextual discussion of each site. For this reason, we have decided to describe each type of object as it appears in the sequence, since the diachronic structure has also been used to organise the index of this monograph. In this way, idiosyncratic objects such as the hammerstones with fracture angles, anvils, etc, will be described at the point where they are relevant.

The same is true of the methods of exploitation; in previous studies (de la Torre & Mora 2004; de la Torre *et al.* 2003, 2004) the systems of reduction identified could be discussed in advance, since the sample was small and well located geographically and stratigraphically. It was emphasised in those studies that the classification was valid exclusively for the sample being analysed at the time, and that the extrapolation *en bloc* of those systems to other archaeological assemblages was not recommended. A more meaningful approach would be to systematise them as they appeared in the archaeological sequence, rather than start with a long list of alternative forms of exploitation, technical options that would not be understood without studying each site first.

We are aware that postponing the definition of each type of object or method of exploitation until it first appears in the archaeological record requires the line of reasoning to be followed continuously. This drawback, which makes it impossible to avoid other descriptions or to skip from one part of the study to another, has been carefully considered; each technological phenomenon we describe reflects a specific technical structure that does not allow the various definitions to be taken out of context. Thus, the classification of the various percussion objects could not be understood if we were to restrict ourselves to mentioning the groups identified without offering any technological explanation. This has happened with other examples such as the polyhedrons or choppers, which were rapidly (and superficially) interpreted in another study (de la Torre & Mora 2004), but which in reality present

Dorsal face	Striking platform	
	Cortical	Non-cortical
Cortical		
Cortex > 50%		
Cortex < 50%		
Non-cortical		

Table 1.4. Cortex in the whole flakes.

a more complex set of problems than we had initially realised. Furthermore, we shall not restrict ourselves to describing the typical Oldowan processes of *débitage*, but will also discuss operational sequences of Acheulean *façonnage*, which require a preliminary contextualisation impossible to synthesise in advance. For all these reasons, we trust that the reader will forgive the absence of the traditional description of each category in this section on methodology, and wait for them to appear in the discussion that begins in the next chapter.

That decision affects the systematisation of the cores, the different types of hammerstones and retouched pieces but fortunately it is unnecessary to delay the description of knapping products, which can be categorised analytically irrespective of their characteristics in each site. The percentages of corticality in the flakes have been calculated by combining the presence of cortex in the striking platform and on the dorsal face of the products (tabl. 1.4), although in this study they will only be applied to complete flakes. Combining the cortical character of the striking platform and the dorsal face is very useful, since it enables combined inferences to be made on the exploitation phase of the core and its processes of rotation. Toth's types (1982) are redundant with respect to the characters of table 1.4, since the latter includes all the possibilities contemplated by Toth and is in fact more detailed. However, since Toth's method of classifying the cortex (and not the flake technology, as many mistakenly believe) is so widespread, this attribute will also be included in the analysis of the flakes.

The calculation of the number of dorsal scars of the flakes is a common practice in lithic technology, and has been carried out systematically in African archaeology in recent decades (for example Isaac 1977; Noll 2000; Kimura 1997, Ludwig 1999; Texier 1995; etc.). This variable provides information on the recurrence of knapping on the actual *débitage* surfaces, and is, together with the direction of the preliminary detachments, a basic attribute for deducing the methods of exploitation by which flakes are obtained. These diacritical structures have been very commonly used in European archaeology since their definition (Dauvois 1976), but have received little attention in Africa, which must surely be due to the poor quality of the raw materials available, since it is well known how difficult it is to identify the direction of preliminary detachments in materials other than chert. Most of the material in Olduvai is quartz, in which the ripples are not well preserved and it is usually impossible to reliably reconstruct the direction of the blows preserved on the dorsal faces. For this reason it has sometimes been impossible to determine the direction of the previous scars. In fact, the diacritical outlines of the flakes included in each chapter should be regarded as minimum variations that must be greater than we have been able to identify.

In Olduvai, there is a wide variety of rocks, with metamorphic rocks including quartzes, quartzites and gneisses, and the lavas including basalts, phonolites and trachyandesites. Given the petrological similarity between the Olduvai's quartzes and quartzites (Hay 1976), both will be referred to by the generic term quartzes, most frequently employed in the literature. With regard to the lavas, the differences between the basalts and phonolites are conspicuous, but are not so marked in the case of the trachyandesites. For this reason, and also with a desire to synthesise, in the description of each site they will all be included in the general category of lavas, although in chapter 9 they will be treated separately in order to analyse the sources of supply of each raw material.

We hope that on the basis of the rigorous study of the various lithic collections, we shall be able to offer a systematic picture of the techniques employed in each site. From this starting point, the specific conclusions on each assemblage will be integrated within a broader contextual framework. Our aims are to understand how these craftsmen adapted to their environment and to reconstruct the technological strategies developed by the hominids of the Plio-Pleistocene in Olduvai.

Chapter 2

DK

The archaeological context

The DK site, the oldest of those studied in Olduvai, is situated in the northern part of the eastern Main Gorge. In stratigraphic terms, it is located above the basalt at the base of the Upper Member of Bed I, and its limits are defined by the underlying Tuff IA and the Tuff IB, the latter deposited just above DK. In the original publication (Leakey 1971) a chronology of around 1.75 my was estimated for Tuff IB. However, we now have new dates that put Tuff IB at 1,845±0,002 my (Blumenschine *et al.* 2003), which would make DK even older.

In 1961, Leakey (1971) carried out excavations at 4 points of the gully, referred to as Trial Trench (in which an area of 6 x 4.5 m was opened), DK IA (12,9 x 7,5 m), DK I Strips 1-111 (16,2 x 13,5 m), DK IB (7,5 m x 6 m) and DK IC (16,5 x 5,4 m). The excavations did not open a continuous stretch, but 3 separate places: a central part (trenches A and B), 80 metres away from the Trial Trench and about 100 metres from Trench C. The resulting stratigraphic core from base to surface consisted of:

- Level 4. Silts, clays and tuffs filling depressions in the basalt (at the base of the Upper Member of Bed I);
- Level 3. 30-75 cm of grey-buff clayey tuff. The archaeological materials were concentrated in a 9 cm deposit, with a density of 5,6 pieces per m^3;
- Level 2. 60-75 cm of buff-coloured clayey tuff. The archaeological materials were concentrated in a 67,5 cm deposit, with a density of 2,3 pieces per m^3;
- Level 1. 45-60 cm of brown clay with lenses of fine-grained white tuff. The archaeological materials were concentrated in a 52,5 cm deposit, with a density of 1 piece per m^3;
- 1,2-1,5 meters of Tuff IB.

Kroll (1994:113) states that 231 m^2 were opened in level 3 of DK, and Potts (1988:333) calculates that a total of 345 m^2 were excavated, estimating a density of 32.4 pieces per m^3, which would seem higher than that suggested by Leakey (1971:260), the 4.9 artefacts per m^2 suggested by Kimura (2002:296) and the 0.18 artefacts per m^2 calculated by Isaac and Crader (1981:64). Leakey found fauna and industry in levels 1, 2 and 3, although the only appreciable concentration was located in the lower part of level 3, thus constituting a clearly-defined archaeological horizon on a paleosol, compared with the scattered objects in the rest of the sequence. This paleosol at the base of level 3 was eroded before the industry and bones were deposited, showing several channels that Leakey (1971:23) attributes to game tracks.

Potts (1988) underlines that, despite the fact that the general sedimentary context in the site is one of silty clays, there also are gravels and pebbles of 2-64 mm scattered amongst finer sediments, not just in the excavation site but also in all the deposits below Tuff IB in this area. For this reason, Potts (1988:59) notes that the processes that formed DK were much more complex than Leakey suggested, and the site could have been a depression into which sedimentary deposits were washed with considerable force from various directions, including natural cobbles but also bones and artefacts.

Apart from two species of turtle, in levels 2 and 3 of DK bovidae, suidae, equidae, carnivores, proboscidea, rhinoceros, hippopotamidae, giraffidae and primates were identified. In fact, there was a greater variety of species present in DK than in any other part of Bed I (Potts 1988). Geochemical analyses indicate humidity of 800 mm per annum, which, together with the study of the fauna, led Potts (1988) to reconstruct the site as a humid savannah environment, with closed eco-system associated with meadows and pools (see also Plummer & Bishop 1994).

It is difficult to determine how great a part the action of hominids played in the accumulation of bones. Levels 1 and 2 contain scattered materials that could have accumulated naturally. According to Potts (1988:64), 11% of the bones in DK level 3 and 13% in level 2 display clear fluvial abrasion. However, on the basis of the patterns of skeletal representation, Bunn (1986) asserts that there is clear evidence of anthropic contribution in level 3, with anatomical elements typical of what he calls home bases. Shipman (1986) and Potts (1988) also find cut marks on some of the bones that, together with other analyses such as studies of the patterns of bone fracture (Potts 1988) and the possible existence of bone tools (Shipman 1989), definitively demonstrate human modification of a considerable part of the bone assemblage.

In the main excavation area (DK IA), Leakey (1971:24) identified a circle of stones that she believed could be a dwelling. This circle consisted of vesicular basalts very similar to the lavas that form the bedrock of DK a few centimetres below level 3. Potts (1988), although recognising that the blocks that comprise the circular structure are too large (5-20 cm) to have been carried by water, also stated that it was the same type of vesicular lava that forms the bedrock. Thus Potts (1988) suggested that the circular arrangement of these blocks of basalt could have been produced by the radial distribution of the roots of trees, and that the few bones and artefacts found within the circle would have been deposited later by the action of water.

Given the scarcity of materials in level 1, and the concentration of remains in level 2 and particularly in level 3, it was decided to study the whole of the lithic assemblage together, treating it as a "single cultural stratigraphic unit" (Leakey 1971:25), even though levels 1 and 2 were classified as sites with diffused materials and level 3 as a living floor (Leakey 1971:258).

Leakey's decision to study all the DK lithic material together means that it is now impossible to differentiate artefacts according to levels, since the pieces in the collections in the Museum of Nairobi are only occasionally labelled with information about which sondage they were found in, and very rarely which level they were ascribed to. For this reason, and although in the collection of bones it is possible to differentiate materials by levels, in this study the whole of the lithic collection will be analysed together.

The industry of DK as a whole has been studied by Potts (1988), Ludwig (1999) and Kimura (2002), and part of it by Sahnouni (1991) and Willoughby (1987), who analysed polyhedrons and supposed spheroids, and by Bower (1977) and Wynn (1981, 1989), who studied a number of choppers, apart from the original work published by Leakey (1971). This author studied an original assemblage of 1198 items (Leakey, 1971:39), which was reduced to 1163 when Potts (1988:333) analysed the collections, to 1157 after Ludwig's study (1999:28), to 1134 in the study by Kimura (2002:296), but which has increased again in this analysis (n=1180).

General characteristics of the lithic collection

Materials with different sedimentary histories appear to be present in DK. Originally, the blunt ridges of many pieces was attributed to possible diagenesis that would have caused the rounding of their edges. However, in the course of the study, this rounding was also observed in pieces of quartz, for which the only possible explanation was fluvial abrasion. Thus examples such as the quartz core drawn in figure 12:6

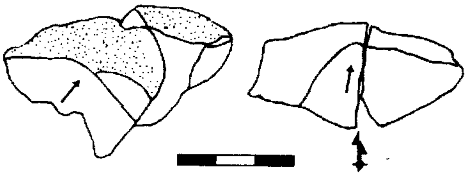


Figure 2.1. Phonolite refitting of two flake fragments (left) and two split fragments (right). Both refits were identified previously to this study.

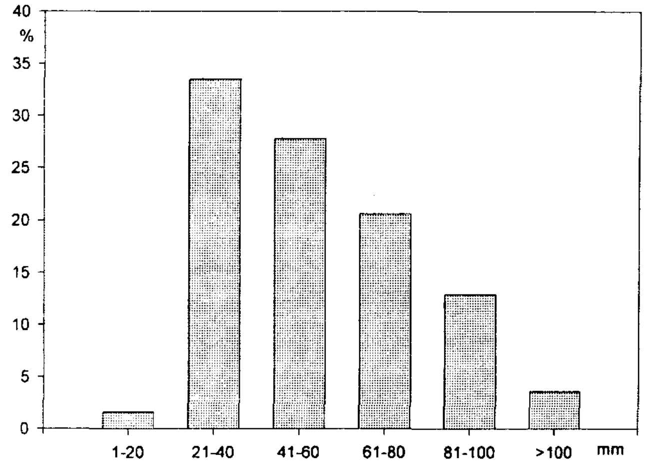


Figure 2.2. Length patterns in the lithic collection from DK (excluding unmodified pieces).

of Leakey (1971:30) is completely rounded and does not belong to the same original set as other pieces in the collection. As in the case of a chert flake fragment, also very rounded, and which we cite here because of the surprise expressed by Hay (1976) at the presence of chert in DK, at a point in the sedimentary sequence where this raw material was not available. After observing the signs of mechanical traction it displays, it can be said that in DK this chert has a post-depositional history unrelated with the main occupation of the site.

It is not our intention to claim the derivative character of the main DK set. In fact, we have some refits (fig. 2.1), something that always provides evidence of the preservation of the original assemblage. Furthermore, the edges of most of the lithic material are very fresh and confirm the primary position of a large proportion of the remains. But, in any case, when classifying the industry by size ranges (fig. 2.2), it was observed that the general dimensions of the collection bear a certain similarity to the structure of sites through which water passed, where the smallest elements are the first to disappear (Schick 1984). Thus we see in DK that the percentage of lithic pieces that are less than 20 mm is very small, although from the next size range (21-40 mm) onwards the frequencies of objects become closer to a normal distribution. Perhaps this indicates that in DK the sorting process was not very intensive, and only eliminated the smallest microdebris without displacing the rest of the archaeological material.

	Unmodified material included		Unmodified material excluded	
	N	%	N	%
Test Cores	7	0.6	7	0.7
Cores	69	5.8	69	6.8
Retouched pieces	10	0.8	10	1
Hammerstones	33	2.8	33	3.2
Whole flakes	115	9.7	115	11.3
Chips	140	11.9	140	13.7
Flake fragments	511	43.3	511	50
Angular fragments	132	11.2	132	12.9
Hammerstone fragments	2	0.2	2	0.2
Fractured hammerstones	2	0.2	2	0.2
Unmodified material	159	13.5	-	-
Total	1180	100	1021	100

Table 2.1. Lithic categories at DK.

In any case, if we add this present analysis of the industry to the comments made by Leakey herself (1971:24) on the abrasion of some of the lithic material from level 3, the information provided by Potts (1988) on the hydrologic disturbance of the fauna and the uneven distribution of the archaeological remains through the 1.6 metre depth of the sequence, it seems obvious that in DK we cannot talk about a single period of occupation but of various episodes of archaeological, and also natural accumulation.

Leakey (1971) considered the industry of DK to be typically Oldowan, with a predominance of choppers, polyhedrons and discoids amongst what she considered to be artefacts and an abundance of flakes amongst the *débitage*. Potts (1988:348) adjusted the percentages of each category slightly, but in general he respected the typology developed by Leakey, as did Kimura (2002) and Ludwig (1999). The present classification (tabl. 2.1) is different from those proposed earlier. The first question to consider is related with the manuports or unmodified lithic material. Leakey (1971:24 and 39) noted the impossibility of considering many of the blocks of vesicular lava scattered over the surface of the excavation to be manuports, since they seemed to have been created by the underlying bedrock breaking up. Consequently in DK she only collected and inventoried the materials in which she observed signs of use. Thus, in her monograph, Leakey (1971:37) describes a numerous collection of cobbles, boulders and nodules that appear to have some signs of use, but not sufficient to classify them either as cores or hammerstones.

In this present review, however, no indisputable signs of use have been found in these pieces, and most of them do not display any kind of human modification. In fact, Leakey herself (1971:37) said that these blocks and pebbles that had apparently been used were of the same vesicular lava that formed the bedrock, in contrast with the material indisputably knapped, habitually working in good quality basalts. Therefore, since there are no clear signs of use and these blocks are of the same raw material as the bedrock, they would seem to be natural pieces and not brought and/or modified by hominids. In terms of quantity (n=159) this unmodified material might be considered unimportant compared with the rest of the collection (see tabl. 2.1). However, this would be a mistake: Potts (1988:350) calculated rather more than 93 kilograms of raw material was worked in DK. This author is thus inconsistent, because there were materials that, as in the present analysis, he considered natural (Potts 1988:348), but he preferred to include them in his recounts as manuports (Potts 1988:350), despite the fact that Leakey herself (1971) rejected the concept of manuports in DK due to the sedimentary context, which was full of natural blocks. In this review, the total collection inventoried adds up to about 103 kilograms. However, when we eliminate the unmodified lithic material from the sample, on the assumption that it is unrelated with human activity, we find that the true lithic industry adds up to little more than 53,700 grams. That is, the actual raw materials brought by hominids to DK would be reduced to almost half that proposed by Potts (1988), which is of enormous importance when considering the real incidence of human activity. Of course, we should not completely exclude the possibility of a human origin for all the unmodified lithic material or that with inconspicuous modifications. Thus, for example, there are up to 10 unmodified pieces of quartz, which, since this raw material is exogenous to the sedimentary context of the site, suggests that they arrived there through human action. In any case, this unmodified quartz represents 0.8% of the number of the DK items and a total of 1,300 grams of raw material, so it is still perfectly valid to propose drastically reducing the volume of raw material related with human activity compared with Potts' estimates (fig. 2.3).

Raw Materials

After restricting the action of hominids to the management of a total of 53-55 kilograms – most of which were lavas (fig. 2.3) – we can study how the raw materials are distributed in terms of technological categories. In table 2.2, it can be seen that the distribution both of the quartzes and the lavas agrees with the general division of technological categories in the site (fig. 2.4). Thus flake fragments, chunks and chips are the most numerous categories for both raw materials, followed by whole flakes.

However, when we compare the two raw materials in terms of the primary categories represented, some less explicit patterns appear in the percentage description. Thus the Lien test (Volle

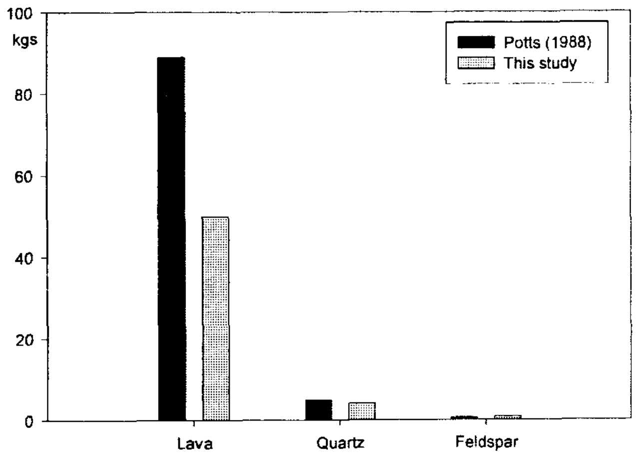


Figure 2.3. Total number of kilograms taken to DK. In his recount of the weight, Potts (1988:350) includes materials that he considers manuports or doubtful (Potts 1988:348), despite the fact that in the context of DK the concept of basalt manuports is not accepted. Potts (1988) is followed in talking of feldspars when generally these pieces were identified as gneiss.

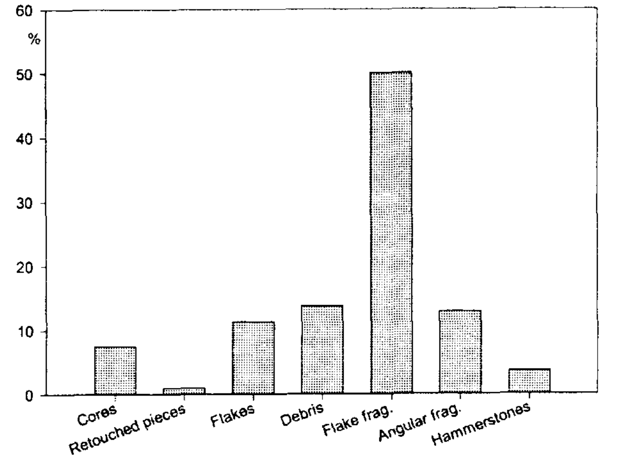


Figure 2.4. Relative frequencies of the categories from DK.

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	0	0	7	0.9	7	0.7
Cores	3	1.4	66	8.2	69	6.8
Retouched pieces	5	2.3	5	0.6	10	1
Hammerstones & frag.	3	1.4	34	4.1	37	3.6
Whole flakes	14	6.5	101	12.5	115	11.3
Chips	46	21.5	94	11.7	140	13.7
Flake fragments	110	51.4	401	49.8	511	50
Angular fragments	33	15.4	98	12.2	132	12.9
Total	214	100	806	100	1021*	100

Table 2.2. Lithic categories in DK classified by raw materials. * The total includes a chunk of gneiss/feldspar which does not appear in the table. The rounded chert fragment and the unmodified lithic material have also been excluded.

1981) indicates a certain duality in the representation of some categories by the raw material (fig. 2.5); the quartz chips, although less frequent (n=46) than the lava debris (n=94) in absolute terms, are more significant in statistical terms. Something very similar occurs with the retouched pieces, which in absolute terms are very scarce in both raw materials (5 quartz pieces and 5 lava pieces), but enormously significant within the quartz group precisely because of its small population. Figure 2.5 also shows a relative scarcity of quartz cores, compared with the abundance of lava cores.

Interpreting the behavioural significance of this statistical trend is not so simple. The clearest pattern is that related with the abundance of lava cores and the scarcity of quartz cores; in the sedimentary context of DK there is a large number of blocks and natural fragments of lava, which could be used immediately as blanks for extracting flakes. Moreover, Hay (1976) and Potts (1988) emphasise the presence of nearby streams from which basalt and phonolite cobbles could be obtained that were of better quality than the vesicular lavas from the DK bedrock. However, the quartz appears to come directly from Naibor Soit, an inselberg some 2-3 km to the northwest of DK (see fig. 1.1). That the source of quartz was further away would not only explain the smaller quantity of quartz in general (fig. 2.3), but also the scarcity of quartz cores in DK. Thus these could either have been taken away when the site was abandoned, or never have been included in the knapping activities of DK, where in this hypothetical case only the products and not the cores would have been brought. This latter proposal is difficult to sustain, since quartz knapping debris are more abundant in percentage terms, and indicate the importance of the *débitage* processes in DK, so in principle it cannot be suggested that the products came into the site already flaked. However, the comparative abundance of retouched quartz compared with the lavas can be linked with more intensive use of a scarce raw material, in this case quartz.

The knapping products

The knapping products (flakes, flake fragments, chunks and chips) are the most numerous groups in the DK assemblage

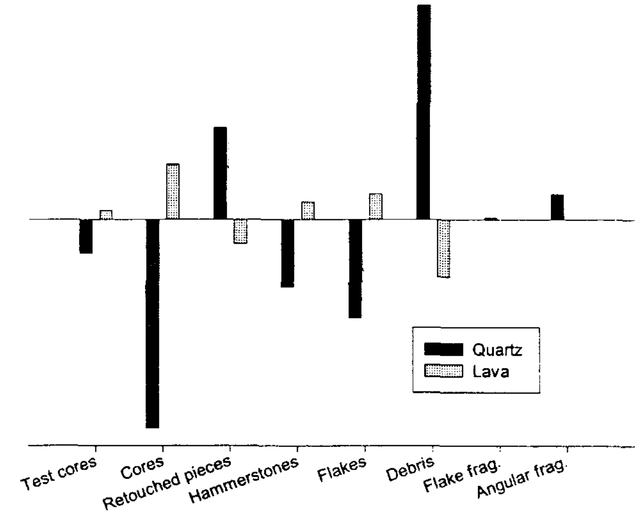


Figure 2.5. Lien Test comparing categories and raw material.

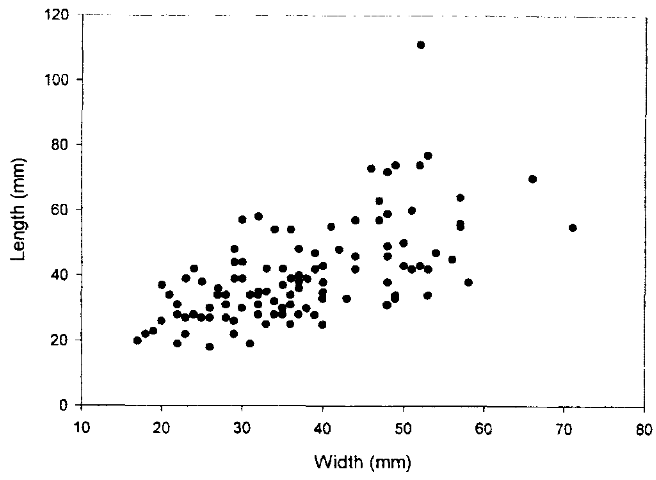


Figure 2.6. Size patterns in the whole flakes.

	Minimum	Maximum	Mean	Std. deviation
Length	18	111	40.18	14.803
Width	17	71	37.41	11.215
Thickness	4	29	11.89	5.404
Weight	2	95	22.6	22.174

Table 2.3. Dimensions (mm. and gr.) of whole flakes from DK.

(see again fig. 2.4), so it would seem obvious that flake production was the main activity pursued in DK. With an average length of 40.18 mm (see tabl. 2.3), whole flakes are however a slightly smaller normal range (fig. 2.7). In morphometric terms, flakes appear to come from a longitudinal pattern of extraction method, something that is also seen in the length/width ratios of these pieces (fig. 2.6), suggesting an elongated rather than rectangular structure.

There are not many of the flakes from initial roughing-out that have cortical butts or full cortical dorsal faces or that are almost totally cortical (4.3%), but a considerable percentage of the pieces have some remains of cortex (see tabl. 2.4). 10.4% of the flakes display natural butts and up to 47.9% of all the flakes have signs of cortex on their dorsal faces (fig. 2.8). The abundance of knapping products with remains of cortex suggests that the raw material was not very intensively exploited, and that there was little recurrence in the core reduction strategies. This pattern is repeated systematically both in the basalts and in the phonolites, which, to judge from the structure of the cortex, are stream cobbles. The position of the cortex in the flakes suggests unifacial and unidirectional strategies in which the whole of the perimeter of the core was rotated, but without changing the striking platform, in a similar way to that proposed by Toth (1982, 1985, 1987) in Koobi Fora.

The butts are nearly all unifaceted (85.2%) and only a few are bifaceted (4.3%), no flake being documented with greater preparation of the knapping platforms (fig. 2.9). Even so, the scarce presence of cortical butts (10.4%) indicates that, either the striking platforms of the cores were prepared or, more

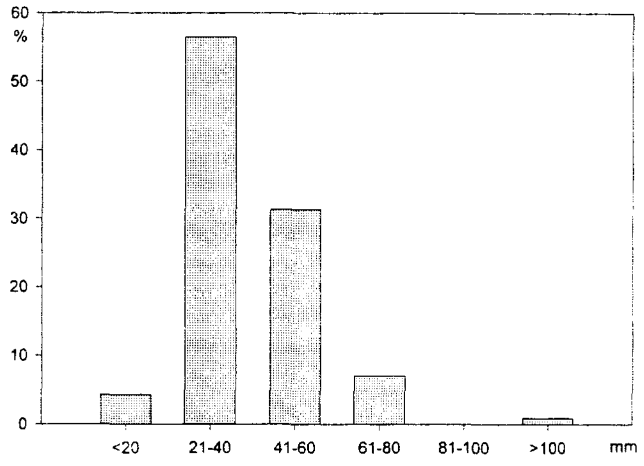


Figure 2.7. Maximum length patterns in the whole flakes.

Dorsal face	Striking platform				Total	
	Cortical		Non-cortical			
	N	%	N	%	N	%
Full cortex	2	1.7	4	3.5	6	5.2
Cortex > 50%	3	2.6	18	15.7	21	18.3
Cortex < 50%	4	3.5	33	28.7	37	32.2
Non-cortical	3	2.6	47	40.9	50	43.5
Total	12	10.4	102	88.8	114	99.2

Table 2.4. Cortical frequencies in the whole flakes from DK.

probably, there was more than one sequence of knapping on each surface exploited. In fact, the flakes without cortex belonging to a generation later than the decortication of the core are also numerous (at least 40.9%), and also present longitudinal patterns which suggest the continuation of knapping from the same platforms from which the initial flaking was carried out (fig. 2.10). Moreover, and despite the dominant unidirectional pattern, up to 3.5% of all the complete flakes were also edge-core flakes, indicating a rather more complex

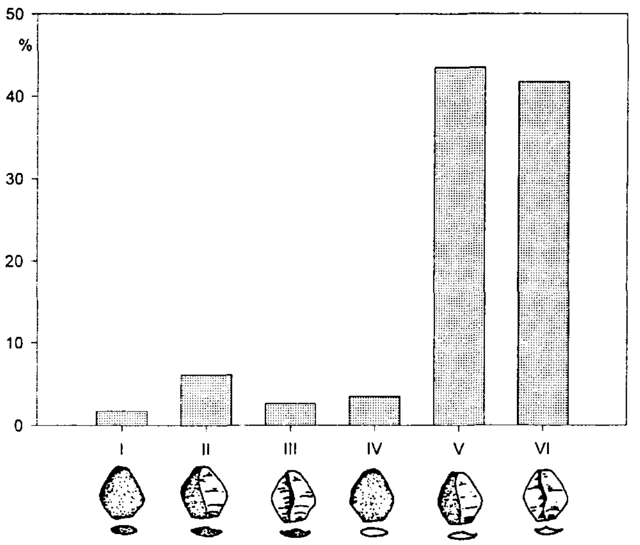


Figure 2.8. Whole flakes from DK according to Toth's (1982) classification.

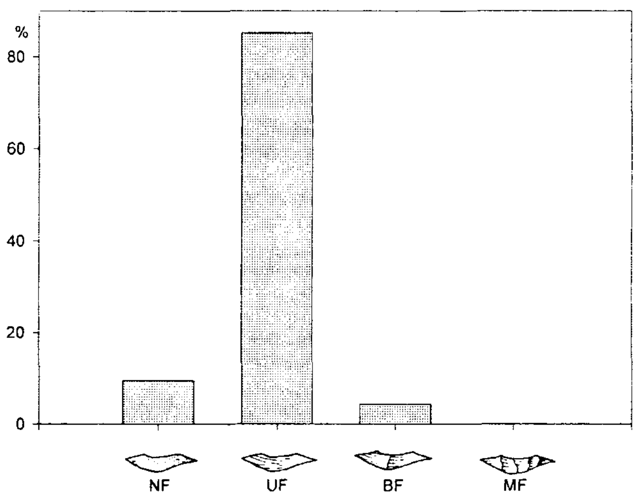


Figure 2.9. Types of striking platforms in the whole flakes from DK.

bifacial handling of the edges than the bulk of the knapping products would seem to indicate (fig. 2.11).

Despite the technological simplicity, good quality flakes were obtained with few knapping accidents. This is probably due not only to the technical expertise of the craftsmen, but also the good quality of most of the phonolites and some of the basalts. This, moreover, shows how much knowledge the hominids of DK had of the mechanical properties of the raw materials, since they generally avoided working with the vesicular lavas available in the site itself, and on the contrary imported basalt and phonolite stream cobbles of very superior quality.

In short, these flakes can be defined as optimum products obtained from relatively simple knapping strategies. An analysis of the dorsal faces supports this hypothesis: the number of previous detachments in the flakes (fig. 2.12) is usually between 1-2 previous scars (50%), although there is a considerable percentage of flakes with 3-4 previous scars (34.2%) and a few with more (5.3%). In the lavas it is difficult to determine the direction of the previous extractions on the dorsal faces of the flakes, although an estimate has been made; most of the reconstructed patterns on the dorsal faces of the flakes belong to a unidirectional knapping technique (fig. 2.13), in which there is some recurrence but not enough to modify the direction of the *débitage*. There are also various examples of flakes indicative of cores being rotated 90° (transversal pattern), which therefore implies the use of an alternative knapping platform. In fact, the third group of examples suggests the existence of two knapping platforms at opposite ends, thus allowing the flakes to be produced in both directions. Finally, in the fourth series of flakes described in figure 2.13, an almost radial handling of the knapping surfaces can be seen that, given that the scars do not usually cut across each other and that they do not really point towards the centre, we have preferred to refer to as a cordal pattern (*sensu* Böeda 1993) and not really centripetal, a distinction that has a certain relevance as will be seen when we describe the knapping methods discerned from an analysis of the cores.

Retouched pieces

According to the present study, retouched flakes (with only 10 examples) constitute a very small percentage (0.8-1%) of the total DK collection. This finding must be emphasised, since our analysis is radically different from the original one carried out by Leakey (1971:39), who considered that this group consisted of 31 items, including side scrapers, burins and sundry tools, and constituted 20.2% of all the tools. Kimura (2002) repeated Leakey's percentages with little modification, so also emphasised the abundant presence of retouched pieces in DK.

However, when the supposed artefacts are analysed in detail, it is observed that many of them cannot be considered retouched. A significant example is that of the burins (Leakey 1971:36, fig. 17): none of them displays burin blows. Furthermore, all three are small blocks (and not flakes), in which the alleged blows do not start from the edge and the scars form obtuse angles. In addition, in one of them the burin blow is in fact a modern fracture. None of the three displays any kind of human modification and all of them can be considered chunks. It would seem advisable to recall the warning made by Potts (1991), who doubted that burins were present in the Bed I sites of Olduvai. In DK, at least, they are not documented.

Something very similar happens with the supposed utilized flakes shown in figure 18 of the Olduvai monograph (Leakey 1971:38); with the exception of a single example that could be retouched, the other pieces are flake fragments with pseudo-retouching or that are extremely rounded, in which it would seem unwise to claim traces of use.

In short, the only pieces that do seem to have been subject to secondary modification are those in figure 2.14, which shows

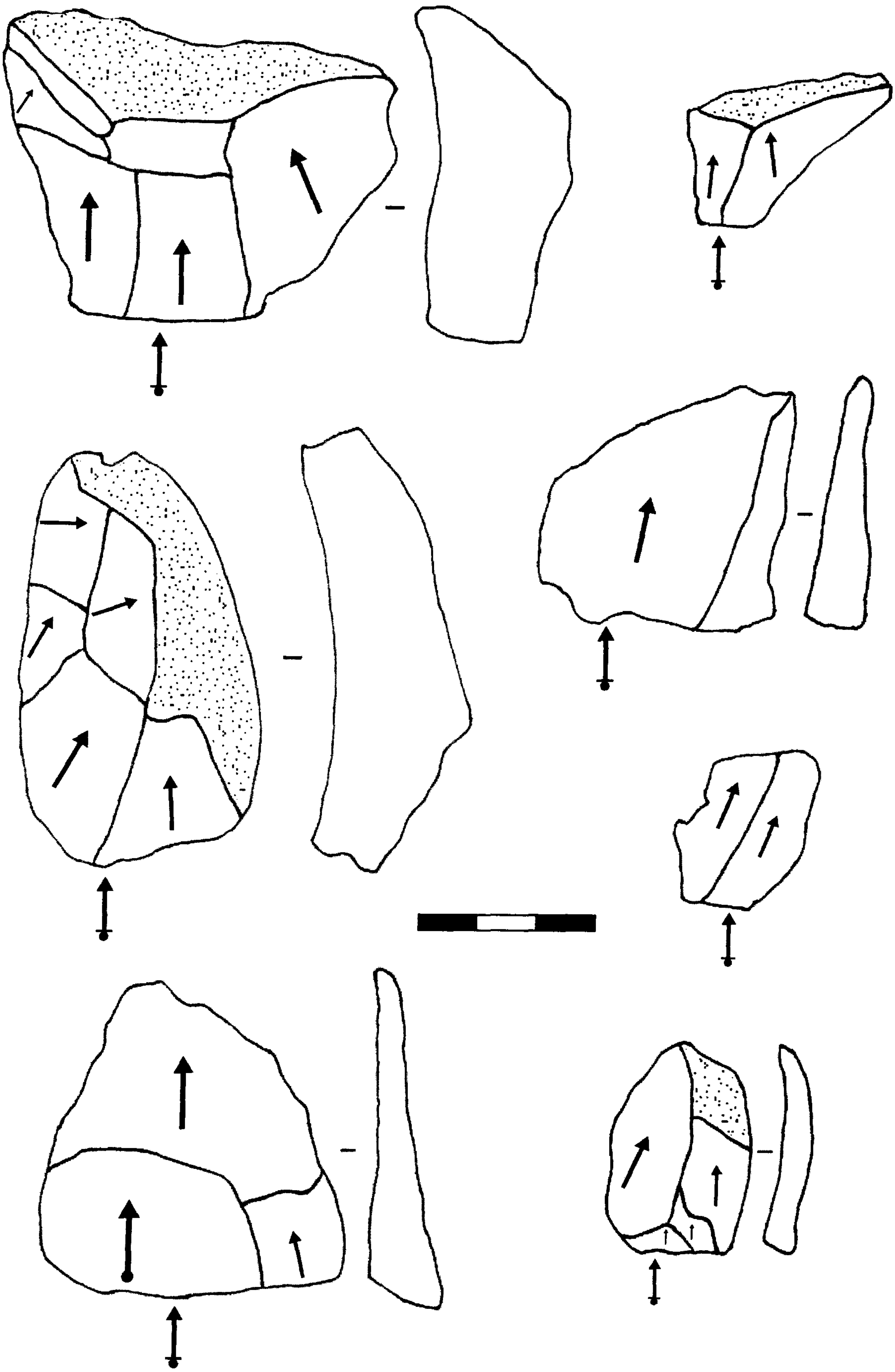


Figure 2.10. Examples of lava longitudinal flakes with unidirectional dorsal patterns.

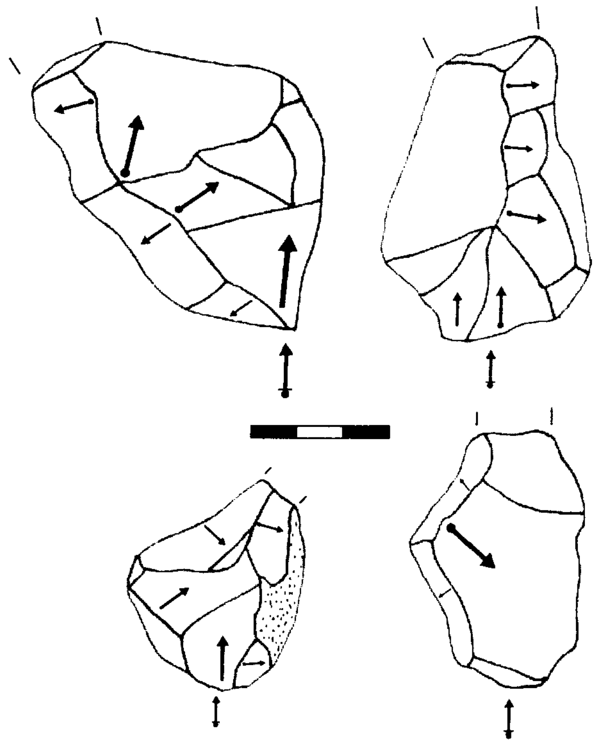


Figure 2.11. Examples of edge-core flakes from DK.

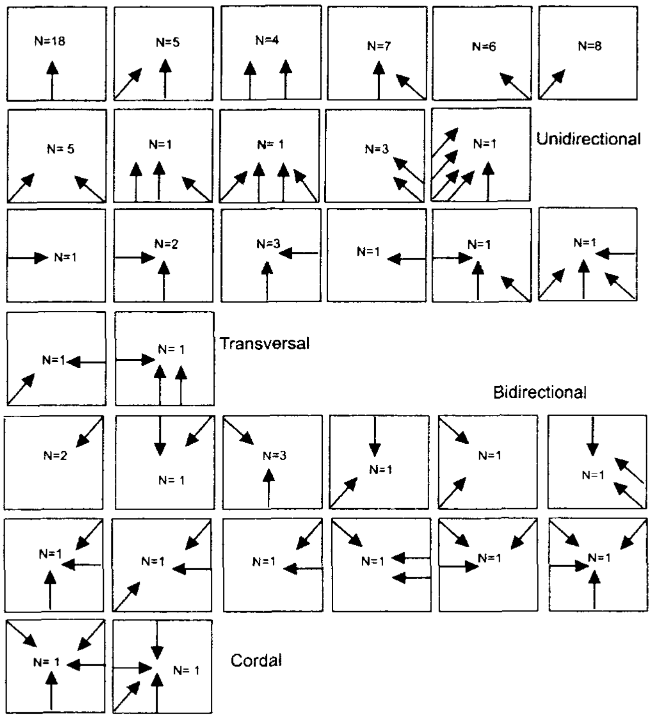


Figure 2.13. Diacritic schemes of the whole flakes from DK.

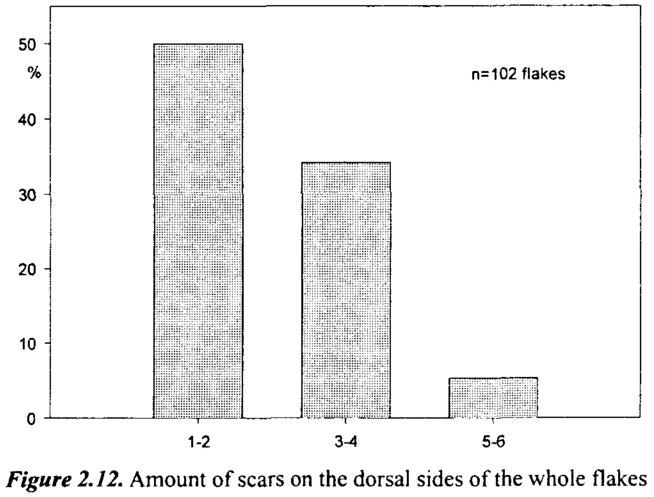


Figure 2.12. Amount of scars on the dorsal sides of the whole flakes from DK.

various artefacts classified by Leakey (1971:35) as light-duty scrapers. Of these, only 3 pieces were retouched as complete flakes, while the other retouched items (70%) used various flake fragments as blanks. Perhaps it is the fragmentation of these blanks that explains why the average size of the retouched pieces (36,3 x 29,9 x 14,4 mm) is slightly smaller than average for the flakes (40,18 x 37,41 x 11,89 mm), but the difference is not great enough to suggest that blanks were selected on the basis of size. Where there does seem to have been a selection is in the raw material: it will be recalled from figure 2.5 that both the real percentages and the Lien test indicated a preference in the choice of quartz for retouching. The χ^2 test was conducted to compare the representation of raw materials used for flakes and retouched pieces, and once again a highly significant difference is seen in the distribution of the quartz, for which a clear preference is documented amongst the retouched pieces. In the case of DK, and perhaps due to the scarcity of quartz in the immediate area, the hominids intensified the use of this raw material by submitting it to more secondary modification than that documented amongst the lavas.

With regard to the type of retouched pieces, denticulate side scrapers (50%) and transversal side scrapers (30%) predominate, followed by a single example of notched and lateral side scrapers (fig. 2.14). We can say little more about the group of retouched flakes, except to emphasise their minimal significance (if we remember that they account for a tiny 0.8% of the total) of these objects in the whole of the lithic collection, concluding that they were not important items in the activities associated with this first Oldowan technology in the Olduvai sequence.

The DK cores

The objects classified in the group of cores include a number of the categories that Leakey (1971:39) considered tools, such as choppers, polyhedrons, discoids, subspheroids and heavy-duty scrapers. Taken together, the pieces classified by Leakey (1971) in these categories come to 123 cores. Potts (1988:349) calculated 131 cores and 17 test cores, and Ludwig (1999:213) identified 189 cores. Our recounts (see again tabl. 2.1) are substantially different: only 69 pieces have been classified as cores, to which we could add 7 test cores (i.e. cores with one or two detachments). Between them, these two categories account for 7.5% of the whole collection, a

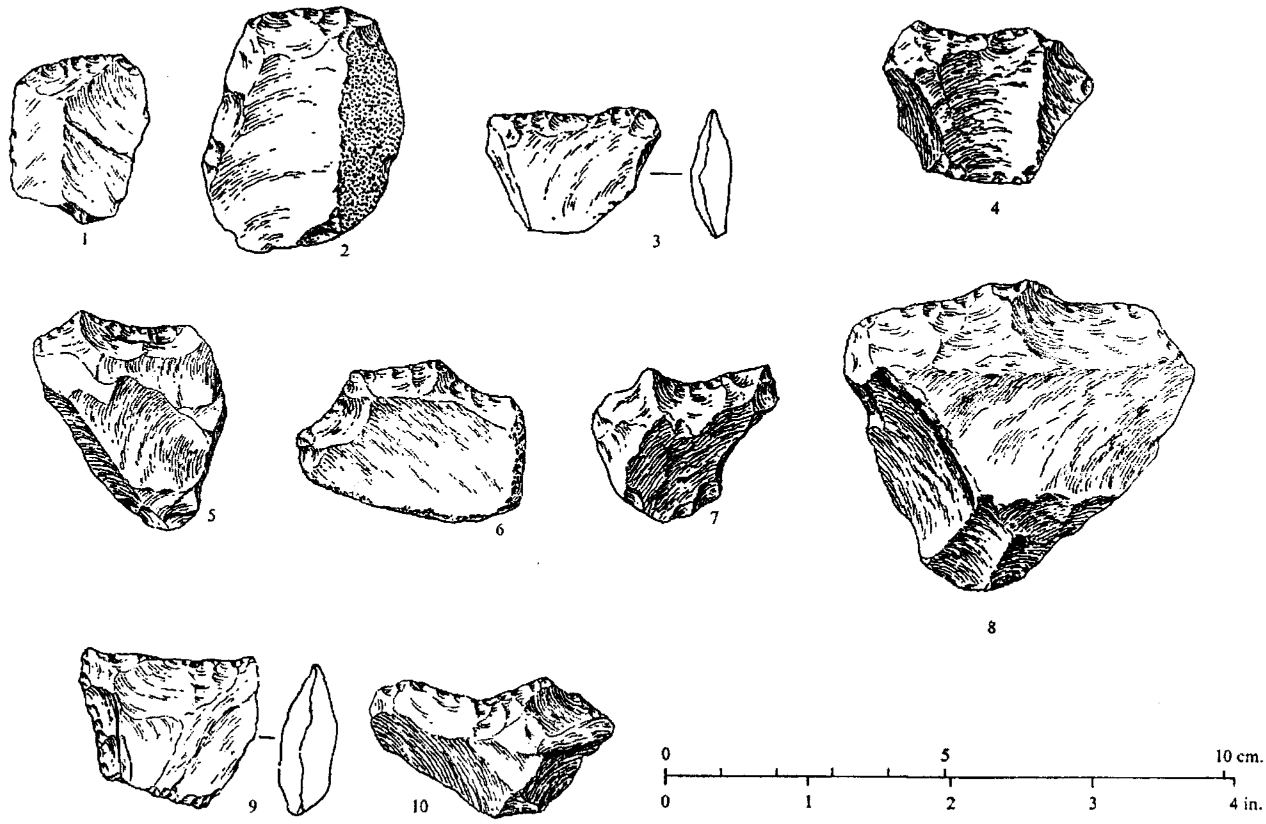


Figure 2.14. DK retouched pieces. Pieces 1-3 are transversal side scrapers, piece 4 is a lateral side scraper, pieces 5-9 are denticulate side scrapers and piece 10 is a denticulate grooved tool. The other pieces in figure 16 in Leakey (1971:35) are not in our opinion retouched pieces.

long way from the percentage proposed, for example, by Kimura (2002:301), of around 16%.

The fundamental difference between the classification proposed by Kimura (2002), Potts (1988) and Ludwig (1999), on one hand, and the one presented here on the other, is that those authors accepted (with the exception of a few isolated examples) the ascriptions of Leakey (1971), while here the criteria used to classify each piece have been reviewed individually. Following the approach of Toth (1982), Potts (1988), Ludwig (1999) and Kimura (2002) all included the objects classified by Leakey (1971) as subspheroids, heavy duty scrapers, discoids, polyhedrons, etc, in the broadest category of cores, without discussing the nature of these objects in depth.

Here, on the contrary, it has been observed that not only do the differences between polyhedrons, discoids, etc., evaporate, as proposed by Toth (1982, 1987), but in practice many of the pieces were not even knapped. This is the case with pieces originally classified as polyhedrons, discoids and choppers (fig. 2.15), which are actually simple chunks. This problem is exacerbated in the pieces classified by Leakey (1971) as polyhedrons, which she identified as such because the abundance of planes and angles, but which are actually the result of natural fractures. Of course, real cores knapped as polyhedrons do exist in DK (see also Sahnouni 1991), and in fact the most representative examples were presented by Leakey (1971:32). The same thing happens with most of the choppers drawn in the original monograph (Leakey 1971, fig. 8 and ff). However, other less characteristic pieces, which were not therefore drawn in the monograph, were classified as choppers by Leakey when they were in fact objects with angles produced by natural fracturing.

In the objects classified by Leakey (1971) as discoids the confusion is even greater, and some of them are in reality natural pieces. The recurrence of this problem of classification even led us to systematise certain patterns in order to characterise these "false discoids", such as the existence of faint scars that do not start at any point on the edge of the supposed core, the documentation of what are assumed to be knapping surfaces that are in fact flat or even concave, and the abundance of obtuse angles or surfaces with false convex scars. Thus Leakey (1971) classified some pieces as discoid because they were basically disc-forms, but without observing that in reality they were fortuitous shapes of natural pieces. This question is of some importance, since some authors, such as Gowlett (1986), Davidson (2002; Davidson & Noble 1993) and even ourselves (de la Torre & Mora 2004; de la Torre *et al.* 2003) had attributed a technological meaning to pieces on the basis of the illustrations available (Leakey 1971, fig. 12 and 14), without studying at first hand materials that proved not to be what they were originally claimed.

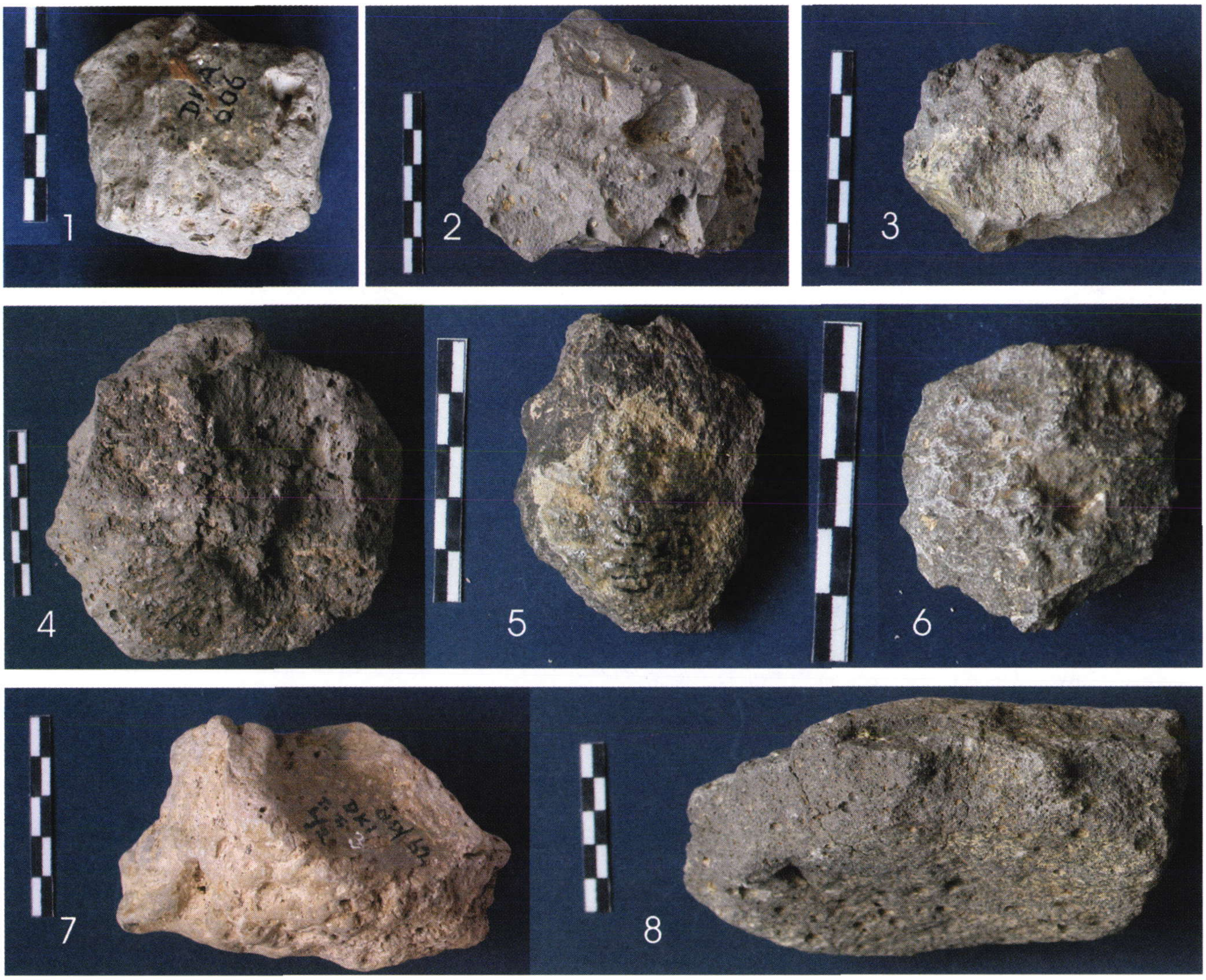


Figure 2.15. Examples of natural pieces classified by Leakey (1971) as polyhedrons (cases 1-3), discoids (4-6) and choppers (7-8).

In any case, the 69 pieces (6.8% of the whole collection) that show indisputable signs of having been submitted to intentional *débitage*, and the 7 blocks (0.7% of the total) that could have some isolated scars, constitute a sufficient sample to provide a technological characterisation of the industry of DK. Including the basalts and phonolites in the general category of lavas, we observe that the latter are the dominant raw materials and make up 95.7% of the total, compared with 4.3% of quartz cores. This pattern is consistent with what is observed in the other lithic categories, in which there are always few quartzes, and indicates once more that the use of metamorphic rocks was a subsidiary question in DK.

Although no origin can be assigned to 24.6% of the pieces, it seems that most of the cores used stream cobbles as blanks (42.0%) compared with 33.3% of cores that were blocks of lava. This is probably related with the quality of the raw materials, since the blanks from the streams were of far superior quality.

Since the best lavas (phonolite and basalt cobbles) were not available in the immediate vicinity (compared with the vesicular lavas, present in the site itself), it seems obvious that the hominids preferred to import certain raw materials. Even so, the cores were never intensively worked (most of them still preserve considerable percentages of cortex, which implies a lack of interest in maintaining long sequences of reduction and/or the ability to do so). Nevertheless, the variation in size seen in the cores should be emphasised (tabl. 2.5 and fig. 2.17); this would indicate differences in the intensity of the reduction and compels us to be cautious when proposing general patterns of exploitation.

It is important to emphasise the relationship between cores and knapping products. Basing himself on Leakey's data (1971), McNabb (1998) conducted an attractive speculative exercise: by calculating a minimum of 3 extractions per core and a maximum of 15 extractions, and on the basis of the frequencies offered by Leakey, this author estimated that the number of lava flakes in DK should be somewhere between 366 and 1830.

Brantingham (1998) also used Leakey's data (1971) to estimate the number of flakes obtained from each core in the site, calculating an index of 4.3 flakes per core in the lavas and 12.4 flakes per core in the examples of quartz. Although the frequencies calculated by McNabb (1998) and Brantingham (1998) cannot be used here given our contradiction with the lists given by Leakey, we can make a new estimate. By counting the number of extractions displayed by the cores, and although most of the cores have between 4-6 extractions each (fig. 2.16), an average of 6.3 detachments has been calculated for each piece, with a minimum of one scar per object (in the case of some test cores) and a maximum of 14 extractions. Following McNabb's deduction (1998), this would give a minimum of 76 flakes (including cores and test cores) and a maximum of 1064, with an average of around 478 pieces, considerably fewer than the number inferred by McNabb (1998:19). Testing these speculative calculations is complicated, since the number of flakes (n=115) cannot be dissociated from the flake fragments (n=511) that we have identified in the collection. In any case, the general impression denotes certain coherence between the amount of knapping and the total number of cores identified.

	Minimum	Maximum	Mean	Std. deviation
Length	30	117	67.93	19.146
Width	25	100	62.78	17.992
Thickness	18	81	48.25	14.435
Weight	20	1300	321.81	241.672

Table 2.5. Mean sizes (mm and gr.) of the cores from DK.

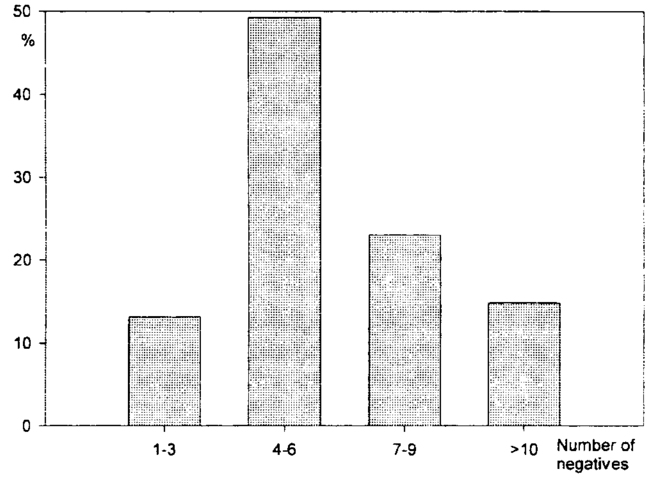


Figure 2.16. Amount of scars on the cores from DK.

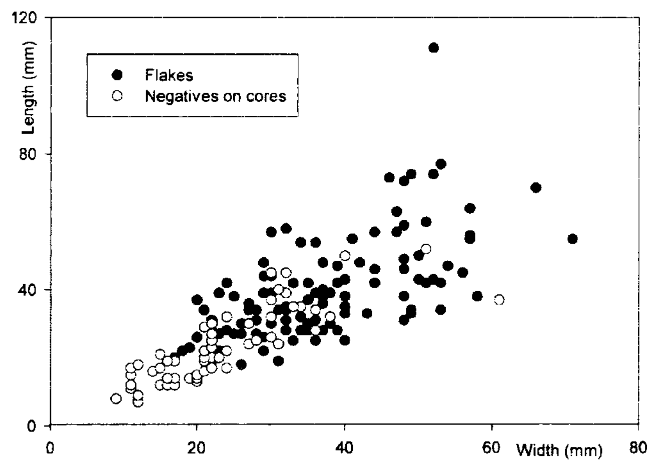


Figure 2.17. Size scatter diagram (length and width) of the scars on cores and flakes from DK.

Systems of exploitation

The variability of specific examples of exploitation is such, that the systematisation of the methods of reduction can ultimately create almost as many groups as cores documented. That is why one of our objectives has been to synthesise the examples within broad categories. The most general of these categorisations is that which divides the DK cores (n=69) into **unifacial** (36.2%), **bifacial** (53.6%) and polyhedral or **multifacial** (10.1%). Of the unifacial cores, the most common reduction strategy (n=21) is that which uses a single striking platform in the horizontal plane, from which longitudinal flakes are obtained in the transversal and sagital planes to form an angle that is nearly a right angle. It is the typical *unidirectional abrupt unifacial method,* which in DK moreover does not usually occupy the whole of the periphery of the core but only part of it. Thus from unprepared blanks a sequence of flakes is generally obtained in a single plane, without rotating the piece to exploit the whole of the transversal and sagital planes (see fig. 2.18).

Next to this unifacial exploitation of a single plane, there are also a few examples (n=5) that we will consider separately, although they also reflect this philosophy: they are *unidirectional unifacial abrupt cores with independent planes.* In these, the technical process is the same as in the previous case; a natural plane is chosen and a sequence of extracting flakes is carried out by forming an abrupt angle between the striking platform and the knapping surface. However, in these cases, when the knapping surface is exhausted, instead of abandoning the core it is turned in search of new angles from which flakes can be obtained. This technique is not bifacial exploitation, since there is no interaction between two surfaces worked. On the contrary, in these unifacial cores unprepared independent planes are used as striking or exploitation surfaces (fig. 2.19).

These systems of unifacial abrupt reduction, centred on the exploitation of transversal and sagital planes from striking platforms in the horizontal plane, are accompanied in DK by a few examples (n=3) of what have been termed a *unifacial peripheral exploitation strategy.* Here the roles of the planes are reversed, and the working of the cores is centred on the exploitation of the horizontal plane, from unprepared striking platforms in the transversal and sagital planes (fig. 2.20). This method is similar to the unifacial centripetal system that we described in Peninj (de la Torre & Mora 2004), but is not exactly the same, since in the examples of the unifacial

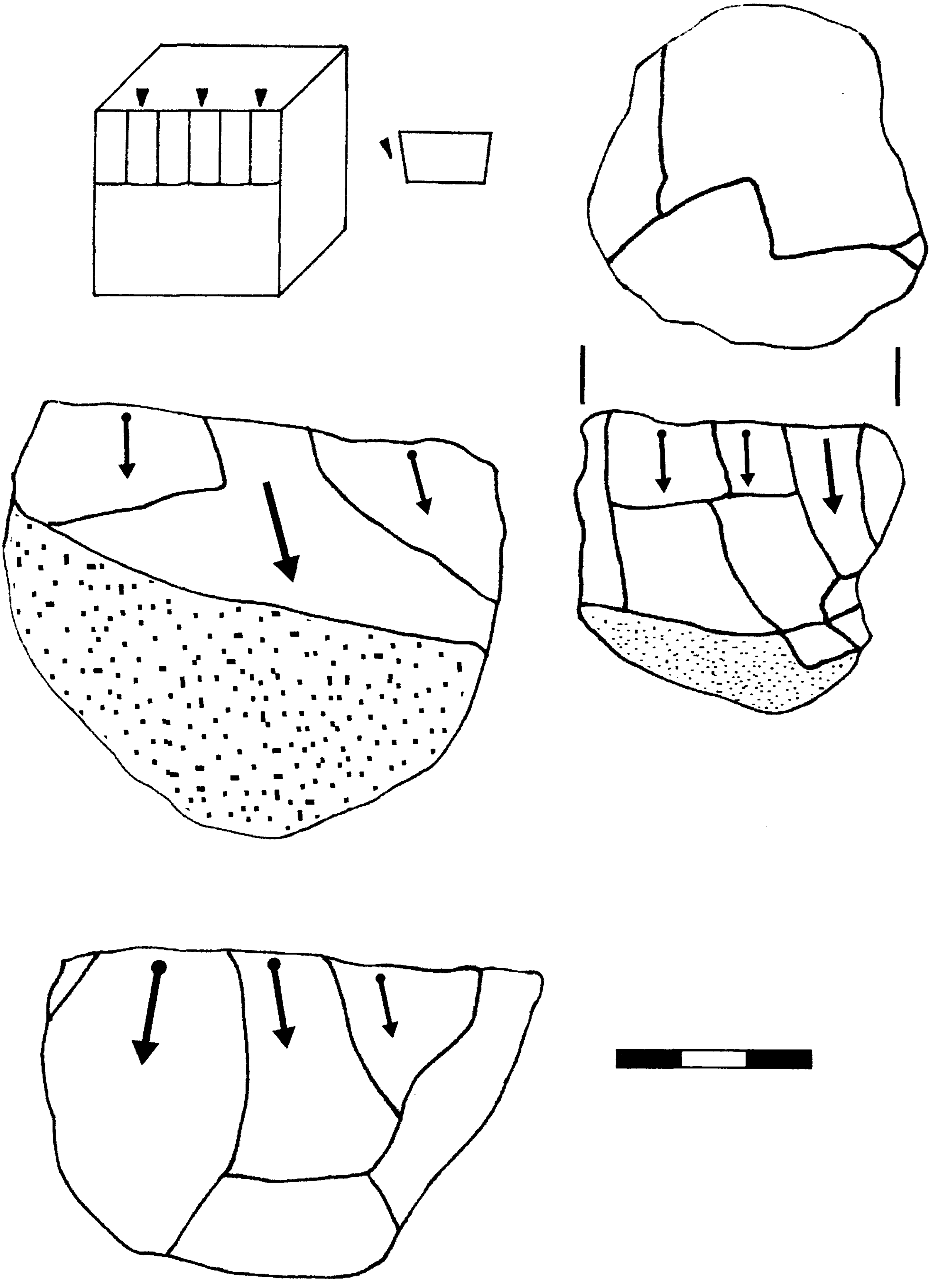


Figure 2.18. Examples of lava cores partially reduced by the unidirectional abrupt unifacial strategy.

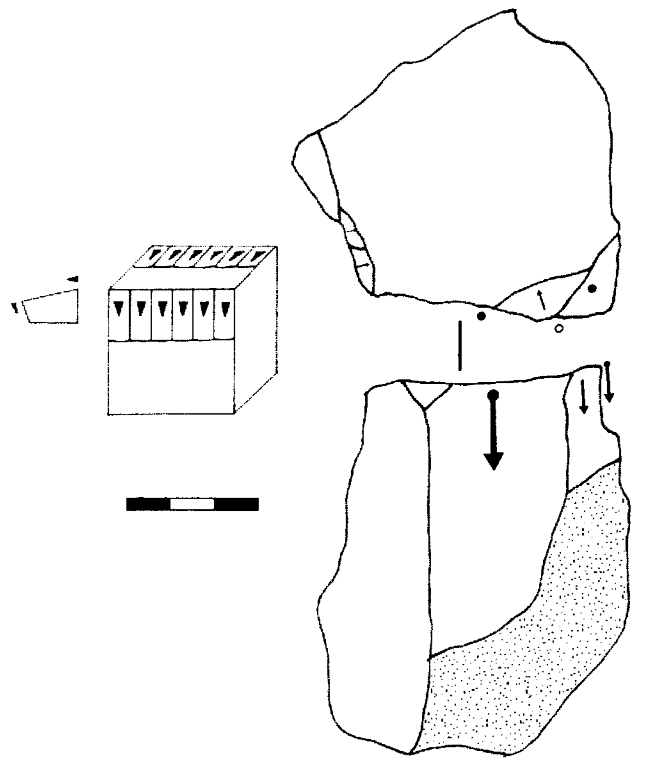


Figure 2.19. An example of a lava core with unifacial abrupt exploitation in independent planes.

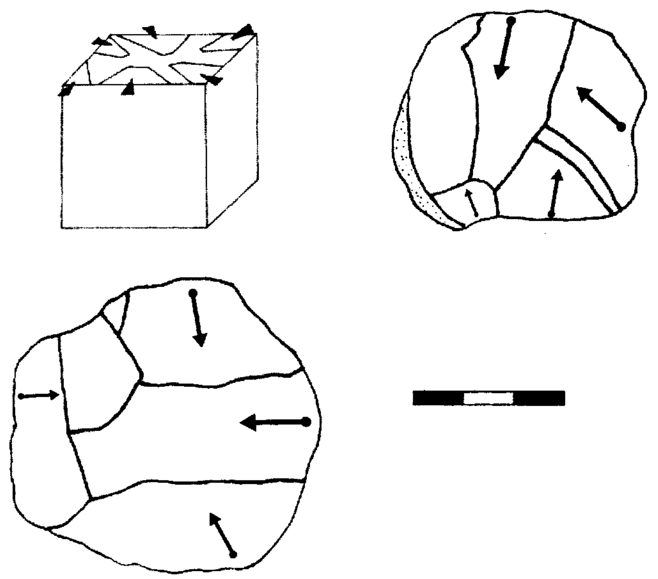


Figure 2.20. Examples of unifacial cores with peripheral exploitation of the horizontal plane.

peripheral system at DK, the extractions do not converge in the centre of the surface worked, which results in the core becoming collapsed and means it has to be abandoned.

The bifacial cores are the most abundant in DK, with a total of 37 examples. Three main groups are represented: the first is that of *bifacial abrupt method,* with 14 examples (20.3% of the total sample of cores). The technical strategy is identical to that of the unifacial abrupt method, only in this case there is interchange between the striking and exploitation surfaces, and therefore a edge is formed at the interface of the two planes (fig. 2.21). As in the case of the unifacial examples, here too we document cores in which only a single area of the piece is exploited (bifacial abrupt partial exploitation), and others in which the interaction between the exploitation and preparation surfaces is extended to the whole of the volume of the core (bifacial abrupt total exploitation).

The next most important group (n=12 and 15.8% of the total number of cores) is that of those referred to here as using *bifacial peripheral strategies*. These cores have two asymmetric exploitation surfaces, one of which acts as preparation plane for the extractions from the main surface. In principle this method is similar to the bifacial hierarchical centripetal system defined in Peninj (de la Torre & Mora 2004; de la Torre *et al.* 2003, 2004). As happens in Lake Natron, in DK these cores display a system of bifacial and hierarchical exploitation, which in practice has led (erroneously) to comparing the DK examples with those produced by the discoid method (Leakey 1971; Gowlett 1986; Davidson & Noble 1993) or Levallois (de la Torre *et al.* 2003). We no longer believe this to be the case; the fundamental difference between Peninj's so-called bifacial centripetal method and this one found in DK is that, on analysing in detail the latter's main exploitation surfaces, it is observed that the extractions are not distributed in a radial pattern (as in the case of the centripetal system) but in an anarchical way (fig. 2.22).

This difference could be compared with Böeda's (1993) distinction between radial and cordal management of cores, and we do not consider it superfluous; in the cores we refer to here as bifacial peripheral (a name given because of the exploitation of the horizontal plane from the whole of its periphery) the volume of the main plane is exploited, invading the whole of its surface. However (and here is where it differs from the centripetal methods), in the peripheral cores there is no notion of interaction between one extraction and the next, that is, of the scars of a sequence serving to create convexities used in the subsequent phase. If we remember that it is this notion of interaction between extractions which basically characterises the Levallois recurrent centripetal method *sensu* Böeda (1994), it would seem clear that this sophisticated technical skill is not generally seen in DK cores, although there is a single example that could be ascribed to the bifacial hierarchical centripetal system, and another with an alternating edge similar to that of the discoid method.

The other major group of bifacial exploitation strategies in DK is that of the *bifacial simple partial* cores (fig. 2.23), better known as bifacial choppers or chopping tools (Leakey 1971). These pieces constitute 14.5% of all the cores from the site (n=10), to which is added a single example (1.4%) of the similar *unifacial simple partial system* (unifacial chopper). In bifacial simple partial exploitation, the scars of the extrac-

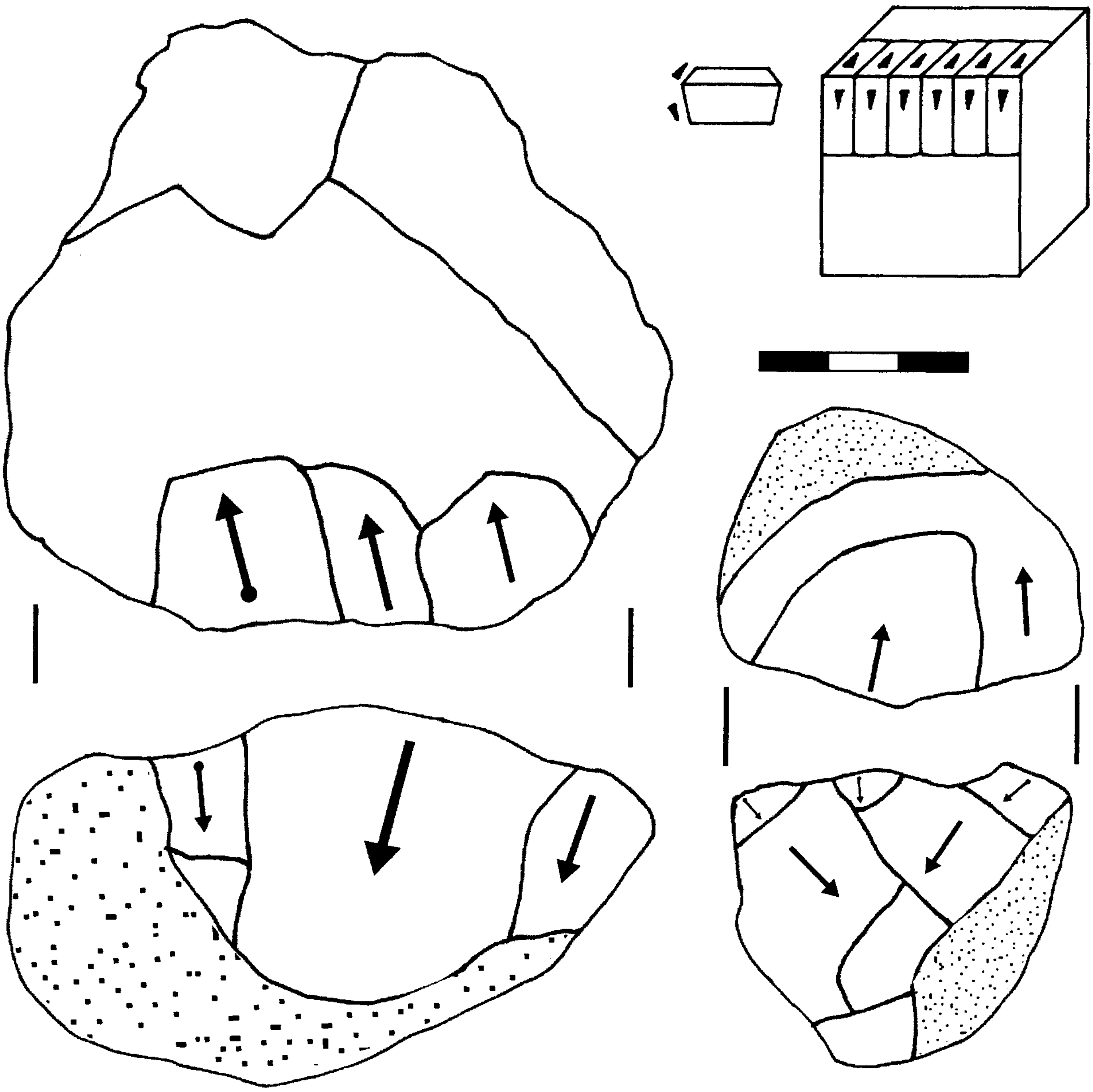


Figure 2.21. Examples of bifacial abrupt lava cores.

tions on one of the planes are used as platforms for obtaining flakes in another adjacent one, a edge of configuration being produced which forms an acute angle (de la Torre & Mora 2004). This edge, which occupies only a specific area of the piece and not the whole of its perimeter, has been considered by some (Leakey 1971; Roche 1980; de la Torre & Mora 2004), as indicative of a process of *façonnage* rather than of simply obtaining flakes.

However, the DK evidence does not point towards the choppers being artefacts rather than simply cores, since the edges of these pieces are perfectly preserved and display no signs of having been used for anything other than producing flakes. This contrasts with the cortical areas of the choppers themselves; thus it cannot be by chance that, of the only 6 cores that have traces of pitting, 4 are choppers. This pitting is concentrated in the cortical areas opposite the knapping edges and demonstrates that, when the pieces were used in as a blunt instrument, the traces of use are preserved quite conspicuously. These traces are not documented in the edges of the choppers, and therefore indicate that they were used specifically as cores for obtaining flakes.

After describing the uni- and bifacial strategies in the DK site, we still have to look at the *multifacial* or *polyhedral system*, which accounts for 10.1% of the collection of cores (n=7). As already stated, most of those considered by Leakey (1971) to be polyhedrons proved to be natural pieces. Contrary to an earlier proposal (de la Torre & Mora 2004), we have included the multifacial and polyhedral system in the same category.

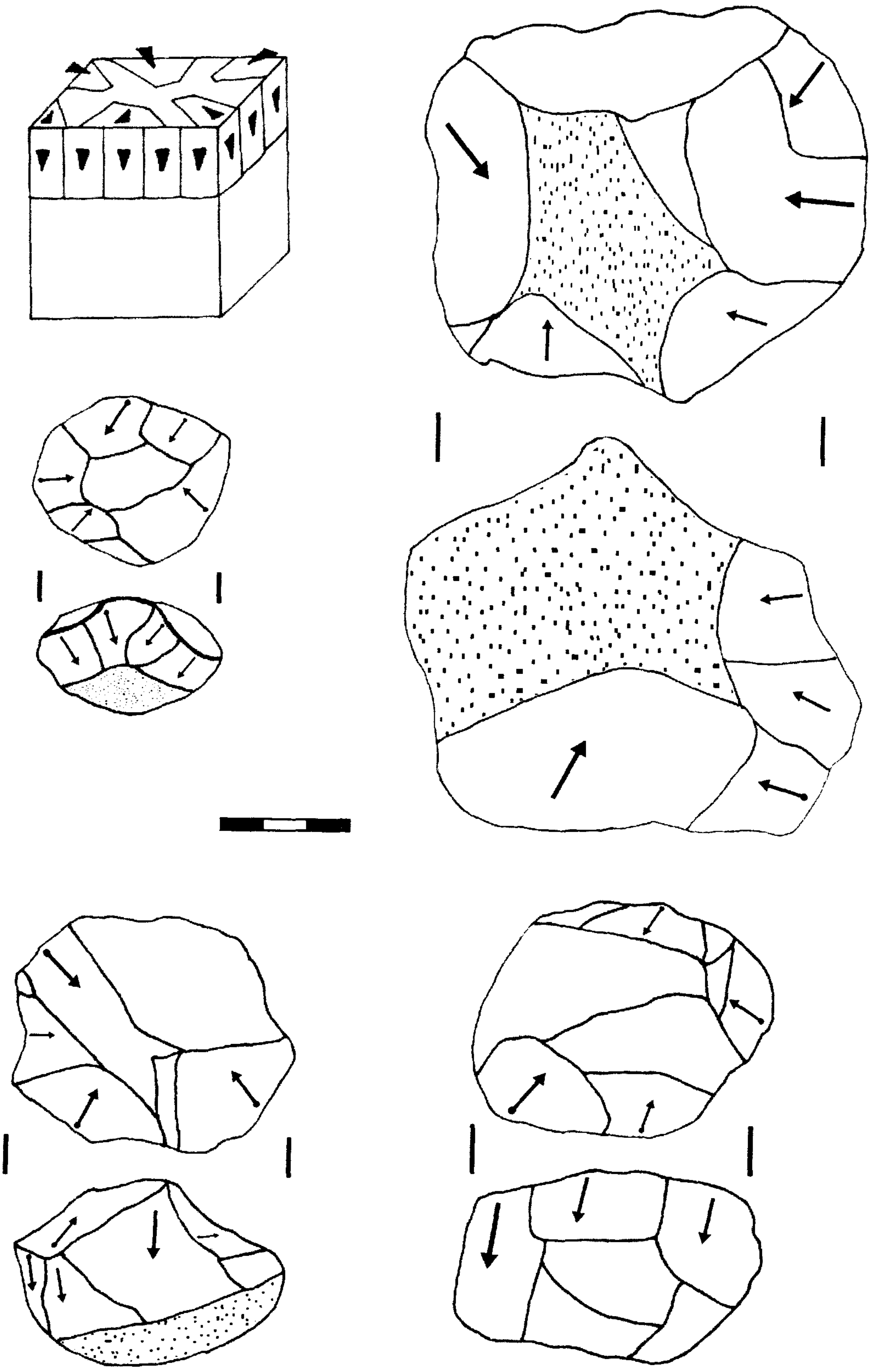


Figure 2.22. Bifacial peripheral lava cores from DK.

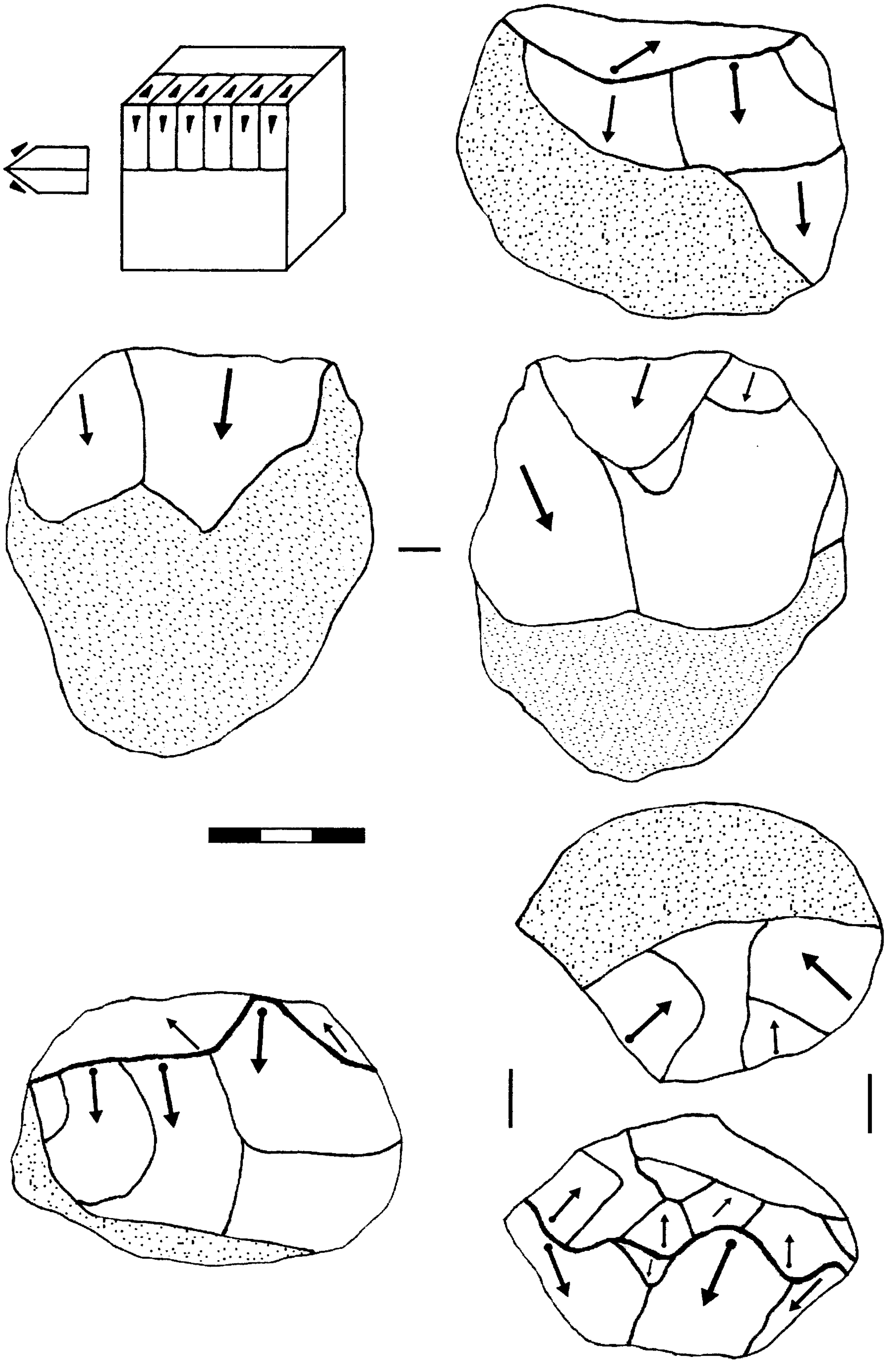


Figure 2.23. Bifacial simple partial cores.

The distinction that we previously made between the two followed the proposal of Texier and Roche (1995), who observed that the multiple striking platforms indicated the search for a spherical form through a process of *façonnage*. However, neither in the DK collection nor in that of many other Olduvai sites have we been able to sustain this hypothesis; the few cores with more than two striking platforms – the criterion that Leakey (1971) used to ascribe pieces to the category of polyhedrons – do not indicate an orderly reduction designed to seek out specific shapes (Texier & Roche 1995), but quite the reverse: they are generally exhausted cores, in which the absence of suitable angles in an exploitation surface led the tool-maker to look for successive knapping platforms that he did not prepare and which he abandoned when they were no longer useable. In short, the polyhedral or, more accurately the multifacial system, implies a strategy of expeditious knapping, without preparation of the knapping platforms or rejuvenation of the edges and/or exploitation surfaces, and that when a knapping plane was exhausted it was abandoned and a better one found to continue a reduction that was not predetermined (fig. 2.24).

Percussion objects

In DK we have identified 43 objects that show signs of percussion (4.2% of the total collection), which is a considerable percentage in relation with other categories such as the cores and even the flakes (tabl. 2.1 and 2.2). Of these 43 objects with traces of pitting, 6 are also cores (mainly choppers), which indicate that some of the pieces were multi-functional, that before becoming cores for obtaining flakes they were used as hammerstones. Leaving aside the fragments broken off in the course of hammering, we see that the vast majority of the pieces (n=33) are typical hammerstones, to which we could add the 6 cores with pitting, also certainly used as knapping hammerstones. There is only one example of what we have called hammerstones with fracture angles, related with activities other than obtaining flakes, but in view of their minor importance in DK, they will not be described here but when we study FLK North.

Of the knapping hammerstones, 93.5% are of lava and only 6.5% of quartz. Although this is not surprising in view of the predominance of the lavas in all the DK categories, it is notable that in all cases high-quality rounded cobbles were chosen, very different from the vesicular blocks of lava typical of the site's substrate. These cobbles must surely come from the same sources as those used as blanks for cores, as the overlapping of the sizes in the two categories would indicate (fig. 2.25). This shows that the hominids selected the most suitable objects as hammerstones, both in terms of their ergonomic shape and the regularity of the cobbles' cortical surfaces. In addition, the variability of shapes and sizes (tabl. 2.6) could suggest an adaptation of the dimensions of each core to the type of product desired.

	Minimum	Maximum	Mean	Std. deviation
Length	61	110	83.65	12 698
Width	50	95	70.48	12 124
Thickness	15	77	55.94	11 625
Weight	125	950	462.90	203 911

Table 2.6. Dimensions (mm and gr.) of knapping hammerstones from DK.

Conclusions

As we said earlier, the total volume of raw materials brought to the site was probably very much lower than that proposed by Potts (1988), the number of kilograms of lavas and quartzes modified and/or transported by hominids being reduced by almost half. The question is difficult to resolve with certainty, and it is possible that by eliminating from the analysis all the unmodified material due to the contextual problems already described, we are overlooking pieces brought in by hominids although they were not worked. This would apply to some rounded cobbles of lava without any trace of use, but that according to Leakey (1971) and Potts (1988) do not belong to the substrate formed of vesicular blocks of lava. In spite of this, it has been demonstrated that a large proportion of the material, since it was not modified and was of local origin, cannot be included in the scope of the hominids' activities, and must be considered natural and not archaeological.

With regard to the relations between the lithic categories represented in DK, those associated with the activities of producing flakes dominate, this group including all the products of *débitage* and also cores and knapping hammerstones. Within this strategy of flake production, the initial decortication phase (which includes complete flakes with more than 50% cortex) is relatively important (11.7%), which is not the case with the *façonnage* or retouching process (4.3%). It is not possible to offer precise data on the processes in which the artefacts were used, in view of the absence of use-wear analyses. Even so, the presence of associated bones, and the evidence of anthropic contribution and human modification of much of this bone collection (Bunn 1986; Potts 1988; Shipman 1989), suggests that the knapping activities were related to the processing of several of the carcasses.

With regard to the systems of knapping used, the most abundant are those related with longitudinal and unidirectional exploitation, using both uni- and bifacial abrupt strategies (fig. 2.26). Together with these knapping methods the peripheral unifacial and bifacial exploitation of the horizontal planes is also important, as is the working of partial edges with simple angles (unifacial and bifacial choppers). The knapping products documented in DK (fig. 2.10 and 2.11) are consistent with the technical strategies described on the basis of the cores, presenting elongated longitudinal morphometric modules, with unidirectional scars and the absence of signs that would suggest the rotation of the cores.

Flakes of this type can be ascribed to systems of exploitation of choppers such as those described by Toth (1982, 1985) and

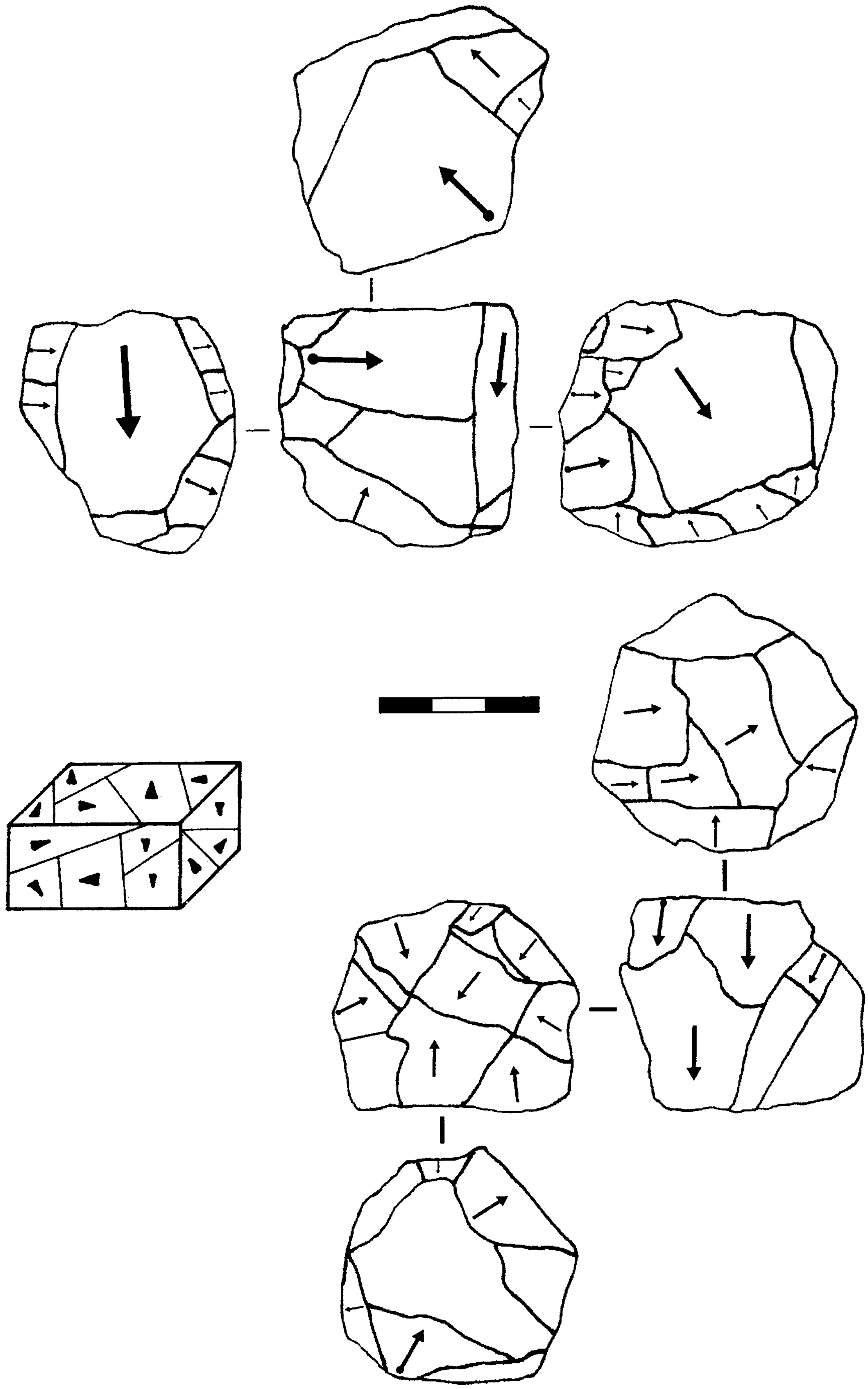


Figure 2.24. Multifacial cores from DK.

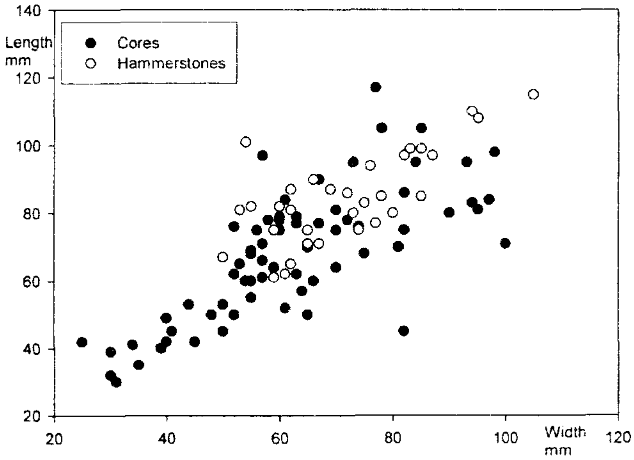


Figure 2.25. Sizes of cores and hammerstones from DK.

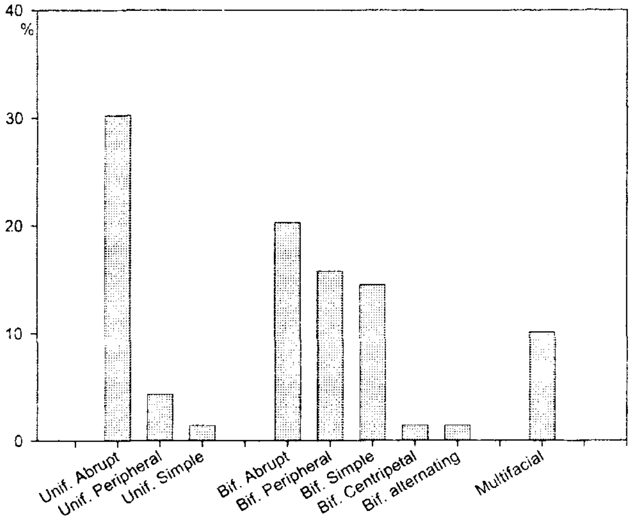


Figure 2.26. Percentages of the knapping methods at DK.

Roche (1980), and neither is it difficult to relate these products with unidirectional abrupt technique; in both cases, the exploitation of the surface(s) is always carried out from the same point, irrespective of whether a single surface (unifacial) or two (bifacial) surfaces are worked. However, these flakes can also be produced by unidirectional patterns of a peripheral kind: as has already been said, in this peripheral system, the scars of the flakes are not intercepted by subsequent extractions. This implies that there is no interaction between one extraction and the next, and therefore the notion of predetermining flakes using the convexities created by previous ones did not exist.

In short, the hominids of DK obtained high quality flakes using efficient knapping techniques, in which there was some preparation of the knapping platforms (some of the bifacial patterns observed appear to be trying to achieve this), a hierarchy of surfaces (related with this preparation, as in the peripheral bifacial technique) and of course rejuvenation of the cores (see fig. 2.11). Even so, no predetermination of the flakes or the knapping strategies is documented; it is a technological system based on short sequences of production, and once the convexities had been lost the cores were generally abandoned and no attempt was made to restructure their morphology.

In broader terms, and to conclude, we can say that in DK there is an immediate and local technological strategy. By this we mean there was a short production cycle, which would have started with obtaining cobbles situated a few dozen metres from the site. Practically all the raw material is volcanic and therefore local, there being very few pieces (in this case quartzes) that may have been transported from other points in the landscape. Furthermore, after this local selection of the raw materials the first stages of decortication would be carried out in the site itself, as the high percentages of cortex in the knapping products indicates. Obtaining flakes, the main objective of the production cycle in DK, was carried out using relatively simple, though certainly effective reduction strategies, but these did not include processes of restructuring the cores or predetermining the blanks. These cores were generally scarcely exploited and the intensity of the reduction is not high. In short, in DK all the elements of the production cycle appear to be present, with the exception of knapping debris, which constitute an important deficit, but is due more to taphonomic than behavioural causes.

Therefore, the dynamics of exotic elements being brought into the site and specific artefacts subsequently being taken away from it are not evident; the hominids exploited the raw material available in the vicinity, carried out a series of knapping activities (certainly related to the consumption of carcasses), and then abandoned the set of lithic tools they had created. The efficiency of that behaviour is evidenced in the quality of the products obtained. However, at the same time that efficiency was related with a management of resources in DK that does not display any of the typical elements of planned technological strategies, but obtaining, producing, using and immediately discarding stone objects.

Chapter 3

FLK ZINJ

Introduction

FLK Zinj is the best known site in the African Plio-Pleistocene. The palaeontology (Gentry & Gentry 1978; Harris & White 1979; Fernández-Jalvo *et al.* 1998; Plummer & Bishop 1994; Brodkorb & Mourer-Chauviré 1984; Stewart 1994; Auffenberg 1981; Butler & Greenwood 1973; etc), zooarchaeology (Bunn 1982; Bunn & Kroll 1986; Potts 1988; Oliver 1994; Blumenschine 1995), and the lithic industry (Leakey 1971; Ludwig 1999; Potts 1988; Kroll & Isaac 1984; Kimura 2002) have undergone first-hand analyses, in conjunction with different studies derived from that original information (Capaldo 1997; Domínguez-Rodrigo 1997; Kappelman 1984; Marean *et al.* 1992; Lupo 1998; Binford 1988; etc). Level FLK 22 (or FLK Zinj) is part of the FLK gully, in the central part of the Gorge. Excavations commenced in 1959 after the discovery of the *Zinjanthropus* cranium (OH 5), and continued throughout 1960. Level FLK 22 is 6 metres below the Tuff IF and is therefore slightly older than 1,749±0,007 my (Walter *et al.* 1991).

Leakey (1971) distinguished several levels containing lithic and bone pieces in very low densities in the interval between Level 22 and the Tuff IF, which led her to interpret them as levels with diffused materials. As stated by Isaac and Crader (1981), these levels indicate the densities typical of natural landscapes; Level 15, with 9 so-called artefacts and 259 bone remains, or Level 13, with 11 lithic pieces and 187 bone fragments, contrast greatly with the vast concentration documented in level FLK 22 and suggest the idea of background deposits in sedimentary sequences that are unrelated to archaeological sites.

According to Leakey (1971:49), Level FLK 22 was composed by silty clays approximately 30 cm thick, subsequently noting (Leakey 1971:260) that the thickness of the archaeological material was merely 9 cm. It is a very low or zero energy context, even though Leakey (1971:49) mentions the presence of a small stream that crosses a good part of the site, as well as a 1.5-metre depression in the excavation surface. For Potts (1988:29), both elements indicate the existence of certain erosion phenomena. The upper part of the clays had already been altered by the processes for the formation of a paleosol, which indicates the subaerial exposition of the archaeological material over an indefinite period. It is hard to establish this interval, and estimations based on the bone weathering stages vary, from a few months according to Bunn (1982) for the definitive burying of the remains, to the 5-10 years Potts (1986:30) calculates, and the 10-15 years suggested by Fernández-Jalvo *et al.* (1998). In any case, Bunn (Bunn & Kroll 1986:434), specifies that we are contemplating two different things. On the one hand, bone accumulation processes (which he sees as speedy processes) and, on the other, bone burying processes, which could be slower, as Potts (1986, 1988) pointed out on account of the bone weathering stages, and Kappelman (1984) stated considering sedimentation rates.

Potts (1988:369) estimates that a 290 m² surface was opened in FLK Zinj which Kroll (1994:113) increases to 300 m² and Blumenschine and Masao (1991) to 315 m². A spectacular amount of remains have been unearthed, 2647 lithic pieces and 40172 bones remains according to Potts' aggregates (1988:369). Kimura (2002:296) estimates an average of 8.3 artefacts per m², and Isaac and Crader (1981:64) calculate 7.75 lithic pieces per m².

Leakey (1971:49) noted the enormous density of lithic and bone remains in the central part of the excavation. That concentration, characterised by the millimetric size of the lithic and bone fragments, had a 6.30 x 4.50 metre diameter. The original map shows that the concentration stops abruptly towards the south and east, where Leakey (1971) refers to a marginal 2.4-2.7 metre area where remains are very scattered, after which the amount of archaeological material increases anew. Finally, the density of pieces is very low in the western area of the excavation (cutting E), with a predominance of so-called manuports, and resembles the descriptions of assemblages with scattered material like FLKNN-3 (Leakey 1971:50) or the actual upper levels of FLK. Consequently, it is feasible to assume that this peripheral part of the main concentration underwent a different formation process.

Therefore, it is convenient to quote Binford *et al.*, who "*suspect that the diffuse scatters of large bones and large lithics* (in this part of FLK Zinj) *result from a generalized, episodial accumulation on the landscape that is unrelated in any integrated fashion to the localised activities indicated by the circular and elongate clusters*" (1988:131). These authors reproduce Leakey's warning, who stated that "*the proportions of tool types and of utilised and unmodified material from various parts of the occupation floor are strikingly dissimilar, to the extent that separate analysis of the finds from the central and from the different marginal areas would give entirely different pictures of the industry*" (1971:50).

In his zoo-archaeological analysis, Bunn (1982) identified over 100 groups of bone refits. Many fragments refit bones with tooth and cut marks, consequently enabling the reconstruction of the patterns depicting the movement of the carnivores and hominids that inhabited the site. Both agents' activities are limited almost exclusively to the main concentration area, which once again points towards a contemporaneity of this group as opposed to the scattered materials in the rest of the level. Kroll and Isaac (1984) underscore the fact that both the hominids and the carnivores acted on the whole of the main concentration; consequently noting the difficulty of establishing which was the primary accumulation agent. Yet, given the fact that the bone distribution was very similar to that of the industry, it was considered a basically anthropic pattern, in which the processing of the carcasses by the hominids was a focussed activity, linked to lithic knapping (Kroll & Isaac 1984). Binford *et al.* (1988) propose an interpretation that counters the maps, considering that the presence of bones bearing tooth marks throughout the whole of the main patch area indicates that the carnivores were the main accumulation agents.

Although the spatial dynamics of the bone remains are well-known, the same cannot be said of the lithic material. Kroll (Kroll & Isaac 1984) accessed the maps for the stone material in FLK Zinj, and worked with the lithic refits. Yet we do not know of any published plans that considers lithic refits. These refits obviously do exist, as documented when re-examining the collection. Although our dedication to searching for refits did not unearth sufficient results to present systematic conclusions, we located several refit assemblages (fig. 3.1) that enable the corroboration of the contemporaneity of the material. Unfortunately, it has been impossible to access the original maps, therefore we cannot set forth issues regarding the spatial association of the lithic collection.

Although we mentioned Potts' (1988) reference to a total of 40,172 bone remains, this is not the only available aggregate. Bunn (1982) counted up to 60,000 specimens, of which 16,000 belonged to microfauna and another 40,000 to non-identifiable mammal bones of which 2575 were under 10 mm, 35,033 ranged between 10-20 mm, and 2800 were larger than 20 mm (Bunn 1982). These great density of remains cannot be attributed to activities carried out by hominids or other large carnivores; Brodkorb and Mourer-Chauviré (1984) identify three different owl species, which reveal a wooded savannah landscape, and suggest these birds could have accumulated the microfauna, as proposed also by Klein (1986) and Fernández-Jalvo *et al.* (1998). Likewise, the abundant fishes must have been deposited during the seasonal regression of the lacustrine area (Stewart 1994), since the shore of the lake would have been 1 km from the site (Hay 1976).

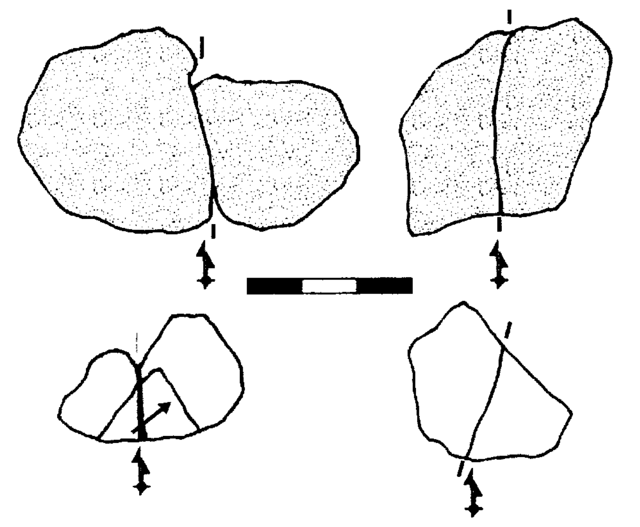


Figure 3.1. Refits documented in this study of FLK Zinj. All have been generated by the Siret accident. They are all quartz flake fragments, except for the last one, a lava item which had already been identified by a previous researcher.

In all, a very significant part of the bone assemblage – at least the part containing microfauna remains (amounting to tens of thousands of pieces in FLK Zinj) – was not linked to human site formation processes. Furthermore, no less than 54% of the bone collection measures less than 1 cm (Potts 1988). In fact, according to Bunn (1982) only 3500 bone remains belong to identifiable mammals. According to this author, the bovidae are the most numerous (MNI=29 individuals), with examples of all sizes. There is also an MNI of 5 suids and 5 equidae, alongside a minimum of 2 giraffes, as well as carnivore and hominid scatters, and a few fragments of hippopotamus and elephant (Bunn 1982). The latter would have appeared in the site fortuitously, since they are only represented via scattered tooth fragments. Potts (1988) performed a parallel analysis, which coincides in general with Bunn's (1982) study, although it sometimes clashes with the MNI, mainly in terms of the bovidae aggregate.

Bunn (Bunn & Kroll 1986) documented cut marks on all bovid genera, and on suids, equidae and giraffes. He also found 400 bone remains with tooth marks made by large carnivores, like hyenas. The number of cut marks and their anatomical position (Bunn & Kroll 1986), as well as the skeletal representation (Bunn 1986) and the fracture patterns (Bunn 1991), suggested hominids accessed carcasses earlier. Even so, the original studies published in the 1980s either furthered this hypothesis, proposing a mixed scene combining

	Unmodified material included		Unmod. material excluded	
	N	%	N	%
Test cores	19	0.7	19	0.7
Cores	49	1.8	49	1.9
Retouched pieces	15	0.6	15	0.6
Hammerstones	21	0.8	21	0.8
Anvils*	2	0.1	2	0.1
Whole flakes	125	4.7	125	4.9
Chips	1320	49.5	1320	51.6
Flake fragments	865	32.5	865	33.8
Angular fragments	131	4.9	131	5.1
Hammerstones fragments	5	0.2	5	0.2
Fractured hammerstones	6	0.2	6	0.2
Unmodified pieces	107	4	-	-
Total	2664	100	2557	100

Table 3.1. Lithic categories in FLK Zinj.(*) Artefacts included in more than one category.

hunting and scavenging (Potts 1989) or directly set out the proposal that hominids accessed carcasses secondly (Shipman 1986). Based on these studies, a range of works appeared in favour of one or another hypothesis, considering the original information published by Bunn, Shipman and Potts. Thus, profiles of skeletal representation have been used to defend hominids' secondary access to carcasses (Binford 1986, 1988; Blumenschine 1991; Marean *et al.* 1992; Capaldo 1997), percentages and the location of the marks have been used to defend primary (Oliver 1994; Domínguez-Rodrigo 1997) or secondary access (Blumenschine 1995; Blumenschine & Selvaggio 1991), etc.

Regardless of each author's position, they all agree on stressing that the hominids' action on the bone assemblages in FLK Zinj was primordial, and nobody rejects the fact that a large proportion of the bones were modified anthropically. Proceeding from this starting point, we can now contextualise the systematic analysis of the industry in the general sphere of carcass modification as a fundamental activity in FLK Zinj.

General characteristics

To our knowledge, the FLK Zinj lithic assemblage has been studied by Leakey (1971), Potts (1988, 1991; Petraglia & Potts 1994), Ludwig (1999), Kimura (2002) and partially (a sample of the choppers) by Bower (1977). As occurred in DK, in FLK Zinj the general aggregate of objects changes in terms of the investigator, ranging from 2470 objects analysed by Leakey (1971:261) – actually 2479 if we consider her own list (1971:58), and 2575 if we consider the 96 pieces this author considers manuports –, to Ludwig's (1999:28) 2284, Kimura's (2002:296) 2497 and Potts' (1988:369) 2647 objects. Our aggregate is larger, since we have identified 2664 pieces, several of which were in drawers corresponding to other sites, which could explain the differences between the analyses presented by Ludwig (1999) and Kimura (2002). The works by Ludwig, Kimura and Potts add new variables to the attributes identified for each piece by Leakey (1971), but do not question the original classification. Consequently, and even with certain nuances, they support the main characteristics suggested by Leakey (1971), who stressed the high percentage of polyhedrons and side scrapers, and included FLK Zinj in the typical Oldowan. Not long afterwards, Leakey (1975) insisted on FLK Zinj's specificity compared to other Oldowan sites, given the scarcity of choppers and the predominance of light-duty scrapers in FLK 22.

This classification offers different results. The first issue lies in dealing with the problem of the manuports or the unmodified lithic material. These objects compose a relevant percentage (4%) of the collection, exceeding the amount of cores, retouched pieces, hammerstones, etc. (tabl. 3.1). Leakey (1971:58) already observed a large frequency of manuports (n=96), which Potts (1988:377) increased slightly (n=99). We have observed that some of the artefacts previously classified as "utilised materials" do not present any visible human traces, thus the category of unmodified material increases once again (n=107).

In itself, the representation of the categories obtained in the total of the collection (tabl. 3.1) raises certain questions, since it is hard to consider that the so-called manuports (*i.e.* potential cores or supposed raw material reserves transported to the site), constitute a larger percentage than the percentage of cores and test cores combined. Furthermore, the so-called manuports present a percentage that is quite similar to the percentage of flakes, when in fact the amount of knapping products usually exceeds the number of cores from which they proceed four-fold, as indeed occurs in the Zinj collection. However, the argument supporting the high relative frequency of unmodified objects is not sound enough to reject their relationship with the rest of the sequence, and calls for other comparisons.

If the so-called manuports were unmodified raw materials accumulated as stock for their subsequent reduction, it would be logical to think that the average size of the manuports (*i.e.* nodules that have not yet been exploited) should be larger than that of the cores, which would be merely the same natural blocks subject to a process of anthropic reduction. Since the knapping process basically involves a loss of core mass, the critical variable to be analysed in this case is the weight of the objects. In line with this reasoning, the weight of the manuports should be greater than that of the exploited cores. The Kolmogorov-Smirnov test corroborated the normality of the distribution of the weights of both the cores and of the supposed manuports, and a T-test was performed subsequently to compare both categories. The results show both samples have a similar average weight in essence, and therefore do not support the aforementioned hypothesis that allow to consider manuports as potential cores.

Alongside these metric comparisons, it is also pertinent to check the representation of each category in terms of the raw material located at the site. As shown in table 3.2 and figure 3.2, quartz predominates as the main raw material in the site as a whole, with 69.4% of the cores, 79.8% of the flakes and 95.9% of the flake fragments made from this raw material. Although Potts (1988:245) described a high number of unmodified quartz blocks, our revision shows that the non-modified objects are fundamentally lavas (99.1%), and appear alien to regular knapping activities at the site. A chi-square test was performed to compare the distribution of raw materials between the cores and the unmodified lithic materials. If the latter were really raw material reserves, it would be logical to consider that the representation of the different types (lava and quartz) would be similar in both categories. Once again, the test presented negative results, rejecting the hypothesis that both samples were from the same assemblage. Therefore, this makes it difficult to consider the proposition stating that the supposed manuports were in the site as functional raw material reserves.

In all, the different comparisons between the modified lithic material (cores, flakes, hammerstones, etc) and the unmodified material, the supposed manuports, display major differences between both samples. These differences are not conspicuous merely via statistical tests, but also by means of analysing more specific aspects such as the quality of the material. Most of the so-called manuports are of very poor quality and are covered by vacuoles which make them unsuitable for knapping, and many of them present extremely irregular forms which render them inappropriate for other activities such as percussion or throwing. As shown in figure 3.2, the hammerstones and anvils present similar percentages to the supposed manuports in the representation of the lavas. However, in this case, the qualitative criterion is essential: whilst most of the unmodified objects are weathered and irregular lavas, among the hammerstones the pattern is the opposite. Numerous examples of very fine-grained lavas can be identified which must have been highly suitable for percussion activities.

On the basis of the analytical study of unmodified material and its comparison to the rest of the collection, we find very serious conflicts that question the relationship between both samples. One last reflection could be of help in this sense. In total, we estimate that in FLK Zinj there is slightly over 74 kilogrammes of lithic material. Of this amount, 30.72 kg are unmodified objects. Thus, would it be logical to consider that the hominids transported almost half of the lithic material to the site and then did not modify it in any manner?

In our opinion it is quite improbable, and requires the reconsideration of the whole study dedicated to lithic material. Relative frequencies do not change excessively when removing the unmodified objects (see tabl. 3.1). This is due to the very high number of chips (n=1320), which renders the sample of supposed manuports (n=107) insignificant from a quantitative point of view. Nonetheless, these pieces are not irrelevant in terms of their contribution to the total weight of the raw material found at the site. Potts (1988:379) estimates approximately 72 kilograms for the artefact assemblage. If we remove the 30 kilograms of material we consider of natural origin, the FLK Zinj collection is halved, and therefore, conditions all inferences on the intensity of human occupation. Consequently, it is essential that we consider a quite plausible hypothesis based on the fact that no type of raw material reserve was being accumulated in FLK Zinj (*contra* Potts 1988, 1991), and that the hominid's activity was mainly linked to the knapping of lavas and quartzes.

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	-	-	19	6.7	19	0.7
Cores	34	1.4	15	5.3	49	1.8
Retouched pieces	14	0.6	1	0.4	15	0.6
Hammerstones & frag.	9	0.3	23	8.2	32	1.2
Anvils*	2	0.1	-	-	2	0.1
Whole flakes	99	4.2	26	9.2	125	4.7
Chips	1278	53.7	42	14.9	1320	49.5
Flake fragments	830	34.9	35	12.4	865	32.5
Angular fragments	115	4.8	15	5.3	130	4.9
Unmodified pieces	1	0.1	106	37.6	107	4
Total	2381	100	282	100	2663	100

Table 3.2. FLK Zinj categories broken down by raw material. Not including a gneiss chunk, being the single example of this raw material in the whole site, which henceforth will not be considered in the analysis. (*) Objects included in more than one category.

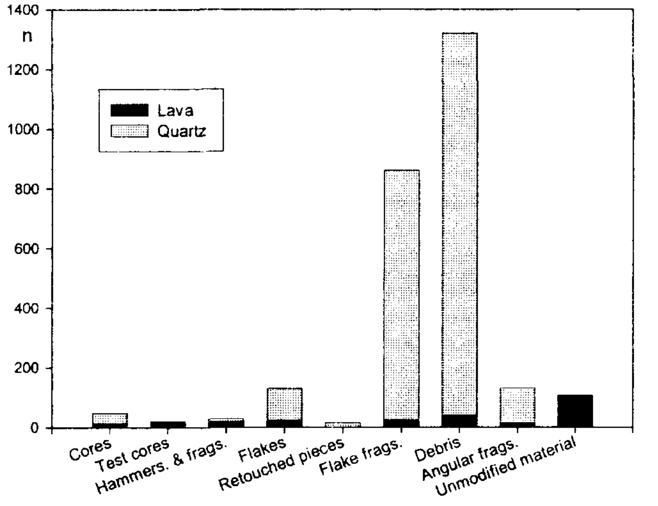


Figure 3.2. Absolute frequencies of the categories according to raw materials.

	Quartz	Lava	Total
Test cores	-	9698	9698
Cores	5593	7238	12831
Débitage	10683	1821	12504
Hammerstones	917	7580	8497
Total	**17193**	**26337**	**43530**

Table 3.3. Weight (grams) of the lithic categories according to raw materials.

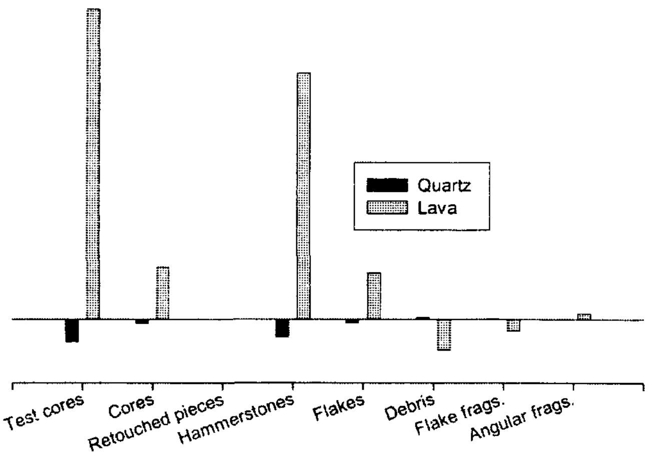


Figure 3.3. Lien Test comparing frequencies and raw materials.

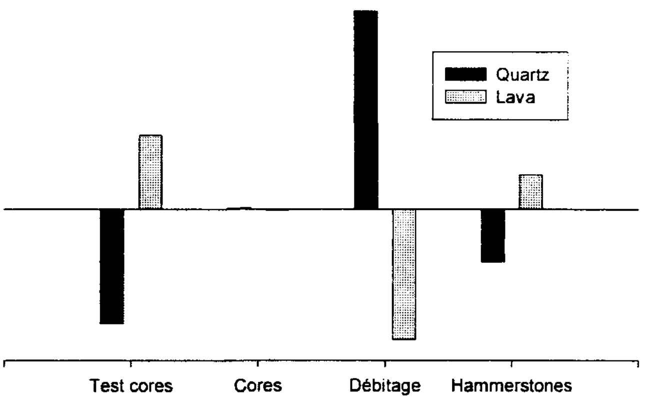


Figure 3.4. Lien Test comparing number of kilograms in each general category and raw materials.

Raw materials

The apparent predominance of quartz among lithic material has been mentioned before. In fact, when we remove the so-called manuports from the aggregates, the lava percentages drop all the more, from 10.6% to 6.9%, leaving a total prevalence of quartz in absolute frequencies (93.1%). Nonetheless, it is essential to highlight the fact that such predominance in the number of pieces does not correspond to a real trend in the exploitation of each raw material; erroneously assessing the incidence of each raw material in terms of the number of objects and not considering the total weight, Kimura (2002:295) stated that quartz predominates in FLK Zinj to the detriment of lavas, and compared this dynamic to the reversed pattern in DK. This is not correct; although quantitatively quartzes (n=2380) do seem much more abundant than lavas (n=176), we are, in fact, dealing with an inaccuracy brought about by the vast amount of quartz knapping debris. Consequently, upon assessing the total weight of the raw materials bearing anthropic modification traces (tabl. 3.3), we see that lavas, with over 26 kg of modified material, were more relevant than quartzes, since scarcely over 17 kgs were taken to the site. Since only a few authors (we have only found Brantingham 1998) have supported the predominance of the weight of the lavas, and the rest of the studies (for example Féblot-Augustins 1990; Kimura 2002; Ludwig 1999; etc) have stressed the relevance of quartz as the dominant raw material in FLK Zinj, we must consider the opposite line of argument which we are developing herein.

In an attempt to determine the relationship between raw materials and their distribution in technological categories, two inferential tests have been performed, one based on the objects' absolute frequencies (fig. 3.3) and the other based exclusively on the weight in kilograms of the structural categories (fig. 3.4). Figure 3.3 shows that, in comparative terms, there is an overabundance of lavas in the representation of test cores and hammerstones. Both have a relatively plausible explanation. Most of the test cores, some dubious, correspond to vesicular lavas which we consider local, not transported. Hence, it would be no surprise that the hominids had tested and immediately abandoned poor quality local blocks, whilst the quartzes, found in distant locations, hardly ever were discarded at the site without previous knapping. The issue of lava hammerstones to the detriment of quartz hammerstones is a constant that appears in most Olduvai sites, and is always explained in the same manner. Whilst the nearby streams contained gravel bars with phonolite and basalt cobbles with ergonomic and rounded shapes that could ideally be used as hammerstones, quartz usually (although not always) has a tabular origin and, therefore, presents morphologies unsuited for this type of task.

Comparing the number of kilograms used to configure each technological category (fig. 3.4), we see that the same pattern is repeated in the infra-representation of hammerstones and test cores made of quartz. The Lien test represented in figure 3.4 mitigates the apparent relative overabundance of lava cores to the detriment of the quartz cores in the graphic represented in figure 3.3. Above all, the inferential test represented in figure 3.4 highlights the abundance of quartz *débitage* (flakes, flake fragments, debris) compared to lavas.

This led several authors to erroneously consider FLK Zinj as an essentially quartz-based assemblage, sending us back to table 3.3: the total number of flakes, flake fragments, etc. compose over 10 kilograms of quartz that were, therefore, employed for *débitage* processes. This contrasts acutely with the employment of lavas for *débitage*, with products not even reaching 2 kilograms. This indicates a much greater exploitation of a raw material, quartz, which in absolute terms (about 17 kilograms) is less relevant than lava (approximately 26 kilograms). Moreover, the fact that the 15 lava cores weighs more (7238 grams) than the 34 quartz cores (5593 grams), alongside the almost 10 kilograms of lava test cores, indicates, once again, that the intensity of the reduction of this raw material was quite inferior to that of quartz.

Therefore, we are facing a differential use of raw materials, probably conditioned by two factors: quality and availability. As regards the former, FLK Zinj quartzes are good quality, thus allowing for controlled knapping. This is not the case of the vesicular lavas, with irregularities and vacuoles that provide only a few flakes. Nonetheless, FLK Zinj also presents numerous high-quality phonolite and basalt cobbles, generally used as hammerstones, which could provide well-made flakes, as documented in the assemblage.

As regards the availability of the raw materials, it has already been proposed that the vesicular lavas could have been found in the actual site, from the weathering of the basaltic level, the FLK Zinj's substratum. This local abundance, alongside their poor quality, could explain the low intensity of reduction observed in these lavas. It has also been commented that higher quality phonolite and basalt cobbles must have been available in an area relatively near the site, in stream channels. In contrast, quartz seems to have a distant origin, probably Naibor Soit (Hay 1976). Therefore, the excellent quality of the quartzes, alongside their remote origin, leading the hominids that settled in FLK Zinj to exploit that raw material more intensely.

Knapping products

From a quantitative level, *débitage* is the most important category of the collection (tabl. 3.1) although, as aforementioned, this would not be the case if we were referring to the total volume of raw material. In any case, the knapping debris comprises the most relevant percentage (51.6%), followed by different types of flake fragments and complete flakes – 4.7% (fig. 3.5). Therefore, the importance of *débitage* processes in the site is quite obvious.

As regards complete flakes, our aggregate (n=125) is substantially inferior to the 258 flakes Leakey described (1971:58). This is due to the fact that Leakey classified items that are actual fractured knapping products as whole flakes. Therefore the former should be contemplated in a different category in the general *débitage* group. Our analysis highlights the great metric homogeneity of the flakes, concentrated in the 21-40 mm range, maximum lengths and widths (tabl. 3.4 and fig. 3.6 & 3.7). The scant lava flakes are slightly smaller (33.77 mm maximum length) than the quartz flakes (37.58 mm), but are included in the same interval (fig. 3.6), and therefore show no significant metric differences. Differences between quartz and lava flakes appear in the cortex indices. Table 3.5 shows that flakes without any type of cortex compose the most relevant percentage (62.4%). Nonetheless, breaking down the flakes in terms of the raw material (fig. 3.8) shows that lava items do not follow the general pattern since, percentage-wise, the cortical types are more frequent in lavas than in quartzes.

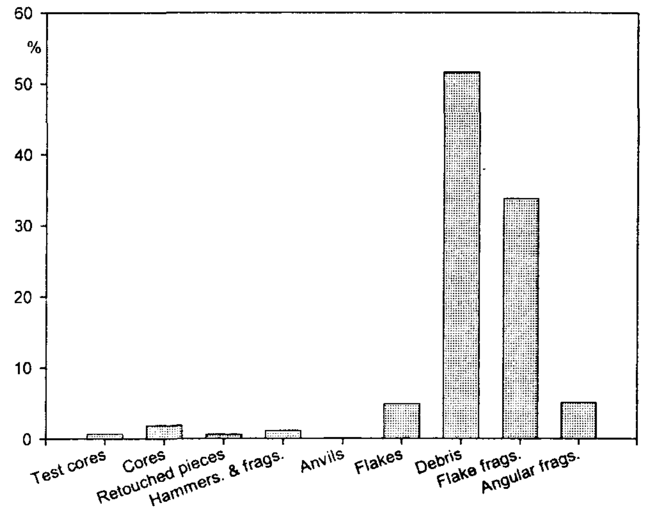


Figure 3.5. Percentages of the categories at FLK Zinj, excluding unmodified lithic material.

	Minimum	Maximum	Mean	Std. deviation
Length	16	82	36.78	12.13
Width	4	76	32.88	11.59
Thickness	4	36	11.51	5.45
Weight	1	174	18.89	24.21

Table 3.4. Dimensions (mm. and gr.) of whole flakes from FLK Zinj.

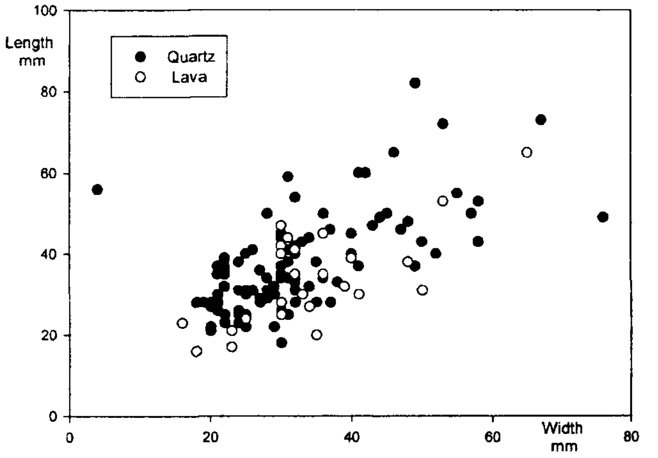


Figure 3.6. Size scatter diagram of whole flakes' dimensions.

Obviously, the difficulty of identifying cortical areas in quartzes prevents an exact evaluation of their relevance in the assemblage. In any case, and even if we focused on FLK Zinj lavas – where it is easier to locate cortical areas –, we seem to be facing a different pattern. Lava flakes are primarily cortical, many of them almost first generation (fig. 3.8). These lava flakes come from low-quality blocks, and in fact present abundant irregularities and vacuoles. That must be the reason for the poor manufacture of these flakes, which generally present blunt edges and irregular morphologies; nonetheless, some good quality items have also been documented (fig. 3.9). Altogether, the scarce number of items, the high cortex percentage and the low quality of these

Dorsal face	Striking platfom				Total	
	Cortical		Non- cortical			
	N	%	N	%	N	%
Full cortex	2	1.6	3	2.4	5	4
Cortex > 50%	4	3.2	10	0.8	14	11.2
Cortex < 50%	1	0.8	22	17.6	23	18.4
Non-cortical	5	4	78	62.4	83	66.4
Total	12	9.6	113	90.4	125	100

Table 3.5. Absolute and relative frequencies of cortex in the whole flakes from FLK Zinj.

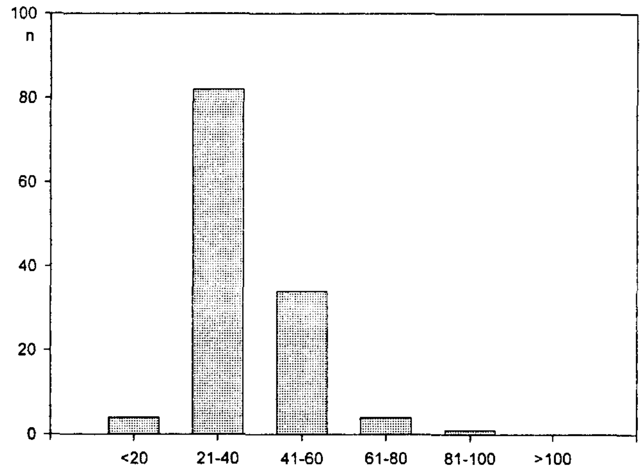


Figure 3.7. Length patterns in the whole flakes (mm).

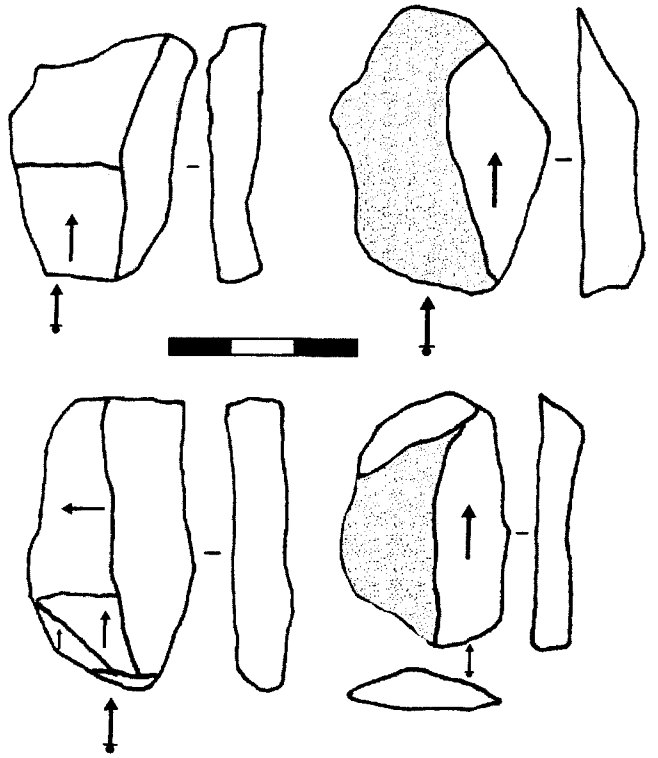


Figure 3.9. High-quality lava flakes from FLK Zinj.

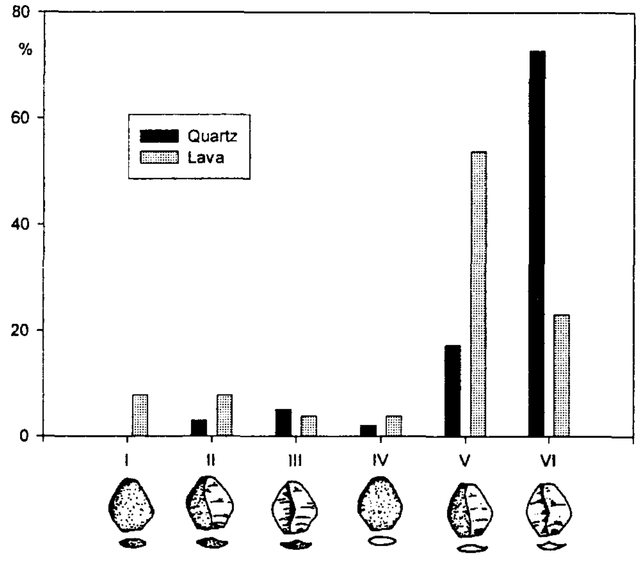


Figure 3.8. Types of flakes at FLK Zinj (divided by raw material), according to Toth's (1982) classification.

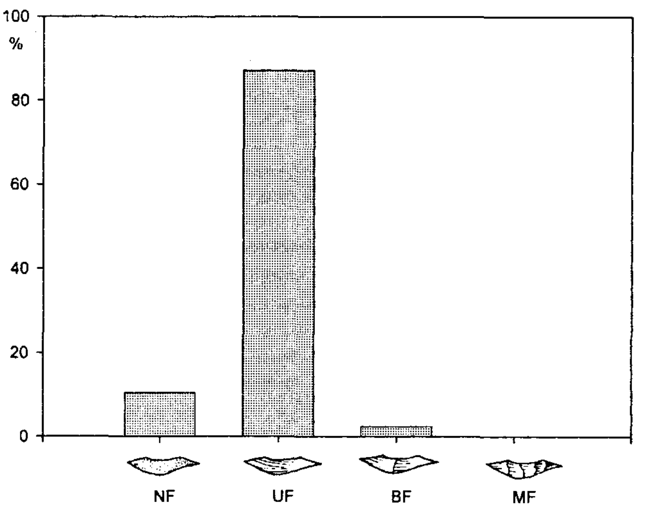


Figure 3.10. Types of striking platforms in the whole flakes from FLK Zinj.

lava flakes, seem to link their production to local vesicular blocks, which would only have been exploited occasionally, and are therefore not linked to the general quartz *débitage* strategy.

In the whole collection of flakes there is a dominant pattern in the management of striking platforms (fig. 3.10), with a predominance of non-cortical butts (90.4%). In any case, knapping platforms are not usually prepared, with 87.2% unifaceted butts and only 2.4% dihedral butts, with no multifaceted butts documented.

Despite the lack of preparation of knapping platforms, the quality of most quartz flakes is surprising. As occurs in DK, this suggests unidirectional exploitation, producing flakes with elongated morphologies and fine, regular sections. The analysis of the number of scars on the dorsal

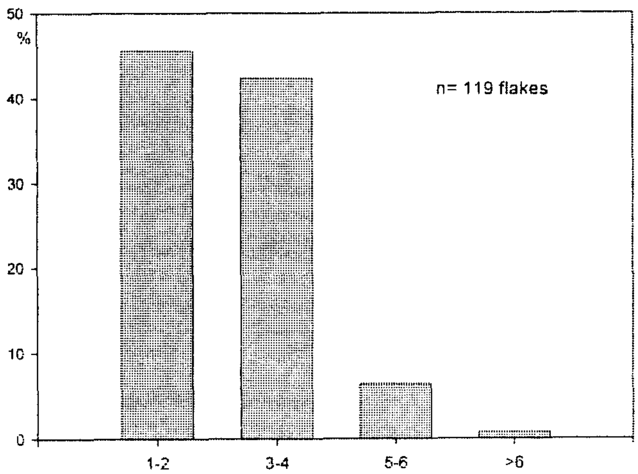


Figure 3.11. Amount of scars on the dorsal sides of the whole flakes.

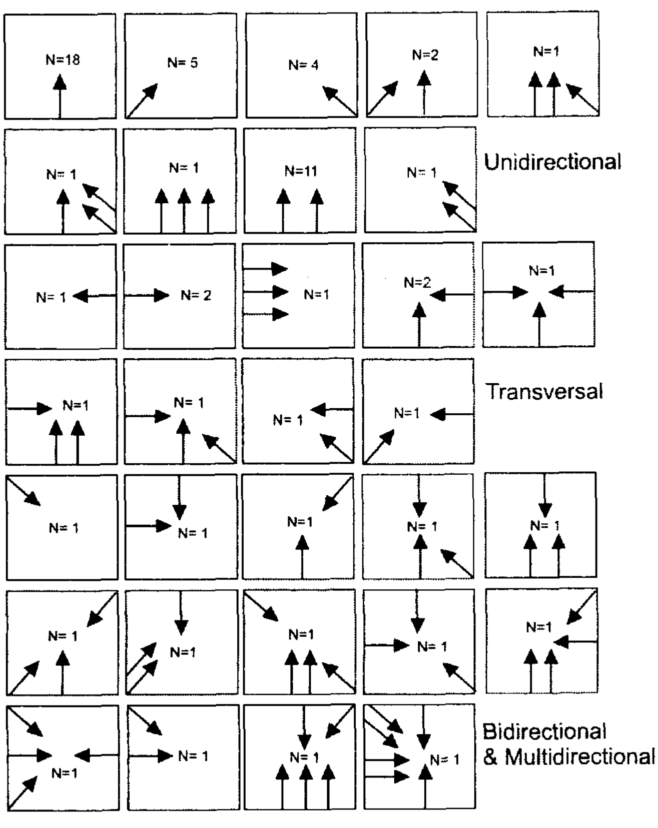


Figure 3.12. Diacritic schemes of the whole flakes.

faces indicates a relatively recurrent exploitation of the same knapping surfaces, with 45.6% flakes presenting 1-2 previous scars, and a very similar percentage (47.6%) of items from a slightly more intense reduction (fig. 3.11). Another indication that supports the recurrence in the exploitation appears in the fact that there are a few edge-core flakes which, albeit composing a minimum percentage (5.6%) of the total flakes, do suggest an interest in rejuvenating knapping surfaces that had lost the appropriate angles.

Identifying the direction of the previous scars on the dorsal sides of the quartz flakes can be even more complicated than in the lava examples described in DK. Nonetheless, one example (n=70) from the flake collection has been used to perform a minimum estimation. The main pattern is unidirectional (fig. 3.12), although there are also examples of core rotation, indicating a recurrent exploitation based on multidirectional management.

Altogether, we can refer to knapping products with unifaceted butts from cores with unprepared striking platforms, and in which the direction of the dorsal scars indicates the predominance of unifacial methods which do not present core rotation (fig. 3.13). Flakes suggest the craftsmen were not usually interested in and/or were not capable of rejuvenating the exploitation surfaces. As aforementioned, there are few edge-core flakes and there is little evidence of a systematic rejuvenation of these cores' edges. The number of scars per flake – predominantly 1-2 detachments – also indicates relatively short knapping sequences, although there are some flakes that suggest certain recurrence in their exploitation.

Retouched pieces

Leakey (1971:58) counts 18 light-duty scrapers and 4 burins, as well as over 70 flakes and fragments that present utilization traces. Ludwig (1999) and Kimura (2002) did not contemplate this category in their classifications, and Potts (1988) reduced the number of scrapers from 18 to 9 items. At first, Potts (1988:377) maintained Leakey's classification (1971) as regards burins, but subsequently stated that these pieces could be natural (Potts 1991). After disagreeing with Leakey's criteria (1971) for the DK study, we thought we would also discard most of the so-called retouched items in FLK Zinj. Nonetheless, this was not the case, and we have classified 15 items as such, reaching a total similar to the 22 retouched

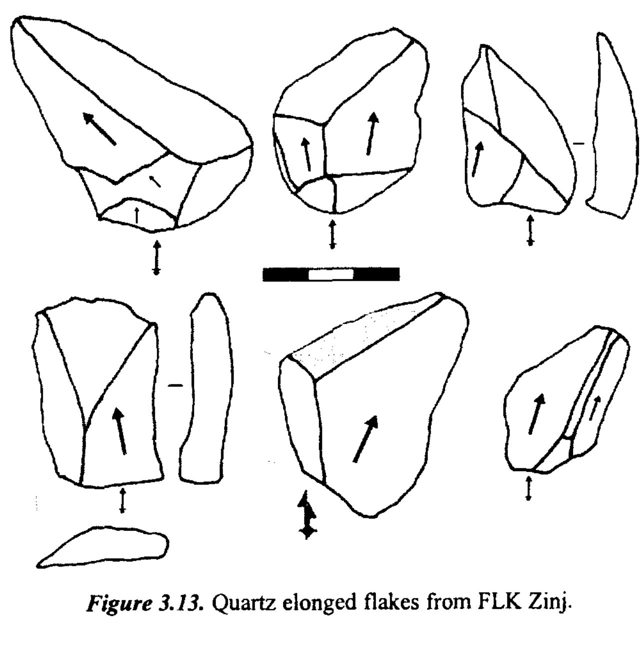


Figure 3.13. Quartz elonged flakes from FLK Zinj.

pieces Leakey proposed. In any case, in quantitative terms, these retouched items suppose a minimum percentage of the collection (0.6%) and of the raw material used in this category (in total, only 653 grams among slightly over 43 worked kilograms).

The first issue concerns the burins: none endure a thorough analysis, since in-depth studies indicate that the so-called burin blows are merely fractures. Potts (1991) had voiced doubts regarding the existence of real burins in Bed I, but provided no analytical arguments to discard them. It is ambiguous to distinguish a split fracture ("Siret" flake) from a real burin; consequently, the classification sometimes depends on subjective criteria. Nonetheless, in this case we were lucky enough to identify two fragments that refit, and precisely corresponded to a flake represented in the monograph (Leakey 1971:57) as a burin (fig. 3.14). Thus, this specific example allows us to interpret the so-called burins as knapping fractures and, as in DK, rule out their existence in this part of the Olduvai sequence.

As regards the pieces classified as authentic retouched pieces (fig. 3.16 and 3.17), the predominant raw material is quartz, with only 1 of the 15 retouched objects made of lava. Consequently, retouched pieces follow the same pattern as the rest of the *débitage*, with an absolute prevalence of quartz and a merely incidental presence of lava. 11 of the retouched pieces (73.3%) are flake fragments, in opposition to only 4

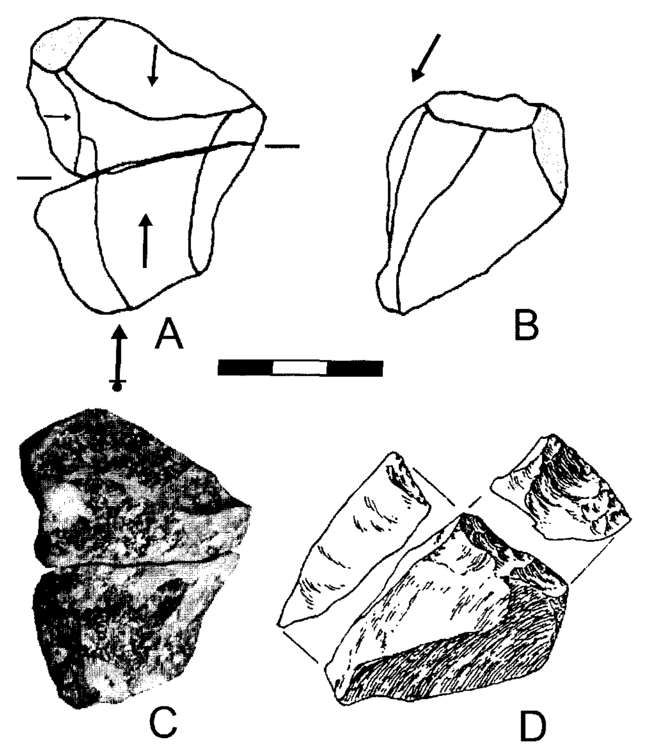


Figure 3.14. Refit of two flake fragments from FLK Zinj. Figure d is part of one of Leakey's (1971:57) plates and represents a so-called quartz burin (b). Nonetheless, it is merely the distal part of a fractured flake (a, c), and therefore, is not a burin blow.

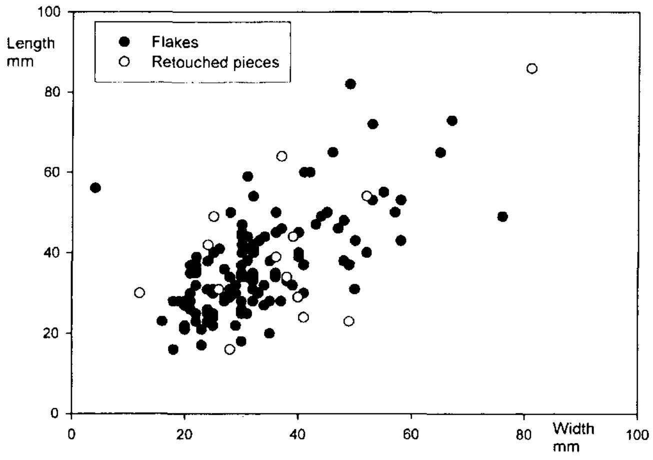


Figure 3.15. Dimensions of the retouched pieces compared with whole flakes.

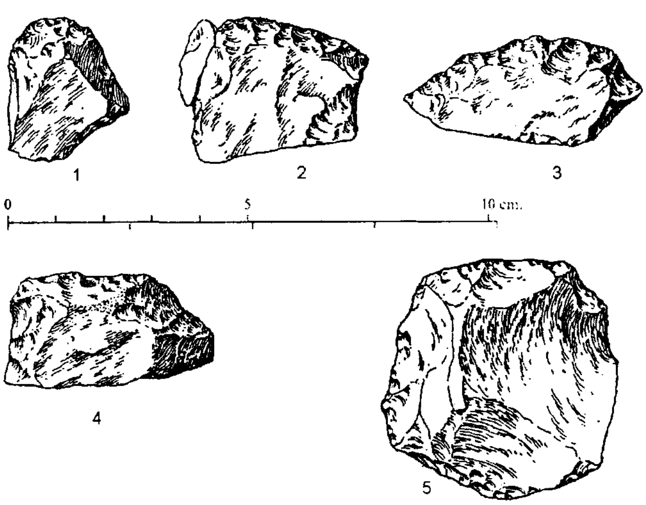


Figure 3.16. Actual retouched pieces from Leakey (1971:57). 1-3: lateral side scrapers; 4: transversal side scraper; 5: lateral-transversal side scraper.

examples of whole flakes. Despite the fragmented character, the average size of the retouched pieces is slightly bigger (40.27 mm maximum length) than flakes (36.78 mm), but do not follow a specific morphometric trend (fig. 3.15) and can be included in the size scatter interval for flakes. In all, neither the raw material nor the dimensions of the retouched pieces stand out in the patterns observed for the rest of the *débitage,* which indicates no preferential selection of blanks for retouching.

Typologically, there is a prevalence of scrapers, especially lateral side scrapers, with 8 examples (53.3%), followed by transversal scrapers with 3 examples (20%) and one single case of a lateral-transversal side scraper. There are also 2 notches and a possible end scraper, which are actually incidental examples in the general dynamics of FLK Zinj, where retouched pieces were not a basic, but a residual element in the framework of the activities performed.

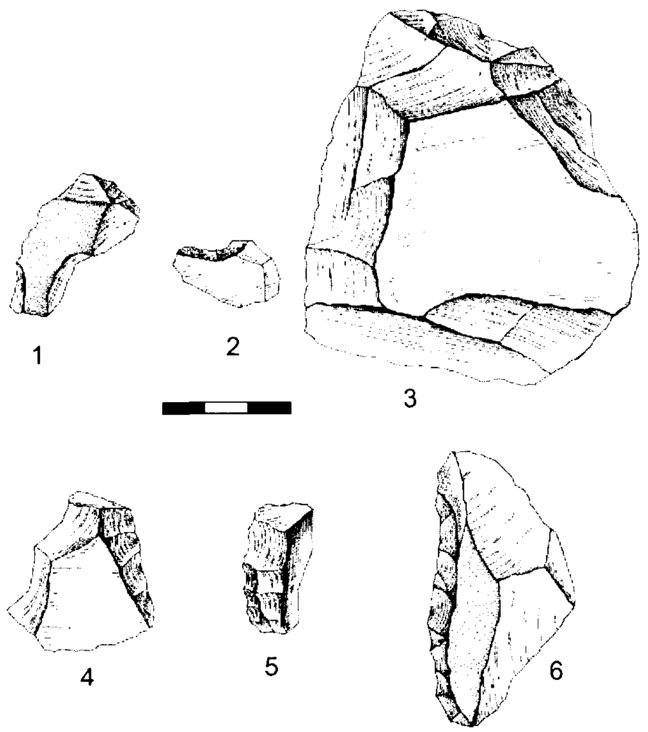


Figure 3.17. Retouched pieces from FLK Zinj. All examples are quartz pieces except number 4 (basalt). 1: end scraper; 2: notch; 3-6: side scrapers (drawn by N. Morán).

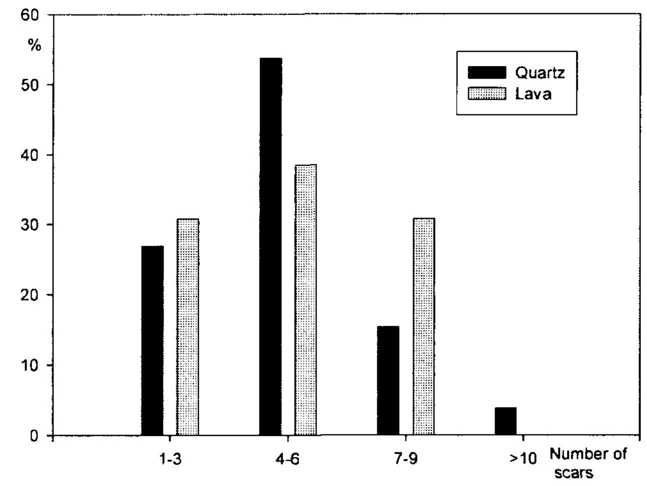


Figure 3.18. Amount of scars on the quartz and lava cores from FLK Zinj.

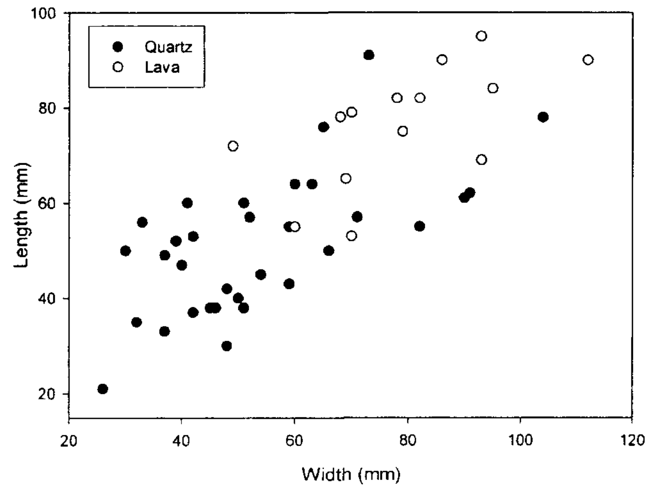


Figure 3.19. Size scatter diagram on cores according to raw material.

Cores

With 49 items, cores compose 1.8% of the total percentage of objects from the site (tabl. 3.2). They seem irrelevant from a quantitative viewpoint. Yet, considering the real volume of employed raw materials, cores are still more relevant than the *débitage* (tabl. 3.3). This classification of cores includes objects Leakey (1971:58) considered artefacts, such as choppers, polyhedrons, discoids and heavy-duty scrapers. Adding all these categories would amount to 38 pieces, still lower than our aggregate, although Leakey did also include 155 core fragments which have merely been considered as cores in this analysis. Potts (1988:378) contributed a similar number of cores (n=28), including several test cores (incidental cores in his terms), and abundant core fragments. Kimura (2002:301) contributed no absolute frequencies, although in view of her percentages, we suppose she classified 84 pieces as cores. Finally, Ludwig (1999:28) identified 37 cores, which leads us to believe he merely included in this category objects that Leakey (1971) classified as choppers, polyhedrons and discoids. In all, core frequencies vary too much in terms of each investigator, therefore we must reconsider the enormous subjectivity implied in any system of analysis.

Considering the issue of the raw materials first, we come upon a dichotomy between the quartz and lava cores. Although the latter are numerically inferior to the quartz cores (see again tabl. 3.2), we have also underscored previously that, as regards the total volume of the raw material, there is paradoxically a greater amount of lavas. This difference could be explained in view of the vast intensity of reduction quartzes underwent. Nonetheless, our aggregates indicate that the number of detachments on cores is identical for both raw materials, with a mean of 5 scars both in quartzes and lavas. The classification of cores in terms of the number of scars (fig. 3.18) does not offer a clear pattern either, therefore we only find significant differences when comparing the dimensions of the quartz and lava cores (fig. 3.19), since the lava pieces are invariably larger (see also tabl. 3.6). Although this trend could be explained given that, hypothetically, the natural lava blanks were larger, given the vast volume of quartz *débitage* and the scarce number of lava products (which are also usually cortical), it seems feasible to link the small quartz cores to the greater intensity of the exploitation of such raw material.

Cortex percentages in cores (fig. 3.20) support this hypothesis, since we found no basalt core in which reduction had been sufficiently intense to eliminate the whole cortex, and in the

		Minimum	Maximum	Mean	Std. deviation
Quartz	Length	21	91	51.27	14.54
	Width	26	104	54.15	18.59
	Thickness	17	72	35.03	11.2
	Weight	18	650	152.27	129.35
Lava	Length	53	95	76.35	12.57
	Width	49	112	78.85	16.26
	Thickness	37	87	59	12.3
	Weight	183	1000	473.42	257.78

Table 3.6. Dimensions of cores at FLK Zinj.

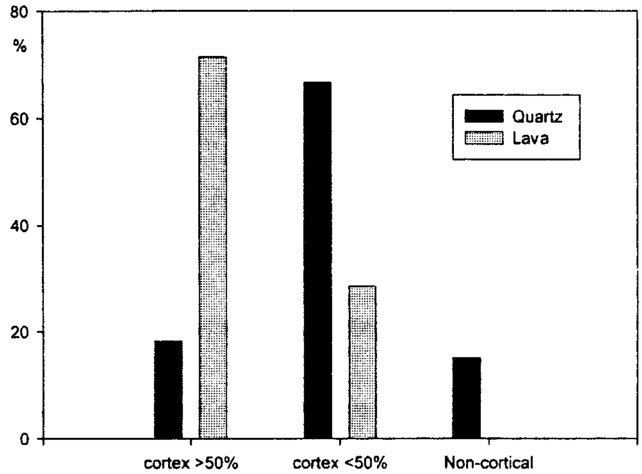


Figure 3.20. Cortical percentages on lava and quartz cores.

most abundant examples of lava (71.4%), cortex prevails over the knapped area. Quartz patterns are different, since many cores present residual cortex. Consequently, there is another argument to support a greater intensity of the reduction of quartzes as opposed to the marginal exploitation of lavas.

Continuing this problem regarding the intensity of the reduction, we can assess the relationship between knapping products and cores, as performed in DK. Based on Leakey's (1971) data and Potts' (1988) information for the lava material, Brantingham (1998: 83) indicates a total of 15 cores and 111 flakes, estimating an average of 7.4 flakes per core. McNabb (1998:17-19), also considering lavas based on Leakey's (1971) publication, counts 18 cores and, contemplating a minimum of 3 and a maximum of 15 scars per core, calculates a minimum of 108 flakes and a maximum of 540. Since both Brantingham (1998) and McNabb (1998) base their calculations on Leakey's (1971) aggregates and said volumes do not coincide with ours, we can reformulate this hypothesis. Based on this analysis, we calculate an average 5.3 flakes per lava core, taking into account cores with a minimum of two detachments and a maximum of 9 scars. Implementing McNabb's reasoning, this would produce a minimum of 42 lava flakes and a maximum of 126. Nonetheless, we only have 26 items at the site. Actually, adding the basalt flake fragments (tabl. 3.2) and whole flakes we could approach the minimum levels established in McNabb's proposal. Nonetheless, there is still a shortfall as regards lava *débitage*, especially given that we have not even considered the test cores, which would further increase the expected number of flakes.

Leakey (1971) had already stressed the imbalance between flakes and what she called choppers and heavy-duty scrapers. In a subsequent work, Leakey (1975) proposed an explanation for the lack of lava flakes in the fact that heavy-duty tools were not manufactured in the sites; therefore, they were already shaped when transported. This statement contains a conceptual contradiction, since we consider these heavy duty tools as cores, not as tools. From this standpoint, it would be logical to think that these lava pieces were flaked at the site, and that the flakes obtained were transported subsequently. In all, endorsing either of these options would imply the acceptance of a model similar to that proposed by Potts when stating that the Olduvai assemblages "*show every indication of a far more complex series of episodes of stone transport, flaking, preferential removal of cores or flakes from sites, and repeated introduction and modification of flaked pieces at sites*" (1991:163). Binford (1987) takes advantage of this imbalance between choppers and basalt flakes as another argument in favour of the multiplicity of events on the site. In his opinion, the deficit proves the artefacts originated from different occupation episodes which were mixed, but were in fact independent. This time we do not agree with Binford (1987), since morphologically and technically the flakes and cores made of lava present common, coherent characteristics, and we do not consider the quantitative criterion Binford puts forward is enough to refer to different taphonomic histories in each of these categories.

We can also apply McNabb's calculations (1998) to quartz cores. According to our classification, there are 34 quartz cores, which present a minimum of 3 and a maximum of 12 detachments, with an average of 5.2 scars per core. Therefore, there would be a minimum of 102 flakes and a maximum of 408 pieces. Although the number of whole quartz flakes recovered in the site (n=99) does not amount to the calculated minimum, if we obtained a minimum number of individuals among the quartz flake fragments (n=830) we may reach the interval contemplated in our calculation. Consequently, it seems that, as regards quartzes, there seems to be an internal coherence between the core percentages and the produced *débitage*. Therefore, we disagree with McNabb (1998:17), who suggested a deficit of quartz cores in FLK Zinj, which would have been transported from the site after undergoing knapping processes. We do not support this stance; hominids transported quartz cores to the site, exploited them intensely generating hundred of flakes and fragments and thousands of chips, and then discarded them, once exhausted, in the site itself.

Core exploitation systems

In FLK Zinj, Leakey (1971:58) mentioned core-type tools like choppers, polyhedrons, discoids and heavy-duty scrapers. They can all be assigned to the different knapping systems

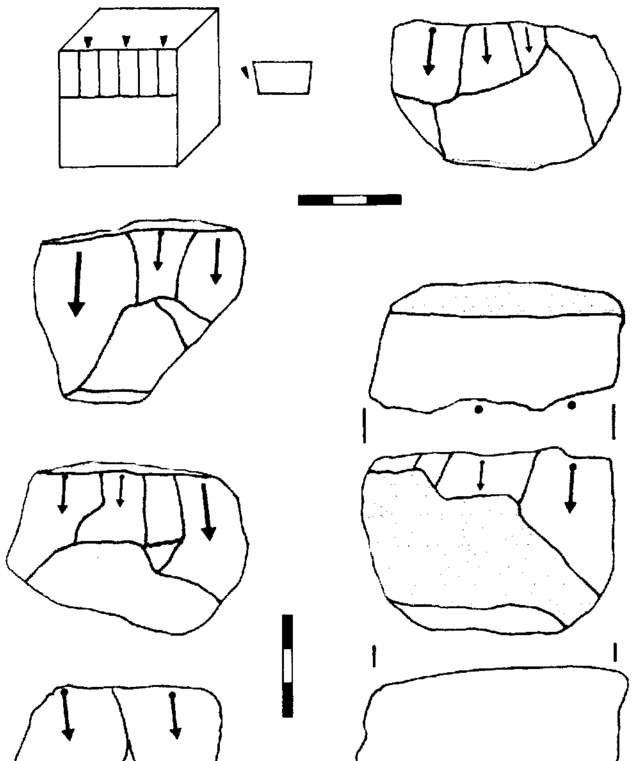


Figure 3.21. Unifacial abrupt partial quartz cores. They are interesting in view of their small size and the general reduction strategy, consisting in employing one of the natural tabular planes as a striking platform to obtain a short sequence of flakes on a single exploitation surface.

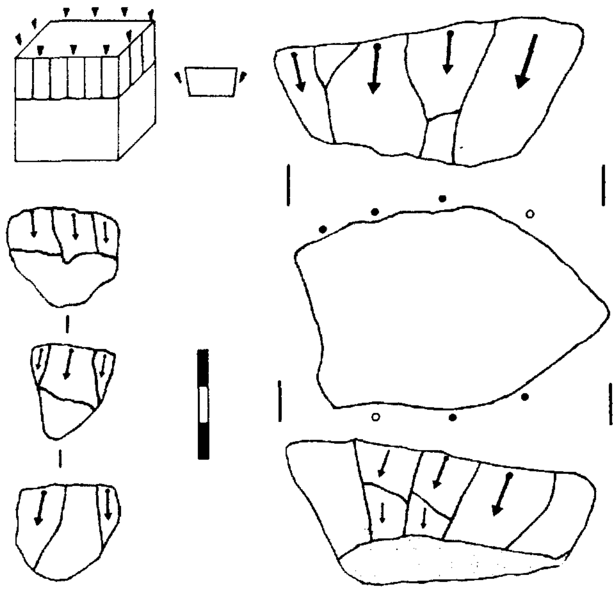


Figure 3.22. Unifacial abrupt total quartz cores. Note the exploitaion of the whole periphery from a natural plane, both on the meium-sized block and the small quartz fragment.

that we are progressively describing in this book. The most general division divides the FLK Zinj cores (n=49) into unifacial (49%) and bifacial (48,9%), alongside a single core on Kombewa flake which is considered separately. According to the current technological classification, the most relevant exploitation system is the *unifacial abrupt unidirectional* system, which comprises 44.7% of the cores. This group gathers a good part of the pieces Leakey (1971) considered heavy-duty scrapers. Nonetheless, these abrupt angle detachments which Leakey (1971) considered retouched pieces, seem to be linked more precisely to flake detachment, and have therefore been included in the unifacial or bifacial abrupt systems. As in DK, the unifacial abrupt unidirectional method was employed in FLK Zinj both on a single surface (29.8% of the cores) and on independent platforms (14.9%). Nevertheless, the same system was always employed: after selecting an unprepared striking platform, an exploitation surface was knapped until it lost the appropriate angles. Instead of rejuvenating the necessary volumes, the core was discarded – single plane unifacial abrupt system (fig. 3.21 and 3.22) – or rotated until finding a new exploitation surface – independent plane unifacial abrupt system (fig. 3.23). Quartz cores were exploited maximising the blocks' natural tabular shapes as striking platforms, which were used to exploit the periphery of the core. Moreover, that periphery was not always exhausted, and there are many examples in which reduction is partial and craftsmen could not completely configure the core circumference. This exploitation model could provide the aforementioned elongated flakes with longitudinal dorsal patterns.

Sometimes the abrupt detachment method stems from a bifacial scheme (*bifacial abrupt system*), presenting scars on the horizontal plane that could be used to reactivate the platforms and the exploitation of the transversal and sagital planes. We cannot certainly say that detachments from one plane were used to prepare those of the another, therefore it seems more appropriate to refer to a simple interaction between surfaces, considering both as exploitation surfaces. In general, platform preparation is scarcely defined in these cores, in which the most important factor was to exploit a surface until exhaustion and then discard the piece. Furthermore, this bifacial abrupt system (fig. 3.24 and 3.25) achieves a relevant percentage (29.8%) in terms of the total number of cores.

Alongside this type of exploitation, there is a *unifacial simple partial system* (unifacial choppers), with 4.3% of the total number of cores. The interesting thing is that these cores, alongside the bifacial choppers (also 4.3%), are all lava-based. Nonetheless, as occurs in DK, FLK Zinj presents no use-wear traces on the ridges of the choppers that allow them to be classified as artefacts and they are, once again, considered simply another example of the variability of the knapping methods employed on the site. FLK Zinj also presents the *bifacial peripheral system*, albeit represented only by a 4.3% of the total number of cores (fig. 3.26).

The last relevant type of exploitation is the *bifacial alternate system*. In DK, this method was only identified on one core, therefore in that chapter we did not insist on its description.

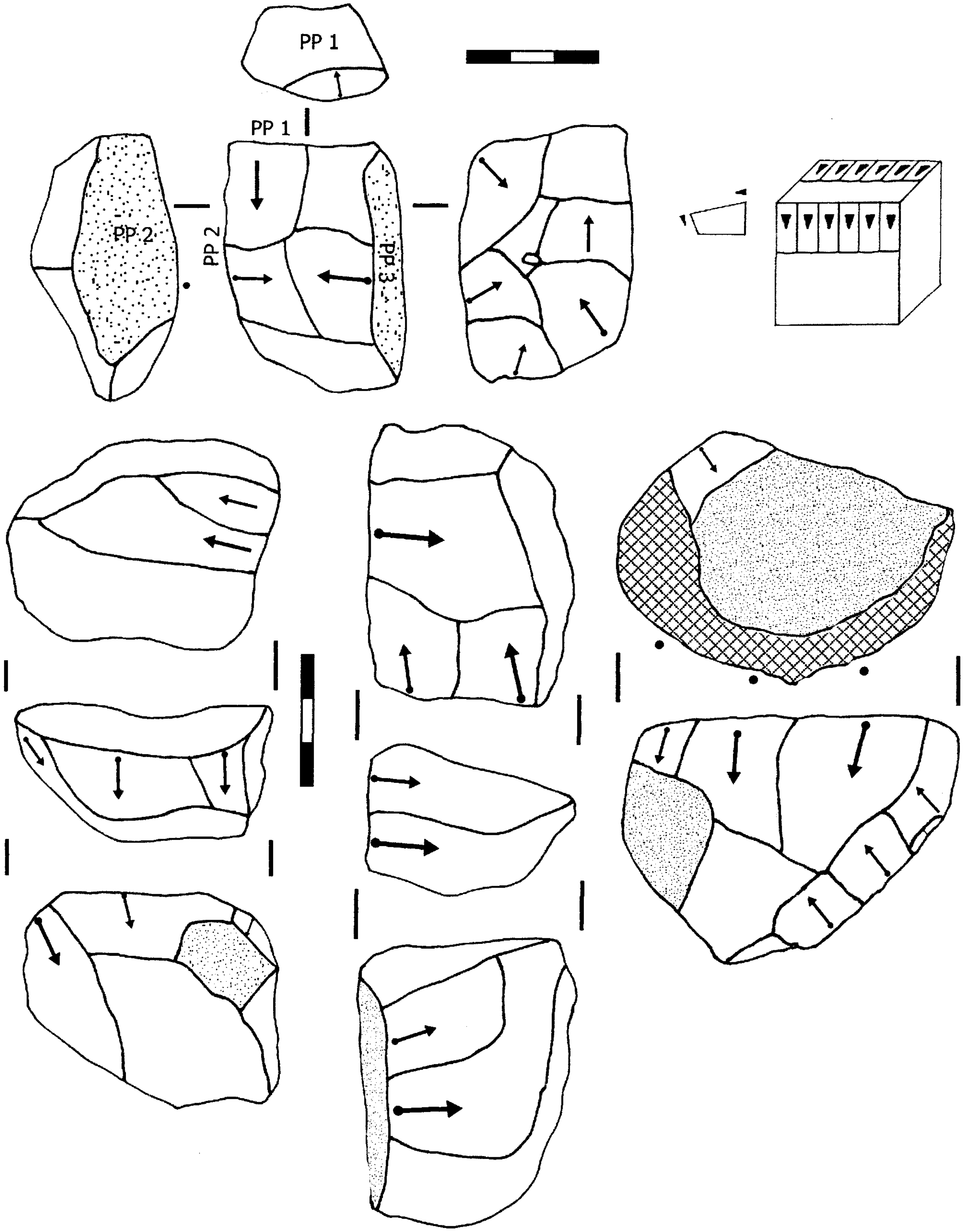


Figure 3.23. Unifacial abrupt unidirectional cores on independent planes. All examples are made of quartz. The weave in the core on the right hand indicates a battered area. Note the example of the upper part of this figure; percussion platforms (PP) 2 and 3 are cortical, indicating the small size of many of the exploited quartz blocks.

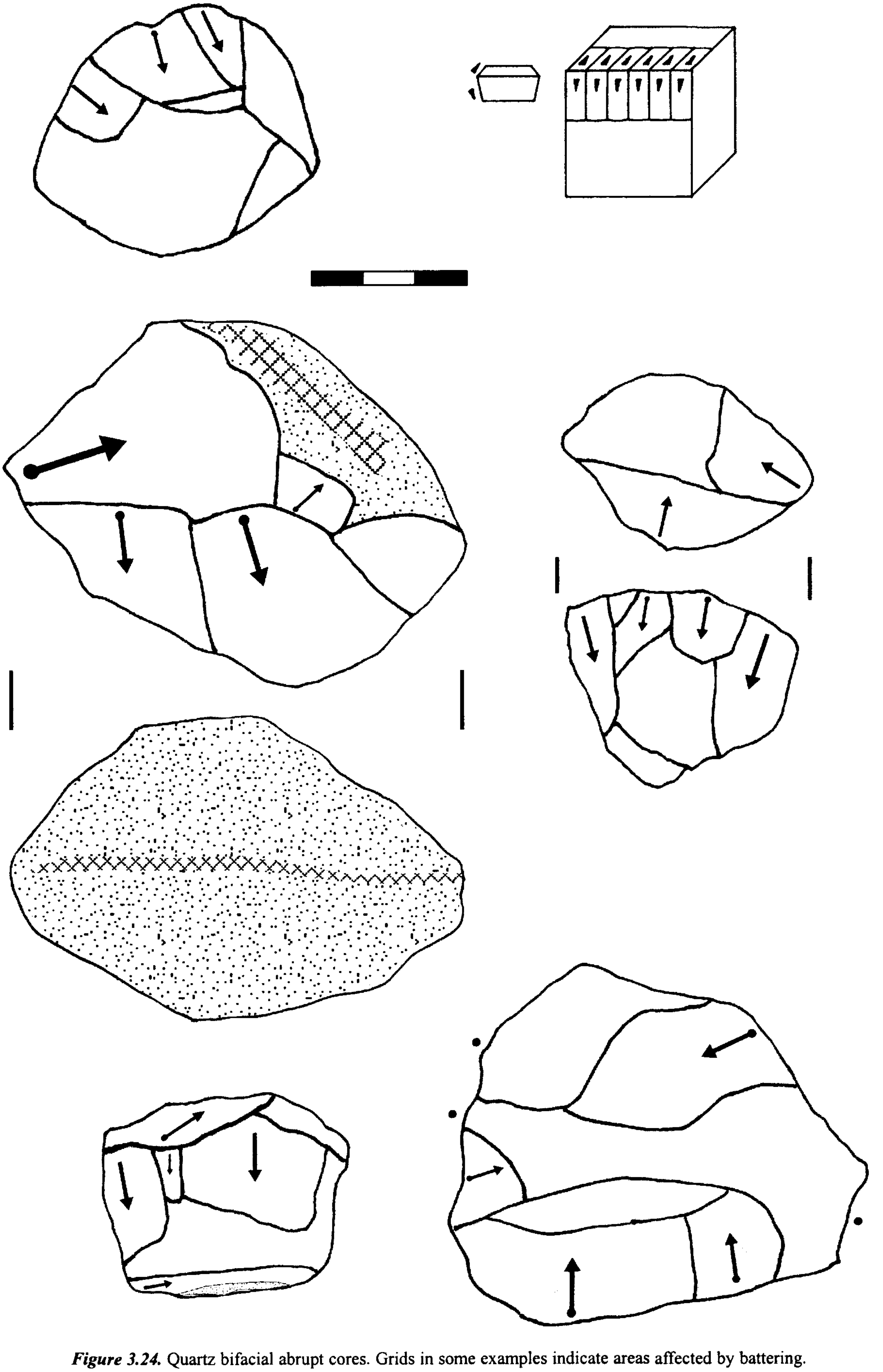


Figure 3.24. Quartz bifacial abrupt cores. Grids in some examples indicate areas affected by battering.

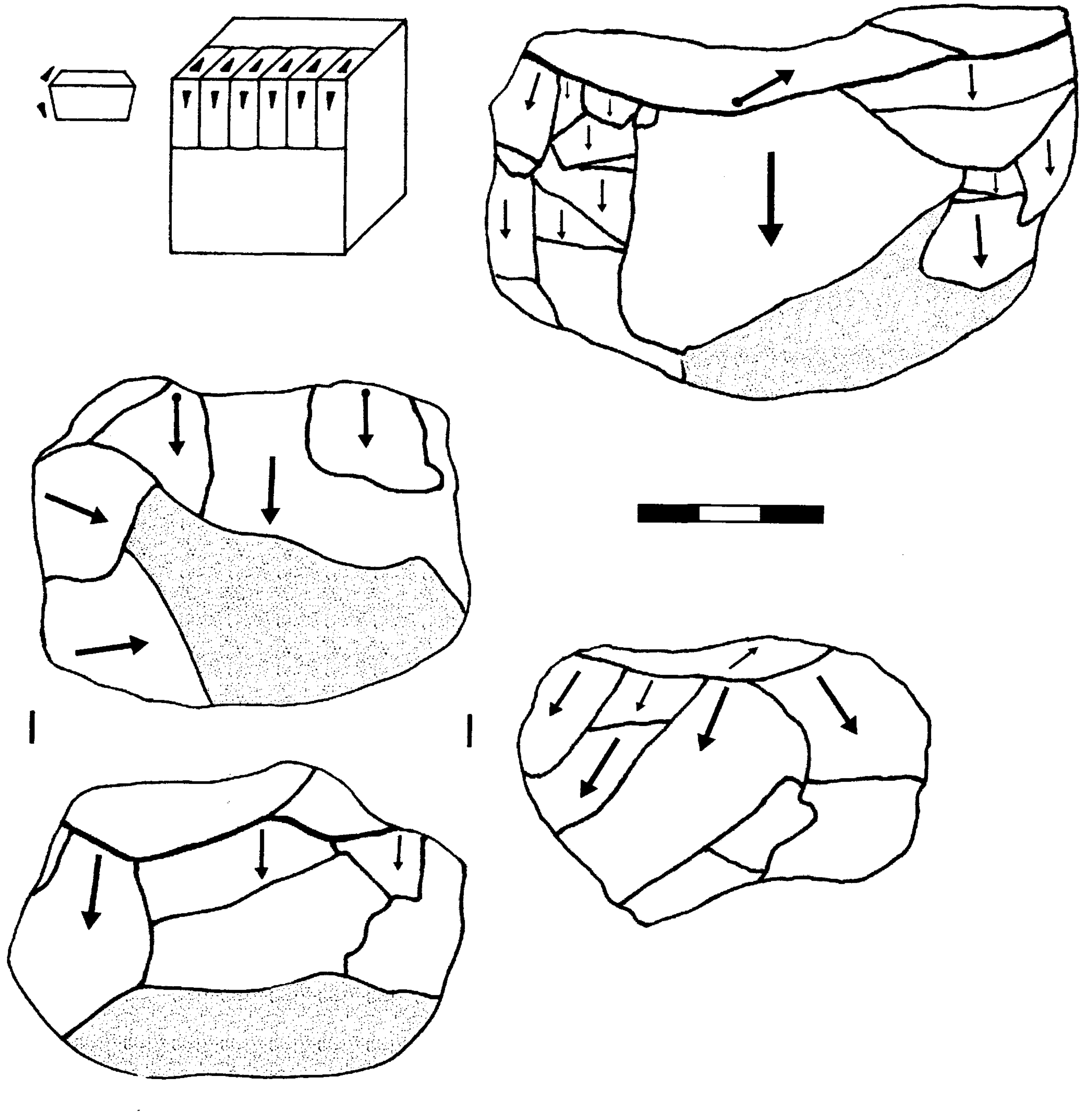


Figure 3.25. Bifacial abrupt lava cores.

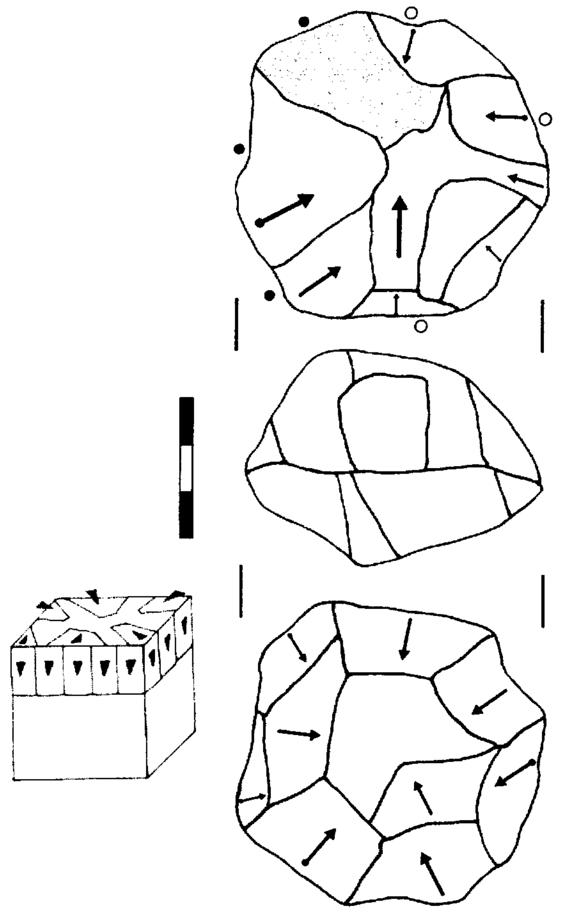


Figure 3.26. Bifacial peripheral quartz cores.

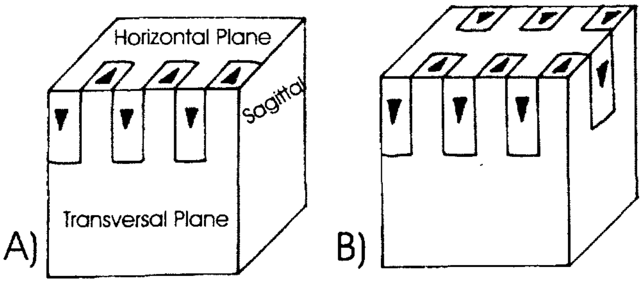


Figure 3.27. A: ideal schema for the bifacial alternate partial exploitation method. B: bifacial alternate total method.

On the contrary, in FLK Zinj, the bifacial alternate method accounts for 10.7% of the cores and calls for greater attention. It is characterised by a zigzag configuration plane that manages a bifacial edge by means of alternating detachments from each plane. Such alternation enables the creation of consecutive striking platforms on each surface, and also creates convexities to extract another subsequent series in the next sequence steered by the "guide ridge". It is important to stress the idea that the whole volume of the core is not exploited, only the area closest to the edge, since it is precisely this factor which differentiates this method from the discoid system. Therefore, in the bifacial alternate method the alternation in the exploitation allows craftsmen to solve the angle problem for the subsequent series of flakes. Nonetheless, it does not maintain an adequate volume on the surfaces, which end up collapsing until the core has to be discarded.

A lot of these pieces do not present detachments over the whole circumference, which led Leakey (1971) to classify them as choppers. We have considered them bifacial alternate partial cores (fig. 3.27a), thus differentiating them from those that present knapping all over the periphery of the core – bifacial alternate total system (fig. 3.27b). Despite the technical errors implied in the employment of a edge and not a complete surface (which ends up collapsing the exploitation plane completely), we consider the finding of this system in a site as old as FLK Zinj relevant, since it demonstrates that hominids were capable of understanding the dynamics of interaction between surfaces and the advantages of changing the striking plane systematically by alternating detachments (fig. 3.28). This suggests an ever greater control over geometric concepts implicit in lithic knapping.

Percussion objects

Before considering percussion objects as such, we must underscore a fact that was not documented in DK, but which as from FLK Zinj and in other sites in the sequence will appear as a constant. A great part of the quartz *débitage*, if maintaining the typical characteristics that identify them as knapping products (butt, ventral face, negatives of previous detachments on the dorsal face, etc), present many battering traces. It is evident that in FLK Zinj an important amount of flakes had formerly been part of objects linked to percussion, which were subsequently recycled as cores: battering on the dorsal faces of the flakes support this notion. This does not only apply to flakes; 13 of the cores from FLK Zinj (i.e. 26.5%) present traces of having been used as percussion objects before and/or after being used as cores. Altogether, it is important to assume the polyvalence of many of the categories we identify, which were most certainly included in multifunctional dynamics.

Considering whole hammerstones, broken hammerstones and fragments detached from hammerstones (tabl 3.1), these objects compose over 8 kilograms of raw material and resemble the global volume established for other categories which could, in principle, be considered more significant (see again tabl. 3.3). Of the 21 identified knapping hammerstones, 18 are made of lava and only 3 of quartz. These lava hammerstones, in opposition to the so-called manuports made of vesicular raw material, are high-quality dense, rounded and homogenous cobbles made of basalt and phonolite. Therefore, hominids were obviously selecting a specific type of blanks for their hammerstones, both in terms of the raw material and the ergonomic sizes, morphologies and weights (tabl. 3.7).

We have also identified two anvils alongside these typical knapping hammerstones. Both are made of quartz and also present detachments that mark them as cores, although such

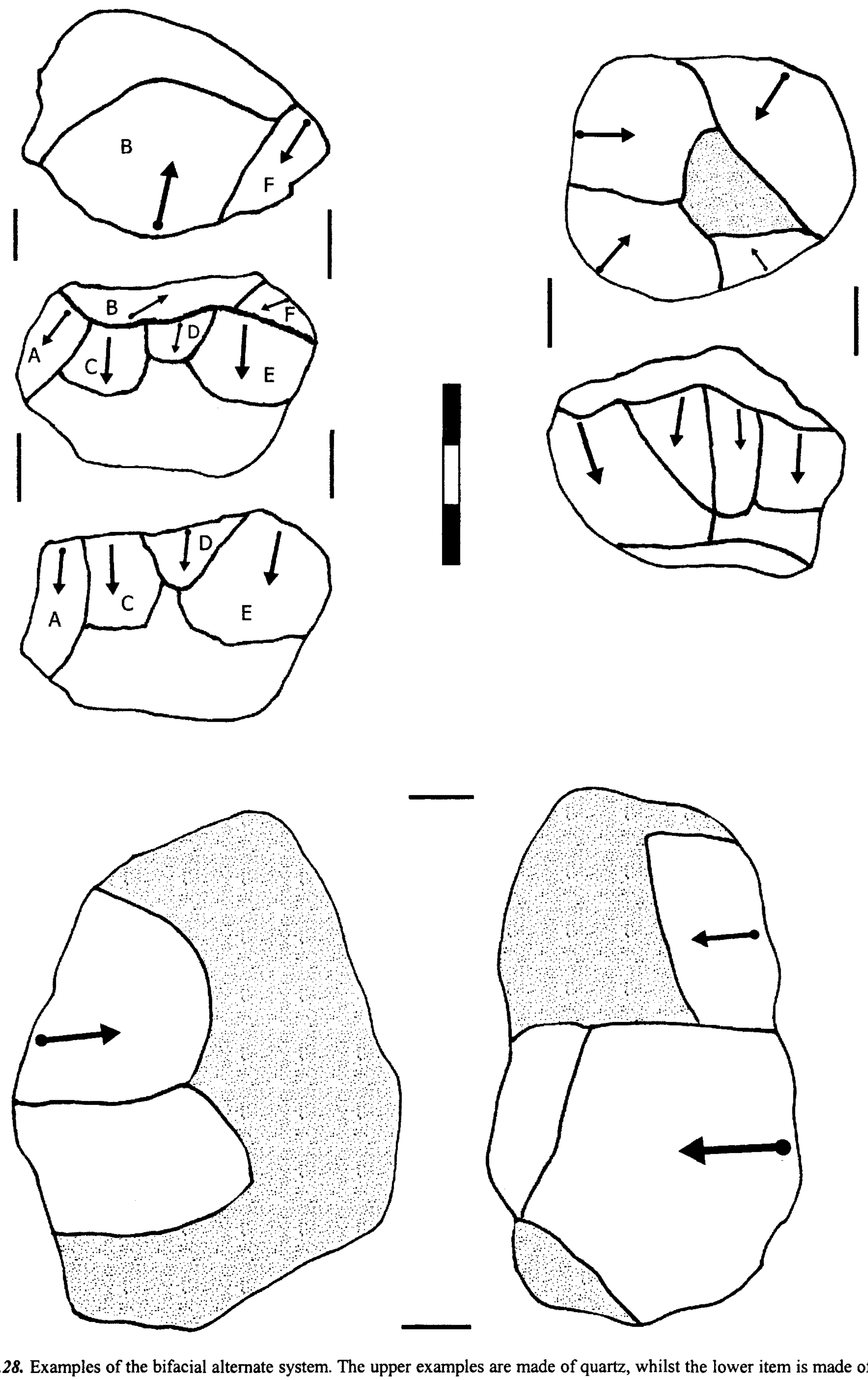


Figure 3.28. Examples of the bifacial alternate system. The upper examples are made of quartz, whilst the lower item is made of basalt.

	Minimum	Maximum	Mean	Std. deviation
Length	47	95	75.89	13.06
Width	43	80	66.78	9.6
Thickness	34	75	51.94	12.09
Weight	91	692	351.36	160.68

Table.* *3.7. Dimensions of knapping hammerstones at FLK Zinj.

scars could also have been created by percussion fractures. This type of object achieves fundamental relevance in subsequent sites such as FLK North. We will, consequently, refer to anvils in depth in the following chapter.

In FLK Zinj, we must highlight the clear dichotomy existing between the management of raw material; most of the lavas were used as knapping hammerstones to obtain flakes from quartz cores. Whilst the vesicular lavas that characterise unmodified material are not good for knapping, the basalts and phonolites that appear on hammerstones present excellent qualities to be used as cores. Nonetheless, and although we have several lava cores, the hominids used those basalts and phonolites preferentially as hammerstones. This could be based on a cultural, not a merely functional selection (said lavas are as good quality as the quartzes), and therefore we would be facing idiosyncratic preferences, not merely practical inclinations.

Conclusions

With a view to reconstructing the behavioural patterns that generated the site, the first level of analysis should be based on formation processes. Capaldo (1997) proposes the reconstruction of a "natural history" of the site, which would begin with a stage in which the humans and carnivores would act, followed by a subaerial stage, a diagenetic stage and a last excavation stage. We would like to commence analysing the last stage. FLK Zinj presents hundreds of lithic debris under 5 mm, and Bunn (1982) also comments on the vast amount of tiny bone fragments. Therefore, it seems obvious that Leakey (1971) took great care to sieve and recover all the materials that appeared. This aspect, alongside the mapping of all the remains and the excavation of a large surface of the site (around 300 m²), guarantee the quality of the available sample from an informative point of view.

As regards the diagenic stage, Capaldo (1997) states that chemical soil processes, fossilisation, the compacting of sediments or animal-related alterations, did not have a serious bearing on the FLK Zinj assemblage. In fact, all the archaeological material was recovered from a sedimentary sequence under 9 cm (Leakey 1971), which once again indicates the high resolution of the assemblage. The previous subaerial stage is subject to more varied interpretations; different authors establish periods ranging from few months (Bunn & Kroll 1986) to even a few years (Potts 1986) required to bury the bone assemblage. As regards the hydraulic alteration, Potts (1988) affirms that up to 15% of the bone remains are abraded, and that some showed preferential orientations typical of a water-based rearrangement. Concerning the lithic industry, Petraglia and Potts (1994) dedicated a monographic study to postdepositional alteration processes. These authors underscored the existence of certain taphonomic alteration processes, and proposed the examples of the lava artefacts, whose edges were usually weathered, thus linking them to an important lapse of time before the burying of the remains, stating that *"the occurrence of hominid and other animal activity (...) over a multi-year period of surface exposure likely contributed to spatial rearrangement of objects at this site"* (Petraglia & Potts 1994:246). That subaerial weathering does not imply severe postdepositional alterations or a relevant hydraulic rearrangement. In the course of this study, we have observed that over 700 quartz fragments are under 5 mm, and no less than 86.7% (n=2309) of the lithic collection is under 20 mm long (fig. 3.29). If we consider this alongside the enormous amount of millimetric bone fragments, we can say that the vast integrity of FLK Zinj is guaranteed.

Indeed, we need to further the issue of weathering and deposit formation processes in order to contemplate the issue of the manuports. Throughout this chapter, we have defended the hypothesis that most of the so-called "unmodified objects of anthropic provenance" are merely natural pieces. We have based our statements on the direct comparison of these objects with pieces genuinely modified by hominids. Nonetheless, we must now offer some contextual arguments to justify the natural presence of large scale clasts in fine-grained sediments such as the ones that characterise FLK Zinj.

We have previously pointed out that the archaeological record of FLK Zinj was subjected to low or zero hydraulic transport (Petraglia & Potts 1994; Potts 1988; etc). Yet, this does not mean that the formation of the archaeological site responds to a single depositional event. On the basis of the bone weathering stages a sedimentation interval that ranges between several months (i.e. Bunn 1982; Bunn & Kroll 1986) and a few years (Potts 1986, 1988) is proposed. Regardless of the real

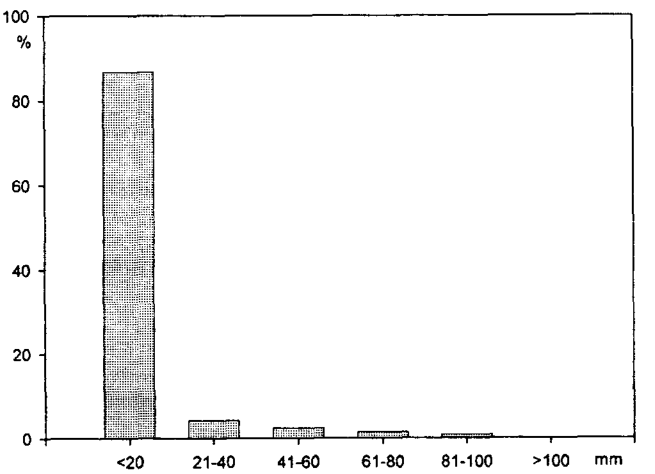


Figure 3.29. Length patterns in all the lithics from FLK Zinj, excluding unmodified material.

deposition interval, a weak paleosol was formed and, as verified even for the Olduvai sequence (i.e. Ashley & Driese 2000), this supposes the combination of a variety of biotic and sedimentary agents in a complex formation sequence.

In this complex site formation process, we must not exclude the possibility of hydraulic supplies of natural clasts, although as we have stated, even though the archaeological remains do not present traces of fluvial traction, the existence of a small channel 35 cm deep and 53 cm wide was documented at FLK Zinj (Leakey 1971; Potts 1988). Even if this channel did not have sufficient significance to alter the original configuration of the archaeological remains, it could have dragged natural clasts from nearby areas. Or perhaps, more probably, the channel eroded and redistributed levels underlying the FLK Zinj site in which there were fragments of lava that were thereby incorporated to the FLK Zinj clay paleosol.

In fact, we do not believe that it was mere coincidence that most of the supposed manuports from FLK Zinj are of a very irregular vesicular lava which is identical to the basalt that emerges from the immediate proximities of the site. Furthermore, the majority of the supposed manuports that Leakey (1971, fig. 24) plots in the *Zinjanthropus* Floor plan are located on the periphery (western and southern area) of the archaeological concentration. Leakey (1967:427) realised the peculiar distribution of the supposed manuports, but finally she did not take it in account. In our opinion, that distribution should be linked to the natural deposition processes of the clasts, and probably of some of the bones (see also Binford *et al.* 1988:131). Despite the silty clays that configure the main body of the stratigraphical level, we consider the erosion of lower levels, the redistribution of clasts and other micro-scale processes that take place in the formation of sites, could have led to archaeological remains becoming mixed with totally different lithic materials produced by natural sedimentation. As we will see below, this hypothesis has relevant consequences as regards assessing the different interpretations of the behaviour that generated FLK Zinj.

After reconsidering the stages of excavation, diagenesis and weathering, we will analyse the last stage included in the reconstruction of what Capaldo (1997) called FLK Zinj's "natural history," which analyses the role played by hominids and carnivores. The first major point is to stress that all researchers, even those who most criticised the integrity of the sequence (Binford 1986, 1987, 1988; Binford *et al.* 1988), assume the participation of two different actors on the FLK Zinj assemblage, hominids and carnivores. Another issue, beyond this work, is to elucidate if hominids accessed carcasses first (Bunn 1982, 1986, 1989, 1991; Bunn & Kroll 1986; Domínguez-Rodrigo 1997; Oliver 1994) or if hominids were transporting to the site carcasses and anatomical portions taken from other carnivores (Binford 1986; Binford *et al.* 1988; Shipman 1986; Blumenschine 1995; Capaldo 1997; Marean *et al.* 1992; Madrigal & Blumenschine 2000; etc). In any case, the presence of cut marks and tooth marks on the bones indicate that both actors partook in the final configuration of the assemblage.

The second point is the direct link between the remains of fauna and the lithic industry. Three factors indicate this relationship. The first is the spatial association that brings together the main patch of bones and the practical entirety of the lithics on a concrete spot. It is no coincidence that in such accumulation, the bone material is completely fragmented and coincides with the area dedicated to quartz *débitage*, whilst complete bones are found in the periphery of the concentration – according to Binford *et al.* (1988) belonging to an different depositional event, not to the main patch – alongside the unmodified material which we have considered natural herein. The second factor that links the remains of fauna and the lithic industry is that the bones present obvious cut marks (Bunn 1982; Potts 1988; Oliver 1994), produced by flakes like the ones analysed herein. Thirdly, we have a vast collection of percussion marks on bone midshafts (Bunn 1989; Blumenschine 1995), which indicate a more (Blumenschine 1991, 1995; Marean *et al.* 1992; Madrigal & Blumenschine 2000) or less relevant (for example Lupo 1998) marrow extraction. Since the two quartz anvils do not seem related to the bipolar technique – only found in FLK Zinj in isolated examples –, these lithic pieces were quite probably used for bone-marrow processing, as proposed by the available experiments (Blumenschine 1995; Blumenschine & Selvaggio 1991; Bunn 1989; etc). Together, all these factors denote that the recovered lithic industry was linked to carcass processing activities.

We can now summarise the type of technological strategies the hominids used to modify these bone remains. Although we do not rule out that part of the unmodified lava objects were genuinely supplied anthropically and are not merely clasts that were deposited naturally, after the hypothesis set forth in the previous pages, we would rather overlook them when analysing the lithic assemblage. This can be applied to lavas, of possible local provenance, but not to quartzes, of certain exogenous provenance. Potts (1988) refers to up to 21 blocks of unmodified quartz, which would be genuine manuports. In this analysis, however, we have observed use traces on all except one, which would be the only manuport and, consequently, the only representative of the raw material transportation stage. This would mean that practically all the lithic material transported to the site was employed during the activities performed there, denying any kind of stockpiling activity for a subsequent visit. With regard to the decortication stage, the knapping products with predominant cortex compose 15.2% of the total number of whole flakes (tabl. 3.5). Yet, when contemplating that percentage with the rest of the lithic assemblage, the initial flaking processes are limited to a mere 0.7%, therefore entailing an enormous drop regarding the relative importance of this activity. The same occurs with the tool retouching processes which, as mentioned previously, only composed 0.6% of the total of the collection. In all, FLK Zinj sees an absolute prevalence of regular flake production activities linked, quite certainly, to carcass processing, and – therefore – to the stage envisaging the employment of the artefacts.

Figure 3.30. Typical unifacial exploitation at FLK Zinj, from natural platforms on small quartz blocks.

After explaining the relevance of the *débitage* processes, it would be necessary to insist on the methods used to obtain knapping products: the FLK Zinj hominids did not generally prepare the cores' striking platforms, detaching flakes from surfaces using a unidirectional exploitation from abrupt planes (fig. 3.30), both unifacial and bifacially. Those were the most widespread knapping methods (fig. 3.31), although we have also documented slightly more elaborate systems, such as those involving the bifacial management of edges based on alternating detachments (fig. 3.32), or methods linked to a bifacial peripheral exploitation. None is very complex, and they do not involve a rejuvenation of the knapping surfaces. As a result, the detachment sequences were never very long, since after a few detachments, the core lost the required angles and was discarded.

However, it is not an unorganised or ineffective knapping strategy, quite the opposite. In our opinion, it is a specific, efficient and structured technology. Specific in that the reduction processes follow specific guidelines which, albeit simple, are repeated constantly on the cores and imply a particular knapping system. Furthermore, it is perfectly efficient since they obtain high-quality flakes with well-defined sizes and morphologies. Finally, it is a structured technology given the clear dichotomy between the raw materials used for each task; the *débitage* focuses on quartz, whilst knapping hammerstones are invariably made of basalt and phonolite. As mentioned, there is a selection of raw materials for each tasks which, given the similar quality of lavas from fluvial beds and tabular quartzes, can be explained not through functional criteria, but through specifically cultural grounds.

After describing the site's contextual, taphonomic, zooarchaeological and technological characteristics, it is necessary to briefly consider the nature of FLK Zinj in a more general framework of settlement strategies followed by the Olduvai hominids. Given the evident juxtaposition of bones and lithics, the scarce taphonomic alteration, the limited vertical placement opposed to the vast horizontal area, and the exceptional state of preservation of the remains, FLK Zinj was considered the basic model to define the Olduvai living floors (Leakey 1971) and subsequently type C sites of the African Plio-Pleistocene (Isaac & Crader 1981). Furthermore, FLK Zinj has not only been used as a reference to systematise sites contextually, it has also been considered a paradigm to elaborate different models from which to interpret the behaviour of early humans. Essentially based on the FLK Zinj site,

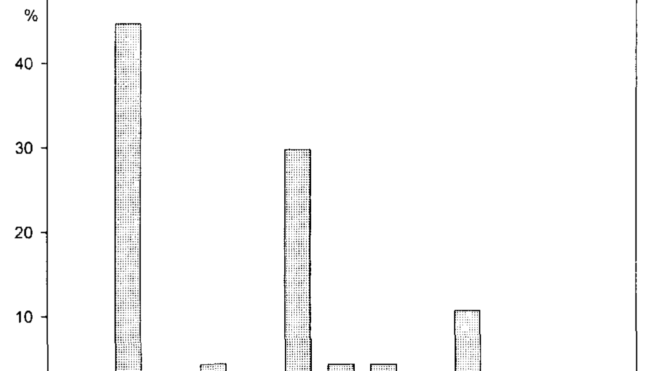


Figure 3.31. Percentages of the knapping methods at FLK Zinj.

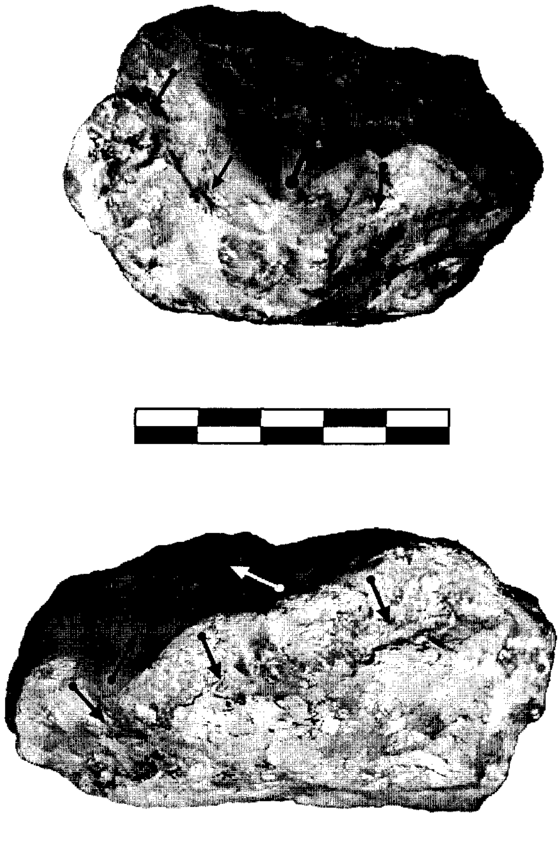


Figure 3.32. Examples of quartz cores with alternate bifacial edge.

Isaac (1978) defined his home-base model and subsequently his central-place foraging pattern (Isaac 1983, 1984), whilst Potts (1988) used it as the example for his stone-cache model and his subsequent resource transport hypothesis (Potts 1991), and Binford (1987, 1988) used it as the paradigm for the fortuitous aggregation of independent depositional events. This is no place to discuss the different hypotheses, but we would like to reflect on the materials described herein. Kroll and Isaac (1984) speculated on the fact that most part of the lithic assemblages documented in Koobi Fora or Olduvai could actually have been manufactured by one or two craftsmen in under an hour. This, in a sense, could also be applied to the FLK Zinj case, where there are about 40 kilograms of knapped stones. Considering that the lava cobbles would have been collected near the site, we would only have to explain the import of the slightly over 17 kilograms of quartz documented. Hence, based exclusively on the information provided by the industry, we cannot conclude a recurrent occupation of the site.

Fortunately, the bone remains provide fundamental complementary information. Considering the hominids were the main actors as regards bone accumulation, this settlement would have received fauna remains from very different ecological niches. Moreover, the trip to Naibor Soit, albeit nearby, would make hominids pass by several ecological niches to stock up with quartzes. In all, we see that FLK Zinj was a focal point to which mineral and vegetable resources were taken from different areas of the Olduvai basin, similar to how Isaac (1984) imagined.

Chapter 4

FLK NORTH

Introduction

FLK North is part of the same gully as the FLK I complex, and is located a few dozen metres from FLK Zinj. According to the original description (Leakey 1971), FLK North has a 7.2 m stratigraphic thickness, in which 8 archaeological levels were identified. Five of these assemblages (Levels 6-1) are located in the Upper Member of Bed I, 1.5 m below Tuff IF (which limits the sequences in Bed I and II). Above Tuff IF, and therefore in the base of the Lower Member of Bed II, Leakey excavated levels FLK North Clay with Root Casts and FLK North *Deinotherium* Level. Excavation processes were carried out in that same sedimentary complex in the lower part of the Middle Member of Bed II, unearthing the most recent of all the FLK North levels, known as the Sandy Conglomerate.

Excavations were performed between 1960 and 1962, in 6 trenches measuring up to 7 metres long, and with a width ranging between 1.8 m and 3.15 m and a 1.8 m to 3 m depth (Leakey 1971:62). Although Leakey (1971:61) considered that functionally four of the levels (Levels 5-1) of FLK North Bed I were living floors and the other was a butchering site (Level 6), in the same work she specified that Levels 5-1 were sites with diffused materials, in which the archaeological remains were scattered along a thick stratigraphical sequence (Leakey 1971:258).

The interpretation of FLK North 6 was still sustained, a level which, alongside the *Deinotherium* Level, would embody two examples of butchering sites in the FLK North sequence. This lack of decision regarding the nature of the FLK North levels also appears in subsequent re-examinations: Potts (1994:20) calculates the densities for bone and lithic remains by m^3 in Levels 6-1, concluding that all units could respond to background deposits scattered naturally around the landscape, and not to intentional human accumulation. Nonetheless, Potts (1994) does not rule out them being human accumulations, since other areas of Bed I present densities even lower than in FLK North that are unquestionably remains deposited naturally.

The materials in FLK North have undergone numerous re-examinations. We can mention the paleontological investigations by Gentry and Gentry (1978) and Plummer and Bishop (1994) on the bovidae in the whole FLK North sequence, and works by Andrews (1983) on the microfauna in Level 1-2 and by Denys *et al.* (1996) and Fernández-Jalvo *et al.* (1998) on the micromammals in all levels of the site. Zoo-archaeological works have focused on Levels 6 and 1-2 (Bunn 1982, 1986; Potts 1988), paying less attention to the rest of the sequence (Shipman 1986). With regard to the industry, apart from Leakey's (1971) original study, we also have Sussman's (1987) use-wear analysis on several pieces from Level 1-2 and the *Deinotherium* Level, Sahnouni's (1991) on polyhedrons, Potts' (1988) re-examination of Level 6, the analysis of the choppers in some of the levels by Bower (1977) and Wynn (1981, 1989), and those in Level 1-2 by Roche (1980), Willoughby's (1987) analysis of spheroids in Levels 1-4 and the Sandy Conglomerate Level, the complete study of the Sandy Conglomerate Level (Kimura 1999), as well as Ludwig's (1999) unpublished work on the whole sequence of the site and by Kyara (1999) and Kimura (1997) on the FLK North levels located in Bed II. The quality of these contribution is uneven, biased by the variety of approaches and perspectives, which prevent a global vision. Hereunder we present a re-examination of the lithic industry from several of the archaeological levels in FLK North, starting with the oldest, FLK North Level 6, until reaching the most recent, FLK North Sandy Conglomerate.

FLK North Level 6

The bone assemblage

According to Leakey (1971:64), Level 6 was only excavated in Trenches IV and V and in a small part of Trench II. The thickness of the archaeological level reached 52.5 cm (Leakey 1971:260). Based on that information, we estimate a 56 m^2 area maximum, although the excavated surface was probably smaller, perhaps 37 m^2 - as Potts (1988:24) proposes - or 35 m^2 - as Isaac and Crader (1981) suggest -.

Leakey (1971) highlighted the finding of an almost complete *Elephas recki* skeleton linked to artefacts in Trenches IV and V, although she also indicated the presence of bovid remains and of a second elephant (albeit represented only via a few scattered remains) alongside the main *Elephas recki* carcass. As regards the industry, Leakey described a collection of 123 pieces linked to the elephant carcass, 77.2% of which would be *débitage* and the rest heavy duty tools. Given the apparent association between lithic and bone remains, Leakey considered Level 6 as a butchering site.

According to Leakey (1971:64), the *Elephas recki* skeleton was well preserved; with only the tusks and part of the skull missing. Leakey mentioned a movement of the remains, which she attributed to carnivores. In all, Leakey (1971:252) counted a total of 614 bone specimens, most of which belonged to the elephant, followed by remains of bovids, suids and carnivores, with a residual amount of remains from equidae, giraffids and hippopotamidae. Subsequent fauna studies modified part of Leakey's inventory. Bunn (1982) counted 622 bone specimens, of which, apart from 6 unrecognisable bone remains, 211 were fragments of the *Elephas recki* and another 405 were identifiable fragments from other taxa. Bunn (1982) indicated that, aside from the *Elephas recki*, there were another 35 individuals in Level 6. According to this author, the bone density was too high to be natural, and bones from several species supposedly presented cut marks (but see Domínguez-Rodrigo *et al.* in press). Bunn (1986) then modified this interpretation radically; by using patterns of skeletal representation, he went back to Leakey's (1971) original classification. The over 400 animal bones, apart from the elephant carcass, corresponded to a natural deposition background.

Binford (1981), Potts (1988) and Shipman (1986) also analysed the configuration of Level 6. Binford noted that the industry was not necessarily linked to the elephant carcass, but that it could be linked to the remains of the other individuals represented in the level. Potts (1988) disagreed, stating that most of the archaeological material was concentrated in Trenches IV and V, where the complete assemblage of artefacts were located, all the elephant bones and 95% of the macromammals. This author believes the spatial association between the industry and bone remains is irrefutable. Concurring with Bunn (1982), Potts (1988) proposes a complex taphonomic history, which contemplates the death of the elephant *in situ*, the selective transport of artefacts and bones from other animals (mainly bovids) to the site, and the interaction with other carnivores. Shipman (1986) observed that most of the cut marks on the elephant were located by the metacarpus and the ribs. She considered that both the percentage of marks and their distribution indicate a secondary access to the elephant carcass by the hominids. Shipman (1986) also draws attention to the presence of cut marks on several bones of *Parmularius*, therefore admitting that at least part of the bone assemblage linked to the *Elephas* skeleton had an archaeological origin (Bunn 1982; Potts 1988), not a natural provenance (Bunn 1986; Binford 1981). Thus, the interpretation of the bone remains from FLK North 6 is still currently under debate, since a recent zoo-archaeological study (Domínguez-Rodrigo *et al.* in press) suggests the absence of any kind of human modification in the bone assemblage, therefore proposing that the relationship between industry and fauna is absolutely fortuitous.

The lithic industry

The FLK North 6 lithic assemblage has been studied by Leakey (1971), Potts (1988) and Ludwig (1999). It consists of a small collection of 130 artefacts, which Leakey (1971:64) interpreted as the result of *débitage* activities. Potts' (1988:388) re-analysis reduced the original number of choppers to only one, and doubled the number of manuports identified by Leakey (1971:64). Our study has yielded different results (tabl. 4.1). One of the most remarkable features of the assemblage is that 52 pieces (40,3%) out of the 130 artefacts show battering damage. Taking into account that most of the assemblage is composed of chips smaller than 20 mm in which it is not possible to identify such traces, it is logical to think that the representation of battered pieces could be even higher. If we express this feature per amount of lithic mass represented, 14.378 grams out of the 16.539 grams of raw material represented bear traces of battering. In sum, the fact that over 14 kg out of the 16 kg represented are related to battering activities should be indicative of the nature of the assemblage.

In FLK North 6, knapping activities are represented by 4 cores suggesting *débitage* processes, although it is symptomatic that the only core in quartz also shows traces of battering (fig. 4.1). Two of the cores are bifacial choppers and the other two were created by reduction through abrupt flaking, one of them is unifacial and the other one is bifacial. None of them present long sequences of reduction and they indicate a moderate exploitation. The identification of the flaking products is, however, more problematic. The techno-morphological features that identify actual flakes are hard to observe in the FLK North 6 pieces previously identified as flakes. Very

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	-	-	-	-	-	-
Cores	1	0.9	3	14.3	4	3.1
Retouched pieces	-	-	-	-	1	0.8
Knapping hammerstones	-	-	10	47.6	10	7.8
Hamm. fract. angles	-	-	1	4.8	1	0.8
Anvils	9	8.3	1	4.8	10	7.8
Whole flakes	6	5.6	3	14.3	9	7
Frag. < 20 mm	35	32.4	-	-	35	27.1
Possible flake fragments	17	15.7	1	4.8	18	14
Angular fragments	9	8.3	-	-	9	7
Battered fragments	30	27.8	-	-	30	23.3
Unmodified material	-	-	2	9.5	2	1.6
Total	107	100	21	100	130*	100

Table 4.1. Lithic categories and raw materials at FLK North Level 6. (*) Included one chert retouched piece and one chert flake fragment not recorded in the rest of the table.

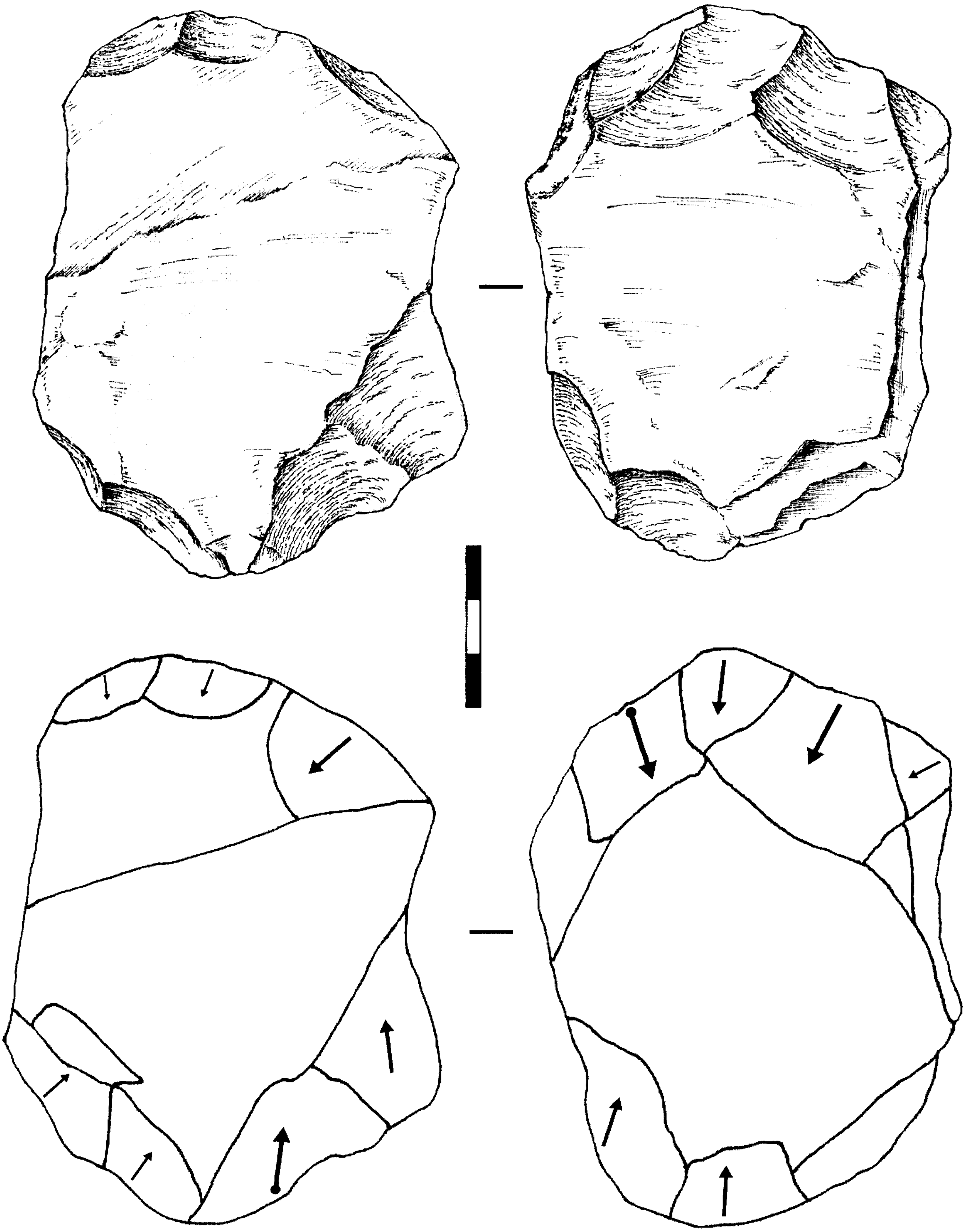


Figure 4.1. Bifacial partial quartz core from FLK North Level 6 (drawn by N. Morán).

often, it is difficult to differentiate these features from those produced by other activities. As a matter of fact, most of the 6 quartz flakes identified as such cannot be clearly defended to be actual flakes, and it should not be casual that the few undoubted flakes are from different raw materials. If it is difficult to identify possible flakes to any *débitage* system, it is even more difficult to link most of the purported knapping waste (flake fragments, angular fragments and chips) to any intentional flaking. A large number of the purported flake fragments, irregular and fairly small (<2 mm), even if lacking any traces of battering, could also be the result of processes alternative to *débitage*, making the percentages of products of intentional flaking even smaller.

In the present study, a total of 10 hammerstones have been identified, more than double as reported by Leakey (1971). They are high-quality rounded lava cobbles. In several of them, the battering traces are not very conspicuous. This may explain why Potts (1988) identified some of them as manuports. Anvils are the most relevant category of the artefacts represented at FLK North 6. As can be seen in table 4.1, these artefacts make up only 7.8% of the assemblage, but they account for almost half of the weigh of the lithic assemblage (7,642 g).

It is important to reflect now on the definition of this kind of objects. The description of the Olduvai anvils Leakey offers (1971:7) is still valid, as she considered these pieces as "*cuboid blocks or broken cobblestones with edges of approximately 90° on which there is battered utilisation, usually including plunging scars*". In an attempt to complete this description, it could be added that in these anvils, the natural tabular planes of the quartz blocks act as platforms that receive the blows from the active hammerstones. This is due to the regular surface visible on these tabular shapes, which allow one of the flat sides to be used as a percussion platform (A) whilst the opposite side (B) is positioned on a stable ground. Given the percussion processes (see fig. 4.2), platform A is full of impact marks, especially by the edges of the block and cause the abrading of the whole periphery of the platform. Platform B, although it does not receive direct blows, also experiences *écaillés* and fractures given the force transmitted to the block and being in contact with the ground, especially on the edges of the piece. Furthermore, and as a result of this whole process, the surface of the block exposed between the two natural planes (C) is also modified by percussion, generating numerous scars with hinged and stepped morphologies throughout the whole periphery of the block.

This shows that several small fragments were detached from anvils due to percussion during battering activities. This is where the purported *débitage* fits the functional interpretation resulting from our study. Many of the purported flake fragments lack the typical features that would identify them as actual flakes. They lack bulbs, dorsal faces with previous scars, butts, etc. Alternatively, the battering traces in some of them, together with the repetition of specific morphologies and sizes observed in the scars on the anvils, would indicate that most of these fragments could be the involuntary result of battering activities generated through percussion on the anvils. Given the morphological patterns observed, there have been distinguished several types of what we have designated "positives detached from the anvil" (see fig. 4.3).

The first group encompasses fragments that even emulate genuine edge-core flakes, breaking away part of the anvil's natural percussion platform (platform A) and plane C. Some of them are characterised by their triangular transversal sections and an elongated morphology (group 1.1.), whilst others are wide and short positives with sagittal sections that form a simple angle with an internal concave face (group 1.2.). As can be observed in figure 4.3, the weakest part of the blocks are the fragments detached from the anvil edges during the battering process.

A second group of positives is formed by fragments detached particularly from plane C of the anvil. The most common, herein designated group 2.1., are very thin fragments that

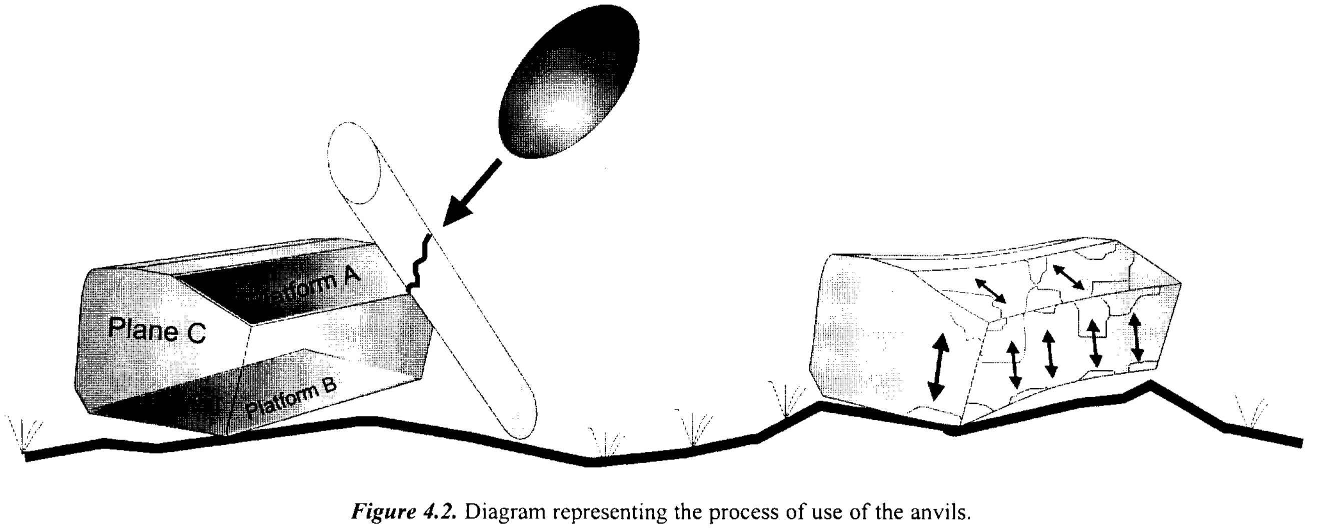


Figure 4.2. Diagram representing the process of use of the anvils.

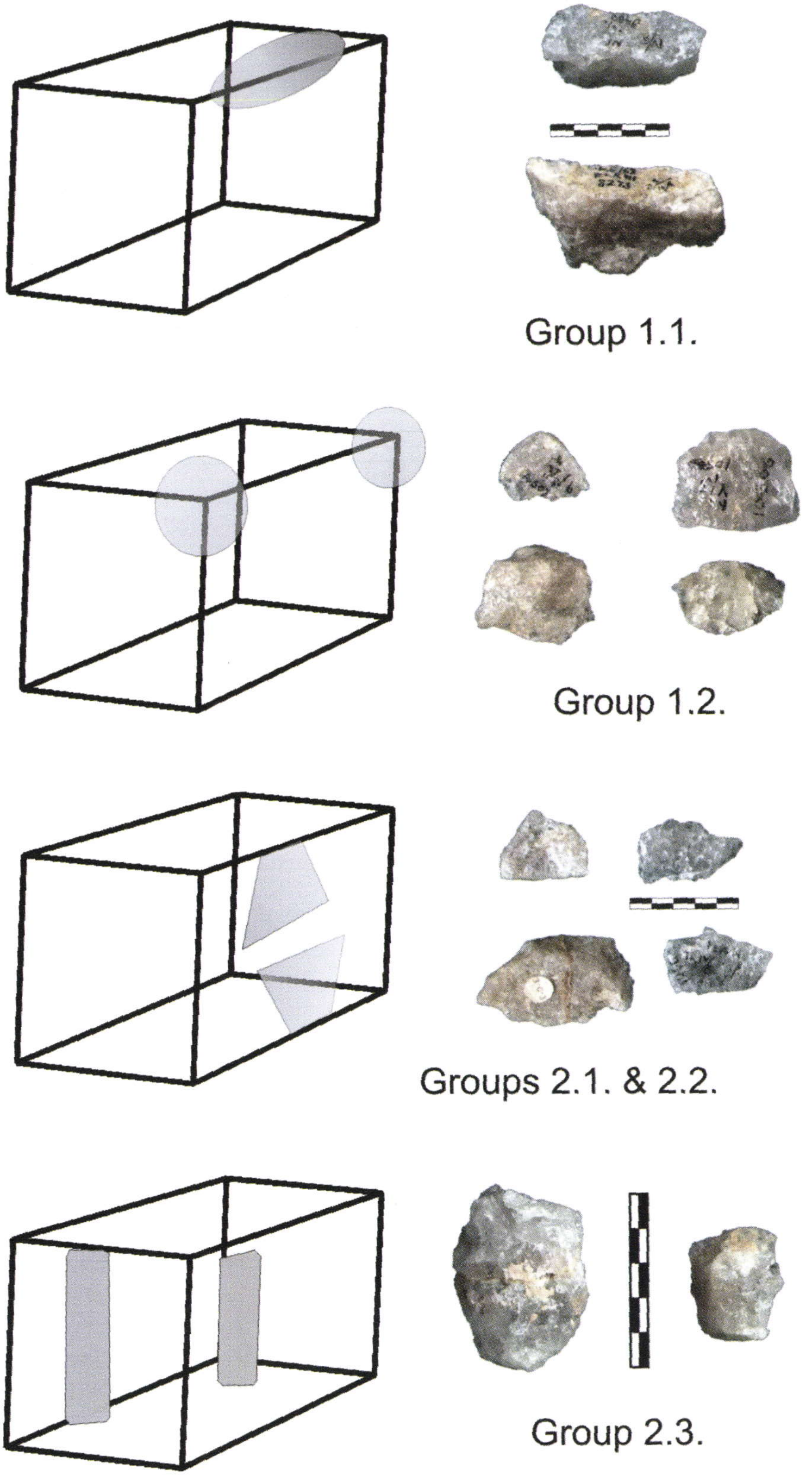


Figure 4.3. Different modalities of the products generated during the activities in which anvils are used. All examples are from FLK North 6, but the different modalities also are found in the remaining levels from FLK North and in later sites.

present wide and short morphologies, without butt, bulb or ridges on the dorsal face. These fragments produce negatives with obtuse angles and convex scars - instead of the typical concave morphology of the conchoidal fractures - on the anvils, that responds to superficial chipping of the blocks. Alongside these elements, there are thick and irregular positives (group 2.2.), genuine chunks from the fracturing of the anvils. Finally, we have identified positive bases with long typometric modules, that can even present a butt (group 2.3.). In this case, their classification as elements from percussion processes and not *débitage* is established given the irregularity of the dorsal face (which does not present ridges from previous extractions), the sinuous concavity on the ventral face (impossible on conchoidal fracture) and the thickness and abrading of the edges of the piece.

The classification of the positives detached by percussion presented above responds to morphological parameters, since the technological processes that generate these products actually respond to the same cause: the gradual modification of the anvils due to percussion activities performed on these passive objects. Nonetheless, it is relevant to discriminate the different shapes of percussion positives with a view to underlining the morphological variability and stressing the danger of confusion, which led Leakey (1971) to classify pieces generated spontaneously on the anvils' transversal planes as flake and flake fragments. This reclassification is of paramount importance, since a large number of the small items can be assigned to processes that resulted in the involuntary fragmentation of the anvils and not to activities involving the production of flakes. This leads to reflect on the role of percussion processes in the activities performed by hominids and the functionality of the studied sites. FLK North is a good example of this situation: with the exception of a few pieces, the entire lithic assemblage of this level could be interpreted as the result of percussion rather than flaking. Taking this presumption into consideration, the behavioural interpretation of the occupation can change radically.

FLK North Level 5

Artefacts and bones were concentrated in the upper part of the level, although scattered remains were also located along the whole 45 cm thickness. Leakey (1971) documented earth movements that could have caused the postdepositional fractures of bone remains. It is relevant to note the finding of a terminal phalanx of a hominid foot, probably *Homo habilis* (OH 10). Leakey (1971:67) documented small concentrations of bones from microfauna interpreted as carnivore faeces.

Excluding the microfauna, 2210 bone specimens were recovered, with a predominance of bovids, followed by carnivores and suids, and documenting a residual presence of elephants, hippos, giraffes, equids, turtles, snakes, birds, etc. (Leakey 1971:252). Despite the large amount of bones, only Shipman (1986) performed a partial zoo-archaeological study, documenting a few examples of bones with cut marks.

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	-	-	1	1.1	1	0.6
Cores	2	2.6	13	14.9	15	9.2
Retouched pieces	1	1.3	-	-	1	0.6
Knapping hammerstones	-	-	17	19.5	17	9.9
Hamm. fract. angles	-	-	5	5.7	5	3.1
Anvils	9	11.8	-	-	9	5.5
Whole flakes	2	2.6	3	3.4	5	3.1
Frag. < 20 mm	2	2.6	2	2.3	4	2.5
Possible flake fragments	36	47.4	12	13.8	48	29.4
Angular fragments	22	28.9	1	1.1	23	14.1
Battered fragments	-	-	2	2.3	2	1.2
Unmodified material	2	2.6	31	35.6	33	20.8
Total	76	100	87	100	163	100

Table 4.2. Lithic categories and raw materials at FLK North Level 5.

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	-	-	1	1.8	1	0.7
Cores	2	2.6	13	23.2	15	11.3
Retouched pieces	1	1.3	-	-	1	0.7
Knapping hammerstones	-	-	17	30.4	17	12.8
Hamm. fract. angles	-	-	5	8.9	5	3.7
Anvils	9	11.8	-	-	9	6.8
Whole flakes	2	2.6	3	5.4	5	3.7
Frag. < 20 mm	2	2.6	2	3.6	4	3
Possible flake fragments	36	47.4	12	21.4	48	36.3
Angular fragments	22	28.9	1	1.8	23	17.4
Battered fragments	-	-	2	3.6	2	1.5
Unmodified material	2	2.6	-	-	2	1.5
Total	76	100	56	100	132	100

Table 4.3. Lithic collection at FLK North Level 5 excluding the supposed lava manuports. Quartz unmodified objects are included, assuming that quartz always was transported to the site.

On Level 5, Leakey (1971) documented 151 lithic artefacts, among which "*débitage*" was predominant and choppers were the most common tool type. Leakey also identified 29 manuports. When Ludwig (1999) reanalyzed the assemblage, he studied only 111 artefacts. We have been able to spot 163 pieces, including the purported manuports. Table 4.2 shows that unmodified stones are extremely well represented, only outnumbered by the possible flake fragments. As was the case of the FLK Zinj site, we estimate that several of the lava "manuports" could be natural rocks already present on the ground when the site was formed. This would also be supported by the fact that in most of the modified pieces, quartz is the predominant type of raw material (de la Torre & Mora 2005). Of the 23,823 grams of lithic material collected on Level 5, the supposed lava manuports composed 7305 grams, therefore totalling a volume larger than the quartzes (5134 grams). After subtracting the unmodified lava material, basalts and phonolites still prevail (10,818 grams) over the slightly above 5 kilograms of quartz, although we can see (tabl. 4.3) how the categories and percentages for each type of object are reorganised. If the supposed manuports are set aside, one feature that is surprising is the high number of cores with respect to flakes. Most of the cores are made on lava, whereas most of

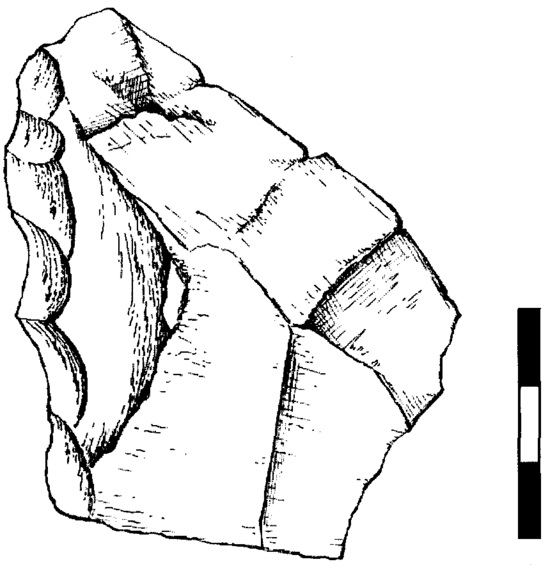


Figure 4.4. Quartz lateral side scraper, unique retouched piece from FLK North Level 5 (drawn by N. Morán).

the purported *débitage* (namely, small fragments) is made of quartz (tabl. 4.3). This is an important contradiction that demands explanation. Quartz *débitage* can be demonstrated by the presence of cores, refitting pieces and even one retouched flake (fig. 4.4.). However, the presence of artefacts functionally related to percussion is also important. The quartz anvils make up 3,736 grams out of the 5 kg of raw material represented. Thus, it may seem reasonable to interpret a substantial part of the purported flake fragments as the result of battering activities and, therefore, as being positives detached from anvils as is the case in the FLK North 6 (fig. 4.3).

The vast amount of cores is surprising. With a considerable sample (n=15), if compared to the rest of the assemblage, the main knapping processes described in previous chapters are represented. There is a predominance of choppers, both unifacial (20%) and bifacial (26.7%), all made of lava. Both the unifacial abrupt system (13.3%) and the bifacial system (also 13.3% with two samples) are frequent, as is the bifacial peripheral model (13,3%), with one sample in lava and the other in quartz. Moreover, there are also individual examples of the multifacial method and the unifacial peripheral model (fig. 4.5). Consequently, the variability of the knapping methods is proven in Level 5, as is the importance of the *débitage* processes. This does not coincide with the terms suggested in the rest of the assemblage. If we were to consider the flake fragments as whole flakes, which is quite questionable, we would come up with a maximum of 15 lava flakes. This implies an index of slightly over one flake per core, which is highly improbable, especially if we recall the structure of several of these cores.

In view of this shortfall, proposing plausible hypotheses emerges as a difficult task. Indeed, there was *in situ* lava knapping; the fragments recovered and even the existence of refits between cores and flakes verify this notion. Nonetheless, a great number of *débitage* products are missing, products which should have been found in the site in

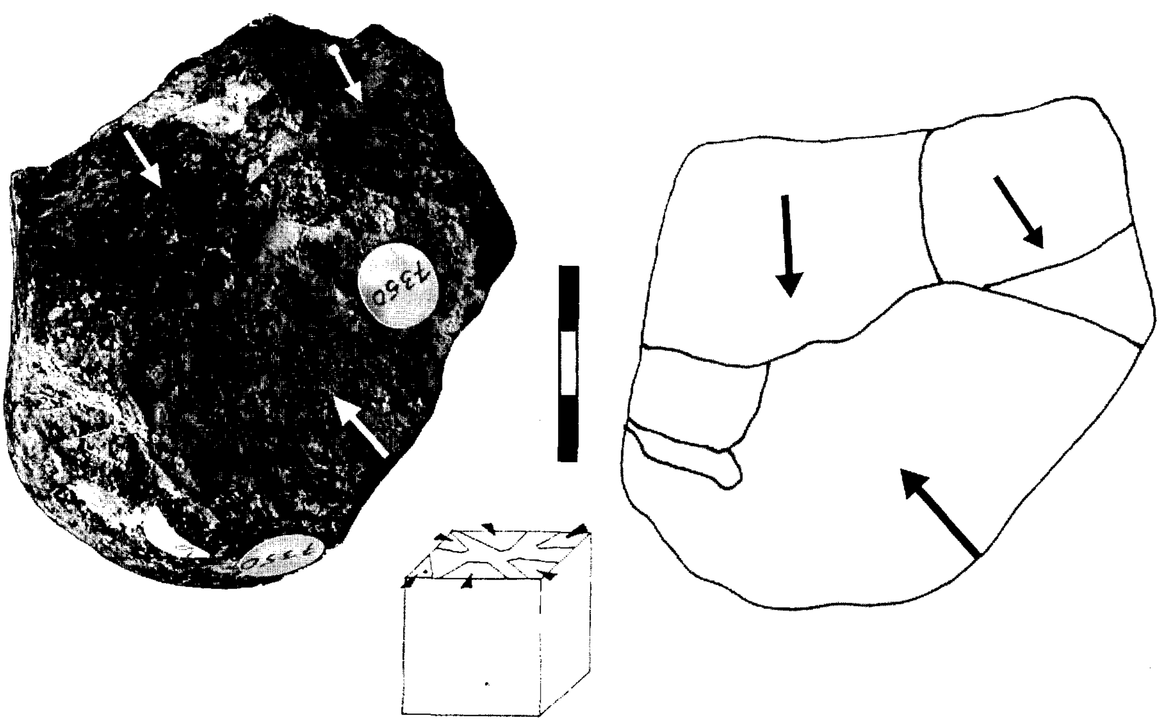


Figure 4.5. Unifacial peripheral lava core from FLK North 5.

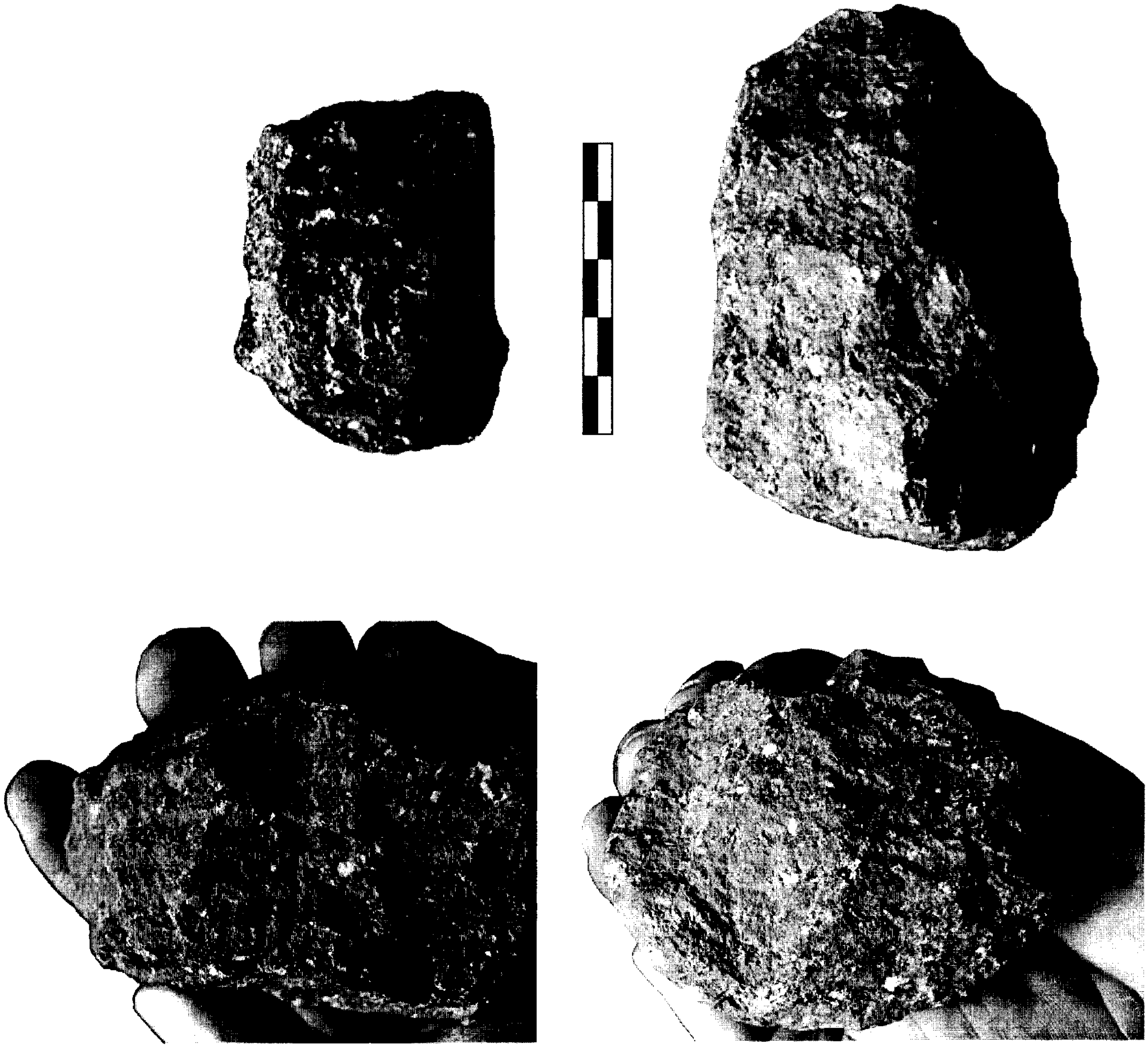


Figure 4.6. Cobbles from FLK North Level 5 with fractured angles caused by heavy percussion activities.

view of the core frequencies observed. This same assumption can be made as regards quartz. The actual percussion activities generate hundreds of fragments linked to large sized objects such as anvils. Nonetheless, such frequencies are not observed in FLK North 5. Consequently, an alternative option lies in considering a sorting process that suppressed the smaller fragments. In FLK North 5, the pieces under 20 mm long only represent 3% (tabl. 4.3). In FLK Zinj, for comparison's sake, these *debris* reached 49.5%. Thus, the differences are quite clear.

As regards hammerstones, FLK North 5 presents the same trends as other analysed assemblages, with basalt and phonolite cobbles appearing as the most prevalent blanks employed as knapping hammerstones. At Level 5, hammerstones constitute 30.4% of the lava pieces, being represented by higher numbers than cores and even combined frequencies of flakes and flake fragments (tabl. 4.3). Given their high number and their size, it can argued that elements of high dimensions are better represented than smaller ones and battering activities seem to be well supported. The lack of smaller sized pieces may be the result of post-depositional processes involving some hydraulic disturbance.

It is important to refer to the objects we have designated hammerstones with fracture angles. These items have been mentioned in other sites, but we delayed a systematic description until we had a sufficient sample. FLK North Level 5 has provided 5 of these objects, therefore we can now focus on their analysis. If classic hammerstones are characterised by pitting on cortical areas, rounded shapes and homogenous cobbles, hammerstones with fracture angles present battering traces along orthogonal non-cortical planes. These fracture planes are generated by the percussion activities. The process is as follows: when hitting an item with the hammerstone, the active element is fractured, producing orthogonal planes and irregular ridges. Instead of replacing the hammerstone or finding an undamaged area on the same piece -as occurs with classic hammerstones- in this case the generated fracture angles are used to continue banging the passive item. Thus, on these active pieces the area used for percussion becomes completely fractured (see fig. 4.6).

Due to this process, the ridges that formed the fracture planes are abraded by the battering, presenting sinuous edges along the ridge's silhouette. The generation of these planes is best explained through the existence of "simultaneous scars" on both sides of the ridges generated by the fracture planes: when hitting the hammerstone ridge generated by previous battering, the impact makes fragments of the hammerstone that are detached from both sides of the ridge simultaneously.

Quite often classic hammerstones ended up breaking after their use, and this could lead some to state that hammerstones with fracture angles are simply broken knapping hammerstones. However, in these pieces the battering affects previously fractured angles, meaning that the angles generated by fractures were employed after they were no longer effective for percussion activities linked to lithic knapping. Moreover, the battering marks appear on the ridges (fig. 4.7) seems to indicate that it was precisely these natural angles created by percussion which were used principally to perform the task.

In conclusion, the lithic collection in Level 5 does not have a good internal coherence, since it is lacking in major elements from the *chaîne opératoire*, most importantly those linked to production activities, such as flakes and knapping waste. On the other hand, there is a relative profusion of large sized elements like cores, and especially of anvils and different types of hammerstones. This indicates that percussion activities, not necessarily linked to lithic knapping, were more important than considered at first. Furthermore, it once again underscores the infra-representation of small elements, perhaps removed from the assemblage via postdepositional processes. Therefore, it is important to bear Leakey's (1971) warning in mind, since she considered this level contained diffused material, therefore making it difficult to reconstruct the activities performed by the hominids accurately.

FLK North Level 4

264 m² were excavated in Level 4, a vast area that only unearthed 84 lithic pieces and 929 bones of large mammals, according to Leakey (1971:260), concentrated in a thickness of 27 cm. Once again, the most abundant taxa are bovids, followed by carnivores and suids, alongside remains of giraffes, equids and hippos (Leakey 1971:253). As occurs in Level 5, the only zoo-archaeological re-examination was performed by Shipman (1986), who studied a small sample (131 specimens) of the bone assemblage without finding any traces of

Figure 4.7. Detail of the battering on the ridge of a hammerstone with fracture angles from FLK North Level 5.

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	-	-	-	-	-	-
Cores	-	-	8	15,4	8	9,6
Retouched pieces	-	-	-	-	-	-
Knapping hammerstones	1	3,2	9	17,3	10	12
Hamm. fract. angles	3	9,7	-	-	3	3,6
Anvils	1	3,2	-	-	1	1,2
Whole flakes	-	-	4	7,7	4	4,8
Frag. < 20 mm	5	16,1	-	-	5	6
Possible flake fragments	7	22,6	3	5,8	10	12
Angular fragments	14	45,2	-	-	14	16,9
Battered fragments	-	-	-	-	-	-
Unmodified material	-	-	28	53,8	28	33,7
Total	31	100	52	100	83	100

Table 4.4. Lithic collection at FLK North Level 4.

human modification. Nonetheless, the fact that Level 4 contains the greatest accumulation of microfauna species in the whole Bed I (Fernández-Jalvo *et al.* 1998) is quite peculiar.

According to Leakey (1971:69), the lithic assemblage of FLK North 4 was composed of 67 flaked pieces and 25 manuports. This small assemblage was deemed even smaller by Ludwig (1999:28) who identified 55 pieces, among which there were 28 cores and only 23 *débitage* products. According to Leakey, choppers and polyhedrons were the most abundant artefacts, whereas the purported *débitage* only constituted 29,8%. In our study, we have found 83 pieces, including unmodified lithic material. As in the underlying level, the most striking feature of FLK North 4 is the abundance of non-modified pieces. As can be seen in table 4.4, the purported manuports are the most abundant type of the assemblage (28 pieces; 53,8%). Including the non-modified material, there is a total of 18,392 grams of raw material at this level. Unmodified stones are the most important type accounting for 8,294

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	-	-	-	-	-	-
Cores	-	-	8	33.3	8	14.5
Retouched pieces	-	-	-	-	-	-
Knapping hammerstones	1	3.2	9	37.5	10	18.2
Hamm. fract. angles	3	9.7	-	-	3	5.4
Anvils	1	3.2	-	-	1	1.8
Whole flakes	-	-	4	16.7	4	7.3
Frag. < 20 mm	5	16.1	-	-	5	9.1
Possible flake fragments	7	22.6	3	12.5	10	18.2
Angular fragments	14	45.2	-	-	14	25.5
Battered fragments	-	-	-	-	-	-
Total	31	100	24	100	55	100

Table 4.5. Lithic collection at FLK North Level 4 excluding unmodified objects.

grams, almost the double as in quartz pieces (4,313 grams). Once again, we consider it is a mistake to consider the unmodified vesicular lavas as related to the flakes and used artefacts. Therefore, as in the previous case, non-modified lithic material from this level was also excluded from our analysis. Table 4.5 shows that flaking products are very lowly represented compared to other sites.

Only larger artefacts like cores and hammerstones appear in high frequencies. This brings up the issue of taphonomic bias and differential preservation according to size. As a matter of fact, from a proportional perspective, the number of hammerstones made of phonolite and basalt cobbles is so high that it appears as slightly suspicious. Therefore we have considered the possibility that some of the battering observed on these pieces could, in fact, have been produced by mechanical causes, which would make these items natural pieces, corresponding to the unmodified material category.

Among the eight identified cores, there are methods based on different types of exploitation: unifacial and bifacial simple, bifacial abrupt (fig. 4.8), unifacial peripheral and multifacial (fig. 4.9). Hence, the presence of knapping activities is clearly documented on this level. Nonetheless, we have not come upon products linked to these activities and the few available cannot be used to typify their most relevant features.

In sum, as was the case with the previous level, this assemblage is extremely small and very likely biased, making impossible any technological or behavioural interpretation. We must not forget that this is a 55-piece assemblage in a excavated area spreading out over no less than 264 m². Therefore, it seems obvious that, either via vertical migration processes or fluvial postdepositional activities, this is a completely sorted sample that even prevents its classification as a level of occupation. Consequently, we will have to turn to Leakey's (1971) original classification once again, considering it a level with diffused material.

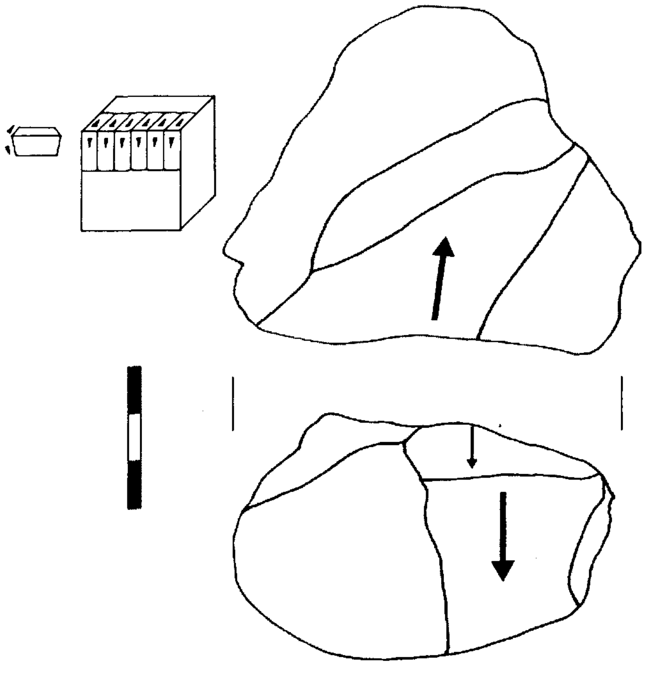


Figure 4.8. Bifacial abrupt lava core from FLK North Level 4.

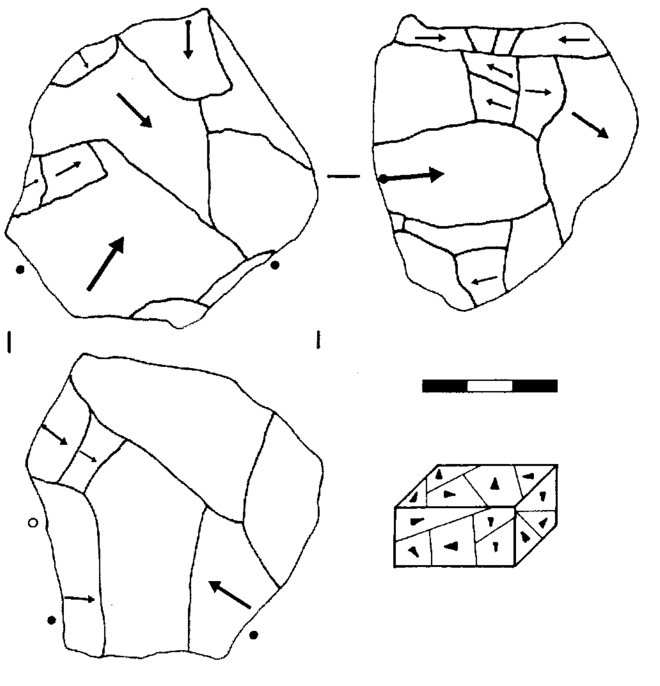


Figure 4.9. Example of the multifacial system at FLK North Level 4.

FLK North Levels 3 and 1-2

In a homogenous clay sequence just under Tuff IF, Leakey (1971:70) distinguished two occupation periods. The main period is located in the upper part of the deposit (52.5 cm thick), coinciding with the so-called Level 1. Level 2 is composed by scarce remains located a few centimetres under Level 1, which are according to Leakey disperse materials corresponding to the upper occupation, which have sunk slightly into the underlying sediments. The archaeological materials in the lower part of the clay deposits (15 cm thick) correspond to a previous occupation and were discriminated as a different level, Level 3, although according to Bunn

(1986) Levels 1-2 could not be separated from Level 3 in the Trial Trench. This refers to an excavation which Kroll (1994:113) estimates at about 100 m².

Excluding the microfauna remains, in Level 3 Leakey (1971:253) counted up to 1254 specimens of large mammals in which, as in other levels, a predominance of bovids was noticeable, followed by carnivores, suids, and low percentages of equids, giraffes and rhinoceros. Level 1-2 presents more fauna than the rest of the FLK North sequence. Among the macrofauna, with a total number of 3294 specimens (Leakey 1971:261), we once again encounter an prevalence of bovids, followed by carnivores, suids and, secondly, equidae, hippopotamidae, turtles, primates, rhinoceros, etc. After a partial approximation (Bunn 1982), Bunn subsequently performed a systematic zoo-archaeological analysis of Level 1-2 (Bunn 1986). He observed that the most frequent species in the site was *Parmularius altidens*, followed by *Antidorcas recki* and several small bovids. Bunn (1986) highlighted the similarity between FLK North Level 1-2 and FLK Zinj, suggesting a selective transportation of the most nutritive parts of the carcasses to both sites. The patterns of skeletal representation were interpreted as evidence that FLK North Level 1-2 had been used as a reference point in the landscape, to where meat and lithic resources were brought systematically (Bunn 1986). According to Bunn (1982), the cut marks were less profuse than in FLK Zinj, although they were well represented in the *Parmularius altidens* sample. In her partial study of the assemblage, Shipman (1986) also identified cut marks on the *Parmularius*, as well as on the *Antidorcas recki* and other bovids, which were probably transported from other ecological niches (Plummer & Bishop 1994).

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	-	-	5	4.8	5	2.3
Cores	-	-	11	10.6	11	5.1
Retouched pieces	3	2.7	-	-	3	1.4
Knapping hammerstones	2	1.8	24	23.1	26	12.1
Hamm. fract. angles	-	-	4	3.9	4	1.9
Anvils	8	7.3	1	1	9	4.2
Whole flakes	8	7.3	8	7.7	16	7.5
Frag. < 20 mm	17	15.5	1	1	18	8.4
Possible flake fragments	52	47.3	7	6.7	59	27.6
Angular fragments	19	17.3	-	-	19	8.9
Battered fragments	-	-	-	-	-	-
Unmodified material	1	0.9	43	41.3	44	20.6
Total	110	100	104	100	214	100

Table 4.6. Lithic categories at FLK North Level 3.

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	-	-	5	8.2	5	2.9
Cores	-	-	11	18.1	11	6.4
Retouched pieces	3	2.7	-	-	3	1.7
Knapping hammerstones	2	1.8	24	39.3	26	15.2
Hamm. fract. angles	-	-	4	6.5	4	2.3
Anvils	8	7.3	1	1.6	9	5.2
Whole flakes	8	7.3	8	13.1	16	9.3
Frag. < 20 mm	17	15.5	1	1.6	18	10.5
Possible flake fragments	52	47.3	7	11.5	59	34.5
Angular fragments	19	17.3	-	-	19	11.1
Battered fragments	-	-	-	-	-	-
Unmodified material	1	0.9	-	-	1	0.5
Total	110	100	61	100	171	100

Table 4.7. Lithic collection at FLK North Level 3 excluding unmodified lava objects.

The large quantity of microfauna remains is surprising, a fact which led Leakey (1971:253) to think that they were part of the hominids diet (but see Andrews 1983; Fernández-Jalvo *et al.* 1998, 1999). Palaeontologists (Denys *et al.* 1996; Andrews 1983; etc) suggest this microfauna reflects a wet climate, with more vegetation than expected from the geological study (Hay 1976). Consequently, FLK North must have been very close to a source of fresh water, whilst the sedimentation medium in FLK Zinj was much less oxidising (Denys *et al.* 1996). As regards the industry, a very small number of items have been recovered from Level 3. More have been retrieved from Level 1-2, where Leakey (1971:83-84) counts a total number of 1440 pieces, of which 235 from Trench IV were lost before reaching Nairobi and were not included in subsequent analysis.

The FLK North 3 lithic assemblage is composed of 171 pieces and 39 manuports, according to Leakey (1971:72). Ludwig (1999) studied 121 artefacts, but we have counted up to 214 pieces, including non-modified material (tabl. 4.6). A total of 28,800 grams is the mass volume of this assemblage. Once again the poor quality of the non-modified pieces suggested their natural origin. If we exclude them from the analysis it can be noticed that the total amount of quartz transported (3,700 grams) is smaller than the lavas showing traces of hominid use (15,482 grams).

Although globally the over 19 kilograms of knapped and/or transported pieces could provide a vast amount of information, a detailed analysis of table 4.7 requires to be cautious before laying down any behavioural inference; Flakes and debris are once more underrepresented compared to the abundant presence of cores and anvils. One hypothesis would be that the enormous amount of objects linked to percussion (knapping hammerstones, hammerstones with fracture angles, anvils, etc) indicates that hominids interacted with the bone assemblage simply by breaking the bones, which would be the reason why there are no knapping products. Nonetheless, in subsequent chapters we will see how the actual percussion processes generate vast amounts of millimetric chips; which implies that waste should also have been documented in this case. Furthermore, there are 11 lava cores in this Level 3, which indicate that the knapping processes did constitute a relevant activity. Nonetheless, their products are genuinely scant (fig. 4.10). Therefore, we believe that, as occurred in the previous levels, Level 3 is a taphonomically sorted assemblage. The vast amount of microfauna recovered (Andrews 1983; Fernández-Jalvo *et al.* 1998) indicates a

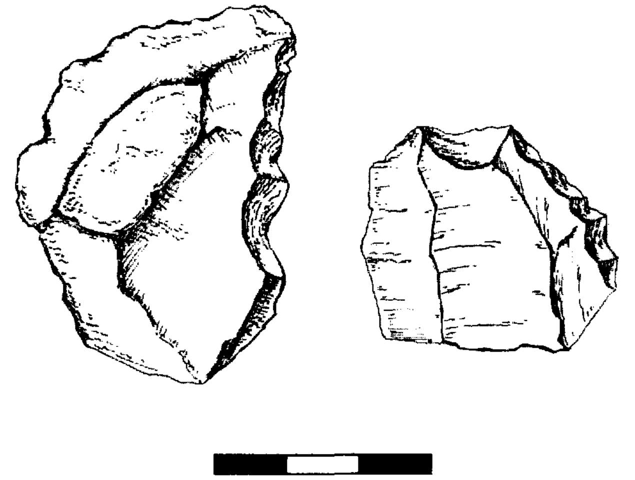


Figure 4.10. Quartz side scrapers from FLK North Level 3 (drawn by N. Morán).

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	2	0.2	14	2.5	16	1.1
Cores	8	0.9	77	13.5	85	5.9
Retouched pieces	6	0.7	2	0.4	8	0.5
Knapping hammerst. & frags.	9	1	67	11.7	76	5.2
Hamm. fract. angles	6	0.7	7	1.2	13	0.8
Spheroids & Subspheroids	1	0.1	-	-	1	0.1
Anvils	24	2.7	1	0.2	25	1.7
Whole flakes	39	4.4	45	7.9	84	5.7
Frag. < 20 mm	212	24	10	1.8	222	15.2
Flake fragments	458	51.8	84	14.7	543*	37.3
Angular fragments	97	11	20	3.5	117	8
Battered fragments	20	2.2	-	-	20	1.4
Unmodified material	2	0.2	244	42.7	246	16.9
Total	884	100	571	100	1456	100

Table 4.8. Lithic categories at FLK North Level 1-2. (*) A gneiss fragment is included.

practically zero energy deposition context. Yet, we should also considerer that palaeontologists do not link the presence of micromammals to human activity. Thus, there would be no difficulty in proposing two different deposition events that were finally integrated in the same stratigraphic level, which Leakey (1971) subsequently identified as a homogenous Level 3.

The contextual entity and the amount of lithic remains in Level 1-2 is substantially greater than that of any other FLK North level. It is necessary to bear in mind that the designation Level 1-2 stems from the impossibility of distinguishing two different levels of occupation, and the fact that, according to Leakey (1971), the few pieces from Level 2 are occupation remains from Level 1 which underwent a vertical movement. Hence, it is a homogenous assemblage belonging to a single level of occupation, thus justifying Leakey's (1971) joint processing, which we adhere to herein.

Leakey (1971) studied a total number of 1205 artefacts, alongside which we should consider no less than 170 so-called manuports. As in previous cases, we consider a good part of the so-called manuports are nothing of the sort. In FLK North, not only do we have a quantitatively relevant sample - 246 according to our study (tabl. 4.8) -, but we also have more explicit information in the original description: Leakey (1971:83) underscored the fact that unmodified cobbles were particularly common in Level 1-2, but that their provenance must be anthropic since there was no hydraulic disturbance in the assemblage. Alongside these high quality lava cobbles, Leakey also noted the presence of vesicular basalt blocks which she stated could not have been used for knapping activities, and therefore suggests they could have been used as missiles.

FLK North 1-2 provides a sufficiently ample portion that allows us to perform a statistic comparison between the so-called manuports with the material under consideration. As occurs on the previous levels, it is also surprising that North 1-2 has so-called raw material reserves that triple the percentage of cores. Once again, it seems difficult to explain why the hominids accumulated more unaltered lithic material than they actually modified. Referring to the hypothesis that the weight of the supposed manuports should be greater than that of the cores if they were genuinely raw material reserves, a T-Test was performed to compare both populations. As the data was not homoscedastic, it was necessary to transform the weight variable by Naperian logarithm, and then verify the normal distribution implementing the Kolmogorov-Smirnov test (see de la Torre & Mora 2005). However, the subsequent T-test assumed the equivalence of the averages in both samples; that is to say, both the unmodified objects and the cores have a similar weight, without visible substantial differences in size of the supposed manuports that would lead us to assume their subsequent reduction as cores.

A chi-square test was carried out in order to verify if the distribution of raw materials is similar in unmodified objects and in the cores. This time, phonolites were also included in the comparison of quartzes and basalts. The results are similar to those obtained for FLK Zinj, rejecting the option that both samples (cores and unmodified objects) come from the same population. That is to say, the raw material that predominates in the manuports does not coincide with the distribution of the cores, thus it seems difficult to sustain that the latter were selected from the unmodified lithic material.

On the basis of the analytical comparisons performed (de la Torre & Mora 2005), we consider we have justified the hypothesis asserting that most of the unmodified objects are not related to the activities of lithic artefact production and use. However, even though the visual analysis of the supposed manuports in FLK Zinj have already shed some light on the origin of these materials, given the bad quality of almost all of them, the pattern is not as evident in FLK North 1-2. In the different levels of FLK North some high quality river cobbles very similar to the blanks which were used as hammerstones can be identified, although they do not present

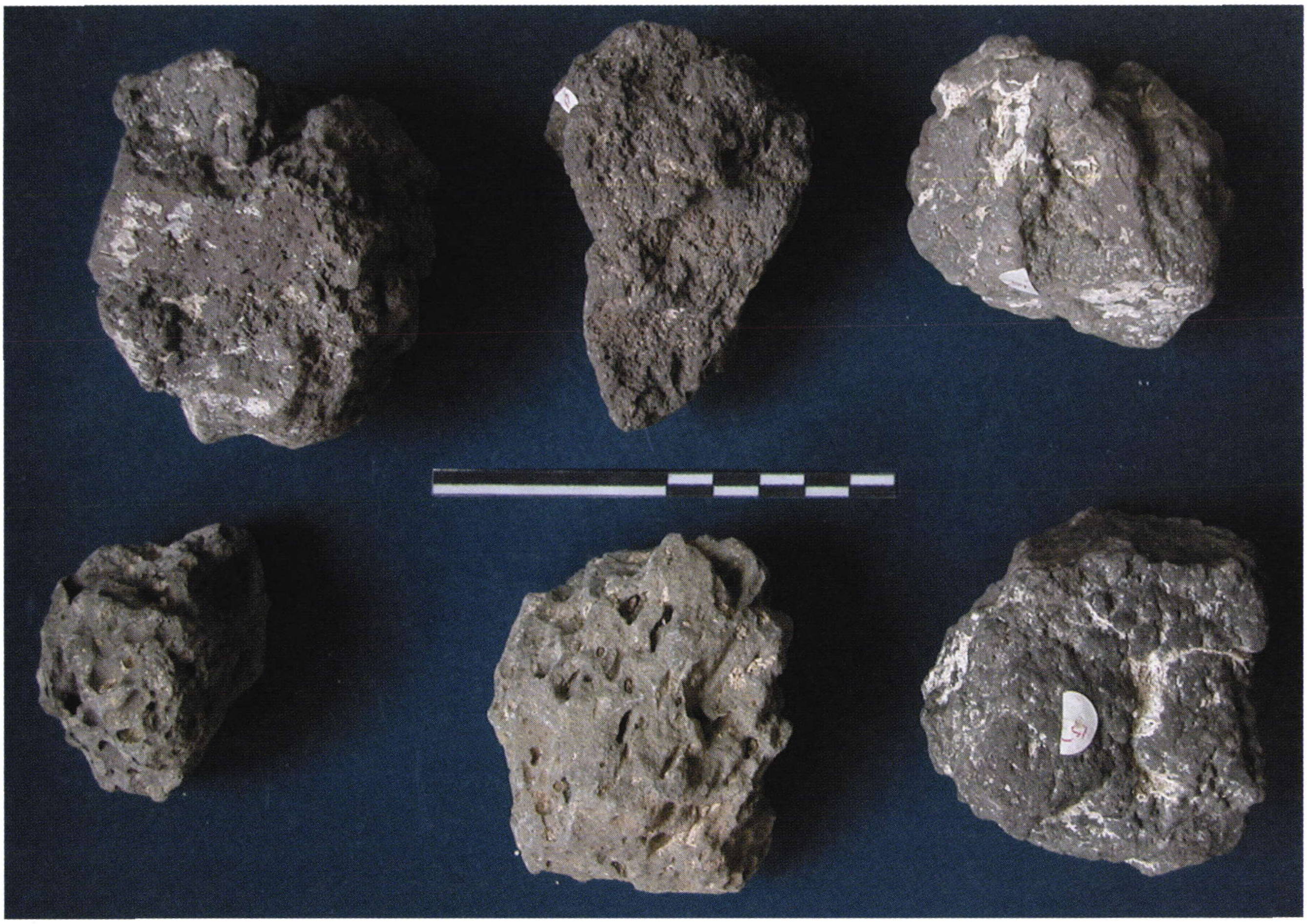


Figure 4.11. Basalt unmodified material at FLK North Level 1-2. See morphological irregularity of the pieces and their vesicular structure. These lavas are inadequate for knapping, and cannot be considered as raw material reserves.

traces of utilisation. Therefore, we cannot exclude the possibility that some of these unmodified river cobbles were supplied anthropically. Nonetheless, alongside these items there are numerous lava pieces, some vesicular and of extremely poor quality (see fig. 4.11) which, alongside the reduced size of some of them (30-40 mm), also provide qualitative information rejecting a human accumulation of these pieces. Therefore, we find it preferable to remove the unmodified lavas from the study. This decision is not irrelevant, since of the total number of 160,775 grams of lithic material weighed in Level 1-2, no less than 73 kilograms were allocated to those so-called manuports. Consequently, we remove almost half of the material. An issue that has relevant implications when assessing human incidence.

Raw materials in FLK North 1-2

Based on table 4.9, one could consider that quartz was the main raw material employed in FLK North 1-2 (see fig. 4.12). Nonetheless, if we rule out the number of objects and focus on the real influence of lavas and quartzes in terms of the contribution of raw material to the site, we find that phonolites and basalts were actually the most important materials (tabl. 4.10). We cannot connect this relevance of lavas to categories linked to percussion, since only the group of lava cores exceeds the whole amount of quartz material, which shows that lavas were involved in knapping dynamics.

The Lien Test was performed to elucidate the contradiction between the vast amount of lava cores and the high percentage of quartz products (fig. 4.13 and 4.14). The conditional frequencies obtained indicate that the most informative categories are the pairs composed by cores-lavas (positive association), hammerstones-lavas (positive association), cores-quartzes (negative association) and chips-lavas (negative association). Figure 4.13 shows an overabundance of lava cores compared to quartz cores, a pattern that is repeated quite similarly among hammerstones. Nonetheless, the frequencies for debris and lava flake fragments are quite inferior, compared to the profusion of those of quartz. It is hard to interpret this comparative test in behavioural terms. As regards the knapping hammerstones, we have already stressed the preference for lavas over quartzes, therefore the results are coherent in this sense. Nonetheless, the difference in percentages between lavas and quartzes in the hammerstone category is one thing, and the disparity between hammerstones and the other categories is another. Table 4.10 indicates that the weight of the hammerstones exceeds that of quartz material in absolute terms, and

	Quartz		Lava		Total	
	n	%	n	%	n	%
Test cores	2	0.2	14	4.2	16	1.3
Cores	8	0.9	77	23.5	85	7
Retouched pieces	6	0.7	2	0.6	8	0.6
Knapping hammerstones & frags.	9	1	67	20.4	76	6.2
Hamm. fract. angles	6	0.7	7	2.1	13	1
Esferoides	1	0.1	-	-	1	0.1
Anvils	24	2.7	1	0.3	25	2
Whole flakes	39	4.4	45	13.7	84	6.9
Frag. < 20 mm	212	24	10	3	222	18.3
Flake fragments	458	51.8	84	25.6	542	44.8
Angular fragments	97	11	20	6.1	117	9.6
Battered fragments	20	2.2	-	-	20	1.6
Unmodified material	2	0.2	-	-	2	0.1
Total	884	100	327	100	1211	100

Table 4.9. Lithic assemblage at FLK North Level 1-2, excluding unmodified lava objects and the gneiss fragment.

	Quartz	**Lava**	**Total**
Test cores	365	4682	5047
Cores	1647	26187	27834
Débitage & frags.	9797	3426	13223
Hammerstones	2398	28028	30426
Anvils	9797	800	10597
Manuports	440	-	440
Total	24444	63123	87567

Table 4.10. Total weight (in grams) of the general categories according to raw material at FLK North 1-2, excluding the unmodified lava pieces

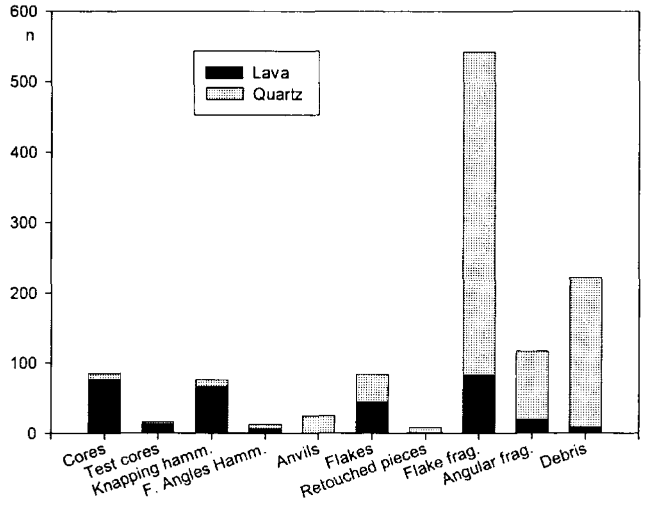


Figure 4.12. Absolute frequencies of lithic categories at FLK North 1-2, according to raw material.

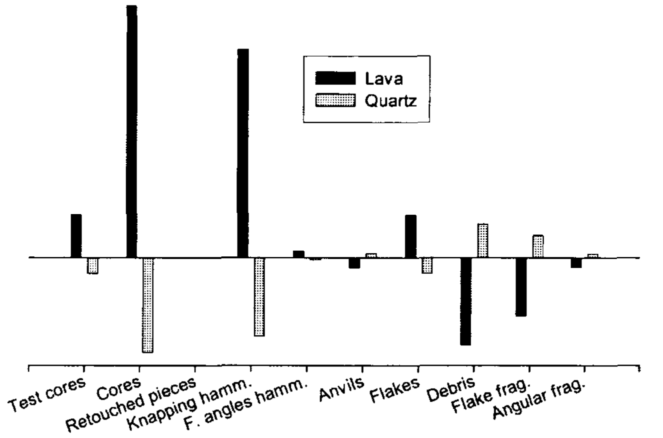


Figure 4.13. Lien Test comparing each technological category and raw materials.

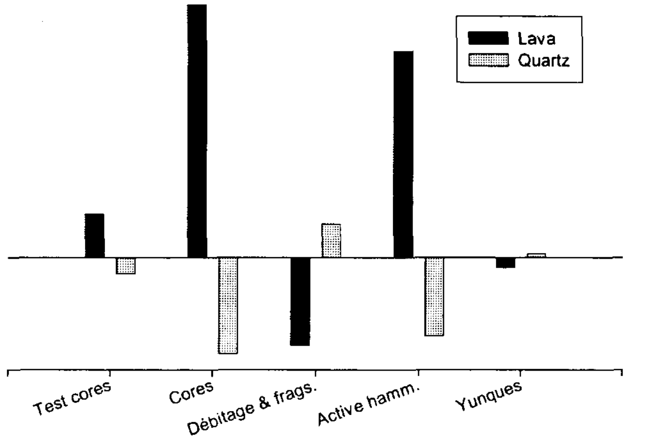


Figure 4.14. Lien Test comparing raw materials and general categories at FLK North 1-2.

even that of the actual lava cores. This trend is illogical. Therefore, we cannot rule out (as suggested for other levels of FLK North) that natural mechanical processes produced the battering on some of the pieces with diffused abraded areas, thus making them part of the unmodified lithic material.

The overabundance of lava cores represented in figure 4.13 could be explained as an intentional selection of basalt and phonolite knapped objects over quartzes. Nevertheless, this contradicts the patterns indicated in the knapping waste (chips), in which the basalts are almost absent, proportionally, - and also in absolute terms, in reality (tabl. 4.9). This incoherence led to the classification of all the *débitage* groups (flakes, flake fragments, debris, etc) in one single group which was then compared to other general categories, with a view to simplify the statistic comparison (fig. 4.14). Yet, the aforementioned pattern becomes even more evident, with a contradiction between the frequencies of lavas and quartzes among the flaked pieces (cores and test cores, chiefly in lava), and the actual flakes and derivates (principally in quartz).

How can we explain this trend? A similar imbalance (albeit not as obvious) was previously described in FLK Zinj. In that site, we commented Binford's (1987) hypothesis, who maintained that said incoherence regarding raw materials was due to the fact that the quartz flakes and the lava cores corresponded to different depositional events. Although for a single example like Zinj (or any other site) we could consider a dynamic of this kind, it does seem difficult to assume the existence of a recurring pattern of natural events that always select the quartz flakes and the lava cores. This obviously makes no sense. Actually, the taphonomic explanations are not reliable for the FLK North 1-2 case. In certain previous levels we turned to postdepositional causes to explain the over-representation of cores compared to other categories, basically *débitage* categories. Nonetheless, Level 1-2 presents a profusion of millimetric debris, which does not, ever, indicate a severe hydraulic bias. The problem is, simply, that these debris are made of quartz, and not lava as would be expected given the vast amount of basalt and phonolite cores. In any case, we must also question our own assertions on the level's high resolution, since Roche (1980:87-88) registered signs of roundness and even doubted the contextual integrity of this Level 1-2.

One final argument against Binford (1987) and his hypothesis sustaining a diachrony between the choppers (lava) and the *débitage* (quartz), is that the basalt and phonolite flakes present technical features that link them to knapping systems deduced from core analysis. That is to say, there is a negative balance of knapping products compared to the number of cores documented, but, despite this fact and from a technical viewpoint, these flakes coincide with the knapping strategies represented in the cores.

Brantingham (1998:83) used Leakey's (1971) data to calculate an average of only 0.6 flakes per core in FLK North 1-2. McNabb (1998) speculated that there must have been at least 315 lava flakes and 1575 at the most. As regards FLK North 1-2, the lava cores range between a minimum of 2 and 14 detachments, with an average of 5.64 scares per core. Considering McNabb's (1998) calculations, we could estimate a minimum of 154 flakes and a maximum of 1078. This is nowhere near the real number of lava flakes (n=45), even if we were to add the flake fragments (see tabl. 4.8).

Quartz cores are quite scant (n=8) and are generally smaller than lava cores (fig. 4.15). This is probably not due to a greater reduction of the pieces but to the original size of the blanks, since the number of detachments is similar to that of the lava cores (fig. 4.16). Using McNabb's (1998) calculations, there should be between 24 and 96 flakes. Dividing the number of quartz flakes between the number of cores documented in this raw material gives an average of 4.8 flakes per core. This coincides broadly with the estimation calculated using the aggregate of the core scars, which indicates an average of 6.4 flakes per core. If we contemplate the considerable amount of other *débitage* objects, it seems clear that the distribution of quartz does present a coherent structure in the different knapping categories.

Since there are no features amongst the quartzes that allow us to refer to postdepositional biases, we find ourselves back at the starting point of the discordance between cores and products made of lava. In order to explain this customary preponderance of quartz *débitage*, Brantingham (1998) suggests the greater fragmentation of this raw material in view of its

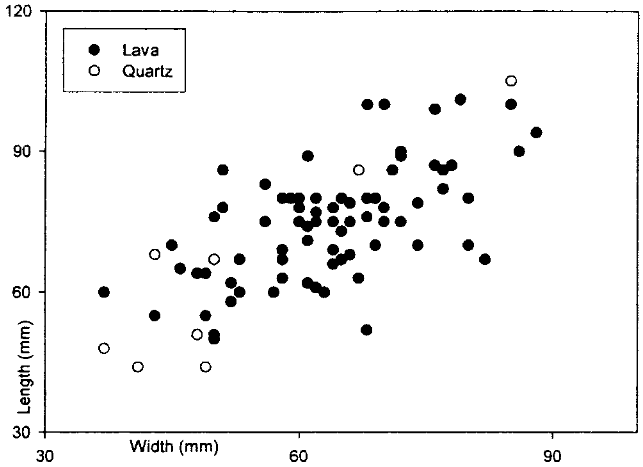


Figure 4.15. Size scatter diagram of lava and quartz cores.

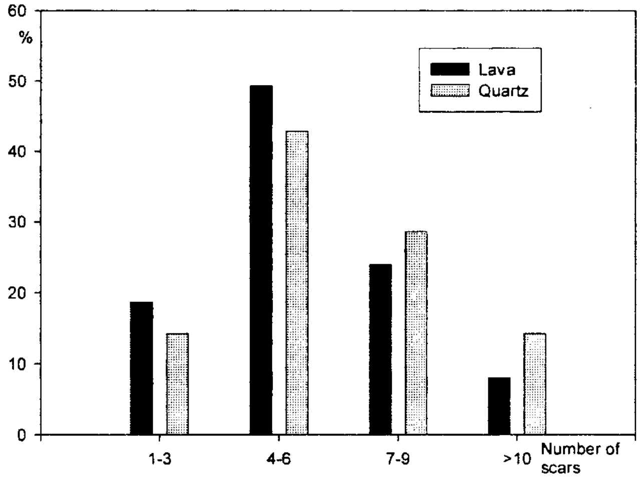


Figure 4.16. Amount of scars on the quartz and lava cores from FLK North 1-2.

mechanical characteristics as regards disintegrating crystal. Although this could explain the abundance of quartz fragments, it does not solve the low number of lava flakes compared to the number of cores. Therefore it seems that the only answer lies in turning to behavioural parameters to explain this incoherence.

Brantingham (1998) uses precisely FLK North 1-2, and FxJj 50 (Koobi Fora), as paradigms of the high level of mobility envisaged in the strategies for managing raw materials, using North 1-2 to study the low proportion of lava products. Although this author employed the aggregates published by Leakey (1971), we agree with his conclusions entirely; despite it being evident that *in situ* lava knapping did occur in FLK North 1-2, a good part of this material was imported and/or exported. One possibility maintains that the core forms were already flaked when they entered the site. This would be applicable to the choppers (which compose a good part of these core forms) if they were instruments employed in different activities performed to manage the documented carcas-

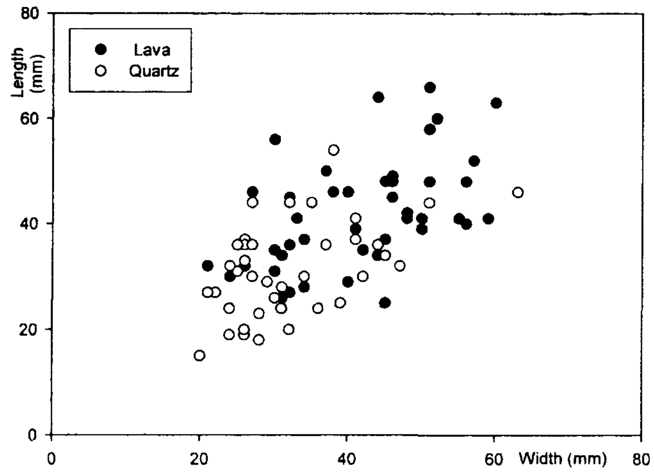


Figure 4.17. Dimensions of the whole flakes at FLK North Level 1-2.

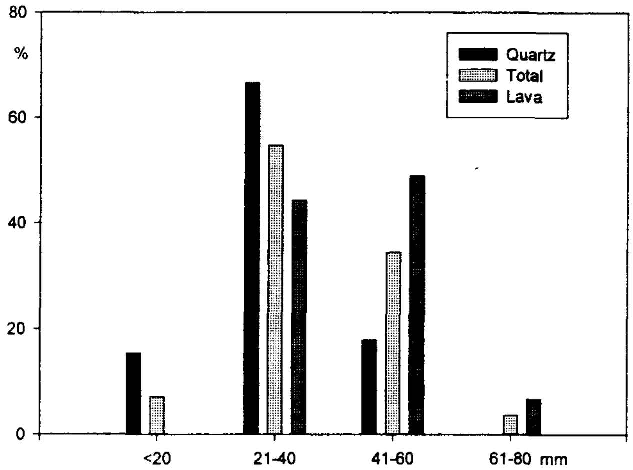


Figure 4.18. Maximum length patterns in the whole flakes.

	Minimum	Maximum	Mean	Std. deviation
Length	15	66	37.11	11.013
Width	20	63	37.56	10.763
Thickness	5	24	11.35	4.164
Weight	3	65	18.46	14.498

Table 4.11. Dimensions of the whole flakes at FLK North Level 1-2.

Dorsal face	Striking platform				Total	
	Cortical		Non-cortical			
	N	%	N	%	N	%
Full cortex	7	8.3	6	7.1	14	16.7
Cortex > 50%	4	4.8	10	11.9	13	15.5
Cortex < 50%	2	2.4	16	19	18	21.4
Non-cortical	1	1.2	38	45.2	39	46.4
Total	14	16.7	70	83.3	84	100

Table 4.12. Cortical frequencies in the whole flakes from FLK North 1-2.

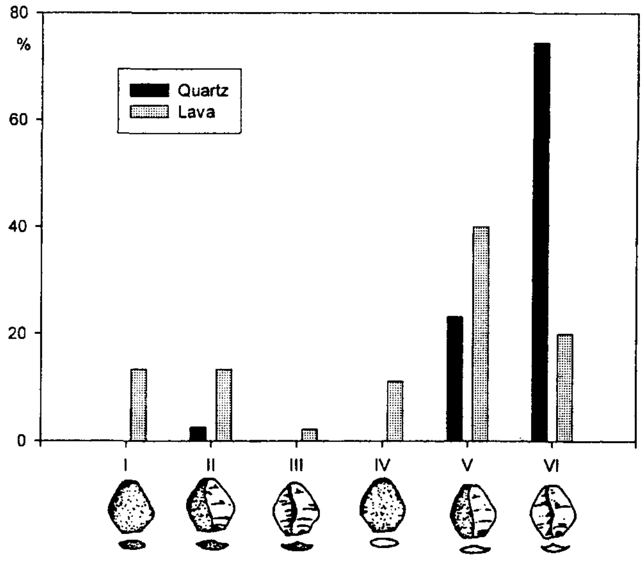


Figure 4.19. Types of flakes at FLK North 1-2, according to Toth´s (1982) classification.

ses. If they were only cores, there would be no place for considering that they were already flaked upon entering the site, since it would be illogical to think hominids transported cores that were not subsequently exploited. Hence, if we consider the large pieces were only cores, it would be logical to think that the lava flakes were the pieces that were exported, once they had been flaked in the site.

Neither alternative is problem-free. To consider choppers as completed artefacts that were already shaped when brought to the site supposes a good contextual explanation for the scarce amount of lava debris, but shows other objections, such as the lack of conspicuous utilisation marks on the ridges, which are generally intact. If they had been used as artefacts, they would preserve marks on the edges. We will refer to the use of these pieces in chapter 9 and will therefore move on. As regards the hypothesis stressing that the lava cores were flaked at the actual site and that the flakes obtained were subsequently exported, we stumble upon a contextual problem: this option would have generated an amount of chips much greater than the volume documented, which would at least appear as evidence of *débitage* processes. Consequently, neither of the alternatives presents conclusive arguments and we will need to pursue other hypothesis to explain the considerable bias that appears as regards the *chaîne opératoire* of lavas. In any case, we are, as in FLK Zinj, facing a behavioural strategy encompassing a functional division of raw materials and in which, as Potts (1988, 1991) stated, the dynamics for rearranging, discarding and exporting lithic elements are part of a structured organisation implemented to manage the landscape.

Knapping products

We also encounter differences between quartzes and lavas in terms of knapping products. Although quartz and lava flakes are considered in the same size scatter interval (tabl. 4.11 and

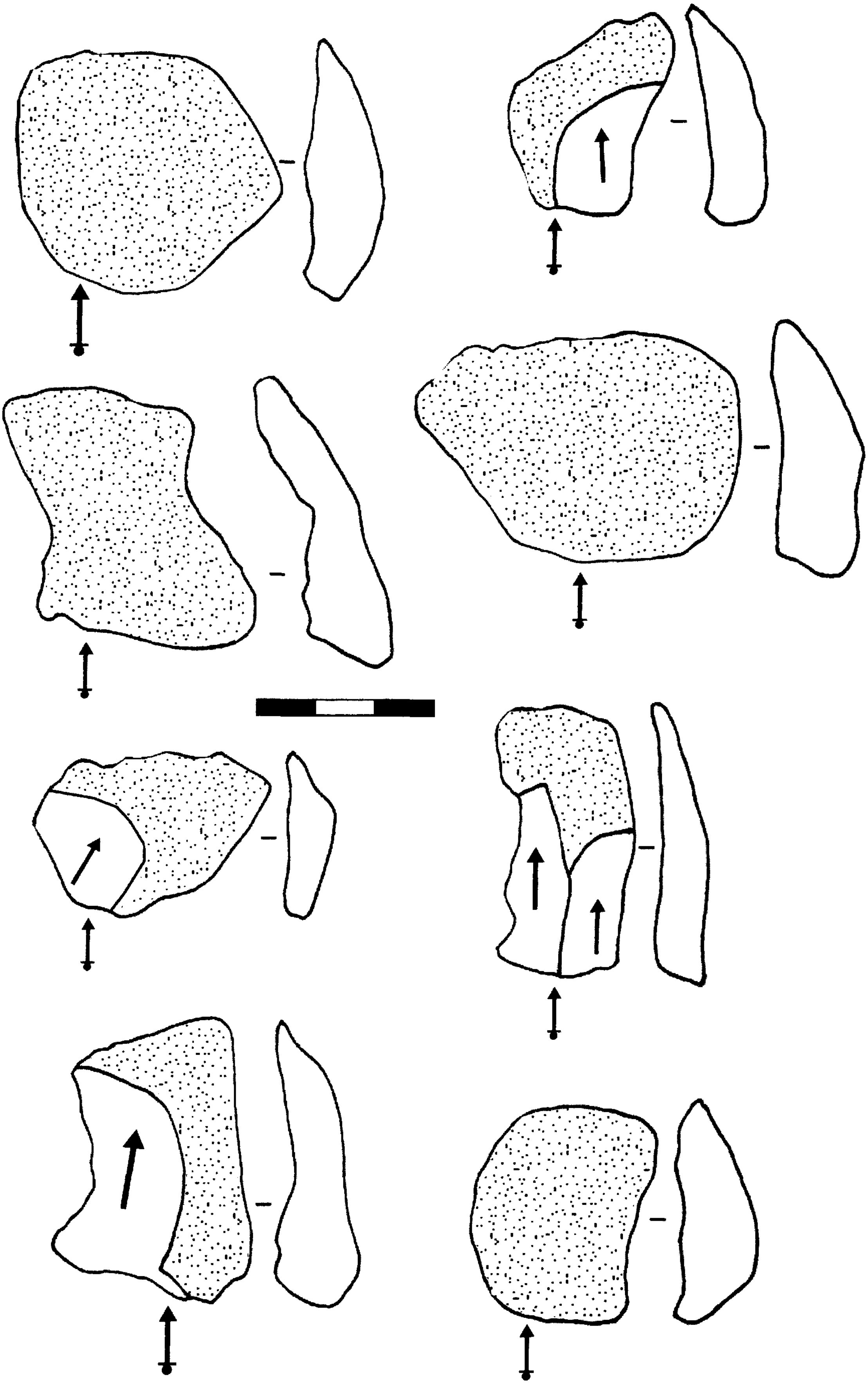


Figure 4.20. Examples of phonolite flakes with cortex at FLK North Level 1-2.

fig. 4.17), quartz flakes are systematically smaller than lava flakes (fig. 4.18). This comes as no surprise, since quartz cores are also smaller than lava cores (fig. 4.15).

The cortex percentages are extremely relevant in Level 1-2 flakes (tabl. 4.12): 53.6% of the dorsal faces maintain some cortex, and 16.7% of the flakes also present cortex on the butt. Therefore, the initial flaking stages obviously had a great bearing on *débitage* activities. We have already mentioned that it is difficult to identify cortical areas on tabular quartzes. Thus, cortical index patterns are underestimated systematically. With this in view, we have segmented our flake sample in terms of raw materials (fig. 4.19). In doing so, we see that quartz flakes were preventing the elucidation of the lava distribution pattern. Lava flakes are essentially cortical (fig. 4.20).

As regards the technological information retrieved after analysing the butts of the flakes, it seems that the cores' striking platforms were worked recurrently; although the dorsal faces usually present cortex remains, only 14 of the 84 flakes have cortical butts. Altogether, the striking platforms do not seem to have been prepared and were rarely (2.4%) bifaceted (fig. 4.21).

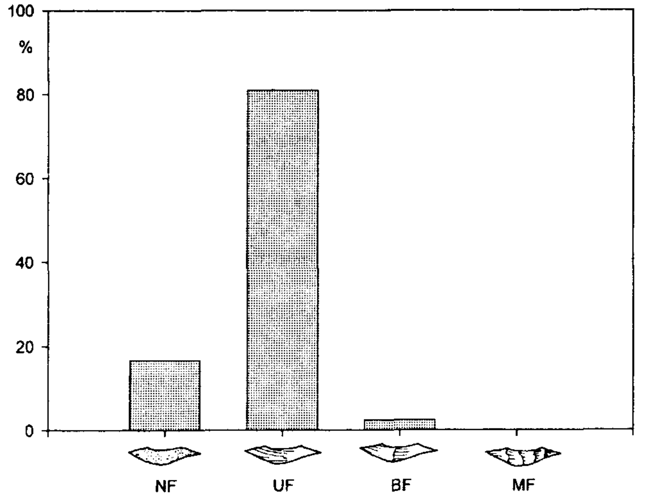


Figure 4.21. Types of striking platforms in the whole flakes.

Despite their cortical nature, lava flakes usually present an excellent manufacture. This can also be applied to most of the quartz pieces (fig. 4.22). If we only consider the items that present ridges from previous detachments, 47.8% of the flakes have 1-2 scars, 44.9% have between 3-4 scars and 7.2% have between 5-6 scars. This constitutes an average of 2.6 previous detachments per flake, and there does not seem to be a differential pattern between quartz flakes (2.8 scars per flake) and lava flakes (2.5 scars), which present a very similar distribution (fig. 4.23). Therefore, this time a greater intensity of the reduction of quartzes is not applicable.

The direction of the scars on the flakes informs of the systems used to reduce the cores. Figure 4.24 depicts how, as in DK and FLK Zinj, the unidirectional pattern prevails in FLK North 1-2, with cases in which the cores' exploitation surface is rotated partially, and some examples in which these knapping surfaces are worked multidirectionally.

In all, the Level 1-2 flakes are characterised by butts that are generally unifaceted and by longitudinal morphologies with dorsal faces that are typical of unidirectional knapping systems. Although some edge-core flakes have been documented, the analysis we have performed regarding the flakes does not suggest the striking platforms underwent systematic rejuvenation. In fact, most of the lava flakes seem to have been produced by a chopper-type knapping, a reduction which, moreover, would be performed in the actual site, given the high cortex percentages in these knapping products. This clashes with one of the aforementioned hypotheses regarding the transportation of shaped choppers to the site (fig. 4.19). As regards quartz flakes, they are also produced by a systematic reduction of blocks of that raw material. Despite their size, which is usually inferior to those of lavas, they do not seem to have been produced by a more intense reduction, but by the raw material constrictions quartz imposes.

Retouched pieces

Leakey (1971:81-82) referred to 12 light-duty scrapers and up to 68 flakes and flake fragments bearing traces of having been retouched or utilised. Sussman (1987) chose a sample to sift for use-wear traces, and only found two pieces presenting traces of wood working. We have identified 8 retouched pieces, observing that several of the items described by Leakey (1971:82) do not belong to this category. All retouched pieces, aside from one, come from a flake fragment blank, despite which they maintain a size similar to the average whole flakes (see tabl. 4.13 and compare to tabl. 4.11). If we consider that 6 of the 8 retouched pieces are made of quartz, and recall that the quartz flakes were smaller than the total average, we could propose that these blanks were chosen in view of their larger size. The 8 retouched pieces are side scrapers, one lateral, the other transversal and the other 6 are denticulates (fig. 4.25). In any case, we must recall that in Level 1-2 retouched pieces represent only 0.6% of the total and only 135 grams of the over 87 kilograms of anthropically altered lithic material, therefore their relevance is very limited.

Cores and knapping systems in FLK North 1-2

Since we have already submitted a good part of the information when analysing core representation and lava and quartz

	Minimum	Maximum	Mean	Std. deviation
Length	22	49	35.67	11.639
Thickness	26	49	35.5	8.758
Width	8	19	13.17	4.167
Weight	6	55	22.5	18.075

Table 4.13. Dimensions of the retouched pieces at FLK North Level 1-2.

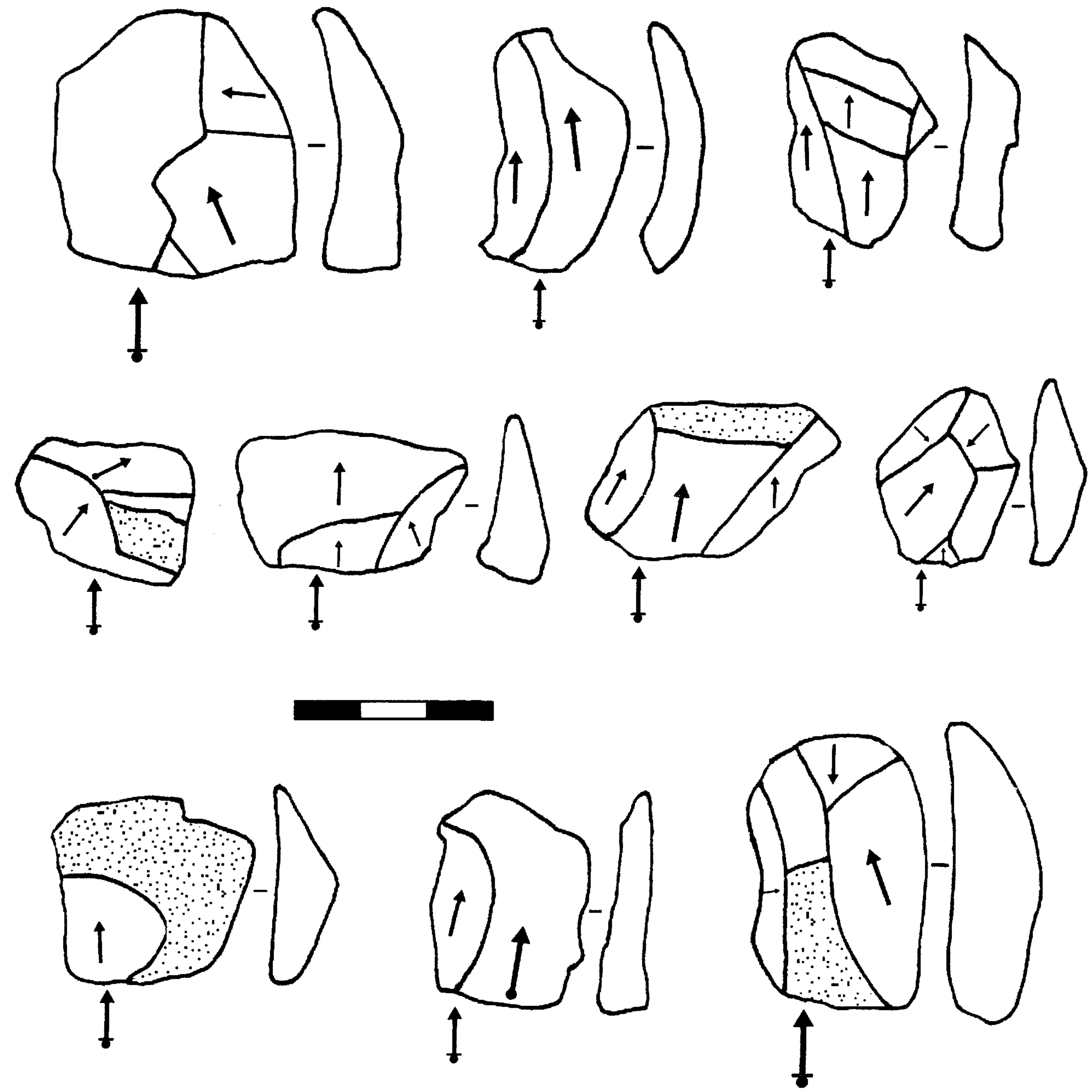


Figure 4.22. Quartz flakes at FLK North 1-2.

products, this section will deal with exploitation methods. Leakey (1971) insisted on the major importance of choppers, summing almost 100 samples. Subsequently, Roche (1980) recorded 78 choppers, underscoring the prevalence of phonolite as a raw material, cobbles as the main blank for their manufacture and an average of 2-3 scars per piece.

In view that we use the simple or abrupt angle criterion to discriminate different knapping systems, our technological aggregate differs slightly to Roche's (1980), and is completely different to Leakey's (1971) typological approximation. According to our recount, there are 49 choppers (including unifacial and bifacial choppers), which, nonetheless, still compose the most important category, with 57.7% of the total number of cores (fig. 4.26). The number of quartz cores is so minor that is does not allow for statistic comparisons with the sample of lava cores, and there does not seem to be a specific exploitation method associated to metamorphic materials. Neither does there seem to be a preferential selection between the lavas for manufacturing choppers, the number of items in phonolite and basalt appear in quite similar percentages. Choppers are mainly bifacial, with 47.1% of the total number of cores, although unifacial choppers (10.6%) still compose one of the main systems. This is consistent with the characteristics of the lava flakes; most present morphological features linked to a chopper-type exploitation, with high percentages of cortex, unidirectional knapping, etc.

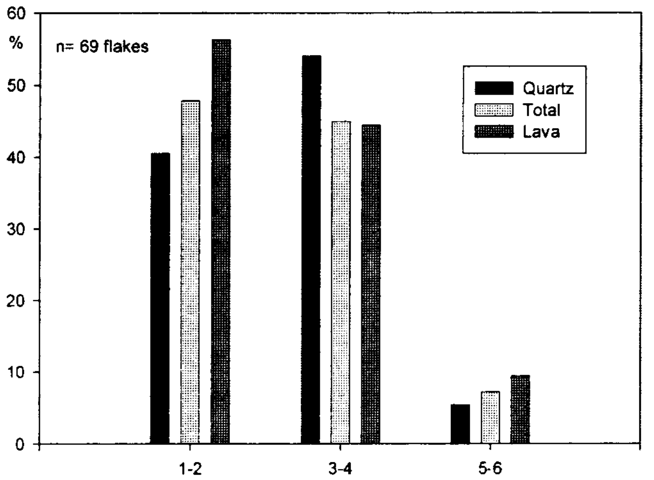


Figure 4.23. Amount of scars on the dorsal sides of the whole flakes.

Leakey (1971:73) had noticed a complementary use of the choppers' cortical areas and considered they had been employed as hammerstones, an aspect we also reflect in our analysis; of the 85 cores from Level 1-2, 28.2% (n=24) present traces of pitting on their surface. It is symptomatic that no less than 22 of these 24 pieces are choppers. This is due to a simple fact: the blanks for these pieces were essentially cobbles, identical to those used as simple knapping hammerstones. It would be no surprise to think that, after being used as active hammerstones, such cobbles were used for flake removal, thus becoming cores.

We also documented other types of exploitation. The bifacial abrupt exploitation totals 17.7% of the whole number of cores (fig. 4.26), whilst the unifacial abrupt method totals 9.5%. Leakey (1971) had classified some as choppers, as Roche (1980) surely did too. In truth, given that most only show a partial exploitation of the core periphery, and employ the same cobbles as the unifacial and bifacial simple methods, the difference between both systems could be very subtle, and therefore extremely subjective. Alongside these items, we also documented examples of unifacial and bifacial peripheral systems (both achieving a 7.2% of the total number of cores) (fig. 4.27) and several multifacial pieces (8.3%). In any case, we observed that the variety of systems could simply have been produced by a more intense exploitation of the choppers, which would have generated a more complex reduction, in line with the pattern described by Potts (1991).

Percussion objects in FLK North 1-2

Knapping hammerstones, hammerstones with fracture angles and anvils compose a very important percentage in terms of

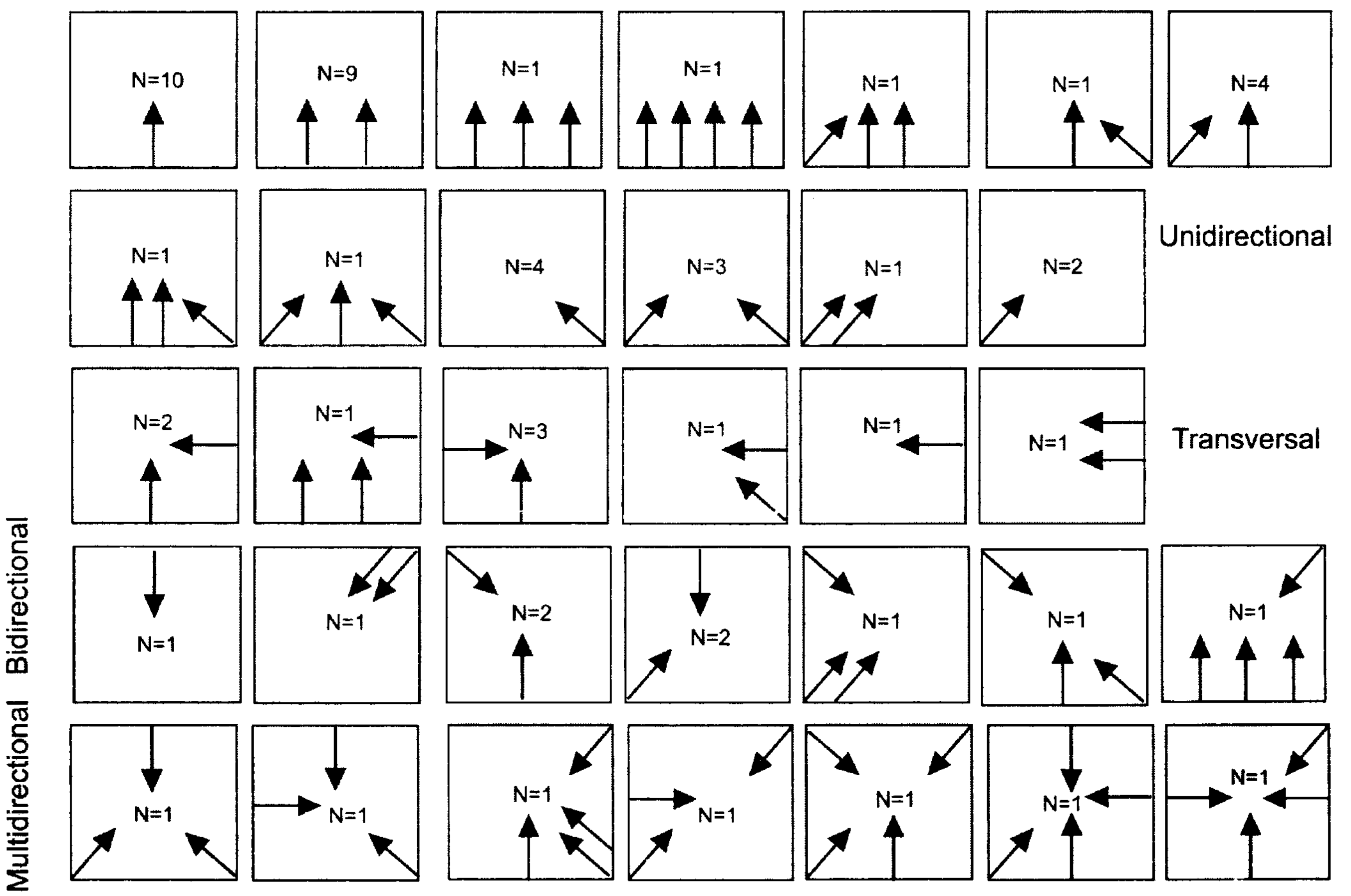


Figure 4.24. Diacritic schemes of the whole flakes.

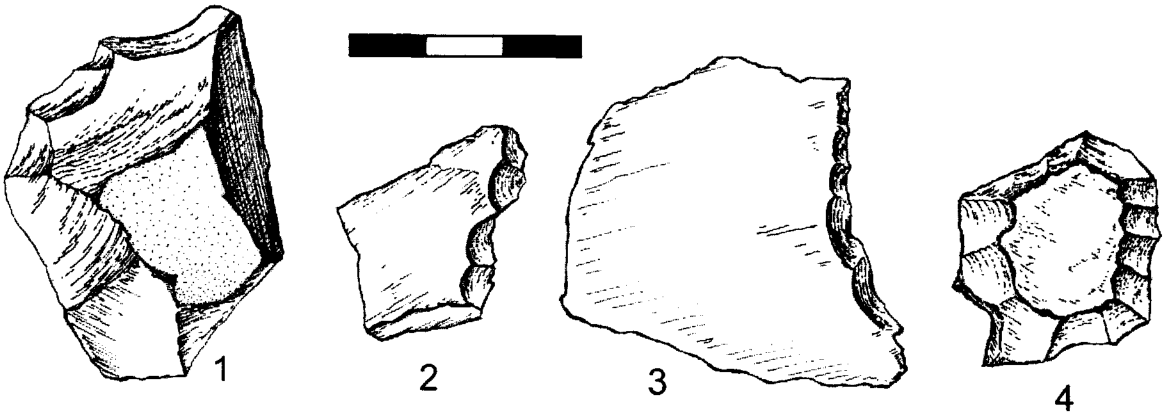


Figure 4.25. Quartz side scrapers from Level 1-2 (drawn by N. Morán).

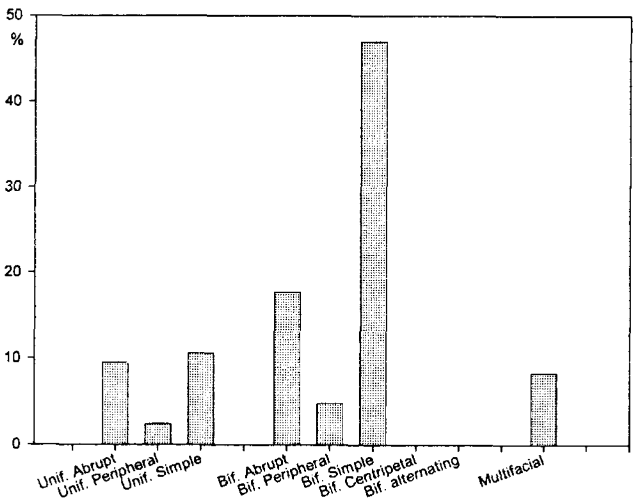


Figure 4.26. Knapping systems on the cores at FLK North 1-2.

	Minimum	Maximum	Mean	Std. deviation
Length	52	114	79.06	10.863
Thickness	46	83	64.85	8.436
Width	29	75	52.35	9.795
Weight	130	800	390.56	151.267

Table 4.14. Dimensions of the knapping hammerstones from FLK North 1-2.

	Minimum	Maximum	Mean	Std. deviation
Length	40	130	88.84	19.642
Thickness	41	96	67.95	14.316
Width	39	83	56.89	11.737
Weight	164	1150	557.74	252.752

Table 4.15. Dimensions of the anvils at FLK North 1-2.

the total number of items found in FLK North 1-2 (tabl. 4.9). In fact, among the hammerstones and anvils, percussion activities total 41 kilograms of raw material, exceeding any other technological categories (tabl. 4.10). If we add all the objects that present traces of pitting (most of the chopper-type cores preserve this type of traces on their cortical areas) to this figure, we discover that up to 52 of the 87 kilograms of raw material from Level 1-2 were at some time used directly in percussion processes. Therefore, it is essential to insist on the importance of these activities.

The most common objects are the knapping hammerstones which, as in other sites, are mainly phonolite and basalt cobbles to the detriment of quartz blocks (tabl. 4.9). The size, ergonomics and regular morphology of these lava cobbles make them appropriate for use as active hammerstones (tabl. 4.14). Hammerstones with fracture angles compose a relatively important percentage, with Level 1-2 presenting a more balanced percentage between quartzes and lavas (tabl. 4.9). Willoughby (1987) referred to isolated cases of spheroids and subspheroids from Level 5 of FLK North. Yet in Level 1-2, Willoughby (1987:11) identified 12 subspheroids and spheroids. However, we only identified one example in Level 1-2, and no examples in any of the previous levels. Thus, we will postpone describing these objects until we reach the section dedicated to the FLK North Sandy Conglomerate, which unearthed a sufficiently relevant sample that can define this category systematically.

Finally, Level 1-2 has 25 anvils, accounting for over 10 kilograms of raw material, approaching the total volume of *débitage*. The use of quartz for these objects is obvious (24 of the 25 pieces are quartz), and can be the reason for part of the so-called quartz *débitage*, which would, in fact, be nothing but fragments detached from anvils, during a process identical to the procedure described in the previous section. They were not selected as immobile elements on which to perform tasks in view of their size, since they are small enough to be used single-handedly (tabl. 4.15). More specifically, they were probably employed as anvils given their tabular shape, since this facilitated their stability on the ground.

Therefore, we see that percussion processes were clearly a very relevant activity in FLK North 1-2. Obviously, a great part of these processes were linked to *débitage*, as we can see through the knapping hammerstones. Nonetheless, the hammerstones with fracture angles and, especially the anvils,

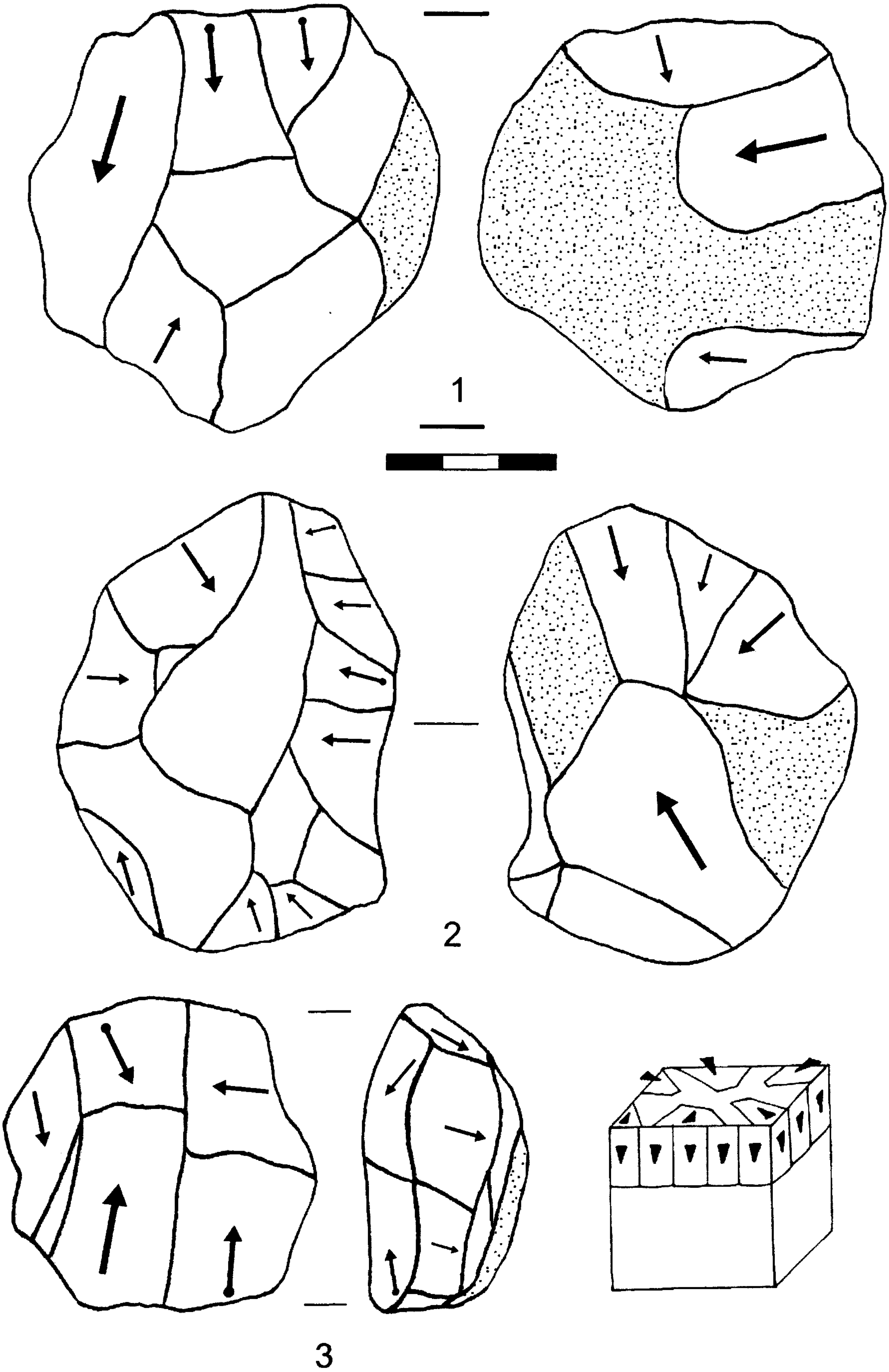


Figure 4.27. Bifacial peripheral cores. 1-2: lava; 3: quartz.

indicate that percussion activities not related to the management of lithic resources were also performed. Given the vast amount of fauna linked to lithic material, and the possibility of marrow extraction activities being performed by the hominids in this Level 1-2 (Blumenschine 1991; Bunn 1986, 1989; etc), we could link items such as the anvils (and probably a good part of the active hammerstones) to carcass processing.

The intensity of human activity is, therefore, verified for Level 1-2. The vast amount of fauna from different ecological niches, the documentation of percussion and cut marks, the presence of at least 87 kilograms of raw material modified and/or transported from different sources on more than one occasion, the intensity of the reduction, etc., all indicate that hominids considered FLK North 1-2 a reference point on the landscape, in which they performed subsistence activities and tool production activities jointly.

Deinotherium Level

The description of this level commences the analysis of the archaeological evidence from Bed II, and - consequently - of the sites after 1.75 my. We have not considered it appropriate, in this monograph, to trace a dividing line between the evidence discovered under Tuff IF and the evidence from Bed II, since in FLK North we have a continuous sequence which should be studied as a whole. We have not analysed the Clay with Root Casts Level, since in a thickness of 1.35 m this level only produced 21 lithic artefacts and a few fossil remains (n=174), usually set in nodular concretions. Leakey (1971:84) asserts that they are disperse remains that do not compose a genuine archaeological level. Therefore, we do not think it appropriate to spend time analysing materials with such as meagre informative value.

The same occurs with the level in question; the skeleton of a *Deinotherium bozasi* supposedly linked to the lithic industry was located approximately 2 metres above the base of Bed II. This skeleton was in a poor state of preservation, except for the tusks. Since the foot bones were found considerably below the rest of the skeleton, Leakey suggests the animal died trapped in a swamp. Alongside the remains of the *Deinotherium*, Leakey (1971:254) refers to the isolated presence of other taxa. The lithic assemblage, composed by 23 artefacts and 16 so-called manuports, seemed associated to the *Deinotherium* skeleton, with a chopper located in the pelvic area of the carcass (Leakey 1971:85). Altogether, this association has not been granted the same reliability as the connection documented in FLK North 6, therefore it has not been ruled out an accidental coincidence of the elephant skeleton and the lithic industry (Isaac & Crader 1981:63).

To our knowledge, no zoo-archaeological re-examination have been performed on the fauna recovered. As regards the industry, Kyara (1999) studied the raw materials and Kimura (1997) and Ludwig (1999) analysed the technology. The latter mentioned a total number of 20 pieces, among which he analysed 10 cores and 8 *débitage* products, and Kimura (1997:203) spoke of 22 artefacts, totalling 16 cores and 6 products. We have located 23 pieces and 13 unmodified objects. No knapping products were found (tabl. 4.16). Furthermore, of the total of slightly over 7600 grams of lithic material, the so-called lava manuports sum 2 kilograms. As in other occasions, the unmodified lavas compose the dominant category, which does not make much sense from a behavioural standpoint. Consequently, we - once again - believe these must be natural items. Actually, this time the pieces classified as lava hammerstones could also possibly be natural, given the great general inconsistence visible in the internal structure of the lithic assemblage.

As a result, human evidence would be limited to a meagre 4 kilograms and a half of quartz (tabl. 4.17) and, with the exception of a few isolated examples of *débitage*, it would be linked exclusively to percussion processes. Despite the fact that the number of artefacts in the *Deinotherium* Level is similar to the underlying assemblage (Clay with Root Casts Level), we decided to analyse it in view of its historiographic relevance, since it has been considered a reference in literature referring to the processing of large carcasses (Clark 1972; Clark & Haynes 1970; Isaac & Crader 1981; Crader 1983; etc). Nonetheless, the lithic assemblage's internal structure is not at all coherent, since it is lacking in *débitage* or small fragments that would allow us to refer to *in situ* activities, merely presenting large objects which almost exclusively suggest percussion processes. Thus, we can propose two alternatives; the first, as Isaac and Crader (1981) mentioned tentatively, deeming the association between the bones and the industry as accidental, in view of which the lithic remains would come from an occupation in which the smaller fragments would have been eliminated, perhaps by sorting processes. The other possibility believes that the industry is linked to the bone remains; in this case, we would be dealing with an extremely episodic occupation, in which quartz blocks were employed to perform limited percussion activities.

	Quartz		Lava		Total	
	n	%	n	%	n	%
Cores	3	14.3	-	-	3	8.6
Hammerstones	4	19	4	28.6	8	22.9
Anvils	7	33.3	-	-	7	20
Battered fragments	4	19	-	-	4	11.4
Unmodified material	3	14.3	10	71.4	13	37.1
Total	21	100	14	100	36*	100

Table 4.16. Lithic categories at FLK North *Deinotherium*. (*) Included a quartz flake not recorded in the table.

	Quartz	**Lava**	**Total**
Cores	562	-	562
Hammerstones	1115	1019	2134
Anvils	2311	-	2311
Manuports	623	-	623
Total	4611	1019	5630

Table 4.17. Weigth (grams) of lithic categories at FLK North *Deinotherium* excluding umodified pieces.

Sandy Conglomerate Level

This is the last level in FLK North described in Leakey's (1971) monograph, and the last Oldowan level we will consider in this book. Located in the lower part of the Middle Member of Bed II, Leakey (1971:111) merely indicates this level's correlation with HWK East Levels 3-5, without providing contextual information. She also notes that the sediments in this level were not sifted (which, in her opinion, explains the low *débitage* percentage), and underscores the high percentage of chert pieces, which does not appear in other parts of the Olduvai sequence. Likewise, she notes the absence of bone remains (Leakey 1971:254), which limits the archaeological evidence to 234 lithic pieces. As stated previously, aggregates vary in terms of the author, from the 234 pieces Leakey (1971) mentions, to the 175 analysed by Ludwig (1999:32), the 248 contemplated in our total, and the 226 counted by Kimura (1999:811), which she then reduces to 224 (Kimura 2002:301).

Despite the low number of items, the Sandy Conglomerate level presents interesting features. Almost all these important characteristics are linked to the novel use of a new raw material in the Olduvai sequence, chert. This raw material was available in the deposition interval between Tuffs IF and IIB, which corresponds to the period when FLK North Sandy Conglomerate (henceforth FLK North SC) was created. Furthermore, this is the first time we encounter an assemblage in which quartz is predominant, not only quantitatively (as occurs in most of the analysed sites), but also in terms of the total number of kilograms taken to the settlement. Figure 4.28 shows that the quartz, with over 25 kilograms of raw material modified anthropically, is the most relevant group, followed by lavas (slightly over 20 kilograms) and then by chert (lagging behind with 1650 grams).

This time there is no call for debating the issue of the lava unmodified material; Leakey, although she does not explain this level's sedimentary context, does state that "*because of the nature of the deposit, it is not posible to determine*

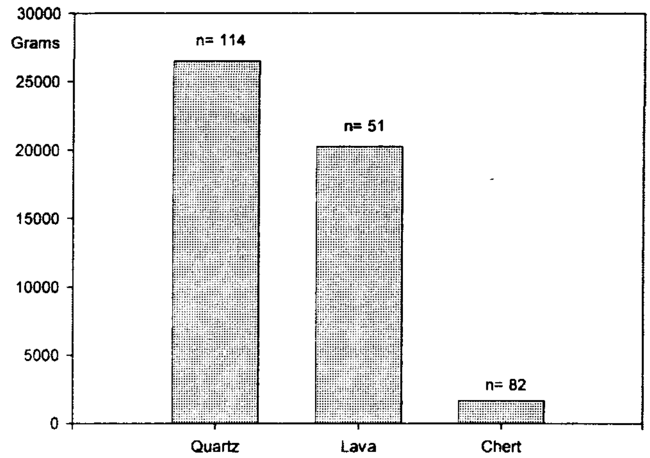


Figure 4.28. Total weight of each raw material at FLK North *Sandy Conglomerate.*

whether these are manuports or are of natural origin" (1971:114). Since this level of FLK North is synchronous in time-related and sedimentary terms with the HWK East Sandy Conglomerate, we can turn to the description Leakey (1971:96) made of the latter, in which she noted the existence of a major conglomerate with many lava pebbles. Therefore, it is surprising to see that Kimura (1997:210) included unmodified lithic material in her aggregates, when Leakey (1971) herself had already stated that, in this case, such pieces had a natural origin.

The immediate existence of lava pebbles makes the prevalence of the quartzes in the assemblage even more relevant, since - in principle - they would have a remoter origin. Moreover, quartz has a very marked distribution, intimately linked to percussion objects (tabl. 4.18 and fig. 4.29). This slant does not only appear in quartzes. If we consider the percentages for each category, we see certain distribution as regards raw materials. So as to check this fact statistically, a global χ^2 of table 4.18 was performed, resulting in highly significant differences between categories in terms of the raw

	Quartz		Lava		Chert		Total	
	n	%	n	%	n	%	n	%
Test cores	2	1.8	2	3.9	2	2.4	6	2.4
Cores	3	2.6	7	13.7	6	7.3	16	6.4
Retouched pieces	-	-	1	2	4	4.9	5	2
Knapping hammerstones & frags.	2	1.8	30	58.8	-	-	32	12.9
Hamm. fract. angles	1	0.9	2	3.9	-	-	3	1.2
Spheroids & Subspheroids	47	41.2	-	-	-	-	47	19
Anvils	-	-	2	3.9	-	-	2	0.8
Whole flakes	6	5.3	1	2	43	52.4	50	20.2
Frag. < 20 mm	-	-	-	-	-	-	-	-
Flake fragments	11	9.6	2	3.9	24	29.3	37	14.9
Angular fragments	32	28	3	5.9	2	2.4	37	14.9
Battered fragments	9	7.9	1	2	-	-	10	4
Unmodified material	1	0.9	-	-	1	1.2	2	0.8
Total	114	100	51	100	82	100	248*	100*

Table 4.18. Categories represented in FLK North SC. (*) Including an unmodified block of gneiss not contemplated in the rest of the table. These aggregates do not coincide with Kimura's (1999:815), since she counted 109 quartz pieces, 43 lava pieces and 73 chert pieces.

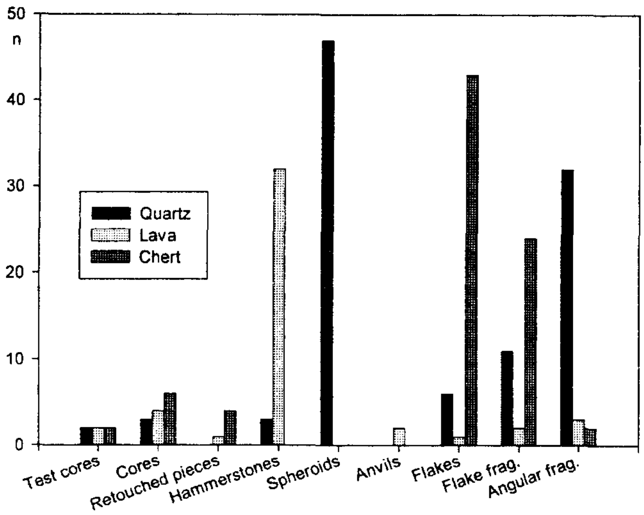


Figure 4.29. Distribution of raw materials according to technological categories at FLK North SC.

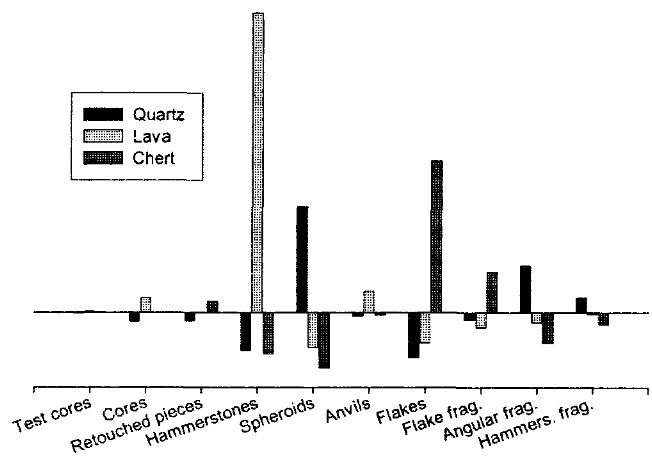


Figure 4.30. Lien Test comparing raw materials and lithic categories at FLK North SC.

material. Putting this same data through the Lien test, which is much more graphical (fig. 4.30), we find three essential trends: the predominance of lava hammerstones to the detriment of quartz and chert hammerstones, the profusion of chert flakes compared to other raw materials, and the over-representation of quartz in the spheroid group.

None of the previous sites has shown such an obvious trend in the distribution of categories per raw material. Therefore, opposite to what we have done in other chapters in which we described each technological category separately, the descriptive criterion implemented for this section will be the raw material: in FLK North SC quartz, lavas and chert respond to different *chaînes opératoires*, and should, for that reason, be treated differently.

The chaîne opératoire *of lavas*

Worked phonolites, trachytes and basalts only account for 51 pieces of the assemblage, but suppose no less than 20,269 grams. As occurred previously, the knapping hammerstones compose the most important category (see tabl. 4.18), being high quality cobbles with ergonomic sizes (tabl. 4.19) and morphologies. Once again, lavas show a flagrant contradiction between the number of *débitage* products and the amount of cores. We cannot attribute the absence of flakes to taphonomic processes, since these products abound among chert objects. Therefore, we need to turn to behavioural causes, either via the import of shaped core forms or the export of the flakes obtained. Both hypothesis encounter serious objections, as commented in the section dedicated to Level 1-2.

	Minimum	Maximum	Mean	Std. deviation
Length	60	112	84.55	14.532
Thickness	43	101	71.17	14.533
Width	35	87	57.17	12.918
Weight	180	1054	510.72	268.165

Table 4.19. Dimensions of lava hammerstones at FLK North SC.

It is hard to explain the enormous deficit of knapping products detected systematically among lavas. Even more so when we delve in the exploitation systems detected in the cores; we documented three choppers, two of which were bifacial and one unifacial; we found a single unifacial abrupt core and three cores that had been reduced using the bifacial peripheral system (fig. 4.31). Most of them did not undergo intense shaping, but this does not justify the fact that there is only one whole lava flake and a few fragments. Thus, there is obviously a bias, probably an anthropic bias, which acted to the detriment of knapping products made of lava.

In any case, we must not forget the fact that most phonolites, trachytes and basalts were linked to percussion activities. Alongside the aforementioned active hammerstones (among which there are some with fracture angles, not only knapping hammerstones), there are also two lava anvils, highly infrequent in the FLK North sequence, where quartz tabular blanks were the most common anvils.

The chaîne opératoire *of quartzes*

Quartzes were also used in a novel way in FLK North SC. This novelty consists in the massive presence of objects which Leakey (1971) called subspheroids and spheroids. Leakey (1971) suggested the existence of subspheroids even at the beginning of the Olduvai sequence, classifying certain objects from DK as such, which Willoughby (1987) accepted in her re-examination. Nevertheless, here, these objects have only started to appear in FLK North Level 1-2, where we find one of such pieces. Yet, FLK North SC produced an enormous sample of subspheroids and spheroids. In fact, these objects total 19 of the 26 kilograms of quartz taken to the site. This results in a vast population that allows us to determine some of their characteristics.

Leakey proposed a ranking from more angular pieces (subspheroids) to more rounded pieces (spheroids), stating that

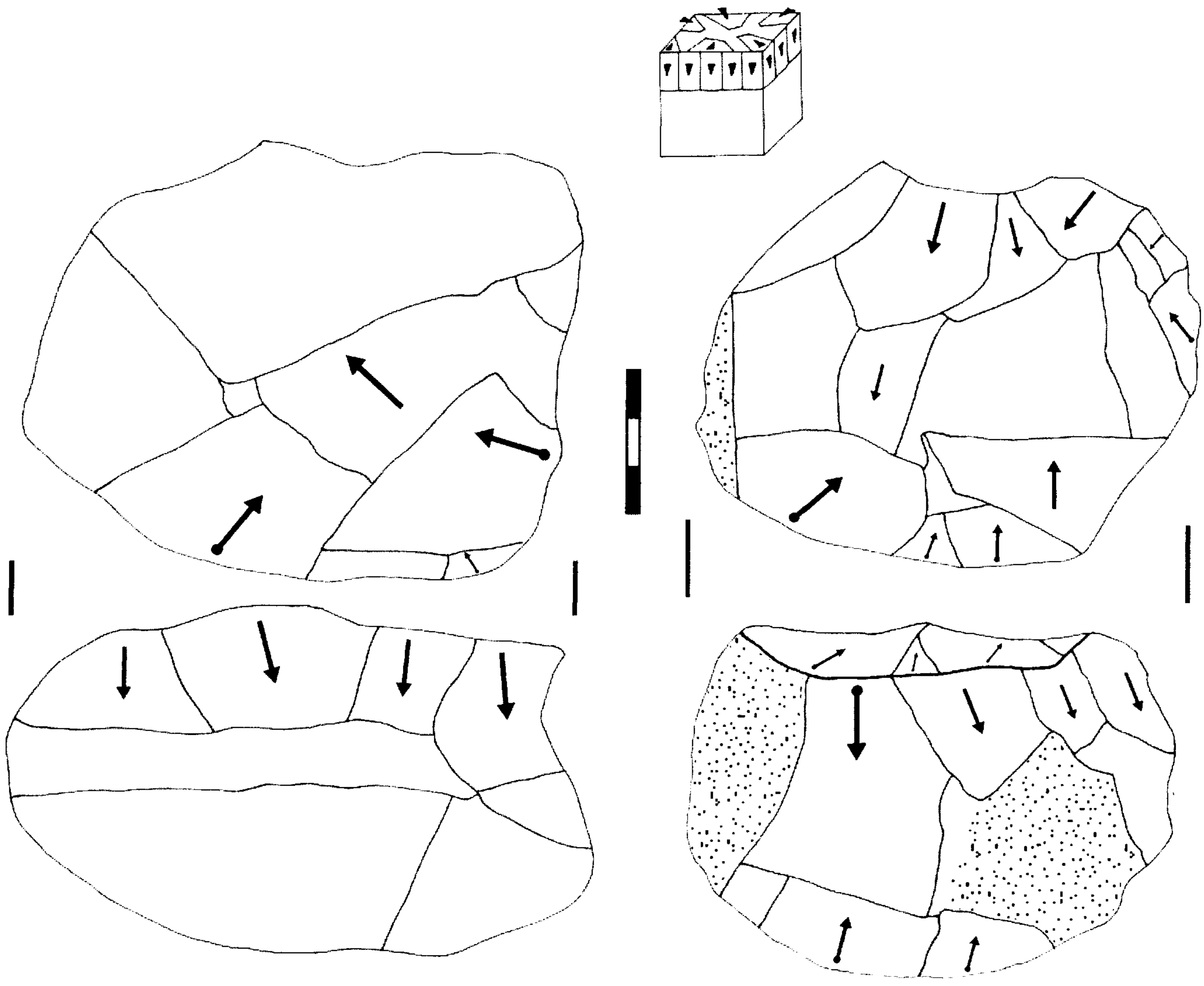


Figure 4.31. Bifacial peripheral partial lava cores from FLK North SC.

"faceted specimens in which the projecting ridges remain or have been only partly removed are more numerous" (1971:6), and consequently distinguished them from the so-called *bolas*, pieces completely rounded by pitting. The procedure consists in subjecting the quartz pieces to an intense percussion process that generates natural facets on the blocks. These facets usually present intense battering on the ridges, quite often with simultaneous extractions on both sides of the edge. These objects represent the first stage (stage 1) of the use of the quartz blocks, that present multiple facets given percussion activities, and include the pieces already described in FLK North 5 referring to the different types of hammerstones with fracture angles. With continuous use, battering spread all over the piece and the ridges collapsed, starting to blur the original shape of the quartz block. In order to integrate the items in discrete categories, this type of pieces has been included in what we have designated stage 2 of the reduction process, although it is actually the same process as that of the previous stage, but entailing a greater level of intensity of the percussion (see fig. 4.32). Finally, quartz pieces totally rounded by battering have been found at Bed II in Olduvai, which could be considered genuine spheroids and compose stage 3 or the final stage of modification once they have lost their original shape completely.

We segmented the types of subspheroids and spheroids by phases so as to offer a more comprehensible explanation of the work processes that generate these morphologies. Nonetheless, we ultimately decided to follow Leakey's (1971) terms, with a view to homogenising the nomenclature. As a result, we will always refer to subspheroids and spheroids when dealing with pieces presenting the characteristics described above, whilst the comments voiced by other authors (for example Willoughby 1987) regarding these objects must be taken with certain reservation and will be debated in chapter 9.

Regardless of these denominations, we are facing a continuum in the alteration of the original morphologies of the quartz blanks, a modification produced by a heavy

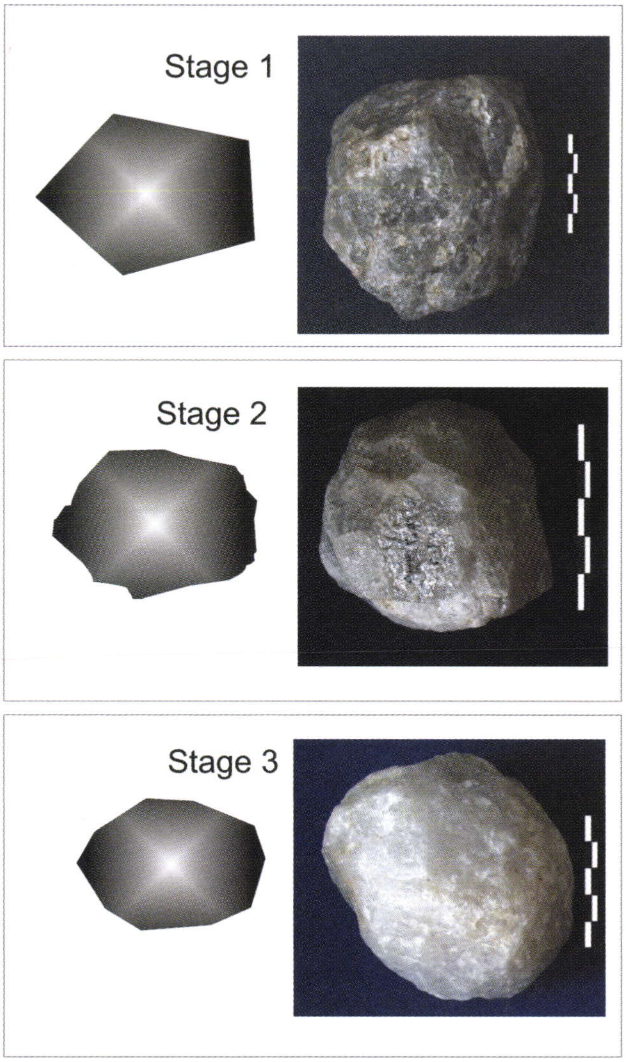


Figure 4.32. Examples of subspheroids and spheroids from FLK North SC, and diagrams representing the ideal stages of the reduction of the quartz blocks.

percussion activity. This prolongation of the life of an artefact (turning an angular block into a totally rounded sphere requires the pieces to be used intensively) is unprecedented in the Olduvai sequence, where pieces were - until now - discarded after a few knapping sequences or after little use. The fact that it only applies to quartzes is also exceptional. Table 4.18 indicates that quartzes in FLK North SC were almost exclusively linked to percussion activities; we only have 3 cores (fig. 4.33) and a few flakes that refer to *débitage* processes (fig. 4.34). Likewise, most of the chunks are probably parts detached from hammerstones and spheroids during percussion processes. If this is considered in combination with the fragments that do present pitting marks, and knapping hammerstones, hammerstones with fracture angles and, obviously, the actual spheroids and subspheroids, it seems clear that the *chaîne opératoire* of quartzes was basically linked to percussion activities.

The chaîne opératoire *of chert*

Alongside HWK East (Leakey 1971) and MNK Chert Factory (Stiles *et al.* 1974), FLK North SC is one of the few examples of chert exploitation in Bed II in Olduvai. The presence of chert allows us to analyse how hominids responded technically to the availability of a novel raw material, which presented knapping capacities that were superior to quartzes and basalts.

The hominids of FLK North SC were unquestionably aware of the mechanical advantages chert entailed. Table 4.18 shows that among the only 1650 grams of chert, there are more cores and flakes than in the total 47 kilograms totalled by lavas and quartzes. Chert was obviously used intensely for *débitage* activities, and it is therefore essential to explain those knapping processes. In this case, it is interesting to start with the cores, not the knapping products. This is due to a simple reason; the flake production and the management of chert cores was completely conditioned by the minuscule size of the available nodules, which measured a maximum of 5-6 centimetres long, with irregular morphologies, covered completely by cortex. These natural forms prevented hominids from obtaining flakes immediately; they had to rough-out the knapping platforms first. Tool-makers understood this fact, since 6 of the 7 chert cores were exploited using a similar bifacial abrupt strategy (fig. 4.35 and 4.36). The knapping platform was prepared removing any irregular cortical surfaces. The roughed-out surface was subsequently used in the horizontal plane as a striking platform to exploit the transversal and sagital planes. In view of these cores, which were very small (tabl. 4.20) and presented sharp edges, craftsmen could only reduce the cores partially, not knapping the whole circumference, leaving a good part of the surface reserved as cortex, most probably to be able to hold the small core during the knapping process. Hence, the flakes were always obtained from the same exploitation plane, without changing the original platform the core.

Among the knapping products, it is surprising to see the high quantity of flakes and flake fragments, on the one hand, and the absolute absence of chips, on the other: Leakey (1971) noted that she did not sift the sediments on this level, therefore no millimetric remains were recovered. Yet, the profusion of flakes does require further investigation; given the number of flakes, we can calculate an average of 6.8 flakes per core, an average that would increase if we considered the relative profusion of flake fragments. Chert cores, for which we calculate a minimum of 4 scars and a maximum of 10, present an average number of 6 scars per core, which coincides with the rate

	Minimum	Maximum	Mean
Length	39	67	51,17
Thickness	29	59	44,83
Width	21	43	29,67

Table 4.20. Dimensions of chert cores at FLK North SC.

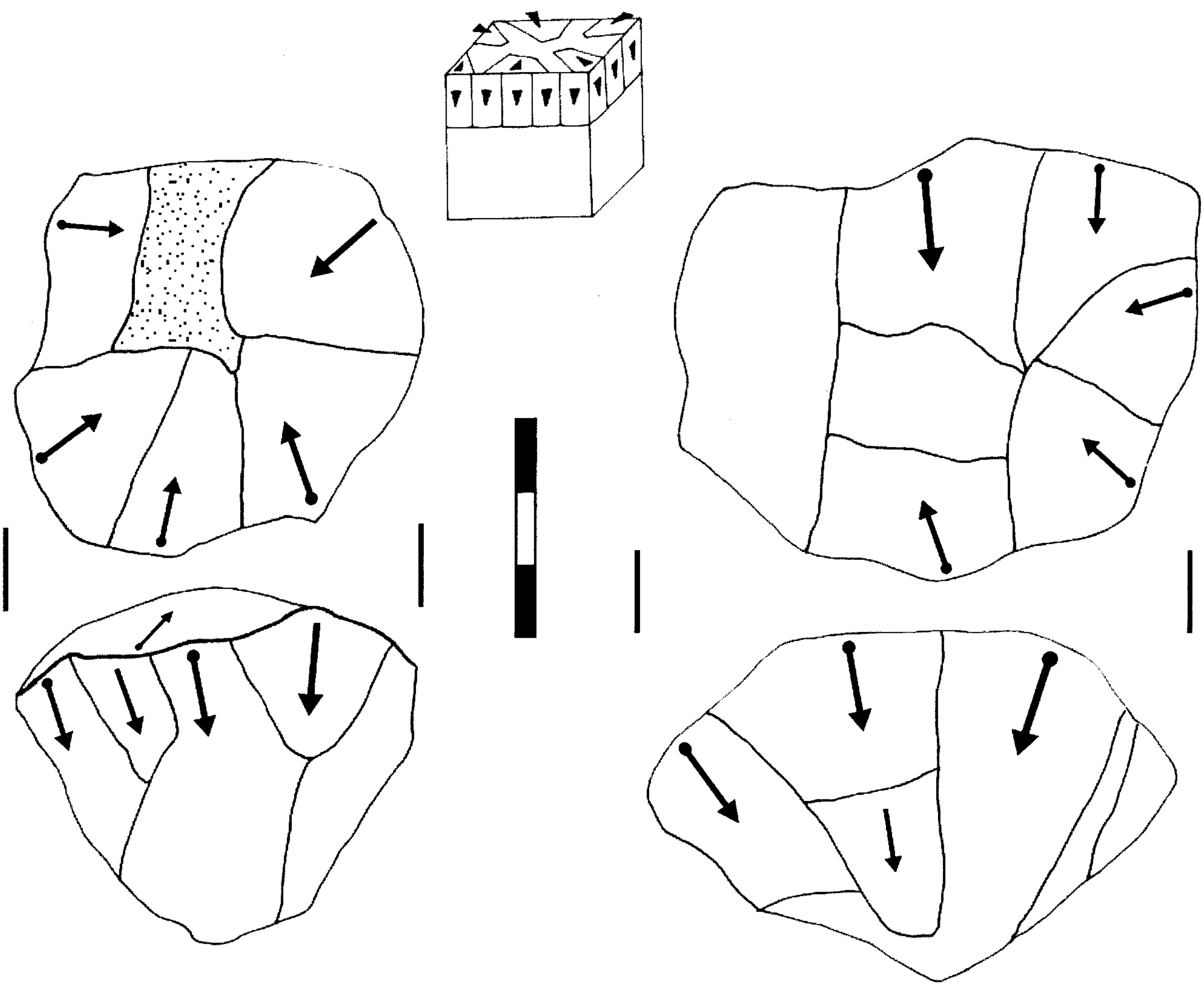


Figure 4.33. Bifacial peripheral quartz cores from FLK North SC.

obtained dividing the number of flakes by the number of cores. An average of 6 scars per core in such small nodules least us to ponder on the intensity of the chert reduction, especially when we consider the fact that in other sites cores presented a lower number of scars, which nonetheless were bigger in size.

The size of the flakes is also interesting. Whole flakes have an average length of 3 cms (tabl. 4.21). At first this seems small. Yet, table 4.20 shows that the cores are merely a few centimetres longer than the flakes, and these cores are in fact considered in the size scatter interval of the actual flakes (fig. 4.37). This indicates that, despite the small chert nodules, tool-makers were able to manage small blanks to obtain the largest possible flakes, many presenting sizes similar to the cores themselves. This supposes a vast technological ability to overcome the constrictions imposed by the dimension of the small available nodules, and maximise the good qualities chert offers as a raw material.

The chert flakes' attributes coincide with the information obtained from the cores. Thus, the high cortex percentage on

	Minimum	Maximum	Mean	Std. deviation
Length	20	81	33.56	10.234
Thickness	20	62	30.28	9.009
Width	4	27	10.79	4.632
Weight	3	113	12.3	16.813

Table 4.21. Dimensions of chert flakes at FLK North SC.

the flakes' butts and dorsal faces (tabl. 4.22 and fig. 4.38) suggest an *in situ* decortication of the nodules. Nonetheless, although roughing out was performed in the site itself (87.1% of the dorsal faces present cortex remains), the cores were worked on knapping platforms without cortex (80.6% of the butts presents no cortex remains). Altogether, the decortication of the knapping platforms (required to obtain flakes on the *débitage* surface) does not imply a preparation of the butts, with most of them being unifaceted (fig. 4.39).

We have some examples of core rejuvenation, which suggests a bifacial interaction between the knapping platform and surface. In any case, the flakes present a longitudinal pattern of

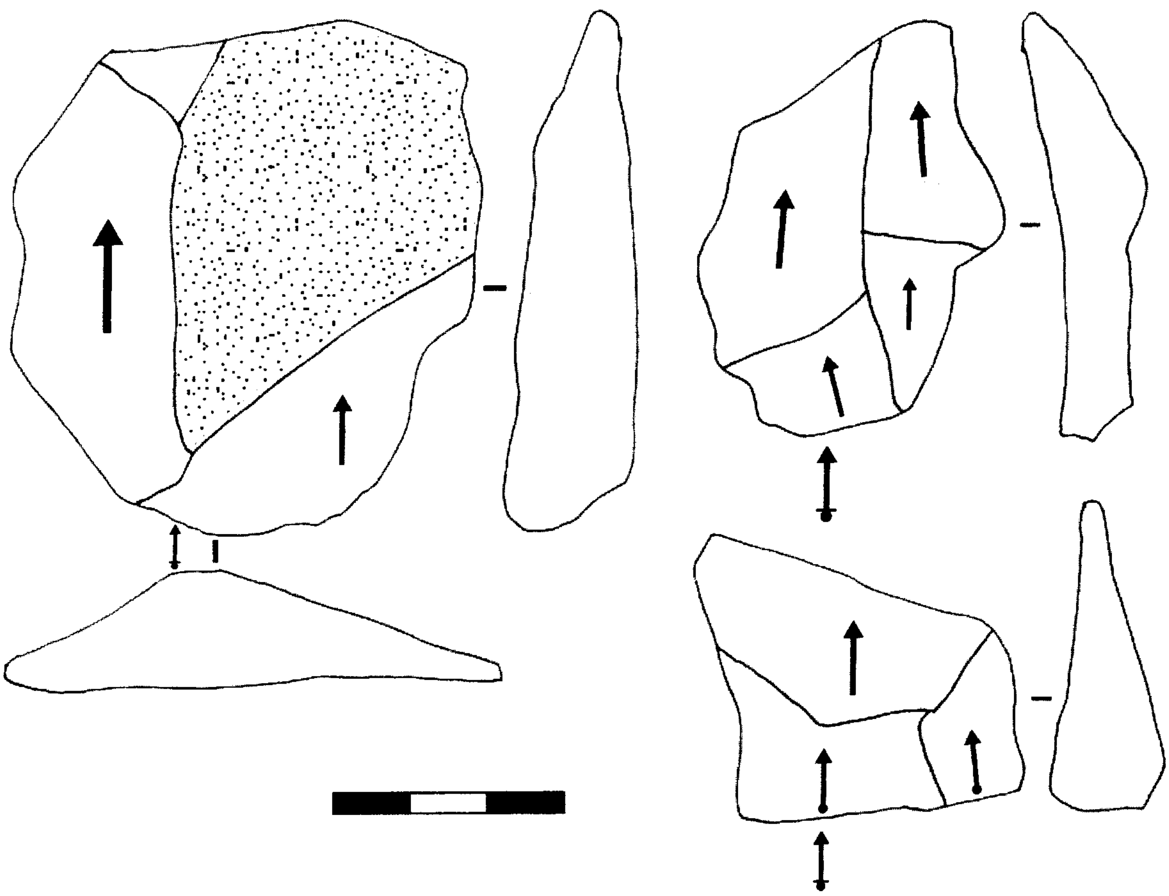


Figure 4.34. Quartz flakes from FLK North SC.

Dorsal face	Striking platform				Total	
	Cortical		Non-cortical			
	N	%	N	%	N	%
Full cortex	3	9.7	2	6.5	5	16.1
Cortex > 50%	2	6.5	4	12.9	6	19.4
Cortex < 50%	1	3.2	15	48.4	16	51.6
Non-cortical	0	0	4	12.9	4	12.9
Total	6	19.4	25	80.6	31	100

Table 4.22. Cortical percentages on a sample (n=31) of the whole flakes at FLK North SC.

parallel detachments, reproducing the unidirectional schema described above for the cores (fig. 4.40). In all, we are dealing with small flakes that present an optimal manufacture, with thin sections and sharp edges that indicate the ability of a craftsman who had to reduce very small and irregular nodules, battling the technical problems involved.

Finally we refer to retouched objects. Leakey (1971) described 23 chert formal tools and 36 flakes and retouched or used fragments. Kimura (1999, 2002) only mentioned percentages, and therefore, turning to her original study (Kimura 1997:207), this author describes up to 18 retouched chert items, probably making her aggregate coincide with the objects represented in fig. 55 by Leakey (1971:113).We have only classified 4 chert artefacts as retouched objects (tabl. 4.18), with the other items proposed by Leakey having been formed by the natural pseudo-retouching of the edges (fig. 4.41). We should not overlook FLK North Sandy Conglomerate's sedimentary context. It is composed by sand interbedded with pebbles, which indicates certain energy in the deposition of the archaeological material (which also supports the absence of knapping debris) or, at least, a probable friction between the sedimentary particles and the artefacts. Indeed, most of the chert pieces from FLK North SC are excellently preserved. Nonetheless, the edges of the chert pieces, sharper than most quartzes and lavas, are also more sensitive to damage (pseudo-retouching in this case) produced by the sediment itself. Most of the so-called retouched pieces Leakey (1971) describes present a very marginal modification on the edges, which is irregular, not systematic. Therefore, and although several are subject to equifinality, we believe the majority are not clear enough to be considered retouched pieces.

Consequently, we doubt that "the production of retouched flakes is simply raw material related, and may not be suggestive of technological development of the toolmaker" (Kimura 2002:302). This author asserted that the assemblage with most retouched pieces she had studied was FLK North SC. It is no coincidence to see that the second site on her list of

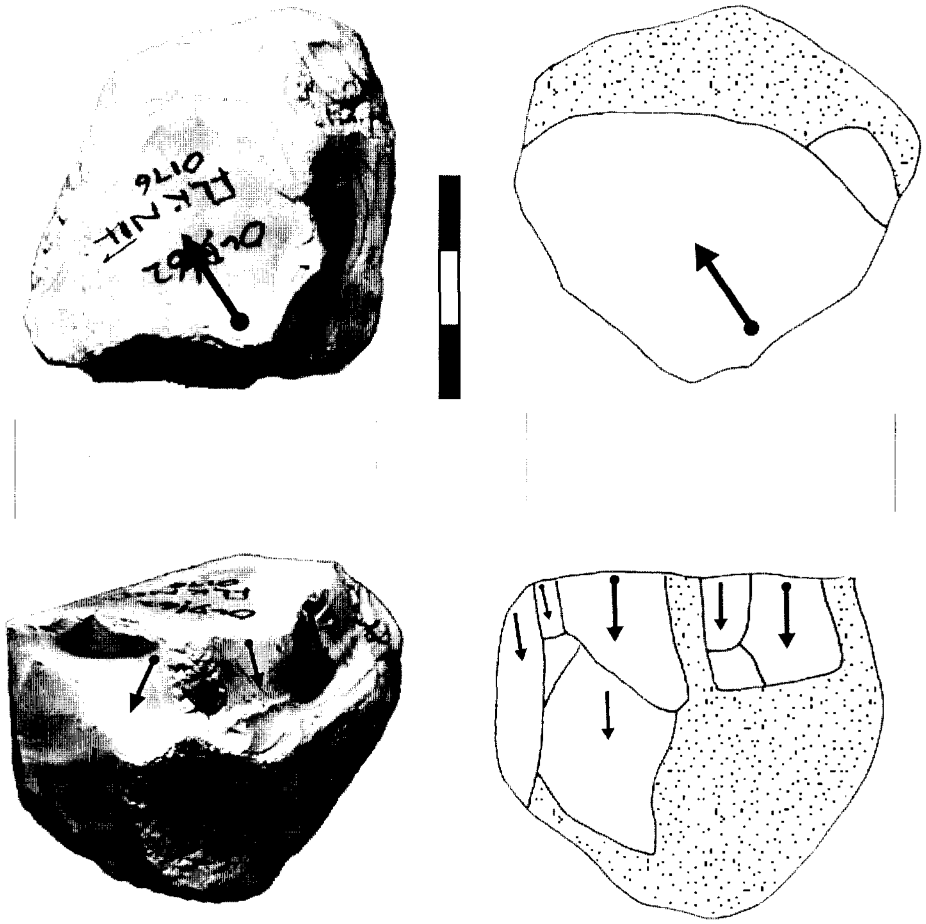


Figure 4.35. Chert nodule reduced using the bifacial abrupt partial system. The nodule is almost complete and preserves most of the cortex; despite the excellent quality of the chert, cores are scarcely exhausted (contradicting Kimura 1997, 1999).

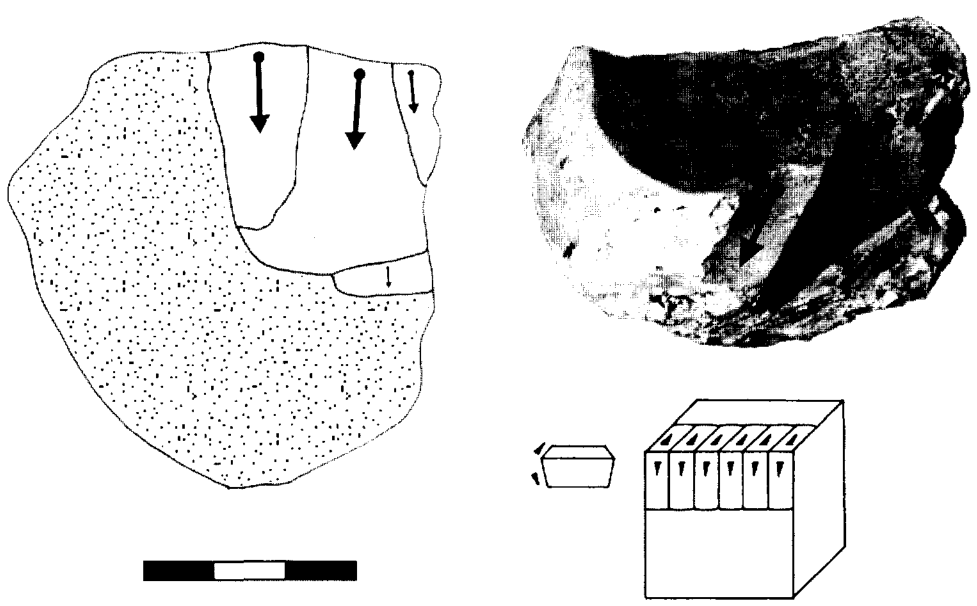


Figure 4.36. Chert core exploited using the bifacial abrupt partial system. As in the previous figure, it is a small chert nodule with a deep cortex layer which makes it difficult to strike knapping platforms. Therefore, the horizontal plane is cleaned with a single detachment, which is subsequently used as a striking platform to obtain flakes in the transversal plane. As occurs with the previous figure, the core is scarcely exhausted, despite the excellent quality of the raw material.

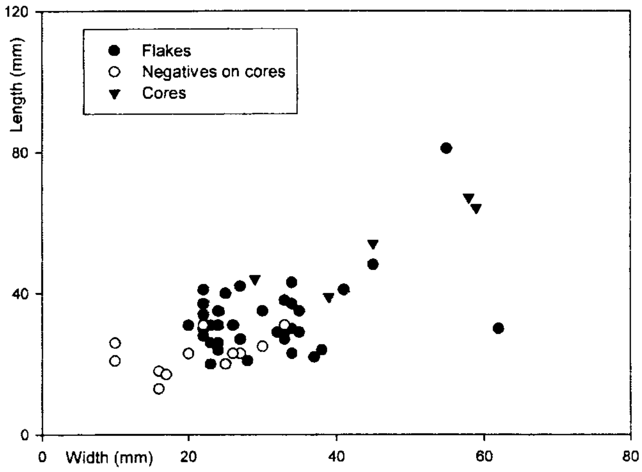


Figure 4.37. Size scatter diagram of the cores, flakes, and scars on cores at FLK North SC.

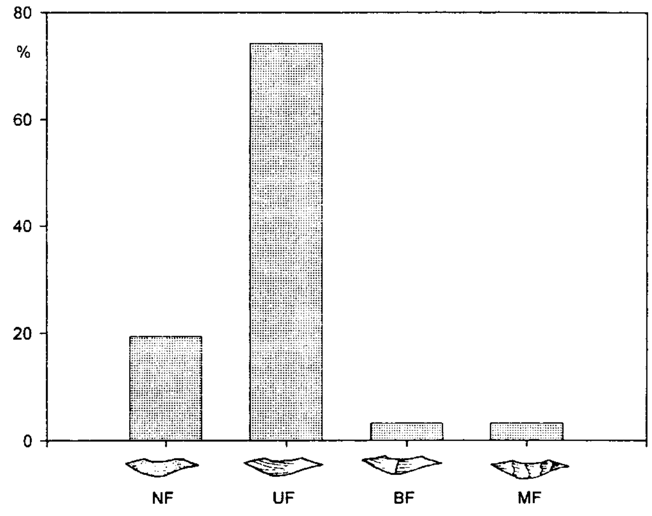


Figure 4.39. Types of striking platforms in the whole flakes from FLK North SC.

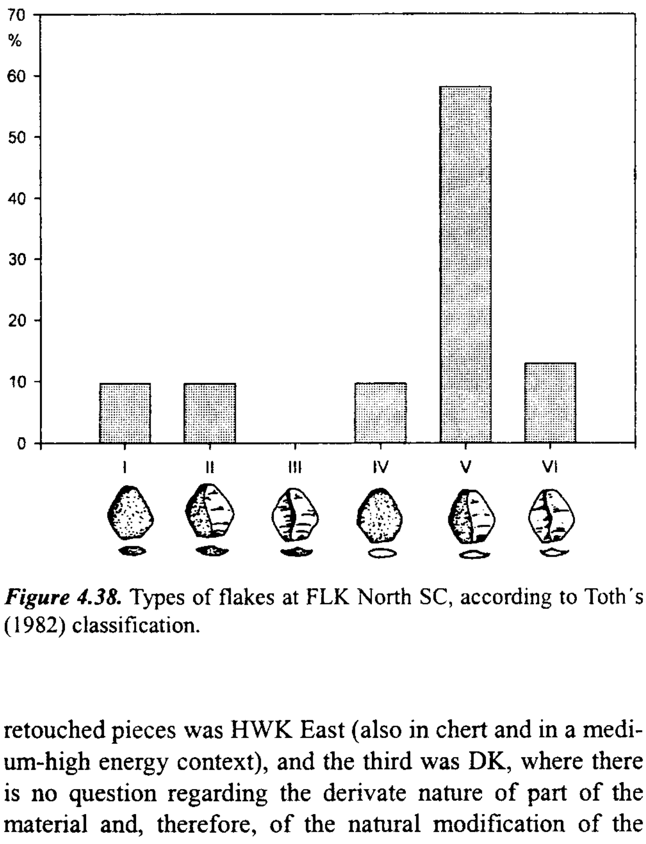


Figure 4.38. Types of flakes at FLK North SC, according to Toth's (1982) classification.

retouched pieces was HWK East (also in chert and in a medium-high energy context), and the third was DK, where there is no question regarding the derivate nature of part of the material and, therefore, of the natural modification of the edges. Thanks to the information gathered in DK and FLK North SC, we believe Kimura has attributed purely mechanical process to human action, reaching mistaken behavioural and evolutionary conclusions based on this confusion.

To conclude this section, we would like to reflect on the global structure of the assemblage. Some authors (Kimura 1999; Ludwig 1999) have granted this assemblage a high level of postdepositional alteration, despite Leakey (1971) never making explicit comments in this respect, and believed that most part of the assemblage presents intact edges. The pseudo-retouching some chert pieces underwent, can be explained in view of the actual sandy context, whilst the absence of debris was caused by the fact that the sediment was not sifted. Consequently, and without excluding a possible postdepositional alteration, the collection does not seem to have suffered severe taphonomic processes. This calls for the construction of a sound interpretation of the behaviour that generated this peculiar concentration, which - for the first time - presents relevant amounts of a new type of artefact, the subspheroid/spheroid, indicating an intense use of the same objects before they were discarded. Moreover, we find a *chaîne opératoire* for lava focused on using cobbles as hammerstones, and cores which, nonetheless, lack their respective knapping products. Alongside all this, we also observe a very focalised use of chert for flake production. Furthermore, this must be considered in line with the almost complete absence of bones. We could be tempted to attribute this final characteristic to the sedimentary context, but it seems fauna appears in relevant quantities in the same stratigraphic level in HWK East (Leakey 1971:254-257). Therefore, the absence of bones in FLK North SC is not necessarily linked to taphonomic causes. In that case, given the fragmentary nature of the *chaîne opératoire* of lavas, the fact quartzes focus on percussion objects and the dearth of fauna, could perhaps be used to suggest a hypothesis considering that the occupation of this FLK North SC level was linked to chert *débitage*. This would appear as a satisfactory explanation and would support the apparent coherence of the *chaîne opératoire* of chert. Nonetheless, the sole problem would be the fact that less than 2 kilograms of raw material were invested in chert processing, whilst the site presents over 48 kilograms of lithic material. Considering this fact, the hypothesis loses all grounds and requires we pursue alternative interpretations.

Conclusions

FLK North is the most interesting assemblage in Olduvai for a diachronic study, since it presents up to 8 levels bearing

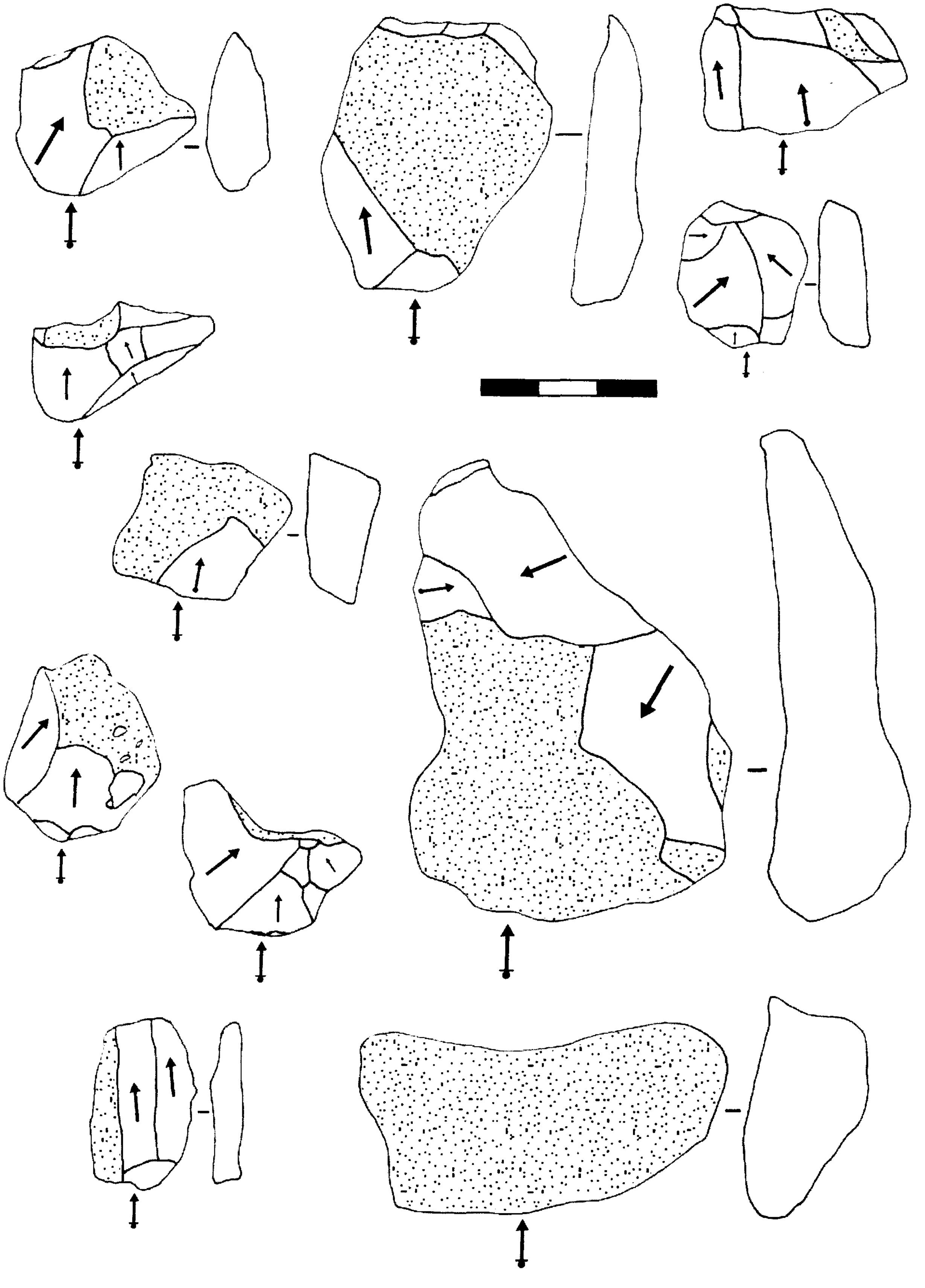


Figure 4.40. Chert flakes from FLK North SC. All of them show important amounts of cortex.

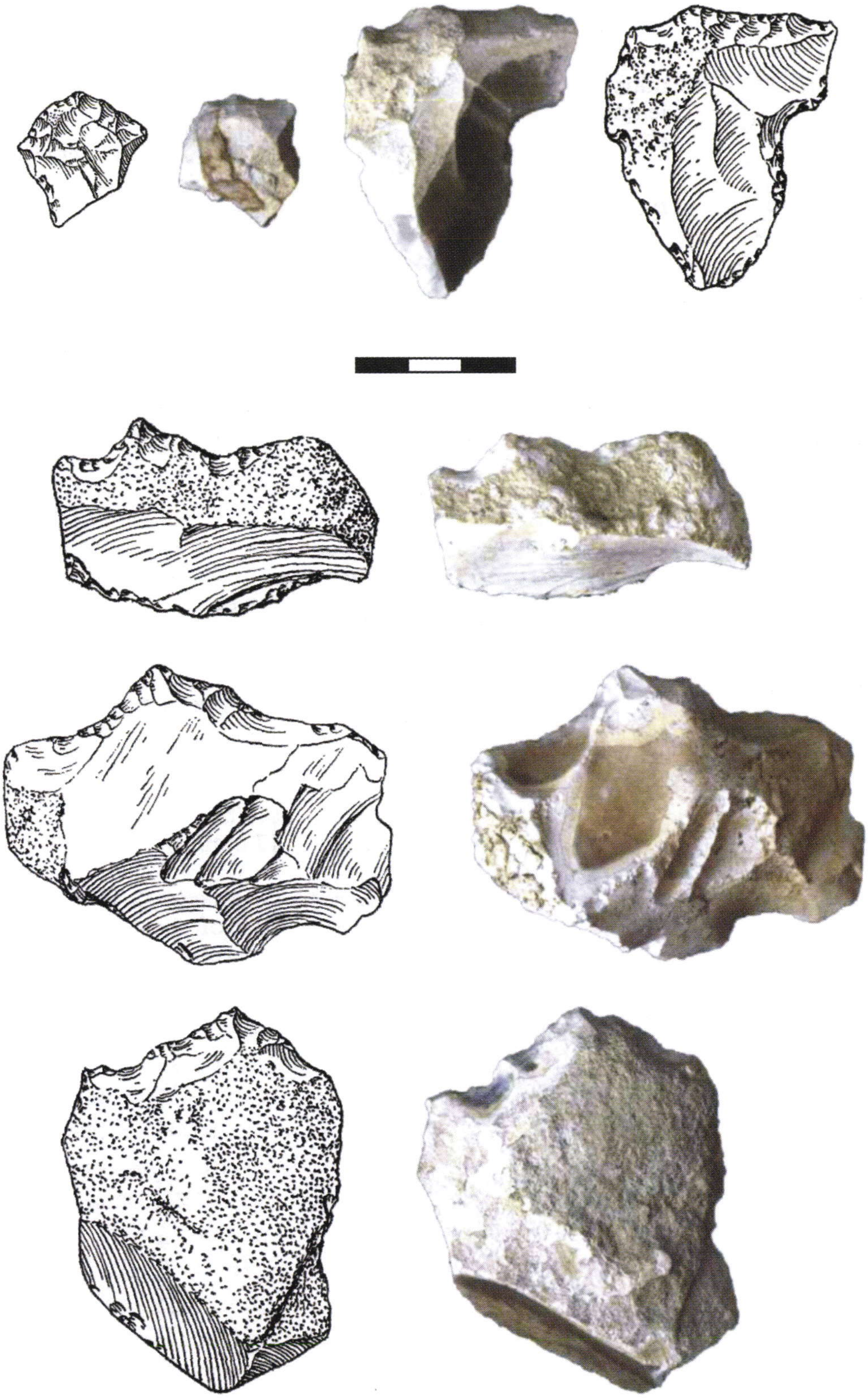


Figure 4.41. According to Leakey these are so-called chert retouched pieces. Although several present modified edges, this cannot be assigned with reliability to intentional retouching. Layout composed based on photographs and pieces from fig. 55 of the Olduvai monograph (Leakey 1971:113).

archaeological material, which allow us to analyse how the strategies the hominids developed in one same point of the territory changed over time. Although this is not strictly true from a palaeo-environmental perspective (since the landscape surrounding FLK North varied over time), it is relevant in terms of the provisioning of raw materials, the availability of which (although it endured diachronic alterations) was more predictable than the biotic resources.

We must recall the time scale we have employed. Levels 6-1, located under Tuff IF, are slightly older than 1.75 my (Walter *et al.* 1991, 1992). *Deinotherium* Level, on the Lower Member of Bed II, must be slightly more recent than 1.75 my, and older than the 1.66 my estimated for Tuff IIA (Manega 1993). Finally, the FLK North Sandy Conglomerate, in the Middle Member of Bed II, located above Tuff IIA and below Tuff IIB, must be older than 1.6 my. In all, we are dealing with approximately 150,000 years from the top of the FLK North sequence to the lower levels, which, *in principle*, supposes an exceptional example to study the diachronic variability of technologic strategies. This goal has not been achieved entirely, mainly due to contextual problems, since several levels do not present a coherent internal organisation.

A first approximation to contextual issues is performed comparing the densities of the remains found in each level, in order to assess the contribution of each one to the FLK North assemblage. This presents an initial problem, whether or not to include unmodified lithic material. This is no banal issue. Firstly, since if we add all the levels in FLK North (except the Sandy Conglomerate, where Leakey herself rejected the presence of manuports), we have 101 kilograms of unmodified lavas (excluding quartzes, in principle transported anthropically) from the total amount of 311 kilograms of raw material analysed on this site. That is to say, a third part of the lithic material in FLK North did not undergo human modification, yet Leakey (1971) states it was transported by the hominids. Throughout this chapter we have demonstrated that this hypothesis is not sound, primarily through specific comparisons on each level between the unmodified and the modified material. Nonetheless, we also find more general contextual arguments that reinforce the natural provenance hypothesis.

Although Leakey (1971:61) considered that functionally four of the levels (Levels 5-1) of FLK North Bed I were living floors and the other was a butchering site (Level 6), in the same work she specified that Levels 5-1 were sites with diffused materials, in which the archaeological remains were scattered along a thick stratigraphical sequence (Leakey 1971:258). Potts (1994:20) is also ambiguous when assessing the contextual integrity of FLK North, initially stating that the densities in Levels 5- 1 are very similar to non-human backgrounds, to immediately move on to state that the systematic superimposition of archaeological levels in FLK North is due to an anomaly in the landscape unrelated to natural causes.

FLK North Level 6 and *Deinotherium* Level, which Leakey (1971) considered as belonging to single archaeological events but fortuitously linked to a natural background of bones (also Bunn 1986), also seem to correspond to long formation periods with different *tempos* in the deposition of the carcasses (Leakey 1971; Bunn 1986; Potts 1988, 1994). Therefore, despite once again encountering - as occurred in FLK Zinj - clay contexts linked to low energy sedimentation, it is easy to propose processes such as the ones stated by Ashley and Driese (2000), Mack *et al.* (2002), etc, regarding the complexity of the formation of the strata associated with a lake-margin. It would be perfectly plausible to consider a natural explanation for a large part of the unmodified clasts which could have their origin in, for example, small hydraulic events like sheet flows.

Another possibility to consider is the vertical migration of lithic objects. FLK North is around 7.2 m in depth (Leakey 1971:61). Therefore, speaking of generally very fine sediments such as clays, there could have been vertical movements of large elements, a fact that is very common in archaeological sites (i.e. Cahen & Moeyersons 1977; Villa 1982; Villa & Courtin 1983; Hofman 1986; Gifford-González *et al.* 1985; etc). Leakey herself (1967) observed that part of the archaeological remains of FLK North Level 1-2 "*appear to have sunk down from the higher level, either when the clay was wet, or else down cracks which form when it becomes dry*" (Leakey 1967:428). Likewise, vertical migration was one of the possibilities Hay (1976) considered to explain the presence of pebbles in clay deposits in many of the Olduvai contexts. According to this author, in Olduvai we must contemplate the possibility whereby pebbles originally deposited in a level above the unconsolidated sediments could subsequently be scattered vertically via trampling or burrowing by animals, or by the effect of the roots themselves (Hay 1976:85).

We could consider this in combination with the earth movements which according to Leakey (1971:67) affected Level 5 in FLK North, for example. Hay (1996:228) also described an erosive channel, full of gravel in the basal deposits in Bed II precisely here in FLK North. Therefore, it would be easy to imagine some of these cobbles, given the permeability of the sediment, migrating to the archaeological deposits. Therefore, it seems justified to assert that these vertical migration processes could have occurred systematically in FLK North, mixing elements from different depositional stages and, among them, natural cobbles which were fortuitously associated with archaeological remains.

As a whole, it is viable to assume the possible existence of small hydraulic events, slow sedimentation processes, vertical migrations, and a variety of events that mixed a natural background deposit of bones with genuine archaeological remains (i.e. Leakey 1971; Isaac & Crader 1981; Bunn 1986), or at least archaeological pieces from different occupations of the site (Potts 1988). Considering all the above processes, it would seem appropriate to justify the non-anthropic presence of unmodified stones in FLK North which we now know were also scattered naturally around the landscape of the Olduvai lake-margin.

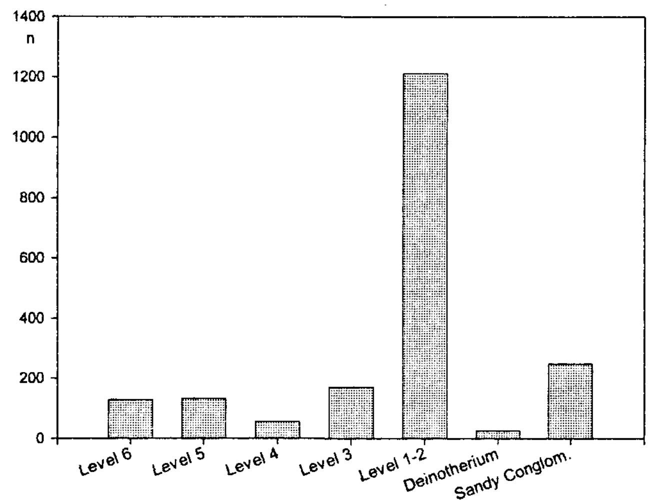


Figure 4.42. Number of pieces in each level of FLK North. Lava unmodified material is excluded.

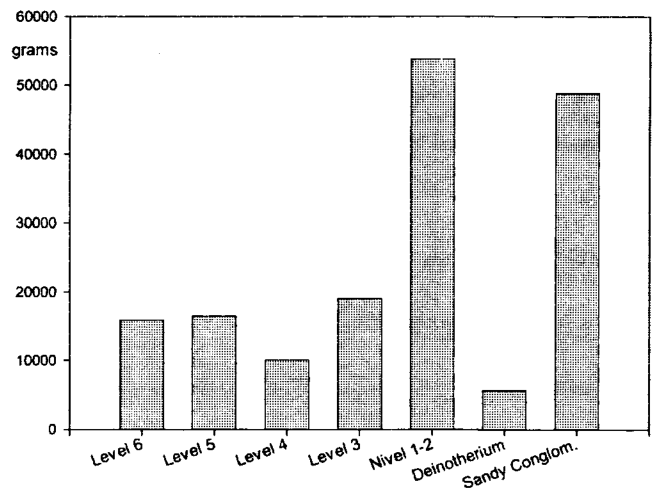


Figure 4.43. Total amount of raw material (in grams) transported to each level of FLK North. Again, lava unmodified material is excluded.

The debate on manuports must lead us to consider the integrity of the rest of the collections obtained from each level. Leakey (1971:259) considered Levels 5-1 of FLK North as low-energy clay deposits, in which bone remains and lithic remains were scattered and did not form genuine living floors. This author said nothing about the Sandy Conglomerate Level, and included Levels 6 and *Deinotherium* among the examples of butchering sites. Nonetheless, upon comparing the number of pieces (fig. 4.42) or the total weight of shaped raw materials (fig. 4.43), we see that Levels 1-2 and the Sandy Conglomerate Level are the most important. This issue is not limited to comparing absolute frequencies or global weights, it is also linked to the internal coherence of each assemblage. Hence, it is no coincidence that Levels 1-2 and the Sandy Conglomerate Level are precisely the two levels that seem to present the most coherent structure in terms of the different lithic categories and also the two that have the highest remain densities.

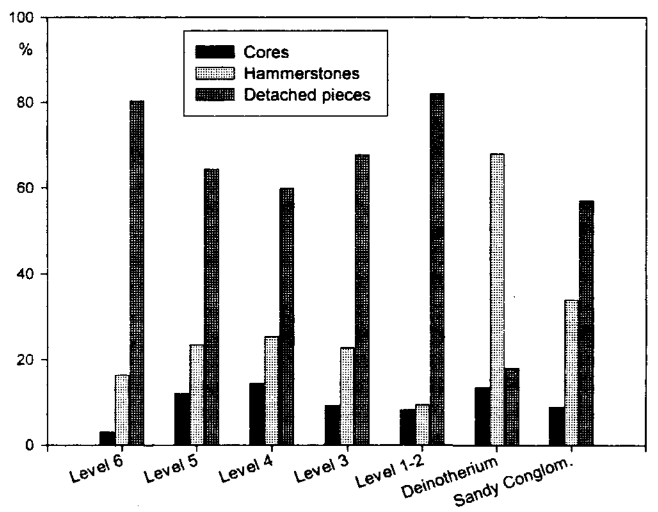


Figure 4.44. General lithic categories in each level. Cores include test cores, hammerstones contain all objects related to such activity (knapping hammerstones, hammerstones with fracture angles, anvils), and products include flakes and derived products.

We must bear in mind that knapping products were almost nonexistent in Levels 6, 5, 4, 3 and *Deinotherium*. In FLK Zinj *débitage* exceeds 90% of the total amount of items, which also occurs in DK, despite the fact that we do not discard certain hydraulic biases in the latter. Figure 4.44 shows that only Level 1-2 and perhaps Level 6 present a sufficiently high rate of knapping products (or percussion fragments) to have a coherent proportion in terms of the large objects (cores and hammerstones). With the exception of the Sandy Conglomerate Level (where we know not all small fragments were collected), it seems obvious that the rest of the levels present a severe taphonomic bias. Leakey (1971) had already mentioned it for Levels 5, 4 and 3, and therefore, we see no need to insist on these assemblages. It is more relevant to turn to Levels 6, 1-2, *Deinotherium* and Sandy Conglomerate, where our interpretation appears as an alterative to the existing hypothesis.

FLK North 6 has been a reference point in the literature, appearing as the paradigm of butchering sites in Africa (Isaac 1982, 1984; Isaac & Crader 1981; Clark 1972; Clark & Haynes 1970; Leakey 1971, 1975; etc). Nevertheless, in this description, we have stressed the problems referred to zooarchaeological interpretation, which have led to contradicting conclusions regarding a natural (Binford 1981; Domínguez-Rodrigo *et al.* in press) or human (Potts 1988) origin of the fauna linked to the elephant, even in the works of one same author (Bunn 1982; *contra* Bunn 1986). Furthermore, it is not clear that the elephant remains were modified anthropically, since whilst some researchers note the presence of cut marks on this *Elephas recki* (Shipman 1986; Potts 1988; Bunn 1982, 1986), others consider the elephant presents no human traces (Domínguez-Rodrigo *et al.* in press). The scarce lithic industry in this level seems to be related to battering activities. Anvils and hammerstones are predominant over flakes, which are basically absent from the assemblage (see tabl. 4.1). Leakey (1979:92) had thought that the high number of anvils at the site could be related to the breakage of bones to obtain marrow. However, Leakey herself discarded the idea given that most elements are fairly complete. On the other hand, Crader (1983) stresses the elephant's fragmented nature, which would lead us back to the idea that anvils were used to process the carcass, as occurs with the few flakes and fragments that could have been produced by the documented cut marks. This alternative is not entirely plausible, since the small size of the documented anvils makes it hard to conceive them being employed as blanks to fracture large elephant bones.

Some years ago, it was stressed that "*the position and condition of the FLKN6 carcass also suggests minimal hominid or carnivore disturbance*" (Crader 1983:130), a statement that has been supported by the most recent zoo-archaeological studies (Domínguez-Rodrigo *et al.* in press). This statement can also be supported on the basis of the analysis of the lithic industry: As we have seen in figure 4.42 and 4.43, Level 6 has an artefact density similar to Levels 5, 4 and 3, classified by Leakey (1971) as levels with diffused materials. The distribution of lithic types at the FLK North 6 does not show qualitative or quantitative differences with respect to those levels either. We could argue that the presence of another 35 macromammals in Level 6 (Bunn 1982) is a clear indication of their human transportation. Yet this is not strictly true, since Bunn (1986) himself does not reject the fact that they could have been deposited naturally (Domínguez-Rodrigo *et al.* in press). No authors question the scarce archaeological integrity of some examples like Levels 5, 4 and 3, despite the number of represented macromammals being very similar to FLK North 6 (Shipman 1986). The distribution of artefacts cannot be distinguished from the distribution in other levels either. Therefore, we suggest an in-depth re-examination of the interpretation of the so-called butchering site in Level 6, and grant it the same level of archaeological integrity as more eroded assemblages like Levels 5, 4 and 3.

Continuing the butchering site issue, we should also re-examine the interpretation of the *Deinotherium* Level. Although they decided to include it among the type B sites or butchering sites, Isaac and Crader (1981:63) did not rule out the fact that the association between the elephant and the scarce amount of lithic pieces were coincidental. Furthermore, although tooth marks had been documented, there were no traces of human modification, which led them to conclude that "*it is not possible to determine whether the site really served as the butchery place for a large animal or not*" (Crader 1983:129). Our description of the lithic collection indicates it comes from a completely fragmented *chaîne opératoire* and presents an unconnected structure. Furthermore, the densities of both the industry and the bone remains are practically identical to those of assemblages with diffuse material like Levels 6, 5, 4, 3. Therefore, and with even more arguments than in Level 6, we believe the proposal suggesting the *Deinotherium* level as a butchering site should be ruled out.

As regards Level 1-2, we have already stated Leakey's contradictions, since she initially considered this assemblage as a living floor (1971:61), most probably referring only to its functional connotation, and subsequently insisting on linking its contextual integrity to sites with diffused artefacts and not genuine living floors (Leakey 1971:258). Potts stated that "*even FLK North 1/2 had artefact-bone densities similar to those in the background scatter across the paleolandscape of Member 1 Olorgesailie*" (1994:20). Isaac and Crader (1981), however, included Level 1-2 in type C sites, i.e. those presenting conspicuous concentrations of artefacts and bones from different species. Bunn (1986) agreed with this diagnosis, whilst Shipman (1986) found several bone remains with cut marks that also proved the relationship between fauna and industry.

The internal structure of the lithic collection is coherent and allows for a reliable assessment of the technical guidelines. *Débitage* activities were very relevant in FLK North 1-2, as occurred in other analysed sites like DK and FLK Zinj. However, Level 1-2 presents a greater importance of percussion processes, not always linked to flake production activities. This suggests a novelty in the time sequence under analysis, and has evident behavioural connotations.

Perhaps given the absence of bone material in the deposit, the Sandy Conglomerate level in FLK North has not been given much attention. Leakey (1971:258) herself ignored this level in her conclusions on the contextual and functional character of the sites included in her monograph. Nonetheless, and although we cannot exclude certain taphonomic biases given the sandy sediments in which the industry was recovered, we believe the collection from the SC Level presents a good archaeological resolution, at least better than the resolution of Levels 6, 5, 4, 3 and *Deinotherium*. Its relevance does not only lie in its contextual integrity, since this level presents an unprecedented processing of the raw materials, with a clear division between the categories of artefacts in terms of each raw material. Alongside the novel documentation of the chert industry. This calls for an in-depth re-examination of the assemblage, with a view to understanding the function of a site in which the absence of fauna could not be linked to taphonomic causes (see above) and in which one of the main goals was obtaining of chert products.

Bearing this in mind, it is fundamental to contextualise the SC Level in the general framework of chert exploitation in Olduvai. Hay (1976) noted that chert was formed inside the lake during the deposition of Bed I. Subsequently, when the lake declined, the chert was episodically exposed during the deposition period of the basal part of the Middle member of Bed II. HWK East Sandy Conglomerate, FLK North SC and MNK Chert Factory were formed at that time, all in a 1 kilometre radius. Stiles (1991, 1998; Stiles *et al.* 1974) has studied MNK Chert Factory, and proposed this site would have acted as an atelier from which artefacts were transported to other points of the basin. The density of lithic remains in MNK Chert Factory (henceforth MNK CF) is spectacular, with a 5 x 2 m pit only 20 cms deep unearthing over 30,000 chert pieces, all despite the fact that Stiles *et al.* (1974) state that the exploited chert nodules do not come from an area near the site (contradicting Kimura 1997, 1999). Stiles (1991, 1998) compared a sample from MNK CF to a contemporary level in HWK East, and concluded that the flakes in HWK East could have been transported knapped from MNK CF, which for this author *"suggests that early hominids could plan ahead, and the bias in the selection and transport of whole flakes to another place over time demonstrate 'logistically organized' behaviour"* (Stiles 1991:13).

His assertions are debatable, since Stiles bases his conclusions on the size difference between the flakes in both sites: with 20-40 mm flakes prevailing in HWK East and flakes under 10 mm prevailing in MNK CF (see Stiles *et al.* 1974:301). This, according to Stiles, supposes a clear evidence of the transportation of certain blanks from one site to another. Nonetheless, this could be linked exclusively to a greater profusion of knapping waste (i.e., pieces under 10 mm) in MNK CF, and not to the fact that hominids selected pieces in view of their size and then transported them to HWK East, despite Stiles *et al.* (1974) insisting on the absence of taphonomic biases in the latter site. In fact, in FLK North SC the size range is also around 20-40 mm, but we cannot consider the flakes were already knapped when transported to the site. The core study - which Stiles (1991,1998; Stiles *et al.* 1994) never performed in MNK - suggests nodules were introduced intact in FLK North, and that the cores were roughed-out, exploited and subsequently discarded in the site. Altogether, it does not seem appropriate to elaborate general conclusions, as Stiles aims to, based merely on the study of a flake sample, without even considering the rest of the categories represented in the site.

Since we do not have a technological study of the MNK CF by Stiles (1991, 1998; Stiles *et al.* 1974), it is hard to perform reliable comparison with FLK North SC based on his analysis, and therefore we have to rely on Kimura's (1997, 1999). According to this author, the natural chert nodules in MNK CF are even smaller than the recovered cores, which suggests that the hominids selected the largest nodules as blanks for flake production. Furthermore, Kimura (1999) observes that cores are less worked in MNK CF than in FLK North SC, estimating an average of only 2.9 scars per core in the former, in comparison to the 6.8 scars estimated for Level SC. Kimura's (1999) analysis provides an interesting conclusion, underscoring the scarce amount of chert cores in MNK CF compared to the number of flakes. This author considers this evidence of the fact that cores were transported to other sites once flaked. This would not be the case though for FLK North SC, since we consider the small chert nodules were decorticated in the site although, nevertheless, we cannot rule out the raw material being transported from MNK CF.

The petrological analyses performed on the chert from MNK CF (Stiles *et al.* 1974) have demonstrated the variability of the provenance of the nodules found in the site, thus indicating different source areas for different types of chert. Kimura (1997, 1999) considers this changeability could have a local explanation, proposing an autochthonous origin for all recovered nodules. In any case, and despite these interpretative differences, the MNK CF example appears as a compulsory reference point to interpret the function of FLK North SC; in MNK CF, as in FLK North SC, bone remains are practically nonexistent (Stiles 1998). Therefore, the stratigraphic concurrence, close topography and technical similarity between both assemblages underscore the relevance that the exploitation of an exceptional and prized resource, chert, had in the occupation of the Sandy Conglomerate Level, the last level in FLK North and also the last Oldowan assemblage we have studied in the Olduvai sequence.

Chapter 5

EF-HR

Introduction

EF-HR is the oldest of the sites Leakey (1971) excavated above Tuff IIB. Although for several decades its chronology has been established around 1.4 my, the most recent dates (Manega 1993) establish its age must range between the 1.6 my and 1.5 my established for Tuffs IIB and IIC, below and above EF-HR respectively.

In 1963, Leakey (1971) uncovered a 5.7 x 6.6 metre surface which she subsequently expanded through several pits. The archaeological level appeared directly above a limestone stratum, linked to a clay deposit which in some locations had been eroded by a gravel channel. According to Leakey (1971:124), most of the artefacts were concentrated in the area where gravel and clay came into contact, proposing the hypothesis that the lithic pieces had originally been included in the clays and that some of them had subsequently been transported by the flowing water. The pieces appeared in a level merely 9 cms thick, which led Leakey (1971:260) to estimate an average of approximately 13 artefacts per m^2. Leakey notes that most pieces appeared in two concentrations in the highest area of the clay surface, separated by the depression formed by the stream, about 60-75 cm deep. Thus, this author interpreted the assemblage as a small temporal camp located on both sides of a shallow stream.

The lithic industry has an exceptionally preservation, since pieces present intact edges. Nonetheless, Leakey (1971) documented some rounded pieces linked to the stream, which probably have a postdepositional history different to that of the rest of the assemblage. Bone remains are very scarce and poorly preserved, except for a complete giraffe skull found in the stream, which Leakey (1971:126) attributes to human accumulation.

General characteristics

Despite its importance as one of the first Acheulean sites ever discovered, EF-HR has not been given the same attention as Bed I assemblages. However, as well as Leakey (1971), several other researchers have re-examined the collection partially or totally, for example Stiles (1977), Bower (1977), Kimura (2002), Ludwig (1999) and Kyara (1999). As occurred previously, the number of items varies for each researcher; therefore, whilst the original work only contemplated 522 pieces (Leakey 1971:136), Kimura (2002:296) totals 553 items. Ludwig (1999:31) counted 481 pieces, and in this study we have only found 429. Since Leakey's frequencies for knapping products coincide *grosso modo* with our estimations (tabl. 5.1), it would seem that the sample that disappeared when we performed our analysis could correspond to large objects like cores and hammerstones.

Although table 5.1 could prove that the scant number of items indicates the marginality of human activities, that impression disappears when bearing in mind the total volume of raw material transported to EF-HR (tabl. 5.2), since hominids worked over 46 kilograms of quartzes and lavas. The total weight for the transported raw material was probably much greater, but the authors that have had access to the whole collection (for example Kimura 2002) have not included data that could allow this estimation. In any case, suffice it to say that FLK Zinj, one of the sites for which we assume a systematic and repetitive occupation of the same area over a long period of time, presented no more than 44 kilograms of worked lithic material.

	Quartz		Lava		Total	
	n	%	n	%	n	%
Cores	2	1.3	4	1.4	6	1.4
Core fragments	-	-	3	1.1	3	0.7
Large Cutting Tools	9	6	20	7.2	29	6.8
Small retouched pieces	1	0.7	4	1.4	5	1.2
Hammerstones	3	2	1	0.4	4	0.9
Blanks for L.C.T.*	1	0.7	1	0.4	2	0.5
Whole flakes	10	6.7	68	24.4	78	18.1
Flake fragments	79	52.7	142	50.6	221	51.5
Frag. < 20 mm	4	2.7	19	6.8	23	5.4
Angular fragments	38	25.3	16	5.7	54	12.6
Hammerstone fragments	3	2	1	0.4	4	0.9
Total	150	100	279	100	429	100

Table 5.1. Lithic categories according to raw materials from EF-HR.

	Quartz (g)	Lava (g)	Total (g)
Cores	676	1628	2304
Large Cutting Tools	4238	13215	17453
Small retouched pieces	132	1203	1335
Hammerstones	221	298	519
Blanks for L.C.T.	-	1473	1473
Whole flakes	1318	4612	5930
Flake fragments	1674	11003	12677
Frag. < 20 mm	8	51	59
Angular fragments	2891	1341	4232
Hammerstone fragments	350	56	406
Total	11508	34880	46388

Table 5.2. Total weight of general lithic categories.

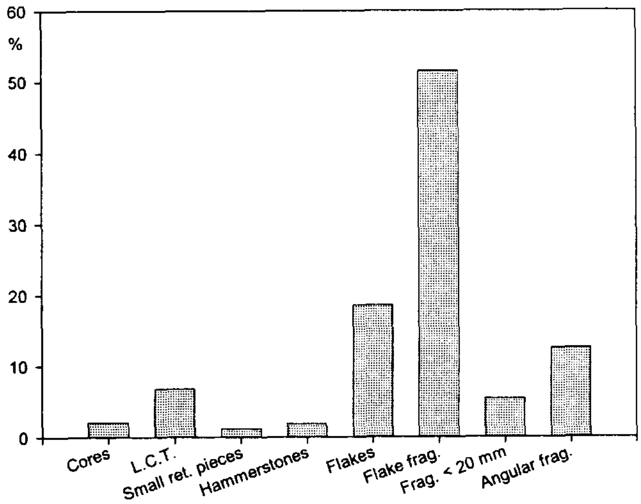


Figure. 5.1. Lithic categories at EF-HR. L.C.T.: large cutting tools.

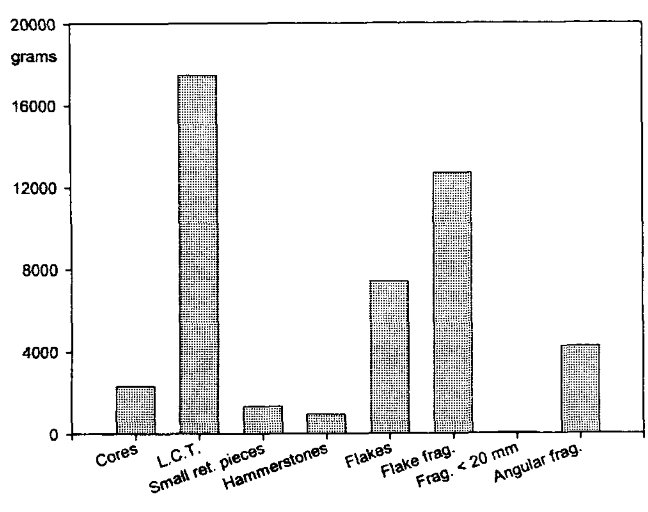


Figure. 5.2. Weight (in grams) of each general category at EF-HR.

With under 500 analysed pieces, EF-HR already exceeds the total volume of modified raw material in FLK Zinj. Thus, EF-HR is not relevant in view of the absolute frequencies of the objects but given the volume of raw material; therefore, we should continuously consider the genuine contribution of each of these categories. This is noticeable in figure 5.1; flake fragments, flakes and chunks are the most numerous pieces. Nonetheless, when considering the weight of the objects, we note that the large cutting tools were the most important items in terms of the investment of raw material (fig. 5.2). Therefore, and despite the meagre amount of items (n=29), the large cutting tools category should be considered the site's most relevant category.

As regards raw material, three fourths of the slightly over 46 kilograms worked in EF-HR correspond to lava knapping, whilst only 11 kilograms of quartzes were modified anthropically (tabl. 5.2). This pattern is not new, since we saw in DK, FLK Zinj or FLK North that, even when quartzes could exceed lavas in number, the latter is always more important in terms of the volume of raw material. Moreover, in EF-HR quartzes were generally used the same way as lavas (fig. 5.3).

The Lien test (fig. 5.4) shows there are only two categories presenting a vast difference between quartzes and lavas; one corresponds to chunks and the other to flakes. Both can be explained taking into consideration the constrictions inherent to the raw material and not an intentional technical dichotomy. Given the low coherence of quartz crystals, when this material fractures it smashes more easily than other raw materials and generates many amorphous fragments (for example Amick & Mauldin 1997). This could be one reason to explain the greater abundance of quartz chunks compared to lavas, without ruling out the fact that a good part of these fragments would have fortuitously detached from quartz hammerstones, the sole category that shows a prevalence of this raw material. Likewise, the greater relative profusion of whole lava flakes could be explained in view of the lower fragmentation of such raw material, which produces *débitage* products more easily, without them breaking during the knapping processes.

Quartz and lavas do not seem to have been used differently to manufacture specific categories, since, proportionally, there is a very similar number of large cutting tools, the most frequent type of object present in EF-HR. Nonetheless, this should not mask the real trend: phonolites, trachytes and basalts were the most frequently used raw materials.

Knapping products

EF-HR presents 80 whole flakes (including the blanks for large cutting tools), a total that exceeds other sites which, nevertheless, present a greater number of lithic remains. There are no differences between the size of the knapping products, with the low number of quartz flakes included in a size interval very similar to lavas (fig. 5.5). Although the average length has been established at approximately 5 centimetres (tabl. 5.3), there are a great number of examples in a superior size range (fig. 5.6), which proves the considerable size of many of these flakes.

If in other sites the tabular nature of the quartz blocks sometimes hampered the reliability of the cortex percentages, in

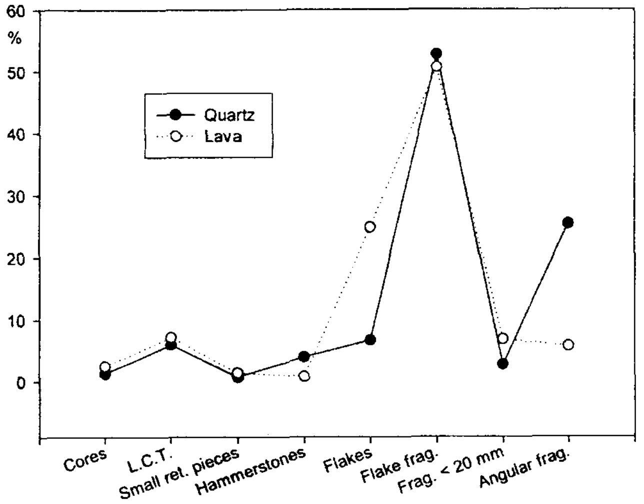


Figure 5.3. Representation of categories in terms of raw materials documented in EF-HR.

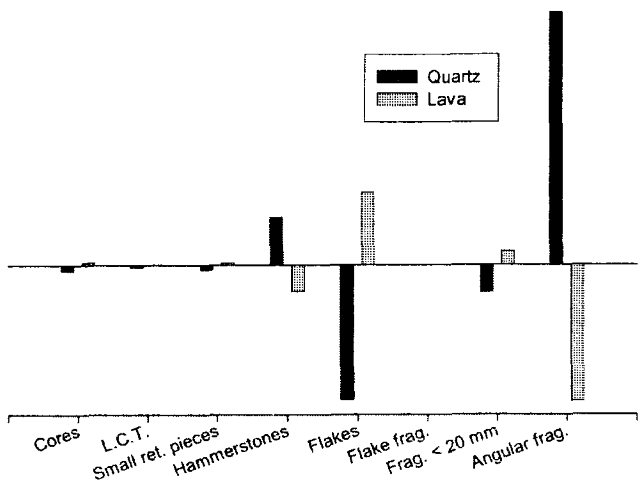


Figure 5.4. Lien Test comparing categories and raw material.

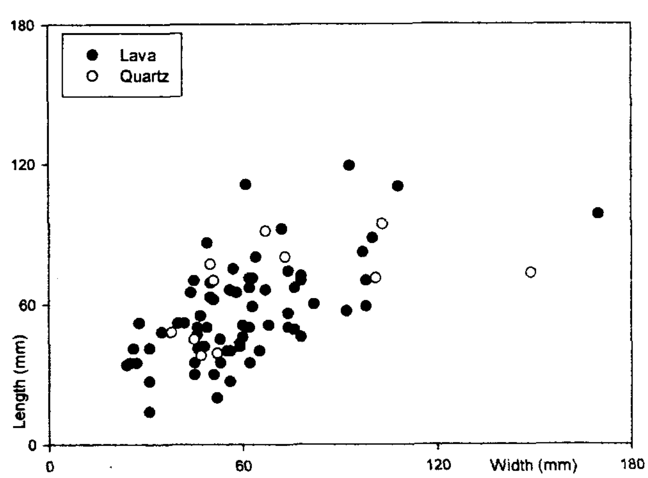


Figure 5.5. Dimensions of the quartz and lava whole flakes.

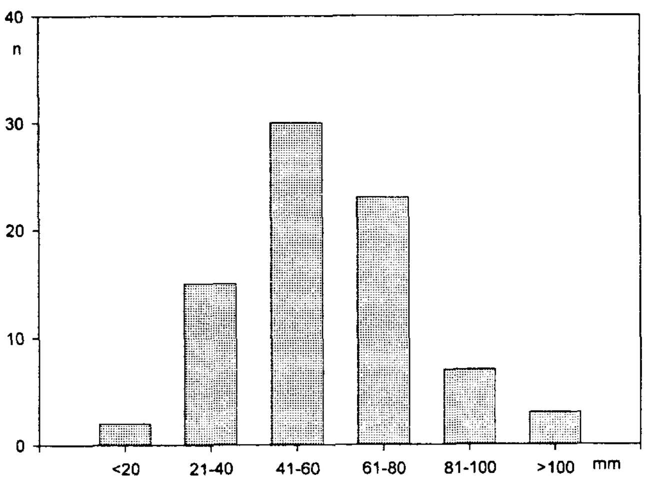


Figure 5.6. Length patterns of the whole flakes.

	Minimum	Maximum	Mean	Std. deviation
Length	14	119	57.65	21.246
Width	24	170	61.55	25.267
Thickness	3	65	17.86	9.679
Weight	3	882	92.54	138.81

Table 5.3. Dimensions of the whole flakes.

Dorsal face	Striking platform				Total	
	Cortical		Non-cortical			
	N	%	N	%	N	%
Full cortex	2	2.5	1	1.3	1	1.3
Cortex > 50%	-	-	8	10	8	10
Cortex < 50%	3	3.8	18	22.5	21	26.3
Ncortical	6	7.5	42	52.5	48	60
Total	11	13.8	69	86.3	80	100

Table 5.4. Cortical frequencies in the whole flakes.

EF-HR a good part of these metamorphic rocks appear as stream cobbles, in which it is much easier to identify cortical areas. Therefore, adding quartz and lava flakes, we find that up to 40% of these products preserve cortex remains on their dorsal faces, and up to 13.8% on the butts (tabl. 5.4). Consequently, a good part of the initial flaking was obviously performed in the site itself, since flakes of all the types contemplated by Villa (1983) and Toth (1982) were found within (see fig. 5.7).

The analysis of the flakes' butts (fig. 5.8) shows that knapping platforms were generally unprepared and that a high number were cortical. However, the percentage of dihedral or multifaceted butts is substantially greater than in previously analysed sites. This implies greater attention to the preparation of striking platforms. The quantitative information we have to date already allows the inference of certain technolo-

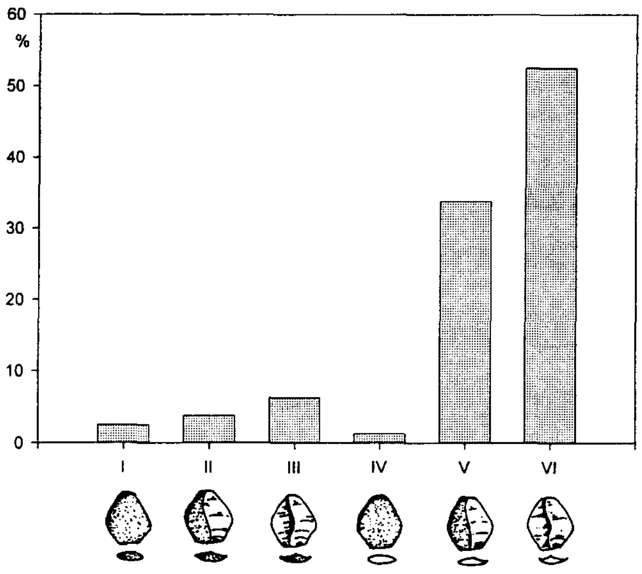


Figure 5.7. Whole flakes according to Toth's (1982) classification.

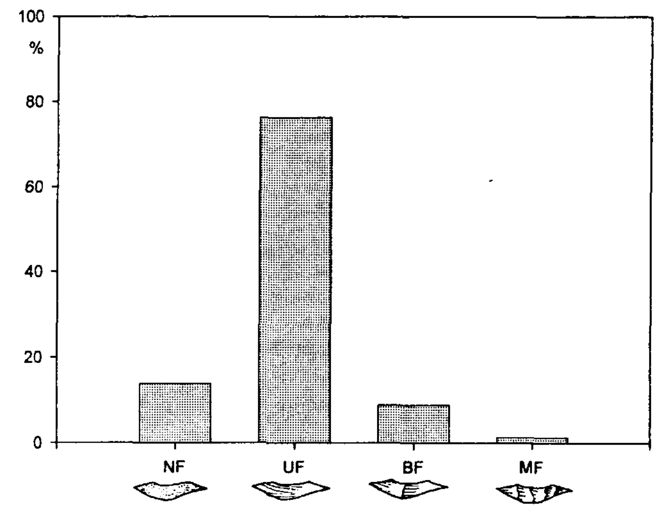


Figure 5.8. Types of striking platforms in the whole flakes.

gical differences compared to knapping products obtained in the Oldowan sites. Nonetheless, limiting the work to a quantitative study of independent attributes (Ludwig 1999; Kimura 2002) prevents a correct comprehension of the underlying technical strategies. So as to understand the genuine dimension the technological change EF-HR involves, we should focus on the qualitative nature of each individual object. An initial example that proves the need for monographic consideration appears in the analysis of flake fragments and chunks: just these fragments total approximately 17 kilograms of worked raw material. Furthermore, studying these fragments indicates a vast profusion of Siret accidents during the knapping process (fig. 5.9), which also suggests that a too great force was applied on high-quality cores. The strong blows should come as no surprise, since the size of the Siret flakes and other fragments indicate the nodules must have been enormous (fig. 5.9 and 5.10). Moreover, both the presence of numerous split fractures and the profusion of large discarded flake fragments indicate that the processes for decorticating the large cores could have been performed *in situ* in the actual settlement. We are referring to flake fragments weighing an average 300 grams each, which were not employed after the technical error that fractured them. This would not make sense if such processes had not been carried out in the site itself. Therefore, the fact that the large nodules were exploited *in situ* (an aspect that is hard to prove, as we will see below), would be extremely relevant when assessing the transportation of raw materials.

EF-HR presents a great number of whole flakes, generally with excellent morphologies, edges and sections. Considering the ranges proposed in figure 5.6, but particularly taking qualitative characteristics into consideration, we can distinguish three types of flakes, small, medium and large. This distinction is based mainly on their position in the *chaîne opératoire*, not on metrical criteria.

The small-sized flakes (fig. 5.11) are characterised by a 3-5 cm metrical module, dorsal faces with 2-4 previous scars and a generally longitudinal unidirectional pattern. It is hard to reliably differentiate flakes obtained from a typical *débitage* system, those obtained from the preparation of nodules for the detachment of large Acheulean blanks, or even from those obtained from the *façonnage* of such blanks. There are some criteria to distinguish these flakes, for example the angle formed between the ventral face and the butt (generally very wide in pieces linked to obtaining and/or the *façonnage* of blanks) or the actual size of the butts (substantially smaller in typical *débitage* than in other processes). However, these attributes are not sufficiently defined to assign flakes to one process and or another confidently. We have consequently decided to include small-sized flakes in a single group. In any case, in view of the low number of cores from the most classical *débitage* system, we could assign most of these flakes to processes linked to obtaining blanks for large cutting tools.

Medium-sized flakes, between 5-8 cms, are certainly linked to sequences for obtaining large blanks. Here the question lies in assigning these flakes either to the preparation of nodules to obtain these large blanks, or to the *façonnage* of such pieces. In general, we favour the first option, since the large cutting tools did not undergo a relevant secondary reduction. On the other hand, these medium-sized flakes, whose dorsal faces frequently indicate a multidirectional pattern, suggest a systematic working of the knapping surfaces from which they originated (fig. 5.12 and 5.13). Occasionally, given their length and width, these medium-sized flakes could be included among the blanks for large cutting tools. Herein, this categorisation is explained considering the meagre thickness of their sections, which contrasts with the forcefulness of objects considered as blanks for large cutting tools, and that of the retouched pieces themselves.

Finally we will move on to analyse the group of the large flakes which, without undergoing secondary modification, present all the features that make them potential blanks for

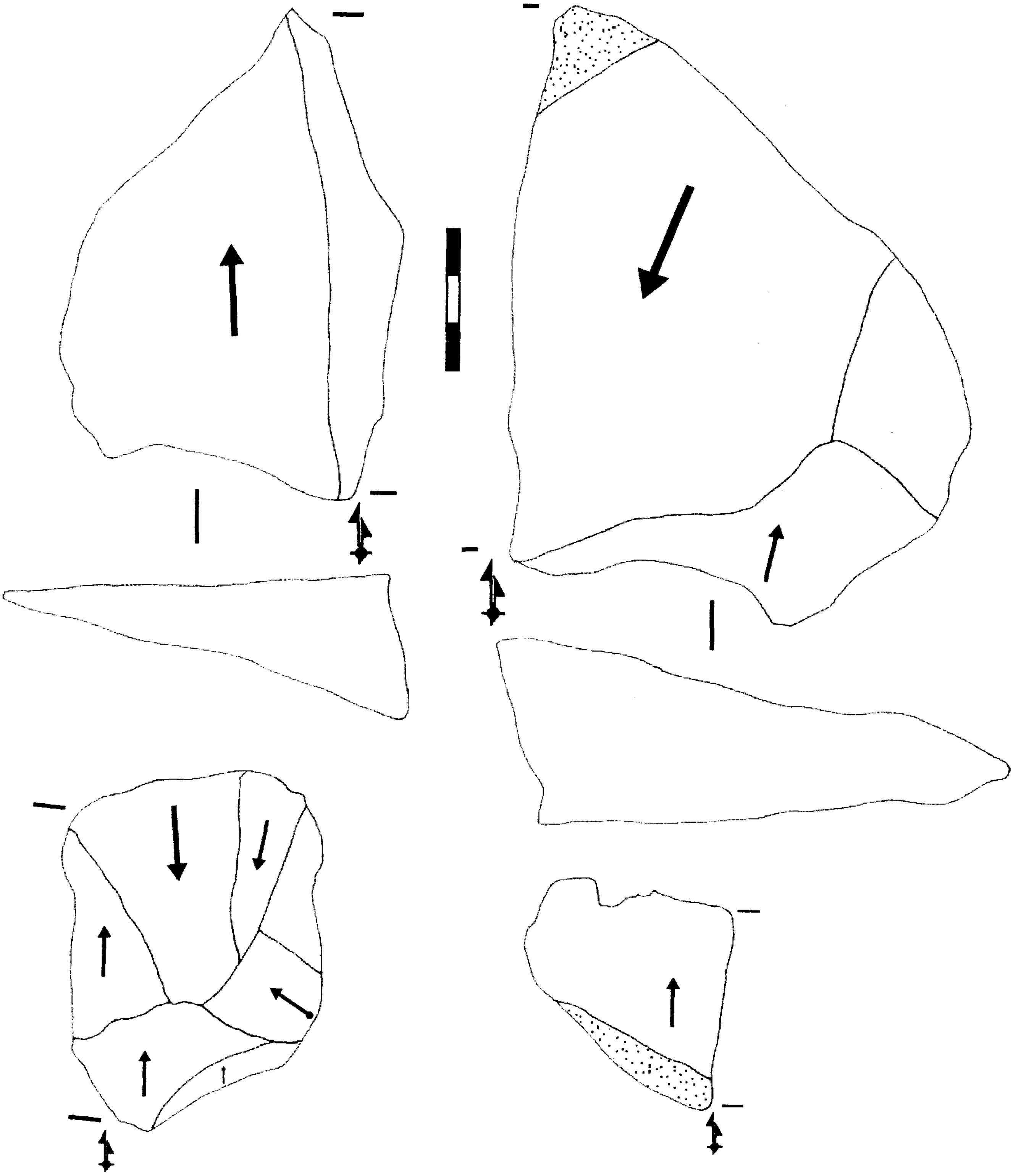


Figure 5.9. Examples of split fractures (Siret flakes) from EF-HR. All of them are high-quality basalt except the third, a quartz fragment.

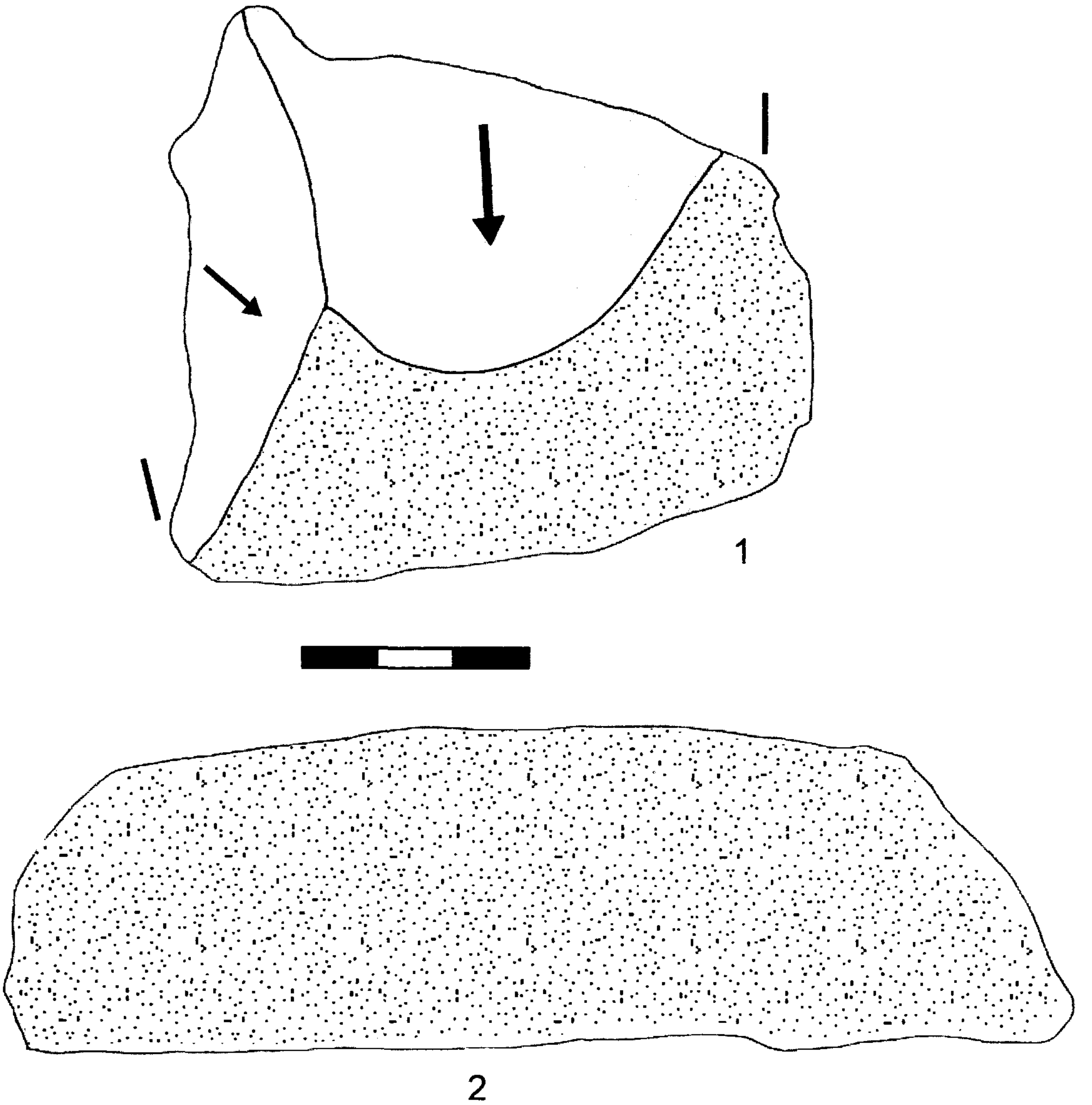


Figure 5.10. Examples of fragments from EF-HR. 1: phonolite flake fragment, with most of the surface covered by fluvial cortex indicating a large original boulder; 2: quartz chunk, also with fluvial cortex denoting a large original cobble.

large cutting tools (fig. 5.14). Table 5.1 shows we have only considered two whole flakes as large flakes, although really their technological genesis could be applied to all large cutting tools. Therefore, and since the sample is larger among retouched items than among the blanks presenting no secondary modification, we will postpone our hypothesis on the way these flakes were produced.

In all, EF-HR presents a vast collection of flakes that suggest different stages and even different types of reduction. Some of them, the smallest amount, are linked to the typical *débitage* system for knapping small cores. The rest of the flakes seem to be linked to the *chaîne opératoire* for the production of large cutting tools, involving the corresponding reduction stages, from the initial flaking of the nodules to the preparation of the knapping surfaces which would subsequently produce the large blanks that would finally be retouched. Consequently, these facts suppose an important structuring of the knapping systems, which is noticeable in the flakes' dorsal patterns (fig. 5.15 and 5.16), which indicate a systematic exploitation of the knapping surfaces. Furthermore, as stated above, the final goal is to obtain blanks that will subsequently be retouched.

Retouched pieces

This section includes two groups, the small retouched pieces and the large cutting tools on huge blanks. Table 5.5 shows that even items which we consider small retouched pieces are much bigger than those available in other previously studied Oldowan sites. The difference between these pieces and those considered large cutting tools fades from a metrical viewpoint, but we have thought it relevant to distinguish them given the lesser "blunt" nature of the five side scrapers that

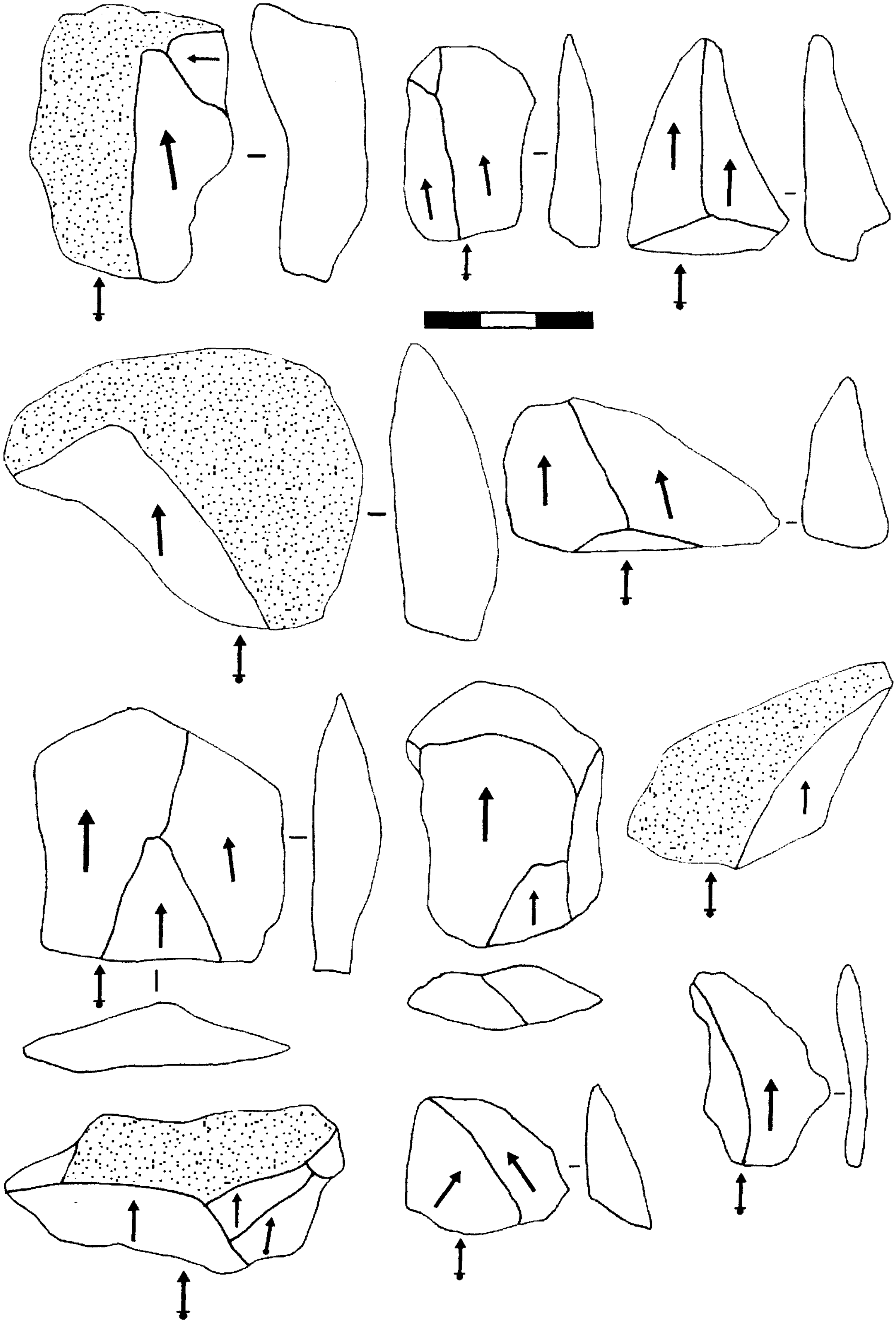
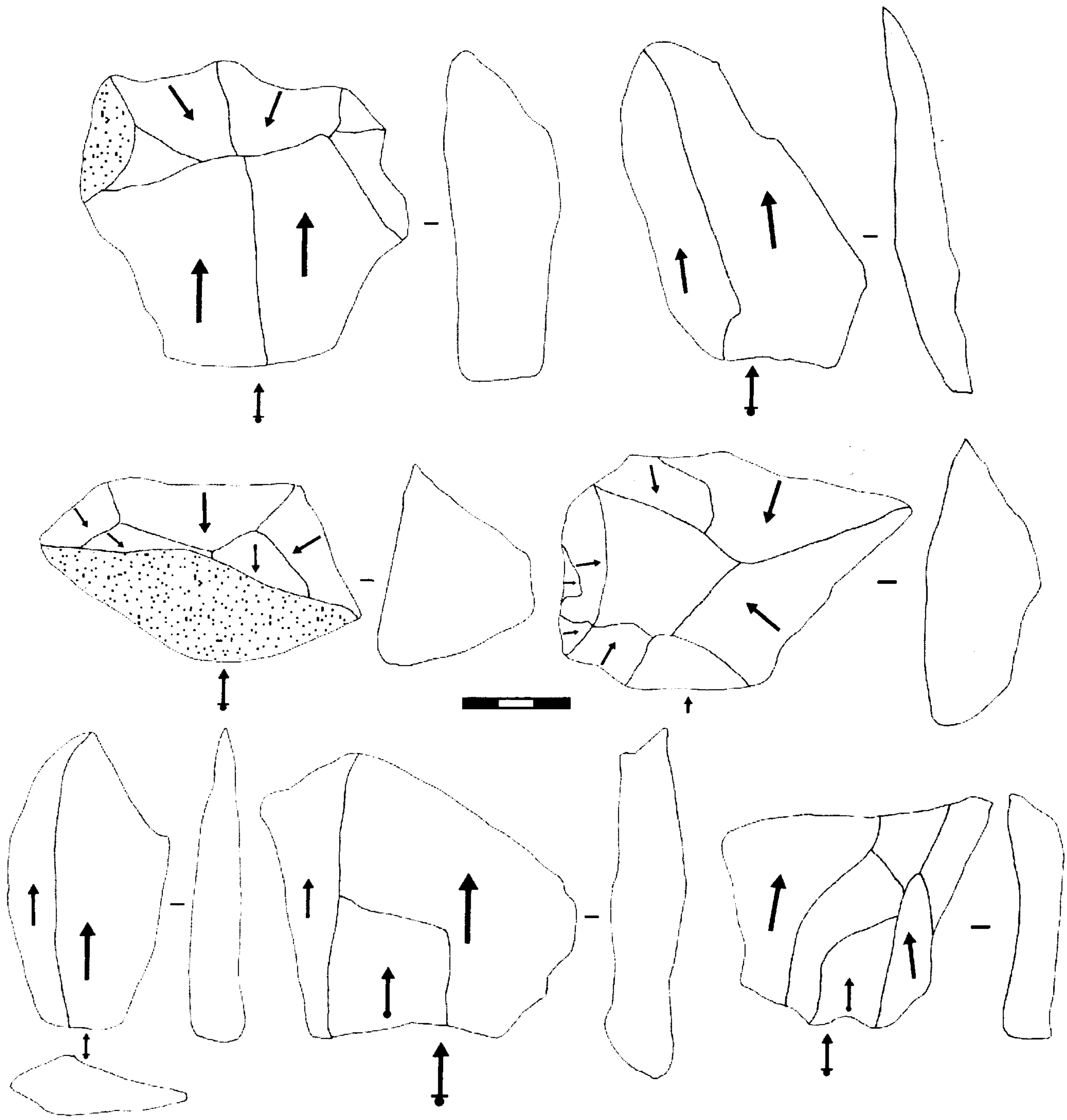


Figure 5.11. Examples of small-sized lava flakes.



form the group of the small retouched pieces. In any case, their profusion and relevance in the assemblage is insignificant compared to the large cutting tools, therefore we should focus on the latter.

The first problem we encounter upon describing the large cutting tools is linked to terminology. One of the most successful systematisations for the classification of the assemblages from the African Acheulean was proposed by Kleindienst (1962), although explicitly stating that such "*classification is deliberately based on morphology, insofar as technique can be divorced from form, and takes no account of the quality of workmanship or 'finish'*" (Kleindienst 1962:83). The author considered the artefacts we are dealing with at present, i.e. large cutting tools, were tools with sharp edges, a size ranging between 10-30 cm, which could be classified in five main groups (see Kleindienst 1962). In his re-examination of the African Acheulean, Isaac (1977) grouped all the types Kleindienst (1962) defined in what he called large cutting tools. Hence, Isaac (1977) simplified the previous typology, although

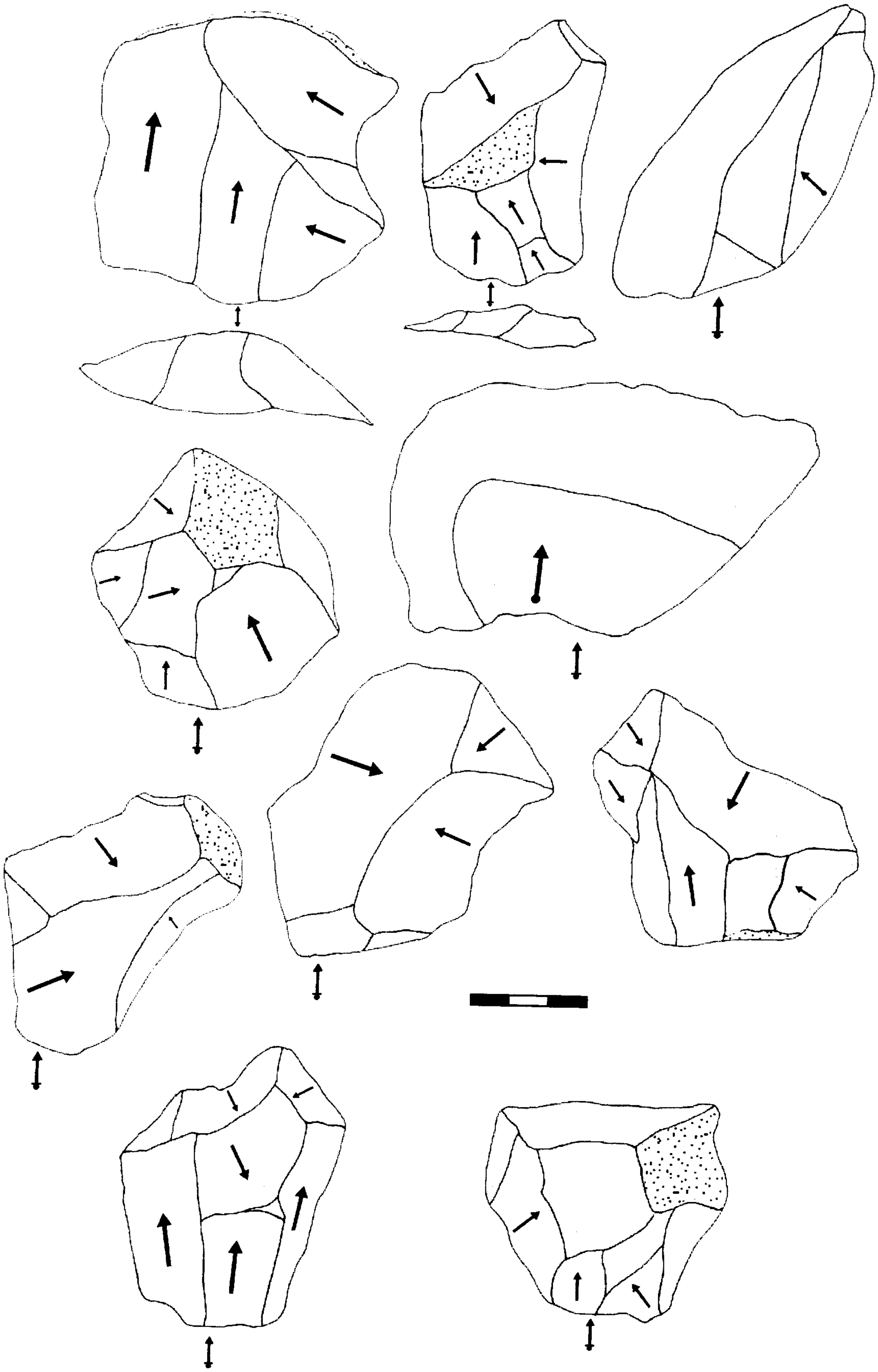


Figure 5.13. Medium-sized lava flakes.

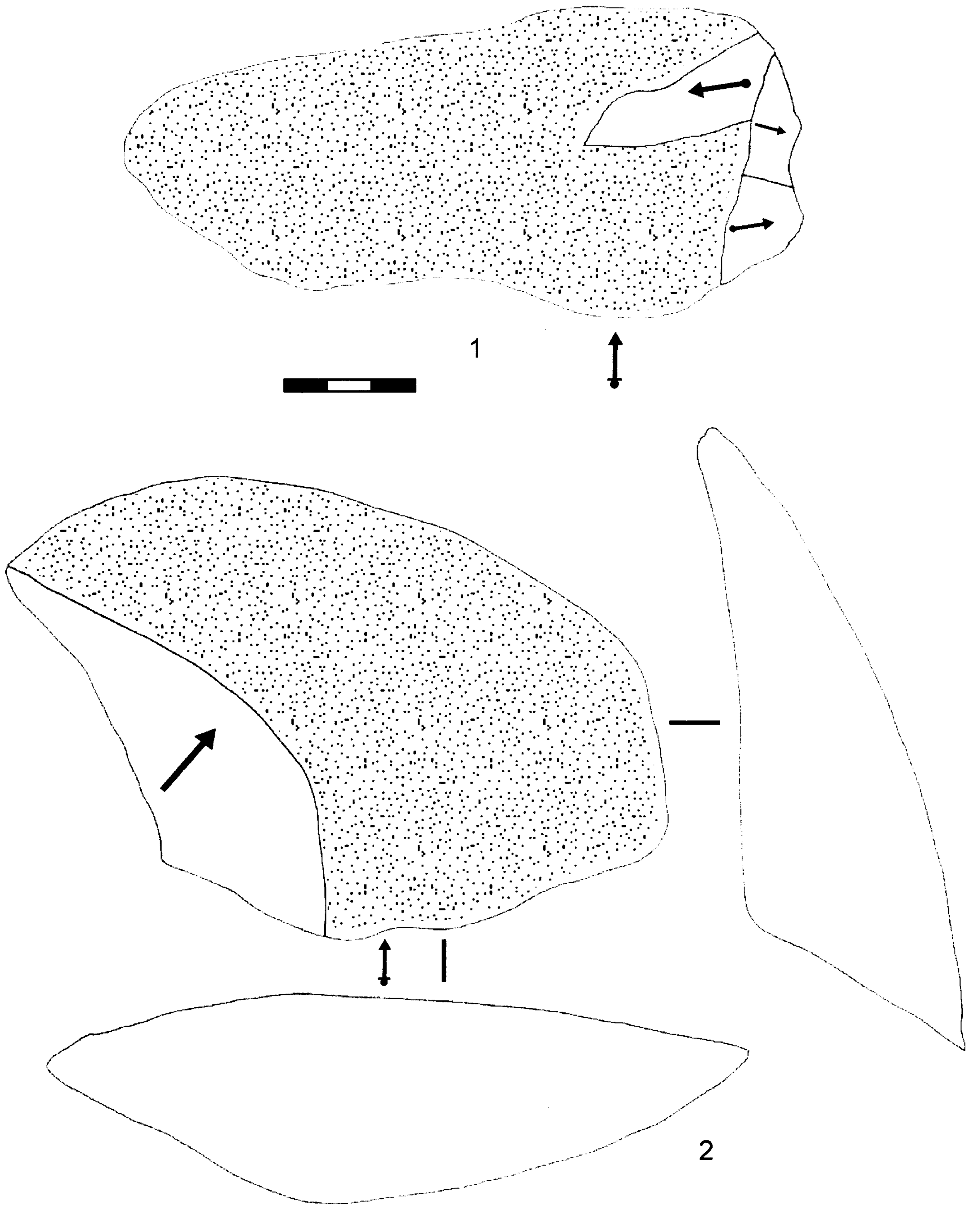


Figure 5.14. Large flakes, typical blanks for large cutting tools, in this case without secondary modifications. 1: quartz example with fluvial cortex; 2: basalt example, the fluvial cortex denoting a large original cobble.

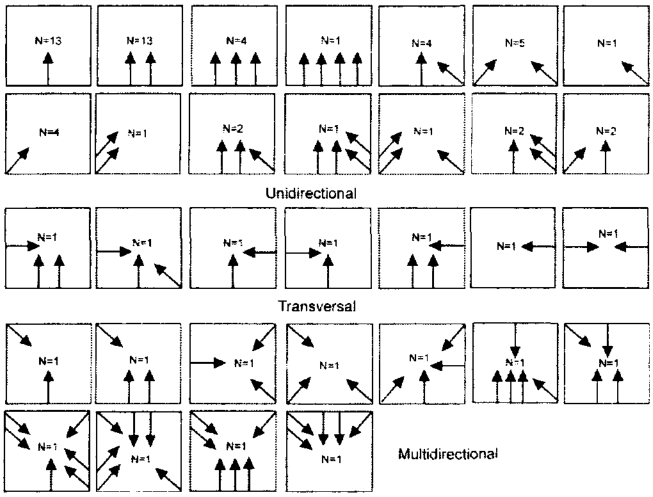


Figure 5.15. Diacritic schemes of the dorsal flaking on the whole flakes.

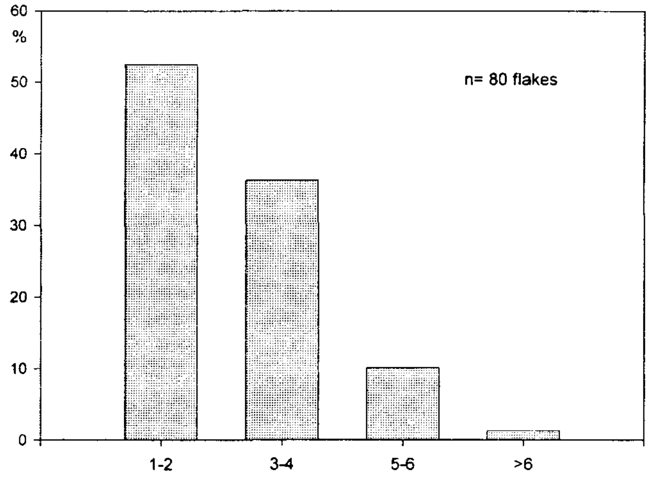


Figure 5.16. Number of scars on the dorsal sides of the whole flakes.

	Minimum	Maximum	Mean	Std. deviation
Length	68	101	81.8	12.657
Width	61	120	83.4	22.93
Thickness	28	49	36.4	8.764
Weight	132	528	267	159.543

Table 5.5. Dimensions of the small retouched pieces.

he still contemplated the existence of discreet types of bifaces, cleavers, picks, triedres and knives. This designation has been successful, and recently the term large cutting tools still prevails in the classifications aiming to organise this type of artefacts (for example Isaac *et al.* 1997; Clark & Kleindienst 2001; Noll 2000; etc). As regards the Olduvai monograph, Leakey (1971:5) favoured a synthesis of the different types of bifaces, considered alongside the groups of cleavers and picks, without furthering more complex subdivisions.

In EF-HR, Leakey (1971:124-126) asserted the prevalence of oval bifaces, although she also noted the presence of picks, triedres and a cleaver. The problem is that, from a technological perspective, it proves hard to sustain the validity of the typological groups Leakey (1971) defined. Consequently, we should initially analyse the way these pieces were obtained to then move on to investigate if we can establish a typological standardisation. Leakey (1971:126) herself noted that a good part of these pieces used large flakes as blanks. Indeed, our analysis of these blanks shows that 26 of the 29 pieces are flakes, with two other objects in which the retouch does not allow us to identify the original blank and one showing that it was worked directly on a block. Although not frequent, we sometimes find that the butt was thinned by a retouch that also gives the flake's proximal area a sharp edge. In pieces that preserve the butt, this element forms a wide angle with the ventral face. Such angle, alongside the thickness of the butts, indicate that the percussion point on the knapping platform was always distant from the edge of the core. Consequently, hominids aimed to obtain a specific volume, involving the loss of raw material on the horizontal plane (knapping platform), the transversal plane (exploitation surface with previous detachments) and plane h′ (see fig. 5.17). This hypothesis is corroborated in view of the actual examples from EF-HR, with large retouched blanks with cortical butts and distal ends with cortex removed from the opposite platform, indicating both the large size of the cobbles and the interaction between the different core surfaces.

The dorsal faces of the large cutting tools show that the cores from which they originate are not very structured: although an average of 7.6 previous detachments have been estimated for each blank, several are mainly cortical and over a half present cortex remains on their dorsal faces. Small-sized flakes could have been used to rejuvenate knapping platforms, whilst the medium-sized flakes were mostly probably used to prepare knapping surfaces prior to the detachment of the large blanks. Yet in general, it does not seem that cores were prepared extensively; hominids selected high quality large boulders (we have estimated elements weighing over 2-3 kilograms) which, after little or no preparation, they struck heavily to obtain large-size flakes which they retouched subsequently. Therefore, we need to consider the secondary modification patterns (i.e. retouching) such blanks underwent.

The problem we face is the systematisation of these objects. Leakey (1971) gathered all objects under the terms bifaces, picks and cleavers, but in our opinion the designation biface is already risky. To begin with, bearing in mind the fact that most of the EF-HR pieces do not present bifacial retouch but unifacial retouch. Actually, the only similarity between these artefacts and real bifaces lies in their genuinely large size (tabl. 5.6). On all other counts, they are much closer to different types of enormous scrapers, which employ the ventral faces of large flakes as striking platforms to retouch the edge on the dorsal face: of the 29 pieces, only 15 present shaped ventral faces, with the rest of the surface free of any other type of modification. Therefore, we should refer to unifaces instead of pieces worked bifacially.

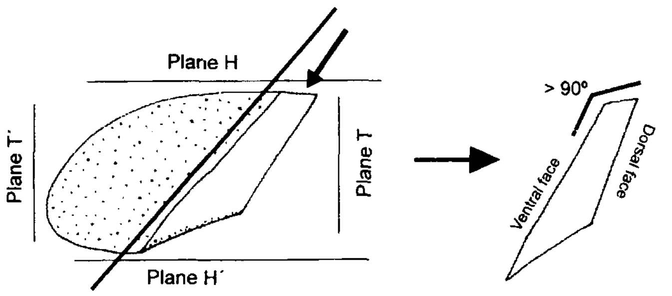


Figure 5.17. Ideal representation of the process for obtaining large flakes, which – when obtained – detach part of the knapping platform (Horizontal Plane), from the knapping surface (Transversal Plane) and the surface on the opposite side to the knapping platform (prime Horizontal Plane).

	Minimum	Maximum	Mean	Std. deviation
Length	73	235	123.86	38.975
Width	62	197	109.69	38.47
Thickness	27	63	43.55	8.79
Weight	306	1375	605.52	222.32

Table 5.6. Dimensions of the large cutting tools.

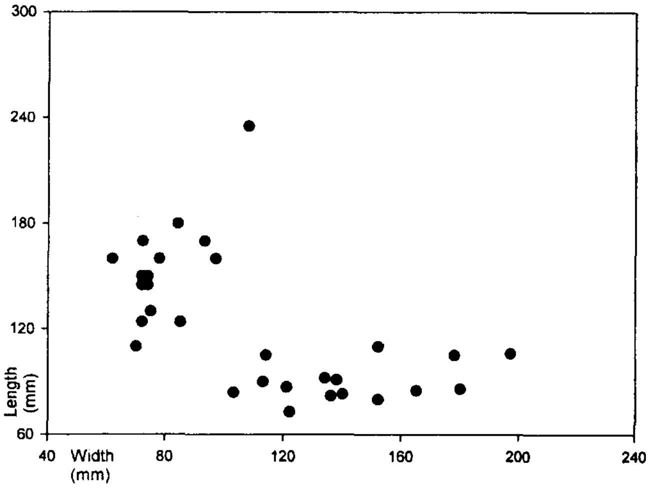


Figure 5.18. Dimensions of the large cutting tools. The graph shows two groups, one with pieces that are longer than they are wide and others that are wider than they are short. The elongated pattern is artificial, however, since the pieces for which the original butt position cannot be established are oriented in terms of their major axis, which is assigned the length variable. Actually, the flakes for which the butt has been established (oriented in terms of the technological axis of flaking) are always wider than they are long.

Furthermore, on artefacts presenting bifacial retouch, such secondary modification is never invasive, i.e. knappers do not work the whole surface, but simply modify the edges slightly. This is very significant since, whilst in genuine bifaces *façonnage* aims to obtain two proportionate volumes, thus involving interaction between both surfaces, bifacial retouch in EF-HR only aims to rectify the morphology of the edges, without ever creating two surfaces separated by an intersection plane. Furthermore, we find another difference with genuine bifaces: in EF-HR retouch usually is denticulated, with a simple angle and normal width. This means that, firstly, the edges of the pieces are discontinuous and carelessly created, and therefore do not present the regularity of the edges found on real bifaces. Secondly, simple angle blows break the rim penetrating too far into the edge, and the lack of depth in the width of the retouch collapsed the central part of the worked surface.

Therefore, EF-HR presents none of the concepts linked to biface shaping, showing simply a formal similarity based on the size and morphology of these artefacts. As regards the morphologic similarity between these large cutting tools and genuine bifaces, the main aspect is that their generally pointed nature – as Leakey (1971:126) stated – is obtained from the simple intersection between two or three blows that create a flat or trihedral point. As regards size, table 5.6 shows the bluntness of these pieces, frequently weighing over one kilogram, and the profusion of wide, short flakes over long, thin ones (fig. 5.18). This is linked to the technological process, since the great width of these flakes is determined by the large butts, which usually take up the whole width of the flakes; when dealing a heavy blow to an area distant from the edge of the core on wide surfaces, the resulting flake detaches a good part of the striking platform, at the same time determining the wide, short morphology of the blank.

In conclusion, we can summarise the characteristics of these large cutting tools by saying that they are large, wide, short flakes, with well-developed, thick sections which, given the vast volume they detached from the core, left knapping surfaces exhausted, requiring a complete rejuvenation process. The large blanks obtained were only partially modified by retouch, which was limited to shaping the edges, never the volume of the dorsal and/or ventral surfaces. This retouch aimed to modify or create a unifacial or bifacial edge and, frequently, to obtain a point on one of the lateral ends of the flake, although the existence of at least three cleavers is also documented. In our opinion, any attempt at systematising the common characteristics of what are actually large scrapers cannot be taken any further than this. The pieces from EF-HR are large, sometimes sharp, sometimes pointed, shaped on a flake or on a block, etc. Despite this variability, they all share certain attributes: general modification of the shape of the object and the creation of massive edges. Nonetheless, we cannot assign these pieces to biface typological groups or integrate them in any morphological assemblage. Therefore, we have decided to present hereunder some specific examples of the pieces from EF-HR, hoping that the individualised *X-rays* will enable the comprehension of the genuine dimension of the technological strategies that gave way to these characteristic objects (see fig. 5.19 to 5.25).

The *chaîne opératoire*

The basic goal for stone working in EF-HR focused on obtaining large blanks which were subsequently retouched.

As table 5.2 demonstrated, there are over 17 kilograms of raw material turned into large cutting tools, and surely most of the other categories (flakes, flake fragments, etc) correspond to secondary products generated when obtaining large retouch blanks. In any case, we need to reconsider the percentages of the different categories so as to understand the type of *chaînes opératoires* that governed the technology in EF-HR.

Firstly, the manifest lack of chips is notable, composing slightly over 5% (tabl. 5.1). As regards EF-HR, knapping debris are not generated solely during flake production activities, but also (and quite pronouncedly in this case) during the processes involving the *façonnage* of large objects. This underscores the scarce debris index. We have considered three hypotheses to explain this infra-representation. The first is that the site could have been affected by hydrologic processes. Bearing in mind the stream that cuts through the site dividing it in two, the truth is that, except for the pieces Leakey (1971) recovered exactly from the actual stream, the rest of the collection is in exceptionally preservation conditions, and we cannot sustain that items have undergone any kind of hydraulic traction.

A second hypothesis suggests that both the *débitage* products and the retouched objects were manufactured in another location and then transported to the site; therefore, the millimetric debris would have been left in the original knapping area. This hypothesis cannot be discarded since, as we will see below, the site also lacks other elements (mainly the cores) which should appear if knapping had been a predominant activity. Without excluding this explanation, we should also consider the profusion of fragments and pieces discarded after knapping mistakes. As aforementioned, it is pointless to document over 16 kilograms of discarded fragments without considering the need for *in situ* knapping in the site itself. In fact, we even have refitted some fragments, which indicate that the knapping accident was produced in the actual settlement.

A third explanation for the lack of chips in the collection could be linked to the conditions in which the remains were recovered. Leakey (1971) could not perform the map of the site since a storm moved the archaeological material on display. This could have caused the rains to shift the smallest pieces, or could simply mean Leakey did not sift the sediment for such reason. Furthermore, as regards EF-HR we know Leakey added surface material to the general aggregates, which always hinders the proportion of small remains, and could alter the relative frequencies expected for each category. In any case, these factors unrelated to the actual occupation of EF-HR, could provide a good explanation to justify the fact that size ranges seem to favour greater dimensions.

Another surprising infra-representation appears in the amount of hammerstones, since only 4 were discovered (tabl. 5.1). Moreover, the three quartz hammerstones are quite fragmented, and the single lava hammerstone is too small to be used to detach large blanks and would have been more appropriate for *façonnage* processes. Indeed, knapping activities were performed in the site, since we have both hammerstones and some typical "hammerstone flakes" that detached fortuitously from the cortical surfaces of cobbles after pounding. However, the hammerstones are not big enough to have produced large flakes. Once again we encounter two alternatives; Leakey (1971:136) referred to up to 10 utilised cobblestones, which would be added to the 4 aforementioned hammerstones. Leakey (1971:132-133) also refers to 9 quartz subspheroids and spheroids that could have been used as active percussion elements. These pieces could be part of the group of materials we could not find in the National Museum at Nairobi, and could in fact be the hammerstones missing from the site. Another alternative is that there were only the 4 hammerstones Leakey described, which we re-examined, and that we are, once again, facing a missing link in the *chaîne opératoire* we are trying to reconstruct.

The most important inconsistency appears in terms of the cores. Not a single core studied in EF-HR is linked to the production sequence for the large blanks. Of the 6 documented cores, two were exploited using a unifacial abrupt system, another using a bifacial abrupt system, a fourth example employed multifacial exploitation, and the two final samples used a bifacial peripheral strategy (fig. 5.26). These strategies do not coincide with the method applied for obtaining large flakes. This does not simply evoke the technical schema, since if we turn to a metric comparison (tabl. 5.7) we find that these cores are unrelated to the *chaîne opératoire* for the production of large blanks: none of the cores are larger or at least similar to the large cutting tools. A fact which, obviously, makes it impossible to believe the large blanks come from these cores.

The outcome is that the cores in EF-HR belong to a different *chaîne opératoire* than the large blanks. With an average of 9 detachments per piece, these cores' scars range between 28 mm long and 31 mm wide, which does not even coincide with the range of the small flakes that we have analysed. Therefore, we are facing a strategy very focused on flake *débitage* employing systems already studied in Oldowan sites, which do not aim to obtain large blanks. Moreover, we must consider the fact that these cores composed under two kilograms of the total amount of raw material transported to the site, even less than the total composed by flakes and fragments. Therefore, it seems obvious to think that the knapping process for small flakes was a peripheral activity in EF-HR, which focused on obtaining large blanks which were subsequently retouched.

The problem is that we did not document a single example of block or cobblestone that could have been employed to detach these large flakes. Considering the large size of many of the retouched items, which also present a fluvial cortex, it seems appropriate to think the cores that produced them were huge basalt, phonolite and (to a lesser degree) quartz boulders. Perhaps the large size of the boulders deterred the hominids from transporting these cores to EF-HR. Consequently, we face the possibility of such large blanks being obtained in streams, and that only the flakes were transported to the site.

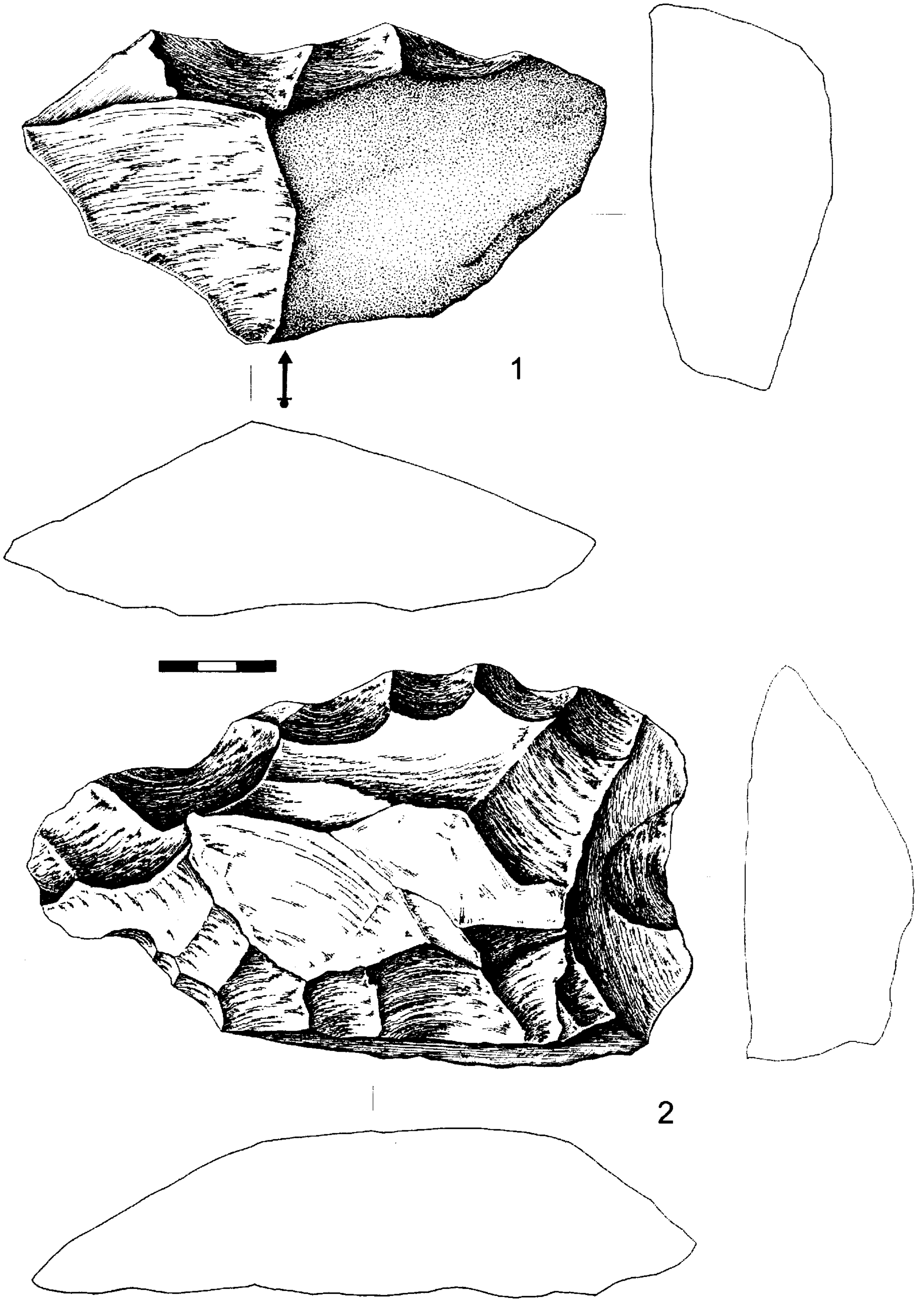


Figure 5.19. Lava large cutting tools. They could be classified in the knives group, since they both present an abrupt area that coincides with the butt and on the opposite side to a retouched edge. 1: basalt flake with an unifacial, transversal, denticulate and abrupt retouch. The dorsal face was not worked significantly before the flake was detached; 2: phonolite flake with a broken butt. Except for a few isolated blows on the ventral face, the retouching is unifacial, denticulate, with a simple angle and focused on the transversal edge of the flake (drawn by N. Morán).

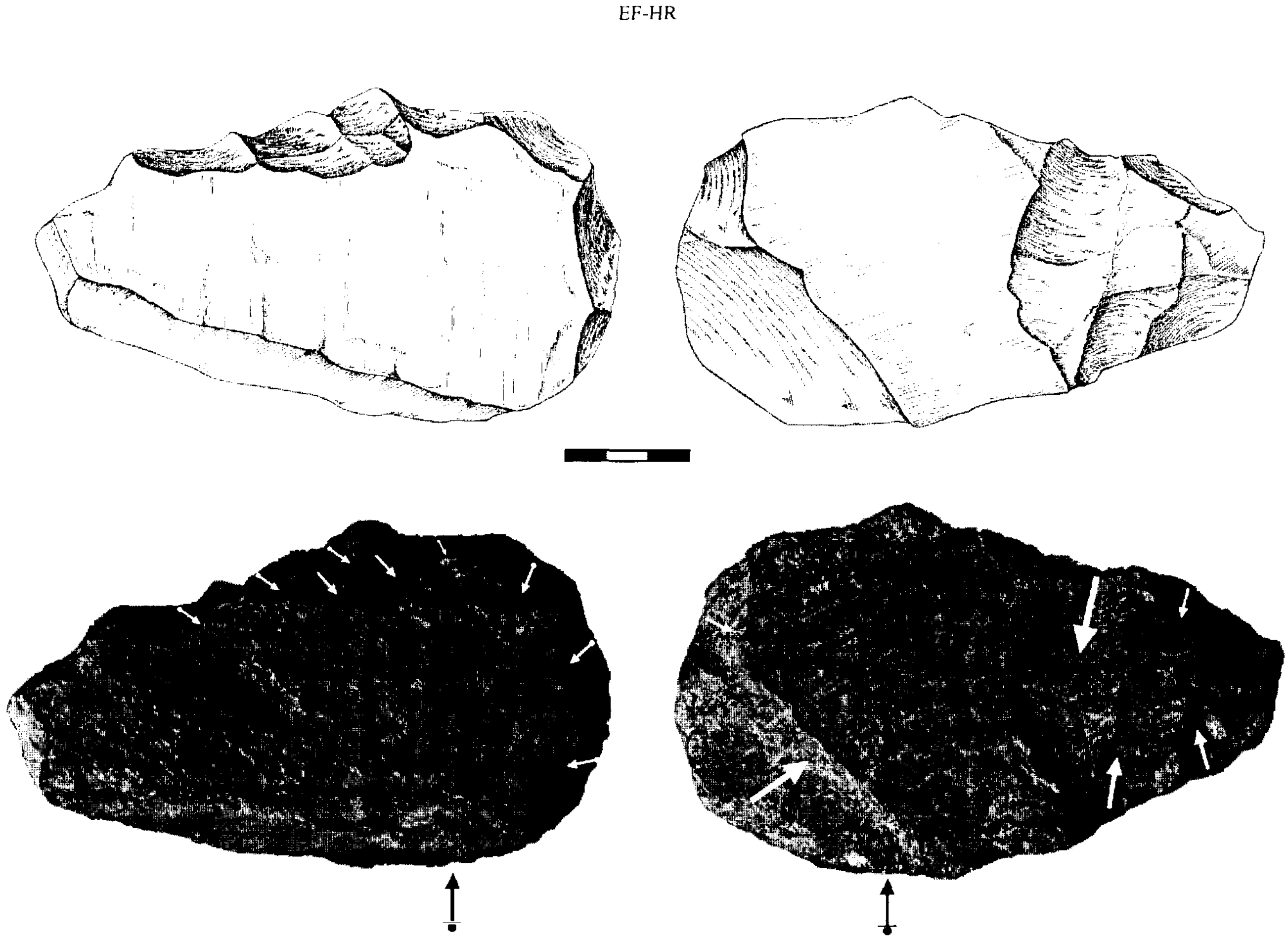


Figure 5.20. As with the figures in the previous example, this basalt retouched flake could be classified in the knives group, since the butt forms an abrupt back on the opposite side to a modified transversal edge with a retouch that is denticulate, simple and normal. The ventral face presents a continuous and flat retouch on the right side that creates a sharp area (drawn by N. Morán).

This is the most plausible hypothesis. Yet, as aforementioned, we have found large flake fragments caused by technical errors, which were discarded in the actual site. Their presence can only be explained assuming the importance of *in situ* knapping. Unfortunately, we are unaware of the configuration or characteristics of the stream linked to the clays in EF-HR. Leakey (1971:136) mentions the existence of cobblestones in this gravel, but does not describe their nature. Kyara (1999) mentions the fact that the blocks in this stream are very large, and in fact links them to the obtaining of what he calls the EF-HR bifaces. As a speculation, we could propose the large cores used to extract flake blanks were obtained there, which accounts for them being left in the stream.

In any case, the *chaîne opératoire* in EF-HR aims, primordially, to obtain large flakes that acted as blanks for subsequent retouch. There is an alternative *chaîne opératoire* for the production of small flakes, as the documented cores suggest, but this is a peripheral option. In fact, the characteristics of most of the small flakes seem to connect them to the preparation of cores for large blanks, o to the actual *façonnage* of the large flakes; not to the *débitage* of small cores. The items we have called medium-sized flakes are frequently longer than the *débitage* cores, and are linked to the production of large blanks. Furthermore, the production of these large flakes is directly linked to obtaining enormous blanks that will be retouched subsequently (fig. 5.27). Figure 5.28 displays the fact that the large cutting tools are invariably bigger than the other categories. That is to say, the largest objects were retouched.

We are contemplating a selection of specific blanks that were subsequently modified to achieve a concrete morphology. Therefore, we must consider such morphology. Leakey (1971, 1975), Stiles (1980, 1991) and others have always referred to the term bifaces to define the pieces from EF-HR. Nonetheless, none of the artefacts we have studied falls under such designation. In her illustrations, Leakey (1971: fig. 63-68) chose to represent the largest and most spectacular pieces. Yet, not even these items can be considered bifaces after studying their diacritical schemes. The fact is that the exam-

	Minimum	Maximum	Mean	Std. deviation
Length	65	105	80.83	14.317
Width	57	73	64	6
Thickness	39	50	45.17	4.07
Weight	204	423	325.67	84.123

Table 5.7. Dimensions of the cores.

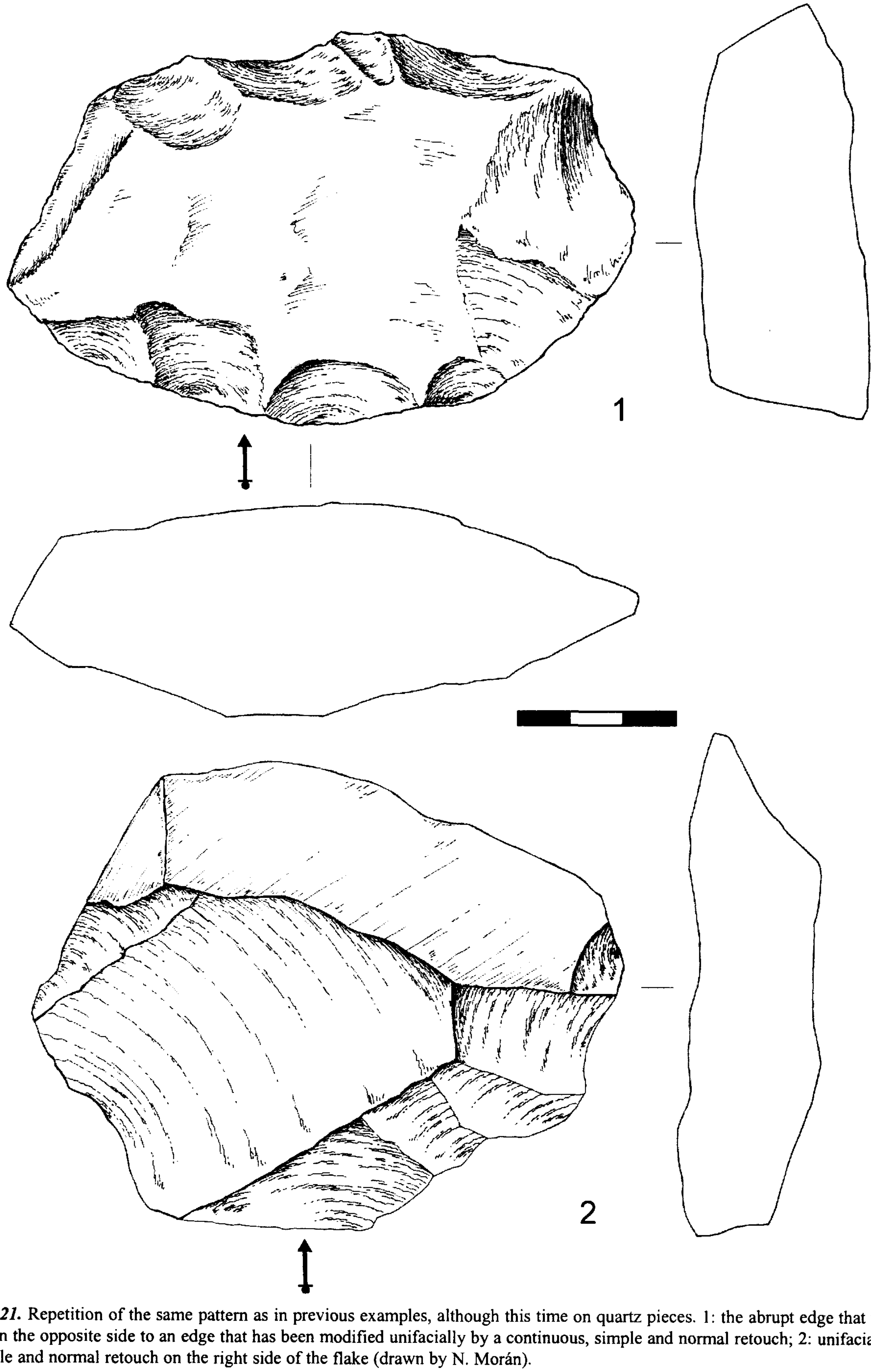


Figure 5.21. Repetition of the same pattern as in previous examples, although this time on quartz pieces. 1: the abrupt edge that represents the butt on the opposite side to an edge that has been modified unifacially by a continuous, simple and normal retouch; 2: unifacial denticulate, simple and normal retouch on the right side of the flake (drawn by N. Morán).

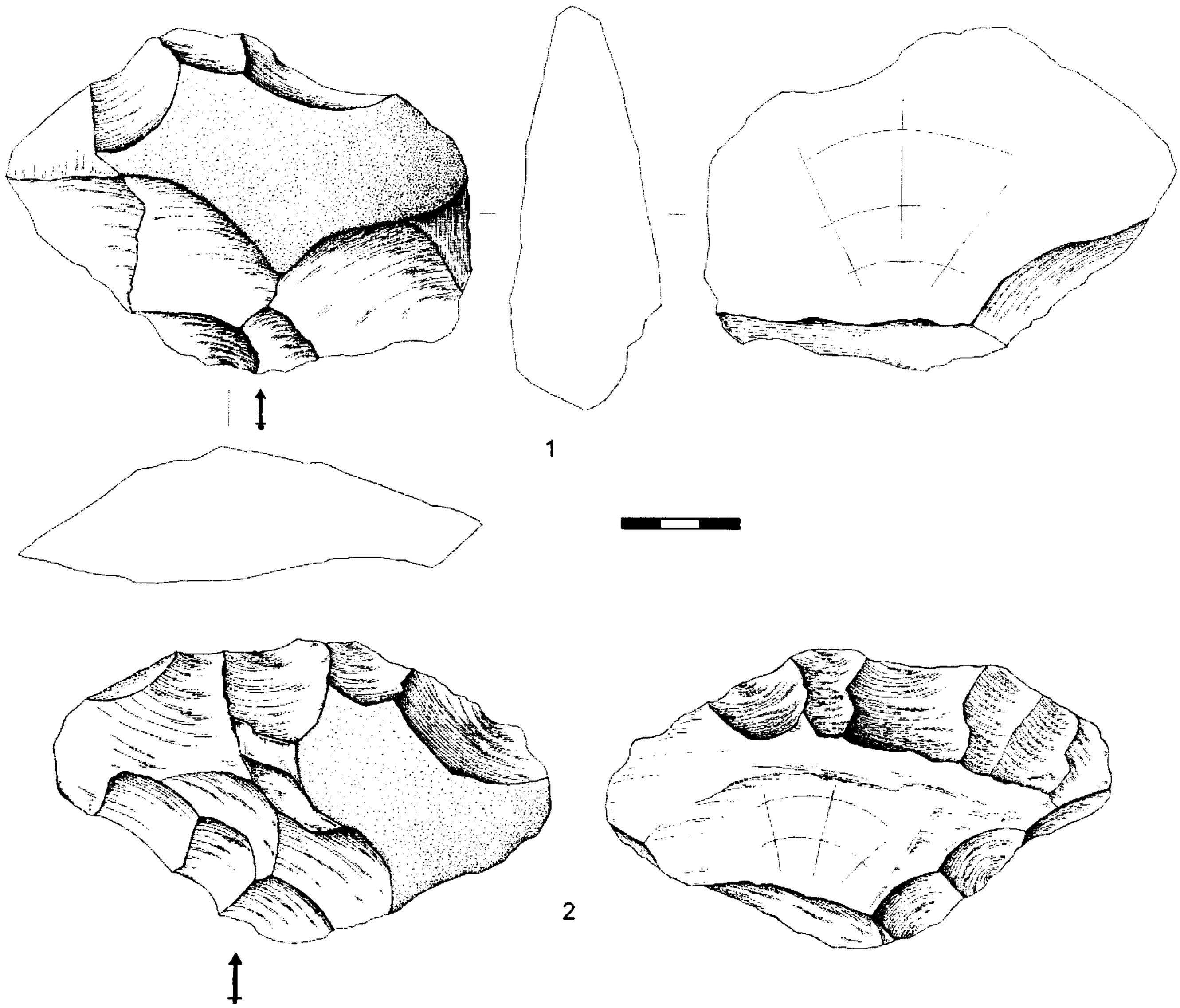
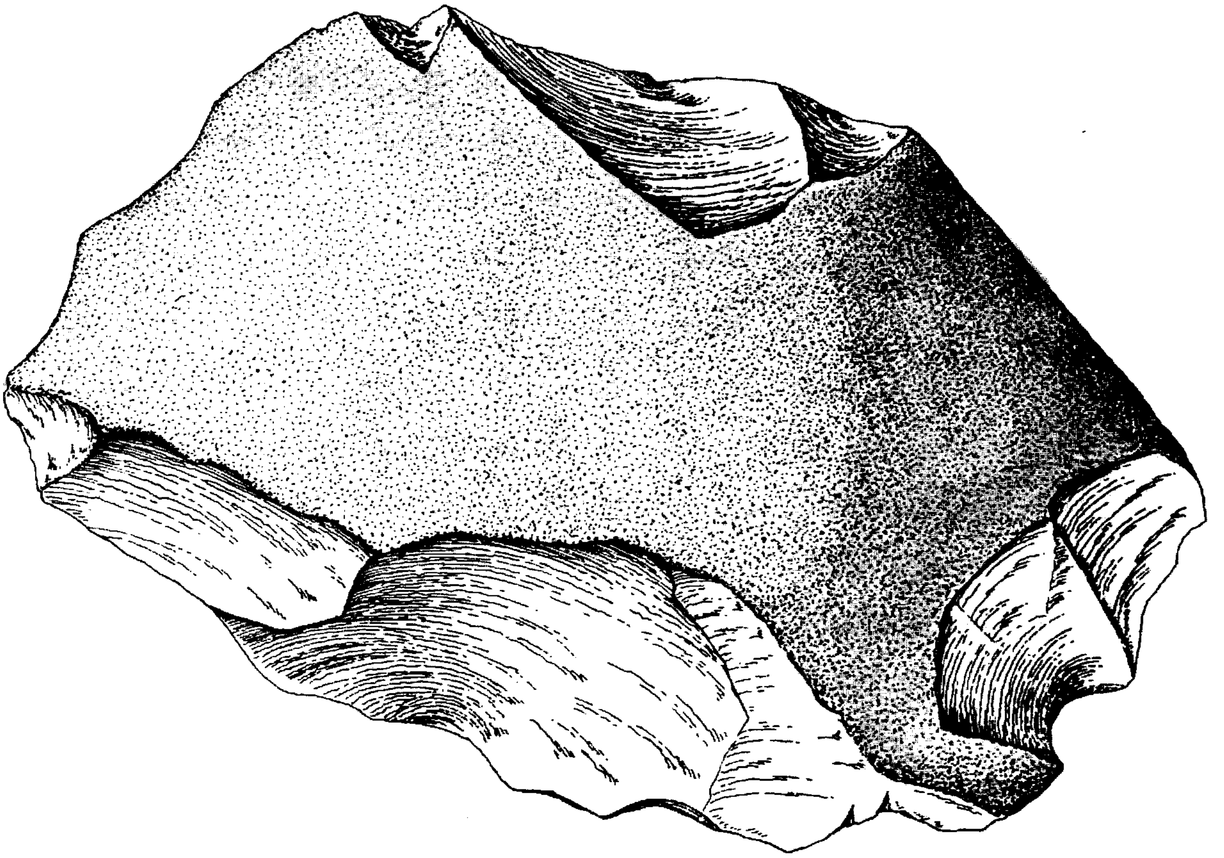


Figure 5.22. 1: this object could also be classed as knife, with unifacial transversal denticulation, and a single blow on the ventral side of this basalt flake; 2: basalt flake with partially eliminated butt. In this case we no longer have an abrupt end on the opposite side to a retouched edge; instead both the proximal and distal parts are modified via bifacial continuous, simple angle retouch. Retouch converges on the ventral face, most probably intending to create a pointed area (drawn by N. Morán).

ples depicted in the monograph are always large flakes that have undergone little retouching, which is limited to the modification of the edges. The pieces described in figures 5.19 to 5.25 present the same characteristics, a scant amount of retouching, generally unifacial, limited to the dorsal face, altering only the edges, without penetrating in the volume of the artefacts.

Most respond to the Kleindienst's (1962) designation of knives: In EF-HR most of the large cutting tools present an abrupt side (generally the flake's actual butt) on the opposite side to a retouched edge. They are really enormous side scrapers, usually presenting a unifacial retouch that is simple, denticulate or continuous. Sometimes, the retouch converging on two edges creates pointed areas on one of the lateral ends. These are not sophisticated points, but are achieved by two or three opposite blows that generate a sharp end, sometimes in the shape of a triedre. Alongside these pieces we find three examples that could be classified as cleavers, although it is hard to assume a technical predetermination in their realisation, essential requirement when referring to genuine cleavers (Roche & Texier 1996; Texier & Roche 1995b).

We do not consider the classification of large cutting tools should be taken any further, since there is no typological standardisation in EF-HR; the morphology of these retouches is larger or smaller, thicker or thinner, in terms of the blank used in the retouch processes. Yet such retouch never aims to correct the volumes of the object; it merely modifies the morphology occasionally to obtain a point. Beyond this fact, each



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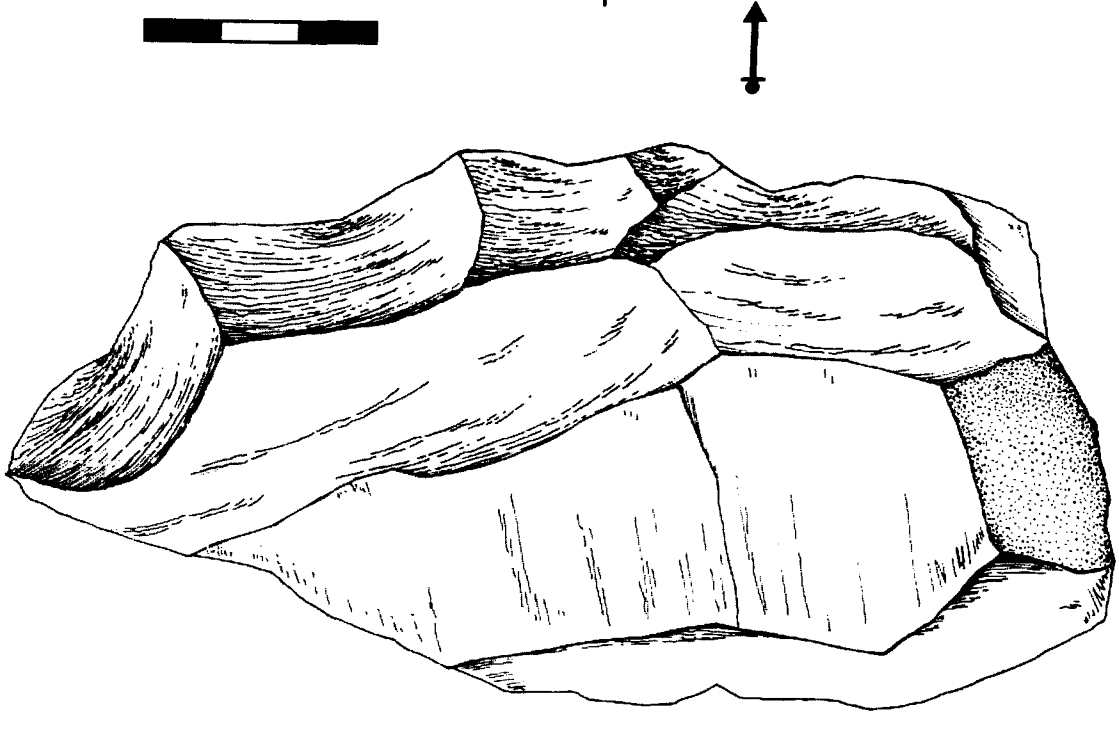

2

Figure 5.23. 1: first generation basalt flake, completely cortical except for a few retouch blows on the dorsal face and no blows on the ventral face. Leakey (1971) classified it as a biface, although it could be considered a cleaver with a cortical edge; 2: basalt flake fragment. This piece has lost its butt and only presents a unifacial retouch on a single edge, that is denticulate, and with a simple angle (drawn by N. Morán).

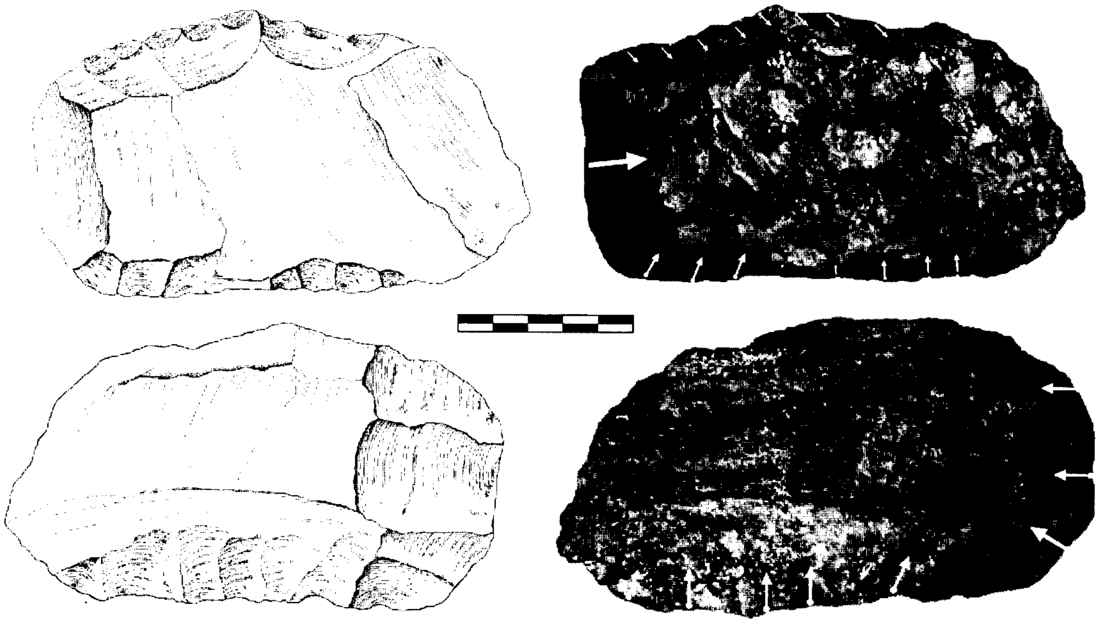

Figure 5.24. Quartz large cutting tool, most probably created on a tabular block, not on a flake. Retouching is sometimes bifacial, although we see a prevalence of unifacial, continuous and abrupt retouch, which only affects the edges, without penetrating the volume of the piece (drawn by N. Morán).

piece is different. If anything, we could refer to a certain standardisation of the goal to be achieved through retouching large blanks: to obtain resistant edges, generally on the opposite side to a dorsal face, and usually accompanied by the creation of a point. It is symptomatic to observe that the EF-HR knappers did not want the natural edges found on large flakes, and preferred to transform them via retouching. The explanation seems easy: the natural edges, given their narrow angles, do not present a resistant mass. Therefore, they prefer to modify them using a simple retouch that creates wider angles which are, consequently, stronger. The same thing applies to points, since they are never delicate but present an available mass thanks to notch-type retouch that generates trihedral sections which are highly resistant. This is all accompanied regularly by an abrupt back that gives pieces an ergonomic shape, frequently maximising the mass of the butt of the flake.

EF-HR presents a series of uncertainties that cannot be solved through the available data. Kimura (2002:296) attributes the assemblage an important postdepositional alteration, but presents no arguments to support her conclusions. Actually, the material is in an exceptional state of preservation, which leads us to believe the clay-based artefacts were found in a primary position. Nonetheless, we lack certain elements from the *chaîne opératoire*, such as the cores which produced the large flakes. These flakes could have been taken directly to the site from raw material supply points. The following question is what were the objects transported to the site used for. These pieces sometimes weigh over one kilogram. We have already noted that their technical features indicate they were employed in heavy duty activities, which would certainly have been the case in view of their large size.

Nonetheless, bone remains are almost inexistent in this site. We are dealing with over 46 kilograms of worked raw material in an excavated surface no larger than 30 m², although the site was probably much bigger. Consequently, it seems obvious to think that, given the location of EF-HR, it was intensely occupied by hominids and focused on the production of enormous objects used for forceful activities. The currently unsolvable problem is discovering such activities. Until that day comes, we can at least state that the Olduvai hominids had developed a new technology. This new strategy allowed them to obtain large products they subsequently turned into other objects, an activity which, up until this site, had not been contemplated in the management of lithic resources in the region. The qualitative difference is, unquestionably, fundamental.

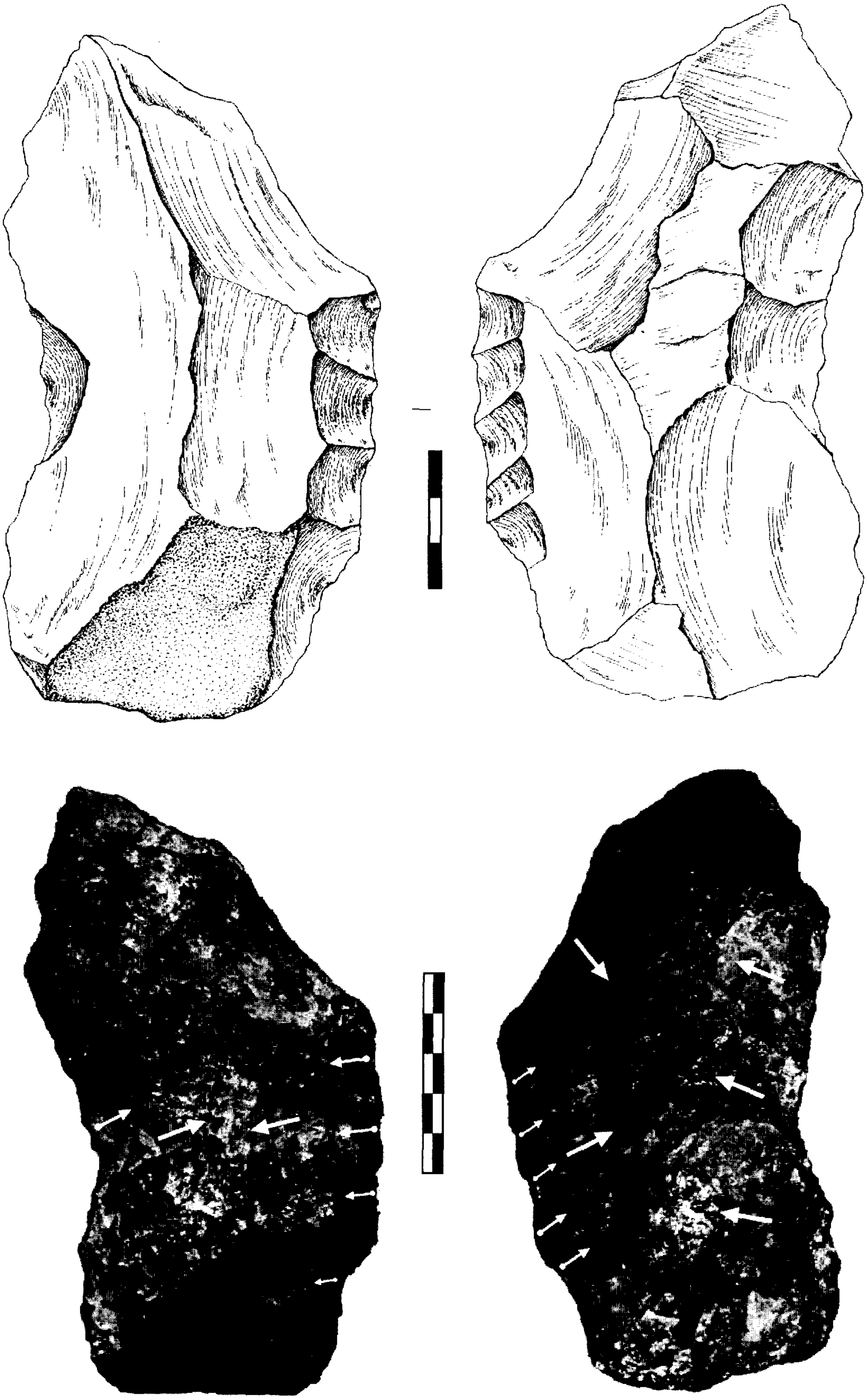

Figure 5.25. Quartz large cutting tool, indeterminate blank. Retouch only appears on the medial area and the right proximal area, with a bifacial continuous, simple method. The other scars do not seem to have been produced by retouching but by previous flaking of the core (drawn by N. Morán).

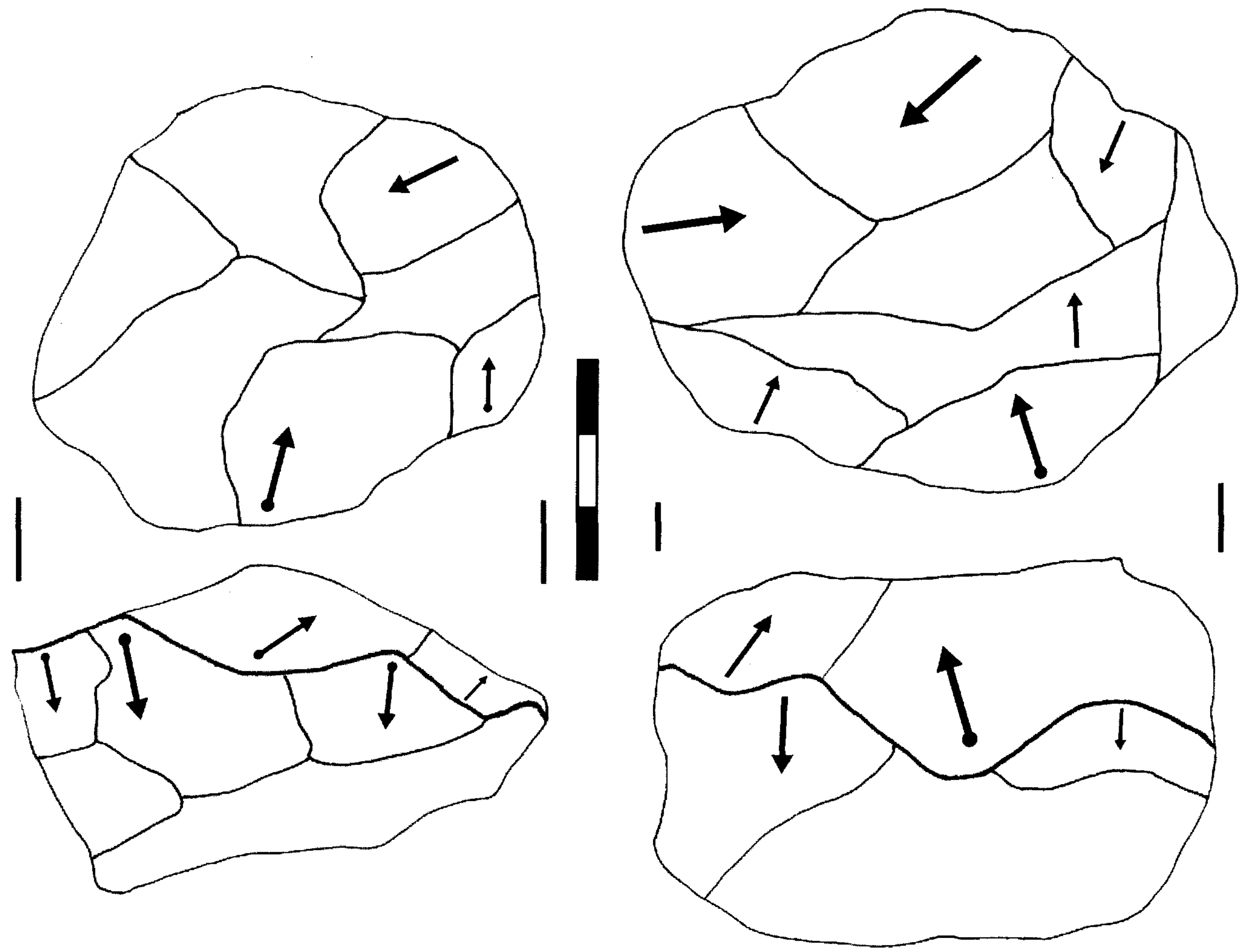

Figure 5.26. Basalt cores, bifacial peripheral system. This *débitage* is unrelated technically and metrically to the production of large blanks.

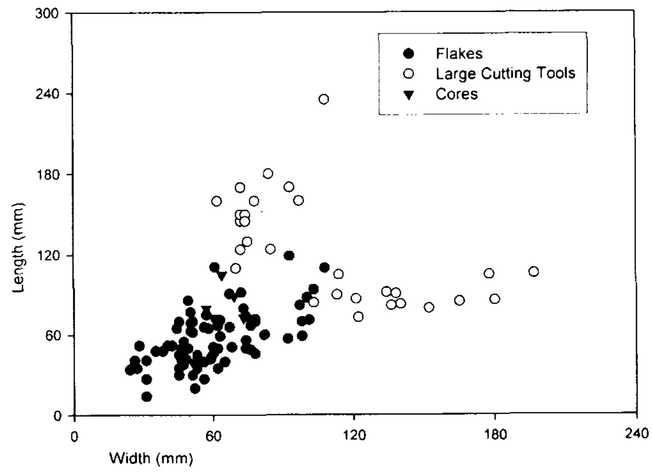

Figure 5.28. Dimensions of the main categories at EF-HR.

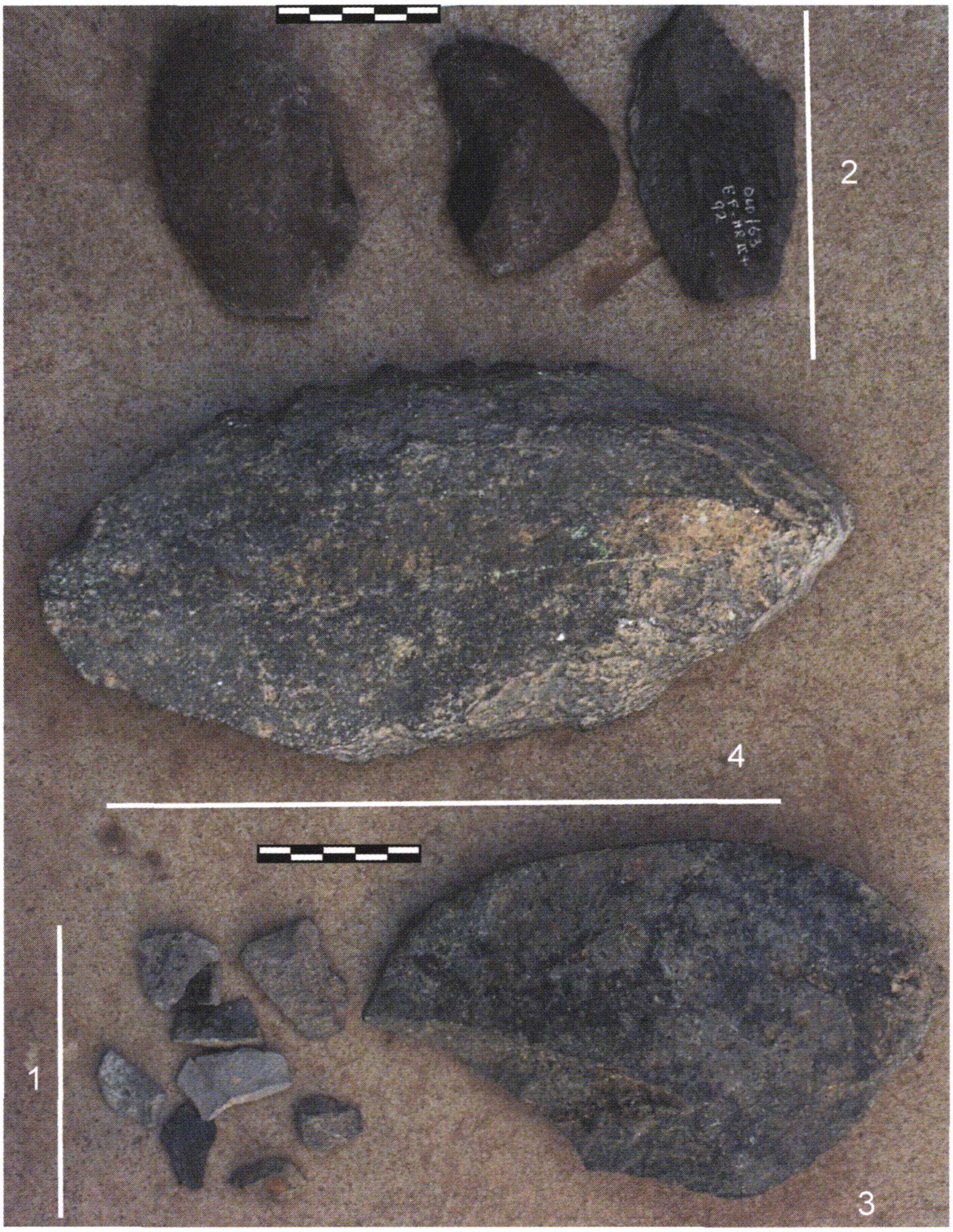

Figure 5.27. Main categories at EF-HR. 1: small-sized flakes; 2: medium-sized flakes for preparing cores for the detachment of large blanks; 3: large blank without retouching. It corresponds to the example drawn in figure 5.14 no. 2; 4: large cutting tool. It corresponds to the example drawn in Leakey (1971:129).

Chapter 6

FC WEST OCCUPATION FLOOR

Introduction

The FC West site is stratigraphically located in the Middle Member of Bed II, above Tuff IIB. Although it is more recent than EF-HR, the chronology of FC West also ranges near 1.6-1.5 my estimated respectively for Tuffs IIB and IIC (Manega 1993). Leakey (1971) opened a trench from the base of Bed III to the lower part of Bed II, locating two main archaeological levels, both in the Middle Member of Bed; FC West Occupation Floor (OF) and, right above it, level FC West Reworked Tuff.

FC West Reworked Tuff has a low archaeological resolution; the remains appeared in a thickness of 72 centimetres, and Leakey (1971:260) calculated a density of 7.6 pieces per m³. On the other hand, in FC West OF almost 1200 lithic artefacts and 127 bone remains were recovered from 51 m² of excavated surface, only 9 centimetres thick, which led Leakey (1971:260) to estimate a density of 92 pieces per m³, and Isaac and Crader (1981:64) to establish an average 67.2 artefacts per m². This makes FC West OF the densest concentration of remains in Olduvai Beds I and II (Petraglia & Potts 1994). Therefore, it is a well-defined assemblage that preserves a good part of its original archaeological integrity. In fact, given the sedimentary context the archaeological material appeared in – a clay paleosol similar to those typical of Bed I –, Leakey (1971:258) considered this level an occupation floor.

Despite these facts, Leakey (1971:157) assumed certain hydraulic alteration. Hence, she explicitly stated that the 251 unmodified cobbles and blocks recovered during the excavation could be natural, thus avoiding a reference to manuports (Leakey 1971:161). In this respect, Petraglia and Potts' insistence is surprising, since when referring to these 251 objects, they state that "*these stones were considered to be manuports carried by hominids to the site, an interpretation consistent with that of other sites (e.g. FLK-22) where plentiful manuports were found* (1994:240)". When speaking of FLK-22, arguments were presented rejecting an anthropic contribution

	Quartz		Lava		Gneiss		Chert		Total	
	n	%	n	%	n	%	n	%	N	%
Test cores	-	-	3	1.6	1	14.3	-	-	4	0.3
Cores	12	1.2	27	14.3	-	-	-	-	39	3.2
Core fragments	2	0.2	-	-	-	-	-	-	2	0.2
Large Cutting Tools	2	0.2	-	-	-	-	-	-	2	0.2
Small retouched pieces	13	1.3	-	-	-	-	-	-	13	1.1
Knapping hammerstones	27	2.7	57	30.2	-	-	-	-	84	7
Hamm. fract. angles	26	2.6	5	2.6	-	-	-	-	31	2.6
Anvils	6	0.6	1	0.5	1	14.3	-	-	8	0.7
Whole flakes	43	4.3	25	13.2	1	14.3	-	-	69	5.7
Flake fragments	405	40.3	20	10.6	-	-	-	-	425	35.4
Frag. < 20 mm	230	22.9	-	-	-	-	-	-	230	19.2
Angular fragments	211	21	12	6.3	2	28.6	-	-	225	18.7
Hammerstone fragments	23	2.3	7	3.7	-	-	-	-	30	2.5
Unmodified material	4	0.4	32	16.9	2	28.6	1	100	39	3.2
Total	1004	100	189	100	7	100	1	100	1201	100

Table 6.1. Lithic material studied in FC West Occupation Floor. We assume the 251 objects Leakey (1971) referred to as natural items are not included in the collection housed in the Nairobi Museum. Most of the objects classified as items without knapping and/or percussion traces mainly belong to those Leakey inscribed in the utilised cobblestones category. It is symptomatic that our recount of these pieces (n=39) is similar to Kimura's (2002:296), who counts a total of 35 so-called manuports.

of the unmodified material. This is not required in this section, since Leakey (1971) herself mentions the probable natural origin of the items. Thus, and although the unmodified material is contemplated briefly in the analysis (tabl. 6.1), these objects will be excluded from the study this chapter is based on.

Our constant insistence on the manuports issue is not trivial, in the case of FC West OF precisely taking into consideration the taphonomic implications. Petraglia and Potts (1994) turn to the weight of the objects to indicate the hydraulic alteration each assemblage underwent: the greater the percentage of very heavy objects, the more important the hydraulic disturbance that transported the smaller pieces. Their analysis concludes that, in terms of the weight of the objects, FC West OF is precisely the site presenting the greatest hydraulic alteration. Nonetheless, this outcome could be conditioned by the fact that their analysis included unmodified cobbles and blocks, which are generally heavy objects. Leakey (1971:164) totalled a number of 1184 lithic items, excluding the 251 unmodified blocks and cobbles. Petraglia and Potts (1994:242) counted up to 1196 pieces, and 1201 have been considered in this work. Our aggregate (tabl. 6.1) does not include the 251 objects Leakey (1971) identified as natural items, but does embrace a great number of pieces which both Leakey and Petraglia and Potts (1994) most probably considered modified, although they have been classified herein as pieces that have not undergone human alteration. This unmodified material totals 10,525 grams, which composes an important volume of raw material. If we subtracted those objects from Petraglia and Potts' (1994) calculations based on the weight ranges at FC West OF, that parameter would possibly no longer conclude that this level had experienced the greatest hydraulic alteration, if compared to all the sites they studied.

In any case, there do seem to be other arguments in favour of the assemblage having undergone certain taphonomic alteration. The documentation of two different concentrations in the dispersion of remains in FC West OF, for Leakey (1971:261) can be compared to a similar one located in FLK North, and for Petraglia and Potts (1994:247) appears as a hint towards the existence of space vacuums linked to fluvial processes. This fact, considered alongside the alteration of the edges of part of the stone pieces, would indicate the assemblage had experienced some disturbance. In all, and given the clay context, the vast amount of millimetric remains and the high quality preservation of most of the lithic material, post-depositional processes would only have affected the site lightly (Leakey 1971), perhaps transporting remains over a very short distance, not moving them far from their original location (Petraglia & Potts 1994).

General characteristics

Leakey (1971:157) underscored the prevalence of quartz as the most used raw material, and mentioned choppers as the most profuse artefacts, alongside 5 fragments of bifaces and a vast amount of *débitage*. Our classification (tabl. 6.1 and fig. 6.1) offers different results. The first issue is linked to the raw material; table 6.2 shows that, as regards absolute frequencies, quartz objects are up to five times more abundant than lava pieces. When turning to statistical evidence to compare their proportional distribution by category (fig. 6.2), it becomes obvious that (as occurs in some FLK North levels) there is an overrepresentation of lava cores and hammerstones to the detriment of quartz objects. The low number of lava items is concentrated in specific categories, precisely those that are stand out in the Lien test (fig. 6.2), whilst quartz objects are more diversified in the different technological categories. Nonetheless, and differing from the sites in Bed I, here in FC West basalt is very high quality, with a very fine texture, without irregularities, and almost always comes from streams. On the other hand, quartz is predominantly tabular (although there are a great number of quartz stream cobbles).

As well as comparing absolute frequencies, the analysis has also included a classification of the different categories based

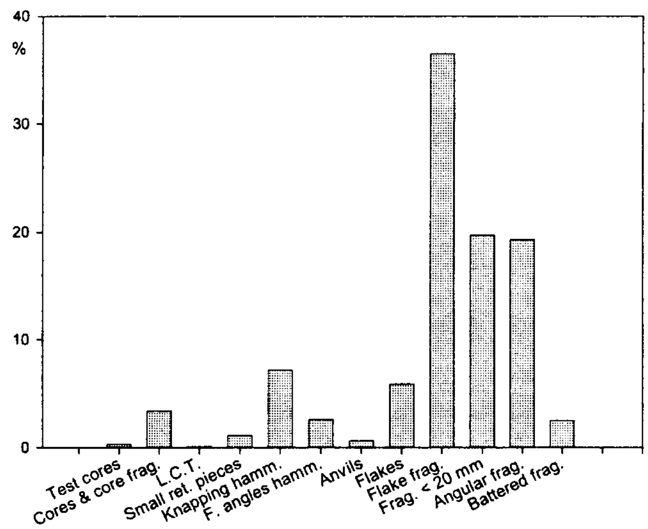

Figure 6.1. General lithic categories at FC West OF.

	Quartz		Lava		Total	
	n	%	n	%	N	%
Test cores	-	-	3	1.9	4*	0.3
Cores	12	1.2	27	17.1	39	3.3
Core fragments	2	0.2	-	-	2	0.1
Large Cutting Tools	2	0.2	-	-	2	0.1
Small retouched pieces	13	1.3	-	-	13	1.1
Knapping hammerstones	27	2.7	57	36.3	84	7.2
Hamm. fract. angles	26	2.6	5	3.1	31	2.6
Anvils	6	0.6	1	0.6	8*	0.6
Whole flakes	43	4.3	25	15.9	69*	5.9
Flake fragments	405	40.5	20	12.7	425	36.5
Frag. < 20 mm	230	23	-	-	230	19.7
Angular fragments	211	21.1	12	7.6	225*	19.3
Hammerstone fragments	23	2.3	7	4.4	30	2.5
Total	1000	100	157	100	1162*	100

Table 6.2. Lithic categories at FC West OF, excluding all the unmodified objects. (*) Including gneiss pieces.

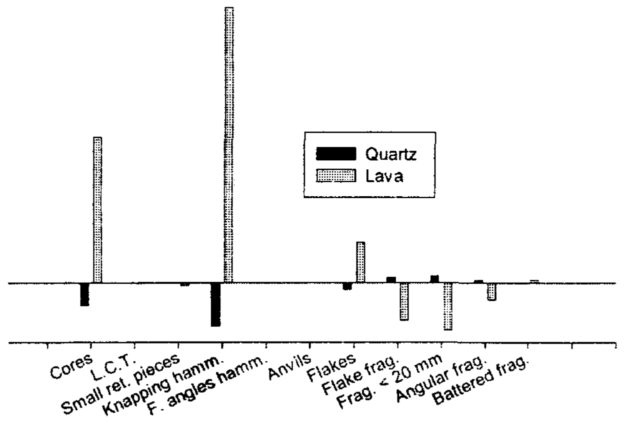

Figure 6.2. Lien Test comparing frequencies of lithic categories and raw materials.

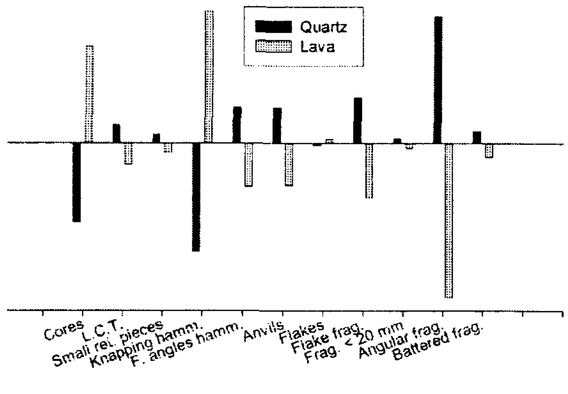

Figure 6.3. Lien Test comparing the weight of lithic categories and raw materials.

	Quartz	Lava	Total
Cores	4822	12047	16869
Large Cutting Tools	1290	-	1290
Small retouched pieces	590	-	590
Knapping hammerstones	10626	21857	32483
Hamm. fract. angles	7163	1898	9061
Anvils	4402	673	5075
Whole flakes	1328	1756	3084
Flake fragments	5478	781	6259
Frag. < 20 mm	321	-	321
Angular fragments	11572	769	12341
Hammerstone fragments	839	-	839
Total	48431	39781	88212

Table 6.3. Weight in grams of each category. These calculations should be considered alongside the 1461 grams of worked gneiss. In total, the modified lithic material in FC West Occupation Floor amounts to 89673 grams.

on the number of worked kilograms of each raw material (tabl. 6.3). Compared to sites like FLK North or FLK Zinj (in which the total weight of the lavas was finally greater than that of the quartzes, contrary to the absolute frequency trend), in FC West OF the global weight of worked quartz surpasses that of the lavas. The statistical comparison of the number of kilograms for each category (fig. 6.3) confirms the trend observed in figure 6.2 (predominance of lavas among cores and knapping hammerstones), but also underlines the imbalances in favour of quartzes as regards the following categories: chunks, flake fragments, anvils and hammerstones with fracture angles.

There is an overrepresentation of lavas as regards quartzes in terms of the use of knapping hammerstones (fig. 6.2 and 6.3), although this trend is documented in practically all analysed sites. The original morphology of the lava cobbles makes them ideal blanks as knapping hammerstones, an aspect that led hominids to prefer these objects, aware of the advantages. There is, nonetheless, one exception, since FC West OF presents numerous quartz stream cobbles, which were also used as hammerstones. In fact, figure 6.3 shows that hammerstones with fracture angles are proportionally more important in quartz than in lava.

The second great discordance in the representation of quartzes and lavas appears in the core category. Despite the quartz *débitage* being much greater than the lava *débitage* (including flakes, so-called flake fragments and debris, quartzes total 678 pieces compared to 45 lava objects), the number of lava cores is unexplainably greater (n=27) than quartz cores (n=12).

With an average 5.75 detachments per core, the minimum number of scars is set at 2 and the maximum at 14. If we implement McNabb's (1998) predictions, we would have a range of 24-168 quartz flakes and 54-378 basalt flakes. These estimations are far from the real recounts, especially as regards lavas where, as in other sites, there is a chronic deficit of *débitage* products. Hypotheses to explain the absence of lava knapping products were already explored in the description of FLK North. The same interpretations (output of lava flakes, input of cores/flaked lava artefacts) can also be applied for FC West OF, and will, therefore, be re-examined in the general synthesis included in chapter 9. In any case, we once again encounter a very important deficit of lava *débitage* in terms of the number of cores, a lack that becomes even more noticeable upon observing that those lava cores double the amount of quartz cores, whilst the *débitage* total for the latter almost increases the amount of lava fivefold.

Knapping products

FC West OF presents 69 whole flakes, 62% of which are made of quartz and the rest are in basalt, except for a single example in gneiss. Lava flakes are generally larger than quartz flakes (fig. 6.4). In fact, the 25 basalt flakes total quite a lot more grams of raw material than the 43 grams of quartz (see tabl. 6.3). Their dimensions were compared statistically (T Test for independent samples) and the results demonstrated there is no equality either in terms of the dimensions or the variations, therefore concluding that there is a significant difference of flakes in terms of the raw material (tabl. 6.4 and 6.5). In any case, all the flakes from FC West OF are included in a size range between 20-60 mm (fig. 6.5). Although there

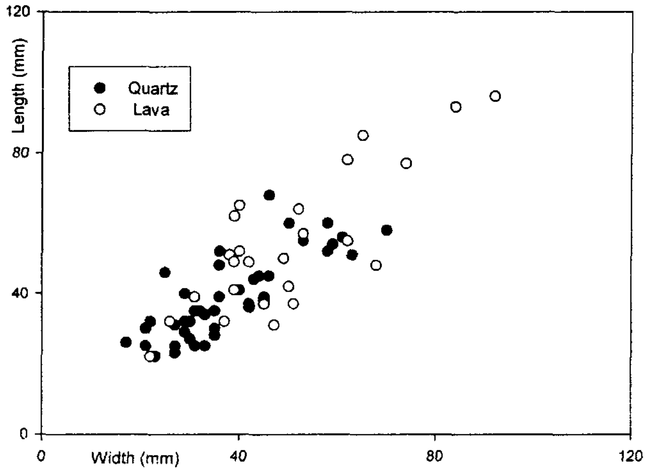

Figure 6.4. Dimensions of the whole flakes.

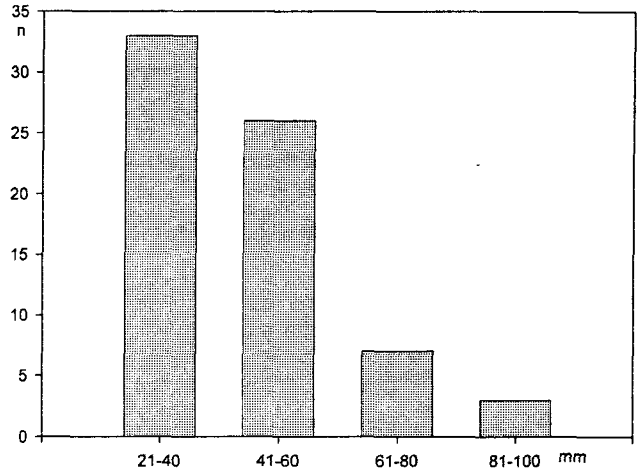

Figure 6.5. Length patterns in the whole flakes.

	Minimum	Maximum	Mean	Std. deviation
Length	22	68	39.23	11.85
Width	17	70	38.26	12.797
Thickness	6	37	15.44	6.891
Weight	3	123	30.88	27.984

Table 6.4. Size of the quartz whole flakes (mm and grs.).

	Minimum	Maximum	Mean	Std. deviation
Length	22	96	53.76	19.787
Width	22	92	49.88	17.13
Thickness	7	46	17.32	10.447
Weight	4	387	70.24	91.253

Table 6.5. Size of the lava whole flakes (mm and grs.).

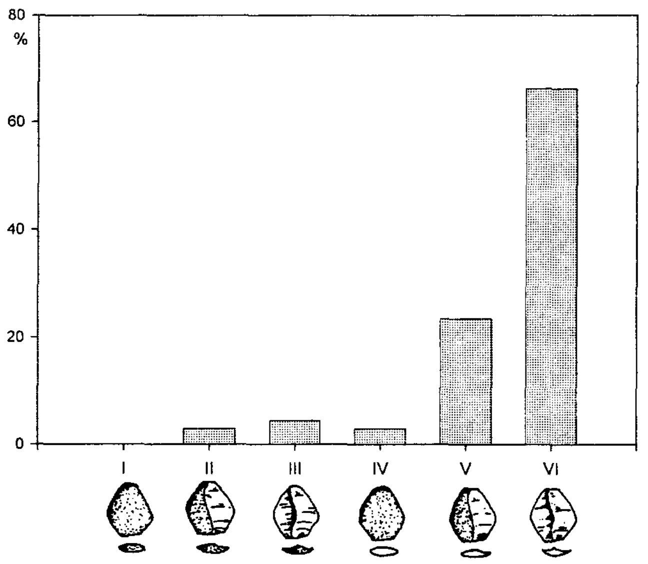

Figure 6.6. Types of flakes according to Toth´s (1982) classification.

Dorsal face	Striking platform				Total	
	Cortical		Non-cortical			
	N	%	N	%	N	%
Full cortex	-	-	2	2.9	2	2.9
Cortex > 50%	2	2.9	5	7.4	7	10.3
Cortex < 50%	-	-	13	19.1	13	19.1
Non-cortical	3	4.4	43	63.2	46	67.6
Total	5	7.4	63	92.6	68	100

Table 6.6. Cortical frequencies in the whole flakes.

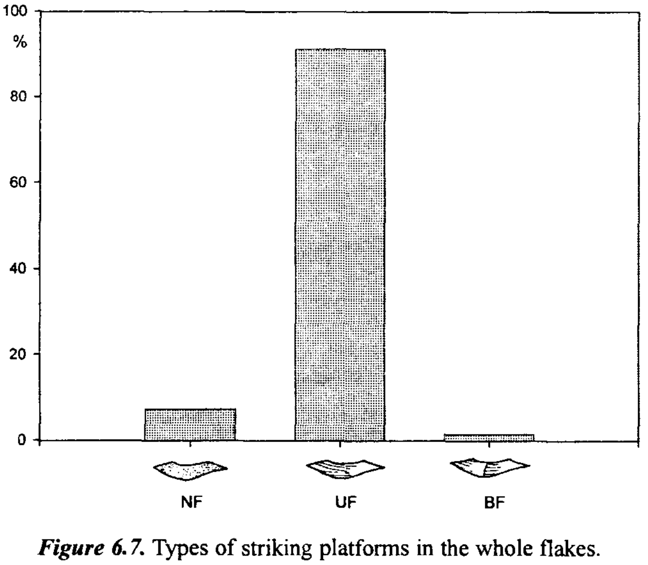

Figure 6.7. Types of striking platforms in the whole flakes.

are a few larger examples, this site does not present the large flakes production system described in EF-HR.

As regards the technical specifications, no initial flaking products have been documented, with less presence of examples with cortex remains on their dorsal faces (tabl. 6.6 and fig. 6.6) in this level than in others. It is generally a case of flakes produced via previously modified platforms, although the butts are not usually faceted (fig. 6.7). The examples represented in fig. 6.8 and 6.9 show that both the quartz and basalt flakes were produced using an effective *débitage* system. With an average 2.8 previous scars on their dorsal faces, these flakes also seem to indicate various knapping systems. Consequently, figure 6.10 shows that, despite

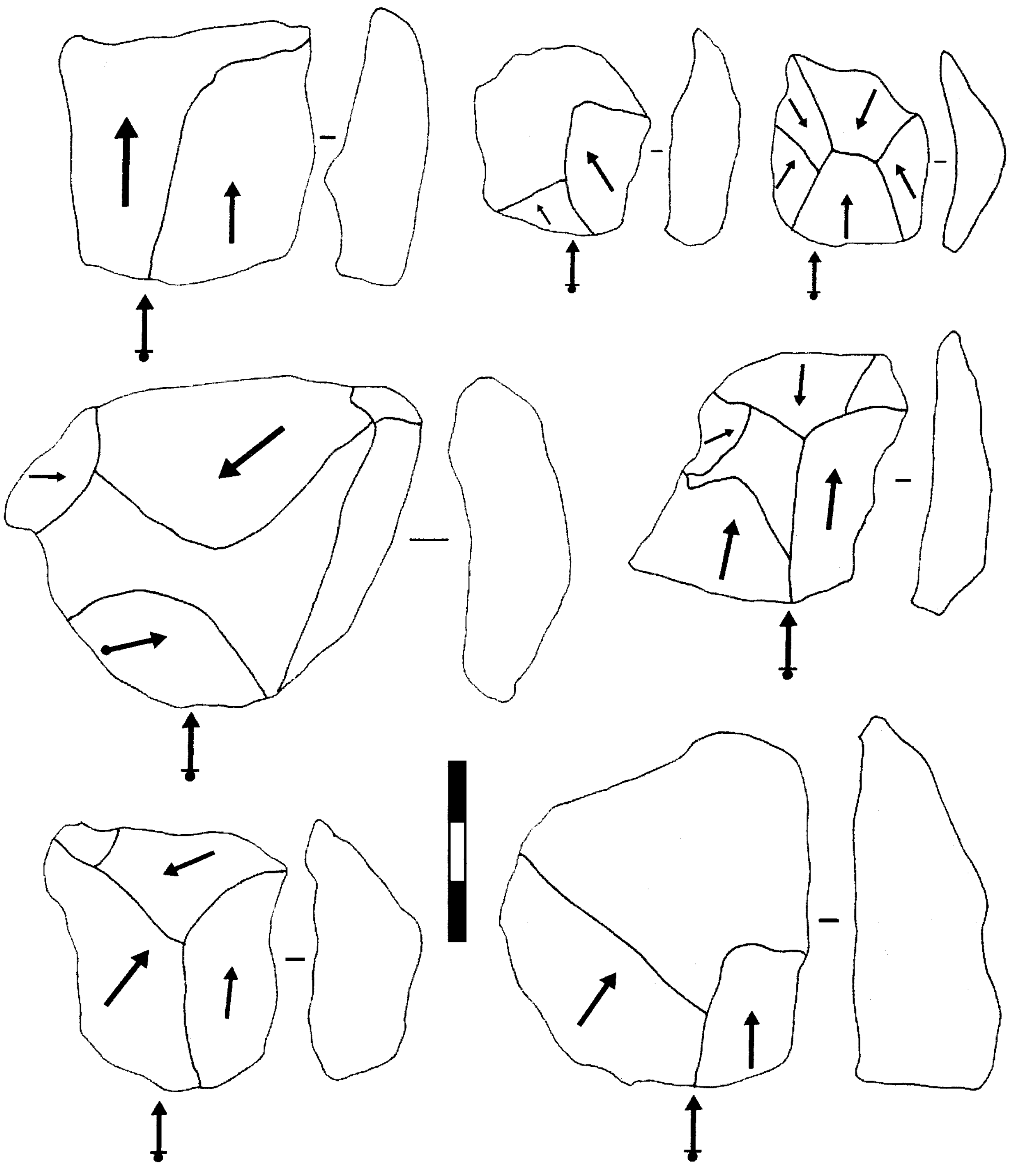

Figure 6.8. Quartz flakes at FC West OF.

the prevalence of unidirectional knapping, several flakes also indicate partial core rotation (transversal pattern). Furthermore, some examples denote a more structured management of the knapping surfaces, which were exploited from different directions during the same reduction sequence.

There is a vast amount of flake fragments. This profusion is restricted to the production sequences for quartz (tabl. 6.2), since all *débitage* categories are underrepresented as regards lava items. The same occurs with remains under 20 mm and quartz chunks. With regard to debris, the relative abundance among quartzes suggests both that lithic activities were per-

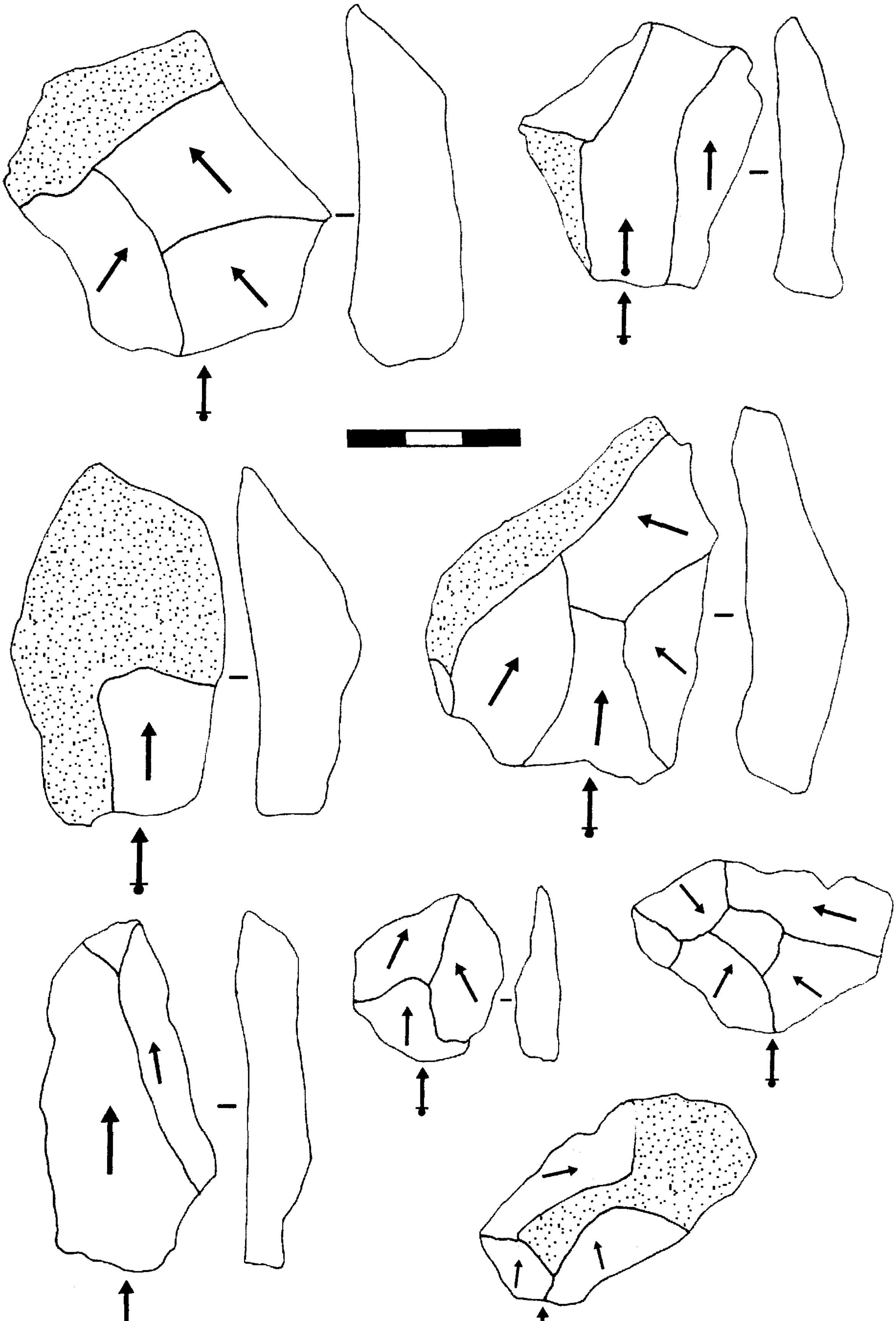

Figure 6.9. Basalt and phonolite flakes

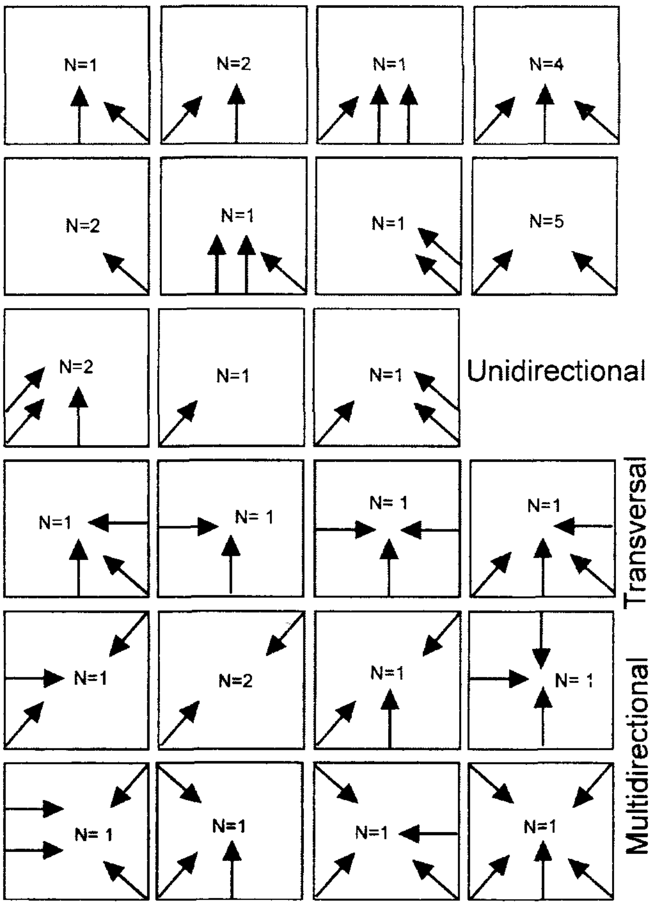

Figure 6.10. Diacritic schemes of the whole flakes.

formed *in situ*, and also that there was no severe hydraulic disturbance in the site. On the other hand, the fact that not a single basalt or phonolite chip has been documented is surprising, and seems to reject the consideration of the production of lava *débitage* being carried out in FC West OF, even partially. This lack of lava debris complements the lava flake deficit, thus consolidating the idea that practically all the basalt and phonolite material was flaked before it entered the site.

With reference to chunks, it is easy to assimilate the deficit as regards lavas (it simply follows the general pattern for *débitage* in this raw material), but it is not that easy to explain the great abundance among quartzes. Quartz chunks compose 21.1% of that raw material, five times more frequent than flakes. As occurred in FLK North, we think that in FC West OF a good part of these fragments must have involuntarily detached from the quartz hammerstones and anvils during percussion processes. Although we have calculated that only 19.6% of these chunks presents battering on any of their surfaces, given their small size, we cannot exclude the fact that the number of pieces of this type generated by percussion processes (not knapping processes) were greater. In fact, a good part of the 425 flake fragments counted could, in fact, be nothing of the kind; as demonstrated in the chapter dedicated to FLK North, percussion activities generate fragments that can be mistaken for broken flakes.

Despite this equifinality regarding the analytical allocation of each object, in FC West OF two arguments appear as the grounds to assign a good part of the so-called quartz *débitage* to percussion processes; one is the actual overabundance of categories like the so-called flake fragments or chunks, which are too abundant if compared to the percentages of quartz cores or the flakes themselves. The second argument appears in the vast amount of quartz hammerstones. Many of these items are hammerstones with fracture angles, and therefore the corresponding detached fragments should also be present. In our opinion this is, actually, the case; the fact is that normally these fragments have been included in *débitage* categories, thus mistaking the processes by which they were generated. The scope of this reinterpretation of the fragments is quite significant, since we are referring to over 16 kilograms of raw material (tabl. 6.3) which could be assigned to percussion processes and not to *débitage*, which would, in its turn, lead to a substantial modification of the general interpretation of the activities performed in FC West OF.

Cores and knapping systems

Notwithstanding the previous paragraph, knapping activities were also relevant in FC West OF. Given the metric differences observed between quartz and basalt flakes, an initial analysis was performed to see if basalt cores were also larger than quartz ones. The graphic in figure 6.11 shows that quartz cores are smaller than lava cores, but are in the same size range. Means were compared via Student's T Test considering both the length and the weight. This test concluded that there are no significant differences regarding the dimensions in terms of the raw material. Therefore, statistical comparisons cannot be used to consolidate the hypothesis suggested when describing flakes, for which there is a statistically significant difference regarding the dimensions of the different raw materials. Thus, it seems that the average dimensions (tabl. 6.7) are valid for the whole sample of represented cores.

Given the number of cores and whole flakes (tabl. 6.2), it has been estimated that among the quartzes there is an average of

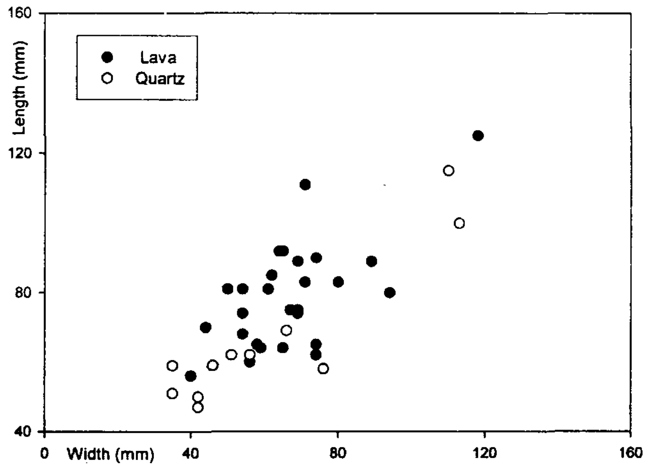

Figure 6.11. Dimensions of the lava and quartz cores.

	Minimum	Maximum	Mean	Std. deviation
Length	47	125	75.42	18.011
Width	35	118	65.18	19.871
Thickness	22	100	49.18	15.598
Weight	41	2049	387.92	378.117

Table 6.7. Dimensions of the cores (mm and grs.).

3.5 flakes per core. This coincides with the rates observed for quartz cores, with an average of 5.5 scars from previous detachments. If whole flakes are considered alongside flake fragments (assuming that at least one part of them was effectively produced by *débitage* activities), the results are coherent regarding the proportion of products/cores. That is to say, there are no imbalances between the cores and flakes, and the *débitage* activities performed when exploiting the quartzes were performed in the site itself.

The complete opposite occurs with lavas. If test cores are considered alongside cores and the number of items is compared to the number of lava flakes (tabl. 6.2), the resulting proportion is 0.8 whole flakes per core. This is obviously impossible. Especially since an average 5.86 previous detachments have been counted on each core, and some examples present up even to 14 previous scars. If this is considered alongside the lack of knapping waste and the general scarcity of all *débitage* categories, it seems even more obvious that in FC West OF lava cores were taken to the site, but no knapping processes were performed *in situ*.

In other cases like FLK North we could offer an alternative hypothesis, stating that perhaps the initial flaking of the cores was performed in the site and that the basalt flakes were subsequently exported, leaving the cores in the site. This hypothesis, albeit highly improbably, could at least be contemplated as an alternative. Yet, in FC West OF, that possibility cannot even be considered, since the total lack of lava chips discards the thought of the cores being worked *in situ*, and the abundant profusion of millimetric quartz fragments rejects taphonomic causes being used to explain the deficit of lava debris. Thus, there is no other solution but to assume lava cores were transported to FC West OF but were not knapped in the site. This, obviously, supposes a conceptual contradiction which would call for a re-examination to conclude whether these objects are in fact cores, as stated over the last decades (Toth 1982; Isaac 1986; this work), or artefacts, as Leakey (1971) proposed originally, an idea that has been rescued in recent years (Kimura 1997, 1999). It is a complex matter and should be dealt with comprehensively, as we will do in chapter 9.

As regards reduction strategies, and despite the low number of tools among quartzes (n=12), they do not seem to have been manipulated following a different exploitation pattern than lavas, since quartz cores appear in all knapping varieties. In fact, an χ^2 was performed representing the distribution of knapping systems by raw material, although it did not provide any significant differences. Consequently, a joint study of the exploitation systems can be performed without segmenting the sample by raw materials. Figure 6.12 shows that the commonest reduction method was the bifacial abrupt mode (31.6%), followed by the unifacial abrupt system (23,6%).

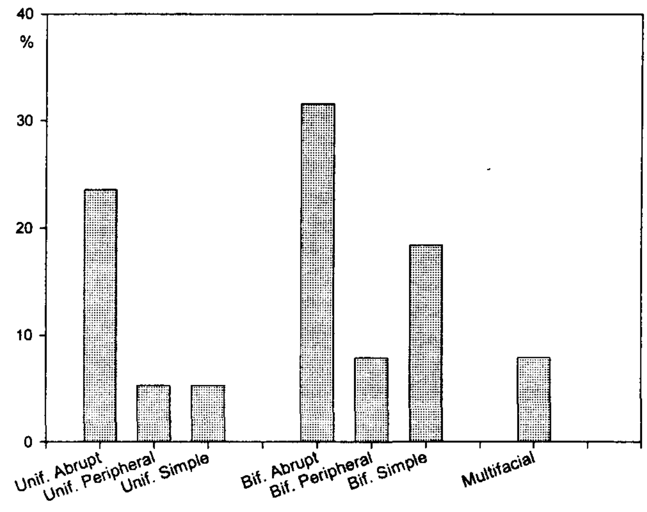

Figure 6.12. Knapping systems in the cores from FC West OF.

These methods will not been furthered in this section, since they have been described in preceding chapters. Nevertheless, there is room for a reflection on the issue of whether these large lava objects are cores or artefacts. In particular, the discrimination between exploitation edges with simple or abrupt angles (de la Torre & Mora 2004) was performed with a view to assessing the functional potential of the objects: whilst the edges with simples angles (unifacial and bifacial choppers) could, in principle, have a functional significance, the abrupt systems are unavoidably connected to flakes extraction, since the surfaces created cannot be used in any other context beyond *débitage*. In FC West OF most cores correspond to an abrupt exploitation system (fig. 6.13), and therefore, in this case, it would be logical to think that they were blanks for flakes extraction, not artefacts. However, at this point in the line of argument, the same contradiction reappears: if they were really cores, where are the lava flakes?

The following group, in terms of relevance among exploitation systems, encompasses the choppers, both unifacial (5.3%) and, mainly, bifacial (18.4%). If choppers were artefacts imported directly to the site (which would explain the deficit of lava flakes), this type of object would have been made mainly in basalt or phonolite. Although, as aforementioned, a global χ^2 was performed with all the cores and it proved no significant differences in the distribution of knapping systems, another χ^2 was carried out solely comparing the presence of choppers by raw material. Nonetheless, the statistical test showed that there is a homogenous distribution of quartzes and lavas, thus ruling out the possibility of arguing that lava choppers were imported to the site preferably. This once again underlines the contradiction inherent to the deficit of flakes. To make the matter even more complicated, there

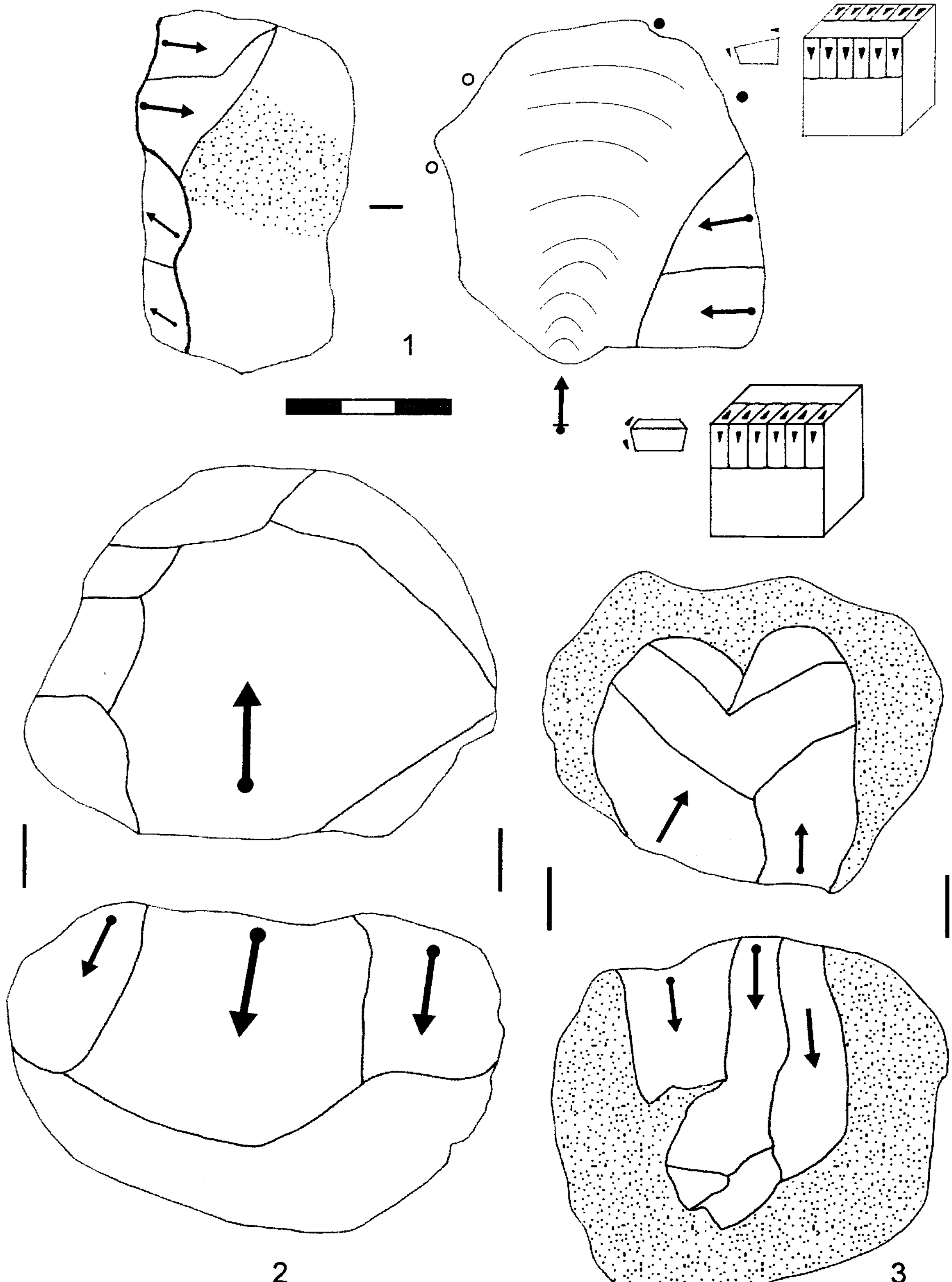

Figure 6.13. 1: core on a unifacial abrupt phonolite flake with independent planes; 2-3: lava cores exploited following the bifacial abrupt partial method.

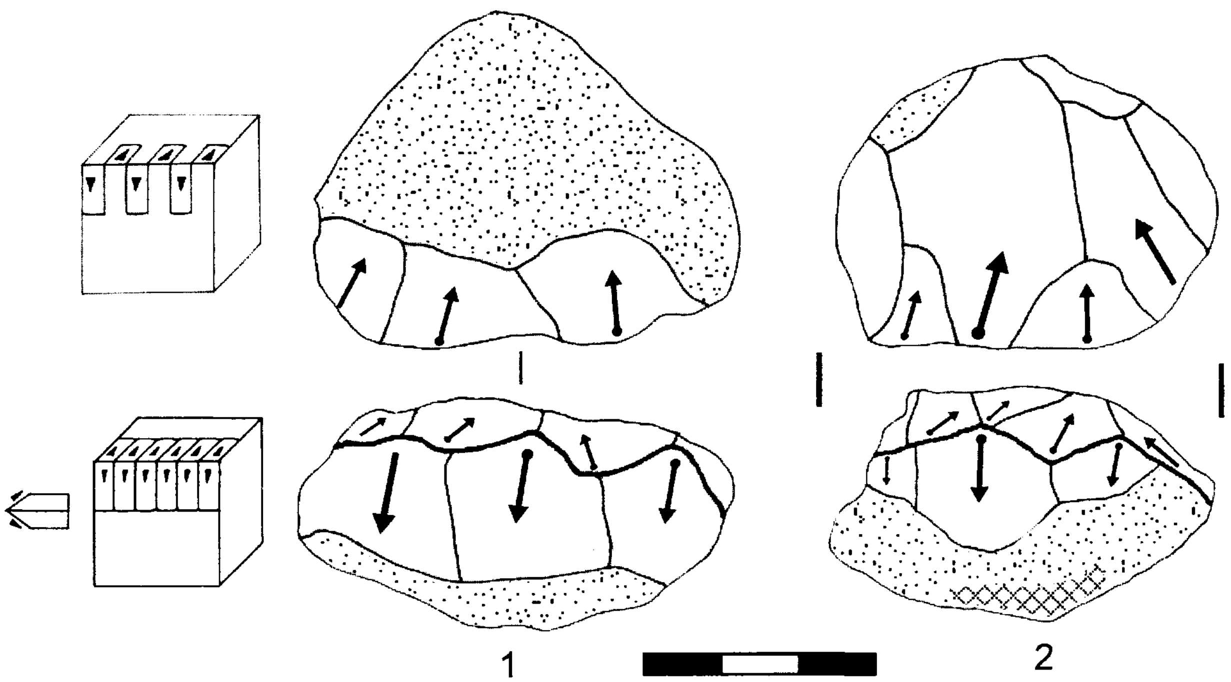

Figure 6.14. Examples of the bifacial simple partial system. In these cases the management of the edge is performed alternately, therefore they could also be classified in the bifacial alternate partial method defined in DK. Note the small size of the two cores, both in basalt (1) and in quartz (2). The quartz example also presents signs of battering on the cortical base.

are some examples of the bifacial simple partial system that are surprisingly small-sized (fig. 6.14). This makes it hard to conceive them as blanks for flake production. In all, there are contradicting arguments, some for and some against the distribution of these objects in core or artefact categories, without any of them contributing to explain the manifest lack of lava *débitage*.

The peripheral exploitation system used for the horizontal plane, both via the preparation of platforms (bifacial peripheral) and natural platforms (unifacial peripheral), provided 5 examples in FC West OF, composing 13.2% of the total amount of cores. Both the unifacial and bifacial examples (fig. 6.15) seem more structured than the older sites like DK or FLK Zinj, and in several cases only a mere nuance stops them from being included in the bifacial hierarchical centripetal system. In any case, the management of the cores reveals a capacity to exploit certain knapping surfaces systematically and rejuvenate exhausted planes (fig. 6.16), and therefore contrasts with the superficial reduction most of the unifacial and bifacial choppers were subjected to.

In all, FC West OF presents a high number of cores that underline the variability of the knapping methods employed. Cores are an average 7 centimetres long (maximum length) (tabl. 6.7) and, in view of the scars preserved on the cores, the resulting flakes would be approximately 3-5 centimetres, which in fact coincides with the information for knapping products. Nonetheless, this distances the *chaîne opératoire* documented for FC West OF from the production of large blanks, implicit in the strategies observed in EF-HR, an older

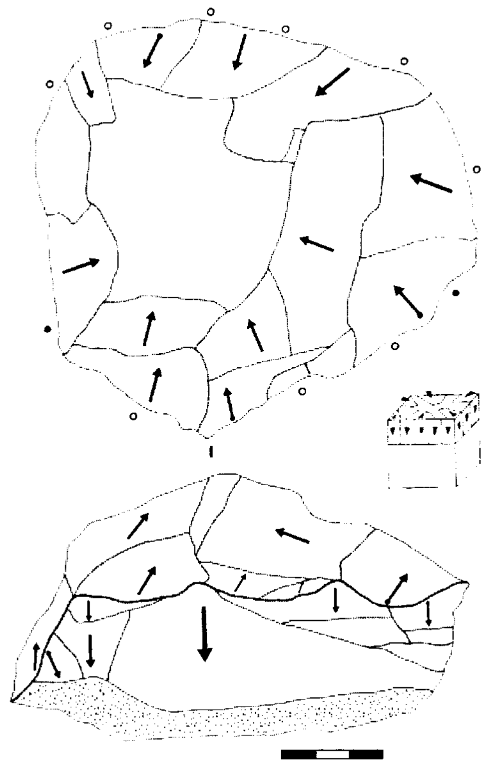

Figure 6.15. Basalt core classified as bifacial total peripheral. This is a good example of the difficulty involved in allocating cores to specific knapping systems, since this piece presents a simple angle edge on both planes that could inscribe it in the chopper group. Nonetheless, the exploitation throughout the whole periphery of the piece and the recurrent exploitation led to its inclusion in the bifacial peripheral model.

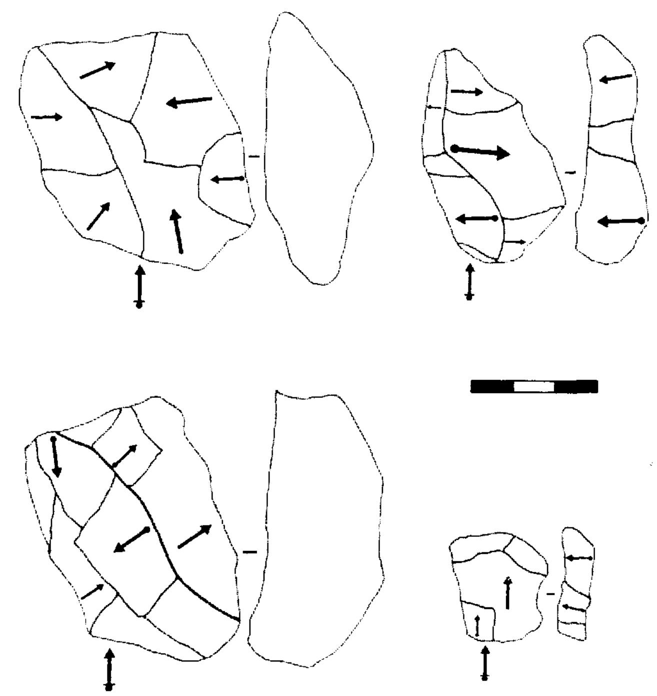

Figure 6.16. Edge-core flakes that show the rejuvenation of the cores' bifacial edge. It is symptomatic that all examples are in quartz, strengthening the idea that this raw material was reduced *in situ*, whilst there are no documented examples of rejuvenation among the lavas.

site. Therefore, these conclusions call for an analysis of the retouched blanks with a view to furthering the differences or similarities that could appear between the two sites.

Retouched objects

FC West OF presents 13 small retouched pieces. Although all the pieces are made of quartz, it is hard to sustain that this is due to a preferential selection of this raw material, since it probably only perpetuates the deficit trend observed among lava *débitage*. Neither is there a selection of retouching blanks in terms of their size; comparing the length and weight of the whole quartz flakes and the retouched objects (tabl. 6.8) using Student's statistical T test shows a parity in the means of both categories. Nonetheless, all retouched objects were created on flake fragments, not whole products. Therefore, there are no grounds to exclude the fact that the original blanks could have been larger.

Leakey (1971:160) mentioned the prevalence of side scrapers, and also referred to the presence of two awls and a burin.

	Minimum	Maximum	Mean	Std. deviation
Length	27	79	45.23	13.299
Width	23	53	35.54	8.599
Thickness	14	38	18.62	6.104
Weight	14	140	45.38	32.875

Table 6.8. Dimensions of the small retouched pieces (mm and grs.).

However, we have interpreted the two so-called awls as simple flake fragments, and the piece Leakey classified as a burin is actually a Siret flake, mistaken once again as in the DK and FLK Zinj cases. Among the objects considered herein as genuine retouched items (fig. 6.17), there is a predominance of lateral side scrapers, with 7 objects, followed by denticulate side scrapers, with 5 objects, and a single case that could be classified as an end scraper. Small-sized retouched objects only compose 1.1% of the total number of items in the collection and total a mere 590 grams in the over 88 kilograms of worked lithic material. In any case, and since other categories like debris and fragments (in terms of absolute frequencies) and cores and hammerstones (in terms of the global weight of each category) undervalue the percentage-based representation of retouched objects, it is more operative to compare the number of these pieces in terms of the amount of flakes. In undertaking this task, the results show that the percentage of retouched objects is much greater than in older sites, and consequently (yet without forgetting that in FC West OF they compose an irrelevant sample) the quantitative increase of these retouched items compared to other previous sites is underscored.

The presence of large cutting tools is not evident in FC West OF either. Leakey (1971) stated that in this site there were only five bifaces, all fragmented. Considering the objects Leakey classified as bifaces, in our opinion only two genuinely belong to the large cutting tools category, with the other being three simple chunks (fig. 6.18). As regards the two which do seem authentic (fig. 6.19 and 6.20), they are both fragmented, as Leakey asserted, and therefore provide a limited amount of technological information. The example in figure 6.19 indicates the hominids in FC West OF also obtained large flakes, in this case broken by the technical accident of a Siret fracture, and proves a production of large flakes that is not represented, however, in the cores documented in the site.

On the other hand, the example in figure 6.20 involves the shaping of a large tabular block made of quartz, in which both sides are managed unifacially in order to create a edge which probably broke during the retouching process, when the knapper was trying to create a pointed area on the distal end. The *façonnage* method, which corresponds to a rhomboidal reduction system, will be explained in detail based on examples from TK; therefore we will not dedicate more time to it in this section. At present it is important to underscore the relevance of the documentation of large pieces which (albeit scarce in number compared to the frequencies of other categories) at least prove the fact that the hominids in FC West OF shared the technological knowledge of those who generated the EF-HR inventory, and those who would subsequently form the TK site.

Percussion objects

In FC West OF, the three percussion objects categories (knapping hammerstones, hammerstones with fracture angles, and

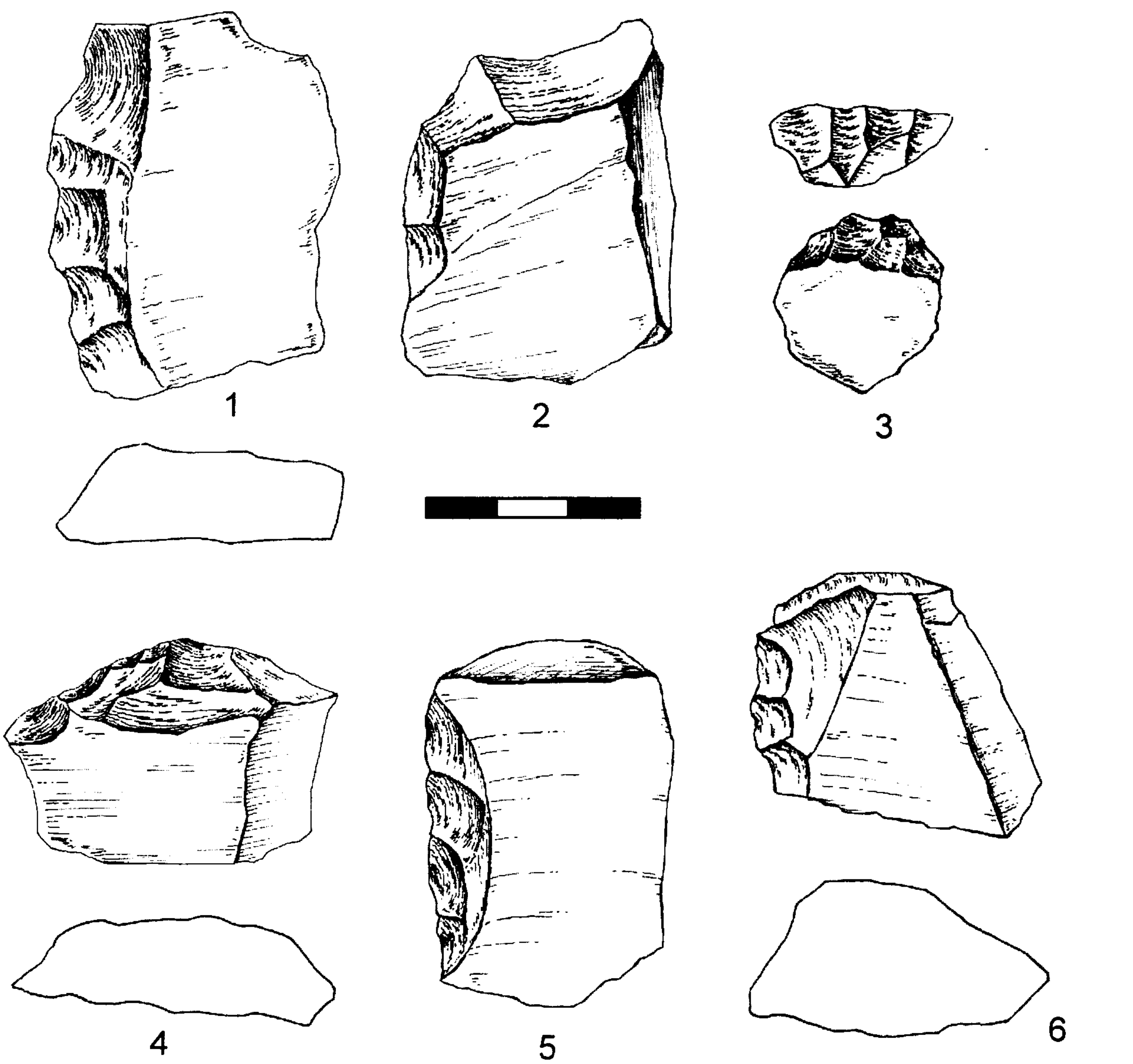

Figure 6.17. Quartz small retouched pieces. 1-2: denticulate side scrapers; 3: possible end scraper; 4-6: lateral and transversal side scrapers (drawn by N. Morán).

anvils) compose 46,619 grams of the 88 kilograms of worked lithic material. The fact that over half of the raw material was invested in objects linked to percussion indicates the relevance these activities must have had in the site. The distribution of the different objects by raw material has been referred to above: knapping hammerstones are mainly in lava, whilst hammerstones with fracture angles are mainly in quartz (see again fig. 6.2 and 6.3).

Table 6.9 and 6.10 and figure 6.21 show that both knapping hammerstones and hammerstones with fracture angles are similar in size. The statistical test envisaging a comparison of the different means using Student's T test confirms that there are no significant differences between both samples. Knapping hammerstones are generally good quality items, being fine grain phonolites and lavas stream cobbles. Their average size and weight (tabl. 6.9) make them suited for

	Minimum	Maximum	Mean	Std. deviation
Length	43	113	74.25	16.239
Width	29	95	60.8	14.27
Thickness	26	89	48.24	13.095
Weight	86	1128	345.3	211.062

Table 6.9. Dimensions of the knapping hammerstones (mm and grs.).

	Minimum	Maximum	Mean	Std. deviation
Length	39	110	68.77	15.485
Width	37	85	59.26	13.254
Thickness	28	71	48.9	12.637
Weight	76	633	292.29	161.49

Table 6.10. Dimensions of the hammerstones with fracture angles (mm and grs.).

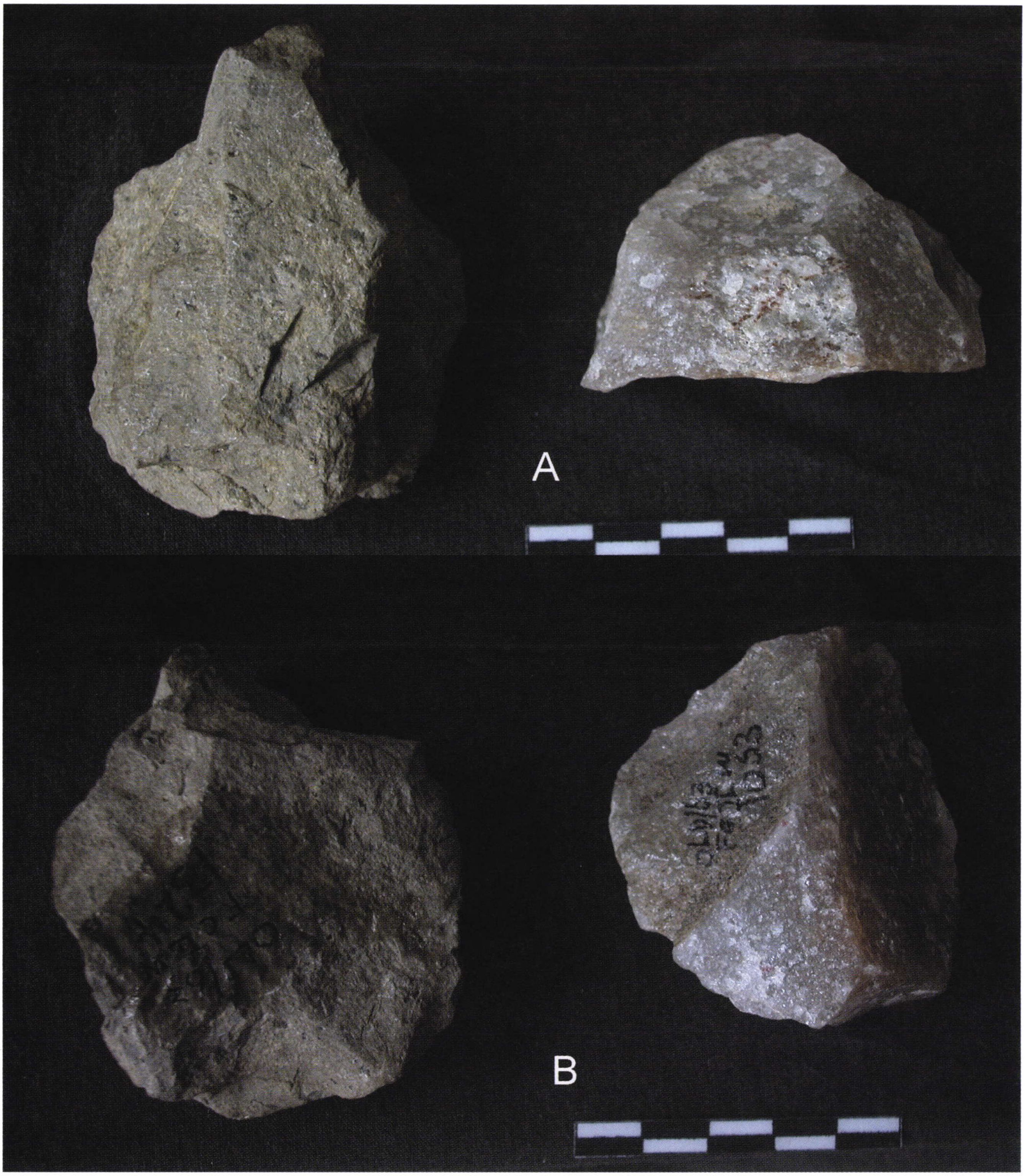

Figure 6.18. Pieces Leakey (1971) classified as broken bifaces. In our opinion, they do not present any characteristic that allows for their consideration even in the retouched objects category, therefore, despite their large size, we have classified them as chunks or flake fragments. A: dorsal face; B: ventral face.

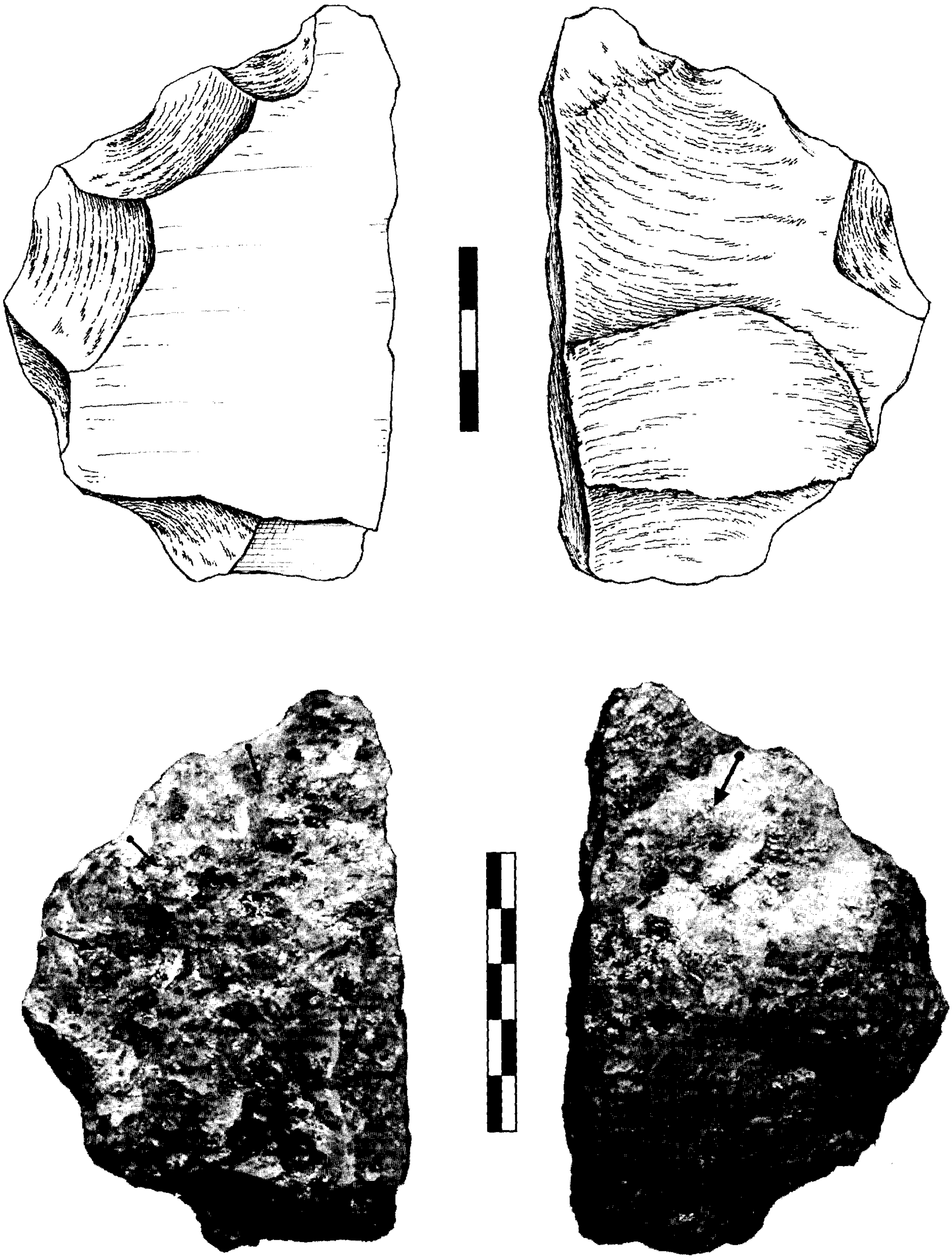

Figure 6.19. Large cutting tool on quartz flake fragment, broken by the Siret accident. The *façonnage* could be performed with the soft-ham mer technique (drawing: N. Morán).

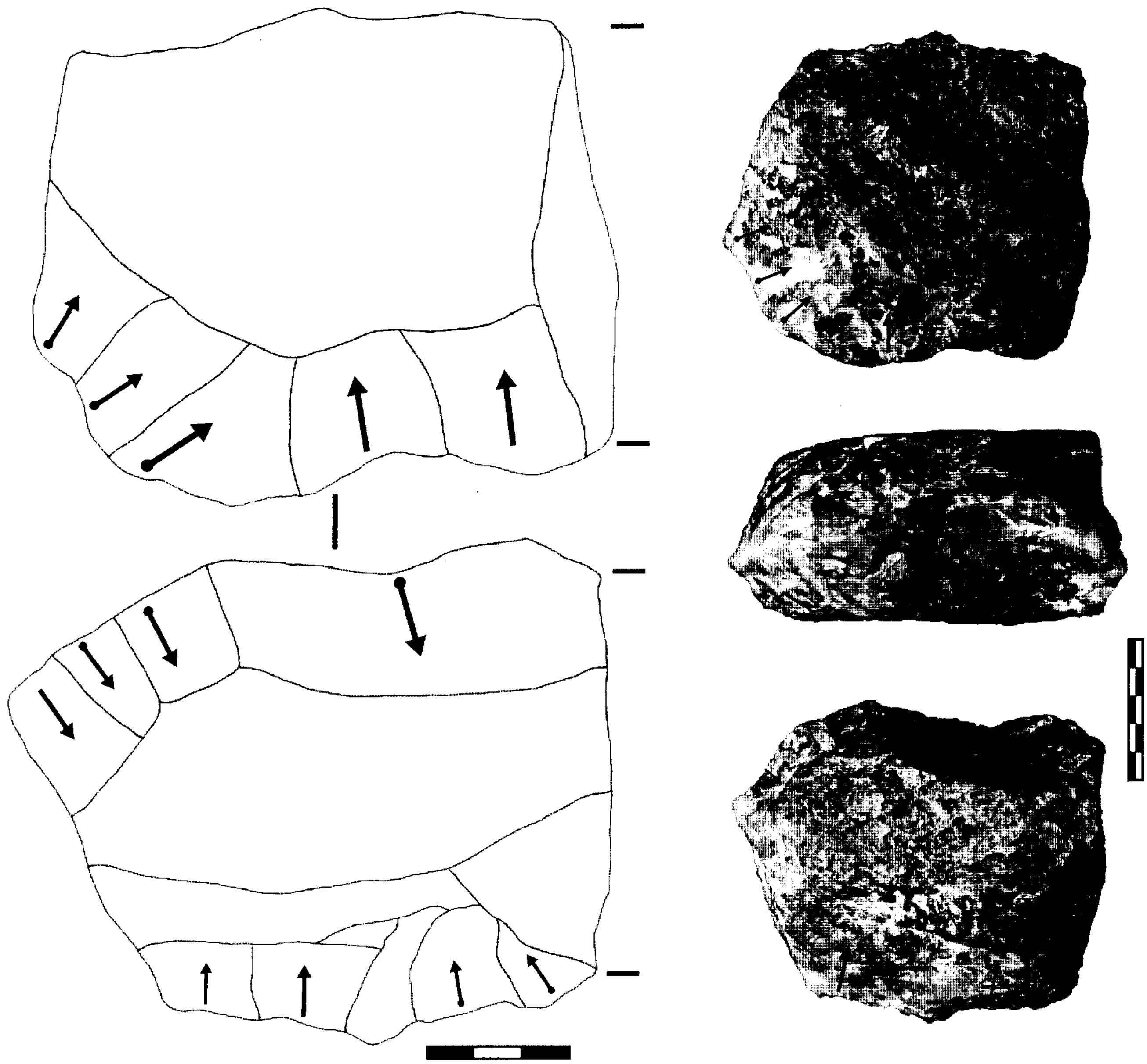

Figure 6.20. Large cutting tool on quartz tabular block from FC West OF. The right part is broken, perhaps caused by the actual retouch. Retouching is always unifacial, with direct retouching on one side, inverted on the other, giving the worked block a rhomboidal shape.

knapping processes, also presenting different morphologies that indicate the alternation in the use of hammerstones in terms of the activity performed, either *débitage* on larger pieces or *façonnage* on the smaller examples. Therefore, the characteristics of these hammerstones coincide with the features of the rest of the lithic material, which means the size of the hammerstones are suitable for performing the documented knapping processes, which focus primarily on the reduction of average size cores (5-10 centimetres) and peripherally on retouching small quartz fragments.

As aforementioned, hammerstones with fracture angles are characterised by the intense battering linked to ridges caused unintentionally during percussion processes. In FC West OF this process is particularly evident, with a profusion of pieces with false knapping ridges that organise so-called detachments on both sides of the edge. Nonetheless, the ridges on these pieces, which Leakey (1971) sometimes classified as choppers, were produced by the simultaneous explosion of fragments of raw material on both sides of the edge, which is generated in its turn by the fracture planes produced during pounding (fig. 6.22). As defined in chapter 4, and also referred to in chapter 9, these completely battered ridges cannot be linked to knapping processes and must be related to other heavy-duty activities.

Consequently, we insist on the importance of anvils in FC West OF, which were most certainly connected to the same

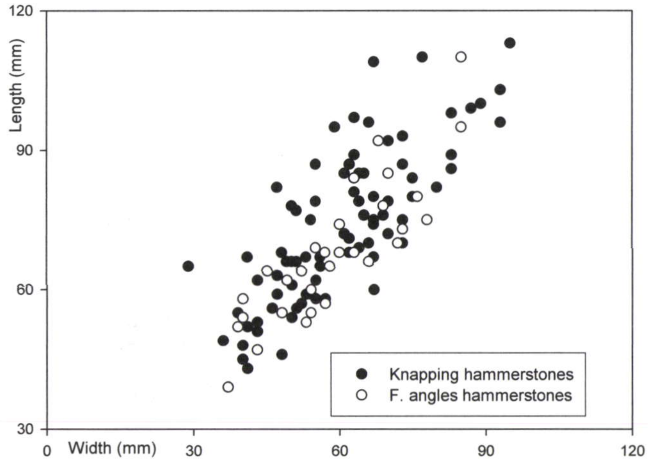

Figure 6.21. Dimensions of the knapping hammerstones, and hammerstones with fracture angles.

	Minimum	Maximum	Mean	Std. deviation	Variance
Length	49	132	90,13	27,053	731,839
Width	51	107	78	19,413	376,857
Thickness	49	85	60,5	14,56	212
Weight	217	1827	756,75	553,864	306765,07

Table 6.11. Dimensions of the anvils (mm and grs.).

activities as hammerstones with fracture angles. If anvils are a minority (n=8) from a quantitative perspective, in terms of the volume of raw material invested they exceed the total number of whole flakes (tabl. 6.3). In fact, despite their enormous variance, these anvils are generally bigger and heavier (tabl. 6.11) than the other categories, which also supports their nature as static elements used to perform forceful percussion activities. As previously, tabular quartz blocks are selected as anvils. This preference becomes more relevant in FC West, since in the context of this site there were also quartz stream cobbles, which were nonetheless used for different purposes.

The issue of the spheroids appears linked to the question of the quartz stream cobbles. In FC West OF, Leakey (1971:159) counted a total of 10 spheroids and 38 subspheroids, practically all in quartz. Willoughby (1987:27) respected that original classification, analysing 48 so-called spheroids and subspheroids. Yet in our recounts (tabl. 6.1 and 6.2), there is not a single example allocated to those categories. Several of the objects Leakey (1971) and Willoughby (1987) classified as subspheroids have been allocated, in this study, to the category of hammerstones with fracture angles. As stated in chapter 4, this type of hammerstones responds to what we call stage 1 envisaging the rounding of the ridges (see fig. 4.32). That is to say, we are probably using different names to refer to similar or identical objects, generated by the same process: the rounding of the quartzes' natural planes caused by intense percussion activities.

Nonetheless, this only refers to some of the objects Leakey and Willoughby classified as spheroids. Many of the objects

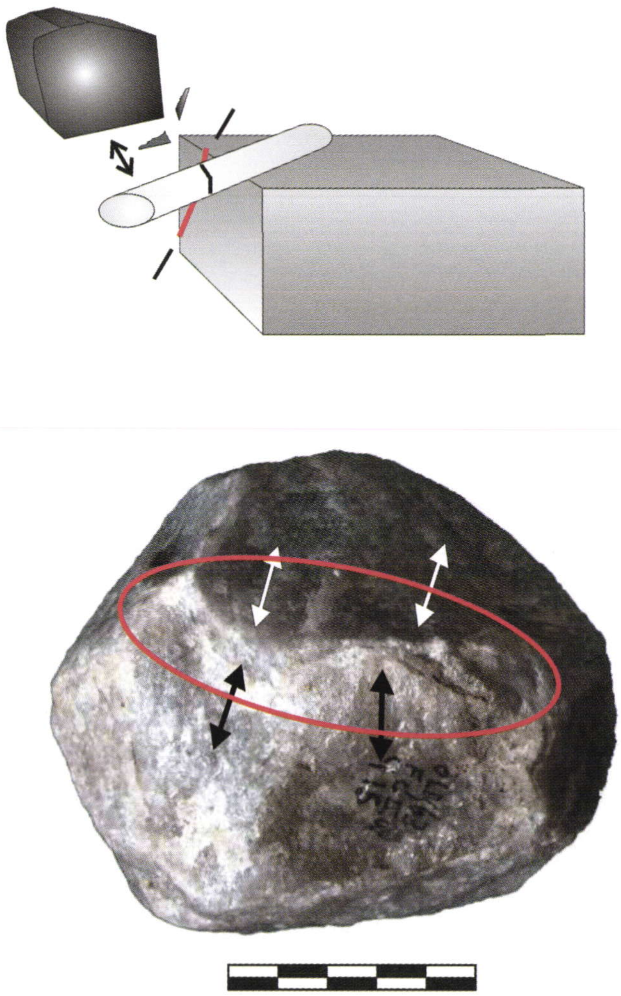

Figure 6.22. Diagram of the process entailing the fracturing of the ridge of the hammerstone, with an example from FC West OF.

these authors considered spheroids are actually simple chunks, some of which do effectively present percussion traces, but which are in no case objects rounded by use, but parts detached from other pieces due to that percussion activity (fig. 6.23). Finally, some of the objects originally classified as spheroids are actually rounded simply because they are stream cobbles. This is a relevant fact, since it is quite different to classify an object as a spheroid because it has acquired a rounded shape after being subjected to human modification, and to classify it as such simply because it is a natural stream cobble, which is actually completely cortical. We will come back to this issue in chapter 9, but it is essential to at least outline the idea in this section. Although FC West OF does present a good number of objects covered by pitting traces, the genuine spherical shapes have a natural origin, and were not caused by a technological conception performed by the hominids. This matter has obvious chrono-cultural implications.

At the beginning of this section, it was mentioned that percussion objects, in all categories, compose over 46 kilograms of the total amount of worked raw material unearthed at the site.

Figure 6.23. Pieces Leakey (1971) classified as spheroids at FC West OF, which are actually fragments detached from hammerstones. See the small size of many of them, measuring less than 4 centimetres long.

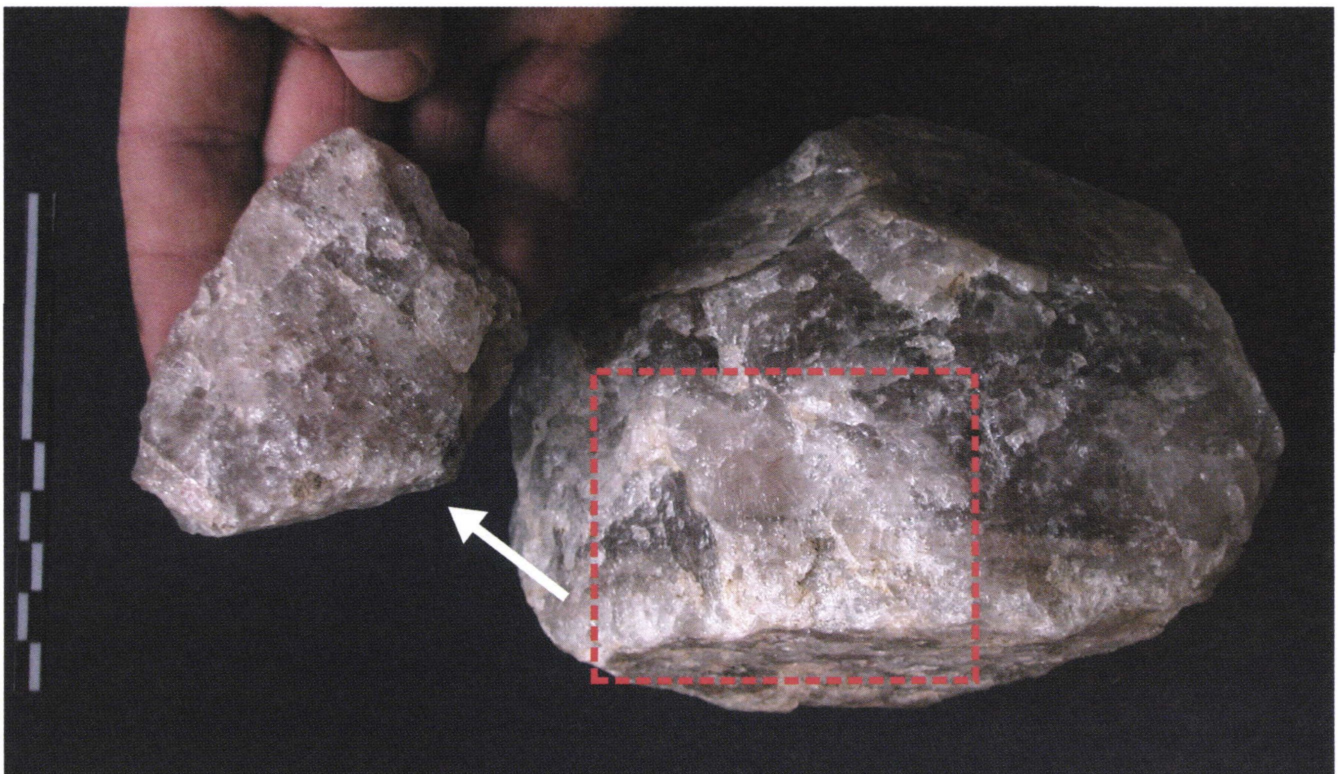

Figure 6.24. Quartz fragment detached from an anvil at FLK West during the percussion processes.

Yet this is only a minimum estimation. The inclusion of all the objects that present traces of battering produces 58,145 grams of the 88,212 grams of raw material that were at some time linked to percussion activities. Up to 26.7% of the cores from FC West OF present traces of pitting that link them to a previous use as hammerstones, and there is a great amount of fragments that also present these traces; furthermore, a great part of these fragments were probably generated during those processes. Consequently, it is a case of underscoring yet again the importance of percussion activities in the site although, given the relevance of anvils and hammerstones with fracture angles, they were not always linked to knapping activities.

Technological strategies at FC West Occupation Floor

Lithic resources were managed in two different ways in FC West OF. First, a great amount of raw material was invested in flake production activities. With this group including cores, retouched objects and, obviously, whole flakes, it totals 21,833 grams. This section presents a series of ambiguous categories that can be assigned partly to processes linked to knapping but also to alternative activities. One of these categories obviously focuses on the so-called knapping hammerstones, which despite their name could also have been used for other percussion activities. All categories of fragments usually allocated to *débitage* processes, but which could also be generated by alternative percussion activities (fig. 6.24), are also subject to equifinality.

Consequently, and with a view to being conservative in our estimation, these categories have not been given a specific activity. In principle, the objects unmistakably linked to percussion activities different to lithic knapping would be hammerstones with fracture angles and anvils. These two categories already compose a total of 14,136 grams, which contrasts with the scarcely over 21 kilograms that can be related to *débitage* with certainty. In all, the first assertion to underscore is the coexistence of two ways of using lithic raw material in FC West OF, and the fact that one of them is not linked to the transformation of those rocks into artefacts, but to the direct use of these objects for other types of activities.

Although it is relatively simple to rule out lithic knapping as the activity that generated a good part of the inventory, it is quite different to discern which specific process created it. The easiest option would be to link those anvils and hammerstones with fracture angles to bone marrow processing. Nonetheless, the possibility that that was the activity linked to such a heavy-duty percussion is quite limited; in FC West OF there are only 127 bone remains. This shortage cannot be explained using taphonomic preservation issues, since Leakey (1971:157) explicitly mentioned that, despite their scarcity, the bone fragments were well preserved. Therefore, there are not sufficient arguments to link the presence of anvils and hammerstones to the management of animal resources, and we should pursue alternative interpretations to explain the forceful percussion activities documented.

The other relevant activity performed in FC West OF was linked to *débitage* processes. There are a great number of cores that enable the reconstruction of knapping strategies. The exploitation systems employed in FC West OF are very similar to any of those analysed previously in DK, FLK Zinj or FLK North, and also closely resemble the cores preserved in EF-HR. There is a predominance of reduction methods without an intense structuring of the knapping platforms and/or surfaces, with a profusion of cortical areas and a shortage of exhausted cores that would refer to long exploitation sequences. The knapping products obtained are quite small (3-5 centimetres), and seem to be the main goal of the reduction. Thus, retouched pieces on this type of flakes are not abundant, and repeat the characteristics observed formerly in older sites such as FLK Zinj or FLK North, where retouching is never implemented to change the general morphology of the pieces but simply to modify the edge.

Alongside this type of artefacts, there are only two examples of large cutting tools, which nonetheless provide relevant information: alongside the unverified possibility of soft hammerstones being used (see fig. 6.19), this data confirms the fact that the FC West OF hominids, as in EF-HR, obtained large blanks which they subsequently retouched. The example in figure 6.20 also indicates that these craftsmen modified large natural blocks intentionally with a view to giving them a forceful edge. The fact that only two of this type of artefacts have been unearthed is surprising, especially because the technology implicit in their manufacturing (destined to the *façonnage* of large blanks) is not linked to the kind of exploitation that appears as the dominant system used in the assemblage (which focuses on the *débitage* of small blanks unmodified secondarily). As regards the retouched flake, it was not discarded after a technical mistake, since the retouch is subsequent to the fracture of the Siret flake, but the retouched quartz block could have been discarded when it broke. Therefore, it seems that the importance of large cutting tools was marginal in FC West OF. Moreover, and since they are not linked technologically to the other artefacts (none of the documented quartz cores could be used to obtain this type of blanks), they were probably transported to the site once completely shaped.

The issue of the input/output dynamics of artefacts calls for a final consideration of the greatest contradiction described in this chapter: the overrepresentation of lava cores compared to quartz cores appears alongside the incomprehensible deficit of basalt and phonolite products. The previous pages have explored different possibilities to explain this imbalance, although none is based on solid grounds. In any case, it seems that the movement of objects *towards* the site (not so much *from* the site) was a systematic event; the total lack of lava knapping waste indicates that cores were already flaked when they entered the site, just as the lack of large cores suggest the import of large cutting tools. The behavioural and functional interpretation of this pattern is, nevertheless, a lot more complex.

In all, it could be said that FC West OF offers more questions than answers. We assume it has substantial contextual integrity, which makes it the site with the greatest remain density in the whole of Olduvai (Petraglia & Potts 1994). Furthermore, all these remains were concentrated in a thickness measuring merely 9-10 centimetres, which suggests a relatively short formation period. Nonetheless, the site does not fulfil any of the expectations that could have arisen; the bone remains are scarce due to non-taphonomic causes, therefore they were not the focus of the hominids activity. Percussion activities were very intense but, precisely in view of the shortage of bone remains, they do not seem to have been linked to carcass processing. Lava cores are very profuse, yet products generated thereof have not appeared.

Moreover, large cutting tools exist, but in a completely residual manner. After studying the new technological boom EF-HR entails, something similar would have been expected of FC West OF. The required technical knowledge has been documented in FC West OF, yet only incidentally. Thus, whilst EF-HR presented a strategy completely focused on the *façonnage* of large blanks, in FC West OF the interest lies in the *débitage* of small flakes. These differences could be due to a functional option, as Hay (1976) noted previously, but it would be interesting to have information on the types of natural blanks available in the immediate landscape: perhaps their small size limited the technical possibilities developed in FC West OF, and therefore forced hominids to import large cutting tools to the site. In all, the information available for FC West OF makes it difficult to perform any type of general interpretation, and therefore, paradoxically, generates more questions than answers.

Chapter 7

TK

Introduction

The TK gully is located in the northern part of the Olduvai Gorge (see fig. 1.1). The trenches Leakey (1971) excavated encompass the upper part of Bed II, from its top in contact with Bed III and 4 metres deep, identifying 5 archaeological levels. These levels are located above Tuff IIC (around 1.5 my), and near the base of Bed III with a chronology estimated around 1.33 my (Manega 1993). Consequently, we can integrate these archaeological remains in a wide temporal span, nearer 1.33 my than 1.5 my. As regards the stratigraphic succession, and according to Leakey (1971:172), the following archaeological levels have been established, from top to base:

Level 5: the highest in the sequence, it has 1.2 metres of tuffs and clays interbedded with limestones. The base of Bed III appears above these limestones. It is composed by tuff deposits, and contains diffused artefacts.

Level 4: what Leakey (1971:172) designated TK Upper Occupation Floor is, according to this author, a living floor that rests on a clay paleosol in the contact with the overlying tuff. The archaeological deposit is 9 centimetres thick.

Level 3: known as the Intermediate Level, it is below TK Upper Floor and right above TK Lower Floor. It is characterised by tuff sediments with diffused artefacts.

Level 2: another clay paleosol appears 3 metres below the base of Bed III, and approximately 60 centimetres deeper than the Upper Floor, presenting a great number of archaeological remains, also concentrated in an area that is 9 centimetres thick. Leakey (1971) called it TK Lower Occupation Floor.

Level 1: under the paleosol there is a tuff that was eroded by a channel about 90 centimetres thick. It was full of clays and sands, in which Leakey (1971) identified bone remains (only 43 specimens) and lithics (1436 artefacts). Most of the lithic material is quite small, and Leakey did not exclude the possibility that they could have come from the overlying Lower Occupation Floor.

The variable remain densities pointed towards the fact that "*this site appears to represent a camping ground which was reoccupied intensively on two occasions and perhaps visited temporarily at the times when the tuffs between the Upper and Lower Floors and above the Upper Floor were deposited*" (Leakey 1971:173). She considered TK Lower & Upper Floor as genuine living floors in pristine conditions, compared to the other levels, which would be assemblages containing diffused material. That argument led us to focus on TK Lower & Upper Floor, leaving the other levels of the gully out of our analysis. Since in TK Lower & Upper Floor (henceforth TK LF and TK UF, respectively) remains were concentrated in deposits only 9 centimetres thick, Leakey (1971: 260) estimated the lower level had a density of up to 58 pieces per m^3 and the upper level 73 objects per m^3, only surpassed by FC West in the Olduvai sequence. The two trenches (one measuring 6 x 7.5 m and the other 8.7 x 4.5 m) Leakey (1971:172) excavated in TK only amounted to 84 m^2 of exposed surface. Therefore, the thousands of lithic artefacts recovered represented a prodigious concentration.

Both Leakey (1971) and Isaac and Crader (1981) considered both TK levels had not undergone relevant postdepositional alterations, with the former including them in her general classification as living floors and the latter among Type A sites, i.e. sites with concentrations of lithic material but no fauna remains. Despite the vast amount of lithic objects recovered from both levels, bone remains are scarce (230 pieces in TK UF and only 147 specimens in the lower TK LF).

Leakey (1971:261) notes the weathering that affects most of the bone remains in both levels of TK, which, alongside the actual context the remains were found in (a paleosol), indicates that the archaeological collection was exposed on the surface over a long period of time. As a result, we cannot exclude postdepositional disturbances that could have contributed to the disappearance of the bone remains. All these issues must have altered the original configuration of the remains, and hydraulic processes could have partially affected the assemblage (Petraglia & Potts 1994). Despite the poor preservation of the fauna, several tribes of bovidae were identified (Gentry & Gentry 1978:39), alongside proboscideans, equids, suids, giraffids, etc. (Leakey 1971:257). Furthermore, the maps recurrently offer a pattern of juxtaposition between the fauna and the lithic material. In fact, it has been suggested that the modifications visible on the jaw of the *Hippotamus gorgops* from TK LF were caused by hominids (Hill 1983).

General characteristics

Beyond Leakey's (1971) original study, there are first hand studies on choppers (Bower 1977), polyhedrons (Sahnouni 1991), spheroids (Willoughby 1987), raw materials (Kyara 1999) and on the typology (Stiles 1977) of both levels, on the postdepositional alterations of the industry (Petraglia & Potts 1994) and on the technology (Kimura 2002) as regards TK UF, and on the techno-typological characteristics of level TK LF (Ludwig 1999). The authors that analyse both levels (Bower 1977; Willoughby 1987; Kyara 1999) focus mainly on specific aspects, not on the general features of the collections, whilst the analyses of whole collections (Kimura 2002; Ludwig 1999) only examine one of the two assemblages.

At first, Leakey (1971) classified TK LF as a Developed Oldowan B, but then went on to rectify her conclusion and allocated the level to the Acheulean (Leakey 1975). Ludwig (1999) furthered Leakey's (1975) final proposal and included TK LF among the Acheulean assemblages. Kimura (2002) did not stop to rectify the allocation of TK UF to the Developed Oldowan B, which Leakey kept intact in subsequent publications (Leakey 1971, 1975, 1979). As regards aggregates, Ludwig (1999:31) offers a total (n=2115) that is very similar to Leakey's (n=2150) for TK LF, which does not occur with Kimura (2002:296), who studied less pieces (n=4622) in TK UF than Leakey described (n=5180).

These imbalances are probably due to the aggregates for the smaller fragments, which has led us to count more pieces than Leakey herself, with a total number of 2325 lithic remains in TK LF and 5268 in TK UF, although this does include unmodified lithic material, which Leakey (1971) always considered in a different aggregate. In any case, we have obviously analysed all the collection unearthed during the excavations, which will enable a detailed and representative description.

Categories represented in TK Lower Floor

Leakey (1971:183) mentioned 21 manuports, 11 of which were in lava and the rest in quartz, which she contemplated alongside a collection with a prevalence of *débitage*. This study only considers 11 unmodified objects (tabl. 7.1). Furthermore, and in opposition to other sites, we can safely say that at least the quartz objects are genuine manuports: the unmodified quartz objects are enormous tabular blocks, generally weighing over half a kilogram (tabl. 7.2). They can feasibly be considered genuine raw material reserves transported intentionally to the site, not only given their tabular shape

	Quartz		Lava		Gneiss		Total	
	n	%	n	%	n	%	N	%
Test cores	1	0	1	1.9	-	-	2	0.1
Cores	5	0.2	3	5.5	-	-	8	0.3
Large Cutting Tools	7	0.3	3	5.5	-	-	10	0.4
Small retouched pieces	20	0.9	-	-	-	-	20	0.8
Knapping hammerstones	1	0	1	1.9	-	-	2	0.1
Hamm. fract. angles	7	0.3	2	3.7	-	-	9	0.4
Spheroids & Subspheroids	3	0.1	-	-	1	50	4	0.2
Anvils & anvils fragments	16	0.8	1	1.9	1	50	18	0.7
Whole flakes	35	1.6	7	13	-	-	42	1.8
Flake fragments	271	11.9	25	46.3	-	-	296	12.7
Angular frag. & frag. < 20 mm	1890	83.3	1	1.9	-	-	1891	81.3
Battered fragments	9	0.4	3	5.5	-	-	12	0.5
Unmodified material	4	0.2	7	13	-	-	11	0.5
Total	2269	100	54	100	2	100	2325	100

Table 7.1. Lithic categories at TK Lower Floor.

	Minimum	Maximum	Mean	Std. deviation
Length	92	190	149.25	41.58
Width	54	150	98.5	42.65
Thickness	31	55	43	11.343
Weight	230	1854	892	694.055

Table 7.2. Dimensions (mm and grams) of the unmodified quartz blocks at TK Lower Floor.

(which is not linked to natural mechanical traction), but also given the fact that the size of these natural blocks and that of the anvils and the large cutting tools coincide. The lava unmodified material are blocks and cobbles that cannot easily be considered as anthropically transported pieces (i.e. manuports), especially since, as proven for TK UF, they quite probably could have appeared in the sequence naturally.

As regards the distribution of the rest of the categories, there is an absolute quantitative predominance of all types of fragments (tabl. 7.1), essentially chips. In fact, when this data is represented graphically (fig. 7.1) it is hard to infer the importance of the

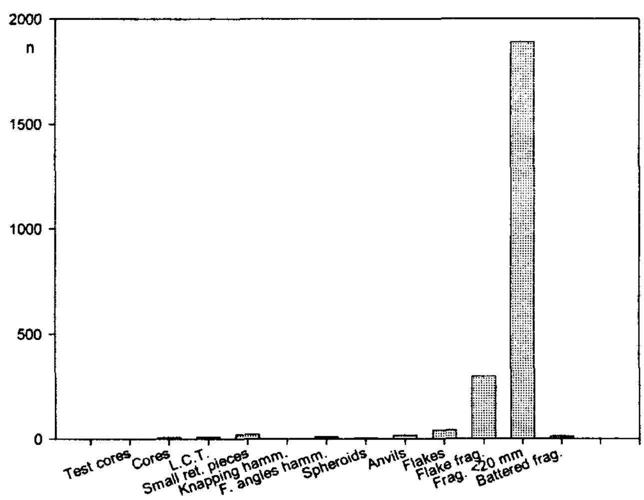

Figure 7.1. Absolute frequencies of the lithic categories at TK Lower Floor.

	Quartz	Lava	Total
Test cores	1830	1151	2981
Cores	2273	2079	4352
Large Cutting Tools	6659	941	7600
Small retouched pieces	1802	-	1802
Knapping hammerstones & frag.	1759	1933	3692
Hamm. fract. angles	4187	1706	5893
Spheroids & Subspheroids	2693	-	2693
Anvils	7525	-	7525
Whole flakes	4577	263	4840
Flake fragments	8845	301	9146
Angular frag. & frag. < 20 mm	10756	105	10861
Unmodified material	3568	2595	6163
Total	56474	11074	69018*

Table 7.3. Raw material invested in each lithic category at TK Lower Floor. (*) Including 1470 grams of worked gneiss.

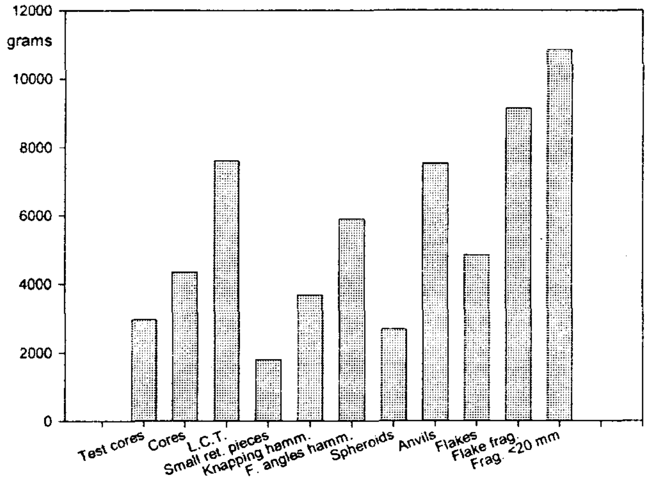

Figure 7.2. Total weight of each category at TK Lower Floor.

other categories, concealed by the vast amount of quartz fragments. This pattern indicates the management of the lithic material, or at least of the quartzes, was performed in the site itself. We cannot assess the genuine incidence of each category only using absolute frequencies; therefore it is essential to turn to the contribution to each category in terms of the investment in raw material (tabl. 7.3 and fig. 7.2). This shows that, although objects linked to *débitage* are very important, other categories like large cutting tools, anvils and different types of hammerstones involve a great investment of raw material.

Tables 7.1 and 7.3 also denote the vast noticeable difference between the transformations of quartzes as regards basalts. Although quartz is four times more important than lava from a global perspective, the comparative relation of raw materials in the Lien tests indicates an overrepresentation of lavas (fig. 7.3). The exception appears in the category encompassing millimetric fragments, which actually explains the trend; there are too many worked objects in lava (retouched pieces, cores, hammerstones, etc) for the number of *débitage* waste produced in that raw material.

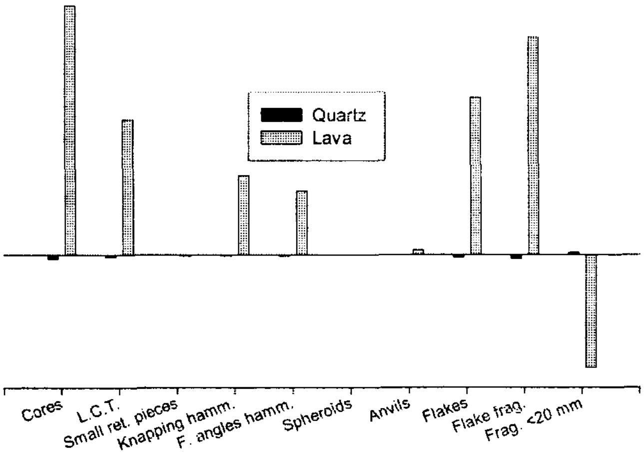

Figure 7.3. Lien Test comparing frequencies and raw materials at TK LF.

The archaeological explanation for this trend is clear. The lack of millimetric fragments in basalt and trachyte (considering that among quartzes there are 1890 items and a single item in lava) indicates that knapping activities performed on volcanic material was performed out of the site. The same comparison of technical categories by raw material, yet considering global weights not absolute frequencies, offers similar results (fig. 7.4); only the heavy-duty categories (cores, hammerstones, etc.) are proportionally well represented among lavas. The amount of raw material invested in the *débitage* of volcanic rocks is, on the other hand, practically nonexistent. This pattern mirrors the trend that appeared previously in FC West and FLK North, where quartz is always worked *in situ* whilst lava objects seem to be imported once flaked.

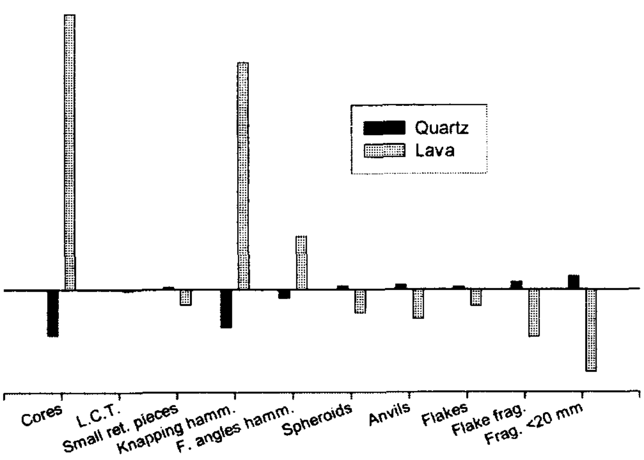

Figure 7.4. Lien Test comparing weight of each category and raw materials at TK LF.

Categories represented in TK Upper Floor

There is a surprising amount of lithic remains in this level, doubling the number of items in TK LF. Leakey (1971:196) counted 4573 artefacts and 139 manuports, slightly under the

	Quartz		Lava		Gneiss		Total	
	n	%	n	%	n	%	N	%
Test cores	-	-	5	2.2	-	-	5	0.1
Cores	7	0.2	11	4.8	1	33.3	19	0.3
Large Cutting Tools	4	0.1	6	2.6	-	-	10	0.1
Fractured L.C.T.	4	0.1	3	1.3	-	-	7	0.1
Small retouched pieces	24	0.5	1	0.4	-	-	25	0.4
Knapping hammerstones	5	0.1	19	6.9	-	-	24	0.4
Hamm. fract. angles	21	0.4	7	3.1	-	-	28	0.5
Spheroids & Subspheroids	47	0.9	1	0.4	-	-	48	0.9
Anvils & anvils fragments	31	0.6	2	0.9	-	-	33	0.6
Whole flakes	22	0.4	20	8.6	-	-	42	0.7
Flake fragments	1346	26.7	84	36.1	-	-	1430	27.1
Frags. < 20 mm	3117	61.9	5	2.2	-	-	3122	59.2
Angular fragments	168	3.3	2	0.9	1	33.3	171	3.2
Hammerstone frag.	2	0	1	0.4	-	-	3	0.1
Anvil fragments	58	1.2	-	-	-	-	58	1.1
Battered fragments	164	3.3	-	-	-	-	164	3.1
Unmodified material	12	0.3	66	28.4	1	33.3	79	1.4
Total	5032	100	233	100	3	100	5268	100

Table 7.4. Lithic categories at TK Upper Floor.

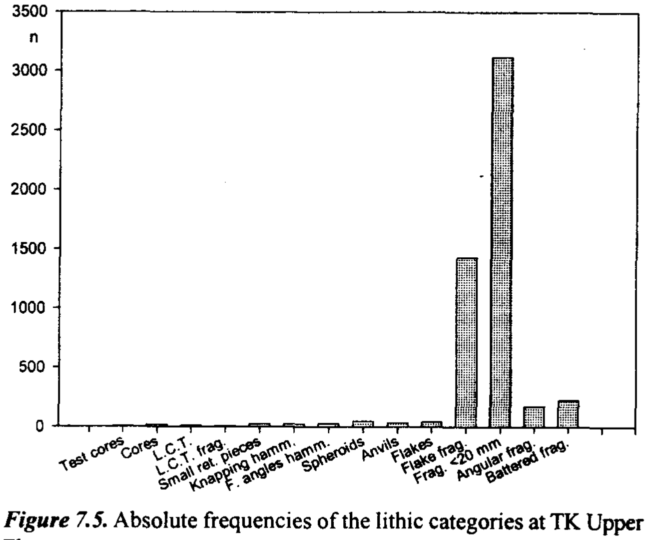

Figure 7.5. Absolute frequencies of the lithic categories at TK Upper Floor.

	Quartz	Lava	Total
Test cores	-	1609	1609
Cores	832	4192	5024
Large Cutting Tools	3754	4557	8311
Fractured L.C.T.	504	480	984
Small retouched pieces	1478	93	1571
Knapping hamm. & frags.	2270	7644	9914
Hamm. fract. angles	6115	4606	10721
Spheroids & Subspheroids	15672	272	15944
Anvils	15239	1473	16712
Whole flakes	1185	614	1799
Flake fragments	31985	1946	33931
Frags. < 20 mm	12570	12	12582
Angular fragments	12745	120	12865
Battered fragments	9918	-	9918
Unmodified material	3884	15756	19640
Total	118151	43374	162330*

Table 7.5. Raw material invested in each lithic category at TK Upper Floor. (*) Including 805 grams of worked gneiss.

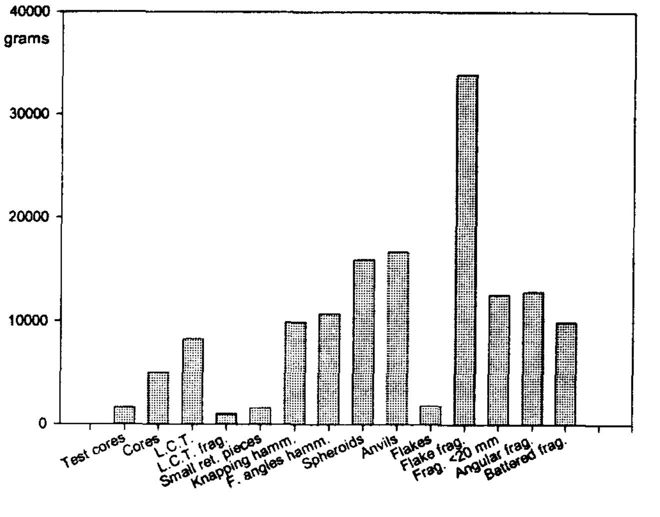

Figure 7.6. Total weight of each category at TK Upper Floor.

5032 analysed herein (tabl. 7.4). The unmodified quartzes are fragments with different sizes which are generally angular, thus strengthening the conclusion that they could actually be manuports. This does not occur with lavas, where there are over 15 kilograms of unmodified material (tabl. 7.5): although part of them are large cobbles that could have been potential blanks for cores, an important sample of unmodified lavas are small rounded fragments with a 4-5 centimetre diameter, which cannot be considered raw material reserves and which are, actually, natural clasts of the sediment.

These clasts indicate that the sedimentary context, although it was basically a clay paleosol, must have had, at some time, sufficient energy to drag larger pieces; a theory that would strengthen the idea Petraglia and Potts (1994) proposed regarding a slight hydraulic alteration. Thus, it seems clear that a good part of the unmodified lava material has a natural origin, and will therefore not be considered in the global recounts on the lithic collection unearthed in TK UF.

As regards the lithic material genuinely subject to human alteration, the *débitage* categories are the most important as regards the number of items (tabl. 7.4 and fig. 7.5), to the extent that they prevent an assessment of the relevance of the other objects. Turning once again to the contribution of each category to the total volume of raw material (tabl. 7.5 and fig. 7.6), shows that, although the fragment categories are the most relevant, other types of objects like anvils and the different types of active hammerstones or large cutting tools constitute essential groups.

As occurred in the underlying level, in TK UF quartz is the most important raw material, not only as regards the number of items, but also as regards the global weight, especially if the 15 kilograms of unmodified material are subtracted from the slightly over 43 kilograms of lavas and compared to the 118 kilograms of quartz transported to the site (tabl. 7.5). The comparison of the number of items in each raw material offers significant results; as in TK LF, the Lien test for absolute fre-

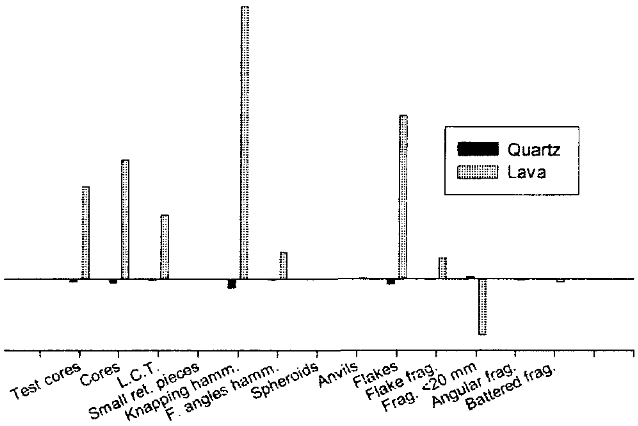

Figure 7.7. Lien Test comparing frequencies and raw materials at TK UF.

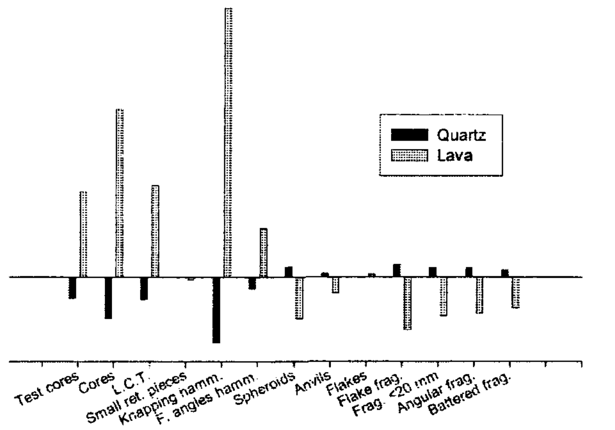

Figure 7.8. Lien Test comparing weight of each category and raw materials at TK UF.

quencies (fig. 7.7) indicates a relative abundance of core-like lava items compared to quartz objects, a trend that is inverted in the chips category. In the flake group, lavas are also comparatively more profuse than quartzes. Yet, there is an absolute absence of small fragments among lavas opposed to the profusion found among quartzes, which once again suggests that reduction processes performed on lavas were not carried out in the site.

The same Lien test, if linked to the number of grams invested per category, not the amount of objects, provides a similar result (fig. 7.8). In all, there is a relative profusion of lava knapping hammerstones. Once again, there is a relative overabundance of core-like objects and large forms among lavas, whilst the comparison continues to provide a similar result in smaller categories. Once again, everything suggests the great intensity of the reduction performed *in situ* upon quartzes compared to the import of lava objects that were transported once flaked.

Knapping products

Provisionally, this section should include all the categories in principle linked to *débitage* activities, which flake fragments, chunks, debris and, obviously, whole flakes are supposed to be. As regards the latter, the existence of a quantitatively identical population (n=42) in both levels of TK allows for a reliable comparison of the qualitative characteristics of each sample. The first aspect analysed was the size of the whole

		Minimum	Maximum	Mean	Std. deviation
Lower Floor	Length	16	120	52.81	26.592
	Width	22	148	54.86	27.449
	Thickness	5	74	19.64	14.778
	Weight	3	830	115.24	204.285
Upper Floor	Length	21	100	44.67	17.13
	Width	22	95	44.4	17.229
	Thickness	6	33	15.71	6.341
	Weight	3	290	42.83	57.748

Table 7.6. Dimensions (mm and grams) of the whole flakes in both levels of TK.

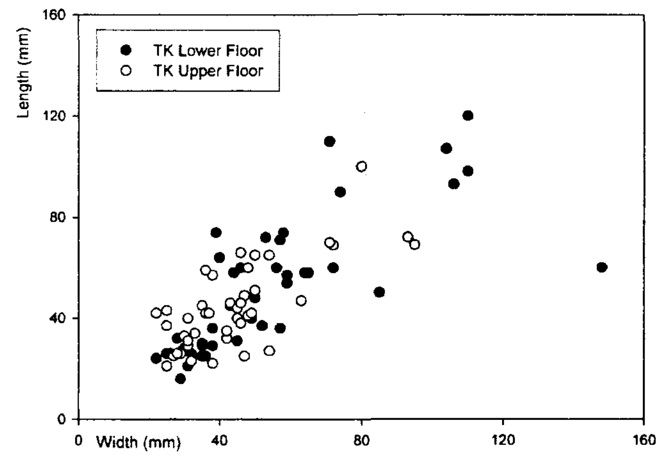

Figure 7.9. Dimensions of the whole flakes at TK LF and UF.

flakes (tabl. 7.6), for which the lengths of the items from both levels were compared, with the T test indicating a statistically significant parity among means. This is represented graphically (fig. 7.9), and is interesting with a view to assessing technical similarities and differences between knapping products from both levels. Moreover, the existence of metric differences between quartz and lava flakes was also considered. In TK LF, the sample of lava products is so small that no representative results could be obtained, but in TK UF lava flakes are almost as numerous as quartz flakes (see again tabl. 7.4). Means were compared again using the T test, and once again showed a statistically significant parity between the lengths of lava and quartz flakes in TK UF (fig. 7.10).

The technical similarities between the flakes from both levels are amazing. Consequently, they present almost identical cortex percentages in TK LF and TK UF (tabl. 7.7), with a similar trend in the distribution of cortical areas according to the Toth's types (fig. 7.11). In both levels, the flakes' butts indicate unprepared striking platforms, which were usually lacking in cortex, although some flakes with prepared butts have appeared in TK UF (fig. 7.12).

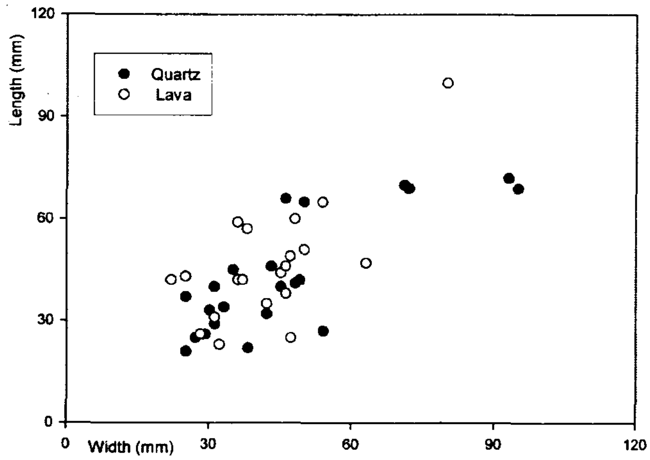

Figure 7.10. Dimensions of quartz and lava flakes at TK UF.

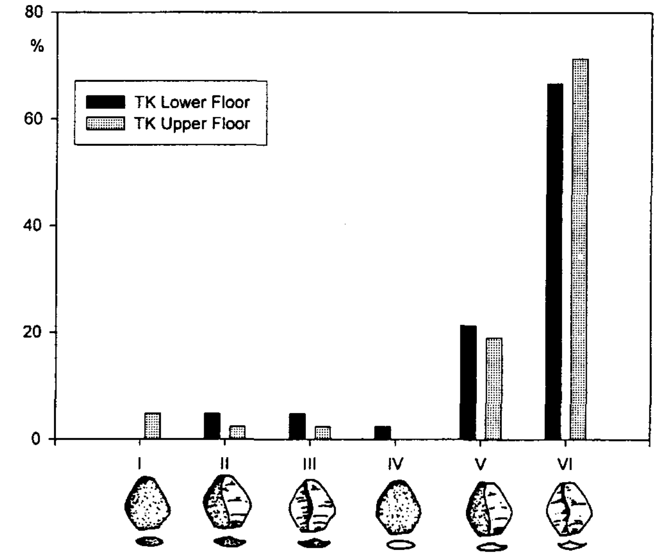

Figure 7.11. Types of flakes at TK LF and UF according to Toth's (1982) classification.

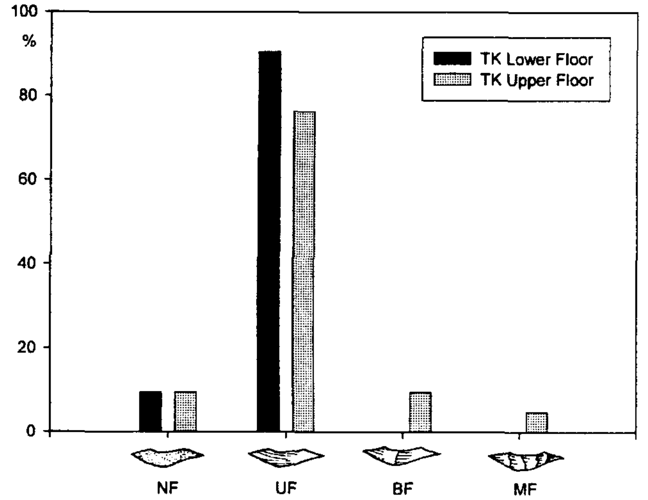

Figure 7.12. Types of striking platforms in the whole flakes from TK.

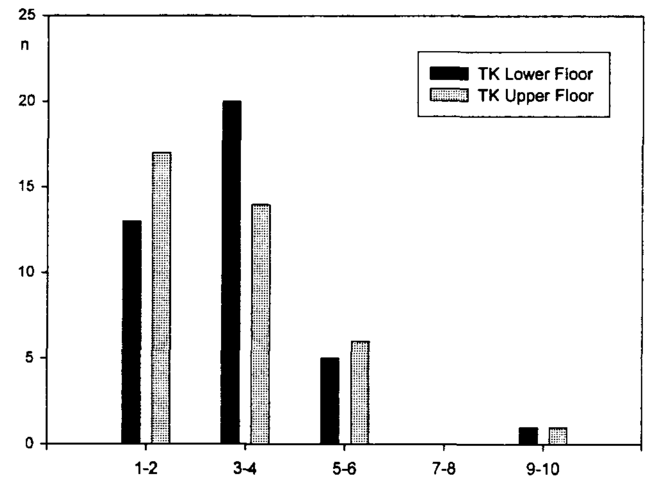

Figure 7.13. Scar patterns on the dorsal sides of whole flakes at TK LF and UF.

The knapping patterns deduced from the flakes' dorsal faces are also analogous in TK LF and TK UF. In TK LF whole flakes present an average of 3.2 previous detachments, quite similar to the mean for TK UF, with 3.1 previous scars, with both presenting similar detachment ranges (fig. 7.13). Furthermore, the flakes from both levels indicate that the cores from which they originated were more structured than in previous sites, providing examples of dorsal faces that denote a recurrent and multidirectional pattern as regards the exploitation of the knapping surfaces (fig. 7.14).

As in EF-HR, TK presents flakes that seem to come from different stages of the *chaîne opératoire* and even from different

Dorsal face	Striking platform								Total			
	Cortical				Non-cortical							
	N		%		N		%		N		%	
	LF	UF	LF	UF	LF	UF	LF	UF	LF	UF	LF	UF
Full cortex	-	2	-	4.8	1	-	2.4	-	1	2	2.4	4.8
Cortex > 50%	-	-	-	-	2	2	4.8	4.8	2	2	4.8	4.8
Cortex < 50%	2	1	4.8	2.4	7	7	16.7	16.7	9	8	21.4	19
Non-cortical	2	1	4.8	2.4	28	29	66.7	69.1	30	30	71.4	71.4
Total	4	4	9.5	9.5	38	38	90.5	90.5	42	42	100	100

Table 7.7. Cortical frequencies in the whole flakes from TK LF and UF.

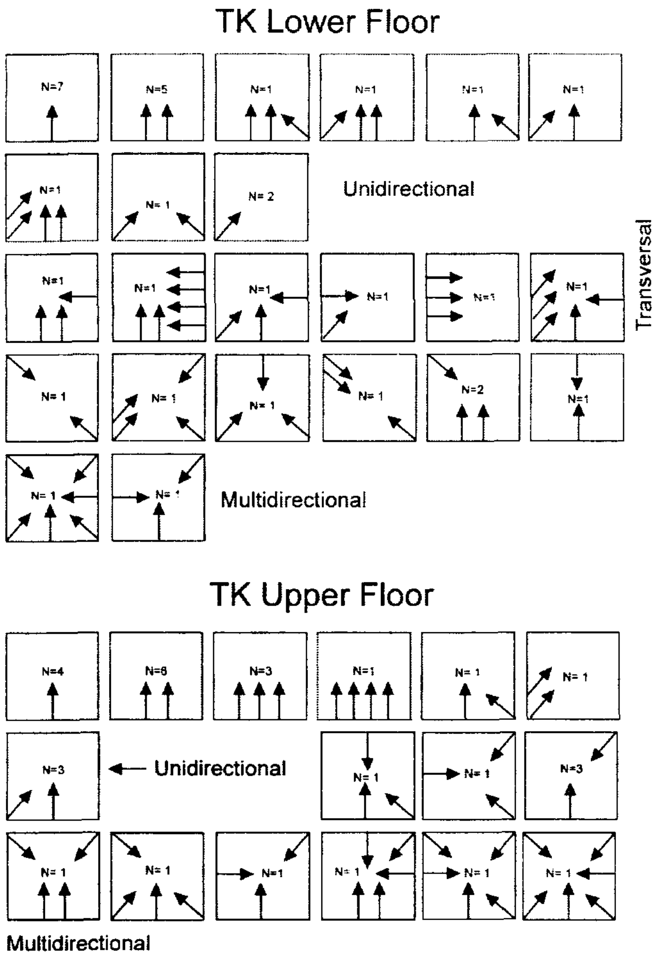

Figure 7.14. Diacritic schemes of the whole flakes at TK (both levels).

knapping systems. Two different types of flakes have appeared. One kind includes the typical *débitage* products measuring 3-5 centimetres, that compose the largest assemblage both in LF and in UF (fig. 7.9). These flakes usually present unifaceted butts, well-developed sections and relatively simple dorsal faces, with 2-3 previous detachments (fig. 7.15 and 7.16). They appear both in quartz and lava, and were generated using the classical system for the production of small-sized flakes described in all the aforementioned sites.

Alongside these small-sized flakes, there is a group of larger objects. Although there are some examples from TK UF, most appear in the level below. Figure 7.9 showed that there are flakes in TK LF that exceed 10 centimetres long, and table 7.6 indicates that some weigh up to 800 grams, thus being genuinely heavy-duty objects. These enormous flakes could be, as in EF-HR, large blanks that subsequently became retouched items. Nonetheless, as explained below, the large cutting tools from TK do not follow the same strategy as in EF-HR, with blocks becoming secondary artefacts, not large flakes.

In TK LF the categories of fragments total over 19 kilograms of raw material, and over 60 kilograms in UF (tabl. 7.3 and 7.5). That is to say, in both levels the different types of fragments compose practically half of the lithic material modified by hominids. The enormous amount of kilograms of flake fragments can be explained, at least partially, in view of the large size of many of the objects: many large fragments were detached from the cores and discarded directly (or at least, were not modified secondarily) after technical errors produced in the actual knapping processes during which the large flakes were obtained. In any case, the over 8 kilograms of non-used flake fragments unearthed in LF and the over 31 kilograms from UF suggest a sensational waste of raw material.

The LF and UF collections present a vast amount of angular and millimetric fragments. The vast amount of quartz chips points to the local nature of the knapping on this raw material, indicating an opposite trend among lavas. With rates above 80% on both levels, the percentage of quartz fragments in TK resembles the aggregates documented in sites like FLK Zinj, with the difference that in TK the importance is not only quantitative, but also relevant in terms of the raw material invested (or wasted, in this case). In both levels the frequency of chips and chunks is too high, in terms of the number of cores and flakes. Therefore, it is useless to attribute their origin solely to knapping processes. As stated in previous chapters, it is hard to allocate this type of fragments to a specific activity accurately, since they do not usually present diagnostic traces that enable researchers to include them in one process or the other. Nonetheless, both in LF and (mainly) in UF percussion activities are extremely well developed (spheroids, anvils and other quartz objects bear witness to this fact), and therefore many of the documented chunks (and probably a lot of the objects classified as flake fragments) were probably generated during these processes and not during knapping. Thus, many should be considered alongside the fragments which do present traces that show they originated from the breaking of the anvils and hammerstones, increasing the number of lithic items linked to percussion activities.

It is important to bear in mind that whole flakes represent 1.8% of the total in TK LF and merely 0.7% in TK UF. Therefore, it is hard to maintain that their production was the primordial goal of the human activities. Despite their technical efficiency, these flakes are peripheral elements in the dominant *chaîne opératoire*. In any case, and irrespective of their marginality, we must describe the processes by which these flakes were obtained, which we will embark upon in the following section.

Cores and *débitage* systems

As occurs with flakes, cores are not relevant categories in any of the two levels in TK. TK LF produced 8 cores whilst UF offered 19, totalling slightly over 4 kilograms in the older level and approximately 5 kilograms in the overlying level (tabl. 7.3 and 7.5). As regards core dimensions (tabl. 7.8), the pieces from TK LF seem larger than those from UF. Yet, the

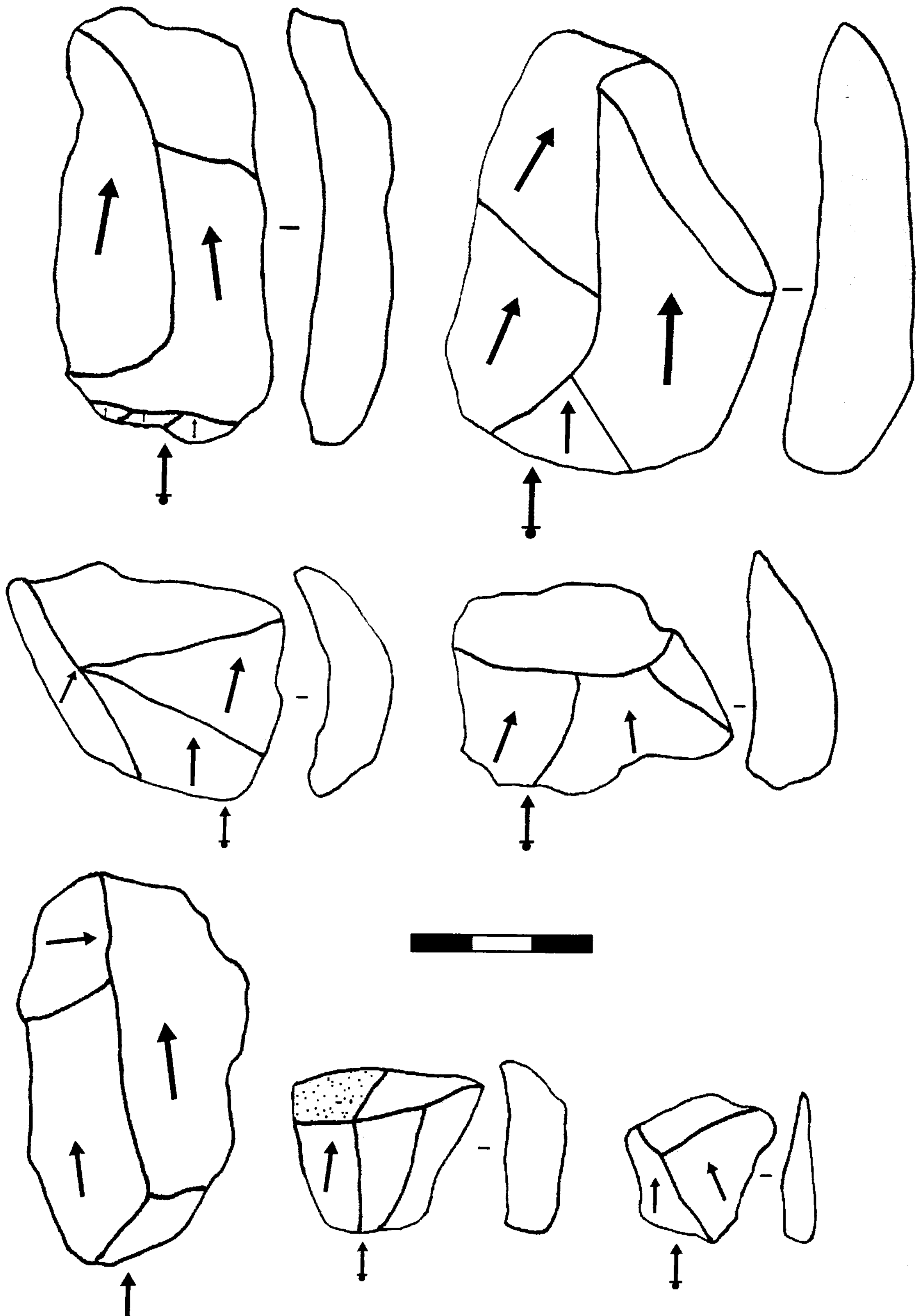

Figure 7.15. Small-sized quartz flakes at TK LF.

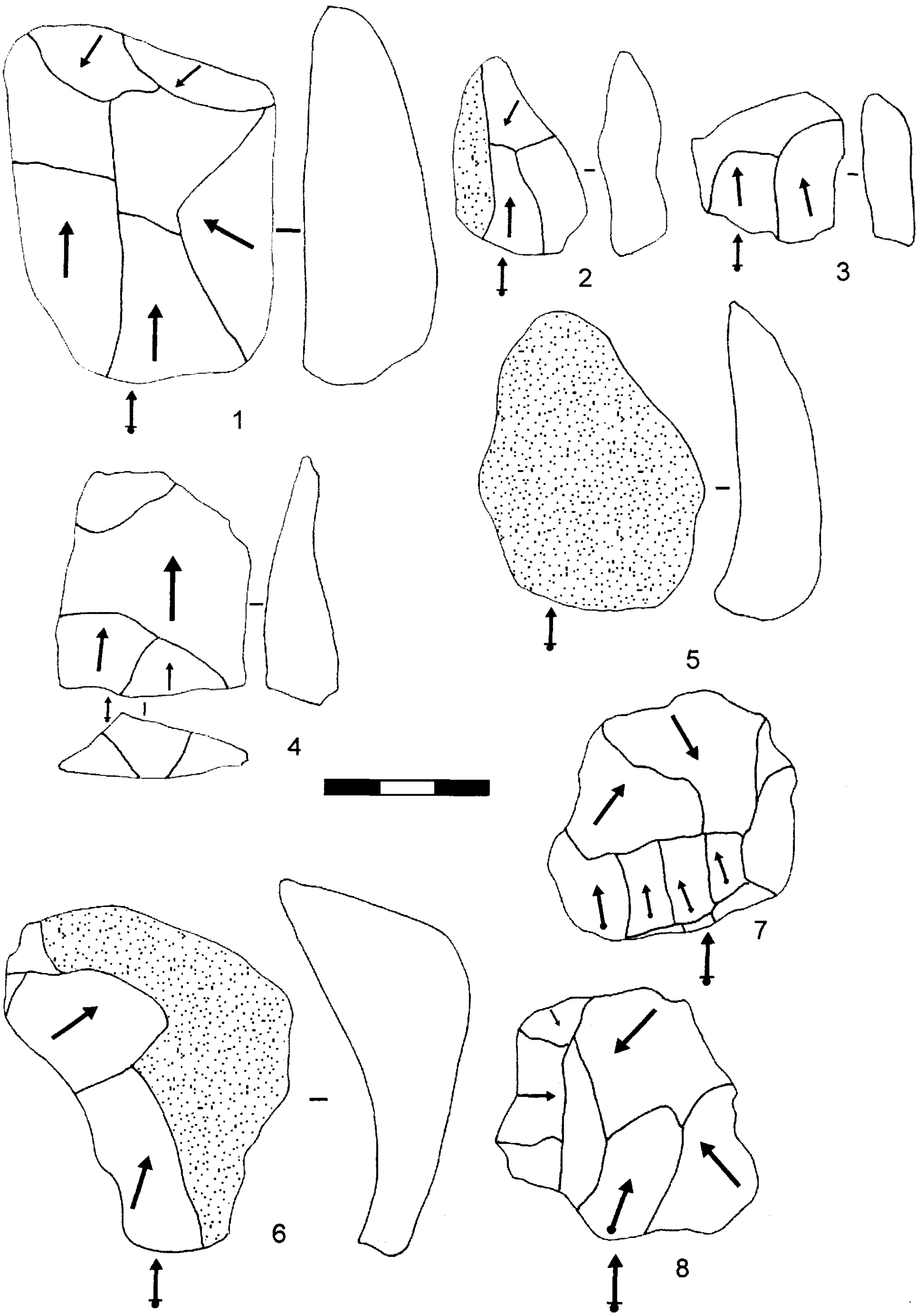

Figure 7.16. Small-sized flakes at TK UF. All examples are lava flakes, except 1 and 2, quartz flakes.

		Minimum	Maximum	Mean	Std. deviation
Lower Floor	Length	50	160	94.63	35.42
	Width	47	97	69.75	20.155
	Thickness	34	88	54.25	19.869
	Weight	113	1186	544	431.054
Upper Floor	Length	44	140	77.89	22.736
	Width	38	145	66.11	23.121
	Thickness	26	68	47.89	11.172
	Weight	47	1341	295.67	301.05

Table 7.8. Dimensions of the cores at TK (mm and grams).

test used to analyse mean parity (Student's T test) demonstrated that there are no statistically significant differences in terms of the length and weight of both core populations, and in fact their dimensions always keep within a similar range (fig. 7.17). These cores measure 8-9 centimetres long and are considerably heavy (see again tabl. 7.8). Therefore, it seems obvious that, compared to other previous Oldowan sites, there is an increase of the size of the blanks for flake obtaining processes, although similar *débitage* systems were implemented.

The cores in both levels also present similarities in terms of the number of detachments on each piece (9 flakes per core in LF and 8.8 in UF), and the range of scars (fig. 7.18). Using McNabb's (1998) calculations, and since in TK LF cores (n=8) present a minimum of 3 detachments and a maximum of 19, there should be at least 24 flakes and a maximum of 152, without considering those obtained from the *façonnage* of the large cutting tools. As regards quartzes, the cores/flakes ratio (7:35) is more ore less coherent, especially when considering the vast amount of flake fragments documented in Level LF. Yet, when moving on to the lavas, the deficit (3 cores: 7 flakes) observed in other sites also appears here and - albeit not as evidently as in FLK North or FC West -, it seems obvious that lava flake production was merely incidental in TK LF. The almost total absence of volcanic chips gives evidence of this notion.

In TK UF the pattern is almost identical. With a minimum of 2 detachments per core and a maximum of 17, there should be a minimum of 14 quartz flakes and a maximum of 119. Among the lavas this pattern ranges between 22-187 flakes. The frequencies observed for flakes in both raw materials merely fulfil the minimum expected frequencies (tabl. 7.4), especially among the lavas, where there are less flakes than among quartzes, despite the number of cores being substantially greater. Consequently, certain contradictions arise, not only concerning quantitative aspects but also metric issues as well: the core scars are systematically smaller than the flakes. This pattern is interpreted as evidence of the recurrence of the reduction sequences, and therefore also of the fact that flake production was more important than the absolute frequencies imply. Therefore, this information provides an additional argument that represents a lava flake deficit compared to the number of cores, which can only be explained using behavioural criteria, not taphonomic causes. The problem, ob-

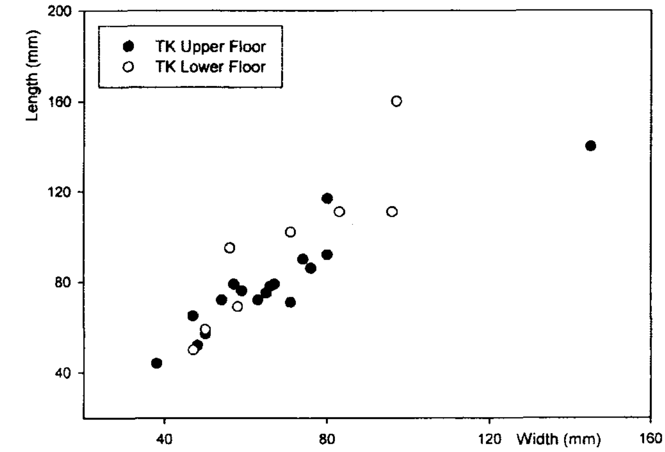

Figure 7.17. Dimensions of the cores at TK LF and UF.

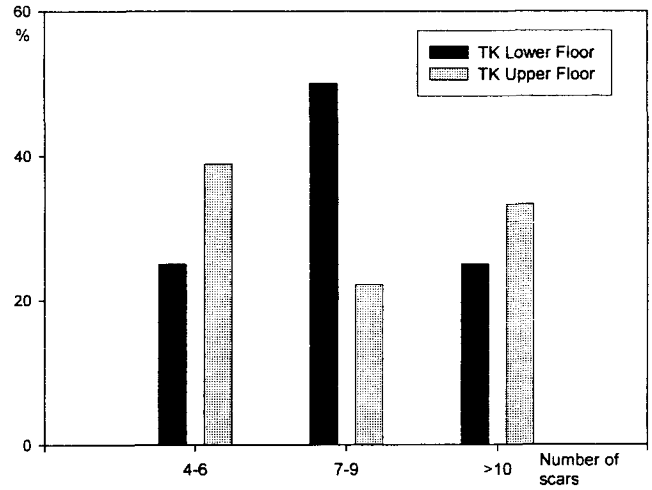

Figure 7.18. Amount of scars on the cores from TK.

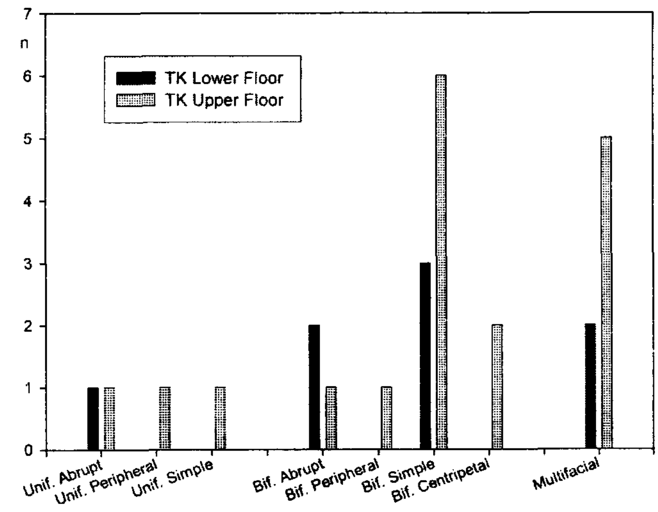

Figure 7.19. Absolute frequencies of the knapping systems at TK (both levels).

viously, lies in deducing the type of behaviour that led the Olduvai hominids to store knapping products separate from the cores from which they came from.

With regard to exploitation methods, there are no significant differences between both levels. The bifacial simple partial system and multifacial cores (fig. 7.19) dominate in both assemblages, although it is important to state that TK UF presents a series of examples that could be included in the bifacial hierarchical centripetal exploitation, which is practically unknown in the whole of the previous Olduvai sequence. Choppers appear both in quartz and lava, and present the same characteristics as in other sites, with simple angle partial edges opposite cortical areas (fig. 7.20 and 7.21). Multifacial or polyhedral cores are more profuse in TK than in previous sites. This trend can probably be explained in view of the greater intensity of the reduction observed in this assemblage. One of the two polyhedral cores from LF is made of quartz, whilst this raw material was used for three of the five polyhedral cores from UF. This data has been included so as to underscore that there is no visible trend in the emergence of quartz polyhedrons, and that, therefore, they are not necessarily linked to subspheroids and spheroids (where a clear preference towards quartz is noticeable), as some authors have suggested (for example Willoughby 1987; Texier & Roche 1995).

TK UF presents a core allocated to the bifacial peripheral strategy with a prepared striking platform, where detachments are managed around an edge without working the volume of the core. The working of the whole of the knapping surface appears in the core represented in figure 7.22, presenting a hierarchical organisation of the planes (one for preparation, another for exploitation). It is symptomatic to see the difference between the size of the example represented in figure 7.22 and figure 7.23, as well as the greater structuring noticeable on the smaller of the cores compared to the vast cortical areas on the larger core's preparation surface. This could prove the existence of recurrent exploitation stages using the same reduction system throughout the whole knapping sequence.

The sizes and reduction methods implemented when working with the cores in both levels coincide with the trends observed when referring to flakes. Although the cores from TK are *grosso modo* larger than in other sites, the knapping products are also generally larger. This system was used to produce flakes with an average size ranging between 3-5 centimetres, and in which cores are obviously always larger than flakes (fig. 7.24). Yet figure 7.24 also indicates that there are a series of flakes, some over 10 centimetres long, that exceed the general size range established for cores. These are the aforementioned large flakes, produced by a knapping system similar to that implemented to obtain large cutting tools as described in EF-HR. Nevertheless, the large cutting tools in TK are usually shaped on blocks; therefore, large flakes would not be linked to that *chaîne opératoire*. It does not seem likely that these large flakes come from the *débitage* cores documented in the site, although there are even rejuvenation products from those large blanks. Thus, we encounter a new mystery, since enormous flakes have been found, yet without their corresponding cores, and furthermore, these items are not related to the *façonnage* of the large cutting tools.

Retouched pieces

The small retouched pieces are almost exclusively in quartz and generally on flake fragments, thus following the general trend established for the rest of the lithic categories (tabl. 7.1 and 7.4). Composing 0.8% of the total number of items in TK LF and 0.4% in UF, the slightly over two kilograms of small retouched pieces in the oldest level and the almost four kilograms in the more recent one, suppose an insignificant volume of raw material compared to the rest of the collection. In any case, they are important in view of their qualitative information. In fact, it is important to recall that in LF the number of whole flakes (n=42) is not, from a comparative perspective, that greater than the number of retouched pieces (n=20), with a pattern that is also quite similar in level UF (42 flakes compared to 25 retouched objects).

The dimensions of these small retouched pieces are similar in both levels (tabl. 7.9), and Student's T test shows a statistically significant equality in the means regarding length and weight. The same results are obtained after when comparing the dimensions (length and weight) of the whole flakes assemblage in both TK levels and the small retouched pieces, since the Student T test also proves equality between means. This can be verified graphically thanks to figure 7.25.

In terms of the typological characterisation, in TK LF Leakey (1971) described a great number of side scrapers and different types of end scrapers, as well as burins, awls and *outils écaillés*. With regard to the pieces classified as end scrapers, in our opinion Leakey (1971:180) was attributing the natural, spontaneous forms of certain fragments to an intentional retouch process, whilst in fact the scarce numbers of retouched objects are merely simple side scrapers. The same occurs with burins; none is genuine, with the other groups of retouched pieces also limited to different types of side scrapers (fig. 7.26).

Our classification of the small retouched pieces from TK UF differs from Leakey's (1971). This author referred to 77 side

		Minimum	Maximum	Mean	Std. deviation
Lower Floor	Length	25	93	51.3	17.945
	Width	24	85	45.2	16.913
	Thickness	10	47	21.1	9.222
	Weight	11	414	90.1	97.924
Upper Floor	Length	17	84	47.12	18.791
	Width	20	75	36.92	15.055
	Thickness	10	25	15.88	4.157
	Weight	7	212	62.84	66.227

Table 7.9. Dimensions of the small retouched pieces from TK (mm and grams).

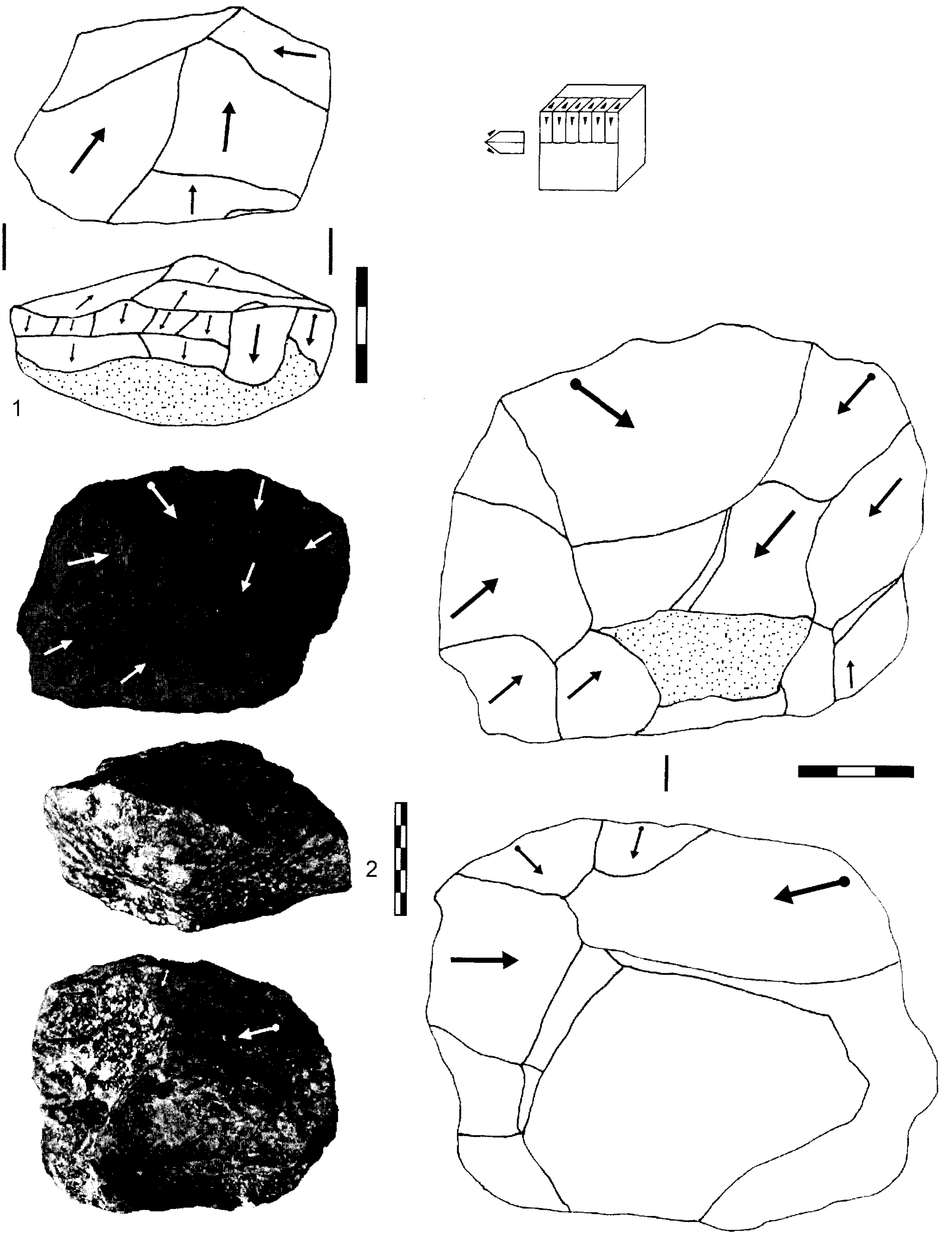

Figure 7.20. Bifacial partial simple cores from TK LF. 1: basalt; 2: quartz.

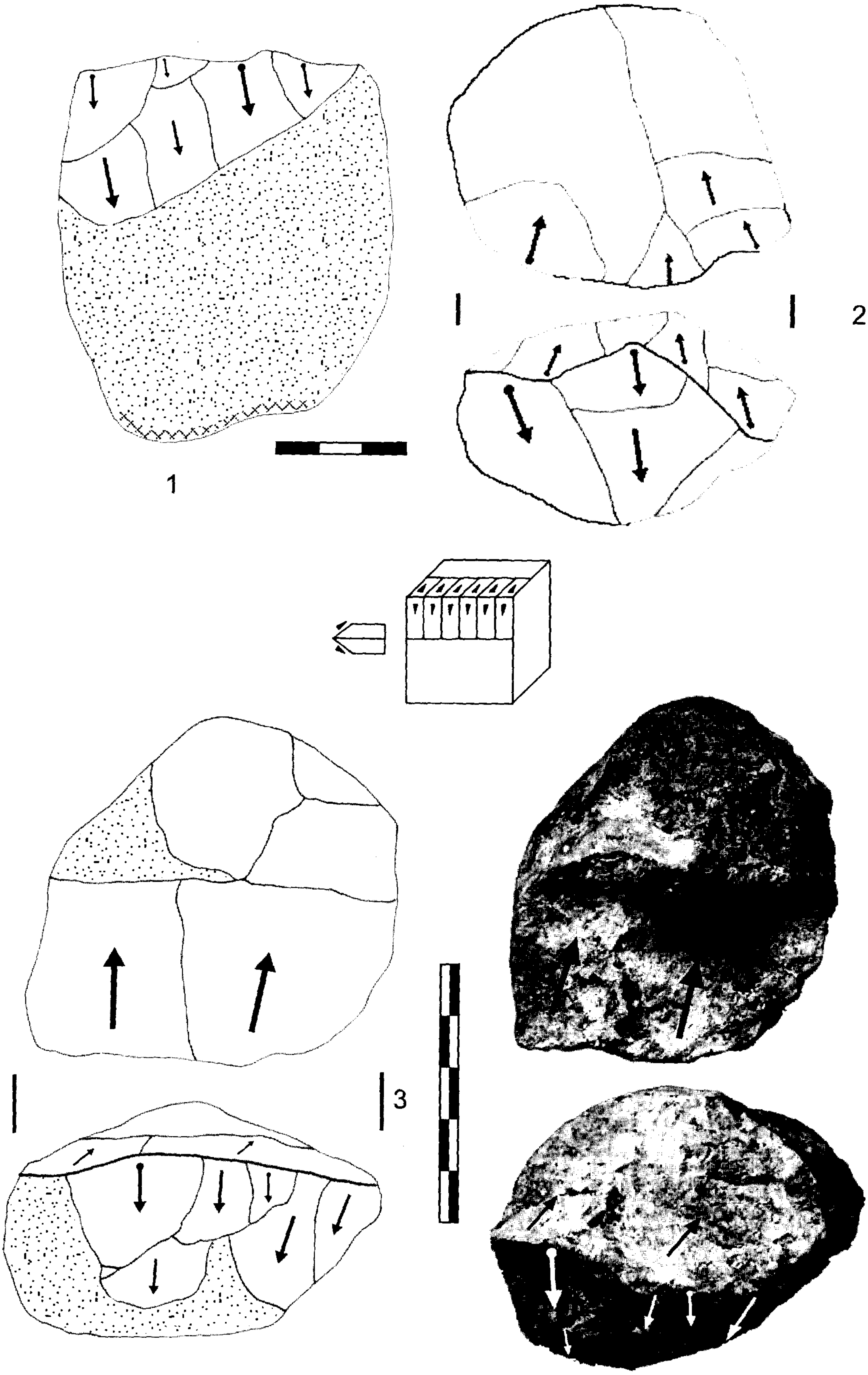

Figure 7.21. Choppers in TK UF. 1: basal unifacial simple partial exploitation, with percussion marks on the cortical base; 2: quartz chopper with alternate bifacial detachments; 3: phonolite bifacial simple partial system.

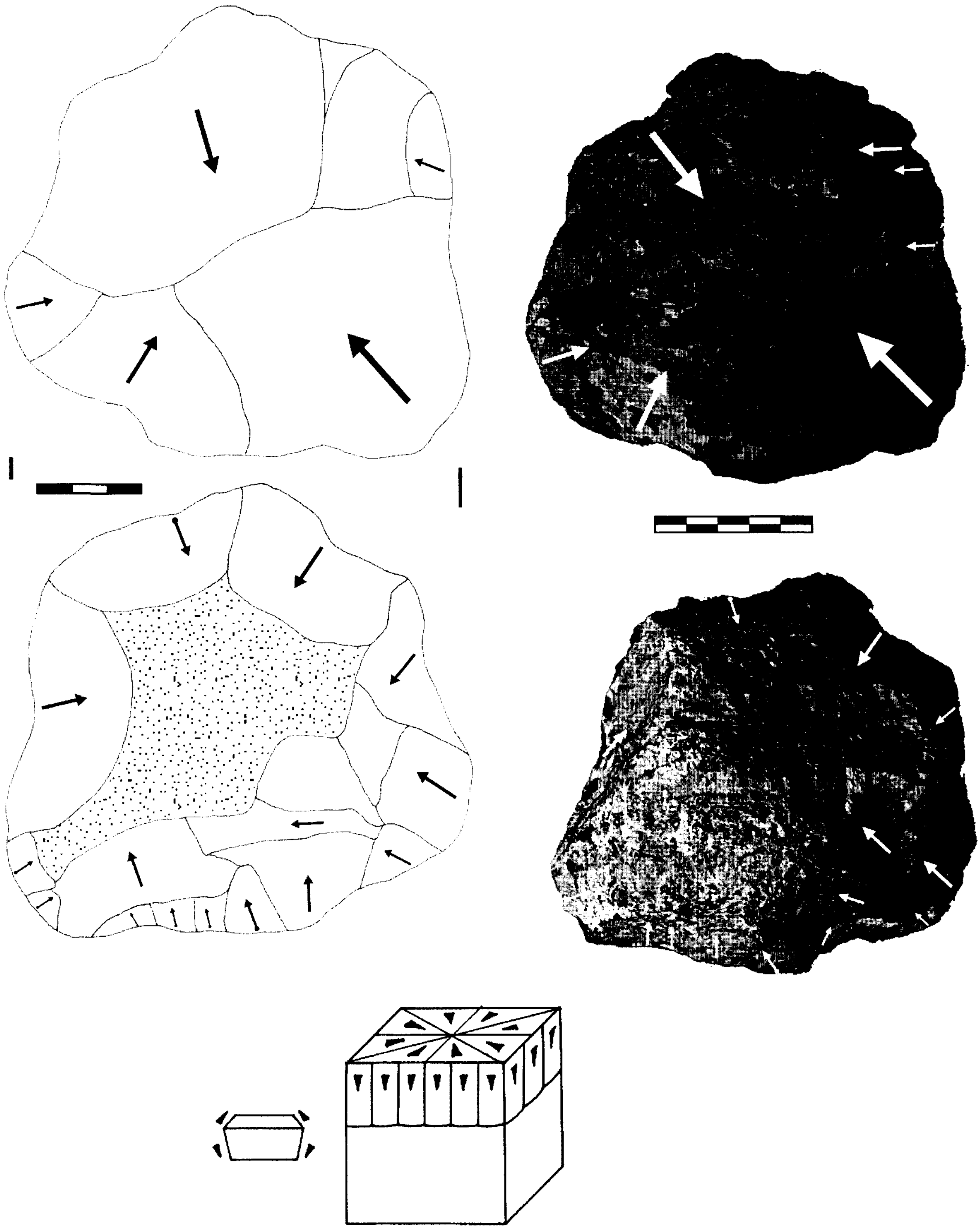

Figure 7.22. Large basalt core in TK UF, exploited using the bifacial hierarchical centripetal system.

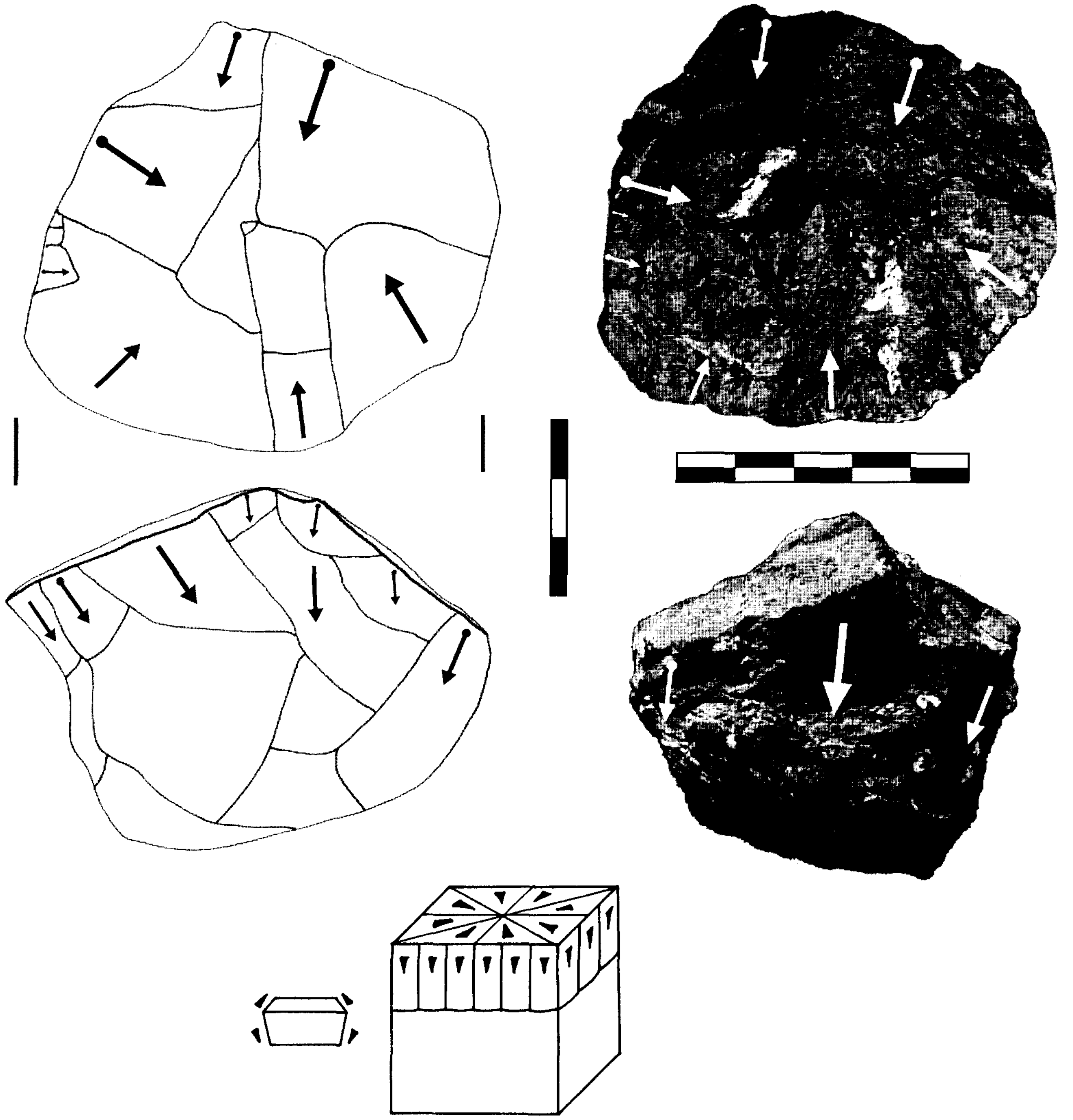

Figure 7.23. Another example of the bifacial hierarchical centripetal system, also in basalt and from TK UF, although in a more advanced stage of exploitation than examples from figure 7.22.

scrapers and end scrapers, of all types, and a great number of burins and awls, counting a total of almost one hundred small retouched pieces. In our total, we have considered most of the so-called burins, awls and end scrapers as simple flake fragments, Siret or chunks, and have only identified 25 small retouched pieces, all continuous or denticulate side scrapers (fig. 7.27). Furthermore, some of these objects are quite large, seeming more similar to the heavy-duty objects from EF-HR than small retouched pieces (fig. 7.28). In fact, the limit between one and the other becomes subjective, and the examples from figure 7.28 are only included in the small retouched pieces group given the truly enormous size of the large cutting tools in TK. In all, it is more than evident that in TK, as occurred in EF-HR or FC West, secondarily modified blanks are larger than those in the sites in Bed I.

Altogether, we cannot refer to standardised retouched pieces like burins, or propose the existence of specific morphologies

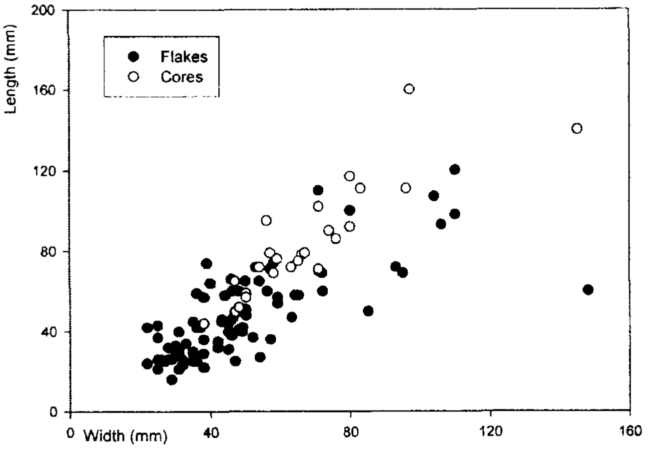

Figure 7.24. Dimensions of the flakes and cores from both levels of TK.

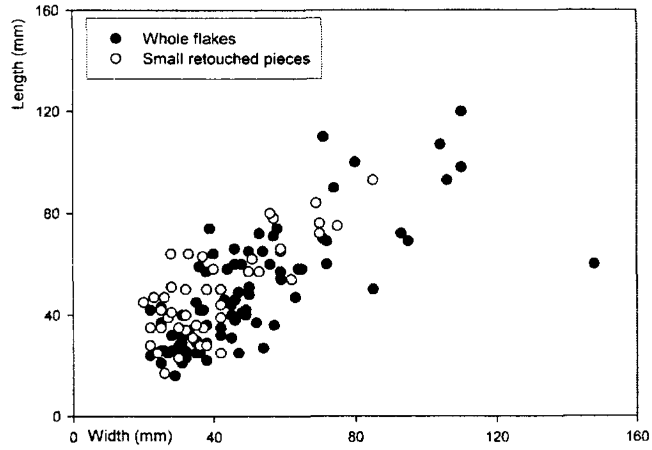

Figure 7.25. Dimensions of the small retouched pieces at TK.

like awls, nosed scrapers, etc. In fact, most of the objects originally considered retouched pieces are nothing of the sort. They are flake fragments or chunks even. Hence, the absolute frequencies for small retouched pieces proposed herein (tabl. 7.1 and 7.4) differ from Leakey's, drastically cutting the number of pieces subjected to secondary modifications.

Despite the scarce relevance in absolute terms, the relative frequencies of these retouched pieces are very high compared to other categories like flakes or cores, and take on greater importance if compared to the shortage of this type of pieces in older sites. Therefore, the small retouched pieces, which have been reduced to side scrapers and denticulates herein, have a qualitative importance only exceeded by another group of objects, which will be described below: large cutting tools.

The objects we have designated as large cutting tools were classified by Leakey (1971) as genuine bifaces. Their relevance in both levels of TK is critical, since Leakey (1971, 1975) used these pieces for the cultural allocation of both the assemblages. As mentioned above, at first Leakey (1971) classified TK LF and UF as Developed Oldowan B, and then changed the category of TK LF to Acheulean (Leakey 1975). This is no place to assess the cultural connotation of the industrial classifications (see chapter 9), although it is necessary to mention why Leakey rectified her initial consideration. In the original publication both levels were included in the Developed Oldowan category in view of the scarce biface percentage (15 bifaces in TK LF and 24 in UF). Nonetheless, upon reclassifying TK LF, Leakey (1975) stated that, despite the shortage, the bifaces from that lower level presented the same characteristics as other Acheulean sites, and that those qualitative features should be considered to decide their cultural allocation. Since in all subsequent publications focusing on this inventory (for example Bower 1977; Davis 1980; Stiles 1979, 1980; Kimura 2002; Ludwig 1999; etc) have continued to respect the nomenclature set down by Leakey, and given the fact that she based her arguments on the features of the bifaces, it is essential to study the attributes of the large shaped pieces in TK.

The first issue is the actual identification of those large cutting tools. In fact, we suggest that some of the pieces Leakey classified as bifaces, are actually chunks (fig. 7.29). This is critically relevant in terms of metrical comparisons between bifaces (one of the basic criteria Leakey implemented to differentiate Oldowan and Acheulean), and also implies major imbalances as regards the number of items. In TK UF, where Leakey (1971:174-175) counted up to 15 bifaces considering whole and fragmented pieces, our total only amounts to 10 large cutting tools, some of which are not even the same as those Leakey called bifaces. In TK UF, where the examples from figure 7.29 were unearthed and where Leakey (1971:187-189) counted 24 bifaces, we have only identified 10 large cutting tools and 7 possible fragments from that kind of items.

Despite the low absolute frequency, we agree with Leakey in thinking that the large cutting tools compose a fundamental category in the technical activities developed in TK. It is important to recall that, in terms of the raw material invested to obtain them, these pieces constitute one of the main groups in both levels (fig. 7.2 and 7.6). Consequently, it is significant to state that, despite the chronic bias of lavas in both levels, in TK LF 3 of the 10 large cutting tools are volcanic rocks, and that in UF large quartz tools are a minority (tabl. 7.4). Given the profusion of quartz from a quantitative viewpoint in both assemblages, and the general shortage of lavas in the *débitage* categories, it seems obvious that the basalt large cutting tools entered the site once worked.

Regarding dimensions (tabl. 7.10), it is important to state that Student's T test demonstrated that the length and the weight of the large cutting tools from both levels in TK present an identical distribution; i.e. no significant differences appear with reference to the dimensions of both populations. Therefore, one of Leakey's (1971, 1975) arguments to distinguish the "bifaces" from LF and those from UF, based on the smaller size of the so-called Oldowan bifaces, collapses when the comparison is limited only to whole pieces that have undergone genuine working processes (fig. 7.30).

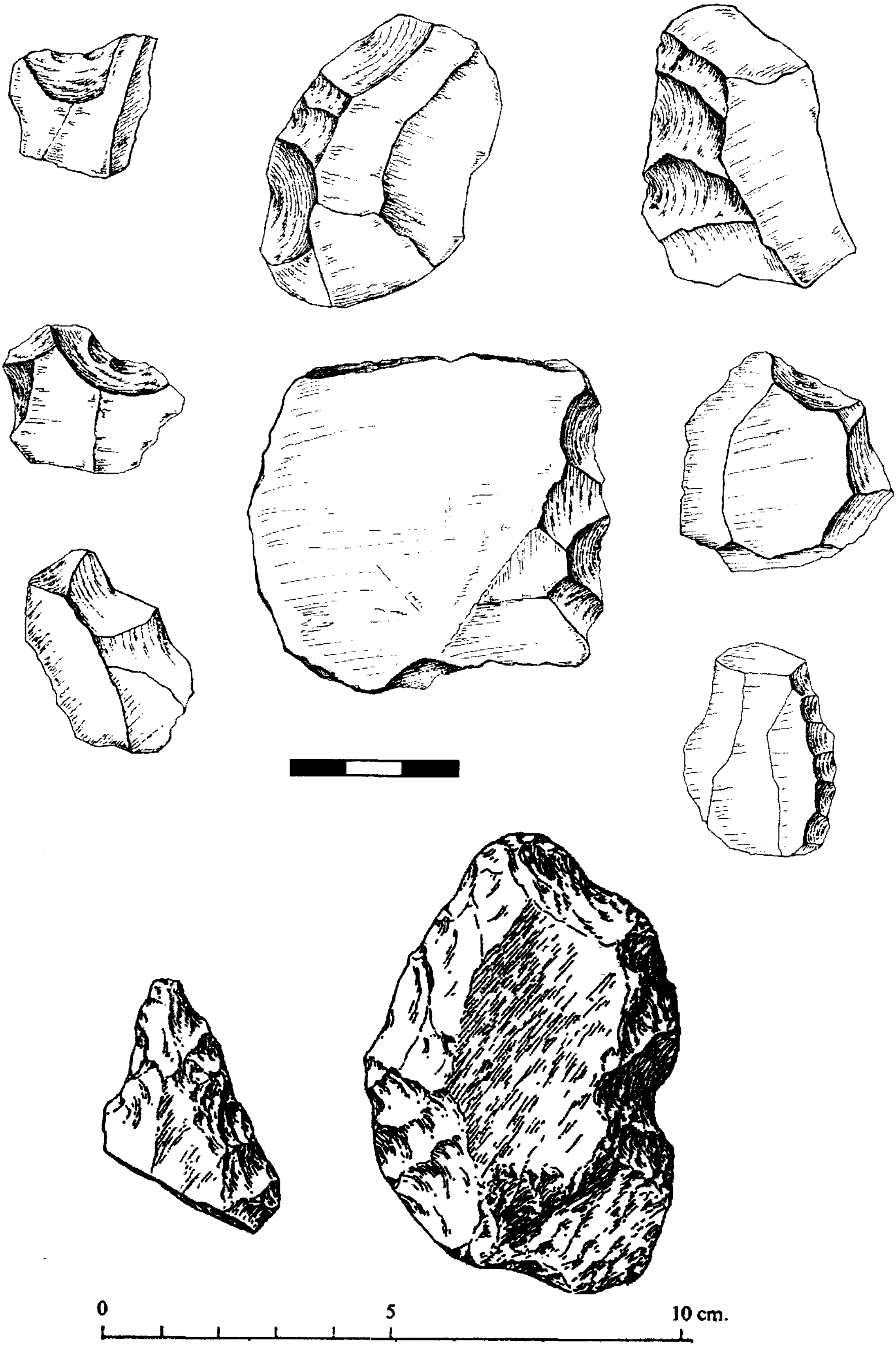

Figure 7.26. Small retouched pieces (side scrapers, notches and denticulates) in quartzite from TK LF. All drawings by N. Morán, except the last two taken from Leakey (1971:182), in our opinion the only examples that were genuinely retouched of all the pieces from TK LF represented in figure 84 of Leakey's monograph.

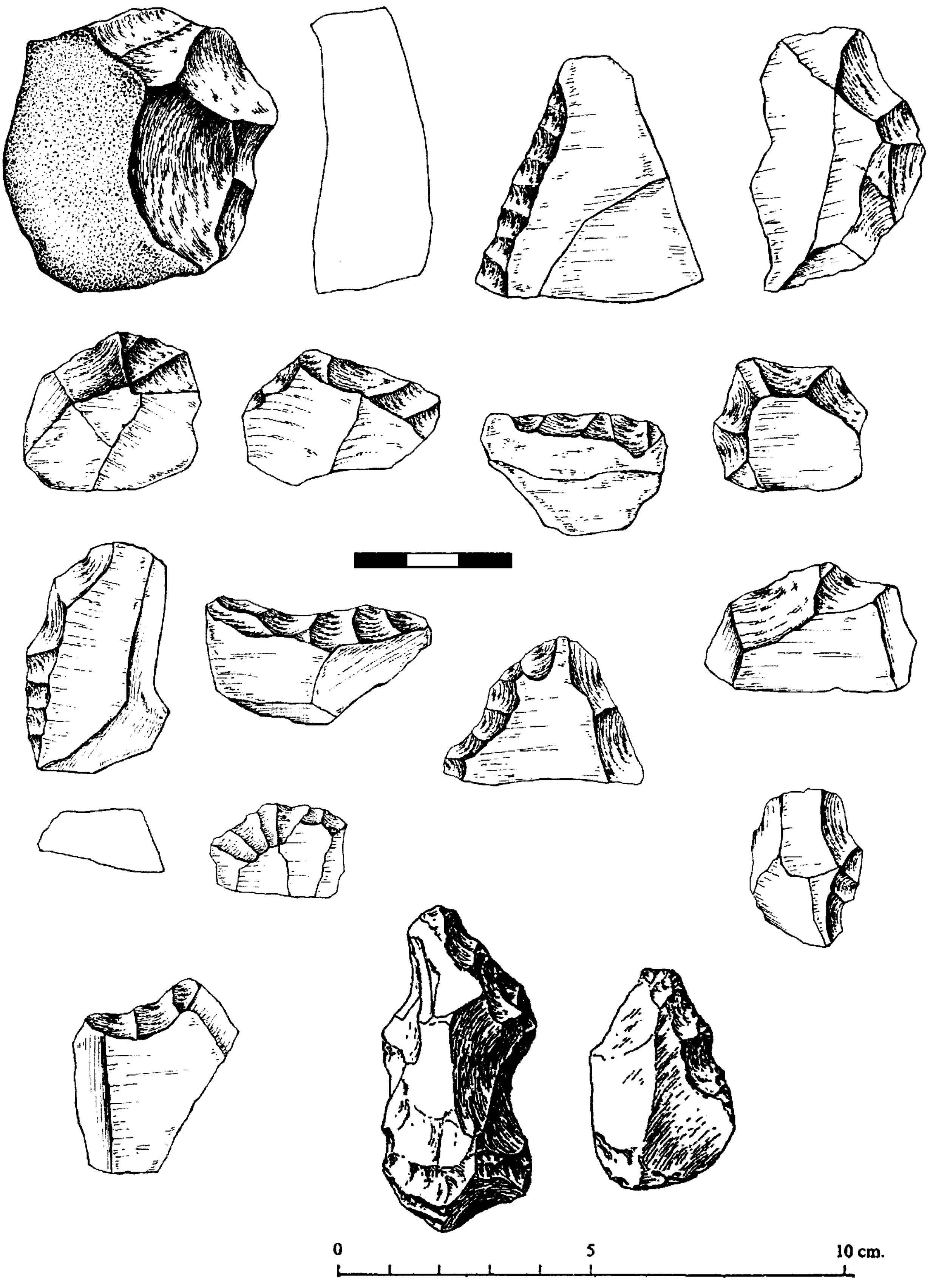

Figure 7.27. Small side scrapers and denticulates in TK UF. All examples in quartzite except of the first one which is in basalt. The last two examples are from Leakey (1971:182), and are in our opinion the only retouched pieces from UF in figure 84 of the monograph. Other drawings by N. Morán.

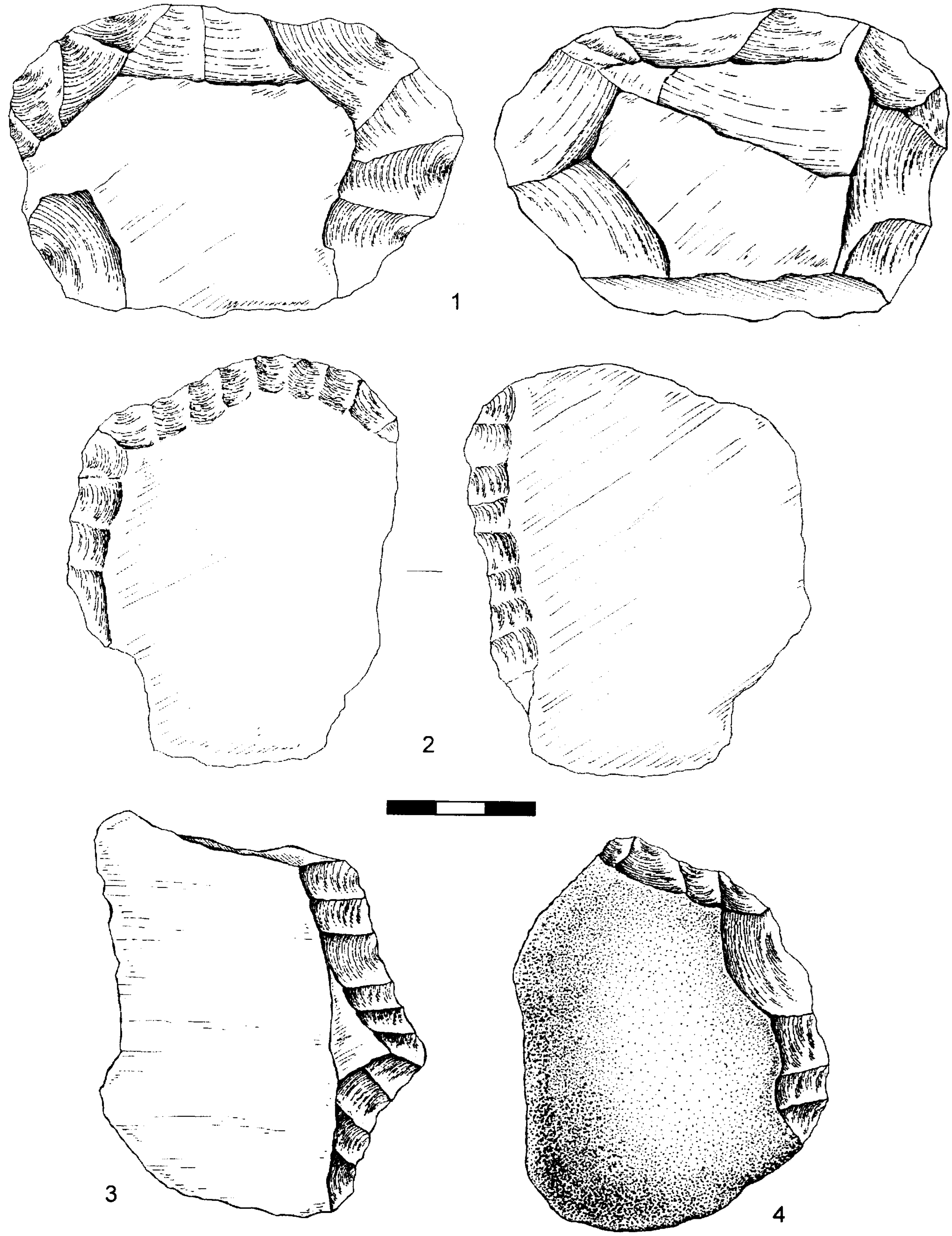

Figure 7.28. Medium-sized retouched pieces from TK UF. 1: quartz bifacial simple side scraper; 2: denticulate quartz side scraper. A small natural fragment of a quartz block is used to retouch the edge; 3: tabular quartz fragment with retouched edge, creating a simple side scraper; 4: small basalt cobble with a retouched edge forming a simple side scraper (drawings by N. Morán).

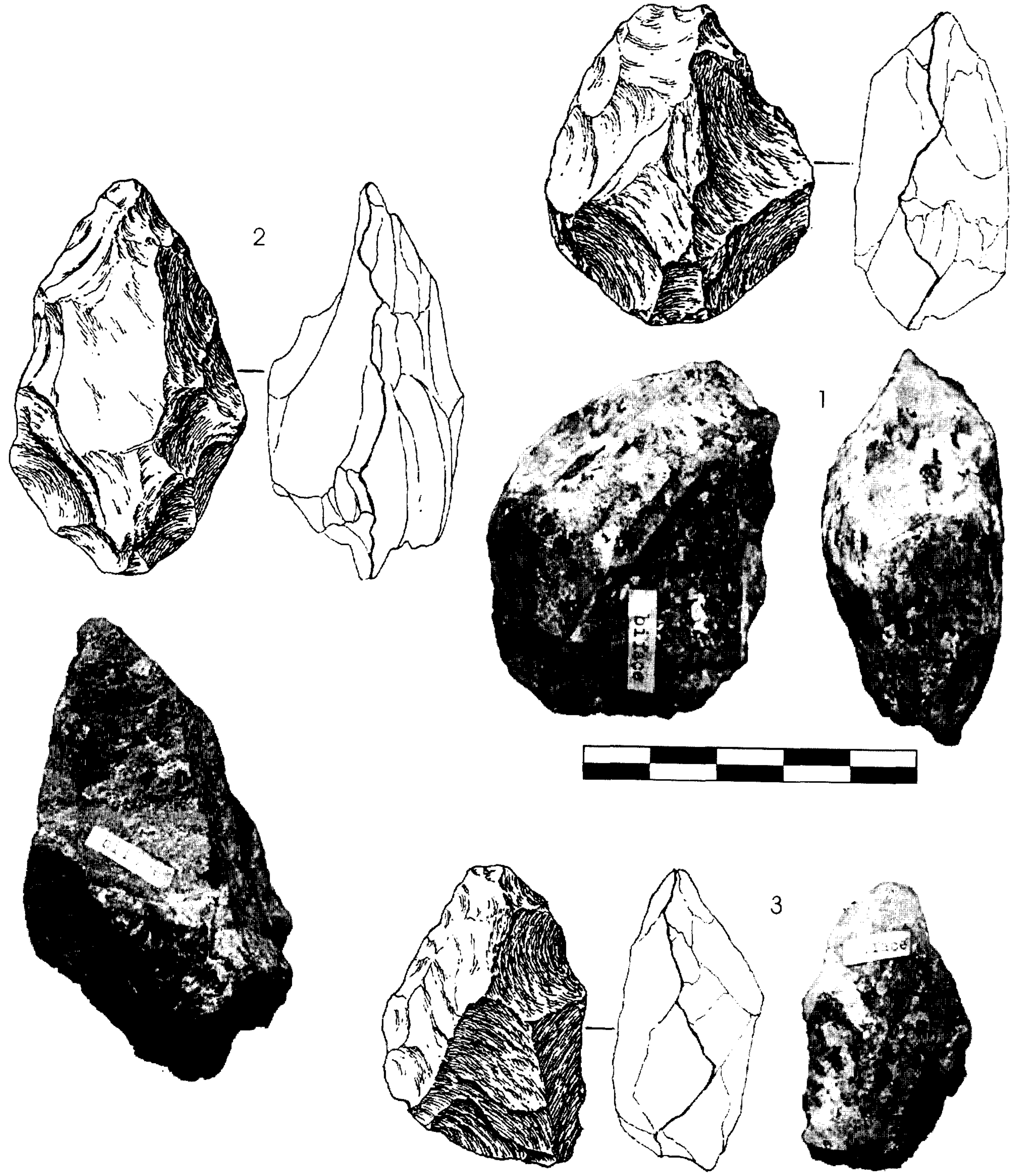

Figure 7.29. Bifaces from TK UF according to Leakey (1971:190). No. 2 could be a fragment of basalt biface since it has an edge presenting retouching on both surfaces. Nonetheless, its small size is not due to the technical tradition that manufactures small bifaces (which would, according to Leakey, associate it to the Developed Oldowan B), but is simply due to the fact that it is a fragment detached from a larger shaped piece. Nos. 1 and 3 are, in our opinion, large quartz chunks, not shaped pieces. The edge on No. 1 is completely blunt, and the ridges do not seem to have been caused by knapping, but by fracture.

		N*	Minimum	Maximum	Mean	Std. deviation
Lower Floor	Length	9	100	290	156.11	60.267
	Width	9	60	118	86.11	16.12
	Thickness	9	30	55	44.67	7.73
	Weight	9	289	2230	844.44	604.792
Upper Floor	Length	10	73	265	137.9	58.685
	Width	10	59	168	97.4	31.994
	Thickness	10	27	74	46.4	15.414
	Weight	10	199	1788	831.1	585.038

Table 7.10. Dimensions (mm and grams) of the large cutting tools from TK. (*) Only complete examples.

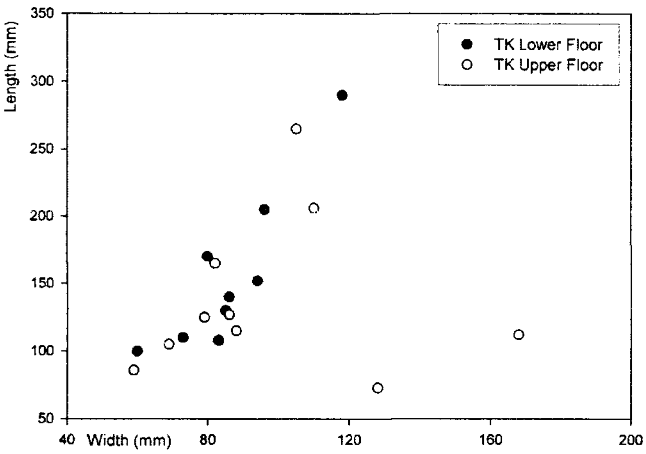

Figure 7.30. Dimensions of the large cutting tools. The tendency observable in some pieces in which the X axis strays from the main concentration is explained via measurement criteria; in the few objects for which the technological axis could be oriented, the length was measured from the butt to the distal point. As in EF-HR, these are short, thick flakes, therefore their length is well below their width. Since most of the material was divided in terms of the typological axis, they appear as two different groups when we are in fact processing a very homogeneous sample, from a metrical point of view.

The intensity of the reduction was also similar. TK LF shows a minimum of 3 detachments in the less worked piece and approximately 19 on the piece that has experienced the most intense reduction, with an average of 8.75 scars per object. TK UF, with a minimum of merely two blows and a maximum of 15 detachments, presents an average of 8 scars, quite similar to the underlying level. The other main argument Leakey (1971) outlined, i.e. the preferential selection of flakes as blanks in the Acheulean and of cobbles or blocks in the Oldowan, is not fulfilled in TK either. In the lower level, only two of the large cutting tools have been shaped on flake, despite their consideration as Acheulean items; another 4 pieces were shaped on blocks, and it is impossible to identify the original blank used for the other 3 items. In TK UF, of the 10 whole pieces, 3 used flakes as blanks, another three modified a cobble directly, one piece was shaped on a block and the 3 remaining pieces were worked on an indeterminate blank. In all, no specific pattern can be delimited to discriminate between both levels, neither considering metric terms, the intensity of the reduction or even the type of supports used for retouching. Therefore, the following step calls for an examination of possible differences that could appear in the *façonnage* methods.

TK presents what could be considered as perhaps the most stunning *façonnage* system in Beds I and II, and it should come as no surprise that it appears in both levels, not merely in one of them. We have called this system the rhomboidal reduction method and, whilst it is similar to the technique described by Bar-Yosef and Goren-Inbar (1993:153-154) in 'Ubeidiya, it consists in exploiting the quartz blocks' tabular planes as opposite striking platforms. The *façonnage* process for these blocks is performed as follows (see fig. 7.31): the horizontal plane (henceforth PH), which exploits the block's tabular surface, acts as a striking platform from which one of the edges is struck (edge 1) so as to create a unifacial ridge. Subsequently, instead of turning the block over and striking that edge 1 from the opposite horizontal plane (PH′), that PH′ is used to work the opposite edge (edge 2). Consequently, this produces a continuous ridge around the whole of the piece's perimeter, in which there is generally no interaction between the detachments from one face and the other. The only area that presents a recurrent bifaciality is the tip. In these areas, the unifacial retouch on edge 1 from the PH opposes another retouch from PH′ also on that edge 1; the same usually occurs on the other edge. Therefore, and via a bifacial retouch with simple angles on both planes, the craftsmen obtained a forceful tip on one of the ends of the block.

This type of tasks generate "false" bifaces since, with the exception of the tip of the piece, the volume is never distributed on two planes, either symmetrical or asymmetrical, since only the edge of each surface is modified. In fact, knappers are not interested in penetrating the blocks; they only aim to modify the external edges, with a view to creating objects with forceful rims. Nonetheless, these pieces are always connected to a pointed tip. That tip is the only area on the whole of the artefact to undergo intense bifacial works, which could possibly explain the great amount of this type of fragments (fig. 7.32), probably resulting from knapping mistakes that occurred during the manufacturing process.

In any case, the knapping method, which denotes a truly relevant technical complexity, cannot be connected to the bifacial *façonnage* of the volumes, and is in fact linked to an alternating and/or bifacial work of the edges of blocks presenting suitable natural morphologies. This original strategy implemented to obtain large cutting tools appears in both levels in TK (which once again rejects a cultural difference between LF and UF), and will be more comprehensible after understanding figures 7.33 to 7.38.

In this so-called rhomboidal system, there is an example (fig. 7.39) that differs slightly from the previous models. As previously, the exploitation is unifacial, since there is no interaction of the strikes on one edge, or an alteration of the blows on both surfaces. On the other hand, the knapper worked a whole plane first, and once shaped, he moved on to the other

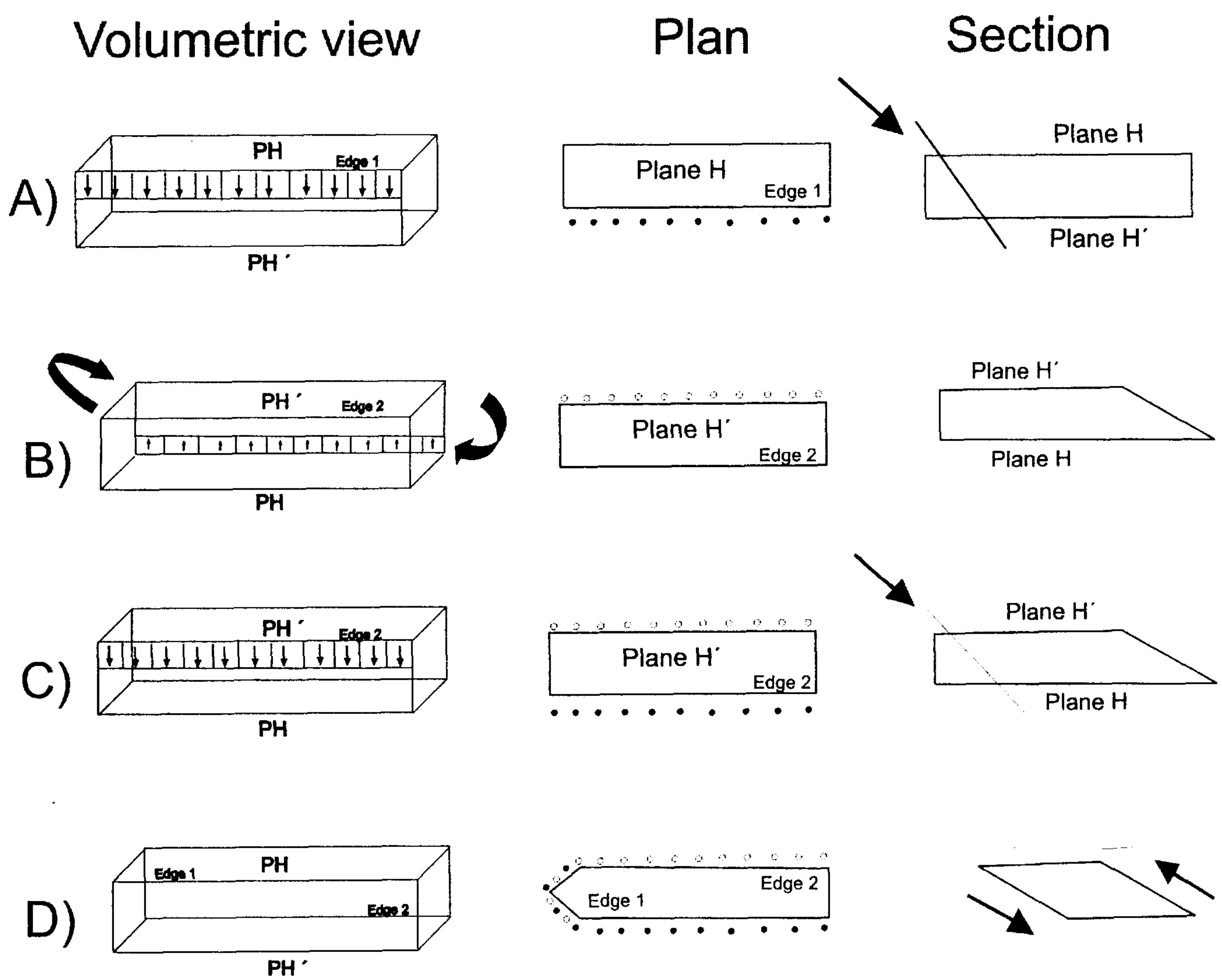

Figure 7.31. Ideal diagrams for rhomboidal exploitation used for large cutting tools. A: the Horizontal Plane (PH) acts as a striking platform on the edge of the piece; B: this produces an edge in the PH, which leads knapper to turn over the block; C: the same work is performed from the PH´ on edge 2, which is the edge opposite to edge 1 on the PH; D: this produces two edges worked unifacially, and one distal end that is worked bifacially to obtain a point.

surface. Compared to previous examples, the first innovation lies in the fact that when working this excellent quality basalt, tool-maker is interested in working the entire volume of each surface, based on invasive detachments, many of which have a flat angle.

The second innovation appears in that, quite probably, this piece was shaped using a soft hammerstone. As aforementioned, figure 6.19 demonstrated soft percussion could have been performed in FC West. Nonetheless, that example is not as evident as the current one. Especially as regards figure 7.39, but also in terms of other examples such as the one represented in figure 7.40, these objects present the typical traces left by a soft hammerstone (Newcomer 1971), with flat, invasive detachments, that do not break the piece's edge, leaving very diffuse negative bulbs of percussion on a perfectly regular edge. If this is considered alongside the presence of certain flakes with lineal butts that could have been generated by this type of *façonnage*, it is possible to assume that -at least as regards TK LF - the hominids could have possibly used soft hammerstones to shape the large cutting tools. If this were the case, and although it is difficult to soundly confirm the presence of a soft hammerstone using these analytical parameters (Mewhinney 1964), we would be facing the oldest known evidence of the use of organic materials in lithic knapping processes.

Unquestionably, the large cutting tools composed one of the most important categories in TK. The volume of raw material invested, the relatively standardised forms they present and the careful transformation give notice of the relevance they had in the technical activities performed in the site. Moreover, it is essential to state that there are no relevant differences between the types of large cutting tools represented on both

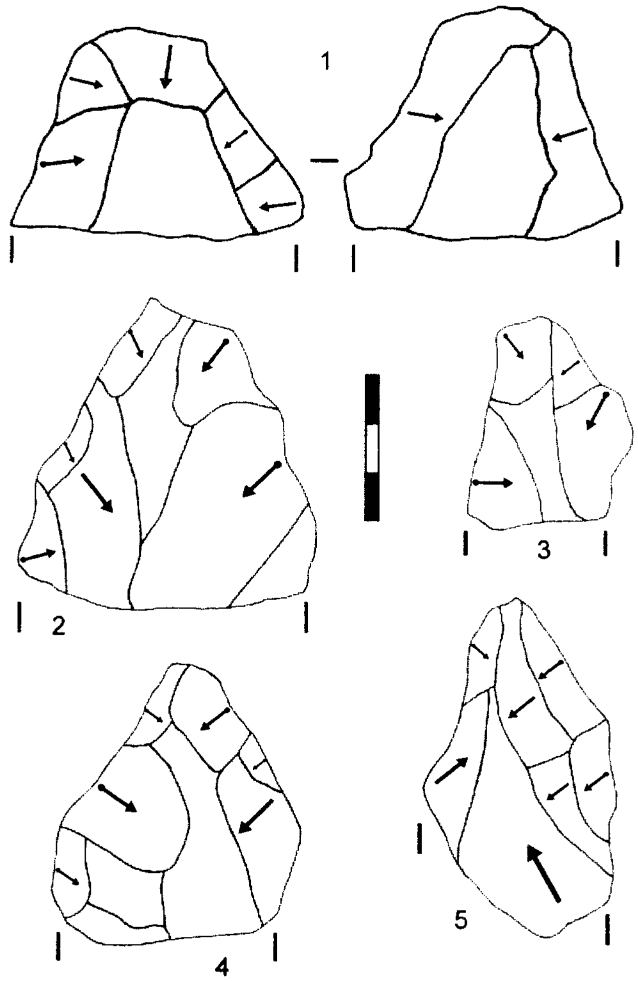

Figure 7.32. Possible points from large cutting tools fractured by accident during knapping and/or use. 1: example from TK LF; 2-5: examples from TK UF.

Percussion objects

Percussion processes, both in TK LF and UF, were one of the most important activities. Tallying the different types of hammerstones and fragments with percussion traces (tabl. 7.3), TK LF totals 19,803 grams of raw material exclusively linked to these processes, which could be considered alongside a vast amount of the quartz angular fragments which are devoid of percussion traces but were surely generated during such an activity. This trend is even more evident in TK UF, with a minimum of 63,208 grams of raw material invested in percussion activities, without considering the large amount of chunks and millimetric fragments that were almost certainly also caused by these activities.

The shortage of knapping hammerstones in TK LF is surprising, although it is compensated by the number of hammerstones with fracture angles, which could previously been used for *débitage* processes. Nonetheless, they are relatively profuse in TK UF, and present the trend observed previously in other sites, with a predominance of lava stream cobbles as blanks. The dimensions (tabl. 7.11) vary, and it is particularly interesting to document large pieces, ideal for obtaining large flakes, alongside small hammerstones perfect for retouching and the final shaping of the large cutting tools.

Hammerstones with fracture angles are the most relevant category concerning percussion objects in TK LF, and generally appear on quartz cobbles (tabl. 7.1). They also abound in TK UF, usually in quartz (tabl. 7.4), although in this level the number is substantially lower than the subspheroid-spheroid category. The comparison of average maximum lengths and weights of the hammerstones with fracture angles from both levels indicates there are differences between the occupations in terms of weight (greater in TK LF), although concerning levels. Consequently, the objects Leakey (1971) called bifaces should not be used as an argument to distinguish TK LF and UF from a cultural point of view. As regards that definition of bifaces, the term presents a series of problems, since it is not exactly a bifacial strategy in most cases. In all, and compared to EF-HR or FC West, in TK there are examples that could be classified as genuine bifaces (fig. 7.41), although they do not compose the dominant trend.

In fact, this criterion should not be used to distinguish TK from the previous Acheulean sites. In our opinion, both TK levels present an identical technological strategy, which consists in the configuration of large tools, with forceful edges and pointed ends. Whilst EF-HR basically presents large side scrapers on flakes, of different morphologies, TK gives notice of a search for more standardised forms which always present a pointed area; whether they were shaped on a flake (fig. 7.42) or a cobble (fig. 7.43 and 7.44) is indifferent, it should not be used with cultural connotations, and responds to a shared goal: the pursuit for enormous forceful edges.

		N	Minimum	Maximum	Mean	Std. deviation
Lower Floor	Length	2	84	86	85	1.414
	Width	2	77	97	87	14.142
	Thickness	2	61	92	76.5	21.92
	Weight	2	568	870	719	213.546
Upper Floor	Length	24	57	180	86.83	25.052
	Width	24	41	125	68.63	20.295
	Thickness	24	30	96	55.67	17.522
	Weight	24	79	1317	387.83	328.844

Table 7.11. Knapping hammerstones at TK (mm and grams).

		N	Minimum	Maximum	Mean	Std. deviation
Lower Floor	Length	9	62	129	87.22	23.6
	Width	9	59	97	72.78	15.106
	Thickness	9	42	88	61.33	16.148
	Weight	9	270	1113	654.78	363.687
Upper Floor	Length	28	51	106	82.29	13.51
	Width	28	30	98	63.93	16.434
	Thickness	28	28	91	51.39	14.786
	Weight	28	76	1074	382.89	264.354

Table 7.12. Hammerstones with fracture angles at TK (mm and grams).

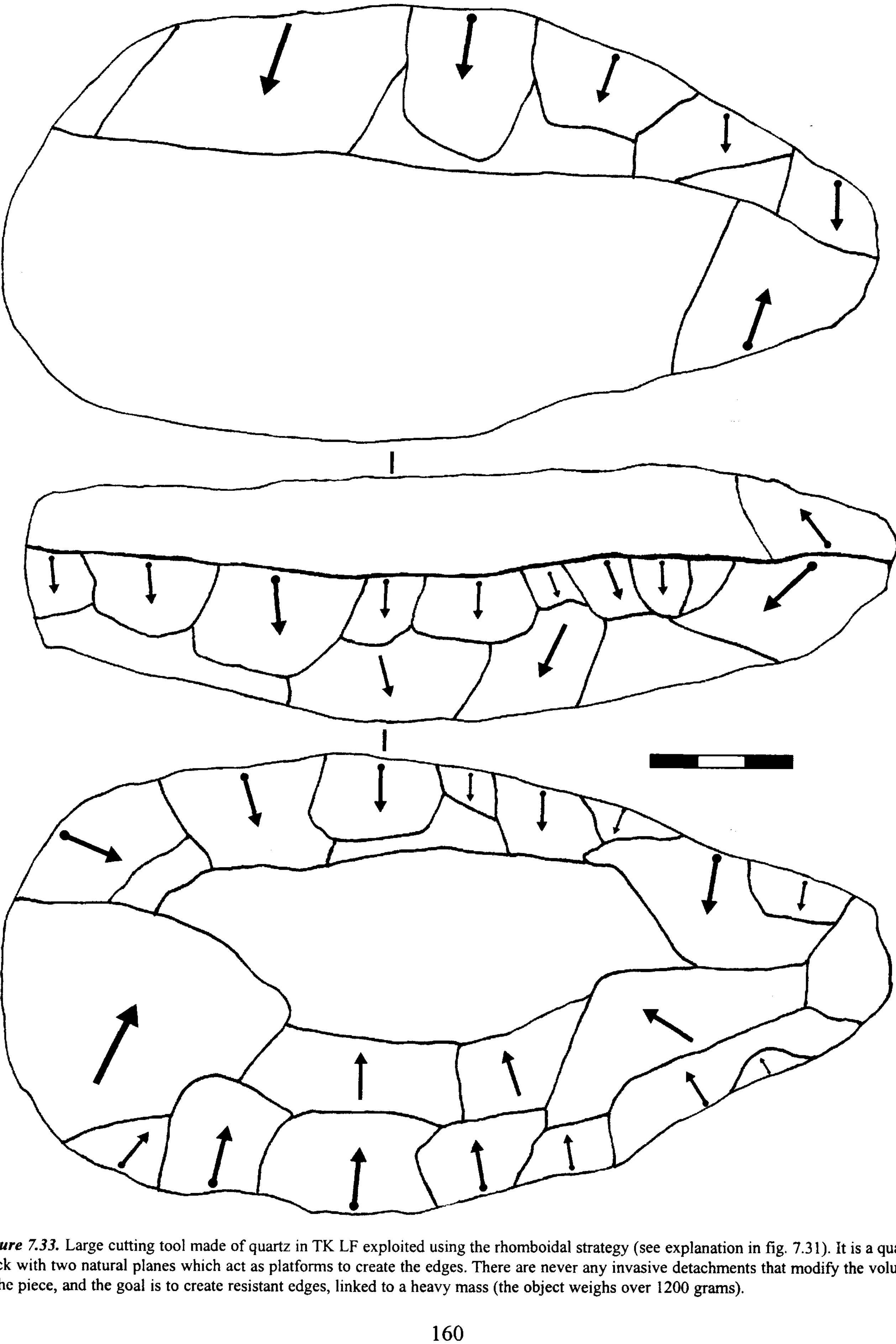

Figure 7.33. Large cutting tool made of quartz in TK LF exploited using the rhomboidal strategy (see explanation in fig. 7.31). It is a quartz block with two natural planes which act as platforms to create the edges. There are never any invasive detachments that modify the volume of the piece, and the goal is to create resistant edges, linked to a heavy mass (the object weighs over 1200 grams).

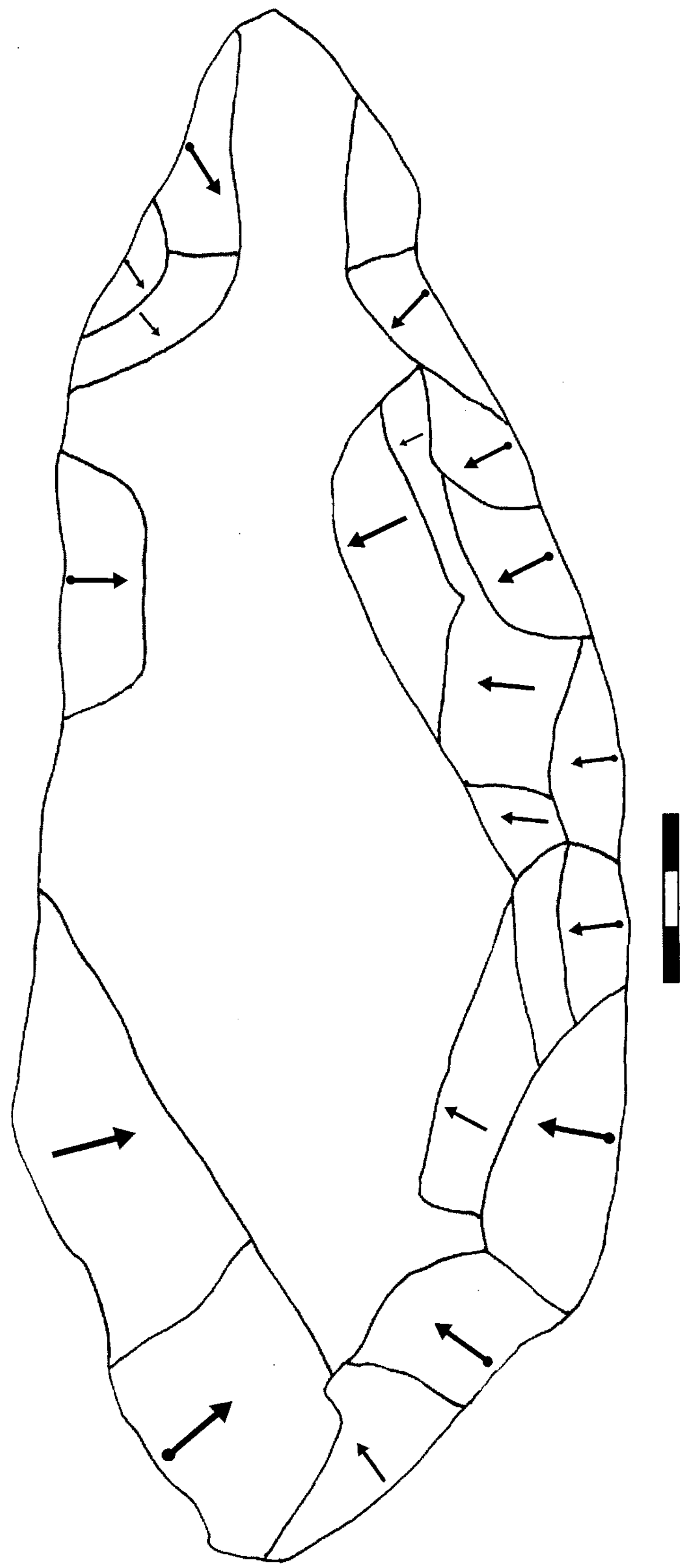

Figure 7.34. Another quartz example from TK LF worked using the rhomboidal strategy. This figure depicts what is known as Face A, with simple angle detachments from the PH, which compose a unifacial edge sometimes appearing opposite to a flat retouch from PH′. Subsequently, the other edge is exploited from PH′ (Face B) also via simple-angled retouching, which becomes bifacial especially when working the point. As in the previous case, the volume of the piece is not shaped, with activities focusing only on the outer edge, obtaining an object weighing over 2,200 grams with a forceful edge.

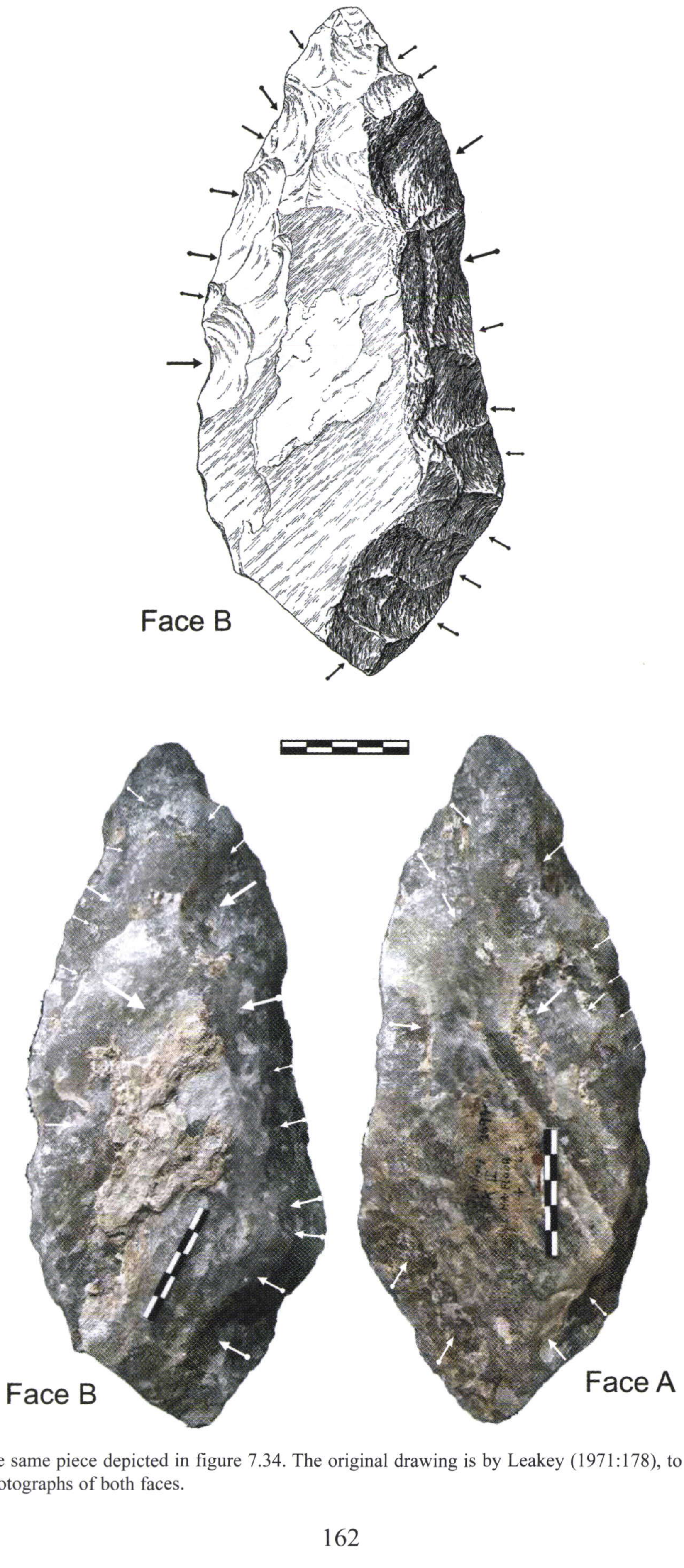

Figure 7.35. Face B of the same piece depicted in figure 7.34. The original drawing is by Leakey (1971:178), to which we have added the diacritical diagram and photographs of both faces.

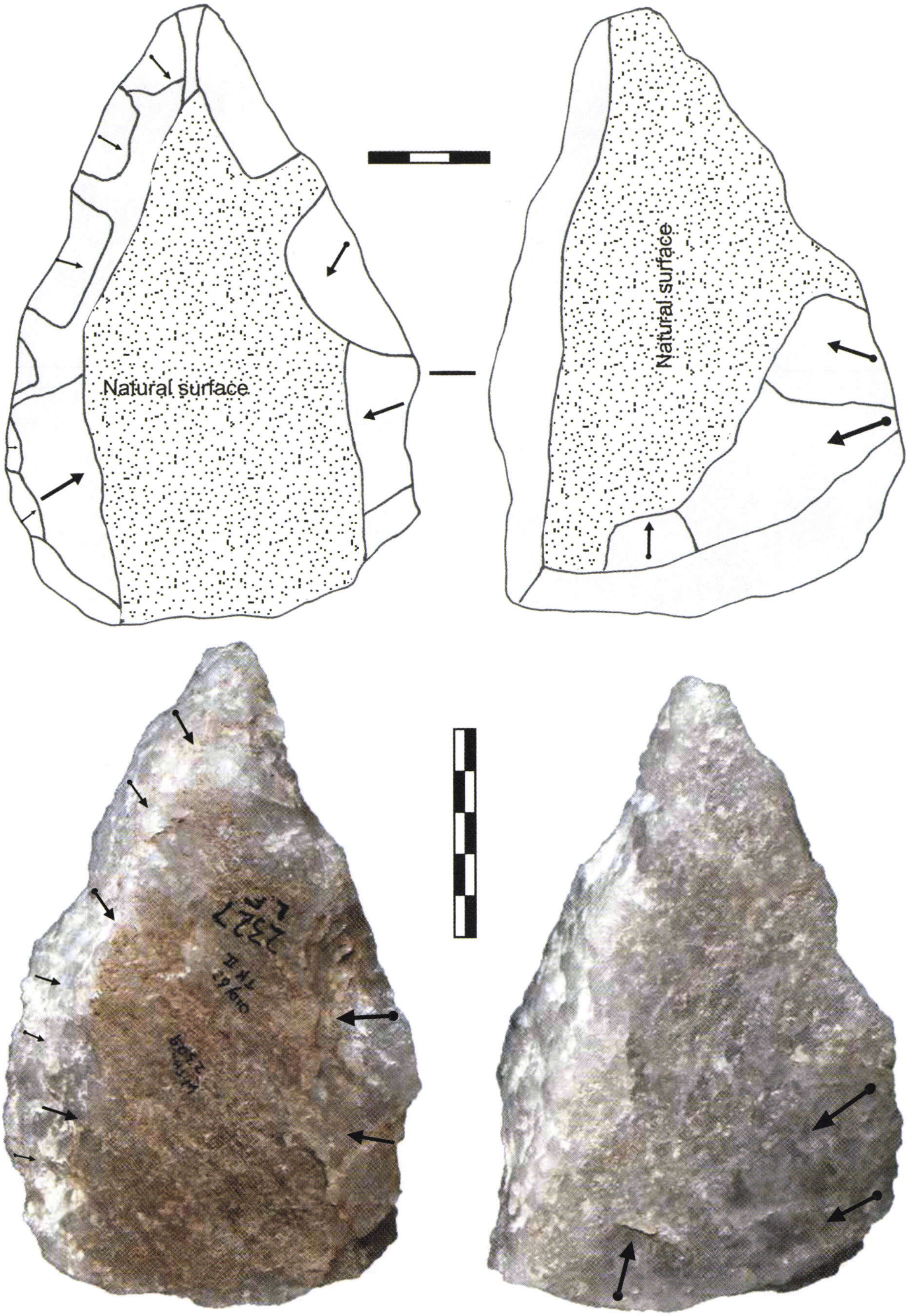

Figure 7.36. Large cutting tool made on quartz block. Example from TK LF.

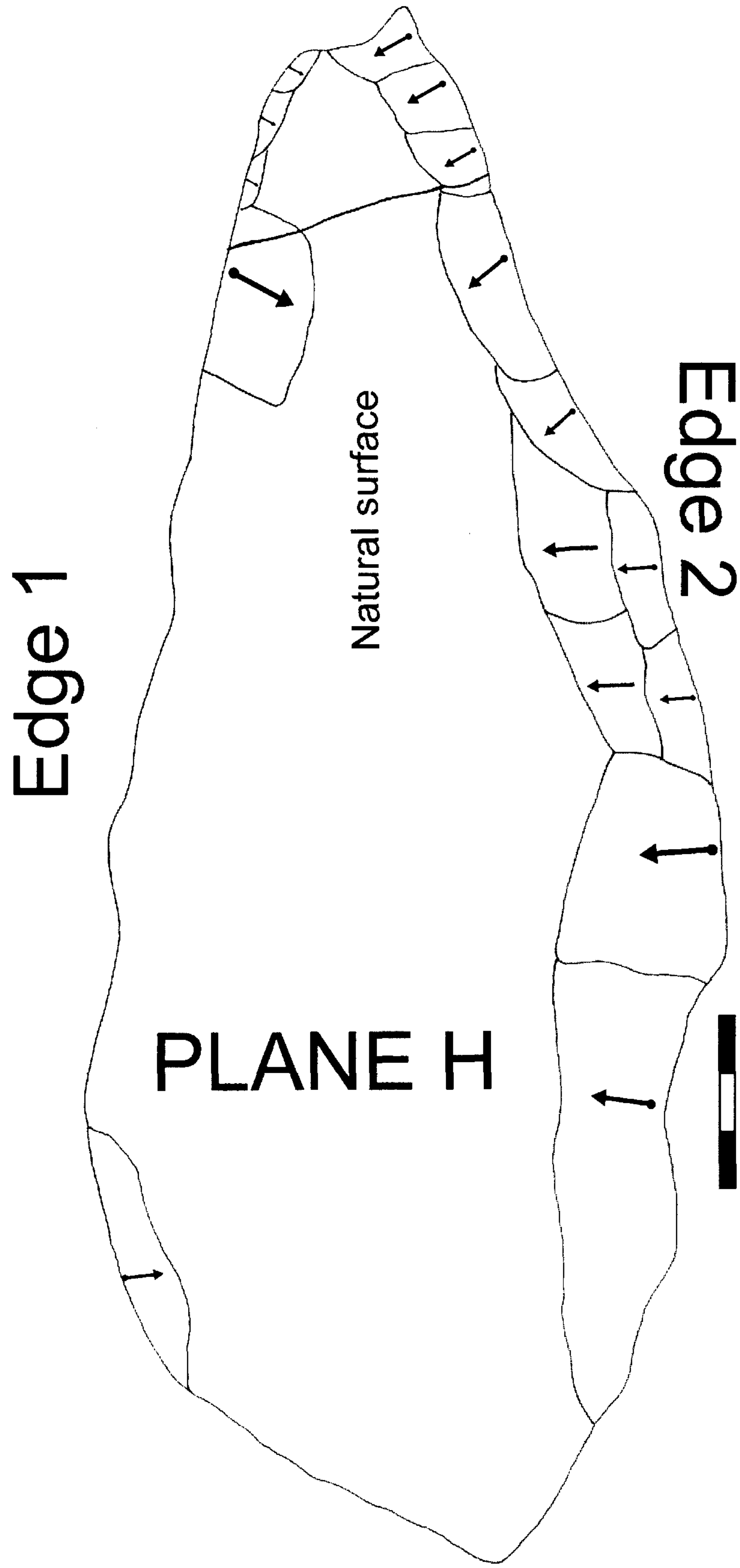

Figure 7.37. Large cutting tool made on quartz block from TK UF. The exploitation is identical to that documented in the underlying level; plane H acts as the striking platform to retouch edge 1 with an abrupt angle around the whole perimeter except on the pointed area, where detachments are performed with a simple angle and are alternated with some flat angle extractions from PH′. Edge 2 is also worked from this PH, combining flat-angled extractions from PH′ with simple-angled retouch performed from this PH.

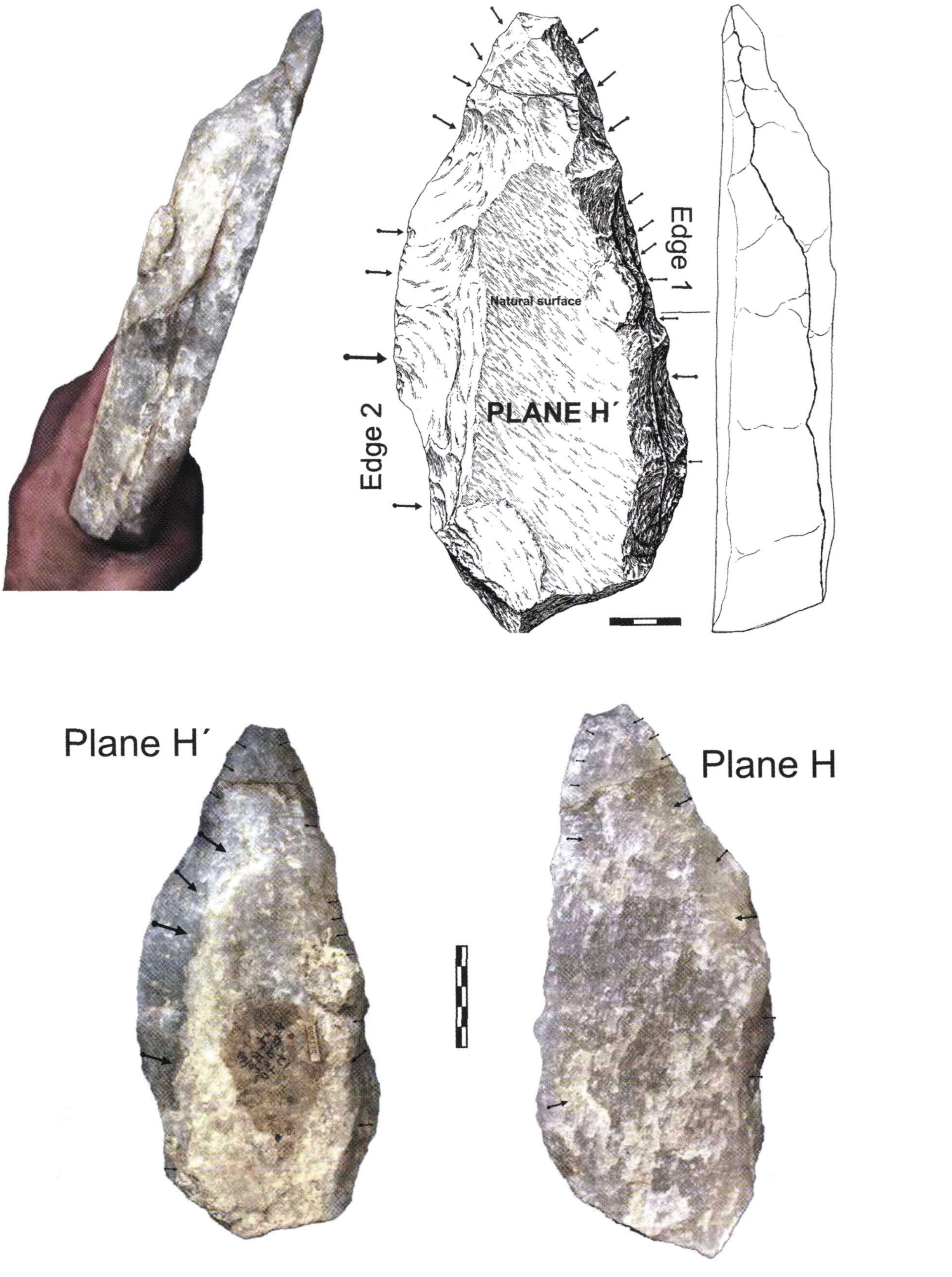

Figure 7.38. The other face of the same piece represented in figure 7.37; in this case the diacritical diagram is based on an original drawing by Leakey (1971:188), and photographs of both faces. Here, the PH´ acts as a striking platform essentially to work edge 2. Edge 2 is practically not worked from this PH´, except for the point. By using this rhomboidal strategy, a new false symmetry is achieved and a ridge is created around the whole perimeter of the piece.

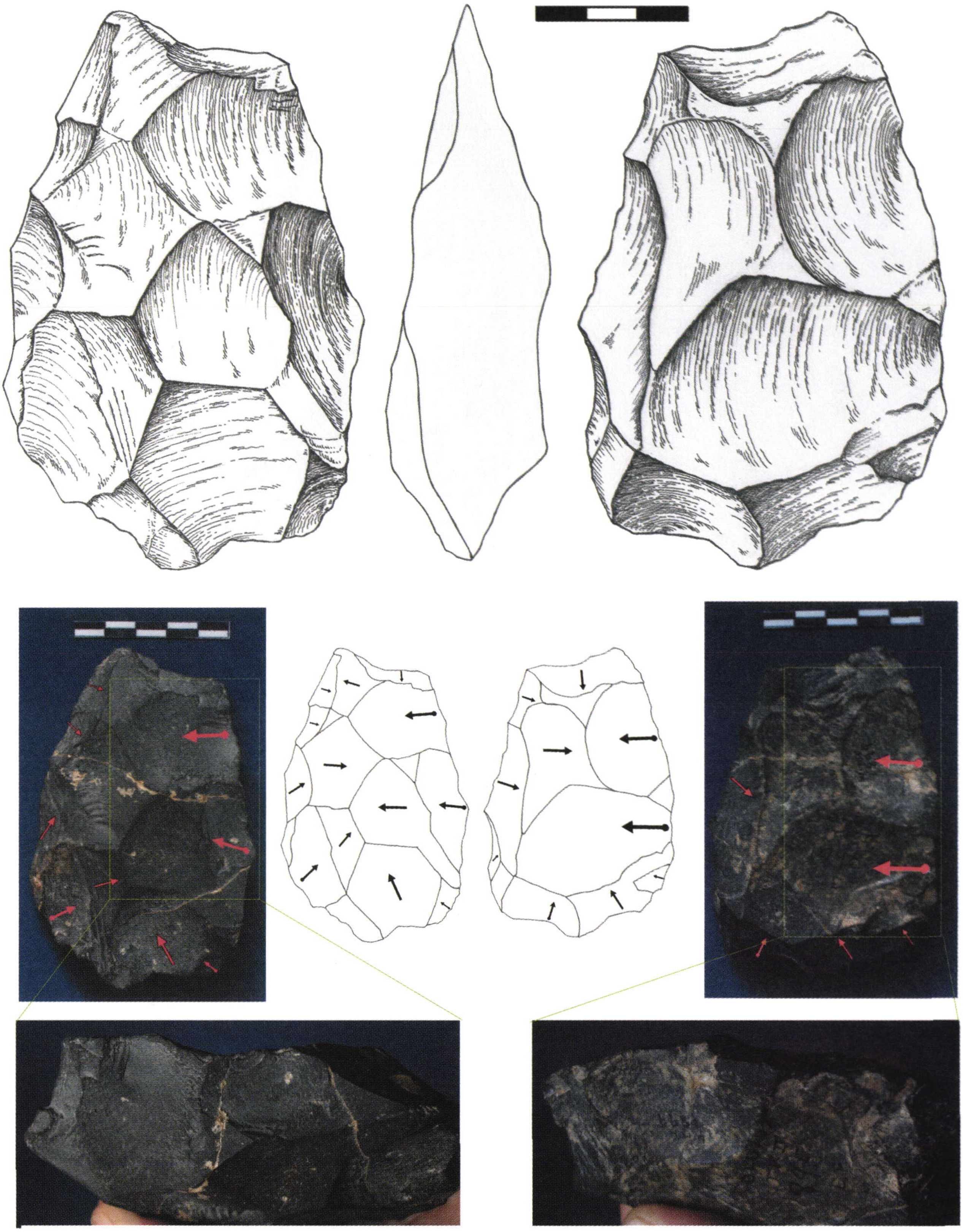

Figure 7.39. Large cutting tool made on high-quality fine grain basalt in TK LF. Both surfaces are worked with simple and/or flat-angled invasive detachments, managing the whole volume of the piece, not only the edges. Nonetheless, there is no bifacial interaction between edges; first one plane is worked and the second plane is only worked on once the former has been thinned. The final *façonnage* was probably performed using a soft hammerstone, since detachments are very flat-angled and invasive, whilst the ridge presents a more or less regular outline (drawing by N. Morán).

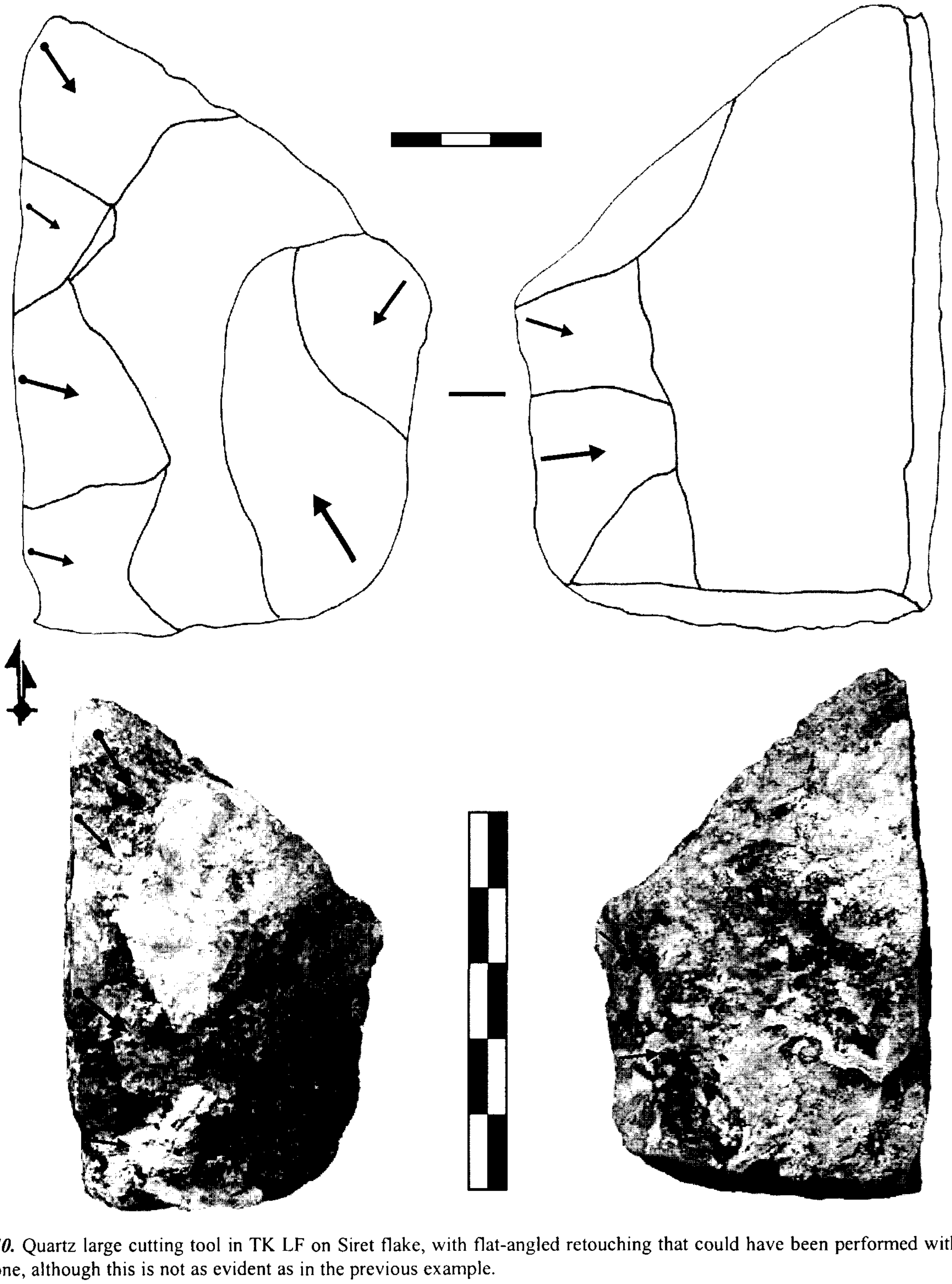

Figure 7.40. Quartz large cutting tool in TK LF on Siret flake, with flat-angled retouching that could have been performed with an elastic hammerstone, although this is not as evident as in the previous example.

the length, both samples could belong to one same population (tabl. 7.12).

The issue of the hammerstones with fracture angles takes on a special relevance in TK LF, since in our inventory this category includes several objects Leakey (1971) classified as knapped pieces. Nonetheless, they do not present any of the attributes typical of knapping processes; the so-called detachments do not come from any of the edges, the scars present convex forms or the concavities appear in the centre, not by the edge, and the few times in which the strike comes from the edge, the ridge is completely battered and the detachment does not genuinely stem from the edge, but from a inner area, forming obtuse angles that could not have been created by a knapping process. In all, it seems that these modifications were produced by percussion, not by knapping. If we include

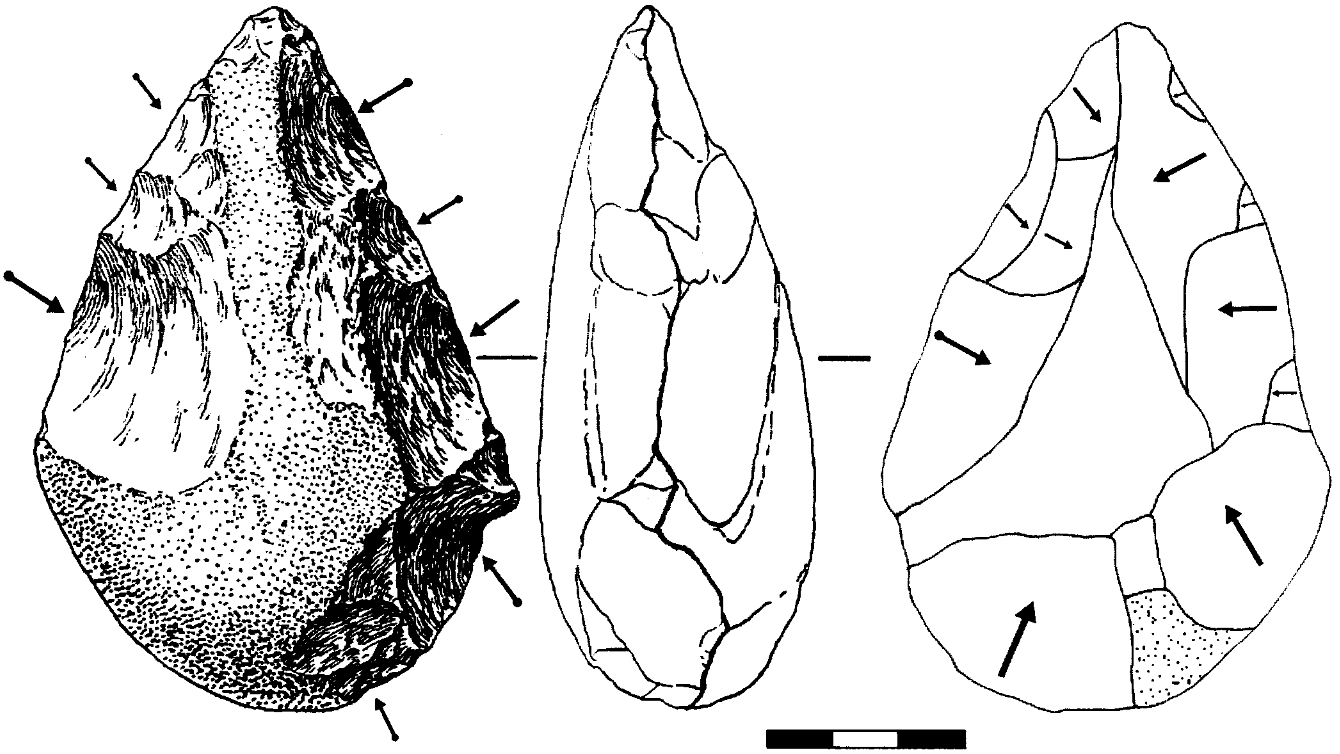

Figure 7.41. Biface on basalt cobble in TK UF. Diacritical diagrams based on Leakey (1971:190).

these objects (most of which are made of quartz) in our category of hammerstones with fracture angles, we could be facing the first stage of the alteration of the quartz blocks that led to the subsequent formation of the subspheroids and finally of the spheroids.

As regards the latter, Leakey (1971) counted 60 subspheroids and 16 spheroids in TK UF, and 31 subspheroids-spheroids in TK LF. An examination of Leakey's (1971:175 and 191) description unveils that she referred to subspheroids under 3 centimetres in diameter, and others that did not exceed 5 centimetres. Willoughby (1987:27) seems to agree, since she provides the same amount of spheroids-subspheroids. Nevertheless, in our opinion, a good part of these objects are merely small-sized chunks; pieces that do not present any traces of knapping or ridges, with natural surfaces that do not even present percussion scars. Furthermore, an important amount of these objects classified as subspheroids- spheroids are under 3 centimetres in diameter, which is functionally ineffective. In all, we consider these fragments are nothing but pieces detached from genuine hammerstones. Moreover, as aforementioned when referring to unmodified lava material, we mentioned the existence of basalt clasts measuring 4-5 centimetres which probably have a natural origin. This hydraulic deposition could also be contemplated for rounded quartz pieces which, in any case, cannot be included among the objects considered subspheroids or spheroids.

According to this aggregate, TK LF only presents 4 subspheroids/spheroids, whilst this frequency escalates enormously in TK UF, with 48 of these objects. As aforementioned, the objects denominated hammerstones with fracture angles herein could simply comprise an initial stage of the modification of quartz blocks. This argument grows sounder as regards TK, since most of the hammerstones with fracture angles are made of quartz, a trend that is invariable among subspheroids and spheroids. Consequently, the presence of the latter would simply indicate a greater intensity in terms of the use of quartzes in percussion processes. Subspheroids/spheroids are usually smaller than hammerstones with fracture angles (fig. 7.45), although they are obviously in the same size scatter as the latter. The fact that the spheroids and subspheroids (see also tabl. 7.13) are generally smaller than other percussion categories can be interpreted as another indication of the intensity with which they were used. In any case, in TK UF spheroids and subspheroids had a qualitative exceptional importance and, since they total 16 kilograms of raw material, they suggest percussion activities were especially relevant and intense.

		N	Minimum	Maximum	Mean	Std. deviation
Lower Floor	Length	4	80	96	87.25	7.182
	Width	4	75	88	81	6.055
	Thickness	4	72	88	81	6.683
	Weight	4	630	920	830.75	135.517
Upper Floor	Length	47	44	150	67.57	17.178
	Width	47	38	140	59.28	16.353
	Thickness	47	30	104	50.85	13.418
	Weight	47	71	3100	333.96	465.008

Table 7.13. Dimensions of subspheroids and spheroids (mm and grams).

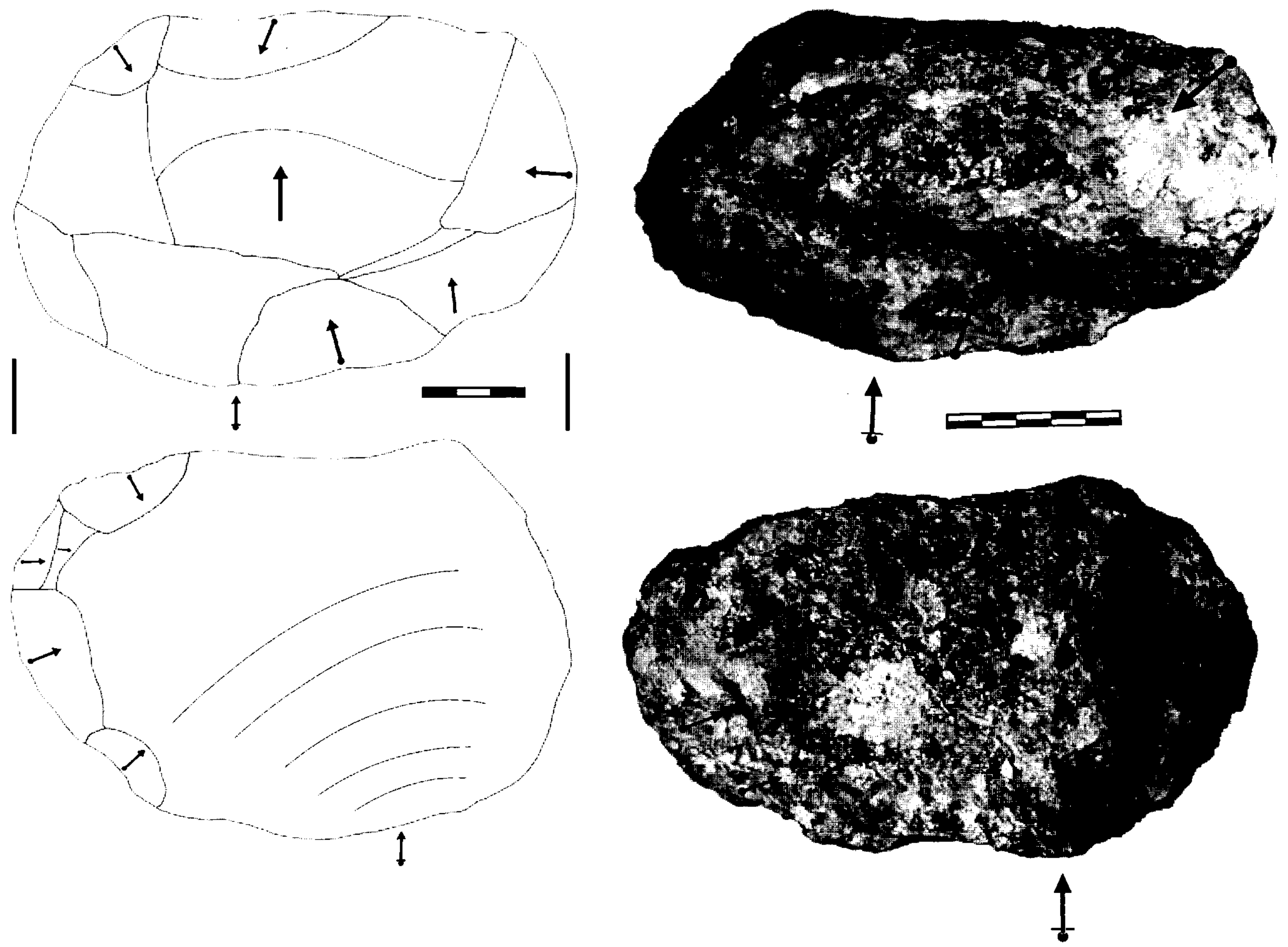

Figure 7.42. Large cutting tool in TK UF. Enormous quartz flake weighing over 1300 grams, that nonetheless presents slight retouching, limited to the edges, performed directly on the transversal distal edge, and reversed on the lateral right side. This piece represents the typical strategy observed in EF-HR, where this type of enormous side scrapers on flake appeared showing slight retouching processes, but forceful edges.

The importance of the spheroids and subspheroids in terms of the raw material invested in percussion processes is only surpassed by anvils. With over 7 kilograms in TK LF and almost 17 kilograms in TK UF (tabl. 7.3 and 7.5), the anvil group is relevant not only in terms of the global weight, but also from a quantitative perspective. It is important to bear in mind that there are more anvils than cores in TK LF, and that not only does this trend appear in TK UF, but anvils almost amount to the same total as flakes (tabl. 7.1 and 7.4). As in the rest of the sites where anvils have appeared, in TK these objects are mainly made of quartz. The anvils found in TK are larger than in other assemblages, and there are several examples over 10 centimetres maximum lengths that weight almost 2 kilograms (tabl. 7.14). There is a huge metric and morphological similarity between the anvils from both levels (fig. 7.46), corroborated using Student's T analysing the equality of the length and weight averages.

The tabular blocks used as anvils (fig. 7.47) are practically identically in terms of their size and shape to those used as blanks for manufacturing some of the large cutting tools on both levels. The presence of identical blocks in different occupations and the fact that the same blocks are used both to manufacture large cutting tools (in principle a category that must have been very valued given the time invested in their production) and as simple platforms on which heavy-duty activities were performed (i.e. anvils, objects without intentional modification, therefore, more expeditious items), can lead to two conclusions. In the first place, the source of the raw material was located nearby, and, secondly, that it was profuse enough to be used extensively.

		N	Minimum	Maximum	Mean	Std. deviation
Lower Floor	Length	8	67	140	93.5	23.139
	Width	8	49	105	72.13	20.733
	Thickness	8	36	85	59.25	17.613
	Weight	8	218	1889	765	591.252
Upper Floor	Length	33	57	155	93	26.858
	Width	33	45	130	73.79	22.352
	Thickness	33	25	89	52.24	16.832
	Weight	33	85	1901	506.42	413.574

Table 7.14. Dimensions of the anvils (mm and grams).

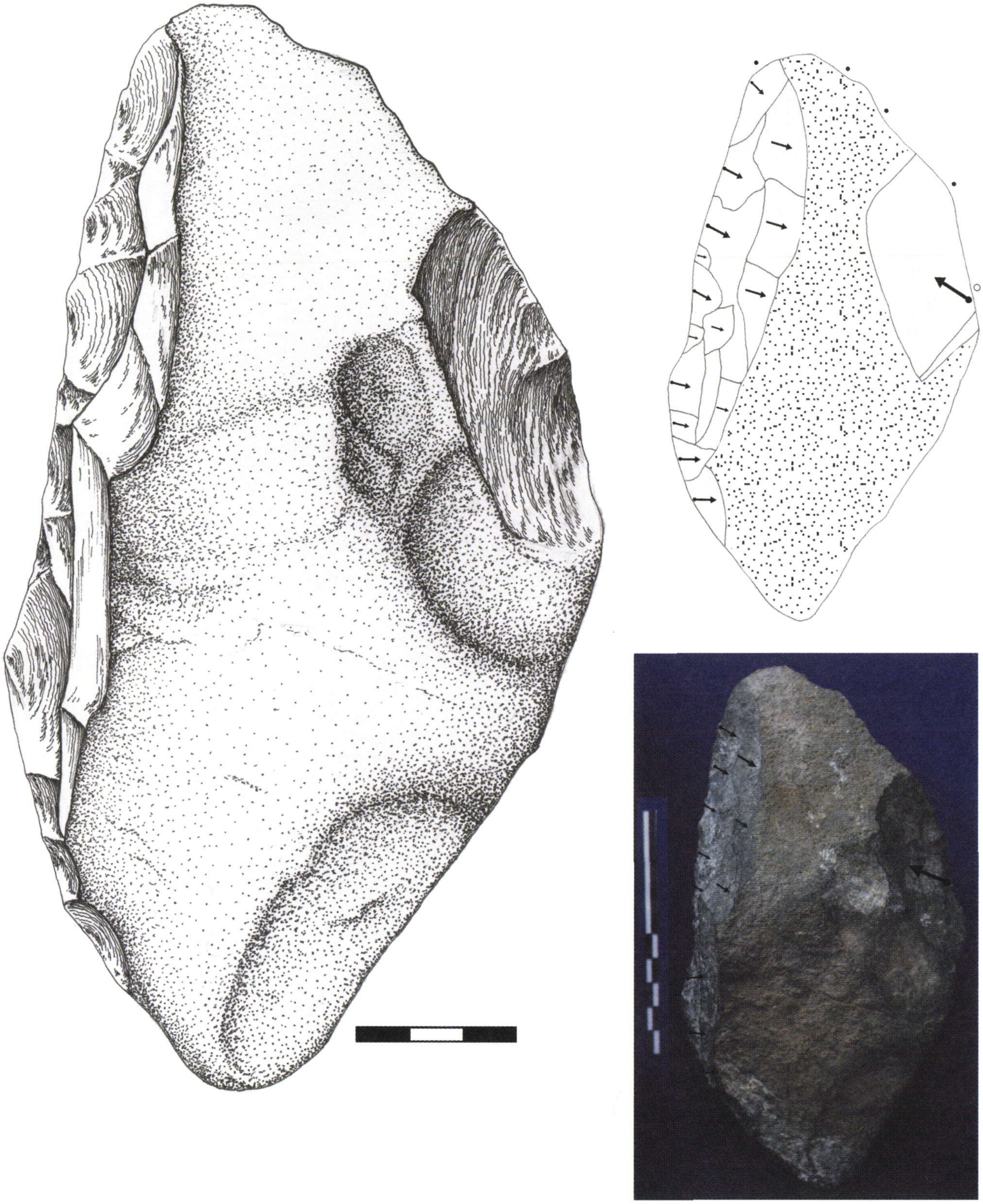

Figure 7.43. Large cutting tool on basalt cobble in TK UF. It is actually the same rhomboidal exploitation system presented in the examples on quartz blocks. The plane depicted in this figure is used as a striking platform for abrupt detachments from the face in figure 7.44, focusing almost exclusively on the distal part to create the point visible in the other figure (drawing: N. Morán).

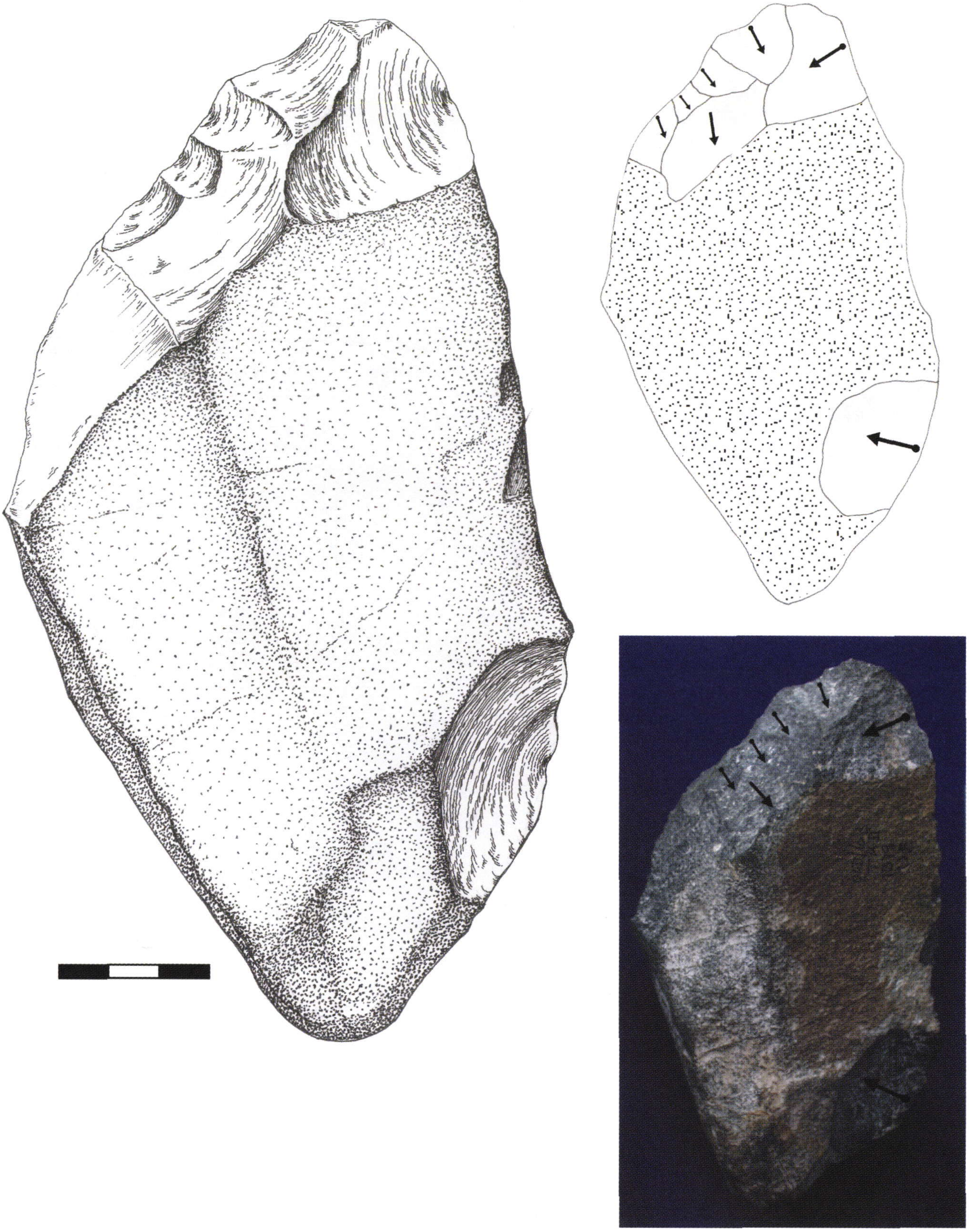

Figure 7.44. The other face of the example represented in the previous figure. The whole of this cortical platform is used to retouch the edge of the face depicted in figure 7.43, whilst in this figure it concentrates detachments on the distal part, to create a pointed area (drawing: N. Morán).

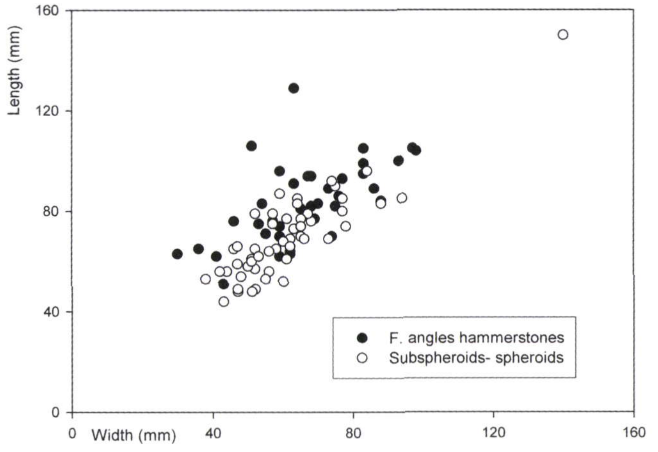

Figure 7.45. Dimensions of the hammerstones with fracture angles and subspheroids/spheroids.

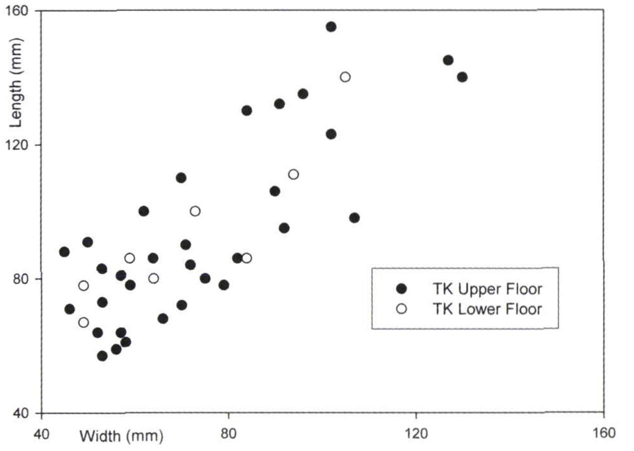

Figure 7.46. Dimensions of the anvils in both levels of TK.

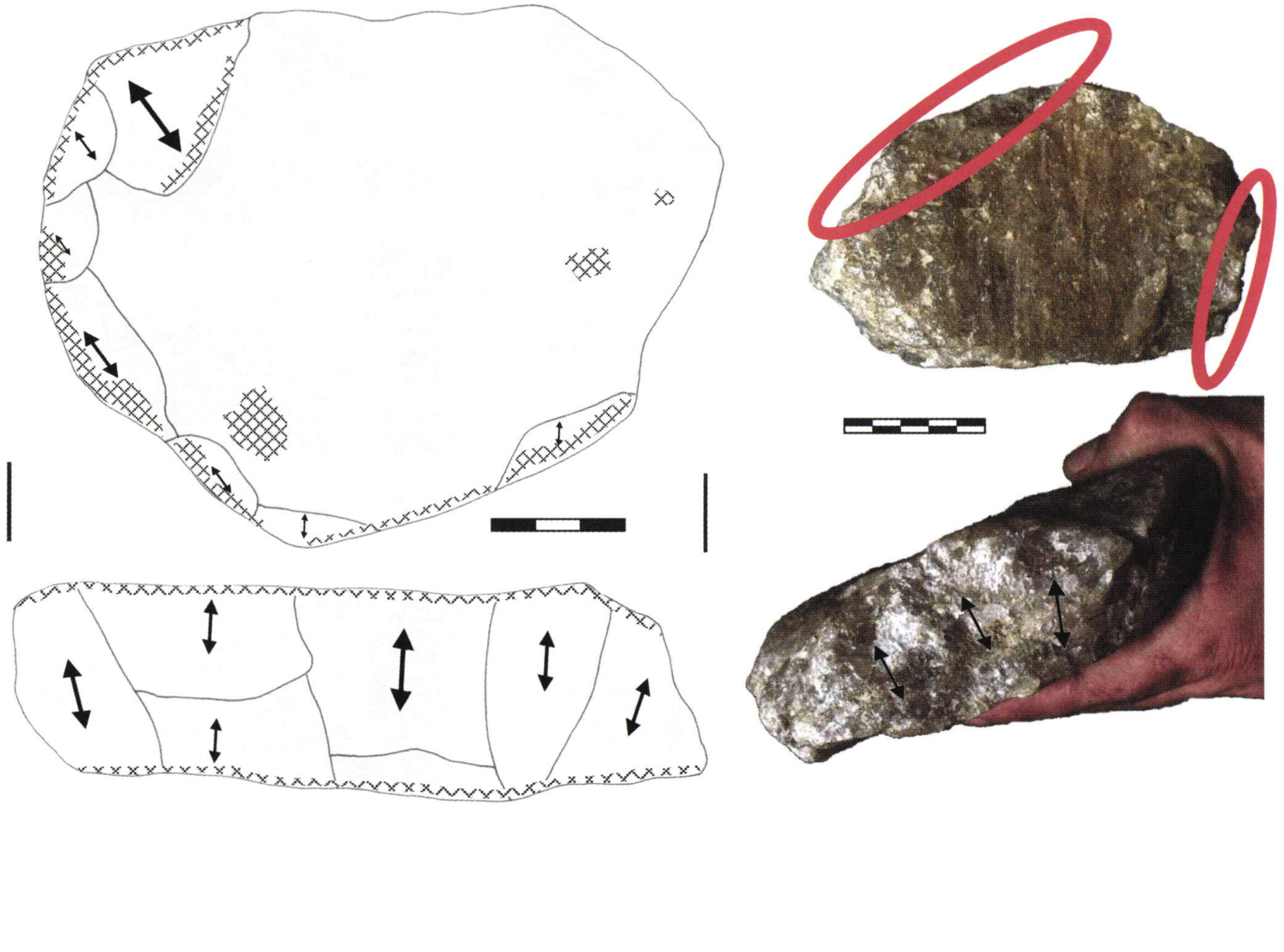

Figure 7.47. Anvil from TK UF on an enormous tabular quartz block. The circles indicate the areas most affected by striking, and the bidirectional arrows indicate the scars of the bipolar fragments detached during percussion.

The major importance of percussion activities performed in TK must be underscored. These activities are not limited to different active and passive hammerstone categories. Both in TK LF and in TK UF, it is amazing to see the amount of small fragments devoid of butts, ridges or dorsal faces that could allow us to safely attribute them to knapping processes. The progressive modification processes hammerstones with fracture angles, spheroids and anvils underwent must have generated thousands of fragments, fragments which we precisely include in the millimetric chips categories, given the difficulty of safely allocating them to a specific technical activity. All these objects, considered alongside the huge amount of kilograms invested in percussion objects, provide an idea of the relevance these processes had in TK.

Conclusions

The first issue lies in a joint assessment of the similarities and differences in the inventory of both levels in TK. Although the absolute frequencies in TK LF (n=2269) are substantially lower than those in TK UF (n=5268), we can in no case refer to differences regarding the material or the intensity of the occupation. Leakey (1971:174) warned that the lower level was only excavated in one of the two trenches (specifically, the smallest one, measuring 6 x 7.5 m), therefore it is logical that less pieces were unearthed. Consequently, if we consider the number of pieces recovered from each level and the difference in terms of the size of the excavated surface, the proportion between both levels corresponds perfectly, although Leakey (1971) calculated a slightly greater density for UF than for LF.

The Lien tests provides interesting results in the general comparison of the categories in both levels (fig. 7.48): TK LF presents proportionally more flakes and retouched pieces than the upper level, whilst the latter presents an overrepresentation of spheroids and hammerstones. The rest of the categories seem to be identical on both levels. This statistical trend has a notable archaeological coherence; the categories that predominate in TK UF (knapping hammerstones, hammerstones with fracture angles and spheroids) are directly linked to percussion activities. Categories that abound proportionally in TK LF (flakes and retouched pieces), however, are linked to knapping processes.

This obviously does not exclude the fact that knapping activities and heavy-duty percussion processes were used alternatively in both settlements. Both processes have been documented both in LF and in UF. In any case, and since we have insisted on the fact that - from a technical point of view - both levels are practically identical, if we were establish a difference between the lower and upper floors in TK, that discrimination would probably be based on the greater intensity of the percussion processes in the most recent assemblage.

As in other sites analysed previously, both levels in TK prove quartz was worked *in situ*, since there are elements in practically all stages of the *chaîne opératoire*. Consequently, enormous quartz manuports that could have been perfect blanks for large cutting tools or to be used as anvils have been identified. There is also (at least in TK LF) a coherent proportion between quartz flakes and cores. Moreover, the hammerstones, retouched pieces and different size fragments indicate the intensity of the quartz reduction performed *in situ*. There are some imbalances between certain large quartz flakes and the small quartz cores. Since the quartz large cutting tools are usually tabular, these flakes could possibly not come from the same reduction sequences as identified on the preserved cores. Yet, apart from that possible exception, quartz did undergo all stages of the *chaîne opératoire* at the actual site. Hominids imported natural blocks, which were used either as knapping blanks (cores, large cutting tools) or as platforms to perform percussion activities (anvils), which were transformed into different object categories and broken down until they were discarded in the settlement itself.

The contribution of quartz blocks is amazing: in LF there are over 56 kilograms whilst at least 118 kilograms appeared in UF (tabl. 7.3 and 7.5). Considered independently, this enormous amount of the same raw material in a specific point of the landscape should already make us consider the availability of quartz in the territory. The intensity of the transport of one same type of rock, the size of many of the objects that almost weigh two kilograms, the presence of large blocks without any trace of use (real manuports), or the employment of enormous blanks simply as platforms on which to perform a specific activity (anvils), all indicate that the hominids in TK were not concerned in optimising the benefits of the transported raw material. Rather, in view of the discarded fragments and the vast amount of kilograms included in the waste categories, we could say that the craftsmen were not at all concerned about maximising the performance of the quartzes. It is hard to rationalise such an exaggerated waste of raw material, as documented in both settlements. Furthermore, quartz was not even used primarily to obtain flakes or sharp edges. In TK LF, obtaining sharp edges could still be sus-

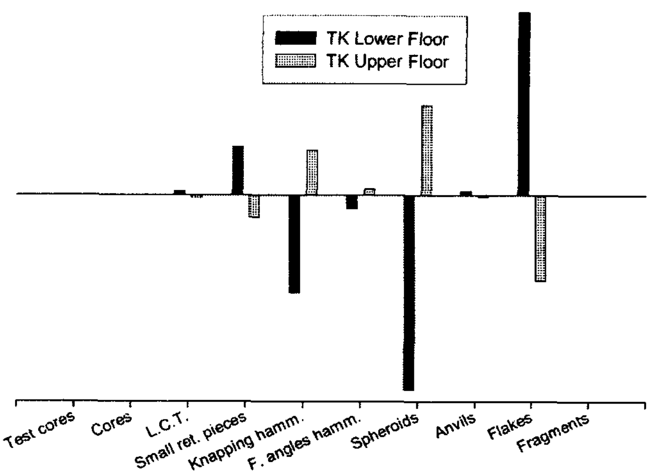

Figure 7.48. Lien Test comparing absolute frequencies of the different categories at TK LF and UF.

tained as one of the main goals expected of the activities performed: taking into consideration retouched pieces and flakes would total approximately 13 of the 56 kilograms of quartz documented (tabl. 7.1 and 7.3). Yet, in TK UF there are not even 7 kilograms of sharp edges among the 118 kilograms of quartz transported, thus composing an incidental portion of the assemblage.

Actually, in TK (mainly in the most recent level) knapping activities were peripheral processes in terms of quartz management. Therein, the most noticeable aspects are the *façonnage* of a few objects, the *débitage* of a few flakes, but a very intense processing of lithic categories connected to activities other than knapping. The profusion of hammerstones with fracture angles indicates those ridges were used to strike objects, not to detach flakes. Likewise, the anvils present surfaces that are entirely modified by percussion, a more intense process than the procedure that would be caused if they were used as platforms for bipolar knapping. Neither does it seem that these anvils were used as blanks on which to place the large blocks being worked on to obtain the large cutting tools. In that case, those shaped pieces would present percussion and alteration traces; which is not the case. Moreover, although spheroids could have perfectly been used in their final rounding stage as knapping hammerstones, during the stages in which the angles were broken they would not have presented suitable surfaces, and also show a percussion intensity that is not documented in *débitage* processes.

Nevertheless, although it seems obvious that quartz participated in percussion actions, not in knapping processes, the activities it was used for are still unclear. In order to answer this question, we should turn to the bone inventory from TK to justify the massive use of quartz in carcass management processes. However, TK presents an almost nonexistent bone collection, which is poorly preserved; therefore the investment of these huge amounts of quartz is subject to a serious functional uncertainty.

Continuing along the line of the uncertainties, it is time to consider the *chaîne opératoire* of lavas. Here, the problems we encounter regarding interpretation are even more serious than in the case of the quartzes. In principle, we should not deny the presence of *in situ* knapping, since there are fragments that reveal the existence of technical errors in the actual site, some cortical flakes that coincide with the exploitation systems observed on the cores, and in fact groups of pieces that seem to come from the same cores have even been documented. Nonetheless, the proportions of the *débitage* are quite inferior to those expected in view of the number of cores. In fact, there are no examples that could be included among knapping waste, a fact that raises even more doubts regarding the existence of flake production activities performed *in situ*. As opposed to what occurs in other sites, TK does not present a concentration of lavas in the percussion categories. Quite the opposite: the scarce number of items are usually linked to knapping activities; a few cores and flakes, some large cutting tools and the occasional *débitage* fragments. The problem is, paradoxically, that these *débitage* processes do not seem to have been performed in the site where they were found, and must have been imported once worked. As a hypothesis, we could suggest that they were imported for their quality; although throughout Bed II in Olduvai we have seen how the quality of the lavas employed increases, in TK, as occurs in EF-HR, the trend becomes specially evident, since phonolites, trachytes and very fine basalts with an excellent potential for knapping have been located.

Consequently, in opposition to quartzes, the *chaîne opératoire* of the lavas from TK is very fragmented, suggesting that there was a space-time separation between the processes entailing obtaining, decorticating, producing and discarding the lithic remains. In any case, the lavas had a peripheral importance in the activities performed in TK if compared to quartzes. Excluding unmodified material, in TK LF the 8479 grams of lavas comprise a mere 13.4% of the total amount of worked raw material, and in TK UF the 27618 grams of basalts, phonolites and trachytes suppose 19.3%. Except for one of the few pieces in gneiss, the rest of the raw material included was made of quartz. Therefore, we are facing a dichotomy in the selection and use of raw materials, which was probably linked to the function of the settlement, in which percussion activities (whichever they were) seem to have been much more important than knapping processes.

Despite the marginality in terms of the investment of raw material, we would like to conclude this chapter mentioning the guidelines that govern the manufacture of the large cutting tools, given their technical connotations and their chrono-cultural implications. In both levels of TK there are examples obtained from the so-called rhomboidal strategy, which entails a unifacial exploitation from opposite planes of each of the edges of the piece. In these cases, as with other shaped objects on cobble, block or flakes, it seems like the goal is always the same: to achieve elongated morphologies and, most importantly, pointed ends. They are always large objects that do not pursue a bilateral symmetry or the correct distribution of the surfaces, but rather aim to obtain forceful edges. Contrary to EF-HR or FC West, TK does present examples that could be classified as bifaces, at least in terms of the management of two surfaces separated by one edge (fig. 7.39 and 7.41). Therefore, although craftsmen do have the technical know-how, they still prefer to work the edges, not the volumes.

In any case, and with regard to historical-cultural estimations, we do not think there is proof to separate TK Lower Floor from the upper level from a technological point of view based on those large cutting tools (fig. 7.49). That is to say, if - in view of its technical features - Leakey (1975) finally considered TK LF as an Acheulean occupation, an analysis of the shaped pieces (be they genuine bifaces or not) cannot sustain its discrimination from TK UF. In our opinion, both levels in TK belong to a single technological tradition. The presence of large flakes, and especially the existence of objects whose morphology is modified secondarily via *façonnage* to obtain forceful edges, leads us to include both assemblages in the Acheulean technology.

Figure 7.49. Large cutting tools identical, morphologically and technologically, from different levels. A: TK Upper Floor; B: TK Lower Floor.

The lithic knowledge implied in these objects allows the technical and/or cultural identification of this site. Nonetheless, and to conclude the chapter, we must underscore the fact that these large cutting tools were simply one part of the activities developed. In fact, it is a peripheral category in the assemblage of worked material, presenting few whole examples and some more fragments of these shaped items that indicate the pieces were knapped and/or used *in situ*. In all other respects, the technology in TK focused on different processes, most probably linked to alternative activities connected to percussion. Considering the material recovered from the rest of the levels that compose the site alongside the assemblages from LF and UF, Leakey (1971:197) totalled over 10,000 pieces in TK. From this point of view, the reasons that led the hominids to collect over 200 kilograms of lithics in a specific point of the landscape are a mystery, as is the fact that they were subjected to such intense work processes as noticeable in the LF and UF inventory. Unfortunately, based on the available evidence it is hard to reconstruct these activities, and until we have alternative information to that provided by lithic material, answering that question will be a complicated task.

Chapter 8

BK

Introduction

The BK gully is located in the Side Gorge, approximately 3.2 km from the confluence with the Main Gorge (see fig. 1.1). Excavations were performed during the 1950s and 1960s via numerous trenches throughout the whole outcrop. Most part of the stone and bone material appeared linked to a channel deposit, which led Leakey (1971:198-199) to underline the impossibility of ruling out a single occupation, and to consider the whole deposit as a single archaeological horizon, 1.5 metres thick. Despite the fact that BK presents one of the lowest densities in terms of archaeological remains, with only 5.3 pieces per m³ (Leakey 1971:260), it does present (after FLK Zinj and FLK North Level 1-2) the most important collection of macro-mammals unearthed in Olduvai, with almost 3000 remains, and the greatest number of lithic artefacts in the whole of Bed I and II, with 6801 pieces unearthed just in the 1963 excavation (Leakey 1971:261), from an area that Monahan (1996:96) estimated as measuring 114 m².

A concentration of *Pelorovis oldowayensis* remains linked to clay sediments was found next to the channel deposit where most of the lithic pieces were located. Leakey (1971:199) mentioned 24 individuals of this species, whilst Gentry and Gentry (1978:45) identified a MNI of 14. Louis Leakey (1957) suggested these animals had been hunted massively, with the hominids guiding them to a swampy area where they would have been trapped. Leakey (1971) completed this interpretation stating that the channel deposit contained the remains of a camp set up on the banks of the stream, which would have been rearranged into the channel after the occupation; furthermore, it would have been connected to the processing of the *Pelorovis* carcasses. Over recent years, different alternatives have been proposed contemplating a natural catastrophic death to explain the profusion of *Pelorovis* (Capaldo & Peters 1995). In any case, the human incidence on at least a good part of the fauna in BK is well documented: first by Leakey (1971) and then by Shipman (1989), who have mentioned the presence of bone tools in BK, with several anvils among them. Furthermore, the unique zoo-archaeological study (Monahan 1996), suggests that the hominids had access to size 3-4 animals and, to a lesser extent, to size 1-2 carcasses. In fact, Monahan (1996) thinks hominids were the main accumulation agents in BK.

It is difficult to come to precise conclusions based on the analysis of the lithic industry; the enormous amount of artefacts analysed in the Olduvai monograph (Leakey 1971) is but a small part of the collection (1963 field season), and the museum in Nairobi stores the items mingled with pieces from other previous campaigns; moreover, not all the material from previous years is preserved. Kyara (1999) denounces the fact that, of the total of almost 12,000 pieces catalogued in BK, in Nairobi he could only access 4,615 items. These are most certainly the reasons that have led investigators to perform analyses based on specific categories – for example Sahnouni (1991) as regards polyhedrons and Dies & Dies (1980) with reference to choppers –, specific aspects – like Kyara's (1999) study of raw materials – or a sampling of the whole collection – like Ludwig (1999), who only studied 900 pieces.

We have selected BK as the last site to be studied in Olduvai in terms of its chrono-stratigraphic position; first, because BK is the most recent archaeological assemblage in Bed II. Therefore, studying its main characteristics enables us to close the sequence commenced in DK, the oldest site in Olduvai, and consequently to encounter a sound reference to tackle the technological modifications that occurred throughout over half a million years. In the second place, the over 1.33 my calculated for BK (Manega 1993) enables the assessment of the technical capacities in Olduvai at a time when the existence of relatively complex knapping methods has already been verified in the neighbouring basin of Lake Natron (de la Torre *et al*. 2003).

In view of the contextual problems that arise upon attempting to reconstruct whole technical sequences, it was hardly operative to undertake a comprehensive analysis of the BK collection. Since the goal was to compare knapping methods between sites, not the relationships between the categories of the same assemblage, only some objects were studied, precisely those which allowed us to assess the strategies and technical skills of the hominids that inhabited BK.

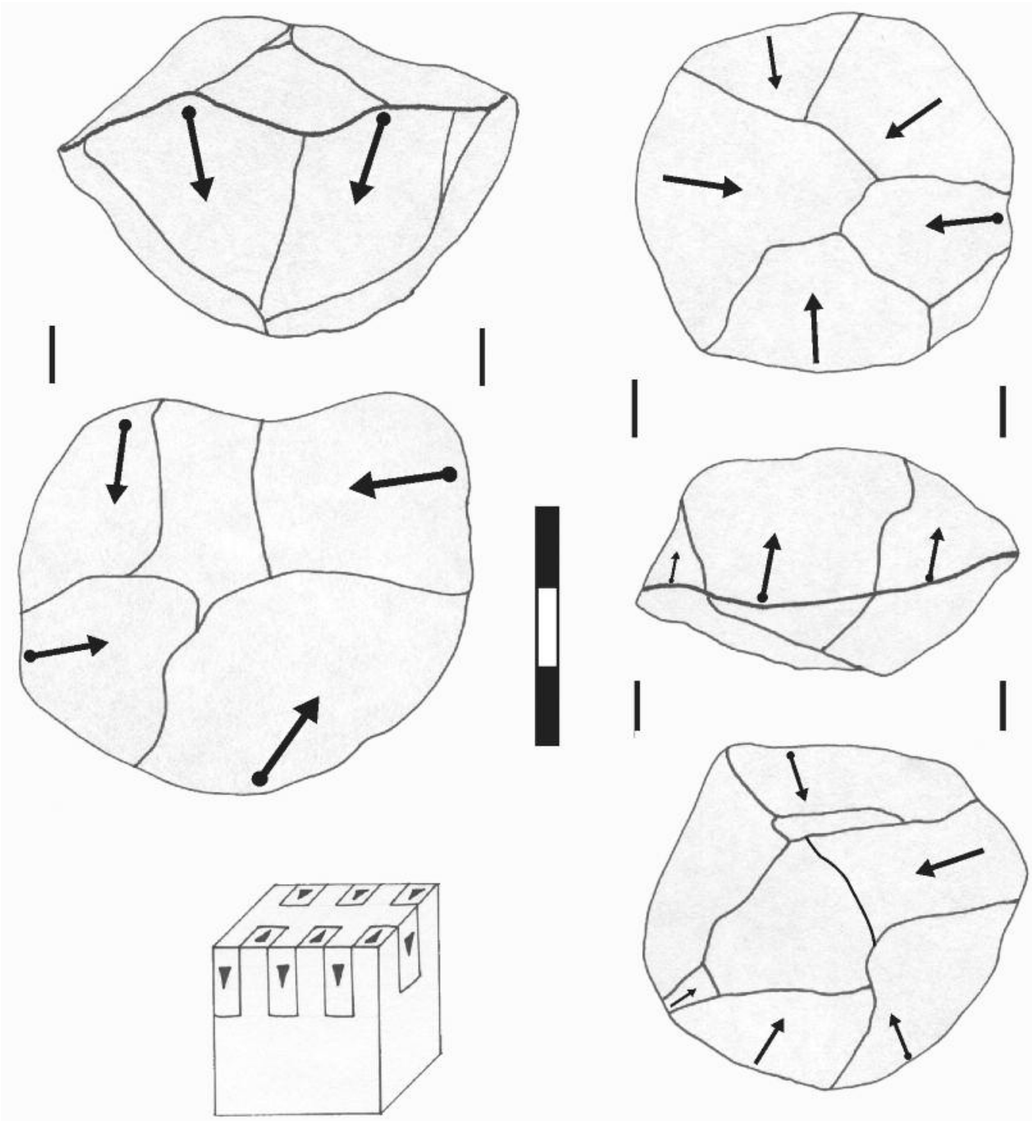

Figure 8.1. Quartz discoid cores from BK. The small size of both examples is quite surprising, since they barely exceed 5 centimetres maximum length.

This is the only case in which a partial analysis of the collection has been performed, therefore there is no call for stopping to consider quantitative issues based on percentages, dimensions or proportions. In fact, this section will only include qualitative aspects with a view to producing a technical definition of the reduction strategies implemented, which will be used to contextualise some of the considerations proposed in the next chapter. Two categories are assessed in the subsequent pages: cores, considered the best exponents of knapping methods present in the site, and bifaces, considered cultural and technical markers.

Cores

BK presents a very high number of cores, which has allowed to identify practically all the systems described previously for the other sites, such as unifacial and bifacial simple, abrupt, multifacial methods, etc. This section will focus on the objects Leakey (1971) classified as discoids, since in previous works (without having first hand knowledge of the materials) we had proposed their similarity to the Peninj technology (de la Torre & Mora 2004). Leakey (1971:210) asserted that in BK there were over 100 examples of this type of cores, which was characterised by bifacial and radial knapping. Upon reexamining the artefacts Leakey classified as discoids, we have observed that many of them are actually un-knapped fragments with natural morphologies similar to discs, whilst others are genuine cores, albeit exploited using different knapping systems. Despite these facts, there are also over a dozen cores that do enable a debate on well-structured knapping methods. Although other works (de la Torre 2005) debate new nuances in terms of the difference between discoid methods and Levallois (see Slimak 1998-1999, 2003; Mourre 2003; Terradas 2003; Lenoir & Turq, 1995; etc), herein we will follow Böeda's (1993) proposal to differentiate both systems, distinguishing them, at the same time, from the bifacial hierarchical centripetal exploitation defined in Peninj (de la Torre *et al*. 2003).

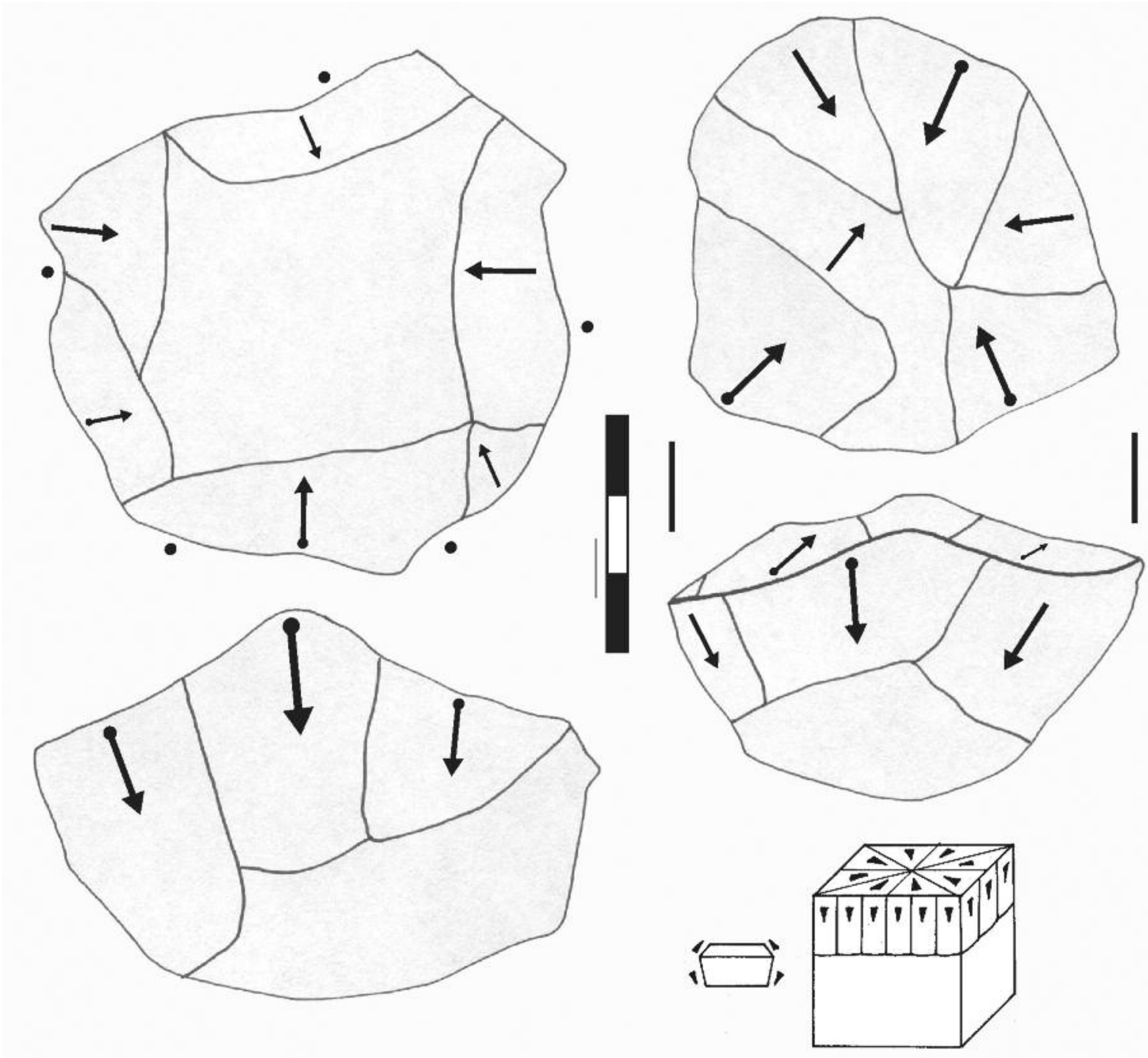

Figure 8.2. Hierarchical bifacial centripetal quartz cores at BK.

The discoid method unquestionably exists in BK. As mentioned in the chapters dedicated to DK and FLK Zinj, cores with bifacial edges and alternate detachments were found in those sites. Nonetheless, the reduction of these pieces was limited to the edge area, implementing a peripheral exploitation that did not penetrate the central volume of the cores and which entailed a swift and unsolvable exhaustion of the cores. In BK, knappers already manage the whole of the cores' surface, using bifacial alternate detachments that exploit the whole of the volume of the pieces. As suggested in figure 8.1, the planes of these cores are not hierarchical, with detachments made in a simple angle with the edge and in which striking is alternate. That is to say, the platform is prepared to strike a flake by using the scar from a previous detachment on the opposite surface. This core management can be included in the consideration of the discoid method *sensu* Böeda (1993), and represents a novel method in the Olduvai sequence.

Something similar occurs with the bifacial hierarchical centripetal system. Although this method had appeared exceptionally in other sites in the sequence, BK presents plentiful cores exploited systematically according to this method (fig. 8.2). Consequently, there are several cores in which one surface is used as the preparation plane for the radial extractions performed on the main surface. Furthermore, this type of cores has appeared in different stages of reduction (fig. 8.3), an aspect that indicates that the method was used systematically, respecting the same knapping structure throughout the different exploitation stages. Although the new proposals (for example Slimak 2003) suggest we should perhaps include this bifacial hierarchical centripetal method in the discoid system, this does not diminish the importance of documenting the fact that such a structured strategy appeared in a 1.3 my site like BK.

In BK, the presence of the Levallois method *sensu estricto* could even be maintained. Some cores present all the characteristics that define this system, such as the hierarchical organisation of the surfaces, the secant angle of the detachments on the preparation plane and the parallel or subparallel scars on the exploitation plane, and percussion performed with a hard hammer. Even the existence of lateral and distal convexities has been verified on the *débitage* surface, an

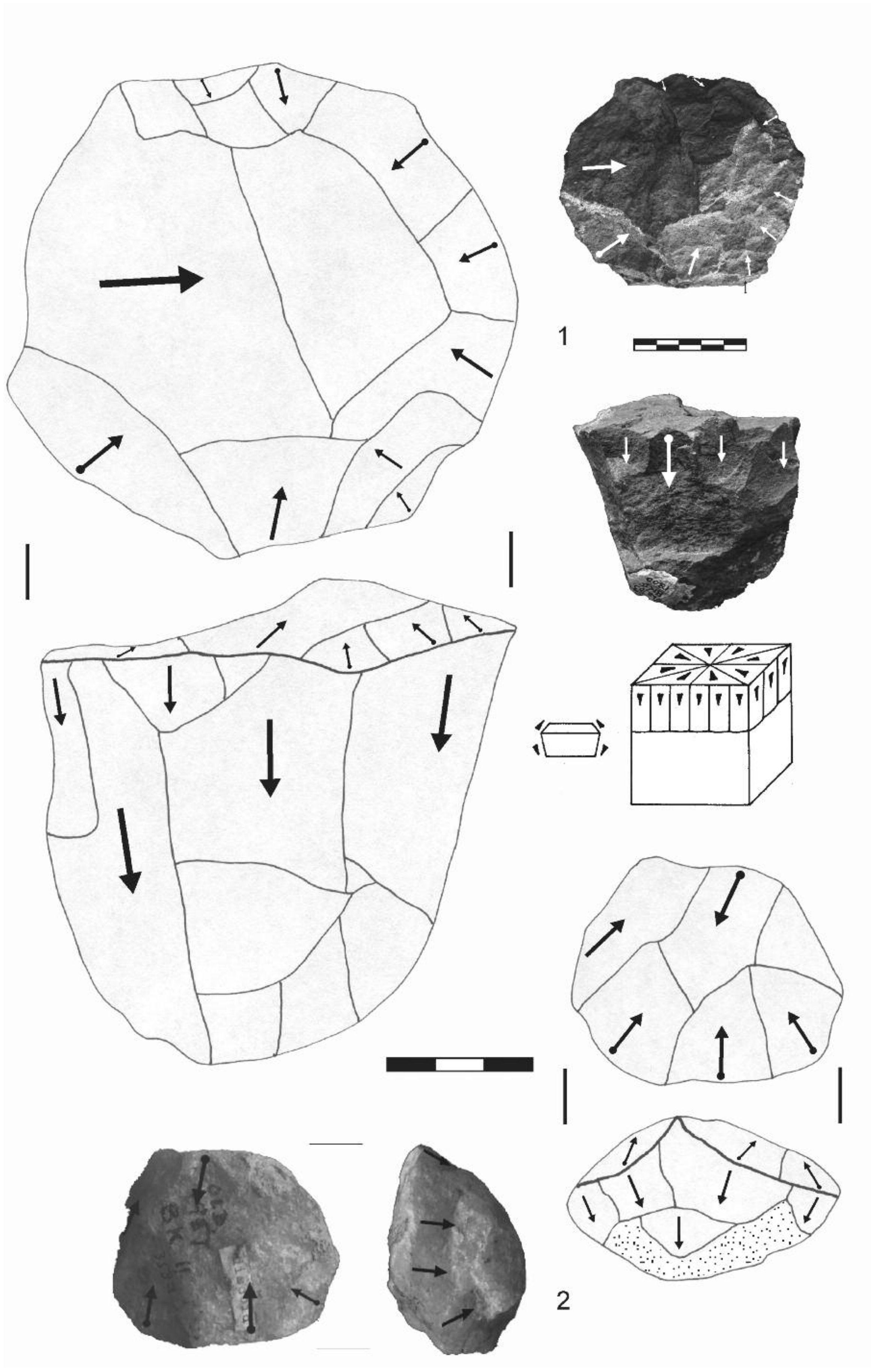

Figure 8.3. Hierarchical bifacial centripetal cores at BK. 1: basalt example in an early reduction stage; 2: exhausted quartz core.

aspect that does not appear in the discoid method, is diffuse in our hierarchical centripetal system and is essential to Levallois (Slimak 2003; Terradas 2003). This type of cores had not been documented in any of the previously studied sites, and supposes a technical Rubicon in the path towards the predetermination of the products.

In all, BK presents *débitage* systems that are, supposedly, typical of the Middle Palaeolithic. The goal is to obtain flakes with an average size ranging between 3-5 centimetres, and this is achieved using well-structured knapping methods which include a predetermination of the flake production. These products are similar, both morphologically and metrically, to the items obtained in the Oldowan, and that was one of the reasons that led Leakey (1971) to consider BK another example of Developed Oldowan B. The other argument Leakey put forward for the cultural assignment was the characterisation of the bifaces, which are described in the following section.

Bifaces

Leakey (1971:204) counted 80 bifaces in BK. Most were considered diminute bifaces, with an average maximum length of 5 centimetres, with many not even exceeding 4 centimetres. The small size of the bifaces, alongside their frequency, was one of the main arguments used to classify BK as Developed Oldowan B and not as Acheulean.

As regards the issue of the items Leakey called diminute bifaces, a good many can be proven to be chunks (fig. 8.4). The few pieces that do present a secondary retouching are flakes with isolated blows or small retouches which only modify the edges of the pieces, without penetrating the surfaces. In all, the diminute bifaces category does not exist, and is in fact completely unrelated to genuine bifaces (fig. 8.5).

Genuine large shaped pieces are a different matter. Opposed to the situation in EF-HR (and in TK to a lesser extent), BK does present genuine bifaces. The pieces from fig. 8.6, 8.7, 8.8 and 8.9 are objects worked bifacially, with detachments that are not limited to the edge but invade the whole surface, and aim to achieve a pointed morphology with two or more symmetrical planes. They all present a moderate size, approximately 10-12 centimetres maximum length and, as Leakey (1971) stated, most are worked on cobble, not on flake. Precisely the cobble blank for these bifaces is another of the arguments Leakey used to assign this industry to the Oldowan and not to the Acheulean. Nonetheless, it is paradoxical to see that, in the case of this so-called BK Oldowan, the objects are genuine bifaces, with the exploitation of the surfaces (not of the edges) and a management that pursues the symmetrical reduction of the volumes of the piece, which does not occur on the simple scrapers (which are enormous, however) from the Acheulean holotype, EF-HR.

Although this chapter underscores the relevance of genuine bifaces on cobbles in BK, large flakes have also appeared in this site, some of which are huge and present retouching (fig. 8.10). These pieces are similar to those of EF-HR in their morphology, and technologically they tell of the knapper's ability to obtain enormous blanks. Furthermore, BK also has enormous cores (fig. 8.11) which were used to obtain large flake blanks; paradoxically these items do not appear in EF-HR. Consequently, it does not seem realistic to continue sustaining a technological or cultural distinction between BK and sites like EF-HR, and perhaps this calls for the consideration of the technical continuity among the assemblages in the upper part of Olduvai Bed II.

Conclusions

The goal of this brief description was, more than to describe an assemblage (BK) or specific categories (bifaces and cores), to verify the existence of certain technical parameters. The systematic documentation of cores exploited using complex knapping methods such as the discoid or the Levallois technique, give way to the assumption that hominids were already aware of those concepts 1.3 my ago. Although this proposal had been presented for other supposedly Oldowan assemblages like Nyabusosi (Texier 1995) or Peninj (de la Torre *et al*. 2003), it is especially significant to underline the fact that it has also been documented in Olduvai, still the most important archaeological complex in Eastern Africa to understand the technical activities carried out during the Lower Pleistocene.

These *débitage* methods must be connected to *façonnage* systems linked to different *chaînes opératoires* in the same site: BK presents strategies for obtaining small-sized flakes (3-5 centimetre flakes) in one same assemblage, in which blocks were also worked to obtain specific morphologies through *façonnage* (i.e., the aforementioned genuine bifaces on core). Furthermore, the production of enormous flakes (most certainly potential blanks for large cutting tools) has also been documented in the same assemblage. This concentration has major implications, since it seems to favour a diversification of knapping activities in the same technological complex.

This leads to a final consideration on the techno-cultural phylogeny applicable to BK. In terms of the investment of raw material, there is probably a profusion of knapping systems linked to the production of small-sized flakes. From this perspective, BK could resemble previous traditions like the Oldowan. Without considering the smallest pieces (since in our opinion they are not even retouched), bifaces are certainly relatively small and regularly use blocks and cobbles as blanks. Yet, they are actually bifaces. This cannot be said of EF-HR. Thus, in BK pieces do undergo systematic *façonnage* processes, which aim to modify the morphology of the blocks completely to create a biconvex section and two more or less symmetric and bifacial surfaces. This differs from the aspects documented in EF-HR, where the goal lays in obtaining forceful edges via the slight modification of the edges of the large flakes. Consequently, as aforementioned, it would be absurd for a site like EF-HR devoid of bifaces to be assigned

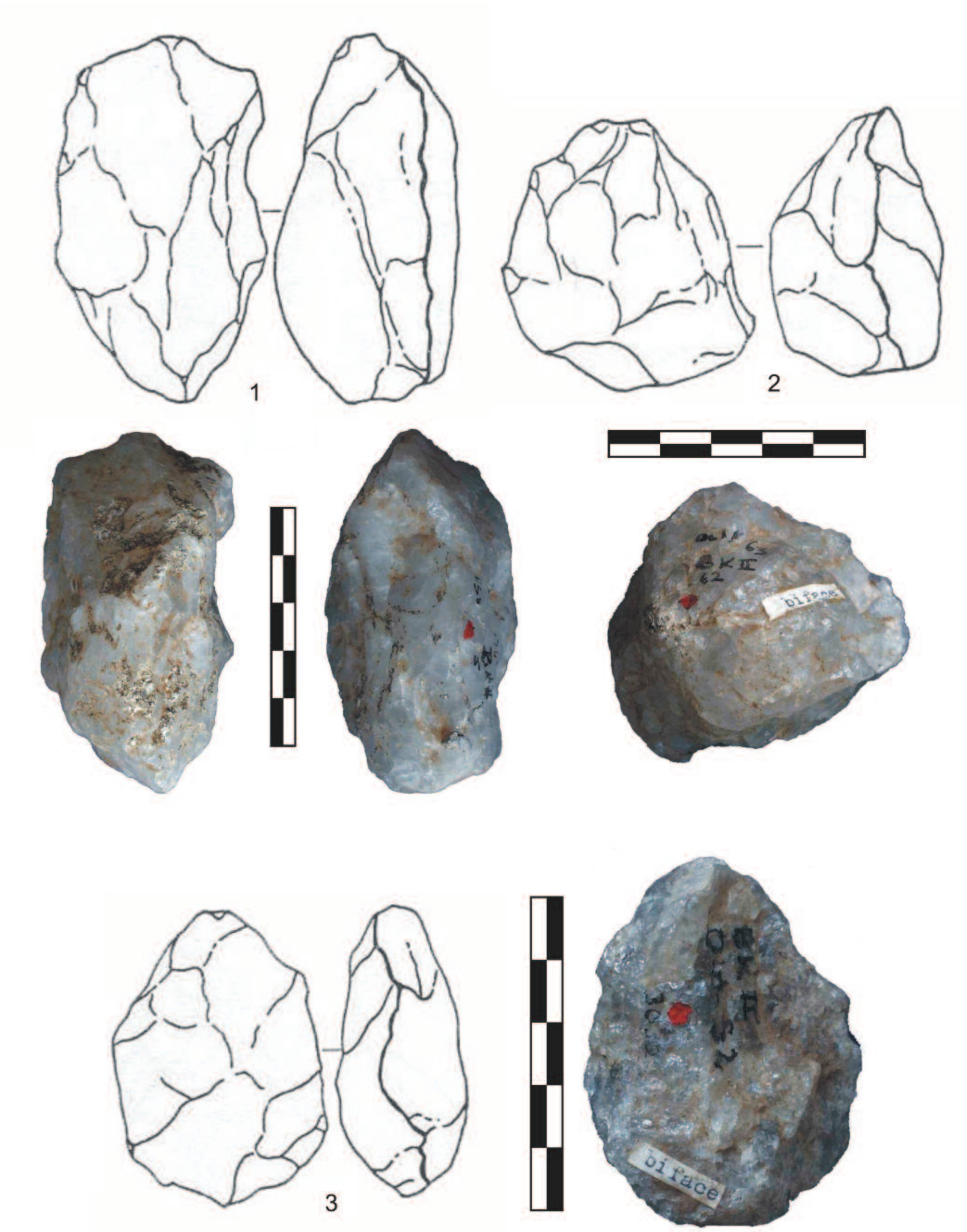

Figure 8.4. Pieces classified as "diminute bifaces" by Leakey (1971:205). In our opinion they are merely fragments, which had not any kind of retouching.

Figure 8.5. Genuine biface alongside the so-called “diminute bifaces,” classified herein as chunks.

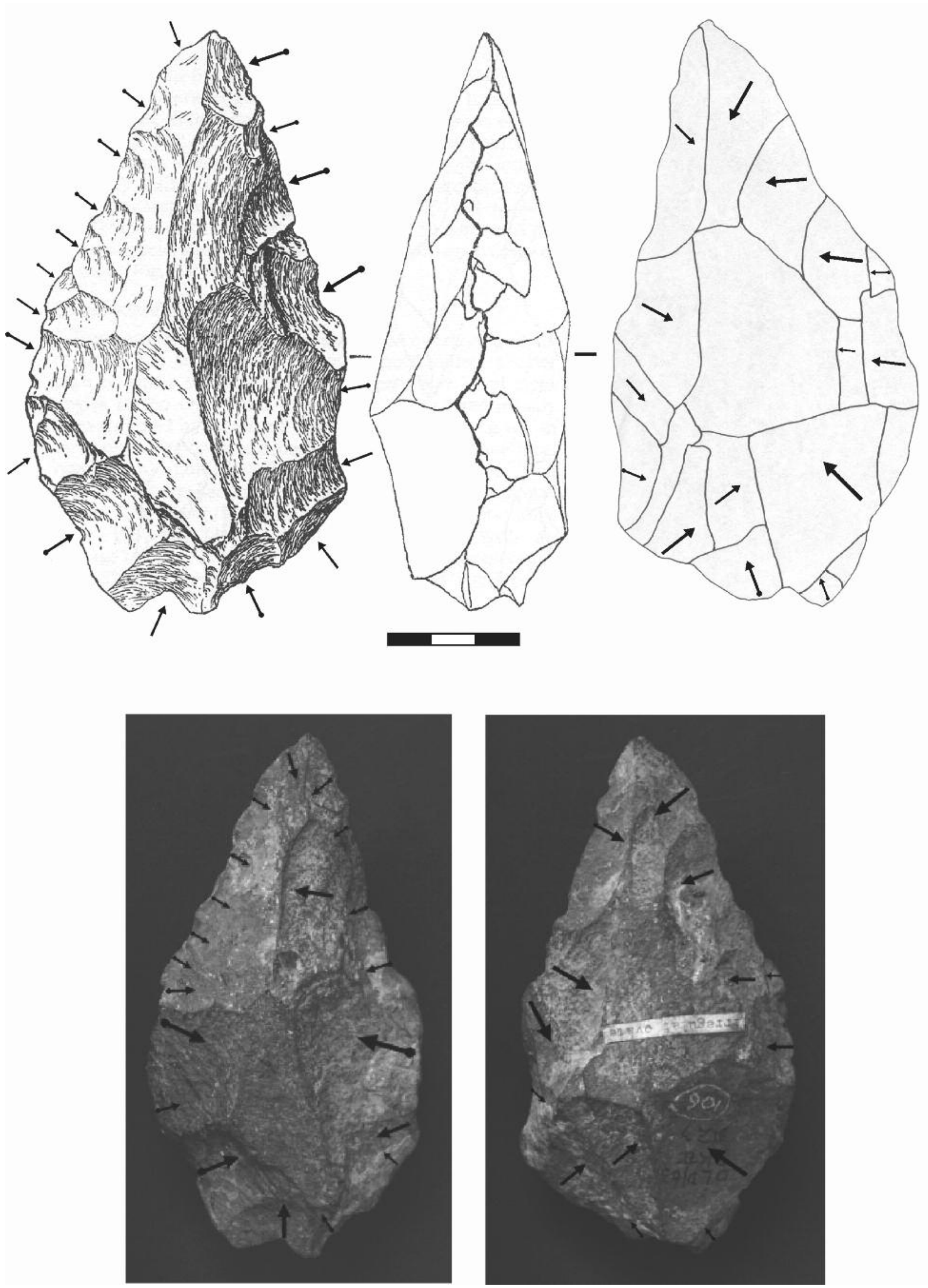

Figure 8.6. Lava biface from BK. Diacritical schemes based on Leakey (1971:206). The blank is indeterminable, since the piece is completely covered by *façonnage* scars. After studying the order of the flake detachments, it becomes clear that a whole surface was worked first, after which the second surface was thinned. Retouching is usually flat, although the angle tends to be simple and even abrupt on the base of the piece, surely an intentional response to create a blunter base opposite the worked point.

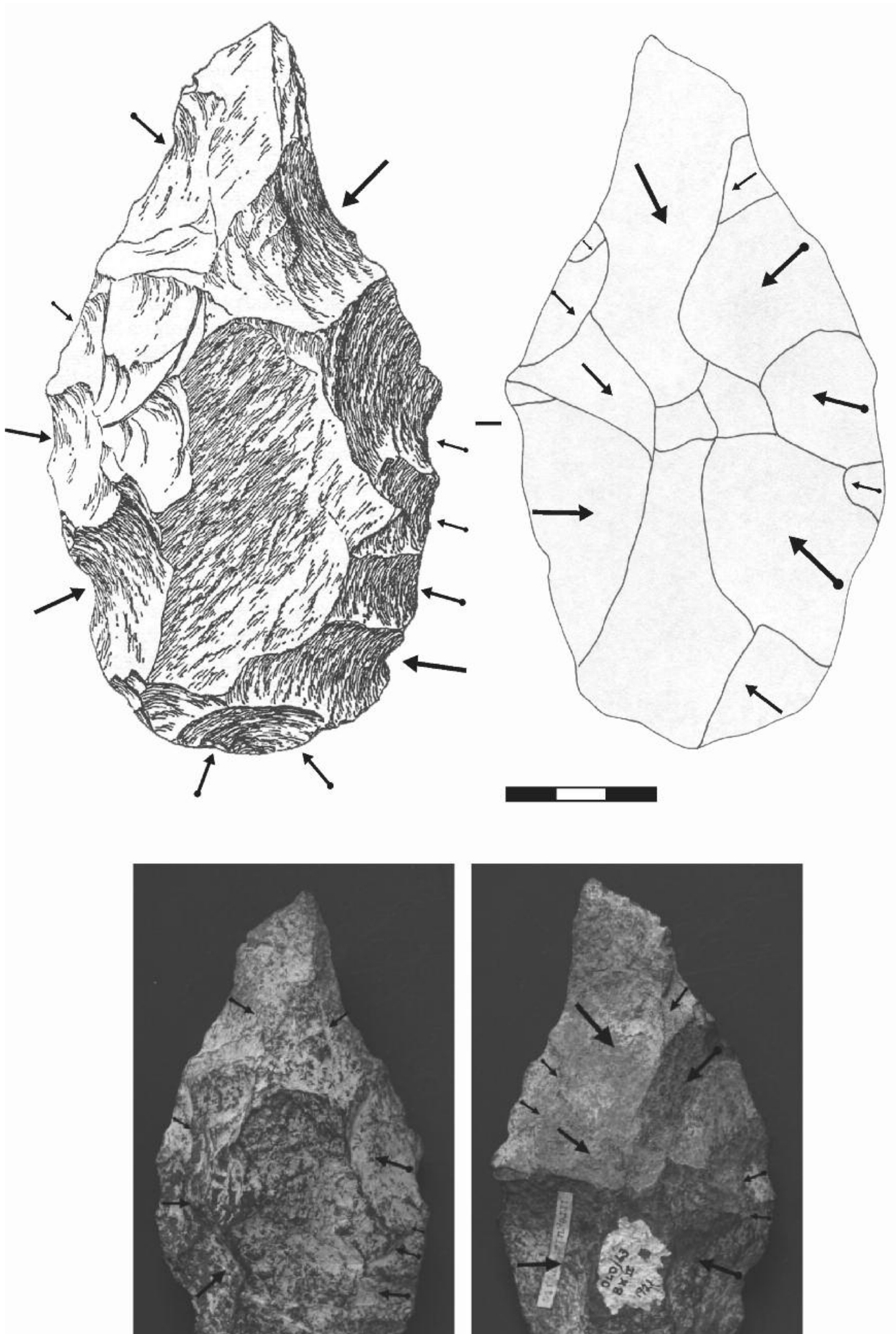

Figure 8.7. Lava biface. Diacritical schemas based on Leakey (1971:206). This piece could probably have been thinned with a soft hammer, since the detachments are very flat and invasive and do not break the edge. This piece presents a high level of symmetry between both surfaces, which is quite uncommon in the examples from older sites.

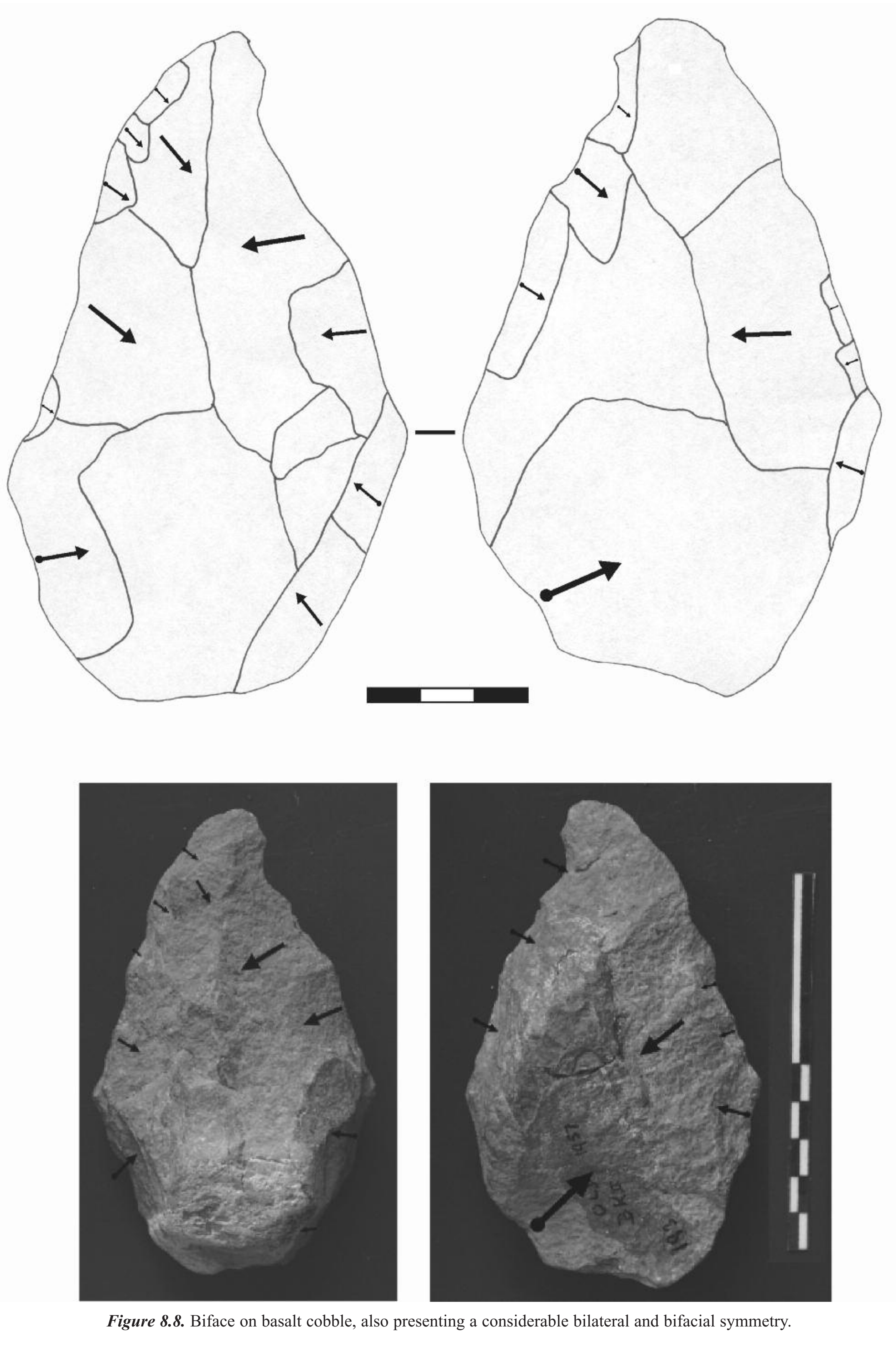

Figure 8.8. Biface on basalt cobble, also presenting a considerable bilateral and bifacial symmetry.

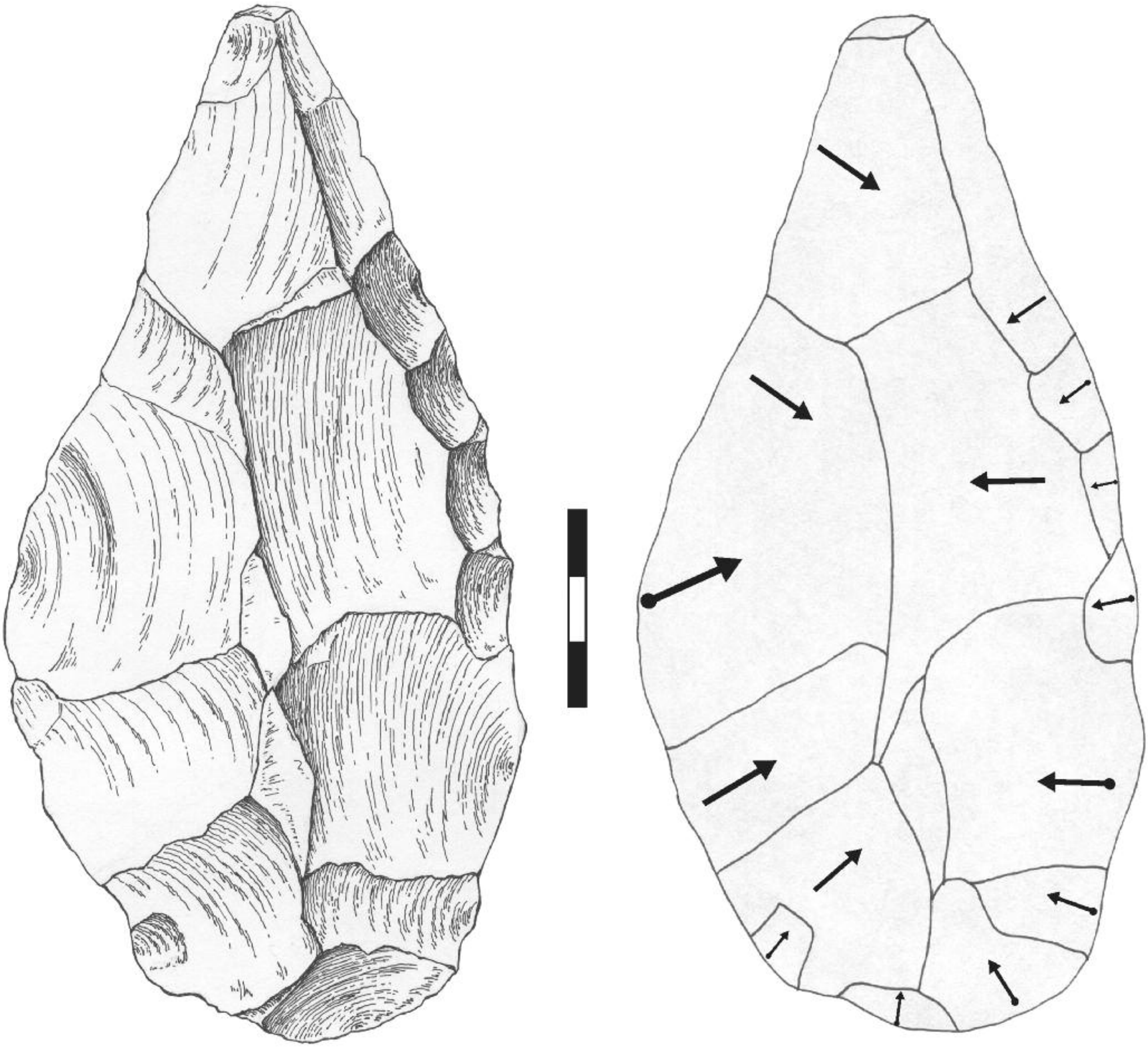

Figure 8.9. Basalt biface (drawing N. Morán).

to the Acheulean (which is precisely defined by the presence of these pieces), whilst BK, where bifacial *façonnage* is recurrent and creates standardised morphologies, were considered Oldowan.

Moreover, in BK the management of enormous blocks of raw material manipulated to obtain large blanks has also been documented; operations were carried out in a manner similar to EF-HR, TK or FC West. In view of these facts, we believe BK is simply another assemblage in the same technical tradition commenced in Olduvai in times of EF-HR. BK hominids had very sophisticated technical skills, which allowed them to obtain flakes using well structured knapping systems, and to manage blocks and flakes to achieve a morphological standardisation of the bifaces. From then on, and during the formation of Beds III and IV, Acheulean technology continued developing and the hominids occupied the now almost inexistent Olduvai Lake and had to adapt to the new environmental conditions. That is, however, a different issue that should be considered in other monographic works. Our analysis concludes here, at the top of Bed II, and requires a global synthesis that develops the most relevant aspects described in this book.

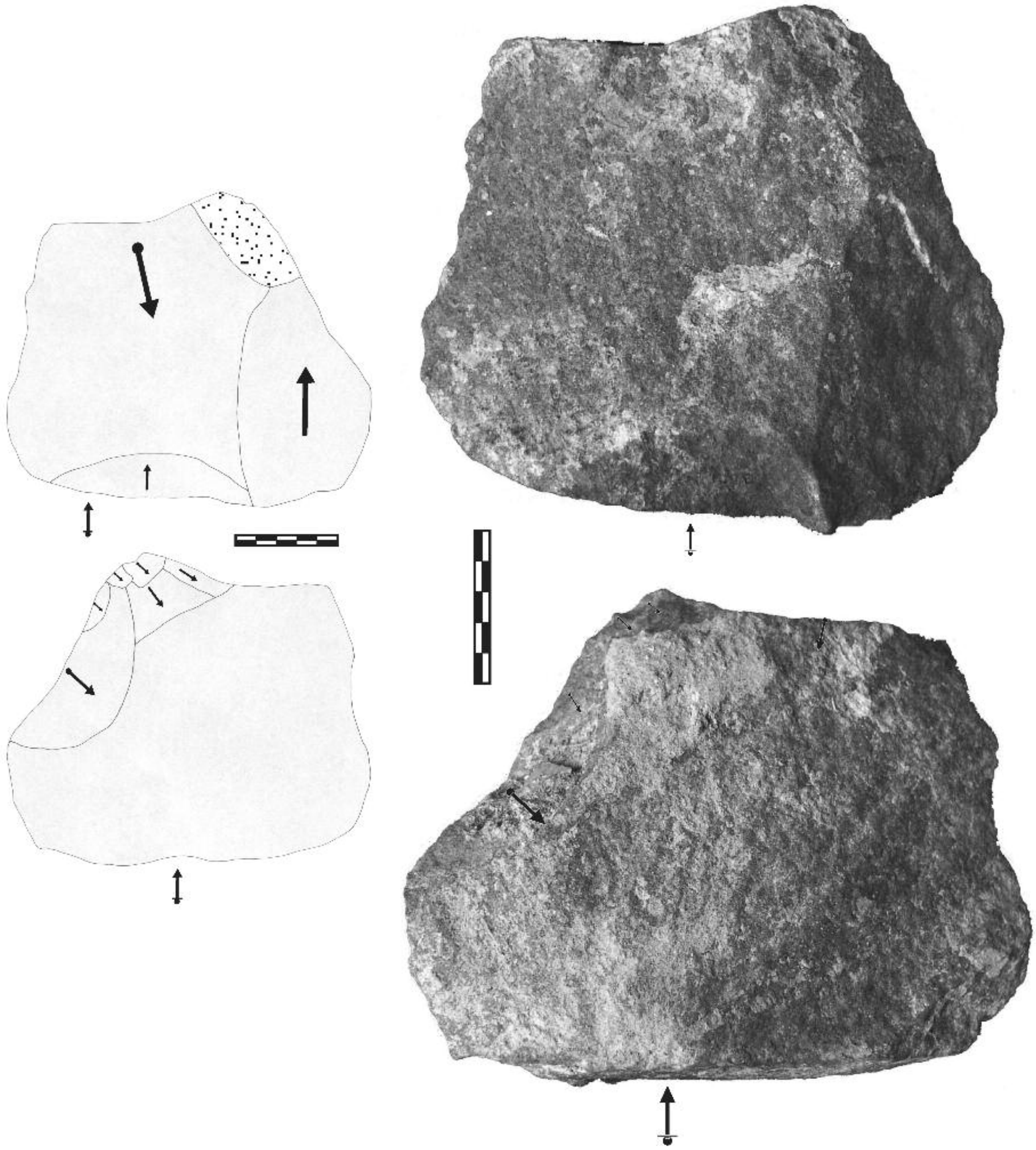

Figure 8.10. Large cutting tool on flake. The flake is over 14 centimetres long and weighs over 2 kilograms. This confirms BK hominids were aware of and used the techniques required to obtain large blanks.

Figure 8.11. Quartz core, most probably used for the detachment of blanks for large cutting tools. This piece measures over 32 centimetres maximum length and weighs over 6900 grams.

Chapter 9

TECHNOLOGICAL STRATEGIES IN OLDUVAI BEDS I AND II

Introduction

Throughout the previous chapters we have studied the Olduvai sites from an *intrasite* perspective, focusing on the specific characteristics of each assemblage and observing the relationships and coherence between the different lithic categories. This is the only way to understand the technological strategies and the most useful approach to reconstruct the *chaînes opératoires* that generated the inventory.

This chapter includes a synthesis of the most relevant aspects of the interpretation of each site. Alongside the individual contribution to each site, in this section we will increase the comparative framework, going from studying the relationships between the categories in one site to analyse the patterns observed in the same categories in different sites.

Thus, *intrasite* and *intersite* characterisation will be combined to reconstruct the technological strategies implemented in each assemblage, attempting to discern possible diachronic changes throughout the sequence. It is important to bear in mind the exceptional chrono-stratigraphic inventory the Lower Pleistocene in Olduvai represents. After commencing the study in DK and concluding in BK, the sites we have examined spread over a time span of over half a million years (tabl. 9.1).

In this chapter, the first section will consider the archaeological resolution of each assemblage, in the frame of the debate on the processes that formed the Olduvai record. After dedicating a few pages to the raw materials issue, another important subject matter will be the analysis of the dichotomy between knapping and percussion activities, a topic that has not been given a suitable amount of attention in the bibliography, and which is extremely relevant in Olduvai. This and other issues regarding the organisation of the technology and its connection to the provisioning of raw materials and the use of the territory will be studied in depth. Furthermore, we will dedicate a few lines to the debate on the distinction between the Oldowan and the Acheulean, Leakey's (1971) classification, and the technological and cultural derivations that appear in the differences observed between the assemblages.

Site formation processes at Olduvai

The identification of the agents that contributed to the formation of the assemblages is a constant concern in the literature

Site	Bed	Chronology	Palaeogeography (Hay, 1976:113)	Cultural entity Leakey (1971, 1975)	Cultural entity This work
DK	I	>1,84 my	Inland	Oldowan	Oldowan
FLK Zinj	I	>1,76 my	Lake margin	Oldowan	Oldowan
FLK North Level 6	I	>1,75 my	Lake margin	Oldowan	Oldowan
FLK North Level 5	I	>1,75 my	Lake margin	Oldowan	Oldowan
FLK North Level 4	I	>1,75 my	Lake margin	Oldowan	Oldowan
FLK North Level 3	I	>1,75 my	Lake margin	Oldowan	Oldowan
FLK North Level 1-2	I	>1,75 my	Lake margin	Oldowan	Oldowan
FLK North *Deinotherium*	II	>1,66 my	Lake margin	Indeterminate	Oldowan
FLK North Sandy Congl.	II	>1,60 my	Lake margin	Developed Oldowan A	Oldowan
EF-HR	II	>1,50 my	Inland*	Acheulean	Acheulean
FC West Floor	II	>1,50 my	Lake margin	Developed Oldowan B	Acheulean
TK Lower Floor	II	>1,20 my	Indeterminate*	Acheulean	Acheulean
TK Upper Floor	II	>1,20 my	Indeterminate*	Developed Oldowan B	Acheulean
BK	II	>1,20 my	Indeterminate*	Developed Oldowan B	Acheulean

Table 9.1. General characteristics of analysed sites. For chronological details, see Walter *et al.* (1991, 1992), Hay (1992), Blumenschine *et al.* (2003), Manega (1993), and chapter 1 in this work. (*) Associated to a fluvial channel.

dedicated to Plio-Pleistocene archaeology, with numerous references to general issues on the site formation processes (Schick 1984; Domínguez-Rodrigo & de la Torre 1999; Kroll & Isaac 1984; Foley 1981; Isaac & Crader 1981; Binford 1987), focusing specifically on Olduvai (Potts 1988; Petraglia & Potts 1994; Blumenschine & Masao 1991), or areas that share similar characteristics like Koobi Fora (Kroll 1994; Stern 1993, 1994; etc).

Mary Leakey (1971) was the first researcher to systematise the Olduvai inventory. This author referred initially to living floors, where the archaeological remains are located in paleosols with a vertical distribution over 9-10 centimetres. In Beds I and II in Olduvai, among the living floors, Leakey included DK Level 3, FLKNN Levels 1 and 3, FLK Zinj, HWK East Level 1, EF-HR, FC West Floor, SHK Annexe Site, TK LF and TK UF. The second group Leakey (1971:258) established was composed by the butchering sites, characterised by the association of artefacts to a large carcass or a small group of mammals. In this modality, she included the assemblages from FLK North Level 6 and FLK North *Deinotherium*. Another group of sites comprised those with diffused material, where artefacts and bone remains are not concentrated in a homogeneous sequence, but are dispersed along a vast stratigraphic level. According to Leakey (1971:258), DK Levels 1 and 2, FLK NN Level 2, FLK Levels 7 and 10-21, FLK North Levels 5-1, HWK East Level 2, MNK (both levels), FC West Reworked Tuff Level, as well as tuff above the channel at SHK and the Upper and Intermediate tuffs at TK, should be included in this site modality. Leakey also referred to a fourth group, the stream channel occurrences; BK and the channel levels at TK and SHK, were, according to this author, the clearest examples in Beds I and II in Olduvai.

Isaac developed a systematisation of the Plio-Pleistocene assemblages based on their depositional and archaeological characteristics (Isaac 1981, 1984; Isaac & Crader 1981; Kroll & Isaac 1984). Isaac and Crader (1981) assumed that the archaeological material can be located horizontally in the landscape, but may also appear vertically throughout the width of a sedimentary sequence. Consequently, they defined the following types of assemblages: *Type A sites* were concentrations of artefacts with little or no bones, delimited horizontally and vertically. These authors included EF-HR, FC West Floor, TK LF and TK UF, and linked them to lithic workshops.

Type B sites, also containing materials concentrated horizontally and vertically, were those in which a single carcass is documented linked to lithic artefacts. In Olduvai, according to Isaac and Crader (1981), FLK North 6 and FLK North *Deinotherium* could be considered examples of this type of sites, and in fact coincide with the definition Leakey (1971) gave for butchering sites. The last group of assemblages with high archaeological integrity has been designated *Type C sites*, in which the materials are found well-demarcated horizontally and vertically, with a high number lithic artefacts linked to carcass remains from different species. This section would include those mentioned in DK, FLK NN Levels 3 and 1, FLK Zinj, FLK North Level 1-2, HWK East 1 and SHK Annex, and correspond to Leakey's (1971) living floors.

Moving on to assemblages with diffused material, Isaac and Crader (1981) referred to *Type D sites*, those in which, with or without bones, artefacts can be locally abundant but are diffused along a vast sedimentary width devoid of individual horizons. This type of assemblages actually coincide with Leakey's (1971) definition of levels with diffused artefacts, therefore Isaac and Crader (1981) also included in this section part of the inventory from DK, as well as FLK North Levels 5, 4 and 3 – but not Level 1-2 as Leakey (1971:258) proposed -, HWK East Levels 2-5, both levels at MNK, FC West Reworked Tuff, SHK Main, and both tuff levels at TK.

Isaac and Crader (1981) also referred to *Type G sites*, that may or may not be concentrated vertically and horizontally, but are characterised by having been transported and redeposited in another geological context. As did Leakey (1971), these authors included the BK assemblage in this group, alongside the stream deposit levels in TK and SHK. Finally, Isaac and Crader (1981) established the existence of *Type O sites*, which only present bones, and for which it is very hard to demonstrate the activity hominids carried out as regards the accumulation process. These authors did not contemplate this category in the classification of Olduvai Beds I and II (Isaac & Crader 1981:50).

The systematisation of the African Plio-Pleistocene assemblages Isaac (1981, 1984; Isaac & Crader 1981; Kroll & Isaac 1984; etc) suggests, even considering the role of the postdepositional processes, is similar to Leakey's (1971) classification. This consideration accepts that patches with high densities of material respond to direct occupations of a specific point of the landscape, which can only be disintegrated considering taphonomic and sedimentary reasons.

This paradigm that conceives a systematic occupation of specific locations, clashes frontally with the ideas presented first by Binford (1985, 1987) and then by Blumenschine (Blumenschine & Masao 1991) regarding the formation of the Olduvai sites. According to Binford (1987) all the so-called living floors (i.e., all sites concentrated horizontally and vertically) correspond to the same processes that generated the levels with diffused material, although in the former, the existence of a stable surface, generally a paleosol, prevents remains scattering vertically. Consequently, according to Binford, sites with high densities of material like FLK Zinj can be explained considering the stability of the surfaces, which leads to the existence of more episodic events per sedimentation unit. In short, type A-C sites and type D-G sites as defined by Isaac, "*both are the consequence of many discrete, non integrated events of tool manufacture, use, and discard, but on the stable land surfaces this palimpsest is vertically undifferentiated in the archaeological record*" (Binford 1987:26).

Moving along similar grounds, Blumenschine and Masao (1991) use excavations in Lower Bed II to document bone

Site	Excavated area (m²)				Level thickness (cm)			
	Potts (1988) Petraglia & Potts (1994:239)	Kroll & Isaac (1984:12)	Harris & Capaldo (1993:206)	Kimura (2002:296)	Leakey (1971)*	Kappelman (1984:177)	Potts (1988) Petraglia & Potts (1994:239)	Kimura (2002:296)
DK (all levels)	345	231	233	231	129	131.1	n.3= 9 n.2= 68	166-216
FLK Zinj	290	300	282	300	9	9.1	9-10	10
FLK North Level 6	37	35	36	-	52.5	53.3	50	-
FLK North Level 5	-	115	115	-	45	45.7	-	-
FLK North Level 4	-	80	82	-	27	27.4	-	-
FLK North Level 3	-	110	105	-	15	15.2	-	-
FLK North Level 1-2	-	100	106	-	52.5	53.3	-	-
FLK North *Deinotherium*	-	-	-	-	60	-	-	-
FLK North Sandy Congl.	-	-	-	-	30	-	-	>30
EF-HR	-	-	-	40	9	-	-	10
FC West Floor	18	-	15	20	9	-	10	10
TK Lower Floor	-	-	42	-	9	-	-	-
TK Upper Floor	80	-	36	102	9	-	10	10
BK	-	-	-	-	150	-	-	-

Table 9.2. Area excavated and thickness of the levels studied. (*) Leakey's (1971:260) measurements were presented in feet and we have converted them according to the ratio 1 foot = 30 centimetres.

Site	Number of items (Leakey, 1971)		Density of artefacts / m²			Density of bones / m²
	Lithic	Bone*	Isaac & Crader (1981:64)	Harris & Capaldo (1993: 206)	Kimura (2002:296)	Isaac & Crader (1981:64)
DK (all levels)	1198	9984	0.18	5.14	4.9	1.5
FLK Zinj	2470	3510	7.75	8.76	8.3	11.33
FLK North Level 6	123	614	0.59	3.42	-	2.93
FLK North Level 5	151	2210	0.27	1.31	-	3.97
FLK North Level 4	67	929	0.3	0.82	-	4.14
FLK North Level 3	171	1254	1.06	1.63	-	7.71
FLK North Level 1-2	1205	3294	4.63	11.37	-	12.64
FLK North *Deinotherium*	23	-	-	-	-	-
FLK North Sandy Congl.	234	-	-	-	-	-
EF-HR	522	34	11.76	-	13.8	0.78
FC West Floor	1184	127	67.2	78.93	56.4	7.1
TK Lower Floor	2153	147	51.89	51.26	-	3.52
TK Upper Floor	5180	230	65.66	143.89	45.3	2.96
BK	6801	2957	3.45	-	-	1.5

Table 9.3. Recounts of the archaeological collections at the analysed sites. (*) Microfauna and avifauna are excluded. See Potts (1988) for bone and lithic density estimations by volume of sediment (m³), not by excavated surface (m²).

and artefact densities in the whole landscape that are similar to those which were, supposedly, restricted to living floors. According to these authors, hominids did not occupy specific points of the landscape, they generated a continuous archaeological record throughout the whole territory. Consequently, whilst Binford (1987) debated the validity of vertical concentrations as a diagnostic criterion to refer to living floors, Blumenschine and Masao (1991) criticised the horizontal demarcations, once again questioning the concept of archaeological concentrations in specific locations of the landscape.

Constant contradictions appear in the information exposed by each author. Tables 9.2 and 9.3 are a good example of the disparity as regards the analysis, and prove a certain degree of laxness in the study of Leakey's (1971) monograph – which researchers use to extract data from directly – and a scarce interest in comparing results to the information in previous publications. Some of the contradictions can be explained easily. For example, when Harris and Capaldo (1993) propose an excavated area of 36 m² in TK UF forgetting that two identical trenches were dug out, not just one, or when Petraglia and Potts (1994) suppose an 18 m² area in FC West Floor although Leakey (1971:156) expressly stated that 170 feet² (about 51 m²) had been excavated.

Although they are not structural errors, the contradictions observed in the different publications demand we treat some information with certain precaution, especially those based on estimations that depend on data already published by Leakey (1971), which have not been obtained directly, like the calculations regarding the densities of the material (tabl. 9.3). These contradictions are not limited to researchers who work with second hand data, they also appear among those who have accessed the collections directly. Throughout the previous chapters, the number of items in each site differed in terms of the researcher. Given the contradictions existing

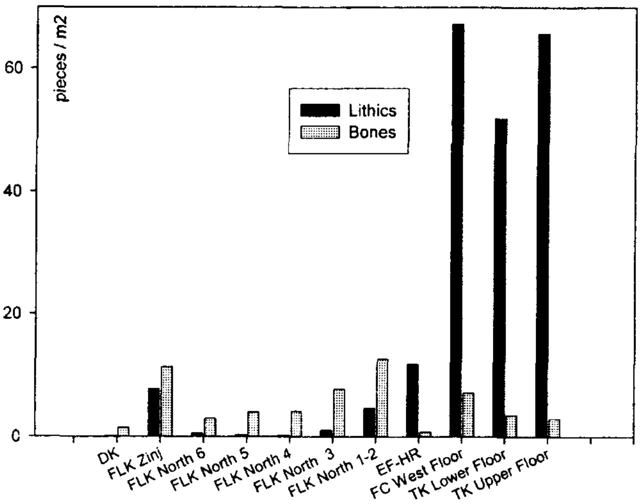

Figure 9.1. Bone and lithic densities per m², according to calculations by Isaac and Crader (1981).

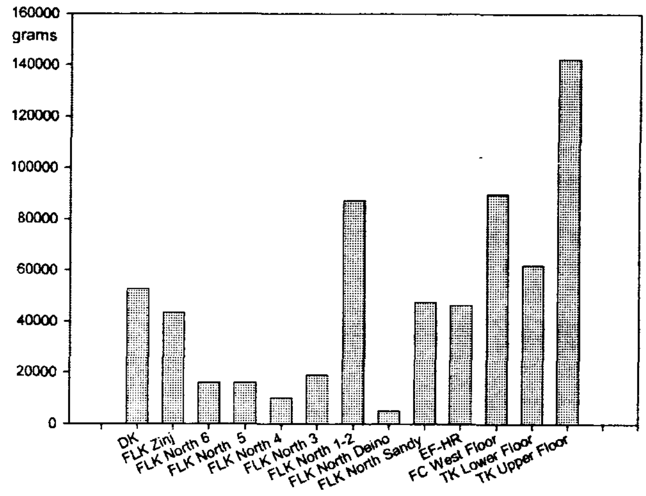

Figure 9.2. Total volume of transported raw material to each analysed Olduvai site, according to the present study.

Site	Frequencies		Lithic proportions	
	Number of pieces*	Total weight (grams)	Detached pieces %	Flaked pieces %
DK (all levels)	1021	52714	89.2	10.8
FLK Zinj	2557	43530	96.2	3.8
FLK North Level 6	128	15948	80.5	19.5
FLK North Level 5	130	15952	64.7	35.3
FLK North Level 4	55	10098	60	40
FLK North Level 3	170	18954	67.9	32.1
FLK North Level 1-2	1210	87019	88.5	11.5
FLK North *Deinotherium*	23	5021	50	50
FLK North Sandy Congl.	245	47494	57.3	42.7
EF-HR	429	46388	97.7	2.3
FC West Floor	1162	89673	85.8	14.2
TK Lower Floor	2314	62025	98.2	1.8
TK Upper Floor	5189	142367	97.1	2.9
BK	**	**	**	**

Table 9.4. Characteristics of the sites according to this study. (*) All unmodified lithic material is excluded. (**) Quantitative study not performed.

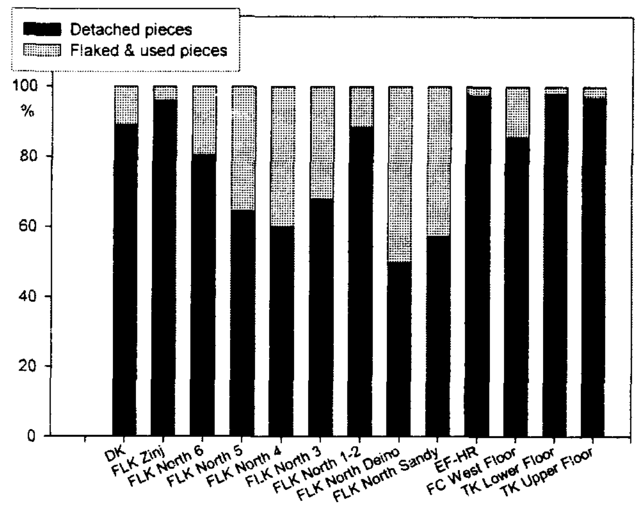

Figure 9.3. Proportions of detached and flaked pieces at the Olduvai sites.

between the different investigators, it seems quite difficult to construct explanatory frameworks based on conflicting data. Consequently, albeit expounding the estimations made by other authors (tabl. 9.2 and 9.3), and considering the most reliable ones at length (fig. 9.1), we will move on to evaluate the sites based on our own results.

Of all the assemblages studied, TK UF is the level with the greatest number of lithic pieces, followed by FLK Zinj (tabl. 9.4). Nevertheless, absolute frequencies for artefacts are not indicative *per se* of the relevance of human activity. At most, they can provide information on the level of fragmentation of the lithic material. The most relevant parameter in this sense is the total weight of the worked raw material, since this factor provides genuine information on the volume of lithic material employed. Thus, comparing all the assemblages in terms of the total volume of worked raw material, trends differ from the patterns provided upon comparing the number of items (fig. 9.2): of all the analysed sites, the location on the landscape where the hominids accumulated the greatest amount of worked raw material was TK UF, but this time followed by FC West and FLK North 1-2, not by FLK Zinj.

Another method implemented to assess the quality of the inventory is to compare the frequencies of small-sized objects to the frequency of large ones, since millimetric chips disappear swiftly from assemblages affected by hydraulic processes. Isaac (1986) referred to detached pieces compared to flaked pieces, to distinguish the objects detached during knapping from those they were detached from. Upon integrating flakes and different detached fragments (including small fragments caused by pounding, not only items caused by knapping) in the detached pieces group, and with flaked pieces including heavy-duty artefacts (cores, hammerstones, etc), our goal is to reach a dichotomic classification, assuming that the proportions of small-sized objects also indicate the level of postdepositional alteration (Schick 1984; Isaac & Marshall 1981).

The data from table 9.4 represented in figure 9.3, indicates that levels 6-3 and *Deinotherium* in FLK North are assemblages with a lower proportion of detached pieces. This reached higher extents in FLK North 4 and 3 where, as aforementioned, the number of cores exceeded the number of knapping products. The shortage of small-sized elements compared to the profusion of objects as heavy as cores, anvils or hammerstones, must be linked to an important postdepositional disturbance (Petraglia & Potts 1994). Schick (1984) noted that in assemblages that had experienced most hydraulic alteration, the proportion of cores compared to the *débitage* never exceeded 10%. In FLK North 6-3 and *Deinotherium*, the rate of cores in terms of flakes and fragments is even greater, which indicates the importance of postdepositional processes in the formation of these levels.

This coincides with other parameters such as the density of objects, very low in these levels of FLK North, and the global volume of raw material, which is also very depleted. In contrast, sites with more kilograms of raw material and/or artefact density, have the highest proportions of detached pieces. The sole exception appears in FLK Sandy Conglomerate, where there are almost 48 kilograms of worked raw material (fig. 9.2) and yet a relatively low proportion of detached pieces. This time the explanation is simple. As mentioned in chapter 4, Leakey (1971) noted that in this level the sediment was not sifted; this factor probably altered the real proportions of the categories.

Given the coincidence as regards the results for the densities, global volumes of raw material and proportions of the detached/flaked pieces, one could think that we are comparing redundant characters. Yet we do not think this is the case; there could be very high artefact densities in areas where the volume of raw material transported is, nonetheless, quite low. FLK Zinj is an example that proves this notion, since not many kilograms of raw material were taken to the site, although they were exploited intensely (it presents the second greatest number of items in the whole of the Olduvai sequence), generating an extremely high percentage of detached pieces (96.2%) in a very small space – 7.75 pieces per m^2 according to Isaac and Crader (1981). If this were also the case in FLK North 6 and *Deinotherium*, which have been interpreted as limited occupations that are perfectly defined, there should be a low number of kilograms of raw material, which should at least be well-demarcated horizontally and vertically without taphonomic disturbances that could alter the proportions of the objects. These conditions do not appear in any of the levels of FLK North (except in Level 1-2), and call for a consideration of the human influence on rather dense bone assemblages (fig. 9.1).

The importance of postdepositional processes in DK cannot be denied: Potts (1988) noted the presence of a great number of cobbles in clay sediments, in chapter 2 we referred to some rounded quartzes (that do not present a diagenesis that could explain the roundness of the edges), and insisted on the vertical dispersion of archaeological remains. This does not imply that it is a re-deposited assemblage as BK could be. In DK there are a great number of intact artefacts, refits, associations between fauna and lithic items, etc., that suggest the assemblage maintains a good part of its original internal coherence. Consequently, we could refer to a moderate postdepositional alteration in which low energy hydraulic processes, linked to a vertical migration of the objects, could have mixed artefacts with different taphonomic histories without modifying the site's original configuration significantly.

We also attribute certain postdepositional alteration to levels 6-3 and *Deinotherium* in FLK North, although the origins probably differ from those of DK. There is no need to expand on FLK North levels 5-3, since both Leakey (1971) and, subsequently, Isaac (Isaac & Crader 1981; Kroll & Isaac 1984) agreed in considering them levels with diffused artefacts. In this case, and opposed to DK, it does not seem likely that hydraulic traction was the agent of alteration. These are low energy clay sediments and the few quartz artefacts are in a excellent state of preservation. Therefore, it would be more feasible to assume processes similar to those described by Leakey (1971) and underscored by Binford (1987), in which isolated artefacts or items from previous or subsequent occupations were dispersed via vertical migration processes.

The fact that both Leakey (1971) and Isaac & Crader (1981) considered levels 5-3 in FLK North as assemblages with diffused material takes on a special importance when compared to Levels 6 and *Deinotherium*, since the latter actually present the same features as the other collections, as Potts (1994) stated. They have similar proportions of flaked and detached pieces, artefact densities as low as in levels with diffused material, a similar number of items and a similar total volume of raw material and, specially, a density of bone remains that is practically identical in FLK North Level 6 (see tabl. 9.3) and probably lower in FLK North *Deinotherium*. It was precisely the bone remains (the presence of the *Elephas* in FLK North 6 and another proboscidean in FLK North *Deinotherium*) which led to these levels being distinguished from others in FLK North. Therefore, the fact that the bone material cannot be used to discriminate assemblages counters a particular assignation of levels 6 and *Deinotherium*.

We will not go into a taphonomic discussion on the carcasses unearthed in FLK North 6 and *Deinotherium*, turning to the monographic analyses performed by Crader (1981) and Domínguez-Rodrigo *et al.* (in press). Following Potts (1994), we consider FLK North 6 and FLK North *Deinotherium* do not present qualitative nor quantitative differences compared to levels 5-3. If the latter are considered background deposits with fortuitous associations between bones and artefacts, it is possible to propose that North 6 and *Deinotherium* Level were of the same nature, or at least propose that human presence was episodic. Assuming the hypothetical natural accumulation of carcasses in a specific location of the landscape in which there were coincidentally a few dozen lithic artefacts, the following reflection comes to mind: "*it is possible that over time type B sites may begin to look like sites of type C even though the events we usually imagine to be responsible for type C sites (hominid transport of stone and bone to a specific location or 'home base') did not occur*" (Crader 1983:126).

Finally, we would like to comment on FLK Zinj, FLK North Levels 1-2 and Sandy Conglomerate, EF-HR, FC West and TK. In our opinion, they all experienced minimum postdepositional disturbance. Petraglia and Potts (1994) would coincide with this analysis as regards FLK Zinj, but not so much when referred to FC West and TK Upper Floor. Nevertheless, the latter also present scant postdepositional alteration. In both there is a vast proportion of millimetric fragments and the distribution of the categories is coherent with the assemblages undisturbed by hydraulic traction. As regards the roundness Petraglia and Potts (1994) described among the lavas, they could be explained taking diagenesis processes into consideration.

As regards EF-HR and FLK North Sandy Conglomerate, the absence of knapping waste can be explained considering the characteristics of the excavation (the sediments were not sifted), not taphonomic processes. In fact, the lava artefacts from EF-HR are prodigiously preserved, and Leakey (1971) noted that they were unearthed in a level 10 centimetres thick. Thus, Kimura's (2002) classification is surprising, since she assigns a medium degree postdepositional disturbance to EF-HR, and refers to serious taphonomic alterations in FLK North Sandy Conglomerate, simply because neither present hardly any knapping waste. This author forgets that Leakey (1971) herself noted that sediments had not been sifted in FLK North SC, and that in EF-HR issues connected to the excavation had prevented the recuperation of all the archaeological material. Some pieces from FLK North SC present pseudo-retouching, although it could be due to friction with the sediment. Certainly, the only argument that can be used to refer to a certain degree of alteration in FLK North SC is the sandy context in which the artefacts were found. Chert is a sensitive indicator of hydraulic displacement, since the mechanical traction immediately collapses its edges. Nonetheless, no rounded chert pieces were found in FLK North SC. Paradoxically, FLK North SC has never been paid much attention in the syntheses dedicated to Olduvai (tabl. 9.2 and 9.3 show that practically none of the authors refer to this site), when it does, in fact, present a relevant volume of knapped raw material. In our opinion, the integrity of this site must have been high and would only require a controlled excavation and recuperation. Something similar occurs with FLK North 1-2, which – although it has not received as much attention as other assemblages in Bed I – presents the greatest bone remains density in the whole sequence (tabl. 9.3 and fig. 9.1) and a lithic collection weighing over 87 kilograms that doubles, for example, that of FLK Zinj (tabl. 9.4). The fact that materials were found in a deposit 50 centimetres thick, led Leakey (1971) to consider it a level with diffused artefacts. Nonetheless, in view of the great density of remains, Isaac and Crader (1981) included it in Type C assemblages. We do not consider FLK North 1-2 an eroded level. Without excluding the presence of small postdepositional alterations, mainly linked to the vertical migrations these artefacts experienced, we believe the taphonomic alteration was minimum in FLK North 1-2 and, therefore, alongside EF-HR FC West, TK (both levels), FLK Zinj and (probably) FLK North Sandy Conglomerate, it composes another example of the sites in a primary position in Olduvai.

After revising the contextual characteristics of each site, we can add the functional connotations implied in Isaac and Crader's (1981) classification to taphonomic assessment. Table 9.5 presents a comparison between the classifications for the different sites. Our interpretation resembles Isaac and Crader's (1981), although it varies in the classification of certain levels. We have assigned DK to Type D sites given that materials are diffused vertically. Yet, we could have included it in Type C sites, since in our opinion DK presents good archaeological integrity, preserving the association between

Site	Leakey (1971:258)	Isaac & Crader (1981:52)	This work: Postdepositional disturbance	This work: Classification
DK (all levels)	N. 3: Living floor N.1-2: diffused material	Type D	Medium	Type D
FLK Zinj	Living floor	Type C	Low	Type C
FLK North Level 6	Butchering site	Type B	Low-Medium	Type D-O
FLK North Level 5	Site with diffused material	Type D	Medium	Type D-O
FLK North Level 4	Site with diffused material	Type D	Medium	Type D-O
FLK North Level 3	Site with diffused material	Type D	Medium	Type D-O
FLK North Level 1-2	Site with diffused material	Type C	Low	Type C
FLK North *Deinotherium*	Butchering site	Type B	Medium	Type D-O
FLK North Sandy Congl.	Site with diffused material	-	Low	Type A
EF-HR	Living floor	Type A	Low	Type A
FC West Floor	Living floor	Type A	Low	Type A
TK Lower Floor	Living floor	Type A	Low	Type A
TK Upper Floor	Living floor	Type A	Low	Type A
BK	Stream channel site	Type G	High	Type G

Table 9.5. Interpretation of the analysed sites.

lithic categories and between the lithics and the fauna, in a vast collection in terms of the number of items and the global volume of raw material. We believe the differences between DK and FLK North 1-2 are not relevant. Therefore, if Isaac and Crader (1981) ignored their own definition of Type C sites (which as such were restricted to vertical depositions not over 10 centimetres thick) to include FLK North 1-2 in this category, we should also make an exception with DK and incorporate it in this group. In any case, relevant juxtapositions as regards bones and artefacts with clear traces of association between them (*sensu* Isaac 1983) are documented in DK, FLK Zinj and FLK North 1-2. Consequently, functionally (albeit not in postdepositional terms) they would both be the same type of archaeological assemblage.

As regards Type A sites, there is no difference between Isaac and Crader's (1981) classification and ours, except for including FLK North Sandy Conglomerate in the EF-HR, FC West, TK LF and TK UF group. These sites present a high density of lithic artefacts, yet the bone material is incidental (fig. 9.1 and tabl. 9.3). Their functionality will be tackled below but, for the moment, we can underscore the differences they present compared to other assemblages also in a primary position like FLK Zinj or FLK North 1-2, where the main activity does seem to have been linked to carcass processing.

Finally, this section will refer to assemblages with diffused material. Isaac and Crader (1981) included levels 5-3 in FLK North among Type D sites. We have classified these levels following their arrangement, although we think the association between lithic pieces and fauna may be fortuitous, and therefore do not rule out that FLK North 5-3, characterised by the important amount of fauna recovered, could in fact be paleontological levels with lithic pieces that have migrated from upper levels. Quite probably, *Deinotherium* Level could also be paleontological, as stated by Isaac and Crader (1981), who did not exclude the fortuity of the association of fauna and the industry. The same occurs in FLK North 6, where the relationship between fauna and industry is also being questioned (Domínguez-Rodrigo *et al.* in press), and presents a distribution of bones and lithic material that is identical to upper levels, as already proposed by Potts (1994).

In Olduvai, postdepositional processes affected all assemblages to a greater or lesser extent, and have to be considered when attempting to reconstruct the activities the hominids performed. A good example of this interrelation between natural processes and human activities appears in the fortuitous association that could exist between bones and lithics in certain assemblages like FLK North 6-3 and *Deinotherium*. Another is the accidental connection that could appear between artefacts and unmodified lithic material. This issue has been a recurring problem throughout previous chapters, in which we have postponed a systematic explanation that could demonstrate a fortuitous association between knapped pieces and natural stones. Thus, before assessing the activities performed by the hominids, we must settle the issue of the so-called manuports in the Olduvai sequence.

Unmodified lithic material at Olduvai

Practically all the sites analysed in this work present unmodified lithic material. In all sites, we have dedicated some paragraphs to arguing the natural, non-human character of the accumulation of these unmodified pieces. Our insistence is far from unwarranted, given that since the publication of Leakey's (1971) monograph, the so-called manuports have played a decisive role in the interpretation of the Olduvai hominids' behavioural strategies.

As far as we know, the first reference in African Plio-Pleistocene archaeology to the term manuport comes from Mary Leakey (1966) herself, who proposed the name for those unmodified objects located on living floors which were devoid of hydraulic disturbance. According to this idea, manuports were to be considered as that "*which conveys the essential and only common characteristic, i.e., that the stones have been transported by human agency*" (Leakey 1967:422). Not long afterwards, in her most relevant work on Olduvai Beds I & II, Leakey (1971) still defined manuports as those "*which lack evidence of modification but appear to have been imported to the sites by hominid agency*" (Leakey 1971:8). Along the same line, other definitions consider that manuports "*are exogenous pieces of stone raw material that show no sign of artificial chipping or use*" (Potts 1988:235) or, in a more restrictive manner, they assume that "*such unmodified stones can be recognized as having been objects introduced by hominids only if they are found in beds that are otherwise devoid of large stones*" (Isaac *et al.* 1997:275). Other definitions grant manuports a functionality, by proposing that "*they are unaltered examples of the kind of lithic material typically used either as tools or to make tools and are considered to have been transported by hominids to the site where they were found*" (Potts 1991:158) or, more explicitly, asserting that manuports "*may represent stones subjected to such slight utilization that no trace remains, or raw material intended for manufacture into tools, or they may possibly be missiles*" (Leakey 1967:422). In all, these and other definitions, coincide in granting the term manuport a similar meaning; they are to be considered as lithic objects non-modified anthropically but which were supposed to be accumulated by hominids, given that they are located in a stratigraphical deposit that differs from the sedimentary context where they are deposited naturally.

Based on these assumptions, different theories have been developed in terms of the presence of manuports in the Olduvai sites. Potts' hypothesis (1988) is particularly relevant, in conceiving the Olduvai sites as stone caches, specific locations of the landscape where stones, both modified and unmodified, were transported and would be visited repeatedly to obtain or manufacture tools at the same time as hominids processed the food obtained in the surroundings of such spots. Manuports play a crucial role in this behavioural proposal. In the first place, it is assumed that "*the accumulation of some stone materials, especially manuports, which subsequently show no or little sign of utilisation probably does reflect, in* *part, unhindered acquisition of a resource in high abundance*" (Potts 1988:242). Furthermore, this author also considers that the transport of unmodified lithic material in Olduvai gave notice of a strategy focused on the reoccupation of the sites, i.e. the hominids would stockpile raw materials in advance for a subsequent visit to the area, where there would be a reiteration of the occupations (Potts 1988). In all, both in the stone-cache model (Potts 1988) and in the subsequent reformulation of the resource transport hypothesis (Potts 1991), the accumulation of unmodified lithic material was an organised strategy, which was repeated systematically. It would explain the constant high percentage of manuports in several of the Olduvai Bed I sites. The hominids accumulated a stock of raw materials with a view to a subsequent reoccupation of the settlement, which implies that the hominids' movements around the landscape were planned, and would, in truth, involve the genuine innovation of the Oldowan (Potts 1991).

Alongside the hypotheses that aim to explain the concentrations of modified and natural lithic material in specific areas of the landscape, there are also numerous contributions regarding the functionality of said manuports. The most parsimonious and realist theories assume that the Bed I manuports in Olduvai are reserves of raw material accumulated for their subsequent use as cores and the production of flakes. Other activities proposed for certain manuports, such as those linked to food processing (i.e. Isaac & Crader 1981), normally leave conspicuous and inconspicuous marks on the pieces, and in any case are classified under the "utilised materials" category created by Leakey (1971). Nonetheless, a third explanation has been sought for most of the unmodified lithic material, which has considered manuports as missiles. Thus, authors such as B. Isaac (1987) or Cannell (2002) have used the ethnographic record or actualistic parallels as a comparative framework to justify the hypothesis that Olduvai manuports and spheroids could have been missiles, whilst others such as Calvin (2002) or Bingham (2000) have based their work on socio-evolutionary speculations, and Blumenschine & Peters (1998) included this hypothesis in the framework of the paleo-ecological reconstruction of the activities performed by the Olduvai hominids.

As a conclusion, since the original publication of the Olduvai Bed I and Bed II record (Leakey 1971), many papers have incorporated the manuport category to the behavioural interpretations of the sites (i.e. Isaac 1978, 1983; Blumenschine & Peters 1998), and in fact in models such as Potts' (1988, 1991), these objects compose one of the basic pillars of the line of argument that supports the hypothesis. Furthering this proposal, in recent years Potts (1994; Potts *et al.* 1999) has used the Olduvai manuports as a genuine cultural feature that differentiates this region from others with a similar chronology, asserting "*Olduvai hominids evidently practiced a way of using stone that involved the movement of unmodified rocks, or manuports, over considerable distances. Most of the major clusters and minor assemblages of in situ artefacts include abundant manuports, and in this respect the archaeological record of Olduvai differs from that of Turkana or other late Plio-Pleistocene basins*", given that according to this author "*Manuports typically make up 20-60% of the stones recovered from M.D. Leakey's excavations in Beds I and II, in contrast with 0-6% of the stones from sites in the Turkana basin*" (Potts *et al.* 1999:784).

However, in this work we aim to present an alternative proposal. We assert that the Olduvai Bed I manuports cannot be used to elaborate hypotheses on the hominids' settlement strategies, nor is it viable to discuss the pieces' functionality. To do so, we set forth a basic explanation: we consider that most of the unmodified lithic objects from the Olduvai Bed I sites are not manuports but instead ecofacts, i.e. stones deposited naturally and associated fortuitously to the archaeological materials. When analysing each site, our arguments have been based on comparing the quantitative and qualitative characteristics of the knapped material and the unmodified objects. According to our study, there does not seem to be a connection between the type and quality of the raw material, size, etc.

Although we have attempted to present convincing proofs to support the fact that the knapped material is not connected to the unmodified pieces, the weakest point in the argumentation has been to conceive an alternative setting that justifies why large stones are located in low energy contexts. This line of argument is especially relevant, since it is precisely the metric conflict between the predominant sedimentary matrix (clays) and the large associated stones, which led researchers to propose the impossibility of them being deposited in the locations naturally and led them to turn to the anthropic supply of these rocks, considering them genuine manuports.

In fact, the location of large clasts in clay contexts without the energy capacity to transport them was the only argument implemented to consider that they had been introduced anthropically. In short, this leads to the assumption that these anomalies in the heterometries of the sedimentary matrix cannot be produced naturally. In this case, and considering we are referring to intentional human accumulations, it would be logical to think that we would not encounter this phenomenon beyond the clusters of archaeological remains formed by the sites, at least in the sedimentary contexts associated with the lake margin. At these locations, deposition would always be linked to clays and other low energy sediments, devoid of large natural clasts.

However, Leakey herself already contradicted this hypothesis when describing the DK stratigraphy, by stating that "*a characteristic feature of the whole bed was the presence of small pebbles of lava, quartz and pink feldspar in otherwise fine-grained sediments*" (Leakey 1971:21). The interesting fact is that here, Leakey did not refer to the lava substratum, but to the overlying sediments with a clay structure in which, despite this, she found rather large clasts. Geological studies on Olduvai also support this proposal; Hay (1976:46) referred to the appearance in the eastern lake-margin deposits of the

Main Gorge in Olduvai of a large variety of basement and volcanic detritus, some pebble size and some up to 64 mm long, made of different raw materials. They appeared independently or formed small assemblages located in mudflat sediments. Given the supposed lithological anomaly these large clasts contained in clay deposits such as those described in Olduvai, Hay himself (1976) even explored the possibility of them being manuports, although he proposed sheet floods and small streams as the most probable agents, which could have transported the clasts to the mudflat paleosols and even to the lake-margins. Since, according to Hay (1976), the pebbles and cobbles were scattered all over the facies of the lake-margin (and not only in the assemblages clustered in the archaeological sites), it would not be very realistic to consider that the hominids scattered clasts along the Olduvai basin, and it is more parsimonious to propose a natural deposition.

The complexity of the pedogenic processes in the Olduvai sequence has been verified in the latest studies, which show that the paleosol of the lake-margin of the Lower Bed II was affected by multiple pyroclastic episodes, mass movement, sheet flow and debris-fan processes (Ashley & Driese 2000: 1077), which could have left considerable volcanic material in low energy sedimentary contexts. In addition to all this evidence, the current archaeological project in Olduvai has made a series of trenches in the Lowermost Bed II (i.e. Blumenschine & Masao 1991; Blumenschine & Peters 1998), and the sedimentary analysis of those pits (Ashley & Hay 2002) once again provides significant data. The lithologic analyses (Ashley & Hay 2002: 115, tabl. 1) indicate that the fragments of volcanic rocks compose relevant percentages linked to short events, typical of a medium with a system involving ephemeral, shallow and multichannel flows, always in a lake-margin environment.

As stated above, the offsite analyses of the Olduvai geology indicate the regular presence of medium-sized volcanic clasts in lake-margin sedimentary contexts. However, this is not the only available evidence: Deocampo (2002) describes current formation processes of the wetland deposits in sedimentary basins similar to Olduvai, such as lake Eyasi, Ngorongoro and Natron. In these contemporary lake-margin wetlands, Deocampo (2002) observes coarse-grained deposits from the streams that drain the basin. These streams often erode and are wedged in the wetland substrate, transporting coarse sediments from the outcrops that are being eroded and thus are mixed with typical lake-margin sediments.

The analytical framework supplied by Deocampo's work (2002) led us to visit several of the lake-margins he describes as well as other nearby margins, in order to search for examples similar to the model that appears in Olduvai. All the visited lake basins presented positive results. For example, at lake Manyara we observed lake-margin wetland deposits characterised by clay sediments. However, it also presented angular cobbles in different sizes (50-200 mm). These cobbles sometimes appeared isolated and others in small patches (see fig. 9.4). It is interesting to point out that the examples of natural cobbles observed in Lake Manyara are located in lake-margin deposits that are very near the perennial lake (approximately 200-300 metres), and thus even closer than the FLK sites. Therefore, despite observing deposits that are even more typically lacustrine than the Olduvai deposits, at Manyara we registered a variety of volcanic cobbles which in another context would have been considered manuports, and are merely the result of complex natural lake-margin deposit formation processes.

These objects were also documented in Eyasi, where we located cobbles and pebbles over 100 mm in the mudflat on the lake's eastern margin (see fig. 9.5 a-b). In this case the source area for these materials - the escarpment - was further away than in Lake Manyara. At Ndutu (fig. 9.5 c-d), cobbles appear in the lake-margin deposits which were originally from a small nearby outcrop. At Lake Natron, we also found a variety of volcanic cobbles in the mudflat deposits of the lake, although given the area of the basin, they were from the fluvial processes described by Deocampo (2002) or entered the lake sediments directly via gravitational phenomena in the area where the shores of the lake practically reach the escarpment (fig. 9.6).

In short, all our observations at lake margins with such different sedimentary supplies as the Manyara, Natron, Eyasi and Ndutu provided identical results: either by sheet flows, interbedding, erosion, gravitation, reworking processes, bioturbation, etc, the sedimentary contexts of clays typical of lake-margin wetlands present an array of volcanic clasts of a variety of sizes, morphologies and origins. These occur both isolated and in small clusters, which in principle do not seem to correspond to the sedimentary dynamic where they are located, but which have nonetheless been deposited in these locations naturally, not anthropically.

These clasts are also located in the paleosols of the lacustrine mudflat with lake-margin origin in the Olduvai deposits. Given the supposed lithological anomaly these large clasts contained in clay deposits such as those described in Olduvai, Hay himself (1976) even explored the possibility of them being manuports, although he proposed sheet floods and small streams as the most probable agents, which could have transported the clasts to the mudflat paleosols and even to the lake-margins. Since, according to Hay (1976), the pebbles and cobbles were scattered all over the facies of the lake-margin (and not only in the assemblages clustered in the archaeological sites), it would not be very realistic to consider that the hominids scattered clasts along the Olduvai basin, and it is more parsimonious to propose a natural deposition. Thus, if we add the contemporary references presented in this section to the offsite evidence of Olduvai, we can evidently conceive the existence of natural processes that incorporate large cobbles to low energy sediments such as those typical of lake-margin deposits.

Throughout this work, we have aimed to deconstruct precisely the idea asserting that in Olduvai Bed I the genuine manu-

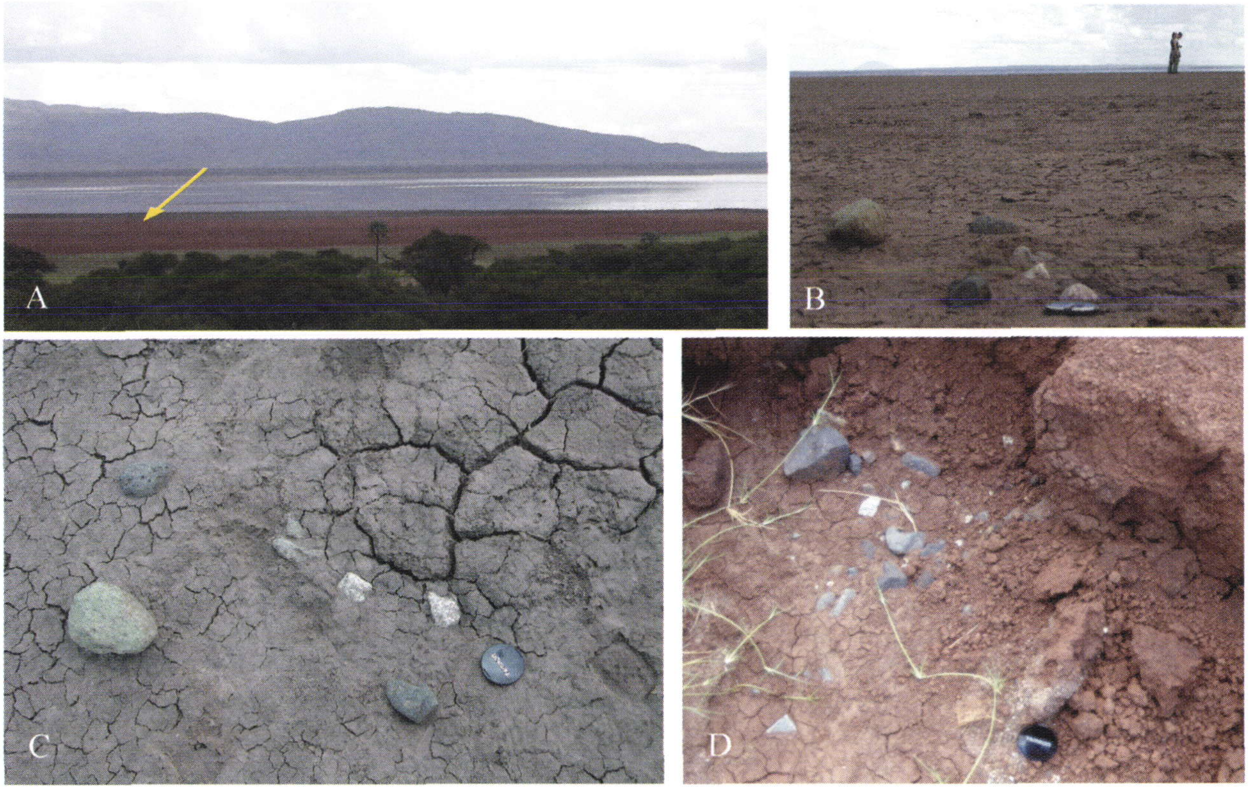

Figure 9.4. Contemporary examples of lava clasts in the lake-margin at Lake Manyara. A: landscape of the shore of Lake Manyara; area where clasts were documented is marked; B-C: examples of clasts in the mudflat surface; D: buried clasts in mudflat contexts of the lake-margin of Lake Manyara.

Figure 9.5. A: lake-margin of the east shoreline of Lake Eyasi; B: detail of the clasts located in the surface of the mudflat in Lake Eyasi. See presence of fish by clasts that indicates the recurrent lacustrine flooding of these deposits; C:. floodplain of the small Lake Ndutu; D:. detail of the clasts located on the shores of Lake Ndutu.

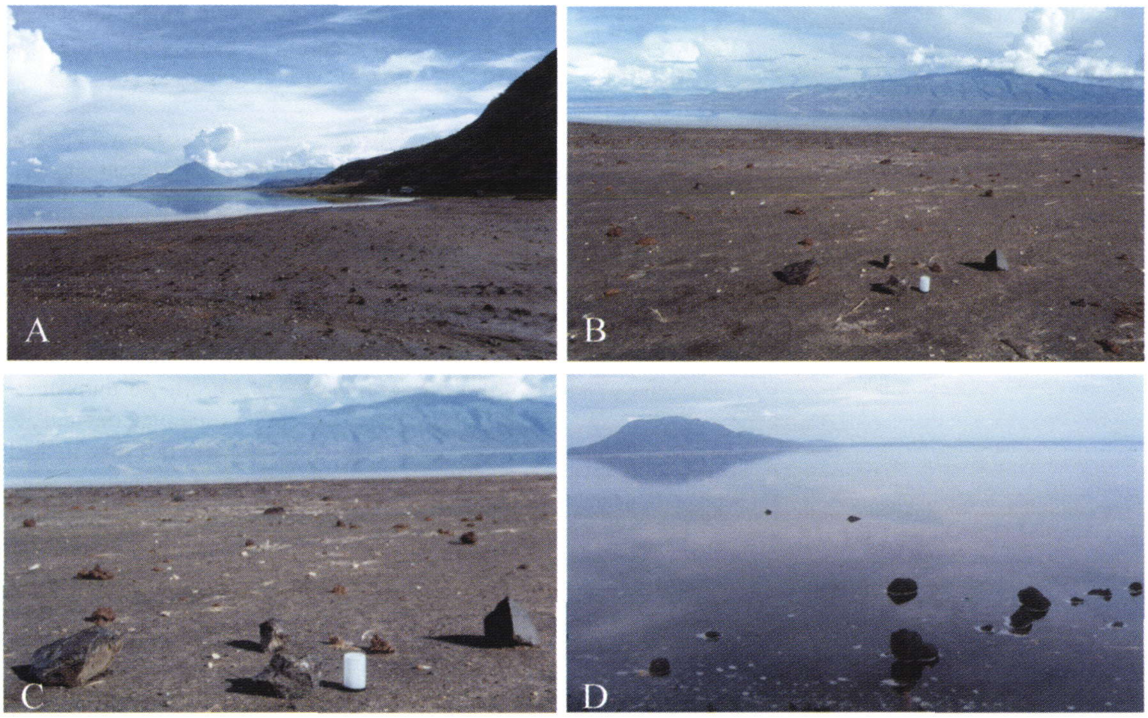

Figure 9.6. A: central-western shore of lake Natron beside the escarpment; B-C: details of the lava clasts in the lake's clay contexts beside the escarpment, probably deposited by gravitation processes; D: basalt clasts in the lake itself in the northwestern area of Lake Natron.

ports compose significant percentages. In order to do so, we started by comparing the items with traces of anthropical modification to those that do not present any traces of human alteration. In this sense, we consider we have provided sufficient arguments to defend the statement that a great part of the unmodified objects cannot be considered potential raw material reserves, as they do not present the same characteristics found among objects that have been subjected to anthropical alteration.

With the sedimentary conflict between large clasts and low energy contexts being the only argument used to justify the human transportation of these objects, the subsequent step was to find out if the pattern can appear in natural circumstances. Both the geological research on Olduvai (Hay 1976; Ashley & Hay 2002; Ashley & Driese 2000) and on other lake-margin environments (i.e. Talbot *et al.* 1994; Mack *et al.* 2002; etc) stress the complexity of mudflat formation processes and the possibility of finding detritic deposits in typical clay sediments. Contextual frameworks such as those presented by Deocampo (2002) also allowed us to verify the presence of large clasts. We personally visited several lakes in North Tanzania to find clasts that were present - isolated and in small patches - similar to the supposed manuports, but which had been deposited naturally in low energy contexts.

Consequently, the main argument to consider natural clasts as elements transported anthropically fades; large-sized rocks do appear in low energy contexts. This section calls for a brief revision of the previous section of this chapter, dedicated to the formation of the Olduvai sites. On the basis of these examples, we have presented a hypothesis regarding the formation of the sites at Olduvai, in which we put forward a natural explanation for many of the so-called manuports. Without doubting the more or less primary nature of the archaeological remains, at least as regards Type C sites, we also assume the dynamic features implicit in the formation processes of any archaeological site. That is to say, we believe in the existence of different agents (biotic and physical) involved in the formation of the sites, on the basis of the aggregation of natural and archaeological elements from successive events. Our proposal to interpret events that took place in FLK Zinj, DK, FLK North (all levels) can be summarised perfectly in the scenarios described by Foley (1981:172, fig. 12) for a more general sphere: the successive filling and erosion processes created cumulative palimpsests giving a multi-causality of events. From this dynamic perspective, and considering the existence of large clasts in the lake-margin landscape, it is not hard to image these items being easily transported to the area where the archaeological remains were located, and then misinterpreted as manuports.

The implications of this hypothesis are extremely important in terms of the archaeological interpretation of the sites (tabl. 9.6 and fig. 9.7): in DK, where – given the proximity of the lava substratum – Leakey (1971) did not accept the existence of manuports, approximately 50% of the pieces this author considered archaeological have been classified in our inventory as unmodified material. If this were the case, and since in DK lavas without traces of employment have been deposited naturally, this would imply a reduction that would halve the genuine archaeological collection from this site. As regards

Site (all levels)	Knapped and/or utilised material %	Unmodified material %	Total kg (approx.)
DK	50.8	49.2	103
FLK ZINJ	58.6	41.4	74
FLK NORTH	64.3	35.7	311
EF-HR	100	0	47
FC WEST	89.4	10.6	100
TK	87.9	12.1	231

Table 9.6. Total number of kilograms studied in each site, with the percentage of kilograms of unmodified raw material compared to the knapped and/or used material. Specific data for each level and the distribution per raw materials can be obtained in the chapters dedicated to each site.

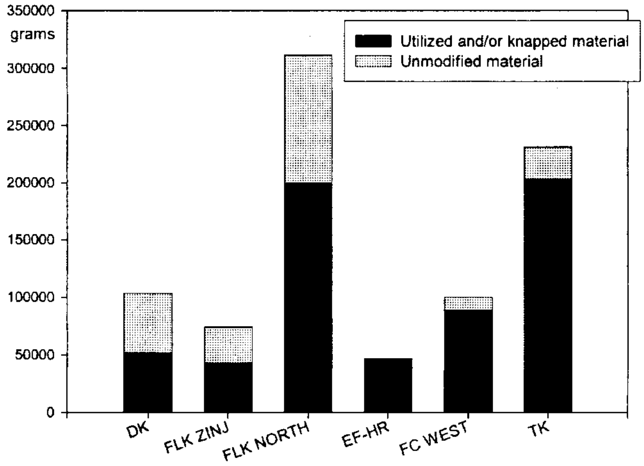

Figure 9.7. Total weight of worked raw material and unmodified pieces at the Olduvai sites.

FLK Zinj, the corresponding chapter was dedicated comprehensively to the possibility that the unmodified lavas were produced by *in situ* weathering of the underlying substratum, and that they were incorporated to the site via postdepositional processes, not human activities. Since unmodified quartz blocks are practically nonexistent in FLK Zinj, and lavas devoid of human traces probably have a natural origin, over 30 kilograms of raw material would be removed directly from the genuine archaeological sample, thus reducing it to almost half its size.

In FLK North, discarding the unmodified material would imply eliminating approximately 35.7% of the collection, slightly less than in previous sites. Nonetheless, 35% of the unmodified material composes 111 kilograms of stones (including all raw materials), which entails an enormous amount of pieces eliminated from the analysis. The contextual framework in which such an important volume of raw material could have been incorporated naturally to the site was analysed in chapter 4. It is important to bear in mind that this stratigraphical sequence measures over 7 metres and spreads out over at least two hundred square metres, and that Leakey (1971) herself spoke of the systematic dispersion of artefacts via vertical migration. Therefore, it would not be surprising that they ended up appearing in the same levels as materials with different depositional histories. This is precisely what we think occurred in FLK North, at least as regards the 101 kilograms of unmodified lavas.

Table 9.6 demonstrates that the sites from the second half of Bed II (EF-HR, FC West and TK) present much lower frequencies of unmodified material than those in Bed I. Does this prove behavioural differences between the hominids of both periods? We think not; Leakey (1971) stated expressly that in FC West, most of the unmodified material must have come from the natural deposit of a nearby stream. Furthermore, this reason probably led the author to not collect unknapped pieces in EF-HR. In all, we think that in Bed I Leakey collected all the unmodified material and attributed it to human accumulation by the mere fact that, in the low energy sediments where the sites were located, no natural origin could be conceived to explain the large clasts. In the middle and upper part of Bed II, where sites are usually connected to streams, it was easier to attribute the existence of unmodified lithic material in the assemblages to natural causes and, therefore, the percentages of so-called manuports were lower.

The processes whereby African archaeological sites were formed have been studied extensively, both considering general aspects (for example Foley 1981; Gifford & Behrensmenyer 1977; Gifford-González *et al.* 1999; Schick 1984; Stern 1993, 1994; Kroll 1994; etc), and more specific issues in Olduvai (Kroll & Isaac 1984; Potts 1988; Petraglia & Potts 1994), always insisting on the multiplicity of events involved in the site formation processes.

Yet the matter of the so-called Olduvai manuports is still pending, and there is recent research (i.e. Potts *et al.* 1999; Cannell 2002) that continues to use these objects to propose behavioural models. Throughout this book, we have attempted to show that many of the so-called manuports are actually natural occurrences unrelated to hominid activities. We are obviously not trying to deny the concept of "unmodified object transported anthropically", and, in fact, some of them probably were accumulated intentionally, i.e. they are genuine manuports.

Both TK levels, where there are large unrounded quartz blocks without traces of use, but with characteristics identical to those of employed/knapped material, can be used as examples. Other unmodified chert pieces in FLK North Sandy Conglomerate, or unmodified quartz pieces in other levels of FLK North, quartz and gneiss pieces in FC West, etc., could have been transported by the hominids who did not use them subsequently. This is, in fact, the most logical interpretation. Nonetheless, and mainly considering them alongside lavas, which were scattered around the whole basin via the great number of streams flowing towards the lake, we think that a lot of the so-called manuports used to present the different behavioural hypotheses responded to a natural deposition. We believe it is necessary to recognise that there are a number of non-human processes that can create assemblages which may resemble those attributed to human activities (i.e.

Behrensmeyer 1983). This could have occurred at Olduvai Bed I, and we may be granting cultural significance to issues that could be explained via natural causes and that, in all, the supposed accumulations of hominid raw material reserves are merely natural ecofacts. By analysing the distribution of the lithic raw materials on the Olduvai landscape, we can understand if that artificial accumulation of stones was really necessary. The next section will deal with this issue.

Raw materials at Olduvai

The whole sedimentary basin in Olduvai is positioned on a metamorphic substratum with a profusion of quartz and gneiss-schist formations, that crop out like inselbergs and kopjes. These outcrops were already exposed in the period when Olduvai Beds I and II were formed, and are, alongside the volcanoes in the Crater Highlands, the source areas from which the whole of the detrital sedimentation has been transported, since these rocks reached the lake via the streams.

Hay's (1976) study of the Olduvai geology established the reference framework to position the source area for each of the raw materials found at the sites. Since then, several analyses have appeared assessing the influence of the availability of the raw materials in the technological strategies (Kyara 1999; Stiles 1991, 1998; Féblot-Augustins 1997; Blumenschine & Peters 1998).

In his direct revision of the raw materials used at the sites in Bed II, Kyara (1999:116) distinguished nine different rocks (quartz, quartzite, purple quartzite, gneiss, green phonolite, porphyritic phonolite, basalt, trachyandesite and chert), although considering how difficult it was to differentiate varieties, he ended up grouping them in three categories, quartzites (all the metamorphic rocks, quartz, quartzite, purple quartzite, and gneiss), volcanic rocks (phonolites, basalts, and trachyandesites) and chert. In previous chapters, we have also synthesised the groups of raw material in order to facilitate comparisons between the three main families of rocks, yet it is now interesting to discriminate which are the original outcrops of each one.

The Naibor Soit inselberg is located near the confluence between the Main Gorge and the Lateral Gorge, about 2-3 kilometres away (fig. 9.8). It is a metamorphic kopje comprising thick-grained tabular quartzites, with different qualities that Kyara (1999) attributes to each of the hills (Main Hill, Southern Outlier, Manyata Hill, etc). In Naibor Soit, quartzite is available in different blanks; the largest are the gigantic blocks found *in situ*, although there are also large blocks detached from the outcrops and diffused along the hillsides. The most abundant morphology are the small tabular blocks disseminated around the proximities of the inselberg.

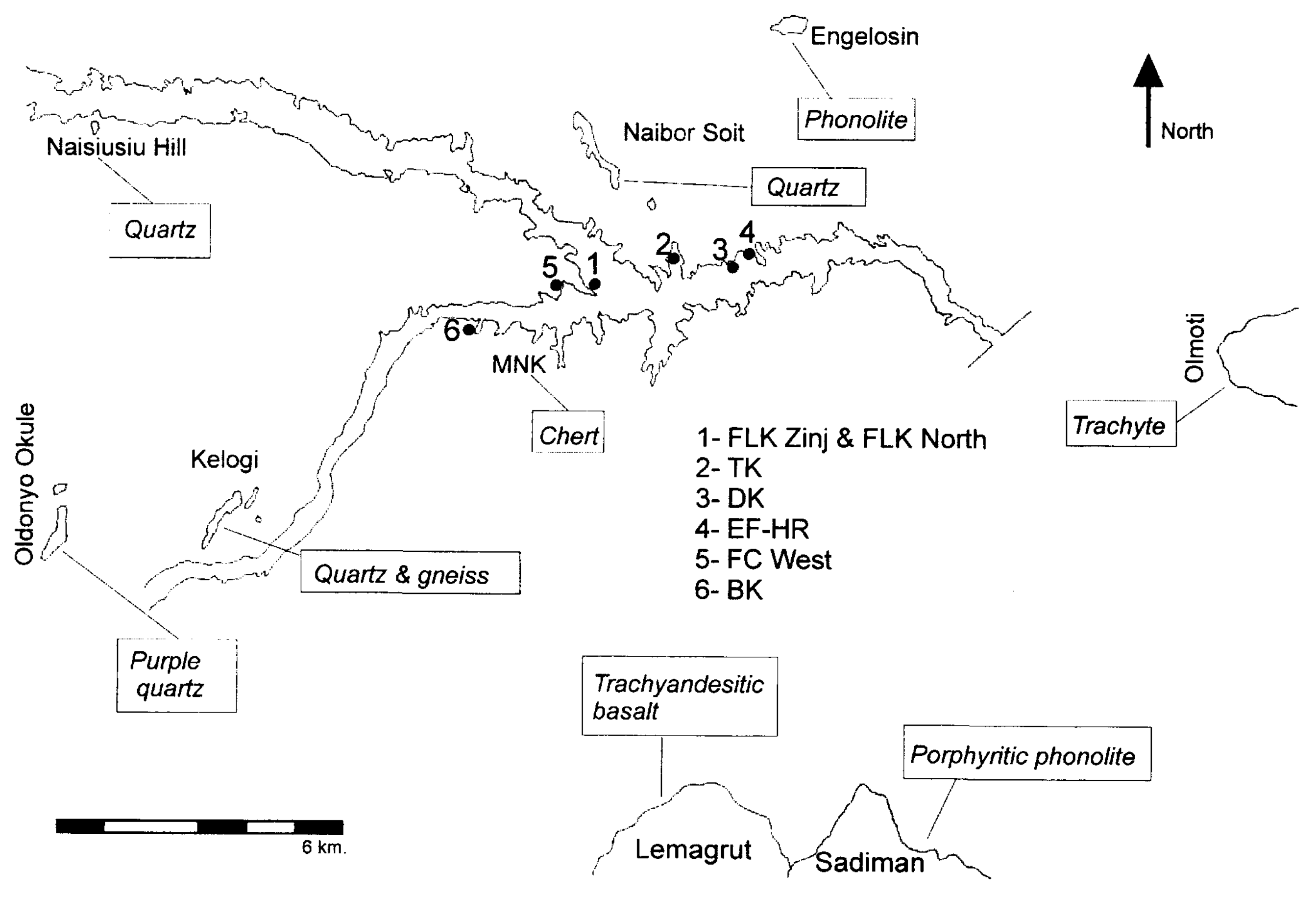

Figure 9.8. Raw materials sources at Olduvai - from Leakey (1971) and Kyara (1999)-.

Kyara (1999) also mentions the Shifting Sand outcrop, 4 kilometres to the northwest of Naibor Soit, presenting blocks of medium and fine-grained gneiss and quartzite. Engelosin is a volcanic inselberg, located over 10 kilometres from the central area of the gorge, presenting large-size phonolite cobbles according to Kyara (1999). Nevertheless, Hay (1976) insisted on the tabular nature of these phonolites, underscoring their exceptional quality for knapping given their fine grain and their high density and compaction. The Olmoti crater should also be considered when analysing areas used for lava provisioning, located 9 kilometres east of the convergence of the two gorges, in which there are large blocks of olivines and trachyandesites (Kyara 1999), which were the main source for the lavas that compose Bed I's substratum.

The Kelogi inselberg, slightly over 9 kilometres from the convergence of the two gorges, presents outcrops of gneiss and granite, with enormous fragments detached by weathering but with different qualities for knapping. In Oldoinyo Okule, a small quartzite hill 4 kilometres west of Kelogi, there are large tabular blocks of high-quality purple quartzite. Naisiusiu, about 11 kilometres northwest of the convergence of the gorges, is a metamorphic outcrop with quartzite and gneiss that may have been used for provisioning for the sites on the Lateral Gorge (Kyara 1999; Blumenschine & Peters 1998).

Beyond the metamorphic and volcanic outcrops that surround the immediate environment of the Olduvai basin to one side, one must consider remoter areas, such as the volcanoes Lemagrut, Sadiman and the Ngorongoro Complex. The contribution of rocks to the basin from these formations was performed via seasonal rivers whose source appeared in the Crater Highlands and flowed into the Olduvai lake. Kyara (1999) indicates three main streams that appeared during the formation of Bed II, in which there were blocks and cobbles of phonolites, basalts and trachytes measuring over 70 centimetres long, that could have been used as blanks to obtain large cutting tools. There were other streams both during the Bed I and the Bed II periods, which must also have been used as raw material sources. The availability was essentially limited to the eastern part of the lake, where the streams from Crater Highlands were located.

Chert was available in the time span between Tuff IF and Tuff IIB. Chert had formed in the inner area of the saline lake during the deposition of Bed I and II (Hay 1976), and according to Kyara (1999) there would be two main outcrops after the lacustrine regression; the most important being the one in MNK, on the Lateral Gorge, only 1.5 kilometres away from the convergence with the Main Gorge. Furthermore, chert was also available in the intersection between the Fifth Fault and the Main Gorge.

Hay (1976) concluded that practically all the artefacts from both Bed I and Bed II, came from a catchment area with a radius no larger than 4 kilometres, and that most were from an area with a radius no larger than 2 kilometres. Hay (1976) noted a preference for the use of lavas from the Sadiman volcano when manufacturing of heavy duty tools, which could be obtained from the streams that flowed into the lake from the Crater Highlands, in a radius also under 2 kilometres from all the sites. The lavas from Sadiman, especially phonolites-nephelinites, were used quite commonly in the Oldowan, although their use dropped gradually in the so-called Developed Oldowan A and B. Since those lavas would be equally available, Hay (1976) considered hominids had intentionally chosen not to continue using them. The opposite occurred with the Engelosin phonolites, which do not appear in any of the sites in Bed I, and are documented for the first time in the sites at the base of Bed II, and become progressively more abundant, especially in the sites above Tuff IIA, until achieving their maximum rate in Beds III and IV. Given that this phonolite is only available in tabular blocks *in situ*, the gradual increase of this raw material would also imply the increase of the radius of the procurement areas (Hay 1976).

According to Hay (1976), practically all the quartz/quartzite comes from Naibor Soit, with all sites in a radius under 5 kilometres from this outcrop. Nevertheless, some quartzite artefacts found in the lower part of Bed II were from Kelogi. Hay (1976) emphasises the progressive increase of quartz in the sites, becoming the main raw material in the Acheulean in Bed II and subsequently also in Beds III and IV. Kyara (1999) insists on this matter, stating that in the assemblages of the Lower Member of Bed II, metamorphic rocks compose 35% of the total amount of raw materials, to increase to 60% in the lower part of the Middle Member, and to 82% in the upper part of the same Middle Member, with the Upper Member of Bed II comprising 95% of the number of lithic items.

This contrasts with the reverse trend observed as regards basalts, that compose 25% in the base of Bed II, only 10% in the lower part of the Middle Member, 5% in the upper part of the same Middle Member and just 3% of the total number of artefacts in the top of Bed II (Kyara 1999). With reference to phonolites and trachytes, the trend is identical and, despite Hay's (1976) previous statements regarding the increase of the Engelosin phonolites, Kyara (1999) affirms that the shortage in the lower part of Bed II becomes an absolute absence at the top of this sequence.

As regards less representative raw materials, Hay (1976) noted the presence of gneiss in DK, FLK Zinj, TK, etc., from Kelogi. Chert is also noteworthy. This raw material always appears in white, opaque irregular-size nodules. During the formation of Bed I, chert was located under the sites, and was, therefore, not available. According to Hay (1976) this local chert could only have been employed in specific stages of Bed II (in the time span between Tuff IF and Tuff IIB), and also during the Ndutu and Naisiusiu Beds. Hay (1976) asserts that isolated pieces of chert have been documented in many other sites, from DK or FLK Zinj to FC West, EF-HR or SHK, where there is no recognised source and the scarce number of items leads us to think they could be redeposited fragments.

In all, throughout the sequence, raw materials were always obtained in the Olduvai basin (Hay 1976). According to this author, the material was collected in the area near the sites, although he does state that as from Bed I some artefacts from as far as 8 kilometres away have been documented, and observes that the amount of raw materials from distant resources increased throughout Bed II. In his study of Bed II, Kyara (1999) observed an initial balance between volcanic and metamorphic rocks in the basal part of this formation, which – with the development of the sequence – becomes a complete profusion of quartzes/quartzites. According to Kyara (1999:392), this trend is linked to the hominids' increased mobility, given that in the basal part of Bed II the profusion of lavas suggests a basically local collection area (these rocks are from the great many streams that watered the basin), whilst in the middle part of Bed II the amount of exotic quartzes/quartzites exceed basalts in a 11 to 1 ratio, and therefore indicate a greater level of mobility.

We will now move on to perform a more detailed approximation than the diachronic analysis presented by Hay (1976) and Kyara (1996), focusing specifically on each of the analysed sites. We can momentarily abandon the general classification we proposed for raw materials in three main groups (lavas, quartzes and chert), and discriminate each of the subgroups with a view to locating the corresponding outcrops. In our opinion, any interpretation regarding the management of the raw materials should consider the weight of the objects as the essential variable. Table 9.7 and figure 9.9 present the distribution of raw materials in each site, thus allowing a synthesis of the descriptions illustrated in the corresponding chapters.

As aforementioned, in DK there was a profusion of lavas: table 9.7 shows basalts, followed by phonolites, are the main volcanic rocks in the assemblage. On the other hand, quartzes are very scarce. Sometimes, this shortage of metamorphic rocks has been linked to the fact that Naibor Soit is further away from this site when compared to others such as FLK Zinj. Yet, no more than 2-3 kilometres separated DK from this inselberg, a distance that was in fact hardly greater than the distance that separates it from FLK Zinj (see fig. 9.8). As Potts (1988) stated, hominids may have had to cross several different ecological habitats to reach Naibor Soit. The hominids from FLK Zinj had to embark on a similar journey, and despite this fact the latter site presents much greater quartz proportions. In DK it seems that hominids, simply, preferred to exploit raw materials in the immediate environment. Chapter 2 referred to the fact that DK was near a stream, in which hominids found the 5-10 centimetre basalt and phonolite cobbles they used as cores.

The collection pattern in FLK Zinj is slightly different. Although there is also a profusion of lavas in the total volume of worked raw material, in quantitative terms most are quartzes. The over 17 kilograms of quartz from FLK Zinj were subjected to an intensive use that was a lot greater than that applied to lavas, perhaps given the further distance hominids had to travel to obtain the tabular blocks. It is important to mention the small size of the quartz blocks in FLK Zinj since, if they were transported from Naibor Soit as were large blanks used in the Acheulean periods (Hay 1976), we could consider that in one same location in the landscape, Naibor Soit, human groups separated chronologically, culturally and biologically, were performing a differential selection of the morphologies and sizes of the blocks they would transport.

Going back to FLK Zinj, Kyara (1999) calculates that the 2 kilometre distance that separated it from the Naibor Soit inselberg could have been covered in about 40 minutes. Therefore, although hominids had to cross several ecologic niches to reach the quartz outcrops, the journey was not that long. The phonolites and basalts were probably found in a nearby stream, which allowed hominids to always have enough raw material in the surrounding areas and did not have to make long journeys to collect supplies. The anecdotal presence of gneiss, as in DK, should not be used to indicate

	Quartz	Basalt	Phonolite	Trachyte*	Gneiss	Chert**
DK	2803	42044	7859	0	8	-
FLK Zinj	17193	24317	2020	0	19	-
FLK North 6-Deino.	45268	73050	25092	4551	10	-
FLK North Sandy C.	25628	12310	7959	0	0	1597
EF-HR	11508	32432	2111	337	0	-
FC West	48431	33835	5535	411	1461	-
TK Lower Floor	52906	8056	12	411	640	-
TK Upper Floor	114267	24409	3038	171	482	-

Table 9.7. Number of grams invested in the knapped and/or used material in each raw material in the sites studied. (*) It was sometimes hard to distinguish trachyte from basalts (in fact there is a trachyandesite basalt from the volcano Lemagrut), therefore some of the artefacts considered herein as basalt could possibly be trachyte. (**) Hay (1976) also mentions the presence of chert in DK, FLK Zinj and in EF-HR. Nonetheless, these are isolated pieces and the few that have been studied herein are rounded and seem to come from a different context than the rest of the assemblage.

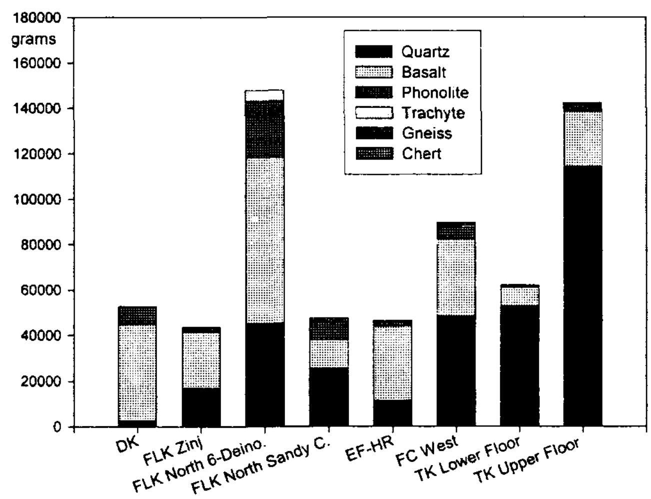

Figure 9.9. Number of grams transported of each raw material to the global total for each site. Only the worked material is considered.

trips to Kelogi, over 9 kilometres away. Both Hay (1976) and Kyara (1999) recognised the low quality of this raw material for knapping, and in fact the pieces we have analysed could be natural. In our opinion, as occurs with chert, these gneiss pieces could have a different depositional history. According to our calculations, for sites in Bed I, these pieces should not be used to prove the hominids introduced raw materials from faraway sources, even accidentally.

We have noted that DK's topographic location is not a sound enough argument to explain the differences in the use of raw materials compared to FLK Zinj. FLK North can be very enlightening in this sense. Located slightly over 200 metres from FLK Zinj (thus in an almost identical paleo-geographic position), materials have been employed according to a different pattern. Given the low significance of the Levels 6-3 and *Deinotherium*, we can integrate them alongside Level 1-2 in order to perform a general comparison. Table 9.7 shows that the number of kilograms of quartz, proportion-wise, is lower in FLK North (30.5%) than in FLK Zinj (39.4%). Yet, the source from where these metamorphic rocks were collected is the same (Naibor Soit), and the destination of the quartzes is practically identical (FLK complex). Consequently, it seems that the hominids that occupied FLK North shortly after those from FLK Zinj focused more on exploiting other raw materials. Both Leakey (1971) and Hay (1976) had insisted on the relevance of phonolites as regards heavy duty tools in FLK North, which we have also verified in our study, after counting up to 25 kilograms of this raw material in Levels 6-*Deinotherium*. These phonolites are very high quality, presenting a quality for knapping superior to that of the lavas used in DK and FLK Zinj. This could perhaps be explained given the proximity of a new stream that did not exist in FLK Zinj times, containing phonolite cobbles from the Crater Highlands or the Engelosin. In any case, this suggests that the hominids knew how to maximise the resources surrounding the settlement they occupied, and how to collect other materials like quartz that came from distant sources.

That temporary exploitation of the immediate environment is evident in North Sandy Conglomerate: as aforementioned, chert was only available at specific moments of the Olduvai sequence. We know it was available during the occupation of FLK North SC, when there were literally thousands of nodules barely one kilometre away from the settlement, in MNK (fig. 9.8). It has been said that there was a genuine chert factory (Stiles *et al.* 1974; Stiles 1991 1998) in the latter, and the hominids that occupied FLK North SC probably accessed MNK to collect small nodules. Obviously, as in previous levels, these hominids also transported basalts and phonolites, most certainly from some nearby stream. Furthermore, this site shows a predominance of quartz pieces (53.9% of the total weight of the worked raw materials), most of which were from Naibor Soit. In any case, the novel presence of chert does not extend the territory used to collect raw materials, which would still be nearby (approximately one kilometre), at least as regards lavas and this chert, and local (about 2 kilometres) for quartz.

The scarce presence of quartz in EF-HR (24.8% of the total weight of the worked raw material) has been explained taking into consideration its proximity to DK (where there are not many metamorphic rocks) and its remoteness from Naibor Soit. As aforementioned when referring to DK, it is a 2-3 kilometre distance and, albeit from a location further east than FLK Zinj or FLK North (which travelled from the south), it would take the EF-HR hominids a similar amount of time to reach the location. Once again, we do not consider the topographic position to explain the shortage of quartzes in EF-HR. In sites in Bed IV like PDK or WK, in the same area of the Gorge, albeit even further away from Naibor Soit than EF-HR, there are assemblages that present an absolute profusion of quartzite (Leakey & Roe 1994:101 and the following), which was collected from that inselberg (Jones 1994). Therefore, the shortage of quartzes in EF-HR must be interpreted as a cultural election, not as a characteristic predetermined by the environment.

We must not blunder when referring to the coincidence between DK and EF-HR as regards the profusion of lavas. It is extremely important to underscore the fact that, although basalts are the most abundant raw materials in both, they are not at all alike. Whilst in DK they are small pebbles, that vary in their quality, EF-HR presents enormous flakes from even larger cores, and – furthermore – present excellent knapping qualities. This implies the fact that the EF-HR hominids, although they occupied a geo-morphological environment similar to DK (at least as regards the configuration of the streams that flowed from the eastern Crater Highlands, although we know that the paleo-ecological environment had changed), selected completely different raw materials. In EF-HR it was not simply a case of collecting lava cobbles from nearby streams; what mattered was finding those that had the quality and size to allow the obtaining of enormous blanks that could be used to produce large cutting tools. Thanks to Kyara (1999) we know that blocks over 70 centimetres long were available in some of the streams in the inner area of the basin. Therefore, it was a case of selecting the most suitable items.

Neither do we consider FC West's paleo-geographic position a factor that would condition the supply of raw materials. Quartzes predominate in this area, despite its being further away from Naibor Soit than FLK Zinj or FLK North. A great many quartzite stream cobbles start to appear in FC West, thus implying that it was no longer necessary to travel directly to the outcrops in the inselbergs to obtain part of those metamorphic rocks, since those cobbles were available in gravel bars. The hominids from FC West focused specially on the management of stream cobbles both of quartz and basalt (37.7% of the total weight) and phonolite (6.1%). Furthermore, one kilogram and a half of worked gneiss was also unearthed, alongside other blocks in this raw material without traces of human modification. Since they are not stream blanks and given that, albeit very scarce, the pieces were unquestionably used, when referring to gneiss we could speak of a transportation of remote raw materials which, if transported from Kelogi, would involve a journey over at least 8 kilometres.

In both levels of TK, the exploitation of raw material focuses mainly on quartzes. Of all the aforementioned areas (fig. 9.8) this site is the closest to Naibor Soit, and this inselberg could well have been the main provisioning point. Both levels present some pieces in worked gneiss, which would once again lead to the assumption that materials were transported from Kelogi, over 9 kilometres south of TK. In this case, we must stress an aforementioned idea: TK presents quartz retouched pieces, anvils and unmodified blocks heavier than two kilograms, measuring 15-20 centimetres. This means that they were transporting enormous quartz tabular fragments to TK, most certainly from the same place that the FLK Zinj hominids obtained the small fragments they subsequently transformed into cores.

There are two main implications in this observation. The first is that the hominids that visited Naibor Soit and then moved to TK selected tabular blocks that were a lot larger than those selected by groups who transported quartzes to FLK Zinj hundreds of thousands of years before. Secondly, the FLK Zinj hominids submitted these small blocks to intense reduction processes until exhausting them and generating thousands of waste fragments. The TK craftsmen also produced thousands of chips and fragments, yet a fundamental difference appears: those humans were prepared to leave large blocks unemployed (genuine manuports), or to use them as simple blanks on which to batter other objects (anvils). That is to say, in TK raw material was used extensively, a fact that contrasts with the intensity of the reduction in areas such as FLK Zinj, for example.

Although Blumenschine and Peters (1998) speculated on possible journeys to the sides of the mountains to collect materials, we consider hominids did not travel to Sadiman, Lemagrut or Ngorongoro for volcanic rocks, but turned to the streams that flowed into the Olduvai basin from those Crater Highlands. The problem is, as Potts (1988) said, that we are unaware of the exact distance that separated the excavated sites and the streams that were used as raw material sources. In any case, we support Jones' (1994) idea, stating that these streams would always have been located in the immediate area surrounding each site.

A different problem appears in terms of the metamorphic rocks, especially quartzes. Most of the analyses that refer to raw material sources for quartzes usually only mention Naibor Soit as the sole supply point. Yet, Blumenschine and Peters (1998) underscore the fact that in the stages of the lacustrine transgression in Bed I and the lower part of Bed II, this inselberg would have been surrounded by the lake and, therefore, hominids would not have been able to access it. Furthermore, the examinations have shown that quartzite was available in other areas such as Naisiusiu or Oldonyo Okule. In this sense, it would be interesting to perform petrographic analysis so as to compare the archaeological material to the matter that appears in other outcrops. We should also consider whether all the quartzite / quartz came directly from the inselbergs. Assemblages like FC West present a great number of quartzes from stream contexts. This has important connotations, since it would be one thing that the hominids had to travel to an inselberg like Naibor Soit from FC West, and another that they simply needed to journey to a nearby stream to obtain the quartzes they required.

This issue is not usually considered when analysing assemblages, and can distort the explanations on the hominids' mobility. We must be cautious when interpreting quartz management, not only as regards this mobility, but also in terms of the intensity of the reduction. Figure 9.10 is a good example; there are quartz anvils weighing over 10 kilograms in MNK, other levels of TK and FC West, and in SHK there is a quartz cobble, which was used as an anvil, that weighs over 20 kilograms. In such cases, when considering the inferences as regards the energetic cost or the intensity of the reduction, it may be extremely relevant to state that these pieces did not come directly from Naibor Soit, but from a nearby stream.

In any case, the hominids had a vast range of possibilities when selecting raw materials. As Potts (1988) noted, the lithic resources were located in well-known areas that were obviously immobile, thus their collection is a predictable factor. We can conclude this section as it began, attempting to observe general diachronic patterns in the use of raw materials. Figure 9.11 shows the trends as regards the most important materials. There is always a dichotomy between basalts and quartzes, whilst the percentages of phonolites are more or

Figure 9.10. Quartz anvils on enormous stream cobbles in MNK and SHK. The item on the left weighs over 20 kilograms, which illustrates the energy required to transport it if the raw materials source were at a considerable distance from the site.

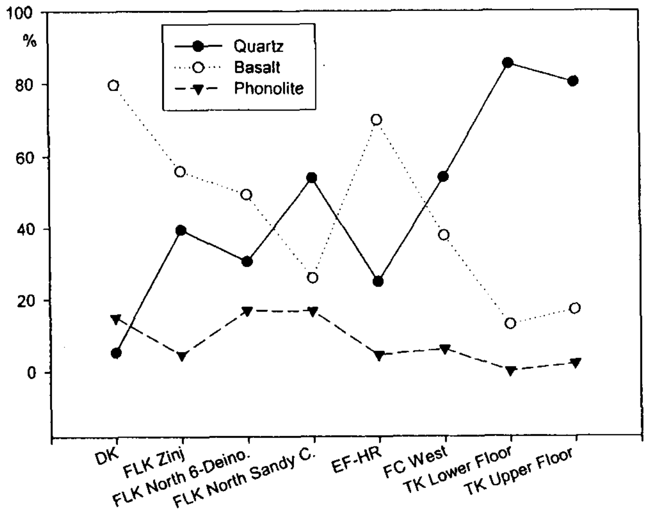

Figure 9.11. Weight percentages of the main raw materials in the analysed sites.

less stable. Basalts prevail in the oldest assemblages, and quartz becomes more important with the development of the sequence, with the exception of EF-HR. This trend has been described on many occasions (Leakey 1971; Hay 1976; Jones 1994; Kyara 1999, etc), and – in this diachronic sense – our contribution lies in insisting on the importance of considering the weight of the objects, a factor that truly demonstrates the relevance of each material.

Consequently, we will avoid errors such as those committed by Kimura (2002) who, when working with the number of items and not the weight of the raw materials, affirmed that quartz was the predominant raw material in FLK Zinj. In fact, she concludes that in all the sites she analyses there is always a profusion of the raw material from the closest source (Kimura 2002). Yet, our analysis does not suggest that the differences in terms of the frequencies of raw materials can be explained using geographic factors. The new works performed in Olduvai are a good basis in this sense, since they have not documented a significant connection between, for example, the distance from Naibor Soit and the frequency of quartz artefacts in the different excavations (Blumenschine & Masao 1991). Therefore, in our opinion, the differences as regards the management of raw materials should be linked to issues based on cultural or strategic elections, not on paleotopographical factors.

It is essential to insist more on qualitative differences than on quantitative disparities; in DK, FLK Zinj and FLK North (all levels), we see that hominids were obtaining immediate raw materials (lavas) and local raw materials (quartzes), as small cobbles and blocks. Although an increased quality of the raw materials is noticeable in FLK North, in Bed I it does not seem like an important criterion contemplated when selecting rocks. Only FLK North Sandy Conglomerate, with a very intense exploitation of chert (in knapping activities) and quartzes (through the reduction into spheroids completely modified by percussion), seems to present a qualitative shift in the management of raw materials.

This shift is identified perfectly in EF-HR; from then on, it is a case of achieving large high quality blanks. The EF-HR hominids that travelled to streams similar to DK no longer selected small lava blocks without focusing on the qualities, but pursued large fine grain boulders, and the craftsmen from TK who travelled to Naibor Soit no longer collected small irregular quality quartz fragments as transported by knappers in FLK Zinj, but selected large quartz blocks without irregularities that could be turned into large cutting tools, anvils, etc.

Quite often, the systematic transportation of raw materials was not strictly linked to knapping processes, but to alternative subsistence activities. In the scale of inferences we are outlining in this chapter, and after questioning why and how hominids obtained the rocks they used in the sites, it is now time to consider which activities they performed, apart from knapping.

Percussion activities at Olduvai

Leakey's (1971) classification for African percussion tools includes them in the utilised material category. As regards percussion activities, utilised materials encompassed anvils, hammerstones and cobblestones, nodules and blocks. The latter were characterised in that they did not show artificial shaping but did present some evidence of utilisation, such as chipping, blunting of the edges, smashing and battering. According to Leakey, classic hammerstones were water-worn cobblestones with pitting, bruising and shattering. Leakey divided anvils into those from the Oldowan sites - which she considered right-angled natural cuboid blocks with battered sides including plunging scars -, and the anvils from the Developed Oldowan - where pieces were shaped before they were used -. Alongside the employment of the edges, Leakey described some cones of percussion and bruising on the upper and lower faces of the anvils.

Subsequent classification systems followed Leakey (1971), although they introduced some variations. Isaac *et al.* (1997) included the types Leakey had already considered (anvils, hammerstones, modified battered cobbles) in the pounded pieces category, and added the spheroids and subspheroids, according to Leakey (1971) pieces that were subjected to intentional shaping but which - from Isaac and his collaborators' perspective - were simple hammerstones. This same option has been maintained by Clark & Kleindienst (2001), including spheroids and subspheroids in the pounded group but not knapped material, therefore modifying their own previous classifications on their role as heavy-duty tools (see Clark & Kleindienst 1974).

At Melka Kunturé percussion materials comprise a high percentage in the Oldowan and Early Acheulean assemblages, classified by Chavaillon (1979) into two main groups. The former was composed by battered cobbles and hammerstones and the latter by fractured cobbles. In an attempt to find a technological sense for the analysed materials, Chavaillon (1979) subdivided the hammerstones and battered cobbles group into active hammerstones (which generally had a regular, oval or rounded shape) and passive hammerstones. The passive or fixed hammerstones could be of two different types; on the one hand, small, hand-held hammerstones, and on the other anvils - strictly speaking -, which were large and weighed several kilograms, with a stable base and heavy battering on upper sides and mainly on the ridges.

As can be observed, and despite some differences in the classification systems, all these typologies coincide in distinguishing two main groups in the percussion material, active hammers (classic hammerstones) and passive hammerstones (anvils), regardless of the subtypes and variants each author may include when analysing the collections. Although in Koobi Fora anvils or spheroids are absent or appear incidentally (Isaac *et al.* 1997), both in the Olduvai sequence (Leakey 1971; Leakey & Roe 1994) and at Melka Kunturé (Chavaillon 1979; Chavaillon & Chavaillon 1976, 1981) these percussion objects were extremely profuse, and have been used as chrono-cultural markers to distinguish the Oldowan from the Developed Oldowan (i.e. Leakey 1971, 1975).

The present analysis of Olduvai assemblages has revealed an even greater frequency of percussion items than the amount established by Leakey (1971). Hence, it is of vital importance to further our knowledge on these percussion materials and, most importantly, on the technical processes used to generate them. The study we have carried out manifests not only the great amount but also the enormous variety of lithic elements linked to percussion in Olduvai. In fact, the morphology of many of the pieces indicates that these percussion materials were not always linked to knapping activities, but to other working processes.

Before verifying through systematic use-wear analysis, it is risky to speculate which type of functional activities generated the materials preserved at the sites. Nonetheless, we consider that - on the basis of an analytical approach - it will at least be possible to discriminate the importance of the battered items in the assemblages, and if they can be included in the knapping processes, or if other technical alternatives should be sought. Given these parameters, and the differentiation between active percussion elements - hard pieces that transmit a force intended to modify another item (fig. 9.12a) - and passive percussion elements - hard pieces that receive the force transmitted by another item, either to modify the transmitter object (fig. 9.12b) or another intermediate piece between the transmitter and the receptor (fig. 9.12c) -, we summarize the results obtained in our study of the Olduvai Bed I & II assemblages.

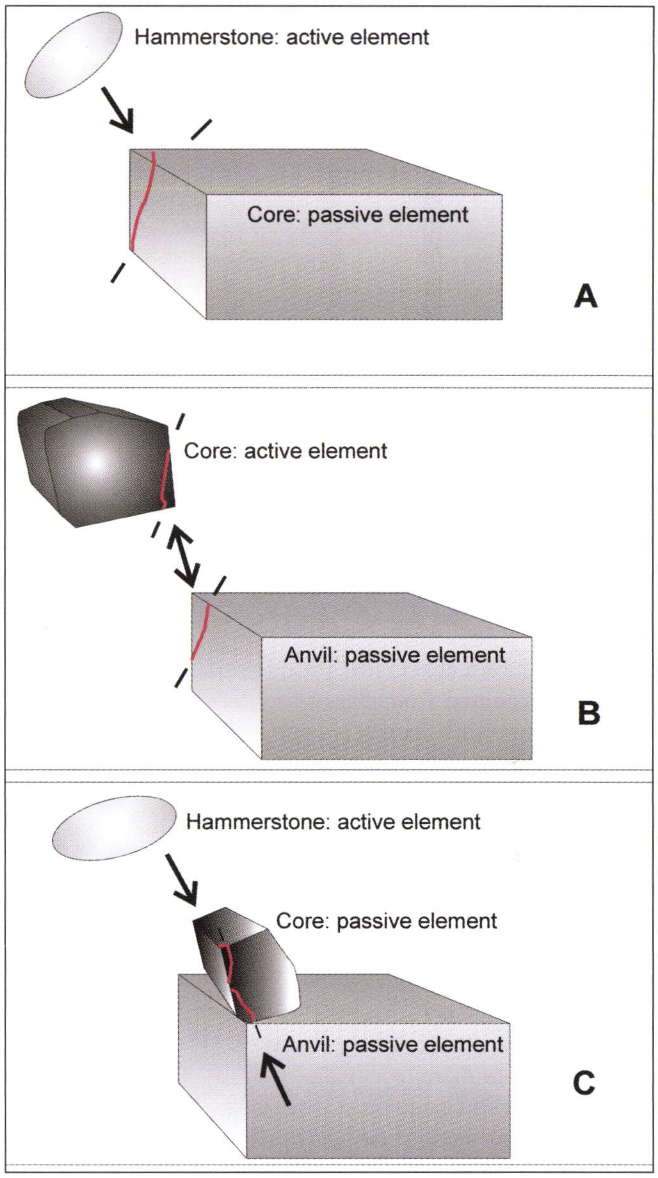

Figure 9.12. Diagram of the different modalities of interaction between active and passive percussion elements.

Active percussion elements

Active hammerstones used for knapping activities

The most common active hammers in any Palaeolithic archaeological site are always hammerstones used to modify another lithic item. Although everybody is well aware of the characteristics of these hammerstones, it is important to explain their main features, given that in the Olduvai sequence is not the only category of active hammerstones. Typical hammerstones are natural rounded forms, that generally have a fluvial origin, without intentional human modifications and with a weight and morphology that would have allowed them to be held. The main feature that identifies these objects as hammerstones is the presence of areas with extremely concentrated pitting, that depending on the intensity with which they were used can even form shattering and bruising areas. The fundamental requisite to identify hammerstones employed for lithic knapping is that - regardless of the size and weight - the area of the piece that came into contact with the core maintains a compact and homogeneous structure. When hammerstones present fracture angles, the area

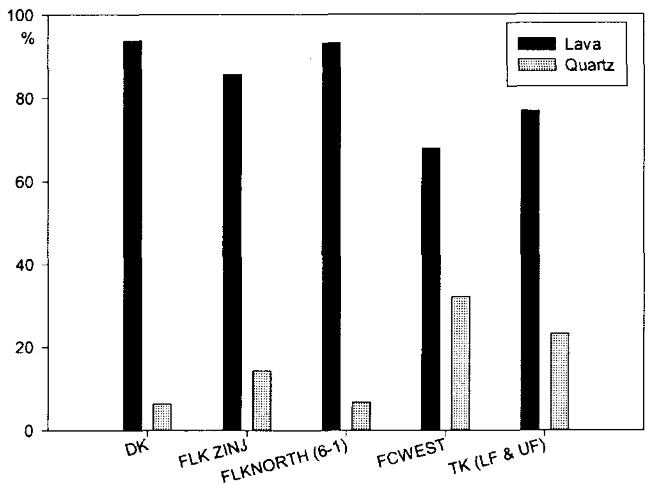

Figure 9.13. Distribution by raw materials of the knapping hammerstones in some sites of the Olduvai sequence.

used for knapping is rotated or the piece is discarded, since in order to produce a conchoidal fracture on the core, the force must be transmitted from the hammerstone uniformly; this does not occur when hammerstones start to present fracture points.

Although representation in percentage terms varies throughout the Olduvai sequence, these classic hammerstones are always identified in all the sites. Usually they are fluvial cobbles and are thus rounded blanks with ergonomic shapes that enables their use as hand-held hammerstones. The predominant raw materials are lavas (mainly basalts, trachytes and phonolytes), which always appear in greater percentages than quartzes (fig. 9.13). There is certainly an increase of quartz hammerstones in more recent sites such as FC West and TK, a tendency that some authors (i.e. Schick & Toth 1994; Jones 1994) have associated to the discovery of the advantages of quartz, which is a better raw material for hammerstones, given its greater plasticity to absorb impacts. However, it does not seem to be the case at Olduvai, where even in the sites where quartzes was used as the predominant raw material, hammerstones are usually made of lava. Thus, there is an intentional selection of specific lavas when choosing hammerstones. This selection is probably related to the nature of the blanks, since most of the lavas present rounded shapes that denote a fluvial origin and facilitate their use as knapping hammerstones. In contrast, quartzes usually present tabular and angular shapes that are not suitable for this task.

The selection of lava cobbles is not the only consistent pattern noticeable throughout the Olduvai sequence. For example, it is relatively frequent to document cores that were previously used as hammerstones, as indicated the presence of battering on many of the pieces, generally located on the opposite side to the knapped area, and coinciding with cortical areas without presenting any other human modification apart from the pitting produced by percussion. Albeit the multi-functionality of the cores-hammerstones is especially frequent in Bed I sites such as FLK Zinj and FLK North (where over 23% of the cores present battering marks), they are also present in a large number of later assemblages such as FC West and both levels of TK. It shows the real polyvalence of many of the static categories created by archaeologists and, at the same time, informs on the technological flexibility of the *chaînes opératoires* we are analysing.

Another interesting fact is the metrical homogeneity noticeable in most of the classic hammerstones found throughout the sequence. In all sites, there is a maximum size ranging between 70-80 mm and, surprisingly, all items are very similar in terms of their weight, ranging between 350-380 grs in FLK Zinj, FC West and FLK North, and 410-450 grs in TK and DK. It is difficult to assess if this is due to the availability of the cobbles of a specific size in the nearby streams, or if it is an intentional response linked to the selection of optimal blanks to be used as hammerstones. In any case, all the features indicate a certain degree of homogeneity in terms of the items used as hammerstones linked to knapping. Thus, probably hominids selected specific blanks with which to carry out this activity.

Active hammerstones with fracture angles

The description of this type of hammerstones was already comprehensively analysed in chapter 4. They are blocks or cobbles that were used in active percussion activities, generating ridges and fractures that were subsequently used to continue striking. Occasionally, it is difficult to distinguish these negatives generated spontaneously by percussion activities from those created specifically by knapping. This led Leakey (1971) to classify some pieces as choppers and polyhedrons which had not really been subjected to knapping, but had instead been fractured by percussion activities. Many of the hammerstones with fracture angles present very similar planes to those that appear in core forms like choppers. However, the similarity is exclusively morphological. Many of them present features that are not related to the principles of conchoidal fracture: several of the so-called choppers and cores do not present impact points on the negatives, nor do they stem from the edge of the piece but from the central part of the negative. Furthermore, the scars have irregular shapes without a set directionality, whilst the edges of the ridges present rims that cannot have been generated using a conventional knapping system. Moreover, they always present step and hinge scars. All these facts, linked to the battering of the ridges and the convex angles on the detachments, demonstrate the products were generated by activities other than knapping.

Consequently, we can speculate about the functionality of this type of hammerstone. We have already stated that they cannot be the classic active hammerstones linked to knapping activities; the objects we are currently describing present a support area (generally a cobble) that maintains the original cortical structure, whilst the opposite area is completely covered by ridges generated by heavy percussion activities that also produced the battering of the natural edges. These angles and irregularities on the surfaces affected by percussion show that these items could not have been used as lithic knapping hammerstones: there is no specific area on this active element which, upon coming into contact with the hammered element, could transmit the force uniformly to generate a conchoidal fracture. Furthermore, and as mentioned previously in chapter 4, it is impossible to sustain that they are simply fractured knapping hammerstones which were subsequently discarded, since in this group the abrasion generated by percussion affects previously fractured planes.

There are two patterns in this group of hammerstones with fracture angles; in the first place, in several of the pieces established in this category, the battered section appears along a large area of the cobble covered by orthogonal planes. These tools, like the one presented in figure 9.14, must have been ideal for activities perhaps more closely linked to the processing / crushing of organic elements, for which active percussion elements would have needed a large contact area to place the item to be modified.

Alongside this type of hammers with battering distributed along several planes of the fracture, there are others in which percussion seems to have focused on one ridge. This battered ridge, produced by successive actions such as those described in the process for figure 6.22, suggests that in this case the intense percussion activity is linked to the need to attain dihedral angles. Speculating, and until we can verify by use-wear analysis, the most plausible activity to have been performed with these objects is the chopping of wood, bone or other organic elements. This technical gesture requires the combination of two factors: a force applied severely, and an obtuse dihedral angle that could resist the impacts on the material being processed.

Figure 9.14. Example of a typical hammerstone with fracture angles from TK Lower Floor. Circle indicates battering areas.

Researchers are well aware that precisely this functional proposal designated the Oldowan choppers and thus requires we make a momentary halt at this point. After the formal definition of choppers (e.g. Leakey 1971), over the last decades the fact that they are standardised artefacts has been questioned, proposing that these pieces are really simple cores used to obtain flakes (Isaac 1986; Toth 1985; etc). The fact that the choppers have been considered as genuine tools and not mere cores is due to the knapping system employed for these objects, which creates a unifacial (chopper) or a bifacial edge (chopping tool) with simple angles, supposedly appropriate for activities similar to those described in the previous paragraph.

Regardless of the typological and even technological aspects involved in the manufacturing of the choppers, the matter is that, when these objects were used for heavy duty activities such as chopping wood or breaking bones, the traces generated on the ridges are always extremely evident and even conspicuous to the naked eye, as demonstrated by experiments (e.g. Ashton *et al.* 1992). In view of preservation problems such as diagenesis or roundness, it is difficult to notice these traces on some archaeological sites. However, this is far from a problem in Olduvai, where the preservation is generally excellent. Thus, if the unifacial or bifacial objects with partial edges and simple angles from Olduvai had been used for chopping activities, the damages on the ridges (pitting, abrasion, step fractures, etc) would be perfectly visible.

This is not the case in any of the analysed sites, in which the chopper-type cores usually present perfectly preserved knapping edges. As stated before, the lack of traces denoting use on the ridges of the choppers cannot be put down to preservation factors. Furthermore, on many of the cortical areas opposite the knapped area, a number of these cores have cortical areas presenting perfectly conspicuous battering that is indicative of their polyvalent use as hammerstones. If the ridges had also been for the chopping activities the typological definition proposes, those marks also should appear on the edges. Thus, at least on the basis of the Olduvai sequence, it does not seem suitable to continue to grant choppers functional connotations, since these tools – even in their name itself – suggest a function that has not been justified.

The idea that choppers are primordially cores is not new and has been claimed for several decades (Toth 1982, 1985; Isaac 1986; Isaac *et al.* 1997; Ashton *et al.* 1992, etc). However, it has not been sufficiently contrasted in Olduvai. Consequently, it was needed to present specific arguments from the Olduvai sequence against the use of choppers for the activities their name presupposes. This can all be summarised in the idea that, if the edges of these objects had been used for chopping activities, the marks would have been preserved: the presence of battering marks on other categories of artefacts, and even on the cortical areas of the choppers themselves (but not on the ridges) indicate that, when the lithic objects were used for such heavy duty activities, the edges could under no circumstances have remained undamaged.

Unfortunately, the chopper issue is not solved as simply; although all the functional evidence indicates that they are cores and not artefacts, after studying their relationship with other categories (essentially knapping products), we find little arguments to consider them mere blanks for flake extraction (see below). In any case, the attention we have granted the issue of the so-called choppers is not gratuitous. As stated above, we believe that many hammerstones with fracture angles were used precisely for chopping activities. Sometimes, as in the case of the active elements - in which battering is focalised on a ridge produced by percussion fractures -, the morphological similarity between these hammers and the chopper-type cores is very important. The essential difference is that the edge created in the cores is due to intentional knapping processes employed to obtain flakes, and does not present traces of battering or of use of the edge itself. Conversely, as regards hammerstones with fracture angles, scars are caused by percussion activities, with irregular, battered and stepped ridges. Hence, we can only reconstruct the process that led to the creation of each piece on the basis of a meticulous analysis. This explains some of Leakey's wrong assignments including them in the category of knapped objects when actually they did not belong to any of the *débitage* or *façonnage* processes, but instead to percussion activities or even to natural processes.

Subspheroids, spheroids and stone balls

Worked stones with spheroid shapes have been tackled in many studies on the African Early Stone Age. The pioneering work of Clark (1955) is the most comprehensive, and defines stone balls and similar objects as pieces knapped in facets until achieving a spherical shape, which presented intentional battering that reduced the irregularities of the ridges until they became completely blunt. According to Clark (1955), the best way to achieve these morphotypes consisted in placing the object and processing it on an anvil, extracting small fragments until achieving a spherical shape. This author also explored the functional possibilities these objects presented, proposing their possible use as missiles, without excluding the fact that they could be hammerstones used for knapping or crushing nuts.

Years later, Kleindienst (1962) established three categories, missiles (in fact natural pieces, with isolated anthropic modifications), polyhedrons (objects with many facets and negatives) and *bolas* (quasi-spherical pieces with a smooth surface obtained by battering processes). Over subsequent years, successive typological proposals (i.e. Leakey 1971; Clark & Kleindienst 1974) continued to classify spheroids and subspheroids as tools with intentional and standardised shapes. Similarly, some authors continued to suggest these spherical pieces were used as missiles (e.g. Leakey 1979), something which has been the object of speculation in later years (B. Isaac 1987; Bingham 2000; Calvin 2002; etc). Over last decades, there have been published some works related to the analysis and interpretation of spherical forms in Early Stone Age sites, considering both the analysis of the archaeological assemblages (e.g. Willoughby 1987; Sahnouni 1991, 1998; Jones 1994), and experimental replicas (Schick & Toth 1994; Sahnouni *et al.* 1997; Texier & Roche 1995).

Willoughby (1987), as did Leakey (1971), set out that spheroids and similar forms are diagnostic markers between the different cultural facies of the Olduvai sequence, indicating their particular relevance during the Developed Oldowan B (*sensu* Leakey 1971). Moreover, according to Willoughby (1987) the spheroids are merely the end result of a continuous reduction process that could commence with choppers and continue through polyhedrons and subspheroids. Upon exploring other options, Willoughby (1987) presents a hypothesis stating that these spheroid forms could have been hammers associated to anvils, since the Olduvai sequence denotes a correlation between the frequencies of both types of tools. She believes that spheroids were linked to pounding activities, thus - instead of being an intentional end form - it is more likely that tools acquired a spherical form through work processes (Willoughby 1987).

Schick and Toth (1994) point towards a similar direction. These authors, via their experimentation, proposed a *continuum* that commenced with the use of blocks as cores, which were then recycled as hammerstones and so on through a long reduction process, to end up acquiring a spheroid shape. According to Schick and Toth (1994), the systematic use of exhausted quartz cores as hammers would have led to battered pieces classified as spheroids, which would not be predetermined forms but instead objects modified spontaneously after being used as hammerstones. Sahnouni *et al.* (1997) follow that hypothesis: their results denote that a moderate reduction of the cores tends to produce unifacial or bifacial choppers, whilst more intense reduction leads to polyhedrons and some subspheroids and, occasionally, faceted spheroids. To sum up, they concluded spheroids are not predetermined pieces, they are the exhausted products of flake production sequences, which could subsequently be used as hammerstones (Sahnouni *et al.* 1997).

Texier and Roche (1995) present a radically different vision. These authors consider that polyhedrons, subspheroids and spheroids are the result of a well-reasoned organisation of the *façonnage*, with these pieces being the desired product of knapping. Thus, polyhedrons, spheroids and subspheroids would be different stages of the same *chaîne opératoire* in which these pieces would not be the consequence of a *débitage*, but the consequence of an intentional *façonnage* (Texier & Roche 1995: 35). According to these authors, polyhedrons, subspheroids and spheroids proceed from the same concept, the controlled reduction of a blank to obtain a regular volume distributed on the basis of a virtual point that has a centre of symmetry - the sphere -. Considering Willoughby's proposal (1987) on the positive correlation in the representation of spheroids and anvils in the Olduvai sequence, Texier and Roche (1995) make an observation that echoes Clark's (1955) conclusions; to control the effectiveness of the percussion when producing spheroids to the greatest extent, the best option is to work the polyhedron on a hard surface: then, percussion becomes double thanks to the effect of the active hammerstone and the anvil. This creates numerous battered areas that give the piece a regular, spherical shape. Thus, Texier and Roche (1995) propose once again an association between both items, spheroids and anvils.

Throughout the literature on the issue, there are certain disagreements as regards the functionality and technique of producing spheroids. Authors such as Schick and Toth (1994) Willoughby (1987) or Sahnouni *et al.* (1997) consider spheroids acquire their morphology after being used intensely as hammerstones, without any further technical predetermination. Others such as Wynn (1989) or Texier and Roche (1995), however, conceive these objects as the end product of an orderly and preconceived *façonnage* process. Despite these opposing viewpoints, all these authors concur that polyhedrons, subspheroids, spheroids and *bolas* are different stages of the same process. Possibly this could be the case in Ain Hanech (Sahnouni 1998; Sahnouni *et al.* 1997) and Isenya (Texier & Roche 1995; Roche & Texier 1996) since both research teams offer arguments regarding the technical *continuum* from polyhedrons to spheroids.

However, it is not possible to put forward this scenario for the production of these pieces at Olduvai. Jones (1994) stresses the fact that most of the polyhedrons in both Bed I and Bed II were manufactured from lavas, whilst the spheroids and subspheroids were almost invariably made of quartz. Therefore, they cannot belong to the same *chaîne opératoire*, since the raw materials employed in the production of each artefact category do not coincide. This problem does not only appear in Olduvai, since in 'Ubeidiya, for example, polyhedrons are primarily made in chert, and spheroids in limestone (Willoughby 1987; Bar-Yosef & Goren-Inbar 1993), and even in Isenya polyhedrons and spheroids are fundamentally made in phonolite whilst *bolas* are made of quartz (Roche & Texier 1996). Coming back to Olduvai, Jones (1994:276-277) also provides convincing morphometric arguments, as he demonstrates that it is impossible for subspheroids to come from polyhedrons. Upon analysing the size of both samples, subspheroids are generally larger than polyhedrons, therefore the spheroids could not have been produced during a later reduction sequence. Consequently, Jones (1994) concluded that the processes that generate spheroids and subspheroids, linked to intense percussion activities, were unrelated to the knapping processes envisaged in the production of Olduvai polyhedrons.

After reanalysing the Olduvai assemblages, our conclusions are similar to those of Jones (1994). The issue of polyhedrons and their contribution to the different sites in the Olduvai sequence is complex, since a great part of the items Leakey (1971) classified as polyhedrons are unmodified natural pieces. As occurred with the choppers (see above), Leakey (1971) often used purely morphological criteria to classify polyhedrons. This resulted in a multitude of natural chunks being assigned to this category, whose multiple angles and ridges were caused by natural fractures, not by knapping or pounding processes: in many of the so-called polyhedrons, the supposed flake extractions do not present negative bulbs, or these elements are located on the central part of the scar, and they present impossible angles, natural ridges, etc. In all, it can be concluded that a high number of the so-called polyhedrons are merely natural irregular chunks. In other cases, some of the pieces considered polyhedrons can be reclassified as belonging to other knapping systems with bifacial structures.

As described in chapter 2, in our analysis very few cores have been assigned to the polyhedral system that implies at least three or more working edges (Leakey 1971:5), and there are even less that could be included in polyhedral strategies according to specific technological definitions (Inizan *et al.* 1995; Texier & Roche 1995). Most of the polyhedrons we have identified are quite small, made of lava and do not present traces of battering. Thus, they do not seem to be related to percussion activities but with knapping processes. Overall, we are in agreement with Jones (1994): The quartz subspheroids and spheroids at Olduvai are from a sequence different to that of the polyhedrons, and should therefore be described individually.

The first problem encountered upon studying spheroid forms at Olduvai is the differentiation between anthropically modified artefacts and pieces with non-artificial rounded forms. As pointed out by Willoughby (1987), natural spheroids are not rare, generated by different processes such as fluvial abrasion, volcanic *lapilli* and even spheroid weathering, in which rocks exfoliate their layers due to the chemical migration of their elements. Therefore, some of the objects classified previously as spheroid artefacts are, in fact, naturally rounded pieces. Conversely, some of the objects classified as subspheroids or spheroids are, according to our study, irregular chunks presenting traces of battering, and not pieces that have been used directly for percussion activities. These pieces are actually fragments that have been detached by the battering, hence the battering traces on their dorsal faces. Thus, classifying the small fragments that have come from genuine tools used during percussion activities as spheroids or subspheroids, demonstrates that the frequencies of these categories were elevated artificially by Leakey (1971). It seems that this problem does not appear exclusively in the counts performed in Beds I & II, since Jones (1994) points out that many of the so-called subspheroids in Bed III, Bed IV and the Masek Beds were merely simple chunks or broken artefacts.

Focusing on Bed II, in sites such as FC West and TK (Lower and Upper Floor), and in the group of quartz objects that were classified as polyhedrons, subspheroids and spheroids, displaying traces of use from activities linked to percussion, two different situations are presented. This dichotomy can be established on the basis of the sedimentary origin of the quartzes employed. Although the quartzes used in the Olduvai sites are usually tabular, there are also (especially in Bed II) quartz cobbles from streams. This distinction was not considered when classifying artefacts (Leakey 1971), and as a consequence the same category of spheroids included objects with different sedimentary origins. Many of the so-called spheroids are quartz cobbles with natural rounded shapes. These pieces present traces of battering that indicate their function as hammerstones, and probably the intensity of much of this pitting led to their classification as spheroids. Even though they could ultimately be used for the same tasks as other spheroids, the morphological genesis process is radically different to that of tabular quartzes, since quartz cobbles have a naturally rounded shape. Therefore, the *chaîne opératoire* of these blanks contradicts the one designed by Texier and Roche (1995), who proposed a knapping management dedicated to the creation of spherical objects; as regards quartz "spheroids" in cobble blanks, the original piece is rounded with cortical surfaces used for percussion activities, then irregular edges are caused by the impacts, and ridges finally become rounded again given the intensity of the percussion.

The processes involved in the production of spheroid shapes from tabular quartz blanks are different nonetheless. Some of Leakey's so-called polyhedrons did not show intentional scars created during knapping but orthogonal planes produced by being used as hammerstones (see chapter 4). Thus, the pounding process generated natural facets on the quartz blocks, and through the phases already defined (see fig. 4.32 an related descriptions), would give a spherical shape to pieces. The distinction between this process in tabular blocks and quartz cobbles is relevant, since these pieces are being included in categories that are morphologically similar but which, nonetheless, have a different origin: so-called spheroids on cobble blanks are easily distinguishable from the spheroids generated by the battering of the natural ridges, since the former, although their whole surface may present battering, still preserve the fluvial cortex and the natural rounded morphology.

Summing up, the process described here is the same as the one proposed by Schick and Toth (1994) and Jones (1994), in which the quartz blocks, after being used as hammerstones, end up taking on a totally rounded shape. At Olduvai, there are objects in different stages of use that allow to reconstruct the technical gestures that generated the spheroid morphologies. As stated before, genuine lava polyhedrons are caused by processes linked to knapping and generally do not present traces of percussion. However, many of the so-called quartz polyhedrons are actually hammerstones with natural fracture angles and do not present scars that could link them to a *débitage* or *façonnage* process. Neither the objects most affected by battering present traces of intentional knapping, and all the modifications visible on these pieces are linked to percussion activities.

In all, we consider that, at least as regards Olduvai, Texier and Roche's (1995) hypothesis on the *façonnage* of polyhedrons and spheroids is not justified; in Beds I and II the rounded shapes of the quartz blocks are obtained via an extremely intense battering of the artefacts. It is a different matter to attempt to clarify if these artefacts have a casual or intentional morphology. As mentioned before, Schick and Toth (1994) considered that they are casual shapes derived from their use as hammerstones. On the opposite side, it has been proposed that the spheroids are preconceived morphotypes obtained from *façonnage* (Texier & Roche 1995). Furthermore, according to these authors, spheroids cannot be merely hammers since the latter generally present one or two picketed ends, whilst the spheroid shapes are completely battered (Roche & Texier 1996; Willoughby 1987). An intermediate solution could be the one presented by Jones (1994), who – albeit considering that the swiftest manner to obtain spheroids is by using them as hammerstones – considers it must have been a deliberate option used by the artisan, in an attempt to produce round shapes suitable for specific purposes.

As Desmond Clark (1955) pointed out, the spheroid phenomenon appears throughout the African continent and ranges over a long period of time, that starts at the Olduvai sites and continues throughout the whole sequence of the Acheulean and the Middle Stone Age. This morphological standardisation, linked to the heavy battering visible on many spheroids, seems to be indicative of a certain interest in attaining perfectly rounded shapes (see also Wynn 1989). The fact that the blocks were used for percussion activities during a certain stage (our stage 1 described at chapter 4) in which, due to the irregularity of tabular shapes, they could not have been used as classic hammerstones, makes it hard to believe that the intense battering processes that led to the creation of completely spheroid shapes (our stage 3) are linked to lithic knapping. Consequently, we may have to pursue other functional alternatives to explain these active hammerstones, even though they have not been verified by use-wear and systematic experimental analyses.

Passive percussion elements

Passive hammerstones or anvils, i.e. the elements that receive the force transmitted by another item, are another important category in the Olduvai sequence. Leakey (1971:7) identified anvils in all sites in Beds I and II, and also indicated that, although during the Oldowan simple cuboid blocks or cobblestones were used, during the Developed Oldowan these blanks were shaped before they were used. According to Leakey (Leakey & Roe 1994), this type of anvils are rarely found in Beds III and IV, since pitted anvils are commoner on the Upper Beds. These pitted anvils are usually boulders and cobbles with pecked depressions (usually isolated or in pairs) which would be associated with the bipolar flaking technique and the *outils écaillés* (Leakey & Roe 1994). In the oldest levels in Olduvai, this type of pitted anvil was only identified incidentally, as in the case of the Sandy Conglomerate Level in FLK North in Lower Bed II (Leakey 1971: plate 17), and after revising these examples we consider it quite dubious that the pits observed are genuinely artificial and not natural.

Since our study is limited to Beds I and II, we will focus on the general category of the Olduvai anvils, referring to the systematic study performed by Goren-Inbar *et al.* (2002) in Gesher Benot Ya'aqov and Jones (1994) in Beds III and IV in Olduvai focusing on pitted anvils.

There is no need to describe the characteristics of the anvils, since they were already set out in chapter 4. Now, it is important to stress that the dynamics involved in the modification of the blocks and the generation of anvils is surprisingly similar throughout the whole of the Bed I and II sequence, being particularly relevant in sites such as FLK North, TK and FC West. In all these assemblages, the dominant raw material in the anvil category is quartz, probably due to the tabular morphology, which ensures the stability of the passive element during the percussion process. These tabular quartz anvils vary as regards size, ranging between 85 mm (e.g. FLK North Levels 6-1) and 90 mm (e.g. TK Lower and Upper Floors) in length and 555 gr and 733 gr respectively. Thus, they are not especially large pieces and could be handled easily. Consequently, although we have observed the presence of necessarily static anvils such as those from MNK (samples weighing over 10 kg) or SHK (with an anvil weighing over 20 kg), in the examples from FLK North, TK or FC West their size should not be considered the criterion to distinguish these objects as passive hammerstones.

We propose that the existence of opposite battered surfaces should be the fact considered to identify anvils. These opposite battered surfaces are always accompanied by step scars on the periphery of the block. It is relevant to mention this last aspect briefly: Leakey (1971) referred to shaped anvils in the Developed Oldowan, in which the blocks' flat upper and lower surfaces would be accompanied by vertical flaking of the pieces' circumference. However, and although we have documented some cores with marks on the knapping platforms which indicate they were used previously as anvils in the Olduvai sequence, this phenomenon entailing the re-use of the items is not analogous to the anvil shaping process Leakey (1971) proposed.

On the contrary, we think that most of the scars that are systematically identified on anvils have been produced precisely by passive percussion processes that generate involuntary modifications on the blocks and not by an intentional shaping. As mentioned in chapter 4 (see again fig. 4.2), the force applied on a surface and transmitted to the other surface in contact with the ground, creates a bipolar phenomenon that produces step scars systematically around the whole circumference of the piece. As stated by Alimen (1963), these negatives produced during the percussion process on anvils can be perfectly differentiated from those generated by flaking: in the case studied herein, the concavities created on the blocks do not respond to a conchoidal fracture, instead they present orthogonal morphologies and obtuse angles.

The correct identification of this process is important, since the appearance of involuntary scars on the surface of the blocks obviously implies the generation of positives detached from the anvils. Our reanalysis has shown that at sites such as FLK North or TK, a large number of the pieces classified as flakes or flake fragments are actually positives spontaneously detached from the anvils due to percussion activities and not intentional products from *débitage*, as thought initially (Leakey 1971). All these fragments present a series of shared features: the first and most relevant are the traces of battering on the external faces, very usual in these supposed products of *débitage*. Furthermore, the majority of these positives do not present a butt or any other attribute that could indicate the direction of the force applied to obtain the so-called flake. Likewise, the dorsal faces of these positives do not present defined ridges or traces of previous detachments.

We have commented the features of these small fragments, when considering the so-called *débitage* in FLK North 6. That description is valid for other levels of FLK North, FC West or TK, and we will consequently not insist on this issue. However, it is important to point out that most of the works that have attempted to offer an explanation that is either typological (i.e. Leakey 1971; Chavaillon 1979; Isaac *et al.* 1997; etc) or technological (i.e. Schick & Toth 1994; Texier & Roche 1995; Sahnouni *et al.* 1997; etc) regarding percussion artefacts have focused on the resulting tools (hammerstones, spheroids, anvils, etc), but not on the products generated during these activities (an exception could be found in Jones 1994). Thus, when the small pieces formerly classified as flakes or flake fragments are revised meticulously - as we have done in this work - it has become apparent that many of them stem from the use of the anvils and are not related to knapping activities.

Finally, we must question the functionality of these anvils. In the upper Beds, Leakey (Leakey & Roe 1994) linked the existence of pitted anvils to bipolar knapping and the production of *outils écaillés*. Jones (1994) performed replication experiments and proposed that both the *outils écaillés* and the punches and pitted anvils from Beds III and IV were created by striking small quartz/quartzite flakes between an anvil and a hammerstone, in a process very similar to the one observed for more recent contexts (i.e. Le Brun-Ricalens 1989). However, this does not seem to be the case for the sites we have analysed at Beds I and II: the so-called *outils écaillés* seem rather like positives with battering detached from the anvils and not flakes obtained from a bipolar technique. Furthermore, the severe fractures and battering on the Olduvai anvils do not respond to isolated modifications generated by the positioning of a core on the surface, as required by the bipolar technique.

It must also be considered that these passive hammers were part of the *chaîne opératoire* linked to the anvil-chipping technique, consisting of striking a core held in both hands on a fixed anvil on the floor (see i.e. Shen & Wang 2000; Kleindienst & Keller 1976). However, we do not think this to be the case for the Olduvai anvils either, since in Oldowan sites such as FLK North the flakes obtained are smaller, and in Acheulean assemblages such as TK, the large flakes seem to have been obtained by direct percussion with a hard hammerstone. Nevertheless, it would be interesting to have descriptions of the anvils resulting from experimental activities linked to the anvil-chipping technique, which have up to now been limited to the analysis of the cores and generated products (Shen & Wang 2000; Kleindienst & Keller 1976), but not to the analysis of passive hammerstones.

Another alternative could be that the Olduvai anvils had been used to process small nuts, as documented at other archaeological sites (i.e. Chavaillon & Chavaillon 1976; Goren-Inbar *et al.* 2002) and is widely recorded in ethological contexts (Boesch & Boesch 1983, 1993, 2000; Mercader *et al.* 2002; etc). However, it is difficult to assess this hypothesis for sites such as FLK North or TK, since the anvils do not present the typical pits described at Melka Kunturé (Chavaillon & Chavaillon 1976) or Gesher Benot Ya'aqov (Goren-Inbar *et al.* 2002) and, even though the horizontal planes (platforms A and B) present signs of battering throughout their surface, impacts are not concentrated on the central part but on the edges (plane C). Nevertheless, activities related with nut processing should not be discarded, and require further investigation by comparisons between anvils used by chimpanzees and the archaeological samples.

As occurs in the examples described in the Sahara (Alimen 1963) and 'Ubeidiya (Bar-Yosef & Goren-Inbar 1993), most of the battering on the anvils studied at Olduvai appears on the contact area between the horizontal (platforms A and B) and transversal planes (plane C), where the ridges are completely disfigured by percussion. Given the major damage by battering noticeable on many of these anvils, the fractures must have been generated by much heavier processes. Therefore, taking into account the Bar-Yosef and Goren-Inbar (1993:110) hypothesis for the examples in 'Ubeidiya, we propose that the majority of the Olduvai anvils could have been used for interposing elongated elements such as bone diaphyses between the edge of the anvil and the ground. In doing so, the battering would primarily affect the ridge of the anvil and would unintentionally generate a large number of lithic positives from the fracture of the passive hammerstone.

This hypothesis should be verified with more detailed analyses, since the option of the fractured bones is not completely convincing either. The fracture of the midshafts could have been performed more comfortably placing the bone on the surface of the anvil and not on the edge. Furthermore, the Olduvai anvils are sometimes too small to have been used as blanks for the large bones. Therefore, we should not exclude the fact that a good part of these anvils could have been used to process other organic materials that have not been preserved.

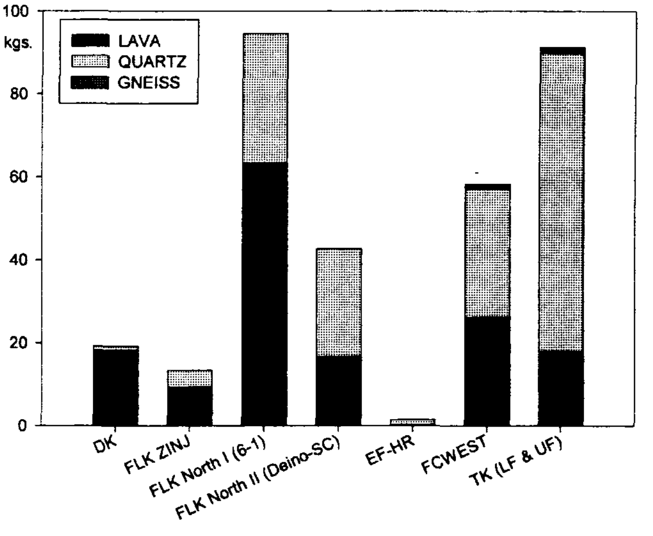

Figure 9.15. Weight in kilograms of the raw materials represented for the percussion items (including active and passive objects as well as generated products) from each of the analysed sites.

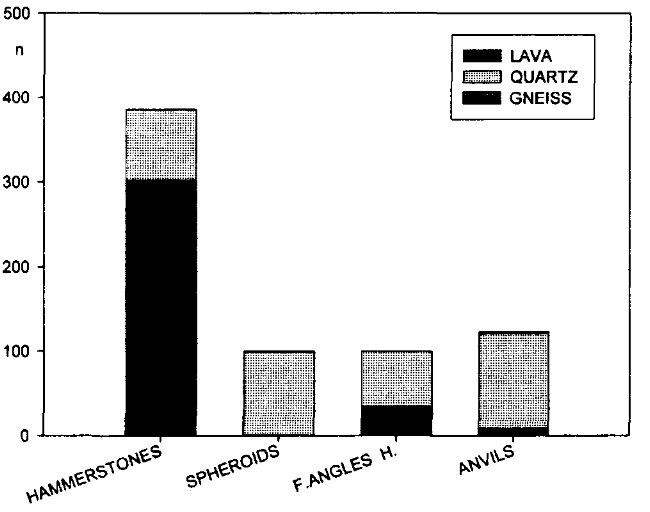

Figure 9.16. Total number and raw materials of active and passive percussion items in the Olduvai sequence (DK, FLK Zinj, FLK North all levels, FC West, EF-HR and TK (both levels), excluding the products (chips and fragments) generated spontaneously.

Relationships between percussion objects in Olduvai Beds I and II

Throughout the previous pages we have attempted to present a meticulous description of the technological patterns involved in percussion activities at Olduvai. This presentation has been based fundamentally on the description of the different categories of pieces documented at the Bed I and II sequence and the technical processes that generated them. It is now necessary to portray a quantitative assessment of the percussion items, with a view to evaluating the relevance of the specific percussion processes in the framework of the activities performed at each site.

Focusing on more specific issues, it also seems clear that the Olduvai hominids always used lavas and quartzes simultaneously as raw materials for their percussion activities. Although the percussion materials denote a gradual increase of the relevance of quartz (fig. 9.15), the increase of metamor-

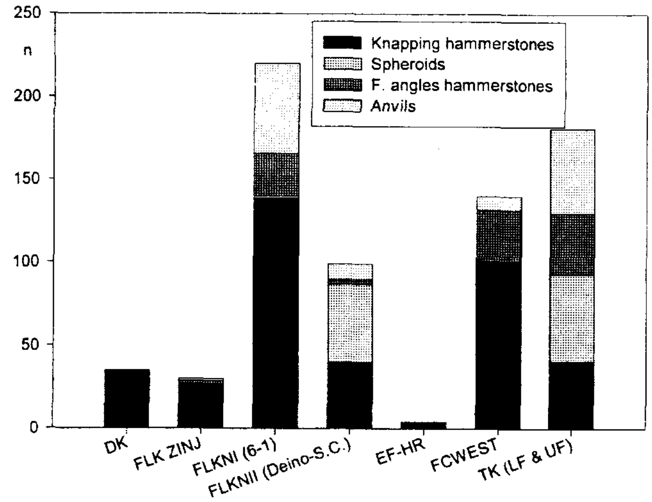

Figure 9.17. Absolute frequencies of the different pounded pieces categories in each of the analysed sites.

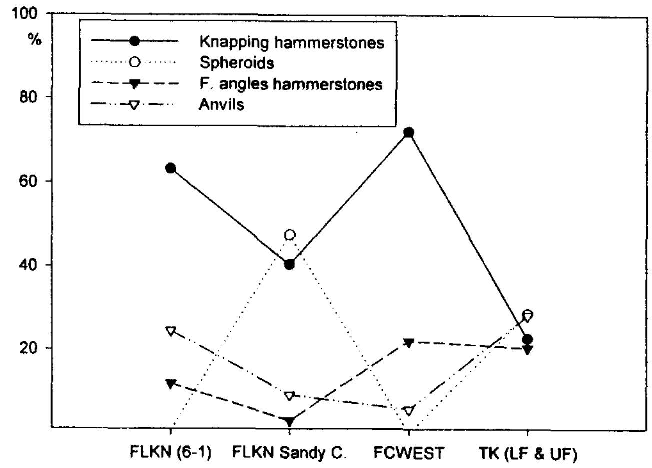

Figure 9.18. Relative frequencies of the different percussion categories in the sites with the greatest variety of pounded pieces.

phic rocks with the development of the sequence seems proven in all sites and lithic categories in Bed II, and is therefore not exclusive to the items linked to percussion.

As regards the distribution of raw materials, the joint analysis of all the percussion categories indicates a general preference for lavas as knapping hammerstones (fig. 9.16). As aforementioned, this partly contradicts Schick and Toth's (1993) proposals and our own opinion (de la Torre *et al.* 2003, 2004; de la Torre & Mora 2004), in that we consider spheroids and hammerstones with fracture angles (mainly in quartz) as categories that are unconnected to classic hammerstones, as we will debate below. With reference to anvils, they do seem to be closely linked to the availability of quartzes, and this is probably due to the tabular nature of the pieces, which allows their stable positioning on the floor as occurs with the flat platforms made of chert and basalt in 'Ubeidiya (Bar-Yosef & Goren-Inbar 1993).

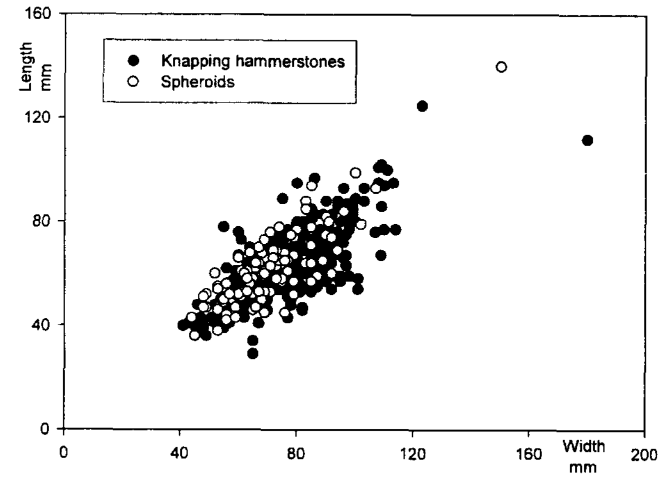

Figure 9.19. Size (length and width) of the classic hammerstones and subspheroids-spheroids in different stages of transformation.

The representation of the categories of tools throughout the sequence offers interesting patterns. Knapping hammerstones are always the most abundant pounding artefacts (fig. 9.17): In EF-HR 100% of the percussion artefacts are classic hammerstones, and in DK these objects compose 97.1% of the total, with a very similar pattern to FLK Zinj (90%). It is found a slightly lower percentage at FC West (72.1%) and FLK North I (Levels 6-1) (63.2%), whilst at TK (both levels) it drops to 54.4% and at FLK North II (*Deinotherium* Level and Sandy Conglomerate Level) the rate of classic hammerstones decreases to 40.4%. Figure 9.17 also shows that in Middle-Upper Bed II, except for EF-HR, different modalities of pounded pieces accompany classic hammerstones, which could be linked to a greater variety of activities performed at each site.

On the basis of the relative frequencies of the tools with the greatest variety of categories of pounded pieces at the sites, it can be discerned a pattern linked to their distribution (fig. 9.18). As aforementioned, Willoughby (1987) proposed a functional association between spheroids and anvils, a suggestion collected subsequently (i.e. Texier & Roche 1995). Unfortunately, our results are not very enlightening in this respect: although at FC West and TK there is a co-variation in both categories of items (fig. 9.18), at FLK North II (*Deinotherium* and Sandy Conglomerate Levels) - where spheroids are the most abundant category (47.5%) - anvils are very scarce (9.1%).

The relative frequencies shows a strong negative correlation between classic hammerstones and spheroids (see fig. 9.18). Thus, the percentage of spheroids at FLK North I (Levels 6-1) are practically nonexistent (0.5%), whilst there is a 63.2% of classic hammerstones. The same pattern occurs at FC West, with 72.1% knapping hammerstones but not a single spheroid. The opposite occurs at FLK North II and TK, where classic hammerstones attain their lowest frequencies and spheroids appear in the highest percentages (47.5% and

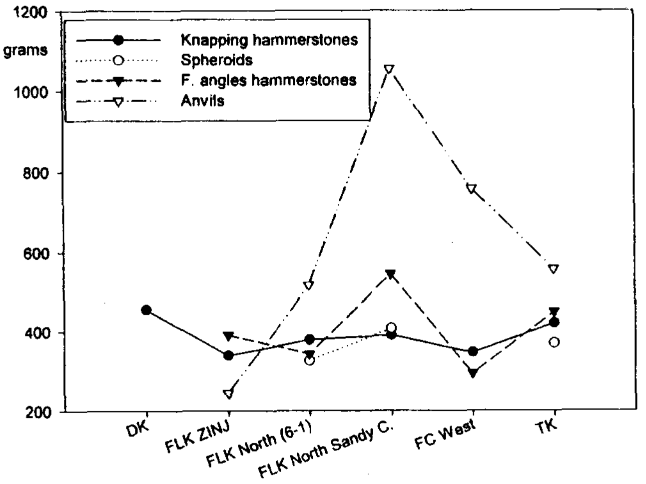

Figure 9.20a. Mean weight of the different categories in several of the sites. EF-HR excluded given the low number of items.

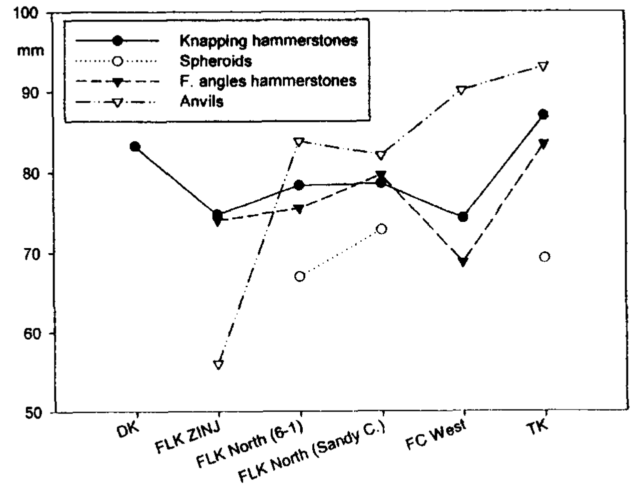

Figure 9.20b. Mean length of the different categories in some of the analysed sites.

28.7% respectively). In our opinion, this reverse correlation between two categories created by archaeologists can only be masking reality, a reality that implies that both samples belong to the same group.

Other quantitative tests (i.e. fig. 9.19) support that suggestion, since there is an overlapping of the sizes of the hammerstones and spheroids (including in this category the different stages of the rounding of the ridges of the quartzes). Figure 9.20a is also enlightening in this sense, because there is a very similar distribution as regards the mean weights of spheroids and hammerstones. Thus, on the basis of the recounts of items and quantitative analyses, it is possible to propose that the Olduvai spheroids were performing the same function as other hammerstones, as suggested by experimental studies (i.e. Schick & Toth 1994; Sahnouni *et al.* 1997; *contra* Texier & Roche 1995).

Figure 9.20a and especially figure 9.20b are also very illustrative as regards the real nature of the hammerstones with fracture angles. Figure 9.20a shows that hammerstones with fracture angles also have a similar weight to classic hammerstones and spheroids. Figure 9.20b is even more illuminating, since it denotes an identical co-variation in the mean sizes of the classic hammerstones and the hammerstones with fracture angles. This variation is most probably due to the size of the cobbles available in the environment of each site, and not to the selection performed by the hominids themselves. In sum, once again the data indicates that, as occurred with the spheroids, it is a type of tool very similar to classic hammerstones. This is not at all strange since, when it was presented the description of the hammerstones with fracture angles (see chapter 4), we already insisted on the continuity of a process that began with the use of cobbles as knapping hammerstones which - when they started to break - were still used for complementary activities. In this case the quantitative analyses do not provide new information, since these types of hammerstones with fracture angles were made on the same types of blanks as classic hammerstones. Therefore, the only feature that would differentiate both types of objects would be that the battered ridges observed on the hammerstones with fracture angles are not suitable for knapping.

The relevance of percussion processes at Olduvai

The Oldowan and African Early Acheulean defined in Olduvai have always been considered a paradigm to assess the technical capacity of Plio-Pleistocene hominids. Nonetheless, these capacities have been linked exclusively to the knapping activities described in each site. Beyond our revisions (Mora & de la Torre 2005; de la Torre & Mora in press), only some authors (i.e. Chavaillon 1979; Chavaillon & Piperno 2004) have performed a deep analysis of the percussion tools in the oldest African archaeological sequences, while others have stressed the importance of percussion activities in the earliest phases of human evolution (de Beaune 2004). Remarkably, ethological studies (i.e. Boesch & Boesch-Achermann 2000; Mercader *et al.* 2002; etc), have underlined the significance of percussion processes amongst chimpanzees and the similarities with the archaeological record.

Zooarchaeologists have also insisted on the relevance of some percussion processes carried out in the earliest archaeological sites (i.e. Binford 1984; Bunn 1989; Capaldo & Blumenschine 1994; Blumenschine & Selvaggio 1991; Madrigal & Blumenschine 2000). Bone marrow extraction activities carried out in Olduvai using percussion processes are well documented (Bunn 1989; Shipman 1989; Blumenschine 1995). Even the existence of bone anvils probably related to this type of bone marrow processing have been identified (Leakey 1971; Shipman 1989). However, both experimental studies on the hammer-on-anvil technique (Bunn 1989; Capaldo & Blumenschine 1994; Blumenschine & Selvaggio 1991; Blumenschine *et al.* 1996), and the analyses of archaeological materials from the Olduvai fauna (Bunn

1982, 1986, 1989; Blumenschine 1995; Shipman 1989), have focused on marks produced on the bones, but not on the modifications generated on the lithic materials.

Although a number of authors have performed studies on the lithic industries of the Olduvai sequence (i.e. Leakey 1971; Potts 1988, 1991; Ludwig 1999; Kimura 1999, 2002; etc), none of them (except perhaps for Leakey with her typological descriptions) have stressed the relevance of percussion processes on the sites. Scholars such as Potts (1988) have insisted on the scarce incidence of battered artefacts in Olduvai Bed I, where according to this author the pounding pieces would only compose 1-12% of the total, and therefore, consider bone marrow processing activities irrelevant (Potts 1988:238; *contra* Binford 1984).

However, figure 9.21 demonstrates a different view, suggesting the relevance of these percussion activities at the Olduvai sites. In fact, the volume of raw material linked to percussion processes in some sites like TK, FC West or FLK North (all levels) exceeds knapping activities. This enormous abundance of percussion processes over knapping activities leads to consider both the activities performed by the hominids at these locations and the actual functionality of the sites from a radically different perspective. Consequently, in opposition to the ideas proposed by Potts (1991) - based on a technology focusing essentially on detaching cutting flakes -, the production of tools (i.e., from knapping processes) actually had a secondary importance in some of the Olduvai sites, which in reality specialised in the intensive use of artefacts linked to percussion.

It is possible that part of this scarce attention towards percussion processes is due to the problems inherent to studying quartz, and the ambiguity of many of its attributes (see Knight

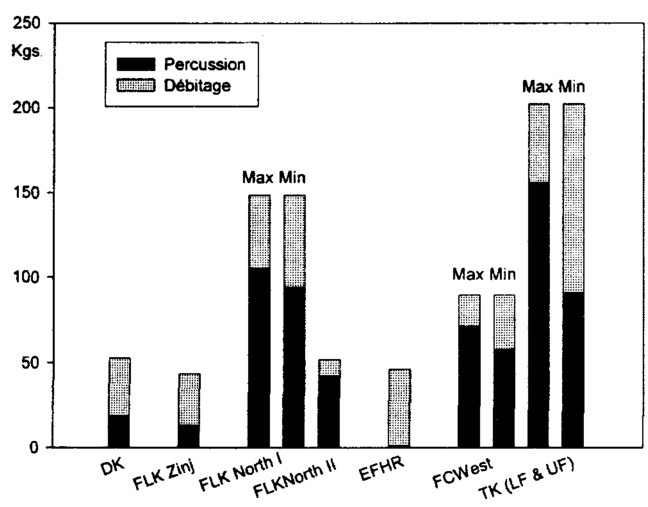

Figure 9.21. Weight in kilograms of the general categories represented at each of the analysed sites. The complexity of assigning part of the products to knapping activities or to percussion activities has led to present maximum and minimum estimates for objects linked to percussion for several sites (FLK North I, FC West and TK).

1991; Bracco 1993; Mourre 1997). In fact, it is difficult to characterise many of the features of the analysed materials, therefore we have often had to use indicative criteria such as precisely the lack of features that define knapping (existence of butts, bulbs, negative bulbs, ridges, etc). Consequently, we are aware of the ambiguity which we also introduce by aiming to categorise the objects. Nonetheless, we hope that the analytical description via the presentation of criteria such as the step fractures, pitting, battering, absence of knapping platforms, irregularities and impossible angles for knapping, etc, are enough to justify our classification.

We are also aware of the problems raised with the categorisation of active percussion elements. Figure 9.20a is a perfect example of how active percussion elements compose a homogenous group that is very distinct from anvils from a morphometrical perspective. As mentioned previously, it is relevant to stress that the classic hammerstones, hammerstones with fracture angles, with battered ridges, spheroids, and even anvils do not compose discrete morphotypes, and can be elements of the same *chaîne opératoire*. Yet this does not refer solely to these objects; it would be possible to find (and this has actually been documented) cores used previously as anvils. Furthermore, there are anvils that present typical battering denoting their use as active hammerstones. Obviously, there are also pieces with uniform battering linked to knapping activities that present completely abraded ridges due to a complementary battering use...

In summary, the Olduvai artefacts compose a dynamic sequence in which objects had a polyfunctional use and in which the morphotypes identified by archaeologists were interrelated with one another. Despite these considerations, we believe a distinction can be made between different categories, based on the stage of use in which the items were abandoned in order to discriminate the activities performed. It is important to emphasise that at sites such as TK or FLK North I over 100 kilograms of raw material were used for percussion activities (see fig. 9.21), activities which in these assemblages and in others such as FC West or FLK North II were the most significant documented procedures (processing animal carcasses? vegetables?). Thus, our aim is to stress the variability of activities performed by the Plio-Pleistocene tool-makers: Olduvai hominids did not only use lithic material for knapping, they also invested a great amount of the stock of raw material in activities linked to the percussion of other elements. After explaining the importance of these activities, we can move on to assess the knapping strategies throughout the Olduvai sequence.

Knapping activities at Olduvai

A great number of specific reduction options appear over the half-a-million-year time span of the record analysed herein. After having paid specific attention to each of the technical systems represented, there is no need to return to detailed descriptions. On the other hand, the interest lies in considering general issues that allow the discernment of vaster pat-

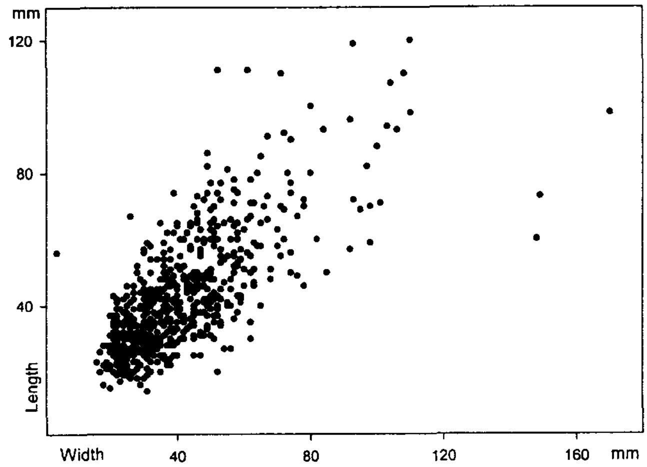

Figure 9.22. Size of the whole flakes at the analysed sites. The main concentration is located between 3-5 centimetres long and wide, and the greatest scattering of flakes corresponds to enormous products in EF-HR, FC West and TK, which are actually unrelated to small-sized *débitage* systems.

terns. In our opinion, knapping strategies in Olduvai can be divided into two main groups, small-sized *débitage* systems and the systems envisaging the management of large blanks. This division separates the sites from a chronological viewpoint (Oldowan assemblages on the one hand and Acheulean ones on the other), and therefore has diachronic connotations. Yet this division also has a functional meaning, since the Acheulean sites present a complementarity between small-sized *débitage* methods and processes for obtaining and subsequently modifying large blanks.

We can advance a few notions on the distinction between the Oldowan and the Acheulean that will be furthered below. Considering the Oldowan as a cores and flakes technology opposite the Acheulean based on large cutting tools, it may seem slightly inappropriate to refer to an "Oldowan exploitation" with regard to the management of small cores in the Acheulean sites. Therefore, it would be suitable to defer the chrono-cultural distinction between the Oldowan and the Acheulean, focusing at present on the technical differences between the small-sized *débitage* systems (both in the Oldowan and the Acheulean) and the management of large blanks, which is typically Acheulean.

We consider the *chaîne opératoire* for small-sized *débitage* as a knapping strategy based on obtaining small-sized flakes (3-5 centimetres), via reduced cores of lava (essentially small stream cobbles) and quartz (generally small-sized tabular fragments), and in which objects presenting secondary modification are practically nonexistent. In general, this *débitage* system has been identified from the base of the Bed I sequence (DK) to the top of Bed II (BK), and in our opinion no significant changes appeared in the *débitage* systems until the TK and BK periods. Therefore, there is a call for a brief revision of the three main categories that define this knapping strategy: flakes, retouched pieces and cores.

Reduction sequences of small-sized débitage*: knapping products*

As regards whole knapping products, the characteristics are similar in almost all sites. Most of the flakes measure about 3-5 centimetres long, with a similar width, and suggest a rather homogenous metric module (fig. 9.22).

Throughout the whole sequence, the usual process consisted of obtaining flakes from faintly prepared knapping platforms (tabl. 9.8 and fig. 9.23). A similar pattern can be identified in the ranges of previous detachments noticeable on the flakes, a good indication of the intensity of the reduction of the knapping surfaces. Flakes with under 4 scars (fig. 9.24 and tabl. 9.9) are the most common, and the few examples that have appeared as from EF-HR with more structured dorsal faces, belong to products linked to the management of the large blanks, and not to the *débitage* system for small-sized flakes. The cortex percentages are not good technical indicators, since upon comparing trends (tabl. 9.10 and fig. 9.25), we see that the differences are explained more precisely by external problems of identification of cortical surfaces than by parameters that are actually technological. It is no coincidence that FLK North Sandy Conglomerate (where chert presents easily recognisable cortex) and DK (with a prevalence of stream basalts with cortical areas) are the two assemblages with the lowest reduction intensity. In any case, if we were to consider these results valid, the high percentages of flakes with cortex indicate not so much the exploitation sys-

Butt	%							
	DK	FLK Zinj	FLK North Levell-2	FLK North Sandy C	EF-HR	FC West	TK LF	TK UF
Non-facceted	9.5	10.4	16.7	19.4	13.8	7.4	9.5	9.5
Unifaceted	85.2	87.2	81	74.2	76.3	91.2	90.5	76.2
Bifaceted	4.3	2.4	2.4	3.2	8.8	1.5	0	9.5
Multifaceted	0	0	0	3.2	1.3	0	0	4.8

Table 9.8. Types of striking platforms in the whole flakes at Olduvai.

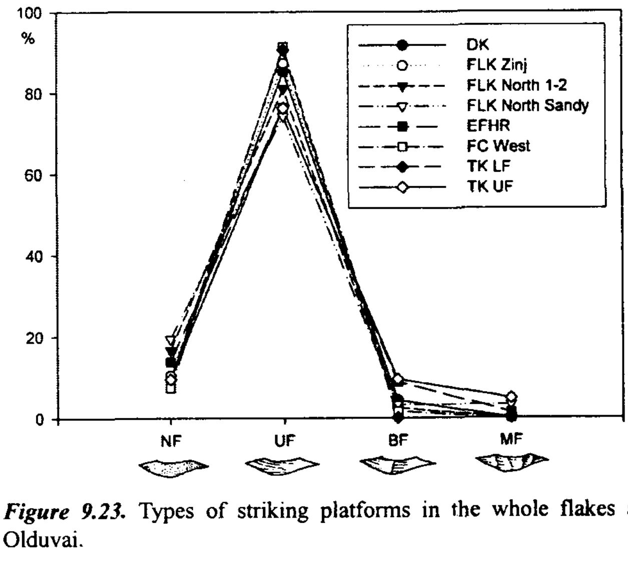

Figure 9.23. Types of striking platforms in the whole flakes at Olduvai.

Number of negatives	%							
	DK	FLK ZINJ	FLK North Level 1-2	FLK North Sandy C	EF-HR	FC WEST	TK LF	TK UF
1-2 scars	50	45.6	47.8	32	52.5	33.3	13	17
3-4 scars	34	42.4	44.9	28	36.3	55.1	20	14
5-6 scars	5.3	6.4	7.2	0	10.1	4.3	5	6
>6	0	0.8	0	0	1.3	1.4	1	1

Table 9.9. Previous scars on the dorsal faces of the Olduvai whole flakes.

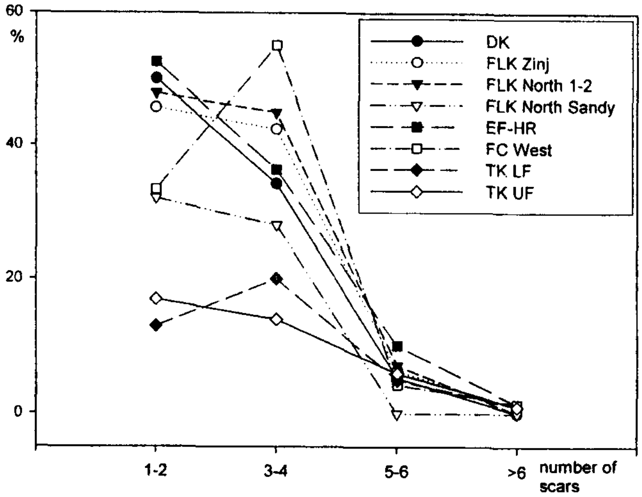

Figure 9.24. Number of scars on the dorsal faces of the whole flakes at Olduvai.

Toth's types	%							
	DK	FLK Zinj	FLK North Level 1-2	FLK North Sandy C	EF-HR	FC West	TK LF	TK UF
I	1.7	1.6	7.1	9.7	2.5	0	0	4.8
II	6.1	4	8.3	9.7	3.8	2.9	4.8	2.4
III	2.6	4.8	1.2	0	6.3	4.4	4.8	2.4
IV	3.5	2.4	6	9.7	1.3	2.9	2.4	0
V	43.5	24.8	32.1	58.1	33.8	23.5	21.4	19
VI	41.7	62.4	45.2	12.9	52.5	66.2	66.7	71.4

Table 9.10. Types of flakes at Olduvai, according to Toth's (1982) classification

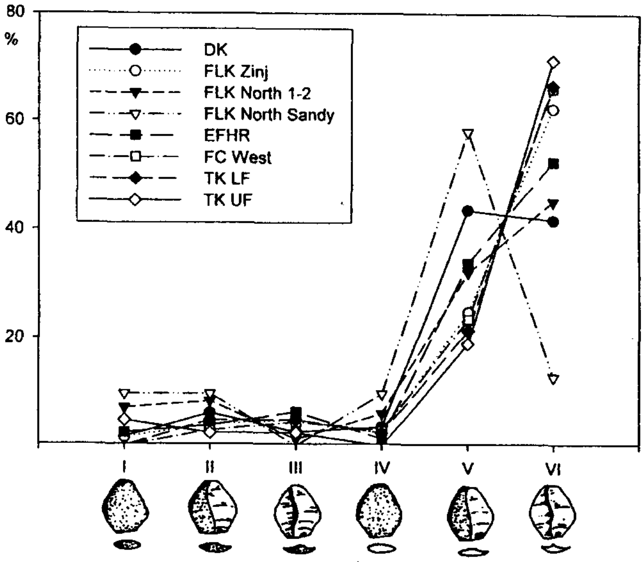

Figure 9.25. Cortex percentages on the whole flakes at Olduvai, according to Toth's (1982) categories.

tem, but the fact that the hominids were transporting almost whole nodules to the settlements.

In all, it seems that the knapping products linked to small-size *débitage* systems were similar throughout the whole Olduvai sequence, regardless of distinctions between the Oldowan or Acheulean sites, at least until reaching the top of Bed II (TK and BK). Flakes have similar lengths and widths, about 3-5 centimetres. They present non-cortical butts that indicate knapping platforms were initially roughed-out, although generally not prepared. The dorsal faces are not very structured, although they always present some previous detachments that indicate a certain recurrence in the exploitation of the same surfaces. This reduction, in view of the scars from previous flakes, was usually unidirectional, although there are examples that indicate a rotation of the exploitation planes. Despite the absence of a genuine technical predetermination, these knapping products present more or less standard morphologies, similar in size, with thin sections and optimal edges, that indicate a more than notable ability to obtain high-quality flakes.

Reduction sequences of small-sized débitage*: cores*

The dimensions of the cores obviously vary in each site since, at least as regards lavas, the size must have depended on the cobbles available in the nearby streams. The selection performed by the hominids also influenced the collection, since they selected, for example, small blocks of quartz in FLK Zinj or high-quality lava cobbles in FLK North. Likewise, in Acheulean sites like FC West small-sized cores are systematically larger than in the previous period. Therefore, some sort of cultural selection is undeniable.

The dimensions of most of the cores for the production of small-sized flakes are similar throughout the sequence, around 8-10 centimetres long and wide. The main difference appears in the raw material, since quartz cores are systematically smaller than lava cores (fig. 9.26). Despite the differences between metamorphic and volcanic rocks, most cores are concentrated in the same group, between 8-10 centimetres. A different problem appears when assessing the intensity of the reduction of the cores. This issue was already set out by Kimura (2002), who stated that the intensity of the exploitation did not change throughout the sequence. According to our cortex percentages on the cores from each site (fig. 9.27), TK suggests the greatest reduction of the pieces, followed by FLK Zinj. Therefore, this aspect should not be linked to diachronic issues. Kimura (2002) based her argument on the absence of a diachronic evolution of the intensity of the reduction on the number of scars per core. Given the fact that when studying a core, only the last

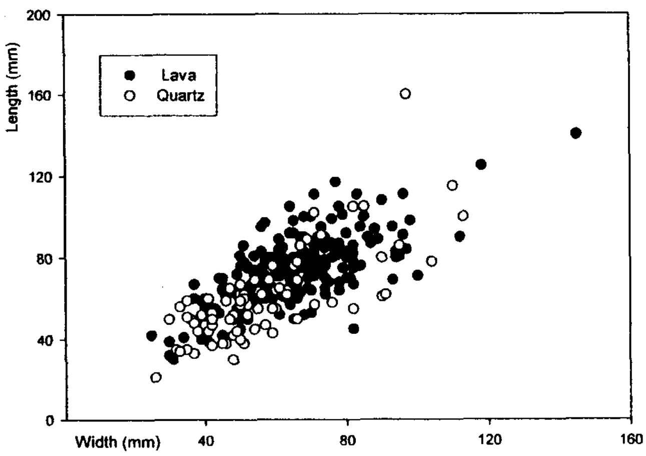

Figure 9.26. Dimensions of the cores at Olduvai sites.

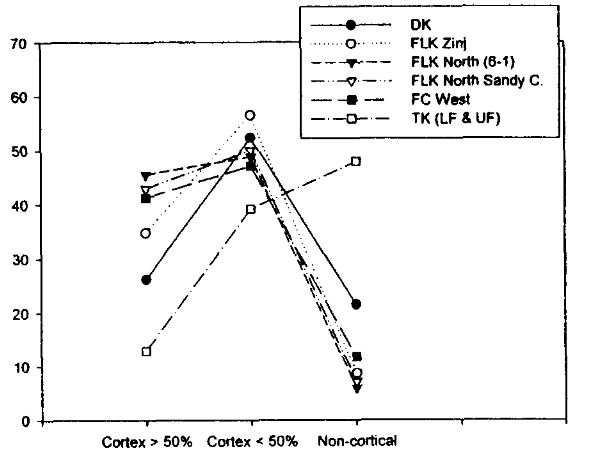

Figure 9.27. Cortex percentages at the sites with more cores at Olduvai.

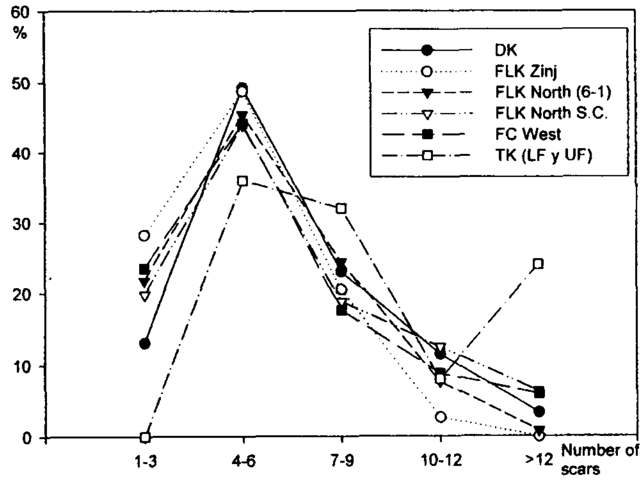

Figure 9.28. Number of detachments in the Olduvai cores.

	%						
	DK	FLK Zinj	FLK North 1-2	FC West	FLK North S.C.	TK LF	TK UF
Unif. Abrupt	30	44.7	9.5	23.6	12.5	12.5	5.6
Unif. Peripheral	4.3	0	2.4	5.3	0	0	5.6
Unif. Simple Partial	1.4	4.3	10.6	5.3	6.3	0	5.6
Bif. Abrupt	20	29.8	17.7	31.6	31.3	25	5.6
Bif. Peripheral	16	4.3	4.8	7.9	37.5	0	5.6
Bif. Simple Partial	15	4.3	47	18.4	12.5	37.5	33.3
Bif. Centripetal	1.4	0	0	0	0	0	11.1
Bif. Alternate	1.4	10.7	0	0	0	0	0
Multifacial	10	0	8.3	7.9	0	25	27.7

Table 9.11. Core exploitation systems of the Olduvai sites.

stage of reduction remains, it is hardly decisive to base one's arguments on this attribute. In figure 9.28 we apply these calculations, observing that only TK presents a different trend to the rest of the sites, where cores usually present 4-6 scars.

In all, cores linked to small-size *débitage* systems share the same characteristics. They measure about 8-10 centimetres, and the number of scars, cortex percentages and general configuration suggest short exploitation sequences. Blocks and cobbles were selected at the raw material sources, transported to the sites in different reduction stages, and exploited there using short knapping sequences until they were discarded. This pattern is repeated systematically in all sites analysed, although TK presents certain novel features, such as a greater size and greater intensity of the reduction of the cores. The management of the blocks of raw material was performed according to different reduction methods. Therefore, it is essential to re-examine the technical patterns employed.

Reduction sequences of small-sized débitage*: knapping methods*

In this book, the definition of the different knapping methods has been established as we identified a new technical system in the sequence. It is no coincidence that almost all these methods were already defined in the chapter dedicated to DK, since the oldest site in Olduvai already presents most of the reduction possibilities known to hominids during Beds I and II. We should therefore elude any type of evolutionary connotation in the technical parameters, since they were very similar over half a million years. At least, from the bottom of the archaeological sequence to TK, with the latter denoting certain new technological features that became evident in BK.

Table 9.11 shows the percentage-based distribution of the different reduction options. As occurs in figure 9.29, no diachronic trend appears in favour of a specific type of reduction. Nevertheless, the constant predominance of two technical systems is noticeable, the unifacial/bifacial simple partial method (that Leakey classified as choppers) and the unifacial/bifacial abrupt process (that Leakey usually considered heavy duty scrapers). Considering they are non-hierarchical knapping systems, their unifacial or bifacial character simply indicates the need to prepare knapping platforms or not (or more precisely to remove the cortex).

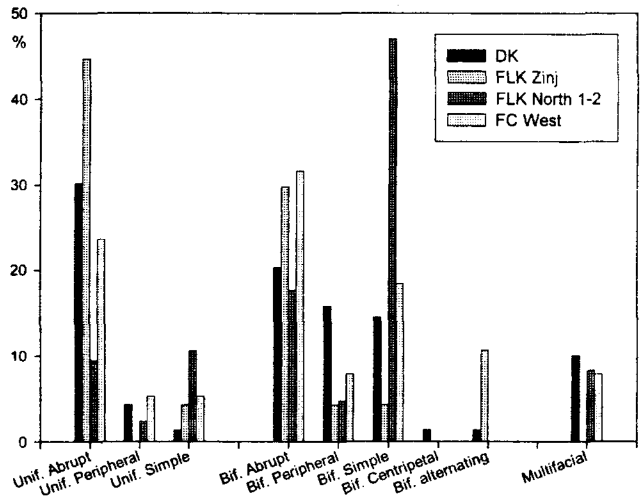

Figure 9.29. Diagram of the knapping systems at the sites with more cores at Olduvai.

DK and FLK Zinj show a prevalence of abrupt cores (tabl. 9.11). When natural flat surfaces formed by the tabular platforms of the small blocks are available, as appears commonly in FLK Zinj, the surfaces do not even require bifacial interaction, and that natural plane is used as a knapping platform for a unifacial abrupt exploitation. Other times, when craftsmen aimed to prolong the core's lifespan or simply rejuvenate the striking platform, they created a bifacial interaction edge that divided the abrupt exploitation surfaces into two different surfaces.

In assemblages like FLK North 1-2 or TK, the most important system is the bifacial simple partial method, i.e. the system that produces bifacial choppers. If these pieces were artefacts (Leakey 1971; Kimura 1997; Roche 1980; etc), it would be relevant to distinguish the bifacial simple system from the abrupt method, since the former creates a forceful ridge that does not exist in the latter. Yet, if the choppers are actually cores (Toth 1982; Isaac 1986; Potts 1991), as proposed when stressing the absence of traces on these pieces' edges, the discrimination of the bifacial abrupt method can be limited to a mere nuance without further importance. On the condition that these items are cores and not artefacts, which is as yet unclear (see below).

The rest of the knapping systems are secondary in all sites. The multifacial or polyhedral system, for example, is only genuinely important in TK Lower Floor and Upper Floor (tabl. 9.11). We have already insisted on the fact that this system does not seem to be connected to the intentional *façonnage* proposed by Texier and Roche (1995), but seems more like a continuation of the exploitation of exhausted cores. Although we have argued these issues, we would like to propose an additional reflection: the higher percentage of multifacial cores in TK, precisely the site where figures 9.27 and 9.28 note a greater intensity of the reduction.

Finally, we will move on to refer to what could be designated as structured knapping methods. Based on illustrations by Leakey (1971), different authors (Gowlett 1986; Davidson & Noble 1993), us among them (de la Torre *et al.* 2003; de la Torre & Mora 2004), misinterpreted the DK cores, comparing them to knapping methods typical of the Middle Palaeolithic. This error lies in the interpretation, since most of the cores Leakey (1971) classified as discoids are similar to these items from a morphological (although not from a technological) point of view. Moreover, many of them are not even cores (see chapter 2). In DK, the exploitation of horizontal surfaces is usually limited to peripheral methods, that never penetrate the inner area of the pieces, exploiting only the edge. This leads to a rapid exhaustion of the cores. This pattern appears throughout the Olduvai sequence, where the tool-makers can never manage the central volume of the cores, which leads to the knapping surfaces being exhausted easily.

The change that occurred in the knapping methods (and here we see a qualitative distinction between the small-sized knapping systems in the Oldowan and Acheulean sites) can be perceived in TK, and especially in BK. In the latter, cores have been assigned to the discoid method, both in the most specific definitions (Böeda 1993) and in the most general descriptions (Lenoir & Turq 1995; Slimak 1998-1999, 2003; Terradas 2003; etc). Moreover, in BK and TK UF there are examples exploited implementing the bifacial centripetal hierarchical method defined in Peninj (de la Torre *et al.* 2003) and we could even include some in the recurring centripetal Levallois method *sensu* Böeda (1993, 1994). In short, *débitage* methods that incorporate novel technical parameters have been identified at the top of the Bed II sequence and in completely Acheulean contexts. We can still consider these systems as typical of the production of small-sized flakes, since the goal is to obtain products measuring 3-5 centimetres that are completely unrelated to the *chaînes opératoires* for large blanks. Yet, they differ in the way they are obtained. Or, at least, this method is complemented with other methods that are still employed. In times of TK and (essentially) BK, craftsmen were capable of reducing cores exploiting the whole volume of the piece, not only the periphery, thus avoiding a rapid exhaustion. Moreover, there is a hierarchical organization of the knapping planes, using one surface as the preparation plane and the other as the surface on which to obtain flakes, which could be pre-established. In all, the knapping system is perfectly structured and maintained throughout a long reduction sequence, in which tool-makers controlled the exploitation of raw material and managed it more optimally.

Yet this is not the rule in the exploitation of the Olduvai cores. During the whole of Bed I and most of Bed II, the hominids did not care for exploiting the raw material intensely. Perhaps due to their ignorance or their technical incapacity, the FLK Zinj, DK and FLK North hominids, and partly those from EF-HR, TK and FC West, selected small blocks or pebbles which were only partially exploited. Perhaps, as proposed by Toth (1982) as regards Koobi Fora and as Potts (1988) recovered for Olduvai, many of the types of cores belong to different stages of one same reduction chain. In any case, these stages of the reduction sequence were always short. In general, the Olduvai hominids were not concerned with exploiting (or were not skilled to exploit) the cores intensely. They obtained cobbles or blanks from streams and prepared them if necessary, and then, they discarded them after a few flake detachment sequences. Nevertheless, the knapping strategy for this *chaîne opératoire* was optimal, and high-quality flakes were obtained. Sometimes, not very often, these flakes underwent a secondary modification; thus becoming retouched objects.

Reduction sequences of small-sized **débitage***: small retouched pieces*

The items Leakey (1971) called light-duty tools always composed, according to her calculations, relevant percentages in all the Olduvai sites. Leakey described a typology of small retouched pieces, with burins, all kinds of end scrapers, awls, side scrapers, etc. Some authors like Isaac (1986) questioned the validity of the types defined and the true importance of the small retouched pieces in the Oldowan assemblages. Along these same lines, Potts (1991) doubted the presence of burins in Bed I, and his percentages of light-duty tools are more restricted than Leakey's (1971).

In our re-examination, we have observed that most of the retouched pieces Leakey proposed are debatable. The so-called burins are generally Siret fragments, and other categories like awls and end scrapers are only morphologically similar to these objects, but are usually not even retouched. In other cases, like FLK North Sandy Conglomerate, the delicate chert edges explain the abundance of so-called retouched pieces, which have in fact been altered by postdepositional damage. In all, the percentage of retouched flakes or fragments is always extremely low (see tabl. 9.12), and connected to two recurring types, continuous side scrapers and denticulates, which do not present standard shapes, but have only been retouched to modify one or two of the piece's edges, without creating specific morphologies.

Another issue is assessing whether a diachronic trend can be determined. Leakey (1971) mentioned changes throughout the sequence, and Kimura (1999, 2002) returns to this issue. Without debating Leakey's calculations, Kimura maintains that the greatest percentages of retouched pieces appear in the assemblages of the so-called Developed Oldowan A such as FLK North SC and HWK East, followed by others like DK, concluding that "*the analysis point out that the production of retouched flakes is simply raw material related, and may not be suggestive of technological development of the toolmaker*" (Kimura 2002:302). This argument already seems slightly doubtful in itself, since we are unaware of the connection between the availability of raw material and an artefact being retouched. If there are different raw materials it is perfectly viable that the knapper chose one or another to subject it to secondary retouching. However, it does not seem very sensible to suppose that the knapper would only retouch it if it were in a specific raw material or, as Kimura proposes, that the hominids retouched pieces in FLK North SC or HWK East because chert was available in these areas, whilst not in other sites because retouching artefacts is linked to the exploitation of chert. Actually, we think the high percentages of retouched items that Kimura (1999, 2002) observed in these sites is due precisely to postdepositional pseudo-retouching, which does affect chert preferentially, given the susceptibility of the pieces' edges. It is no coincidence that Kimura (2002) considers DK the following most important assemblage as regards the number of retouched pieces, being precisely a site with a consistent pattern of artefacts with post-depositional damage, i.e. pseudo-retouching.

Returning to the quest for possible diachronic trends in the frequency and variability of the small retouched pieces, table 9.12 shows no conspicuous change in the type of retouched pieces throughout the sequence. So-called "evolved" artefacts like end scrapers did appear in FLK Zinj but not in more recent sites like TK. Therefore, the typological patterns are recurrent in all sites, with a prevalence of continuous or denticulate scrapers without specific morphologies. As regards diachronic tendencies, it is hard to assess this issue in comparative terms. We have established a rate based on the number of retouched pieces divided by the number of whole flakes in each assemblage. Although this may seem like an arbitrary selection, it is one of the few possible comparisons since, given the amount of percussion elements documented in the sites, the whole flakes category is one of the few to which we

	%						
	DK	FLK Zinj	FLK North 1-2	FLK North S.C.	FC West	TK LF	TK UF
Denticulate side scrapers	60	13.3	75	20	38.5	30	32
Continuous side scrapers	40	80	25	60	53.8	70	68
End scrapers	0	6.7	0	0	7.7	0	0
Others	0	0	0	20	0	0	0
Total number	10	15	8	5	13	20	25

Table 9.12. Small retouched pieces at Olduvai.

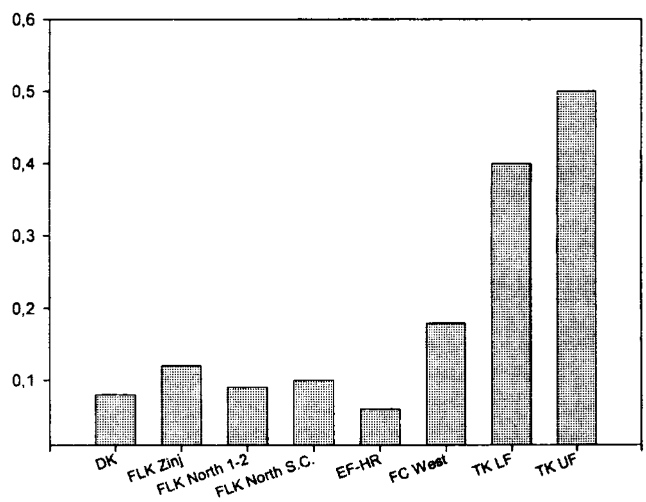

Figure 9.30. Index of small retouched pieces in each site, obtained dividing number of retouched pieces between the total of whole flakes.

can still assign *débitage* processes safely; a category also encompassing the small retouched pieces. A trend appears upon calculating this rate (fig. 9.30): the percentage of retouched items is stable in the Oldowan sites, with the scale indicating the scant relevance of this category. Nevertheless, and except in EF-HR, in all Acheulean assemblages the relative frequency of the small retouched pieces escalates compared to the number of whole flakes. Now, the secondary modification of the products is a systematic activity. Despite this fact, these small retouched pieces do not characterise the Acheulean assemblages, and we should move on to analyse the features that define this new technology.

The chaîne opératoire *for the production of large blanks*

In the Acheulean sites, alongside the *chaînes opératoires* for percussion and those typical of small-sized *débitage*, a new production system appears, linked to the management of large blanks. This management is employed in two spectrums: formerly, to obtaining blanks, generally large flakes; secondly, in their subsequent modification, undergoing retouching activities.

When referring to large cutting tools we mean a type of object that, regardless of the blank (be it flake or cobble/block), presents identical features, specifically the working of the edges of the large pieces (generally over 10 centimetres) to create rims and pointed areas. The characteristics of the *façonnage* employed for these artefacts was described in chapters 5 and 7, and will, therefore, not be repeated herein. We would merely like to state that no genuine bifaces have appeared in the Acheulean sites of EF-HR, FC West and TK. That is to say, the large cutting tools are not divided into symmetrical or asymmetrical planes, with an invasive retouch that modified the whole surface of the artefact. In fact, this type of pieces do not even fulfil the requirements proposed by Böeda *et al.* (1990) to refer to an intentional *façonnage* of the bifacial artefacts. In all, they are large side scrapers with edges retouched unifacially or bifacially, in which the retouching never aims to manage the whole volume of the object or divide it into two different planes.

In contrast, the genuine goal of both the pieces retouched on flake and on cobble or block, is to configure an edge with the least number of retouches possible, generally connected to a point that does present a more meticulous manufacture. This is the technical pattern that appears in EF-HR, FC West and in both levels of TK. In contrast, the objects analysed in BK could be included in a genuine definition of bifaces. The BK artefacts present a configuration edge that separates two symmetrical planes, with invasive scars that manage the whole volume of each surface, with a meticulous *façonnage* on the edges to create continuous rims, with pointed areas. The difference between BK and the previous assemblages lies precisely in the existence of genuine bifaces, although this site also presents the same unifacial large cutting tools as in previous sites and with an identical management of the large blanks, which allows us to connect all the collections considered Acheulean herein according to a technological perspective.

Despite the qualitative importance of the large blanks (with or without retouching), their quantitative relevance was always limited. Only two of these objects have appeared in FC West, and both are fractured, weighing only slightly over one kilogram of the 88 kilograms of worked raw material. In both levels of TK, these pieces amounted to 27 items, composing slightly over 15 kilograms in a site with over 220 kilograms of worked lithic material. The large cutting tools only supposed a relevant percentage in EF-HR, in an assemblage which, quite certainly, focused on obtaining these artefacts.

Therefore, it is essential to underline the fact that the difference between the Oldowan and the Acheulean does not only lie in the existence of the large cutting tools as such, but in the actual technology needed to obtain these large blanks. In the Acheulean sites, even in those where the large cutting tools were obtained on blocks, like TK, we find flakes that are quite different to those typical of the Oldowan. They are large products, with well-structured dorsal patterns, high quality sections and rims, which come from enormous cores that have, nevertheless, not been found in the sites.

Given the absence of this type of cores, we have to turn to experimental studies to analyse how those large flakes would have been obtained (i.e. Madsen & Goren-Inbar 2004). Kleindienst and Keller (1976:181) proposed that striking the core against the anvil (see fig. 9.12b) would produce large blanks for bifaces and cleavers. Jones (1981, 1994) performed experiments on the manufacturing of the bifaces in Beds III, IV and Masek. This author notes that, so as to obtain large lava flakes, the fastest and easiest method is to strike (not throw) the hammerstone on large blocks placed on the floor. Although Jones (1994) does not detail the method in which these large cores would be prepared, he does state that up to 10 enormous flakes weighing half a kilogram each (therefore quite similar to the flakes described in this monograph) were obtained per core. Notable strength and ability are needed to obtain flakes of this size and manufacture, although, as Jones (1981) reminded, obtaining and retouching these large blanks can be performed in under two minutes.

Anyhow, it is a novel technique for obtaining blanks for retouching that should be considered alongside the probable use of the soft hammerstone in the *façonnage* of the retouched pieces (although not for the production of large flakes), as set out in the examples from chapter 6 and (especially) chapter 7. If this were confirmed, it would be the first known evidence of the use of organic materials as hammerstones, and would appear as an additional fact to incorporate to the reflection on the origin of the Acheulean technology.

The aforementioned, considered alongside the space-time separation implied by the transport of flakes from the supply point where they were obtained to the settlement where they were discarded, supposes a qualitative shift as regards Oldowan sites, and implies a division, perhaps biological, most probably cultural and certainly technological, between the assemblages prior to the Middle Member of Bed II and subsequent sites. We must further an issue that is, actually, more connected to historical-cultural issues than to the reconstruction of technological strategies we have embarked on previously.

Oldowan, developed Oldowan and Acheulean at Olduvai

Basically, we owe the definition of these concepts according to diachronic, typological and cultural connotations to Leakey (1967, 1971, 1975). According to this author, all the sites in Bed I and those in the bottom of Bed II should be assigned to the Oldowan. Based on the frequencies of the objects, the Oldowan was characterised by the profusion of choppers, polyhedrons, discoids, side scrapers, occasional subspheroids and burins, alongside hammerstones, used nodules and flakes. According to Leakey, the Developed Oldowan A appeared precisely after the deposition of Tuff IIA and still in the Lower Member of Bed II. The Developed Oldowan A presents all the types of artefacts from the previous period, but shows an obvious increase of spheroids and subspheroids, and a greater number and variety of light duty tools.

Two new cultures appeared after the deposition of Tuff IIB, both linked to a new artefact, the biface. According to Leakey (1971:2), and following the proposal suggested years before by Kleindienst (1962), assemblages with over 40% of bifaces in the tool group should be classified as Acheulean; therefore, she included EF-HR in that culture. Leakey warned that these initial Acheulean forms presented bifaces that were minimally prepared, with vast internal variability. The author also stated that the lithic items was contemporary to or even earlier to what she called the Developed Oldowan B. The latter was characterised by a small percentage of bifaces: the presence of these objects distinguished Developed Oldowan B from the previous A type, but the scant number of bifaces prevented these sites from being considered Acheulean assemblages (Leakey 1971:2). The evidence of more side scapers, burins, awls and other artefacts than in Developed Oldowan A was also a decisive factor to differentiate both cultures (Leakey 1975).

Leakey (1971:271) stated that the Acheulean and the Developed Oldowan B not only differed in the biface frequencies, but also in their characteristics. Although no typological differences can be proposed (since Leakey noted the absence of standardisation as regards these pieces), there did seem to be disparity in terms of the size, morphology and manufacture method. Consequently, Leakey considered the Acheulean bifaces followed a homogenous pattern, with more or less regular sizes and shapes, almost always using flakes as blanks, whilst in the Developed Oldowan B, morphologies and dimensions were arbitrary, and the bifaces were usually smaller than those found in the Acheulean and shaped on cobbles or blocks. Although Leakey (1971) did not exclude the fact that these differences could be explained in view of the functionality of the sites, she favoured the existence of two different cultural traditions, proposing that there were two groups of hominids in Bed II, *Homo habilis* – still using the Oldowan technology – and *Homo erectus* – implementing a new Acheulean culture. This coexistence of both industries spread throughout the upper part of Bed II, and Leakey (1975; Leakey & Roe 1994), when referring to Beds III, IV and Masek, still mentioned a coexistence of the Oldowan (now Developed Oldowan C) and the Acheulean.

Since Leakey (1967, 1971, 1975) proposed a chrono-stratigraphic and cultural division of the industries in Beds I and II, studies based specifically on the problems of distinguishing between the Developed Oldowan and the Acheulean have been plentiful (for example Gowlett 1988; Bower 1977; Davis 1980; Stiles 1979, 1980; etc).

One of the first alternatives to Leakey's (1971) cultural and biological interpretation was proposed by Hay (1976). This author stated that all the Acheulean sites in the Olduvai basin were far from the lake, whilst the Oldowan assemblages were less than one kilometre from the lake shoreline. This led to a functional interpretation to explain differences that had formerly been connected to historical-cultural issues. Isaac (1971:293) had already remarked that the Oldowan assemblages of Bed II were located in the lakes floodplains, whilst the Acheulean sites were linked to more remote streams. In fact, Hay (1990:33) himself notes that Isaac had already suggested the hypothesis stating that the technical differences in the Developed Oldowan and the Acheulean could be explained given the different use of the settlement by the same group of hominids, although the latter never published it expressly.

Despite the appeal of this hypothesis, most of the works that debated the relationships between the Developed Oldowan and the Acheulean focused on taxonomic issues linked to the interpretation of lithic assemblages, although always respecting Leakey's (1971, 1975) original classification regarding each assemblage (see tabl. 9.1). Stiles (1977, 1979, 1980, 1991) carried out multivariate analyses considering the metrics of the bifaces from the sites Leakey (1975) classified as Acheulean (EF-HR and TK LF) and Oldowan (TK UF and FC West), asserting that there were significant differences in the bifaces of both groups. Stiles concluded that the differences between the Acheulean and Oldowan assemblages were limited only to the characteristics of the bifaces, stating that these differences could be explained by the availability of raw material and not by cultural or biological matters. According to Stiles, once the bifaces are documented in the sites, we have to refer to an Acheulean Industrial Complex, and therefore *"this suggests that one population with a wide range of variability is being sampled and that the Developed Oldowan B and Acheulian are not distinct industries"* (Stiles 1980:192).

Davis (1980) questioned Stiles' arguments regarding the similitude between the Developed Oldowan and the Early Acheulean. Using second hand data and complex multivariate analyses, Davis (1980) came to conclusions that conflicted absolutely with Stiles', stating that the differences between both groups were notable and that Leakey's (1971) original interpretation should be sustained. In this pendular movement of interpretations, Gowlett (1988) asserted, also using Main Component Analysis, that the Oldowan bifaces were similar to those found in the Acheulean, and that therefore no differences could be outlined between them. Although this conclusion was the same as Stiles' (1977, 1980), who did not accept the existence of a Developed Oldowan after the emergence of the Acheulean either, this same author (Stiles 1991) criticised Gowlett (1988) for proposing a homogeneity between bifaces that Stiles considered different, albeit basing his findings on raw material, not cultural explanations. In this oscillation of interpretations, Roe (1994) compared the metrics of the (so-called) bifaces in Beds I and II to the samples in Beds III, IV and Masek, observing that there were very significant differences between the artefacts from the Developed Oldowan and the ones from the Acheulean. Even more so, he stated that Developed Oldowan B in Bed II and type C in Bed IV were identical in the morphology of their bifaces and very different to the ones from the Acheulean in the whole sequence (Roe 1994). Finally, Jones (1994) explained the differences as regards the sizes of the bifaces from the Developed Oldowan and the Acheulean simply considering the intensity of the reduction. Thus, he stated that they were the same human groups, but that, in terms of the availability of raw materials and the requirements regarding the use of the bifaces, these items would be more or less reduced, giving way to so-called Oldowan pieces (the smaller bifaces) or Acheulean items (in the first stages of reduction).

Most of these contradicting interpretations have two common features: they are based on complex multivariate analysis – except for Jones (1994) – and on published data, not collected by the authors themselves – except for Stiles (1977). For example, Callow (1994) based his analysis of the bifaces in Bed II on data obtained from Leakey's drawings, without examining the original pieces. Therein lies precisely one of the problems this debate encompasses. A simple reflection appears after wondering what would happen if we were to remove all the pieces Leakey (1971) classified as bifaces from the complex multivariate analyses, since herein, after studying the actual collections, many of those pieces have been included among natural items or chunks. When the so-called bifaces are studied directly, we see that a lot of the small-sized items from the Developed Oldowan are not bifaces, quite often they are not even retouched pieces and, those which can be classified as large cutting tools, are similar to those considered as Acheulean examples. Consequently, part of the statistic argument on the proportions of the so-called bifaces would be invalidated. In its turn, this would also invalidate the deductions on the variability of the assemblages and their cultural implications.

Another major problem appears when assuming Leakey's (1971) cultural allocations uncritically, without performing a previous reflection on the terminological, chronological and cultural connotations implicit in this definition. This does not only affect the discussion that arose in the 1980's on the taxonomic allocation of the assemblages, but to more recent works: Monahan (1996: 96) assumes Leakey's (1971) division between Developed Oldowan A, B and Acheulean, without even incorporating the corrections the author herself included subsequently (Leakey 1975), whilst others like Kimura (1997, 1999, 2002) respect Leakey's (1971, 1975) terminology even after carrying out first hand examinations of the collections.

In our opinion, any assessment regarding the Olduvai assemblages must be based on a direct analysis of the collections. Without a global study of each site it is impossible to understand the individual categories it is composed of. Suffice it to mention the TK Lower Floor example, initially considered a Developed Oldowan B example (Leakey 1971) and then an Acheulean one (Leakey 1975): its 10 large cutting tools (not bifaces) constitute less than a fifth of all the worked lithic material. Chapter 7 also demonstrated that both levels of TK have a representation that is practically identical as regards all categories (anvils, cores, flakes, retouched pieces, etc) and raw materials (quartzes and lavas), and in fact the genuine large cutting tools are practically identical in terms of their manufacture in both assemblages. Then, why consider them different cultural facies ?

Thus, we share Gowlett's (1986) consideration; if the Acheulean is a synonym for biface, technologically (not functionally) one example is as important as forty, since it is a qualitative feature, based on the capacity and/or intent to impose a specific shape via retouching a large blank. Any of these objects is produced following a regular, systematic pattern, based on the mental predetermination of the desired shape (Clark 1996). Therefore, categorising assemblages as belonging to the Developed Oldowan or the Acheulean in terms of the biface proportion cannot be an acceptable criterion. Actually, Leakey herself must have come to a similar conclusion, since in her final considerations on the difference between the Acheulean and the Oldowan she stated that "*basically, the factor that distinguishes the two traditions is an inability to detach large flakes in the Developed Oldowan*" (Leakey 1975:485).

In our opinion, this is precisely the key to the difference between the Oldowan and the Acheulean in Olduvai: that obtaining and modifying large flakes. True enough, in the early stages of Bed II there are elements that differ from those documented in Bed I, such as the appearance of spheroids in assemblages like FLK North Sandy Conglomerate. Yet, this could be linked to the substitution of traditional hammerstones (Isaac 1982:238), perhaps because the immediate surroundings were lacking in lava stream cobbles (Kyara 1999:354). Apart from the issue of the spheroids, FLK North SC presents exactly the same characteristics as other Oldowan sites like DK or FLK Zinj. In fact, the small chert nodules, despite being a novel resource, were exploited following a knapping strategy identical to the procedure that could have been used by the hominids that generated the previous assemblages.

Therefore, we insist on the fact that the qualitative change appears in the management of large cores. FC West, which Leakey (1971, 1975) considered Developed Oldowan, provided considerable huge flakes alongside a couple of large cutting tools. The scarce number is not indicative of an Oldowan cultural entity, but simply of the fact that the production and/or use of these large artefacts was not the main goal of the occupation. Proportionally, the two TK levels present a similar number of these large cutting tools, and we know that percussion processes were the most relevant activities in these sites. Both levels are technologically identical, therefore, although some authors (i.e. Kimura 2002) maintain a cultural separation, there are no grounds on which to support this theory. Either both are considered Oldowan or both are considered Acheulean. In view of the retouched pieces weighing over two kilograms, the selection seems obvious. EF-HR, the only site Leakey (1971) originally considered Acheulean, has not suffered misinterpretations simply because the production of large cutting tools was the main activity developed. In other sites, the knapping processes appeared alongside other activities like percussion. It is important to bear BK in mind, an assemblage Leakey (1971, 1975) classified as Developed Oldowan B, when it was the sole example presenting genuine bifaces. It would be paradoxical that we were to consider EF-HR, where there are no bifaces, only enormous side scrapers, an Acheulean site, whilst BK, the only site in Bed II where these bifaces do exist, is classified as Oldowan.

In short, these are the main differences between the Oldowan and the Acheulean. In our opinion, there is no such thing as the Developed Oldowan. Considering the assemblages we have examined, DK, FLK Zinj and all levels of FLK North can be established as Oldowan sites. In all of them, regardless of the percussion activities (which appear in the sites irrespective of their cultural assignment), knapping processes focused on the management of small-size cores which produced flakes that were most probably used directly. Since the emergence of EF-HR, and during the time span encompassing FC West, TK and BK, the strategies for the management of lithic resources have undergone a series of changes. As Isaac (1986) mentioned, we documented an increase in the level of technical complexity, given the incorporation of a new step in the process for manufacturing artefacts, consisting in the detachment of enormous flakes and the quest for large blocks that would be used as blanks for large cutting tools. This innovation could have included preconceived rules for design for the first time (Isaac 1986:233), and appeared alongside an increase of small retouched pieces. In all, and simplifying the definition of both technologies to the greatest extent, there is a shift from an Oldowan trend, based on a technical sequence consisting of only two stages (flake detachment and their immediate use), to the Acheulean composed by at least three stages (flake detachment, secondary modification and imposition of a specific morphology, and subsequent use). Most certainly, this was also accompanied by a change in the way the territory was managed. The last section of this chapter will attempt to dilucidate these activities.

The management of the landscape in Beds I and II at Olduvai

After examining the processes for the formation of the settlements, the objects that do (or do not) belong to archaeological collections, the artefacts linked to percussion processes, those linked to knapping activities and, in all, the technological differences observed between the two main groups of sites, there is one last step to mount in the scale of inferences: the specific functionality of each settlement and its role in the management of the landscape carried out by the hominids that occupied the Olduvai basin in the Lower Pleistocene.

In this section, the goal is to reconstruct those movement and functionality patterns considering our work performed on the lithic collections. Previous chapters have been dedicated to the relationships between categories in each of the sites, and in this chapter we have also compared the distribution of these categories throughout the sequence. One last test could be a global comparison of all the categories, with a view to discerning trends linked to the functionality of the settlements. Figure 9.31 includes a Factorial Analysis of Correspondences with a very simple list of correlations, based on table 9.13, i.e., on the distribution of the categories in each site. Although some of the associations are obvious and have already been described, such as the one that linked FLK North Sandy Conglomerate to spheroids or the association that underscores the vast relative amount of small retouched pieces and TK Lower Floor, there are others that can be connected to the functionality of the settlements.

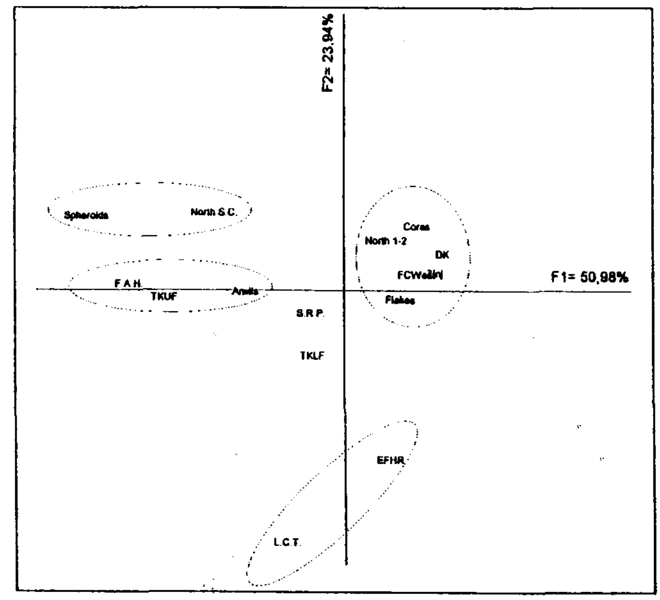

Figure 9.31. Factorial Analysis comparing the most important sites and the most informative lithic categories. S.R.P.: small retouched pieces. F.A.H.: fractured angles hammerstones. L.C.T.: large cutting tools.

	DK		FLK Zinj		FLK North 1-2		FLK North S.C.		EF-HR		FC West		TK LF		TK UF	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Test cores	7	0.7	19	0.7	16	1.3	6	2.4	-	-	4	0.4	2	0.1	5	0.1
Cores	69	6.8	49	1.9	85	7	16	6.4	6	1.4	39	3.3	8	0.3	19	0.3
Large Cutting Tools									29	6.8	2	0.1	10	0.4	17	0.3
Small retouched pieces	10	1	15	0.6	8	0.6	5	2	5	1.2	13	1.1	20	0.8	25	0.4
Hammerstones & frag.	36	3.5	30	1	76	6.2	32	12.9	8	1.8	114	9.7	14	0.6	27	0.5
Hamm. fract. angles	1	0.1	-	-	13	1	3	1.2	-	-	31	2.6	9	0.4	28	0.5
Spheroids & Subspheroids	-	-	-	-	1	0.1	47	19	-	-	-	-	4	0.2	48	0.9
Anvils & frag.	-	-	2	0.2	25	2	2	0.8	-	-	8	0.6	18	0.7	33	0.6
Whole flakes	115	11.3	125	4.9	84	6.9	50	20.2	80	18.6	69	5.9	42	1.8	42	0.8
Frag. < 20 mm	140	13.7	1320	51.6	222	18.3	-	-	23	5.4	230	19.7	1891*	81,3*	3122	60
Flake fragments	511	50	865	33.8	542	44.9	37	14.9	221	51.5	425	36.5	296	12.7	1430	27.4
Angular fragments	132	12.9	130	5.1	117	9.6	37	14.9	54	12.6	225	19.3	*	*	171	3.2
Others	-	-	2	0.2	20	1.6	13	4.9	3	0.7	2	0.1	11	0.5	235	4.5
Total number	1021	100	2557	100	1210	100	248	100	429	100	1162	100	2325	100	5202	100

Table 9.13. Lithic categories at Olduvai sites. Lava unmodified material is excluded, but not the rest of unmodified pieces. (*) Both categories (chunks and chips) were synthesized.

In this figure 9.31, the exclusive association between EF-HR and large cutting tools becomes evident, as does the importance of percussion processes in TK Upper Floor (which is linked to the presence of hammers and anvils). All the Acheulean assemblages are located in that lower left quadrant, probably given their connection to large cutting tools. FC West is the exception, since although it is considered Acheulean herein, is located near Oldowan assemblages like FLK Zinj, FLK North 1-2, and DK. This underscores the relationship between these sites and *débitage* processes, which indicated that in Oldowan assemblages the most important activities were the production of small-sized flakes, which also predominated in an Acheulean site like FC West. At this point, it is pertinent to summarise the activities performed in each site, and link them to the information we have regarding the sources for the procurement of raw material.

The Olduvai territory in the Oldowan

Commencing with the oldest site, in chapter 2 we underlined the immediateness of the technological strategies in DK. The lithic material is essentially local, based on the exploitation of lavas that were probably obtained in the site's immediate surroundings. Furthermore, there do not seem to be any voids in the *chaîne opératoire* that imply the contribution or exportation of specific lithic elements. The DK hominids transported cobbles to the settlement, knapped them without actually exhausting them and discarded cores in the same place. Quite certainly, this must have been linked to the processing of animal carcasses. According to Potts (1988), DK represents a humid savannah habitat with closed vegetation. Both this author and Plummer and Bishop (1994) insist on the variety of animal species represented, which came from different ecological niches. Thus, despite the local nature of the exploitation of lithic resources, the verified relationship between the bones and the lithic concentration suggests that hominids were visiting different ecological areas, and transporting bone remains to a specific point in the landscape. We must also consider the presence of quartz in the site. Despite the assemblage presenting a low quartz count (not even 3 kilograms), if we deem this quartz to have come from Naibor Soit, we find another element to assess the transport of resources which, in this case too, as occurred regarding the provision of carcasses, will imply a journey venturing over at least 3 kilometres and through different ecological niches. Without forgetting the postdepositional problems it presents, it is possible to say that DK was occupied repeatedly, with hominids returning systematically, bringing remains from over 70 different mammals and almost 53 kilograms of lithic material to this specific point of the landscape.

A similar behavioural framework can be constructed for FLK Zinj. FLK Zinj gives notice of an ecological change towards more open vegetation and a drier climate than in times of DK, with a mosaic of herbaceous areas, acacias and small gallery forests (Potts 1988). As regards the fauna, there are around 40 different mammals represented in the site, many of which present cut and percussion marks. In itself this concentration of bone remains suggests an important accumulation activity, and this fact becomes even more relevant when observing the variability of represented ecological niches, with carcasses from open, intermediate and closed habitats (Potts 1988; Plummer & Bishop 1994; Capaldo 1997; etc). This implies that the hominids moved around a good part of the Olduvai basin in search of animal resources.

This mobility was not limited to obtaining carcasses, but spread to the search for lithic resources. Although in terms of the raw material transported to the site the lavas exceed the number of worked kilograms in quartz, the former metamorphic rocks were reduced more intensely. In fact, in FLK Zinj there are up to 17 kilograms of quartz – without excluding the fact that this number could increase to 20 kilograms, as suggested by Potts (1988). Although the lavas were probably obtained from a nearby stream, the tabular quartzes came from Naibor Soit, about 2 kilometres from FLK Zinj. As Potts

(1988) reasons, although one single person could transport 20 kilograms of quartzite to the site in a single journey from the Naibor Soit inselberg, the blocks that have appeared in FLK Zinj are not usually over half a kilogram, which means that at least 30 rocks this size were transported, which in its turn means the more than one journey was needed or more than one person collected the material.

In FLK Zinj the presence of trees during the occupation has been documented effectively (Klein 1986; Fernández-Jalvo *et al.* 1998; etc), which could have been what attracted the hominids to the settlement (Kroll & Isaac 1984). In short, the fact is that the site was occupied systematically over an indefinite time span that led to the accumulation, in a specific point of the landscape, of over 40 kilograms of knapped stone and a good number of large mammals from different ecological areas.

Neighbouring site FLK North also produced an exceptional assemblage. Here, the behavioural interpretation of the different levels is more complex than in FLK Zinj, where there is a single level of occupation. A good example appears in FLK North 6, which has generally been considered an elephant butchering site (Leakey 1971; Bunn 1986; Potts 1988; Isaac & Crader 1981; Kroll & Isaac 1984; etc), despite its contextual problems (Bunn 1982; Crader 1983; Potts 1988; Domínguez-Rodrigo *et al.* in press). In a previous section we compared FLK North 6 and the deposits of diffused material, since the artefact and fauna densities are similar. It seems clear that the hominids' actions were limited; the 128 lithic objects do not even weigh 16 kilograms, and are linked almost exclusively to percussion activities. Potts (1988) disagrees, and given the vast amount of bone remains, proposes that it is another example of the systematic transportation of bones and artefacts to the same place. Nonetheless, the artefact density is too low to assume an automatic connection between all the fauna and the lithic industry. Bunn's (1986) hypothesis is more probable, considering that a good part of the bone remains probably accumulated naturally, and that the lithic industry was probably part of an isolated episode envisaging the maximisation of nutritional resources, not necessarily linked to the exploitation of carcasses that has been documented (Domínguez-Rodrigo *et al.* in press).

In order to sustain this hypothesis, we also find the interpretations of the levels that appear above FLK North 6, such as FLK North 5, 4 and 3 and *Deinotherium*, which all researchers (Bunn 1982; Crader 1983; Potts 1988), including Potts (1994), consider assemblages with diffused material, devoid of archaeological integrity. As aforementioned, the density of the bone and lithic remains are similar to those in FLK North 6, which leads us to think that only the presence of large proboscideans (*Elephas recki* in Level 6 and *Deinotherium* in the level bearing the same name) gave way to their interpretation as butchering sites and not levels with diffused artefacts. Also in Olduvai Bed I, why not, and despite the exceptional conservation of the archaeological record, post-depositional alterations must have affected the preservation of the assemblages. Therefore, we should assume the dynamic processes implicit in the formation of any archaeological site (Bunn 1982; Crader 1983; Potts 1988), instead of considering them static and unaltered reflections of a unique moment.

Although our goal is not to comment assemblages we have not analysed directly, we think this problem should be applied to sites that have not been studied in this monograph such as FLK NN levels 3-1. These sites present major fauna concentrations, despite the fact that, for example in FLK NN 2 there is not a single lithic artefact, and that Leakey (1971) herself considered it a paleontological site. Nevertheless, levels 3 and 1 have been classified as living floors (Leakey 1971) or Type C sites (Isaac & Crader 1981). The fact is that FLK NN 3 only has 72 lithic pieces, 23 of which are so-called manuports and compose (counting the unmodified lithic material, which we do not usually include herein) under 14 kilograms of lithic material (Potts 1988:359). That is to say, there are 49 modified pieces in an area that Isaac and Crader (1981:57) calculated to measure 200 m^2. Therefore, the density of pieces is even lower than in levels that are considered "diffused."

The exact same thing happens in FLK NN 1, where Leakey (1971:47) referred to only 17 lithic pieces, almost all of them core forms, and a density of artefacts even lower than in FLK NN 3 and, obviously, lower than that of levels with diffused material like FLK North 5, 4 and 3. So, why are FLK NN 3 and 1 considered living floors or sites with a systematic concentration of bone and lithic remains? Actually, this is because the bone concentration seems too intense to have been produced by natural causes. In short, when analysing arguments in detail to consider these assemblages archaeological entities, FLK NN 3-1 and also FLK North 6 and *Deinotherium* present the same features as FLK North 5-3. Consequently, if the latter are considered spontaneous concentrations with diffused archaeological remains, the former should also be analysed from that perspective.

Level 1-2 is the FLK North assemblage with the greatest archaeological integrity. Despite the evident postdepositional alterations Leakey (1971) identified, we classified this assemblage as a Type C site, as proposed by Isaac and Crader (1981). Bunn (1986) considered it to be very similar to FLK Zinj in the configuration of the bone material, identifying many human traces. Furthermore, the hominids were accumulating bovids from different ecological niches, with a marked increase of individuals from more open habitats (Plummer & Bishop 1994). FLK North 1-2 presents over 60 kilograms of worked lavas and almost 25 kilograms of quartz. As regards lavas, the hominids probably still travelled to nearby streams for cobbles, with a relative profusion of good quality phonolites. This systematic contribution of cobbles gives notice of the intensity of the occupation, since only the volume of lavas in FLK North 1-2 exceeds the assemblage of knapped material in previous sites like DK or FLK Zinj. The FLK North hominids also ensured they had a good amount of quartzes, which given their tabular nature must have been obtained directly in Naibor Soit. The over 24 kilograms of quartz, distributed in a great number of different blocks, must have required a series of journeys to Naibor Soit. In the 2 kilometres trip, the hominids must have passed through several ecological niches.

This technological study shows that the hominids from FLK North 1-2 performed two types of activities. One focused on obtaining flakes with sharp edges, attained through the same methods, or similar processes, as those used in DK and FLK Zinj. The other type of activity was closely linked to percussion processes, with a great number of active elements (hammerstones) and passive items (anvils) used in a *chaîne opératoire* in which the most important goal was not to produce sharp elements, but to use the raw material directly to fracture other objects, probably the bones which the lithic material appears linked to. Percussion processes are well documented in FLK Zinj, and are the main activity in the small FLK North 6 assemblage, attaining a genuinely important volume of raw material in FLK North 1-2. In fact, a good part of the quartzes were used exclusively in these percussion processes.

This must lead to a reflection on the logics for the provisioning of lithic resources, which were not always linked to the quest for potential blanks to produce sharp tools. In effect, the fact that the hominids travelled to Naibor Soit for the blocks of quartz that would subsequently be used simply as anvils, indicates that the energy required to embark on these journeys for provisions was not as immense as we tend to think. We could go even further, and note that perhaps the tool-makers controlled and were sufficiently acquainted with the landscape to be able to cross through different ecological habitats to select blocks that would make suitable anvils, when this supposed need could have been covered using other blanks like the actual bones – see the bone anvils Shipman (1989) describes in Olduvai – or roots, as used by the chimpanzees (see Boesch & Boesch 1983, 1984; Sugiyama 1993, 1997; McGrew 1992; etc). In all, we could say that the energetic cost of importing quartzes from Naibor Soit was so low that knappers did not have to optimise their benefits by exploiting this lithic resource intensely, and that the FLK North hominids could actually choose which type of activity they wished to perform with each raw material.

This specific point of the landscape also accommodates the settlement called FLK North Sandy Conglomerate. This assemblage's function is harder to infer than the previous sites given the absence of bones, which cannot be explained mechanically due to preservation problems (see chapter 4). Nevertheless, FLK North SC has an important volume of raw material, with over 47 kilograms of worked stone. As in Level 1-2, percussion activities were also relevant in FLK North SC, and there is, in fact, a novel element: quartz subspheroids-spheroids which, notwithstanding their functionality, indicate the great intensity of the percussion processes. Alongside these elements, there is a qualitatively important collection of chert pieces, used for specific knapping activities.

Although it is hard to establish the functionality of the site given the lack of bone remains, FLK North SC was clearly a specific point on the landscape used to accumulate rocks from different areas. A good part of the quartz is tabular, and was most probably imported from Naibor Soit. Furthermore, there are over 20 kilograms of lavas, with high-quality basalts and phonolites that were probably from nearby streams. The hominids in FLK North SC did not only travel North in search of raw materials, i.e. to Naibor Soit, but also journeyed South. In that southern region, probably in MNK, tool-makers obtained small chert nodules that they transported whole to FLK North SC (*contra* Kimura 1999), where they were exploited in a fashion similar to that of previous sites, aiming to obtain sharp products. Although we cannot establish the reason why, we can say the Olduvai hominids travelled to different points of the basin to obtain different raw materials and that, as regards FLK North SC more specifically than in previous assemblages, they used them for different activities in terms of the qualities of each of the rocks.

The Olduvai territory in the Acheulean

EF-HR shows a pattern different to that of previous sites. Here, a good part of the quartz has a stream origin, which excludes journeys to Naibor Soit. We assume that practically all the raw material used in EF-HR has a local, even an immediate, provenance. Kyara (1999) asserted that the same stream that severs the site in two parts could have been the source for the provision of all the artefacts. We interpret EF-HR as a location for obtaining blanks for large cutting tools, where many *façonnage* processes were also performed. The bone sample in EF-HR is practically nonexistent, and other percussion activities beyond actual lithic knapping events have not been documented either, although these processes are typical in other Acheulean assemblages.

In all, EF-HR would be included in what Geneste (1985) called extraction and exploitation facies (based on obtaining and the primary modification of blanks that would subsequently be transported to another location), to expand the somewhat ambiguous definition Isaac and Crader (1981) proposed for Type A sites, established as such simply considering the lack of associated fauna. Although this has not been verified yet, we can assume that the knappers obtained large-sized flakes from enormous cores located in a stream near the site, and that the main *façonnage* activities were performed in the actual settlement. Consequently, this would explain the low frequency of objects (which even so still amounts to over 46 kilograms of worked raw material), which were also destined almost exclusively to the shaping of blanks obtained in the same location. If this hypothesis was verified, this would be a location for the extraction of blanks in which practically no other activity was performed. Therefore it would be linked to a more segmented use of the landscape, in which the processes for the obtaining of blanks would be separated from the activities whereby instruments were finally used.

The exact opposite occurs in FC West. The latter presents bone remains which, albeit not abundant, could explain the functionality of the site somewhat. Part of the lithic industry is linked to activities dedicated to obtaining small-sized flakes, following the same patterns as described in the Oldowan. Possibly this *débitage* of small-sized flakes could be linked to the exploitation of bone resources. This would also apply to percussion objects, very profuse in FC West. Although the technological study and the characteristics of some of the knapping products indicate this is an Acheulean site, in fact, from a typological standpoint, only a couple of large cutting tools justify the assignment to this culture. As regards the functionality, it is tremendously interesting to document this pattern, since it shows a situation that is the complete reverse of EF-HR. If in the latter, there was a monographic activity (obtaining large blanks) using local materials (as expected of an atelier or extraction location), the exact opposite appears in FC West, with a shortage of large blanks, great technical variability (*débitage* and percussion processes, accompanied – tangentially – by *façonnage* activities) and an enormous diversity of raw materials.

We have already underscored the vast amount of raw materials in FC West (tabl. 9.7). The documentation of gneiss is quite relevant, which given the volume and classification can no longer be considered natural fragments that have appeared in the site accidentally. Yet, in FC West hominids were interested in obtaining gneiss, and may possibly have travelled for it to Kelogi, about 8 kilometres away. These journeys to the South of the basin were accompanied by the transportation of quartzes from Naibor Soit to the northern areas and possibly also from other outcrops. If in EF-HR a good part of the quartzes had a stream provenance, tabular blocks have also appeared here in FC West, which must have been transported from the original outcrops.

FC West presents almost 90 kilograms of worked raw material, both from streams (lavas, some quartzes) and different inselbergs (Naibor Soit for quartzes, perhaps Kelogi for gneisses). The concentration of such an amount of raw material in merely 52 m² indicates a high intensity of the occupation. In contrast to EF-HR, different activities were performed in this occupation: intense percussion processes, alongside activities related to small-sized *débitage* (perhaps accompanying percussion objects in carcass possessing). Nevertheless, the manufacture and/or employment of large blanks was a peripheral activity. If, as we sustain herein, the techno-cultural trend in FC West is identical to that of EF-HR, i.e., it corresponds to an Acheulean technology, we would be facing an occupation that is functionally different to that of EF-HR.

TK must also have had a different functionality. This point in the landscape, located relatively near EF-HR, was connected almost exclusively to the exploitation of quartz (see tabl. 9.7). Considering both the Lower Floor and the Upper Floor, there are over 200 kilograms of worked raw material. This total does not include other levels also present in the same stratigraphic assemblage, which – if considered alongside Lower and Upper Floors – would amount to several hundreds of kilograms. We are unaware of the reason that led the hominids to select that specific point of the landscape to perform such prodigious concentrations as TK LF and UF, yet the fact is that in both there was an intense and systematic contribution of quartz blocks. These quartzes were mostly from Naibor Soit, located no further than 2 kilometres away from where hominids obtained enormous blocks. Yet their range of mobility around the area must have been much greater, especially if we consider that the few worked examples in gneiss in both levels were from Kelogi, approximately 10 kilometres South of the site.

At the time, in which the lake had been reduced to less than half of the area it occupied in Bed I, the arid, open landscapes dominated the Olduvai basin (Hay 1976). Therefore, the trophic pressure must have been important in the open habitats the hominids had to cross to obtain the lithic resources they needed. In TK it is obvious that, in any case, this provisioning of raw materials did not imply a serious energetic cost for the hominids; both in TK LF and in UF most of the quartz was invested in percussion activities. The fact that the craftsmen that occupied both levels saw no objection to using enormous blocks weighing over one kilogram simply as anvils, indicates that the saving of raw material did not condition their technological strategies. In fact, we suggest the opposite: the TK hominids transported quartz blocks systematically over a distance of at least 2 kilometres, carrying large-size rock fragments. Despite this effort, although some were used to manufacture some large cutting tools, this *façonnage* activity was a peripheral issue in the site.

Actually, the TK hominids used most of those 200 kilograms of quartz for percussion processes, perhaps linked to the few bones documented in both levels. Although we cannot state which type of objects they were fracturing, we can guarantee these percussion activities were the hominids centre of attention. They used large quartz blocks as simple anvils; several of the blocks were not even used. In short, most of the transported quartz was never used as a blank from which to obtain artefacts. This scarce concern in optimising the benefits of the raw material can be interpreted in two manners: either the hominids of the TK Acheulean (and those of FC West) were managing their raw material ineffectively, or they were simply unaware of the concept of the rationalisation of the potential effectiveness. Since this technology replaced the Oldowan, the second explanation seems more logical. That lack of importance given to optimising the raw material, i.e., the scare assessment of the value of the cost of travelling to Naibor Soit, can be reinterpreted saying that the tool-makers in the Olduvai Acheulean already controlled the landscape to the extent that no effort was required (both in terms of the energy required and the trophic pressure) to travel around the different ecological niches in search of new raw materials.

The management of the territory in Beds I and II

Before considering the differences as regards the use of the landscape in the Olduvai sequence, we must set out a final reflection on the dynamics for the input and output of knapped stones. Leakey (1971) noted that in many of the sites lava *débitage* was inferior to the number of choppers, which indicated that they had been imported to each settlement once shaped. Different authors have considered this issue, some noting that the shortage of lava flakes demonstrates the dynamics for the import and export of certain artefacts (for example Potts 1988; Kimura 1999, 2002; McNabb 1998; Brantingham 1998), whilst others like Binford (1987) consider it demonstrates the fact that different unconnected depositional histories appeared in the assemblages.

The previous chapters have explored different alternatives to interpret this imbalance between the flaked and detached lava pieces. Without describing this contradiction again, we would like to mention two issues. The first is the constant problem that appears regarding the purpose of the choppers: contrary to the traditional opinion that considers choppers as artefacts (for example Leakey 1971; Chavaillon & Chavaillon 1981; Bower 1977; Roche 1980; etc), herein we have supported the idea that they are simply cores (Isaac 1986; Potts 1991; Toth 1982; Ashton *et al.* 1992). We have based our considerations mainly on the lack of traces of employment, which should be noticeable if they really had been used. This is a sound argument, especially since all the cortical parts of the same choppers do present percussion traces, which should also appear on the ridges of the objects if they had also been used.

Unfortunately, the issue is not settled with this argument, since if the lava choppers were only cores we should find the corresponding flakes, which are actually missing in a lot of the sites. The fact that so-called lava cores are identified in the sites but that their products are not is makes no sense; therefore, it could be true that "*contrary to Toth (1982)'s claim that Oldowan 'core tools' primarily represent the source of flakes, the lack of lava flakes and the abundance of cores in the examined samples suggest that lava cores at Olduvai could have been brought into the sites as 'tools' and that they were not primarily the sources of flakes*" (Kimura 1997:84).

The issue of whether they are artefacts or cores is hard to solve at present, but in any case the presence of choppers in the sites without the corresponding flakes indicates intense import and export activities whereby elements were transported to and from the assemblages. The interesting aspect (introducing a second relevant issue in terms of the shortage of flakes compared to lava cores) is that this pattern is not limited to Oldowan assemblages like FLK Zinj or FLK North, but also appears in more recent sites like FC West and TK. Since it is a general trend shared by Oldowan and Acheulean strategies, it seems like the hominids in Beds I and II in Olduvai were transporting lava elements around the area that were shaped prior to their introduction into the sites (if the choppers were artefacts), or exported from the site after occupation (in this case the flakes that would be transported from the settlement if the choppers were simply lava cores).

Finally, we need to assess mobility patterns. Brantingham (1998) implemented ecological principles of inter-specific competition to reconstruct the strategies used by the Olduvai hominids, conceived as short tactics performed over small distances, used to located and consume specific resources according to intermittent competitive pressures. This hypothesis is interesting in view of the region's ecological framework and issues linked to the acquisition of carcasses, since these resources were hardly predictable, scarce and temporary on the landscape, but it not very useful to assess the strategies used to obtain predictable, static objects like lithic materials, which are not subjected to seasonal restrictions such as those contemplated by Speth and Davis (1976). In this book, we have only used the zoo-archaeological record to support technological interpretations. Nevertheless, when analysing settlement patterns it is important to consider paleoecological implications. That is to say, when a hominid from DK or TK travelled to Naibor Soit and transported a quartz block, he was probably crossing more than one ecological niche. Some documents do refer to a trophic pressure existing in Olduvai (for example Potts 1988; Binford *et al.* 1988; Blumenschine 1986, 1991; Bunn 1991; Domínguez-Rodrigo 1997; Monahan 1996; Peters & Blumenschine 1995; Shipman 1986; etc), so in the reconstruction of the movement ranges considered herein, we must assess the risks and advantages of travelling along the lake.

Figure 9.32 shows the patterns of mobility inferred in this chapter. Raw materials sources were practically the same in the Oldowan sites in Bed I and the Acheulean assemblages in Bed II. The sole difference, as regards the location of resources, could be the presence of worked gneiss in FC West and TK (we consider that its documentation in older assemblages like DK, FLK Zinj and FLK North is coincidental). In any case, the existence of gneiss in the Acheulean assemblages did not imply a qualitative shift as regards the management of the landscape, since this raw material always amounts to insignificant percentages in the total weight of the collections. Furthermore, DK, FLK Zinj and FLK North contain a variety of macro-mammals from different ecological regions. This is not documented suitably in Acheulean assemblages and indicates that the hominids from Bed I also enjoyed a certain range of mobility.

Therefore, we think the position or distance to the sources of raw material cannot be considered a factor to distinguish Acheulean and Oldowan sites. Quartz normally came from Naibor Soit, at least in the area of the Gorge where the sites analysed herein are concentrated, all located on the eastern lacustrine margin. This pattern is applicable both for sites in Bed I and in Bed II, and would be similar when referring to obtaining lavas, generally collected in streams.

Beyond technological issues considered in other sections, there are two factors that distinguish the management of the territory in the Oldowan and the Acheulean. One is linked to the intensity of the accumulation of resources; figure 9.33 shows the number of kilograms and the density of lithic pieces in the most important assemblages. Although the area excavated was larger in all the Oldowan sites than in the Acheulean assemblages, in

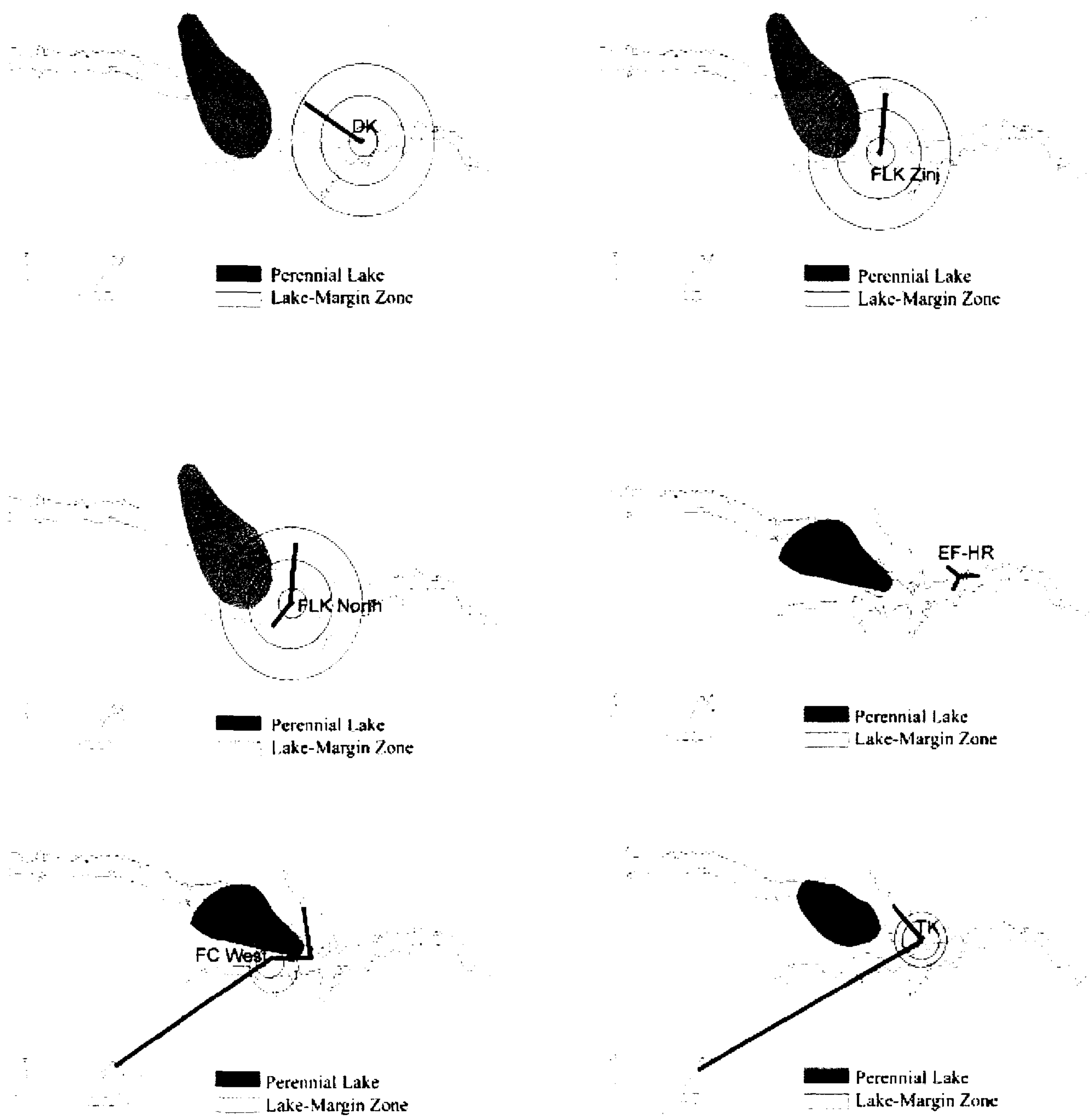

Figure 9.32. Potential areas of mobility in the sites studied. The lines indicate a supply from the areas that were the source of raw material, considering that in all the assemblages there would be a local supply from streams, which would be accompanied (except in EF-HR) by an input of metamorphic rocks from the inselbergs. Circles indicate possible areas where animal resources could have been obtained based on the paleo-ecological information provided via the bone remains, deducing that beyond the lacustrine floodplains there would be open plain areas, gallery forests, etc. The demarcation of the lake and the floodplain margins has been based on Hay's (1976) reconstructions.

absolute terms the number of kilograms was practically always greater in the latter (see also fig. 9.2). In fact, on calculating the number of kilograms per m^2 (quite problematic, as demonstrated in table 9.2), we see that the density of remains is invariably greater in the Acheulean assemblages (fig. 9.34).

This implies that the hominids from the Olduvai Acheulean exploited the landscape more intensely. This does not mean that they occupied the sites for a longer period of time. It implies that the hominids in Bed II were able to and/or were more interested in transporting large quartz block around the

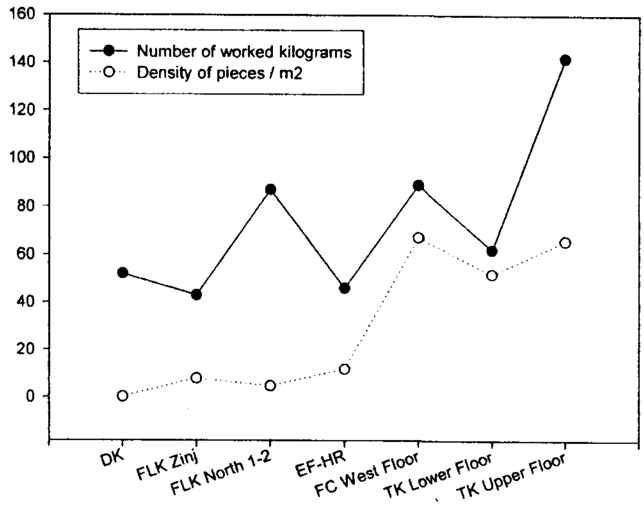

Figure 9.33. Density of lithic artefacts per m² –considering data provided by Isaac & Crader (1981)– and the number of kilograms of worked lithic material in each site.

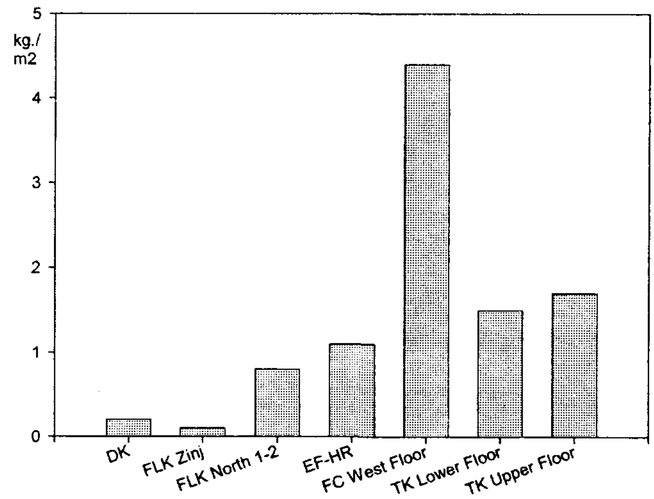

Figure 9.34. Calculation of the number of kilograms per m² in each site.

landscape, until they accumulated, in areas like TK UF, over 114 kilograms of a raw material that was not available in the immediate surroundings. Furthermore, given the extensive use of that raw material (most of the quartzes were not even knapped, just used directly), it seems that these Acheulean craftsmen dominated the landscape well enough to embark on repeated journeys to accumulate a large amount of lithic resources in specific points of the territory.

This does not apply to Oldowan sites, where quartz is reduced intensely (as in FLK Zinj), but where the total volumes of transported raw material never achieve the importance of subsequent assemblages. This difference regarding the contribution of raw material is linked to technological processes. A TK hominid needed two kilograms of quartz to make a single large cutting tool, whilst any of the craftsmen from Bed I could have used those two kilograms to knap 5-10 cores. The technological purpose obviously conditioned the contribution of raw materials.

It is important to state that this technical determination supposed a different use of the territory. Kyara (1999) counted 60 kilograms of genuine quartz manuports in all the sites in Bed II, and we have in fact mentioned several enormous unmodified blocks of this raw material in TK, for example. This is not the case in the Oldowan assemblages, in which quartz was always knapped or used in percussion activities. This means that the Bed II hominids accessed lithic materials very easily, even those that were not in their immediate surroundings such as tabular quartz. Furthermore, it implies that they found it so easy to obtain quartz that they could use it extensively, without having to optimise its transportation. That is to say, toolmakers controlled the landscape to such a great extent that they saw no energetic risk in constantly and intensely importing a resource to specific locations of the territory.

We noted that there were two main differences in the management of the landscape that distinguished the Oldowan and the Acheulean. One, as aforementioned, is linked to the total volume of raw material transported to the sites, much greater in the most recent assemblages. The other major difference is linked to the dynamics of the occupation of the settlements. The Oldowan sites are characterised by what is designated a *generalist* strategy, in which activities do not seem to have been monographic. Assemblages like DK, FLK Zinj and FLK North 1-2 are concentrations of lithics and fauna, where knapping processes, carcass consumption and other percussion activities were performed. As Potts (1988) noted, these assemblages are characterised by their diversity, with faunas from different species and sizes, raw materials with different origins, etc. It is, in short, a strategy in which the diversity of activities also implies that there is no specialisation as regards processes.

This hypothesis conflicts with that presented by Peters and Blumenschine (1996) who, in their riparian model, suggest the sites on the lacustrine margin appear after an exceptional, seasonal use of habitats that are more open, from which they could return swiftly to the piedmont alluvial plain that is devoid of archaeological evidence. This would imply, in our opinion, the presence of sites dedicated to specific activities on the lake's floodplain, when in fact the Oldowan assemblages suggest (given the variability of animal species and knapping and percussion processes) a generalist strategy in a settlement to which different resources were transported and where different activities were performed which, on considering isotopic studies, must have generally been quite a closed habitat (Sikes 1994), therefore relatively safe from contexts with a greater trophic pressure.

Acheulean sites present a more specific function. EF-HR seems to have been a location used for the detachment of blanks for large cutting tools, focusing on the exploitation of raw materials from a single place, probably the stream where the site is located. This is a relevant fact, since it would suppose the assumption of a fragmentation of the *chaîne opératoire*, with blank detachment stages at the supply points and subsequent transport to other sites. Although they have a different nature, both TK occupations seem to have a specific function, which is essentially linked to percussion activities. In both levels, although there are some examples of retouched pieces and some cores and flakes, it seems that the main work processes were linked to using quartz to fracture objects. The fact that the (few) large flakes documented in both TK levels do not coincide with the size of the cores once again suggests a separation between the different stages of the *chaîne opératoire*, which would lead to the transportation of the large flakes directly to the settlement. The only Acheulean site that presents a vast variety of tasks is FC West, and it may be no coincidence that it is the only occupation linked to the lacustrine margin, which is – however – typical of Oldowan settlements.

We propose the use of the territory could have been more segmented in the upper part of Bed II than in previous sites. The Oldowan assemblages are located in the lacustrine margin and (despite all the evidence documented on their journeys through other ecological niches), hominids performed most of their activities in that location. In fact, even the journey to Naibor Soit would be carried out in a habitat that, according to Hay's (1976) palaeographical reconstructions, would still be that of a lake floodplain. Blumenschine and Masao (1991) deny the existence of specific locations on the landscape where hominids formed discreet accumulations, and do not accept the multi-functionality of the assemblages in Bed I and Lower Bed II. In contrast, we do believe there are conspicuous concentrations, at least in the sample Leakey (1971) excavated. Why else would levels as disperse as FLK NN 3-1 or FLK North 6-3 differ so much from large concentrations like FLK Zinj or FLK North 1-2? These concentrations would correspond to strategic locations on the landscape where these lithic and bone resources where transported, and where multifunctional activities were performed. That is to say, it would be similar to what have been called home bases (Isaac 1978) or central-place foraging locations (Isaac 1984), where hominids concentrated diffused resources thanks to a delayed consumption.

That poly-functionality of the assemblages on the lacustrine margin during the Oldowan gave way to a greater segmentation of the activities during the Acheulean. Then, hominids developed greater mobility over the landscape of the Olduvai basin, a fact that would be reflected in the variability of documented ecological niches. In the Acheulean, the Naibor Soit inselberg is no longer included in the lacustrine floodplain (Hay 1976), and Potts (1988:195) links the fact that quartz is pursued in open ecological habitats to an increase of the equid percentages in the sites. According to our hypothesis, in this period hominids were not conditioned by the ecological pressure derived from that greater aridity, and in fact managed landscapes more comprehensively, travelling to specific locations to obtain enormous blanks (EF-HR), accumulating hundreds of kilograms of the same raw material linked almost monographically to percussion processes (TK), and performing more diverse activities such as those identified in FC West.

Obviously, this is only a hypothesis, which stems from the attempt to go beyond technological explanations to distin-

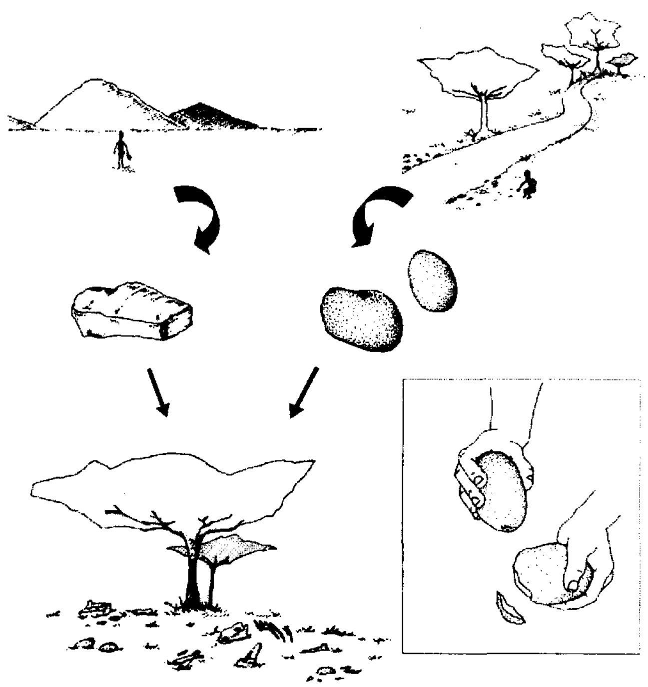

Figure 9.35. Scheme of procurement, transport and use activities of lithic resources in the Oldowan sites (drawn by N. Morán).

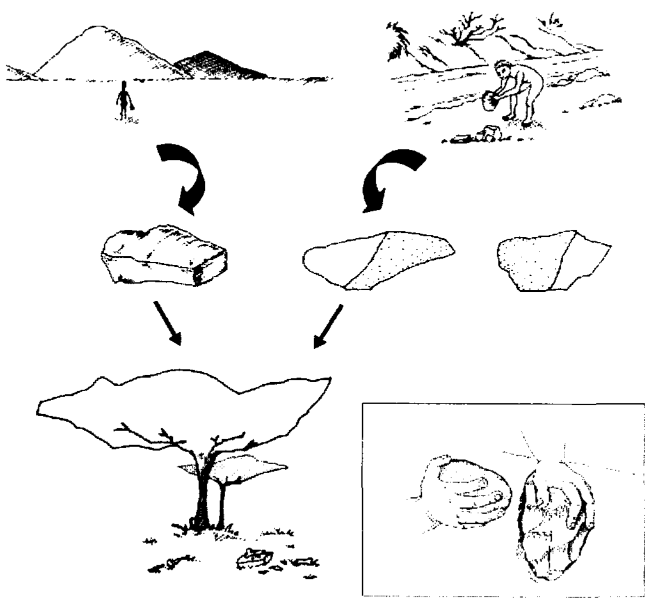

Figure 9.36. Scheme of procurement, transport and use activities of lithic resources in the Acheulean sites (drawn by N. Morán).

guish between the Oldowan and the Acheulean. In our opinion, no Developed Oldowan exists after Tuff IIB that can be distinguished either ecologically, functionally or technically from the contemporary Acheulean. Since the emergence of EF-HR, technological strategies are the same, regardless of the representation of the different categories in each site.

All the previous chapters can be summarised in figures. 9.35 and 9.36. The hominids from the Oldowan at Olduvai travelled to different points of the basin in search of animal resources and lithic materials. Those blocks and cobbles, alongside the remains of carcasses, were concentrated in specific locations of the landscape. In those areas, tool-makers focused their knapping strategies on obtaining flakes that were probably used directly and rarely subjected to secondary modification.

The hominids from the second part of the Bed II also generated different concentrations. However, the input of raw material to the sites was more intense, and more specific activities were performed there. Knapping strategies were not based exclusively on obtaining small flakes for direct use; instead craftsmen travelled to ateliers to obtain large blanks that they subsequently transported to the sites. Among these we find a new artefact, a large blank that the hominids worked secondarily to give it a specific pointed shape, with a forceful rim. We are unaware of what these large artefacts were used for, especially when most of the Acheulean sites present a shortage of bones that could link lithic objects to carcass processing. Nonetheless, we are obviously facing a new technology, an adaptative cultural solution that must have radically changed the way the toolmakers interacted with the different ecological niches.

In all, after defining the characteristics of the Oldowan and Acheulean technological strategies (which was our goal in this re-examination of Beds I and II), it is essential to wonder how and why the Olduvai craftsmen changed their extrasomatic adaptation resources (i.e. their culture, in the vastest sense of the word), and whether that change was directly linked to an environmental stress, a technical innovation or a biological modification/substitution of one hominid species (*Homo habilis*) for another (*Homo ergaster/erectus*). Although it is a very interesting issue, it cannot be answered at present. Nevertheless, it could, why not, lead to another research programme.

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