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	Cultural entity	
			(Hay, 1976:113)	*Leakey (1971, 1975)*	*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

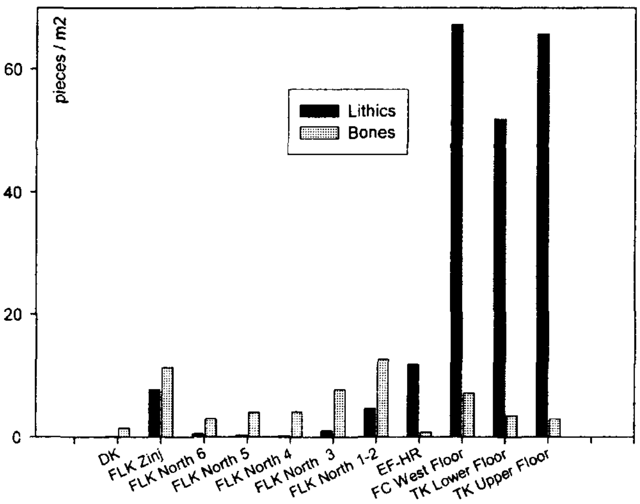

Figure 9.1. Bone and lithic densities per m², according to calculations by Isaac and Crader (1981).

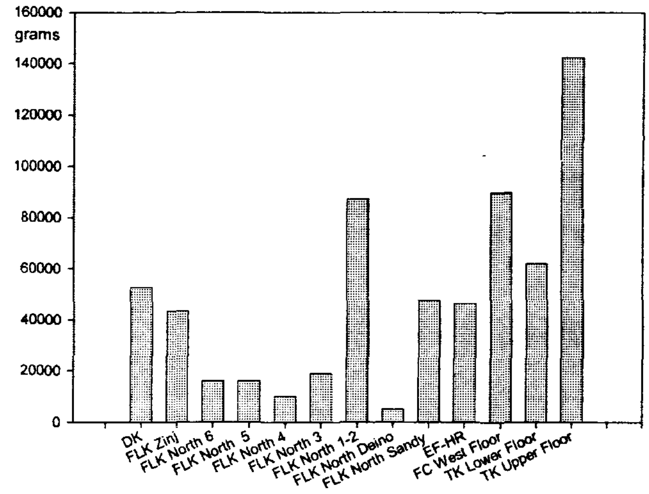

Figure 9.2. Total volume of transported raw material to each analysed Olduvai site, according to the present study.

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.

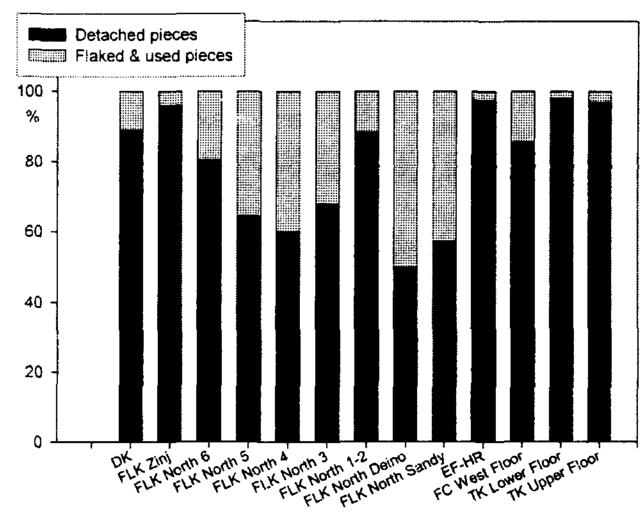

Figure 9.3. Proportions of detached and flaked pieces at the Olduvai sites.

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 m² 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	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-

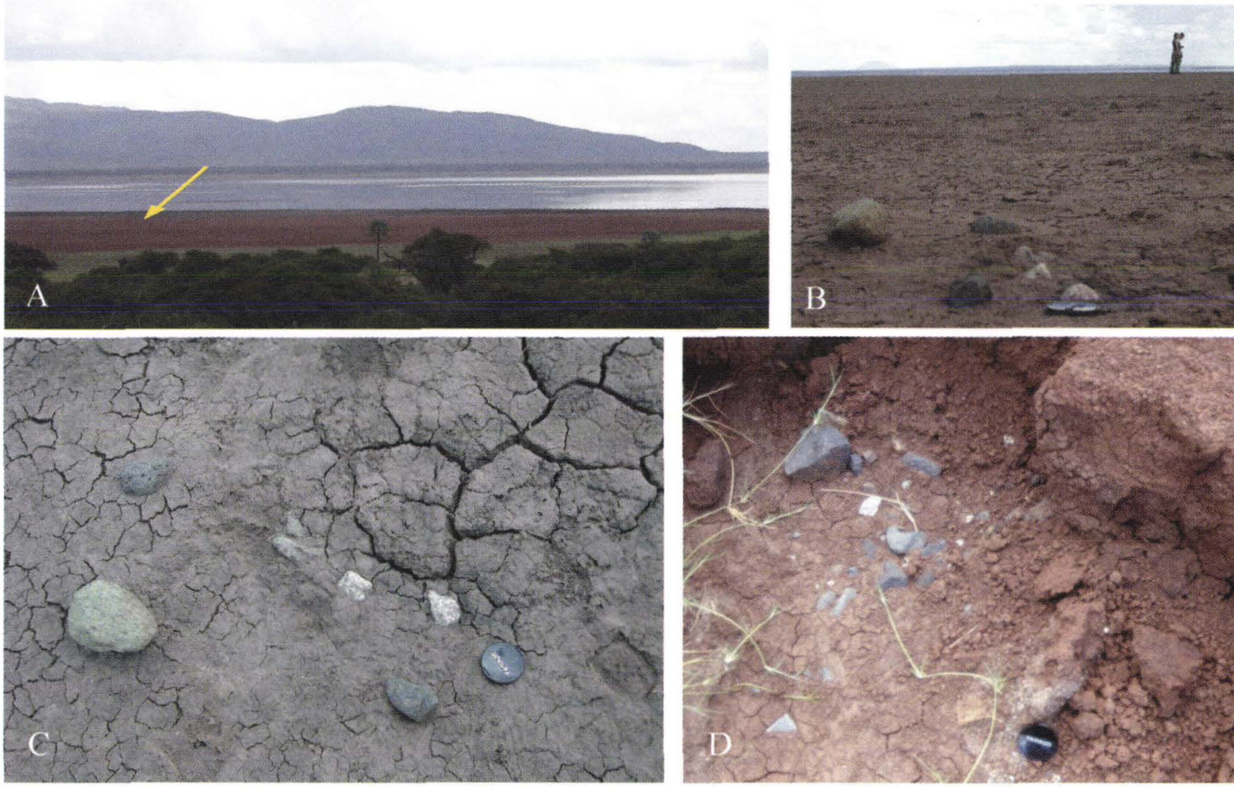

Figure 9.4. Contemporary examples of lava clasts in the lake-margin at Lake Manyara. A: landscape of the shore of Lake Manyara; area where clasts were documented is marked; B-C: examples of clasts in the mudflat surface; D: buried clasts in mudflat contexts of the lake-margin of Lake Manyara.

Figure 9.5. A: lake-margin of the east shoreline of Lake Eyasi; B: detail of the clasts located in the surface of the mud-flat 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.

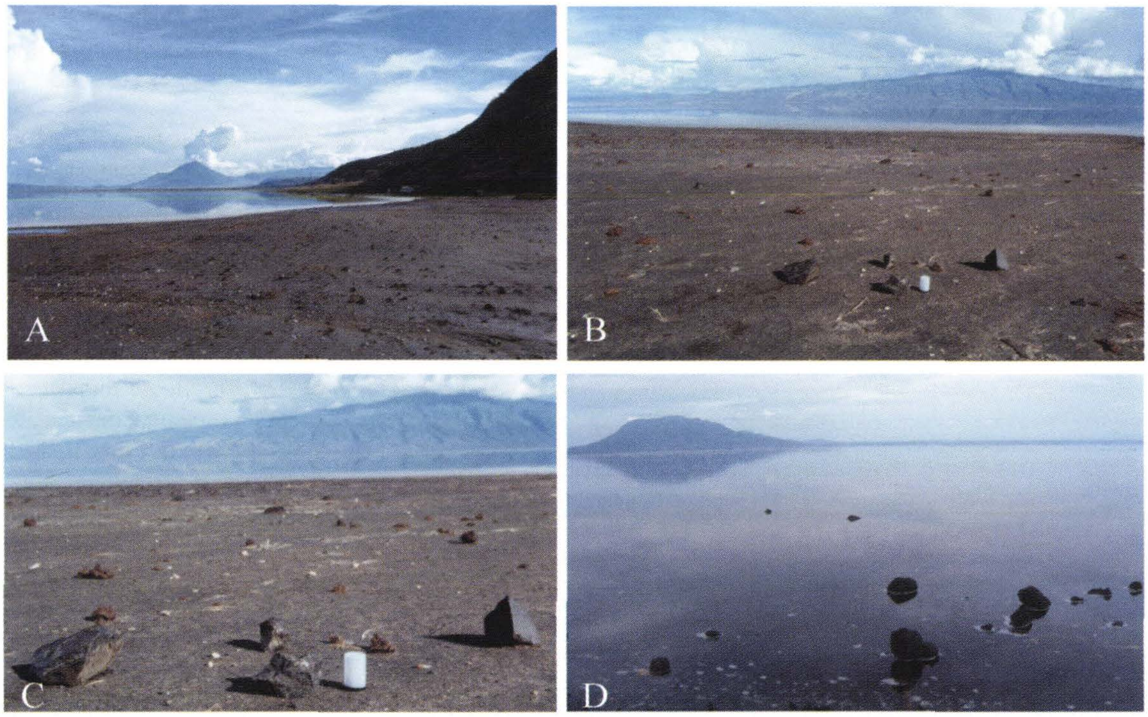

Figure 9.6. A: central-western shore of lake Natron beside the escarpment; B-C: details of the lava clasts in the lake's clay contexts beside the escarpment, probably deposited by gravitation processes; D: basalt clasts in the lake itself in the northwestern area of Lake Natron.

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.

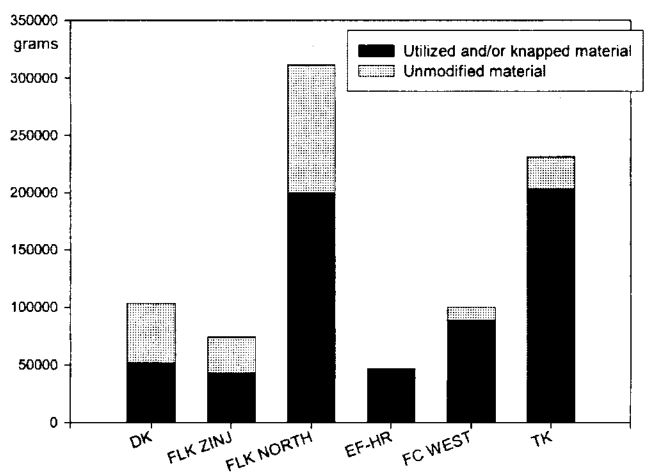

Figure 9.7. Total weight of worked raw material and unmodified pieces at the Olduvai sites.

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.

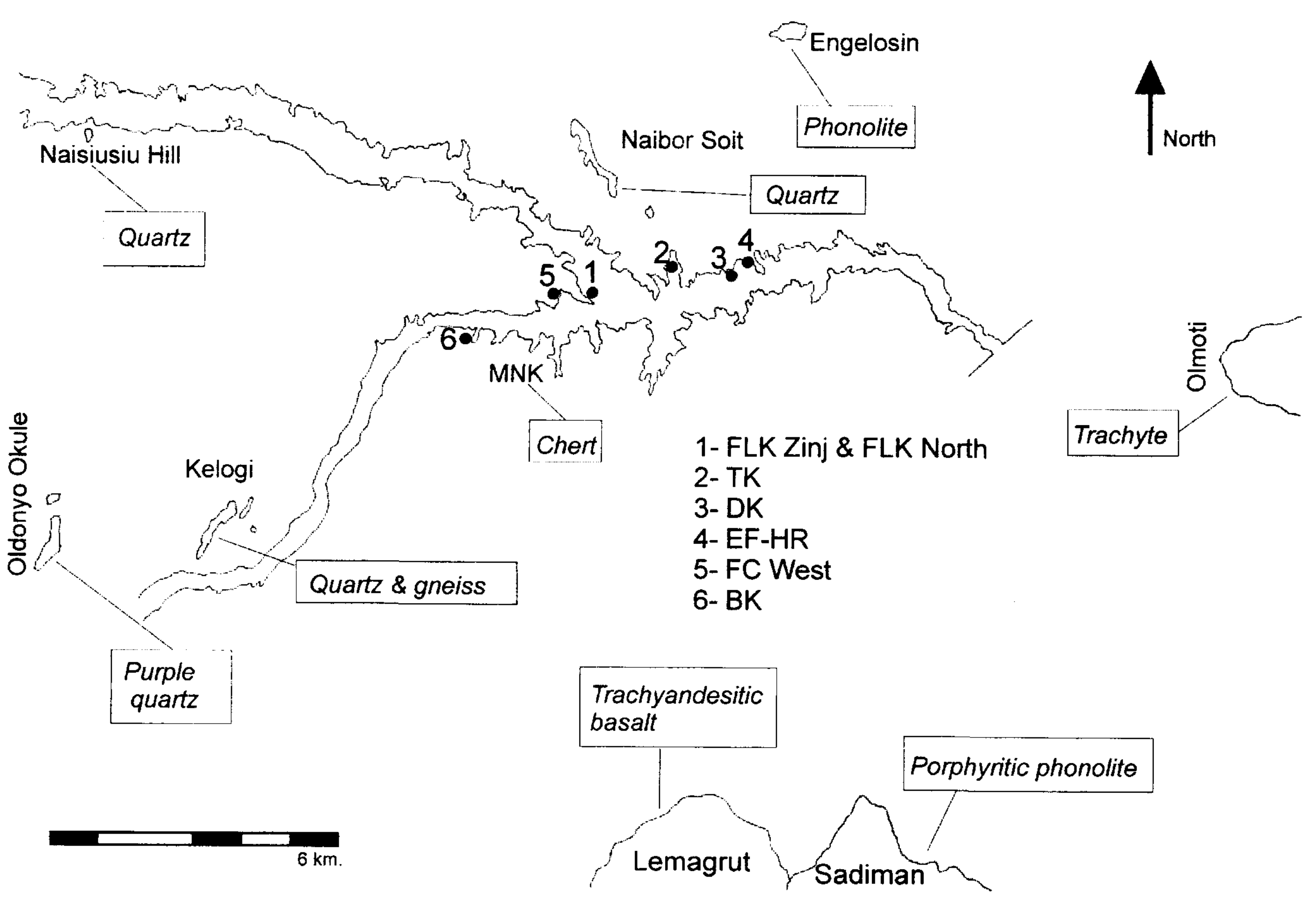

Figure 9.8. Raw materials sources at Olduvai - from Leakey (1971) and Kyara (1999)-.

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

	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.

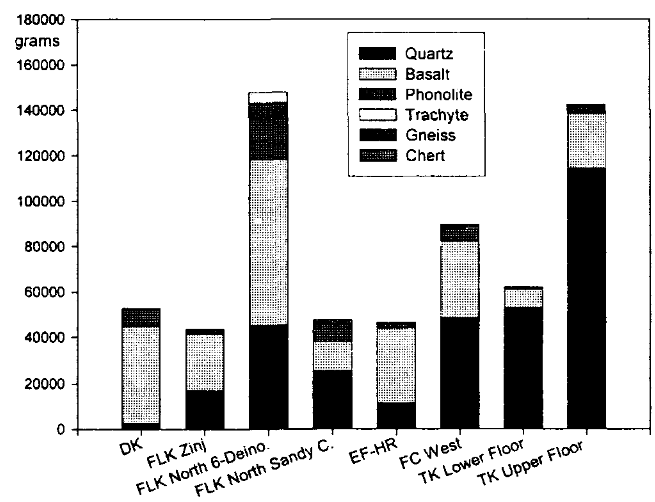

Figure 9.9. Number of grams transported of each raw material to the global total for each site. Only the worked material is considered.

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 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.

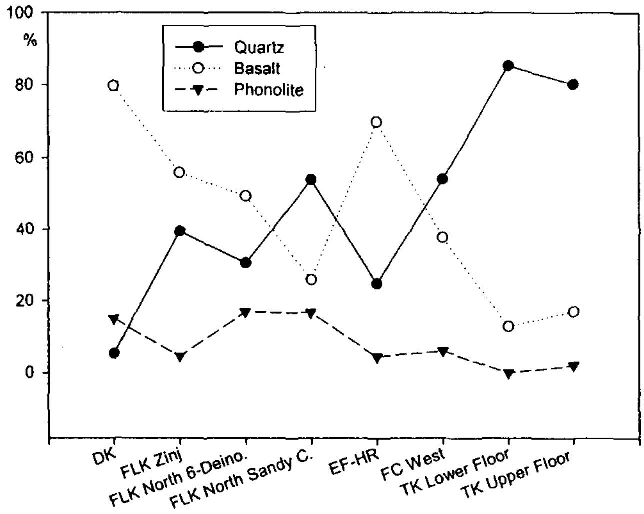

Figure 9.11. Weight percentages of the main raw materials in the analysed sites.

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.

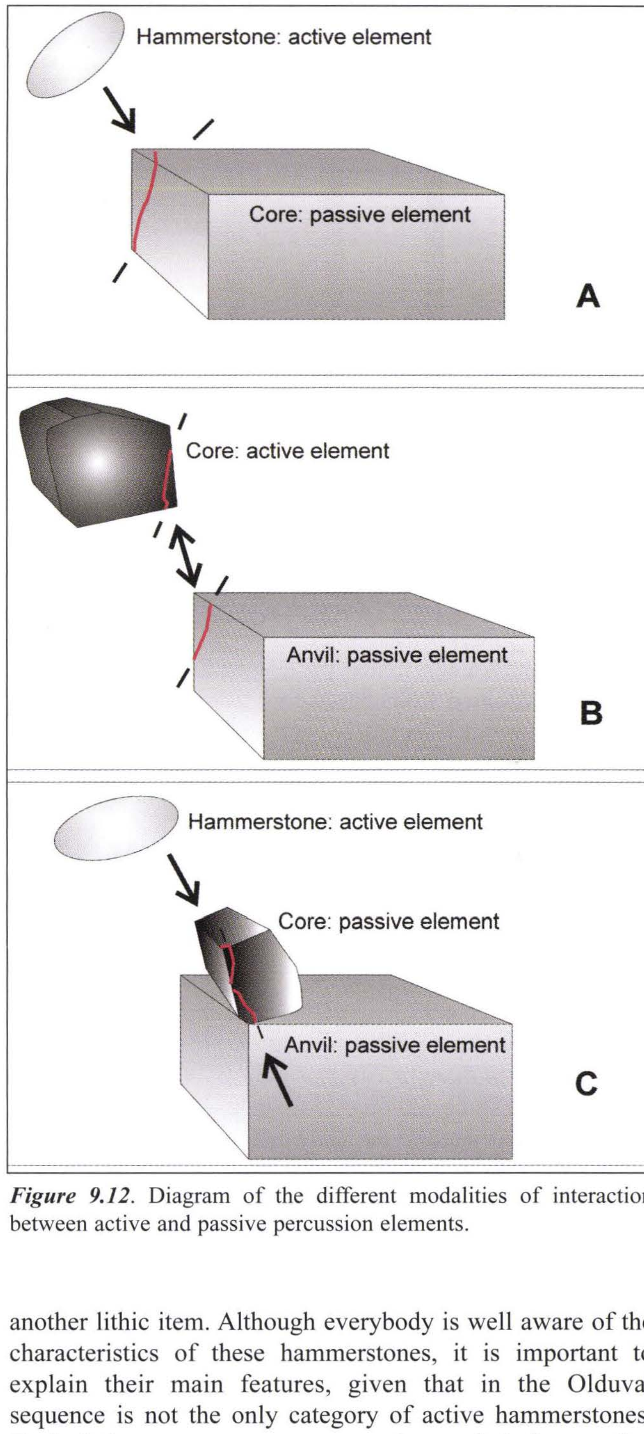

Figure 9.12. Diagram of the different modalities of interaction between active and passive percussion elements.

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

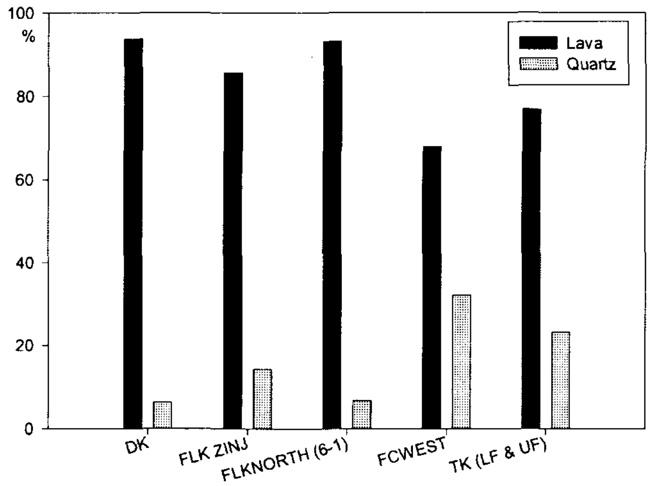

Figure 9.13. Distribution by raw materials of the knapping hammerstones in some sites of the Olduvai sequence.

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 opèratoires* 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 Geshei 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.

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

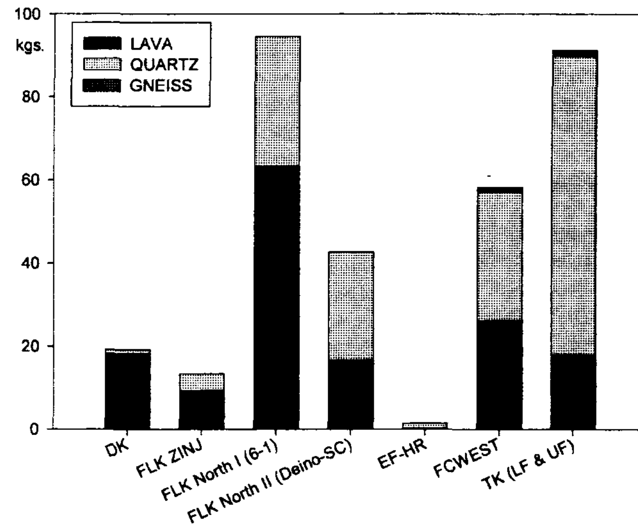

Figure 9.15. Weight in kilograms of the raw materials represented for the percussion items (including active and passive objects as well as generated products) from each of the analysed sites.

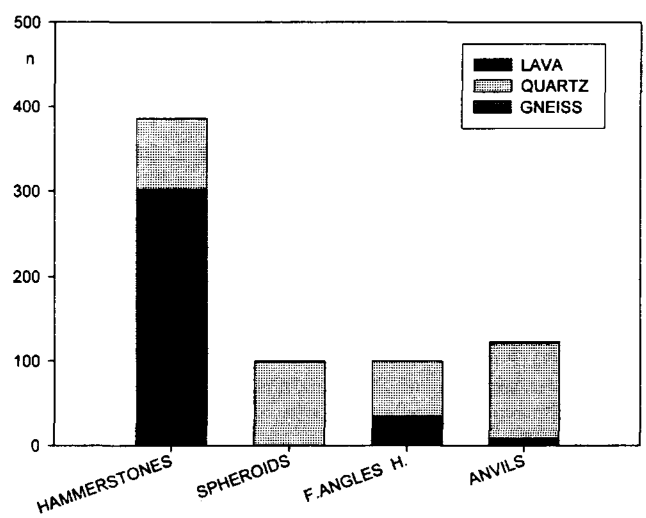

Figure 9.16. Total number and raw materials of active and passive percussion items in the Olduvai sequence (DK, FLK Zinj, FLK North all levels, FC West, EF-HR and TK (both levels), excluding the products (chips and fragments) generated spontaneously.

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-

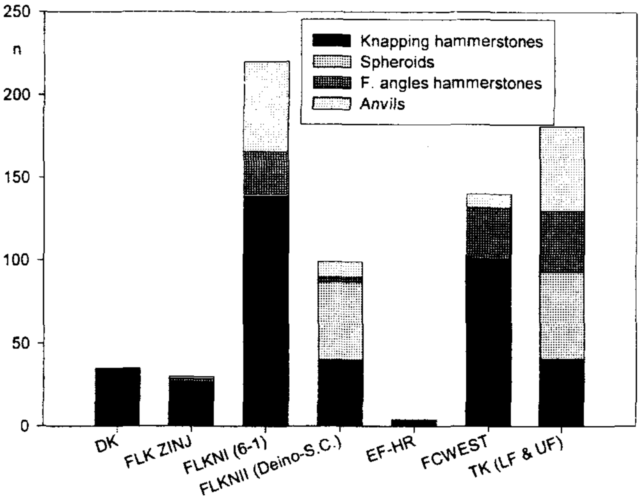

Figure 9.17. Absolute frequencies of the different pounded pieces categories in each of the analysed sites.

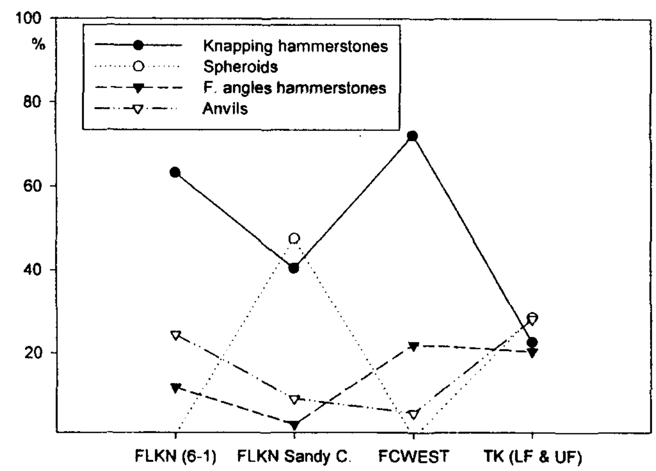

Figure 9.18. Relative frequencies of the different percussion categories in the sites with the greatest variety of pounded pieces.

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).

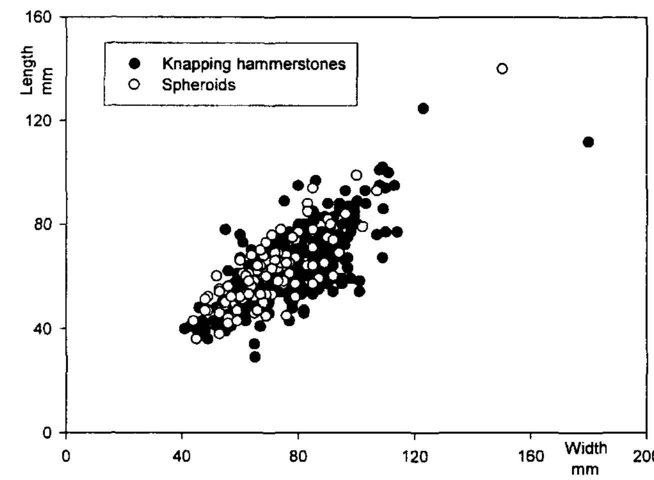

Figure 9.19. Size (length and width) of the classic hammerstones and subspheroids-spheroids in different stages of transformation.

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

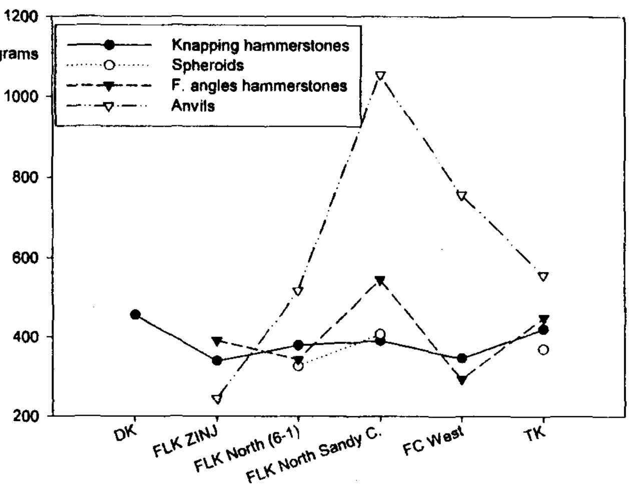

Figure 9.20a. Mean weight of the different categories in several of the sites. EF-HR excluded given the low number of items.

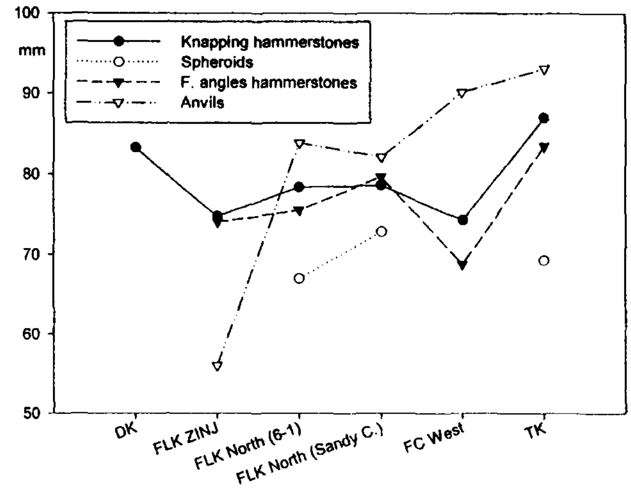

Figure 9.20b. Mean length of the different categories in some of the analysed sites.

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

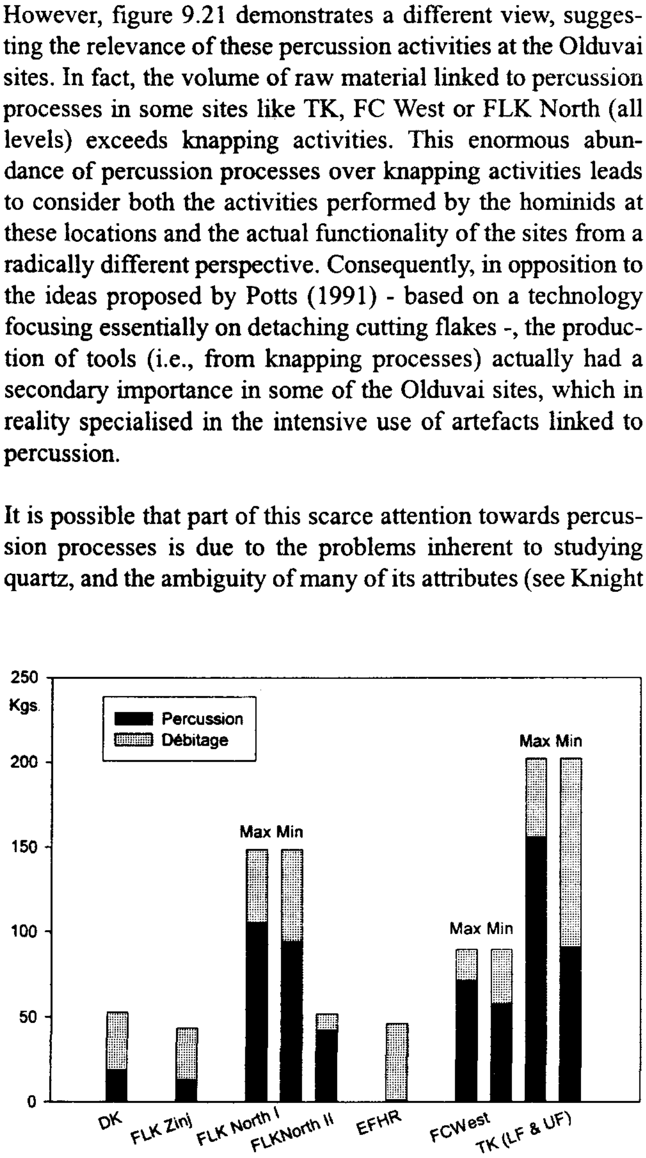

Figure 9.21. Weight in kilograms of the general categories represented at each of the analysed sites. The complexity of assigning part of the products to knapping activities or to percussion activities has led to present maximum and minimum estimates for objects linked to percussion for several sites (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-

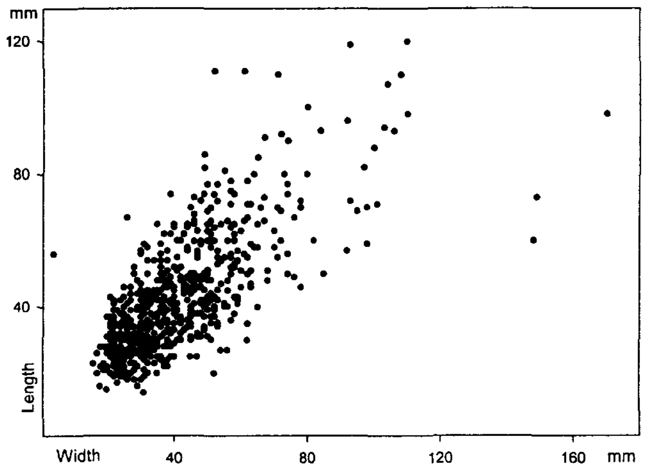

Figure 9.22. Size of the whole flakes at the analysed sites. The main concentration is located between 3-5 centimetres long and wide, and the greatest scattering of flakes corresponds to enormous products in EF-HR, FC West and TK, which are actually unrelated to small-sized *débitage* systems.

tems. 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-faceted	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.

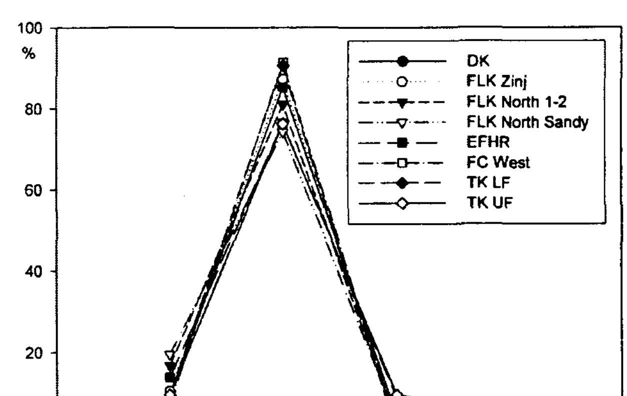

Figure 9.23. Types of striking platforms in the whole flakes at Olduvai.

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.

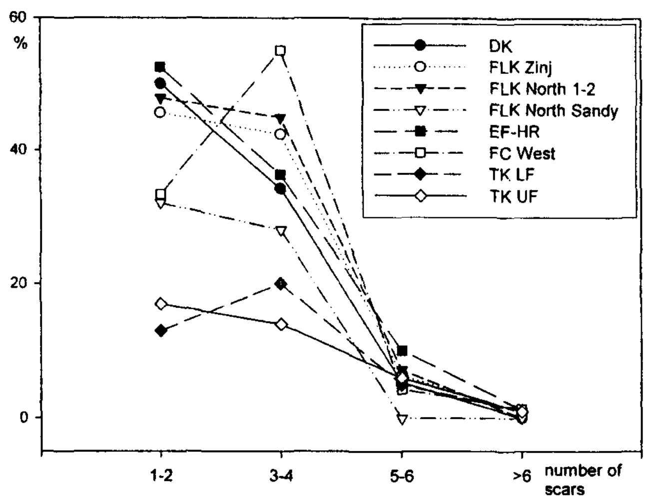

Figure 9.24. Number of scars on the dorsal faces of the whole flakes at Olduvai.

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

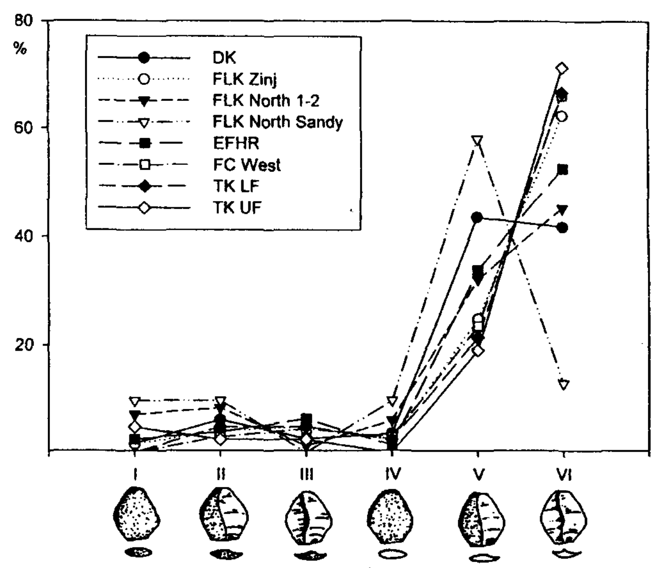

Figure 9.25. Cortex percentages on the whole flakes at Olduvai, according to Toth's (1982) categories.

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

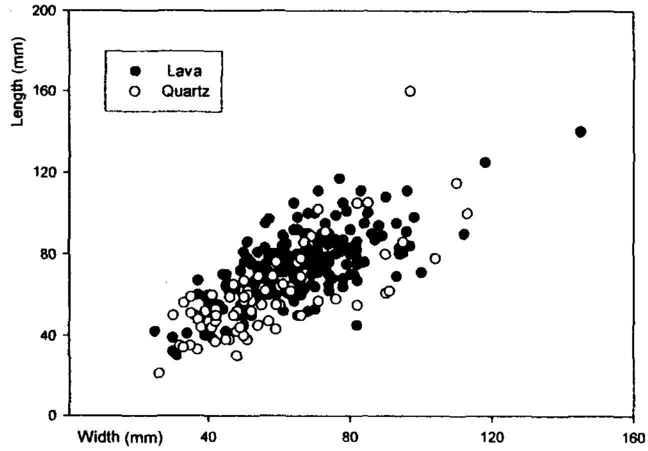

Figure 9.26. Dimensions of the cores at Olduvai sites.

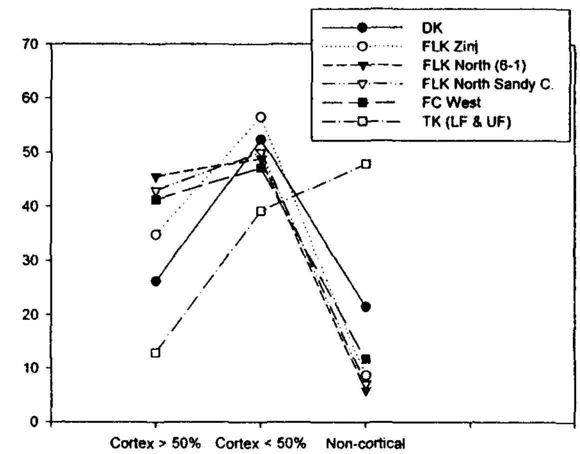

Figure 9.27. Cortex percentages at the sites with more cores at Olduvai.

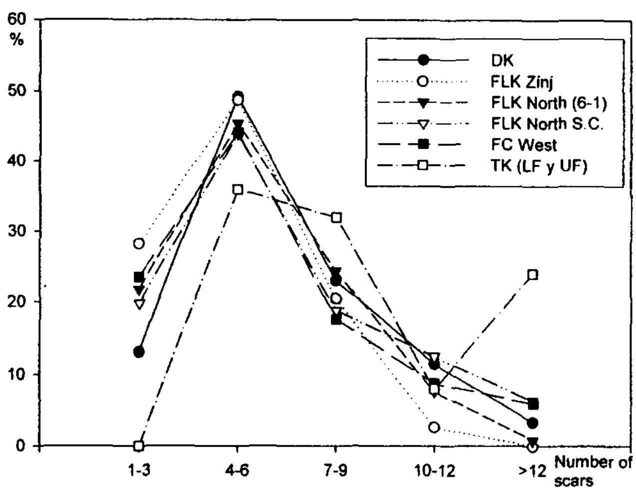

Figure 9.28. Number of detachments in the Olduvai cores.

	%						
	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).

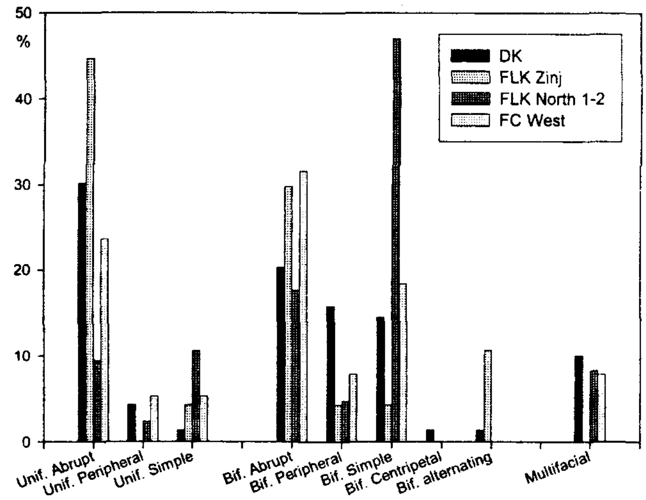

Figure 9.29. Diagram of the knapping systems at the sites with more cores at Olduvai.

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.

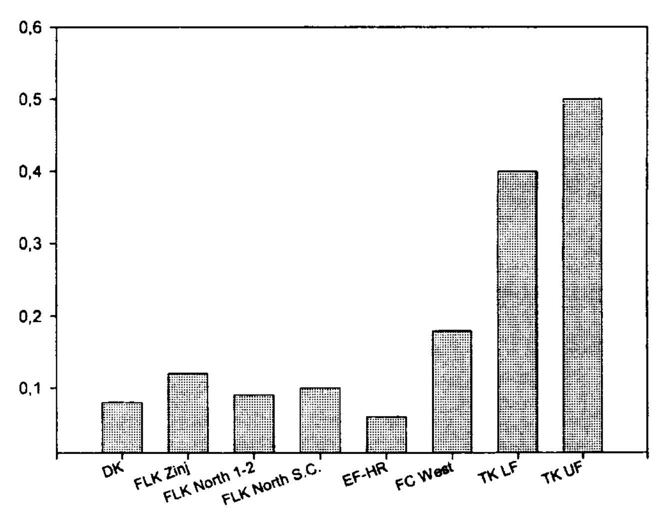

Figure 9.30. Index of small retouched pieces in each site, obtained dividing number of retouched pieces between the total of whole flakes.

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.

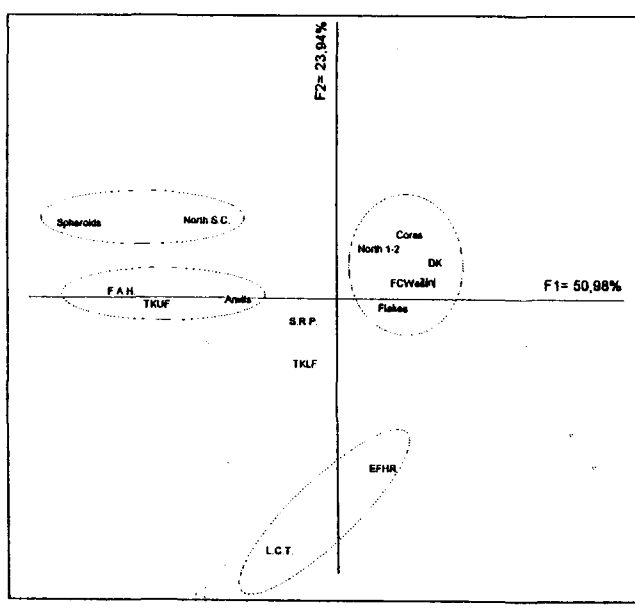

Figure 9.31. Factorial Analysis comparing the most important sites and the most informative lithic categories. S.R.P.: small retouched pieces. F.A.H.: fractured angles hammerstones. L.C.T.: large cutting tools.

	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 m². 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 paleo-ecological 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

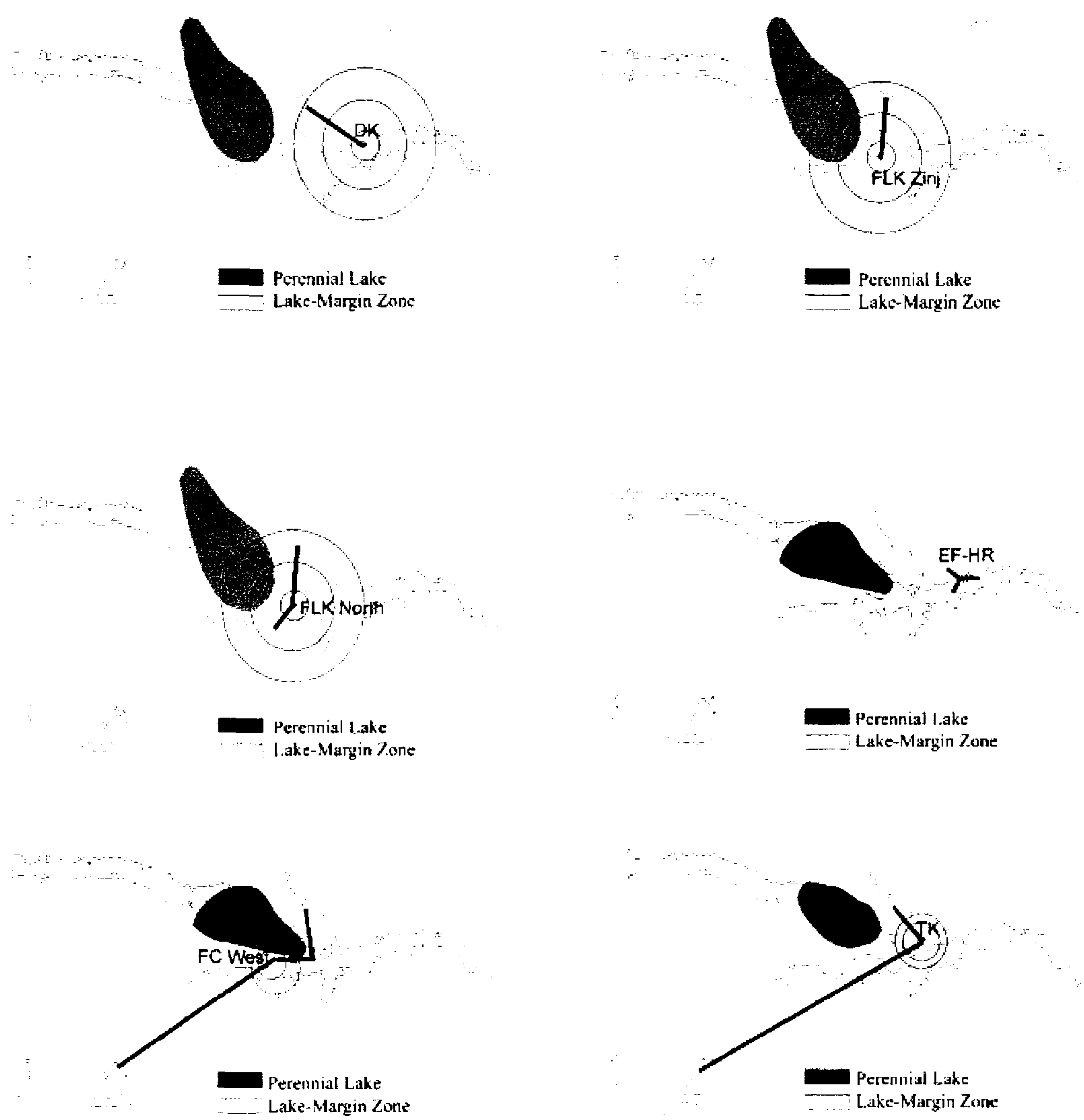

Figure 9.32. Potential areas of mobility in the sites studied. The lines indicate a supply from the areas that were the source of raw material, considering that in all the assemblages there would be a local supply from streams, which would be accompanied (except in EF-HR) by an input of metamorphic rocks 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

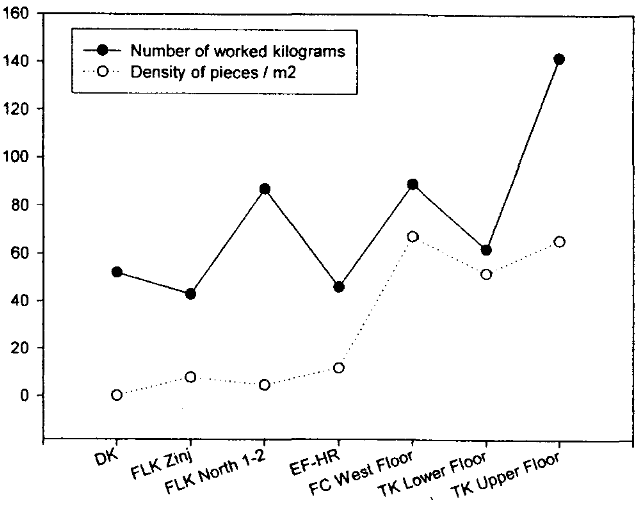

Figure 9.33. Density of lithic artefacts per m² –considering data provided by Isaac & Crader (1981)– and the number of kilograms of worked lithic material in each site.

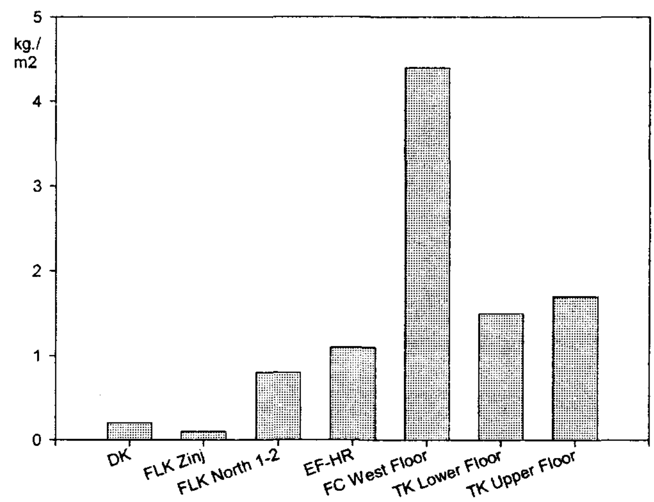

Figure 9.34. Calculation of the number of kilograms per m² in each site.

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-

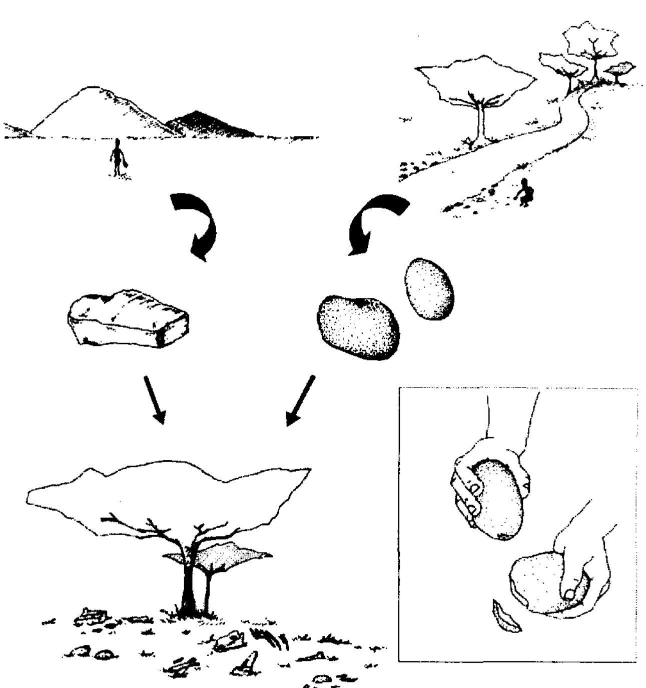

Figure 9.35. Scheme of procurement, transport and use activities of lithic resources in the Oldowan sites (drawn by N. Morán).

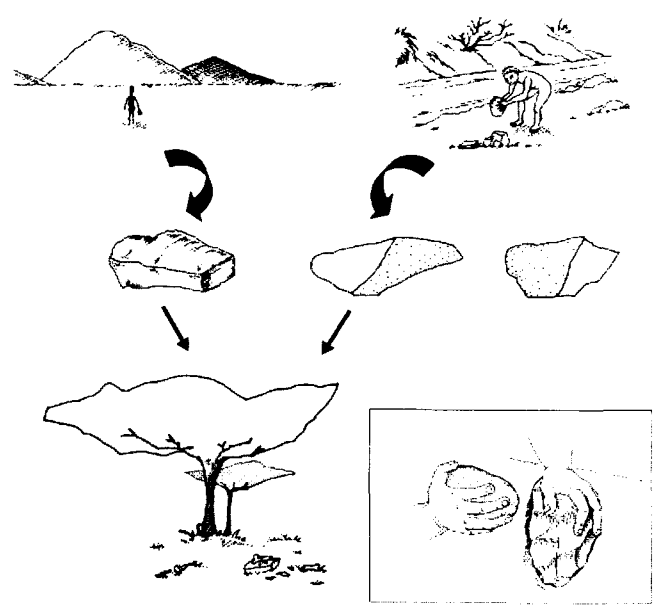

Figure 9.36. Scheme of procurement, transport and use activities of lithic resources in the Acheulean sites (drawn by N. Morán).

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.