Chapter 2

DK

The archaeological context

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

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

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

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

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

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

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

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

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

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

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

General characteristics of the lithic collection

Materials with different sedimentary histories appear to be present in DK. Originally, the blunt ridges of many pieces was attributed to possible diagenesis that would have caused the rounding of their edges. However, in the course of the study, this rounding was also observed in pieces of quartz, for which the only possible explanation was fluvial abrasion. Thus examples such as the quartz core drawn in figure 12:6 of Leakey (1971:30) is completely rounded and does not belong to the same original set as other pieces in the collection. As in the case of a chert flake fragment, also very rounded, and which we cite here because of the surprise expressed by Hay (1976) at the presence of chert in DK, at a point in the sedimentary sequence where this raw material was not available. After observing the signs of mechanical traction it displays, it can be said that in DK this chert has a post-depositional history unrelated with the main occupation of the site.

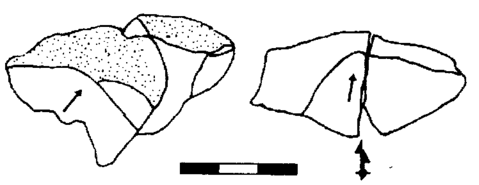

Figure 2.1. Phonolite refitting of two flake fragments (left) and two split fragments (right). Both refits were identified previously to this study.

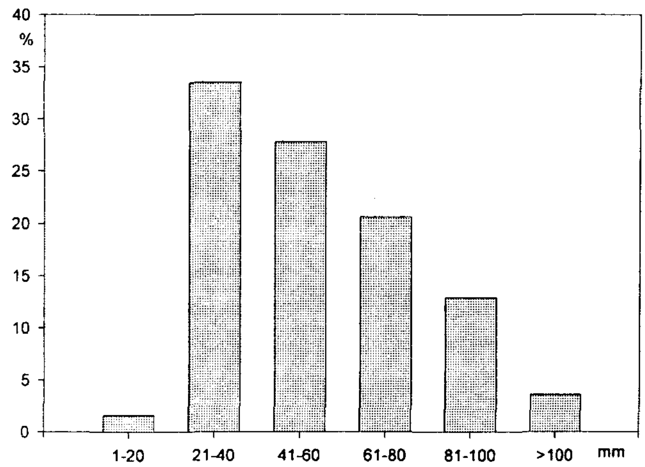

Figure 2.2. Length patterns in the lithic collection from DK (excluding unmodified pieces).

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

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

Table 2.1. Lithic categories at DK.

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

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

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

Raw Materials

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

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

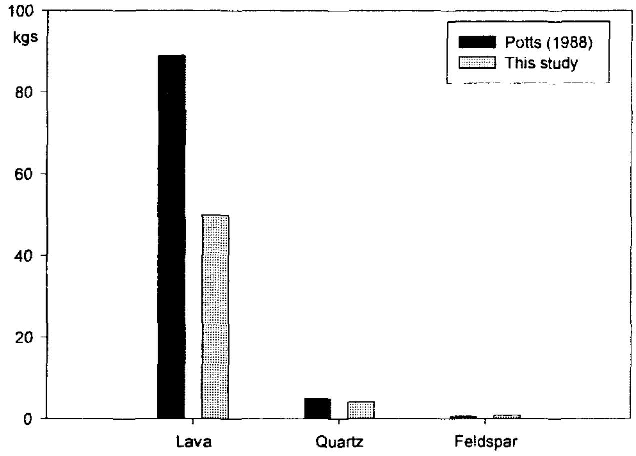

Figure 2.3. Total number of kilograms taken to DK. In his recount of the weight, Potts (1988:350) includes materials that he considers manuports or doubtful (Potts 1988:348), despite the fact that in the context of DK the concept of basalt manuports is not accepted. Potts (1988) is followed in talking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

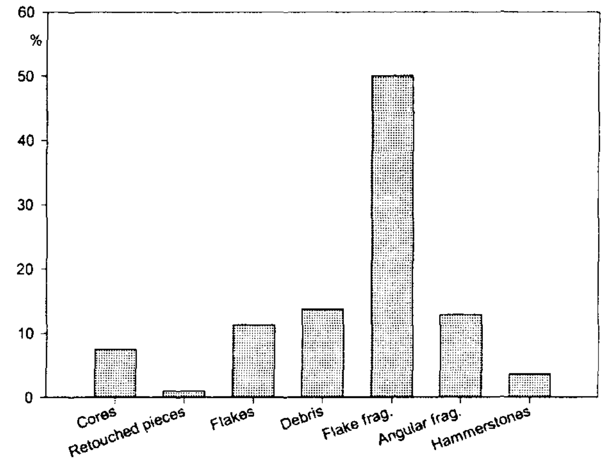

Figure 2.4. Relative frequencies of the categories from DK.

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

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

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

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

The knapping products

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

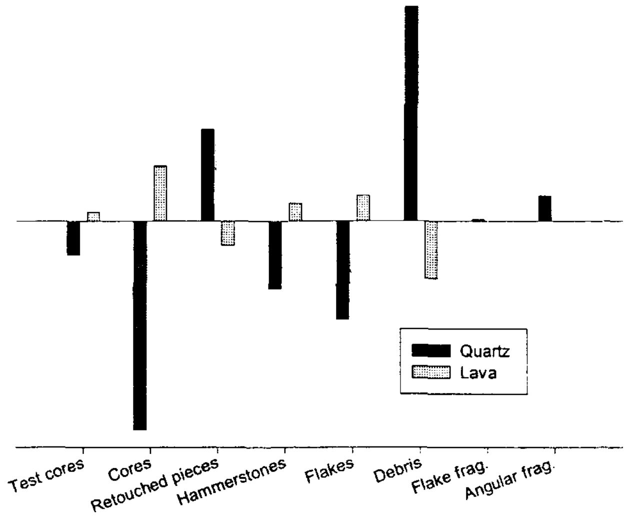

Figure 2.5. Lien Test comparing categories and raw material.

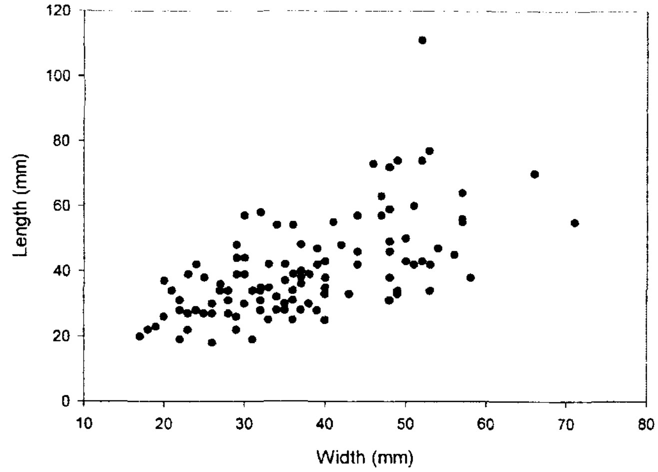

Figure 2.6. Size patterns in the whole flakes.

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

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

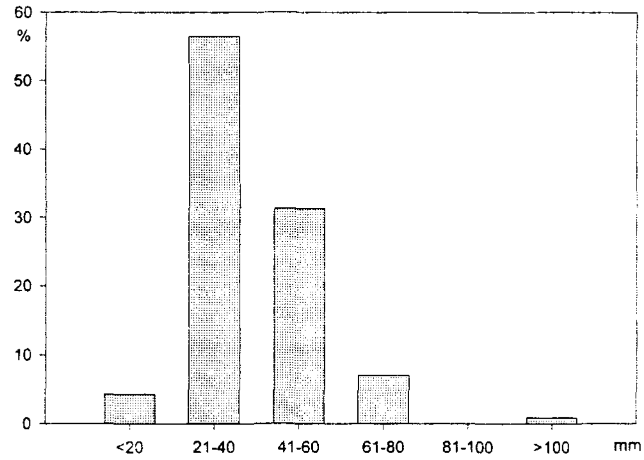

Figure 2.7. Maximum length patterns in the whole flakes.

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

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

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

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

The butts are nearly all unifaceted (85.2%) and only a few are bifaceted (4.3%), no flake being documented with greater preparation of the knapping platforms (fig. 2.9). Even so, the scarce presence of cortical butts (10.4%) indicates that, either the striking platforms of the cores were prepared or, more probably, there was more than one sequence of knapping on each surface exploited. In fact, the flakes without cortex belonging to a generation later than the decortication of the core are also numerous (at least 40.9%), and also present longitudinal patterns which suggest the continuation of knapping from the same platforms from which the initial flaking was carried out (fig. 2.10). Moreover, and despite the dominant unidirectional pattern, up to 3.5% of all the complete flakes were also edge-core flakes, indicating a rather more complex

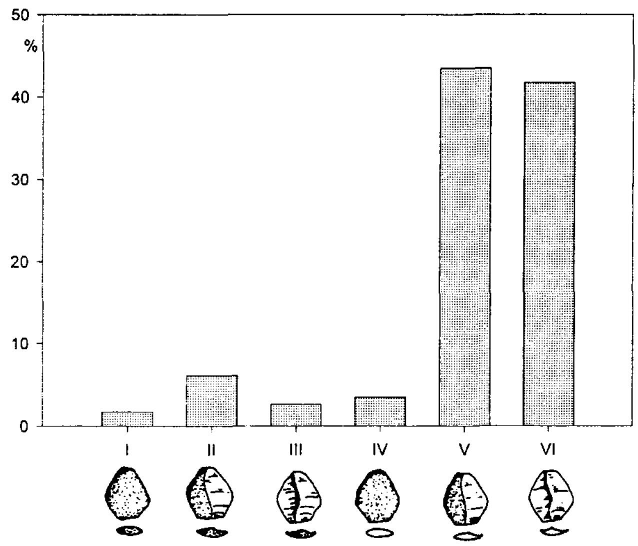

Figure 2.8. Whole flakes from DK according to Toth's (1982) classification.

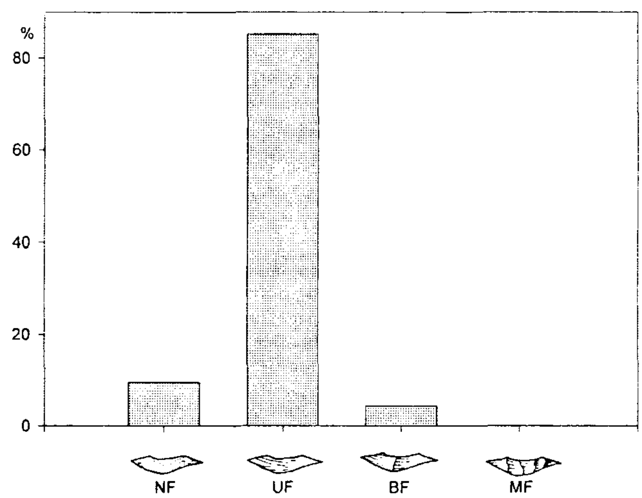

Figure 2.9. Types of striking platforms in the whole flakes from DK.

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

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

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

Retouched pieces

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

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

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

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

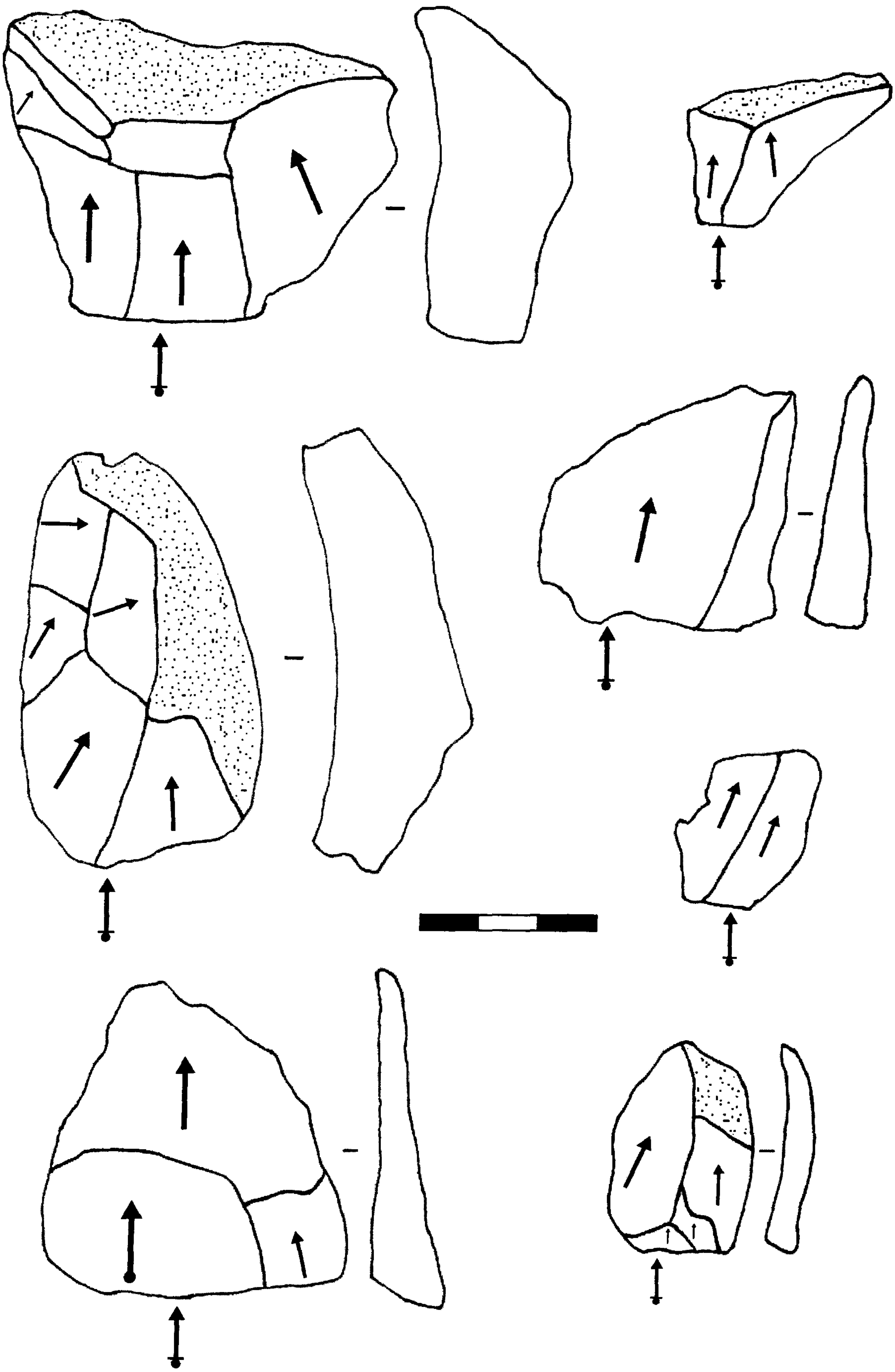

Figure 2.10. Examples of lava longitudinal flakes with unidirectional dorsal patterns.

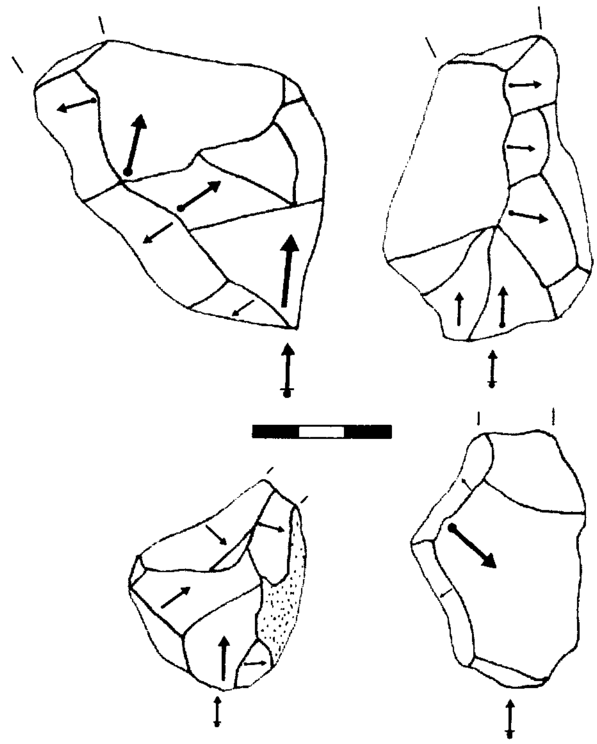

Figure 2.11. Examples of edge-core flakes from DK.

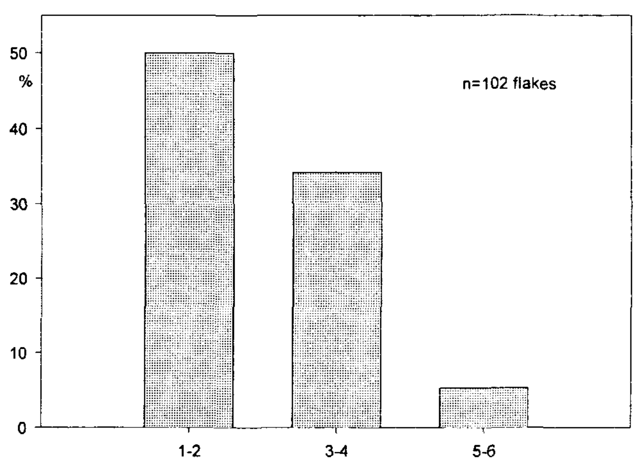

Figure 2.12. Amount of scars on the dorsal sides of the whole flakes from DK.

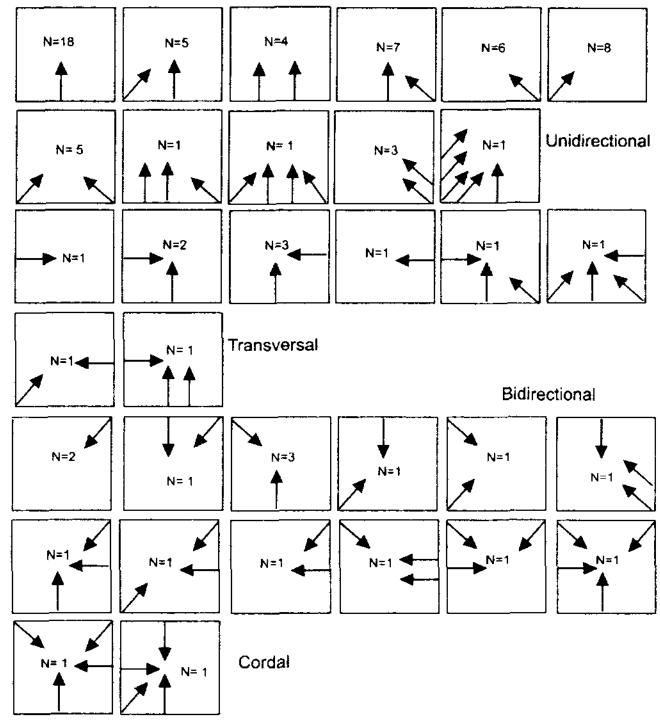

Figure 2.13. Diacritic schemes of the whole flakes from DK.

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

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

The DK cores

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

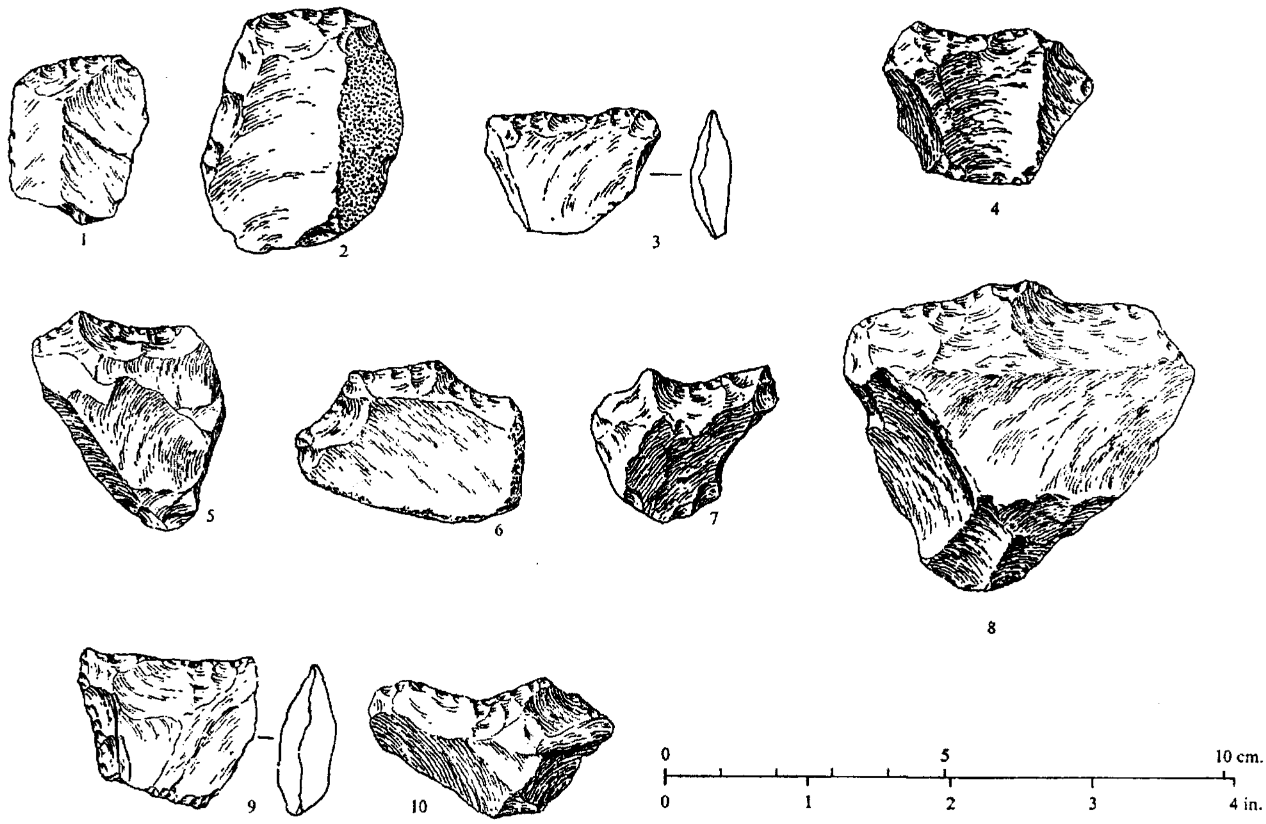

Figure 2.14. DK retouched pieces. Pieces 1-3 are transversal side scrapers, piece 4 is a lateral side scraper, pieces 5-9 are denticulate side scrapers and piece 10 is a denticulate grooved tool. The other pieces in figure 16 in Leakey (1971:35) are not in our opinion retouched pieces.

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

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

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

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

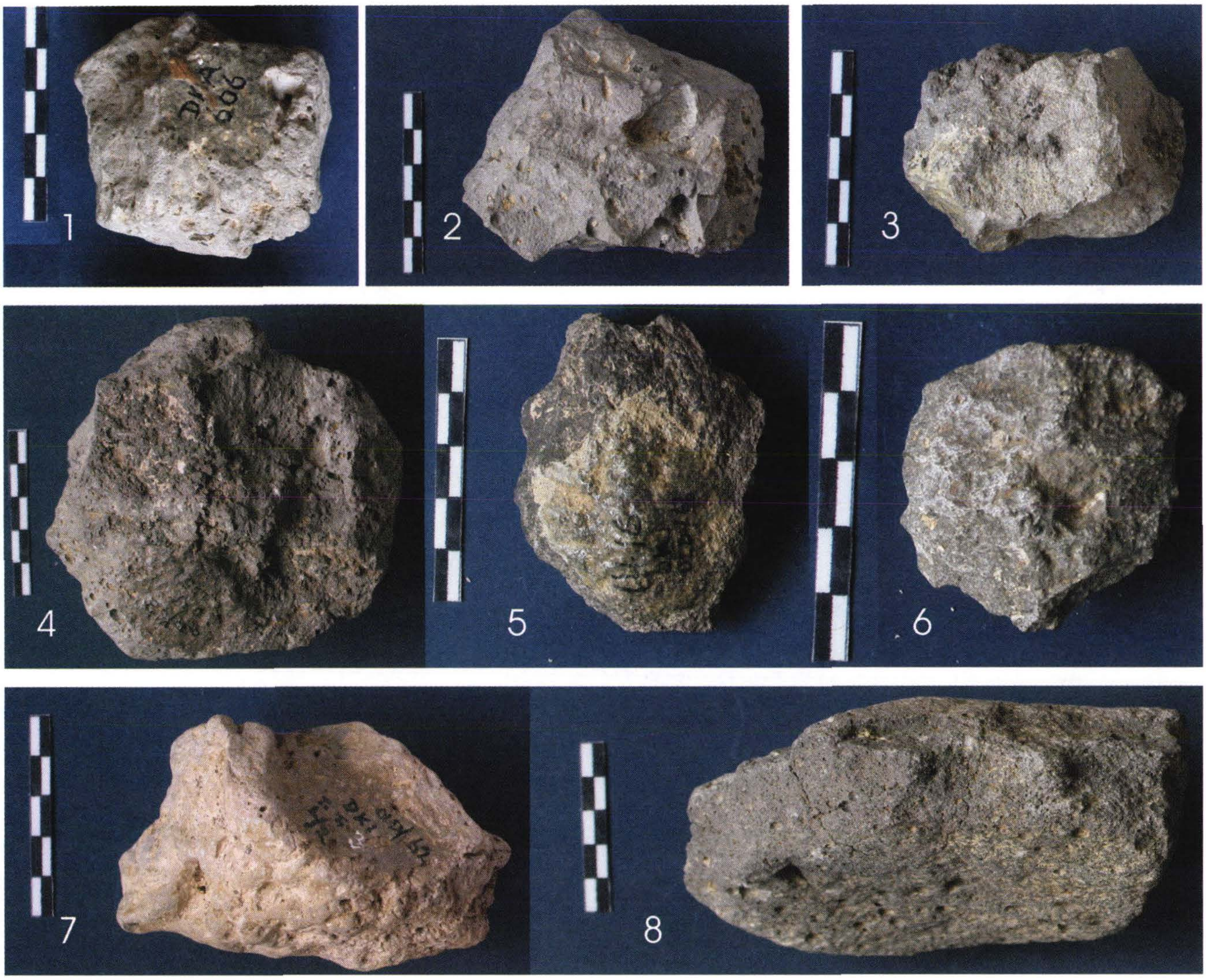

Figure 2.15. Examples of natural pieces classified by Leakey (1971) as polyhedrons (cases 1-3), discoids (4-6) and choppers (7-8).

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

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

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

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

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

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

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

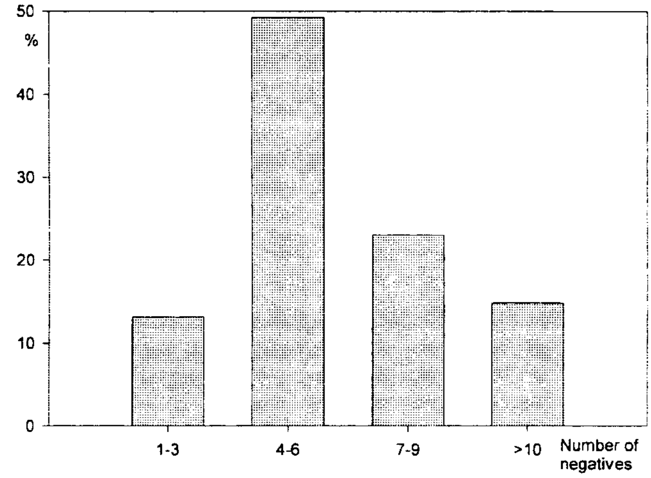

Figure 2.16. Amount of scars on the cores from DK.

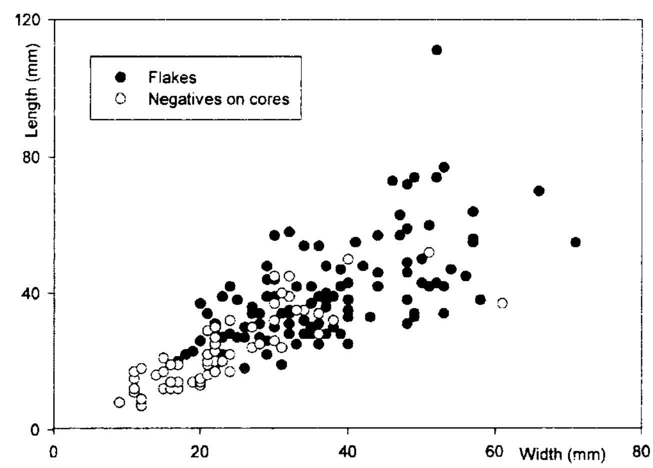

Figure 2.17. Size scatter diagram (length and width) of the scars on cores and flakes from DK.

Systems of exploitation

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

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

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

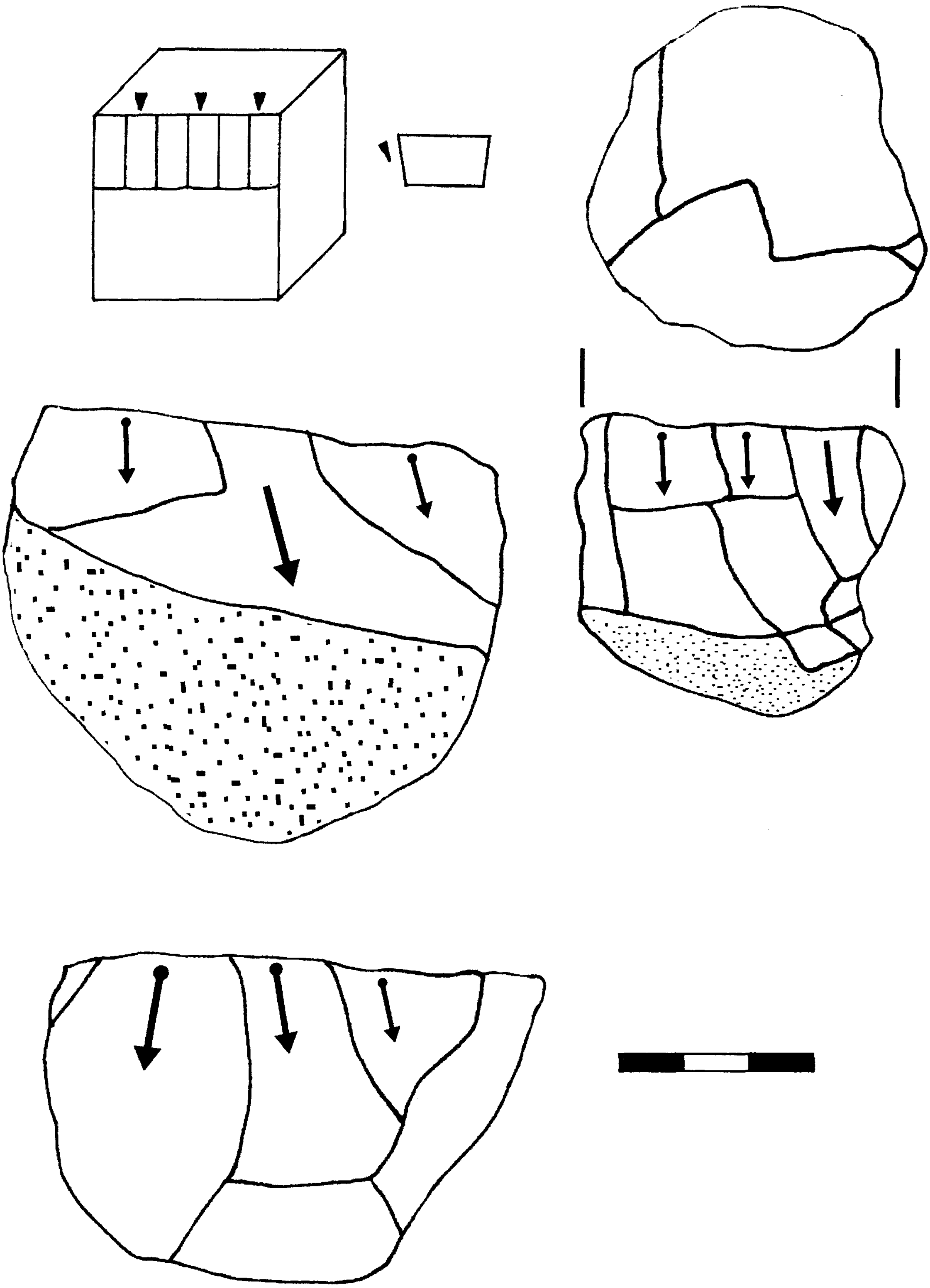

Figure 2.18. Examples of lava cores partially reduced by the unidirectional abrupt unifacial strategy.

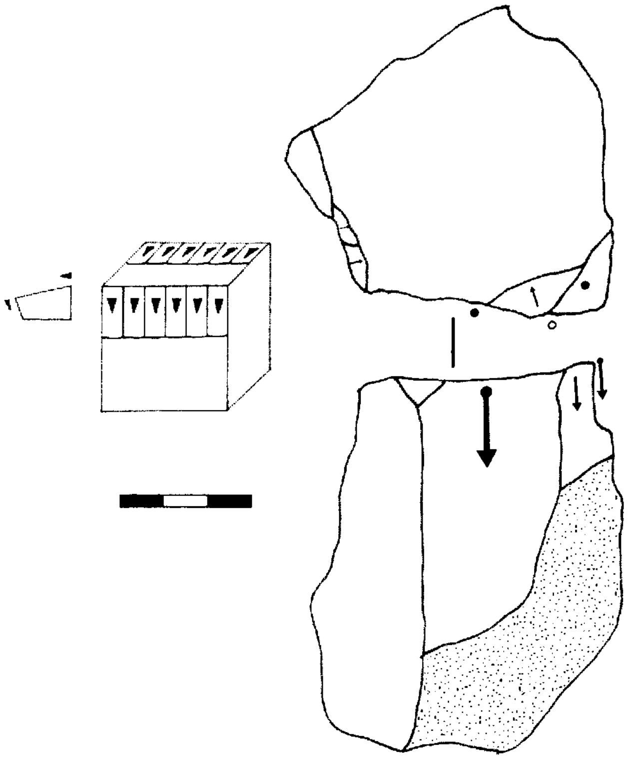

Figure 2.19. An example of a lava core with unifacial abrupt exploitation in independent planes.

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

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

The next most important group (n=12 and 15.8% of the total number of cores) is that of those referred to here as using *bifacial peripheral strategies*. These cores have two asymmetric exploitation surfaces, one of which acts as preparation plane for the extractions from the main surface. In principle this method is similar to the bifacial hierarchical centripetal system defined in Peninj (de la Torre & Mora 2004; de la Torre *et al.* 2003, 2004). As happens in Lake Natron, in DK these cores display a system of bifacial and hierarchical exploitation, which in practice has led (erroneously) to comparing the DK examples with those produced by the discoid method

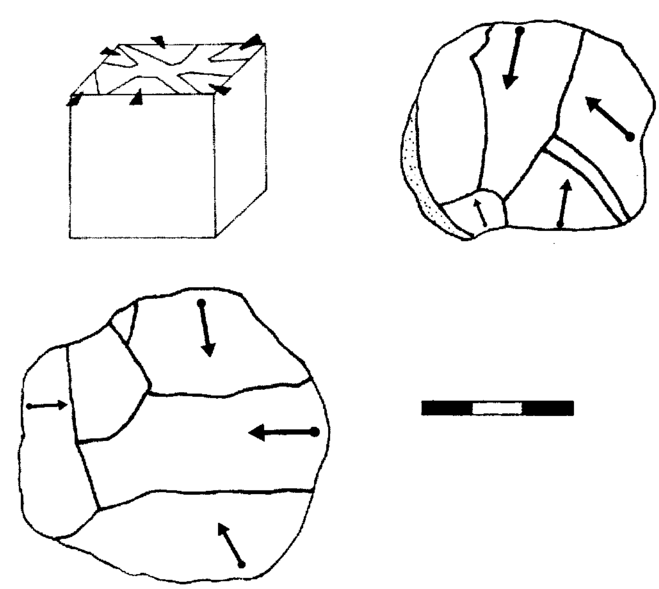

Figure 2.20. Examples of unifacial cores with peripheral exploitation of the horizontal plane.

(Leakey 1971; Gowlett 1986; Davidson & Noble 1993) or Levallois (de la Torre *et al.* 2003). We no longer believe this to be the case; the fundamental difference between Peninj's so-called bifacial centripetal method and this one found in DK is that, on analysing in detail the latter's main exploitation surfaces, it is observed that the extractions are not distributed in a radial pattern (as in the case of the centripetal system) but in an anarchical way (fig. 2.22).

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

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

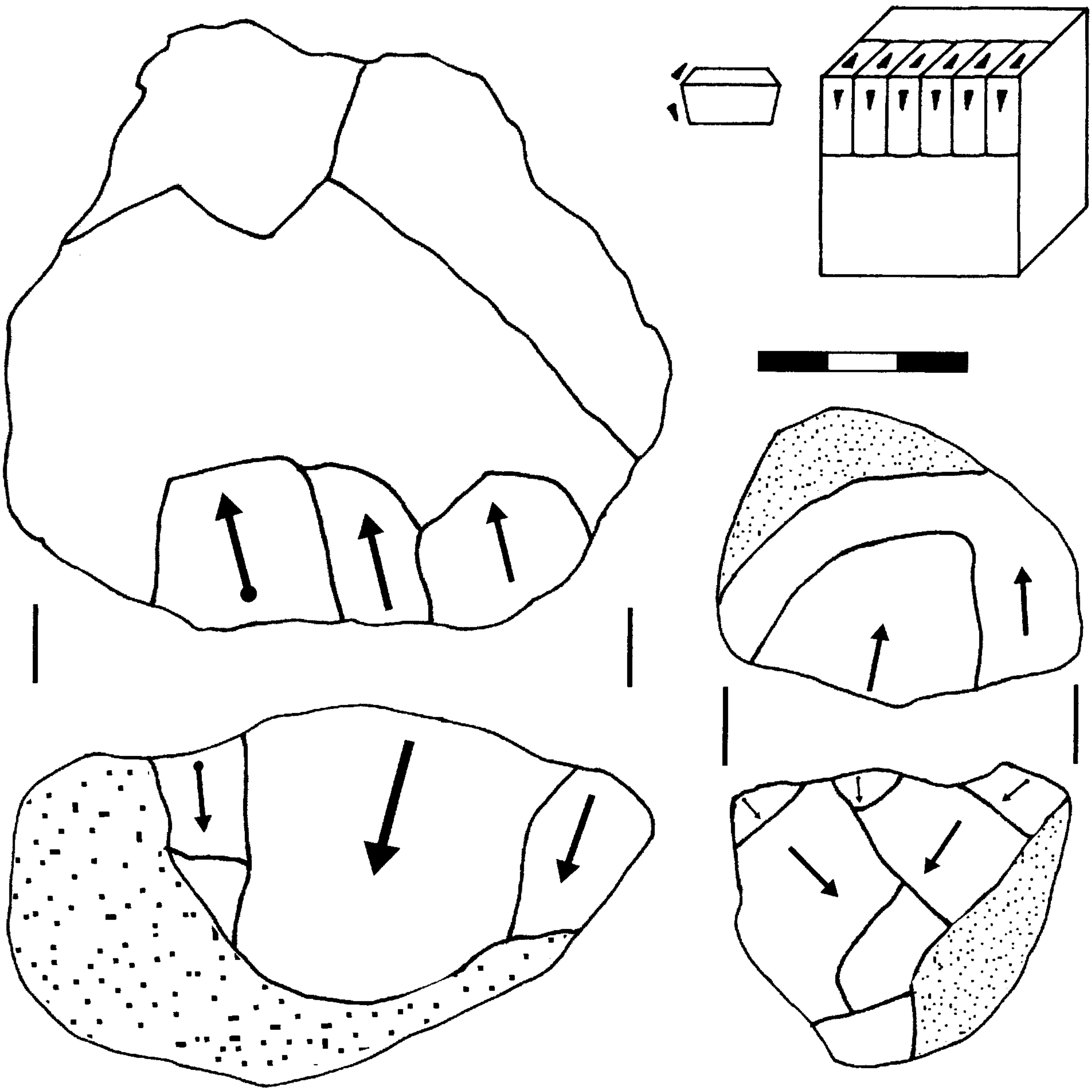

Figure 2.21. Examples of bifacial abrupt lava cores.

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

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

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

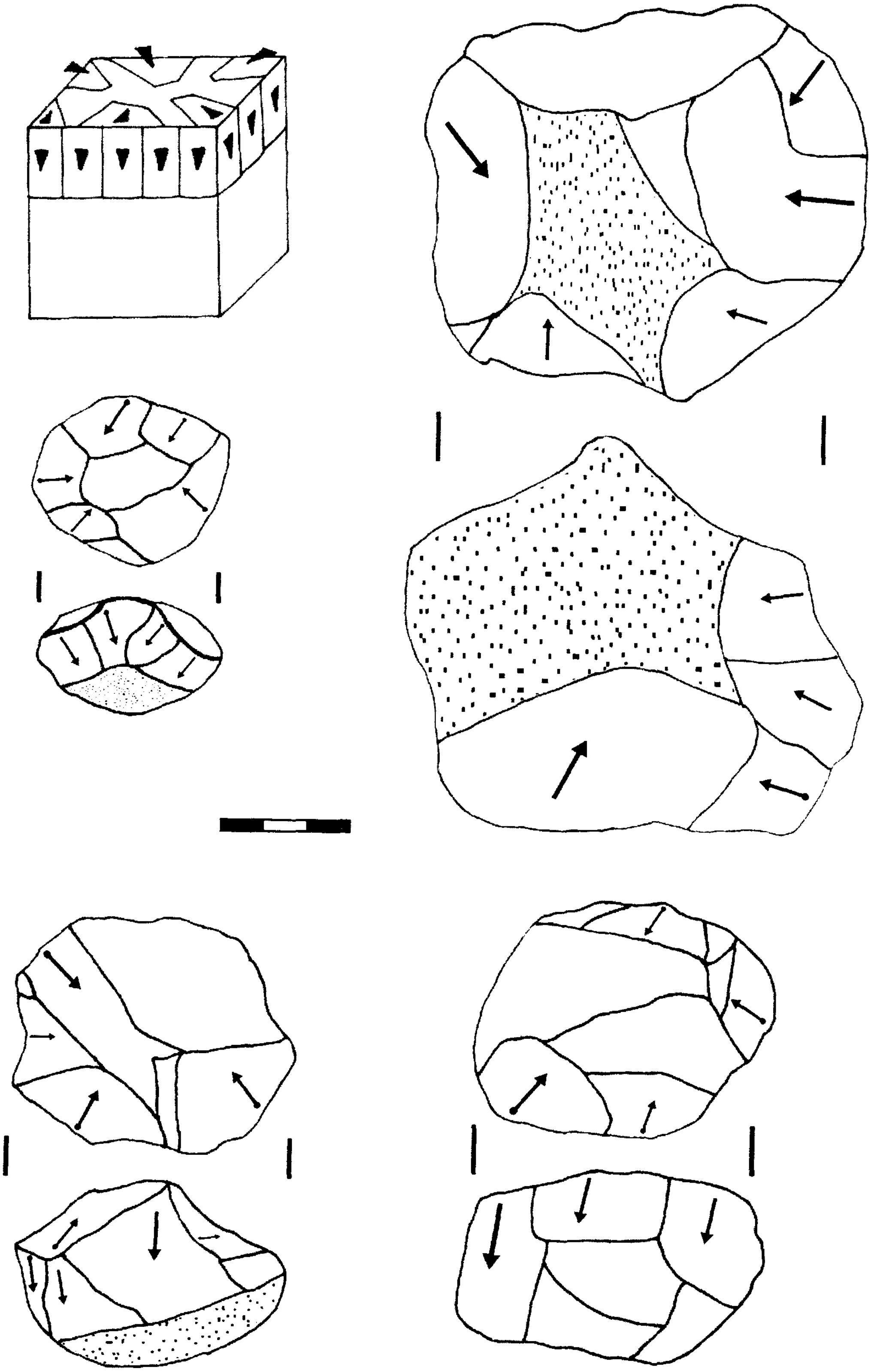

Figure 2.22. Bifacial peripheral lava cores from DK.

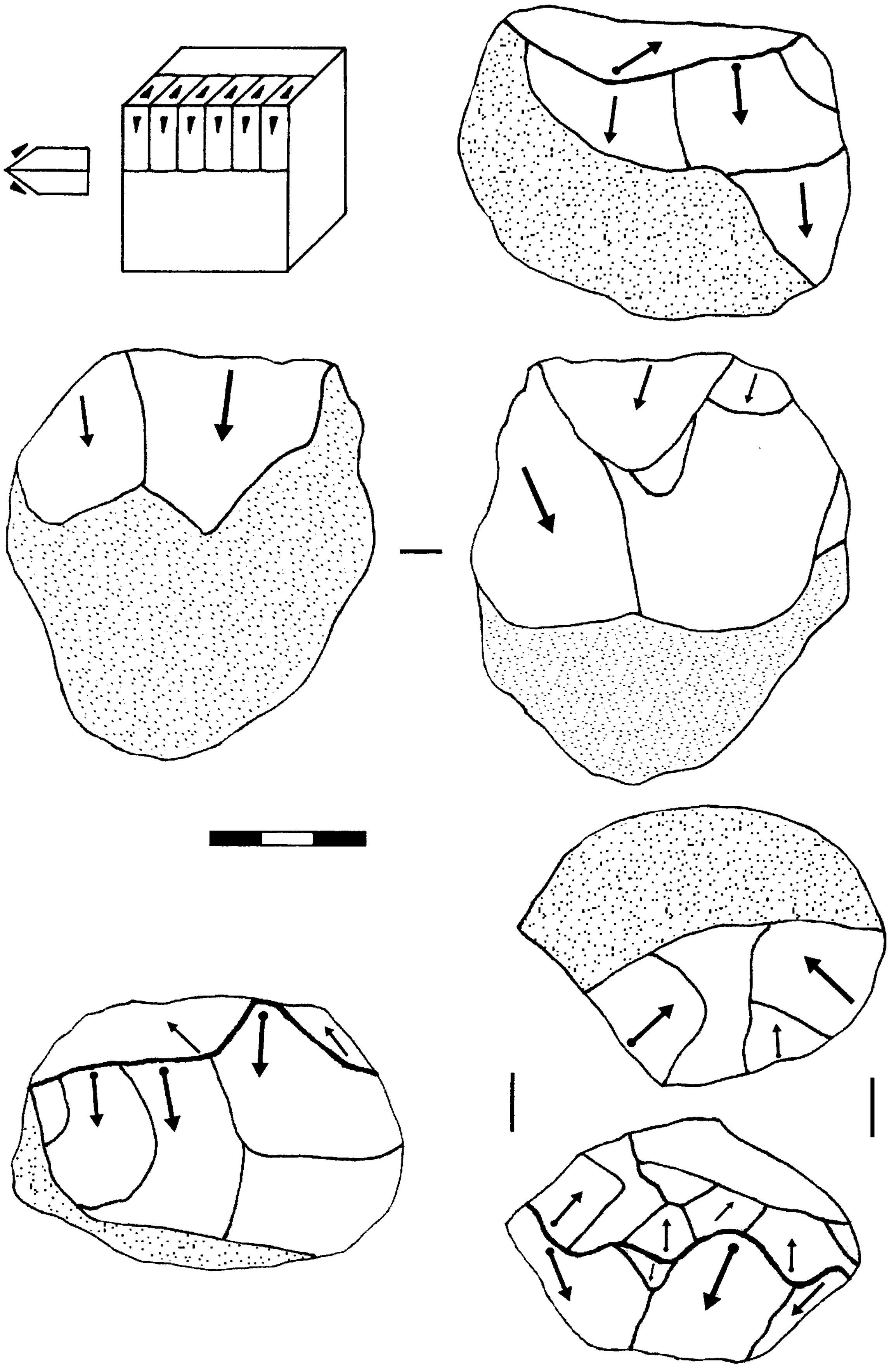

Figure 2.23. Bifacial simple partial cores.

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

Percussion objects

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

Of the knapping hammerstones, 93.5% are of lava and only 6.5% of quartz. Although this is not surprising in view of the predominance of the lavas in all the DK categories, it is notable that in all cases high-quality rounded cobbles were chosen, very different from the vesicular blocks of lava typical of the site's substrate. These cobbles must surely come from the same sources as those used as blanks for cores, as the overlapping of the sizes in the two categories would indicate

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

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

(fig. 2.25). This shows that the hominids selected the most suitable objects as hammerstones, both in terms of their ergonomic shape and the regularity of the cobbles' cortical surfaces. In addition, the variability of shapes and sizes (tabl. 2.6) could suggest an adaptation of the dimensions of each core to the type of product desired.

Conclusions

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

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

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

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

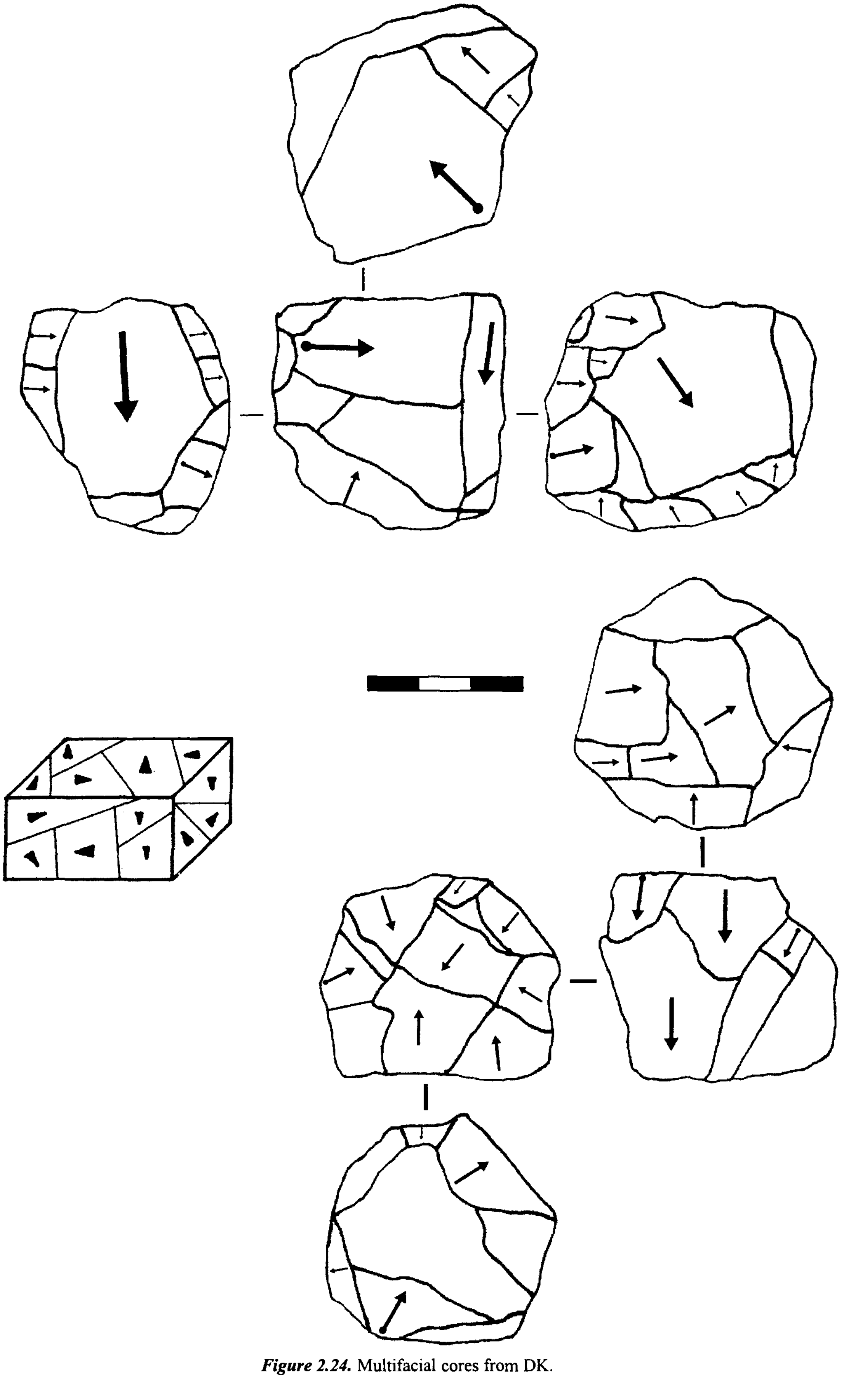

Figure 2.24. Multifacial cores from DK.

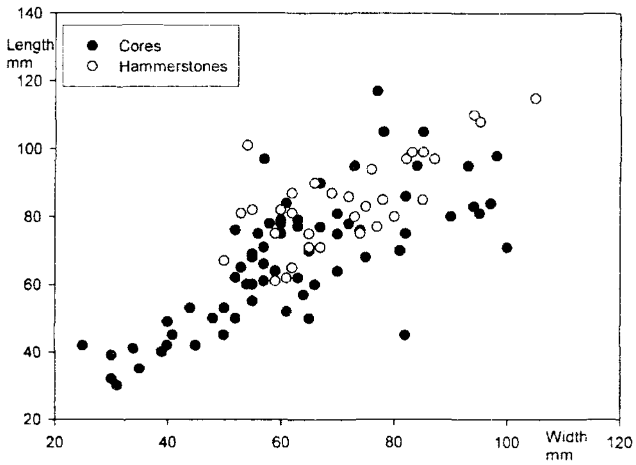

Figure 2.25. Sizes of cores and hammerstones from DK.

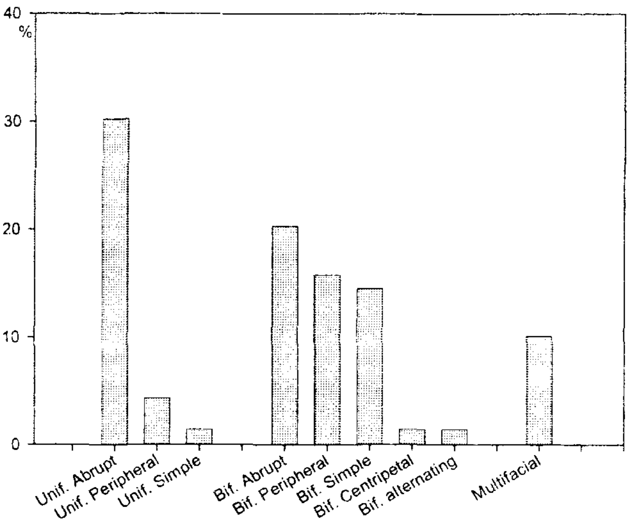

Figure 2.26. Percentages of the knapping methods at DK.

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

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

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

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