THE LECH KRZYŻANIAK EXCAVATIONS IN THE SUDAN

KADERO

Lithic implements

Michał Kobusiewicz

A rich assemblage of implements made by the Kadero inhabitants of various types of rocks constitutes an important source of knowledge about the ways of life and the origin of the human group inhabiting the site under discussion. All stone objects found at the site been brought there by man and, thanks to their particular physical extraordinary durability, have been preserved in Toto.

The great abundance of stone objects in Kadero has practically made it impossible to collect them all. Out of necessity, a selection had to be made already during excavation. However, in order to obtain a sample of inventory that would contain all possible forms of tools, core and debitage, all stone artefacts were collected over am area of 25 square meters, marked as area Id. The area is a part of a more extensive trench situated at the southern part of the site. This whole material has been screened on meshes of 4 millimetres in diameter. The inventory of the Id area, containing 13990 specimens of cores, debitage and retouched tools (an average of 567 artefacts on 1 square meter), will form the basis for characterizing the lithic technology and the typology of retouched tools, as well as the raw material economy of the Kadero inhabitants. Gouges, axes and hammer stones are so numerous in Kadero that collecting them all was beyond technical possibility. However, since they are easily classifiable, a representative selection was made during the exploration, which provides a sufficient basis for the characterization and discussion of these objects, at least for those from he southern section of the site.

Stone material from the Id area (Southern Midden)[1]

Raw materials

There are seven main types of rocks serving as raw materials for tools production in the assemblage of stone artefacts from Kadero. Of particular importance was quartz of which 95 % of objects belonging to the chipped stone assemblage were made. A lesser role was played by chert, also used for the production of retouched tools, less frequently for hammer stones and pebble fabricators; rhyolite was seldom used for producing retouched tools but all gouges, axes and the majority of hammer stones and pebble fabricators were made of this material;

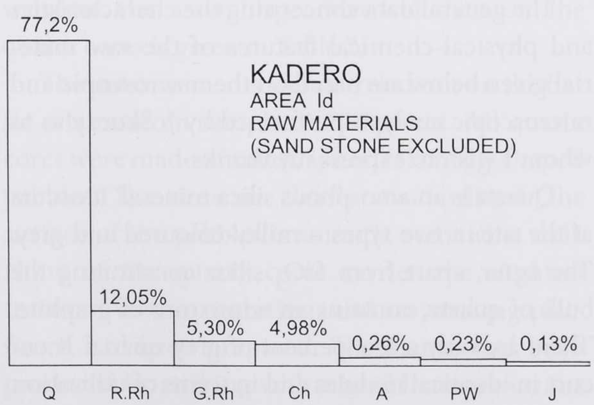

Fig. 1. Kadero. Raw materials from Area Id calculated by weight

1 Chłodnicki, Prehistoric settlement, Fig. 3 - in this volume

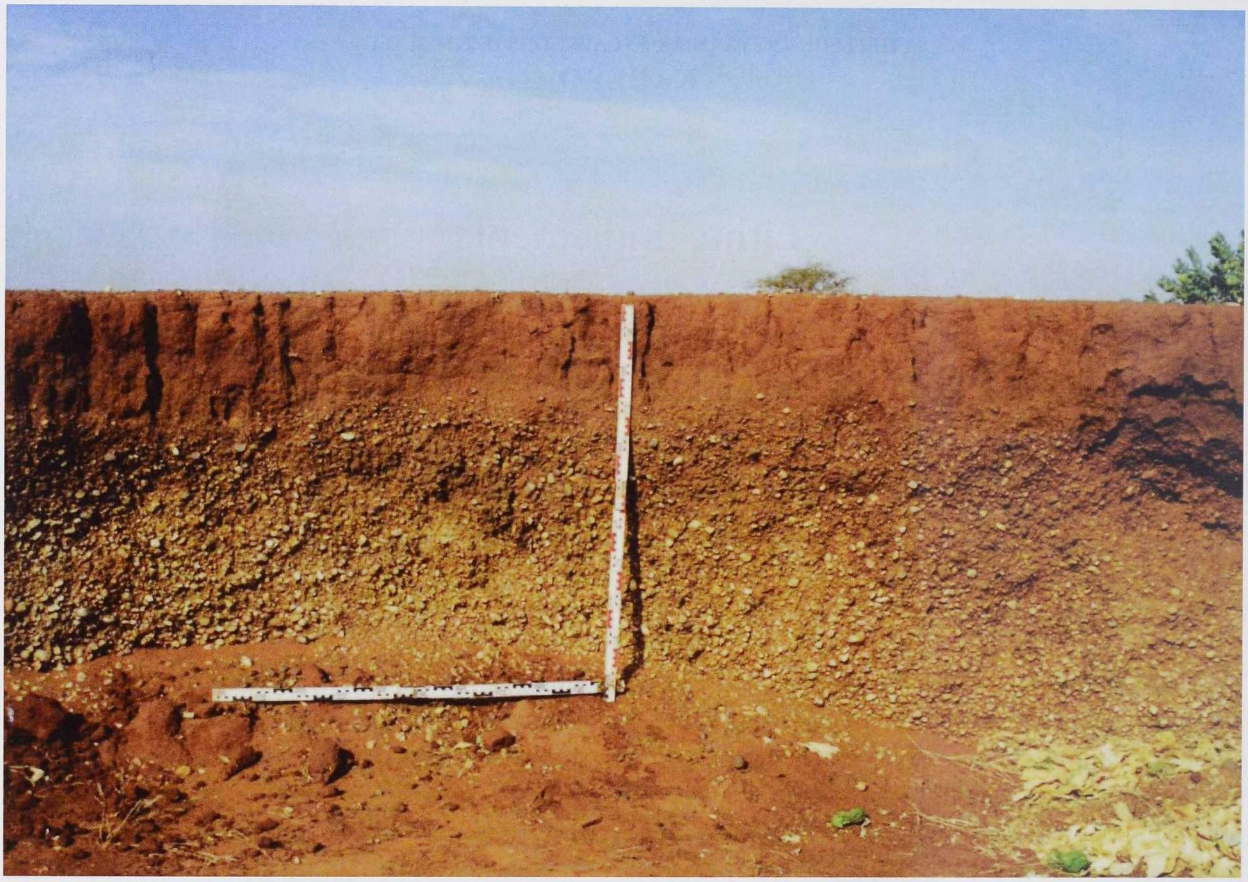

Fig. 2. Kadero. Conglomerate containing quartz pebbles

sand stone, served for the production of grinding stones, grinders and pestles of various kinds. Petrified wood, agate and jasper played an insignificant role. The calculations for the Id area for cores, debitage and retouched tools indicate that of 23884,5 grams of this artefacts 77.2% had been made of quartz, 12.05% of red rhyolite, 5.30% of green rhyolite, 4.98% of chert, , 0.26% of agate 0.23% of petrified wood, and 0.13% of jasper. (Fig. 1)

The general data concerning the characteristics and physical-chemical features of the raw material given below are based on the macroscopic and microscopic analysis performed by J. Skoczylas to whom I wish to express my thanks.

Quartz is an amorphous silica mineral. It occurs at the site in two types – milky-coloured and grey. The latter, apart from SiO_2 silica constituting the bulk of quartz, contains an admixture of graphite. There are only a few percent of grey quartz. It occurs in identical nodules and in terms of utilization has been treated identically to the milky-coloured quartz. Quartz has the hardness of 7 on the ten-grade Mohs scale. It has conchoidal fracture and the specific gravity is 2.65 g/cm^3. The colour of the milky-coloured quartz is white, and that of the greyish kind-white-grey and the material was found in the vicinity. Some 2 km east of the site expands the low plateau, so called planation surface. Here, under a ca 20 cm thick dusty cover, a layer of dense conglomerate occurs, composed mainly of small quartz pebbles ca 2-5 cm in diameter, exactly like those found in the Neolithic settlement (Fig. 2).

Chert is a silica rock of aphanitic structure, composed mainly of chalcedony and quartz. It contains 95%-100% of silica (SiO_2)and ca 2.8% of CaO. It has conchoidal fracture and the hardness of 7 on the Mohs scale. Its colour ranges from yellow to dark brown. It is easily available along the banks of the Nile where it occurs in the form of pebbles.

Rhyolite is an acid cryptocrystalline effusive rock, microscopically homogenous. Rhyolite contain ca 60% of quartz, 10%-65% plagioclase and 15% of dark components. It is often defined as porphyry. It has a good basaltic joining, i.e. a tendency of chipping off into prismatic blocks. The Kadero rhyolithes can be divided into a red-russet type which we shall continue to call red, and less frequently, a bluish-green, type which in terms of origin is identical to the red rhyolite but has a different colouring due to the admixture of sodium. We shall call it green rhyolite. The two kinds are practically identical in terms of their technical features. Yet the Kadero inhabitants apparently differentiated between the two. For example, numerous gouges of all types and the majority of axes have been made of red rhyolite exclusively, while the green kind was not used. Thus, following the prehistoric people inhabiting the site, it seems correct to treat the two kinds of rhyolite separately, as two different kinds of raw material. The nearest occurrence of the two varieties of rhyolite is the area of the VI cataract ca 60 km to the north of Kadero where it occurs in outcrops and blocks.

Petrified wood is mainly composed of chalcedony and fine grain quartz. It developed as a result of the silification process of tree trunks, most often from Carbon and Perm periods, of Araucariae (monkey-puzzle) genus. It is compactly structured, of considerable hardness and high mechanical resistance. Preserved structure of the original tree tissue can be clearly seen, both macro-and microscopically. Its colour is dark grey, often with yellowish stripes. Trunks of petrified wood weather out locally in the vicinity of Kadero occurring on the planation surface ca 2 km east of the site (Fig. 3).

Agate is a fine grain variety of chalcedony. It contains SiO_2 – 98.8% and Fe_2O_3, CaO and H_2O. It has conchoidal fracture, hardness of 6.5 – 7, specific gravity 2.57-2.64 g/cm^3. It occurs in the form of multi-shaped and multi-coloured cortex-covered nodules in the gravel layers.

Jasper is a sedimentary silica rock build up of quartz and chalcedony grains. It has a cryptocrystalline structure and random or band texture. It contains remains of Radiolariae, sponges or Diatoma. Apart from SiO_2, which makes 80%-95% of its bulk, it contains admixtures of Al_2O_3 and Fe_2O_3 up to 20% in all, and CaO – up to 3%-6%. Jasper has a dull shine, conchoidal fracture, hardness of 6.5-7, and specific gravity 2.60 g/cm^3. The Egyptian japers from the Libyan Desert and the Nile valley are usually spherical and yellow in colour. Dark brown jasper obtained in Egypt is also known as the "Nile stone". According to the admixture of iron compounds jasper can also be

Fig. 3. Kadero. Trunk of petrified wood found close to the site

green, red or brown. The specimens found in Kadero are reddish in colour. The very rare pieces of japer must have been brought from the vicinity by the inhabitants of the settlement.

The single granite specimen found at the site (a hammer stone) probably originated from the VI cataract.

Cores

The inventory of chipped stone objects collected from area Id consist of 2162 cores and core fragments. They make up 15.45% of the whole assemblage composed of cores, debitage and retouched tools. (Gouges and hammers stones will be described separately). The weight of all cores and core fragments is 7174.5 grams which make up 30.04% of total assemblage. Table 1 presents the core types that have been distinguished in terms of particular kinds of raw materials.

Quartz cores are strikingly predominant, making up 97.97% of the quantity and 91.19% of weightof the assemblage. Metrical data on the quartz cores is given in Table 2.

The measurements were carried out on the basis of a random sample of 100 pieces. All quartz cores were made of small, spherical or egg-shaped pebbles. The sizes are clearly standardized. The surface of the pebbles is smooth, somewhat dull. None of the quartz cores carries the slightest traces of core preparation, and no striking platforms had been prepared. The blanks had been produced by striking with a hard hammer on the raw surface of a nodule, first flaking off the "cortex" flake and then continuing striking near the emerging edge (Fig.4).

Table 1. Kadero. Absolute and percentage frequencies and weight in grams of particular core types from Area Id

	Core type	Quartz			Chert		
		n.	%	W	n.	%	W
1	Discoidal	-	-	-	8	33.33	55.0
2	Single platform	-	-	-	3	12.50	77.5
3	Opposed platform	-	-	-	1	4.17	40.0
4	Ninety degree platform.	-	-	-	2	8.33	58.0
5	Multiplatform unpatterned	-	-	-	10	44.67	162.5
6	Pebble core	1736	100.00	5362.89	-	-	-
7	Sub total:	1736	100.00		24	100.00	393.0
8	Core fragments	382	(18.03)	1179.61	6	(20.00)	52.0
9	Total	2118	-	6542.50	30	-	445.0

Table 1. (continuation)

	Red Rhyolite			Petrified wood			Agate		
	n.	%	W	n.	%	W	n.	%	W
1	-	-	-	-	-	-	-	-	-
2	-	-	-	1	100.00	11.0	-	-	-
3	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-
5	3	100.00	115.0	-	-	-	2	28.57	13.0
6	-	-	-	-	-	-	5	71.43	30.0
7	3	100.00	115.0	1	100.00	11.0	7	100.00	43.00
8	-	-	-	-	-	-	2	(22.22)	5.0
9	3	100.00	115.0	1	-	11.0	9	-	48.0

Table 1. (continuation)

	Jasper			Total		
	n.	%	W	n.	%	W
1	-	-	-	8	0.45	55.0
2	-	-	-	4	0.23	88.0
3	-	-	-	1	0.06	40.0
4	-	-	-	2	0.11	58.0
5	1	100.00	13.0	16	0.90	303.5
6	-	-	-	1741	98.25	5392.89
7	1	100.00	13.00	1772	100.00	5937.89
8	-	-	-	390	(18.04)	1236.61
9	1	-	13.0	2162	-	7174.50

The strokes have not necessarily been directed near the preceding striking point, but at the most convenient spot on the circumference depending on the way the core and its striking surface was shaped after striking off the previous flake. It seems that the only stable rule was continuing the exploitation of the same round surface until the processed quartz nodule was shortened to such an extent that further exploitation became impossible. The process might be compared to cutting off

Table 2. Kadero. Metrical data on cores from Area Id (measurements in mm)

Core type	n.	Mean	St. Dev.	Range
Pebble core of quartz				
Length	100	16.63	3.77	9 – 30
Width	100	15.68	2.99	9 – 22
Thickness	100	9.09	3.01	5 – 22
Cores of chert (general)				
Length	24	25.92	9.65	10 –48
Width	24	26.75	9.44	15 –46
Thickness	24	16.79	7.00	7 –28
Discoidal cores of chert				
Length	8	26.00	4.84	18 –33
Width	8	21.63	4.58	15 -27
Thickness	8	11.50	2.73	7 – 15
Multiplf. unpatterned cores of chert				
Length	10	21.90	7.09	10 -32
Width	10	25.20	7.83	15 -39
Thickness	10	18.10	7.30	10 -33

incomplete slices from a spherical loaf of bread and this is why we called it “slicing technology”. Only about 4% of quartz cores reveal traces of orientation changes. It seems that some cores had been processed by resting them on a hard supporting stand in the way familiar in the scalling technique. The nodule, however was turned round during processing so, that two distinct scalling poles were not formed. In general, the quartz cores under discussion can not be classified into any of the types known and often described in lithic assemblages of north-eastern Africa or Europe, where the cores are classified in terms of the number of striking platforms and striking directions of the blanks (“platformed core technique”). Our type of cores will be called pebble cores in the present work.

The aim was to obtain possible half circular flakes with a natural, highly arched, sometimes nearly circumspherical back.

The authors of the works on the stone materials from Saggai and Geili present the technology of processing quartz nodules in a similar way. It seems, however, that the scheme presented by them, though basically correct, is too ideal.

The quartz nodules are too small and the material itself too hard to manage (as suggested by the authors) smoothing off the rugged irregularities left after striking off the previous flakes from the processed striking platform before setting down to strike off next ones (Caneva, Zarratini 1983) or consciously split the quartz pebbles by half and than exploit them in the way like single platform cores (Caneva 1988). The striking platforms of quartz cores were exploited with no additional treatment in the hope that every now and then a correct flake would be formed. The remaining irregular flakes and chunks come from failed strokes and unforeseen splitting of the raw material. The types of debitage produced during the processing of pebble cores shall be discussed in the chapter

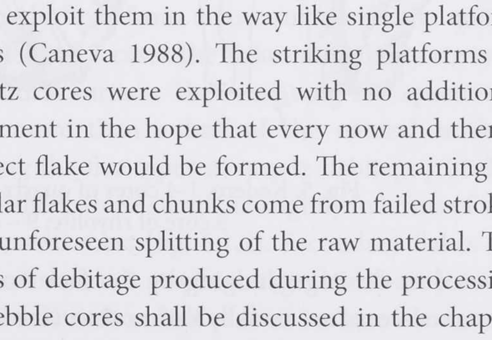

Fig. 4. Kadero. Ideal schema of the exploitation of quartz pebble for flakes production – “slicing technology”

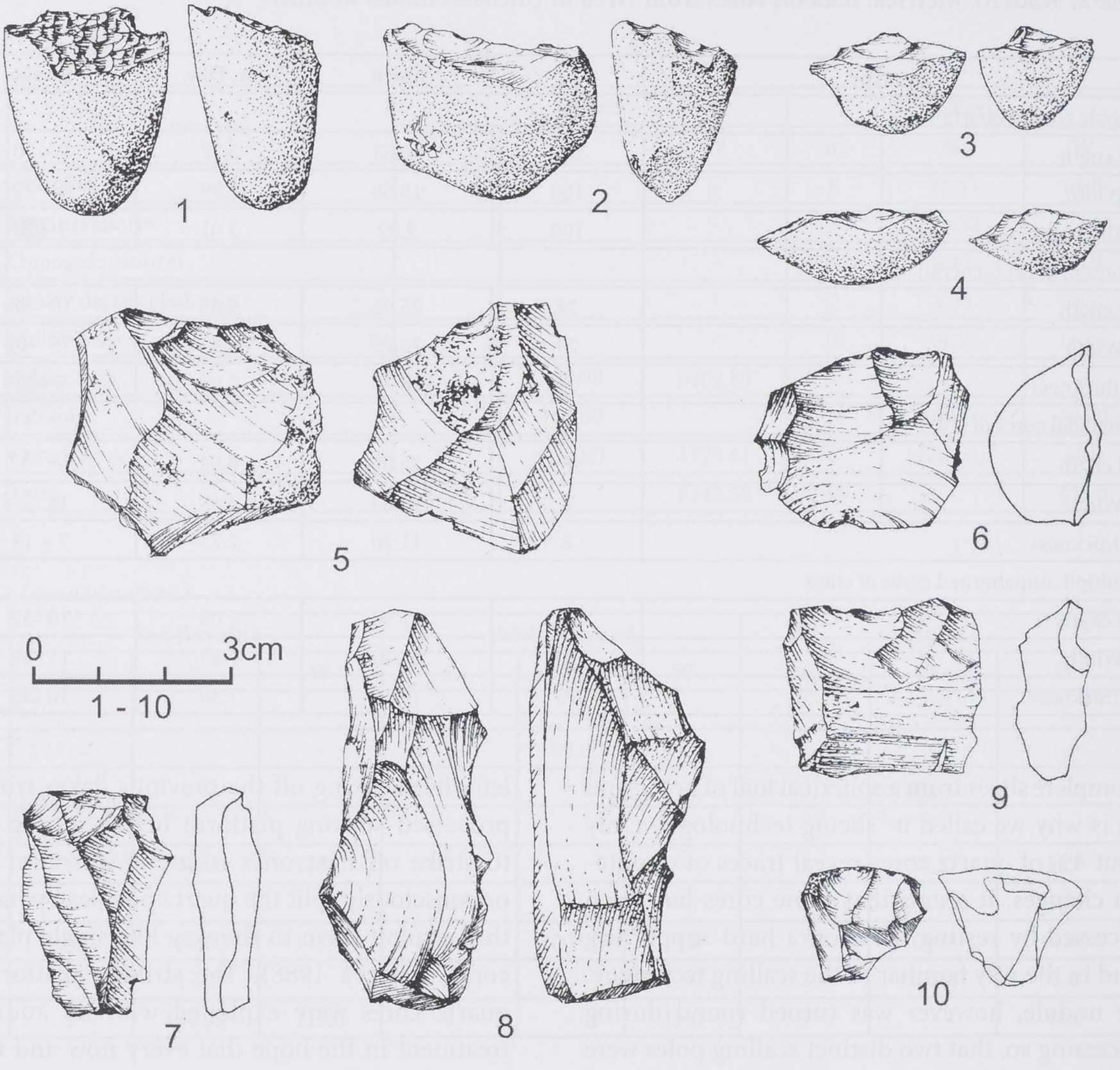

Fig. 5. Kadero. 1-4 cores of quartz (succeeding stages of utilization); 5-7 cores of chert; 8 core of rhyolite; 9 – core of petrified wood; 10 core of agate.

devoted to debitage. Judging by the fact that the preserved cores are usually rather thin (see Table 2) it must be admitted that they had been exploited to the full (Fig. 5:1-4).

In quantitative terms the second group – though considerably less numerous – consists of chert cores. They account for only 1.11% of all cores and 6.20% by general weight. Next to multiplatform unpatterned cores (Fig. 5:5) there have been distinguished specimens of discoidal cores (Fig 5:6), single platform cores (Fig. 5:7), ninety degree cores and one specimen of a double platform core (see Table 1). Still, even if the categories have been formally defined it must be admitted that a very primitive technology was applied for processing chert cores, consisting of a somewhat chaotic striking of very irregular, randomly chosen nodules of material. Only the striking platforms have, at times, been very roughly prepared.

Metrical data on chert cores are given in Table 2 for all cores, generally for the two categories of chert rich enough for statistical analysis. The Table demonstrates their frequencies and weight. The number of specimens of particular types of chert cores is too small to allow any conclusions about any regularities in their sizes. Striking platforms of chert cores are usually of the lisse type, more rarely cortex. Their inclination towards the striking surface ranges between 60° and 85°. As evidenced by their small size, most of the cores are maximally exhausted.

Seven agate cores account for 0.32% of all cores and 0.66% weight. Two of them are multiplatform unpatterned cores 18 x 20 x 19 mm and 20 x 16 x 12 mm in size of irregular shape and different degrees of striking platforms inclinations. They show no traces of preliminary preparation for processing. The remaining five specimens are pebble cores with dimensions and processing technology corresponding to the type of cores made of quartz and described above (Fig. 5:10).

Cores made of other raw materials are very infrequent. Three core specimens of red rhyolite have been defined to be multiplatform unpatterned cores (Fig. 5:8). All three had been made of gouge fragments. Their dimensions are: 60 x 27 x 21 mm, 53 x 28 x 22 mm and 30 x 32 x 14 mm. The only petrified wood core is a single platform core 25 x 30 x 10 mm in size (Fig. 5:9). No preparation for processing can be observed. The striking platform is cortex. The angle of inclination of the striking platform to the striking surface is 52^0. The only specimen of jasper core is a multiplatform unpatterned core 23 x 19 x 18 mm in size. Its shape is irregular and the striking platform angles range between 55^0 and 90^0.

Debitage

In all the Id area has yielded 11647 debitage pieces. This makes 83.62% of the number of specimens of the knapped stone assemblage from area Id under consideration, and 66.75 of its weight, the total weight of the debitage being of 15944.5 gr. Table 3 illustrates the types of debitage isolated within various kinds of raw materials encountered at the site.

It demonstrates the absolute values within a particular type, the percentage they represent, and their weight in gram, for a more precise definition of the used amount of the given type of raw material. Since the material generally is immense, the data for quartz debitage has been estimated on the basis of a random sample of 1000 objects. The same sample served for measuring the quartz debitage in millimetres. Since a detailed analysis revealed that quartz core processing technology was quite different from that for classic cores made of such raw materials like chert, petrified wood or jasper, Table 3 demonstrates only a rough classification of the debitage. A more detailed description of quartz debitage based on the sample mentioned will follow.

It goes without saying that similarly to the cores, the predominance of quartz debitage is truly striking – 92,04% of the total debitage. The amount of quartz debitage, however, is comparatively smaller – only 79.18% of the volume of all debitage collected from the Id area. This means that the average weight of quartz debitage specimens is smaller than that of rhyolite or even chert debitage. The amount of debitage of other raw materials is too small to be analyzed in greater detail at this time. The data on this subject are provided in Table 4.

It can be seen that the red and green rhyolite are the most frequently represented specimens. Jasper, petrified wood and chert debitage is considerably less frequent, while that of agate and quartz are least represented of all. The above statement is supported by Table 5 which presents measurements in millimetres of various types of debitage depending on the material kind.

A detailed technological analysis of quartz debitage has been carried out on the basis of the above mentioned random sample of 1000 specimens. The slicing technology was applied. The selected assemblage contained 231 primary flakes, 246 secondary flakes, 312 ordinary tertiary flakes, 150 quality tertiary flakes and 61 crescent shaped flakes. Primary flakes are specimens struck first, or nearly first, from a row surface of the quartz nodule. In 17 cases the flakes are wholly covered by natural surface. The remaining 214 specimens have more than a half of the natural surface. Among the five types of quartz debitage just distinguished, these stand out slightly in terms of size and massiveness (fig. 6:1,2). Secondary flakes are specimens struck at a later stage than those just described. Less than half of their surface is a natural one (fig. 6:3). They are slightly smaller and thinner than primary flakes (see Table 5).

The next type are tertiary flakes, i.e. flakes usually struck third in succession. Their surface bear no traces of the natural pebble surface. They have been divided into ordinary tertiary flakes of varied random shapes and proportions (fig. 6:4), quality tertiary flakes (fig. 6:5) and crescent shaped flakes (fig. 6:6-7). Production of the two latter was the main goal of quartz pebble processing. The last three mentioned are nearly identical in terms of proportions. Crescent shaped flakes are a tiny bit bigger in size. Yet in general a high level of homogeneity of both sizes and proportions of all

Table 3. Kadero. Absolute and percentage frequencies and weight in grams of particular debitage types from Area Id

	Debitage Type	Quartz			Chert		
		n.	%	W	n.	%	W
1	Primary flakes	2478	23.12	2919.0	64	31.37	210.0
2	Primary blades	-	-	-	3	1.47	15.0
3	Single platform flakes	-	-	-	34	16.67	105.0
4	Resharpening flakes	-	-	-	-	-	-
5	Unidentified flakes	8242	76.88	10372.0	103	50.49	260.0
6	Unidentified blades	-	-	-	-	-	-
7	Sub total:	10720	100.00	13291	204	100.00	590.0
8	Chips and chunks	-	-	-	102	(33.33)	20.0
9	Total:	10720	-	13291	306	-	610.0

Table 3. (continuation):

	Red rhyolite			Green rhyolite			Petrified wood		
	n.	%	W	n.	%	W	n.	%	W
1	10	4.72	92.5	62	37.80	425.0	1	33.33	8.5
2	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-
4	46	21.70	170.0	-	-	-	-	-	-
5	154	72.64	74.0	102	62.20	420.0	2	66.67	5.0
6	2	0.94	7.5	-	-	-	-	-	-
7	212	100.00	344.0	164	100.00	845.0	3	100.00	13.5
8	114	(34.97)	405.0	101	(38.11)	395.0	8	72.73	9.0
9	326	-	749.0	265	-	1240.0	11	-	22.5

Table 3. (continuation):

	Agate			Jasper			Total		
	n.	%	W.	n.	%	W.	n.	%	W.
1	8	61.54	11.0	1	16.67	4.0	2624	23.18	3670.0
2	-	-	-	-	-	-	3	0.03	15.0
3	-	-	-	-	-	-	34	0.30	105.0
4	-	-	-	-	-	-	46	0.41	170.0
5	5	38.46	5.0	5	83.33	12.0	8613	76.07	11148.0
6	-	-	-	-	-	-	2	0.02	7.5
7	13	100.00	16.0	6	100.00	16.0	11322	100.00	15115.5
8	-	-	-	-	-	-	325	(2.79)	829.0
9	13	-	16.0	6	-	16.0	11647	-	15944.5

distinguished types of quartz debitage should be stressed. It undoubtedly resulted from the fact that highly homogenous cores were used for the production, both in terms of size and shape as well as the structure of the material. Since, as mentioned above, quartz cores had not been prepared at all, debitage platforms, barring a few exceptions, are, as a rule, of the "cortex" type.

Tertiary flakes, quality tertiary flakes and crescent-shaped flakes in particular, have often extensive platforms. They often cover as much as two thirds of the flake circumference, and sometimes

Table 4. Kadero. Area Id. Percentage frequencies of number, weight and mean weight of debitage pieces by different kinds of raw material

Raw material	Debitage		
	Number %	**Weight %**	**Mean weight of one debitage piece in grams**
Quartz	92.04	79.18	1.18
Chert	2.63	3.83	1.99
Red rhyolite	2.80	8.87	4.34
Green rhyolite	2.28	7.78	4.68
Petrified wood	0.09	0.14	2.05
Agate	0.11	0.10	1.23
Jasper	0.05	0.10	2.67

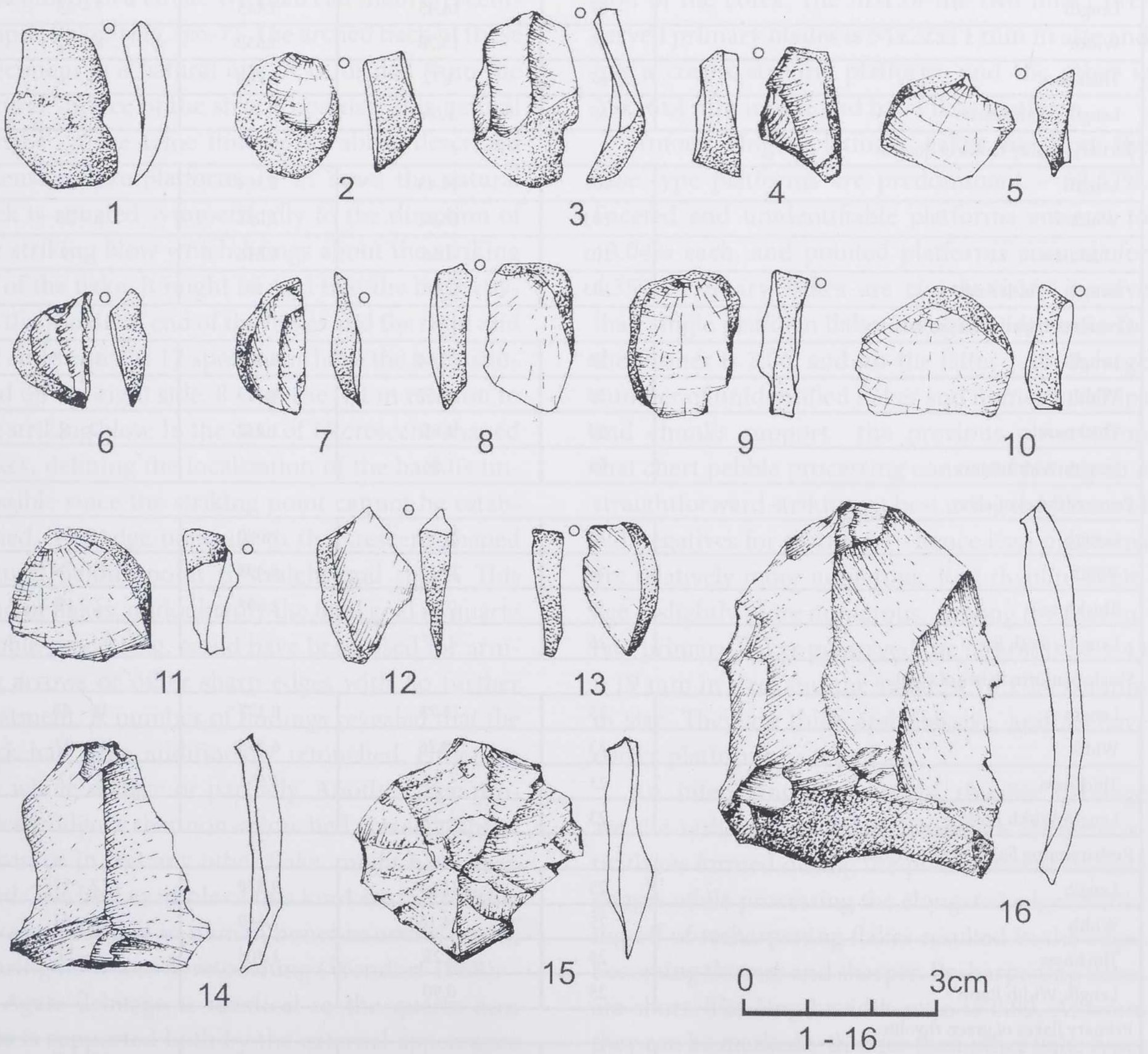

Fig. 6. Kadero. Types of debitage: 1-2 primary flakes of quartz; 3 – secondary flake of quartz; 4 – ordinary tertiary flake of quartz; 5 – quality tertiary flake of quartz; 6-7 – crescent-shape flakes of quartz; 8-13 - different types of natural striking platforms of quartz debitage; 14-16 - resharpening flakes of rhyolite

Table 5. Metrical data on debitage from Area Id (measurements in mm.). Measurements based on a random sample of 1000 pieces of quartz debitage

Type of debitage	n.	Mean	St. Dev.	Range
Primary flakes of quartz				
Length	89	15.99	3.500	8 – 24
Width	89	14.58	3.457	10 – 25
Thickness	89	6.06	1.582	2 – 10
Length:Width Ratio	89	1.09	-	-
Secondary flakes of quartz				
Length	78	16.04	3.663	9 – 25
Width	78	13.64	3.017	8 – 22
Thickness	78	5.10	1.590	2 – 10
Length :Width Ratio	78	1.18	-	-
Tertiary ordinary flakes of quartz				
Length	67	14.43	3.443	7 – 25
Width	67	13.78	3.632	8 – 22
Thickness	67	4.72	1.786	2 – 9
Length :Width Ratio	67	1.05	-	-
Tertiary quality flakes of quartz				
Length	103	14.45	3.364	8 – 26
Width	103	13.61	3.066	8 – 25
Thickness	103	4.66	1.616	1 – 9
Length :Width Ratio	103	1.06	-	-
Crescent-shaped flakes of quartz				
Length	54	15.44	4.396	8 – 27
Width	54	14.57	4.223	6 – 27
Thickness	54	4.65	1.442	2 – 9
Length:Width Ratio	54	1.06	-	-
Primary flakes of chert				
Length	26	21.57	7.090	10 –38
Width	26	20.19	6.498	11 – 39
Thickness	26	7.15	2.507	2 – 12
Length : With Ratio	26	1.07	-	-
Single platform flakes of chert				
Length	23	23.78	8.177	12 – 48
Width	23	19.26	6.595	10 –37
Thickness	23	5.57	2.551	3 – 12
Length:Width Ratio	23	1.23	-	-
Resharpening flakes of red rhyolite				
Length	25	21.68	9.878	12 – 57
Width	25	24.16	7.640	14 – 44
Thickness	25	5.28	1.908	2 – 11
Length:Width Ratio	25	0.90	-	-
Primary flakes of green rhyolite				
Length	28	26.10	9.645	12 – 47
Width	28	29.29	9.513	12 – 54
Thickness	28	9.04	3.877	3 – 19
Length:Width Ratio	28	0.89	-	-

even more (Fig.6:8). There are cases when a "cortex" platform covers the whole circumference of the flake, which thus makes a "slice" struck or, one might say, "cut off" from the nodule of quartz (fig. 6:9). Needles to say, such extensive platforms may be called thus only from the point of view of a platform definition accepted in descriptions of flint technology. An extensive platform may stretch left and right off the striking point (Fig. 6:10) sometimes asymmetrically (Fig.6:11) and at times only to the left or to right of the striking point (Fig. 6:12-13). That kind of regular tertiary flakes (quality tertiary flakes) numbered 211 in the sample. Of these 61 specimens have a definite shape of a half-circle or segment of a circle. We shall call them crescent-shaped flakes (Fig. 6:6-7). The arched back of these specimens is a natural one. It is formed from the natural surface of the struck nodule.. This natural surface at the same time is the above described extensive flake platform. In 21 cases the natural back is situated symmetrically to the direction of the striking blow which brings about the striking off of the flake. It might be said that the back covers the proximal end of the flakes and the right and left sides equally. 17 specimens have the back situated on the right side, 8 – on the left in relation to the striking blow. In the case of 16 crescent-shaped flakes, defining the localization of the back is impossible since the striking point cannot be established. The edge opposite to the crescent-shaped natural flaking point is straight and sharp. This kind of flakes, undoubtedly the final goal in quartz pebble processing, could have been used for arming arrows or other sharp edges with no further treatment. A number of findings revealed that the back had been additionally retouched, either on the whole surface or partially. Another type provides evidence that non-retouched crescent-shape flakes, or in fact any other flake, might have been used. The best example of this kind are microlithic flakes embedded in human bones as arrow-heads, bearing no traces of retouching (Wendorf 1968).

Agate debitage is identical to the quartz one. This is supported both by the external appearance and the dimensions, even if the thesis bases on an observation of only 13 specimens of agate debitage.

Similarly to the cores, the debitage of other kinds of raw materials is represented in relative small numbers. Metrical data for chert debitage are demonstrated in Table 5. The debitage is markedly bigger than the quartz debitage, because the chert cores are bigger than the quartz cores. Platforms of primary flakes of chert are most often of the lisse type – 34,62%, and not infrequently cortex – 26.06%. Unidentifiable platforms account for15.38%, faceted and pointed platforms 11.54%, and dihedral platforms 3.85%.

Variation of platform types do not indicate a careful preparation of platforms but rather that the flakes were struck off from all kinds of planes which already existed on the cores being processed.

This is supported by the above given description of the cores. The first of the two intact preserved primary blades is 54x22x11 mm in size and has a cortex striking platform, and the other is 35x16x4 mm in size and has a lisse platform.

Among single platform flakes of chert the lisse type platforms are predominant – 69.57%. Faceted and unidentifiable platforms amount to 13.04% each, and pointed platforms account for 4.35%. Primary flakes are clearly more massive than single platform flakes. Length:width ratio for the former is 1.06, and for the latter 1.26. A large number of unidentified flakes and numerous chips and chunks support the previous observation that chert pebble processing consisted mainly in a straightforward striking, at best using the planes of old negatives for platforms - hence lisse platforms are relatively more numerous. Red rhyolite debitage is slightly more numerous. Among the four intact primary flakes preserved the largest is 37 x 43 x 19 mm in size, and the smallest 18 x 24 x 6 mm in size. They are thick and massive, and all have cortex platforms.

An interesting category of rhyolite debitage are the resharpened flakes. These are characteristic flakes formed during the production of rhyolite gouges while processing the elongated edges. Striking off of resharpening flakes resulted in the edges becoming thinner and sharper. Resharpening flakes are short. The length:width ratio is 0.89. At times they can be markedly thinner than other flake types (see Table 5). The resharpening flake platform is often typically turned up towards the ventral part of the flake (fig. 6:14-16). 44.00% of the platforms are lisse, 32.00% unidentifiable, and 24.00% - fac-

Table 6. Kadero. Absolute and percentage frequencies and weight in grams of particular types of retouched tools from Area Id

	Tool type	Quartz			Chert		
		n.	%	W	n.	%	W
1	End scrapers	1	0.91	2.5	2	7.14	22.0
2	Simple perforators	5	4.55	13.0	6	21.43	12.0
3	Double backed perforators	11	10.00	13.0	2	7.14	3.0
4	Notched flakes	20	18.18	35.0	4	14.28	19.0
5	Denticulated flakes	13	11.82	30.0	1	3.75	2.5
6	Lunates	20	18.18	12.0	3	10.71	3.0
7	Partially retouched pieces	40	36.36	67.5	10	35.71	5.0
8	Total:	110	100.00	173.0	28	100.00	66.5

Table 6. (continuation)

	Red rhyolite			Green Rhyolite			Petrified wood		
	n.	%	W	n.	%	W	n.	%	W
1	4	12.50	65.0	-	-	-	-	-	-
2	4	12.50	19.0	1	20.00	8.0	-	-	-
3	-	-	-	1	20.00	2.0	-	-	-
4	4	12.50	30.0	2	40.00	11.0	1	100.00	26.0
5	12	37.50	214.0	-	-	-	-	-	-
6	1	3.13	2.0	-	-	-	-	-	-
7	7	21.88	73.0	1	20.00	70.0	-	-	-
8	32	100.00	403.0	5	100.00	91.0	1	100.00	26.0

Table 6. (continuation)

	Agate			Jasper			Total		
	n.	%	W	n.	%	W	n.	%	W
1	-	-	-	-	-	-	7	3.87	89.5
2	-	-	-	-	-	-	16	8.84	52.0
3	-	-	-	-	-	-	14	7.73	18.0
4	-	-	-	-	-	-	31	17.13	121.0
5	-	-	-	-	-	-	26	14.36	17.5
6	1	50.00	0.5	-	-	-	25	13.81	17.5
7	1	50.00	1.5	3	100.00	4.0	62	34.26	221.0
8	2	100.00	2.0	3	100.00	4.0	181	100.00	765.5

eted. Green rhyolite debitage is still more massive than the red one, and is also short proportion–wise (length:width ratio is 0.89). It is represented by primary flakes, numerous unidentified flakes, chips and chunks. Their platforms are almost hundred percent cortex, and they are flakes struck off the raw nodule before any earlier preparation. Single specimens of petrified wood, agate and jasper debitage are to rare to be characterized at this juncture.

Retouched tools

181 retouched tools have been identified in area Id, accounting for only 1.29% of the whole inventory. Their weight comes to 765.5 gram, 3.21 % of the total weight. The types are enumerated according to Tixier's type list (Tixier 1963). Though this list, as composed for the Late Palaeolithic of the Maghreb, is not fully satisfactory, but we do not possess any better. The advantage of applying Tixier's list is the

Table 7. Kadero. Metrical data on retouched tools from Area Id (measurements in mm.). Only wholly preserved pieces have been measured

Tool type	n.	Mean	St. Dev	Range
End scrapers				
Length	7	36.14	10.11	19 – 53
Width	7	29.71	9.38	16 – 42
Thickness	7	10.71	3.33	6 – 17
Simple perforators				
Length	16	26.06	6.85	14 – 40
Width	16	18.56	6.50	11 – 35
Thickness	16	5.69	1.99	2 – 8
Double backed perforators				
Length	10	18.40	5.22	15 –26
Width	10	7.80	0.98	7 – 10
Thickness	10	4.40	0.90	3 – 5
Notched flakes				
Length	27	20.44	8.94	12 – 39
Width	27	18.52	7.61	10 –36
Thickness	27	6.26	2.50	4 – 14
Denticulated flakes				
Length	26	27.73	16.06	11 – 82
Width	26	21.85	10.66	10-48
Thickness	26	7.92	4.04	3 – 22
Lunates of quartz				
Length	17	16.53	2.33	13 – 22
Width	17	8.71	3.01	6 – 17
Thickness	17	4.47	1.14	3 – 7
Retouched pieces of quartz				
Length	39	16.64	5.20	9 – 33
Width	39	13.28	3.17	8 – 21
Thickness	39	5.41	1.58	3 – 9
Retouched pieces of other rocks				
Length	23	24.17	19.03	28 – 98
Width	23	21.13	13.51	8 – 62
Thickness	23	6.83	3.86	3 – 16

possibility to compare the stone inventory in question to other Final Palaeolithic and Neolithic assemblages known from North-eastern Africa just published based on his list. If the definition of the described type here does not fully fit the Tixier's list, it will be explained in the text.

On the other hand Table 7 presents their dimensions based on wholly preserved specimens. Among retouched tools 60.8% are made of quartz, 15.4% of chert, 17.7% of red rhyolite, 2.8% of green rhyolite, 1.7% of jasper, 1.0% of agate and 0.6% of petrified wood.

Endscrapers: Seven specimens. All made of flakes. Four are simple end-scrapers on a flake (Tixier's list type 1). Two made of chert and two of red rhyolite. All tertiary (Fig. 7:1-2).

One is made on a tertiary retouched flake (Type 2) (Fig. 7:3); one on a thick tertiary flake represents a nucleiform end-scraper (Type 4) (Fig. 7:4); one is made on tertiary flake of quartz with the scraping edge slightly nosed (type 6) (Fig. 7:5).

Simple perforators: (Type 12). Sixteen pieces. Three are made on tertiary and two on primary flakes

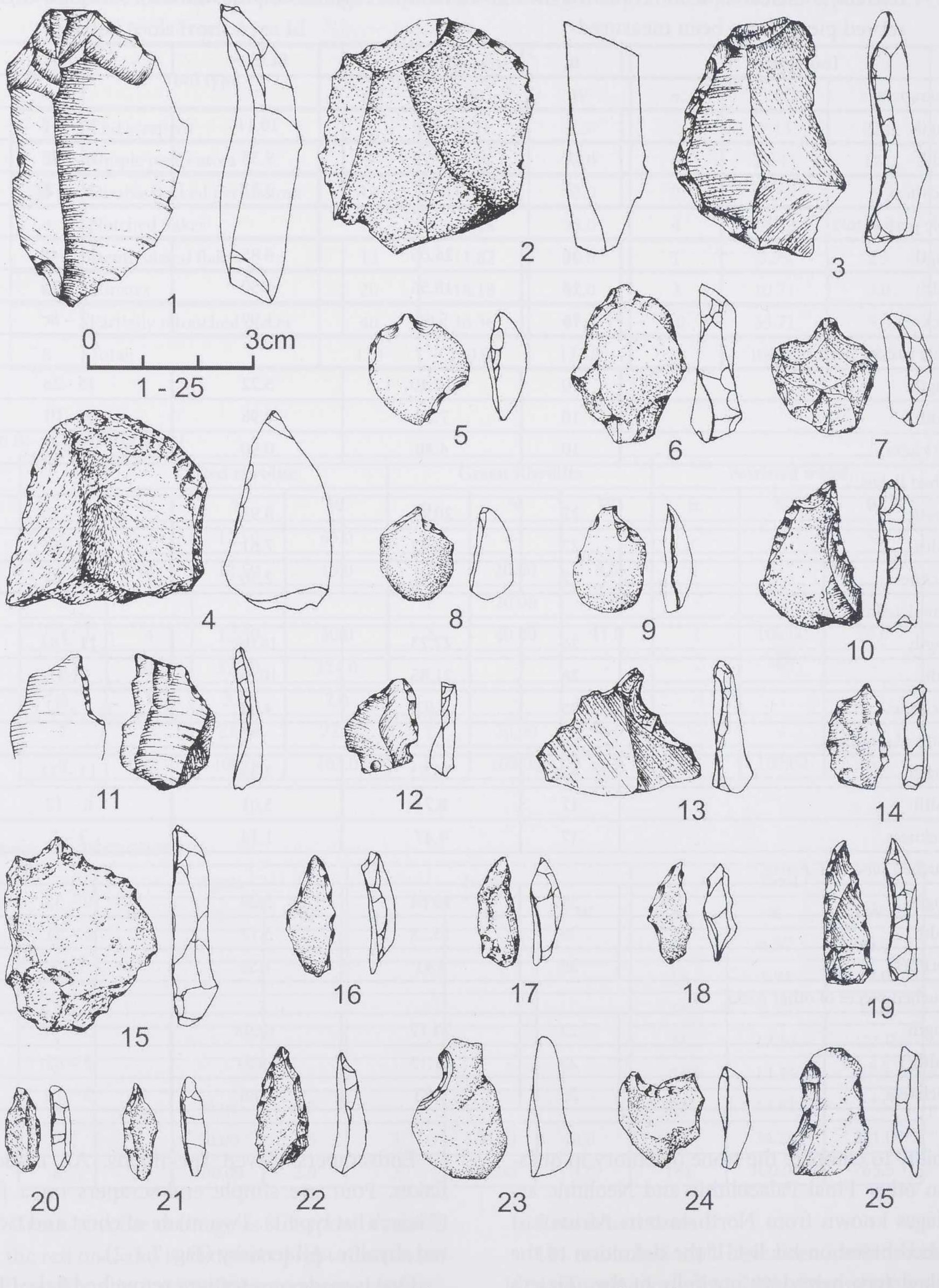

Fig. 7. Kadero. 1-5 – endscrapers; 6-15 – simple perforators; 16-22 – double backed perforators; 23-25 notched flakes.

of quartz (Fig. 7:6-9). One is made on primary (fig. 7:10), two on secondary (Fig. 7:11) and three on tertiary flakes of chert (Fig. 7:12). Out of four simple perforators made of tertiary flakes of red rhyolite, three have alternating retouch (Fig. 7:13-14). The only specimen of green rhyolite is made on a primary flake (Fig. 7:15).

Double backed perforators: (Type 16). Fourteen specimens. One is made on primary, two on

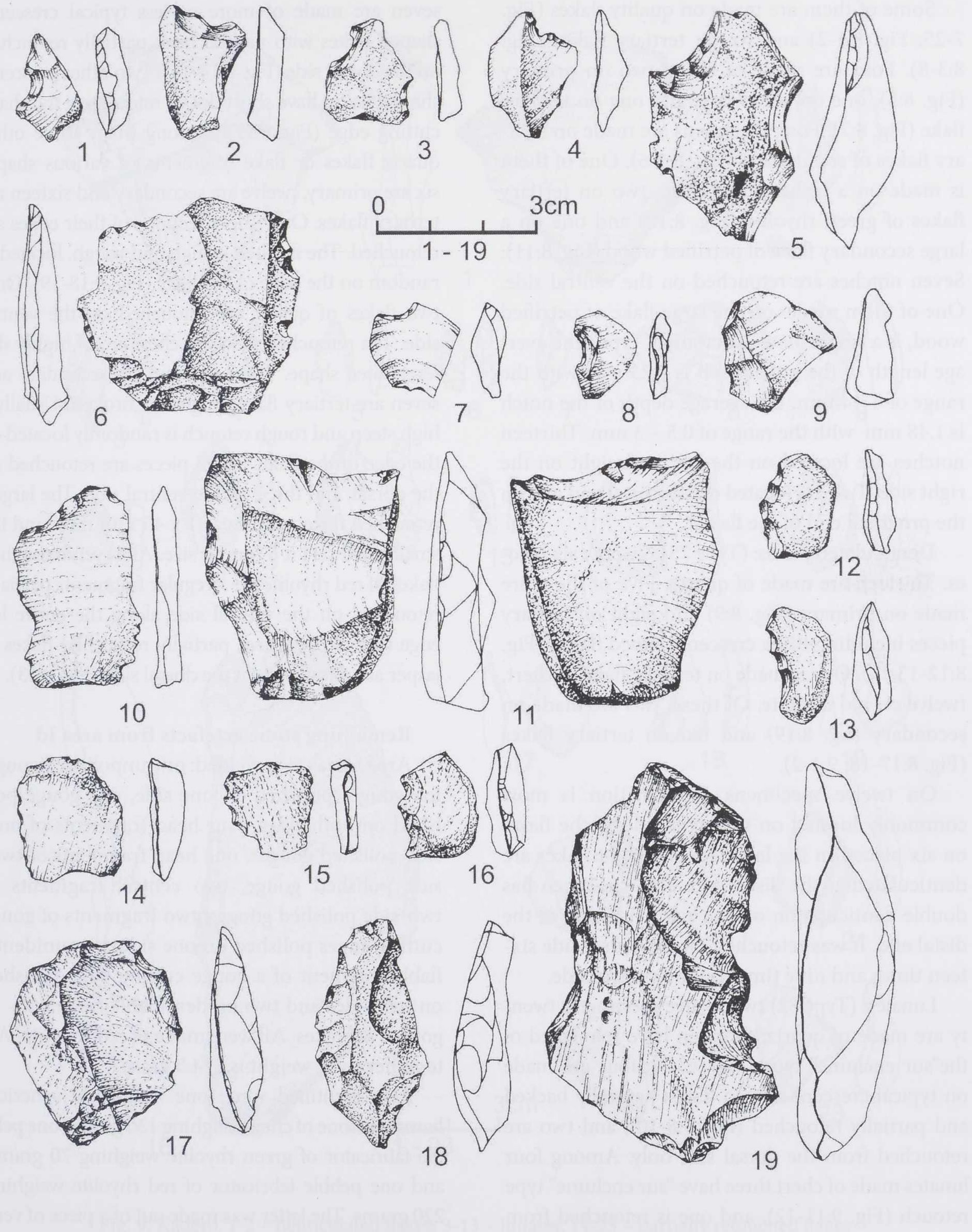

Fig. 8. Kadero. 1-8, 10-11 – notched flakes; 9,12-19 – denticulated flakes

secondary, and eight on tertiary pieces of quartz (Fig. 7:16-20). Two are made on tertiary pieces of chert (Fig. 6:21) and one on a tertiary piece of green rhyolite (Fig. 7:22).

Notched flakes: (Type 74). Thirty one specimens. Twenty of them are made of quartz. Three are made on primary flakes (Fig. 7:23), and eleven on secondary flakes (Fig. 7:24-25).

Some of them are made on quality flakes (Fig. 7-25; Fig. 8:1-2) and six on tertiary flakes (Fig. 8:3-8). Four are made of chert: two on primary (Fig. 8:5), one on secondary, and one on tertiary flake (Fig. 8:7). Four specimens are made on tertiary flakes of red rhyolite (Fig. 8:4-6). One of them is made on a resharpened flake, two on tertiary flakes of green rhyolite (Fig. 8:10) and one on a large secondary flake of petrified wood (Fig. 8:11). Seven notches are retouched on the ventral side. One of them made on the large flake of petrified wood, is a single blow "clactonian" type. The average length of the notch itself is 7.23 mm with the range of 4-14 mm. the average depth of the notch is 1.48 mm with the range of 0.5 – 3 mm. Thirteen notches are located on the left, and eight on the right side. Two are located on the distal and one on the proximal end of the flake.

Denticulated flakes: (Type 75). Twenty six pieces. Thirteen are made of quartz. Five of them are made on primary (Fig. 8:9) and eight on tertiary pieces including three crescent shaped flakes (Fig. 8:12-13,16). One is made on tertiary flake of chert, twelve on red rhyolite. Of these, two are made on secondary (fig. 8:19) and ten on tertiary flakes (Fig. 8:17-18; 9:1-2).

On twelve specimens denticulation is most commonly located on the right side of the flake, on six pieces on the left side, and eight flakes are denticulated at the distal end. One specimen has double denticulation on the right side and at the distal end. It was retouched on the dorsal side sixteen times and nine times on the ventral side.

Lunates: (Type 82) twenty five specimens: twenty are made of quartz; fourteen have retouched of the"sur enclume" type (Fig. 9:3-7); four are made on typical crescent shaped flakes naturally backed and partially retouched (Fig. 9:8-10), and two are retouched from the dorsal side only. Among four lunates made of chert three have "sur enclume" type retouch (Fig. 9:11-12), and one is retouched from the ventral side. A single lunate made of agate is retouched "sur enclume" (Fig. 9: 13). It is practically impossible to conclude on such little objects made of such an illegible raw material as lunates whether the backing was practiced on the right or left edge.

Partially retouched pieces: (Type105). Sixty two specimens. Forty are made of quartz. Among them, seven are made of more or less typical crescent-shaped flakes with natural back partially retouched on the dorsal side (Fig. 9:14-15). Two other crescent-shaped flakes have short dorsal retouch on the sharp cutting edge (Fig. 9:17). Among thirty three other quartz flakes or flake fragments of various shapes six are primary, twelve are secondary and sixteen are tertiary flakes. Only short sections of their edges are retouched. The retouch is high and rough, located at random on the edge of the flake (Fig. 9:18-19). Only two flakes of quartz are retouched on the ventral side. Ten retouched flakes of chert are of highly differentiated shape. Three of them are secondary and seven are tertiary flakes, eight are broken. Usually a high steep and rough retouch is randomly located on the edge of the flake. Seven pieces are retouched on the dorsal, and three on the ventral side. The largest retouched flake measures 51 x 45 x 13 mm, and the smallest 10 x 11 x 6 mm in size. All seven retouched flakes of red rhyolite are irregular fragments partially retouched on the ventral side along the entire left edge (Fig. 9:22). Three partially retouched flakes of jasper are retouched on the dorsal side (Fig. 9:23).

Remaining stone artefacts from area Id

Area Id has also yielded: one unpolished gouge, ten gouges polished on one side, one gouge polished on both sides, four head fragments of one-side polished gouges, one head fragments of two-side polished gouge, two central fragments of two-side polished gouges, two fragments of gouge cutting edges polished on one side, one unidentifiable fragment of a gouge cutting edge polished on two sides and two unidentifiable fragments of gouges and axes. All were made of red rhyolite. Altogether their weight is 874.5 gram.

Also identified were: one irregularly spherical hammer stone of chert weighing 130 grams, one pebble fabricator of green rhyolite weighing 70 grams, and one pebble fabricator of red rhyolite weighing 220 grams. The latter was made out of a piece of very large, thick and probably massive axe, with its sharpened fragment having been used as working edges.

A more detailed description of the above mentioned types of artefacts is included in the description of gouges, axes and hammer stones from all Kadero trenches, and which can be found on succeeding chapters.

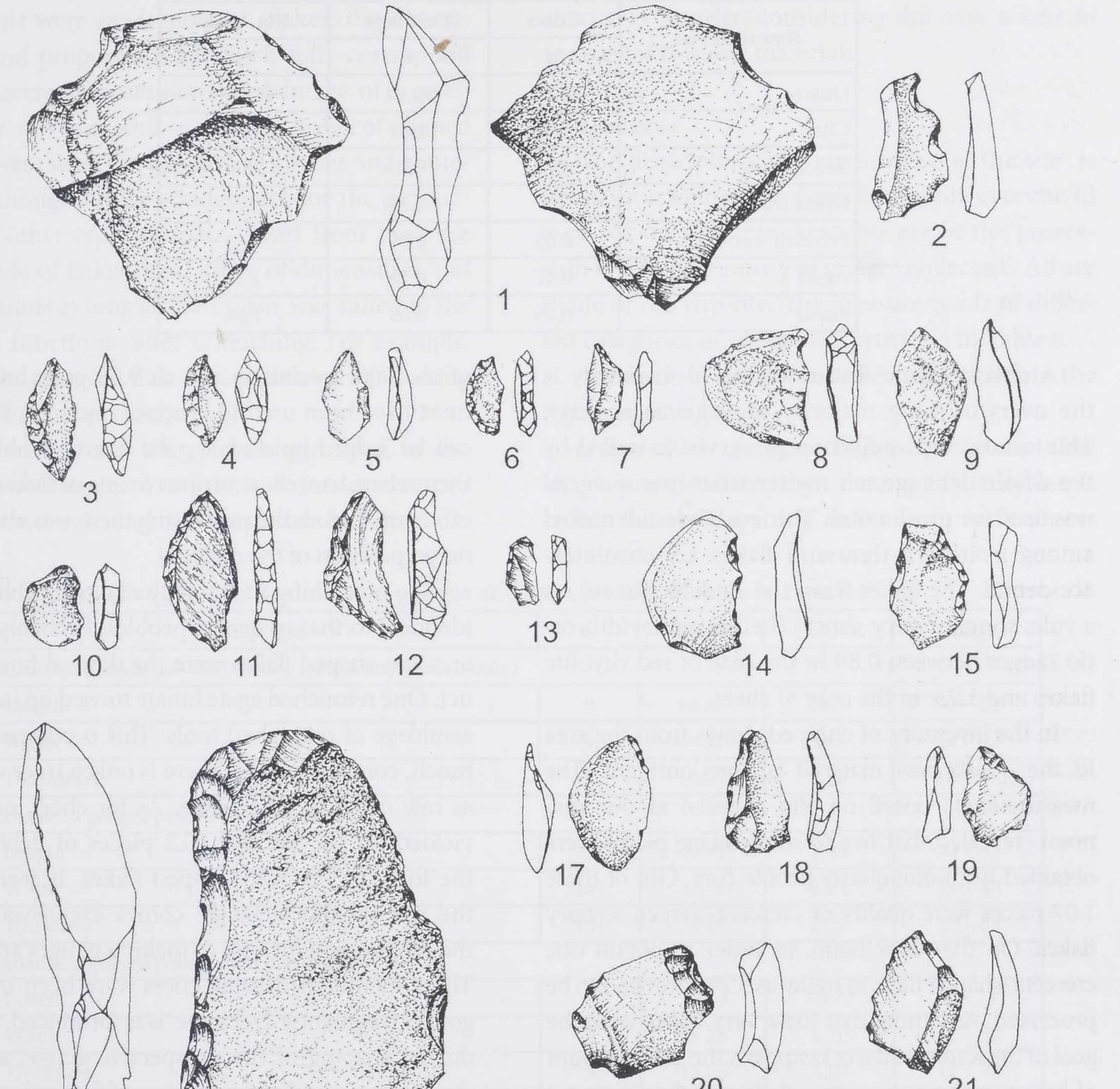

Fig. 9. Kadero. 1-2 – denticulated flakes; 3-13 – lunates; 14-23 – partially retouched flakes

Discussion of cores, debitage and retouched tools

As shown on Table 8, the amounts of particular types of raw materials are very similar in the case of cores and debitage

The distribution for retouched tools is different. The percentage of retouched tools made of quartz is visibly lower, while that of chert and rhyolite tools markedly higher than the percentage of this raw materials for cores end debitage. Chert and rhyolithe were preferred to quartz for tool making. This seems the more obvious when recalling that the diameters of quartz cores rarely exceed 30 mm.

Table 8. Kadero. Percentage of raw material used for cores, debitage and tools

Raw material	Cores	Debitage	Ret. tools
	%	%	%
Quartz	97.95	92.04	60.78
Chert	1.39	2.63	15.47
Red rhyolite	0.14	2.80	17.68
Green rhyolite	-	2.28	2.76
Petrified wood	0.05	0.09	0.55
Agate	0.42	0.11	1.10
Jasper	0.05	0.05	1.66

A characteristic feature of the Id inventory is the overwhelming majority of flake technology. This is indicated by all cores preserved as well as by the whole debitage, no matter what raw material was used for production. The few blades identified among nearly 12 thousand flakes are absolutely accidental. The flakes from the Kadero site are, as a rule, short or very short. Their length:width ratio ranges between 0.89 in the case of red rhyolite flakes and 1.23 in the case of chert.

In the inventory of chipped stones from the area Id the quartz raw material is predominant. The measurements based on the material at our disposal revealed that five to six debitage pieces were obtained from one quartz pebble core. Out of these 1.07 pieces were quality or crescent-shaped tertiary flakes. On the other hand, in order to obtain one crescent-shaped flake as many as 3.24 cores had to be processed. Assuming that these very flakes were the goal of the Kadero quartz knappers, the great amount of hammered quartz scattered all over the site is not surprising. The number of crescent-shaped flakes produced from 2118 cores found over an area of 25 square meters of the Id area could therefore have run to 654 specimens. This required using ca 19.167 kg of quartz pebbles, i.e. 29.30 gram of quartz for the production of one crescent-shape flake. These estimates are based on the number of crescent-shaped flakes actually found in the Id area. More probably however, a considerable amount of the best flakes as the most desirable product were carried away outside of the investigated area. Assuming that only one third stayed in the Id area (pieces of inferior quality) there still was the demand for one core to produce one successful crescent-shaped flake. In such a case the number of crescent-shaped flakes produced from the quartz cores in the Id area would run at a figure of ca 2000 specimens and ca 9.58 gram of quartz must have been used to produce one such flake. As can be judged by studying the quartz pebble cores themselves, as well as various forms of flakes struck off them, before the processing there was absolutely no preparation of the material.

The processing technology of agate pebbles was identical to that of quartz pebbles. Probably, again, crescent-shaped flakes were the desired final product. One retouched agate lunate turned up in the assemblage of retouched tools. This is comparatively much, considering that there is only a trace of agate as raw material on the site. As for chert, one core yielded on the average 10.2 pieces of debitage in the form of variously shaped flakes. It seems that the red rhyolite debitage comes exclusively from the preparation process of making gouges and axes. Three identified rhyolite cores were been made of gouge fragments. Debitage was produced mainly during shaping of the prospective gouge, and the above mentioned resharpening of flakes during the formation of its sharp side-edges or cutting edges. A large number of primary flakes of all kinds of raw material indicates that the materials had been brought to the site without any pre-treatment.

The whole debitage of all kinds of raw materials does not yield any of the so-called characteristic processing wastes, such as core renovation flakes, lames á crête, etc., which are produced in the successive stages of progressing . This is borne out by the study of the cores themselves, none of which bears traces of any pretreatment whatsoever with the exception of some striking platforms noticed on chert cores, though even in these cases the flakes had been struck off a raw or cortex striking platform. The nature of blanks of which the retouched tools had been made, fully supports the above observations concerning cores and debitage. The tools were made only of flakes, the dimensions and proportions of which fully correspond to the average dimensions of debitage of a given kind of raw material. As a rule crescent-shaped flakes were used for producing lunates and sometimes, though rather accidentally, for the production of other types of tools. Apart from this use was made of flakes of all kinds of dimensions and proportions as long as their form was suited to the desired functions after retouching. For example, elongated massive flakes were chosen for making double backed perforators.

Generally the flint technology used in the Kadero settlement was primitive (at least in our understanding), and raw material economy extensive, in particular in the relation to quartz and chert. No wonder, considering the easy access to sources of this raw materials.

Gouges

The description of gouges found at the site is based on specimens collected not only over the Id area but over all trenches . We are in the possession of a full inventory of gouges collected. All are made of red rhyolite. The measurements of different categories of gouges are provided in Table 9.

The Kadero gouges have been divided into the following categories:

Unpolished gouges: Eight specimens. The shape was produced by flaking off fairly large, rather flat resharpening flakes from both planes

Table 9. Kadero (Sudan). Metrical data on gouges and axes (measurements in mm.)

Tool type	n.	Mean	St. Dev.	Range
Exhausted gouges polished on one side (from Area Id only)				
Length	9	60.67	14.73	32 – 78
Width	9	34.11	3.63	32 – 42
Thickness	9	16.67	3.86	16 – 26
Exhausted gouges polished on one side				
Length	101	48.95	7.83	30 – 67
Width	101	32.75	5.04	13 – 40
Thickness	101	14.44	2.01	10 – 25
Exhausted gouges polished on both sides				
Length	8	59.63	10.77	45 -74
Width	8	39.25	6.10	32 – 52
Thickness	8	18.75	4.89	14 – 30
Exhausted unpolished gouges				
Length	4	55.17	11.67	46 – 78
Width	4	33.67	3.77	20 -40
Thickness	4	14.33	2.05	11 - 16
Complete gouges polished				
Length	4	92.75	8.93	84 – 104
Width	4	31.00	3.39	27 – 36
Thickness	4	15.25	2.86	13 -20
Complete axes				
Length	4	66.75	8.04	56 – 75
Width	4	43.75	5.63	35 – 50
Thickness	4	21.25	3.77	15 - 25
Broken axes				
Length	3	34.67	5.73	28 – 42
Width	3	42.33	3.86	37 – 46
Thickness	3	15.33	0.94	14 - 16

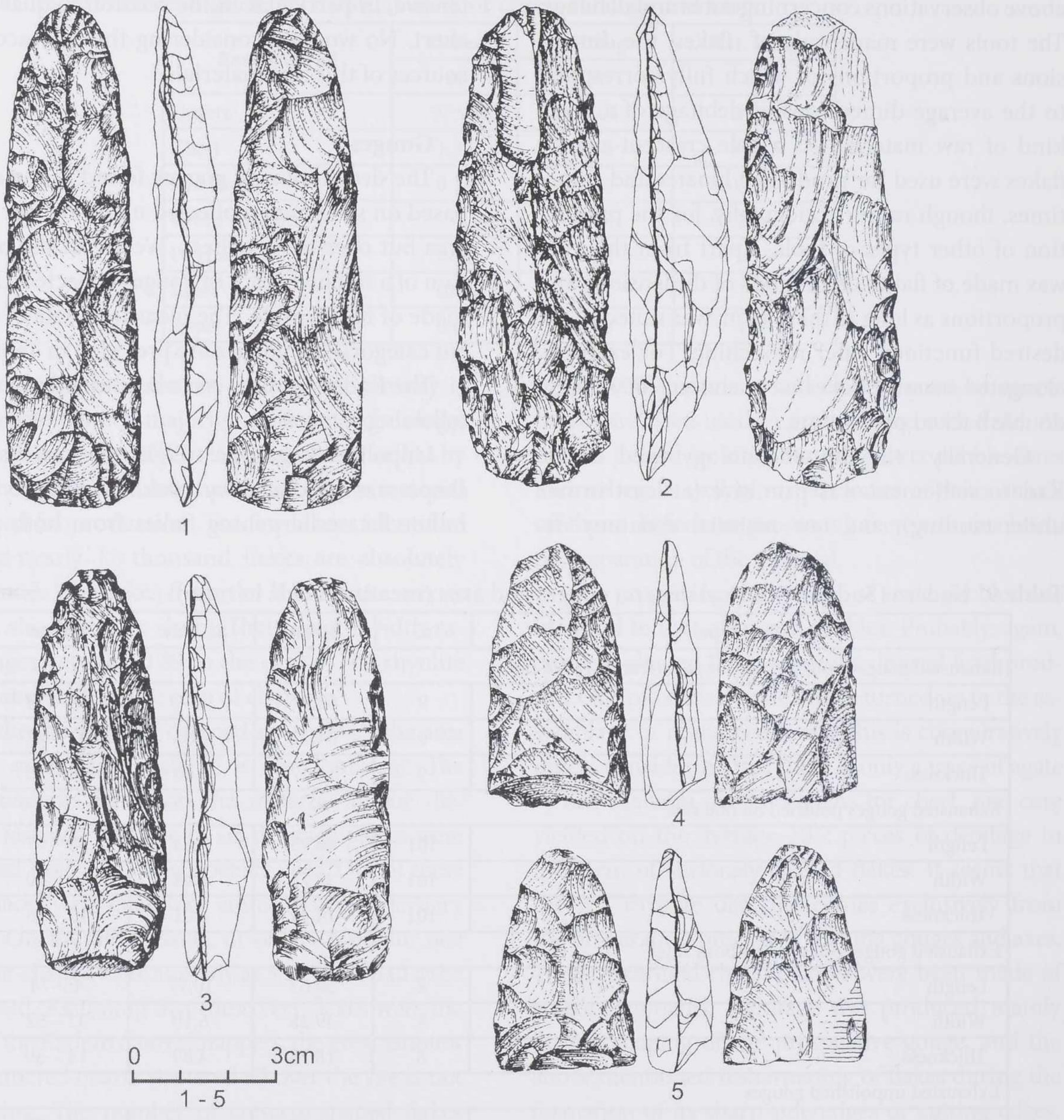

Fig. 10. Kadero. 1-5 – unpolished gouges.

of the prepared gouge with the striking directions running at the straight angle to the edge. After obtaining the desired shape, the final sharpening of the cutting edge was achieved by means of a slight retouching, which meant striking off small flat flakes of a few or several millimetres (Fig. 10:1-3).

The gouges are asymmetrical in shape. One side is flat or only slightly convex, while the other is much convex, at times even highly sloped (Fig. 10:2). Four specimens of unpolished gouges are preserved intact and they seem not have been used, as evidenced by the convex shape of the flat and sharp cutting edge. Four other specimens, on the other hand, have been used, since their cutting edges are blunt. These had been repaired by means of rough retouching, always on one side only. The repaired cutting edge has always a gouge-like shape, and the cutting edge is straight or slightly concave (Fig. 10:4-5). They are much shorter than the specimens described above. Once they were beyond mending they were probably thrown away. The average weight of unpolished unused gouges is 50.62 grams, and used ones – 38.12 grams.

Gouges polished on one side: one hundred and one specimens. All are asymmetrical in shape. The flatter side is formed by flaking only. The convex

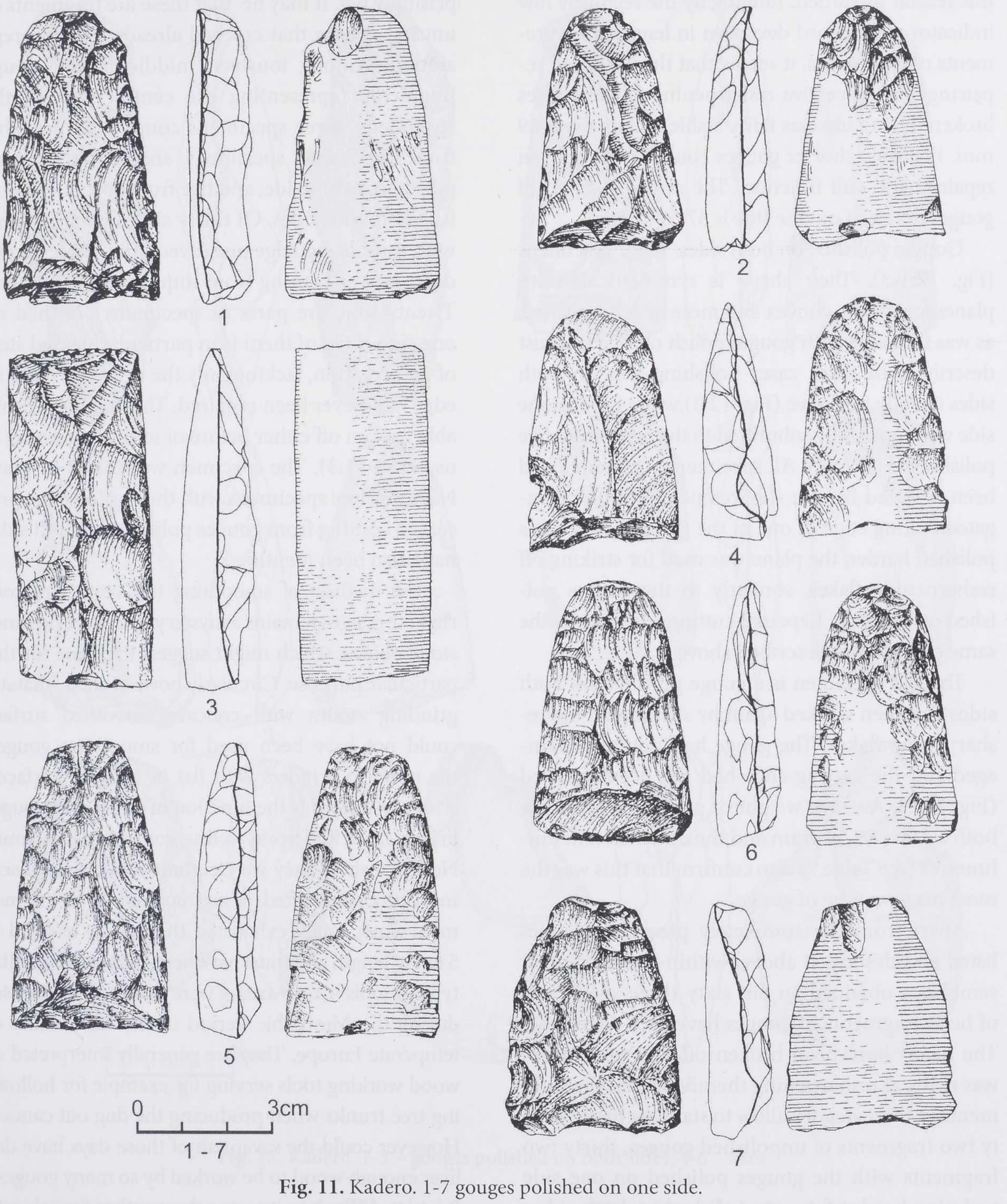

Fig. 11. Kadero. 1-7 gouges polished on one side.

side is polished. Polishing is often partial, covering only the most protruding planes and partially blurring negatives of the flake struck to form the particular plane (Fig. 11:4-6).

It can also be completely polished, entirely cleaning off traces of the negatives that had formerly shaped the more convex plane of the gouge (Fig. 11:1-7). All gouges polished on one side had been used. All their cutting edges had been repaired with retouching directed from the polished, more convex side towards the unpolished flatter side. Similarly to repaired unpolished gouges, the repaired cutting edges are blunt, have an elongated shape and the gouge-like cutting edge is either straight or minimally concave. It seems that the specimens at our disposal had been all used to the full and for this reason discarded. Judging by the relatively low indicator of standard deviation in length measurements of the gouges, it seems that the border of repairing and successive resharpening of the gouges broken during use was fairly stable and of about 49 mm. Probably shorter gouges could not have been repaired and still function. The average weight of gouges polished on one side is 37.61 grams.

Gouges polished on both sides: Eight specimens (Fig. 12:1-3). Their shape is symmetrical. Both planes are evenly convex and more or less polished, as was the same with gouges polish on one side just described. In three cases polishing was on both sides equally intensive (Fig. 12:3),while in four one side was apparently submitted to the more intensive polishing (Fig. 11:2). All specimens mentioned had been repaired by one side retouching of the elongated cutting edge. If one of the gouge's planes was polished harder, the plane was used for striking off resharpening flakes, similarly to the gouges polished on one side. Repaired cutting edges are of the same character as described above.

The last specimen is a gouge polished on both sides and then worked again by striking off big resharpening flakes. The gouge had not been damaged and the cutting edge had not been repaired (Fig. 12:1). Average weight of gouges polished on both sides is 62.50 gram and the dimension in millimetres (see Table 9) also confirm that this was the most massive type of gouge.

Apart from the completely preserved gouges listed and described above, within the gouges assemblages obtained so far, sixty three specimens of head fragments of gouges have been identified. The heads have been broken off and no attempt was made at resharpening them. As far as the fragments in this category allow to state, we have twenty two fragments of unpolished gouges, thirty two fragments with the gouges polished on one side and nine heads of gouges polished on both sides. There is a possibility of an error as far as the estimates of numbers of the first two cases concerned, since often one polished plane or both polished planes of the gouge did not reach the head. The big size and massiveness of the fragments of gouges polished on both sides support the observation that this kind of gouges had big dimensions. The head fragments of unpolished gouges are also surprisingly big. It may be that these are fragments of unused gouges that cracked already during preparation. Among fourteen middle ?sized? gouge fragments representing the central part of the specimens, three specimens come most probably from unpolished specimens, six from specimens polished on one side, and five from specimens polished on both sides. Of thirty six gouge fragments with the cutting edge preserved only three can be described as coming from unpolished specimens. Twenty nine are parts of specimens polished on one side. One of them is in particularly good state of preservation, lacking only the head. The cutting edge had never been repaired. The head had probably broken off either before or at the beginning of use (Fig. 11:3). The specimen was found in grave No. 42. Three specimens with the cutting edge preserved coming from gouges polished on both sides have also been identified.

The method of smoothing the very numerous rhyolite gouges remains a mystery. There are no sandstone objects which might suggest their use for this particular purpose. Circularly bowl-shaped "matate" grinding stones with concave smoothed surface could not have been used for smoothing gouges, the more so grinders with flat or concave surfaces. Also mysterious is the function of numerous gouges known from Kadero, as well as from other Khartoum Neolithic sites. They were certainly intensively used, most probably hafted, being repaired up to the moment when, totally exhausted, they hardly reached ca 5 cm of length and must have been discarded. Similar type of tools – core axes – were produced in masses during the Mesolithic Period in the forest zone of temperate Europe. They are generally interpreted as wood working tools serving for example for hollowing tree trunks when producing the dug out canoes. However could the savannah of those days have deliver enough wood to be worked by so many gouges? It is also difficult to imagine these rather fine objects as farming tools (Haalland 1981). Maybe more convincing is the hypothesis connecting gouges to cattle holding. (Caneva 1988b).

Axes

Among the macrolithic tools from Kadero, axes form a very small group. Four complete specimens and four fragments have been identified. The dimen-

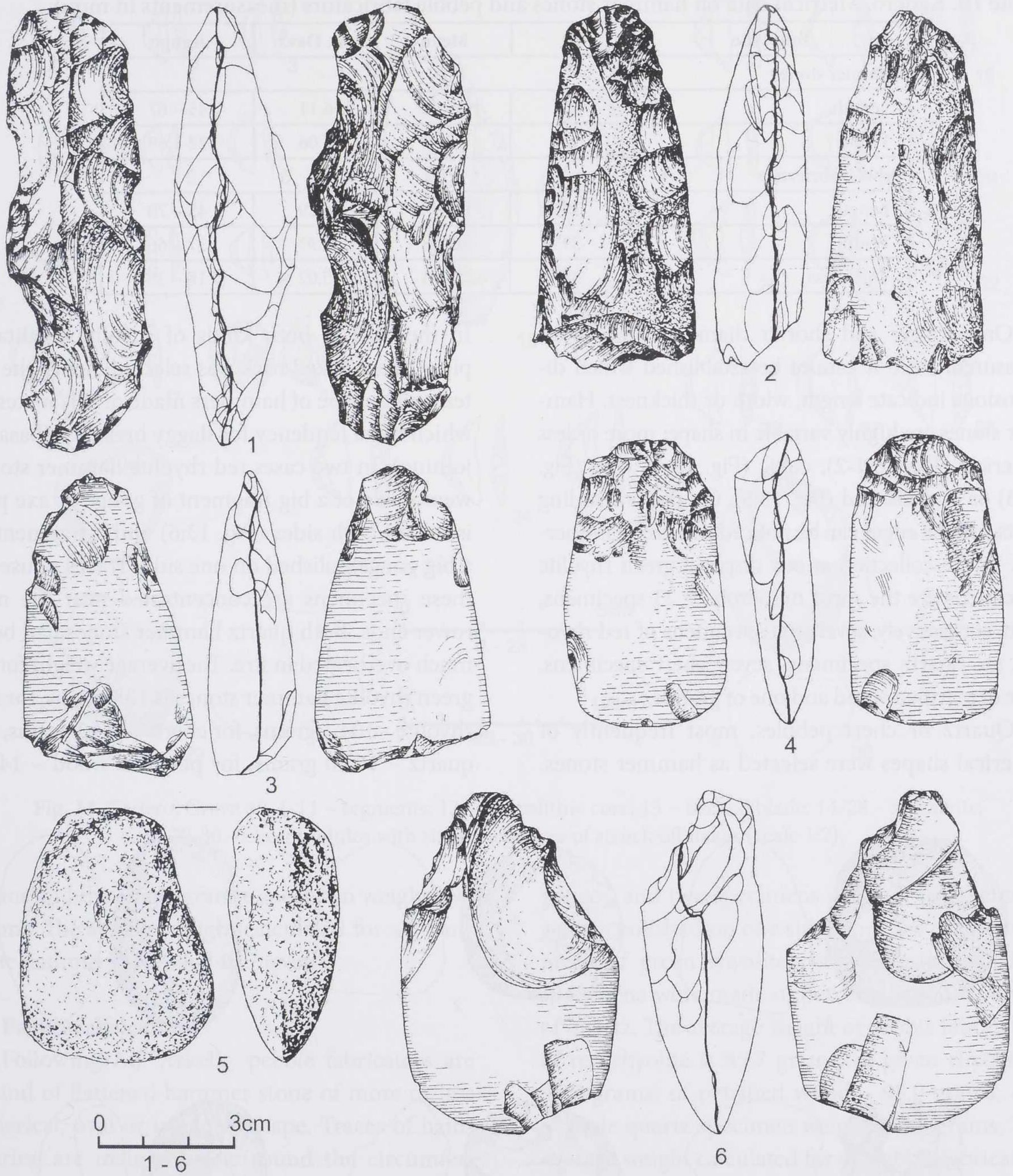

Fig. 12. Kadero. 1-3 – gouges polished on both sides; 4-6 – axes

sions of intact specimens are given in Table 9. Axes here are specimens of symmetrical shape, polished on both sides over a large area. Polishing is particularly precise around the cutting edge. The cutting edge is slightly arched (Fig. 12:4-6). Except for one specimen made of green rhyolite, all specimens had been made of red rhyolite. Apart from this, the material found in Kadero, so far, has yielded forty fragments of gouges and possibly axes of red rhyolite. They all have some parts with surface polished and this serves as criterion for describing them as fragments of the above mentioned types of tools.

Hammer stones

The collection of hammer stones found contains 58 specimens. It constitutes a representative selection from all trenches in Kadero. The dimensions of 50 complete specimens are given in Table 10.

Table 10. Kadero. Metrical data on hammer stones and pebble fabricators (measurements in mm.)

Tool type	n.	Mean	St. Dev.	Range
Hammer stones				
Length	50	55.10	6.11	45 - 67
Width	50	47.50	8.06	22 - 69
Pebble fabricators				
Length	39	58.46	6.29	45 - 70
Width	39	48.08	5.93	37 - 66
Thickness	39	24.64	5.02	18 - 38

Only longer and shorter diameters have been measured, since it cannot be established which dimensions indicate length, width or thickness. Hammer stones are highly variable in shape: more or less spherical (Fig. 13:1-2), cubic (Fig. 13:4), oval (Fig. 13:3) or multifaceted (Fig. 13:5). On the protruding parts and the edges can be noticed traces of hammering. In the collection at our disposal green rhyolite specimens are the most numerous - 23 specimens, then, successively, seventeen specimens of red rhyolite, six quartz specimens, seven chert specimens, four of petrified wood and one of granite.

Quartz or chert pebbles, most frequently of spherical shapes were selected as hammer stones. In the case of both kinds of rhyolite a suitable piece of a cracked rock was selected, hence the often cubic shape of hammers made of this material, which has a tendency for flaggy breakage (basaltic joining). In two cases red rhyolite hammer stones were made of a big fragment of gouge or axe polished on both sides (Fig. 13:6) and a fragment of a big gouge polished on one side. Traces of use on these specimens are concentrated near the narrower ends. Both quartz hammer stones had been much overheated in fire. The average weight for all green rhyolite hammer stones is 138 grams, for red rhyolite - 104,1 grams, for chert - 133.3 grams, for quartz - 165.0 grams, for petrified wood - 140.0

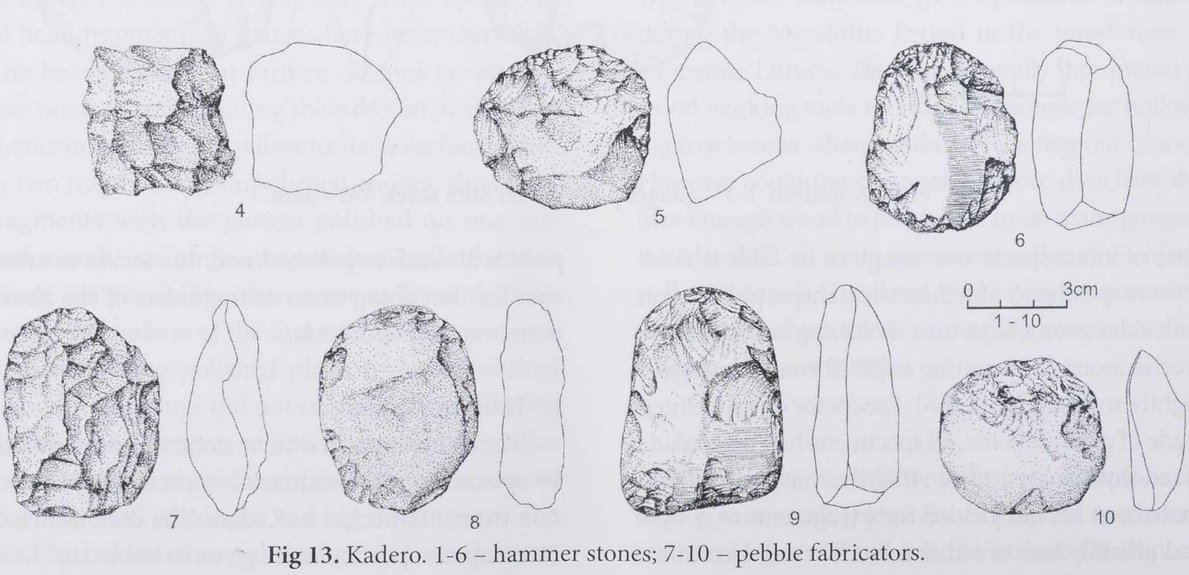

Fig 13. Kadero. 1-6 – hammer stones; 7-10 – pebble fabricators.

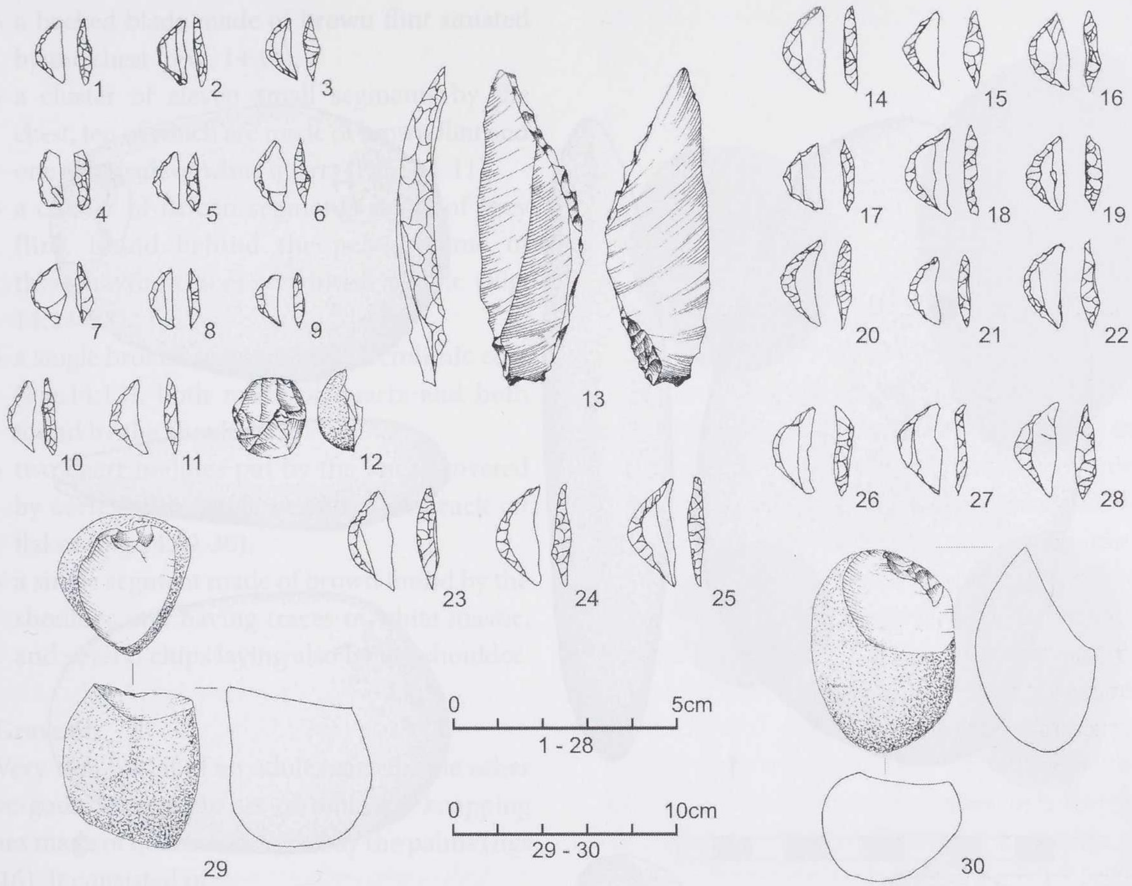

Fig. 14. Kadero. Grave 66. 1-11 – segments; 12 – microlithic core; 13 – backed blade; 14-28 – segments; 29-30 – chert nodules with single negatives of struck off flakes (scale 1:2).

grams and the single granite specimen weighs 290 grams. The average weight calculated for all complete hammer stones is 140.7 grams.

Pebble fabricators

Following A.J. Arkell, pebble fabricators are a kind of flattened hammer stone of more or less spherical, oval or irregular shape. Traces of hammering are mainly visible round the circumference. Thus, mainly the more or less sharp edge was used for striking (Fig. 13:7-10). Table X demonstrates the dimensions of pebble fabricators. As was pointed out by Arkell, the demarcation line between pebble fabricators and common hammer stones is blurred and the two types of hammer stones have sometimes been used alternatively. Forty five specimens of pebble fabricators have been selectively collected from all trenches explored in Kadero. Thirty three specimens are made of red rhyolite, including six made of fragments of axes polished on both sides or smaller gouges, and two specimens made of fragments of gouges polished on one side. They are eight specimens of green rhyolite pebble fabricators. Two specimens were made of petrified wood, and one of quartz. The average weight of pebble fabricators of red rhyolite is 85.7 grams, of green rhyolite – 92.5 grams, of petrified wood – 95.0 grams, and a single quartz specimen weights 86.8 grams. The average weight calculated for all pebble fabricators is 86.8 gram. Thus on the average they are smaller than common hammer stones by 38.31%

The work in Kadero has yielded a large amount of sandstone artefacts. The exact description and analysis of these finds is given in the separate chapter in this volume.

Materials from the burials

The above analysed lithic material represents a typology and a technology of stone assemblages commonly used in the everyday life. From the Neolithic burials from Kadero we have also a number

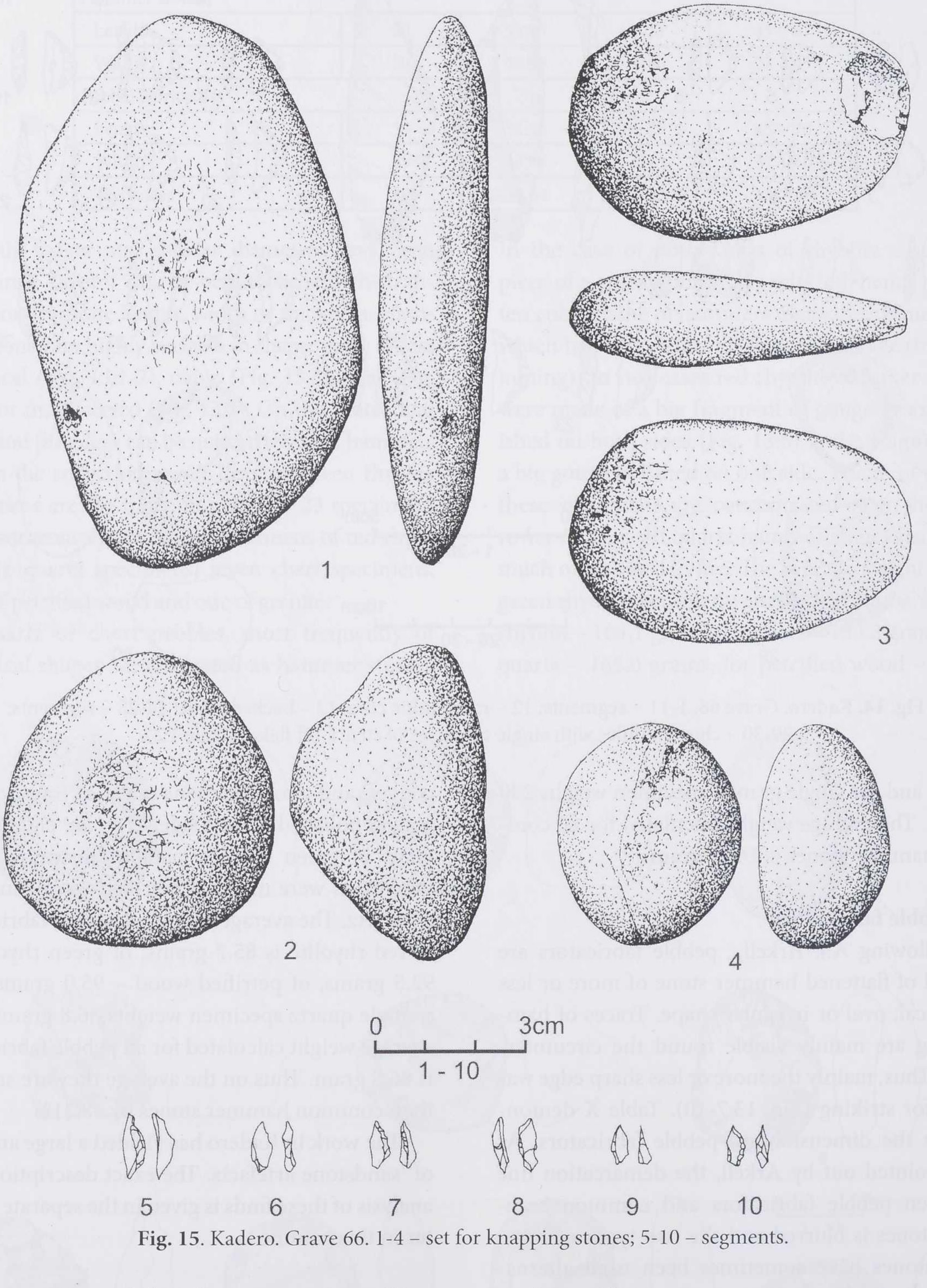

Fig. 15. Kadero. Grave 66. 1-4 – set for knapping stones; 5-10 – segments.

of very interesting lithic objects, sometime telling us more than the finds from the settlement. Four graves delivered relatively numerous artefacts of chipped stones. They are as follows:

Grave 60

A very rich burial of a 35-45 years old man. It contains a rich collection of grave-goods of different kinds, including also :

- a backed blade made of brown flint situated by the chest (Fig. 14:13),
- a cluster of eleven small segments by the chest, ten of which are made of brown flint and one was made of white quartz (Fig.14:1-11),
- a cluster of fifteen segments made of grey flint, found behind the pelvis, some of them having traces of whitish mastic (Fig. 14:14-28),
- a single broken segment and microlithic core (Fig.14:12), both made of quartz and both found by the shoulder,
- two chert nodules put by the knees covered by cortex with single negatives of struck off flakes (Fig.14:29-30),
- a single segment made of brown found by the shoulder, still having traces of white mastic, and several chips laying also by the shoulder.

Grave 66

Very rich burial of an adult man. Beside other grave-gods a complete set of tools for knapping stones made of quartz was found by the palms (figs 15, 16). It consisted of :

- a hammer stone made of fair-sized oval shaped pebble with distinct traces of hammering of both ends (Fig. 15:3),
- a support made of a typical, very flat quartz pebble, roughly rhomboidal in shape, with clearly visible traces of bursting and crushing on one side (Fig.15:1),
- another roughly oval support with traces of use visible on the base of the cone (Fig.15:2),
- relatively large quartz pebble having no traces of knapping (Fig.15:4), probably a supply of raw material ready for use in afterlife.,
- six others very small quartz segments spread over the skeleton occur, five of which were made of white and one of grey quartz (Fig. 15:5-10).

Grave 113

A very rich interment of a 18-24 years old woman. By the knees was found a straight, fifteen centimetres long row of over twenty segments made of quartz, creating a straight cutting edge when mounted, accompanied by several single segments spread over the skeleton.

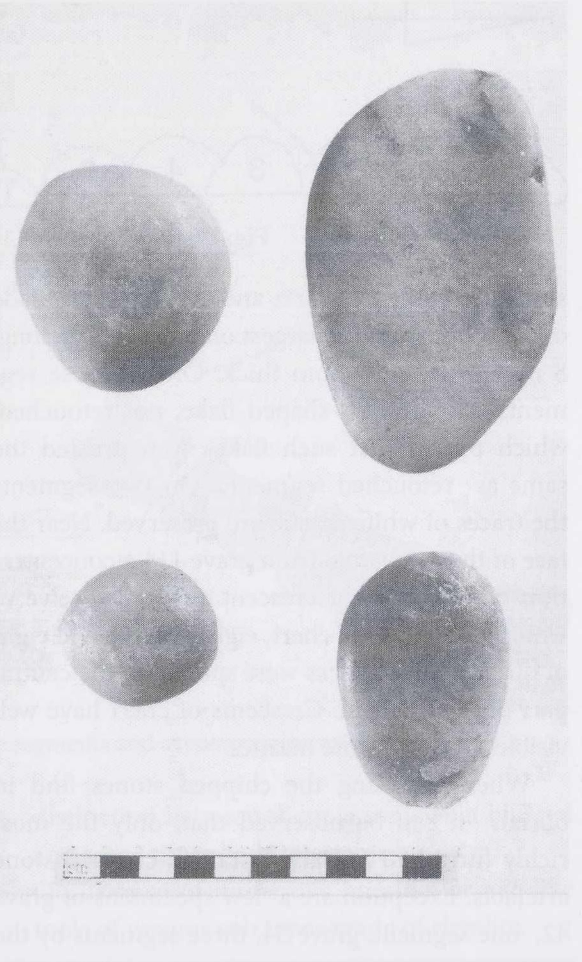

Fig. 16. Kadero. Grave 66. Set for knapping stones.

Grave 114

A rich burial of a 20-30 years old man containing, besides other grave goods, the following objects of knapped stones: by the pelvis a straight row of eleven segments made of quartz (Fig. 17). The largest one is 15 mm long, 6 mm wide and 4 mm thick and the smallest one is 9 mm long, 6 mm wide and 1,5 mm thick. All segments have distinct traces of white mastic on the retouched arched backs.

A few centimetres from this row of segments an assemblage of specimens made of quartz occur, composed of 8 initially struck cores of which only one flake was struck off, one core with two negatives of flakes, two primary flakes, one quality flake and one crescent-shaped flake with natural arched back of a shape and size like the retouched crescents. Near these artefacts one more straight row of segments made of quartz was found (Figs. 18, 19).

Also found by the pelvis in the small space of ca 30 cm in diameter a dense concentration of nine

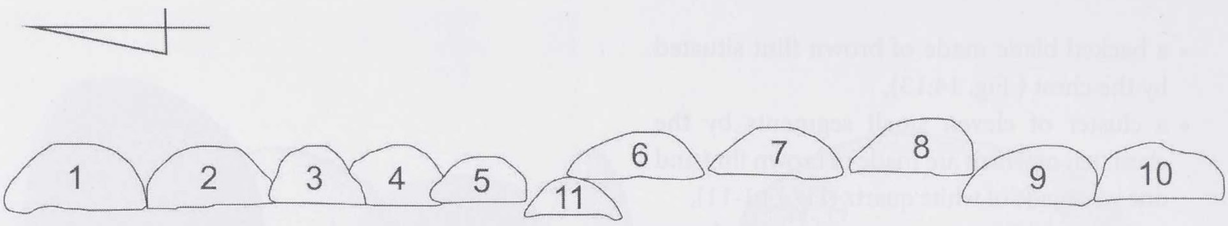

Fig. 17. Kadero. Grave 114. Straight row of eleven segments.

segments made of quartz and one segment made of chert occured. The largest one was 23 mm long, 8 mm wide and 4 mm thick. One of these segments is a crescent-shaped flake, not retouched, which proves that such flakes were treated the same as retouched segments. On two segments the traces of white mastic are preserved. Near the face of the individual from grave 114 a concentration of twenty eight crescent occured, twelve of which were made of chert, eight of agate and eight of quartz. A few pieces were spread on the central part of the skeleton. Crescents of chert have well visible traces of white mastic.

When analysing the chipped stones find in burials it can be observed that, only the most richly furnished burials contained chipped stone artefacts. Exception are a few specimens of grave 42, one segment, grave 54, three segments by the face and a tanged point on the top of the head) . Chipped stones were given to adult men, as well to the adult women. The most popular type of artefacts are segments, all very similar to each other, made mainly of quartz, but also of brown and grey flint and chert. Also cores of quartz and initially struck pebbles of chert occur, as well as a scarce amount of debitage. The irregular dense clusters of microlithic segments, like these found in grave 114, are most probably the remnants of bunches of arrows given as grave-goods. Two kinds of finds merit special attention:

1. repeating several times straight , regular rows of segments deposited all in the same order, with curved, retouched backed edges to one side and the sharp cutting edges to the other. This way the cutting edges created a long, straight line of a kind of the cutting blade (Figs. 17 - 19). When discovered this straight lines of microliths looked mysterious. But visiting the exhibition of archaeology of the site at Kadruka excavated by J. Reynold, I noticed a tool composed of a bone handle with long, straight groove on one side filled by identical segments – inserts, cemented in the groove by a kind of white mastic. Our rows of segments are simply the remnants of such a kind of a knifes. The bone handle has completely decomposed with time.
2. A set of tools for knapping stones from the grave 66 described above. It was the private tool kit of a stone knapper given to him for after life. Such find may suggest the beginnings of specialization in stone knapping technology observed in the Khartoum Neolithic culture.

Kadero lithics from the perspective of the Middle Nile Neolithic

A detailed cultural and chronological analysis of the stone inventory from Kadero is a difficult task. This is due mainly because the raw material used for the production of stone tools is singularly illegible for researcher. The materials in question are quartz and both kinds of rhyolite which account for over 90% of both the amount and bulk of the numeric analyses objects. Moreover, the quality of chert used in Kadero is among the worst possible. Both the forms of cores as well as the shapes of retouched tools are often accidental and governed by the quality of the material used. Such typological features as the placing of the striking platform, the bulb of the flake and striking directions or retouching are often illegible. Hence both understanding and giving a correct description of the technology and typology of the assemblages are beset with difficulties. As in principle the materials used at all late prehistoric sites along the Middle Nile were of the same quality, similar difficulties were encountered by other authors of publications reporting on the sites. The interpretations of particular flint assemblages from the period in question, recorded in the Middle Nile region, reveal a considerable liberty as regards the reading and description of the technology and typology

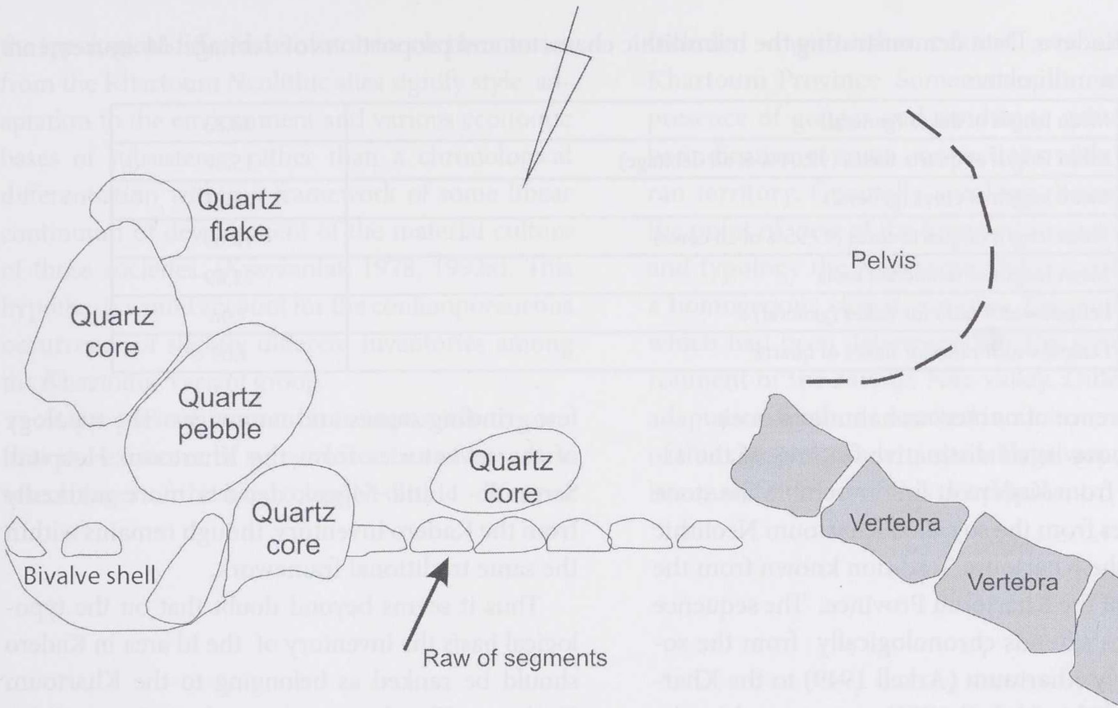

Fig. 18. Kadero. Grave 114. straight row of nine segments and accompanying artefacts

of the objects. Based on different individual type lists, within which variously described types of objects have been placed, the interpretations differ to a considerable degree. For this reason there is no possibility at present of a detailed comparison by means of statistical tests of the flint inventory from Kadero with other so far published, rather scarce inventories from similar sites. Such a comparison can be successfully carried out only after the stone object types found in Neolithic sites of the Middle Nile region have been defined, and after the records have been classified anew presenting a uniform approach to the typology of the stone objects in question. For our purposes it must suffice that we compare the mainly easily legible and obvious features characteristic for the assemblage discussed with other sites known from the Middle Nile region or beyond. These features are as follows:

1. Exclusive usage of flake technology
2. Considerable microlithisation (see Table 9)
3. Raw materials are basically limited to two: quartz for smaller items and rhyolite for larger items (Table 2).
4. Occurrence of three basic types of retouched tools: lunates, perforators, and various kinds of notches, denticulates and retouched flakes; distinction between them is somewhat blurred and some times hard to establish.
5. Occurrence of numerous hoe-like or axe-like tools of various sub types made of rhyolite.

Fig. 19. Kadero. Grave 114. straight row of nine segments and accompanying artefacts

Table 9. Kadero. Data demonstrating the microlithic character and proportions of debitage. Measurements in millimetres

Mean length of flakes (general)	18.83
Mean length of quartz flakes (92.04% of all debitage)	15.27
Mean length of cores (general)	22.61
Mean length of quartz cores (97.95% of all cores)	16.63
Mean length of retouched tools	22.89
Length:width ratio for flakes (general)	1.06
Length:width ratio for flakes of quartz	1.09

6. Occurrence of numerous hammer stones

The above listed distinctive features of the assemblage from Kadero at first resemble the stone inventories from the so called Khartoum Neolithic sites, i.e. the Khartoum Tradition known from the territory of the Khartoum Province. The sequence of the sites extends chronologically from the so-called Early Khartoum (Arkell 1949) to the Khartoum Neolithic (Arkell 1953), represented by the classic sites of the Khartoum Hospital and Shaheinab respectively. As suggested by the research carried out in Kadada (Geus 1984), the sequence can be extended still further. Later some other sites of this tradition have been recognized by excavations. These are: Zakiab (Haalland 1981b), Geili (Abbas Mohammed Ali 1982; Caneva 1984; 1988), Saggai (Caneva, Zarattini 1983), Sarourab I (Abbas Mohammed Ali 1982), Rabak (Haalland 1984; 1989) and Kadruka (Reinold 1994)

The inventory of stone objects from Shaheinab is no doubt the most similar to the Kadero chipped stone assemblage. It carries all the distinctive features of the Kadero finds. They are some noticeable differences, such as, e.g., a relatively bigger size of Shaheinab lunates and double backed perforators, and the presence of large amount of big scrapers and a kind of tanged points which were not found in Kadero. In general, however, the similarity between the two assemblages is striking.

The inventories from Um Direiwa, Geili and Zakiab also reveal the Kadero characteristics, though in the latter the amount of gouges and grinding stones is comparatively smaller and in Geili the gouges are by far less numerous. Judging by the data that have been so far published, the Rabak assemblage from the Lower White Nile in the Kosti region, seems to posses the same typological features, yet like the Zakiab assemblage it contains few grinding stones and no gouges. The typology of the inventories from the Khartoum Hospital, Sarourab 1 and Saggai, departs more markedly from the Kadero inventory, though remains within the same traditional framework.

Thus it seems beyond doubt that on the typological basis the inventory of the Id area in Kadero should be ranked as belonging to the Khartoum Tradition. The decreasing number of microlithic objects, mass use of rhyolite for the production of large tools, and frequent occurrence of gouges of various types as well as very numerous sand stone grinding stones allow to place the inventory in question at the late phase of this tradition, i.e., with the so called Khartoum Neolithic. The Shaheinab site is a type site of this culture along with the sites at Geili, Um Direiwa and Zakiab. This statement agrees with the earlier suggestions about the cultural and chronological affiliations of Kadero (Krzyżaniak 1978, Haalland 1981). It is also confirmed by the radiocarbon dates from Kadero which tally with the dating of the remaining Neolithic sites, carbon dated for the most part to the second half of the 4th millennium B.C. (un- calibrated).

However, there arises a question about the relation of the Kadero assemblage to the other Khartoum Neolithic assemblages. It seems that the precise answer for this question is not possible yet. Carbon dates yielded little information - they are few and wide-ranging, thereby permitting just about any arrangement of the assemblages from Kadero nor do they provide solutions for the finer, typological differences. The reasons are twofold: firstly, establishing the existence and range of differences is far from easy due to the illegibility of the material, and due to diverse individual stands on typology which prevent accurate interpretation of differences. Secondly, it seems highly probable that the typological differences of stone tools inventories from the Khartoum Neolithic sites signify style adaptation to the environment and various economic bases of subsistence rather than a chronological differentiation within a framework of some linear continuum of development of the material culture of those societies. (Krzyżaniak 1978, 1992a). This hypothesis would account for the contemporaneous occurrence of slightly different inventories among the Khartoum Variant group.

At the present moment it is impossible to confirm the existence of some closer ties of the stone assemblages of the Khartoum Neolithic – Kadero included – with other cultural area outside the Khartoum Province. Some analogies, such as the presence of gouges and sandstone grinders, may be indicative of some connections with the Saharan territory. Generally speaking, however, from the point of view of the knapped stone technology and typology the Khartoum Culture sites present a homogenous closed complex, the emergence of which had been determined by the specific environment of the Middle Nile valley. Differences in adaptation methods resulted in an inner evolution of this complex. Kadero assemblage was one of the late manifestation of this development.