Stone implements

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Introduction

The aim of this article is to present the stone implements found at Kadero in the Sudan. The article features a brief description of stone material which belong to the collection of the Poznań Archaeological Museum and which was discovered during many excavation seasons conducted by Lech Krzyżaniak at this very important Neolithic site. The analysis does not include stone objects manufactured by means of traditional stone-working techniques, i.e. knapping or chipping, and tools which were used in a flint workshop i.e. hammerstones, pebble fabricators. Specification and analysis of these finds are presented in a separate chapter by M. Kobusiewicz and the maceheads are presented by K. Ciałowicz (this volume). Here we deal with the descriptions of all types of sandstone tools (grinding stones, pestles, rubbers, polishing stones, drills), cosmetic palettes and grinders made from different raw material.

All investigations carried out in Kadero have yielded a large amount of sandstone artefacts and it was impossible to collect them all. The collection presented in this paper compose a representative selection of all type of tools, which was made by L. Krzyżaniak already during excavating and provides a sufficient basis for a characterization and discussion of those objects. The analyses of the data was supported by observation obtain by the author during the last seasons of excavations at Kadero (Jórdeczka 2003).

Most (if not all) of the presented lithic material is connected with the Neolithic occupation of Kadero 1, and comes from the northern and southern midden, and from the cemetery (Table 1). It is possible, that some of the artefact may be connected with the Early Khartoum material. This phase of occupation was recognized during pottery analyses (M. Chłodnicki, this volume), but it is very difficult to recognize in the stone material.

Raw materials

The petrographic descriptions of stones presented below are based largely on the macroscopic and microscopic analysis performed by J. Skoczylas and M. Mrozek-Wysocka to whom I wish to express my thanks.

In the production of stone implements, Neolithic inhabitants of Kadero used a rather limited set of raw materials. Of particular importance (in respect to quantity) was quartz (95 % of the objects belong to the chipped stone assemblage – Kobusiewicz, this volume), then rhyolite, sandstone, chert, agate, petrified wood, jasper and very rarely diorite and granite. Most of them were describe in separate chapter (Kobusiewicz, this volume).

Sandstone

Sandstone is the main raw material used for the production of ground tools, i.e. grinding stones, grinders, rubbers, polishing stones, stone rings or palettes (in this last case diorite was also used).

Table 1. Kadero. List of stone material from midden and cemetery (except jewellery).

Artifacts	Type	Raw material									Location	
		Amfibol	Diorite		Ochre		Quartz		Sandstone		Midden	Cemetery
		C	*F*	*C*	*F*	*C*	*F*	*C*	*F*	*C*		
Quern	Deep								5	1	6	
	Flat								24		24	
Small lower grindstones	Flat (palettes)								8		8	
	Deep (mortars)								15		15	
Cosmetic palettes	Fan-shaped									1		1
	Oval-shaped		2	1						3	2	4
	Pear-shaped									1		1
	Rectangular-shaped		1							2	1	2
	Trapeze-shaped								1			1
Grinders	Large, spherical, heavy grinders								7	1	8	
	Large disc grinders								62	8	70	
	Small, flat grinders								22	4	26	
	Spherical								7	1	8	
Polishing stones	Two flat surfaces								4	1	5	
	One flat surface								25		25	
	Convex on both sides								21	4	25	
	Small						1	1	1	2	5	
	Triangle (keeled) cross-section									1	1	
Rubbers	Crescent-shaped and hollow									6	6	
	Blade								2	3	5	
	Chisel-shaped								1	1	2	
	Spoon-shaped									5	5	
	Club-shaped									62 (?)	62	
	With grooves									1	1	
Ochre	Pencil					1					1	
	Lumps of ochre				9						9	
"Stick"		1									1	
Rings	Finished								3	1	4	
	Unfinished (?)								6		6	
Summary		1	3	1	9	1	1	1	213	110	331	9

Sandstone is a clastic sedimentary rock of variable colours, composed of small-size (0.063-2 mm) mineral or rock grains and cemented typically by silica, calcite, iron oxides, clays or other elements. It can be found along the Nile Valley from Esna up to Central Sudan. This rock is commonly described as "Nubian sandstone" because it belongs to the stratigraphic sequence known as the Nubia Group (Aston et all. 2000:54-56). It is the main geological rock strata of studied area (Stankowski 2003b:133) Among these sandstones found in Kadero two major groups have been distinguished. The first one is a greyish beige sandstone with framework grains composition mainly of quartz and siliceous-clayey cement. It is fine-grained and well sorted rock with massive structure. Those features determinate on technological properties like high compressive strength and abrasion resistance. The second variety is a beige coarse-grained sandstone with massive random structure. Its ferruginous-calcareous-clayey cement binds rough grains of quartz. Both types of sandstone occur in the vicinity of the site. Sandstone material lies on the ground surface and would have been easy to collect.

Diorite/Gabbro

So far three diorite palettes were found during excavation at Kadero. Diorite and gabbro are phanerocrystalline igneous rocks composed primarily of plagioclase feldspar and either greenish black hornblende amphibole or augite pyroxene. Both the rocks have less than 20% quartz (according to IUGS classification). Diorite and gabbro can only be distinguished from each other by their plagioclase composition, and this must be determined in thin section. Outcrops of these rocks are common in the Eastern Desert (Aston at all. 2000:30).

Ochre

Red pigment was very important in many spheres of activity for the Neolithic inhabitants at Kadero. It was the carrier of cultural information, and among other things used for body decoration, for jewellery production, as a dye for pottery, weapon(?), in ritual and in funerary practices. Red ochres is a natural mineral pigments coloured by the presence of iron (an unhydrated iron oxide – hematite). Red ochre contains a higher percentage of hematite, and common reddish pigment and is accordingly identified as hematite in chemical analyses (Lee & Quirke 2000:113-114).

Manufacturing methods for production of macrolithic stone tools

Several methods were employed, often in combination with one another, for making tools. These include:

Initial coring – this involves striking off flakes from a stone nodule, either in order to shape the stone or to acquire blanks suitable for further shaping into specific tools;

Flaking – this technique is used to give a product its final shape;

Polishing – this can be done in two stages:

- grinding – this involves the removal of any rough edges and/or scarring resulting from the working process;
- smoothing – this is carried out in order to achieve a relatively even and scratch-free surface

Roughening – this involves creating small pits over a smooth surface in order to roughen it.

Further research is needed to establish how sandstone was transported from the source back to the Kadero settlement. Initial shaping, at least in the case of larger tools, was probably carried out at the site where the stone was collected. Work at the settlement was restricted to refining the shape of the tools and surface finishing. The absence (so far) of any cortex flakes[1] in the site's archaeological record may be seen as evidence to support this theory. Only small waste flakes have been noted, which were probably produced during the final stages of tool processing or during the course of reshaping damaged tools.

Confirmation for this interpretation may be find in ethnographic surveys carried out by Randi Haaland in Western Sudan and Tanzania, where she found close relation between women and production of grinding equipment. For example, among the Fur tribe, people still make and use the same type of grinding equipment that we could

1 These pieces result from the removal of the natural, outermost surface of the stone and do not exhibit any traces of intentional working or use.

find on prehistoric sites. In the village of Dorn on northern Darfur, where she did fieldwork in 1978, every woman in the village makes her own grinding stones. Suitable raw material is found in only one area, which has a fine grained type of stone. Each woman has her own quarry where she extracts the raw material and produces the first rough shaping of the grinders. Unfinished tools are then brought back to the village, where the final shaping and pecking of the tools takes place (Haaland 1995:165). Similar observation were made by the author among the people living in Butana, Central Sudan. Local women still make and use stone quern and grinders, and every woman prepares her own grinding equipment (Photo 1. 7).

The study material includes a very large quantity of tools made from much larger, damaged artefacts, which often originally served a completely different purpose. It appears that recycling tools was a common practice among Kadero societies. A similar situation was noted in many sites, for examples at El Geili (Caneva 1988:141-144).

In some instances, where the lump of raw material had a natural shape and size which lent itself to a particular use, the stone was not worked at all (this was most often the case with hammers and small, spherical grinders, for which pebbles of sandstone and other rock were used).

As it was mentioned above, collection presented in this paper composes a selection of artefacts and may not entirely reflect real structure of the lithic (mostly sandstone) material which occurs on the site of Kadero. As an example, a sample collected over an area of 5 squares 2 x 2 m (920-925) was chosen (at the site of the Neolithic cemetery, southern margin of the northern midden – Krzyżaniak 2000:224-225), containing 367 specimens of different type of querns, small lower grindstones, grinders, smoothing tools, pestles, flakes and unidentifiable fragment (an average of ca 73 artefacts on 1 square) (Table 2). Presence of flakes with remains of working surfaces (15,26% of all specimens) confirm important role of reshaping damaged tools.

Table 2. Kadero. Sandstone artifacts collected from squares 920-925

Artifacts	Type	Fragment	Complete	Total	%
Querns	Flat	15	1	17	4,63
Small lower grindstones	Flat	3		3	0,82
	Deep	2		2	0,54
Grinders	Large discoidal	35	7	42	11,44
	Large spherical	6	1	7	1,91
	Small	11	6	17	4,63
Smoothing tools	Small	5	3	8	2,18
Pestles	Borers	4	3	7	1,91
	Irregular	6	4	10	2,72
		87	24		
		112			30,52
Flake with remains of working surface		56		56	15,26
Flake		34		34	9,26
Unidentifiable fragment		165		165	44,96
Total		367			100

Typology and functional analysis

The list of tool types in the Kadero assemblage has been compiled based on comparative studies of similar materials known from other Neolithic sites in the Sudan.

Lower grindstones

Only one complete example of a lower grindstone was found at Kadero thus far. The majority of finds consist of relatively small fragments, making it far more difficult to assess their original forms and classify them in detail (Krzyżaniak 1992:367, Fig. 4a). In only a very few cases did any of these artefacts comprise more than one quarter of the lower grindstone's overall circumference (the minimum required to gauge its original size), however, all of the fragments represent small forms. Therefore the classification outlined below is only relative and does not give a full picture of typological variation among lower grindstones from Kadero 1. Based on the data available the following types of lower grindstone were identified:

1. **guerns** (over 30 cm in length):
   a) large flat (Fig. 1. 6, 7; Photo 1. 2)
   b) large deep (Fig. 1. 1, 2; Photo 1. 1)
2. **small lower grindstones**
   a) flat (palettes) (Fig. 1. 8; Photo 1. 4)
   b) deep (mortars) (Fig. 1. 4,5; Photo 1. 3, 5)

1a) The concave working area is fairly shallow (only a few centimetres deep) and slopes gently down to the centre. The edges are slightly raised, shaped and smoothed. Made of either coarse- or medium-grained stone, roughening is evident on the working surface of these querns. They were probably heavily used, abrasion wearing down their original thickness. The only complete artefact mentioned above was found in Grave 202 (Krzyżaniak 2004a: 51). It has a regular, oval shape (L 320 mm, W 230, Th 60 mm) and its working surface bears traces of delicate pecking. This quern is now exhibited in Sudan National Museum in Khartoum.

1b) All of these querns were made from coarse-grained sandstone. The poor condition of these finds makes it difficult to asses their original size (Krzyżaniak 1989: 367, Fig. 4a). A little more light could be shed on this subject by the large piece of quern discovered at Kadero in 1999. The object in question is of solid proportions and its original diameter is estimated to have been c. 40-50 cm. The deep, working area does not incorporate the whole of the upper face, but only its central section (c. 20-25 cm in diameter), with a pronounced depression in the very middle.

In the case of saddle/channelled querns, their division into two main types – flat and deep – may reflects differences in their functions. The surface characteristics and shape of the large forms suggests that they could have been used for grinding grain, probably sorghum (the discoveries at such sites as Kadero, Zakiab and Umm Direiwa include several imprints of sorghum in potsherds and large number of grindstones – Sadig 2010:72). It seems that flat querns would have been preferable for this task, as they were the only ones which could be used in conjunction with large, spherical, heavy, flat grinders. It is, however, also possible that some large disc grinders may have been employed for this purpose. Intentional roughening visible on the surface of these stones would have increased their abrasive qualities (Arkell 1949:60-63).

It is feasible that large, deep forms of saddle quern could have been used for grinding cereal crops (even though flat forms appear to have been better suited to this task), for crushing a variety of plant materials (fruit, nuts, spices, etc.), for preparing organic and mineral tempers, or for powdering lumps of ochre.

2a) These specimens are characterized by fairly small, flat working surface and regular, more or less oval shape (c. 11-13 cm in diameter, Th 30-40 mm). The edges are either flat or slightly raised. They are similar in shape to cosmetic palettes (indeed it is possible that they are cosmetic palettes). The working surface is slightly rough. They are made of medium grained sandstone.

2b) Small and deep lower grindstones have a regular, oval shape and diameter of c. 11-12 cm. The concave working surface of these stones is fairly deep (> 20 mm), often very

rough, and its edges are quite high. They are made of medium grained sandstone.

Determining the exact function of small, flat lower grindstones is also no simple matter, although the size and shape of their working surfaces puts certain limits on what they could have been used for. Similar forms have been found at Shaheinab (Arkell 1953:47-48), El Geili (Caneva 1988:140-144), and at Shaqadud (Marks & Mohamed-Ali 1991:112-119) – a site located somewhat further from the Nile. Arkell would like to se them as an ochre grinders/palettes or lower grindstones for making maceheads (1953: 47-48).

The purpose of small, deep lower grindstones poses some interesting questions. These artefacts can most adequately be described as mortars. The shape and texture of their working surface is characteristic of this type of utensil. This surface tends to be very coarse and uneven with the numerous traces of chipping. The working surface exhibits traces of both chipping and abrasion, making it easier to be fairly confident in appraising its function. It seems likely that these items were used in conjunction with part of club-shaped pestles, whose working surface bears almost identical traces of use (the tip is flattened from pounding and concentric striations indicative of a rotary action appear on the broader end of the pestle) or with spherical grinders/pounders (Photo 4. 6). This set of tools could have been used e.g. for crushing the kernels of the fruit of a *Ziziphus* sp. tree in order to acquire the seeds inside, which can be used for making a type of flour (see Kubiak-Martens in this volume). Another plausible explanation for these artefacts is that they were used for processing ochre or other mineral dye stuffs.

Similar tools are still using by people living in Butana plain (Sudan), together with spheroid hammerstones (Photo 1. 6).

Cosmetic palettes

This group is relatively small (if we do not include small flat lower grindstones) and quite varied. Artefacts of this type are found both in grave and midden contexts. So far, nine palettes have been found at Kadero.

The sandstone palette from Grave 57 is of pear shape in the flat view (length is 14,8 cm, and the width 12 cm), the working surface is flat and smooth. In the rich Grave 66 a big palette made of diorite (lenght 19,4 cm; breadth 15,2 cm; thickness 4,2 cm) was found. It has a regular, oval shape and a very precisely shaped working surface and edges (Krzyżaniak 1991:525, Fig. 11). The small, oval sandstone palette from Grave 195 (12,7 x 9,8 cm) was found together with a small (7,8 x 3,2 cm), flat and elongated sandstone grinder/smoothing stone.

A similar palette of oval, elongated shape (length 13,8 cm, maximum width 8,9 cm and thickness 3,2 cm) was found in rich grave 202. This sandstone tool is smoothed and has a concave upper side made by rubbing a grinder across the surface. In grave 77 an almost rectangular (with rounded edges) sandstone cosmetic palette was found. The upper, smoothed and slightly concave side represents the working surface (length of 14,2 cm, width 5,8 cm and thickness up to 2,1 cm). A similar palette from grave 189 is a little larger, with maximum length 18,5 cm, maximum width 11 cm and thickness 2,9 cm, and its weight reach 974 (Photo 2. 1). The smoothed working surface is slightly concave. The underside is flat verging on convex, the edges are only slightly rounded and more or less rough since it was originally chipped into shape - visible are traces of chipping, hammering and polishing. This burial contains also a loaf like grinder made of fine grained sandstone (Photo 2. 1 on top), the function of which may be connected to the palette described above. It has a very regular form and smoothed upper, convex side. The working surface is flat and strongly smoothed, in some places even polished (maximum length 11,2 cm, maximum width 4,8 cm and thickness 1,7 cm). A fan-shape sandstone palette from grave 101 (Krzyżaniak 1992a:187, Fig. 40) with a slightly concave working surface has traces of intentional roughening (Photo 2. 2). The underside is strongly smoothed, probably it was used as a grindstone (length 14,4 cm, width 6,4 – 9,7cm and thickness 1,4 cm).

There are five examples of palettes from midden contexts. Two of them, made of sandstone, were found intact. The first one takes the form of a irregular trapeze measuring 12 x 6,5 x 2,6 cm (Fig. 1.

3; Photo 2. 3). The second, oval-shape, measuring 10,2 x 5,4 x 3,2 cm.

Three fragments of palettes were made of diorite and representing three different forms. The artefact of which only a fragment of the edges is preserved has one working surface and was probably of oval shape (Photo 3. 2). The rectangular, two-sided palette has strongly smoothed, flat working surfaces. The edges of this tool were precisely shaped and thinned (Photo 3. 3). A small size palette of high-quality, had an oval shape with one concave (working surface) and one convex side (Photo 3.1). Similar artefact was found in grave 3 at el-Kadada (Reinold, Krzyżaniak 1996:34).

The function of sandstone cosmetic palettes seems fairly self-explanatory. However, there is a great deal of diversity among the items belonging to this group, especially in terms of size and shape. Palettes found as grave goods are relatively large. The two palettes recovered from a midden are very much different. Their shape and surface characteristics do, nevertheless, suggest that they were used for preparing pigments. In one example another function can be observed – underside was used as grinders or smoothing tool (Fig. 3. 3)

This category of artefacts is typical of the Neolithic occupation in Central Sudan and has analogies to discoveries in El Kadada (Geus 1984: 361-372) Shaheinab (Arkell 1953:46 - 48; Krzyżaniak 1992a:187-188) and many other sites.

Grinders

This is the most numerous category of sandstone artefact found in Kadero. Grinders occur in a wide variety of forms, differing in size, shape, surface characteristic and even function, which is however in many cases not entirely clear.

Variation in size are large. The largest grinder noted in this assemblage is 18 cm long, 10 cm wide and 5,1 cm thick, whilst the smallest measures 5,3 x 4,7 x 1,7 cm. Variations of shape range from round to oval. A common feature of these tools is that they all have one or two flat, occasionally slightly convex working surfaces. To make any further, more detailed analysis of this large category easier it has been subdivided into the following groups:

1. flat grinders (104 artefacts)
- a) large, spherical, heavy grinders (8 pieces) (Fig. 2. 1; Photo 4. 1);
- b) large, disc grinders/polishing stones (70 pieces) (Fig. 2. 2,3,5,7; Photo 3. 5; 4. 2);
- c) small flat grinders/polishing stones (26 pieces) (Fig. 2. 4,8-11);

2. spherical grinders/pounders (8 artefacts)

1a) Average dimensions: length 15-20 cm, width 9-12 cm, thickness 3,5-5,5 cm. These are substantial, heavy grinders with one or two flat or slightly convex working surfaces. All of the analyzed grinders show traces of pitting. The edges of these tools were shaped by flaking and were subsequently smoothed.

Large, spherical, heavy grinders were most probably used for grinding grain in combination with the large, flat querns described above. Traces of intentional roughening are visible on their surfaces. These tools were probably designed for use with two hands, working at right angles to the longer axis. All of them were made of coarse-grained sandstone, which was probably determined by their function, since their surfaces were naturally rough.

1b) average dimensions: diameter 12,5-17 cm, thickness 1,4-2,7 cm. Specimen belonging to this group have a relatively regular round or oval shape and their edges are usually polished. Most are two-sided with fairly well-smoothed working surfaces which are either flat or slightly convex (Photo 3. 5). Evidence of roughening is quite widespread. Small scratches can also be seen on some tools (generally perpendicular to the grinder's longer axis), which could indicate the direction in which these tools were used. In several cases these grinders were made from damaged concave querns. They were made from medium- and fine-grained sandstone, with coarser grained material being used on rare occasions.

Interpreting the function of **large disc grinders/polishing stones** poses some problems. The most popular interpretation is that they were used as ochre grinders (Arkell 1953:44-47; Krzyżaniak 1992a:191). Part of them may have served the

same purpose as the group of heavy grinders, as is suggested by their elongated form, traces of use in the shape of striations at right angles to the grinders' longer axis, and their intentionally roughened surface. The fact that these tools are not particularly thick (making them difficult to hold during use on quern) could be a result of intensive exploitation over long period of time, but it is also possible, that this form is intentional and they were used as ochre grinders or polishing stones.

Completely flat, round grinders, occasionally do exhibit clear traces of roughening, are slightly smaller then the elongated variety, and could only have been held in one hand, thus making them more uncomfortable (though not impossible) to use in combination with large, flat querns. It seems likely that they could have been used for grinding ochre to powder for pigment (in Khartoum Hospital examples were found with traces of red or yellow ochre; Arkell 1949: 52-54). Its worth to note, that all tools from this category were made of small grained sandstones, and the character of the working surface and the shape of the tools may suggest, that they were used as grinders/polishing tools for treating smaller objects made of stone, bone or wood (i.e. gouges, maceheads, bone celts, ...). The presence of fragments of sandstone polishing stones at Kadero was mentioned by L. Krzyżaniak (1992a:188).

1c) Average dimensions: diameter 5,5-11 cm, thickness 1,7-3,4 cm. These tools are predominately round or oval and are usually of far less regular shape. They were not as carefully worked as their larger counterparts, as evidenced by the fact that flake scars along their edges are often left rough. They have either one or two well-smoothed, flat or slightly convex working surfaces. In some instances traces of delicate pitting can be seen. Larger, damaged artefacts were often reused to make these grinders, mostly in medium- and coarse-grained sandstone.

Small, flat grinders may also have served the same purpose as their larger counterpart and may have been used together with small lower flat grindstones, which were also interpreted as tools that may have been used for processing ochre. Many of the grinders in this group could also have been used with large, deep querns. In some cases it is possible, that they were used as a smoothing/polishing stones. The chipping frequently noted on the central parts of the working surface of grinders does not always represent traces of roughening (Photo 6. 2). It seems that once they had stopped being used for their original purpose they may have served, for example, as anvil stones (Arkell 1949:60-61). Similar artefacts were frequently noted on Neolithic sites in Wadi Awatib on the Butana plain (Bobrowski, Jórdeczka 2005:40-42, Fig. 5; 7).

2) A modest number (8) of spherical grinders were found at Kadero. As with all other categories, considerable variation was noted among these tools, primarily in terms of size (from 2,3 cm to more than 11 cm in diameter, mostly about 4,5-6 cm). They have a characteristic round, regular shape (Fig. 5. 1-7; Photo 4. 6) with clearly defined working surfaces (one or more) in the form of variously worn and flattened, smoothed areas - evidence that they were used for grinding. In some cases they were also used as hammerstones, which has left characteristic traces of chipping on them. All of the examples were made of medium- or coarse- grained sandstone.

Quartz smoothing stone

One, not complete example of this tool was include to the collection. It was made on quartz pebble, and the stone was not worked at all (raw material had a natural shape and size which lent itself to a particular use). One flat area and edges around it were used as working surfaces. They are polished, partially shiny, with traces of scratches and remains of red pigment (Photo 7. 2). The tool could be used for polishing pottery, organic material or as an ochre grinder. It is 5,4 cm long, 4,4 cm width, and 2,3 cm thick.

Polishing stones

These differ from "standard" grinders flat in shape, being more reminiscent of elongated rectangles or occasionally trapezoids. Their edges and corners are often rounded to a greater or lesser degree. Artefacts belonging to this group are also di-

verse in size, the largest complete specimen being 14 cm long, and the smallest examples measuring no more than a few centimetres. Further subdivisions in this category are, however, based primarily on tool shape and the features of their working surfaces rather than on metric traits. This was dictated by the fact that a wide variety of forms occur within some size ranges, which in turn would have required additional subcategories to be created, significantly expanding the list of tool types. For these reasons smoothing tools were divided into the four following groups:

a) tools with two flat surfaces (5 pieces)

b) tools with one flat surface (20 pieces) (Fig. 3. 4)

c) tools convex on both sides (25 pieces) (Fig. 3. 3; Photo 4. 3)

d) small polishing stones (3 pieces) (Fig. 3. 6; Photo 6. 1)

e) tools with triangle (keeled) cross-section (Photo 3. 6)

a) Average dimensions: length 9-13 cm, width 6-7 cm, thickness 3-4,5 cm. There are few artefacts from Kadero representing this group, and most of those survive only as fragments. They are fairly irregular in shape and their edges are, on the whole, roughly finished. The one exception was a an axe-like tool with two flat surfaces forming an edge. Roughening is evident on the working surfaces of two tools. All items of this category are made from medium- or coarse-grained sandstone.

b) This class encompasses a wide variety of forms, including rectangular and trapezoidal tool, as well as ones with rounded corners and edges. It is difficult to define a size range for this subcategory as none of the items in it survive intact, but it seems probable that they did not exceed 12-13 cm in length and 7-8 cm in width. Variations are also evident in the tools' working surfaces, mostly in terms of how well-smoothed they were.

c) Average dimensions: length 4,7-12 cm, width 4-7,2 cm, thickness 1,8-4,5 cm. They differ in shape and in the nature of their working surfaces. Broadly speaking, this subcategory is represented by irregular forms, most of which were carefully worked and smoothed. None of these artefacts has a flat working surface and all have a relatively stout, transverse section. Their corners are usually rounded, whilst their edges range from being rounded to fairly sharp. The raw materials from which they are made vary, as do their surfaces (tools made from coarse-grained sandstone tend to have rougher surfaces).

d) This category is represented by three complete tools which are very regular in shape.

The first one takes the form of a regular rectangle measuring 5,7 x 3,5 x 1,6 cm (Fig. 3. 6). One of its surfaces is flat; its smoothness suggest that this was probably the working surface. The other side is slightly convex, has rounded edges and faint traces of processing – chipping and smoothing. It is fashioned from a medium-grained sandstone.

The second one is also very regular in form and is wholly worked and polished. Its shape is remains of a small, trapezoidal axe with a short cutting edge and long butt. It measures 5,7 x 4,0 x 2,3 cm. The working area consist of two slightly rounded surfaces forming a cutting edge. This tool is made of medium-grained sandstone.

The third one has a form of rounded triangle, and was made of flat quartz pebble (Photo 6. 1). The working area consist of keeled edges on the whole circumference and is covered by small pits, fissures and scratches, which often overlap each other. On some spots it is also polished. The tool measuring 4,8 x 4,7 x 1,1 cm.

e) This category is represented by only one artefact, found on sq 528. It has very regular oval shape and triangle cross-section. The two upper sites are very smooth, partially polished, with delicate scratches (generally perpendicular to the stones' longer axis), which could indicate the direction in which this tool was used. Third site is flat and much more rough. The tool measuring 12,8 x 6,9 x 2,9 cm. Similar form are known from different

Neolithic sites, e.g. WA4 in Wadi Awatib (Bobrowski, Jórdeczka 2005:40, Fig. 5), Shaqadud (Marks et al. 1985:271, Fig. 11b).

Polishing stones differ discernible in the texture (which ranges from rough to relatively well-smoothed), size, shape, and the degree to which their edges are rounded. Examples with one or two flat surfaces may have been used as smoothing tools (this suggest some of their morphological attributes, such as those of the form of an axe-shaped narrowing at one end) or ochre grinders. Loaf like grinder, similar to some polishing stones with one flat surface was found in grave 189 together with palette (Photo 2. 1). It is particularly difficult to assess the function of tools which are convex on both sides. It is possible that they were used for working bone or wood.

Small polishing stones differ significantly from one another in shape. Nevertheless, it seems that the rectangular form may have served as a small rubber or whetstone, whilst the trapezoidal/axe-shaped form, with rounded working edges converging in the shape of an axe blade, was probably used as a small smoothing/polishing stone. The third one, was probably used as a polishing stone or ochre grinder.

Rubbers

This class of irregular forms of sandstone tools (70 artefacts) encompasses a wide variety of shapes and sizes and is not linked to the series of sandstone grinders. Most of these tools have a roughly oval outline, and almost all have at least one rounded end.

Crescent-shaped and hollow rubbers

Certain similarities can be seen among a group of crescent-shaped tools with one straight or slightly concave edge which, along with the flat surfaces adjacent to it, forms a working surface (Fig. 3. 5; Photo 4. 4, 5). Six examples vary from 8,5 to 10,5 cm in maximum length, 5,0 to 6,5 in maximum width, and 2,0 to 2,8 cm in maximum thickness. They are similar in shape to the artefacts known from Khartoum Hospital (Arkell 1949:64-66).

Most of these tools have a roughly oval outline, and almost all have at least one rounded end, while either one or both of the long edges is, to some extent, keeled. It is suggested that the keeled edge and the rounded end were the most important features. On occasion flatter surfaces were also used for grinding or rubbing. These rubbers were undoubtedly used for smoothing/polishing, probably either bone or wood. One crescent-shaped form, for example, exhibits traces of smoothing both on its inner (concave) edge and outer (convex) surface. On the other hand, artefact made of ferruginous sandstone was used as a ochre grinder – the presence of red stain has been noted on the outer, convex and polished edge (Photo 4. 4).

Blade rubbers

A characteristic feature of this tool is its smooth and more or less convex surface, with the long edges more or less sharp or keeled. They have a rough, flat base, often broken in antiquity as indicated by canker on the fracture. The tip is usually rounded and carefully shaped. Ten examples vary from 8,0 to 10,2 cm in maximum length, 3,8 to 5,3 cm in maximum width, and 2,3 to 3,8 cm in maximum thickness (Fig. 3. 8; Photo 5. 3). It seems that the curved edge approaching the tip rather than the tip itself was important to the user, for the tip is often slightly thicker than the edges, which seem too have been the most vital part of the tool. They are similar in shape to the tools known from Shaheinab (Arkell 1953, p. 51-52). These tools were made of medium-grained sandstone.

Chisel-shaped rubbers

Thus far only two items have been classified under this heading: one is a complete tool (Fig. 3. 7; Photo 5. 4) and the other a damaged one. Their shape resembles that of a short chisel which narrows towards its tip and has a handle that is oval (slightly flattened) in cross-section. The working surface consists of two well-smoothed areas located along the tool's longer axis. The complete example is 14,2 cm long, 9 cm of which comprise the working surface. Both rubbers are made of medium-grained sandstone. It seems possible that they were used for working bone or wood, as a rubber or kind of a wedge (chock).

Spoon-shaped rubbers (smoothing stones/small palettes)

Five artefacts are grouped together in this subcategory because they have similar working surface

and probably served similar purposes. All of them are somewhat flattened, with one slightly concave and noticeably smoothed side. In one instance the other side, which is convex, bears traces of smoothing as well. Examples vary from 6,5 to 10,4 cm in length, 3,8 to 4,2 in width, and 1,6 to 3,4 cm in maximum thickness (Fig. 3. 1, 2; Photo 2. 4; 5. 5).

Defining the precise function of these objects is difficult. One of these artefacts, recovered from excavations at Kadero in 1999, has distinct traces of red ochre on its concave upper face (Photo 2. 4). It seems possible that they were used as smoothing stones for working on convex surfaces or as small palettes for preparing pigments-staffs.

Club-shaped (cylindrical) rubbers/drills

This is a numerous and varied category (62 examples) and one of the diagnostic features of the Khartoum Neolithic. Arkell termed this group of tools tapering cylindrical rubbers (Arkell 1953:52). The shape of tools in this group ranges from slender and oval or round in cross-section, through slender and flattened at one end, to being fairly stocky. The variety of sizes represented is also quite broad. Assuming that some forms have been correctly interpreted as whole tools rather then fragments, their length ranges from 5,5 to 11,5 cm. It is also possible that some of the pestles which survive in fragmentary form may have originally been longer. It is probably also quite common for one tool to be used for a range of functions, resulting in numerous cases of working surfaces being located on various parts of a tool:

a) conical surface used with a rotary action (borers);
b) oblong surface along the tool's longer axis;
c) flat surface;
d) flattened, irregular surface – related to the pounding action of the pestle.

There is also a possibility that some of the areas identified as working surfaces based on the current tool form are actually the remnants of the working surface of a larger tool which was damaged and then recycled.

a) Their working surface is more-or-less conical. Use-wear traces include strong surface abrasion and circular striation patterns indicating rotary action. Thus, they may have served as a form of drill. It is not inconceivable that this sort of tool was used for making holes in stone rings, though it could equally have well been used for working organic materials (Fig. 4. 1, 3, 5-11; Photo 5. 6).

b) The objects which have an oblong working surface that runs along the utensil's longer axis may have been used for working wood or bone. In some instances it is possible that the area identified as the working surface on the basis of use-wear traces actually constitutes that part of the tool which had some kind of fitting attached to it, and was in fact used for an entirely different purpose (e.g. pounding). Most of the tools in this group are made of medium-grained sandstone (Fig. 4. 2, 4, 13).

c) A further variation on the working surfaces is seen in a group of tools which have one or two flat working surfaces. This generally takes the form of a small, flat area which in each instance evidences a slightly different direction of use. These items were probably used for wood- or bone-working (Fig. 4. 12).

d) The last variety of working surface noted is related to the pounding action of the pestle. This surface is irregular, flattened and has evident traces of chipping and damage. These of course, could have been caused by a number of things not necessarily related to use-wear. Quite often a single "pestle" had a number of functions (e.g. some have "borers" located at the opposite and to the pounding surface – Fig. 4. 3).

Rubber with grooves

Only one broken example was found et Kadero (Photo 6. 3). It seems possible to be the fragment of a bigger rubber broken in antiquity and reused in a new function. On one face it has a pair of intersecting grooves, both about 3 mm wide and 3 mm deep. The fragment is 7,5 cm long, 4,5 cm in width, and 3,7 cm in thickness. It was made of fine grained sandstone.

Hammer stones

A large category of tools for which the exact description and analysis is given in the separate chap-

ter (by M. Kobusiewicz). Their pounding surfaces, of which there can be one or more, are typically covered in pits, fissures and scratches of various size and depth, which often overlap each other or occur in clusters. With prolonged use the surface of these stones becomes rough and porous. Most of them were used for flaking and shaping of lithic artefacts, but they could also be used together with lower grindstones (with deep working surface) to crush the nuts and stones of edible fruits.

Ochre

During excavations on Kadero, many pieces of ochre were found. It was very important raw material used for many purposes, e.g. pigment production, jewellery (more information are given in separate chapter). Lumps of ochre were crushed and ground on different types of grinding stones. One artefact found on cemetery context has a special form – it was probably a kind of pencil (length 8 cm, width 2 cm and thickness 1,1 cm.). It has a regular form of elongated triangle with triangle-shape cross-section (Photo 3. 4). All flat surfaces and edges have traces of grinding and scratches. It seems possible, that this artefact was used as a handy stain, and was ground on a palette to produce small portion of pigment.

Stone stick

Interesting form has a small stick (4,65x0,7x0,65 cm) made on crystal of amfibol (or piroksen). It has very smooth, mostly polished, glossy surfaces with two sharp edges and triangle-shaped cross section (Photo 7. 3, 4). On one end delicate scratches are visible. In the small depressions traces of red ochre are preserved. It is possible that it was a kind of tool used for painting, probably on organic material (body?).

Stone rings

The presence of stone rings in Neolithic sites is a singular fact, since these artefacts have been considered characteristic of the Early Khartoum period (Marks et al 1985:271; Fernández et al 2003: 252). The interpretation of the function of this category of items poses many problems. Classifying them typologically is also no easy matter, despite the fact that they differ distinctly in size and shape. The fundamental difficulty in many cases is distinguishing finished products from unfinished items or pre-forms. This is particularly true for six fragments where the holes were not drilled right through the artefact. It is hard to ascertain whether the double-sided depressions represent a stage in the manufacture of the unfinished article, during which some kind of damage occurred leading to the piece being discarded, or whether they represent the remnants of the working surfaces of another type of tool (anvil?). The latter scenario is especially plausible with regard to three large fragments. Their diameter range from 5,5 to 11 cm and thickness from 2,1 to 3,5 cm. The objects have hollows on both sides created mostly by chipping. The fairly large, flat surfaces around the unfinished holes could indicate the artefacts earlier function – they may, for example, have been made from damaged and then recycled flat grinders (Photo 6. 4). One complete ring and three other fragments represents undoubtedly finished products. The first one is of a regular shape, with rounded and polished edges. It has a diameter of ca. 7 cm and is 2,6 cm thick. The hole diameter measures 1,3 cm (Fig. 5. 8; Photo 6. 5). A similar artefact is known from Neolithic es-Sour (Sadig 2010:148, Plate 6.4). The three fragments differ in shape and size. Two of them had a discoidal shape with keeled edges, diameter ca 8 cm, thickness ca 2,5 cm, and the hole diameter measures about 2 – 2,3 cm (Fig. 5. 10; Photo 7. 1). The third fragment has a less regular shape, rounded edges, diameter about 6,7 cm, maximum thickness 2,3 cm and the hole diameter ca 2,5 cm (Fig. 5. 9). All of the artefacts in this group are made of medium-grained sandstone.

The function of these artefacts is probably the most difficult to ascertain of all the sandstone tools recorded at Kadero. Writing about similar finds, Arkell suggested that the diameter of the perforation or hole appears in the majority of cases to have been about 30 mm: just about the diameter of wooden club handle, as seen with the stone-headed clubs still used in the Nuba Mountains (Arkell 1949:63-64). Similarly, A.A. Magid suggests that the stone-rings recovered from the sites of Aneibis, Abu Darbein and El Damer were most likely utilized as weighs for digging-sticks which were used to dig up the subsoil in search of edible roots, tubers, etc (Magid 1995: 68). The Function of stone ring from Early Neo-

lithic site Bir El Lahamda (Blue Nile area, Central Sudan) was also interpreted in this way (Fernández et al 2003:252). The complete ring from Kadero has much smaller perforation, and is therefore not useful for this purposes.

Summary

The Kadero inhabitants used stone in considerable quantities. Sandstone, as a raw material for tool production, undoubtedly played an enormously important role in the late prehistory of the site, and it dominates the macrolithic assemblages of this area. Noteworthy are the skills of local stone workshops, represented by many different types of tools. Thousands of fragments of worn-out grindstones found in settlement deposits at Kadero documented intensive using of this type of tools. It seems to indicate a regular consumption of cereals processed on considerable scale (Krzyżaniak 1984: 311; Klichowska 1984:321-324), e.g. they may have been used for crushing and milling the grains of sorghum, fruits of the African hackberry tree (Krzyżaniak 1992b:368) or the stones of the dom Palm Hyphaena thebaica (Krzyżaniak 1991:513), but also large part of the grindstones were used to perform some other function (Krzyżaniak 1992a: 269-270). Production of pigment from ochre was one of the most important purpose for the manufacture of sandstone objects such as small lower grindstones, flat grinders, hammer stones and palettes. The inhabitants of Kadero also processed wood, bone and horn and for this purpose, beside tools made of rhyolite (e.g. axes, gouges), many sandstone tools were produced and used, such as different type of rubbers and polishing stones.

However numerous questions concerning the function and meaning of the stone artefacts from Kadero are still to be answered.

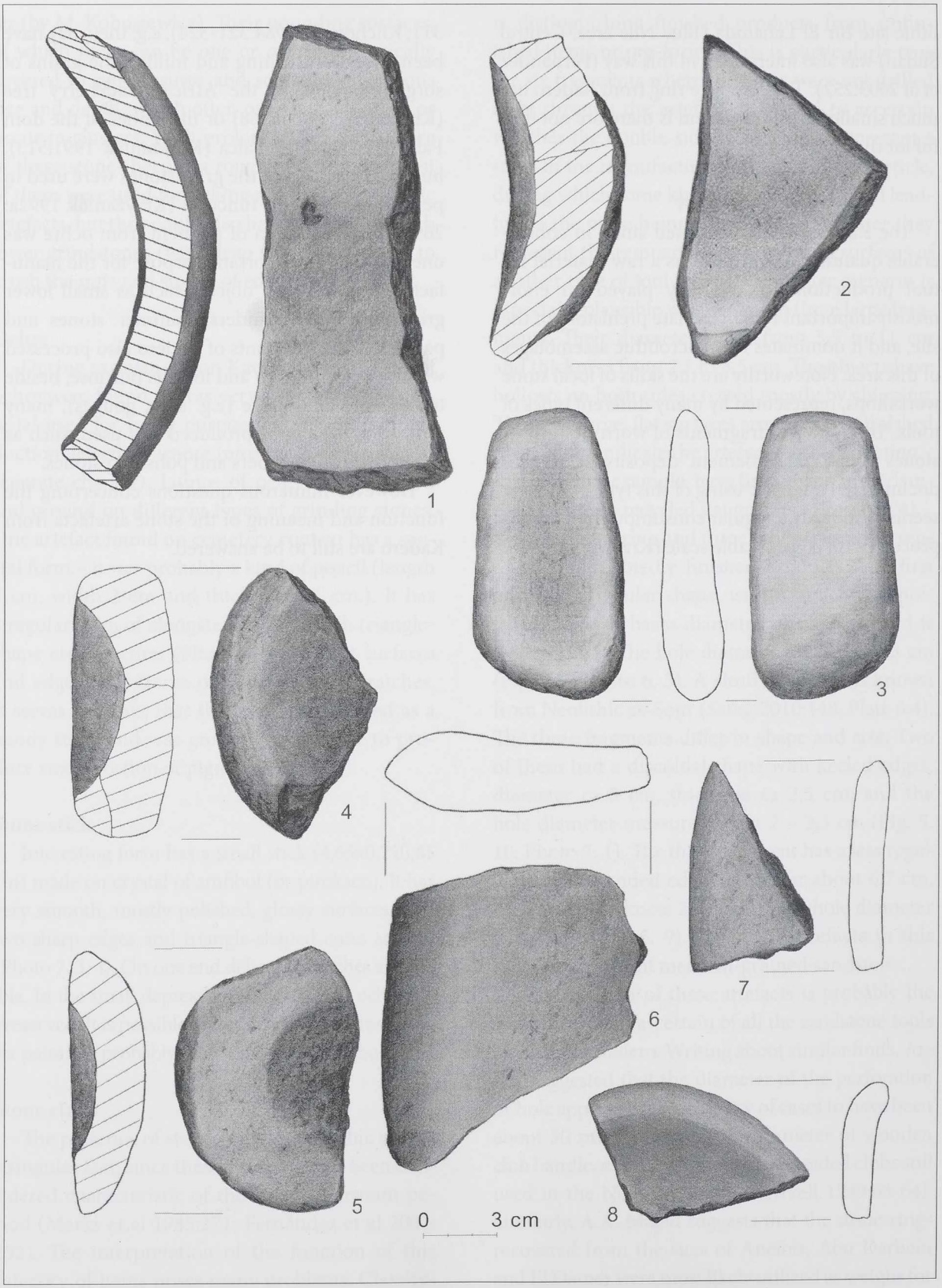


Fig. 1. Kadero. Sandstone tools: 1,2 – fragments of large, deep querns; 3 – small palette; 4, 5 – fragments of small and deep lower grindstones; 6, 7 – fragments of large, flat querns; 8 – fragment of small, flat lower grindstone (palette?).

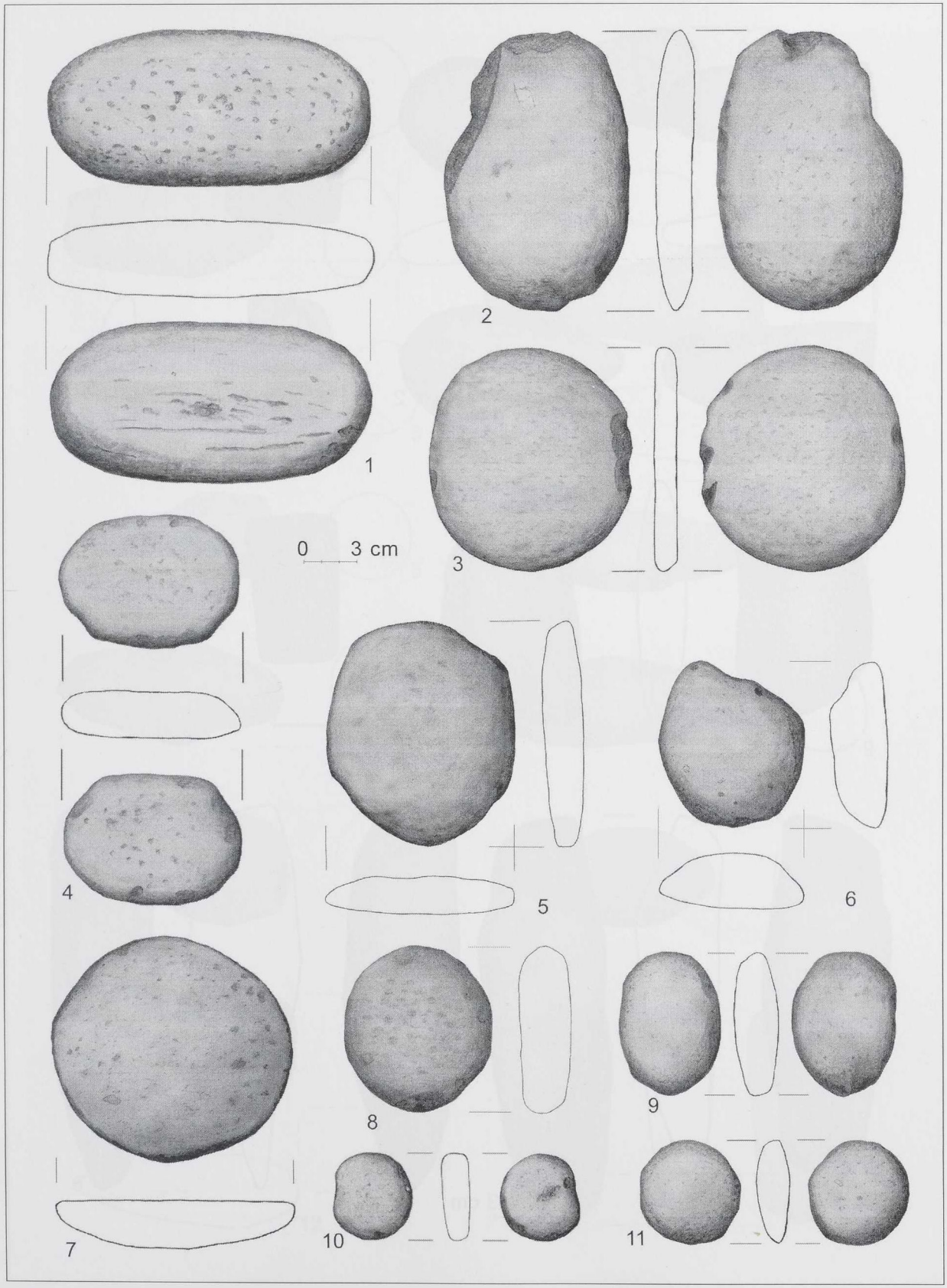


Fig. 2. Kadero. Sandstone tools: 1 - large, spherical, heavy grinder; 2, 3, 5, 7 – large, disc grinders/polishing stones; 4, 6, 8-11 – small flat grinders/polishing stones.

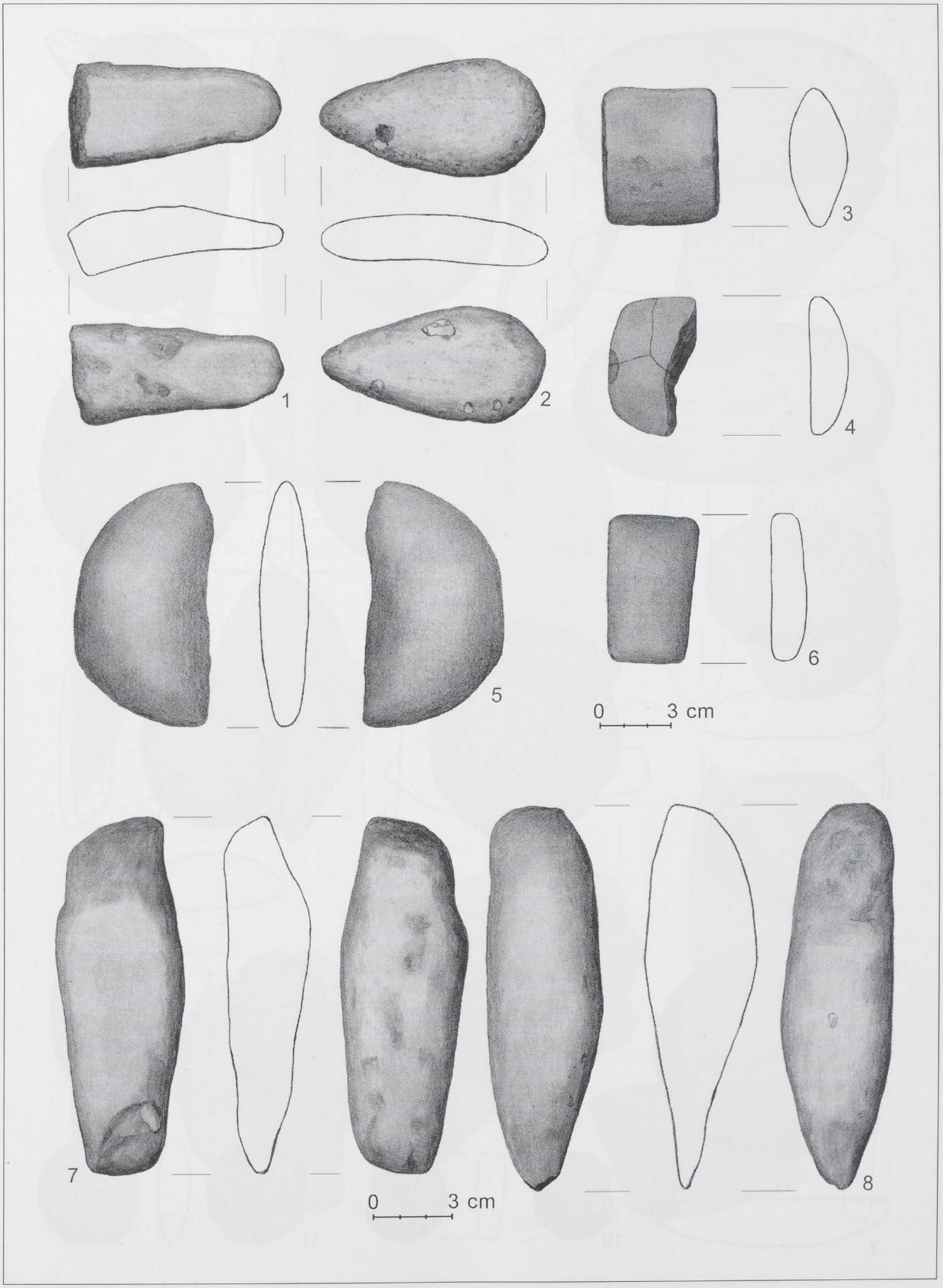


Fig. 3. Kadero. Sandstone tools: 1,2 – spoon-shaped rubbers (smoothing stones/small palettes), 3 – polishing stone convex on both sides; 4 – polishing stone with one flat surface (ochre grinder?); 5 – crescent-shape rubber; 6 – small polishing stone; 7 – chisel-shaped rubber; 8 – blade rubber.

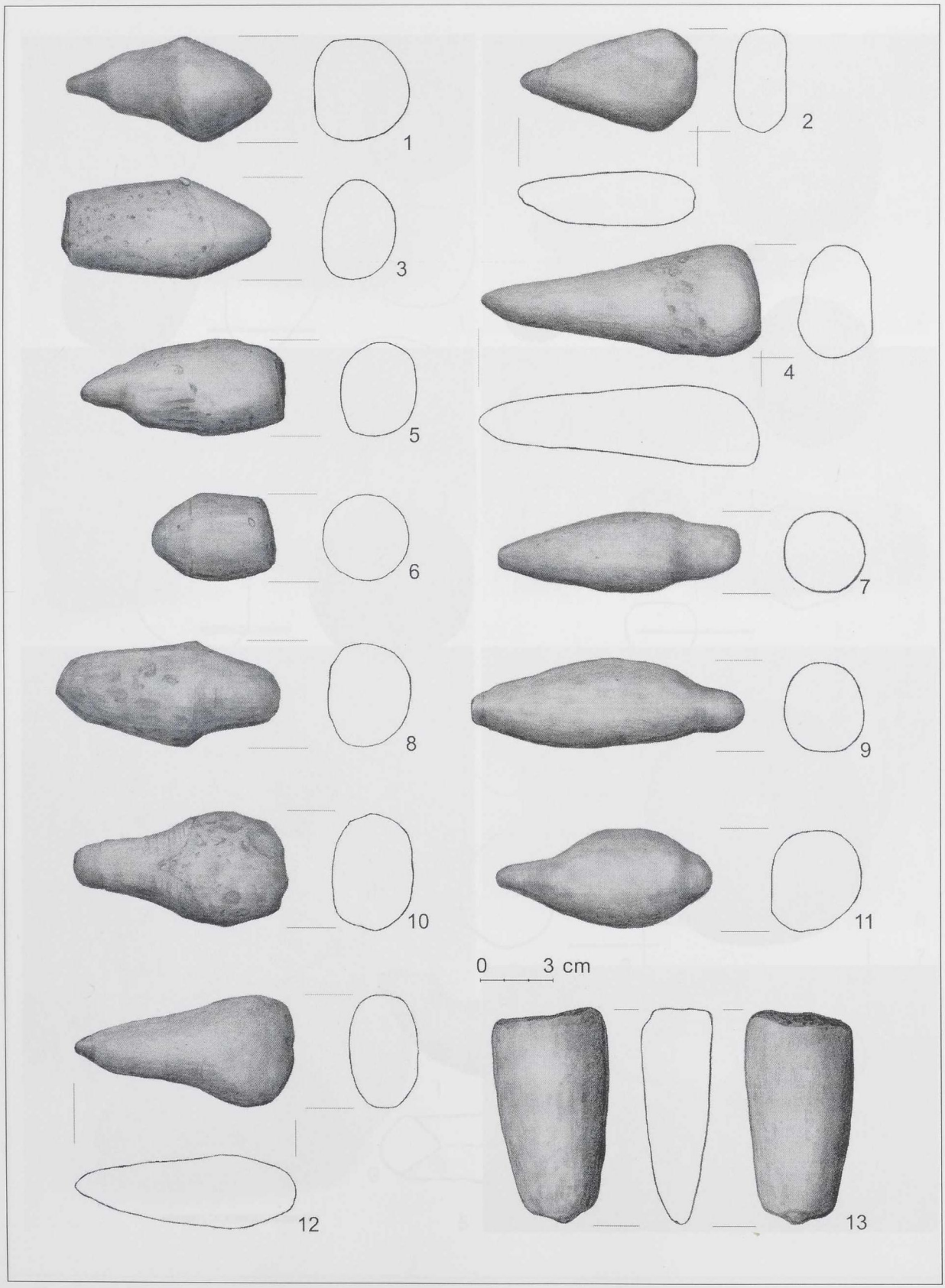


Fig. 4. Kadero. Sandstone tools: 1-13 – club-shaped (cylindrical) rubbers/drills.

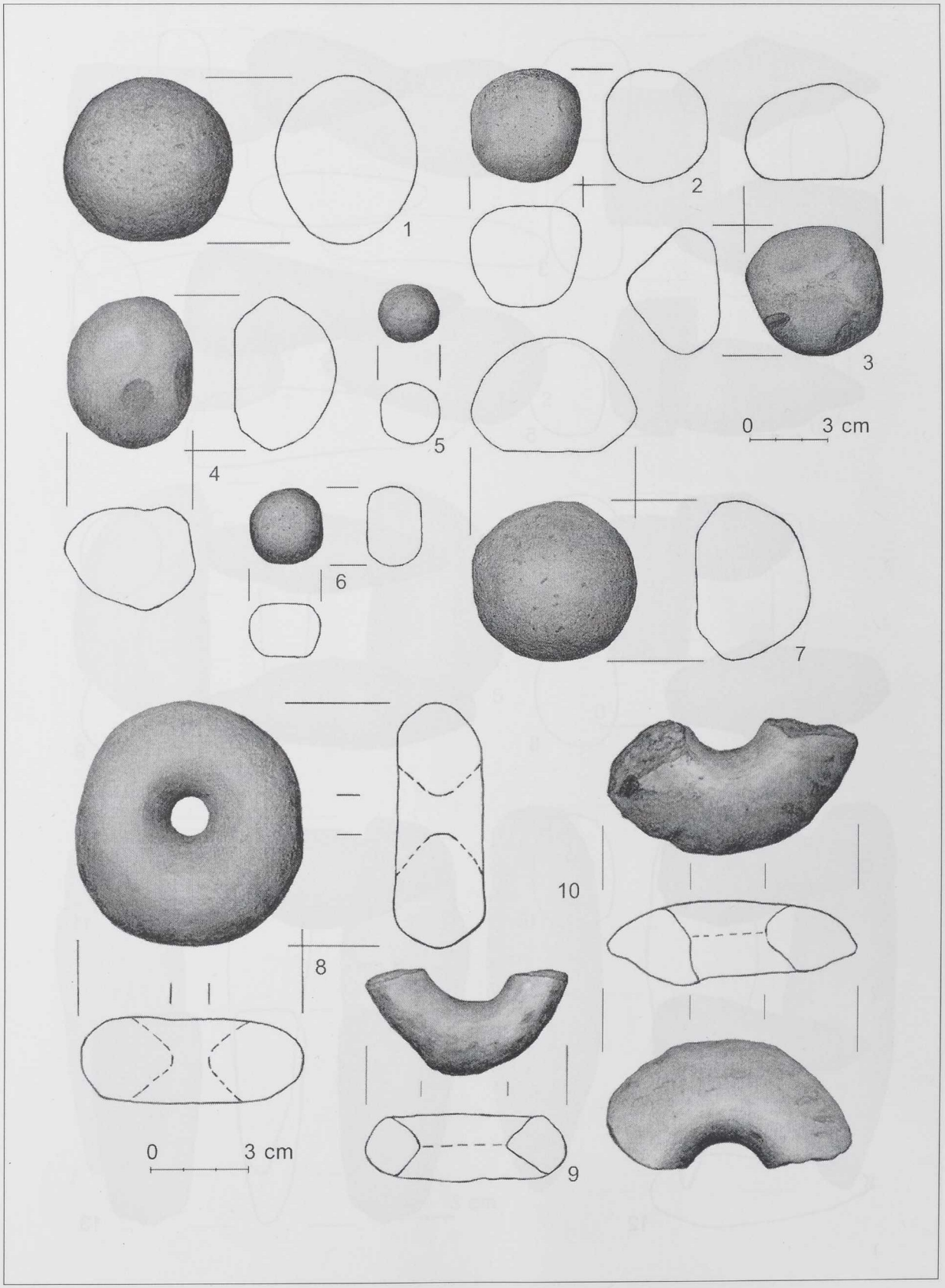
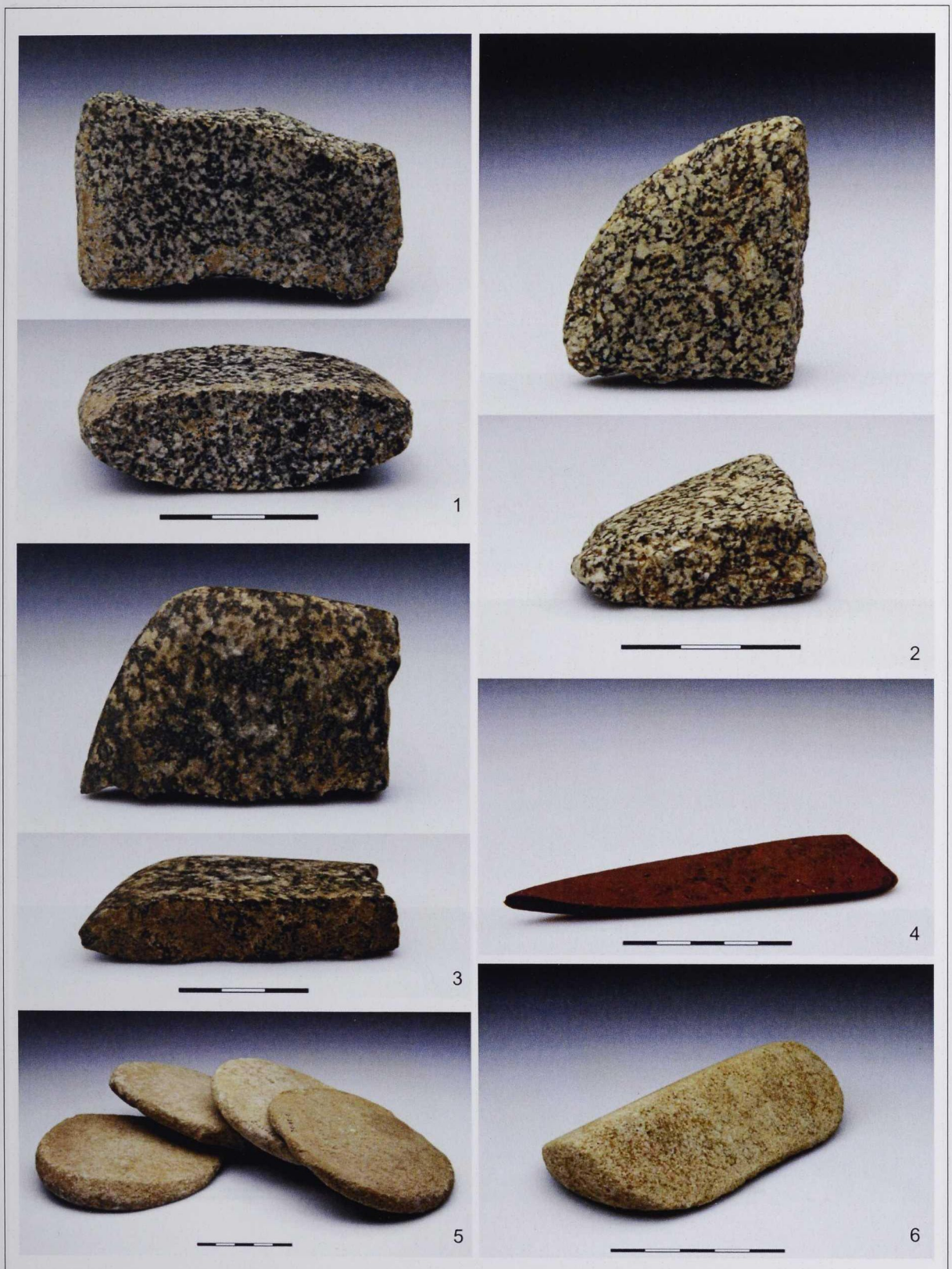


Fig. 5. Kadero. Sandstone tools: 1-7 – pebble grinders/pounders; 8-10 – rings.

Phot. 1. Kadero. Sandstone tools: 1 – fragments of large, deep quern; 2 – fragment of large, flat quern; 3,5 – fragments of small and deep lower grindstones; 4 – fragment of small, flat lower grindstones (palettes?). Naga, Butana Plain: 6 – recently used sandstone deep lower grindstone and grinder/pounder from burned house of nomads; 7 – recently used grinding equipment.

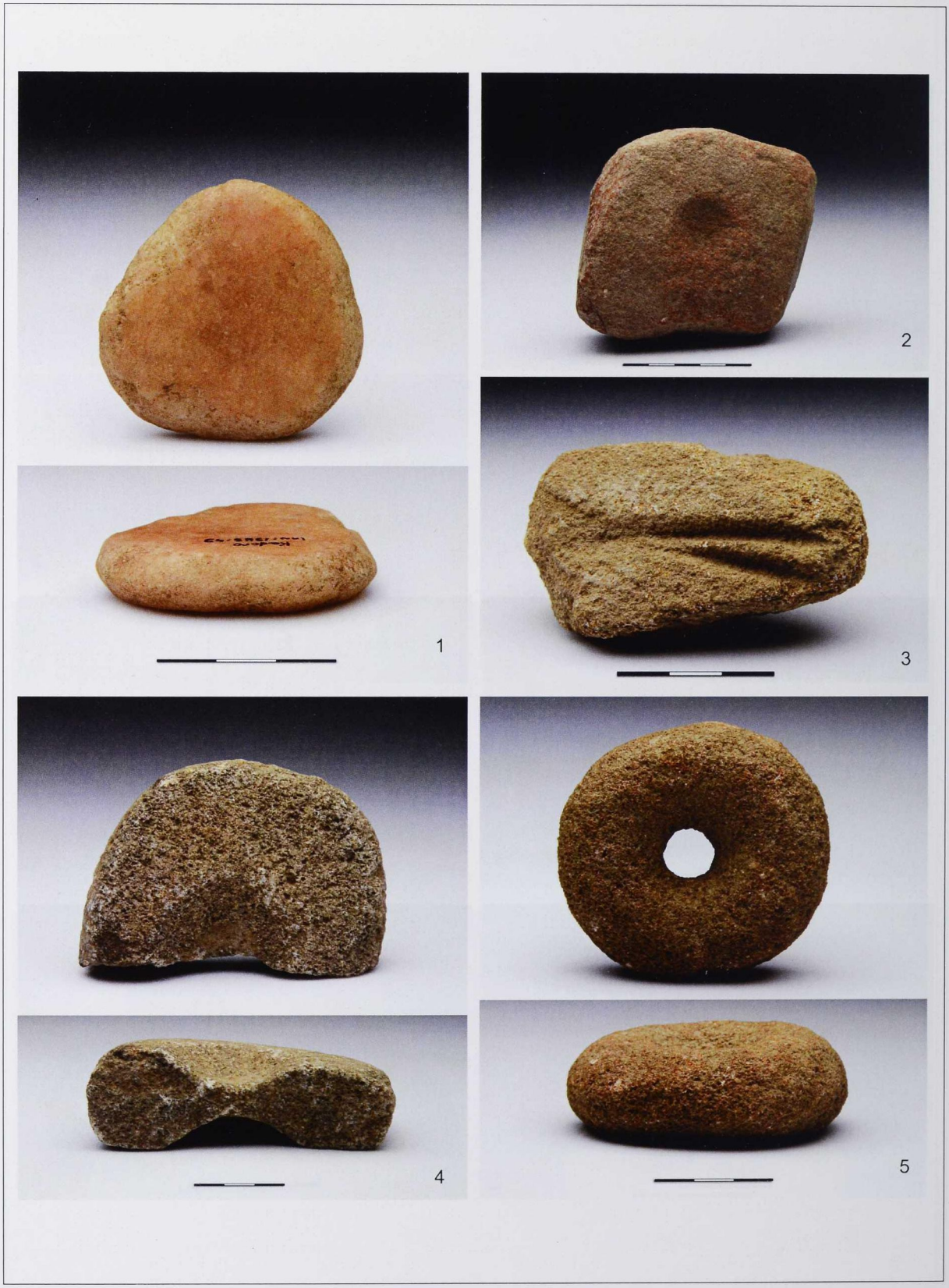
Phot. 2. Kadero. Sandstone tools:1 – palette and grinder from grave 189; 2 – palette from grave 101; 3 – small palette from midden context; 4 - spoon-shaped rubber (smoothing stone or small palettes) with traces of ochre on the working surface



Phot. 3. Kadero. 1-3 – fragments of diorite palettes; 4 – ochre "pencil"; 5 – sandstone large, disc grinders/polishing stones; 6 – polishing stone with triangle (keeled) cross-section.

Phot. 4. Kadero. Sandstone tools:1 - large, spherical, heavy grinder; 2 – large, elongated, disc grinder/polishing stone; 3 – fragments of polishing stone convex on both sides; 4,5 – crescent-shape rubbers/ochre grinders, 6 – pebble grinders/pounders.

Phot. 5. Kadero. Sandstone tools: 1 – small polishing stone; 2- hollow rubber; 3 – blade rubber; 4 – chisel-shape rubber; 5 – spoon-shape rubbers (smoothing stones/small palettes); 6 – club-shaped (cylindrical) rubbers/drills.



Phot. 6. Kadero. 1 – small polishing stone made on quartz; 2 – anvil; 3 - rubber with grooves; 4 – fragment of unfinished (?) ring; 5 – ring; 2-5 – sandstone.

Phot. 7. Kadero. 1- fragment of sandstone ring; 2 – polishing stone/ochre grinder made on quartz pebble; 3,4 - small stick made on crystal of amfibol (or piroksen) with traces of ochre (4 – close up).