An Introduction to the Study of (Late) Prehistoric Ground Stone Artefacts in the Western Part of Jebel Sabaloka in Central Sudan

Úvod do studia pravěkých broušených kamenných artefaktů ze západní části pohoří Sabaloka ve středním Súdánu

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This study is devoted to stone artefacts made from raw materials that are valued for their hardness, tenacity, and texture. They were often ground, and some tools from this category were themselves used for grinding. In addition to shaping artefacts, they were employed in processing of food, crushing minerals and ores, or as parts of digging sticks. Changes in their functional composition generally signal significant subsistence, economic and social changes. As our research focuses on the Sahel region, which has undergone complex formative processes connected with climate change and radical transformation of living conditions, it is necessary to test diverse approaches to utilizing the information potential of finds from this region.

The studied artefacts come from Mesolithic (~9000–5000 cal BC) and Early Neolithic (~5000–3800 cal BC) settlements in the western part of Jebel Sabaloka in central Sudan. We focus on two assemblages from surface collection at the sites of Sphinx (Mesolithic) and Fox Hill (Mesolithic and Early Neolithic). We first provide a critical review of core studies of ground stone artefacts from the region and propose a unified basic terminology. Subsequently, we present a new classification and description system and highlight certain variables which are important to track at the sites. Among other things, our conclusions indicate that although changes occur in the settlement system and domesticated animals appear in the study region in the fifth millennium BC, these changes are reflected neither in the quantity nor in any substantial way in the morphometric characteristics of ground stone artefacts as was the case, for instance, in the Near East.

ground stone artefacts – Mesolithic – Early Neolithic – subsistence – central Sudan – classification of tools

V práci se věnujeme kamenným artefaktům ze surovin ceněných pro jejich tvrdost, soudržnost a zrnitost. V určité fázi výroby byly tvarovány broušením a některé byly samy k této činnosti využívány. Kromě tvarování artefaktů našly kamenné broušené artefakty uplatnění ve zpracování potravin, drcení minerálů a rud, či jako součásti kompozitních nástrojů. Změny v jejich tvarovém a funkčním složení většinou v pravěkých souborech signalizují významné subsistenční, ekonomické a společenské změny. Protože je náš výzkum zaměřen na území Sahelu, které prošlo řadou složitých formativních procesů, spojených se změnou klimatu a s radikální proměnou podmínek k životu, je nutné testovat různé přístupy ke studiu a využití informačního potenciálu místních nálezů, kamenné artefakty nevyjímaje.

Artefakty pochází z mezolitických (~9000–5000 cal BC) a časně neolitických (~5000–3800 cal BC) lokalit v centrálním Súdánu. Předmětem studia byly zejména soubory z povrchových sběrů na lokalitách Sfinga (mezolit) a Liščí kopec (mezolit a časný neolit), ve dvou sousedních ekozónách v západní části pohoří Sabaloka. V článku jsou shrnuty základní práce o daném tématu v regionu a je navrženo sjednocení místní terminologie. Dále je představen nový klasifikační a deskripční systém a jsou vytyčeny některé proměnné, které je důležité nadále sledovat. Z našich závěrů mimo jiné vyplývá, že i když ve sledovaném regionu došlo kolem 5. tis. BC ke změnám v systému sídlení a objevují se kosterní pozůstatky domestikovaných zvířat původem z Předního východu, nelze potvrdit žádné významné změny ani v kvantitě, ale ani nijak zásadně v morfometrickém zastoupení broušených artefaktů. Socio-ekonomický vývoj zde v dané době probíhal jiným směrem, než známe z oblasti Předního východu.

broušené kamenné artefakty – mezolit – časný neolit – subsistence – centrální Súdán – klasifikace nástrojů

1. Introduction

In this work we focus on large stone artefacts, with ground surfaces, made of sedimentary, igneous and metamorphic rocks; the artefacts were collected during surface surveys carried out in the western part of the Sabaloka Mountains (Jebel Sabaloka) in central Sudan (*Fig. 1*). In the region that extends approximately from the confluence of the Atbara and the Nile to the north and the confluence of the White and Blue Niles to the south, these stone artefacts, which are most frequently designated as **ground stone tools** or simply **ground stones** due to their ground surfaces (hereinafter referred to as "**GS**"; e.g., *Wright 1992*; *Adams 2002*; *Rosenberg – Rowan – Gluhak 2016*; *Squitieri – Eitam /eds./ 2019*; *Peacock 2013*; *Hamon 2008*; *Procopiou – Treuil /eds./ 2002*; *Zimmermann 1988*), constitute an important component of Mesolithic (~9000–5000 cal BC) and Early Neolithic (~5000–3800 cal BC) assemblages (e.g., *Garcea 2020*; *Edwards 2004*; *Fernández /ed./ 2003*; *Haaland 1981*). However, after more than seventy years since the pioneering excavations at the Mesolithic and Early Neolithic sites of Khartoum Hospital and Esh Shaheinab (*Arkell 1949*; *1953*) and numerous subsequent field projects in the region (e.g., *Caneva /ed./ 1983*; *1988*; *Clark 1989*; *Marks – Mohamed-Ali /eds./ 1991*; *Fernández /ed./ 2003*; *Chłodnicki – Kobusiewicz – Kroeper /eds./ 2011*), we now know that this specific part of the world, which is of particular interest for investigating adaptation and subsistence strategies, has undergone processes over the past five millennia that have severely affected the preservation of primary contexts and the archaeological record (e.g., *Kuper – Kröpelin 2006*; *Garcea 2006*; *Usai 2016*). Unfortunately, because of erosion and other destructive natural agents, archaeologists must deal with the hard-to-interpret spatial relationships of portable finds to immovable structures (or at times they must deal with the lack of such relationships), a fact that complicates both the chronological classification of various finds and the determination of their function. According to some archaeologists, the GS in central Sudan are most frequently fragmentary and "difficult to classify in any detail" (*Marks – Mohamed-Ali /eds./ 1991*, 96), and are considered to be "poorly diagnostic features" (e.g., *Caneva – Gautier 1994*, 77). However, based on the results of our research to date in Jebel Sabaloka, we are convinced that in this part of Africa these artefacts still have the potential to provide hitherto untapped information (see, e.g., *Adams 2002* for a different part of the world).

The Holocene prehistory of central Sudan begins with the Mesolithic period, locally known as the Early Khartoum Culture, which is distinguished by intensive hunter-fisher-gatherer forms of resource exploitation, well-established pottery production, and, at a certain period, by a high degree of settlement stability. This is followed by the Neolithic period which saw the introduction of domestic animals and development of livestock herding during the Early Neolithic phase, locally known as the Shaheinab Neolithic. There was a subsequent shift to specialised pastoralism with a mobile form of existence and marked extensification of subsistence territories during the Late Neolithic phase (~3800–2700 cal BC; e.g., *Edwards 2004*; *Garcea 2020*). While there are no doubts regarding the "exotic" (Near Eastern) origin of domesticated sheep, goats and at least some cattle in Northeast Africa (*Garcea 2016*), there is no agreement among scholars as to whether the domesticated animals were introduced to central Sudan through demic diffusion with migrations of herders, or through cultural transmission and the incorporation of new species into the local economies (*Garcea 2020*). So far, no unequivocal evidence for plant food production has been found in central Sudan (*Hildebrand et al. 2018*; *Hildebrand – Schilling 2016*; *Magid 2003*; but see *Salvatori – Usai 2019*), although this is one of the main geographic foci of early domestication of sorghum millet (*Brass et al. 2019*; *Winchell et al. 2017*; *2018*). It is still an open question to what extent and how (if at all) the contingent changes in the sources of food were reflected in the material culture of the local communities, for instance in GS.

The monographs by A. J. Arkell on his excavations at the Khartoum Hospital site, dated to the Mesolithic (Early Khartoum Culture; *Arkell 1949*), and at the Esh Shaheinab site, dated to the Early Neolithic (Shaheinab Neolithic; *Arkell 1953*), give a good insight into what specific types of artefacts one can envisage under the designation GS (Arkell refers to them as "stone implements"). In addition to various kinds of hammerstones (spheroid and cuboid pebbles with traces of hammering), Arkell mentions at the former, chronologically earlier site seven basic shapes which he designates (and interprets from the point of view of function) as grinders; lower grindstones; stone rings; rubbers; grooved stones; fishing-line sinkers; and beads. The chronologically younger site of Esh Shaheinab yielded, in addition to the afore-mentioned types, objects which Arkell designates (and interprets from the point of view of function) as celts and mace-heads. These ten basic types and the interpretation of their functions have continued to be largely respected by all subsequent authors of more exhaustive works (e.g., *Haaland 1981*; *Zarattini 1983*; *Caneva 1988a*; *Jórdeczka 2011*; *Magid 2003*). However, with the growing number of recorded sites it has become clear that, on the one hand, (i) we lack standardized terminology and a uniform descriptive and documentation system that would make analysis and comparison of these items from different sites possible, and (ii) there is no broader comparison with areas further downstream of the Nile or in the Western Desert where we might expect some form of contacts (e.g., *Lucarini 2014*; *Lucarini – Radini 2019*; *Shirai 2010*; *Roubet 1989a*; *1989b*; *1989c*; *Banks 1982*; etc.).

Of all the above-mentioned types summarized by Arkell from his excavations, we will concern ourselves only with those that can be most frequently observed on the surfaces of prehistoric settlements. In this work we put aside all special finds including jewellery (beads, pendants, labrets), mace-heads, celts, in other words items that are found only rarely during field prospection or that have been published elsewhere (gouges; see *Kapustka et al. 2019*; *Kapustka – Winiarska-Kabacińska 2020*). Instead we focus our attention on less visually attractive items – of various shape and sizes – for which grinding (the main discriminating attribute for ground stones) does not have to be the sole or the main procedure in their shaping, or the sole method of their use (see e.g., *Adams et al. 2009*). They may combine several methods of manufacture and at the same time represent multifunctional tools that could be used for diverse activities such as percussion, abrasion, polishing, grinding and chopping (*Adams et al. 2009*, 43). In addition, however, they may also constitute parts of composite tools; stone rings, for instance, may have formed part of so-called digging sticks (*Arkell 1949*; *Haaland 1981*).

In the Near East and Europe, but also in other parts of Africa and in North America, artefacts from the GS category have long been of interest to archaeologists as they can throw light on diverse technologies, such as food processing, medicine preparation, mineral or ore processing, manufacturing of tools of various materials,

Fig. 1. *Map of the Nile Valley and the Western Desert of Egypt and Sudan, with the location of Jebel Sabaloka and other sites mentioned in the text marked (red dots).* ***1*** *– Esh Shaheinab, 2 – El Geili,* ***3*** *– Saggai 1,* ***4*** *– Zakiab,* ***5*** *– Kadero,* ***6*** *– Um Direiwa,* ***7*** *– Khartoum Hospital,* ***8*** *– El Qoz,* ***9*** *– Al Mahalab,* ***10*** *– Sheikh el-Amin,* ***11*** *– Sheikh Mustafa 1,* ***12*** *– Shaqadud. Map by L. Vařeková, modification by L. Varadzinová. —* ***Obr. 1.*** *Mapa údolí Nilu a Západní pouště v Egyptě a Súdánu, s lokalizací pohoří Sabaloka a dalších lokalit zmíněných v textu (červené tečky). Mapové podklady: L. Vařeková, upravila L. Varadzinová.*

plastering of floors and walls, and many other activities. GS have also contributed to the study of inequality and social strategies (e.g., *Wright 1992*; *1993*; *1994*; *2000*; *2014*; *Dietrich et al. 2019*; *Shoemaker – Davies Mathew – Moore 2017*; *Rowan – Ebeling /eds./ 2008*; *Rosenberg – Rowan – Gluhak 2016*; *Squitieri – Eitam /eds./ 2019*; *Rosenberg – Garfinkel 2014*; *Peacock 2013*; *Hachem – Hamon 2014*; *Hamon 2008*; *Van Gijn – Houkes 2006*; *Baysal – Wright 2005*; *Dubreuil 2004*; *2001*; *Adams 2002*; *Pavlů – Rulf 1991*; *Zimmermann 1988*).

At the beginning of our work, we will provide an overview of the classification systems for GS that have been used in Sudan and in Egypt over the past seventy years of research and we will briefly look at the terms for individual morphological and functional types. Then, after presenting our research area and the settlement system within this region during the Mesolithic and Early Neolithic, we will carry out a comparison of two assemblages of GS from analytical surface collections conducted at the Mesolithic site of Sphinx (SBK.W-60) and at the Mesolithic to Early Neolithic site of Fox Hill (SBK.W-20). Our goals are the following:

– to unify the terminology and create a descriptive system for GS;

– to show, using two particular sites, what specific types of artefacts and what activities can be identified in the western part of Jebel Sabaloka;

– to ascertain whether these assemblages are specific in some way and whether it is possible to distinguish Mesolithic and Early Neolithic artefacts;

– to outline the themes for future study in this challenging archaeological environment.

2. GS studies and terminology in Sudan and Egypt

2.1. Summary of GS studies in Sudan

The presence of GS at prehistoric sites in central Sudan is mentioned in quite a number of field reports and studies (e.g., *Clark 1989*; *Elamin – Mohammed-Ali 2004*; *Caneva – Gautier 1994*). In this part of the work, we will attempt to provide a chronological summary (according to date of publication) of the history of research into GS in Sudan and we will mention some important works[1] that: a) have shown certain advances (innovative approaches) in GS research; b) facilitate chronological classification of assemblages thereby enabling us to compare the two main periods, i.e. Mesolithic and Early Neolithic; c) contain not only verbal description of GS, but also more specific information regarding the numbers and dimensions of GS and drawn and/or photographic documentation. For terms for describing the morphology of GS types, we mostly rely on the work by *K. Wright* (*1992*, 58, Fig. 2), who focuses on GS from the Near East, but still offers universal methodological procedures for the classification and terminology of these artefacts.

A. J. Arkell (*1949*; *1953*) looks at GS in considerable detail, just as he does other categories of artefacts. He sorts the artefacts on the basis of shape (*Tab. 1*), number and shaping of faces, but also based on certain residues preserved on their faces (specifically ochre), and then based on certain traces of working – especially polishing and smoothing. In the case of grinders, Arkell mentions as many as 14 subtypes from Khartoum Hospital and eight subtypes from Esh Shaheinab. Thanks to his detailed treatment of both sites, we are now aware that GS assemblages from Early Neolithic sites should contain celts and mace-heads (and naturally the so-called gouges). Arkell provides information on the raw materials used and on their sources, and also gives basic dimensions (albeit not very well arranged). His work also contains valuable information on the state of preservation and the fragmentation of the artefacts. He notes certain important details, such as regular circular depressions on opposite faces of grinders, which he regards as evidence for the grinding of ochre (*Arkell 1949*, 62, and Plate 33). However, due to its overly detailed divisions and verbal description of artefacts his classifi-

Main types	**Subtypes**
Hammer-stones	Spheroid, rarely cuboid
Grinders	Pebbles with one or more polished faces
	Pebble g. with traces of a keel
	G. stained with red or yellow ochre
	Sandstone disk g. stained with ochre (circular; oval; with rounded ends and long sides straight)
	Other g. stained with ochre
	Sandstone g. with a flat polished face and traces of a keel
	Small disks of silcrete sandstone with at least one polished or highly smoothed face
	Sandstone disk g. with concave upper side and smooth underside
	Sandstone disk g. with concave upper side and convex underside
	G. used on both sides of which one is flat and the other at least slightly convex
	G. used on convex side only
	G. with two flat surfaces
	G. with some angularity in one of their two major faces
	G. with two slightly convex faces
	G. used as an upper and also lower tool
Lower grindstones	Flat and thin
	L. g. showing a rounded edge, used on one side only
	L. g. used on one side with a smooth deep face
	L. g. with a rounded outer edge with a smooth concave face
	L. g. used on both sides, both concave
	L. g. used on one side only
	L. g. used on both sides, not specified
	L. g. with a regular depression in each face, one with a flat bottom, the second with a rounded bottom
	Sandstone palettes or L. g. for making mace-heads
Grooved stones	
Rubbers	Hollow r.
	Blade r.
	Roughly cylindrical r.
	Small disk r.
	Grooved r.
	Small spherical r.
	R. of oval cross sections
	Tapering cylindrical r.
Fishing-line sinkers	
Celts	Several types, not subject of interest of this work
Stone rings	
Mace-heads	Several types, not subject of interest of this work
Beads	Several types, not subject of interest of this work

Tab. 1. *Typology of GS (Stone implements) after Arkell (1949; 1953). —* ***Tab. 1.*** *Typologie GS podle Arkella.*

[1] In the literature review in this and the next section, we respect the terms used by the authors. The purpose is to show inconsistencies in the naming of artefacts.

cation system is quite difficult to apply to other assemblages.

Nearly thirty years later, *R. Haaland* (*1981*) provided information on GS from several Early Neolithic sites excavated in Khartoum province: Kadero I and II, Zakiab, and Um Direiwa I. An important element of her work is the inclusion of ethno-archaeological observations of artefacts in the context of a living culture. In several Early Neolithic assemblages, Haaland differentiated between hammerstones (made from a variety of materials), upper grindstones, lower grindstones, a separate group of "small grinders with dimples", and then rubbers and stone rings (larger and smaller). She noted "traces of shallow pitting" on some upper and lower grindstones (*Haaland 1981*, 130). Like Arkell (in the case of Esh Shaheinab), Haaland includes mace-heads and pendants, and even a fishing line sinker (but of a different shape from that found at Khartoum Hospital) in her collections of Early Neolithic finds. Moreover, she isolates a group of polished pieces of red ochre. Haaland also defines a separate group of ball-like artefacts, 4–6 cm in size, made of sandstone, for which she finds analogies at Esh Shaheinab. In Haaland's work we encounter the first general definition of upper grinders as ovaloid or round shapes, both faces of which are flat, while she defines lower grinders as saddle quern types with concave working faces – either pecked around the circumference or pecked all over into the desired shape. However, the discussed work does not include specific numbers of whole pieces nor does it provide more specific information on dimensions of individual types (some can be deduced from the drawn documentation).

A little later, *A. Zarattini* (*1983*) summarized information on the GS assemblage from the Mesolithic site of Saggai 1. In a chapter dedicated to this topic she states that varied typology reflects a varied range of different operations (*Zarattini 1983*, 234). Zarattini classified GS into *static* (mortars and querns), and *active* artefacts (upper grindstones, pestles, stone rings, hammerstones). She defines nearly all of the stated types of GS, with verbal descriptions supplemented by basic graphic documentation. Pestles constitute a new group not mentioned in earlier works. In addition, Zarattini classified certain pestle-shaped grinders, which are elongated and polished, within this group. They can have blunt or pointed ends. According to graphic documentation, she also includes stone spheres in this group (*Zarattini 1983*, 236, Figure 2); such objects are mentioned separately by Haaland and included among grinders by Arkell. Unfortunately, Zarattini does not provide the dimensions of artefacts and only the sizes of illustrated pieces can be estimated; nor is there information on total numbers in individual groups. From another work devoted to Saggai 1, we are only told that "pounding and grinding tools were found to be numerous" (*Caneva – Zarattini 1984*, 302). Of interest is information on the presence of three oval grinding stones aligned on the pelvis of the Mesolithic burial no. 2 at this site (*Caneva 1983*, 22).

This work was followed by an overview of the GS assemblage from the Early Neolithic site of El Geili by I. Caneva (*Caneva /ed./ 1988*). It ensues from this work that there were not as many finds of GS at this latter site as compared with the afore-mentioned earlier site of Saggai 1. This work contains some important information, too. For instance, not a single complete lower grindstone (sometimes referred to as a quern) was found at the site. Caneva is the first to draw attention to the fact that the local Early Neolithic deposits were very disturbed by human activity and that their typology is only very provisional (*Caneva 1988a*, 141). This work marks a step forward in that it provides total numbers for individual functional groups, some of which are further divided according to additional morphological details. The site yielded the afore-mentioned lower grindstones, both fragmented and whole upper grinding stones (in addition to undetermined, disk types, oval, oblong, and "soap" shaped pieces are distinguished), rubbers (without further characteristics), and "conical objects".

A combined ethno-archaeological and archaeological approach to the evaluation of diachronic grinding implements from desert areas in Sudan (to the west and north-west of Jebel Sabaloka) and Egypt was provided by W. Schön and U. Holter (*Schön – Holter 1990*). In addition to important observations regarding the use of such artefacts in the context of a living culture, these authors observed the raw material, main metrical characteristics (length, width, thickness) of handstones and milling stones, and their outline in plan view and in transverse-section. In particular, the outline of the transverse section of handstones proved to be the most effective method of classification of this type of tool.

In the early 1990s, a comprehensive evaluation of field research carried out at Shaqadud in the Butana region was published (*Marks – Mohammed-Ali /eds./ 1991*). At the very beginning of the chapter devoted to all stone artefacts from the Shaqadud Midden it is pointed out that the ground stones were very fragmentary and difficult to classify in detail and that very few measurements were taken (*Marks – Mohammed-Ali /eds./ 1991*, 96). Although it is possible to get a general idea of the dimensions of the artefacts from the drawings and photographs (*Marks – Mohammed-Ali /eds./ 1991*, Figs. 6-7, 6-8, 6-9, 6-10, and 8-4), more specific metrical data as well as information on total numbers in the various types and on the proportions of complete and fragmentary pieces is lacking in this work. A. E. Marks classifies the GS into handstones, lower grinding stones (sometimes referred to as querns), pitted stones (handstones with dimples on both faces), rings, rubbers, and balls. In the case of Shaqadud Cave, he also adds so-called rods and grooved artefacts (*Marks – Mohammed-Ali /eds./ 1991*, 186, Fig. 8-4), but these are most likely from Late Neolithic levels that are outside the scope of our work. Several basic handstone subtypes are identified – plano-convex, double flat, handstones. with pits, and crested handstones. Here again we see combined classification based on the shape in plan view, or based on curvature of faces and, at the same time, based on the character of traces of working or manufacturing. In the section dedicated to Shaqadud Midden, the authors arrive at the important conclusion that it is possible to identify the individual vertical levels with different chronological occupation phases of the site during the Mesolithic, the Early Neolithic and the

Main types	Subtypes	More detailed sorting
Hammer stones		
Grinders	1. Flat g.	a) Large spherical
		b) Large disk g./polishing stones
		c) Small flat g./polishing stones
	2. Spherical g./pounders	
Quartz smoothing stones		
Polishing stones		
Stone stick		
Lower grindstones	Querns	a) Large flat
		b) Large deep
	Small lower g.	a) Flat (palettes)
		b) Deep (mortars)
Cosmetic palettes		
Rubbers	Crescent-shaped and hollow r.	
	Blade r.	
	Chisel-shaped r.	
	Spoon-shaped r.	
	Club-shaped (cylindrical) r./drills	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
	R. with grooves	
Rings	Finished	
	Unfinished (?)	
Ochre	Pencil	
	Lumps of ochre	

Tab. 2. *Typology of GS (Stone implements) after Jórdeczka (2011). —* ***Tab. 2.*** *Typologie GS podle Jórdeczky (Jórdeczka 2011).*

Late Neolithic (*Marks – Mohammed-Ali /eds./ 1991*, 118). For instance, rings and balls are absent in the Early Neolithic levels while pitted handstones are absent in the Mesolithic levels. As we have already stated, rods should only be from Late Neolithic levels.

Of the 51 sites with Mesolithic and/or Neolithic finds explored within the scope of the Blue Nile Project (*Fernández /ed./ 2003*), 48 in total yielded Mesolithic finds. GS (termed grindstones in this work) were recorded on 24 of these sites. The total numbers (but not the total numbers for individual types) are known in the case of Sheikh Mustafa-1, El Mahalab and Sheikh el Amin. However, the latter site was occupied during both the Mesolithic and the Early Neolithic. Although we know that all of these sites contain stone grinders (unfortunately, active and passive tools are not differentiated), as well as mortars, stone rings, and, on sites with both periods, rubbers, unfortunately, there is no mention of the numbers in the individual groups, nor of the ratios of whole pieces to fragmentary pieces, and their dimensions are not noted. Thirteen sites recorded by the Blue Nile project also yielded evidence for Early Neolithic activity. Only five sites yielded Early Neolithic assemblages, of which only Hag Yusuf, Bir el Lahamda and Bashaqra Gharb were not contaminated by earlier occupation or by activity associated with subsequent Late Neolithic occupation. GS were recorded on seven sites, unfortunately, their total number (but not the total numbers for the individual types) are known only in the case of Sheikh el Amin, where there was a mixture of finds from the Mesolithic and Early Neolithic (see *above*). Of the five Early Neolithic sites, three assemblages contain not only grindstones, but also rubbers and stone rings. Apart from a mention of many cylindrical rubbers and many rings (and several stone axes) in the case of the site of Rabob, we lack any further information on their numbers. Dimensions of artefacts were not taken at any of the sites, but some of them can be deduced from the accompanying illustrations. We know from this work that the artefacts were mostly in a fragmentary state.

A detailed description and classification, combined with results of analyses of other categories of finds, was published for the Early Neolithic site of Kadero 1 (*Chłodnicki – Kobusiewicz – Kroeper /eds./ 2011*). It was possible to compare finds from the settlement assemblages from the so-called Middens (*Jórdeczka 2011*) and from the Neolithic cemetery (*Krzyżaniak 2011*). In addition to a detailed description of mace-heads and personal adornments (beads, pendants, labrets), which for the moment are not of interest in the context of the present study, this work contains a detailed description of GS (the author uses the term "stone implements"; *Jórdeczka 2011*). Besides determining the raw materials used and specifying the numbers for individual types and subtypes, this work is the first to reflect more closely on the technology used to manufacture GS. Individual types and subtypes are divided according to shapes, size, and the number and shaping of faces. *Jórdeczka* (*2011*, Table 2 and pages 303–310) classifies GS (and accompanies them with abundant drawn and photographic documentation) into ten basic types based on comparison with assemblages published earlier (*Tab. 2*).

The catalogue of grave goods from the cemetery (which is situated at the same location as the settlement) provides important information on the symbolic significance of GS. Basically, at this site the only type of GS that occur among grave goods (if we do not include malachite and ochre lumps, beads, and mace heads) are cosmetic palettes of two different shapes. Generally the palettes occur singly in grave pits, an exception being three pieces found in one grave, and they are only found in the graves of adult males and very small children (sex not indicated). They generally accompany other grave goods, namely pottery vessels, carnelian beads, mace-heads, and other lithics.

In his work, *Jórdeczka* (*2011*, 304) attempts to identify compatible tools, such as grinders and lower grindstones, or club-shaped pestles and spherical grinders associated with small deep mortars. He also interprets the function of tools based on macroscopic use-wear traces. However, at times he sticks to determinations of function based on subjective impressions, shape, and the tradition established by *Arkell* (*1949*; *1953*) or he employs traditional terms for the stone assemblage from the cemetery (for instance, the above-mentioned cosmetic palettes).

This overview of fundamental works that reflect current knowledge of GS in Sudan gives a good idea of (a) the way the individual types of GS have been classified over the course of time, and (b) the basic shapes of GS that occur in a specific chronological interval. The artefacts have always been classed according to the present shape of the piece after collection (for instance, rubbers that have already been used), location and curvature of active surfaces (e.g., grinders, grindstones), the occurrence of residues, as the case may be (ochre pigments on grinders), and more rarely according to the context (palettes as grave goods), analogies (stone rings, pestles), or use-wear traces (hammerstones). In the following section, we briefly extend this overview to include information on current studies of GS in Egypt.

2.2. A short reflection on GS classification in Egypt

Accounts of GS, or more extensive analyses of assemblages of GS, in the areas further downstream or to the west of the Nile may form part of reports on larger areas or on individual sites (e.g., *Wendorf /ed./ 1968*; *Wendorf – Schild – Close /eds./ 1989*; *1993*; *Wendorf – Schild /eds./ 2001*; *Barich et al. 2014*; *Holdaway – Wendrich /eds./ 2017*; *Shirai 2010*), but they also appear in specialised studies and chapters (*Banks 1982*; *Roubet 1989b*; *Schön – Holter 1990*; *Lucarini – Radini 2019*; *Lucarini 2014*). Of all the works stated above, we will focus our attention on those that can be used for description and subsequently for analyses of GS in central Sudan.

The first, specialised methodological work on the GS from the Late Palaeolithic and Neolithic sites in Wadi Kubbaniya (referred to as "grinding implements" in the work) was published by *K. M. Banks* (*1982*). Banks divided his observations of handstones and milling stones (his additional types include mortars and pestles) from several sites in Wadi Kubbaniya into a quantitative section (raw material, length, width, thickness, number of grinding surfaces, depth of the grinding surface), and a qualitative section (shape in plan, shape of the grinding surface, profile, direction of grinding, way of shaping). Banks also recorded the ratios of complete pieces and fragments. Written descriptions of the basic types of GS are supplemented by photographs.

C. Roubet published several chapters on grinding implements from Late Palaeolithic sites in Wadi Kubbaniya (*Roubet 1989a*; *1989b*; *1989c*). Roubet progresses in systematic steps – first and foremost she records traces of manufacture, then she notes the type of raw material, the form of the blank (semi-finished product), maximum dimensions, and dimensions of the grinding surface (*Roubet 1989a*). Subsequently she describes the characteristics of the shapes – sides, ends, and faces. Special attention is paid to traces of use that can facilitate the understanding of, for instance, the direction of grinding and other traces (polishing, grinding). She subsequently divides all of the artefacts into several series, based on whether these are passive or active tools and based on the shaping of the active surface.

Roubet tested the stated procedure using the example of the richest site in Wadi Kubbaniya, designated E-78-3, which yielded as many as 55 GS pieces (*Roubet 1989b*). She divided lower grinding stones (passive group) according to the maximum length (three groups), overall shape (seven groups), and then according to the shape of the base and curvature of the profile (three groups ranging from flat to concave). Active grinding and pounding tools were divided based on their functional surfaces (here she also interpreted chisels and picks), whereas handstones were divided on the basis of the number of working areas, overall shapes (5 groups), and the shape of the profile. In the conclusion to the chapter, Roubet establishes that these tools were used to crush, grind or reduce material to a powder and that those who used them utilized a combination of different pressures and rotation in their work. Roubet supplemented both afore-mentioned chapters with a detailed analyses of a workshop (E-82-1; *Roubet 1989c*) which provided evidence for the process of manufacture and apparently also for the distribution of lower stones (querns). The works by C. Roubet are inspiring and contribute important information on the economy and subsistence of the Late Palaeolithic. The problem with this classification system, however, lies in the fact that it involves overly detailed analyses of a maximum number of variables, which can be difficult when analysing assemblages as large as those in our region of central Sudan.

A similar approach was later adopted by *G. Lucarini* (*2014*) for the analyses of larger assemblages when he evaluated the collection of large stone tools from the Hidden Valley village and basin (Farafra Oasis). Lucarini recorded grinding equipment (grindstones), hammerstones and other tools, and worked with as many as several hundreds of pieces from the Hidden Valley basin. Having adapted the C. Roubet's classification system, he proceeded according to the same steps, with a technological section (including determination of raw materials and their provenance) followed by a typological section, describing morphological and formal characteristics of artefacts (in this work the individual types are presented using photographs). Lucarini classified artefacts based on shape; type of grinding surface (flat, concave, convex); size; alterations (traces of combustion, calcareous crust); and he attempted to trace macro-wear. With regard to the GS (these were mostly gathered by means of surface surveys) Lucarini notes that "use-wear analysis failed to provide significant results for much of the sample" (*Lucarini 2014*, 285). The results of his analyses provide information on the manufacture of grinding equipment that featured only occasional traces of flaking, on their size groups, and on the state of preservation. The work includes information on complete pieces and an overview of basic dimensions. However, types of GS other than the above-mentioned are not dealt with in the work.

Unfortunately, for the time being there is no study focusing on GS from the area of the Nile Delta or the Fayoum Oasis. Most of the prehistoric sites in these regions are associated with inter-war excavations by British or Austrian expeditions (e.g., *Shirai 2018*; *Krzyżaniak 1977*). Mace-heads and grinding tools made from diverse materials, and stone vessels and palettes have been found in Merimde Beni Salama contexts in the Nile Delta. *N. Shirai* (*2010*) evaluated various categories of finds from the Fayoum Oasis, but he states that in the case of GS it is impossible to differentiate between Epipaleolithic and Neolithic finds. At this site GS should include grinding lower troughs, flat upper grinders, palettes and hammerstones. At Kom W site in Fayoum L. Krzyżaniak records as many as 16 grinding troughs (with a concave face) and numerous grinders, as well as a considerable number of hammerstones (around 540), and axe-heads. Unfortunately, his work lacks more detailed information on dimensions (*Krzyżaniak 1977*). Shirai notes the occurrence of both unbroken and fragmented tools. Also, more recent excavation reports on the Fayoum Oasis refer to many milling tools, spatially associated with hearths (though not exclusively) of different dates (*Holdaway et al. 2016*; *Holdaway – Wendrich /eds./ 2017*). Grinding tools should be among finds from both the Early and Middle Holocene. They are found mainly in a fragmentary state (*Holdaway – Wendrich /eds./ 2017*, 46). Most references are to oval shapes, but rectangular forms with flat or concave faces also occur frequently (*Holdaway – Wendrich /eds./ 2017*, 73–74, 109–111). However, in the case of the last cited publication it is impossible to discern whether the tools in question were grinders, or also included querns, and the dimensions of the artefacts are not provided.

The GS from the Nile Delta also include oval quartz cobbles, 6–8 cm in length and 4–5 cm in width, that feature traces of use on the two shorter sides. According to N. Shirai, identical tools also occur at Merimde Beni Salama and El Omari, and they could have been associated with the production of lithics in later phases of occupation. Of particular interest are stone spheres made of sandstone or flint (apparently from the Neolithic; *Shirai 2010*, 274–275), similar to the ball-like artefacts from Sudan (see *above*). Unfortunately, none of the publications mentions their dimensions.

The GS found in Egypt have received somewhat more attention than those found in Sudan, particularly the most distinctive functional group, i.e. tools for grinding and milling. The publications commonly include total numbers of artefacts, their state of preservation (complete, or fragments), information on raw materials (and their provenance), and description of shapes. Written descriptions are usually accompanied by graphic documentation, including photographs. Nevertheless, the development of analytical classification systems and rigorous terminology has been very slow (*Lucarini 2014*, 285; *Roubet 1989a*, 470).

2.3. Summary of terminology and outline of further processing

As can be deduced from the overview above, there is quite a degree of variability in the use of terms for diverse GS shapes, which makes it difficult to compare them over a wider area. This variability can be the result of differing research traditions in the countries of origin of the researchers and of the relevant studies, but it is also likely that the comparatively low importance assigned to GS during the processing of large assemblages, with a predominance of so-called chipped (flaked) and other artefacts, also played a role. Before we proceed to the next sections of this work, it is necessary to clarify what artefacts we envisage under which terms (*Tab. 3*) and to outline how we shall proceed in our analyses. Furthermore, it ensues from the summary of diverse classifications of GS in Sudan that it is essential that we create a new, simple system, using clearly defined rules and incorporating references to graphic documentation. When it comes to analysing GS from surface collections, the issue of time plays a role, particularly in our case where it was necessary to evaluate large quantities of both fragmentary and whole pieces of GS in as short time as possible, following several days in the field.

Our procedure, which we have applied to the collections of GS from two sites in the western part of Jebel Sabaloka, will consist of the following:

All the GS described above will first be classified according to the intensity of reduction and **the methods of manufacture (shaping)**. In some items, the natural surface clearly predominates, with simple flaking being sufficient for their preparation. Various ***types*** of hammerstones typify this class. Other artefacts have retained a surface that is partly natural and partly chipped and ground (*Tab. 4*). Two types of **grinding-milling tools** (hereinafter designated "**GMT**") can be included within this class. It is known from previous works on GS that some tools operated in combination. This applies perhaps most markedly to GMTs which can be divided into two types according to the location and curvature of the working surface: *static (passive) tools*, which include **lower stones**, and *active tools*, with all **upper stones** falling into this type. The types can be further classified into **subtypes** according to the chosen morphometric criteria.

GS include other artefacts whose surfaces were intentionally shaped from the outset, with a clear notion of the resultant form; such items are most often ground and perforated by chipping and drilling. Stone **rings**

***Tab. 3.** Unification of terms of GS types. The types marked with an asterisk (*) are not within the scope of this study. Modified by J. Řídký. — **Tab. 3.** Sjednocení termínů pro GS. Typy označené hvězdičkou nejsou předmětem této práce. Upraveno J. Řídkým.*

Arkell 1949; 1953; Haaland 1981; Zarattini 1983; Caneva 1988; Marks and Mohammed-Ali 1991; Fernández et al. 2003; Jórdeczka 2011; Banks 1982; Roubet 1989a; Lucarini 2014	***Řídký et al.***
Large stone tools; Ground items; Ground stones; Stone implements; Grinding implements	General term: Ground stones -GS-
Milling tools; Grinding tools	Class: Grinding-milling tools -GMT-
Lower grindstones; Lower grinding stones; Milling stones; Lower grinders; Cosmetic palettes; Querns; Mortars; Grinding lower throughs	Type: Lower stones -L-
Upper grindstones; Upper grinding stones; Handstones; Grinders; Small grinders with dimples; Pitted stones; Ball-like artefacts	Type: Upper stones -U-
Stone rings; Rings	Class: Rings -R-
Rubbers; Grooved stones; Grooved artefacts	Class: Abraders -A-
Hammer stones; Polishing stones; Quartz smoothing stones; Pestles; Chisels	Hammerstones*
Celts	Axes*
Mace-heads	Mace-heads*
Beads; Pendants; Labrets	Personal adornments*
Fishing-line sinkers	Fishing-line sinkers*
Picks	Picks*
Red and yellow ochre; Hematite; Pencil	Pigments*

***Tab. 4.** Way of alteration of the main classes of GS, and their possible use. Function according to Arkell (1949; 1953); Haaland (1981); Magid (2003); Jórdeczka (2011); Lucarini (2014). — **Tab. 4.** Způsob tvarování artefaktů hlavních tříd GS a pravděpodobné využití jednotlivých tříd. Podle Arkella, Haalandové, Magida, Jórdeczky a Lucariniho.*

Body alteration	**Class**	**Possible use**
Partly natural, partly chipped and ground	Grinding-milling tools (L+U)	Milling of plant parts; grinding of pigments, clay
Chipped, ground and perforated	Rings	Part of digging stick; maybe status symbols
Abraded / ground	Abraders	Abrading of stone, bone and wood or other organic items; drilling; some shapes maybe pestle-like work

would fall into this class. The most problematic of the classes are items whose surfaces were almost completely ground, but at the same time it is not possible to determine whether this occurred during intentional shaping as in the former case, or whether it is the result of use. All of these morphologically variable items, manufactured exclusively from diverse sandstones, are classified as **abraders**.

Like J. Adams, we will begin our classification with the premise that "The shape of an artifact today does not always reflect its originally designed shape" (*Adams 2002*, 11). For this reason, it is necessary to evaluate differently the items with clearly identifiable original shapes and/or clearly identifiable working faces on the one hand and, on the other, items that were shaped only through their use. In the case of GMTs it is possible to identify not only the raw material and shaping technique, but also the method of their use (differentiation of faces, orientation and movement when in use, manner of grip, reduction of mass, macro-wear from use, etc.).

In contrast, in the case of the majority of abraders their shape is largely the result of their use. The only exceptions might be certain elongated objects with oval sections that could theoretically fulfil the function of pestles (e.g., *Jórdeczka 2011*, 309), but until systematic comparative analyses of use-wear traces are performed, their function as assessed on the basis of morphological analogies or purely subjective impressions cannot be considered as resolved. Abraders were tools used for reduction (shaping) of items made of organic materials (bone, wood, etc.) or of stone (axes/adzes and gouges). If the works mentioned in previous sections refer to abraders to at all, they are consistent in classifying them most frequently according to shape in plan (irregular/regular), shapes of longitudinal and transverse sections, and more rarely according to macroscopic use-wear traces (i.e., faces with grooves).

Hammerstones could be used to crush by impact or by the application of vertical pressure (pestle-like tools), but surprisingly, such objects are virtually absent in our assemblages from surface collections. Their possible use, for instance, in food preparation could be substituted in the given period by certain GMT upper stones. It is also possible that, instead of classic hammerstones (natural pebbles with a suitable shape), the manufacture of chipped (flaked) tools in the given time might have involved the use of the so-called pebble fabricators (*Arkell 1949*, 49) prepared from the same materials as the flaked (chipped) tools, i.e. red and grey rhyolite, and thus were not collected during our surface surveys which focused exclusively on certain raw materials. Given that our work focuses on items made from specific raw materials, we have chosen not include such fabricators in our discussion.

From the evidence presented in the studies mentioned above, it is possible to identify secondary use in the case of some GMTs; this is also an important variable, which can throw light, for instance, on the criteria governing the selection of raw materials and access to their sources. The degree of preservation can provide insights on the availability of suitable raw materials, on the disposal of waste, and on other behaviours of local communities.

As we have seen in the previous two chapters, the possibilities for numerical and metrical comparison of the GS assemblages from the Mesolithic and the Early Neolithic – i.e., comparison with individual groups of types or assessment of the degree of preservation of individual items – are quite limited in central Sudan. Using the available literature, in principle the most useful material (sometimes only providing us with basic information) concerns the assemblages from the "old excavations" at Khartoum Hospital and Esh Shaheinab (*Arkell 1949*; *1953*), and from El Geili (*Caneva 1988a*), and Kadero (*Jórdeczka 2011*). Other parts of Sudan or Egypt do not provide many collections for comparison either. Again, we can use the earlier excavations at Wadi Kubbaniya (*Roubet 1989a*; *1989b*; *1989c*), Tushka (*Wendorf /ed./ 1968*), and Nabta Playa (*Wendorf – Schild /eds./ 2001*). From more recent works, only the data from Hidden Valley in Farafra Oasis (*Lucarini 2014*) is of use to us here.

The publications that we have overviewed in this chapter provide diverse kinds of graphic documentation regarding GSs, ranging from realistic renderings to schematic drawings focused on technology, in some cases supplemented with photographs with a scale. For the purposes of this work, we have chosen the second option (*Fig. 10–14*). In this way it is possible to accentuate certain technological and morphological variables (for instance, location of faces, presence of notches, etc.) that we follow in our work, and at the same time to make comparisons with a proposed descriptive code created on the basis on earlier works and findings from the field (i.e., *Fig. 7*).

3. Study area and collections

Jebel Sabaloka is a mountain of volcanic origin situated in the geographic heart of Mesolithic and Neolithic settlement in central Sudan, ca. 80 km north of Khartoum. The dark, distinctly polygonal *jebel* rises above the surrounding plain to a height of ca. 50 to 100 m and constitutes a prominent morphological feature in the rather flat terrain characteristic of this part of the Sudan. The mass of the *jebel*, formed of tough, resistant volcanic rocks of the ring complex, is sliced in two unequal parts by the Nile (*Almond – Ahmed 1993*, 8). Before the Nile enters Jebel Sabaloka, the waters of the river divide into two branches that pass on either side of Rauwiyan Island (*Fig. 2*). The southern part of the island is dominated by the *mesa*-like Rauwiyan Mountain (594 m) the upper section of which is formed of strongly silicified Nubian sandstone. This Nubian outlier rests partly on the wide screen of Basement gneisses and partly on the intrusions of the ring-dyke suite (*Almond – Ahmed 1993*, 35). The Basement Complex and the ring dyke abound in a variety of hard rocks (mainly different types of rhyolite, basalt and granite) that, together with the silicified sandstone confined to the south-eastern side of the area, constitute good quality raw materials for the production of stone tools (*Fig. 2*).

3.1. Prehistoric settlement landscapes in the western part of Jebel Sabaloka

Since 2009, 32 sites of late prehistoric date have been identified in the western part of the mountain; some of these sites also contain evidence of human occupation during the Pleistocene and historical periods (*Suková – Cílek 2012*; *Suková – Varadzin 2012*; *Varadzinová et al. 2021*; *in press*). Of the Mesolithic and Early Neolithic sites, 30 are distributed in a distinct and coherent belt of occupations running along the north-western and south-western margin of the mountain, spanning **two ecological zones** of differing exploitation potential (*Fig. 2*).

The **Rocky Cities area** (15 sites) in the north-western periphery of the mountain is situated between 2.5 and 5 km from the Nile and is likely to have been dry savannah with limited water sources in the Early to Middle Holocene. The **Lake Basin area** (14 sites) to the south-west of the mountain is a low-lying zone no more than 1.7 km from the Nile. At the beginning of the Holocene this area was characterized by a more humid environment influenced by periodic flooding of the Nile (cf. *Williams et al. 2010*) and a higher level of groundwater, which gave rise to long vanished swamps and marshes. Most of the sites in these two zones are linked to granite outcrops that characterize the low-level desert around the periphery of the mountain. Another site – Jebel Umm Murahik – is situated on a granite knoll at the boundary between the Rocky Cities and the Lake Basin, *ca.* 3 km north-west of the Nile.

Evidence of Mesolithic occupation was found on 28 of the sites, of which 11 contain robust evidence and are likely to have served as settlement sites for some time in the past. The remaining 17 Mesolithic sites are made up of ephemeral sites and small scatters of artefacts (*Varadzinová et al. in press*). The Neolithic period is represented on 15 sites, none of which are situated in the Rocky Cities area. Neolithic finds occur at Jebel Umm Murahik and at every Mesolithic location and on two previously unoccupied sites in the Lake Basin (*Suková – Varadzin 2012*; *Varadzinová et al. in press*). There are only two significant Neolithic sites, both situated in the Lake Basin at locations marked by previous Mesolithic occupation. These diachronic trends in the settlement dynamics in this region, namely a decrease in settlement in the Neolithic period as compared with the Mesolithic, constitute a solid background for our investigation into continuities and discontinuities in subsistence strategies and other traits in the transition between the Mesolithic and the Early Neolithic.

3.2. The occurrence of GS in the study area

Finds of GS were localised during repeated large-scale surface prospections of the research area (2011–2019). Over the course of these campaigns, we recorded all visible movable and immovable archaeological remains (*Suková – Cílek 2012*; *Suková – Varadzin 2012*; *Varadzinová et al. 2021*). In 2019, a surface survey targeting GS was carried out on nine pre-selected late prehistoric occupation sites (*Fig. 2*). Apart from one site (Triple Hollow), all were found to contain at least two site areas delimited by formations of boulders and, with a single exception (Ridges situated in the plain), all are in elevated positions on granite hills or hillocks. Field research progressed by individual site areas. The surface survey was aimed at collecting larger stone artefacts made from

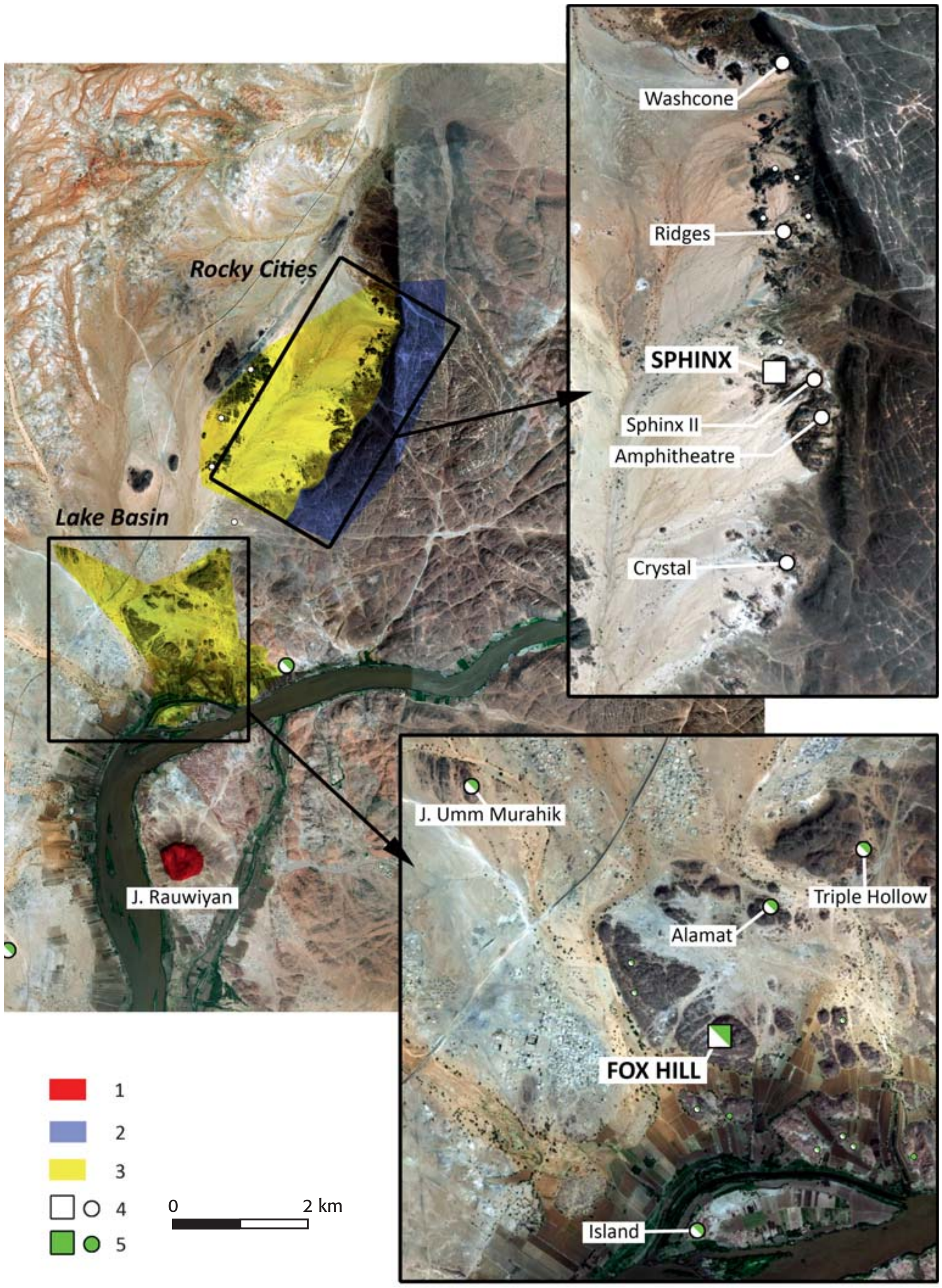


Fig. 2. *Jebel Sabaloka. The sites investigated for GS are indicated with their names.* ***1*** *– Highly silicified sandstones and gritstones at the top of Jebel Rauwiyan (after Almond – Ahmed 1993);* ***2*** *– Porphyry rhyolite;* ***3*** *– Granite;* ***4*** *– Mesolithic;* ***5*** *– Early Neolithic. Large square or circle – residential (settlement) site; small circle – ephemeral location or small scatter. Background: ESRI Base Map – World Imagery Source, Digital Globe (map). Redrawn by L. Varadzin. —* ***Obr. 2.*** *Sabaloka. Označeny jsou lokality s analyzovanými soubory GS.* ***1*** *– silicifikované pískovce ve svrchních partiích hory Rauwiján;* ***2*** *– porfyrický ryolit;* ***3*** *– žula;* ***4*** *– mezolit;* ***5*** *– časný neolit. Větší čtverec nebo kroužek značí větší sídliště; menší kroužek okrajové aktivity. Mapové podklady ESRI Base Map – World Imagery Source, Digital Globe (map). Upravil L. Varadzin.*

specific raw materials (with visible texture), exhibiting specific colours (from light grey through dark grey to reddish), and displaying ground surfaces. These surfaces could attest to shaping or could constitute faces caused by some activity. The presence/absence of morphometric categories was noted and the approximate number (singular finds, tens, high tens, more than one hundred of finds) of artefacts belonging to each category was estimated. In all or most areas of each site, we carried out a random collection of morphologically, but not quantitatively, representative finds numbering up to several tens of pieces per site area. These collections were photographed from two opposite sides and a record was made of their basic morphological and metrical attributes and the raw material used.

Finds of GS were recorded at three types of locations. The first includes **residential (settlement) sites**, of which 11 are confined to the foot of the mountain (*Fig. 2*). These sites are distinguished by surface occupational debris consisting of pottery, lithics, GS and, in some cases, faunal remains or other finds. Although the finds suggest that the sites were occupied at various periods, remains from the Mesolithic and, in several cases, the Early Neolithic always predominate or indicate a significant presence. Although the quantities of finds of GS at these locations vary, none of the settlements exhibit an over- or underrepresentation of these tools compared with other categories of finds. In our opinion this shows that the accumulation of GS was linked to the intensity and/or extended duration of occupation or use of these sites.

Site (areas)	Surveyed area (m²)	Main occupation	Ephemeral occupation	Noted densities of finds		Photographed and classified GS				
				Lower stones	Upper stones	Lower stones	Upper stones	Rings	Others	Total
Alamat	1507	MES	MSA, EN, UHP	x–xx	x–xx			2		2
Amphitheatre	6263	MES	UHP (burials)	xx	xx–xxx	83	130	12	1	227
Crystal	512	MES	MSA, UHP	x–xx	x–xx	2	2	2	1	7
Island	4715	MES, EN, LN, MER, PM	CP, IP, UHP	x–xx	x–xxx	6	25			31
Jebel Umm Murahik	9566	MES	EN, UHP (burials)	x–xx	x–xxx	42	64	10		114
Ridges	1237	MES	UHP	x	x–xx	8	41			49
Sphinx II	582	MES	UHP	xx	x	9	4			13
Triple Hollow	1635	MES	MSA, EN, UHP	xx	xx			4	3	7
Washcone	1112	MES	MSA, UHP	x–xx	x–xx	73	115	1		189
# Total	**27129**					**223**	**381**	**31**	**5**	**640**
% Total						**34,8%**	**59,5%**	**4,8%**	**0,8%**	**100%**

Tab. 5. *Residential sites surveyed for GS. Noted densities for lower and upper stones indicate their occurrence as singular finds (x), in tens (xx), or in hundreds (xxx). Exact numbers are given with random samples of photographed and classified finds (# pieces/whole artefacts). The proportional representation of the individual types need not reflect the reality. Key: CP – Christian period; EN – Early Neolithic period; IP – Islamic period; LN – Late Neolithic period; MER – Meroitic period; MES – Mesolithic period; MSA – Middle Stone Age; PM – Post-Meroitic period; UHP – Unspecified historical period. —* ***Tab. 5.*** *Rezidenční lokality, na nichž proběhly orientační povrchové sběry GS. Hrubé počty naznačují výskyt dolních a horních kamenů jako jednotlivých nálezů (x), nebo v desítkách (xx), či ve stovkách (xxx) nálezů. Přesná čísla jsou uváděna u vzorku fotografovaných a klasifikovaných nálezů. Podíl jednotlivých typů nemusí odrážet realitu.*

The second type of locations covers **ephemeral sites and small scatters** (n = 13). They are characterized by low numbers and densities of surface finds, and an absence or marked underrepresentation of lithics or pottery or both. The GS finds at these locations include upper stones, hammerstones, a few stone chips and, in some cases, fragments of lower stones. A number of these locations coincide with low, flat outcrops of granite whose surfaces bear numerous oval-shaped depressions. They are often located in the north-western and south-western foreland of the mountain in positions with better access to wadis and, hypothetically, also to sources of plant foods, compared with most of the settlement sites. We regard these locations with finds of GS as specialised grinding posts that were not used for settlement. The finds of GS from these locations number several dozen pieces at the most, with the number of upper stones being markedly higher than that of lower stones.

The third type of site corresponds to **locations with isolated finds of stone rings** dispersed loosely in the landscape and not associated with any other evidence of occupation, including temporary activities. Three locations of this kind, each featuring one specimen, were recorded. All three were confined to the Rocky Cities and, interestingly, two contained fragments of finished rings.

Eight of the locations surveyed for GS represent important Mesolithic settlements that also contain relics of ephemeral (i.e., evidently limited in terms of surface area and numbers of finds) occupation in historical periods. The ninth site, Island, features quantitatively more or less balanced traces of occupation (especially pottery) from the Mesolithic, Early and Late Neolithic (~3800–2700 cal BC), Late Meroitic (second–fourth centuries AD), and Post-Meroitic (fourth–sixth centuries AD) periods. According to our estimates made in the field, the number of GS on all of these settlements ranges from several hundreds to more than one thousand pieces per site.

Comparison with other categories of settlement finds further shows that the quantity of GS on the first eight sites correlates with the spatial extent and/or intensity of the Mesolithic occupation. In the case of Island, we did not discern any marked increase in numbers or any difference in the character of GS that might reflect occupation of the site in historical periods; therefore, we assume that here also most of the GS finds date to late prehistory.

On all of these sites, GS assemblages are entirely dominated by GMT. A random sample of photographed and morpho-functionally classified finds of GS that were left on site consists of 640 items, of which most are lower and upper stones of common shapes and raw materials (see *below* and *Tab. 5*). The rest of the sample is made up of fragments of stone rings (n = 31), three small stone spheres (balls), and two other pieces (pestle and palette?). On all of these sites we observed that the larger the dimensions of the original artefacts, the more fragmented the artefacts were (typically lower stones). All collections also included sandstone flakes attesting to local production or secondary modification of GS. In addition, semi-finished pieces of upper stones made of sandstone were identified at the site of Washcone.

3.3. Analysed assemblages

Another line of research was pursued on the two best explored late prehistoric settlements within the research area (see *Fig. 3*): **Sphinx** (SBK.W-60; in 2015) and **Fox Hill** (SBK.W-20; in 2019). On these two sites, systematic surface collection was carried out, lasting several days in each case. As in the surface collection conducted in the wider region, the systematic survey on these two sites focused on larger stone artefacts made from specific raw materials (with visible texture), exhibiting specific colours (from light grey through dark grey to reddish), and displaying ground surfaces.

The site of **Sphinx** extends over the summit and along the foot of a granite hill situated at the north-western periphery of Jebel Sabaloka, *ca.* 3.5 km from the Nile. It is one of the most significant late prehistoric sites in the Rocky Cities with evidence of very intensive Mesolithic occupation between 8200 and 5000 cal BC; part of the site was also used for a limited period as a hunter-gatherer burial ground (*Varadzinová –*

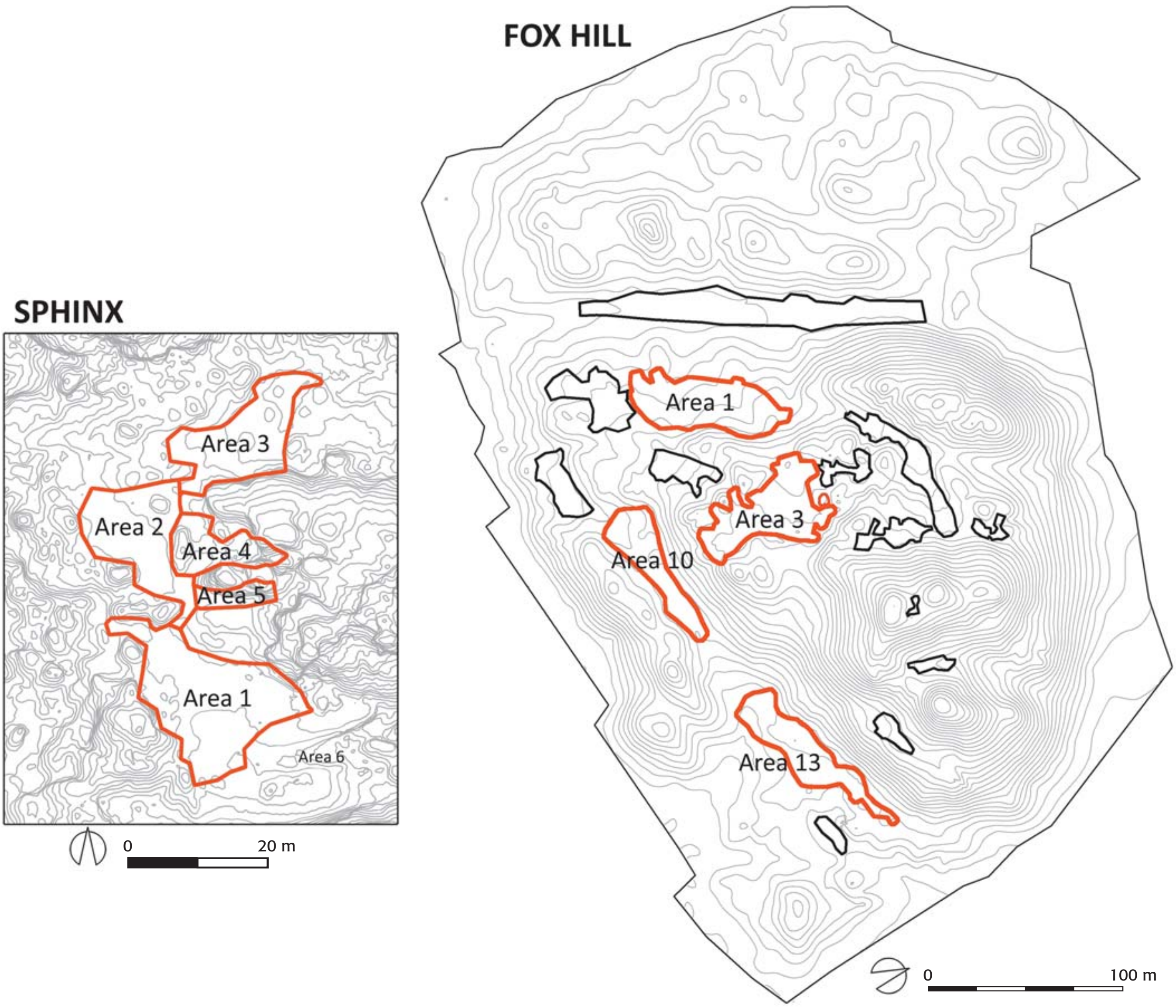


Fig. 3. *Sphinx (left) and Fox Hill (right). Explored areas. Background: after Varadzinová et al. 2018; in press. —* ***Obr. 3.*** *Lokality Sfinga (vlevo) a Liščí kopec (vpravo). Areály se sběry GS. Podle: Varadzinová et al. 2018; in press.*

Varadzin 2017; *Varadzinová et al. 2022*; *in press*). The site consists of a *Main Area* and three subsidiary areas. A detailed surface survey, focused on GS, was performed in the Main Area (792.1 m^2) which is situated *ca.* 15 m above the surrounding plain and which apparently constitutes the settlement core of the site. This area is characterised by a very dense concentration of surface finds (pottery fragments, lithics, GS, faunal remains and other finds) accumulated on the present surface as a consequence of aeolian reduction, erosion and deflation of archaeological soils by as much as 90 cm compared with the former level of the terrain (*Varadzinová Suková et al. 2015*).

In 2015, GS were collected from the entire Main Area over nine days with the aim of obtaining a comprehensive sample of surface finds. The finds from five areas (southern, central, and northern platforms, and northern and southern shelters – in this work Areas 1–5; *Fig. 3*) were registered and documented. The classification and documentation of artefacts was performed by one person over the course of three days (*Fig. 4*). Selected finds were then transferred to the base camp where additional documentation and description were carried out. The initial results of the study of these finds were published in 2017 (*Řídký 2017*). We have been able to build on this work as it verified, inter alia, that the morphometric ratio of artefacts on the surface of the site corresponds to the representation of GS in the archaeological deposits uncovered in a series of test trenches.

The site of **Fox Hill** (ca. 4.1 km south-west of Sphinx) is located on a large granite hill at the south-western foot

Fig. 4. *Field classification of GS at Sphinx (Area 1). Photo: L. Varadzin. —* ***Obr. 4.*** *Průběh zpracování GS na lokalitě Sfinga (Areál 1). Foto: L. Varadzin.*

of Jebel Sabaloka, *ca.* 1.1 km from the Nile. It represents the most important late prehistoric location in the Lake Basin. The site consists of 16 geomorphologically delimited site areas (in this work Areas 1–16; *Fig. 3*) that are situated between 3 and 24 m above the surrounding plain and measure 11648 m² in total. Field research carried out here since 2011 has shown that the principal occupation of this site falls within the Mesolithic and Early Neolithic with both periods represented by abundant settlement remains and human burials (*Suková – Varadzin 2012*; *Varadzinová – Varadzin 2020*; *Varadzinová et al. 2022*; *in press*).

Surface collection of GS focused on the largest Areas, namely 1, 3, 10 and 13, which yield the greatest quantities of surface finds and where the immense surface concentrations of occupational debris were reminiscent of the situation on Sphinx (*Fig. 3*). Just as on the latter site, these concentrations accumulated as a consequence of erosion and deflation of late prehistoric levels (e.g., *Varadzinová et al. 2018*). The field research was carried out over seven days in March 2019 (see *Varadzinová et al. 2021*). Owing to the extent of the areas it was not possible to perform a total collection of GS as was the case at Sphinx. Surface collection in Areas 1 (1756 m²) and 3 (1669 m²) was performed over roughly three days by one person who walked along the long axis of the platforms repeatedly in a zig-zag manner. A further two days were devoted to classification and description of the artefacts on site. Assemblages from Areas 10 (1028 m²) and 13 (1311 m²) were collected by two persons over the course of one day. Classification and description of the artefacts took a further two days. Selected finds from the site were transferred to the base camp to be photographed, drawn and recorded in greater detail.

In the next section we will consider a total of 1357 artefacts (526 kg) from both sites. The finds of GS from Sphinx and Fox Hill were only evaluated macroscopically. We recorded the raw material, shape, and weight of the artefacts. The finds were classified according to their state of preservation and the preserved portion is specified. Morphometric analysis focused on recording the general shape, method of shaping, and size of the artefact, outlines of the use surfaces, macroscopically observable use-wear traces, secondary modifications (including pecking – rejuvenation of active surfaces) and traces of destruction (impact points; bulbs). With selected collections or individual specimens (but always only with completely preserved finds) the tools were measured and drawn in longitudinal and transverse section. Acquired data were entered into a database and drawings and photographs were used to build up a documentation archive.

4. Results

The number of GS from the Mesolithic site at Sphinx amounts to 485 (251 kg) artefacts (GMT = 480; rings = 2; abraders = 3), while the number from the Mesolithic-Early Neolithic of Fox Hill site is 872 (275 kg) artefacts (GMT = 835; rings = 13; abraders = 24). The artefacts were evaluated based on raw materials (section 4.1); technological stages (section 4.2); typology – morphometric criteria according to shape and outlines of both sections (section 4.3); secondary use (section 4.4); and state of preservation (section 4.5). In the description we use the same anatomical terms as *Wright* (*1992*, 58, Fig. 2). Metric variables are indicated in *Fig. 6*.

4.1. Raw materials

The production of GS found at Sphinx and Fox Hill made use of three basic raw materials that differ in structure, cleavage, and provenance (see *Fig. 2*). They

Fig. 5. *Fox Hill. Pieces of quartzites-sandstones of varying texture and colour from Areas 3 (**1**) and 10 (**2**). Photo: J. Řídký. —* ***Obr. 5.*** *Liščí kopec. Kusy nelokálních surovin křemenců-pískovců různé zrnitosti a barev z Areálů 3 (**1**) a 10 (**2**). Foto: J. Řídký.*

Site	Total	Granite (%)	Porphyry rhyolite (%)	Quartzite-sandstone (%)
Sphinx	485	9 (1.9)	18 (3.7)	458 (94.4)
Fox Hill	872	0	5 (0.6)	867 (99.4)
Total	**1357**	**9 (0.7)**	**23 (1.7)**	**1325 (97.6)**

Tab. 6. *Representation of individual stone raw materials in both assemblages. All GS (roughouts, indeterminable) included. —* ***Tab. 6.*** *Výskyt hlavních kamenných surovin v obou souborech. Zahrnuty všechny nálezy, včetně neurčitelných tvarů a polotovarů.*

Site	Final GMT	GMT roughouts
Sphinx	475	5
Fox Hill	827	8
Total	**1302**	**13**

Tab. 7. *Occurrence of technological stages of GMT. —* ***Tab. 7.*** *Výskyt výrobních kategorií GMT – dolních i horních kamenů.*

include granite, porphyry rhyolite and various quartzites-sandstones; the latter can be subdivided into conglomerates and silicified sandstones of various colours (including reddish ferruginous sandstones). Of importance is the varied quality of the raw materials which facilitated the shaping of the tools but at the same time may have limited the length of time for which the tools could be used for their original purpose.

From a qualitative point of view, granites are the poorest raw material for producing GS as they have the worst cleavage and can be worked only through rough battering. Porphyry rhyolites are of slightly better quality, and the varied quartzites-sandstones are the best for shaping (fine battering, grinding). On the other hand, the latter are the softest and the most brittle raw material and are liable to the fastest reduction of mass during frequent use of the tools.

While granite constitutes the geological foundation of both sites and is available in at least two varieties in the western part of Jebel Sabaloka (mica-granite in the Rocky Cities, microgranite in the Lake Basin; *Almond – Ahmed 1993*), porphyry rhyolites show a more localised distribution in the Rocky Cities, where they are found at the edge of the mountain in the vicinity of Sphinx and at other settlements in this zone. Unlike these locally available rocks, the sources of quartzites-sandstones are confined to the area of Jebel Rauwiyan located only 3 km from Fox Hill and 7 km from Sphinx but separated from both sites by the barrier of the Nile. Quality sandstones from Jebel Rauwiyan were also used for manufacturing GS in more recent times (*Arkell 1953*).

Comparison of both sites (*Tab. 6*) shows an absolute predominance of quartzites-sandstones (97%) in the production of GS. As we shall see below, the absolute majority of these items is made up of mere fragments of the original tools, which reflects the rapid wear of these sedimentary raw materials.

4.2. Technological stages

In addition to used tools, which prevail on both sites, the sites in Jebel Sabaloka feature production waste of various undeterminable items in the form of pieces of quartzite-sandstone raw material, flakes of various sizes and GMT blanks (semi-finished products) (*Fig. 5: 1–2*). Although production waste, such as flakes and pieces of raw material, was not quantified during the survey, no area featured these finds in such marked quantities or concentrations that they might indicate the presence of specialised workshops for the communities or groups in a broader region.

Technological stages could only be evaluated in more detail in the case of GMT. Used tools overwhelmingly predominate on both sites, while blanks occur rather sporadically representing only 1.2% of both assemblages combined (*Tab. 7*).

4.3. Morphometric types of artefacts, their use and distribution

Before we describe the individual morphometric classes of GS from the two sites, it is important to outline several important limitations that may significantly influence the identification, classification and especially the comparison of the proportions of the types in the assemblages:

– We must bear in mind that in later periods certain artefacts may have been intentionally sought out, both for purely utilitarian reasons (e.g., GMT; *Caneva /ed./ 1988*, 141; *Jórdeczka 2011*, 302) and because of their eye-catching shapes (e.g., rings; *Arkell 1949*, 63). Therefore, the results of the comparative analyses of the representation and frequency of the various morphological types at the sites must be taken with a degree of caution.

– We classified the artefacts according to their outlines in plan (planar view of the face) and in both sections (longitudinal and transverse). We have not per-

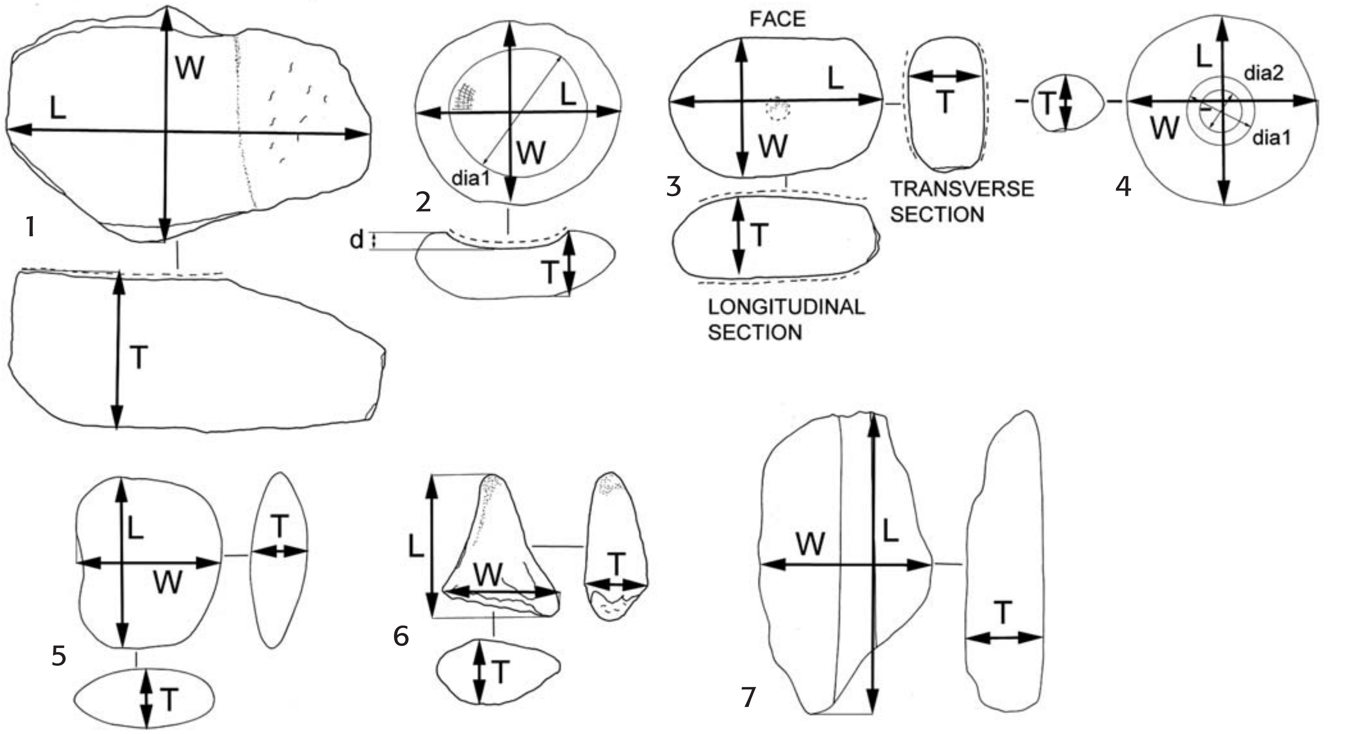


Fig. 6. *Metric variables.* ***L*** *– max. length;* ***W*** *– max. width;* ***T*** *– max. thickness;* ***d*** *– max. depth of the basin;* ***dia1*** *– diameter of the basin (in the case of lower stones) or greater diameter of the drilled hole;* ***dia2*** *– smaller diameter of the drilled hole.* ***1–2*** *– Lower stones;* ***3*** *– Upper stone;* ***4*** *– Ring;* ***5–7*** *– Abraders. Dashed lines show the position of the faces. Modified after Wright 1992. Modified by J. Řídký. —* ***Obr. 6.*** *Sledované metrické údaje.* ***L*** *– max. délka;* ***W*** *– max. šířka;* ***T*** *– max. tloušťka;* ***d*** *– max. hloubka dna;* ***dia1*** *– průměr prohlubně (v případě dolních kamenů) nebo větší průměr vrtání;* ***dia2*** *– menší průměr vrtání.* ***1–2*** *– dolní kameny;* ***3*** *– horní kámen;* ***4*** *– vrtaný disk;* ***5–7*** *– brousky. Přerušované linie zdůrazňují pozici aktivních ploch GMT. Upraveno podle Wright 1992. Úprava: J. Řídký.*

formed comparative analyses of micro-traces that occurred after the manufacture and use. Sometimes, we are not able to distinguish between traces caused by shaping and traces caused by use.

– All of the artefacts derive from redeposited contexts (surface finds, spanning three or more millennia), and thus we lack contextual information (place of use, combination with other tools, etc.) relating to the possible function of the tools.

The anatomical terms and metric variables that are used in this study are indicated in *Fig. 6–9*. As mentioned above, while it is possible in the case of GMT (both lower and upper stones) and rings to determine or roughly estimate their original shape upon manufacture, the same is not true for abraders. With used GMT, therefore, we will assess the face (F), the original shape of the body (*Fig. 7*), and the outlines of the longitudinal (LS) and transverse sections (TS) separately for lower stones (L) and upper stones (U). In the case of rings (R; *Fig. 8*), it is possible to determine, or at least guess, their view in plan and to observe the outline of their transverse section. Unfortunately, we do not know whether some of the biconical holes were intentionally ground during the manufacture of the tools, or whether they are a consequence of their use (for instance as weights on digging sticks). With abraders (A; *Fig. 9*), their entire body was worked. Thus, their shape is probably the result of their use; for this reason, we differentiate abraders according to the basic outline (irregular/regular) of the plan and both sections.

Three basic classes, namely grinding-milling tools (GMT), rings (R), and abraders (A), which are sub-divided according to their method of manufacture, were classified differently for the above reasons, following specially created descriptive systems (*Figures 6–9*) and specific recording procedures (*Figures 10–16*).

CLASS: GRINDING-MILLING TOOLS (GMT)

Type: Lower stones (L) of grinding-milling tool sets

These are passive, portable tools which faced upwards while being used. They may differ from each other in their method of manufacture, in the outline shape of the tool in plan (front view of the face; *Fig. 7: I*), which is the first step in their classification, in the shape and position of the face/faces in plan (*Fig. 7: II. F*), in the outline of the longitudinal (*Fig. 7: II. LS*) and transverse (*Fig. 7: II. TS*) sections, in the number of faces, and in their dimensions.

System of description:

I. Form of the tool

A: Three basic *methods of production* and *shaping* of lower stones have been recorded:

1) rough chipping into a desired shape, in cases where the natural flat surfaces of the raw material (in the form of natural blocks) could be used for the face and for the dorsal side of the tool (*Fig. 10*);

2) careful fine chipping, combined with grinding (*Fig. 11*);

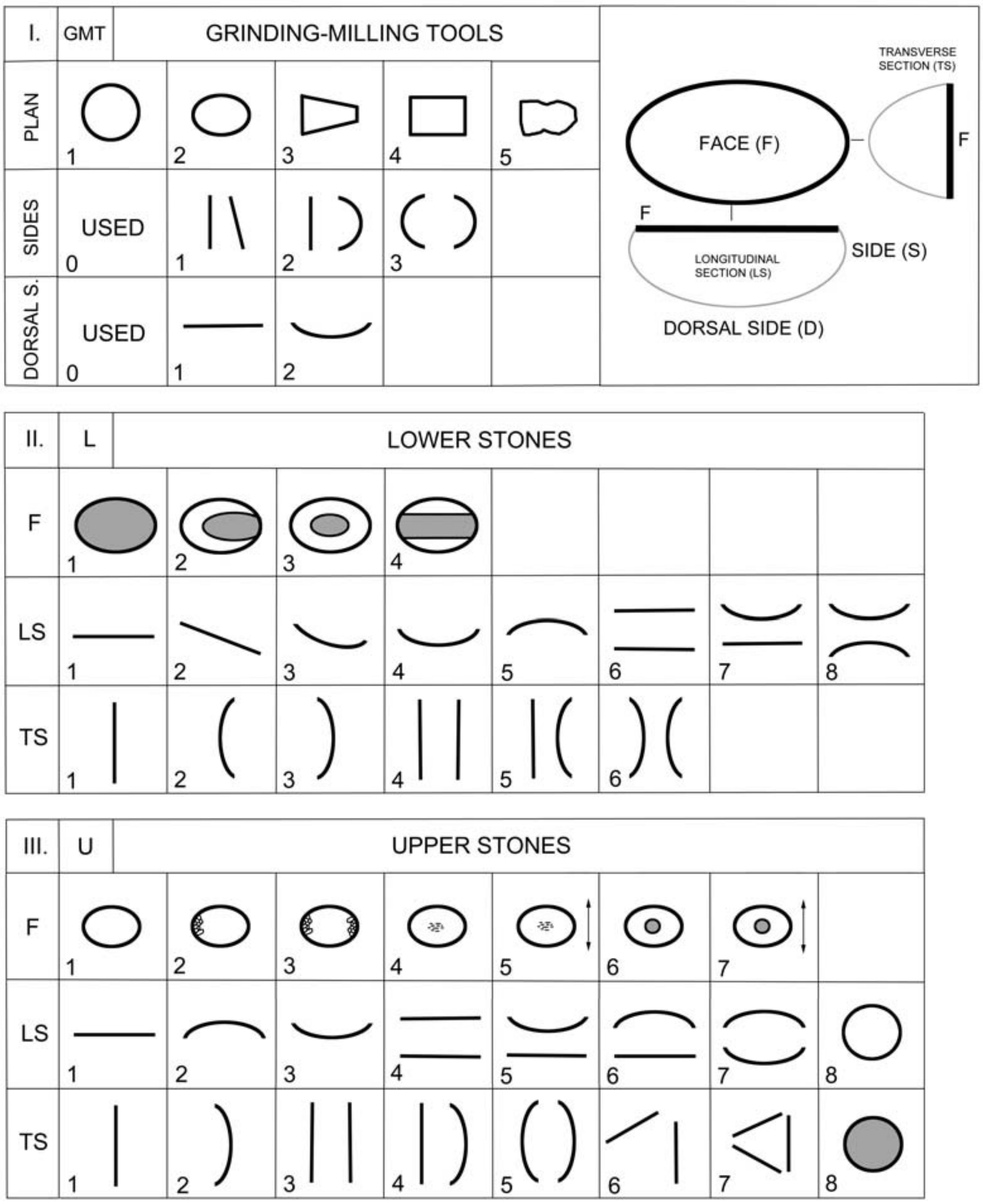


Fig. 7. Description system for GMT. ***I.*** description of the form. "0-Used" means that this part of the body is not a result of deliberate shaping, but rather its face (active part). All GMT documented in Figures 12–14 follow the position of the faces as proposed in this figure. ***II.*** Lower stones (L). Description of the positions of faces (F) and outlines of longitudinal (LS) and transverse (TS) sections. ***III.*** Upper stones (U). Description of other traces on the faces (F) and outlines of longitudinal (LS) and transverse (TS) sections. With F, 1 means the whole face was used for grinding; 2–3: chipped sides, one or both; 4–5: notches in central part, on one or both (No. 5) opposite faces; 6–7: circular depression on one or both (No. 7) opposite faces. With LS, 8 means the tool was used around the perimeter. With TS, 8 means the whole body was used. Typology after J. Řídký. — ***Obr. 7.*** Popisný systém GMT. ***I.*** Popis tvarů. „0 – Used" znamená, že se nejedná o záměrně tvarovanou část, ale o aktivní plochu nástroje. Všechny artefakty GMT na obr. 12–14 zobrazují aktivní plochy ve stejných pozicích jako na tomto obrázku. ***II.*** Spodní kameny (L). Pozice aktivních ploch v nárysu (F) a v křivkách podélných (LS) a příčných (TS) řezů. ***III.*** Horní kameny (U). Popis dalších stop použití na nárysech (F) a polohy aktivních ploch na podélných (LS) a příčných (TS) řezech. V řádku F – 1 znamená, že celý povrch artefaktu (např. u koulí typu US) byl využit pro drcení-mletí; 2–3: výskyt štípání, na jedné nebo obou kratších částech; 4–5: záseky v centrální části, na jedné nebo na obou protilehlých plochách; 6–7: okrouhlá prohlubeň v centrální části na jedné nebo na obou protilehlých plochách. V řádku LS – č. 8 znamená, že nástroj byl používán (a nese stopy využití) po celém obvodu. V řádku TS – č. 8 znamená, že bylo používáno celé tělo (celý povrch) nástroje. Typologie podle J. Řídkého.

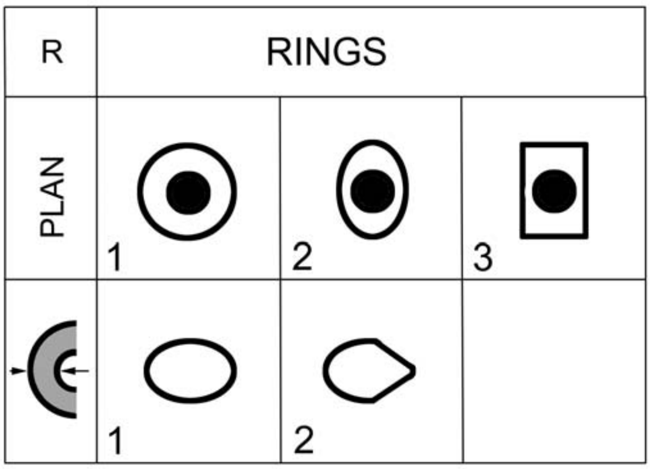


Fig. 8. Description system for rings (R). Outline of the plan view and cross-section: round (**1**) or sharp (**2**). Typology after J. Řídký. — ***Obr. 8.*** Popisný systém vrtaných disků (R). Obrysová křivka v nárysu a oválné (ohlazené) řezy (**1**), nebo ostré (**2**) řezy v důsledku bikónické perforace. Typologie podle J. Řídkého.

3) secondary use of other tools, already ground, such as upper stones (*Fig. 11: 5*).

B: The *outline shape* of the tool *in plan* (*Fig. 7: I*) may be:
1) regular circular;
2) regular oval;
3) regular trapezoidal;
4) regular rectangular;
5) irregular, with the tool only roughly chipped into a sort of triangular to more-less oval shape.

C: The curve of the *sides* (*Fig. 7: I*) may be:
0) modified through use, it is actually the face (active surface);
1) perpendicular or oblique to the dorsal side, achieved through a forceful blow with a hammerstone;
2) combined perpendicular and rounded;
3) rounded resulting from intentional grinding.

D: In both sections, a tool may also differ in the *curve of the dorsal side*, which may be:
0) used, it is actually the face (active part);

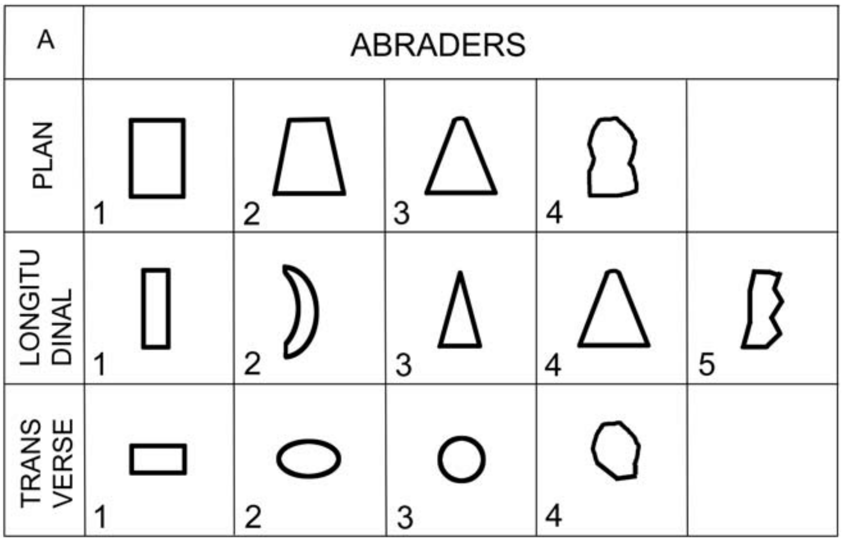


Fig. 9. *Description system of abraders (A), of their plan view and both sections. Typology after J. Řídký —* ***Obr. 9.*** *Popisný systém tvarů brousků (A), v pohledu v nárysu a v obou hlavních řezech. Typologie podle J. Řídkého.*

1) straight, more-or-less parallel with the face, achieved casually through exploitation of a natural nodule (bedrock block), or intentionally modified for the purposes of making the tool more stable;

2) convex, either thanks to the original natural shape of the nodule (pebble – cobble – boulder), or as a consequence of the secondary use of an already shaped upper stone. The convex shape could also be the intention of the producer, whether for a better grip in hand (rather small tools), for easier fixing in a soft surface, or to allow diverse positioning (supporting) of the tool during milling.

II. Faces of the tool

E: *In plan*, the *face* may (*Fig. 7: II. F*):

1) occupy the entire face part of the tool;

2) cover only a certain part of the tool;

3) be mostly oval or circular, is at some distance from the edge of the tool;

4) constitute the so-called open-trough form – longitudinally, the face extends to the edges of the working part, transversely the outline of the face is at some distance from the edge.

F: *In longitudinal section*, the face (faces) may be (*Fig. 7: II. LS*):

1) straight as compared with the dorsal side;

2) oblique;

3) irregularly concave;

4) concave;

5) convex;

6–8) combinations of the above on both opposite sides.

G: *In transverse section*, the face (faces) may be (*Fig. 7: II. TS*):

1) straight in comparison to the dorsal side;

2) concave;

3) convex;

4–6) combinations of the above on both opposite sides.

H: As to the *number of faces*, our assemblages contain lower stones:

1) with only one face;

2) with two faces opposed;

3) theoretically, there can be more than two faces.

Possible subtypes of lower stones

All of the works referred to in Section 2 repeatedly mention the absence (or low representation) of complete lower stones in GS assemblages. At the same time, it is only in the case of complete pieces that it is possible to compare the tools and classify them based on shapes and dimensions. In the two assemblages being considered together here, complete pieces are again rare; they equate to mere 4% of all lower stones. In the first phase of classification, it is possible to compare (i) the occurrence of lower stones according to the number of faces, and (ii) the ratios of lower stones for which flat (straight) and concave faces have been identified (*Tab. 8*). We will now look at specific types.

As far as we could determine, most lower stones feature only one face with only ten stones (1.9%) having two opposed faces. There are no tools with more than two faces. It follows from the same table that flat (straight) outlines of longitudinal section are present in 24% of all determinable lower stones. Thus, lower stones with concave faces of several variants consistently predominate on both sites.

Based on the above-mentioned variables the lower stones may be divided into several morphometric groups (*Tab. 13–14*), with the main criteria of classification including the shape in plan of the face side, the shape of the body, the way the face (faces) have been reduced, and sometimes also dimensions. Comparison of the assemblages from both sites will follow our presentation of the individual types.

As regards the description, for instance, the lower stone from our assemblages, depicted in *Fig. 12: 2*, can also be described using a code, GMTL-311/111, which indicates that this is a grinding-milling tool (GMT), of lower stone type (L), of trapezoidal shape (*Fig. 7: I, Plan 3*), roughly battered with straight sides (*Fig. 7: I, Sides 1*) and a straight dorsal side (*Fig. 7: Dorsal s. 1*), it has a single face (*Fig. 7: II. F 1*) and that face is flat in longitudinal section (*Fig. 7: II. LS 1*) and flat in transverse section (*Fig. 7: II. TS1*).

Fig. 10. *Lower stones of LF subtype.* ***1–2*** *– Sphinx;* ***3–4*** *– Fox Hill. Photo: J. Řídký. —* ***Obr. 10.*** *Dolní kameny podtypu LF.* ***1–2*** *– Sfinga;* ***3–4*** *– Liščí kopec. Foto: J. Řídký.*

Subtype: Lower flat (LF)

These tools were made from porphyry rhyolite, granite, and sandstones of poorer quality. Lower flat subtypes are relatively massive and, in many cases, heavy. They bear comparatively little wear and tend to be well preserved. They are characterised by a trapezoidal to irregularly square and irregularly oval outline of the face side (*Fig. 10* and *Fig. 12*). The sides and dorsal sides are roughly shaped by chipping. The dorsal sides are flat and respect the natural tabular form of the raw material and the way that it was detached from an outcrop.

The face covers more or less the entire face part of the tool and, in longitudinal section, is either parallel with the flat bottom or slightly bevelled. At first sight, the faces of these tools are flat, or slightly concave in only one section, mostly the transverse, as far as we could determine (*Fig. 12: 1–2*). Use-wear traces visible on the finds by the naked eye (striations) indicate that the lower flat types were used predominantly for multi-directional grinding using upper stones with a flat or slightly convex active area. Remains of pecking (rejuvenation of the face) were noted on some specimens.

All in all, the lower flat subtypes (codes GMTL-211/111; GMTL-311/111; GMTL-210/164; GMTL-410/164) can be characterised as multi-purpose querns with low acquisition costs. During grinding, some kind of support was probably necessary to collect the ground products as they fell off the working part. Their shape and weight made these tools portable, but, in many cases, they were obviously not moved often nor were they moved over great distances. The shape of the dorsal side indicates that when in use they were placed on the ground or another stable base, supported where necessary. Dimensions were recorded for 13 finds which are considered to be complete. They measure 10.2–37.0 cm in length (Mean = 18.8 cm; Median = 17.0 cm), 7.2–31.5 cm in width (Mean = 13.7 cm; Median = 12.5 cm), and 3.4–9.2 cm in thickness (Mean = 6.1 cm; Median = 5.9 cm). They weigh 0.371–17.6 kg (Mean = 3.156 kg; Median = 2.005 kg).

Subtype: Lower basin (LB)

These lower stones differ from the previous type in terms of their body shape, which is mostly regular, oval to circular, and the raw material used, which mostly consists of several types of quartzites-sandstones. The bodies of these lower basin types are carefully modelled by fine chipping and/or grinding, which is made possible by the specific use of rocks of sedimentary origin (*Fig. 11*). These subtypes also differ from lower flat types in the face is concave (basin-like) in shape in both sections. Synthesis of the data collected in the field has made it possible to identify four subgroups.

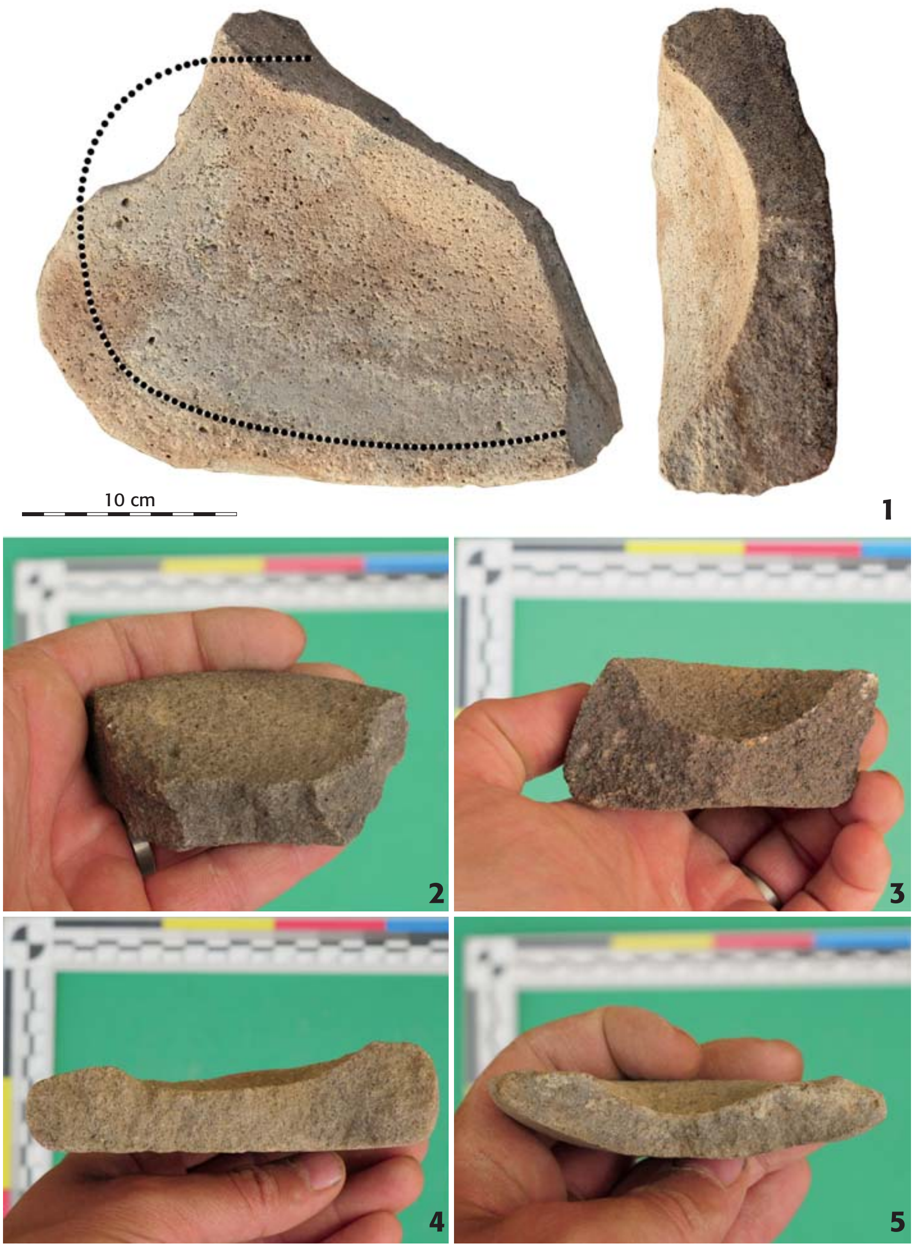


Fig. 11. Lower stones of LB subtype. **1** – Amphitheatre; **2–5** – Fox Hill. Photo: L. Varadzin (**1**) and J. Řídký (**2–5**).— ***Obr. 11.*** Dolní kameny podtypu LB. **1** – Amfiteátr; **2–5** – Liščí kopec. Foto: L. Varadzin (1) a J. Řídký (**2–5**).

Lower basin subtype 1 (LB 1)

In plan these tools are elongated, oval to irregularly oval in shape (*Fig. 11: 1*; *13: 2, 7*). The dorsal side of the tool is usually flat or just slightly convex. The face is oval in plan; in longitudinal section it is flat near the edges and drops into a concave shape at some distance from the edge (see *Fig. 7: II. F 2–3*). With some tools of this type and particularly those made from soft raw materials, it is possible that the entire working part was initially flat, just as with the former type, and that the depression or basin was created through use over time. The reduction of the mass in the distal part of the tool during use could be so pronounced as to require re-shaping (*Fig. 13: 2, 7*). The shape of the dorsal side suggests that the tools were placed on the ground or another solid base when in use.

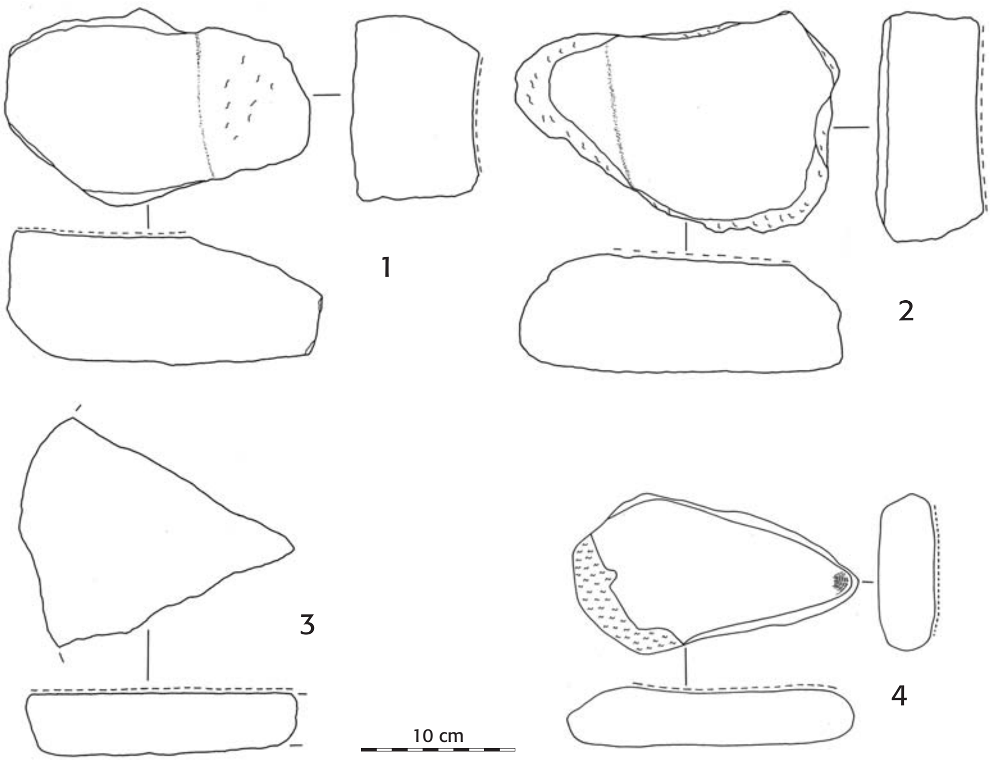
These tools (codes GMTL-231/232; GMTL-230/275; GMTL-230/286) were adapted to grinding in a reciprocal motion using a convex-faced upper stone. Interestingly, the faces of these tools are virtually identical to the oval-shaped bedrock features found on many prehistoric sites in Jebel Sabaloka.

Lower basin subtype 2 (LB 2)

These tools are more or less circular in plan and their dorsal side is rounded (*Fig. 11: 5*). They differ from the previous type in terms of the position of the face and the outlines of both sections (GMTL-132/142); specifically, the sides of the tool are rounded and merge directly into the rounded dorsal side. The overall shape of the tool is thus reminiscent of pottery bowls (*Fig. 13: 1, 3*), even when only fragmentary finds of rims have been preserved (*Fig. 13: 3, 8*).

It is unlikely that such a profile could form solely as a consequence of use, as with lower basin subtype 1. This is confirmed by the discovery of an almost unused

__Fig. 12.__ Lower stones of LF subtype. __1–3__ – Sphinx; __4__ – Fox Hill. Dashed lines show position of the faces. Drawing: J. Řídký — __Obr. 12.__ Dolní kameny podtypu LF. __1–3__ – Sfinga; __4__ – Liščí kopec. Přerušovaná linie vyznačuje pozici aktivních ploch. Kresba: J. Řídký.



Site	LS1	LS4	LS6	LS7	LS8
Sphinx	43	228	2	1	0
Fox Hill	72	165	5	0	2
Total	**115**	**393**	**7**	**1**	**2**

__Tab. 8.__ Occurrence of different outlines of identified longitudinal sections (LS) on lower stones at Sphinx and Fox Hill. For LS codes see Figure 7: II. LS6–LS8 are tools with two opposite faces. — __Tab. 8.__ Výskyt různých křivek podélných řezů (LS) u dolních kamenů na Sfinze a Liščím kopci. Pro kódy využité pro LS viz obr. 7: II. LS6–LS8 jsou nástroje se dvěma protilehlými aktivními plochami.

specimen of a lower stone with distinct surface concavity in a Late Neolithic grave in El-Geili (*Caneva 1988b*, 171, Fig. 9: a). It is thus very likely that these artefacts had a predetermined design from the outset. Assuming that artefacts of this type were indeed used for grinding, we can envisage their being used with a compatible handstone wielded in a circular motion. The bowl-like shape of the bottom was suited to being embedded in loose material or held in hand; alternatively, stones or other material could be used to keep it inclined as desired.

Lower basin subtype 3 (LB 3)

This subtype closely resembles the previous group of finds in terms of raw materials, shape, and the careful working of the tools. However, they differ from it with their straight dorsal sides, greater height of body (the thickness T is greater than the length L) and the more pronounced concavity of the face in both sections (code GMTL-131/342); in addition they generally have smaller dimensions as if they were designed to fit in one hand (*Fig. 11: 2–3*).

These tools could probably only be effectively used in combination with elongated rounded tools (made of wood, bone, or stone), so we can cautiously describe them as "mortars". They were adapted to process smaller quantities of substances, the crushing of which required the application of greater pressure in a circular motion on a smaller area. Analogous finds have previously been reported from the Neolithic site of Kadero (*Jórdeczka 2011*, 317, Photo 1: 3, 5). A similar tool used by today's agro-pastoralists in the Butana Desert (Sudan) is depicted by *Jórdeczka* (*2011*, Photo 1: 6), but the substances it is used to process are not mentioned.

Lower basin subtype 4 (LB 4)

These tools are circular to oval in plan and have a flat or rounded dorsal side; their face can be similar to previous subtypes (codes GMTL-230/465; GMTL-130/375). We separate them from the above-mentioned types on the basis of their smaller dimensions and sometimes also the methods used in their manufacture; in some cases they were produced from secondarily modified upper stones (*Fig. 11: 4*; *13: 5–6*). They are also known from other Mesolithic and Neolithic sites in Sudan (e.g., *Arkell 1949*, Plate 45: 1–2; *1953*, 43, Fig. 10; *Jórdeczka 2011*, 303).

Dimensions of the lower basin subtypes

The only perhaps complete GMT of lower basin subtype 1 from Sphinx was 25 cm in length, 23 cm in width, and 6.1 cm in thickness. It weighed 4.05 kg. Two complete no. 4 subtypes measured 11.0–12.0 cm in length, 10.0–10.5 cm in width, 3.8–4.0 cm in thickness (depth of basin 1 cm), and they weighed 0.35–0.66 kg. The depth of the basin (marked as "d" in *Fig. 6*) was recorded tentatively for 19 morphologically indeterminable lower basin subtype fragments from Sphinx. It varied from 0.4 to 3.3 cm (Mean = 1.7 cm; Median = 1.9 cm).

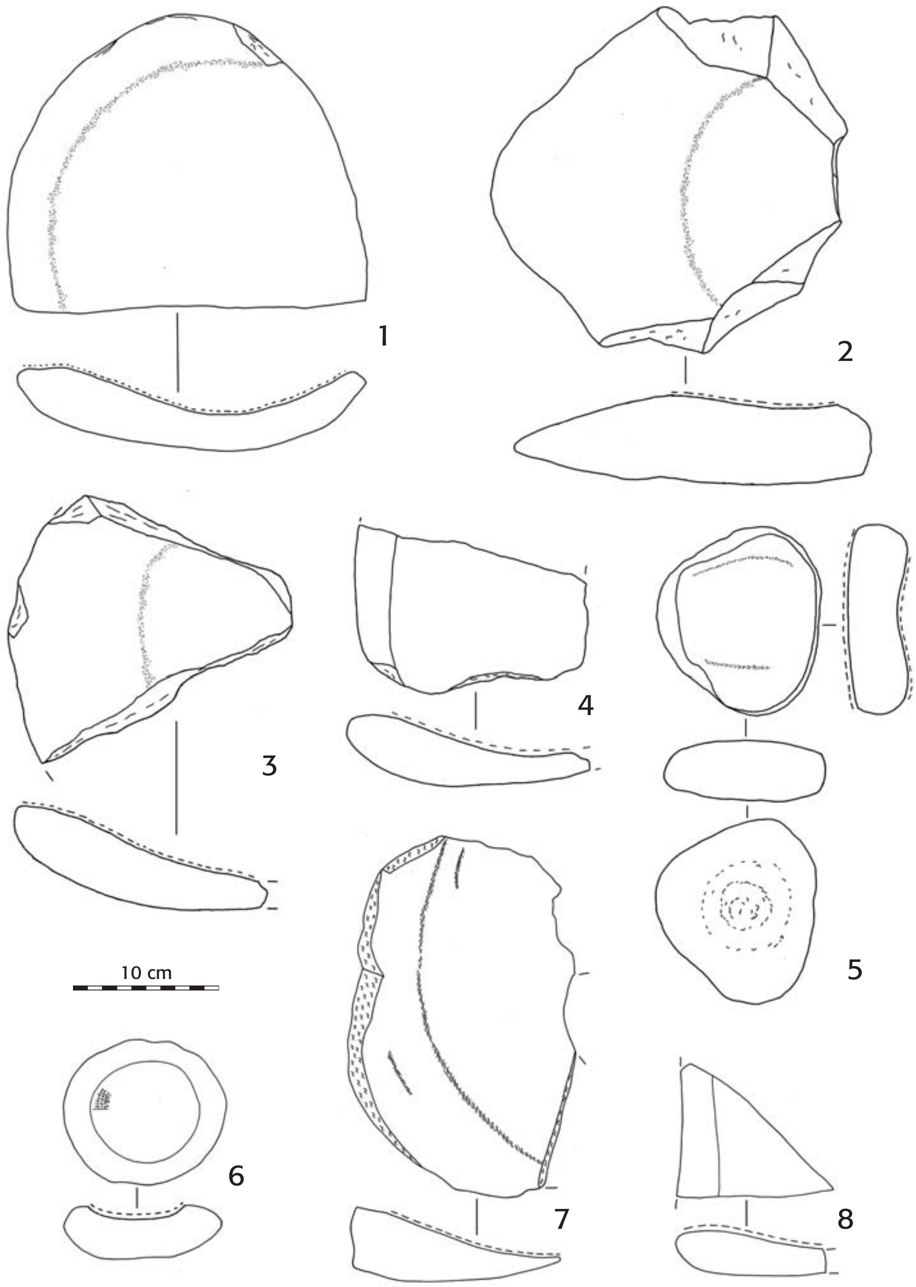


Fig. 13. *Lower stones of LB subtype.* ***1–5*** *– Sphinx;* ***6–8*** *– Fox Hill. Dashed lines show position of the faces. Drawing: J. Řídký. —* ***Obr. 13.*** *Dolní kameny podtypu LB.* ***1–5*** *– Sfinga;* ***6–7*** *– Liščí kopec. Přerušovaná linie vyznačuje pozici aktivních ploch. Kresba: J. Řídký.*

Type: Upper stones (U) of grinding-milling tool sets

These are *active tools* that vary in their method of manufacture and in the outline of the body of the tool in plan. The face is positioned downwards during their use. Upper stones also vary in terms of traces of wear (or manufacture), which can occur on the face of the tool (chipping on the sides, notches in the centre, circular depressions in the centre); in the number of faces; in the shape of the outline in longitudinal section; and in the shape of the outline in transverse section.

System of description:

I. Form of the tool

A: In the case of upper stones, three possible *ways of shaping* have been noted:

1) natural surface, i.e., pebble without modification;
2) rough chipping;
3) fine chipping – grinding.

B: Based on the *outline shape* in plan it is possible to divide upper stones into basic types (*Fig. 7: I*):

1) regular circular;
2) regular oval;
3) regular trapezoidal;
4) regular square/rectangular;
5) irregular.

C: The curve of the *sides* (*Fig. 7: I*) may be:

0) modified through use, it is in fact the face (active part);
1) perpendicular or oblique to the dorsal side, achieved through a forceful blow using a hammerstone;
2) combined perpendicular and rounded;
3) rounded as a consequence of intentional grinding.

D: In both sections, a tool may also differ in the *curve of the dorsal side*, which can be (*Fig. 7: I*):

0) modified through use, it is in fact the face;

1) straight, more-or-less parallel with the working part, achieved casually through exploitation of a natural nodule (bedrock block), or intentionally modified for the purposes of better fixation of the tool;

2) convex, either determined by the original natural shape (pebble – cobble – boulder), or as a consequence of secondary use. The convex shape could also have been the intention of the producer, whether for a better grip in the hand (in the case of small tools), easier securing on soft surfaces, or to allow diverse positioning (supporting) of the tool during milling.

II. Description of faces of the tool

E: *In plan*, the *face* may (*Fig. 7: III. F*):

1) occupy the entire surface of the tool (no other traces of chipping, notches, depressions);

2) occupy the entire surface of the tool, chipped on one side;

3) occupy the entire surface of the tool, chipped on both sides;

4) occupy the entire surface of the tool, notches in the centre;

5) occupy the entire surface of the tool, notches in the centre on both opposite faces;

6) occupy the entire surface of the tool, circular depression in the centre;

7) occupy the entire surface of the tool, circular depression in the centre, on both opposite faces.

F: *In longitudinal section*, the face (faces) may be (*Fig. 7: III. LS*):

1) straight, compared to the dorsal side;
2) convex;
3) concave;
4–7) with two opposite faces, combinations;
8) around the entire perimeter.

G: *In transverse section*, there may be (*Fig. 7: III. TS*):

1) one straight face;
2) one convex face;
3–5) two opposite faces, combinations;
6) two faces next to each other;
7) three or more faces next to each other;
8) the entire body pecked/ground.

H: Altogether, our assemblage includes four options with diverse *numbers of faces*:

1) the face covers practically the entire body that can be arbitrarily rotated, which is presumed only in the case of the so-called spheres (*Fig. 14: 1*);

2) there is only one face on one part;

3) there are two faces (*Fig. 14: 2–7, 9–12*); and

4) there are more than two, in our case three, faces (*Fig. 14: 8*).

Forms of upper stones

In the case of lower stones we could rely on the raw materials and method of manufacture for classifying the artefacts into subtypes, but with upper stones we must choose another approach. We will compare the four shapes identified in our assemblages with the outline of the sections (*Fig. 7: III*) and metrically. Unlike lower stones, an advantage with upper stones is the comparatively frequent preservation of complete pieces, which account for 27% of all pieces from both assemblages.

At the outset it can be stated that longitudinal sections with straight outlines (i.e. flat faces) are less frequent in the case of upper stones, present only in 12% of cases (*Tab. 9*), and are most frequent at Fox Hill. While the straight faces were used on a hard flat surface, most probably in combination with LF subtype lower stones, with motion in all possible directions, the other faces (convex) attest to their use on basin-like surface, ideally in a circular or perpendicular motion (crushing or pounding on lower stones of LB 2 and LB 3). We will examine whether it is possible to trace a relationship between the shape of upper stones, the outline of sections, and metrics.

Circular shaped upper stones feature both straight and convex section outlines (*Fig. 14: 2, 9*), but stones with a convex face or faces largely predominate (LS 2 and LS 7 in *Fig. 7: III. LS*). The circular shaped upper stones have also been found on other sites in Khartoum province (*Arkell 1949*, Plate 26: 1–3; *1953*, Fig. 7, 9). The size of these objects could be inferred from 14 complete pieces. The maximum length is 5.2–10.8 cm, maximum width 4.7–10.4 cm, maximum thickness 2.5–6.1 cm, weight 120–898 g. In the case of length and weight, mean values and medians were recorded, with the latter equating to 8.1 cm (Median = 8 cm) in the case of length, and 425.1 g (Median = 354.5 g) in the case of weight.

Of these circular shaped artefacts with a regular outline in plan view, the regular or almost regular spheres are evidently the most conspicuous (*Fig. 14: 1*; code GMTU-100/188). Only three of these were recorded in the assemblage from Sphinx. Similar spheres were found, for instance, at Khartoum Hospital (*Arkell 1949*, Plate 25), Kadero Midden (*Jórdeczka 2011*, Fig. 5: 1–2), and at a number of other sites.

We observe that central notches (*Fig. 7: III.F 4–5*) and circular depressions (*Fig. 7: III.F 6–7*) on the face(s) almost exclusively occur on oval shaped artefacts (*Fig. 14: 3, 5*). Both opposed faces of these tools, which are oval in plan, are sometimes flat in both sections but more often convex (*Fig. 14: 3–4, 10*). In some cases one of the working surfaces is concave in longitudinal section while the other is straight (see *Fig. 7: III.LS 5*). In general, these oval tools constitute common finds on other late prehistoric sites in central Sudan (e.g., *Arkell 1949*, Plate 26: 4–7). As far as flat faces are concerned, the same applies to them as to the previous type. In the case of convex faces (*Fig. 7: III.LS 2* and *7: III.LS 7*), we can presume that they were used in combination with lower stones of LB1 subtype. Although finds of oval-shaped upper stones with concave faces are recorded on other sites (*Arkell 1949*, Plate 29; *1953*, 45, Fig. 8), they are only sporadic in our assemblages. With oval shapes, it was possible to determine the dimension in the case of 69 complete pieces. The maximum length is 6.2–16.7 cm, maximum width 4.3–11.3 cm, maximum thickness 1.7–8.2 cm, weight 94–1510 g. The mean length is 9.8 cm (Median = 9.9 cm), and the mean weight is 434.9 g (Median = 412 g).

It is probable that rectangular-shaped tools were created through secondary modification of other tools (for instance, lower stones). Once again, both flat and con-

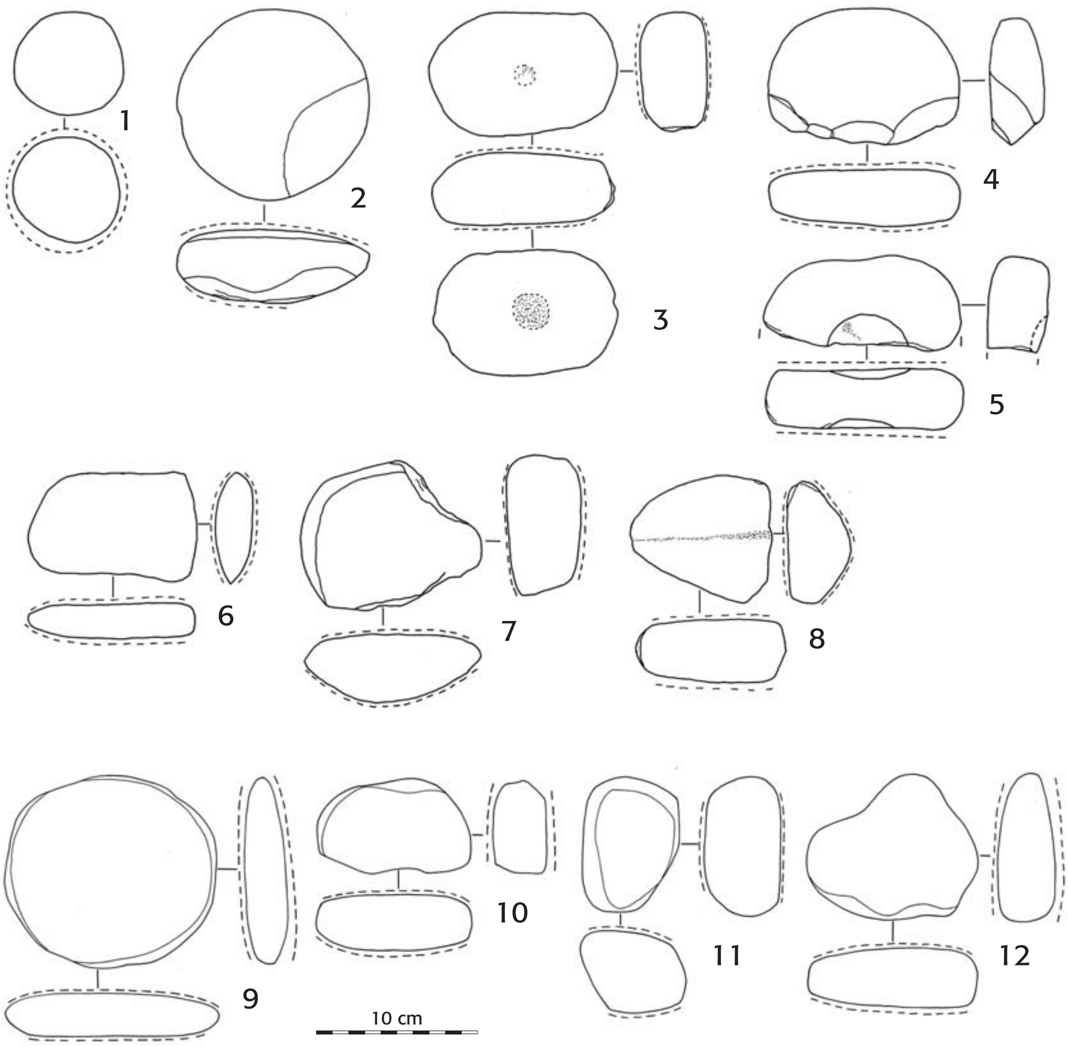


Fig. 14. *Upper stones.* ***1–8*** *– Sphinx;* ***9–12*** *– Fox Hill. Dashed lines show position of the faces. Drawing: J. Řídký.—* ***Obr. 14.*** *Horní kameny.* ***1–8*** *– Sfinga;* ***9–12*** *– Liščí kopec. Přerušovaná linie vyznačuje pozici aktivních ploch. Kresba: J. Řídký.*

Site	LS1	LS2	LS4	LS5	LS7	LS8
Sphinx	0	6	2	1	177	3
Fox Hill	5	0	67	0	378	0
Total	**5**	**6**	**69**	**1**	**555**	**3**

Tab. 9. *Occurrence of different outlines of identified longitudinal sections (LS) of upper stones at Sphinx and Fox Hill. For LS codes see Figure 7: III. LS4, LS5, and LS7 are tools with two opposite faces. —* ***Tab. 9.*** *Výskyt různých křivek podélných řezů (LS) u horních kamenů na Sfinze a Liščím kopci. Pro kódy využité pro LS viz obr. 7: III. LS4, LS5 a LS7 jsou nástroje se dvěma protilehlými aktivními plochami.*

vex faces were recorded with this type (*Fig. 14: 6, 11*). In the case of rectangular shapes, the size could only be determined for 15 complete pieces. The maximum length is 6.4–10.4 cm, maximum width 4.7–7.9 cm, maximum thickness 2.5–4.9 cm, and weight 167–626 g. The mean length is 8.3 cm (Median = 8 cm) and mean weight is 303.3 g (Median = 262 g).

As regards irregular shapes, as far as faces with diverse curved outlines in both sections are concerned, they follow the same pattern as the preceding type (*Fig. 14: 7–8, 12*). It is only in the case of these shapes that we have recorded up to three faces and often also an original natural surface with no traces of shaping or use. It is possible that these pebble forms were used in an *ad hoc* manner. With irregular shapes, the size could only be determined for 7 complete pieces. The maximum length is 9.4–11.6 cm, maximum width 6.7–10.2 cm, maximum thickness 3.3–5.5 cm, and weight 263–597 g. The mean length is 10 cm (Median = 10.3 cm) and mean weight is 3033 g (Median = 262 g).

Possible morphometric subtypes of upper stones

As we can see in the foregoing text, although upper stones in our two assemblages can be most easily divided into four simple shape groups, this division does not necessarily reflect any activities that would facilitate sorting into functional subtypes. This is evidenced by the recurrent occurrence of flat and convex outlines of longitudinal and transverse sections and especially similar metrics and raw materials, irrespective of the shape of the artefact. Some irregularities in the shaping of upper stones, which lead to their inclusion among square or irregular shapes, may also be the result of deliberate shaping to obtain a better grip (comfort features). Using the combination of the above variables, it is consequently possible to classify upper stones into three subtypes according to how they were used in combination as part of simple sets (*Tab. 13–14*).

In terms of description, the upper stone depicted in *Fig. 14: 9*, for instance, can also be described using a code GMTU-130/143 that indicates that this is a GMT of upper stone type (U) of circular shape (*Fig. 7: I. 1*), with rounded sides (*Fig. 7: I.Sides 3*) and faces on both opposite parts (*Fig. 7: I.Dorsal s. 0*), and that the opposite faces (*Fig. 7: III.F 1*) cover the entire surface and are flat in both longitudinal (*Fig. 7: III.LS 4*) and transverse (*Fig. 7: III.TS3*) sections.

Subtype: Upper spheres (US)

As we already mentioned above, regular spheres (code GMTU-100/188; *Fig. 14: 1*) could work in combination with lower stones with regular concave faces. From our assemblages, they would best fit the lower stones of LB2 and LB3 subtypes. Their maximum length is 6.5–7.4 cm (Mean = 6.8 cm; Median = 6.6 cm) and weight 246–409 g (Mean = 327.7 g; Median = 328 g).

Subtype: Upper circular (UC)

Upper stones of regular circular plan view (codes GMTU-130/143; GMTU-130/175; *Fig. 14: 2, 9*), whose flat faces would render them usable in combination with lower stones of LF subtype. However, their longitudinal sections often display convex outlines that also point to their use in combination with some of the LB subtypes, ideally with LB 2 or LB 3. Their maximum length is 5.2–10.8 cm (Mean = 9.5 cm; Median = 9.4 cm), maximum thickness 2.5–6.1 cm (Mean = 4 cm; Median = 3.9 cm), weight 120–898 g (Mean = 417.6 g; Median = 383 g).

Subtype: Upper elongated (UE)

The length of these subtypes is always greater than their width (*Fig. 14: 3–8, 10–12*). Given the occurrence of similar faces of all outlines of sections and their similar metrics, we include all oval, rectangular, and irregular shapes within this subtype group. Compared to the previous subtypes, this particular group features concave faces (*Fig. 7: III. LS 3*) and a combination of a convex shape in longitudinal section and a straight (flat) shape in transverse section (*Fig. 7: III. LS 2* and *7: III. TS 1*), which means that the ends of some UE subtypes may have extended beyond the edges of lower stones and that others may have been used in combination with lower stones with open-trough faces. Most of the UE subtypes, however, could be used in sets with lower stones of LB 1 subtypes and also with bedrock basins.

It is the UE subtypes that most frequently display diverse traces of chipping on sides, notches in the centre of faces (*Fig. 14: 3*), and circular depressions in the centre of faces (*Fig. 14: 5*). Notches and depressions may be found on both opposed faces and may (i) constitute evidence that these artefacts were used as anvils or hammerstones in the shaping of chipped stones, or (ii) they may represent the initial phase of manufacture of stone rings (see *below*). There is also (iii) ethnographic evidence of such depressions being intentionally created to facilitate the grinding of fresh grains of edible grasses (*Cane 1989*). Similar depressions were also recorded in the case of upper stones from the Late Palaeolithic Qadan culture at Tushka in Lower Nubia (*Wendorf /ed./ 1968*). The maximum length of UE subtypes is 6.2–16.7 cm (Mean = 9.6 cm; Median = 9.5 cm), width 4.3–11.3 cm (Mean = 7.6 cm; Median = 7.4 cm), thickness 1.7–8.2 cm (Mean = 4 cm; Median = 3.8 cm), and weight 94–1510 g (Mean = 413.4 g; Median = 384 g).

CLASS: RINGS

The stone rings in our assemblages can be divided into three basic types, according to their shapes (see *Fig. 8*). They are more or less:

1) of circular shape in plan (*Fig. 15: 3–4, 6–7*);
2) of oval shape;
3) of rectangular shape (*Fig. 15: 5*). Rectangular shapes are known also from the Blue Nile region in the Sudan and from other sites (*Fernández – Jimeno – Menéndez 2003*, 239, Fig. 41; *Haaland 1981*). Rings may differ in their transverse section, which can be either 1) irregularly oval (*Fig. 15: 1–3, 5, 9*), or 2) tapered at the biconical perforation (*Fig. 15: 4, 6–8*).

Not a single complete stone ring occurs in our assemblages, and the same is true, with only rare exceptions, on other sites in central Sudan (e.g., *Arkell 1949*, 63; *1953*; *Caneva – Gautier 1994*; *Jórdeczka 2011*). In the case of three pieces from Fox Hill, where at least one half of the artefact is preserved, it is possible to estimate that the maximum length of these items was 7.9–9.8 cm and maximum thickness 2.8–3.0 cm. The diameter of the drilled perforation (dia2; see *Fig. 6*) was 2.2–2.6 cm. These dimensions of finished artefacts correspond to the dimensions of semi-finished rings made from upper stones (7.8–10.1 cm × 5.5–8.5 cm × 3.2–4.2 cm; see *below*). Similar dimensions (length 5.5–11 cm, thickness 2.1–3.5 cm) are recorded for rings from Kadero Midden (*Jórdeczka 2011*, 310).

Further classification into types and subtypes could theoretically be carried out on the basis of metrics, but the number of finds is so low that we have decided to refrain from such attempts in this study (*Tab. 13–14*).

CLASS: ABRADERS

The so-called abraders represent rather enigmatic artefacts. They could be used both actively for drilling and passively (or both) for sharpening bones, shells, the edges of Neolithic gouges and axes, or in the preparation of core bases in the production of chipped artefacts, or as smoothing/polishing stones. Some of them also evoke the pestles known from the Near East during the Epipaleolithic and Neolithic (e.g., for the Near East, *Wright 1992*; for Sudan, *Jórdeczka 2011*, 309). In our assemblage (3 pieces from Sphinx and 24 specimens from Fox Hill; *Tab. 13–14*), these artefacts, all of which are produced from quartzites-sandstones, can be best divided according to their final shape in plan and sections (*Fig. 9*).

Description:

Their *plan* may be:

1) regular square/rectangular;
2) regular trapezoidal;
3) regular conical;
4) irregular.

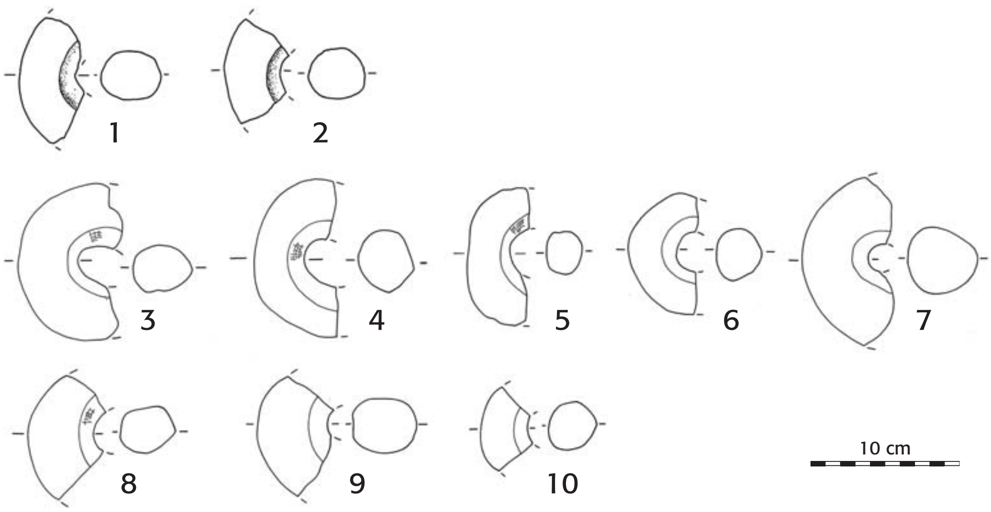


Fig. 15. *Stone ring fragments.* ***1–2*** *– Sphinx;* ***3–10*** *– Fox Hill. Drawing: J. Řídký. —* ***Obr. 15.*** *Fragmenty vrtaných disků.* ***1–2*** *– Sfinga;* ***3–10*** *– Liščí kopec. Kresba: J. Řídký.*

Their *longitudinal section* may be:

1) regular square/rectangular;
2) regularly curved;
3) triangular;
4) conical;
5) irregular.

Their *transverse section* may be:

1) square/rectangular;
2) oval;
3) circular;
4) irregular.

Forms of abraders:

There is a plate form of sandstone-quartzite, irregular in plan view (*Fig. 16: 12*). It is flat, or convex in longitudinal and transverse sections. The flat part features a single U-profile groove. The only complete piece (with a groove) from Fox Hill was 16 cm in length, 9.5 cm in width, 4.4 cm in thickness, and it weighed 0.58 kg. A similar type, but from the excavated trenches and not included in this study, was also noted at Sphinx. Another irregular abrader is flat, or convex in longitudinal or transverse sections (*Fig. 16: 3*). The whole surface was used for reduction of various materials. Similar pieces were also recorded at the Mesolithic site of Khartoum Hospital (*Arkell 1949*, Plate 41), and the Neolithic sites of Esh-Shaheinab (*Arkell 1953*, Plate 24: 3) and Kadero Midden (*Jórdeczka 2011*, Photo 6: 3).

There are other forms with geometric, quadratic, or trapezoid plans (Figure 16: 4–7, 11), and convex, triangular or quadratic longitudinal and transverse sections. Probably the whole surface of the tool was used as a smoother or polishing tool. Similar pieces have been found at the Mesolithic site at Khartoum Hospital (*Arkell 1949*, Plate 37) and at the Early Neolithic site of Kadero (*Jórdeczka 2011*, Fig. 3: 3, 4, 6). Four specimens of this type were collected at Fox Hill and one from Sphinx. Two complete specimens are 8–9 cm long, *ca.* 8 cm wide and *ca.* 2–3 cm thick.

Some abraders have an elongated shape, a regular longitudinal section, and a circular to oval transverse section (*Fig. 16: 8–10*). They are reminiscent of club-shaped cylindrical rubbers/drills or parts thereof (*Jórdeczka 2011*, Fig. 4), or of so-called hollow rubbers described by *Arkell* (*1949*, Plate 38; *1953*, Plate 22, 24). Only two fragments of this form come from Fox Hill.

Other abraders have a triangular plan view, a more-less triangular longitudinal section, and an oval transverse section (*Fig. 16: 1*). The only evidently complete specimen, which comes from Sphinx, was 8.2 cm in length, 6.4 cm in width, 3.5 cm in thickness, and it weighed 0.112 kg. A similar artefact has a trapezoid plan, but its longitudinal sections are bowed with flat sides. The transverse section is quadratic (*Fig. 16: 2*). Similar pieces were recorded at the Neolithic site of Kadero (*Jórdeczka 2011*, Fig. 3: 1–2). Only one fragment of this type was found at Sphinx.

Possible subtypes of abraders

As already mentioned, abraders cannot be simply classified into types and subtypes according to their original shape or the method of manufacture as is the case with the former artefacts. In this work, we attempt a simple classification according to a) the occurrence of flat (facets) or rounded parts, and b) other traces of working, such as grooves.

Abraders flat (AF)

These are items with a square/rectangular, trapezoidial or triangular plan, with straight or convex longitudinal and transverse sections (*Fig. 16: 2, 4–7, 11*). We can envisage that they might have been used for smoothing/abrading of certain hard surfaces, including pottery vessels or house floors.

Abraders oval protruded (AO)

Items of conical to triangular plan, oval in transverse section, protruding and rounded at the end (*Fig. 16: 1*). They might have been used, for instance, as reamers for finishing the bi-conical holes of rings.

Abraders polyhedric (AP)

Items of irregular shape and many straight surfaces (facets; *Fig. 16: 3*). They may be the result of general use for the reduction of various hard surfaces.

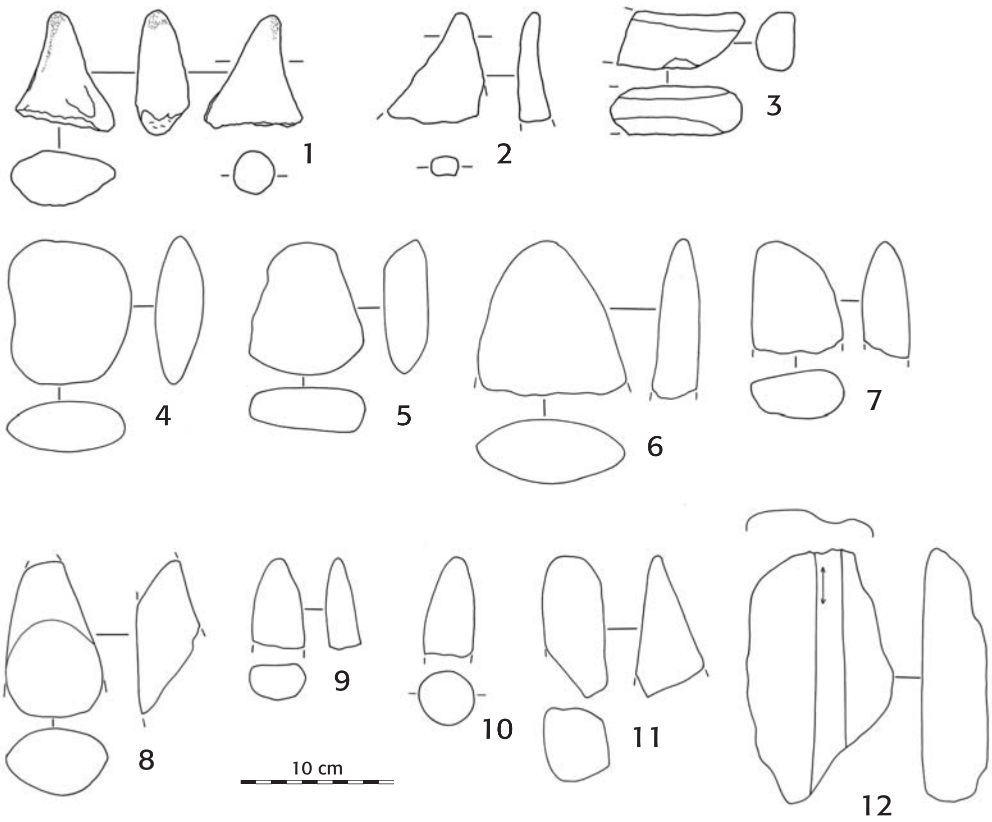


Fig. 16. *Abraders.* ***1–3*** *– Sphinx;* ***4–12*** *– Fox Hill. Drawing: J. Řídký. —* ***Obr. 16.*** *Brousky.* ***1–3*** *– Sfinga;* ***4–12*** *– Liščí kopec. Kresba: J. Řídký.*

Abraders grooved (AG)

Items of irregular shape bearing straight grooves on one or several sides (*Fig. 16: 12*).

4.4. Secondary use of artefacts

In our assemblage we note at least five instances of secondary use of GMT. In all the cases the tools were used for a similar purpose following their secondary modification – i.e. for grinding-milling or pounding. Secondary preparation of upper stones from lower stones (four cases at Sphinx) as well as production of lower stones from upper stones (Fox Hill; we shall return to these cases later) prevails. The assemblage from Sphinx, specifically from Area 6, which is a cleft between two granite boulders on the site's periphery, included two lower stones of LF type (of sandstone and granite) made from another type of lower stones (originally LB type).

On both studied sites, we also encounter two categories of rings: final products and what we call semi-finished products (*Tab. 10*). Semi-finished stone rings are represented by what were originally upper stones or, in rare cases, probably also fragments of lower stones (see *Fig. 17: 1*) of sandstone, with one or, more often, two opposed circular depressions which are unfinished perforations in the centre. Fragmentary finds of unfinished rings predominate (in most cases we can estimate that these represent roughly 50% of the original upper stones; *Fig. 17: 2*), but two complete upper stones with two opposed depressions were encountered too (*Fig. 17: 3*). These whole pieces measure 7.8–10.1 cm in length, 5.5–8.5 cm in width, and 3.2–4.2 cm in thickness at the most, and they weigh at least 202–419 g. In fact, these finds represent another mode of secondary use of artefacts with suitable shapes (in this case oval and flat forms), with required size and of a raw material that allows easy reshaping (brittle sandstones). Similar finds are known for instance from Khartoum Hospital (*Arkell 1949*, Plate 34) and from Kadero Midden (*Jórdeczka 2011*, Photo 6: 4).

Site	Finished rings	Semi-finished products
Sphinx	2	5
Fox Hill	13	25
Total	**15**	**30**

Tab. 10. *Representation of finished rings and semi-finished products on both sites. —* ***Tab. 10.*** *Výskyt vrtaných disků a jejich polotovarů na obou lokalitách.*

4.5. State of preservation of the artefacts

Lower stones and upper stones of GMT can be divided into three groups according to their assessed state of preservation. We assume that:

- tools that are estimated to be no more than one half (up to 50%) of their original size could be used only marginally for their original purpose, i.e., for grinding-milling;
- tools that retain more than half of their original size were still usable for their original purpose, but were destroyed and discarded for one reason or another; and
- tools that we regard as complete may have been intentionally left at sites where the substance being ground or milled was readily available.

Fig. 17. *Stone rings in different stages of manufacture.* ***1–2*** *– Fox Hill, broken semi-finished products, probably damaged during perforation;* ***3*** *– Sphinx, upper stone bearing opposed depressions at the centre. Photo: J. Řídký. —* ***Obr. 17.*** *Vrtané disky v různých fázích výroby.* ***1–2*** *– Liščí kopec, zničené „polotovary", zřejmě během perforace;* ***3*** *– Sfinga, horní kámen s protilehlými prohlubněmi v centrální části. Foto: J. Řídký.*

Sites	100%	≥ 50%	< 50%
Sphinx	9	4	273
Fox Hill	19	3	353
Total	**28**	**7**	**626**

Tab. 11. *Estimated preservation of lower stones from both sites. —* ***Tab. 11.*** *Odhad zachování (%) dolních kamenů z obou lokalit.*

Sites	100%	≥ 50%	< 50%
Sphinx	82	51	56
Fox Hill	96	142	214
Total	**178**	**193**	**270**

Tab. 12. *Estimated preservation of upper stones from both sites. —* ***Tab. 12.*** *Odhad zachování (%) horních kamenů z obou lokalit.*

The comparative table (*Tab. 11*) shows that only a small number of lower stones can be qualified as complete. They represent a mere 3.2% at Sphinx and 5.1% at Fox Hill. Again, it is important to add that in some cases it is uncertain whether the alleged complete tools have the dimensions intended on their production, or whether they represent modified fragments of much larger pieces. The degree of preservation of finds is similar on both sites.

As far as complete pieces of GMT are concerned, the situation is quite different when we compare upper stones from the two sites (*Tab. 12*). As many as 43.4% of the pieces at Sphinx are complete, and when we add to them tools that survive to at least 50% of their original size, the proportion is no less than 70.4% of still usable tools. Similarly, 20.2% of the pieces from Fox Hill are complete, and when we add the tools that retain at least 50% of their original size, the usable tools represent no less than 48.6%. In this respect also the two sites do not differ much from one another.

As for rings (15 pieces in total), the two assemblages do not contain a single complete specimen. Of a total of 27 abraders, only three specimens are probably complete, but this is only a rough estimate as some pieces that we consider as fragments could have been intentionally of small dimensions.

5. Summary and discussion

If we compare GS from our study region and from the Levant, differences can be noticed within a similar chronological horizon (e.g., *Wright 1992*; *Rosenberg – Garfinkel 2014*). These differences are not so much in the quantity of the GS but rather in the spectrum of shapes used (broader spectrum in the Levant) and their sizes. These differences are probably most marked in the case of upper stones belonging to the GMT class (more "double handed" upper stones in the Levant, almost none in Sudan in the given period).

Our morphometric analysis has shown that GS were used to perform several activities. Grinding-milling (*Fig. 18* and *Fig. 19*) of various soft substances produced several pairing possibilities between the GMT – LF subtype and various upper stones with flat (straight) faces (UC and UE). We could see that LB consists of four subtypes LB 1 – LB 4. While LB 1, LB 2, and maybe LB 4 could have worked best with upper stones of UC and UE subtypes (with round or convex faces), and LB 3 could have worked best with regular spheres (US subtypes). All of these tools would have been used in the processing of rather small quantities of products.

Abraders could have been used for smoothing and polishing of certain surfaces (e.g., pottery walls, walls and floors of houses, etc.; i.e., AF, AP), for sharpening organic (bones, shafts; i.e., AG) and inorganic items (axes, gouges), perhaps also for the finishing of holes after drilling (AO?), and even for pounding (AO?). Both sites also feature stone rings (R), which may have been parts of composite digging sticks.

Our study has revealed further important information. On both studied sites, Sphinx and Fox Hill, there

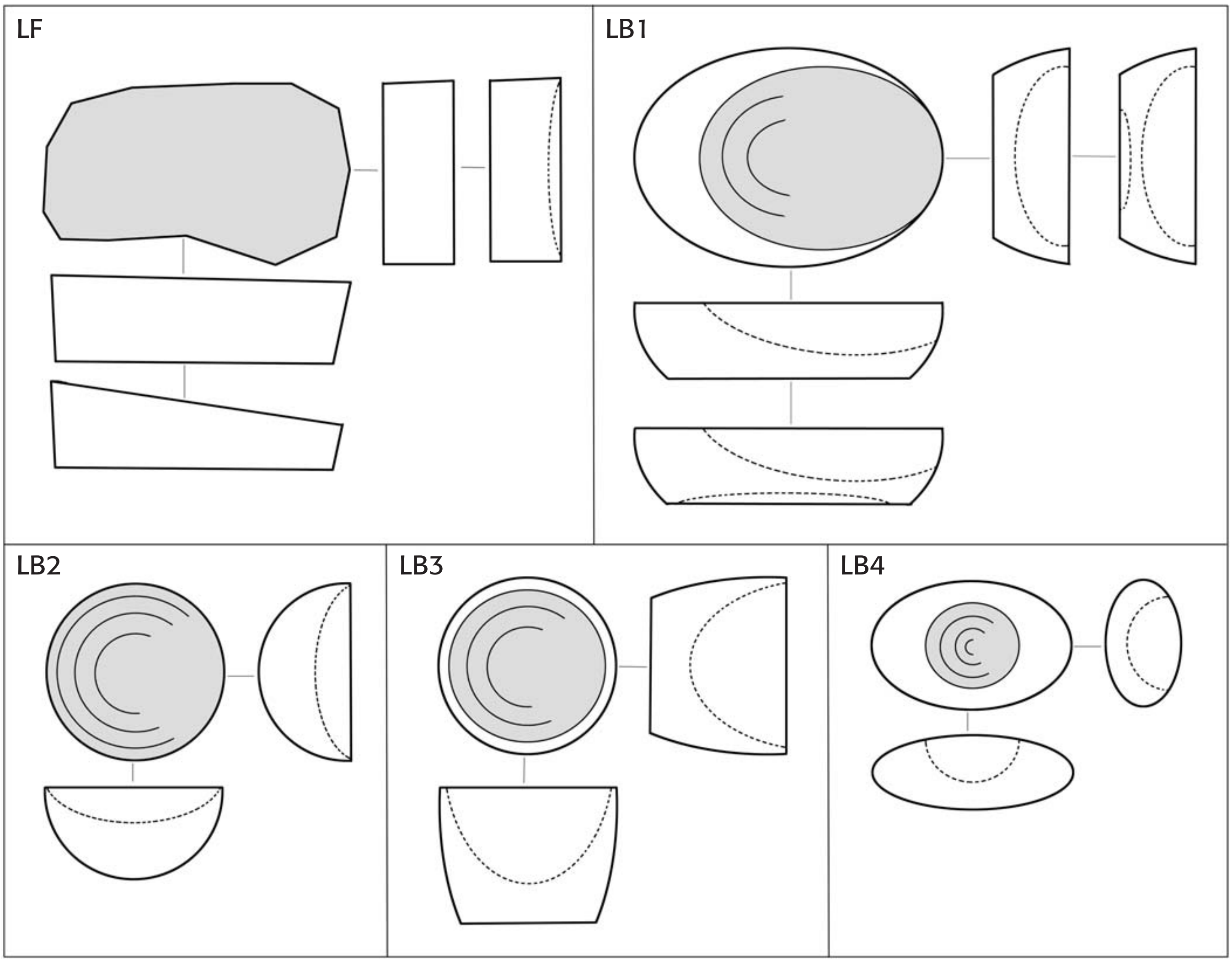


Fig. 18. *Types and subtypes of lower stones from Jebel Sabaloka. Some of them with several variants of longitudinal and transverse sections. Drawing: J. Řídký.*
Obr. 18. *Typy a podtypy dolní kamenů z pohoří Sabaloka. U některých bylo zaznamenáno několik variant podélných a příčných řezů. Kresba: J. Řídký.*

is similar evidence for the manufacture of GS in the form of pieces and flakes of raw material. At the same time, neither of the sites has yielded a single fishing-line sinker. Complete or still usable upper stones occur consistently on the two sites (and on other settlement sites in the region); we will return to this finding below.

Is it possible to distinguish, using other excavated assemblages from other sites, purely Mesolithic and purely Early Neolithic artefacts that might reflect different activities? We could see, for instance, that abraders and rings are more frequent in the GS assemblage from Fox Hill, where remains of Early Neolithic pottery and numerous gouges have been found (*Kapustka et al. 2019*). However, in Section 4 we observed that almost all morphological shape groups – whether lower stones or upper stones – occur on both sites (*Tab. 13–14*). Both sites are also similar in the predominance of lower stones of LB subtypes among the determinable types of lower stones (83.6% at Sphinx; 68.4% at Fox Hill). We can also add that while subtypes LB 1, LB 2 and LB 4 occur on both sites, LB 3 subtype is represented only at Fox Hill, although only a few examples were found. If we look at upper stones, only those shaped as regular spheres (US subtype) come exclusively from Sphinx (only three examples). Otherwise, just as with the lower stones, we can state that all of the other shape variants, with diverse numbers of faces and shapes of faces, are found on both studied sites. The UE subtype unequivocally predominates on the sites.

As far as US subtypes of regular shape and dimensions are concerned, they occur in Middle Palaeolithic, Late Palaeolithic, Mesolithic and Neolithic contexts in Northeast Africa (*Wendorf – Close 1993*; *Roubet 1989b*, 483, Figure 25.11 right; *Zarattini 1983*, 236; *Arkell 1949*, Plate 25; *Jórdeczka 2011*; *Shirai 2010*). Their occurrence during the Early Neolithic is evidenced at the Kadero 1 site, some 50 km from Sabaloka (*Jórdeczka 2011*).

Lower stones are entirely dominated by LB subtypes that were the most demanding both from the point of view of shaping technology and the quantity of transported raw materials required for their manufacture. They are often carefully shaped and they are almost exclusively produced from various quartzites-sandstones. At the same time, these tools show the greatest wear, fragmentation, and rate of recycling. These facts could

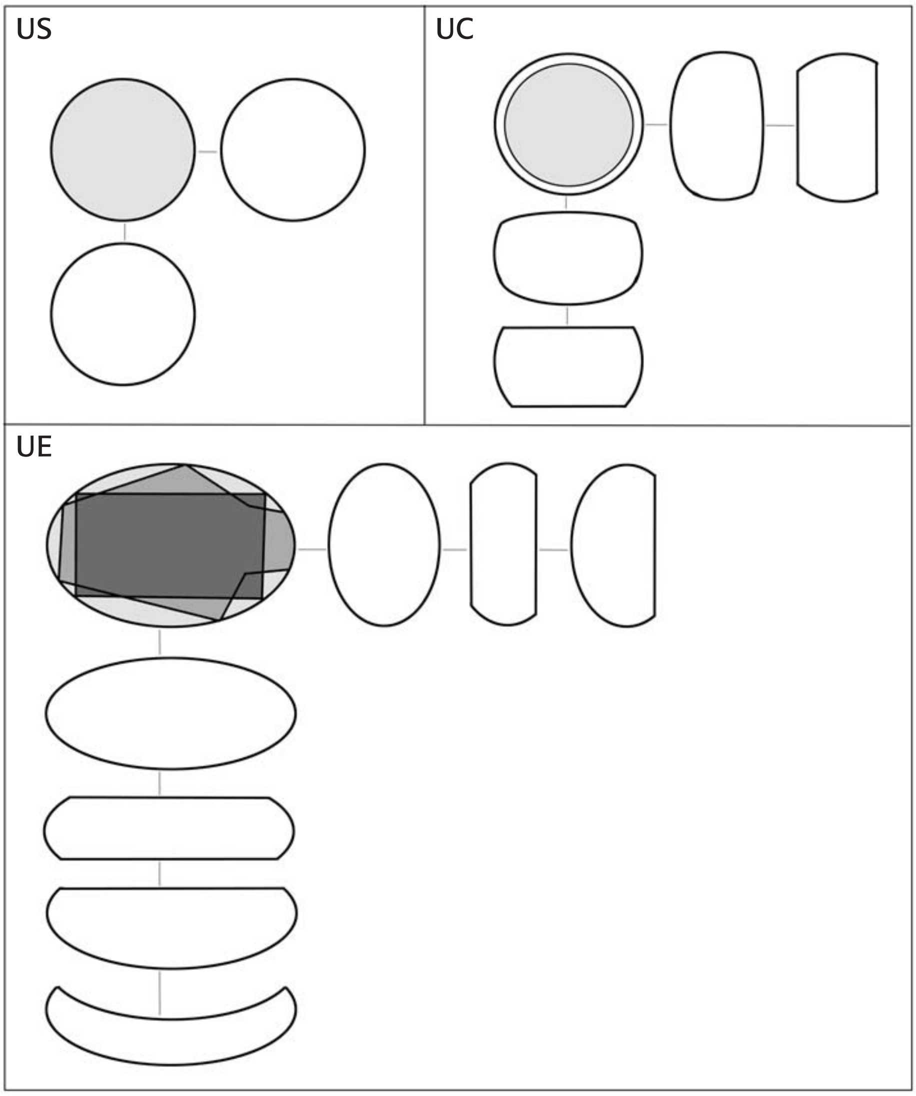


__Fig. 19.__ Three main subtypes of upper stones from Jebel Sabaloka. UE subtype can have several shape variants in plan. UC and UE subtypes can have several variants of longitudinal and transverse sections. Drawing: J. Řídký. — __Obr. 19.__ Tři hlavní podtypy horních kamenů z pohoří Sabaloka. Podtyp UE se vyskytuje v několika tvarových variacích podle pečlivosti výroby. Podtypy UC a UE mohou mít v důsledku používání několik variant podélných a příčných řezů. Kresba: J. Řídký.

imply that considerable significance was attached to these artefacts, which were likely connected with the processing of substances (most probably vegetal foods) for the local communities. Their more or less even distribution in both ecological zones – the Rocky Cities and the Lake Basin – points to quit a generalised use of these artefacts. In the drier zone of the Rocky Cities (where Sphinx is located) they were probably used for the processing of dry seeds (?) while in the more humid environment of the Lake Basin dominated by Fox Hill they may also have been used to process other materials like clay or minerals, edible tubers and roots. In Egypt, lower stones with basin-like active surfaces (LB subtypes in our classification) are sometimes found in

Class		Raw material			All areas (792.1 m²)
Type	Subtype	Granite	Porphyry rhyolite	Quartzite-sandstone	Total
Lower stone	LF	5	4	36	45
Lower stone	LB	4	1	224	229
Lower stone	Unident.	0	0	12	12
Lower stones Σ		**9**	**5**	**272**	**286**
Upper stone	US	0	0	3	3
Upper stone	UC	0	1	9	10
Upper stone	UE	0	12	162	174
Upper stone	Unident.	0	0	7	7
Upper stones Σ		**0**	**13**	**181**	**194**
Rings Σ	**All**	**0**	**0**	**2**	**2**
Abraders Σ	**All**	**0**	**0**	**3**	**3**
Total	**All**	**9**	**18**	**458**	**485**

__Tab. 13.__ Sphinx. Distribution of lower stones, upper stones, rings, and abraders, according to their raw materials. — __Tab. 13.__ Sfinga. Výskyt dolních a horních kamenů, vrtaných disků a brousků podle využitých kamenných surovin.

Tab. 14. *Fox Hill. Distribution of lower stones, upper stones, rings, and abraders, according to their raw materials. —* ***Tab. 14.*** *Liščí kopec. Výskyt dolních a horních kamenů, vrtaných disků a brousků podle využitých kamenných surovin.*

Class		Raw material			All areas (5.764 m²)
Type	**Subtype**	**Granite**	**Porphyry rhyolite**	**Quartzite-sandstone**	**Total**
Lower stone	LF	0	0	77	77
Lower stone	LB	0	0	247	247
Lower stone	Unident.	0	0	51	51
Lower stones Σ		**0**	**0**	**375**	**375**
Upper stone	US	0	0	0	0
Upper stone	UC	0	1	3	4
Upper stone	UE	0	4	444	448
Upper stone	Unident.	0	0	8	8
Upper stones Σ		**0**	**5**	**455**	**460**
Rings Σ	**All**	**0**	**0**	**13**	**13**
Abraders Σ	**All**	**0**	**0**	**24**	**24**
Total	**All**	**0**	**5**	**867**	**872**

Tab. 15. *Comparison of length, width (both in cm) and weight (in kg) of lower stones between Sphinx and Fox Hill. QI = lower quartile (25%); QIII = upper quartile (75%); IQR = interquartile range. —* ***Tab. 15.*** *Srovnání délky a šířky (obě v cm) a hmotnosti (kg) dolních kamenů u Sfingy a Liščího kopce. QI = dolní kvartil (25 %); QIII = horní kvartil (75 %); IQR = rozpětí mezi QI a QIII.*

Site	Cases	Min.	Max.	Mean	Std.Error	Median	QI	QIII	IQR	Range
LENGTH										
Sphinx	8	13,5	37	21,44	3,24	17,75	14,75	31,13	16,4	23,5
Fox Hill	5	10,2	22	14,6	2,18	12	10,95	19,5	8,6	11,8
WIDTH										
Sphinx	8	11,7	31,5	15,65	2,32	13,5	12,13	15,63	3,5	19,8
Fox Hill	5	7,2	14,4	10,5	1,25	10,1	8	13,2	5,2	7,2
WEIGHT										
Sphinx	8	0,92	17,6	4,53	1,93	2,32	1,92	4,9	2,99	16,68
Fox Hill	5	0,37	2,02	0,96	0,34	0,52	0,37	1,77	1,39	1,64

Tab. 16. *Comparison of length, width (both in cm) and weight (in kg) of upper stones between Sphinx and Fox Hill. QI = lower quartile (25%); QIII = upper quartile (75%); IQR = interquartile range. —* ***Tab. 16.*** *Srovnání délky a šířky (obě v cm) a hmotnosti (kg) horních kamenů u Sfingy a Liščího kopce. QI = dolní kvartil (25 %); QIII = horní kvartil (75 %); IQR = rozpětí mezi QI a QIII.*

Site	Cases	Min.	Max.	Mean	Std. Error	Median	QI	QIII	IQR	Range
LENGTH										
All	105	5,2	16,7	9,39	0,19	9,4	7,95	10,4	2,5	11,5
Sphinx	83	5,2	13,5	9,4	0,19	9,4	8,1	10,4	2,3	8,3
Fox Hill	22	6,2	16,7	9,32	0,55	8,95	7,25	10,48	3,2	10,5
WIDTH										
All	105	**4,3**	**11,3**	**7,58**	**0,16**	**7,4**	**6,4**	**8,55**	**2,2**	**7**
Sphinx	83	4,7	11,3	7,66	0,17	7,5	6,4	8,7	2,3	6,6
Fox Hill	22	4,3	10,5	7,26	0,39	6,85	6,15	8,53	2,4	6,2
WEIGHT										
All	105	**0,09**	**1,51**	**0,42**	**0,02**	**0,38**	**0,24**	**0,54**	**0,3**	**1,42**
Sphinx	83	0,12	1,51	0,43	0,02	0,39	0,26	0,56	0,29	1,39
Fox Hill	22	0,09	0,76	0,36	0,04	0,34	0,19	0,51	0,32	0,66

Late Palaeolithic contexts (*Banks 1982*) but their main advent is dated to about *ca.* 5000 BC and is linked to the presence of domesticated sources of food (*Wendorf – Schild /eds./ 2001*, 423). Similar finds dating to this period have been found in the Hidden Valley village of the Farafra Oasis (*Lucarini 2014*, 291). Different activities appear to have been pursued in Jebel Sabaloka and in the whole of central Sudan where this type of lower stone is frequently found on Mesolithic sites (e.g., *Arkell 1949*; *Zarattini 1983*).

We will now look at some of the detail that can be observed on complete pieces. Lower stones from Sphinx are generally larger than those from Fox Hill (*Tab. 15*). However, the overall dimensions could only be compared for 14 complete specimens, nine of which come from Sphinx and only five from Fox Hill. At this stage we should add that even those lower stones that have been preserved and are found on the surface of both sites may already have undergone a degree of modification. The original dimensions may in fact have been greater. Both sites also yielded 280 complete finds of upper stones, of which 105 were measured and weighed (*Tab. 16*). Once again, as we have already seen in Section 4, there are only small differences between the dimensions and weights of the upper stones among the three subtypes classified according to shape and, more importantly, between the two sites. Although the tools found at Sphinx show somewhat larger dimensions, the maximum length of the artefacts only rarely exceeds 10 cm, which we see as the lower limit for grinding-milling using two hands in a side-by-side position. In our opinion, however, effective two-handed use, where the hands are positioned next to each other, ideally requires the tool to be at least 15 cm in length. In our assemblage only one tool meets this criterion – an upper stone of UE subtype from Fox Hill (16.7 x 9.0 x 3.4 cm, weight 0.447 kg).

For verification of our findings on the complete upper stones, we can look at other GS assemblages obtained from test excavations. The Mesolithic site of Khartoum Hospital yielded more than 500 pieces of upper stones; their maximum length equates to 5–16 cm (*Arkell 1949*, 52–60). Published values for 60 complete pieces has made it possible to calculate that the average length of these tools is 8.9 cm (Median = 9 cm). At the Early Neolithic site of Esh-Shaheinab, no less than 300 pieces of upper stones are mentioned by *Arkell* (*1953*, 42–47). It has been possible to ascertain the maximum length of nearly 40 upper stones from this site: 4–16 cm, with a mean of 8.9 cm (Median = 7.8 cm). At the Early Neolithic site of Kadero Midden, upper stones measured 5–20 cm in length, with only a small group of finds being longer than 15 cm (*Jórdeczka 2011*, 305). Although it is not possible to verify our findings using more assemblages, it ensues from the present results that similar trends with regards to the types and dimensions of GMT were widespread in late prehistoric central Sudan. In some cases upper stones also served as preforms for the manufacture of sandstone rings. These artefacts might thus have been a sought-after product, with the reuse of some pieces providing further evidence for the economical use of scarce raw materials.

The above-mentioned frequent occurrence of complete upper stones is not exceptional on prehistoric sites in the Nile Valley and the Western Desert of Egypt. From 90 specimens collected at the Late Palaeolithic sites in Wadi Kubbaniya, 37 pieces (41.1%) were complete (*Wendorf – Schild – Close /eds./ 1989*), and of the 35 examples found at the Final Palaeolithic (Qadan) camps at Tushka, 29 pieces were complete (82.9%; *Wendorf /ed./ 1968*). In the Early and Middle Holocene assemblages from Nabta Playa, where the ratios of fragmentary and complete upper stones could be compared at seven sites (*Wendorf – Schild /eds./ 2001*), 520 of 1427 specimens (36%) were considered complete. In the Hidden Valley village, a total of 13 (57%) out of 23 upper stones were complete, and in the Hidden Valley basin, 22 (35%) out of 62 pieces were complete (*Lucarini 2014*, 288, 294). All of the mentioned sites feature virtually the full range of morphological variants of upper stones, including those with flat and/or convex faces, which we have recorded in the western part of Jebel Sabaloka. Also, comparison of the main dimensions – length and width – of the complete upper stones from Palaeolithic to Early Neolithic assemblages from Sudan and Egypt (*Fig. 20*; and see *Lucarini 2014*, 290, 295) shows a very long tradition in this region of smaller upper stones, particularly suited for one-handed use (both in back-and-forth and circular motions).

The number and intensive use-wear of upper stones and the dominant type of lower stones (LB subtype) clearly show that grinding was a particularly intensive and very frequently practiced activity at both Sphinx and Fox Hill. Nevertheless, the local tools were not morphometrically adapted for grinding larger quantities of products, as were, for instance, the large saddle querns in Europe (e.g., *Hamon 2008*) or elongated two-handed grinders known from East Africa especially in more recent periods (e.g., *Nixon-Darcus – Meresa 2020*). This fact may imply the existence of certain specific methods for the preparation of vegetal foods, which did not involve large-scale storage of foodstuffs.

So-called rings, significant artefacts in Sudan, occurred on both sites. In total, 13 pieces come from Fox Hill and only two fragments from Sphinx. The original maximum length of only three of the ring fragments from Fox Hill can be estimated at 8–10 cm, thickness at 2.8–3.0 cm. Similarly, the Mesolithic site of Khartoum Hospital yielded 12 ring fragments, whose maximum length was estimated by Arkell at 9–11 cm and thickness at 2.9–3.2 cm (*Arkell 1949*). The same author mentions a small number of pieces (including one complete example, with a length of 10 cm and thickness of 3.3 cm) in the Early Neolithic assemblage from Esh Shaheinab (*Arkell 1953*). The Early Neolithic site of Kadero 1 has yielded four fragments of rings, with a maximum length of 8–10 cm and a thickness of 2.8–3 cm (*Jórdeczka 2011*). As stated above, smaller, or larger numbers of rings usually form part of most assemblages dated to the Mesolithic and Early Neolithic. For this reason, this type of artefact cannot be used for chronological determination. In addition, as summarised recently for instance by *M. Jórdezka* (*2011*, 310–311), the functional interpretation of rings is not clear either.

Artefacts from the group termed abraders, but for which we are unable to interpret their exact function (over and beyond their use for grinding-abrading), occur more frequently at Fox Hill (n = 24) than at Sphinx (n = 3). Arkell mentions around 70 pieces of abraders from the Mesolithic site of Khartoum Hospital (*Arkell 1949*) and as many as 169 pieces (!) from the Early Neolithic site of Esh Shaheinab (*Arkell 1953*). Arkell writes that his subtype of cylindrical rubbers should be a characteristic find for the Early Neolithic period in Sudan (*Arkell 1953*, 52). Kadero 1 has yielded 80 abraders, of which as many as 62 pieces may be club-shaped (Arkell's cylindrical) rubbers (*Jórdeczka 2011*, 300, Table 1). In our assemblages, they are referred to as the AO subtype and are represented by a mere three pieces. In our opinion, all three classes of these artefacts reflect the carrying out of specific activities at the sites, but they cannot be used for chronological classification of the sites.

Although Jebel Sabaloka contains outcrops of diverse stone raw materials, the evidence from Sphinx and Fox Hill and other investigated sites indicates that the production of GS during the Mesolithic and Early Neolithic was primarily based on quality quartzites-sandstones, which are distinguished by good abrasive properties and relatively easy workability. By contrast, the hard porphyry rhyolites and granite, which display poorer abrasive properties and workability by grinding, were used only marginally. While granites and rhyolites were accessible directly at or in the vicinity of the late prehistoric sites in the western part of Jebel Sabaloka, the nearest outcrops of quality sandstones are situated on Jebel Rauwiyan on the opposite bank of the Nile some 7 km from Sphinx and 3 km from Fox Hill (*Fig. 2*), where they were only accessible outside the period of Nile

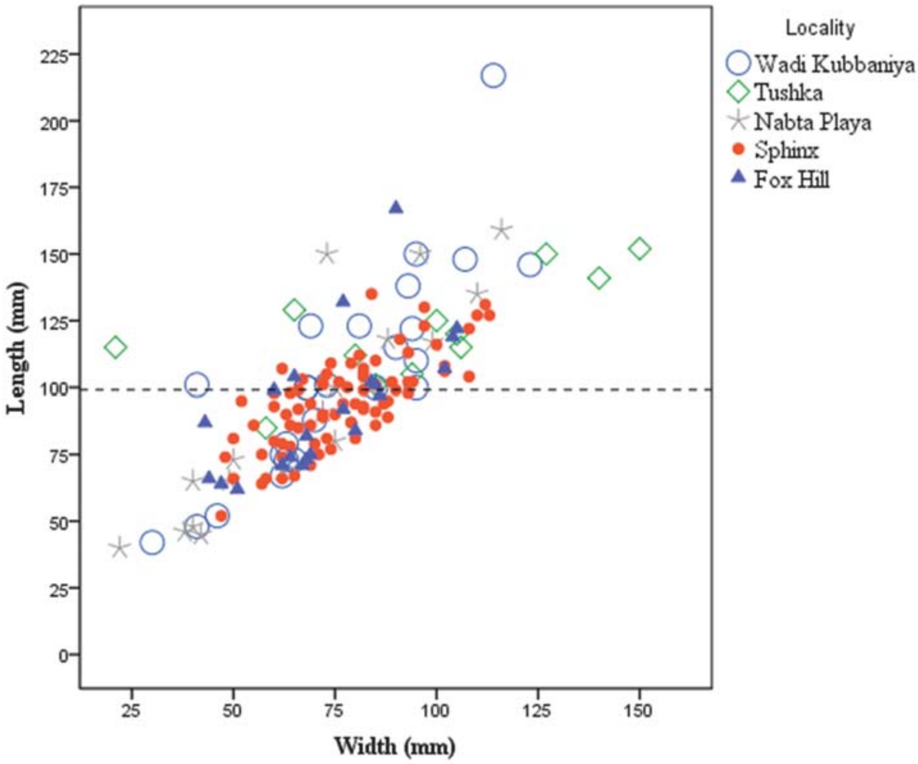


Fig. 20. *Ratio of length and width of upper stones from different localities. Dashed line indicates median (100 mm). In total 157 specimens could be compared. Wadi Kubbaniya (n = 25; Late Palaeolithic), Tushka (n = 12; Late Palaeolithic), Nabta Playa (n = 18; Neolithic), Sphinx (n = 80; Mesolithic), Fox Hill (n = 22; Mesolithic–Early Neolithic). Data from sites outside Sabaloka are based on Wendorf /ed./ 1968; Wendorf – Schild – Close /eds. 1989/; and Wendorf – Schild /eds./ 2001. —* ***Obr. 20.*** *Vztah délky a šířky horních kamenů z různých lokalit. Přerušovaná linie vyznačuje medián (100 mm). Porovnáno bylo 157 kompletních kusů. Wadi Kubbanija (n = 25; pozdní paleolit), Toška (n = 12; pozdní paleolit), Nabta Plaja (n = 18; neolit), Sfinga (n = 80; mezolit), Liščí kopec (n = 22; mezolit–časný neolit). Údaje z lokalit mimo Sabaloku jsou doplněny podle Wendorf /ed./ 1968; Wendorf – Schild – Close /eds./ 1989 a Wendorf – Schild /eds./ 2001.*

flooding, which lasted several months every year (cf. *Allan – Smith 1948*; *Williams – Adamson – Abdulla 1982*). In view of the transportation efforts required, it is therefore likely that the value of quality quartzites-sandstones was higher than that of other raw materials used.

It ensues from the results of our comparative analyses that the artefacts forming the groups of GS designated as GMT (both lower and upper stones), the rings and the large group of abraders cannot be used for chronological classification of sites. If we leave out pottery decorative styles and forms, then the presence/absence of so-called gouges (which we consider as chipped stone artefacts) and bones of domesticated animals constitute the only reliable chronological indicators in the case of the complex transformed assemblages in central Sudan. Within the category of GS, only axes and mace-heads can be included among more reliable indicators. However, neither axes nor mace-heads are attested in the assemblages from surface collections in our study region. We believe that although the groups of artefacts presented in this study cannot be used for chronological classification, they could attest to a certain long-term specialisation of the local communities. The spectrum of types of GS reflects long-term adaptation to the local ecological environments which were rich in subsistence resources, not only during the Mesolithic, but also during the Early Neolithic period.

GS occur on all Mesolithic and Early Neolithic settlements in the western part of Jebel Sabaloka, and large quantities of GMT (both lower and upper stones) always predominate among these finds. The proportion of GMT to pottery, chipped (flaked) lithics and other find categories on given sites always seems to be roughly the same, irrespective of the absolute quantity of the total archaeological debris, which, in other words, indicates a correlation between the quantity of GMT and the intensity or duration of occupation. This shows that grinding-milling was an integral and roughly constant part of the routine activities of the occupants of this region. An important finding in this region, and beyond, is the frequent occurrence of complete upper stones. This indicates that these tools were not transported between sites on a large scale and, also, that the substances processed on these tools were commonly available in the entire research area, irrespective of whether the sites were located in the Lake Basin or the Rocky Cities which represented two ecologically different zones with distinct possibilities for the exploitation of mineral and vegetal resources in the past.

Only a small portion of GMT occurs on non-residential sites that we designate as ephemeral locations and special-task sites (see Section 3). These sites are situated close to local wadis or prehistoric marshes, where the richest and most stable sources of plant foods are likely to have been found. An absolute majority of GMT was identified on settlements that were located on the margins of lowlands and, moreover, in elevated, less accessible positions where it must have been more demanding to transport the substances intended for grinding. Thus, grinding-milling in Sabaloka was unequivocally linked to habitation sites, instead of settlements moving closer to sources of plant foods as is characteristic of some highly mobile hunter-gatherer societies (*Cane 1989*). This might indicate higher residential stability among human groups in Jebel Sabaloka, at least in the Mesolithic (the period to which most of the sites with studied GS date), but a pattern of low mobility cannot be ruled out even for the Early Neolithic.

To sum up, Sphinx and Fox Hill represent two important settlement and burial sites dated to the Mesolithic (Early Khartoum culture), with the latter site also constituting an important settlement and burial location during the Early Neolithic. The comparison of assemblages of GS from these two locations, each of which is the dominant site of a distinct ecological zone with a specific settlement history in this region, shows similar patterns in terms of typological variability, quantitative proportions between types, raw materials used, and patterns of use, reuse, and discard of these artefacts. This suggests marked continuity in the technology and lifestyles associated with these tools throughout the Mesolithic and Early Neolithic.

6. Conclusion

We have attempted to show that the study of GS is meaningful even in such problematic archaeological environments, but it is important to follow several lines of evidence. We have attempted to unify the terminology of GS and offer a well-organised description system for comparative analyses with other sites. The description and classification system is based on the description of basic shapes and basic dimensions of GS.

Although at this phase in our research it is possible to describe the basic activities performed at late prehistoric sites, a more precise functional interpretation of individual types will be possible only after comparative analyses of use-wear traces and, if GS are uncovered in a suitable find context, residue analyses of phytoliths and starch grains from tool faces (e.g., *Lucarini – Radini 2019*; *Lucarini et al. 2016*). The chronological and functional relationship with granite bedrock basins (grinding hollows or bedrock mortars), which can be observed at all Mesolithic sites in the region, and less often at Neolithic ones, is also not entirely clear.

Our evidence shows that in Jebel Sabaloka the ground stones, and in particular the grinding-milling tools, were closely and intensively intertwined with the settlement structure, daily life, and economy of the local late prehistoric groups. This highlights the considerable potential of these tools as a source for the study of settlement and subsistence strategies during Mesolithic and Early Neolithic and in the transition between these two archaeological eras. We have demonstrated that the raw material selection, manufacture, typological spectrum, method of use, and discarding of these tools together generated quite a complex but specific pattern. Our evidence shows that this pattern was already fully developed in (or introduced to) Jebel Sabaloka by the Mesolithic hunter-gatherers between ~9000–5000 cal BC and did not undergo any marked modifications in the subsequent Early Neolithic period (~5000–3800 cal BC), although the Neolithic in this region arguably meant the introduction of domestic animals, stone gouges and axes (of which we have evidence from test excavations), and a clear transformation of the settlement landscape.

In other words, in the western part of Jebel Sabaloka we claim an absence of innovations and quite a clear continuity in the significant segment of economic and domestic life connected with these artefacts between the late hunter-gatherers and early food-producers. Various classes of GS found in the region did not depend on the economy of the groups, which was different between the Mesolithic and Neolithic, but on a range of routine actions linked to daily life in the settlement. Comparison with contemporary GS assemblages from Levant sites (with a mixed economy) may reveal useful information on the function of GS and the activities in which they were involved, but more studies focussed on use-wear traces and residues from working surfaces is needed in our study area.

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Souhrn

1. Úvod

Práce je zaměřena na kamenné artefakty s broušeným povrchem, někdy označované jako makrolity, které jsou nejčastěji vyrobeny z kamenných surovin sedimentárního původu, méně často z vyvřelin nebo z metamorfovaných hornin (*Wright 1992*; *Adams 2002*; *Rosenberg – Rowan – Gluhak 2016*; *Squitieri – Eitam /eds./ 2019*; *Peacock 2013*; *Hamon 2008*; *Procopiou – Treuil /eds./ 2002*; *Zimmermann 1988*). Analyzované kamenné broušené artefakty (GS) pochází z povrchových sběrů v západní části pohoří Sabaloka, ve středním Súdánu (*obr. 1*) a jsou datovány do období mezolitu (~9000–5000 cal BC) a časného neolitu (~5000–3800 cal BC), v místním chronologickém systému (např. *Garcea 2020*).

Mezolit je v této části Súdánu často označován podle místa jednoho z nejdůležitějších výzkumů jako „raný Chartúm" (Early Khartoum), nebo „chartúmský mezolit" (Khartoum Mesolithic). Oproti mezolitu, tak jak je vnímán například ve střední Evropě, jednalo se v této části světa o usedlé nebo polousedlé lovce-sběrače-rybáře, vytvářející kvalitní zdobené keramické nádoby (*Arkell 1949*; *Edwards 2004*; *Garcea 2020*). V období časného neolitu, které je často opět podle místa důležitého výzkumu označováno jako „Šahejnábský neolit" (Shaheinab Neolithic) nebo „chartúmský neolit" (Khartoum Neolithic; dříve též „kultura tesel" – Gouge culture), se na lokalitách objevují kosti hospodářských zvířat a dochází k rozvoji ekonomiky založené především na pastevectví. Zároveň se mění sídelní oikumena, sídlištní lokality se podle rozptylu nálezů prostorově zmenšují a jsou rozmístěny v mnohem větších vzdálenostech (*Arkell 1953*; *Edwards 2004*; *Garcea 2020*). Co se týká nejdůležitějších hospodářských zvířat, v poměrně nedávné době byl potvrzen blízkovýchodní původ ovcí, koz a rovněž dobytka (*Garcea 2016*). Odborníci však zatím nejsou jednotní v názoru, zda došlo k rozšíření domestikovaných zvířat v této části Afriky příchozími populacemi, nebo zda byly uvedené složky „neolitického balíčku“ jen začleněny do dlouhodobě fungujících místních ekonomik a kulturně-sociálních systémů (*Garcea 2020*). Dosud nebyly v této části Súdánu nalezeny žádné přímé důkazy o produkci potravin rostlinného původu, datované do časného neolitu (*Hildebrand et al. 2018*; *Hildebrand – Schilling 2016*; *Magid 2003*; *Winchell et al. 2018*; ale viz *Salvatori – Usai 2019*), i když tato oblast představuje jedno z hlavních geografických ohnisek domestikace čiroku (*Brass et al. 2019*; *Winchell et al. 2017*; *2018*). Je tedy stále spíše otevřenou otázkou, do jaké míry a jak (pokud vůbec) se případné změny ve zdrojích potravy promítly v počátcích neolitu do hmotné kultury místních komunit. V této práci se to pokusíme ověřit na příkladu kamenné broušené industrie (dále jen GS).

GS je běžnou součástí co do četnosti artefaktů archeologicky bohatých mezolitických a neolitických sídlištních souborů. Během výzkumů v oblasti Súdánu však není těmto artefaktům většinou věnována dostatečná pozornost. Problémem při jakémkoli zpracování GS z daných období je nejednotná terminologie a rozdílné přístupy při klasifikaci morfologických a funkčních skupin. Území Sahelu navíc prošlo v průběhu posledních pěti až šesti tisíců let řadou složitých formativních procesů, spojených se změnou klimatu a s radikální proměnou podmínek k životu. Jejich důsledkem jsou obtížně čitelné stratigrafické vztahy a leckdy rozdílné interpretace nálezových souborů. Je tedy velmi důležité testovat různé cesty k využití informačního potenciálu místních nálezů.

První badatelské výzkumy mezolitu a časného neolitu jsou spojeny se jménem A. J. Arkella (*Arkell 1949*; *1953*) a proběhly při rozšiřování nemocnice v hlavním městě Chartúmu (mezolit) a dále na lokalitě Eš-Šahejnáb (časný neolit). Z obou výzkumů byly monograficky publikovány stovky nálezů GS, klasifikované podle rozmanitých kritérií. Na uvedené publikace navázala řada dalších zpracování výzkumů lokalit z mezolitu a neolitu, avšak s rozmanitými přístupy k hodnocení a dokumentaci (*Haaland 1981*; *Zarattini 1983*; *Caneva 1988a*; *Jórdeczka 2011*; *Magid 2003*). Důsledkem je absence všeobecně přijímané terminologie a standardizovaných popisných a dokumentačních postupů. Chybí také širší srovnání s oblastmi na dolním toku Nilu, směrem k Levantě a se soubory z egyptské Západní pouště, což jsou směry důležitých kontaktů.

V naší práci jsme se zaměřili na artefakty větších rozměrů, které lze nejčastěji zachytit ve sběrových souborech a činí podstatnou (a často paradoxně přehlíženou) část nálezového fondu. Původně byly využívány pro aktivity spojené s otloukáním, broušením, leštěním, drcením a mletím. Některé z nich, například v centrální části bikónicky vrtané disky, mohly být součástí rycích holí (jejich interpretace však není jednoznačná). GS je ovšem předmětem dlouhodobého zájmu na Předním východě, v Evropě nebo v Severní Americe, kde je využívána ke studiu technologií, alimentárních strategií, nebo i sociální nerovnosti a sociálních strategií, což umožňuje zobecnění některých zásadních otázek a aplikaci analytických postupů na soubory v různých částech světa (např. *Wright 1992*; *1993*; *1994*; *2000*; *2014*; *Dietrich et al. 2019*; *Shoemaker – Davies Mathew – Moore 2017*; *Rowan – Ebeling /eds./ 2008*; *Rosenberg – Rowan – Gluhak 2016*; *Squitieri – Eitam /eds./ 2019*; *Rosenberg – Garfinkel 2014*; *Peacock 2013*; *Hachem – Hamon 2014*; *Hamon 2008*; *Van Gijn – Houkes 2006*; *Baysal – Wright 2005*; *Dubreuil 2004*; *2001*; *Adams 2002*; *Pavlů – Rulf 1991*; *Zimmermann 1988*).

Na začátku práce jsme shrnuli přehled klasifikačních systémů GS, které byly v Súdánu a Egyptě publikovány za posledních zhruba sedmdesát let výzkumu, a dále uvádíme termíny pro jednotlivé morfologické a funkční typy. Následně, po představení naší výzkumné oblasti a sídelního systému v této oblasti v období mezolitu a časného neolitu, jsme provedli srovnání dvou souborů z analytických povrchových sběrů na mezolitické lokalitě Sfinga (SBK.W-60) a mezolitické až časně neolitické lokalitě Liščí kopec (SBK.W-20) ve dvou rozdílných, ale sousedících, ekozónách v západní části pohoří Sabaloka, které představuje příkladovou oblast pro výzkum mezolitu a neolitu na středním Nilu. Naše cíle byly: 1) Sjednotit terminologii a vytvořit pokud možno jednoduchý a univerzální popisný systém; 2) Pomocí dvou konkrétních a archeologicky nejbohatších lokalit ukázat, které typy artefaktů a jaké aktivity lze zachytit v západní části pohoří Sabaloka; 3) Zjistit, zda jsou tyto soubory v něčem specifické a zda je možné od sebe odlišit artefakty z mezolitu a časného neolitu; 4) Nastínit témata, která lze v budoucnu řešit v tomto archeologicky náročném prostředí.

2. Práce o kamenných broušených artefaktech a využívaných terminologiích v Súdánu a Egyptě

Přehled dosud publikovaných prací o GS v Súdánu nabídl dobrou představu o (a) přístupech k jejich klasifikaci v průběhu posledních 70 let a dále o tom (b), které konkrétní tvary se vyskytují v mezolitu a které spíše v neolitu (*tab. 1–2*). Pro klasifikaci GS byl vždy základem aktuální tvar artefaktů (například domnělých brousků), umístění aktivních (pracovních) ploch a jejich zakřivení v nárysu a bočních pohledech, případně výskyt mikro-residuí na pracovních plochách. Zcela výjimečně se autoři prací opírali o nálezové kontexty, o pracovní stopy, mnohem častěji však o analogie z etnografických výzkumů a o analogie z jiných geografických oblastí.

GS na území dnešního Egypta byla věnována poněkud větší pozornost, zejména nejvýraznější funkční skupině – nástrojům na drcení a mletí především rostlinných zrn a semen. Inspirativní práce většinou obsahují celkové počty artefaktů, údaje o stavu jejich dochování, informace o využívaných surovinách (a o jejich provenienci) a popis tvarů. Tento slovní popis bývá doplněn obrazovou dokumentací, včetně fotografií. Přes všechna pozitiva lze i v uvedených publikacích zaznamenat absenci jednotné terminologie a klasifikačních systémů a dále absenci údajů o počtech některých funkčních skupin (viz např. *Lucarini 2014*, 285; *Roubet 1989a*, 470).

Stejně jako J. L. Adams vycházíme při studiu GS z předpokladu, že „dnešní tvar artefaktu ne vždy odráží jeho původně navržený tvar“ (*Adams 2002*, 11). Z tohoto důvodu bylo nutné odlišně hodnotit předměty s dobře identifikovatelnými původními tvary a/nebo dobře identifikovatelnými pracovními plochami na jedné straně a na straně druhé předměty, jejichž tvar evidentně vznikl až v důsledku jejich používání (např. brousky). Zjednodušena byla též terminologie (*tab. 3–4*).

Všechny artefakty ze specifických surovin, nesoucí stopy po broušení, byly rozděleny do základních tříd podle způsobu tvarování (*tab. 4*). U některých předmětů převládá spíše původní přírodní povrch a k jejich úpravě stačilo jednoduché otloukání (typicky tzv. otloukače/drtiče, které se v našich souborech téměř nevyskytují). Další artefakty mají povrch upravený otloukáním – hrubším i jemným – či broušením. Do této třídy je možné zařadit ruční kamenné mlýnky, využívané pro drcení a mletí rozmanitých produktů. Z předchozích prací vyplývá, že tuto třídu lze podle umístění pracovní plochy a jejího zakřivení rozdělit na dva kompatibilní typy (dvě kompatibilní části) – dolní (statické) kameny a horní (aktivní) kameny. Podle dalších morfometrických kritérií (viz *níže*) lze oba typy dělit do dalších pěti (dolní kameny) a tří (horní kameny) podtypů (*obr. 18–19*).

Do GS patří i další artefakty, jejichž povrch byl od samého začátku redukován s jasnou představou o výsledném tvaru. Minimálně v závěrečné fázi byly tyto artefakty též broušeny a v centrální části perforovány naklepáváním a vrtáním z obou protilehlých stran. Do této třídy náleží vrtané kamenné disky (*obr. 8*). Pro zařazení do tříd jsou vždy nejproblematičtější předměty, jejichž většina povrchu nebo i celý předmět, byly broušeny. Zároveň však nelze jednoznačně rozhodnout, zda k tomu došlo již při primárním tvarování, tak jako v předchozím případě, nebo zda jde až o důsledek dlouhodobého (?) používání. Všechny tyto morfologicky variabilní předměty, vyrobené v námi sledovaném regionu výhradně z různých variant pískovců, jsou klasifikovány jako brousky (*obr. 9*). V práci jsme se naopak nezabývali nástroji, u nichž bylo pro jejich tvarování primárně využíváno otloukání-štípání (tesly), anebo se jedná o vzácné a většinou chronologicky mladší nálezy (bulavy, sekerky a různé závěsky, ozdoby). V našich sběrových souborech se buď nevyskytují, nebo jim byly věnovány úžeji zaměřené práce (např. *Kapustka et al. 2019*).

V publikacích je možné sledovat různé přístupy ke grafické dokumentaci GS, od realistických ztvárnění až po schémata zaměřená spíše na techniku výroby a výrobní (a pracovní) stopy, doplněná v ideálním případě fotografiemi s měřítkem. Pro účely této práce jsme zvolili druhou možnost (*obr. 10–17*). Tímto způsobem je totiž možné zvýraznit určité technologické a morfologické proměnné (např. umístění aktivních částí, přítomnost zářezů atd.), kterými se v práci řídíme, a zároveň lze provést rychlé srovnání s navrženým popisným kódem (např. *obr. 7*).

3. Zájmová oblast a studované soubory

Pohoří (arabsky Jebel) Sabaloka je pohoří sopečného původu nacházející se v geografickém srdci mezolitického a neolitického osídlení středního Súdánu, ca 80 km severně od Chartúmu. Pohoří představuje výrazný geomorfologický útvar v poměrně plochém terénu, charakteristickém pro tuto část Súdánu. Pohoří je Nilem rozděleno na dvě části (*Almond – Ahmed 1993*, 8). Předtím, než Nil vstoupí do pohoří, rozdělí se na dvě ramena, která protékají po obou stranách ostrova Džazírat Wa arabéja (*obr. 2*). Jižní části ostrova dominuje hora Rauwiján (594 m), jejíž horní část je tvořena silně silicifikovaným núbijským pískovcem (*Almond – Ahmed 1993*, 35). Ve spodní části se vyskytují rozmanité tvrdé horniny (především různé druhy ryolitů, čediče a žuly), které spolu se silicifikovaným pískovcem tvoří kvalitní suroviny pro výrobu kamenných nástrojů (*obr. 2*).

První ekozóna, oblast Skalních měst (celkem 15 lokalit) na severozápadním okraji pohoří Sabaloka, se nachází mezi 2,5 a 5 km od Nilu a pravděpodobně to byla v raném až středním holocénu suchá savana s omezenými zdroji vody. Druhá ekozóna, oblast Jezerní pláně (celkem 14 lokalit) na jihozápad od pohoří, je naproti tomu nízko položená zóna ne více než 1,7 km od Nilu, která se na počátku holocénu vyznačovala vlhčím prostředím, ovlivněným periodickými záplavami Nilu (srov. *Williams et al. 2010*). Další tři lokality se nacházejí mimo obě ekozóny. Většina lokalit v obou ekozónách je vázána na žulové výchozy. Důkazy mezolitických aktivit byly nalezeny na 28 lokalitách, období neolitu je zastoupeno na 15 lokalitách, z nichž se však žádná nenachází v oblasti Skalních měst.

Lokalita **Sfinga** je situována na severozápadním okraji pohoří Sabaloka, ca 3,5 km od Nilu. Jedná se o jedno z nejvýznamnějších pozdně pravěkých nalezišť ve Skalních městech, s dokladem velmi intenzivního mezolitického osídlení, přičemž část lokality byla po omezenou dobu využívána také jako pohřebiště (*Varadzinová – Varadzin 2017*; *Varadzinová et al. in press*). Detailní povrchový průzkum zaměřený na GS byl v r. 2015 proveden na ploše 792,1 m². Uvedená plocha se nachází ca 15 m nad okolní krajinou a zřejmě tvoří sídelní jádro lokality. V roce 2015 byly GS sbírány po dobu devíti dnů. Nálezy byly evidovány a dokumentovány v pěti částech, tzv. areálech (v této práci Areály 1–5; *obr. 3*).

Lokalita **Liščí kopec** (ca 4,1 km jihozápadně od Sfingy) se nachází na velkém žulovém návrší v oblasti Jezerní pláně, ca 1,1 km od Nilu. Lokalita se skládá z 16 geomorfologicky vymezených plošin a teras (v této práci Areály 1–16; *obr. 3*), které jsou situovány ve výšce 3 až 24 m nad okolní krajinou a celkem dosahují plochy 11 648 m². Vzhledem k postižení některých plošin mladšími aktivitami a vzhledem k jejich rozsahu nebylo možné provést detailní povrchový sběr na všech částech lokality jako v případě Sfingy. Povrchový sběr v Areálech 1 (1756 m²) a 3 (1669 m²) byl proveden ve třech dnech, soubory z Areálů 10 (1028 m²) a 13 (1311 m²) byly během jednoho dne shromážděny dvěma osobami.

Analýzy proběhly u celkem 1357 artefaktů (526 kg) z obou lokalit. Nálezy GS byly hodnoceny pouze makroskopicky. Evidována byla surovina, tvar a hmotnost artefaktů. Nálezy byly tříděny podle zachovalosti s upřesněním dochované části. Morfometrická analýza byla zaměřena na popis tvaru, způsob tvarování a velikost artefaktu, na obrysové křivky aktivních ploch, na makroskopicky pozorovatelné stopy opotřebení, na sekundární úpravy (včetně omlazení/drsnění aktivních povrchů) nebo na stopy záměrného zničení. Kompletně zachovalé nástroje a další artefakty byly měřeny a zakresleny v podélném i příčném řezu. Získaná data byla zanesena do databáze a z výkresů a fotografií byl vybudován archiv dokumentace.

4. Výsledky

Podíl GS z mezolitické lokality Sfinga činí 485 (251 kg) případů (mlýnky = 480; vrtané disky = 2; brousky = 3), podíl z mezolitické až časně neolitické lokality Liščí kopec tvoří 872 (275 kg) artefaktů (mlýnky = 835; vrtané disky = 13; brousky = 24). Srovnání obou lokalit (*tab. 6*) ukazuje absolutní převahu křemenců-pískovců (97 %) v produkci GS. Naprostou většinu tvoří fragmenty artefaktů, čemuž odpovídá rychlé opotřebení těchto surovin sedimentárního původu. Tři základní třídy artefaktů rozdělené podle výroby – drticí-mlecí nástroje (GMT), vrtané disky (R) a brousky (A) – byly klasifikovány z výše uvedených důvodů odlišně, podle speciálně vytvořených popisných systémů (*obr. 6–9*), liší se i způsob jejich dokumentace (*obr. 10–17*). Na základě zvolených morfometrických kritérií bylo v některých třídách možno rozlišit další typy a podtypy (např. *obr. 18–19*).

V našem souboru zaznamenáváme minimálně pět případů sekundárního použití GMT. Ve všech případech byly nástroje po jejich druhotné úpravě použity k podobnému účelu, pro který byly původně vyrobeny. Převažuje sekundární úprava dolních kamenů na horní kameny (čtyři případy u Sfingy), objevuje se i výroba spodních kamenů z horních kamenů (Liščí kopec).

Na obou studovaných lokalitách se také setkáváme se dvěma výrobními kategoriemi vrtaných disků – s finálními výrobky a tím, co nazýváme polotovary (*tab. 10*). Mezi polotovary zahrnujeme původně horní kameny nebo v ojedinělých případech pravděpodobně i zlomky spodních kamenů z pískovců s jednou, nebo častěji se dvěma protilehlými kruhovými prohlubněmi v centrální části, které nejsou propojené (zřejmě došlo k jejich rozlomení v průběhu perforace). Převažují fragmenty nedokončených disků (ve většině případů lze odhadnout, že jde zhruba o poloviny původních horních kamenů; *obr. 17: 2*), ale byly nalezeny i dva kompletní horní kameny se dvěma protilehlými prohlubněmi (*obr. 17: 3*). Podobné nálezy známe například z prostoru nemocnice v Chartúmu (*Arkell 1949*, tabule 34) nebo z lokality Kadero Midden (*Jórdeczka 2011*, foto 6: 4).

Srovnávací tabulka (*tab. 11*) ukazuje, že pouze minimální počet dolních kamenů může být označen za kompletní. Představují pouhá 3,2 % u Sfingy a 5,1 % u Liščího kopce. Je však důležité dodat, že v některých případech není jisté, zda předpokládané kompletní nástroje mají původní rozměry, nebo zda se jedná o dodatečně upravené fragmenty mnohem větších kusů.

Situace je zcela odlišná, když porovnáme horní kameny z obou lokalit (*tab. 12*). U Sfingy je doloženo 43,4 % kompletních kusů, a když k nim připočteme z více než poloviny dochované (a tedy stále použitelné) nástroje, činí tento podíl 70,4 % nástrojů. Podobně je na Liščím kopci 20,2 % kompletních kusů, a když k tomu znovu připočteme nástroje dochované z více než poloviny, představují použitelné nástroje ne méně než 48,6 %.

Pokud jde o vrtané disky (celkem 15 kusů), nebyl nalezen ani jeden kompletní exemplář. Z celkem 27 brousků jsou pravděpodobně kompletní pouze tři případy, jde však o hrubý odhad, protože některé kusy mohly být záměrně malých rozměrů a jsou považovány za fragmenty.

5. Shrnutí a diskuse

Porovnáme-li GS z našeho zkoumaného regionu a ze současných lokalit z oblasti předovýchodní Levanty, lze zaznamenat některé nápadné rozdíly (např. *Wright 1992*; *Rosenberg – Garfinkel 2014*). Tyto rozdíly nespočívají ani tak v množství artefaktů, jako spíše ve spektru použitých tvarů (širší spektrum v Levantě) a hlavně ve velikostech. Tyto rozdíly jsou pravděpodobně nejmarkantnější u horních kamenů třídy GMT, ve které se objevuje více „dvouručních" (ruce jsou při používání vedle sebe) horních kamenů v Levantě, téměř žádné v Súdánu, ale ani ve větší části severovýchodní Afriky v daném období.

Výsledky morfometrické analýzy naznačily několik činností prováděných s využitím GS, zejména pro drcení-mletí (*obr. 18–19*) různých substancí. Například podtypy LF, které nejlépe pasovaly k různým horním kamenům s plochými (rovnými) plochami (UC a UE). LB typy bylo možné rozdělit do čtyř podtypů LB 1 – LB 4. Zatímco LB 1, LB 2 a možná LB 4 mohly nejlépe fungovat s horními kameny podtypů UC a UE (s kulatými nebo konvexními plochami), LB 3 byly nejlépe kompatibilní s pravidelnými sféroidy (podtypy US). Všechny tyto nástroje však sloužily vzhledem k malým rozměrům ke zpracování spíše menšího množství produktů, což je markantní rozdíl oproti předovýchodním nálezům.

Spodním kamenům zcela dominují podtypy LB, které byly nejnáročnější jak z hlediska technologie tvarování, tak v množství dopravovaných surovin. Jsou často pečlivě tvarované a surovinou pro jejich výrobu jsou téměř výhradně různorodé křemence-pískovce. Tyto nástroje zároveň vykazují největší opotřebení a největší fragmentarizaci. Tyto skutečnosti by mohly naznačovat důležitý význam těchto nástrojů. Jejich víceméně rovnoměrné rozmístění v obou ekozónách – Skalních městech i Jezerní pláni – ukazuje na vcelku univerzální využití těchto artefaktů, nejen při zpracování semen ze sušší zóny Skalních měst (Sfinga), ale například též pro zpracování dalších materiálů jako je jíl nebo minerály, ale i jedlé hlízy a kořeny, vázaných spíše na vlhčí prostředí Jezerní pláně (Liščí kopec). Například v dnešním Egyptě se dolní kameny s podobnými konkávními aktivními plochami (podtypy LB v naší klasifikaci) sice ojediněle vyskytují již v pozdním paleolitu (*Banks 1982*), jejich hlavní využití je však datováno až kolem ca 5000 BC a pravděpodobně souvisí s přítomností domestikovaných zdrojů potravy (*Wendorf – Schild /eds./ 2001*, 423). Podobné nálezy pocházejí z tohoto období z vesnice Hidden Valley v oáze Farafra (*Lucarini 2014*, 291).

Brousky mohly být použity k broušení, hlazení a leštění předmětů (stěny keramických nádob, stěny a podlahy domů atd.; tj. AF, AP), k broušení organických (kosti, ratiště; tj. AG) a dalších předmětů (sekery, tesly), možná i pro čištění průvrtů (AO?). Na obou lokalitách se vyskytují také vrtané disky (R), možná části kompozitních rycích holí.

Důležitou otázkou, kterou jsme v této práci zabývali, je ta, zda je možné třeba i s pomocí dalších souborů z jiných lokalit (včetně stratifikovaných souborů) rozlišit čistě mezolitické a čistě časně neolitické artefakty. Viděli jsme, že například brousky a vrtané disky jsou četnější v souboru z Liščího kopce, kde byly nalezeny fragmenty časně neolitické keramiky a množství tesel (např. *Kapustka et al. 2019*). V kapitole 4 jsme však mohli vidět, že téměř všechny morfologické skupiny se vyskytují na obou lokalitách (*tab. 13–14*). Obě místa jsou podobná v převaze dolních kamenů (podtypů LB – 83,6 % u Sfingy; 68,4 % u Liščího kopce). Můžeme také dodat, že zatímco podtypy LB 1, LB 2 a LB 4 se vyskytují na obou lokalitách, podtyp LB 3 je zastoupen pouze na Liščím kopci, kde však bylo zjištěno jen několik případů. Pokud se podíváme na horní kameny, pouze ty ve tvaru pravidelných koulí/sféroidů (podtyp US) pocházejí výhradně ze Sfingy. Výskyt US v severovýchodní Africe zahrnuje již kontexty středního paleolitu, pozdního paleolitu, mezolitu a neolitu (*Wendorf – Close 1993*; *Roubet 1989b*, 483, obrázek 25.11 vpravo; *Zarattini 1983*; *Jórdeczka 2011*; *Shirai 2010*). Jejich výskyt během časného neolitu je ve středním Súdánu doložen na lokalitě Kadero 1, vzdálené asi 50 km jižně od pohoří Sabaloka (*Jórdeczka 2011*). Jinak můžeme stejně jako u spodních kamenů konstatovat, že se tvarové varianty horních kamenů s podobným počtem a umístěním aktivních ploch nacházejí na obou studovaných lokalitách. Všude jednoznačně převládá podtyp UE.

Na obou studovaných lokalitách existují podobné doklady výroby GS ve formě kusů suroviny a úštěpů. Obě lokality (a další v regionu) vykazují konzistentní výskyt kompletních nebo ještě použitelných horních kamenů.

Častý výskyt kompletních horních kamenů není v pravěku údolí Nilu a egyptské Západní pouště až tak výjimečný. Z 90 exemplářů shromážděných z pozdně paleolitických lokalit ve Wádí Kubbaníja bylo 37 kusů (41,1 %) kompletních (*Wendorf – Schild – Close /eds./ 1989*) a z 35 případů nalezených v pozdně (Qadan) paleolitických lokalitách v Tošce bylo až 29 kusů kompletních (82,9 %; *Wendorf /ed./ 1968*). V souborech raného a středního holocénu z Nabty Plaji, kde bylo možné porovnat poměry fragmentárních a kompletních horních kamenů na sedmi lokalitách (*Wendorf – Schild /eds./ 2001*), bylo 520 z 1427 případů (36 %) považováno za kompletní. V prostoru sídliště Hidden Valley bylo kompletních 13 (57 %) z 23 horních kamenů a v prostoru údolí Hidden Valley bylo kompletních 22 (35 %) ze 62 kusů (*Lucarini 2014*, 288, 294). Na všech zmíněných lokalitách se vyskytují prakticky všechny morfologické varianty horních kamenů, včetně těch s plochými a/nebo konvexními plochami, které jsme registrovali v západní části pohoří Sabaloka. Také srovnání hlavních rozměrů – délky a šířky – kompletních horních kamenů od paleolitu po raně neolitické soubory ze Súdánu a Egypta (*obr. 20*; a viz *Lucarini 2014*, 290, 295) ukazuje na velmi dlouhou tradici v této oblasti. Jedná se o nástroje menších rozměrů, zejména pro použití jednou rukou, nebo oběma rukama na sobě, jak při pohybu tam a zpět, tak krouživým způsobem.

Množství a intenzivní opotřebení horních kamenů a dominantní typ spodních kamenů (podtyp LB) jasně ukazují, že drcení a mletí bylo ve zkoumaném regionu velmi častou činností. Zdejší nástroje však nebyly morfometricky uzpůsobeny pro zpracování většího množství produktů, jako například velké sedlovité mlýnky v Evropě (např. *Hamon 2008*) nebo dvouruční horní kameny známé z východní Afriky zejména v mladších obdobích (např. *Nixon-Darcus – Meresa 2020*).

Z výsledků našich analýz vyplývá, že GS nelze jednoduše použít pro chronologické zařazení do mezolitu či časného neolitu. Pomineme-li dekorativní styly a tvary keramických nádob, pak jedině přítomnost/nepřítomnost plošně štípaných tesel z ryolitů a výskyt kosterních pozůstatků domestikovaných zvířat představuje spolehlivý chronologický ukazatel. Z GS lze mezi spolehlivější neolitické ukazatele zařadit ještě sekery a bulavy, jež se však běžně v povrchových souborech nevyskytují. Domníváme se, že ačkoliv nelze GS použít pro chronologické zařazení lokalit, velmi dobře dokládají tyto artefakty dlouhodobou specializaci místních komunit. Spektrum GS odráží dlouhodobou adaptaci na místní ekologická prostředí bohatá na zdroje obživy nejen v období mezolitu, ale i v období časného neolitu. Důležitým zjištěním (nejen) v tomto regionu je častý výskyt kompletních horních kamenů. To svědčí o tom, že tyto nástroje zřejmě nebyly přepravovány mezi lokalitami, a také o tom, že produkty zpracovávané těmito nástroji byly běžně dostupné. To by mohlo ukazovat na dlouhodobou rezidenční stabilitu v regionu pohoří Sabaloka, přinejmenším v mezolitu (do tohoto období patří většina lokalit), ale model nízké mobility a ekonomické stability nelze vyloučit ani pro časný neolit.

6. Závěr

V naší práci jsme ukázali, že studium GS má smysl i v takto problematickém archeologickém nálezovém prostředí. Pokusili jsme se sjednotit terminologii GS a nabídnout jednoduchý popisný systém pro srovnávací analýzy z jiných oblastí. Klasifikace je založena na popisu základních tvarů GS a využití základních rozměrů. I když je možné v této fázi výzkumu popsat základní činnosti, prováděné na pozdně pravěkých lokalitách, přesnější funkční interpretace jednotlivých typů bude možná až po srovnávacích analýzách pracovních stop, a pokud budou tyto artefakty odkryty ve vhodném nálezovém prostředí, po analýzách fytolitů, škrobových zrn či dalších mikro-residuí z aktivních ploch (např. *Lucarini – Radini 2019*; *Lucarini et al. 2016*). Zcela jasná zatím není ani chronologická a funkční souvislost s vybroušenými pravidelnými prohlubněmi na žulových útvarech, které lze pozorovat na všech mezolitických lokalitách v regionu, méně často na neolitických.

Ukázali jsme, že výběr surovin, výroba, typové spektrum, způsob použití a skartace GS tvoří dohromady poměrně složitý, ale specifický vzorec chování místních komunit. Naše dosavadní výzkumy ukazují, že tento vzorec byl v regionu plně rozvinut již mezolitickými lovci-sběrači-rybáři mezi ~9000–5000 cal BC. V západní části pohoří Sabaloka lze doložit kontinuitu některých aktivit pozdních lovců- sběračů-rybářů a nejstarších zemědělců. Různé třídy GS, nalezené v regionu, nezávisely na ekonomice skupin, která byla tak jako jinde ve světě mezi mezolitem a neolitem odlišná, ale na řadě činností spojených s každodenním životem.

References

Adams, J. L. 2002:
Ground stone analysis. A technological approach. Tucson: The University of Utah Press.

Adams et al. 2009:
Adams, J. L. – Delgado, S. – Dubreuil, L. – Hamon, C. – Plisson, H. – Risch, R. 2009:
Functional analysis of macro-lithic artefacts: a focus on working surfaces. In: Sterke, F. – Eigeland, L. J. – Costa, J. /eds./: Non-Flint Raw Material Use in Prehistory – Old prejudices and new directions. BAR International Series 1939. Oxford, 43–66.

Allan, W. N. – Smith, R. J. 1948:
Irrigation in the Sudan. In: Tothill, J. D. /ed./: Agriculture in the Sudan. London: Oxford University Press, 593–632.

Almond, D. C. – Ahmed, F. 1993:
Field Guide to the Geology of the Sabaloka Inlier, Central Sudan. Khartoum: Khartoum University Press.

Arkell, A. J. 1949:
Early Khartoum. An Account of the excavation of an early occupation site carried out by the Sudan Government Antiquities Service in 1944–5. Oxford: Oxford University Press.

Arkell, A. J. 1953:
Shaheinab. An account of the excavation of a Neolithic occu-

pation site carried out for the Sudan Antiquities Service in 1949–50. Oxford: Oxford University Press.

Banks, K. M. 1982:
Late Paleolithic and Neolithic Grinding Implements in Egypt. Lithic Technology 11/1, 12–20.
DOI: 10.1080/01977261.1982.11760593

Baysal, A. – Wright, K. I. 2005:
Cooking, crafts and curation: the ground stone artefacts from Çatalhöyük, 1995–1999. In: Hodder, I. /ed./: Changing Materialities at Çatalhöyük: reports from the 1995–1999 seasons. Ankara: British Institute at Ankara, McDonald Institute for Archaeological Research.

Barich et al. 2014:
Barich, B. A. – Lucarini, G. – Hamdan, M. A. – Hassan, F. A. /eds./:
From Lake to Sand. The Archaeology of Farafra Oasis Western Desert, Egypt. Florence: F. A. Edizioni All'Insegna del Giglio.

Brass et al. 2019:
Brass, M. – Fuller, D. Q. – MacDonald, K. – Stevens, C. – Adam, A. – Kozieradzka-Ogunmakin, I. – Abdallah, R. – Alawad, O. – Abdalla, A. – Vella Gregory, I. – Wellings, J. – Hassan, F. – Abdelrahman, A.:
New findings on the significance of Jebel Moya in the eastern Sahel. Azania: Archaeological Research in Africa 54(4), 425–444.
https://doi.org/10.1080/0067270X.2019.1691845

Cane, S. 1989:
Australian Aboriginal seed grinding and its archaeological record: a case study from the Western Desert. In: Harris, D. R. – Hillman, G. C. /eds./: Foraging and farming. The evolution of plant exploitation. London: Unwinhyman, 99–119.

Caneva, I. 1983:
Excavating Saggai 1. In: *Caneva, I. /ed./*: 7–29.

Caneva, I. 1988a:
The cultural Equipment of the early Neolithic occupants of Geili. In: *Caneva, I. /ed./*: 141–143.

Caneva, I. 1988b:
Late Neolithic to Recent Graves at Geili. In: *Caneva, I. /ed./*: 151–187.

Caneva, I. /ed./ 1983:
Pottery Using Gatherers and Hunters at Saggai (Sudan): Preconditions for Food Production, Origini XII. Rome.

Caneva, I. /ed./ 1988:
El Geili. The history of a Middle Nile environment 7000 BC – AD 1500. Cambridge Monographs in African Archaeology 29. BAR International Series 424. Oxford.

Caneva, I. – Gautier, A. 1994:
The Desert and the Nile. Archéologie du Nil Moyen 6, 65–92.

Caneva, I. – Zarattini, A. 1984:
Saggai: A Settlement of Hunters-Fishers north of Khartoum. In: Krzyżaniak, L. – Kobusiewicz, M. /eds./: Origin and Early Development of Food-Producing Cultures in North-Eastern Africa. Poznań, 301–306.

Chłodnicki, M. – Kobusiewicz, M. – Kroeper, K. /eds./ 2011:
Kadero. The Lech Kryżaniak excavations in the Sudan. Poznań: Muzeum Archeologiczne w Poznaniu.

Clark, J. D. 1989:
Shabona. An Early Khartoum settlement on the White Nile. In: Krzyżaniak, L. – Kobusiewicz, M. /eds./: Late prehistory of the Nile Basin and the Sahara. Poznań, 387–410.

Dietrich et al. 2019:
Dietrich, L. – Meister, J. – Dietrich, O. – Notroff, J. – Kiep, J. – Heeb, J.:
Cereal processing at Early Neolithic Göbekli Tepe, south-eastern Turkey. PLoS ONE 14(5): e0215214.
https://doi.org/10.1371/journal.pone.0215214

Dubreuil, L. 2001:
Functional Studies of Prehistoric Grindingstones: a Methodological Research. Bulletin du CRFJ 9, 73–87.

Dubreuil, L. 2004:
Long-term trends in Natufian subsistence: a use-wear analysis of ground stone tools. Journal of Archaeological Science 31, 1613–1629.
DOI: 10.1016/j.jas.2004.04.003

Edwards, D. N. 2004:
The Nubian Past: An Archaeology of the Sudan. Routledge.

Elamin, Y. M. – Mohammed-Ali, A. S. 2004:
Umm Marrahi. An early Holocene ceramic site, north of Khartoum (Sudan). Sahara 15, 97–110.

Fernández, V. M. /ed./ 2003:
The Blue Nile Project. Holocene Archaeology in Central Sudan. Complutum 14. Madrid: Servicio de Publicaciones, Universidad Complutense.

Fernández, V. M. – Jimeno, A. – Menéndez, M. 2003:
Archaeological survey in the Blue Nile area, Central Sudan. In: *Fernández, V. M. /ed./*: 201–272.

Garcea, E. A. A. 2006:
Semi-permanent foragers in semi-arid environments of North Africa. World Archaeology 38/2, 197–219.

Garcea, E. A. A. 2016:
Multi-stage dispersal of Southwest Asian domestic livestock and the path of pastoralism in the Middle Nile Valley. Quaternary International 412, 54–64.

Garcea, E. A. A. 2020:
The Prehistory of the Sudan. Springer International Publishing.

Haaland, R. 1981:
Migratory herdsmen and cultivating women. The structure of Neolithic seasonal adaptation in the Khartoum Nile environment. Bergen: Universitet i Bergen.

Hachem, L. – Hamon, C. 2014:
Linear Pottery Culture Household Organisation. An Economic Model. In: Whittle, A. – Bickle, P. /eds./: Early farmers. The view from Archaeology and Science. Proceedings of the Britisch Academy 198, 159–180.
DOI: 10.5871/bacad/9780197265758.003.0009

Hamon, C. 2008:
Functional analysis of stone grinding and polishing tools from the earliest Neolithic of north-western Europe. Journal of Archaeological Science 35, 1502–1520.

Hildebrand, E. A. – Schilling, T. M. 2016:
Storage amidst early agriculture along the Nile: Perspective from Sai Island, Sudan. Quaternary International 412 (Part B), 81–95.

Hildebrand et al. 2018:
Hildebrand, E. A. – Garcea, E. A. A. – Florenzano, A. – Mercuri, A. M.:
Multiscalar perspectives on Holocene climatic and environmental changes in the Sahara and Nile corridor, with special consideration of archaeological sites on Sai Island, Sudan. In: Mercuri, A. M. – D'Andrea, C. – Fornaciari, R. – Höhn, A. /eds./: Plants and people in Africa's past: Progress in African archaeobotany. New York: Springer, 215–245.

Holdaway et al. 2016:
Holdaway, S. J. – Philipps, R. – Emmitt, J. – Wendrich, W.:
The Fayum revisited: Reconsidering the role of the Neolithic package, Fayum north shore, Egypt. Quaternary International 410(A), 173–180.
DOI: 10.1016/j.quaint.2015.11.072

Holdaway, S. J. – Wendrich, W. /eds./ 2017:
The Desert Fayum Reinvestigated. The Early to Mid-Holocene Landscape Archaeology of the Fayum North Shore, Egypt. Monumenta archaeologica 39. Los Angeles: UCLA Cotsen Institute of Archaeology Press.

Jórdeczka, M. 2011:
Stone Implements. In: *Chłodnicki, M. – Kobusiewicz, M. – Kroeper, K. /eds./*: 299–323.

Kapustka, K. – Winiarska-Kabacińska, M. 2020:
Comparison of Different Gouge Collections from Central Sudan. Archaeologia Polona 58, 165–178.

Kapustka et al. 2019:
Kapustka, K. – Lisá, L. – Bajer, A. – Buriánek, D. – Varadzin, L. – Varadzinová, L.:
Gouges: Iconic artifacts of the Early Neolithic period in Central Sudan. African Archaeological Review 36, 505–534.

Krzyżaniak, L. 1977:
Early Farming Cultures on the Lower Nile. Warszawa: Editions Scientifiques de Pologne.

Krzyżaniak, A. 2011:
Neolithic cemetery. In: *Chłodnicki, M. – Kobusiewicz, M. – Kroeper, K. /eds./*: 57–197.

Kuper, R. – Kröpelin, S. 2006:
Climate-Controlled Holocene Occupation in the Sahara: Motor of Africa's Evolution. Science 11/313, Issue 5788, 803–807. DOI: 10.1126/science.1130989

Lucarini, G. 2014:
Large stone tools from the Hidden Valley village and basin. In: Barich, B. E. – Lucarini, G. – Hamdan, M. A. – Hassan, F. A. /eds./: From Lake to Sand. The Archaeology of Farafra Oasis, Western Desert, Egypt. Florence: All'Insegna del Giglio, 285–299.

Lucarini, G. – Radini, A. 2019:
First direct evidence of wild plant grinding process from the holocene sahara: Use-wear and plant micro-residue analysis on ground stone tools from the Farafra Oasis, Egypt. Quaternary International 555, 66–84.

Lucarini et al. 2016:
Lucarini, G. – Radini, A. – Barton, H. – Barker, G.:
The exploitation of wild plants in Neolithic North Africa. Use-wear and residue analysis on non-knapped stone tools from the Haua Fteah cave, Cyrenaica, Libya. Quaternary International 410, 77–92.

Magid, A. A. 2003:
Exploitation of food-plants in the Early and Middle Holocene Blue Nile area, Sudan and neighbouring areas. In: Fernández, V. M. /ed./: The Blue Nile Project. Holocene archaeology in Central Sudan. Complutum 14. Madrid: Servicio de Publicaciones, Universidad Complutense, 345–372.

Marks, A. E. – Mohammed-Ali, A. S. /eds./ 1991:
The Late Prehistory of the Eastern Sahel. Dallas: Southern Methodist University Press.

Nixon-Darcus, L. – Meresa, Y. 2020:
Men at Work: Grinding Stone Production by the Experts and Others in Northern Ethiopia. Journal of Lithic Studies 2020/7, 1–24.
DOI: https://doi.org/10.2218/jls.3091

Pavlů, I. – Rulf, J. 1991:
Stone industry from the Neolithic site of Bylany. Památky archeologické 82, 277–365.

Peacock, D. 2013:
The Stone of Life: Querns, Mills and Flour Production in Europe up to c. AD 500. Southhampton Monographs in Archaeology New Series 1. Southampton: Highfield Press.

Procopiou, H. – Treuil, R. /eds./ 2002:
Moudre et broyer I – Méthodes. Paris: CTHS.

Rosenberg, D. – Garfinkel, Y. 2014:
Shaʿar Hagolan 4. The Ground Stone Industry: Stone Working at the Dawn of Pottery Production in the Southern Levant. Jerusalem: Israel Exploration Society/Institute of Archaeology/The Hebrew University of Jerusalem.

Rosenberg, D. – Rowan, Y. – Gluhak, T. 2016:
Introduction. Leave no stone unturned: Perspectives on ground stone artefact research. In: Rosenberg, D. – Rowan, Y. – Gluhak, T. /eds./: Proceedings of the 1st Meeting of the Association for Ground Stone Tools Research University of Haifa, July 2015. Journal of Lithic Studies 3/3, 1–15.
DOI: https://doi.org/10.2218/jls.v3i3

Roubet, C. 1989a:
Methods of Analysis of Grinding Implements, Chapter 24. In: *Wendorf, F. – Schild, R. – Close, A. E. /eds./*: 470–472.

Roubet, C. 1989b:
The Grinding Stones of Site E-78-3, Wadi Kubbaniya, Chapter 25. In: *Wendorf, F. – Schild, R. – Close, A. E. /eds./*: 473–489.

Roubet, C. 1989c:
Report on Site E-82-1: A Workshop for the Manufacture of Grinding Stones at Wadi Kubbaniya. In: *Wendorf, F. – Schild, R. – Close, A. E. /eds./*: 588–608.

Rowan, Y. M. – Ebeling, J. R. /eds./ 2008:
New Approaches to Old Stones. Recent Studies of Ground Stone Artifacts. London/Oakville: Equinox.

Řídký, J. 2017:
The ground stones from Sphinx. Sudan & Nubia 21, 39–42.

Salvatori, S. – Usai, D. 2019:
The Mesolithic and Neolithic in Sudan. In: Raue, D. /ed./: Handbook of Ancient Nubia, Vol. 1. Berlin/Boston: De Gruyter, 171–193.

Schön, W. – Holter, U. 1990:
Grinding implements from the Neolithic and recent times in desert areas in Egypt and Sudan. Beiträge zur Allgemeinen und Vergleichenden Archäologie 9-10, 359–379.

Shirai, N. 2010:
The Archaeology of the First Farmer-herders in Egypt: New Insights into the Fayum Epipalaeolithic and Neolithic. Leiden: Leiden University Press.

Shirai, N. 2018:
New Light on The Desert Fayum: Restudying Gertrude Caton-Thompson's Fayum Lithic Collections in London. Studies in African Archaeology 15, 603–619.

Shoemaker, A. C. – Davies Mathew, I. J. – Moore, H. L. 2017:
Back to the Grindstone? The Archaeological Potential of Grinding-Stone Studies in Africa with Reference to Contemporary Grinding Practices in Marakwet, Northwest Kenya. African Archaeological Review 34, 415–435.
DOI: 10.1007/s10437-017-9264-0

Squitieri, A. – Eitam, D. /eds./ 2019:
Stone Tools in the Ancient Near East and Egypt. Ground stone tools, rock cut installations and stone vessels from Prehistory to Late Antiquity. Oxford: Archaeopress.

Suková, L. – Cílek, V. 2012:
The landscape and archaeology of Jebel Sabaloka and the Sixth Nile cataract, Sudan. Interdisciplinaria Archaeologica: Natural Sciences in Archaeology III(2), 189–201.

Suková, L. – Varadzin, L. 2012:
Preliminary report on the exploration of Jebel Sabaloka (West Bank), 2009–2012. Sudan & Nubia 16, 118–131.

Usai, D. 2016:
A Picture of Prehistoric Sudan: The Mesolithic and Neolithic

Periods. Oxford Handbooks Online. Online Publication Date: Jun 2016.
DOI:10.1093/oxfordhb/9780199935413.013.56

Van Gijn, A. L. – Houkes, R. 2006:
Stone, procurement and use. In: Louwe, L. P. – Jongste, P. F. B. /eds./: Schipluiden: a neolithic settlement on the dutch north sea coast c. 3500 cal bc. Leiden: Leiden University, 167–193.

Varadzinová, L. – Varadzin, L. 2017:
Sabaloka (West Bank) Research Project. Exploration of the site of Sphinx (SBK.W-60): findings of the 2014 and 2015 field seasons. Sudan & Nubia 21, 23–33, 48–49.

Varadzinová, L. – Varadzin, L. 2020:
The first notes on the second Khartoum Mesolithic cemetery at Jebel Sabaloka (Sudan). Archaeologia Polona 58, 121–133.

Varadzinová et al. 2018:
Varadzinová, L. – Varadzin, L. – Kapustka, K. – Pacina, J.:
Výzkum pravěkého osídlení v pohoří Sabaloka v centrálním Súdánu: poznatky z výzkumné sezóny 2017. Pražské egyptologické studie XX, 35–45.

Varadzinová et al. 2021:
Varadzinová, L. – Varadzin, L. – Garcea, E. A. A. – D'Ercole, G. – Řídký, J. – McCool, J.-P. – Abdallah, A. – Adam, B. A.:
Prehistoric research in the western part of Jebel Sabaloka (spring 2019). Der Antike Sudan 32, 5–27.

Varadzinová et al. 2022:
Varadzinová, L. – Varadzin, L. – Brukner Havelková, P. – Crevecoeur, I. – Garcea, E. A. A.:
Archaeology of Holocene hunter-gatherers at the sixth Nile cataract, central Sudan. Bulletin d'Archéologie Marocaine 27, 101–118.

Varadzinová et al. in press:
Varadzinová, L. – Varadzin, L. – Garcea, E. A. A. – Kapustka, K. – Pacina, J.:
Prehistoric occupation of Jebel Sabaloka. In: Millet, M. – Payraudeau, F. – Tallet, P. – Rondot, V. /eds./: Proceedings of the 14th International Conference for Nubian Studies. Paris: Musée du Louvre.

Varadzinová Suková et al. 2015:
Varadzinová Suková, L. – Varadzin, L. – Bajer, A. – Lisá, L. – Pacina, J. – Pokorný, P.:
Tracing Post-depositional Processes at Mesolithic Occupation Sites in Central Sudan: View from the Site of Sphinx (SBK.W-60) at Jebel Sabaloka. Interdisciplinaria Archaeologica: Natural Sciences in Archaeology VI(2), 133–150.

Wendorf, F. /ed./ 1968:
The Prehistory of Nubia. Volume 2. Dallas: Fort Burgwin Research Center and Southern Methodist University Press.

Wendorf, F. – Close, A. 1993:
BS-11: A Site in the Recessional Beach of West Lake 1. In: *Wendorf, F. – Schild, R. – Close, A. /eds./*: 488–511.

Wendorf, F. – Schild, R. /eds./ 2001:
Holocene Settlement of the Egyptian Sahara. Volume 1. The Archaeology of Nabta Playa. New York: Kluwer Academics/ Plenum Academics.

Wendorf, F. – Schild, R. – Close, A. E. /eds./ 1989:
The Prehistory of Wadi Kubbaniya. Volume 3. Late Paleolithic Archaeology. Dallas: Southern Methodist University Press.

Wendorf, F. – Schild, R. – Close, A. /eds./ 1993:
Egypt during the Last Interglacial. The Middle Paleolithic of Bir Tarfawi and Bir Sahara East. New York and London: Plenum Press.

Williams, M. A. J. – Adamson, D. A. – Abdulla, H. H. 1982:
Landforms and soil of the Gezira: A Quaternary legacy of hte Blue and White Nile rivers. In: Williams, M. A. J. – Adamson, D. A. /eds./: A land between two Niles. Quaternary geology and biology of the central Sudan. Rotterdam: A. A. Balkema, 111–142.

Williams et al. 2010:
Williams, M. A. J. – Williams, F. M. – Duller, G. A. T. – Munro, R. N. – El Tom, O. A. M. – Barrows, T. T. – Macklin, M. – Woodward, J. – Talbot, M. R. – Haberlah, D. – Fluin, J.:
Late Quaternary floods and droughts in the Nile valley, Sudan: New evidence from optically stimulated luminescence and AMS radiocarbon dating. Quaternary Science Reviews 29, 1116–1137.

Winchell et al. 2017:
Winchell, F. – Stevens, C. J. – Murphy, C. – Champion, L. – Fuller, D. Q.:
Evidence for Sorghum Domestication in Fourth Millennium BC Eastern Sudan: Spikelet Morphology from Ceramic Impressions of the Butana Group. Current Anthropology 58(5), 673–683.
https://doi.org/10.1086/693898

Winchell et al. 2018:
Winchell, F. – Brass, M. – Manzo, A. – Beldados, A. – Perna, V. – Murphy, C. – Stevens, C. – Fuller, D. Q.:
On the origins and dissemination of domesticated sorghum and pearl millet across Africa and into India: a view from the Butana Group of the far Eastern Sahel. African Archaeological Review 35, 483–505.
https://doi.org/10.1007/s10437-018-9314-2

Wright, K. I. 1992:
A Classification System for Ground Stone Tools from the Prehistoric Levant. Paléorient 18/2, 53–81.

Wright, K. I. 1993:
Early Holocene Ground Stone Assemblages in the Levant. Levant 55, 93–111.

Wright, K. I. 1994:
Ground-stone tools and hunter-gatherer subsistence in southwest Asia: implications for the transition to farming. American Antiquity 59(2), 238–263.

Wright, K. I. 2000:
The Social Origins of Cooking and Dining in Early Villages of Western Asia. Proceedings of the Prehistoric Society 66, 89–121.

Wright, K. I. 2014:
Domestication and Inequality? Households, Corporate Groups and Food Processing Tools at Neolithic Çatalhöyük. Journal of Anthropological Archaeology 33, 1–33.

Zarattini, A. 1983:
Ground stone implements from Saggai 1. In: *Caneva, I. /ed./*: 234–241.

Zimmermann, A. 1988:
Steine. In: Boelicke, U. – Brandt, D. von – Lüning, J. – Stehli, P. – Zimmermann, A. /eds./: Der bandkeramische Siedlungsplatz Langweiler 8, Gemeinde Aldenhoven, Kreis Düren. Rheinische Ausgrabungen 28, 569–787.

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