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Author
Harrell, James A.

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الأحجار ذات المنفعة

James A. Harrell

Werkzeugsteine
Pierre utilitaire

The utilitarian stones of ancient Egypt were those rocks employed for implements and other mundane articles. Most of these fall into three categories: 1) tools for harvesting, food preparation, and stone working; 2) weapons for hunting, war, and personal protection; and 3) grinding stones for cereals and other plant products, ore rocks for gold and other metals, and raw materials for paint pigments and cosmetics. The three most common rock types used for these purposes were chert, dolerite, granite, metagraywacke, and silicified sandstone. A total of 21 ancient quarries are known for these stones.

يقصد بالأحجار ذات المنفعة المادية تلك الأحجار التي استخدمت في صناعة الأدوات والأشياء البسيطة وتنقسم معظم تلك الأحجار إلى ثلاثة فئات: أولاً: صناعة الأدوات المستخدمة في عملية الحصاد وادوات إعداد الطعام وتشكيل الأحجار؛ وثانياً: صناعة أدوات الصيد والأسلحة وأدوات الحماية الشخصية؛ وثالثاً: صناعة الرحايا لطحن الحبوب والمنتجات النباتية الأخرى، الذهب والنحاس، المعادن والمواد الخام المستخدمة في الصبغات ومواد التجميل. أكثر ثلاث أنواع أحجار شائعة لهذه الاستخدامات هي: الظران ويليه الحجر الرملي السيلسي والدولوريت، بالإضافة إلى أنواع أخريكانت مستخدمة ، حيث تم تحديد واحد وعشرون محجر أثري لهذه الصخور.

The utilitarian stones of ancient Egypt were those rocks employed for implements and other mundane articles. Most of these fall into three categories: 1) tools for harvesting, food preparation, and stone working; 2) weapons for hunting, war, and personal protection; and 3) grinding stones for cereals and other plant products, ore rocks for gold and other metals, and raw materials for paint pigments and cosmetics. Rocks were also used for other ordinary purposes, especially for weights (e.g., loom and net weights, plumb bobs, boat anchors, and measuring weights for balances). Objects from the first two categories, when produced by knapping (i.e., percussion and pressure flaking), are collectively referred to as "lithics." The most common utilitarian stones were chert (or flint), dolerite, granite, metagraywacke (or graywacke), and silicified sandstone (or quartzite), but others were sometimes used as well (especially limestone and vein quartz). A total of 21 ancient quarries are known for these stones, and their locations are provided in Table 1 and Figure 1. The stones exploited for tools and especially weapons were progressively supplanted by metals, initially copper in the late Predynastic Period, then the harder bronze beginning in the Middle Kingdom, and finally the still harder "iron" (actually low-grade steel) by the end of the Late Period. These metals, however, never completely replaced the stone tools and weapons, and

Table 1. Some Utilitarian Stone Varieties and Their Known Quarries*

anorthosite gneiss (light gray with greenish-black specks and streaks; fine- to medium-grained). Used: occasionally for pounders, but also as an ornamental stone. Source: quarry near Gebel el-Asr, Western/Nubian Desert (also known as "Chephren's Quarry"; no. **21** in Figure 1; active from late Predynastic Period to Middle Kingdom).
chert or **flint** (microcrystalline quartz; uniform to mottled light and dark gray, and brown). Used: for tools and weapons. Sources: nine quarries, at the following locations: Ain Barda, Wadi Araba area, Eastern Desert (no. **3** in Figure 1; active in Predynastic Period); Wadi Umm Nikhaybar, Wadi Araba area, Eastern Desert (no. **4** in Figure 1; active in New Kingdom); Wadi el-Sheikh, just east of the Nile Valley opposite the village of el-Fant (no. **5** in Figure 1; active from late Predynastic Period to New Kingdom); Wadi Sojoor, just east of Nile Valley opposite the village of Maghaha (no. **6** in Figure 1; active possibly from Early Dynastic Period to Old Kingdom); Refuf Pass area, northeast Kharga Oasis (no. **11** in Figure 1; active in Predynastic Period); near Nazlet Khater, Nile Valley (no. **7** in Figure 1; active in Palaeolithic Period); near Taramsa, Nile Valley (no. **8** in Figure 1; active in Palaeolithic Period); near Nazlet Safaha, Nile Valley (no. **9** in Figure 1; active in Palaeolithic Period); and near the ruins of Hierakonpolis, just west of the Nile Valley (no. **12** in Figure 1; active in Predynastic Period and New Kingdom).
dolerite, includes **metadolerite** (black; fine- to mainly medium-grained). Used: for pounders. Sources: three sites (all active during the Dynastic Period and perhaps mainly in the New Kingdom) in the following locations in the Aswan area: a definite quarry near Gebel el-Granite (no. **18** in Figure 1); two possible quarries near Hod el-Ruba (no. **19** in Figure 1); and Gebel el-Granite (no. **20** in Figure 1).
granite (coarse variety—reddish to mainly pinkish, very coarse- to mainly coarse-grained; and fine variety—pinkish to reddish or, less often, light gray, medium- to mainly fine-grained). Used: occasionally for grinding stones (coarse variety) and pounders (fine variety), but also as ornamental stones. Source: quarry in Aswan, Nile Valley (no. **17** in Figure 1; active from late Predynastic to Roman Periods).
metagraywacke or **graywacke** (greenish gray to mainly grayish green; a mildly metamorphosed sedimentary rock ranging from metaclaystone to metasiltstone in most small objects, including palettes, to metasandstone in larger objects). Used: for cosmetic palettes, but also as an ornamental stone. Source: quarry in Wadi Hammamat, Eastern Desert (no. **10** in Figure 1; active from late Predynastic to Roman Periods).

Table 1. Some Utilitarian Stone Varieties and Their Known Quarries, cont.*

silicified sandstone or **quartzite** (widely varying in color but most commonly light gray, light to dark brown, or yellowish brown; quartz-cemented; fine- to very coarse-grained but mainly medium- to coarse-grained sandstone that is commonly pebbly; occasionally a sandy pebble conglomerate). Used: for grinding stones and occasionally for pounders and other tools, but also as an ornamental stone. Sources: six quarries, at the following locations: Gebel el-Ahmar near Cairo (no. **1** in Figure 1; active from Early Dynastic to Roman Periods, and possibly earlier); Umm el-Sawan in northeast Fayum (no. **2** in Figure 1; active from late Predynastic Period to Old Kingdom); near Wadi Kubbaniya, just west of the Nile Valley (no. **13** in Figure 1; active in Palaeolithic Period); Wadi Abu Subeira, just east of the Nile Valley (no. **14** in Figure 1; active in Dynastic Period?); near Wadi Abu Aggag, just east of the Nile Valley (no. **15** in Figure 1; active in New Kingdom and Roman Period, and possibly at other times); and Gebel Gulab and Gebel Tingar, Nile Valley opposite Aswan (no. **16** in Figure 1; active from late Predynastic through Roman Periods). Other grinding-stone workings occur in the Aswan region on the west bank of the Nile between the Wadi Kubbaniya and Gebel Gulab/Gebel Tingar quarries, and also on the east bank between the Wadi Abu Subeira and Wadi Abu Aggag quarries. See map in Harrell and Storemyr (2009: Figure 7) for specific locations.
*The following grain-size scale is used for crystalline rocks (igneous and metamorphic): fine <1 mm, medium 1 - 5 mm, coarse 5 mm - 3 cm, and very coarse (or pegmatitic) >3 cm. For the clastic rocks (metasedimentary and silicified sandstone), the Udden-Wentworth grain-size scale is used: boulder >25.6 cm, cobble 6.4 - 25.6 cm, pebble 4 mm - 6.4 mm, granule 2 - 4 mm, very coarse sand 1 - 2 mm, coarse sand 0.5 - 1 mm, medium sand 0.25 - 0.5 mm, fine sand 0.125 - 0.25 mm, very fine sand 0.0625 - 0.125 mm, silt 0.004 - 0.0625 mm, and clay < 0.004 mm.

crushing and grinding were almost always done with stones throughout antiquity.

Stone Tools

Chert was the material of choice for most stone tools as early as the Palaeolithic and continuing through the Dynastic Period (Close 1999; Holmes 1999; Tillman 1999; Hikade 2010). This rock consists of microcrystalline quartz and occurs as nodules in limestone. The terms "chert" and "flint" are variously and inconsistently defined and, for the purposes of this article, are treated as synonymous. Ancient Egyptians referred to chert as ***ds km*** (*des kem*) when it was dark brown or gray, ***ds ḥḏ*** (*des hedj*) and ***ds ṯḥn*** (*des tjehen*) when of lighter color, or sometimes simply as ***ds*** (*des*) (Harris 1961: 138 - 139). Chert was one of the toughest stones available to the Egyptians and had an abrasion (or scratch) hardness superior to that of all the metals, including the best quality iron. It was easily shaped by knapping, but its principal advantage was its ability to provide tools with a sharp, durable edge. It was therefore widely employed for all types of cutting blades, especially knives and sickle teeth, as well as adzes, awls, axes, burins, drill bits, pick heads, and scrapers, among others (fig. 2). Although chert was used throughout the Dynastic Period, the variety of tools and quality of workmanship declined over time as the use of metals increased, with only chert knives and sickle blades remaining relatively common until the Late Period.

Macrocrystalline vein quartz derived from igneous and metamorphic rocks occurs abundantly in all parts of Egypt as surface pebbles and cobbles, and was commonly used for the same tools as chert, as were also a

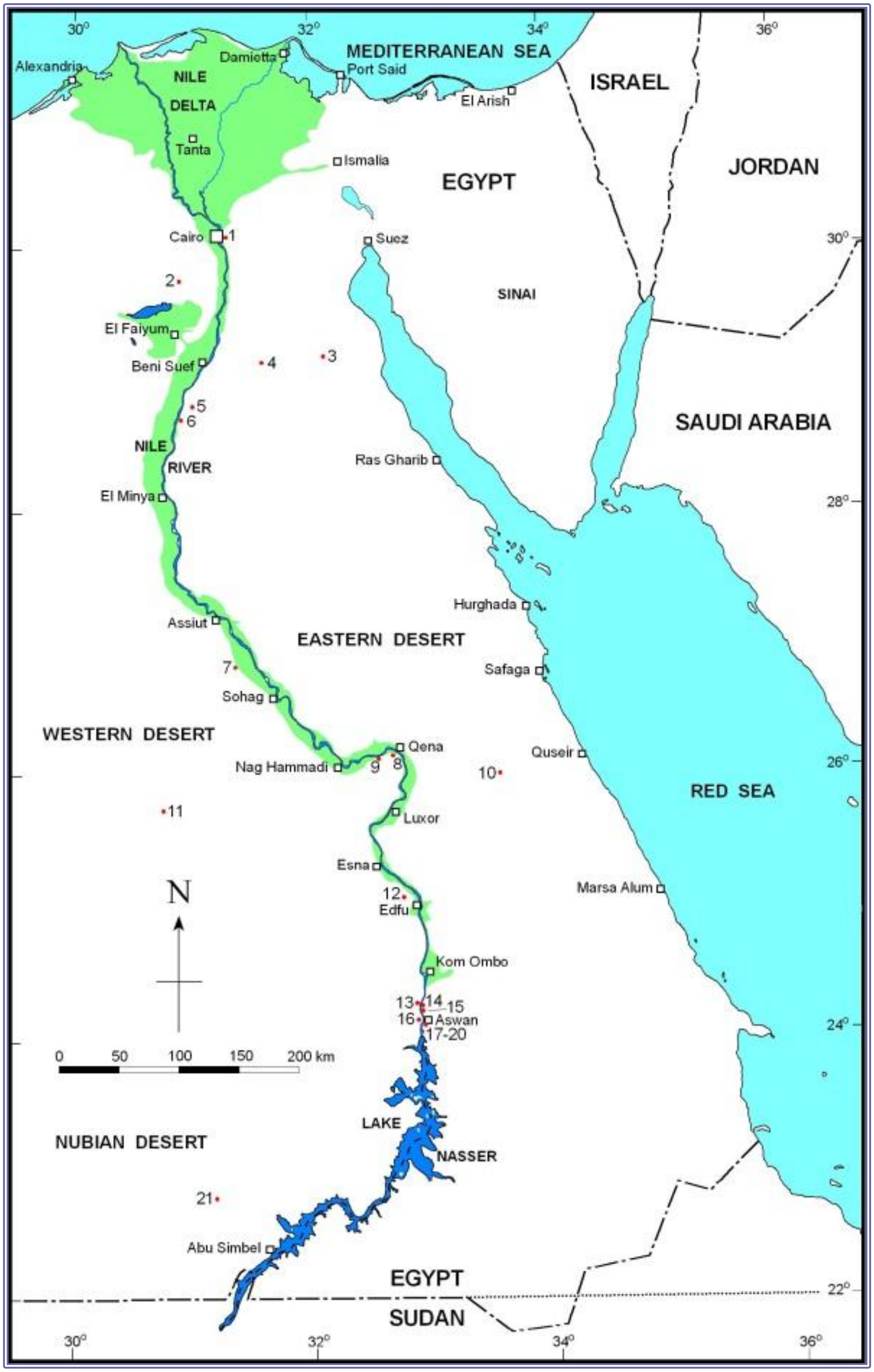

Figure 1. Map of ancient Egyptian utilitarian-stone quarries (numbered).

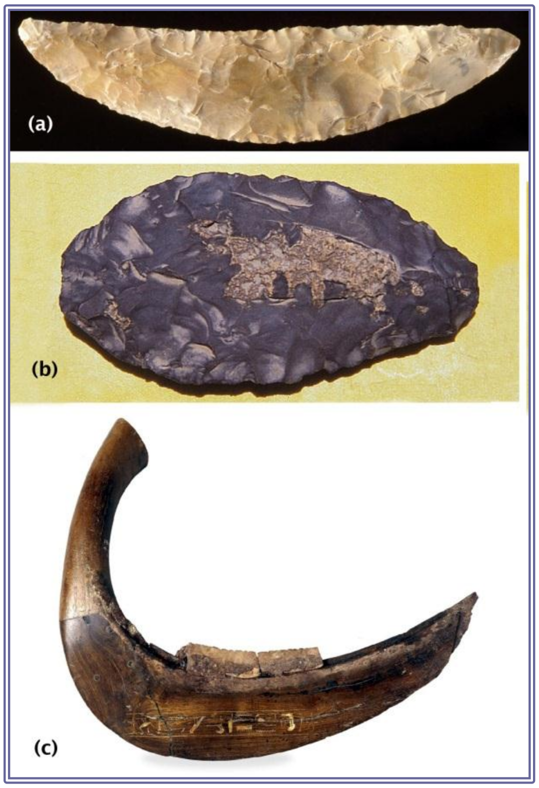

Figure 2. Chert tools: a) knife blade, late Predynastic Period, Abydos (The British Museum, WG.605; length unknown); b) axe blade, Dynastic Period, Wadi el-Sheikh (length 12.6 cm); c) wood sickle with hieroglyphic inscription and chert teeth, Dynasty 18, Thebes (The British Museum, EA 52861; length 28 cm).

variety of other hard, fine-grained rocks, especially silicified sandstone. None of these stones, however, was used to the same extent as chert. Only obsidian (volcanic glass) imported from southern Red Sea or Eastern Mediterranean sources (Wainwright 1927; Zarins 1989) produced tools with a sharper edge, but it was much more brittle as well as more costly, and so was little used.

Chert is common wherever limestone occurs, which is in the Nile Valley walls and on the adjacent desert plateaus between Cairo in the north and Esna in the south. There were undoubtedly many ancient chert quarries but relatively few of these have been reported. From Palaeolithic to Predynastic times chert cobbles were extracted from pits dug into gravel deposits on the Nile River terraces of Middle Egypt (nos. 7 - 9 in Table 1 and Figure 1; Vermeersch et al. 1990; Vermeersch 2002), and at Ain Barda in the Eastern Desert's Wadi Araba (no. 3 in Table 1 and Figure 1; Fontaine 1954: 79, map 2). Pits were also dug into chert-bearing weathering deposits on top of the limestone in the Refuf Pass area of Kharga Oasis during the Predynastic Period (no. 11 in Table 1 and Figure 1; Caton-Thompson and Gardner 1952: 187 - 196, pls. 126 - 127). It was, however, probably more commonly the case in these early periods that chert was not excavated but merely harvested from natural surface accumulations of already loose pieces of rock. Such sources are often referred to as "quarries" in the archaeological literature, but this is a misnomer, as no significant digging occurred. It was only during the Dynastic Period that chert nodules were quarried directly from the limestone bedrock. Of the four true quarries known, the most important is in Wadi el-Sheikh near el-Fashn (no. 5 in Table 1 and Figure 1; Forbes 1900; Baumgärtel 1930; Weisgerber 1982, 1987; Pawlik 2006: 558 - 560; Negro and Cammelli 2010). Here the workings extend 7 km along the north side of Wadi el-Sheikh, making this one of the largest quarries of any rock type to survive from ancient Egypt. It was active from the late Predynastic Period to the New Kingdom, but most of the workings visible today apparently date to the Old and Middle Kingdoms. The thousands of quarry pits and trenches, which are dug into the cherty limestone bedrock, range from a few to several tens of meters across and are surrounded by spoil piles up to a few meters high. In one part of the quarry, the pits drop into vertical shafts up to 8 m deep, and these branch out at the bottom into horizontal tunnels. Other tunnels penetrate the limestone along its exposed edge on the wadi walls. The principal products of the quarry were bifacial blades used for knives and axes, and thin trapezoidal blades used for sickle-teeth and also perhaps as general-purpose cutting tools. About 12 km to the southeast of Wadi el-Sheikh is a similar but smaller chert quarry on the mesa tops along the north side of Wadi Sojoor (no. 6 in Table 1 and Figure 1; Forbes

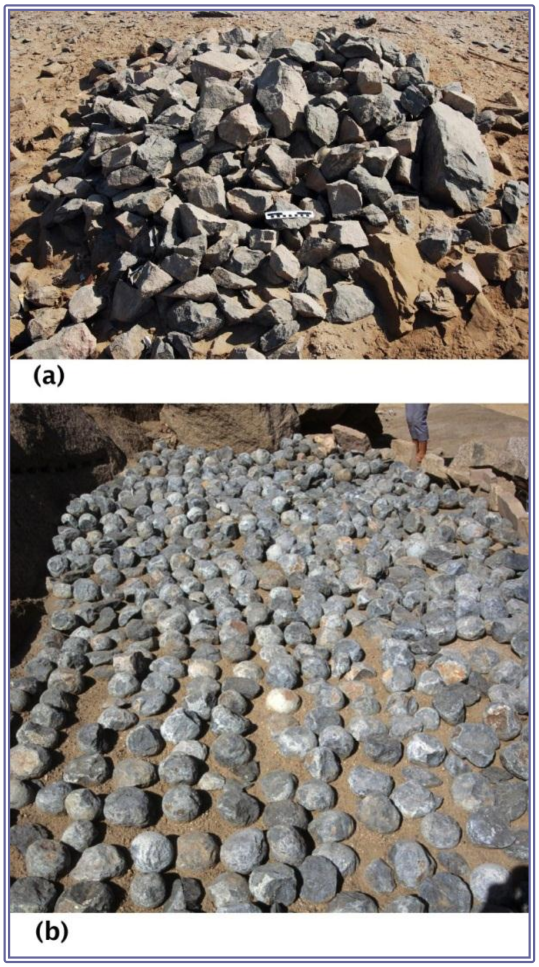

Figure 3. Dolerite pounders from Aswan: a) new pounders in the Gebel el-Granite metadolerite quarry, New Kingdom (?) (no. 18 in Table 1 and Figure 1); b) well-worn, subspherical pounders found in the Unfinished Obelisk granite quarry, Dynasties 18 - 19 (part of no. 17 in Table 1 and Figure 1).

1900). This site is largely unstudied, but the many workings, based on the chert tools found, appear to date to the Early Dynastic Period and Old Kingdom.

The other two known Dynastic chert quarries date to the New Kingdom. A small one, which was also worked in the Predynastic Period, occurs on a hillside near Hierakonpolis in Upper Egypt (no. 12 in Table 1 and Figure 1; Friedman and Youngblood 1999), but a larger and more important site is found in the Eastern Desert's Wadi Umm Nikhaybar (no. 4 in Table 1 and Figure 1). The latter, not yet published outside of the present article, dates to the Ramesside Period and has two large trenches (25 - 28 m long, 3 - 4 m wide, and 2 - 2.5 m deep) cut into the cherty limestone bedrock. Near these is a nearly square, fortress-like building with massive enclosure walls measuring 18 by 21 m. Only trapezoidal blades and the cores they were struck from are found in the knapping area beside the large building; the blades thus appear to be the principal, if not only, product of the quarry.

Dolerite is a black igneous rock that is compositionally similar to basalt but coarser grained. It was the favored material for pounders (also called mauls and hammerstones), which broke and crushed rock through blunt force (Arnold 1991: 258 - 263; Kelany et al. 2010). Pounders were used in quarrying hardstones, such as Aswan granite and many other ornamental stones, and also in mining gold and other metals. They were additionally employed for sculpting the same hardstones into architectural elements, statues, sarcophagi, stelae, vessels, and other objects. Pounders were largely replaced by iron tools (hammers, picks, chisels, and wedges) toward the end of the Late Period, but they continued to be used whenever metal tools were either unavailable or too costly. The smaller pounders were usually elongated pieces of stone with a narrowed waist where a wooden handle was affixed with leather strips. The larger pounders, commonly up to 30 cm across but sometimes larger, were unhafted and so hand-held. In their most familiar form, these are well-rounded, subspherical balls (fig. 3b). Although still debated, it seems likely that this shape was acquired through long use, the original tools having started as angular, irregular to subrectangular pieces of rock (fig. 3a; Kelany et al. 2010: 136 - 137). Although the majority of pounders were of dolerite or its metamorphic equivalent, metadolerite, some were also of fine-grained granite from Aswan, silicified sandstone from near Aswan and Cairo, and anorthosite gneiss from near Gebel el-Asr in the Nubian Desert (nos. 1, 15 – 17, and 21 in Table 1 and Figure 1). The

Figure 4. Ovoid (left) and pear-shaped (right) limestone maceheads, Dynasty 1, Kom el-Ahmar (The British Museum, EA 73961; macehead at right is 7.4 cm in length).

latter three rocks were also used as ornamental stones. What all these materials have in common is a high resistance to impact fracturing, dolerite being the most durable. Although there were probably many dolerite quarries for pounders, only three are known (two probable and one definite), and these are in Aswan (nos. 18 - 20 in Table 1 and Figure 1; Klemm and Klemm 2008: 241 - 242; Kelany et al. 2010: 134 - 136). The one definite quarry is near Gebel el-Granite and is located on a small metadolerite outcrop. Here there are numerous places where both the bedrock surface and loose boulders on top of it have been worked, and beside each of these areas is a pile of angular pieces of metadolerite that are new pounders (see fig. 3a). These range from about 10 to 30 cm across, with most between 15 and 25 cm. Littering the ground, and in places forming a nearly continuous pavement, are metadolerite chippings, which are the by-product of the production of the pounders.

Stone Weapons

Chert was the most commonly used stone for weapons requiring a sharp edge, including arrow and spear points, and axe blades. It was, however, rarely employed for the mace, a stick with a heavy, well-rounded (ovoid, discoidal or pear-shaped) stone mass at one end (fig. 4). Maceheads, which were perforated to hold the stick, were carved from other hard, but easier-to-work, stones. These include most of the ornamental stones used from the late Predynastic Period to the Old Kingdom, and especially limestone, one of the principal building stones of ancient Egypt. Maceheads of the late Predynastic and Early Dynastic Periods were sometimes decorated with carved scenes and apparently served as ceremonial weapons. A good example of this is the famous 1st Dynasty limestone macehead of King Scorpion from Hierakonpolis, now in Oxford's Ashmolean Museum (E.3632).

Most weapons were of stone until well into the Old Kingdom when metal became more common. Stone maceheads and chert arrow points, at least, continued to be made until the end of the Dynastic Period, but the maceheads were largely ceremonial and the chert points served as a less expensive but still effective alternative to the superior metal arrowheads. For example, many of the arrows in the 18th Dynasty tomb of King Tutankhamen had chert points.

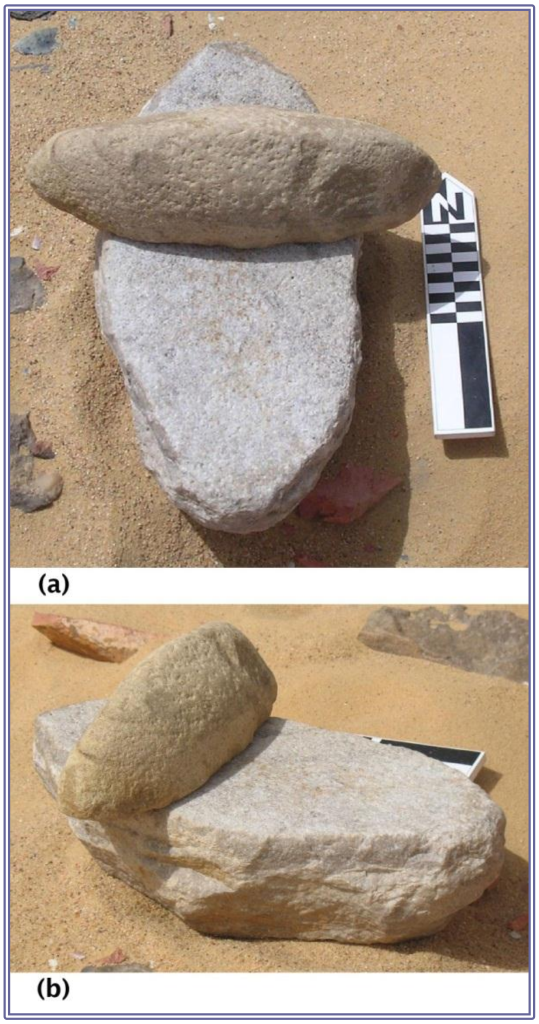

Figure 5. Boat-shaped saddle hand-mill (a and b) for cereal made from silicified sandstone, Middle Kingdom (Chephren's Quarry near Gebel el-Asr; no. 21 in Table 1 and Figure 1; smallest division of scale is 1 cm).

Grinding Stones

Grinding stones (also known as "mill" or "quern" stones) were widely used in all periods of Egyptian history for processing cereals (mainly emmer wheat and barley) and other plant products (those for unguents, perfumes, and other oils, or juices). They were also employed for crushing gold, copper, and other metallic ore rocks prior to smelting. Essentially any hard rock can serve as a grinding stone but, in the case of those used for plant products, there was a strong preference for silicified sandstone during the Predynastic and Dynastic Periods (Bloxam 2007, 2011; Heldal and Storemyr 2007: 78 - 102) and vesicular basalt in the Ptolemaic and Roman Periods (Harrell 1998: 139 - 140; Williams and Peacock 2006). Coarse-grained granite from Aswan was additionally used in all periods. This chronological division is also exhibited in the grinding stones' basic form. In Predynastic and Dynastic times, grinding stones consisted of a large stationary lower stone that was elongated and typically ovoid (often described as "boat-shaped") with a flat (when new) to concave (when worn) upper surface (fig. 5). A smaller, hand-held upper stone (a "rider" or "rubber") was pushed back and forth across the lower stone. The terms "mono" and "matate," derived from Mesoamerican archaeology, are also sometimes applied to the upper and lower parts, respectively, of this so-called "saddle" hand-mill.

Two Greek innovations in cereal grinding technology were introduced into Egypt during the Ptolemaic Period: the "hopper-rubber" and "rotary" hand-mills (Williams-Thorpe and Thorpe 1993: 265 - 270 and 270 - 271, respectively). Both continued in use during Roman times along with the more primitive saddle hand-mills. The hopper-rubber hand-mill, also known as a "Theban hand-mill" (a translation of its ancient Greek name), had a rectangular upper stone into which were cut a trapezoidal grain hopper with a basal slit, and two lateral slots on top (fig. 6). A wooden cross-piece set into the slots served as a handle to push and pull the upper stone across a flat, usually rectangular, lower stone. Holes were sometimes cut into the sides of the upper stone for the insertion of handles (see fig. 6b). The upper and lower grinding surfaces were commonly incised ("dressed") with parallel grooves to enhance the grinding action (see figs. 6a - b). The hopper-rubber hand-mills found in the Nile Valley and Fayum were commonly made from coarse-grained Aswan granite, but at Eastern Desert sites other similarly hard, local rocks were also employed. The rotary hand-mill, usually made from vesicular basalt but also occasionally from coarse-grained granite and silicified

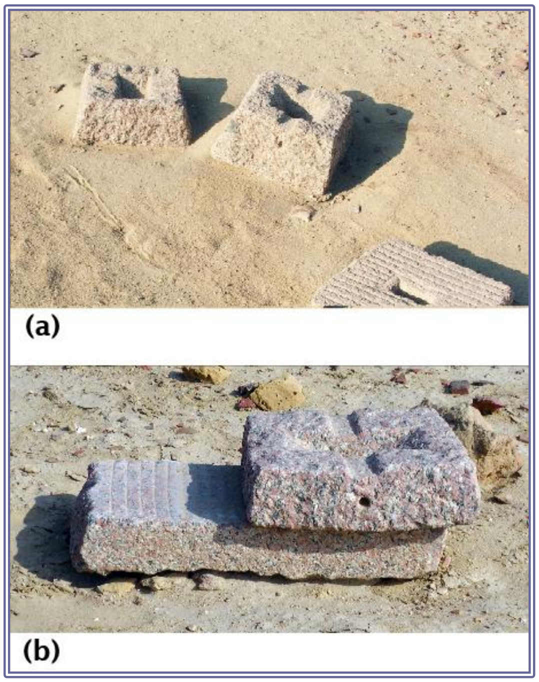

Figure 6. Hopper-rubber hand-mills (a and b) for cereal. Coarse-grained Aswan granite, Roman Period, Karanis, Fayum. Upper stones in (a) measure, left to right, 37 x 37 x 16.5 cm, 39 x 44 x 23 cm, and 43 x 43 x 13 cm; the mill in (b), with unmatched upper and lower grinding stones, measures 60 x 40 x 10 cm (lower) and 45 x 45 x 15 cm (upper).

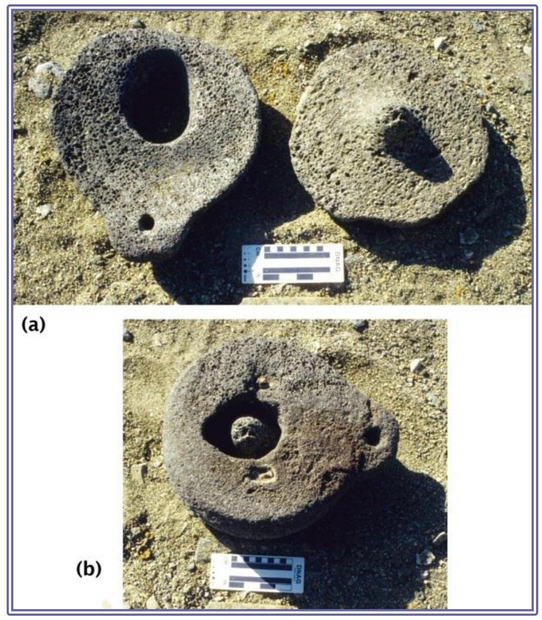

Figure 7. Rotary hand-mill (a and b) for cereal made from vesicular basalt, Roman Period, Shenshef, Eastern Desert (smallest division of scale is 1 cm).

sandstone, arrived in Egypt late in the Ptolemaic Period. This mill type had a stationary circular lower stone with a central conical spindle (fig. 7a, right), and a matching circular upper stone with an axial hole that fit over the spindle (fig. 7a, left). The upper stone was hand-cranked with a wooden handle, set in a hole cut into one side, while grain was fed into the central opening (fig. 7b).

Rotary motion in milling was not only more efficient than the reciprocating motion of the saddle and hopper-rubber hand-mills, but it also allowed for larger mills that harnessed greater power sources. In Egypt during the Roman Period, this led to the first industrial-scale processing of cereals and other agricultural products as exemplified by the "horizontal rotary" and "edge-roller" mills. The former mill type consisted of a matched pair of large circular grinding stones, typically of coarse-grained Aswan granite (fig. 8a). The lower stone was stationary while the upper ("runner") stone turned around a wooden or metal spindle with a lever attached to either the runner or the spindle if the latter was socketed into a square axial hole in the runner. Grain was fed into the upper axial hole while the runner was rotated, via the lever, by either human or animal power. The edge-roller mill, in contrast, consisted of a circular stone (either large or small, and sometimes a pair of such stones) that rolled upright on its outer edge around a circular stone trough (fig. 8b). A wooden lever passed horizontally through the axial hole of the upright stone and attached to a vertical spindle piercing the stationary trough, and this lever was then turned in the same manner as that of the horizontal rotary mill. Whereas all the aforementioned reciprocating and rotary mills ground materials by shearing them, the edge-roller mill merely crushed them, and because of this was especially popular for pressing olives and grapes. The absence of rigorous grinding also meant that softer stones, such as limestone, could be used for edge-roller mills (as in fig. 8b).

Figure 8. Two varieties of industrial-scale rotary mills: a) horizontal mill for cereal, made from coarse-grained Aswan granite, Byzantine Period, St. Simeon Monastery or Deir Amba Hadra near Aswan (diameter of upper or runner stone, with Coptic crosses, is 110 cm); b) edge-roller mill stones for olives made from limestone, Roman Period, Karanis, Fayum (in this unmatched pair, the upper roller stone at right measures 107 x 25 cm and the lower trough stone at left measures 130 x 21 cm).

The granite and silicified sandstone used for grinding stones are the same rocks that were also employed as ornamental stones and no doubt came from the same quarries (nos. 1 - 2 and 13 - 17 in Table 1 and Figure 1). The vesicular basalt preferred for rotary hand-mills does not occur in Egypt, but there are many potential sources in both the southern Red Sea and Eastern Mediterranean regions (Williams-Thorpe and Thorpe 1993; Williams and Peacock 2006). Limited geochemical analyses suggest that at least some of the rock came from volcanic islands in the southern Aegean Sea (Williams and Peacock 2006: 38 - 39). The extra expense incurred by basalt's importation was not a deterrent to its use because it had a highly desirable feature: abundant, large vesicles (originally gas-filled cavities in the lava precursor of this volcanic rock; see fig. 7). The edges of these vesicles act like cutting blades and are continuously sharpened as the stones wear down. To a lesser degree, the same process operates with silicified sandstone, which has smaller open pore spaces between its sand grains. The same cutting action can be achieved in Aswan granite or any other hard rock when the grinding surfaces are cut with parallel grooves, the edges of which function as cutting blades.

The same chronological dichotomy of reciprocating and rotary grinding stones for plant products applies to the reduction of ore rock from mines. The stones used, however, were just the locally available hard rocks and so vary from one site to another. A well-documented evolution in grinding stone technology exists for the gold mines in Egypt's Eastern Desert and Sudan's Nubian Desert (Klemm et al. 2002: 648 - 657). Prior to the New Kingdom, ore rock was reduced through direct crushing by pounders on stone anvils. It was during the New Kingdom that the familiar reciprocating grinding stone ensemble was introduced (fig. 7a). The lower stone originally had a flat surface and then developed an oval depression with use. This, with the accompanying upper (rubber) stone, has been referred to as an "oval" or "dished" hand-mill. The next big innovation occurred in the Ptolemaic Period, when the so-called "saddle quern" was used (fig. 7b). This had an originally downward-curving lower stone (which became more deeply concave with use) and a massive, subtriangular upper stone with two lug handles. This unique form of hand-mill was also employed to a limited extent for grain during the Ptolemaic Period. The final development, in the Roman Period, was the rotary hand-mill (figs. 9c - d) that was larger but otherwise similar in form to those of vesicular basalt used for grinding cereals (see fig. 6). Regardless of the method of grinding, the ore rock was pre-crushed to about pea-size on either a stone anvil (fig. 8a) or in a stone mortar (fig. 8b).

Other types of grinding (and crushing) stones employed in ancient Egypt from the Predynastic Period onward were the mortar and pestle, along with their primitive

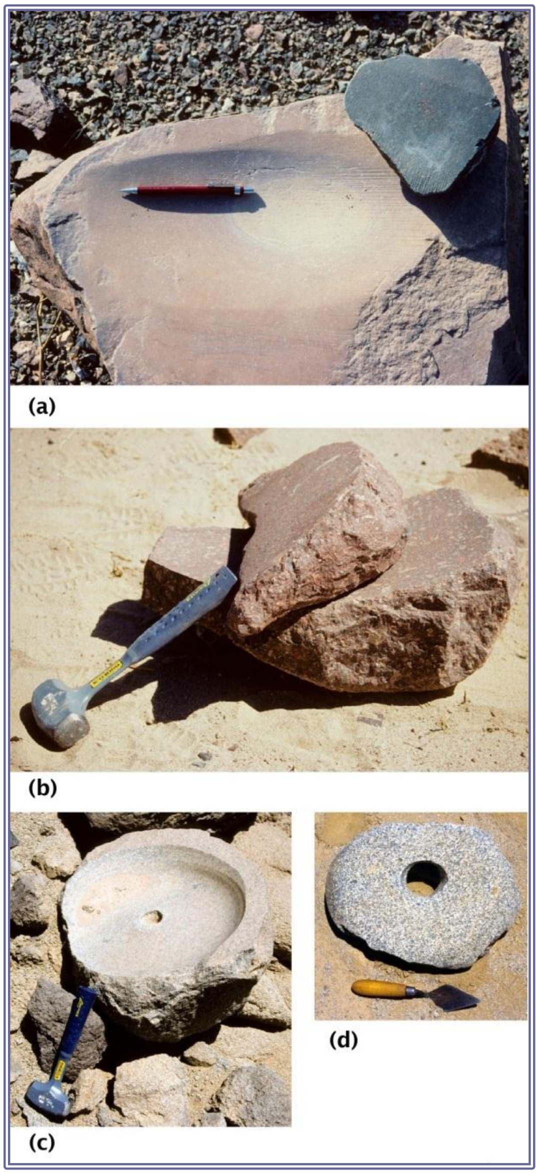

Figure 9. Evolution of grinding stones used for gold ore: a) primitive reciprocating hand-mill from metavolcanic felsite, New Kingdom, Wadi Atalla (length of pencil 14 cm); b) "saddle quern," made from rhyolite porphyry, Ptolemaic Period, Wadi Abu Gerida (length of hammer 27 cm); c and d) rotary mill stones with lower (c) and upper (d) parts made from granodiorite, Roman Period, Bokari (length of hammer in "c" is 27 cm; length of trowel in "d" is 27 cm).

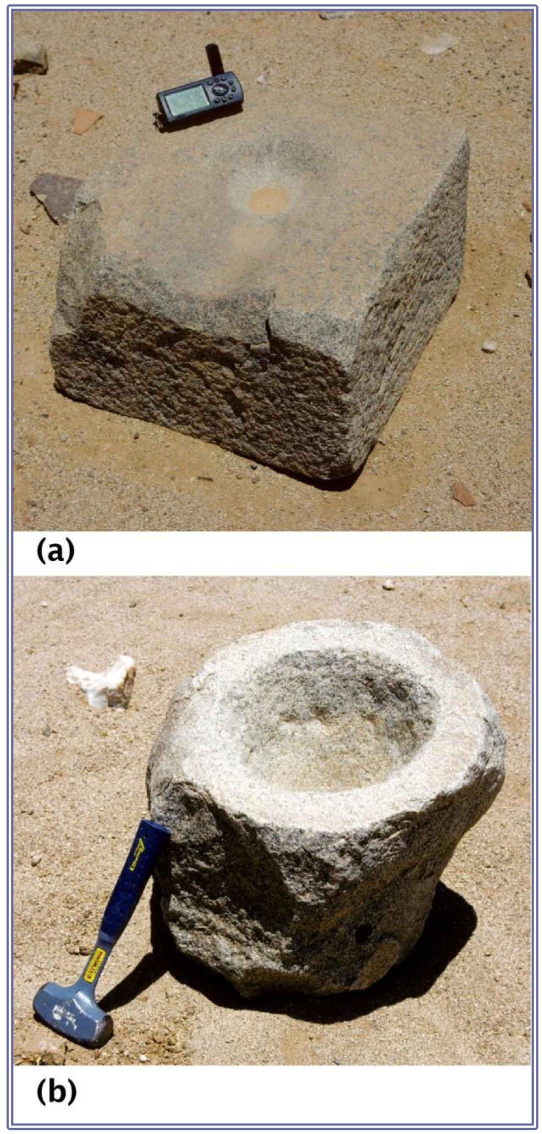

Figure 10. Granodiorite anvil (a) and mortar (b) used for crushing gold ore, Ptolemaic or Roman Periods, Bokari (length of GPS receiver in "a" is 15 cm; length of hammer in "b" is 27 cm).

counterparts, and the pounder (often of white vein quartz) and anvil (of any hard rock), as well as the so-called "palette," which was used principally during the late Predynastic and Dynastic Periods (Ciałowicz 2001). Whereas a wide variety of materials were ground with mortars and pestles, palettes were apparently only used for the preparation of cosmetic eye shadow or kohl, usually powdered green malachite or dark gray galena (fig. 9). The palettes are sometimes elaborately decorated with relief carvings (fig. 9a), such as those on the famous Narmer Palette of the 1st Dynasty from Hierakonpolis, now in Cairo's Egyptian Museum (JE 32169 and CG 14716). In this

case, and in many other examples, the palette seems more of a votive or ceremonial object than a working grinding stone. Many of the more ordinary palettes have zoomorphic outlines (fig. 9b), but other shapes also occur. Essentially all palettes were fashioned from grayish-green metagraywacke (commonly misidentified as "slate" or "schist"), one of the principal ornamental stones of ancient Egypt (no. 10 in Table 1 and Figure 1).

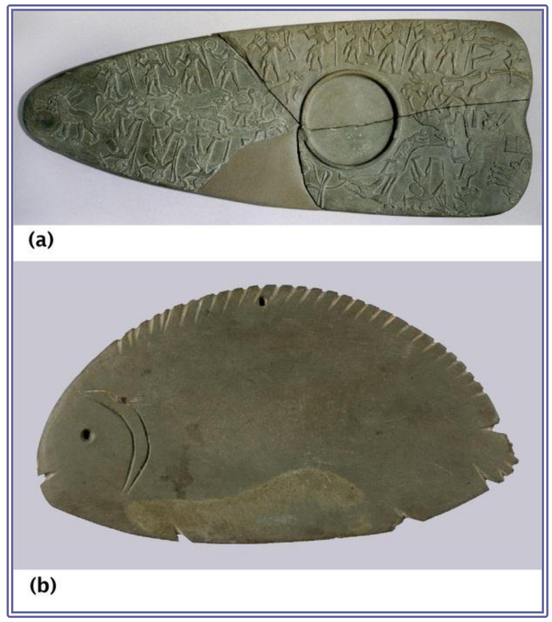

Figure 11. Metagraywacke palettes: a) "Hunters' Palette" with circular grinding area and relief of warriors hunting wild animals, Naqada III, el-Amarna (The British Museum, EA 20792; length 36.8 cm; width 20.3 cm); b) palette in the shape of a fish, Naqada I, Egypt, provenance unknown (The British Museum, EA 57947; length 16.5 cm).

Bibliographic Notes

There are no comprehensive treatments of Egyptian utilitarian stones, but there are numerous specific ones. The treatise by Petrie (1917) on ancient Egyptian tools and weapons is almost entirely concerned with metal objects, but stone plumb bobs (pp. 42 - 43, pl. 47), hafted stone pounders (p. 46, pl. 53) and chert teeth for sickles (p. 46, pl. 55) are described and illustrated. Most of what has been written about the utilitarian stones concerns the knapped (mainly chert) lithics and good summary discussions of these are provided by Close (1999), Holmes (1999), and Tillman (1999). With the exception of unpublished Wadi Umm Nikhaybar, the chert quarries and their products are described by Vermeersch et al. (1990), Vermeersch (2002), Fontaine (1954), Caton-Thompson and Gardner (1952), Baumgärtel (1930), Weisgerber (1982, 1987), Pawlik (2006), and Negro and Cammelli (2010). Dolerite pounders and their quarries are discussed by Kelany et al. (2010), and silicified sandstone quarries for grinding stones are described by Roubet (1989), Heldal (2009), Bloxam (2007, 2009, 2011), Harrell and Storemyr (2009), Heldal and Storemyr (2007), and Heldal et al. (2009). Vesicular basalt grinding stones and their potential sources are covered by Williams-Thorpe and Thorpe (1993) and Williams and Peacock (2006), and an overview of metagraywacke palettes is provided by Ciałowicz (2001). Moritz (1958: 1 - 150) is an old but still excellent account of milling technology in the classical Greek and Roman world, although it includes a greater variety of grain mills than what has so far been reported for Ptolemaic and Roman Egypt. Related *UEE* articles are Hikade (2010) on Palaeolithic and Neolithic stone tools, Bloxam (2010) on general quarrying and mining, and Harrell's articles on building stones, gemstones, and ornamental stones.

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Figure 1. Map of ancient Egyptian utilitarian-stone quarries (numbered). Drawing by the author.

Figure 2. Chert tools: a) knife blade, late Predynastic Period, Abydos (The British Museum, WG.605; length unknown); b) axe blade, Dynastic Period, Wadi el-Sheikh (length 12.6 cm); c) wood sickle with hieroglyphic inscription and chert teeth, Dynasty 18, Thebes (The British Museum, EA 52861; length 28 cm). Photographs (a) and (c) courtesy of The British Museum; photograph (b) by the author.

Figure 3. Dolerite pounders from Aswan: a) new pounders in the Gebel el-Granite metadolerite quarry, New Kingdom (?) (no. 18 in Table 1 and Figure 1); b) well-worn, subspherical pounders found in the Unfinished Obelisk granite quarry, Dynasties 18 - 19 (part of no. 17 in Table 1 and Figure 1). Photographs (a) and (b) by the author.

Figure 4. Ovoid (left) and pear-shaped (right) limestone maceheads, Dynasty 1, Kom el-Ahmar (The British Museum, EA 73961; macehead at right is 7.4 cm in length). Photograph courtesy of The British Museum.

Figure 5. Boat-shaped saddle hand-mill (a and b) for cereal made from silicified sandstone, Middle Kingdom (Chephren's Quarry near Gebel el-Asr; no. 21 in Table 1 and Figure 1; smallest division of scale is 1 cm). Photograph (a) by Elizabeth Bloxam; photograph (b) by Per Storemyr.

Figure 6. Hopper-rubber hand-mills (a and b) for cereal made from coarse-grained Aswan granite, Roman Period, Karanis, Fayum. Upper stones in (a) measure, left to right, 37 x 37 x 16.5 cm, 39 x 44 x 23 cm, and 43 x 43 x 13 cm; the mill in (b), with unmatched upper and lower grinding stones,

measures 60 x 40 x 10 cm (lower) and 45 x 45 x 15 cm (upper). Photograph (a) by URU Fayum Project/Kandace Pansire; photograph (b) by URU Fayum Project/Willeke Wendrich.

Figure 7. Rotary hand-mill (a and b) for cereal made from vesicular basalt, Roman Period, Shenshef, Eastern Desert (smallest division of scale is 1 cm). Photographs (a) and (b) by the author.

Figure 8. Two varieties of industrial-scale rotary mills: a) horizontal mill for cereal made from coarse-grained Aswan granite, Byzantine Period, St. Simeon Monastery or Deir Amba Hadra near Aswan (diameter of upper or runner stone, with Coptic crosses, is 110 cm); b) edge-roller mill stones for olives made from limestone, Roman Period, Karanis, Fayum (in this unmatched pair, the upper roller stone at right measures 107 x 25 cm and the lower trough stone at left measures 130 x 21 cm). Photograph (a) by the author; photograph (b) by URU Fayum Project/Willeke Wendrich.

Figure 9. Evolution of grinding stones used for gold ore: a) primitive reciprocating hand-mill from metavolcanic felsite, New Kingdom, Wadi Atalla (length of pencil 14 cm); b) "saddle quern" made from rhyolite porphyry, Ptolemaic Period, Wadi Abu Gerida (length of hammer 27 cm); c and d) rotary mill stones with lower (c) and upper (d) parts made from granodiorite, Roman Period, Bokari (length of hammer in "c" is 27 cm; length of trowel in "d" is 27 cm). Photographs (a) and (b) by the author.

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