Ancient Egyptian quarries – an illustrated overview

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The surviving remains of ancient Egyptian material culture are dominated by the stones used for building, ornamental, gem, and utilitarian applications. These came mainly from the Nile Valley and Eastern Desert (with some also from the Western Desert), where over 200 quarries have been discovered spanning about 3500 years from the Late Predynastic Period to the Late Roman Period. The harder stones (nearly all the igneous and metamorphic rocks plus silicified sandstone and chert) were quarried using stone tools aided by fire setting and wood levers up until the Late Period, when the stone tools were replaced by iron ones. The softer stones (mainly limestone, sandstone, and travertine) were extracted with copper and, later, bronze picks and chisels during the Dynastic Period, with iron tools again replacing the earlier ones by the end of the Late Period. Until the advent of suitable roadways and wagons rugged enough to transport them in the Greco–Roman Period, the larger pieces of quarried stone were carried on sledges, often along prepared roads, and probably pulled by teams of men to the building sites or to the Nile River for shipping. Ancient quarries are more than just sources of stones, but are also rich archaeological sites with ruins and other cultural remains. Their study and preservation is necessary because they provide a unique perspective on life in ancient Egypt.
Introduction

Much of what remains of ancient Egypt consists of stone. There are building stones for temples, pyramids, and tombs; ornamental stones for vessels, sarcophagi, shrines, stelae, statues, and other sculptures; gemstones for jewelry and the decorative arts; and utilitarian stones for tools, weapons, grinding stones, and other applications. It is with the sources and varieties of these stones that this paper is concerned. We have excluded those rocks supplying precious metals, such as gold and copper, but for these see Ogden (2000) and Klemm et al. (2001, 2002). The term ‘quarry’ is used here for all extraction sites, although those for gemstones (and precious metals) are more commonly referred to as ‘mines.’ In the sections that follow, the geology of Egypt is first summarized in order to provide a general idea of the stones available to the ancient Egyptians. A database of known ancient quarries is then presented and this is followed by a discussion of the various uses to which the quarried stones were put. The paper continues with a description of the quarrying technologies employed, and concludes with a review of the typical archeological remains found at quarry sites. This overview is intended for the general reader and so reference citations are largely omitted from the text but are included in the bibliography.

Overview of Egyptian geology

Egypt’s oldest rocks date to the late Precambrian and early Phanerozoic eons, approximately 500 to 2600 million years ago (Ma), with most forming during the Pan-African Orogeny of 500 to 1200 Ma (see Table 1 for the geologic time scale and the geologic ages of the quarry stones, and attached, fold-out map for the generalized geology of Egypt and the quarry locations). These include both igneous and metamorphic rocks, collectively referred to as Egypt’s ‘crystalline basement complex’. The basement rocks are mostly buried beneath layered sequences of younger Phanerozoic sedimentary rocks. Overlying most of the latter are geologically recent (Quaternary period) deposits of unconsolidated sediments, including fluvial siliciclastic gravel, sand, and mud in the Nile Valley and desert wadis, and aeolian sand in the Eastern Desert and especially in the Western Desert with its vast Saharan ‘sand sea’. During the Quaternary, biogenic deposits accumulated along Egypt’s coasts, with carbonate dunes forming behind the Mediterranean beaches and carbonate reefs forming off the Red Sea shore.

Outcrops of Precambrian basement rocks are restricted to the southern Sinai Peninsula, the southeast and southwest corners of the Western Desert, and the Red Sea Hills of the Eastern Desert. The latter outcrops broaden westward at the latitude of Aswan and extend all the way to the Nile, where they form this river’s ‘First Cataract’. Another five cataracts interrupt the Nile River in northern Sudan. Outcrops of sedimentary rocks, mainly sandstone in southern (Upper) Egypt and limestone to the north in Middle and Lower Egypt, form the ‘walls’ of the Nile Valley and the surfaces of the adjacent plateaus of the Western and Eastern deserts.

During the Paleozoic and Mesozoic eras of the Phanerozoic con, Egypt was alternately elevated above sea level and inundated by shallow seas with mostly

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Table 1. Geologic time scale. Dates are from USGS (2007).

<table>
<thead>
<tr>
<th>Eon</th>
<th>Era</th>
<th>Period</th>
<th>Epoch</th>
<th>Million years before present</th>
<th>Egyptian quarries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Cambrian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>all igneous and metamorphic rock varieties, except basalt; and all gemstones except turquoise and some malachite</td>
</tr>
<tr>
<td>Phanerozoic</td>
<td>Ceno-</td>
<td>Tertiary</td>
<td>Pleistocene</td>
<td>0.0115–1.8</td>
<td>limestone at Dahshur and Gebel el-Gir</td>
</tr>
<tr>
<td></td>
<td>zoic</td>
<td></td>
<td></td>
<td></td>
<td>all anhydrite and gypsum along the Red Sea coast</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Miocene</td>
<td>1.8–5.3</td>
<td>Gebel Amhar silicified sandstone and all basalt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oligocene</td>
<td>23–33.9</td>
<td>all limestone in the Nile Valley, except at Dahshur, Gebel el-Gir and el-Dibabiya; all travertine and chert; and the Umm el-Sawan gypsum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eocene</td>
<td>33.9–55.8</td>
<td>limestone at el-Dibabiya</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>all limestone along the Mediterranean coast</td>
</tr>
<tr>
<td></td>
<td>Ceno-</td>
<td></td>
<td></td>
<td></td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
</tr>
<tr>
<td></td>
<td>zoic</td>
<td></td>
<td>Jurassic</td>
<td>145.5–199.6</td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Triassic</td>
<td>199.6–251</td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Permian</td>
<td>251–299</td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<tr>
<td></td>
<td>Pale-</td>
<td></td>
<td>Carboniferous</td>
<td>299–359.2</td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<tr>
<td></td>
<td>ozoic</td>
<td></td>
<td>Devonian</td>
<td>359.2–416</td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Silurian</td>
<td>416–443.7</td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Ordovician</td>
<td>443.7–488.3</td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<td></td>
<td></td>
<td></td>
<td>Cambrian</td>
<td>488.3–542</td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<tr>
<td></td>
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<td></td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
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<td></td>
<td></td>
<td></td>
<td>all sandstone, including the silicified variety except at Gebel Amhar all turquoise and some malachite</td>
</tr>
</tbody>
</table>
siliciclastic sedimentary rocks forming (conglomerate, sandstone, and mudrock) plus some limestone. The thickest and most areally extensive of these deposits is the Nubia Group (or Sandstone), which dates to the latter part of the Cretaceous period and was deposited in shallow-marine to mainly fluvial environments. From the Late Cretaceous through the Eocene epoch of the Tertiary period, most of Egypt was under a shallow sea and accumulating carbonate sediments that are best represented today by the various Eocene limestone formations. Beginning in the Oligocene epoch and continuing through the Quaternary period, most of Egypt was above sea level and once again receiving predominantly siliciclastic sediments.

The mid-Tertiary uplift of Egypt, which initiated the return of siliciclastic sedimentation, was caused by the opening of the Red Sea, a plate tectonic rifting event that separated the Arabian Peninsula from the African landmass, beginning about 30 Ma. As a consequence of this rifting, the crystalline basement complex was pushed up to form the Red Sea Hills, a south-to-north flowing paleo-Nile river developed along a fracture zone west of the Red Sea Hills, magmatic activity produced dolerite dikes that intruded all earlier rocks, and volcanic eruptions extruded basaltic lava flows. The paleo-Nile was fed by tributaries draining the lands to the west and east of its course in Egypt, but the modern Nile River, with its water sources in the Ethiopian and Ugandan highlands, dates to the late Quaternary. For additional information on the geology of Egypt see Said (1990) and Tawadros (2001), and for a non-technical introduction see Sampsell (2003).

Ancient Egyptian quarries database

Just over 200 ancient quarries are known from Egypt, and these range in age from the Late Predynastic to the Late Roman Period, a span of about 3500 years (see Table 2 for the chronology of ancient Egypt). The attached map shows their distribution and provides, on the back, the names and coordinates of the quarry localities as well as their stone types and general ages. Detailed plans of several of the larger, more important quarries (and the associated quarry landscapes) are provided in Figures 7–8, 19, 21–22, 26, 28 and 32. Nearly all quarries, except those now under Lake Nasser, were located in the field by the authors. Their latitudes and longitudes, as reported here, are those determined from Google Earth satellite images (www.GoogleEarth.com). The workings for most of the quarries are visible on these images, but they are seldom obvious. This database also includes several quarries of medieval Islamic date in Egypt's Eastern Desert. Although it is the most comprehensive list of ancient Egyptian quarries yet published, this database is still incomplete. There are undoubtedly many more quarries awaiting discovery as well as others that will remain unknown because they have been destroyed by urban growth, modern quarrying, or natural weathering and erosion. Moreover, the database does not include quarries earlier than the Late Predynastic Period, such as those of Paleolithic and Neolithic age for tools made from chert (flint) and silicified sandstone (quartzite).

The authors' publications and other selected sources on specific Egyptian quarries and their stones are provided in the bibliography. Other useful sources of information include Lucas (1962, p. 50–74, 386–428), De Putter and Karlshausen (1992), and Klemm and Klemm (1993, 2008). See Figures 10 and 11 for images of selected ancient quarry stones.

Sources and uses of stone in ancient Egypt

Building stones

Limestone and sandstone were the main building stones of ancient Egypt (Figures 1–10). From Early Dynastic times onward, limestone was the material of choice within the limestone region for pyramids, mastaba tombs, and temples. Beginning in the late Middle Kingdom, sandstone was used for all temples within the sandstone region as well as many of those in the southern part of the limestone region. Both limestone and sandstone were also employed for statuary and other non-architectural applications when harder and more attractive orna-

Table 2. Ancient Egyptian chronology. Dates are from Baines and Malek (2000, p. 36–37).

<table>
<thead>
<tr>
<th>Period</th>
<th>ca. 3100–2950 BCE</th>
<th>Dynasties</th>
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<tbody>
<tr>
<td>Late Predynastic Period</td>
<td></td>
<td>2950–2575 BCE</td>
</tr>
<tr>
<td>Early Dynastic Period</td>
<td></td>
<td>2575–2150 BCE</td>
</tr>
<tr>
<td>Old Kingdom</td>
<td></td>
<td>2125–1975 BCE</td>
</tr>
<tr>
<td>First Intermediate Period</td>
<td></td>
<td>1975–1630 BCE</td>
</tr>
<tr>
<td>Middle Kingdom</td>
<td></td>
<td>1630–1540 BCE</td>
</tr>
<tr>
<td>Second Intermediate Period</td>
<td></td>
<td>1540–1075 BCE</td>
</tr>
<tr>
<td>New Kingdom</td>
<td></td>
<td>1075–715 BCE</td>
</tr>
<tr>
<td>Third Intermediate Period</td>
<td></td>
<td>715–332 BCE</td>
</tr>
<tr>
<td>Late Period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greco–Roman Period</td>
<td></td>
<td>332–30 BCE</td>
</tr>
<tr>
<td>Ptolemaic Period</td>
<td></td>
<td>30 BCE–395 CE</td>
</tr>
<tr>
<td>Roman Period</td>
<td></td>
<td>395–640 CE</td>
</tr>
<tr>
<td>Byzantine (or Late Roman)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Islamic Period</td>
<td></td>
<td>640 CE–present</td>
</tr>
</tbody>
</table>

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Figure 1. Limestone quarries near Cairo. Top: open-cut workings at Giza (L2, 4th Dynasty–Old Kingdom) with king Khafre’s (or Chephren’s) pyramid behind. Bottom: open-cut and gallery workings at Zawyet N ayr on Gebel Mokattam (L5, Old and/or Middle Kingdom to New Kingdom) close to Cairo’s Citadel. The latter quarry also provided stone for mosques and other buildings of medieval Islamic Cairo (insert). Photos by Per Storemyr.
Figure 2. Limestone quarries in the Nile Valley. Top: open-cut (left) and gallery (right) workings at Qaw el-Kebir (L75, Old and/or Middle Kingdom to New Kingdom, and Ptolemaic to Roman) near ancient Antaeopolis. Middle left: gallery workings at El-Dhibabiya (L91, 19th Dynasty–New Kingdom, 21st Dynasty–3rd Intermediate Period, and Roman). Middle right: open-cut workings at Beni Hasan (L21, Old and/or Middle Kingdom to New Kingdom, and Roman) near the famous Beni Hasan tombs. Bottom: open-cut workings at Zawyet el-’Amwat (L16, New Kingdom to Roman) in the Zawyet Sultan district. Photos by James Harrell.
Figure 3. Limestone quarry in western Thebes, near Luxor. Top: aerial view of western Thebes with the Wadi el-Muluk quarry (18th Dynasty–New Kingdom, 26th Dynasty–Late Period, and Roman) at the arrow. Bottom and middle right insert: open-cut and gallery workings in the Wadi el-Muluk quarry. Note the red lines on the gallery ceiling in the insert, which mark the progress of the ancient quarrymen. Middle left insert: queen Hatshepsut's temple at Deir el-Bahri, which was built with limestone from the Wadi el-Muluk quarry. Photos by Per Storemyr.
Figure 4. Sandstone quarries in the Nile Valley. Top: open-cut workings at Nag el-Fugani (S12, Ptolemaic), just north of Aswan. Bottom: open-cut workings at Nag el-Hosh (S6, Ptolemaic to Roman) just north of Kom Ombo. Inset: open-cut workings at El-Mahamid (S2, Old and/or Middle Kingdom, and Ptolemaic), near ancient El-Kab.

Photos by Per Storemyr except the insert, which is by James Harrell.
Figure 5. Stone temples. Top: Philae sandstone temple (Ptolemaic–Roman) near Aswan as seen in the early 1900s before its removal to higher ground on a nearby island following the completion of the Aswan High Dam in 1971. Stone for this temple came from the Qertassi quarry (S20), now under Lake Nasser. Bottom right: Hibis sandstone temple (Late Period) in Kharga Oasis, with the stone probably coming from the Gebel el-Teir quarry (S32). Bottom left: calcareous-sandstone temple at Qasr el-Sagha in northern Faiyum (Middle Kingdom), with the stone coming from a quarry probably nearby but not yet identified. Photos by Per Storemyr except the top one, which is from American Colony Jerusalem Collection (1900–1920, PPOC, digital ID: http://hdl.loc.gov/loc.pnp/matpc.01580).
Figure 6. Softstone quarrying technology: Top: vertical trenches and undercut for sandstone blocks in the Gebel el-Silsila quarry (S9b, Middle to New Kingdom, and Ptolemaic to Roman). Bottom: dressed (chiseled) quarry face in sandstone at the Nag el-Hosh quarry (S6, Ptolemaic to Roman). Lower right insert: bedrock surface after removal of limestone blocks by trenching and undercutting in the Giza quarry beside the king Khafre (or Chephren) pyramid (L2, 4th Dynasty-Old Kingdom). Photos by Per Storemyr.
Figure 7. Map showing an ancient quarry landscape covering about 100 km² in the Aswan area, with quarries for granite and granodiorite in Aswan (H6); dolerite in Aswan (H37–38); silicified sandstone at Wadi Abu Aggag (H4); Gebel Galah and Tingar (H5), and Wadi Abu Subeira (H36); and normal (non-silicified) sandstone at numerous localities (S12–13, S16–18, and S38). Map by Per Storemyr based on a survey by the QuarryScapes project as well as on Harrell and Madbouly (2006) for Wadi Abu Aggag and Klemm and Klemm (1993) for the Aswan granite/granodiorite quarries. A Landsat satellite image (ca. 2000) is used as background.
mental stones were not available. Along the Red Sea coast, the temples and other important buildings of the Ptolemaic and Roman Periods were built with blocks of anhydrite and gypsum.

Nearly all the limestone came from Tertiary formations (mainly Eocene but also Paleocene and Pliocene) with the ancient quarries located in the hills and cliffs bordering the Nile Valley between Cairo in the north and Isna in the south. Some limestone, of Quaternary age, was also quarried along the Nile Delta’s Mediterranean coast west of Alexandria. Quarries in the Nile Valley from Isna southward into northern Sudan supplied the sandstone, which came from the Cretaceous Nubia Group. Anhydrite and gypsum were obtained from Egypt’s Red Sea coast, where they occur in various Miocene formations, and gypsum also came from Eocene outcrops in the Faiyum region of the Western Desert.

**Ornamental stones**

In contrast to the plain-looking building stones, those employed for ornamental purposes have attractive colors and patterns, and also take a good polish due to their greater hardness or, in the case of travertine and gypsum, their coarsely crystalline character (Figures 7, 10–29).

The principal applications of these stones and their periods of use are as follows:

1. External veneer on pyramids: Old Kingdom—granite, and granodiorite.
2. Pyramid capstones: Old and Middle Kingdoms—granodiorite, and possibly basalt.
3. Linings of burial chambers and passages in pyramids and mastaba tombs: Early Dynastic Period through Middle Kingdom—granite, granodiorite, and silicified sandstone.
4. Door lintels, jambs, and thresholds of temples: Early Dynastic through Roman Periods—granite, granodiorite, and silicified sandstone.
5. Temple pavements: Old Kingdom—basalt and travertine.
6. Temple columns: Old and Middle Kingdoms—granite.
7. Internal wall veneer, pavement, and columns for temples and other buildings: Roman Period—andesite–dacite porphyry, granite, granodiorite, metaconglomerate, metagabbro, metagraywacke, pegmatitic diorite, quartz diorite, rhyolite porphyry, tonalite gneiss, and trachyandesite porphyry.
9. Barque shrines: Middle and New Kingdoms—granite, silicified sandstone, and travertine.
10. Small statue shrines (naoi): Old Kingdom through Roman Period—granite, andesite–dacite porphyry, and silicified sandstone; and Late Period only—dolerite porphyry.
11. Obelisks: New Kingdom and Roman Period—granite; and New Kingdom only—metaconglomerate, and silicified sandstone.
12. Offering tables: Old Kingdom through Roman Period—granite, granodiorite, metagraywacke, silicified sandstone, and travertine.
13. Small vessels and figurines: Late Predynastic Period through Old Kingdom—andesite porphyry, anorthosite–gabbro gneiss, basalt, granite, metagraywacke, obsidian, pegmatitic diorite, quartz rock crystal, red-and-white limestone breccia, gypsum, serpentinite, silicified (petrified) wood, travertine (the most commonly used stone), tuff, and tuffaceous limestone; and Middle Kingdom and Second Intermediate Period only—blue anhydrite (a stone different from the white anhydrite used in construction).
15. Sarcophagi: Old Kingdom through Roman Period—granite, granodiorite, metagraywacke, and silicified sandstone; and New Kingdom only—travertine; New Kingdom through Late Period only—metaconglomerate; and Late Period only—basalt.
16. Small to colossal statues and other sculptures: Early Dynastic through Roman Periods—granite, granodiorite, metagraywacke, red-and-white limestone breccia, silicified sandstone, and travertine; Old and Middle Kingdoms only—anorthosite–gabbro gneiss; early New Kingdom only—marble, and pyroxene; Late Period only—dolerite porphyry; Late through Roman Periods only—basalt, and metaconglomerate; and Roman Period only—andesite–dacite porphyry.
17. Scarab and shabti figures: New Kingdom through Roman Period
Period—metagraywacke, serpentine, soapstone (steatite), and travertine. (18) Stelae: Old Kingdom through Roman Period—granite, granodiorite, meta-graywacke, and silicified sandstone; and Late Period only—metaconglomerate. (19) Cosmetic and ceremonial palettes: Late Dynastic and Early Dynastic Periods: metagraywacke. Note that many of the above objects were also carved from non-ornamental limestone and sandstone.

During the Dynastic and Ptolemaic Periods, most of the ornamental stone was quarried in the Aswan region (granite, granodiorite, and silicified sandstone) with other smaller quarries located near Cairo (silicified sandstone), in the Western Desert's Faiyum (basalt) and Abu Simbel/Toshka area (anorthosite–gabbro gnéiss), and in the Eastern Desert's Red Sea Hills (marble, metaconglomerate, metagraywacke, and dolerite porphyry). The travertine came from quarries just east of the Nile Valley and from the same Eocene limestone formations supplying building stones, where it occurs as cavity and fissure fillings. The red-and-white limestone breccia also came from these same formations, where it occurs along faults, but no definite quarries have yet been found. Similarly, no quarries are known for the pyroxenite, serpentinite, and soapstone used in pre-Roman times. The many varieties of hardstones employed for vessels came mainly from the Red Sea Hills, where only a few of the quarries have so far been discovered. The basalt and gypsum also used for vessels came from the Faiyum–Cairo region, and the blue anhydrite, which is not known to occur in Egypt, may have been imported. Many of the same quarries for ornamental stones continued to be worked during the Roman Period, but most of the activity at this time involved new quarries producing a wide variety of attractive igneous and metamorphic rocks in the Red Sea Hills.

**Gemstones**

The ancient Egyptians used gemstones for beads, pendants, amulets, inlays, and seals (Figure 30). The materials most commonly employed during the Dynastic Period include: amazonite, carnelian (the most popular stone) and the closely related sard, red jasper, red garnet, lapis lazuli (the most valuable stone and imported from Afghanistan), colorless (rock crystal) quartz, and turquoise. Others occasionally used in this period were banded and sardonyx agate, amethyst (especially during the Middle Kingdom), bluish-white chalcedony, black hematite, yellow jasper (New Kingdom only), malachite, obsidian (imported from an unknown southern Red Sea or Ethiopian source), and white (milky) quartz. During the Greco–Roman Period the same gemstones were used, but there were also new ones, including emerald (green beryl), peridot (olivine) and, imported from India, aquamarine (bluish-green beryl), onyx agate, and sapphire (blue corundum). With the exceptions noted above, all these gemstones are thought to come from Egyptian sources, but the only known quarries are for amazonite, amethyst, carnelian, emerald, peridot, and turquoise. All the native gemstones come from the Precambrian basement rocks with the exceptions of turquoise and some malachite, which are found in sandstone of Jurassic age.

**Utilitarian stones**

Perhaps the most heavily used of all the Egyptian stones is chert (or flint, Figure 31). From Predynastic times onward it was employed for tools (aws, adzes, knife and sickle blades, axe and pick heads, choppers, drill bits, and scrapers) and weapons (dagger blades, and spear and arrow points). Even when metals (copper, bronze, and later iron) became commonplace for these applications, chert was still a popular low-cost alternative. For tools and weapons requiring the sharpest edges, imported obsidian was employed. A wide variety of stones, especially hard ones (including many of the aforementioned ornamental varieties), were used for the heads of maces, a club-like weapon.

From Late Predynastic times into the Late Period, the quarrying and much of the carving of hard ornamental stones was done with tools fashioned from tough, fracture-resistant rocks such as dolerite and others as discussed in a later section (Figure 16). These same rocks were also employed as grinding stones for smoothing rough, carved stone surfaces. The actual polishing of these surfaces was probably done with ordinary, quartz-rich sand of which Egypt abounds. For the softer sandstone and limestone, picks of chert (as well as metal tools) were employed. Grinding stones for grain have been used throughout Egyptian history and were usually carved from the same granite, granodiorite, and silicified sandstone employed for ornamental applications (Figure 31). During the Ptolemaic and Roman Periods, grinding stones made from imported vesicular basalt were popular.

In medieval Islamic times, Egypt had numerous quarries in the Eastern Desert for soapstone (steatite), which was carved into oil lamps and especially cooking vessels (Figures 32–33). Some of these quarries were also worked during the Roman Period. Eye shadow made from finely ground galena (dark gray) and malachite (green) was used by both Egyptian men and women. The grinding was done on cosmetic palettes carved mainly from metagraywacke. Egyptian temples and tombs were richly painted with bright primary colors often made from ground minerals: azurite and lapis lazuli (blue), goethite ochre and orpiment (yellow), gypsum and calcite (white), hematite ochre and realgar (red), and malachite (green). With the exceptions of chert (occurring as nodules in the Eocene limestones) and silicified sandstone (coming from the Cretaceous Nubia Group), essentially all the utilitarian stones were derived from the Precambrian basement rocks.

**Ancient Egyptian quarrying technology**

In considering the quarrying methods employed by the ancient Egyptians, it is useful to first distinguish between the ‘hardstones’ (essentially all the igneous...
Figure 9. Gebel el-Silsila sandstone quarry (S9a, b, Middle to New Kingdom, Ptolemaic to Roman) and its products. Top: view from the east bank across part of the quarry with the west bank workings visible on the other side of the Nile River and the New Kingdom harbor (now filled with vegetation) in the foreground. Bottom left: Ptolemaic to Roman open-cut workings on the east bank. Bottom lower right: Middle Kingdom gallery workings on the east bank. Bottom upper right: sphinxes carved from Gebel el-Silsila sandstone on the avenue joining the Luxor and Karnak temples in Luxor. Photos by Per Storemyr except the bottom left one, which is by James Harrell.
Figure 10. Selected stones from ancient quarries in the Nile Valley and Western Desert. The numbering and sequence of the images follow the list of quarries on the reverse side of the attached, fold-out map. Not all quarries and rock varieties are represented. Photos by James Harrell.
Figure 11. Selected stones from ancient quarries in the Eastern Desert. For further explanation see caption to Figure 10. Photos by James Harrell.
Figure 12. Travertine and gypsum quarries. Top: open-cut workings following a travertine vein in Wadi el-Garawi (T1, Old Kingdom) near Helwan. Bottom: open-cut workings in gypsum at Umm el-Sawan (O1, Early Dynastic to Old Kingdom) in northern Faiyum. Insert: originally underground and later open-cut workings in a travertine cave deposit at Hatnub (T8, 4th–6th Dynasty–Old Kingdom, 12th Dynasty–Middle Kingdom, 18th Dynasty–New Kingdom, and Roman) near El-Amarna. Photos by James Harrell except the bottom one, which is by Per Storemyr.
Figure 13. Hardstone quarries in the Eastern Desert: Top: dolerite porphyry quarry in Rad el-Gamra (H31, 30th Dynasty–Late Period) with roughed-out shrines or nasi at the entrance to the quarry cut. Middle right: tuff and tuffaceous limestone quarry on Gebel Manzal el-Seyl (H10, Early Dynastic). Middle left: pegmatitic diorite quarry in Wadi Umm Shegila (H17, Late Predynastic to Early Dynastic, and Roman). Bottom: metagraywacke quarry in Wadi Hammamat (H28a, Late Predynastic to Roman). Photos by Per Storemyr except the middle left and bottom ones, which are by James Harrell.
Figure 14. Basalt in Old Kingdom temple pavements used to symbolize kmt (the ‘black land’), Egypt’s ancient name and a reference to the dark organic-rich, life-giving soil of the Nile floodplain. Top: pyramid temple of king Sahura at Abu Sir (5th Dynasty). Lower left insert: pyramid temple of king Khufu (or Cheops) at Giza (4th Dynasty). Lower right insert, top: pyramid temple of king Niuserra at Abu Sir (5th Dynasty). Lower right insert, bottom: pyramid temple of king Userkaf at Saqqara (5th Dynasty). The basalt for these pavements came from the Widan el-Faras quarry in the northern Faiyum (H2, see also Figures 21–23). The pyramid temples and associated monuments are excellent places to study the Old Kingdom use of stone for ornamental and architectural purposes. In addition to basalt, there is granite and granodiorite, silicified sandstone, travertine and fine limestone with splendid relief. Photos by Per Storemyr with plans of pyramid complexes after Lehner (1997).
Figure 15. Stone sculptures. Top left: New Kingdom (Amarna Period) head of queen Nefertiti in silicified sandstone, quarry unknown (Egyptian Museum, Cairo). Top right: Late Period statue of Osiris in metagraywacke from Wadi Hammamat (Egyptian Museum, Cairo). Middle left: Ptolemaic statue of a priest in basalt, probably from Widan el-Faraf (Egyptian Museum, Cairo). Middle center: New Kingdom statuette in glazed soapstone (steatite), quarry unknown (Louvre, Paris). Middle right: New Kingdom statue of Khaemwese, son of king Ramesses II, in silicified conglomeritic sandstone, perhaps from Gebel Ahmar (British Museum, London). Bottom: a collection of Dynastic funerary figurines or shabtis, carved, from left to right, in limestone or travertine (3), silicified sandstone, travertine, and metagraywacke (2) (Louvre, Paris). Photos by Per Storemyr.
Figure 16. New Kingdom hardstone quarrying technology at Aswan. Top and upper insert: trenches cut in granite for a colossal statue in the Unfinished Obelisk Quarry at Aswan (part of H6) using dolerite pounders like those shown at bottom right. Bottom left: cracked quarry face produced by fire setting in the silicified sandstone quarry on Gebel Gulab (H5) near Aswan. Geologist Tom Heldal pictured. Photos by Per Storemyr except the bottom right one, which is by James Harrell.
Figure 17. Roman hardstone quarrying technology. Top: abandoned column in tonalite gneiss in the Mons Claudianus quarry (H18) still attached to the bedrock with traces of wedge holes and a chiseled groove along the bottom edge. Middle right: block of metagraywacke in the Wadi Hammamat quarry (H28a) with both wedge holes and pointillé pits. Bottom: dressed (chiseled) quarry face in andesite-dacite porphyry in the Mons Porphyrites quarry (H12a) where multiple courses of blocks were extracted. Photos by Per Storemyr.
Figure 18. Slipway roads: Top: 18 m-wide slipway (quarry road) in the silicified sandstone quarry on Gebel Gulab (H5, New Kingdom) with another slipway from elsewhere in the same quarry (inset). Bottom: slipway descending 500 m from the Lykabettus workings in the andesite–dacite porphyry quarry at Mons Porphyrites (H12a, Roman). Photos by Per Storemyr except the bottom one, which is by James Harrell.
and metamorphic rocks plus silicified sandstone and chert) and the ‘softstones’ (limestone, sandstone, travertine, anhydrite, gypsum, and soapstone). The extraction technologies are very different for each group.

**Hardstone quarrying**

From the Late Predynastic times through most of the Late Period, quarrying of hardstone was done with stone tools (Figure 16). These tools, which are known as pounders or mauls, were hand-held, purpose-shaped pieces of exceptionally hard and tough rock. The most popular material was dolerite, but fine-grained granite, silicified sandstone, and anorthosite gneiss were also utilized. Large, two-handed pounders were employed to either knock off the corners and edges of bedrock outcrops if only relatively small pieces were required, or hack out trenches and undercuts to isolate large blocks from the bedrock. The same tools were also used to reduce and reshape loose boulders resting on the bedrock. The extracted blocks were dressed (trimmed) with smaller stone tools, sometimes mounted on wood handles. Fire setting was employed during the Dynastic Period to weaken hardstone surfaces prior to pounding with a stone tool (Figure 16). Where the ancient quarrymen could exploit natural fractures in the bedrock, copper or bronze gads were hammered into the fractures to widen them. Natu-ral, wedge-shaped splinters of rocks may also have been used in the same way. Wood levers (stout poles or beams) were used to help detach blocks along fractures or cut trenches.

By the 30th Dynasty of the Late Pe-riod, and possibly as early as the 26th Dynasty, ‘iron’ (low-grade steel) tools were first used by the Egyptians for quarr-ying, and included sledge hammers, picks, chisels, and wedges. In extracting blocks from the bedrock or boulders, a line of wedge-shaped holes was first chiseled into the surface (Figures 17 and 27). Iron wedges were then inserted into the holes and these were hammered until the rock split along the line of holes. Thin pieces of iron called ‘feathers’ may have been placed on each side of the wedges to increase the lateral, expansive force of the hammered wedges. The iron-wedge technology improved through the Ptolemaic Period and reached its zenith in Roman times, with little change between then and the present day. A fiction of-ten repeated in the popular archeologi-cal literature is that the wedge holes were cut for wooden wedges which, when wetted, would expand and so split the rock. In reality, this cannot work for the sizes, shapes, spacings, and often inclined orientations of wedge holes found in ancient hardstone quarries. Wooden wedges have been successfully employed in some modern hardstone quarries, but these require different kinds of wedge holes. Another quarrying innovation that first appeared in Egypt during the Ptolemaic Period was the so-called ‘pointillé’ technique, which is still in use today (Figure 17). Whereas wedging is useful for rough splitting, lines of pointillé pits are employed for more precise, controlled separation. In this method, a straight line of small, shallow pits is chiseled across a rock surface. The quarryman then hammers a chisel back and forth along the line of pits until the rock splits. Fire setting and levers continued to be used, but the levers were probably of iron as well as wood.

**Softstone quarrying**

Throughout the Dynastic Period until near the end of the Late Period, when iron tools were adopted, the softstones were quarried with copper (and later bronze) chisels and picks. It is likely that chert pick heads were also commonly em-ployed. Although copper and the harder bronze were tough enough to work the softer stones, these tools were quickly blunted and abraded. They were entirely unsuited for quarrying the hardstones, for which the stone tools were much su-perior. The picks were used to cut vertical trenches on three sides of an intended block which, on its open quarry-face side, was then undercut and detached by a chisel hammered with a wood mallet (Figure 6). These same tools were then employed to dress the extracted blocks. This basic approach to softstone quar-rying remained unchanged during the Ptolemaic and Roman Periods, but the picks and chisels were of iron. On occa-sion, hammered iron wedges were also used to split limestone and sandstone. See Arnold (1991) for additional infor-mation on the tools used for quarrying and dressing stone.

**Quarry excavations and transport**

Quarrying in ancient Egypt was usu-allly done in open pits and trenches. In addition to such ‘open-cut’ workings, in some quarries the workers followed desirable rock layers underground and in the process created cave-like ‘gallery’ quarries (Figures 2–3 and 9 for building stones). Unquarried rock pillars were left to support the roofs in the larger galler-ies but, apart from these, no other precautions were taken to prevent cave-ins. Gallery quarries are relatively common for limestone and travertine, and such excavations locally penetrate over 100 m into hillsides. Many of the limestone galleries later became the sites of Coptic Christian hermitages and monasteries, with some of the latter still active today. With the exception of the Gebel el-Silsila quarry (Figure 9), galleries were never cut into sandstone or any of the hard-stone rock varieties. There are, however, underground workings, as well as open-cuts, in all the emerald quarries (Figure 30) and one of those for chert (Wadi el-Sheikh), but these involve narrow shafts and tunnels more like those found in the ancient Egyptian gold mines.

The choice of quarry location would have been based on several factors, in-cluding the quality of the stone (appear-ance, soundness, and available block sizes), proximity to the building site or workshop for which the stone was des-tined, and proximity to the Nile River if water transport was needed. In the case of limestone and sandstone, the loca-tions of quarries on the sides of the Nile Valley were dictated more by the charac-ter of the rock than ease of accessibility, as evidenced by the many workings high above the more easily reached outcrops at lower elevations. For these build-
ing stones, the quarries were normally restricted to rock layers with uniform coloration and texture, at least moderate hardness, and thicknesses and vertical fracture spacings suitable for the sizes of blocks required.

For the ornamental stones coming from remote parts of the desert, the extra effort required to obtain them was justified by either their exceptional beauty (e.g., travertine with its translucency, and anorthosite–gabbro gneiss with its blue glow in bright sunlight) or their symbolic significance (e.g., metagraywacke with its green color, like new vegetation, signifying good health and regeneration, and the many igneous and metamorphic rocks quarried in the Eastern Desert representing the might and wealth of the Roman Empire). Gemstones were always in demand for jewelry and other decorative arts, and the long and arduous passages to their desert sources were not sufficient to discourage the ancient Egyptians from quarrying them.

During the Dynastic Period, quarried pieces of stone too large to be carried on the backs of men or animals (mainly donkeys but also camels from perhaps the Late Period onward), would have been placed on wooden sledges, which were then pulled by teams of either draft animals or, probably more commonly, men. In order to reduce ground friction, the sledges may have been pulled over either wetted ground or wooden beams ('sleepers') laid crosswise along the sledge's path. The sleepers would have traveled with the sledge, with those left behind picked up and laid down in front of the advancing sledge. It has been suggested that the sledges were sometimes pulled over wood 'rollers', but this is unlikely as rollers would only be effective on ground that was hard, smooth, and relatively flat. Such ground conditions may have existed within some quarries, but in most cases the sledges were pulled across rocky or sandy ground or, at best, roughly made tracks where the rollers would have been ineffective. Specially built quarry tracks or roads were not uncommon during the Dynastic Period. Some were paved with a single course of dry-laid, unshaped, and loosely fitted pieces of the locally available rocks. The most notable of these is the 12 km-long road leading from the Old Kingdom basalt quarry at Widan el-Varas in the Fayyum (Figures 21–23). This is the world's oldest paved road and was constructed from irregular pieces of basalt and silicified wood, and slabs of limestone and sandstone. A complex, 20 km-long network of paved and partially cleared roads of New Kingdom date are found in the silicified sandstone quarries near Aswan at Gebels Gulab/Tingar and, across the Nile, in Wadi Abu Aggag (Figures 7 and

Figure 19. Map of Chephren’s Quarry for anorthosite–gabbro gneiss (H7, Old and Middle Kingdoms) showing nearly 700 workings and associated infrastructure. Insert depicts how the quarry is currently being engulfed by roads and canals of the giant Toshka land reclamation project. Map by Per Storemyr based on a survey by the British–Norwegian mission to Chephren’s Quarry and the QuarryScapes project with a US declassified Corona satellite image (ca. 1965) used as background.
Figure 20. Chephren’s Quarry for anorthosite–gabbro gneiss (H7, Old and Middle Kingdoms). Top: quarry working with roughed-out statue blocks produced from boulders. Middle left: ramp where larger blocks were loaded onto some kind of sled. Middle right: smaller blocks destined for vessels grouped in an ancient collection area. Bottom left: statue of king Khafre (Chephren) carved from gabbro gneiss (Egyptian Museum, Cairo). Bottom right: three vessels (in the front) carved from anorthosite gneiss with the other vessels in the back carved from travertine (Louvre, Paris). Photos by Per Storemyr except the bottom left one, which is from Jon Bodsworth (www.egyptarchive.co.uk).
sites, it is useful to distinguish between those located in or very close to the Nile Valley, and those in the remote desert. The following summary mainly draws from recent archeological research in the Eastern Desert, in the northern Faiyum, at Hatnub, in the Aswan region, and at Chephren’s Quarry near Abu Simbel/Toshka, as well as more general observations. It is important to recognize that Egypt’s desert climate, although already very dry, was slightly more hospitable in ancient times than it is now.

Remote desert quarries

With some notable exceptions, the remote desert quarries usually feature the following groups of archeological remains (Figures 13, 16–29, and 32–35):

1. Places of ‘primary’ stone extraction (e.g., bedrock outcrops and boulders) with tool marks and typically large waste dumps. There may also be ‘secondary’ extraction areas for stone tools and, in the Ptolemaic–Roman Period, nearby smithies for the repair of iron tools. (2) Work areas for dressing the extracted blocks, and then carving them into rough-outs or nearly finished products (many of which remain at the sites). These are sometimes associated with storage areas for such products. (3) Slipways, loading ramps, roads, or other marked routes for transportation of stone within the quarry and away to the Nile Valley. (4) Stone huts with, at times, more elaborate stone structures (such as fortified buildings) forming small to large temporary or permanent settlements used by the quarry workers. (5) Cemeteries for the larger, more permanent settlements. (6) Crude stone shelters within the primary stone-extraction areas, used by the workers as temporary resting places. (7) Wells and cisterns, without which work in the desert would be impossible. (8) Religious or other structures of worship and ritual, from simple stone enclosures and standing stones to shrines and elaborate temples. (9) Cairns and standing stones for marking transport routes and quarry locations. (10) Inscriptions, graffiti and rock art related to the quarrying activities, and sometimes also texts in the form of ostraca. (11) Pottery, generally fragmentary, which usually constitutes the most important dating tool for a site.

In addition to the above remains, at the larger Roman quarries in the Eastern Desert there are the so-called ‘animal lines’, a series of cubicles separated by low stone walls where draft animals were watered and fed. The Romans also built stone huts on hilltops with commanding views of the surrounding area, and these served as lookouts and signaling stations. The source of the vast quantities of food consumed by the quarry workers and their animals is somewhat problematical. It was probably largely brought in from the Nile Valley, but some of the more perishable foods may have been grown in small gardens near the quarry settlements. Although no such gardens have yet been identified, it is unlikely that they would be preserved in an easily recognizable form.

The amount, distribution and kinds of archeological remains at a given quarry is dependent upon the period in which the site was in use, its size, and the longevity and pattern of stone extraction (e.g., periodic campaigns vs. continuous exploitation). Other important factors are the local geography (e.g., exposure to flash floods and wind-blown sand) and the relative importance of the site in terms of the value of its product.

Quarries in the Nile Valley

The Nile Valley quarries supplied nearly all the building stones (limestone and sandstone) as well as the most important ornamental stones (granite and granodiorite), and so in terms of volumes of material extracted, they are usually much larger than the remote desert quarries. Another characteristic of the Nile Valley quarries is a general absence of settlements, wells, and cemeteries because the work force would have resided mainly in the nearby villages on or just beyond the Nile floodplain. These quarries, however, do typically contain many primitive shelters, some roofed over with stone slabs and others mere windbreaks, that were large enough to accommodate one or two men during day-time rest.

Archeology of quarry sites

Quarries are not simply sources of stone, but are also important archeological remains that provide a different perspective on life in ancient Egypt than the sites more commonly studied by archaeologists, such as pyramids, temples, settlements, and cemeteries. In any consideration of the archeology of quarry sites, it is useful to distinguish between those located in or very close to the Nile Valley, and those in the remote desert. The following summary mainly draws from recent archeological research in the Eastern Desert, in the northern Faiyum, at Hatnub, in the Aswan region, and at Chephren’s Quarry near Abu Simbel/Toshka, as well as more general observations. It is important to recognize that Egypt’s desert climate, although already very dry, was slightly more hospitable in ancient times than it is now.

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Figure 21. Map of the Widan el-Faras basalt quarry (H2, Old Kingdom) in the northern Fayyum showing the quarry workings and the 12 km-long paved road leading from the quarry to the quay near Qasr el-Sagha and formerly on the shore of a much higher Fayyum lake. Other quarries and the Middle Kingdom temple at Qasr el-Sagha are also indicated on the map. Map by Per Storemyr based on a survey by the QuarryScapes project with a US declassified Corona satellite image (ca. 1965) used as background.
periods. Those quarries located up to a few kilometers from the Nile may have a larger number of temporary shelters or even stone huts, but still lack settlements. Instead of long-distance roads, there are short slipways leading to nearby construction sites or the river. A canal for water transportation has been recently discovered leading to the Unfinished Obelisk in the Aswan granite quarry, but such constructions are very exceptional. Cairns and standing stones exist, but they are fewer and less obvious than in the desert. Religious or ritual structures, such as small rock-cut shrines and stelae, are commonly present within these quarries, but there are no elaborate temples. Some quarries, however, are located within or very near the precincts of temples and necropoleis with pyramids and mastabas. In general, it is expected that quarries will be located in the immediate vicinity of construction sites, assuming that stone of suitable quality is available. The conspicuous limestone quarry beside Khafre’s pyramid at Giza is a good example of this (Figure 6). Many such quarries, however, have gone unrecognized because they are buried under ancient construction or modern excavation debris, or river- or wind-deposited sediments. Others have been destroyed by later building activities.

Skilled practice and local traditions
Taking a broad view of the extremely long time period covered in this paper, the archaeology of quarry sites suggests that, contrary to the boasts in ancient quarrying inscriptions, relatively small numbers of highly skilled, free craftsmen constituted the primary workforce. Criminals and enslaved war captives comprised only a minor component. The numbers of such personnel were rarely in the hundreds and never in the thousands. However, an often sizeable number of auxiliary personnel were present, and these were responsible for the supply and transport logistics, and guard duties. Life must have been hard, especially at remote desert quarries, but there were exceptions such as at the far-away Roman site of Mons Claudianus in the Eastern Desert. This had as many as 900 workers in its most active period, and boasted a bathhouse and wines imported from other parts of the Roman Empire. Although the quarries were of prime importance for the state and its elites, whether in Dynastic or Ptolemaic Egypt or in distant Rome, in recent years there has been a trend among researchers to downplay the role of central state control in favor of local, family- or clan-based entrepreneurship. Research on such issues

Figure 22. Detailed map of the Widan el-Faras basalt quarry (H2, Old Kingdom) showing the five areas with workings, the network of branching, mostly paved quarry roads, and other associated infrastructure. Map by Per Storemyr based on a survey by the QuarryScapes project with a US declassified Corona satellite image (ca. 1965) used as background.
Figure 23. Widan el-Faras basalt quarry (H2, Old Kingdom). Top: view from the quarry looking south past the peaks of Widan el-Faras toward Lake Quran just visible on the horizon. Middle left: circular waste piles below the quarry produced by the dressing of basalt blocks. Middle right: part of the paved road leading from the quarry (on the escarpment in the distance) to a quay. This segment of the road is made with pieces of silicified (petrified) wood. Bottom: 300 m-long quay near Qar el-Sagha with abandoned basalt blocks littering its surface. Photos by Per Storemyr.
Figure 24. Aswan granite/granodiorite quarry (H6, Early Dynastic to Roman) and its products. Top: part of Aswan’s Unfinished Obelisk Quarry in granite (as seen under archeological excavation in 2003). Bottom right: obelisk of pink, coarse Aswan granite erected for queen Hatsheput in Karnak temple, Luxor. Bottom left: torso of a colossal statue of king Ramesses II carved from dark granodiorite with veins and patches of pink, fine granite from Aswan (originally from the Ramesseum in western Thebes and now in British Museum, London). Photos by Per Storemyr.
Figure 25. Gebel Gulab and Tingar silicified sandstone quarry (H5, New Kingdom and Roman). Top: working in the so-called Khnum’s Quarry with the abandoned base for an obelisk (at center) and the city of Aswan in the background. Bottom: working on Gebel Sidi Osman with an abandoned statue blank (foreground) and the ruins of the medieval St. Simeon’s Coptic monastery in the background. Right insert: quarry workings on Gebel Gulab, where large boulders were reduced to circular waste piles. Photos by Per Storemyr.
has only just begun, but it is an example of the significant role that the archeology of quarry sites can play in understanding life in ancient Egypt.

**Ancient quarry landscapes**
A glance at the maps in this paper (attached map and Figures 7, 8, 19, 21, 22, 26, 28, and 32) reveals that quarry sites may be large, locally more than several tens of square kilometers, and very often form clusters that are intricately linked with each other in terms of logistics and other features. In addition, they have frequently altered the natural landscape to such an extent that we, from a physical perspective, may speak of an ‘ancient quarry landscape’. The tremendous lateral extent of some quarries as well as the great number of quarries overall are two of the greatest challenges in present conservation efforts, especially since land is becoming scarce in Egypt, as shown in other papers in this volume. When smaller (or larger) pieces of a quarry landscape are destroyed, its context may be lost and perhaps rendered impossible to reconstruct when trying to interpret how it was used and perceived in antiquity. The term ‘quarry landscape’ may also be seen as a research perspective on the social and cultural significance such places once held: the relationships among different quarries, and their links with nearby (and more remote) villages were maintained by the people that traversed, worked and settled the physical landscape, and exchanged ideas and more tangible items, such as tools. The quarries were also strongly related to the places where the stones were put in use, again by people for whom stone was important, whether for the elites as a way of exhibiting power or wealth, or for the humble craftsman as a way of supporting his family.

**Acknowledgements**
The authors would like to thank the Supreme Council of Antiquities and the former Egyptian Geological Survey and Mining Authority (now Egyptian Mineral Resources Authority) for permissions to work at quarry sites and for other support. Much appreciation is extended to our fellow quarry researchers, with whom we carried out much of the work: Elizabeth Bloxam, Thomas Bown, Max Brown, Tom Heldal, Adel Kelany, Mohamed Madbouly, Masoud Masoud, and Steven Sidebotham. Many thanks are additionally due to those who provided logistical assistance, Ahmed Bedawy and Karen van Opstal, and who commented on an earlier draft of this paper, Tom Heldal and Ian Shaw. Storemyr’s contribution to this paper has been largely supported by the QuarryScapes.

*Figure 26. Map of the Mons Claudianus tonalite gneiss quarry (H18, Roman) in the central Eastern Desert showing the areas with quarry workings plus selected slipways, roads, and other infrastructure. Also indicated are the contemporary Roman quarries in Wadi Barud for quartz diorite (H19) and Wadi Umm Hayut for tonalite gneiss (H20). Map by Per Storemyr and James Harrell based on Peacock and Maxfield (1997) as well as their own observations with a Landsat satellite image (ca. 2000) used as background.*
Figure 27. Mons Claudianus tonalite gneiss quarry (H18, Roman) and its products. Top: view across a portion of the quarry showing numerous workings and the central complex with a large fortified settlement. Middle left: temple in the quarry settlement. Middle right: working with traces of wedge holes. Bottom left: abandoned column, 18 m long with a diameter of 2.3 m. Bottom right: Pantheon in Rome with seven columns from Mons Claudianus (and one of Aswan granite). Photos by Per Storemyr except the bottom right one, which is from the Bain Collection (ca. 1910–1915, PPOC, digital ID: http://hdl.loc.gov/loc.pnp/ggbain.10183).
Figure 28. Map of the Mons Porphyrites andesite–dacite porphyry quarry (H12a, Roman) in the north-central Eastern Desert, showing the areas with quarry workings plus selected slipways, roads, and other infrastructure. Also indicated are the contemporary Roman quarries in Wadi Umm Sidri for syenite porphyry (H11), Wadi Abu Ma'amel for granite (H12b), Badia for granite (H13), Wadi Umm Towat for trachyandesite porphyry (H14), and Wadi Umm Balad for quartz diorite (H15). Map by Per Storemyr and James Harrell based on Maxfield and Peacock (2001) and their own observations with a Landsat satellite image (ca. 2000) used as background.
Figure 29. Mons Porphyrites andesite–dacite porphyry quarry (H12a, Roman) and its products. Top: the so-called Lykabettus quarry or workings with its workers’ village and the upper part of the slipway seen in Figure 18. Middle left: abandoned roughed-out basin in one of the quarry workings. Middle right: loading ramp northeast of the quarry on the track leading to the Nile Valley. Bottom left: drawing of the facade of medieval St. Mark’s Basilica in Venice showing, at its right edge, a portion of the carving of the Four Tetrarchs (a reused, late Roman sculpture) made from the red andesite–dacite porphyry (or Imperial Porphyry) of Mons Porphyrites (this carving is seen again in the bottom right photograph). Photos by Per Storemyr except the bottom left one from the Detroit Publishing Co. (1890–1900, PPOC, digital ID: http://hdl.loc.gov/loc.pnp/ppmsc.06661), and the bottom right one from Nina Barbieri (Wikimedia Commons, http://commons.wikimedia.org/wiki/File:Venice_%E2%80%93_The_Tetrarchs_03.jpg).
Figure 30. Gemstone quarries. Top: workings for carnelian (shown in upper insert) and other colored varieties of chalcedony at Stela Ridge (G13, Middle Kingdom) west of Abu Simbel in the Western Desert. Bottom: workings for emerald (or green beryl, shown in lower insert) in Wadi Sikait (G6, late Ptolemaic to Roman) in the southern Eastern Desert. Photos by Per Storemyr.
Figure 31. Utilitarian stone quarries. Top and upper insert: silicified sandstone quarry for grinding stones at Gebel Qubbet el-Hawa (part of H5, Dynastic–period unknown) near Aswan. Bottom: chert quarry for blades in Wadi el-Sheikh (H33, Old Kingdom and later Dynastic?). Lower insert: chert borer for hollowing out gypsum vessels found in the northern Faiyum near Qar el-Sagha. Photos by Pet Storemyr except the bottom one, which is by James Harrell.
Figure 32. Map of the principal medieval to modern Islamic soapstone (steatite) quarries in the southern Eastern Desert, including Wadi Abu Qureya (O5, also late Roman?), Wadi el-Humra (O6), Wadi Umm Selim (O7), and Gebel Rod el-Baram (O8, also late Roman). Map by Per Storemyr based on fieldwork by James Harrell (see Harrell and Brown 2008) with a Landsat satellite image (ca. 2000) used as background.
Figure 33. Soapstone (steatite) quarry workings. Top and bottom right: work place and abandoned roughed-out soapstone cooking vessels (Arabic ‘barams’) in the Wadi Abu Qureya quarries. Bottom left: some of the hundreds of small workings in the Gebel Rod el-Barram quarry (O8, late Roman and Islamic). Photos by Per Storemyr.
Figure 34. Quarry settlements and huts. Top: ephemeral Old Kingdom encampment in the Widan el-Faras basalt quarry (H2). Middle left: well-constructed Roman settlement in the Mons Claudianus tonalite gneiss quarry (H18). Bottom right: cistern at the Roman fort guarding the Wadi Umm Balad quartz diorite quarry (H15). Bottom left: either New Kingdom or Roman stone shelter in the silicified sandstone quarry on Gebel Sidi Osman by Gebel Tingar (H5). Photos by Per Storemyr.
Figure 35. Quarry temples and shrines. Top: temple in the Wadi Sikait emerald quarry (G6, late Ptolemaic to Roman) cut into soapstone (talc schist). Bottom: Roman shrine in the Qertassi sandstone quarry (S20, Ptolemaic to Roman) now under Lake Nasser. Middle right insert: an upright stone that may have had a ritual function in the silicified sandstone quarry on Gebel Gulab (H5). Photos by Per Storemyr except the bottom one, which is from Félix Teynard (1850–1860, PPOC, digital ID: http://hdl.loc.gov/loc.pnp/cph.3c27965).
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Bibliography


References


Map showing the quarries for building, ornamental, gem, and utilitarian stones used in Egypt between the Late Predynastic and medieval Islamic periods (ca. 3100 BCE–1500 CE). Prepared in a collaborative effort between The University of Toledo, USA, and the Geological Survey of Norway within the EU-supported QuarryScapes project (Conservation of Ancient Stone Quarry Landscapes in the Eastern Mediterranean - www.quarryscapes.no).

Geology simplified from:
"Geologic Map of Egypt" (Egyptian Geological Survey and Mining Authority 1981).

Research: James Harrell and Per Storemyr
Cartography: Per Storemyr, 2009

Geologic map with the known quarries for building, ornamental, gem, and utilitarian stones used in Egypt between the Late Predynastic and medieval Islamic periods (ca. 3100 BCE–1500 CE). Map by Per Storemyr with geology after Egyptian Geological Survey and Mining Authority (EGSMA 1981) and quarries compiled mainly by James Harrell (see also http://www.eeescience.utoledo.edu/Faculty/Harrell/Egypt/AGRG_Home.html) plus some limestone quarries after Klemm and Klemm (1993, 2008).

List of quarries: see reverse side
Map datum: WGS 84

0 20 40 60 80 100 120 140 160 180 200 km
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| COORDINATES (north latitude and east longitude) are given as decimals degrees, following the WGS84 datum. They represent the center of a quarry or an area of multiple workings comprising a quarry. Main period refers to the periods in which the quarries were primarily worked. In many instances the quarries were also used earlier and later. The following abbreviations are used: U: Unknown

**The Stone Quarries of Ancient Egypt**

**Explanations:**

The quarry numbers correspond with the numbers on the map (front side).

When possible, the quarry names given are those most often used in scholarly publications. Other names refer to the nearest ancient site, modern village, or natural feature, such as wadi (dry water course) or gebel (hill/mountain).

Coordinates (north latitude and east longitude) are given as decimal degrees, following the WGS84 datum. They represent the center of a quarry or an area of multiple workings comprising a quarry. Main period refers to the periods in which the quarries were primarily worked. In many instances the quarries were also used earlier and later. The following abbreviations are used:

**PH:** Prehistoric (Late Predynastic)

**ED:** Early Dynastic

**P:** Pharaonic (Old Kingdom through Late Period)

**GR:** Gezzo–Roman

**B:** Byzantine (Late Roman)

**I:** Islamic

**ULN:** Under Lake Nasser

**State refers to the current condition of the quarries, as determined by visits. The following abbreviations are used:**

**1:** Intact

**2:** Largely intact

**3:** Partially destroyed

**4:** Largely destroyed

**ULN:** Under Lake Nasser

**Unknown**