QuarryScapes: ancient stone quarry landscapes in the Eastern Mediterranean

Geological Survey of Norway, Special Publication, 12

Abu-Jaber, N., Bloxam, E.G., Degryse,P. and Heldal, T. (eds.)

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Situated far out in the Eastern Desert in Egypt, Mons Claudianus is one of the most spectacular quarry landscapes in Egypt. The white tonalite gneiss was called *marmor claudianum* by the Romans, and in particular it was used for large objects such as columns and bathtubs. Giant columns of the stone can be seen in front of Pantheon in Rome. Photo by Tom Heldal.

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The QuarryScapes Project: conservation of ancient stone quarry landscapes in the Eastern Mediterranean

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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 archeological sites with ruins and other cultural remains. Their study and preservation is necessary because they provide a unique perspective on life in ancient Egypt.

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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 eon, Egypt was alternately elevated above sea level and inundated by shallow seas with mostly

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

Eon	Era	Period	Epoch	Million years before present	Egyptian quarries
Phanerozoic	Cenozoic	Quaternary	Holocene	present–0.0115	
			Pleistocene	0.0115–1.8	all limestone along the Mediterranean coast
		Tertiary	Pliocene	1.8–5.3	limestone at Dahshur and Gebel el-Gir
			Miocene	5.3–23	all anhydrite and gypsum along the Red Sea coast
			Oligocene	23–33.9	Gebel Ahmar silicified sandstone and all basalt
			Eocene	33.9–55.8	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
			Paleocene	58.8–65.5	limestone at el-Dibabiya
	Mesozoic	Cretaceous		65.5–145.5	all sandstone, including the silicified variety except at Gebel Ahmar
		Jurassic		145.5–199.6	all turquoise and some malachite
		Triassic		199.6–251	
	Paleozoic	Permian		251–299	
		Carboniferous		299–359.2	
		Devonian		359.2–416	
		Silurian		416–443.7	
		Ordovician		443.7–488.3	
		Cambrian		488.3–542	
Precambrian				542–4,000+	all igneous and metamorphic rock varieties, except basalt; and all gemstones except turquoise and some malachite

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).

Late Predynastic Period		ca. 3100–2950 BCE	
Dynastic Period	Early Dynastic Period	2950–2575 BCE	Dynasties 1–3
	Old Kingdom	2575–2150 BCE	Dynasties 4–8
	First Intermediate Period	2125–1975 BCE	Dynasties 9–11
	Middle Kingdom	1975–1630 BCE	Dynasties 11–14
	Second Intermediate Period	1630–1540 BCE	Dynasties 15–17
	New Kingdom	1540–1075 BCE	Dynasties 18–20
	Third Intermediate Period	1075–715 BCE	Dynasties 21–early 25
	Late Period	715–332	Dynasties late 25–30
Greco–Roman Period	Ptolemaic Period	332–30 BCE	
	Roman Period	30 BCE–395 CE	
	Byzantine (or Late Roman) Period	395–640 CE	
Islamic Period		640 CE–present	

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 Nasr 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.

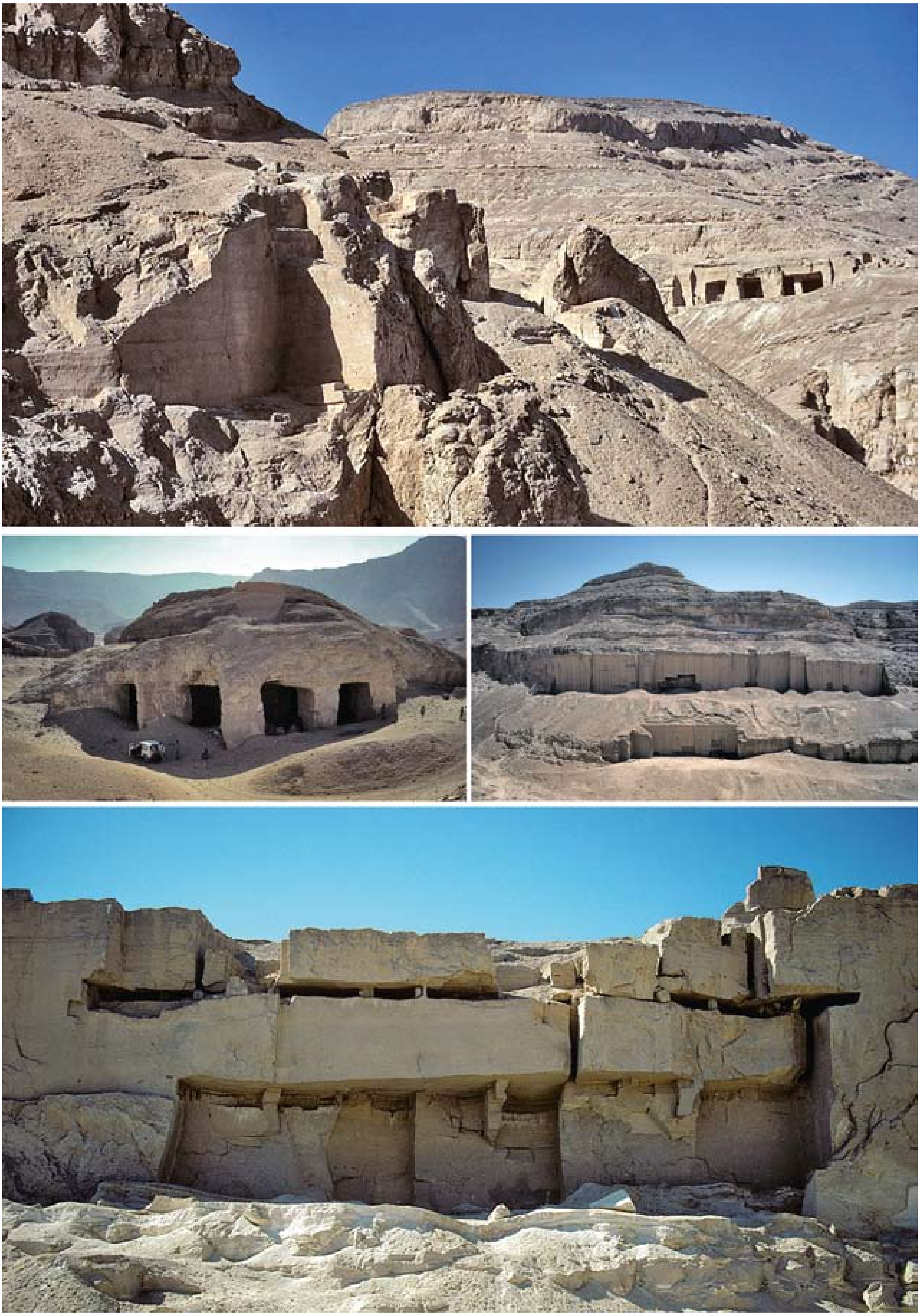

Figure 2. Limestone quarries in the Nile Valley. Top: open-cut (left) and gallery (right) workings at Qaw el-Kebir (L75, Old and/or Middle Kingdom to New Kingdom, and Ptolemaic to Roman) near ancient Antaeopolis. Middle left: gallery workings at El-Dibabiya (L91, 19th Dynasty–New Kingdom, 21st Dynasty–3rd 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.

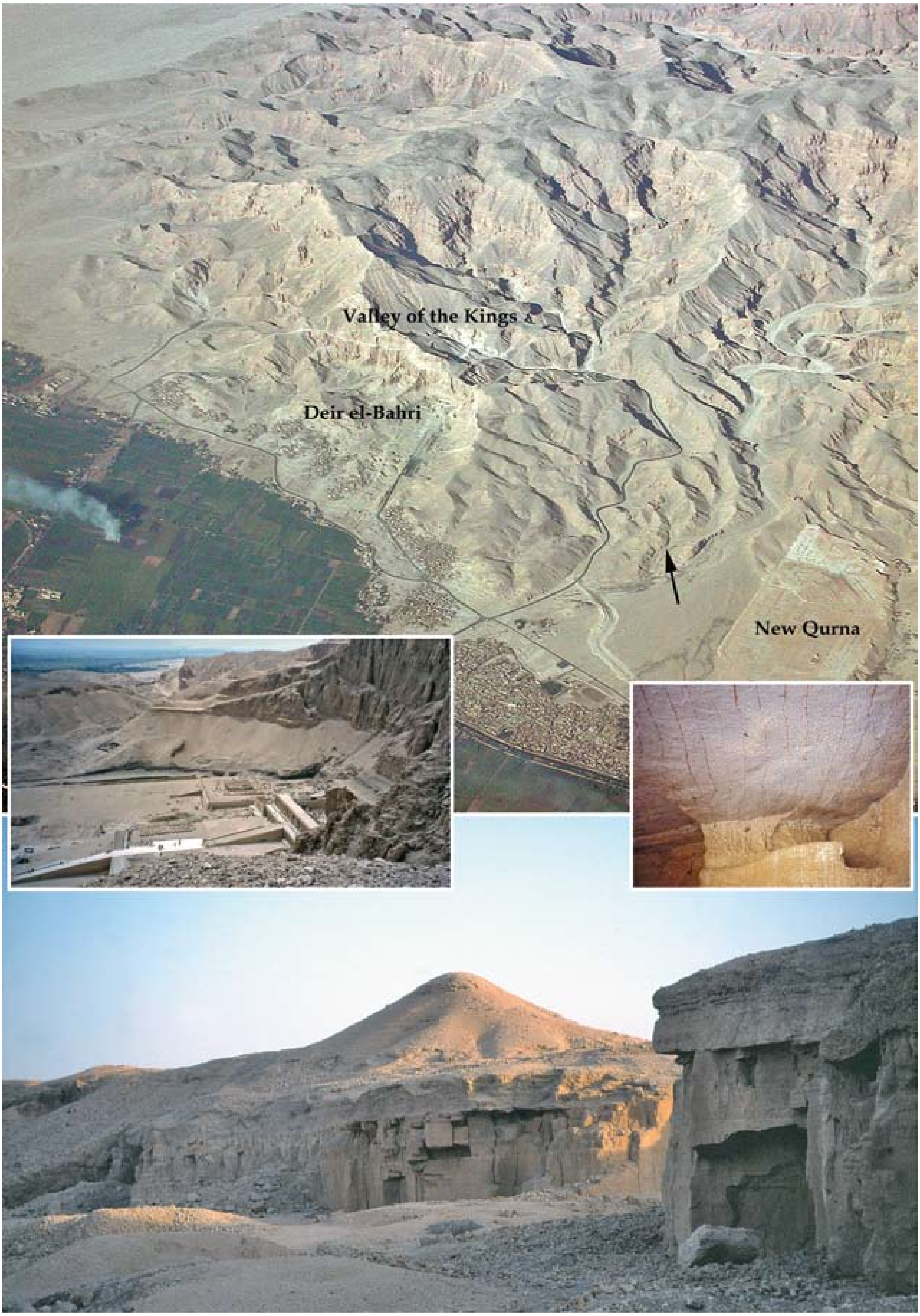

Figure 3. Limestone quarry in western Thebes, near Luxor. Top: aerial view of western Thebes with the Wadi el-Muluk quarry (L85, 18th Dynasty–New Kingdom, 26th Dynasty–Late Period, and Roman) at the arrow. Bottom and middle right insert: open-cut and gallery workings in the Wadi el-Muluk quarry. Note 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.

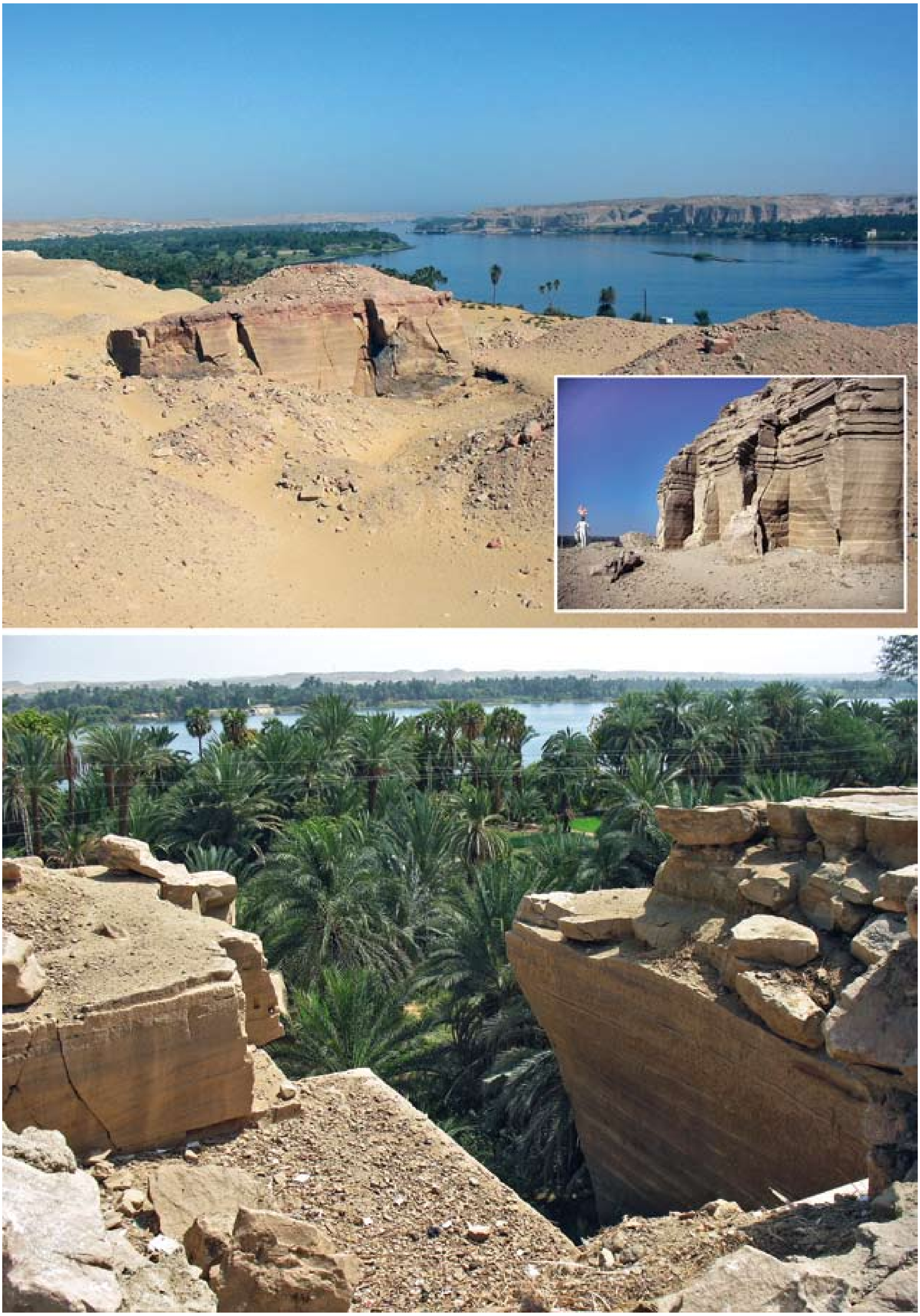

Figure 4. Sandstone quarries in the Nile Valley. Top: open-cut workings at Naq el-Fugani (S12, Ptolemaic), just north of Aswan. Bottom: open-cut workings at Nag el-Hosh (S6, Ptolemaic to Roman) just north of Kom Ombo. Insert: open-cut workings at El-Mahamid (S2, Old and/or Middle Kingdom, and Ptolemaic), near ancient El-Kab. Photos by Per Storemyr except the insert, which is by James Harrell.

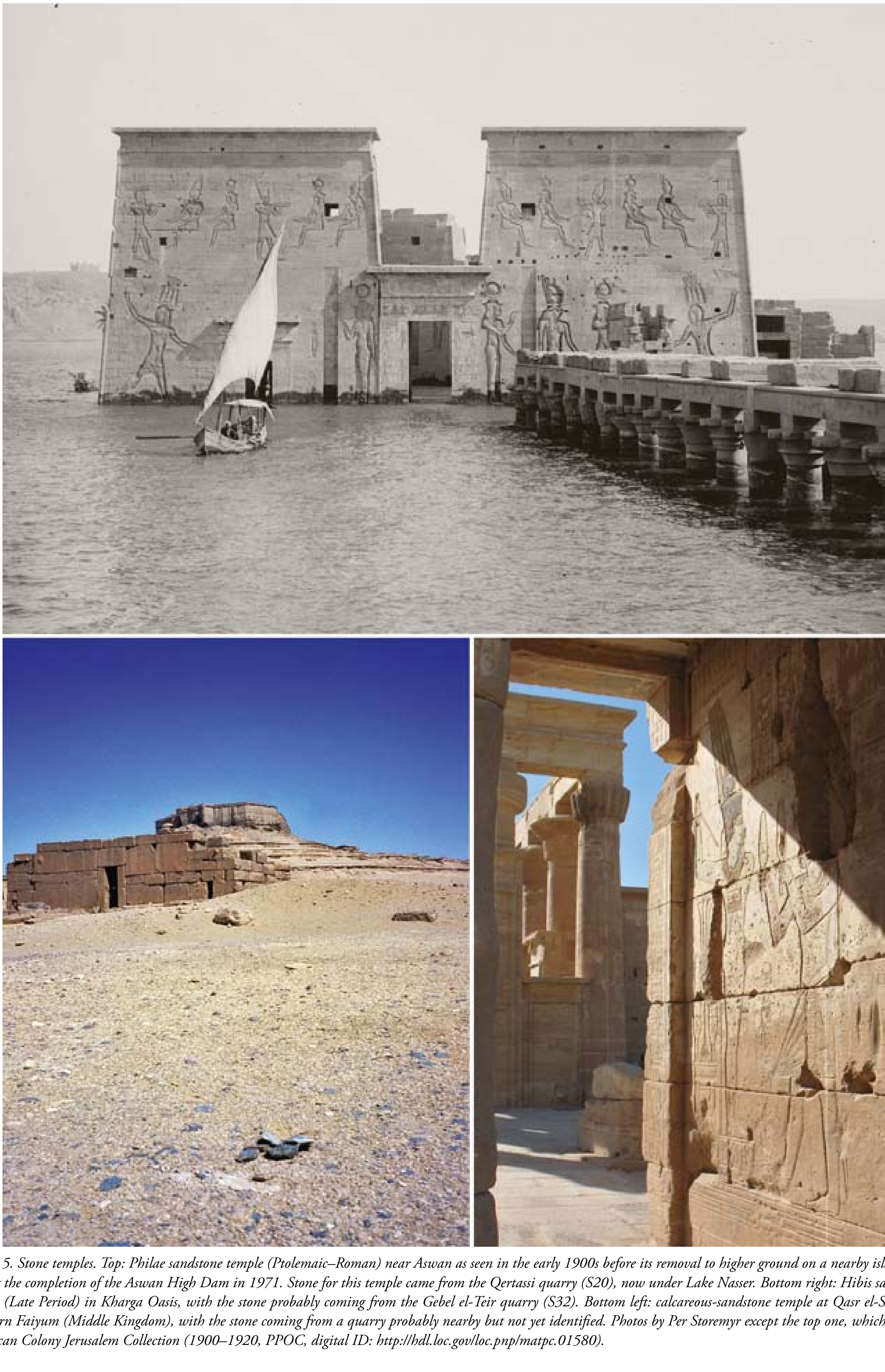

Figure 5. Stone temples. Top: Philae sandstone temple (Ptolemaic–Roman) near Aswan as seen in the early 1900s before its removal to higher ground on a nearby island following the completion of the Aswan High Dam in 1971. Stone for this temple came from the Qertassi quarry (S20), now under Lake Nasser. 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).

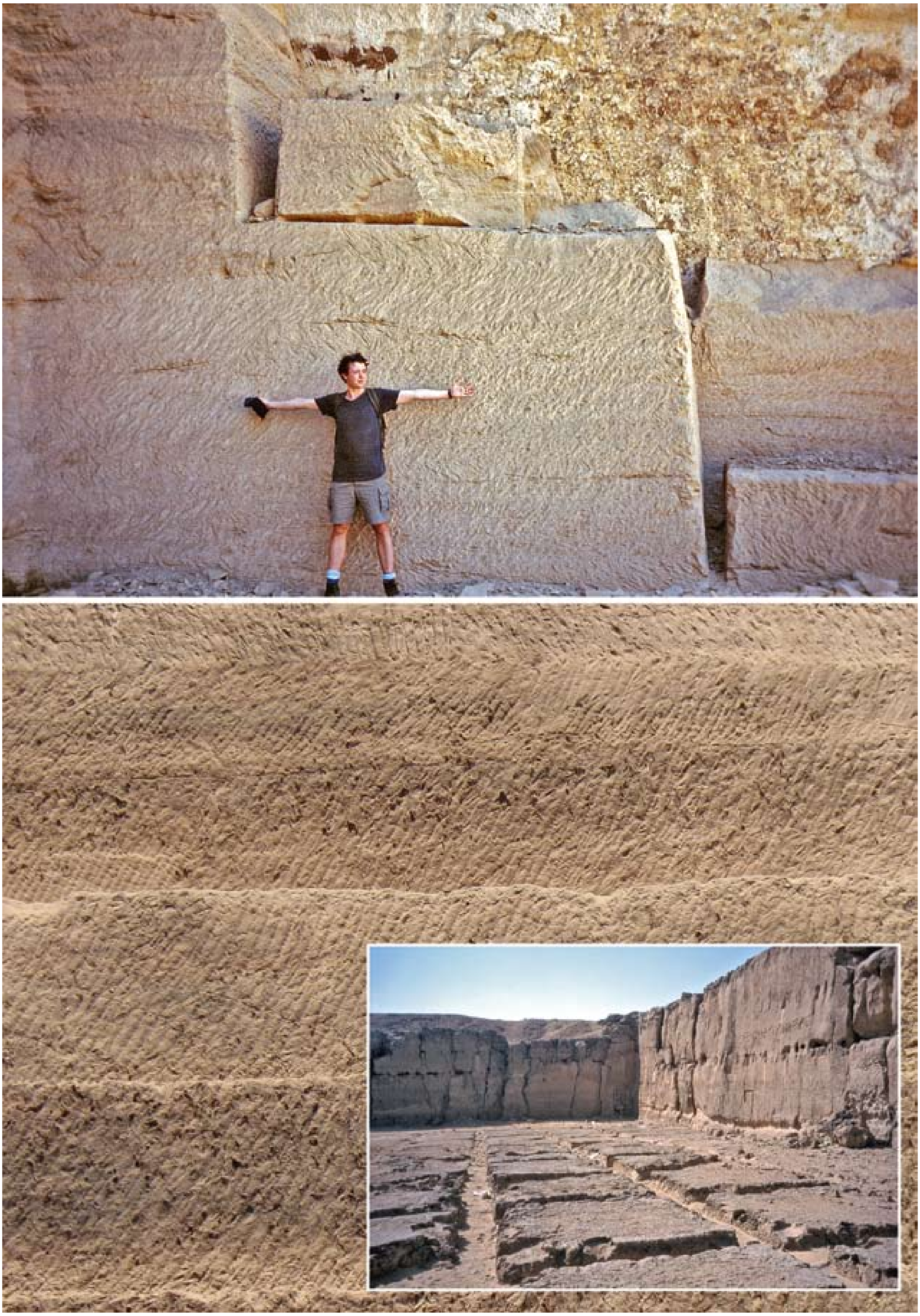

Figure 6. Softstone quarrying technology: Top: vertical trenches and undercuts for sandstone blocks in the Gebel el-Silsila quarry (S9b, Middle to New Kingdom, and Ptolemaic to Roman). Bottom: dressed (chiseled) quarry face in sandstone at the Nag el-Hosh quarry (S6, Ptolemaic to Roman). Lower right 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.

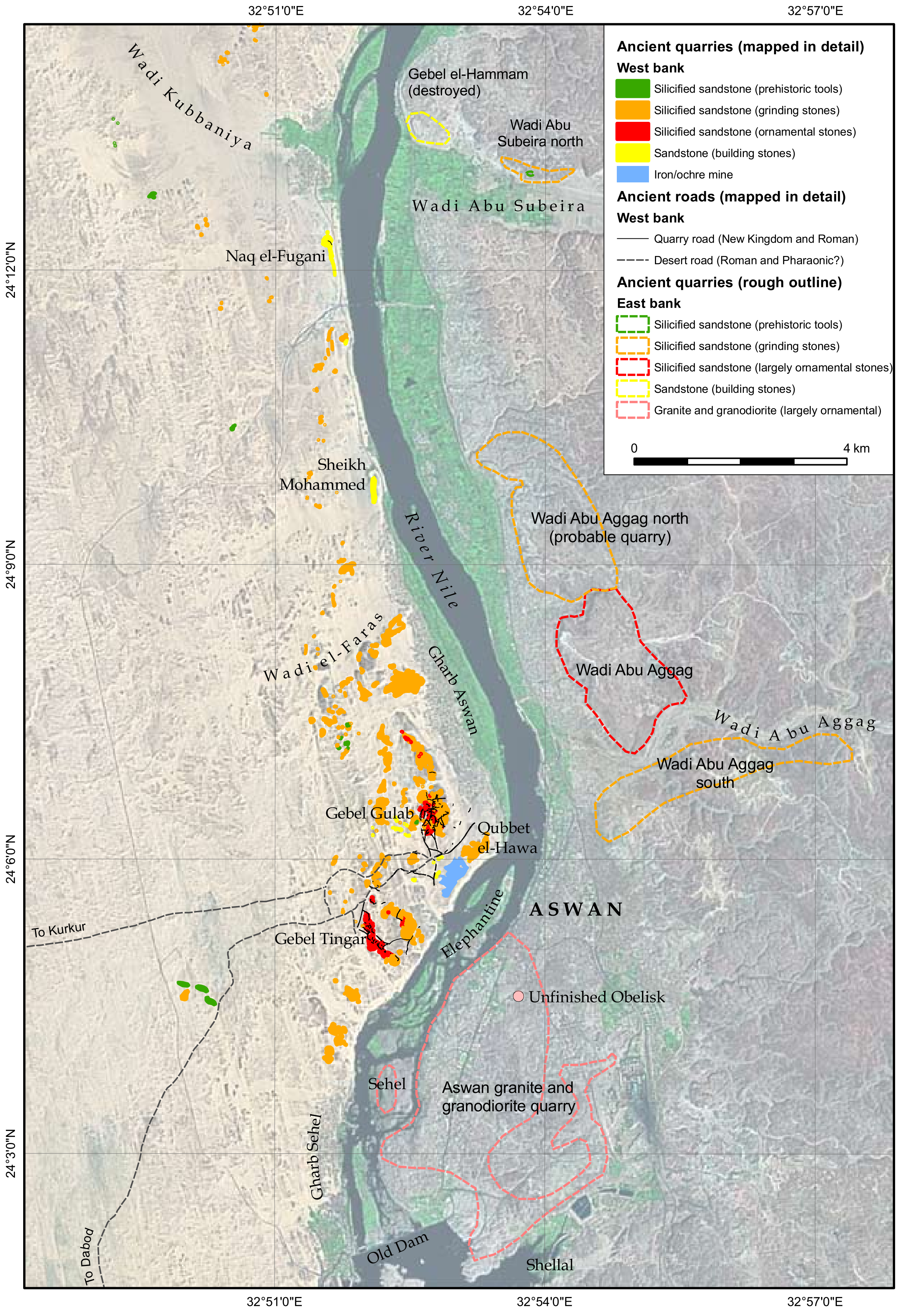

Figure 7. Map showing an ancient quarry landscape covering about 100 km² in the Aswan area, with quarries for granite and granodiorite in Aswan (H6); dolerite in Aswan (H37–38); silicified sandstone at Wadi Abu Aggag (H4), Gebels Gulab and Tingar (H5), and Wadi Abu Subeira (H36); and normal (non-silicified) 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.

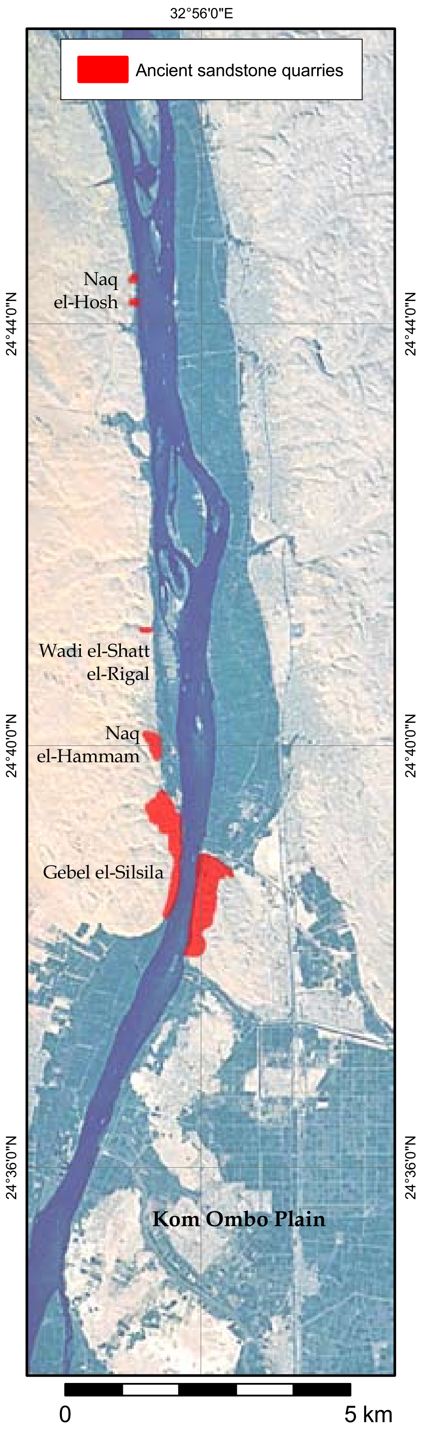

Figure 8. Map of the Kom Ombo area showing the sandstone quarries at Gebel el-Silsila (S9a, b, Middle to New Kingdom, Ptolemaic to Roman), Nag el-Hammam (S8, S35, Middle and/or New Kingdom), Wadi el-Shatt el-Rigal (S7, Middle to New Kingdom), and Naq el-Hosh (S6, Ptolemaic to Roman). The unique location of Gebel el-Silsila, on both sides of the Nile in a narrow 'semi-cataract' zone, is undoubtedly the reason why this area was developed into ancient Egypt's largest sandstone quarry. Map by Per Storemyr based on an outline of quarries in Klemm and Klemm (1993) with the background image from Image Science and Analysis Laboratory, NASA–Johnson Space Center ('The Gateway to Astronaut Photography of Earth,' http://eol.jsc.nasa.gov/scripts/sseop/photo.pl?mission=ISS018&roll=E&frame=15496).

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. (8) Basins: Roman Period—granite, andesite–dacite porphyry, and tonalite gneiss. (9) Barque shrines: Middle and New Kingdoms—granite, silicified sandstone, and travertine. (10) Small statue shrines (naoi): Old Kingdom through Roman Period—granite, granodiorite, metagraywacke, and silicified sandstone; and Late Period only—dolerite porphyry. (11) Obelisks: New Kingdom and Roman Period—granite; and New Kingdom only—metagraywacke, 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). (14) Canopic jars: Old Kingdom through Roman Period—travertine. (15) Sarcophagi: Old Kingdom through Roman Period—granite, granodiorite, metagraywacke, and silicified sandstone; Old through New Kingdoms 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 pyroxenite; 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—metagraywacke, serpentinite, soapstone (steatite), and travertine. (18) Stelae: Old Kingdom through Roman Period—granite, granodiorite, metagraywacke, and silicified sandstone; and Late Period only—metaconglomerate. (19) Cosmetic and ceremonial palettes: Late Predynastic 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 gneiss), 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 cave 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 (awls, 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

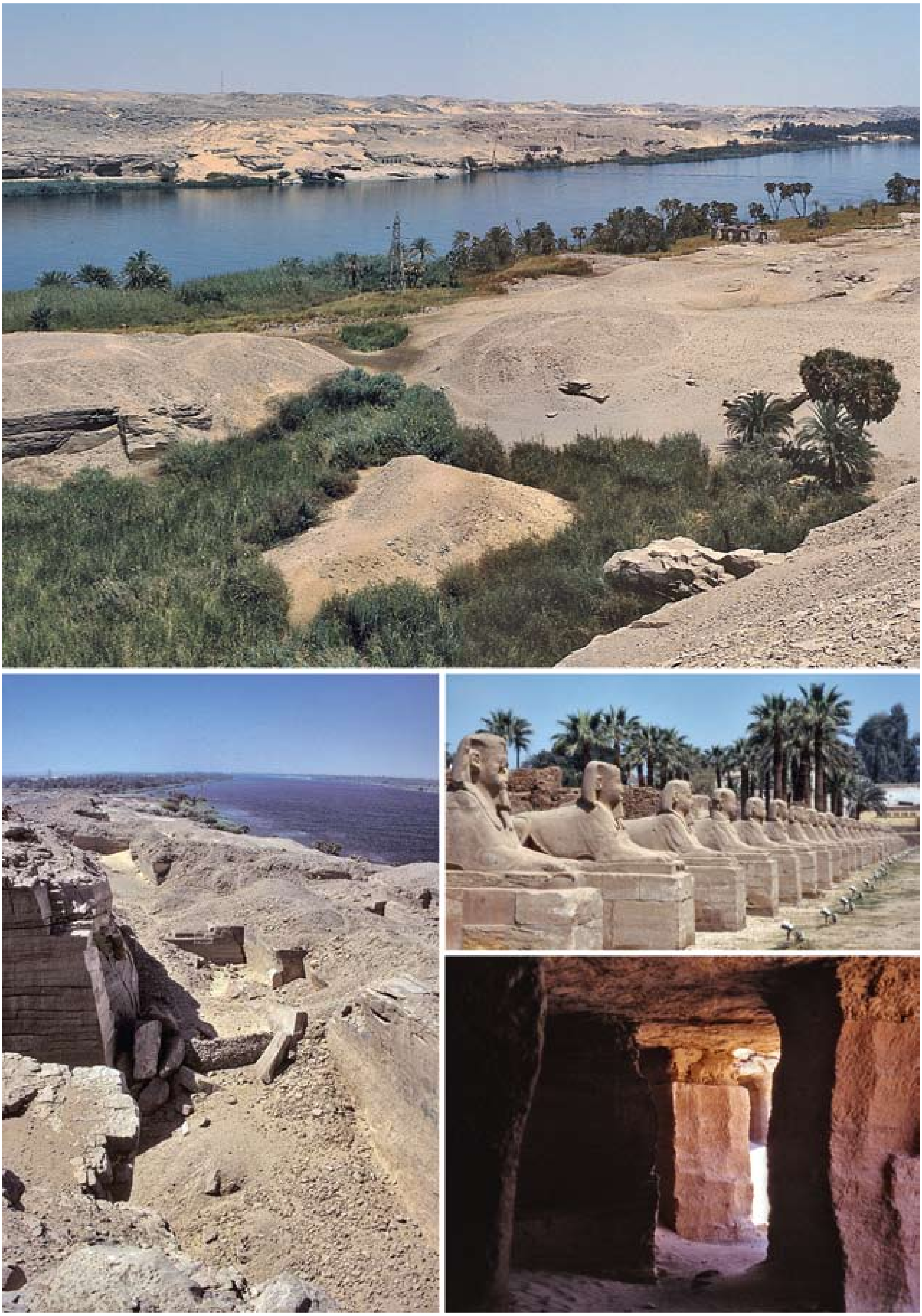

Figure 9. Gebel el-Silsila sandstone quarry (S9a, b, Middle to New Kingdom, Ptolemaic to Roman) and its products. Top: view from the east bank across part of the quarry with the west bank workings visible on the other side of the Nile River and the New Kingdom harbor (now filled with vegetation) in the 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.

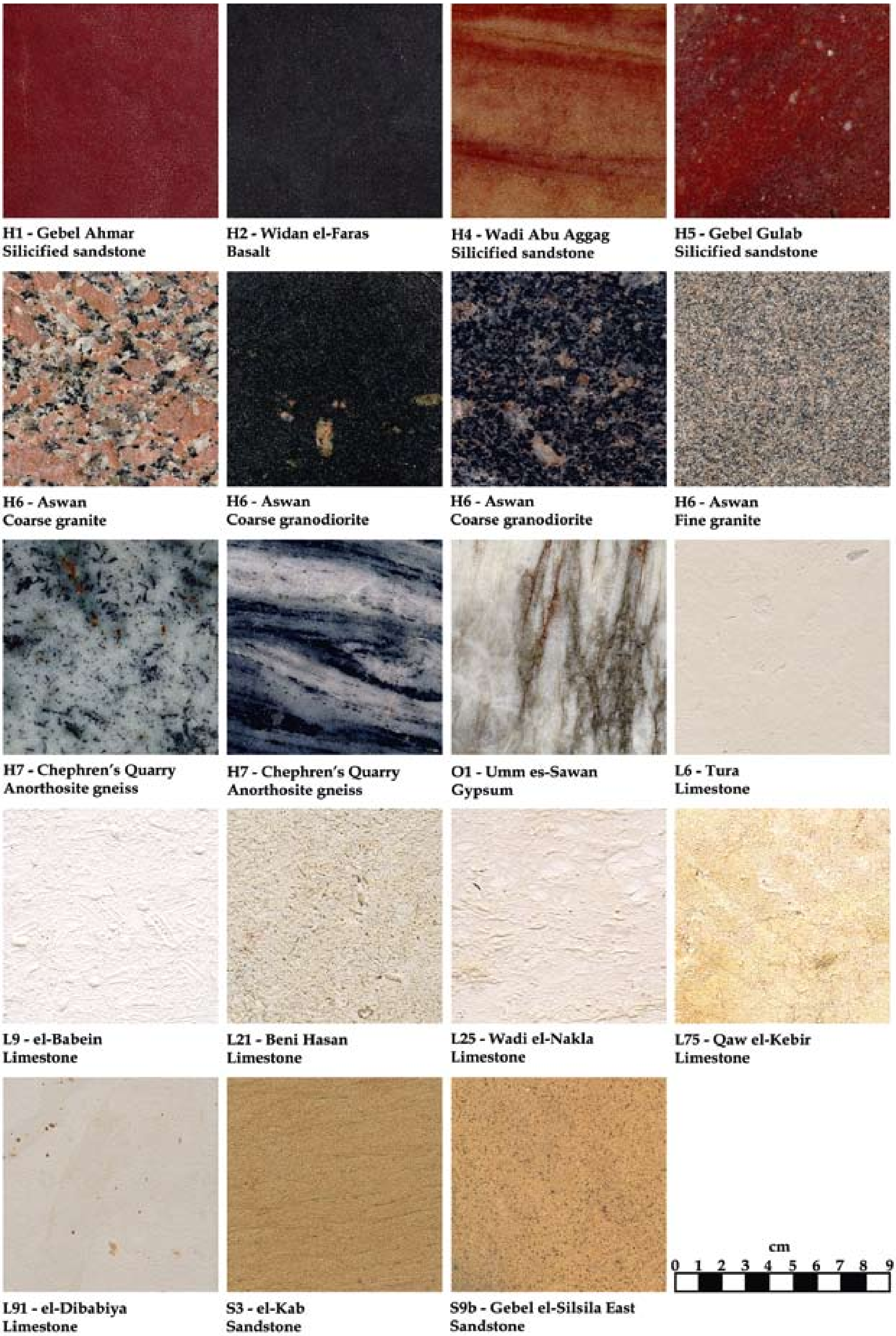

Figure 10. Selected stones from ancient quarries in the Nile Valley and Western Desert. The numbering and sequence of the images follow the list of quarries on the reverse side of the attached, fold-out map. Not all quarries and rock varieties are represented. Photos by James Harrell.

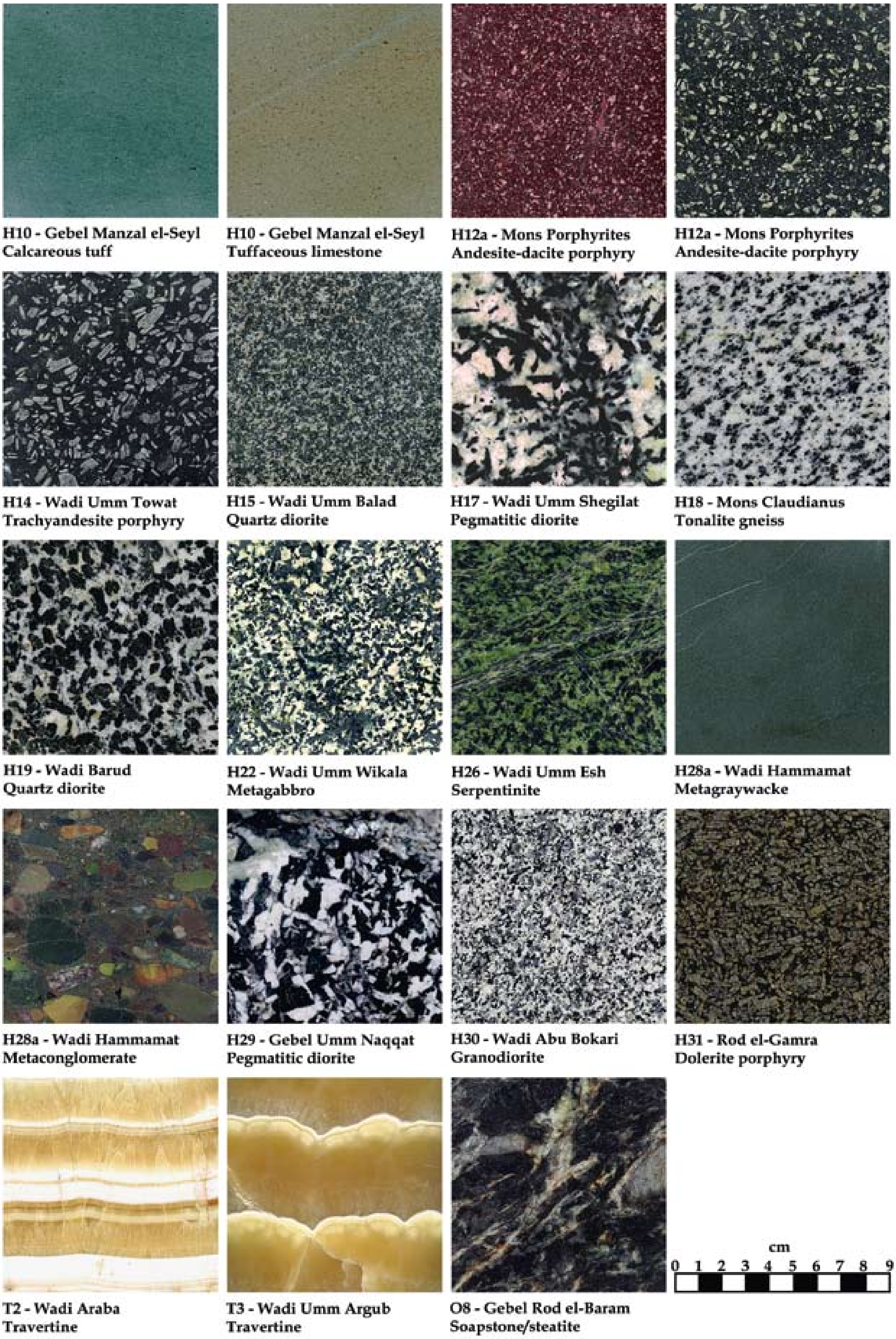

Figure 11. Selected stones from ancient quarries in the Eastern Desert. For further explanation see caption to Figure 10. Photos by James Harrell.

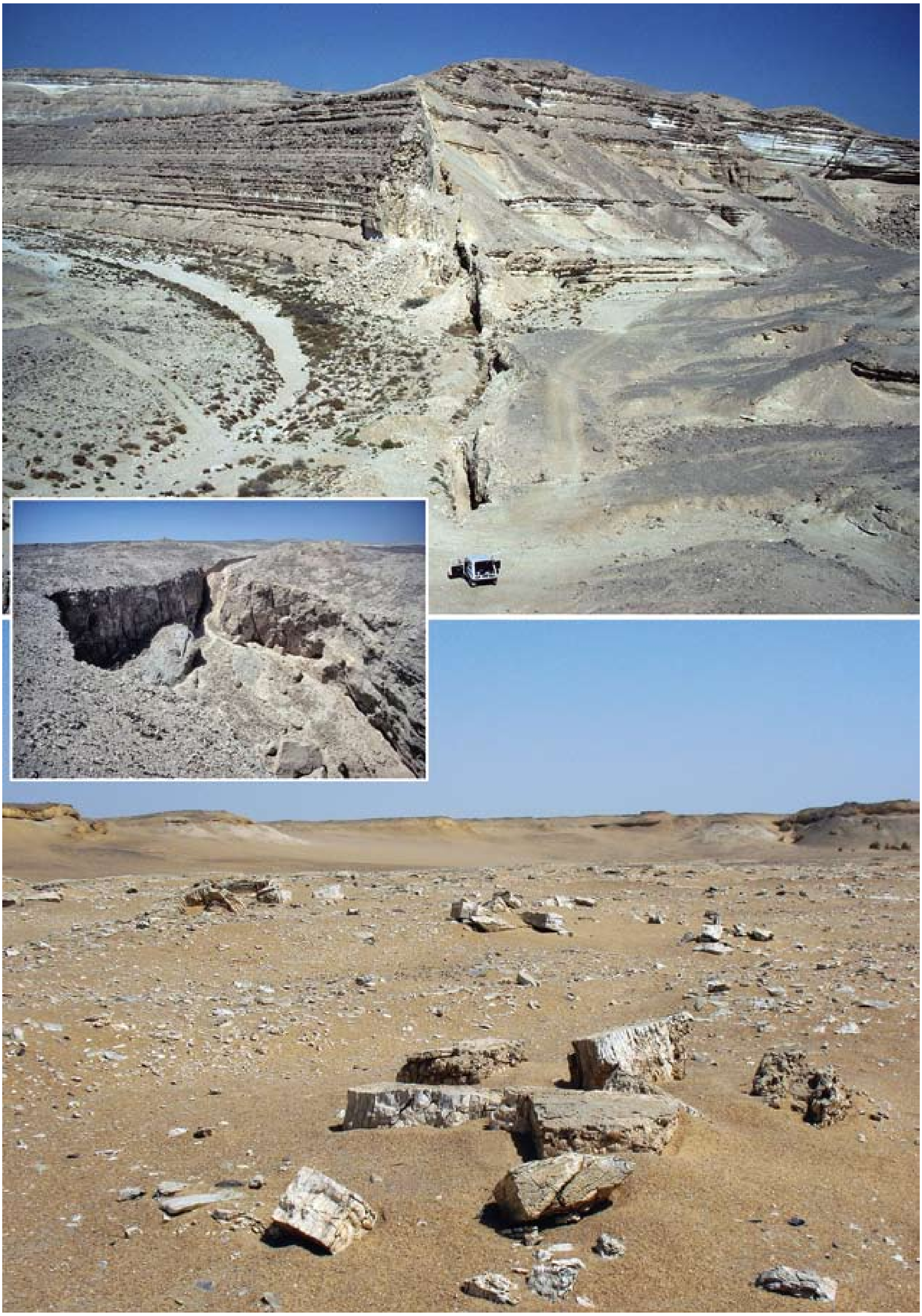

Figure 12. Travertine and gypsum quarries. Top: open-cut workings following a travertine vein in Wadi el-Garawi (T1, Old Kingdom) near Helwan. Bottom: open-cut workings in gypsum at Umm el-Sawan (O1, Early Dynastic to Old Kingdom) in northern Faiyum. Insert: originally underground and later open-cut 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.

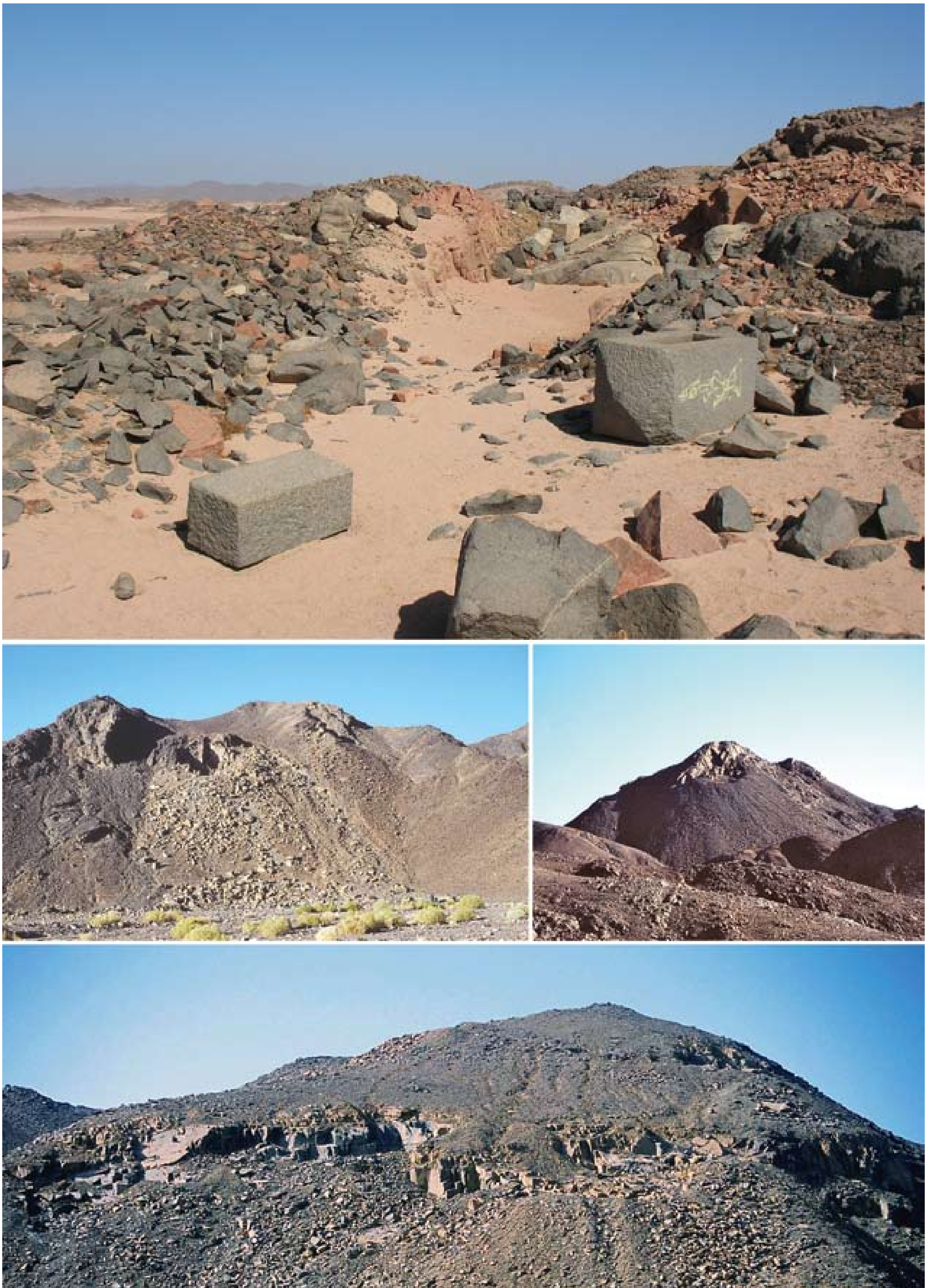

Figure 13. Hardstone quarries in the Eastern Desert: Top: dolerite porphyry quarry in Rod el-Gamra (H31, 30th Dynasty–Late Period) with roughed-out shrines or naoi at the entrance to the quarry cut. Middle right: tuff and tuffaceous limestone quarry on Gebel Manzal el-Seyl (H10, Early Dynastic). Middle left: pegmatitic diorite quarry in Wadi Umm Shegilat (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.

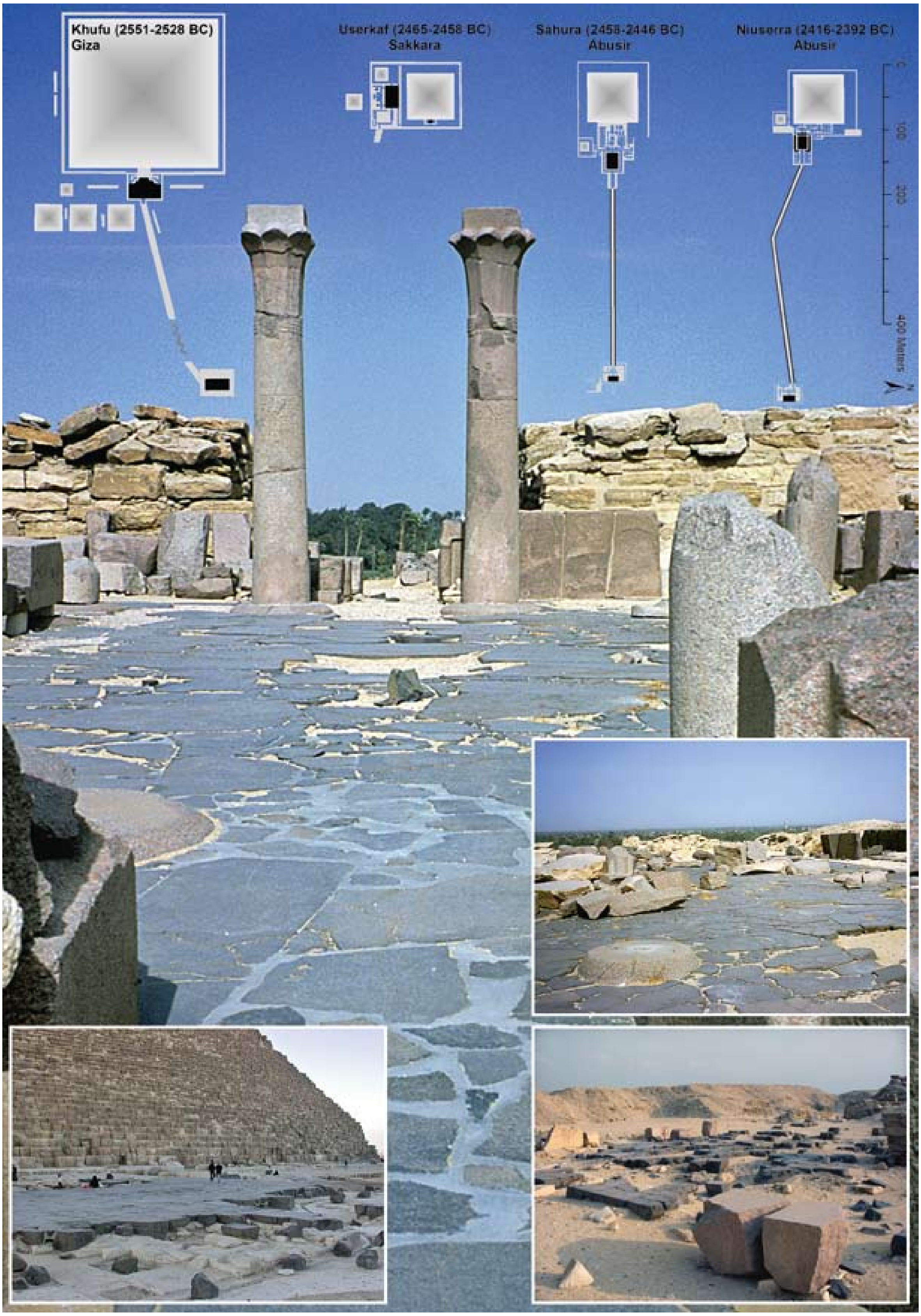

Figure 14. Basalt in Old Kingdom temple pavements used to symbolize kmt (the 'black land'), Egypt's ancient name and a reference to the dark organic-rich, life-giving soil of the Nile floodplain. Top: pyramid temple of king Sahura at Abu Sir (5th Dynasty). Lower left insert: pyramid temple of king Khufu (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 reliefs. 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-Faras (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.

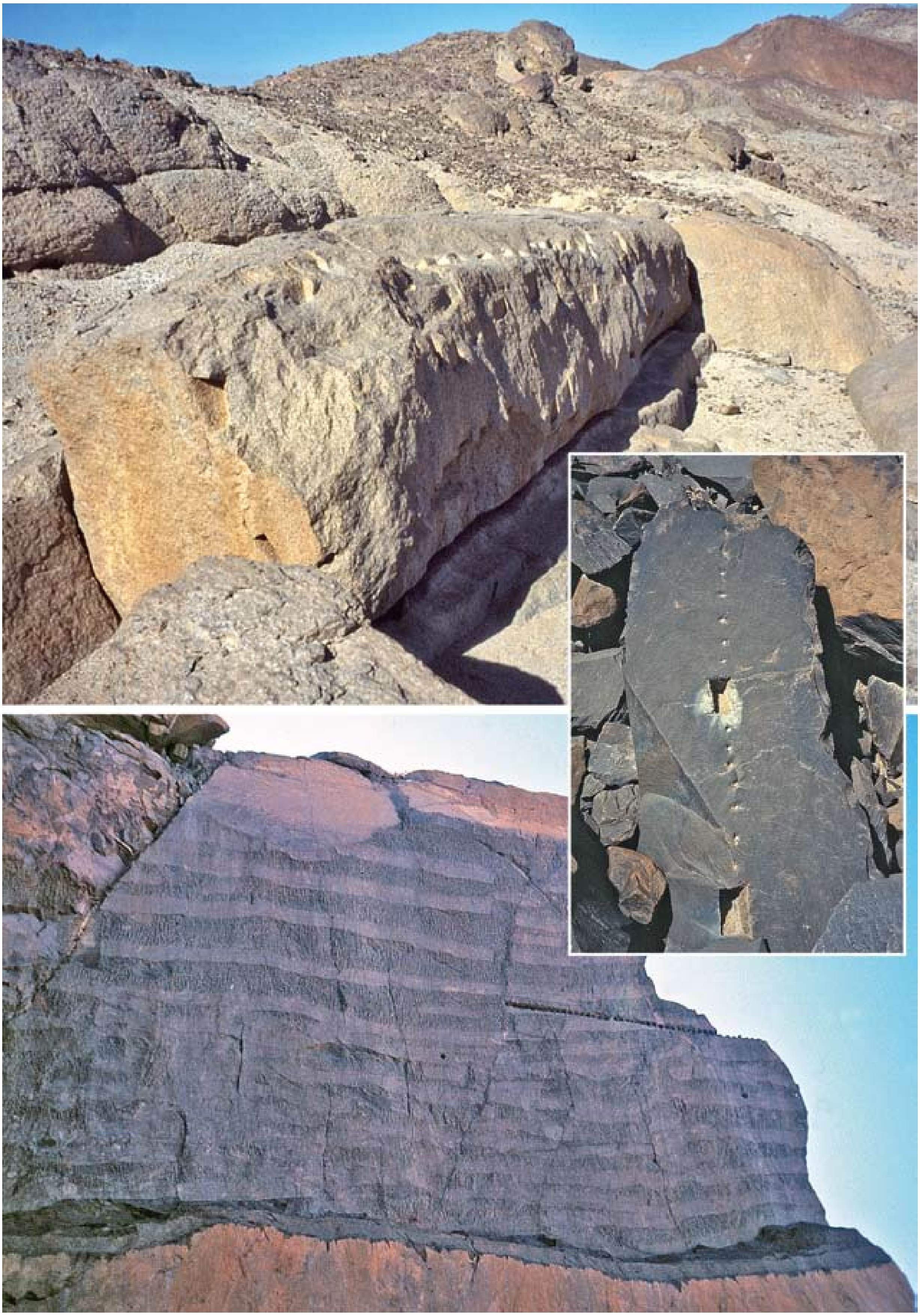

Figure 17. Roman hardstone quarrying technology. Top: abandoned column in tonalite gneiss in the Mons Claudianus quarry (H18) still attached to the bedrock with traces of wedge holes and a chiseled groove along the bottom edge. Middle right: block of metagraywacke in the Wadi Hammamat quarry (H28a) with 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 (insert). 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 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. Natural, 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 Period, and possibly as early as the 26th Dynasty, 'iron' (low-grade steel) tools were first used by the Egyptians for quarrying, 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 often repeated in the popular archeological 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 is 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 employed. 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 superior. 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 quarrying remained unchanged during the Ptolemaic and Roman Periods, but the picks and chisels were of iron. On occasion, hammered iron wedges were also used to split limestone and sandstone. See Arnold (1991) for additional information on the tools used for quarrying and dressing stone.

Quarry excavations and transport

Quarrying in ancient Egypt was usually 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 galleries 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 hardstone 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, including the quality of the stone (appearance, soundness, and available block sizes), proximity to the building site or workshop for which the stone was destined, and proximity to the Nile River if water transport was needed. In the case of limestone and sandstone, the locations of quarries on the sides of the Nile Valley were dictated more by the character 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 building 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 also 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-Faras in the Faiyum (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

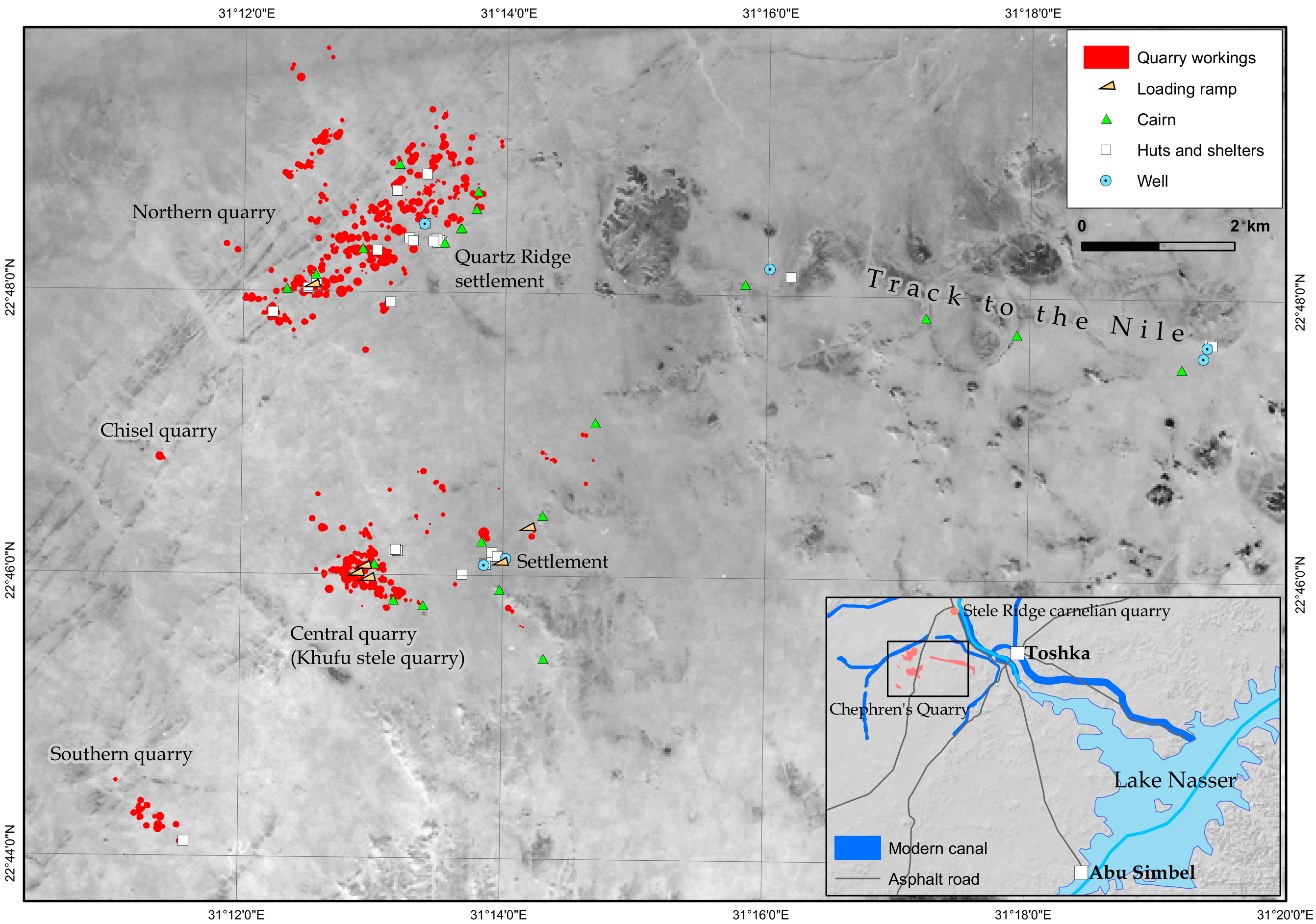

Figure 19. Map of Chephren's Quarry for anorthosite–gabbro gneiss (H7, Old and Middle Kingdoms) showing nearly 700 workings and associated infrastructure. Insert depicts how the quarry is currently being engulfed by roads and canals of the giant Toshka land reclamation project. Map by Per Storemyr based 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.

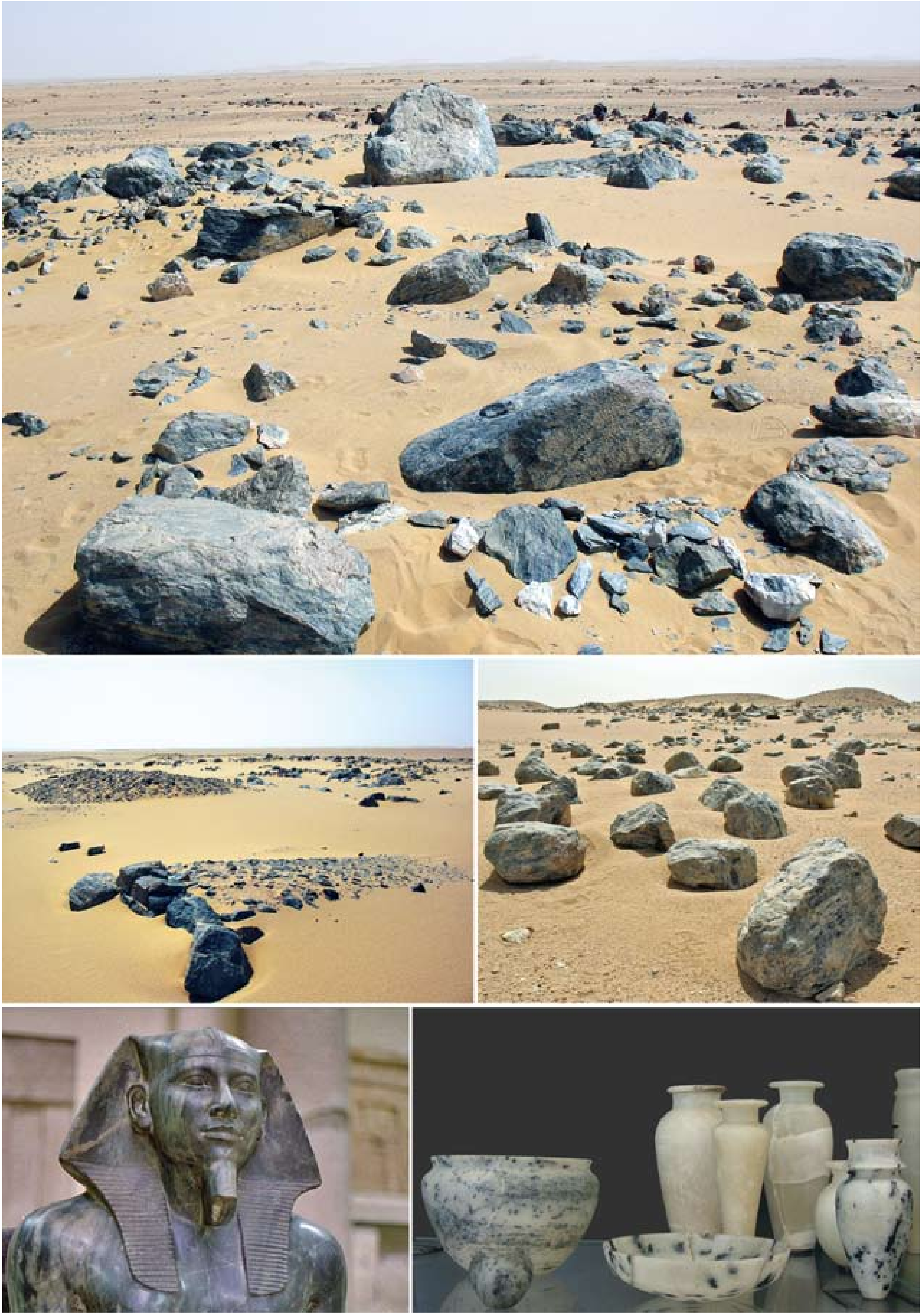

Figure 20. Chephren's Quarry for anorthosite–gabbro gneiss (H7, Old and Middle Kingdoms). Top: quarry working with roughed-out statue blocks produced from boulders. Middle left: ramp where larger blocks were loaded onto some kind of sledge. Middle right: smaller blocks destined for vessels grouped in 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).

18). These were altered and reused in the Roman Period. Most of the Dynastic quarry roads were unpaved, and consisted only of cleared tracks, where the coarser surface gravel was swept to the sides. Where these roads crossed steep declines or surface dips, their bases were built up (and often supported by stone revetments) to reduce and even out the gradients. The outstanding example of this kind of road leads from the Dynastic travertine quarry at Hatnub to the Nile River near the modern village of El-Amarna.

Even though the Egyptians knew about the wheel from earliest Dynastic times, they had no wheeled wagons until the early New Kingdom. It is not known if these were ever used to transport quarry stone, but it is unlikely because without relatively broad roadways with firm, flat surfaces, the heavily laden wagons would either get stuck in the sand or break their wheels on the rocks. In the Roman Period, however, and possibly as early as the Ptolemaic Period, wagons pulled by draft animals were the primary means of land transport for quarried stone and this method was made practical by an extensive, well-built network of roads (cleared, unpaved tracks) linking the desert quarries with the Nile Valley (attached map and Figures 26 and 28). In all periods and for all stones, the quarry products were at least roughed out on site, and occasionally were carved to a nearly finished state. This not only reduced the weight of stone requiring transport, but also had the benefit of revealing any unacceptable flaws in the stone prior to its removal from the quarry (Figures 13, 20, 25, 27 and 31).

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 archaeology 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.

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

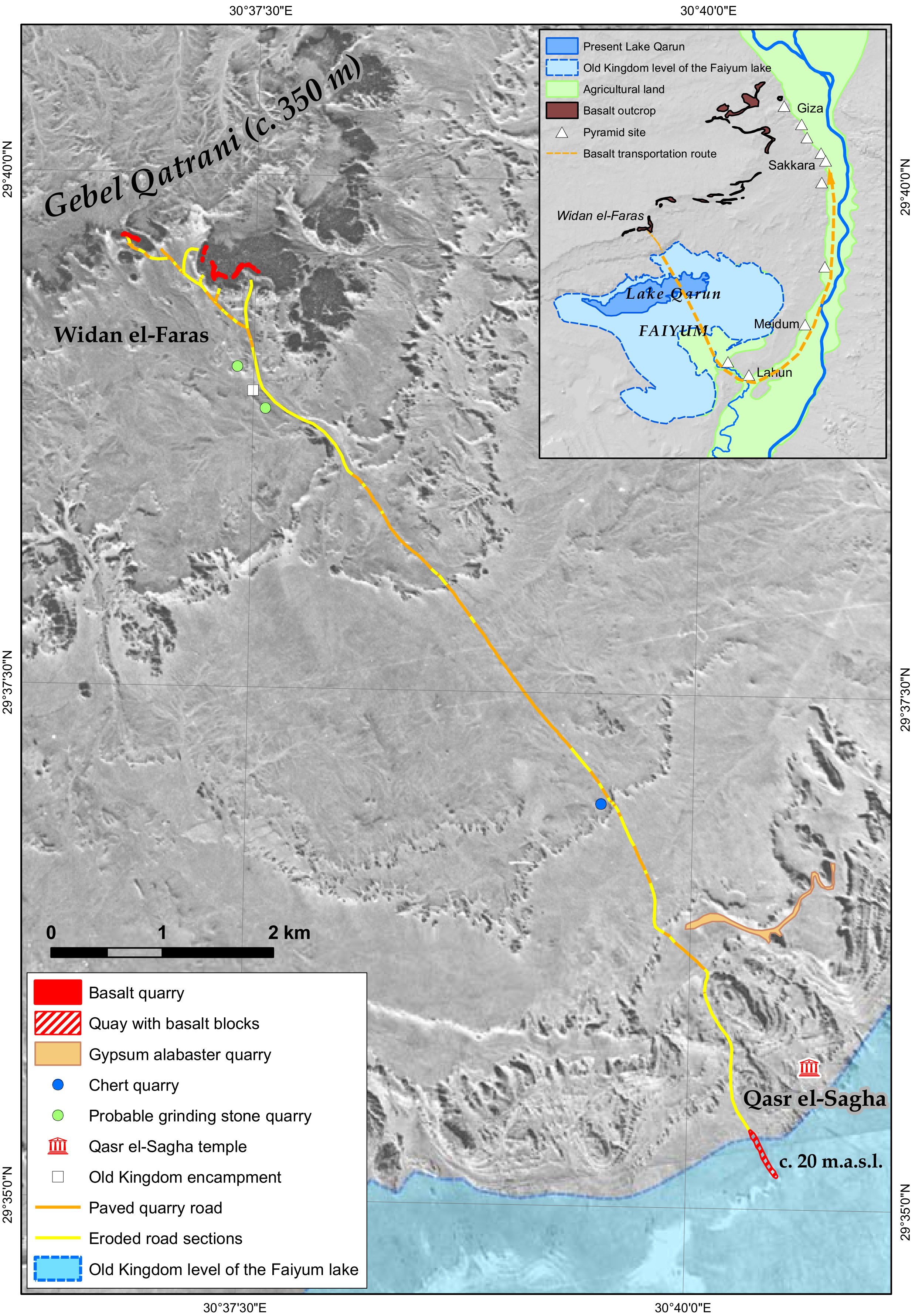

Figure 21. Map of the Widan el-Faras basalt quarry (H2, Old Kingdom) in the northern Faiyum showing the quarry workings and the 12 km-long paved road leading from the quarry to the quay near Qasr el-Sagha and formerly on the shore of a much higher Faiyum lake. Other quarries and the Middle Kingdom temple 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

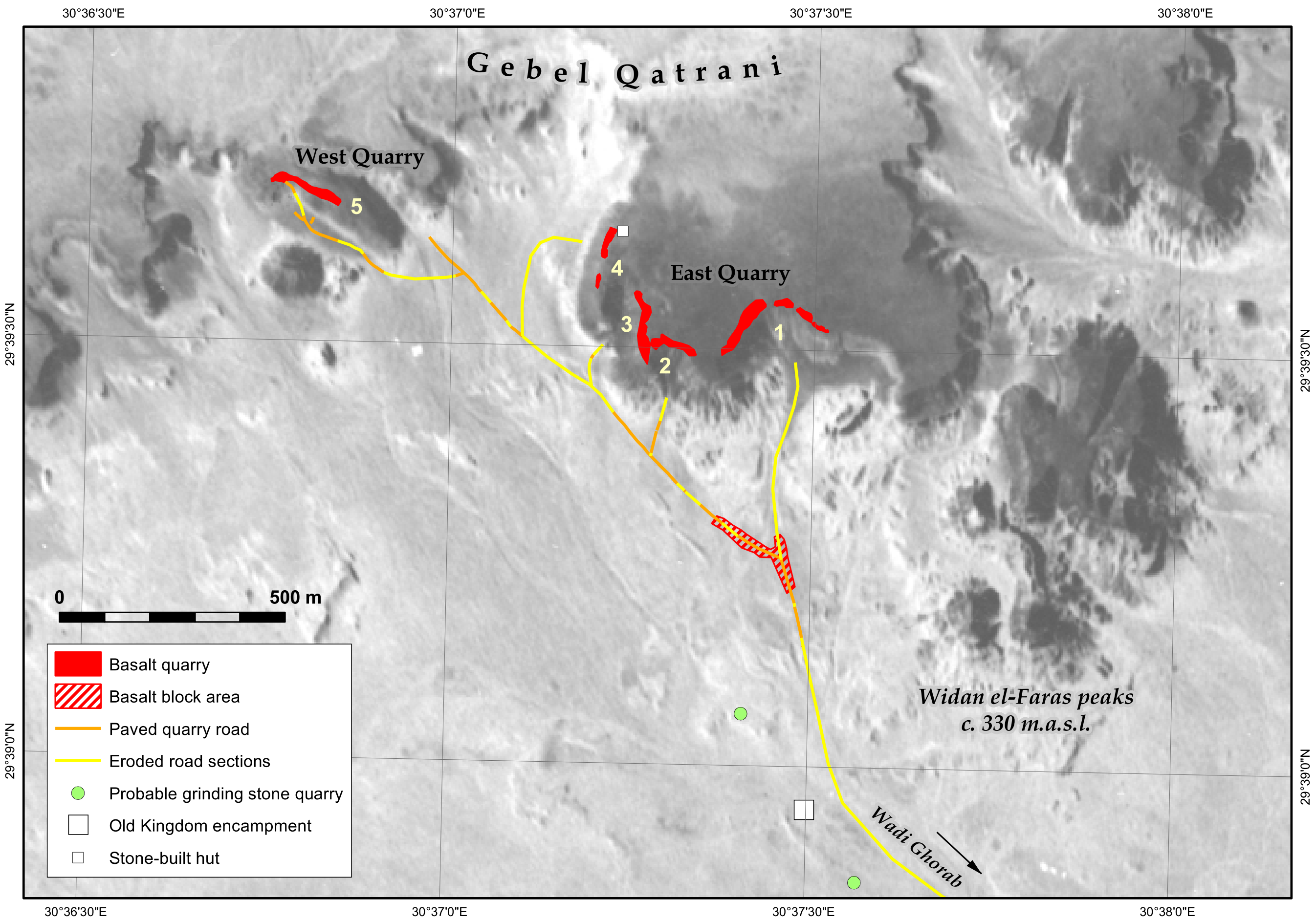

Figure 22. Detailed map of the Widan el-Faras basalt quarry (H2, Old Kingdom) showing the five areas with workings, the network of branching, mostly paved quarry roads, and other associated infrastructure. Map by Per Storemyr based on a survey by the QuarryScapes project with a US declassified Corona 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 Qasr el-Sagha with abandoned basalt blocks littering its surface. Photos by Per Storemyr.

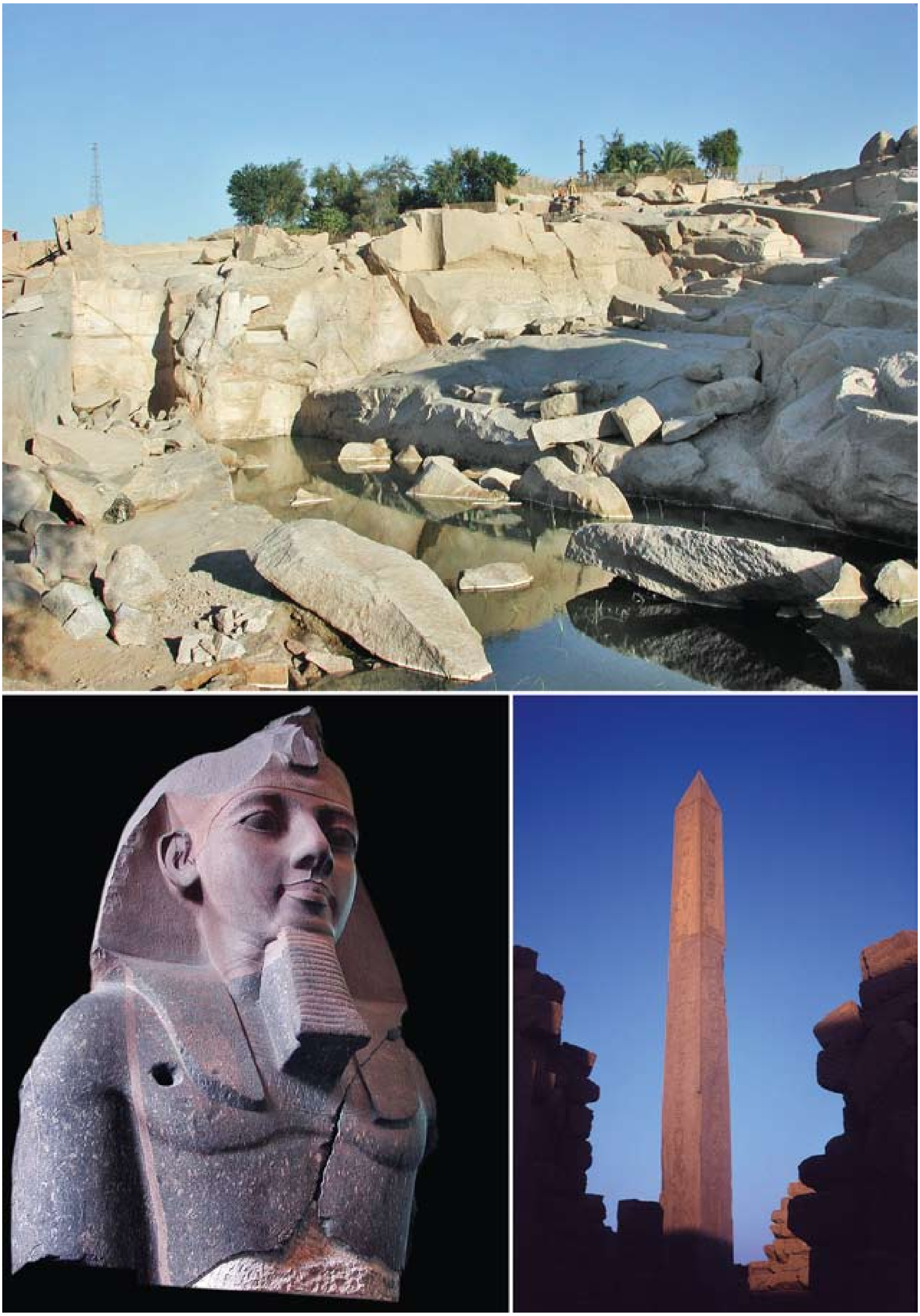

Figure 24. Aswan granite/granodiorite quarry (H6, Early Dynastic to Roman) and its products. Top: part of Aswan's Unfinished Obelisk Quarry in granite (as seen under archeological excavation in 2003). Bottom right: obelisk of pink, coarse Aswan granite erected for queen Hatshepsut in Karnak temple, Luxor. 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.

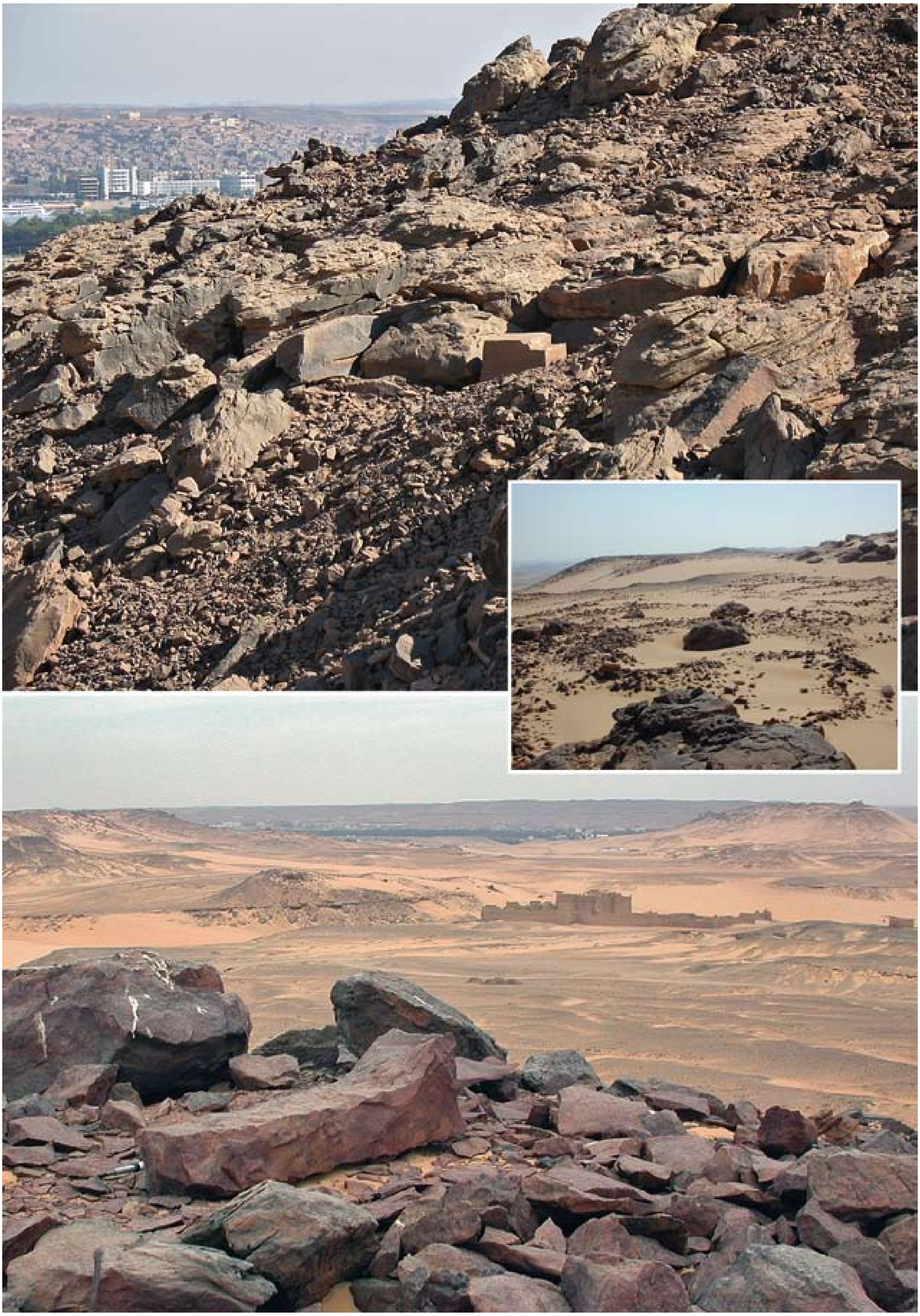

Figure 25. Gebels Gulab and Tingar silicified sandstone quarry (H5, New Kingdom and Roman). Top: working in the so-called Khnum's Quarry with the abandoned base for an obelisk (at center) and the city of Aswan in the background. Bottom: working on Gebel Sidi Osman with an abandoned statue blank (foreground) 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

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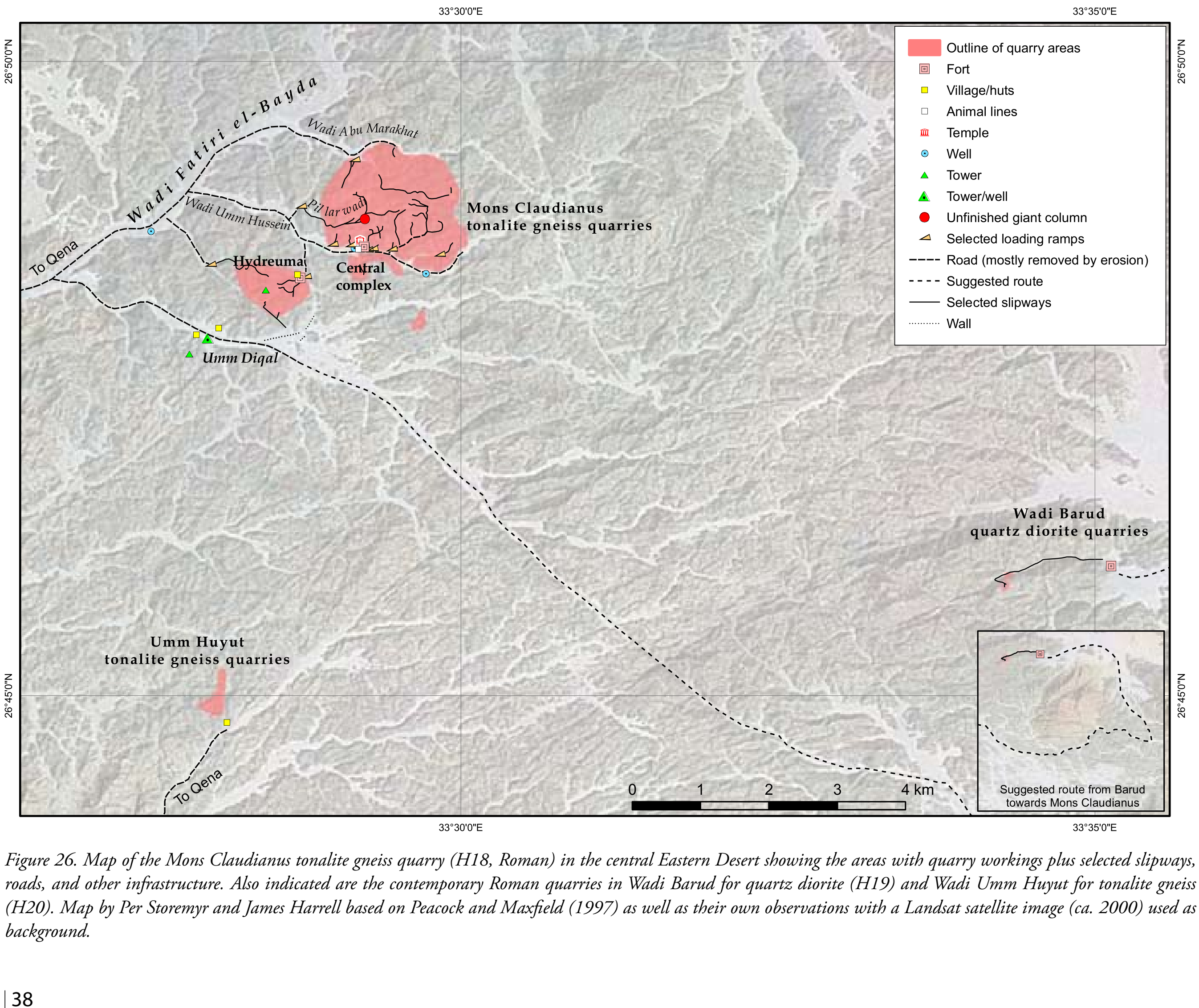

Figure 26. Map of the Mons Claudianus tonalite gneiss quarry (H18, Roman) in the central Eastern Desert showing the areas with quarry workings plus selected slipways, roads, and other infrastructure. Also indicated are the contemporary Roman quarries in Wadi Barud for quartz diorite (H19) and Wadi Umm Huyut 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.

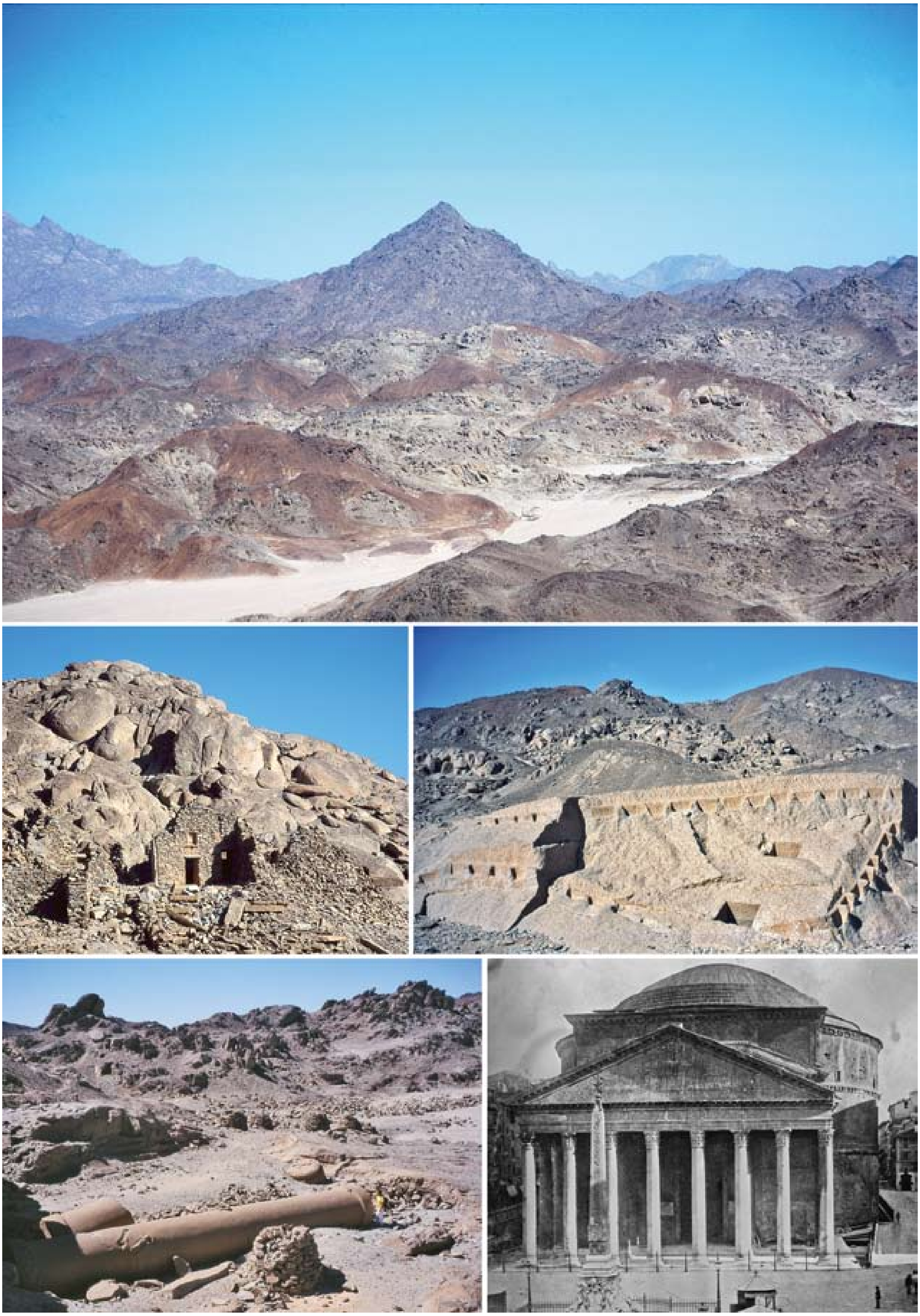

Figure 27. Mons Claudianus tonalite gneiss quarry (H18, Roman) and its products. Top: view across a portion of the quarry showing numerous workings and the central complex with a large fortified settlement. Middle left: temple in the quarry settlement. Middle right: working with traces of wedge holes. 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).

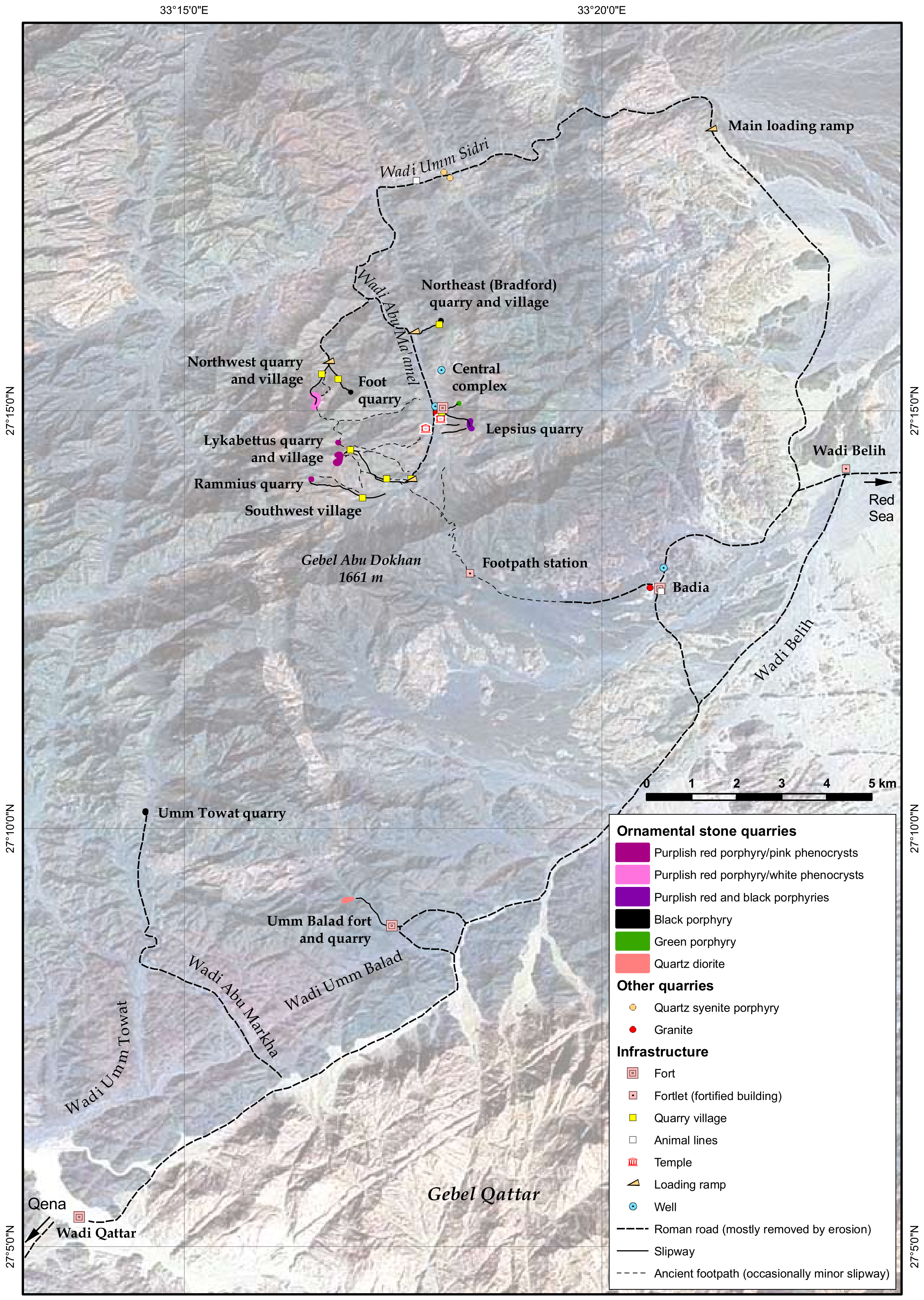

Figure 28. Map of the Mons Porphyrites andesite–dacite porphyry quarry (H12a, Roman) in the north-central Eastern Desert, showing the areas with quarry workings plus selected slipways, roads, and other infrastructure. Also indicated are the contemporary Roman quarries in Wadi Umm Sidri for syenite porphyry (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 Nino 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.

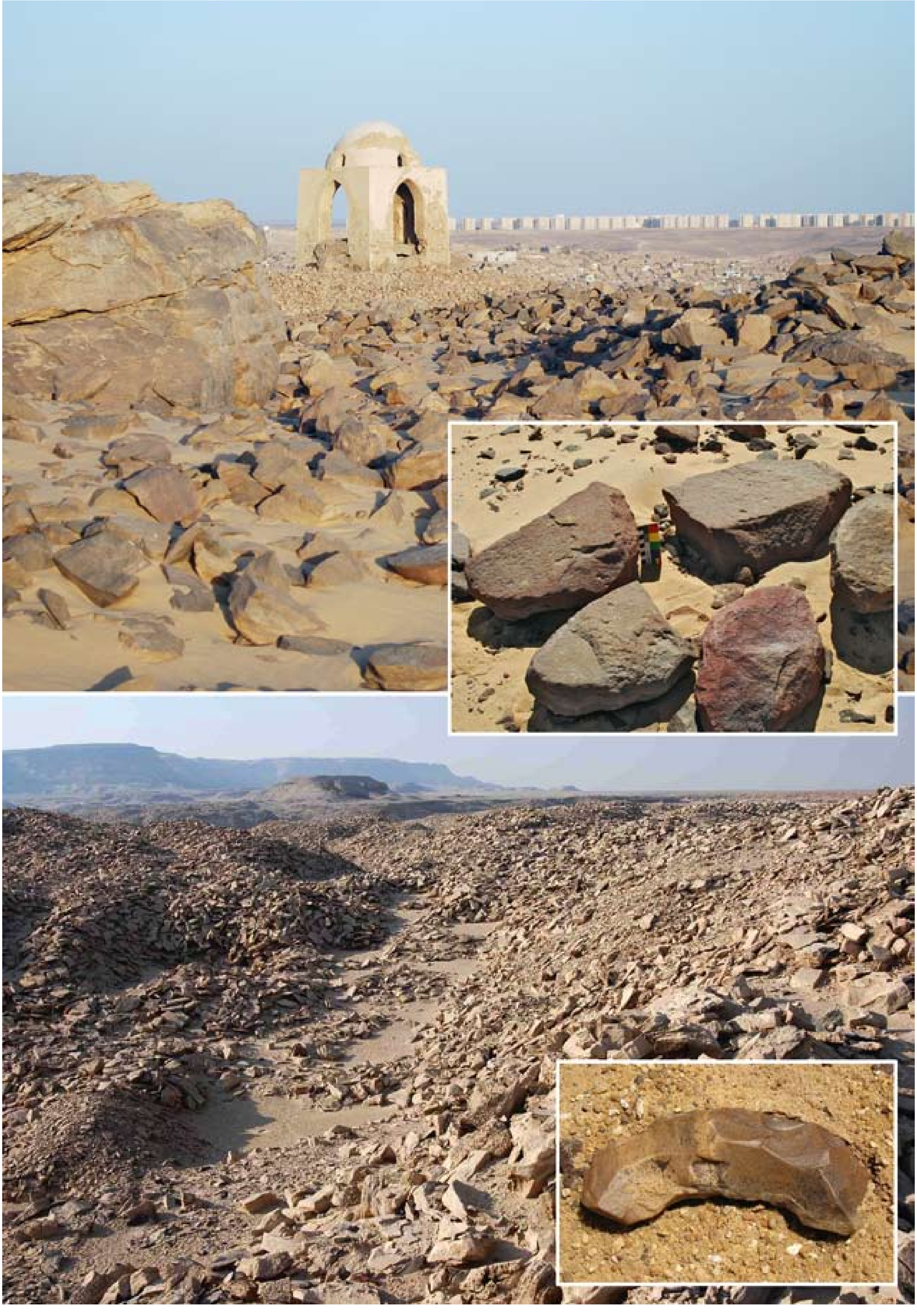

Figure 31. Utilitarian stone quarries. Top and upper insert: silicified sandstone quarry for grinding stones at Gebel Qubbet el-Hawa (part of H5, Dynastic–period unknown) near Aswan. Bottom: chert quarry for blades in Wadi el-Sheikh (H33, Old Kingdom and later Dynastic?). Lower insert: chert borer for hollowing out gypsum vessels found in the northern Faiyum near Qasr el-Sagha. Photos by Per Storemyr except the bottom one, which is by James Harrell.

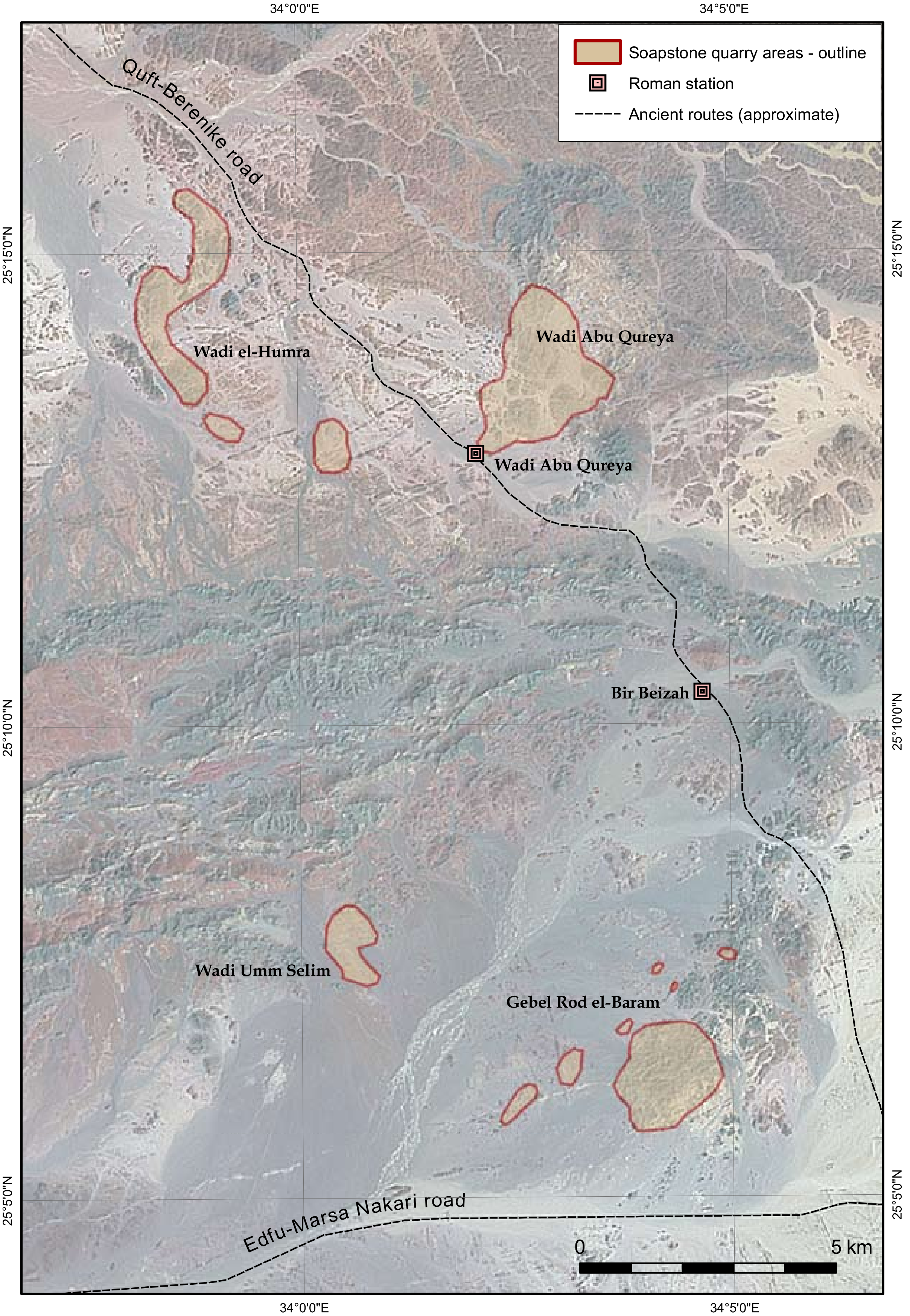

Figure 32. Map of the principal medieval to modern Islamic soapstone (steatite) quarries in the southern Eastern Desert, including Wadi Abu Qureya (O5, also late Roman?), Wadi el-Humra (O6), Wadi Umm Selim (07), and Gebel Rod el-Baram (O8, also late Roman). Map by Per Storemyr based on based on fieldwork 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.

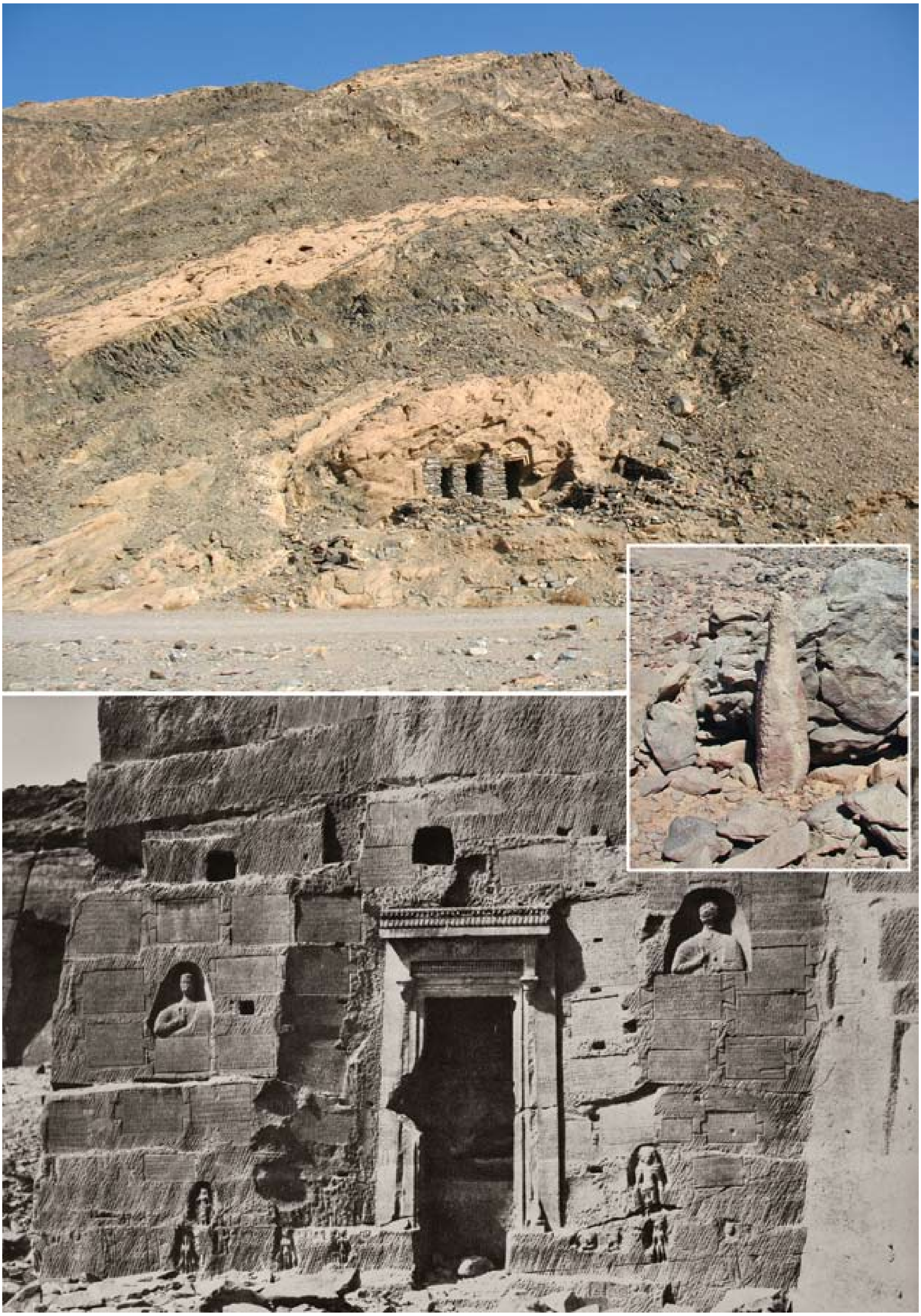

Figure 35. Quarry temples and shrines. Top: temple in the Wadi Sikait emerald quarry (G6, late Ptolemaic to Roman) cut into soapstone (talc schist). Bottom: Roman shrine in the Qertassi sandstone quarry (S20, Ptolemaic to Roman) now under Lake Nasser. Middle right insert: an upright stone that may have 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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The Stone Quarries of Ancient Egypt

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

List of quarries: see reverse side

Map datum: WGS 84

0 25 50 100 150 200 km

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).

Miscellaneous hardstones

No.	Name	N	E	Stone	Main period	State
H1	Gebel Ahmar	30.05266	31.29567	Silicified sandstone	P	4
H2	Widan el-Faras	29.66001	30.62001	Basalt	P	3
H3	Tilal Sawda	28.52001	30.54833	Basalt	GR	3
H4	Wadi Abu Aggag	24.14167	32.91001	Silicified sandstone	P/GR	3
H5	Gebels Gulab and Tingar	24.10676	32.87827	Silicified sandstone	P/GR	1
H6	Aswan	24.06176	32.89661	Granite, granodiorite	P/GR	3
H7	Chephren's Quarry	22.80677	31.22657	Anorthosite-gabbro gneiss	P	2
H10	Gebel Manzal el-Seyl	27.54333	33.13001	Tuff, tuffaceous limestone	PH/ED	1
H11	Wadi Umm Sidri	27.29701	33.30067	Quartz syenite porphyry	GR	1
H12a	Mons Porphyrites	27.25178	33.30165	Andesite-dacite porphyry	GR	1
H12b	Wadi Abu Maamel	27.25033	33.30133	Granite	GR	1
H13	Badia	27.21451	33.34417	Granite	GR	1
H14	Wadi Umm Towat	27.17017	33.24217	Trachyandesite porphyry	GR	1
H15	Wadi Umm Balad	27.15233	33.28517	Quartz diorite	GR	1
H16	Wadi Qattar	27.08001	33.23683	Granodiorite	GR	1
H17	Wadi Umm Shegilat	26.94367	33.24851	Pegmatitic diorite	GR	1
H18	Mons Claudianus	26.80917	33.48667	Tonalite gneiss	GR	1
H19	Wadi Barud	26.76533	33.57167	Quartz diorite	GR	1
H20	Wadi Umm Huyut	26.75101	33.46851	Tonalite gneiss	GR	1
H21	Wadi Fatiri el-Bayda	26.73383	33.32317	Quartz diorite	GR	1
H22	Wadi Umm Wikala	26.43067	33.66367	Metagabbro	GR	1
H23	Wadi Abu Gerida	26.36283	33.28533	Rhyolite porphyry	GR	1
H24	Wadi Maghrabiya	26.31233	33.39633	Metagabbro	GR	1
H26	Wadi Umm Esh	26.06683	33.61233	Serpentinite	GR	4
H27	Bir Umm Fawakhir	26.01283	33.60851	Granodiorite-granite	GR	1
H28a	Wadi Hammamat - E	25.98983	33.56917	Metagraywacke, metaconglomer.	P/GR	1
H28b	Wadi Hammamat - W	25.97767	33.55817	Metaconglomerate	P/GR	1
H29	Gebel Umm Naqqat	25.49633	34.25317	Pegmatitic diorite	PH/ED	1
H30	Wadi Abu Bokari	25.25217	33.76001	Granodiorite	GR	1
H31	Rod el-Gamra	24.76183	33.98833	Dolerite porphyry	P	1
H36	Wadi Abu Subeira	24.21633	32.89751	Silicified sandstone	P/GR	3
H37	Aswan - Hod el-Ruba	24.06083	32.88867	Dolerite	P	4
H38	Aswan - Gebel el-Granite	24.04183	32.88901	Dolerite	P	2
H39	Umm el-Sawan	29.71023	30.88924	Silicified sandstone	P	1

Travertine

No.	Name	N	E	Stone	Main period	State
T1	Wadi el-Garawi	29.81101	31.45951	Travertine	P	3
T2	Wadi Araba / Wadi Askhar	29.07958	32.05163	Travertine	GR	1
T3	Wadi Umm Argub	28.63501	31.26717	Travertine	P	3
T4	el-Qawatir	28.10333	30.81667	Travertine	P	3
T5	Wadi el-Barshawi	27.70617	30.93601	Travertine	P	2
T6	Wadi el-Zebeida east / Abd el-Azziz	27.68951	30.90583	Travertine	P	3
T7	Wadi el-Zebeida east	27.67601	30.92633	Travertine	P	3
T8	Hatnub	27.55501	31.02317	Travertine	P/GR	3
T9	Wadi Assiut	27.31551	31.35933	Travertine	P	4

Other soft stones

No.	Name	N	E	Stone	Main period	State
O1	Umm el-Sawan	29.71167	30.88333	Gypsum	ED/P	1
O2a	Wadi Saqiyah north	26.33117	33.65733	Talc schist	GR	2
O2b	Wadi Saqiyah south	26.32601	33.65551	Talc schist	GR	2
O3	Gebel Rokham	25.29967	33.96567	Marble	P/GR	4
O4	Wadi Mubarak	25.26901	34.43733	Steatite	I	1
O5	Wadi Abu Qureya	25.23251	34.04583	Steatite	I	1
O6	Wadi el-Humra	25.23083	33.98667	Steatite	I	1
O7	Wadi Umm Salim	25.12951	34.00833	Steatite	I	1
O8	Gebel Rod el-Barram	25.10251	34.07283	Steatite	GR/I	1
O9	Wadi el-Anba'ut	24.93017	34.92351	Gypsum	GR	1
O10	Wadi Kamoyid	22.60001	34.97667	Steatite	I	1
O11	Wadi Ma'awad	25.31217	33.67333	Talc schist	GR	1
O12	Qasr el-Sagha	29.60584	30.67388	Gypsum	P	1

Chert

No.	Name	N	E	Stone	Main period	State
H25	Wadi Hameda	26.21183	33.51617	Chert	B	1
H32	Wadi Araba / Wadi Umm Nikhaybar	29.07813	31.59083	Chert	P	1
H33	Wadi el-Sheikh	28.72083	31.01833	Chert	P	1
H34	Hierakonpolis	25.06917	32.77667	Chert	PH/P	2
H35	Wadi Araba / Ain Barda	29.10417	32.08633	Chert	P	2

Gem stones

No.	Name	N	E	Stone	Main period	State
G1	Bir Nasib	29.03667	33.39833	Turquoise	P	3
G2	Serabit el-Khadim	29.03667	33.45833	Turquoise	P	3
G3	Wadi Maghara	28.89717	33.37001	Turquoise	P	4
G4	Abu Diyeiba	26.51917	33.82601	Amethyst	GR	1
G5	Gebel Zabara	24.77167	34.71833	Emerald	B/I	1
G6	Wadi Sikait	24.64883	34.79751	Emerald	GR	2
G7	Wadi Nugrus	24.61675	34.77908	Emerald	GR	1
G9	Wadi el-Hudi	23.96151	33.13067	Amethyst	P	1
G10	Gebel Migif	24.80651	34.45301	Amazonite	P	1
G11	W. Fayrouz/Geb.Hafafit	24.75483	34.57417	Amazonite	GR	4
G12	Zabargad Island	23.60167	36.19133	Peridot	GR	4
G13	Stela Ridge	22.90001	31.31667	Carnelian	P	3
G14	Umm Harba	24.64201	34.82783	Emerald	GR	1
G15	Wadi Abu Rasheid	24.65533	34.75458	Emerald	GR	1
G16	Umm Kabu	24.05001	34.10001	Emerald	GR	1

Limestone

No.	Name	N	E	Main period	State
L1	Mallahet Mariut	30.94686	29.50167	GR	4
L2	Giza	29.97501	31.13251	P	2
L3	Saqqara	29.86917	31.21501	ED	2
L4	el-Lahun	29.23667	30.97083	P	U
L5	Zawyet Nasr (Gebel Mokattam)	30.02667	31.27001	P	3
L6	Tura	29.93333	31.29867	P	3
L7	Masara	29.91501	31.32001	P	3
L8	el-Sawayta	28.37683	30.80101	P	2
L9	el-Babein	28.30467	30.75067	P	2
L10	Deir Gebel el-Teir	28.28167	30.74717	P	3
L11	Tihna el-Gebel	28.18417	30.77501	P	2
L12	el-Hawarta	28.16583	30.77667	GR	2
L13	Nazlet Husein Ali	28.14001	30.77751	GR	2
L14	Sawada	28.07501	30.80933	P	U
L15	Nazlet Sultan Pasha	28.06833	30.81751	P/GR	3
L16	Zawyet el-Amwat	28.05501	30.83167	P/GR	2
L17	Wadi Sheikh Yasin	28.05251	30.84533	P/GR	3
L18	Darb Tila Nufal	28.04501	30.85583	P/GR	2
L19	Dirwa	27.73917	30.70001	GR	2
L20	Nazlet el-Diyaba	27.94001	30.88183	GR	2
L21	Beni Hasan	27.91067	30.87167	P/GR	2
L22	el-Sheikh Timay	27.86167	30.84533	P/GR	3
L23	el-Sheikh Ibada	27.82651	30.87667	P/GR	2
L24	Deir Abu Hennis	27.77933	30.92133	P	2
L25	Wadi el-Nakla	27.75117	30.91933	P/GR	2
L26	Deir el-Bersha north	27.71917	30.89433	P	2
L27	Deir el-Bersha south	27.70601	30.89001	P	3
L28	Sheikh Said	27.69733	30.88951	P	3
L29	Wadi el-Zebeida west	27.69283	30.90167	P	2
L30	Wadu el-Zebeida central	27.68951	30.90583	P	3
L31	Queen Tiy Quarry	27.67817	30.91001	P	1
L32	Amarna north tombs	27.66201	30.92967	P	1
L33	Deir el-Quseir	27.49333	30.87301	U	U
L34	Wadi Abu Helwa	27.42167	30.88167	P	2
L35	Meir	27.43333	30.70683	P	2
L36	Deir el-Amir Tadros	27.37951	30.95783	P	3
L37	Deir Abu Mina	27.35667	31.01467	U	3
L38	el-Maabda	27.34533	31.02833	U	3
L39	Deir el-Gabrawi	27.33883	31.10317	P	3
L40	el-Ketf	27.32667	31.04801	P	2
L41	Arab el-Atiat	27.33451	31.06617	P	2
L42	Talet el-Hagar	27.28951	31.30083	U	2
L43	Assiut / el-Izam	27.15417	31.14833	U	2
L44	Assiut / Drunka	27.15601	31.17583	P	3
L45	el-Aldra Maryam/Deir Drunka	27.10333	31.17033	P	2
L46	Deir Rifa	27.07583	31.18333	P	2
L47	Sidi Abu el-Haris	27.04501	31.22651	U	2
L48	Sidi Abu el-Haris tomb / Deir el-Bileida	27.03967	31.22867	U	2
L49	Deir el-Bileida	27.03251	31.23251	U	2
L50	el-Balyza	27.02151	31.23951	U	2
L51	el-Balyza / Abu Khurs	27.00667	31.24451	U	2
L52	el-Abu Khurs / el-Zaraby	26.98667	31.24851	U	2
L53	el-Zaraby	26.97417	31.25001	P	2
L54	el-Adra Maryam	26.92717	31.28317	P	3
L55	el-Mashaya	26.91501	31.28917	U	3
L56	el-Ghanayim Bahari	26.89001	31.30633	GR	2
L57	Sidi Mansur	26.88083	31.31233	U	2
L58	el-Ghanayim Qibli	26.87067	31.31967	U	2
L59	el-Aghana	26.86001	31.32901	U	2
L60	el-Qarya Bil Diweir	26.84251	31.33401	U	2
L61	Sidi Abu Khiris tomb	26.78151	31.35883	U	2
L62	Nag el-Tawalib	26.77333	31.37651	U	2
L63	Nag Hamad	26.50933	31.66267	GR	3
L64	el-Salmuni	26.20417	31.87583	P	3
L65	Wadi Naqb el-Salmuni	26.19351	31.86583	P	1
L66	Wadi Emu	27.11951	31.35683	U	2
L67	el-Khawalid	27.09351	31.38701	U	2
L68	el-Nazla el-Mustagidda	27.07867	31.39367	U	1
L69	Deir Tasa	27.06333	31.40451	U	2
L70	el-Iqal Bahari	26.99251	31.45917	U	2
L71	el-Baiyadiya	26.95951	31.46133	U	3
L72	el-Iqal el-Qibli	26.94317	31.48017	P/GR	2
L73	el-Hammamiya	26.93717	31.48733	P	2
L74	Antaeopolis	26.92417	31.49251	P	2
L75	Qaw el-Kebir	26.92583	31.50517	P/GR	2
L76	el-Nawawra	26.83533	31.53633	U	2
L77	el-Khazindariya	26.79451	31.54151	P	2
L78	Nazlet el-Haridi	26.77483	31.55351	U	2
L79	Abu el-Nasr	26.76233	31.56367	GR	2
L80	Abu el-Nasr/el-Galawiya	26.76167	31.59333	P	2
L81	el-Galawiya	26.75951	31.62233	U	2
L82	Istabl Antar	26.71283	31.67483	P	2
L83	Qurnet Salamuni	26.61901	31.75483	U	U
L84	el-Salamuni	26.61783	31.76451	P	3
L85	Wadi el-Muluk	25.74633	32.62251	P/GR	2
L86	el-Gebelein / el-Ghrera	25.49767	32.47901	P/GR	4
L87	Nag el-Ahaywa	26.43433	31.83717	P	U
L88	Sidi Musa	26.41501	31.84533	P/GR	2
L89	Nag el-Buza	26.09501	32.30301	U	2
L90	Gebel el-Gir	26.10451	32.69501	P/GR	2
L91	el-Dibabiya	25.50133	32.51933	P/GR	2
L92	Wadi Umm Zanatir	28.93833	32.39501	B	1
L93	Wadi Abu Mu'aymil	28.89833	32.32501	B	3
L94	Wadi el-Sheikh Muhammad	28.12433	30.78701	U	2
L95	Wadi Umm Damarana	28.82483	32.06567	I	4
L96	Abu Sir	29.88301	31.20417	P	2
L97	Dahshur - Mastaba Faraon	29.82017	31.20083	P	2
L98	Dahshur - Red Pyramid	29.80201	31.19667	P	2
L99	Siwa Oasis	29.20501	25.54333	P	4

Sandstone

No.	Name	N	E	Main period	State
S1	Hierakonpolis	25.07567	32.74333	P/GR	2
S2	el-Mahamid	25.13767	32.78267	P/GR	2
S3	el-Kab	25.13451	32.81751	P/GR	1
S4	el-Keijal	25.06833	32.86301	U	2
S5	Nag el-Raqiein	24.74633	32.92033	U	2
S6	Nag el-Hosh	24.73651	32.92117	GR	1
S7	Wadi el-Shatt el-Rigal	24.68501	32.92351	P	1
S8	Nag el-Hammam - N	24.67751	32.92483	P	2
S9a	Gebel el-Silsila - W	24.64901	32.92917	P	2
S9b	Gebel el-Silsila - E	24.64283	32.93333	P/GR	1
S10	el-Kilh Sharq	25.04951	32.88883	GR	2
S11	el-Bueib	24.80983	32.91433	P	3
S12	Nag el-Fuqani	24.20883	32.85883	GR	2
S13	Sheikh Mohammed	24.16283	32.86833	U	1
S14	Sidi el-Hasan	24.34983	32.92801	GR	3
S15	el-Hadedoon	24.30917	32.91133	GR	3
S16	Gebel el-Hammam	24.22717	32.87483	P	4
S17	Gebel Qubbet el-Hawa	24.10183	32.88767	U	2
S18	Aswan	24.06176	32.89501	U	4
S19	Dabod	23.89667	32.85333	GR	ULN
S20	Qertassi	23.70001	32.88501	GR	ULN
S21	Tafa	23.46501	32.86177	GR	ULN
S22	Kalabsha	23.55083	32.86333	GR	ULN
S23	Abu Hor / Merowa	23.45833	32.89167	GR	ULN
S24	Qurta	23.04167	32.66667	P/GR	ULN
S25	Agayba	22.85001	32.55833	U	ULN
S26	Tumas	22.75167	32.14667	P	ULN
S30	Qasr Ibrim	22.64833	31.99167	P/GR	ULN
S31	Nag Deira	22.50667	31.89167	P	ULN
S32	Gebel el-Teir	25.50278	30.55687	P/GR	3
S33	el-Muweih	25.94501	33.39851	GR	2
S34	Bir el-Kanayis	25.00417	33.30001	P/GR	2
S35	Nag el-Hammam - S	24.66601	32.92501	P	2
S36	Bahariya Oasis	28.34701	28.85583	GR	U
S37	Dakla Oasis	25.68167	28.83833	GR	U
S38	Saint Simeon	24.09467	32.87567	P	3

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: Greco–Roman
B: Byzantine (Late Roman)
I: Islamic
U: Unknown

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
U: Unknown