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Elizabeth Bloxam

Steingewinnung
L'extraction de la pierre dans les mines et les carrières

Ancient quarrying and mining sites, which represent some of the most threatened archaeological sites in Egypt, often present extensive cultural landscapes comprising a range of material culture; however, their research potential is still not fully recognized. Hard and soft stone quarrying and gemstone mining in ancient Egypt are poorly understood activities, although both are well attested throughout the Pharaonic era. Current research is re-shaping ideas about, for example, the major use of stone tools and fire in extracting hard stones, transmission of stone-working technologies across often deep time depths, and the role of skilled kin-groups as a social construct rather than large unskilled labor forces.

تعد مواقع التحجير والتعدين بمصر القديمة من أكثر المواقع الأثرية المهددة، وهي تقدم نطاق واسعة من الثقافة المادية، إلا أن أبحاثهم لا تزال غير مكتملة. ويعتبر نشاط المحاجر سواء الأحجار الهشة والصلدة أو مناجم الأحجار الكريمة من الأنشطة المبهمة رغم أن كلاهما له شواهد واضحة خلال العصر الفرعوني. وتعمل الأبحاث الحالية على إعادة تشكيل الأفكار حول، على سبيل المثال، أهم استخدامات الأدوات الحجرية والنار (اللهب) في استخراج الأحجار الصلبة وانتقال تقنيات تشكيل الأحجار عبر فترات متباعدة من الزمن، وكذلك إستخدام مجموعات من العائلات المتمرسة الماهرة كبناء مجتمعي بدلاً من القوة الضخمة من العمالة الغير متدربة.

Research into the technologies used to extract and transport stone and semi-precious stone from quarries and mines is still an underdeveloped field of study in Egyptology, despite the large-scale use of these materials in antiquity. Ancient quarry and mining sites (fig. 1) are the "forgotten" archaeological sites, even though they can comprise material culture such as roads, settlements, epigraphic data, and often spectacular partly finished monumental objects. Moreover, ancient production sites can enhance our understanding of the lives of the non-elite in antiquity, in particular the social organizations of raw material procurement, an aspect that still remains poorly understood. As some of the most endangered archaeological sites in Egypt, ancient production sites are under enormous threat from modern quarrying, urban development, and other mega-projects. Hence, in more recent years, there has been some urgency in documenting these little known fragile cultural landscapes. Incorporating fresh data from recent archaeological and geological surveys of some key ancient quarries and mines, the intention of this article is to review the current status of our knowledge of raw material extraction in antiquity—with a focus on the Pharaonic period—from perspectives such as extraction technologies, logistics, and the social context.

Figure 1. Map of Egypt showing ancient quarries and mines mentioned in the text.

Location and Consumption of Stone and Gemstones

1. Stone. Rocks quarried and crafted in antiquity are usually placed into two broad categories as either "hard" stones or "soft" stones. "Hard" stones are usually igneous rocks such as basalt, granite, diorite, granodiorite, dolerite, and porphyritic rocks, but can also include metamorphic rocks such as gneisses, metagabbro, serpentinite, and sedimentary rocks such as silicified sandstone (often termed "quartzite") and chert. Key hard stone sources exploited during the Pharaonic period are the deposits of granite and granodiorite in Aswan, silicified sandstone at Gebel el-Ahmar near Cairo and on the west bank at Aswan, basalt in the Northern Fayum at Widan el-Faras (fig. 2), and "Chephren gneiss" from Gebel el-Asr ("Chephren's Quarry") in Lower Nubia. The greatest range of other hard stone deposits are located in the Eastern Desert (Aston et al. 2000: 8 - 16).

"Soft" stones usually refer to sedimentary rocks such as sandstone, limestone, gypsum, and travertine. All these rocks occur in a range of geographical locations throughout Egypt, with limestone, sandstone, and travertine deposits largely situated inside the Nile valley between Cairo in the north and Esna in the south. Key soft stone deposits exploited during antiquity occur at Hatnub (travertine), in the region of the Muqattam hills near Cairo (limestone), and between Aswan and Edfu at Gebel el-Silsila (sandstone; fig. 3). The exception to these Nile valley locations are sources of gypsum that occur most densely in the Northern Fayum (Aston et al. 2000: 8 - 16).

Figure 2. Widan el-Faras. Old Kingdom basalt quarries, Northern Fayum desert.

Figure 3. Gebel el-Silsila sandstone quarries between Edfu and Aswan.

It is beyond the scope of this article to cover the whole spectrum of elite stone consumption in antiquity, although in general terms during the Pharaonic period, the greatest use of hard stones occurred between the Predynastic (late 4th millennium BCE) into the mid Old Kingdom (mid 3rd millennium BCE). Stone vessels, life-sized statuary, and elements in monumental architecture were key

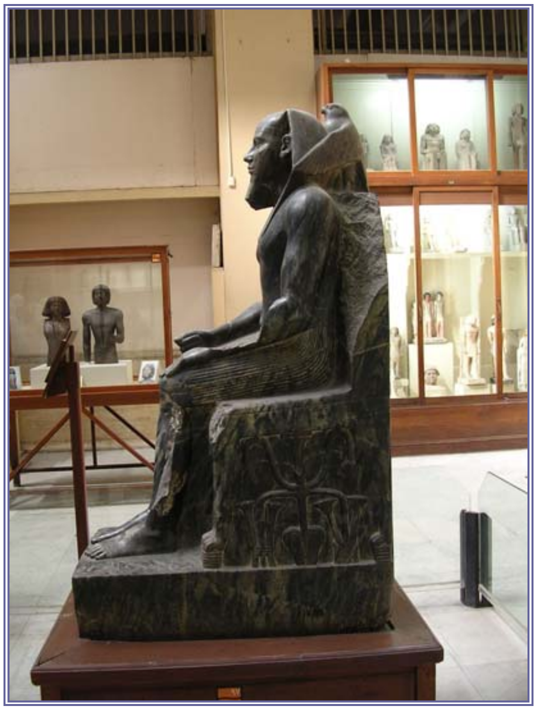

Figure 4. "Chephren gneiss" life-size statue of Khafra in the Egyptian Museum, Cairo. 4th Dynasty.

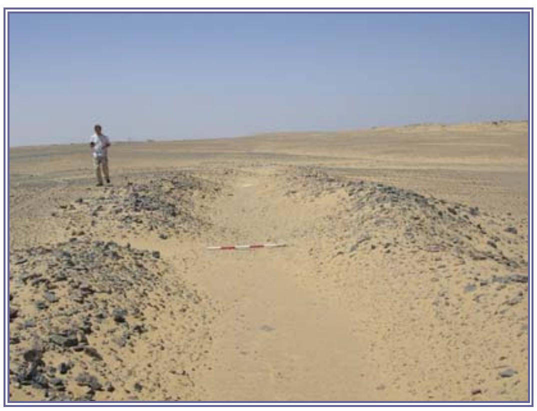

Figure 5. Longitudinal subterranean Middle Kingdom carnelian mine bordered with spoil heaps. Stele Ridge, Lower Nubia.

uses of the largest range of hard stones, peaking between the 4th and 5th Dynasties (fig. 4). Aswan red granite and basalt were the most extensively exploited hard stones utilized in architectural elements of the Old Kingdom pyramid complexes at Giza and Abusir (Mallory-Greenough et al. 2000; Röder 1965). The utilitarian use of largely hard stones for tools, grinding equipment, and other domestic purposes was constant throughout antiquity. Soft stones such as sandstone and limestone were used almost continuously in the construction of monumental buildings from the Early Dynastic into the Roman Period. Travertine was also an important soft stone exploited in antiquity, particularly for stone vessels and also monumental architecture (see *Bibliographic Notes*).

2. Gemstones. Gemstones such as amazonite, amethyst, jasper, garnet, turquoise, peridot, emerald, and carnelian were all mined in Egypt during antiquity, largely for jewelry (Aston et al. 2000: 65). The main geographical locations of some of the most important gemstone mines are in the Eastern Desert, such as Wadi Sikait (emerald; Shaw 2002), the Gebels Migif and Hafafit (amazonite; Harrell and Osman 2007), and Wadi el-Hudi (amethyst; Fakhry 1952; Shaw and Jameson 1993). Stele Ridge in Lower Nubia in the environs of Gebel el-Asr ("Chephren's Quarry") is the only known source of carnelian (fig. 5; Bloxam 2006; Engelbach 1938), and the Sinai has concentrations of turquoise and copper mines, the most well known being at Serabit el-Khadim. All these sources were exploited in antiquity, although the explosion in gemstone mining is most associated with the Middle Kingdom (Shaw 1998, 2002).

Stone Extraction Technologies: A Review

Most of the hard and soft stone sources known in Egypt were exploited to varying degrees and purposes since prehistory into at least the Roman Period. The nature of the deposit, in terms of its physical properties, was a key factor in how the rocks were extracted (Heldal, Bloxam, and Storemyr 2007). Although later quarrying is always destroying evidence of the earliest extraction techniques, it is generally agreed that the earliest hard stone quarrying in the Predynastic for ornamental objects, such as stone vessels, utilized more easily accessible boulders or "blocky" remains of hard stones (Lucas 1934: 201, 211). It was not until the

quest for hard stones used in monumental architecture and life-size statuary that it became necessary to target bedrock (Heldal and Storemyr 2007: 102 - 116).

There is still considerable debate about the technologies of both hard and soft stone extraction, in particular the extent to which metal tools were used (Aston et al. 2000: 7). Given the constant re-use of metal, there is an obvious bias in the archaeological record, because such material in the form of tools is rarely found in production sites. Stone tools are without exception the most common implements found in production sites. Yet in accordance with Arnold (1991: 33 - 36) and also from subsequent studies, there is generally an undervaluing of the role that stone tools did actually play in both the extraction and dressing of stone blocks, even after the introduction of metal technologies (Stocks 2003). Moreover, in the hard stone granite and silicified sandstone quarries in Aswan and the gneiss quarries at Gebel el-Asr ("Chephren's Quarry"), fresh evidence suggests that stone tools in combination with fire were key technologies used in ornamental stone production from the Old Kingdom into at least the Ptolemaic Period (Heldal 2009; Heldal and Storemyr 2007: 104 - 116; Heldal et al. 2005: 15 - 21; Storemyr et al. 2002). Similarly, the use of fire-setting to extract graywacke in the Wadi Hammamat has recently been discovered by the author. Charcoal, burnt flakes of stone, and often fired mud-bricks are key remains left by this process in primary extraction and also in secondary production for channeling, trimming, and shaping blocks. Pounding with stone tools to further flatten and smooth surfaces is also attested by the clearly visible marks left by these tools on partially worked objects found in the quarries (fig. 6).

Figure 6. Partially completed silicified sandstone (quartzite) ornamental object of the New Kingdom (either an Osiride statue or truncated obelisk) showing marks of pounders. Khnum Quarry, west bank Aswan.

Although it is extremely difficult to determine when fire-setting was gradually phased out as a technology in hard stone quarrying, the current view is that with the introduction of iron technology by the Ptolemaic Period, the "wedging" technique took precedence (Aston et al. 2000: 7; Röder 1965). Typified by the distinctive "trapezoidal" wedge holes left on quarry faces, these have been subject to intense scrutiny, in terms of technology as well as establishing chronologies of quarrying (Röder 1965). Metal tools such as picks and chisels seem to have been employed in some part of the process of cutting the wedge holes, given the distinctive marks left by these tools on quarry faces; yet controversy still remains as to whether wood or metal wedges were employed to finally split the stone (Arnold 1991: 39; Aston et al. 2000: 7).

The use of metal in the extraction of soft stones is also problematic; the suggestion from studies of the Gebel el-Silsila sandstone quarries is that "softer copper chisels" were utilized during the Old and Middle Kingdoms, with "harder bronze chisels" coming into use by the New Kingdom (Klemm and Klemm 1981: figs. 32, 38.1 - 38.3). The blocks were then believed to have been levered out using wooden beams. Fresh arguments have suggested that the use of pointed picks and axes has been largely overlooked, and similar to hard stone quarrying, stone tools may have had a greater use in the dressing and quarrying of soft stones with metal chisels employed only for special purposes (Arnold 1991: 33 - 36). In addition, recent research undertaken at the Wadi el-Nakhla limestone gallery quarries near Deir el-Bersha, particularly those of the Late Period, has revealed grids of red ocher

lines on the roof that presumably had some practical purpose in designating work areas for the quarriers (Klemm and Klemm 2008: 91 - 92; Willems et al. 2006; Willems et al. 2004).

It is important to remember that similar to hard stone quarrying, geological awareness was key in determining the best method of extraction. With this aspect in mind, it has to be noted that in the well-preserved Old Kingdom gypsum quarries at Umm el-Sawan, the combination of locally acquired fossilized wood, minimally worked into rod-shaped pieces, found associated with stone hammers largely of chert occurs in significant quantities to suggest their wholesale use as tools (Bloxam and Heldal 2007: 312 - 314; Heldal et al. 2009: 54 - 59).

Finishing of objects in the quarries seems to be dependent upon how far the stone had to travel to the Nile. At the Aswan granite quarries, which lie directly on the Nile, objects seem to have been almost completed in the quarries. The famous "unfinished obelisk" and New Kingdom Osiride statue, which still lie attached to the bedrock, are such examples. In quarries outside of the Nile valley, evidence from discarded objects suggests that they were only partially completed to form rough outlines of their intended final form, probably to reduce the transport weight (figs. 7 and 8; Bloxam 2003; Harrell 2002; Heldal, Bloxam, and Storemyr 2007).

Gemstone Mining

Gemstone mines in Egypt, similar to quarries, are under pressure from modern mining. Due to almost continuous mining of some key resources, their preservation, in terms of identifying the earliest phases of mining, is largely poor. Moreover, given the large quantities of epigraphic data found in mining contexts, such as standing stelae, votive objects, and a temple to Hathor at Serabit el-Khadim, past research has largely focused on documenting these aspects of the material culture, rather than the mines themselves (Bonnet and Valbelle 1997; Fakhry 1952; Gardiner et al. 1955; Sadek 1980 - 1985).

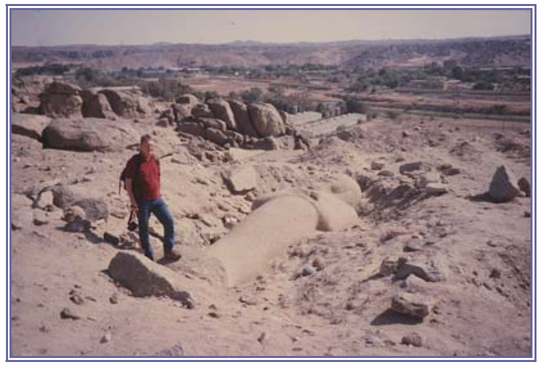

Figure 7. Osiride statue (New Kingdom) lying in the Aswan granite quarries.

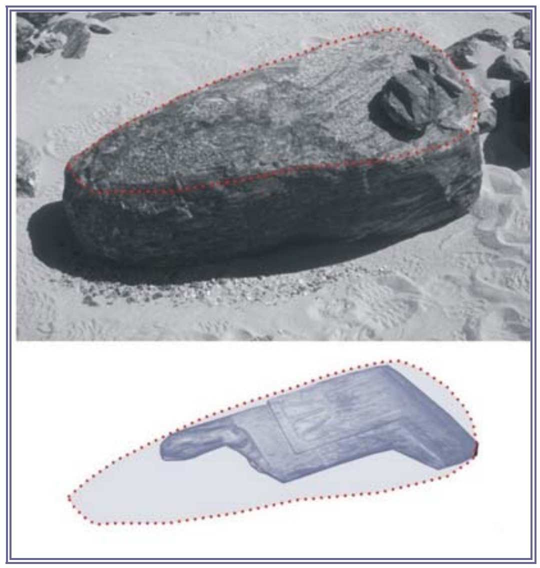

Figure 8. "Chephren gneiss" block at Gebel el-Asr ("Chephren's Quarry") roughly shaped into a statue. Old Kingdom, 4th Dynasty.

Although our knowledge of gemstone extraction techniques in the Pharaonic period is limited, the main corpus of objects remaining in such sites are stone tools, which once again suggests the important role they played in separating gemstones from ore bearing rocks.

The carnelian mines at Stele Ridge in the environs of Gebel el-Asr ("Chephren's Quarry") in Lower Nubia present one of the few well preserved Pharaonic gemstone mining sites, largely of the Middle Kingdom (Bloxam 2006: 289 - 290; Engelbach 1933, 1938). The mines are extremely hard to visualize due to them being sub-surface

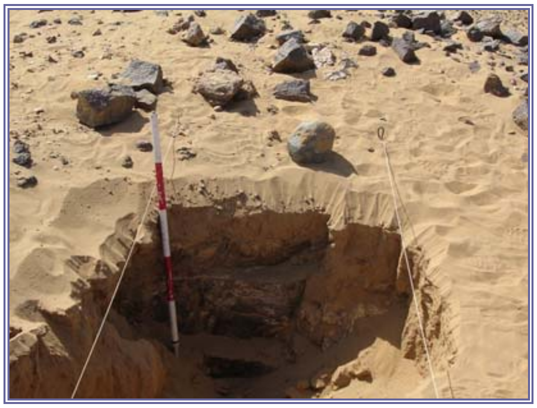

Figure 9. Partially excavated carnelian mine, 1 meter deep. Stone pounder alongside was found in the base of the mine. Stele Ridge, Lower Nubia.

Figure 10. Converging New Kingdom paved roads at Gebel Gulab, west bank Aswan.

extractions characterized on the surface as circular, oval, and longitudinal subterranean trenches surrounded by spoil heaps. These shallow subterranean extractions, often only a meter in depth, were extensively exploited to access the stone that occurs in cracks between granite outcrops. Stone tools seem to have been the main implements used to separate the gemstone from the ore, given the absence of marks made by metal. Pounders found inside an excavated mine and in surrounding areas suggest that the method of mining was by pounding of the granite to release the gemstone (fig. 9; Bloxam 2006: 289).

Stone tool assemblages made up of flint scrapers, hand axes, and pounders comprise the largest corpus of mining tools found at the Serabit el-Khadim turquoise and copper mines. Yet it is interesting to note, given that these mines were intensively exploited between the Middle and New Kingdom, that these assemblages show little variation from those found in earlier nearby Chalcolithic sites, implying no demonstrable transformation between Early Dynastic Period and Middle Kingdom mining techniques (Beit Arieh 1980: 45 - 64; Petrie and Currelly 1906: 161 - 162). Despite the problems in assessing transformations in mining technologies, it is suggested that the Middle Kingdom mines are more represented by horizontal tunneling and mines in the New Kingdom by the creation of large galleries with deep hollows made in the surfaces (Chartier-Raymond et al. 1994: 76; Petrie and Currelly 1906: 60).

Logistics of Stone Transport

Transport infrastructure in quarries can vary according to the nature of the ground surface—and steep descents—over which the stone had to travel on its journey to the Nile. The importance of water in the transport process of large objects was clearly vital, the termini of most quarry roads linking in some way to the Nile or its nearest tributaries (Bloxam 2003; Kelany et al. 2007; Klemm and Klemm 2008: 52). New Kingdom quarry roads associated with the transport of large ornamental objects from the silicified sandstone quarries at Gebel Gulab on the west bank at Aswan are some of the most extensive and best preserved in Egypt (Bloxam and Storemyr 2005; Heldal et al. 2005: 32 - 33; Heldal, Bloxam, Storemyr et al. 2007: 151 - 162). These networks comprise secondary paved roads that lead directly into New Kingdom quarries from where large objects were extracted. The roads all converge onto a central artery, which traverses Gebel Gulab and then changes character into more ramp-like structures to ease passage of the stone down towards the Nile (fig. 10).

The world's oldest paved quarry road connects the Old Kingdom basalt quarries of Widan el-Faras with the shores of ancient Lake Moeris at Qasr el-Sagha in the Northern

Fayum (Bloxam and Storemyr 2002; Harrell and Bown 1995). Constructed from local sandstone, limestone, basalt, and fossilized wood, the terminus of the 11 km road at a quay utilized the waters of Lake Moeris during high Nile floods. Although determining the levels of the Nile flood during the Old Kingdom still remains controversial, there is indirect evidence to make a correlation between high Nile floods and the transport of basalt on a large scale to the pyramids on the Giza plateau at this time.

Due to the lack of archaeological evidence in relation to vehicles associated with the movement of stone, there still remains the archaeological problem as to what type of vehicle was used in the overland transportation of stone. In general, there has been a tendency to rely on the iconographic record to explain these practices, these suggesting the use of low-lying sledges. The Middle Kingdom Djehutihotep transport scene (Newberry 1894: 16 - 26, pls. XII - XIX) as well as a New Kingdom (18th Dynasty) depiction found in the Tura limestone quarries of a sledge conveying a block of stone drawn by oxen are often referred to (Arnold 1991: 61, 278; Charlton 1978: 128; Clarke and Engelbach 1930: 85, 88; Daressy 1911: 262 - 265). To what extent rollers were used under the sledges is still a matter of debate (Arnold 1991: 275; Klemm and Klemm 2008: 52), although the use of unfixed rollers with sledges to move heavy weights over large distances has been proven impractical (Cotterell and Kamminga 1990: 220).

Of the quarry roads described above, there are no wear marks, fixed tracks, or other indicators as to how the stone was moved over them. However, rare vehicle tracks associated with several loading ramps at Gebel el-Asr ("Chephren's Quarry," Old Kingdom) have certainly suggested that other types of conveyance, other than low-lying sledges, were used to transport stone from this quarry to the Nile (Bloxam 2000, 2003, 2007a; Shaw and Bloxam 1999). In essence, it seems as if adaptation to local geomorphological conditions was key, and ways to minimize overland transportation were clearly sought. Recent research in the Aswan granite quarries has indicated that the construction of canals into the "unfinished obelisk quarry" was clearly to avoid any overland movement of these objects (Kelany et al. 2007).

The Social Context

Assessing the social context of quarry and mining expeditions in the Pharaonic period in terms of numbers involved and hierarchies has been difficult to determine, given that associated settlement evidence is scant. Even in quarries outside of the Nile valley, such as Gebel el-Asr ("Chephren's Quarry"), Widan el-Faras, and Umm el-Sawan, only small ephemeral camps characterized by low-level dry-stone walls and the use of natural rock overhangs have provided any evidence of habitation (Bloxam 2003; Bloxam and Storemyr 2002: 33 - 34; Bloxam and Heldal 2007: 315 - 316; Caton-Thompson and Gardner 1934, Vol. 1: 117 - 120; Shaw 1994; Shaw and Bloxam 1999; Shaw et al. 2001). Ceramics are also minimal in these and other quarry sites; hence, estimating the numbers of people involved in these activities is problematic and why there has been a reliance on textual sources. However, even taking into account poor preservation, recent findings cannot attest to quarry labor forces being over a maximum of 200 individuals, thus largely contradicting the Wadi Hammamat quarry inscriptions, which list expeditions into the tens of thousands (Couyat and Montet 1912; Goyon 1957).

In terms of provisioning of the labor force in quarries remote from permanent settlements and crucial access to water, evidence from excavation of two small camps and several wells at Gebel el-Asr ("Chephren's Quarry") in the Western Desert has given us some decisive insights. Constituting dwellings for no more than 25 people, one-third of each camp was devoted to food production, in particular bread making. In addition to consumption of local fish, birds, and mammals, access to water was relatively easy

from shallow wells only up to one meter in depth (Bloxam 2003, 2007a). The shallowness of the wells has provided important insights into the climatic conditions that prevailed during the Old Kingdom exploitation, indicating seasonally wetter periods far removed from what we see today.

Grappling with the archaeological problems of fragmentary data, particularly in terms of understanding the social organization of resource exploitation in the Pharaonic era, it has been important to reassess our ideas about the make up of quarry and mining labor forces from concepts in other areas of the social sciences. In particular cross-cultural comparison, anthropology, social archaeology, and landscape archaeology have provided useful models through which production data can be reinterpreted (Bloxam 2006, 2009b; Bloxam and Heldal 2007; Knapp 1998). Developing such methodologies is important if we are to understand the social context behind these activities, away from largely unreliable explanations via just a few written sources. Recent research is now widening the gap between the textual version of practice vis-à-vis the archaeological record.

It has recently been argued that small groups of specialists, rather than large detachments of unskilled workers, made up quarrying and mining labor forces. These groups, loosely structured around kinship ties, might explain the general observation of undeniably skilled practice and transmission of specific extraction technologies over many generations (Bloxam 2006, 2007a, 2007b, 2009a, 2009b; Bloxam et al. 2009).

Conclusion

Ancient quarrying and mining sites often present extensive cultural landscapes comprising a range of material culture; however, their research potential is still not fully recognized. Current research is re-shaping ideas about these poorly understood activities, for instance, the major use of stone tools and fire in extracting hard stones, transmission of stone-working technologies across often deep time depths, and the role of skilled kin-groups as a social construct rather than large unskilled labor forces. Although questions of chronology of extraction techniques, methods, and development of theoretical approaches to interpretation are still in their early stages, with a continued emphasis on archaeological and geological survey of these sites, the potential exists to further address some of these important questions.

Bibliographic Notes

The pioneering works of James Harrell (1989, 2002), Harrell and Bown (1995), Harrell and Brown (1994), and Dietrich and Rosemarie Klemm (1993, 2008) still provide the most extensive foundation to the study of ancient quarrying and mining, describing their geology, petrography, extraction technologies, and archaeological infrastructure. Other works of James Harrell are listed on his website. For a recent overview of threats to ancient quarries, see Storemyr et al. (2007). A comprehensive bibliography on the early pioneers and others who have studied quarries and mines over the last century is contained in Aston et al. (2000). Late nineteenth and early twentieth century archaeologists and geologists such as Ball (1939), Beadnell (1905), Petrie and Currelly (1906), Weigall (1910, 1913), Timme (1917), Hume (1935, 1937), and Caton-Thompson and Gardner (1934) investigated some ancient quarries as part of larger geological or archaeological expeditions, although archaeological approaches specific to production techniques were not undertaken until the work of Engelbach (1922, 1923) in the Aswan (granite/granodiorite) quarries; see also Clarke and Engelbach (1930), Lucas (1962), and Arnold (1991). For a recent summary of work undertaken during the QuarryScapes project in Egypt, in terms of documenting and mapping ancient quarry landscapes with a view to conservation, see Bloxam (2009a). Also see

the QuarryScapes website that includes an on-line atlas of ancient quarries across the Eastern Mediterranean, as well as a range of downloadable reports from this research project that are mentioned in the text. A volume of papers from the QuarryScapes project is published in Abu-Jaber et al. (2009). For geological explanations, see American Geological Institute (1962) and also Aston et al. (2000). Storemyr et al. (2007), Harrell and Storemyr (2009), and Shawarby et al. (2009) are the most up to date sources for more recent location maps of ancient quarries, their status of preservation, and legal status as registered archaeological sites. A comprehensive overview of hard and soft stone use for ornamental and building purposes during the Pharaonic period can be found in Aston (1994), Aston et al. (2000), and Bloxam (2003), while overviews of ornamental hard stone use in pyramid complexes can be found in Lehner (1997), Verner (2002), and Edwards (1991). Recent findings of prolific grinding stone production across the west bank at Aswan are given by Bloxam et al. (2007) and Bloxam (fc.); further mention of utilitarian uses of hard stones in antiquity are provided by Stocks (2003), Arnold (1991), and Lucas (1934). For archaeological investigations made at Serabit el-Khadim and other associated mining sites, see Petrie and Currelly (1906), Beit Arieh (1980), Beit Arieh et al. (1978), Chartier-Raymond et al. (1994), Giveon (1974), and Rothenberg (1987). For investigations of the galena mines (lead ore) at Gebel Zeit in the Eastern Desert, see Castel and Soukiassian (1989). The Roman quarries in the Eastern Desert at Mons Claudianus (Peacock and Maxfield 1997) and Mons Porphyrities (Maxfield and Peacock 2001) provide important evidence not only of the wedging technique but of partly finished objects such as columns. The excavations have provided evidence for large Roman Period quarry settlements in the Eastern Desert. Also in later mining contexts, such as in the Sikait Zubara region where well-preserved Roman Period settlements are attested, there is a noticeable absence of similarly large settlements in their Pharaonic period counterparts (Shaw 2002: 247; Shaw and Jameson 1993: 96). Transportation of stones has many different aspects, such as the use of high water stands for shipping; see, for instance, Shafei (1960: 193) and Wendorf and Schild (1976: 220) in regard to high floods and the connection between the Nile and ancient Lake Moeris in the Old Kingdom, and Shaw (1986, 1987) on investigations of the ancient quarry road that connects the Hatnub travertine quarries with the Nile. Political, economic, and social strategies in ancient quarrying and mining are addressed by Shaw (1994, 1998, 2002). For more detailed discussion of textual evidence in relation to archaeological evidence in Pharaonic period quarries, see Bloxam et al. (2009). For transliteration of quarrymen/stoneworker/stonemason, see Lesko and Lesko (2002).

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Figure 1. Map of Egypt showing ancient quarries and mines mentioned in the text. (After Shaw 2002: 245.)

Figure 2. Widan el-Faras. Old Kingdom basalt quarries, Northern Fayum desert. Photograph by the author.

Figure 3. Gebel el-Silsila sandstone quarries between Edfu and Aswan. Photograph by the author.

Figure 4. "Chephren gneiss" life-size statue of Khafra in the Egyptian Museum, Cairo. 4th Dynasty. Photograph by the author.

Figure 5. Longitudinal subterranean Middle Kingdom carnelian mine bordered with spoil heaps. Stele Ridge, Lower Nubia. Photograph by the author.

Figure 6. Partially completed silicified sandstone (quartzite) ornamental object of the New Kingdom (either an Osiride statue or truncated obelisk) showing marks of pounders. Khnum Quarry, west bank Aswan. Photograph by the author.

Figure 7. Osiride statue (New Kingdom) lying in the Aswan granite quarries. Photograph by the author.

Figure 8. "Chephren gneiss" block at Gebel el-Asr ("Chephren's Quarry") roughly shaped into a statue. Old Kingdom, 4th Dynasty. Photograph and figure by Tom Heldal.

Figure 9. Partially excavated carnelian mine, 1 meter deep. Stone pounder alongside was found in the base of the mine. Stele Ridge, Lower Nubia. Photograph by the author.

Figure 10. Converging New Kingdom paved roads at Gebel Gulab, west bank Aswan. Photograph by the author.