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Who were the pharaohs' quarrymen?

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The monumental statuary, pyramids, temples and other major structures made of stone are among the most arresting and well known of the cultural achievements of ancient Egypt. The production of these involved the quarrying, preparation, transport and skilled working of huge masses of very hard rock. How were such massive rocks quarried and by whom? How were the quarries of ancient Egypt organized? These are some of the questions explored here.

The pyramids, obelisks, colossal statues and temples of ancient Egypt are testament to an outstanding cultural heritage made of stone. Although much is known from the architectural and building achievements behind such monuments, the actual quarries from which the stone is derived are mainly the forgotten archaeological sites. The logistical and technical feats involved in quarrying and transporting large quantities of stone, sometimes over distances as great as 1,000km, and the social organization behind these activities, have been poorly understood.

Recent archaeological research of three major quarries in Egypt at Widan el-Faras, Chephren's quarry and Gebel Gulab (Fig. 1), exploited between the third and second millennia, has produced new perspectives into stone-quarrying techniques and the social organization underlying these activities.[1] Consumption of stone extracted from these quarries was mainly for elite purposes. Widan el-Faras in the northern Faiyum Desert supplied the basalt used on mortuary-temple floors in some of the Old Kingdom[2] pyramid complexes (Fig. 2), Chephren's quarry near Abu Simbel is the source of the famous blue Chephren Gneiss used for royal statuary and vessels of the Old Kingdom (Fig. 3), and Gebel Gulab in Aswan was the source of silicified sandstone (often termed quartzite) appropriated in the New Kingdom[2] mainly for obelisks and statues.

The written sources

In general, knowledge of the social organization and logistics behind stone quarrying in Egypt has mostly been derived from written records and iconographic depictions of the process. Typically these come from the second millennium (Middle Kingdom) quarry inscriptions in the Wadi Hammamat region of the Eastern Desert. One such expedition, which Senusret I ordered to acquire greywacke for sphinxes and statues, records over 18,000 people being involved and organized along strict hierarchical lines.[3] In the tomb of the noble Djehutihotpe (Middle Kingdom) at Deir el-Bersha,[4] the depiction of his colossal statue being drawn from the travertine quarries at Hatnub on a sledge by almost 200 people (Fig. 4) is often used to explain how stone was transported from quarries. Yet, can these written and iconographic sources be taken as a literal explanation of the quarrying process? Can such large numbers of unskilled workers, strict hierarchies and logistics be perceived in the archaeological record in the quarry sites? Was large-scale quarrying achievable only if centrally organized by the state?

Quarrying techniques: skilled practice?

Quarrying of hard stones, such as granites, gneisses, silicified sandstone and basalt, prior to the Roman period (when tools made of metal took precedence), was an undertaking of immense skill that was mainly accomplished using stone tools and fire. The use of fire as a primary extraction technique and to remove the outer weathered surface of granites, silicified sandstone and gneisses, is evident at Chephren's quarry, Gebel Gulab and the Aswan granite quarries.[5] The fires were skilfully concentrated and targeted by being enclosed by mudbricks, which focused the heat. At the Aswan granite quarries, evidence of fire setting can be observed from the stratigraphies of charcoal, burnt pieces of stone, and fired bricks. Fire setting to extract the large boulders of Chephren Gneiss is also implied from the large deposits of charcoal found inside the extraction sites and in the surrounding spoil heaps. Further shaping of blocks into rough objects combined the use of fire and trimming with stone pounders; the marks left by these tools are still clearly visible.

A geological awareness of the stones' properties can also be attested in many instances in the quarries. At Widan el-Faras the basalt quarries are located along the top of an escarpment, 300m above sea level, meaning that extraction required almost

Figure 1 *Egypt, showing ancient quarries mentioned in the text.*

Figure 2 *Basalt floor (foreground) of Khufu's mortuary temple (Fourth Dynasty).*

Figure 3 *Chephren Gneiss life-size statue of Khafra in the Egyptian Museum, Cairo (Fourth Dynasty).*

acrobatic skills, as the stone had to be worked from the edge of the escarpment back into the deposit (Fig. 5). Yet, this part of the deposit seems to have been specifically selected because of the highly fractured nature of the stone making it easy to wedge out blocks not larger than 1 m^3, the average size used to pave the temple floors.[6] Reducing the amount of block working after extraction seems to have been an important consideration of the quarrying stage, as evidence of further trimming is minimal. Stone tools found in the quarries comprised mainly large and small stone axes, with contracted necks making it possible to attach a handle. Presumably, these tools were used in one or more of these extraction stages. It is interesting to note that all the tools would have been transported to the quarries over quite large distances, as they are of especially hard materials, such as gabbro, gneiss and diorite, which have sources 800 km to the south in the Aswan region.

Forethought to the final crafting process and to the aesthetic appearance of the final product is exemplified at Chephren's quarry, because discarded blocks and partially worked objects seem to have been abandoned if they had been penetrated by unsightly pink granitic veins. These veins are zones of weakness that make the stone more susceptible to fracturing during the stages of final crafting and are never seen in finished objects.

The 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 Osirid statue, which still lie attached to the bedrock, are such examples (Fig. 6).

In quarries outside of the Nile Valley, evidence from discarded objects suggests that they were completed only partially to form rough outlines of their intended final form, probably to reduce the transport weight (Fig. 7).

Logistics: roads, ramps and harbours

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. At Gebel Gulab there is an intricate network

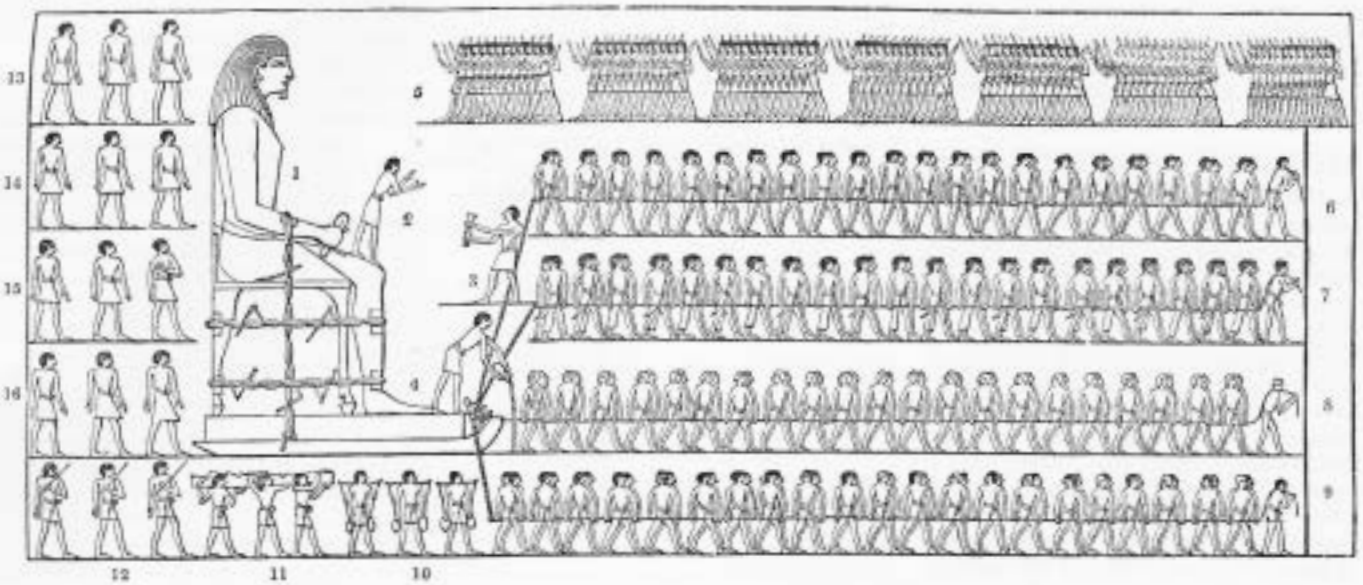


Figure 4 *Djehutihotpe's statue being transported from the Hatnub travertine quarries, as depicted in his (Twelfth Dynasty) tomb at Deir el-Bersha (from Newberry 1895, see* n. *4).*

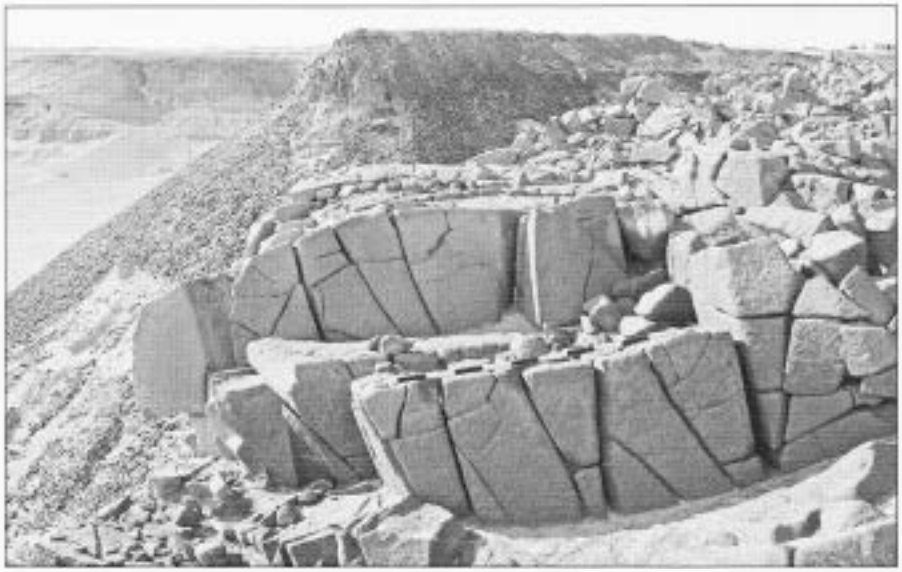


Figure 5 *Old Kingdom basalt quarry at the edge of the escarpment, Widan el-Faras.*

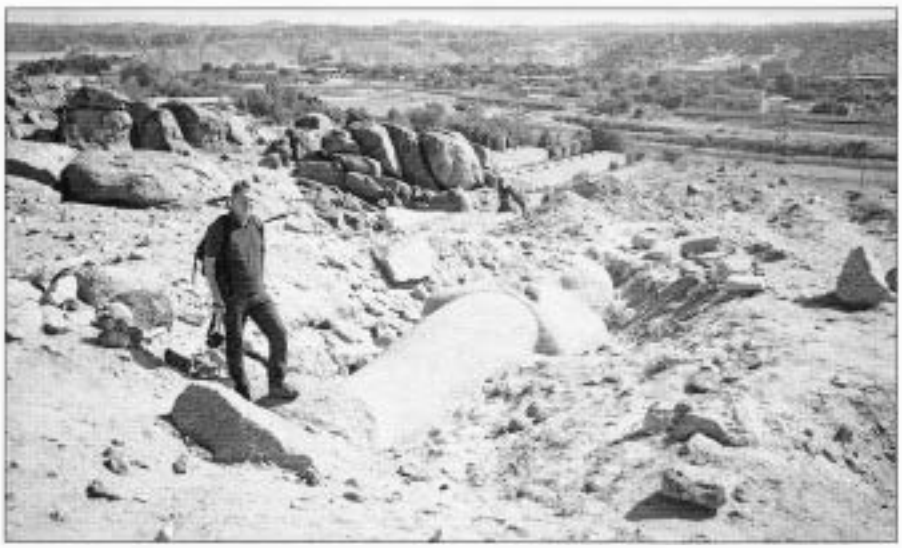


Figure 6 *Osirid statue (New Kingdom) lying in the Aswan granite quarries.*

of roads and ramps that is remarkably well preserved (Fig. 8). These comprise secondary paved roads that lead directly into quarries from where large objects were extracted. These roads all converge onto a central artery which traverses the *gebel* (hill) and then changes character into more ramp-like structures to ease passage of the stone down towards the Nile.[7]

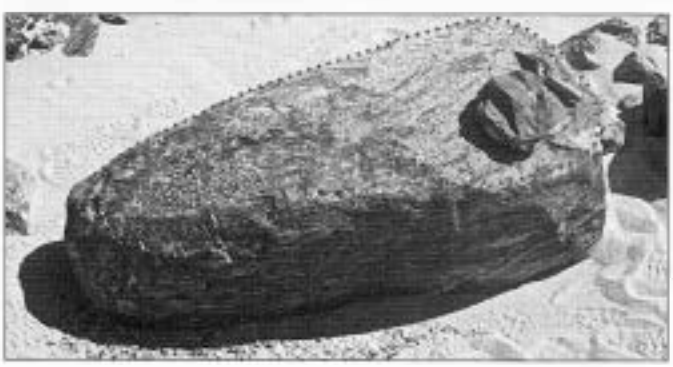
The Old Kingdom 11km-long quarry road at Widan el-Faras, which terminates at a quay on the now-extinct shores of ancient Lake Moeris at Qasr el-Sagha, is the oldest paved road in the world. The road conforms along its entirety to a width of 2.10m, equal to the ancient Egyptian measurement of 4 cubits, and is constructed from sandstone, limestone, basalt and fossilized wood, their intermittent use for certain sections being clearly related to the proximity of these raw materials.[8] The environs surrounding the terminus of the road at a quay are situated within a natural inlet, probably utilized as a harbour at a time when the levels of Lake Moeris were at 22–23m above sea level. 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[9] and the transport of basalt on a large scale to the pyramids on the Giza Plateau at this time. Moreover, basalt is not exploited on such a large scale again in the pharaonic period or even by the late Old Kingdom, when records suggest low Nile floods.[10] Black limestone, probably more locally procured, replaces basalt in the Sixth Dynasty mortuary temple of Pepi I.

The archaeological problem still remains as to what type of vehicle was used to transport the stone along the roads at Widan el-Faras and Gebel Gulab, as no trackmarks are visible on the surfaces. Yet at Chephren's quarry, where no paved roads were constructed, excavation to the base of two loading ramps in the Old Kingdom quarries revealed deep and wide tracks cut into a hard calcrete[11] surface immediately in front of them, suggesting that a vehicle other than a low-lying sledge (as depicted in the iconography) was used (Fig. 9).[12]

Size of labour force and hierarchies

It would be anticipated that large settlement areas and hierarchical structures would exist at the quarries, particularly if the large labour forces described in the written sources were to be accommodated. Yet, such features have not been found in any of the quarries studied. An encampment at Widan el-Faras, consisting of six highly weathered basalt stone circles, is the only evidence of habitation at the basalt quarries (Fig. 10). These single-level stone features were either supports for windbreaks or were tent footings for temporary dwellings. A hearth and plentiful amounts of charcoal were found and small surface scatters of pottery dating between the Fourth and Fifth Dynasties, consistent with the peak in exploitation of Widan el-Faras basalt. The encampment's small size suggests that between 20 and 25 people could have been accommodated here.[13]

At Chephren's quarry a similar situation has been observed with only two camps,



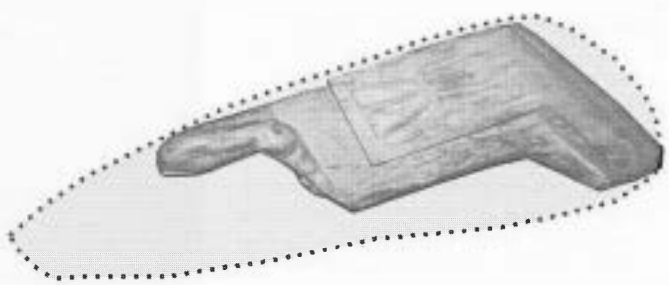


Figure 7 *Chephren Gneiss block at Chephren's quarry roughly shaped into a statue (Old Kingdom) (courtesy of Tom Heldal).*

Figure 8 *New Kingdom paved road at Gebel Gulab, Aswan.*

located 4 km apart along the ancient track leading from the quarries to the Nile, constituting dwellings for no more than 25 people. Each camp comprises a semi-circular drystone wall 1.5 m high by 70 cm thick; partial excavation revealed that a third of each camp was devoted to food production, in particular that of bread-making. Breadmoulds dating between the Third and Fifth Dynasties formed the bulk of the pottery and were found more or less where they were left 5,000 years ago, embedded in a thick ashy layer. Wells to a depth of 1 m below the ground surface are associated with each camp, implying that water, vital for the labour force, was easily accessible.[14] The shallowness of the wells has important implications for the climatic conditions that prevailed during the Old Kingdom exploitation and could indicate seasonally wetter conditions.[15]

Who were the quarrymen?

There are clear discrepancies between how the written and iconographic sources portray raw-material acquisition when compared with the archaeological evidence at the rock sources. A high visibility of the state, deploying large labour forces to extract stone within high levels of social organization, cannot be archaeologically attested. A problem then arises when the quarrying process shows skilled practice, as described above, but undertaken it seems by small groups within low levels of social organization.

If the Middle Kingdom quarry inscription of Senusret I in the Wadi Hammamat is examined more carefully, the actual number of people designated with the title "stoneworkers" is only 100, with another 100 designated as "quarrymen".[16] Hence, actual quarrymen are a mere 200, or less than 10 per cent of the very large detachment of 18,628 people listed in the inscription. If this relatively small number of quarrymen is compared with the archaeological record at Widan el-Faras and Chephren's Quarry, the gap between the numbers mentioned in the inscription becomes closer to the archaeological data. It could be argued that the quarrymen were in fact small groups of specialists, rather than a motley crew of unskilled workers. These groups, loosely structured around kinship ties within well developed social identities, might explain the evidence for skilled transmitted practice. In Mesoamerica, where stone acquisition played an important part in the centralized state of Teotihuacán in the Classic Period, research of quarry sites has similarly emphasized the role of kin groups in the quarrying process.[17]

Quarrying for high-status objects in hard stone during the third and second millennia seems to have been campaign-based for specific purposes, given the standardization of object blanks, seen particularly at Chephren's quarry. Perhaps the deployment of specialists was more regionally based and not necessarily from central administrative or royal capitals. Maybe the northern Faiyum could have been one such regional base, because the stone tools used in the quarries at Widan el-Faras, as well as the nearby Old Kingdom gypsum quarries at Umm es-Sawan, can be sourced to Aswan and Chephren's quarry, some 1,000 km away (Fig. 1). This could imply a connection between the Old Kingdom stoneworkers, either through trading between specialists of prized stone tools, or alternatively the northern Faiyum was a centre where such people resided and from where they were deployed.

Understanding the social and organizational dynamics behind ancient quarrying, and also the role of the state in such activities, are still a continuing field of research, as many important questions remain to be answered. For example, the quarry inscriptions raise some questions, including what symbolism and ideology were attached to the quarrying campaigns, and what the intended audience for these inscriptions was.

Quarries under threat

The significance of quarries as archaeological sites that can enhance our understanding of the technologies and social context of stone procurement in antiquity has been greatly undervalued. In the Eastern Mediterranean as a whole, ancient quarry sites are mostly invisible, undocumented and unprotected, and are being destroyed by activities such as modern development and quarrying. An EU-funded

Figure 9 *Excavated loading ramp at Chephren's quarry, showing vehicle tracks cut into the Old Kingdom ground surface (foreground).*

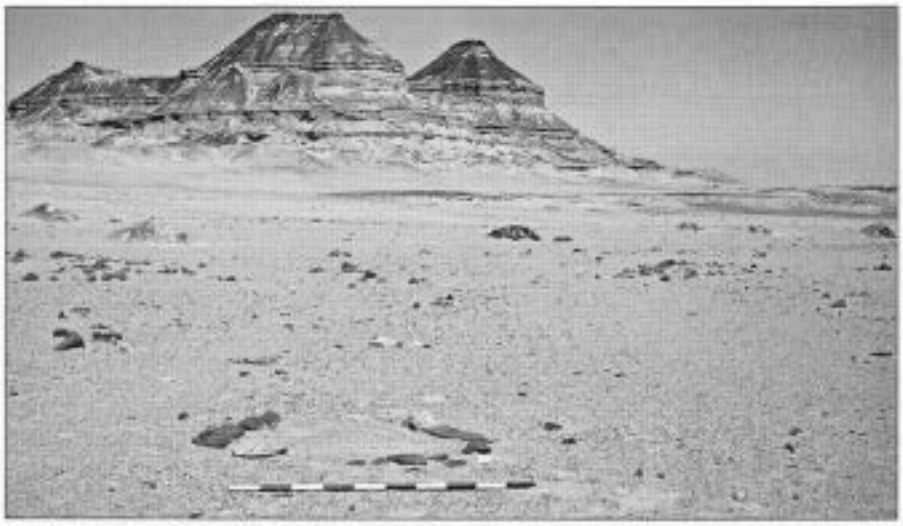


Figure 10 *Hearth in the encampment (foreground) – Widan el-Faras basalt quarries.*

project titled QuarryScapes,[18] in which the Institute of Archaeology (UCL) is a partner, brings together professionals from academic and other institutions in Egypt, Jordan, Turkey, Belgium, Italy and Norway, to focus specifically on the documentation, conservation and heritage management of these fragile archaeological sites.

Notes

1. Tom Heldal and Per Storemyr have been inspirational colleagues in the field surveys of these quarries, especially with geological and technical aspects of this work. Thanks also to Thilo Rehren and Stephen Quirke for valuable input into aspects of this research from technological and Egyptological perspectives respectively. Fieldwork colleagues Ian Shaw (director, Chephren's Quarry Project), Richard Lee, Richard Jones, Adel Kelany, Angus Graham, Judith Bunbury and Ashraf el-Senussi have also contributed greatly. I gratefully acknowledge the support and cooperation of the Supreme Council of Antiquities: Zahi Hawass, Magdy el-Ghandour, Hossam el-Din Ali Ahmed Godia, Ibrahim el-Sayedi and Mohi ed-Din Mustapha. Many thanks also to the Leverhulme Trust for funding my postdoctoral research.
2. Outline chronology of pharaonic period Egypt: Old Kingdom (*c.* 2650–2150) Third–Sixth Dynasty; Middle Kingdom (*c.* 2040–1782) Eleventh–Twelfth Dynasty; New Kingdom (*c.* 1570–1070) Eighteenth–Twentieth Dynasty.
3. See pp. 64–6, pl. 20, no. 87 in *Les inscriptions hiéroglyphiques et hiératiques du Ouâdi Hammâmât*, J. Couyat & P. Montet (Le Caire: Imprimerie de l'Institut Français et Archaéologie Orientale, 1912); also pp. 81–5, no. 61 in *Nouvelles inscriptions rupestres du Wadi Hammamat*, G. Goyon (Paris: Librairie d'Amérique et d'Orient Adrien-Maisonneuve, 1957).
4. P. E. Newberry, *El Bersheh*, part I (London: Egypt Exploration Fund, 1895).
5. Tom Heldal has been instrumental in finding the evidence for fire setting as a forgotten hard-stone extraction technique, see pp. 15–18, 30–31 in T. Heldal, E. G. Bloxam, P. Storemyr, A. Kelany, "The geology and archaeology of the ancient silicified sandstone quarries at Gebel Gulab and Gebel Tingar, Aswan", *Marmora: International Journal for Archaeology, History and Archaeometry of Marbles and Stones* **1**, 11–35, 2005.
6. See pp. 24–26 in E. G. Bloxam & P. Storemyr, "Old Kingdom basalt quarrying activities at Widan el-Faras, northern Faiyum Desert", *Journal of Egyptian Archaeology* **88**, 23–36, 2002.
7. See pp. 23–25, 32–33 in Heldal et al., 2005 (*n.* 5 above); and E. G. Bloxam & P. Storemyr "The quarries of Gebel Gulab and Gebel Tingar, Aswan", *Egyptian Archaeology* **26**, 37–40, 2005.
8. See Bloxam & Storemyr 2002 (*n.* 6 above).
9. See p. 193 in A. Shafei, "Lake Moeris and Lahûn Mi-Wer & Ro-Hûn: the great Nile control project executed by the Ancient Egyptians", *Société de Géographie d'Égypte, Bulletin* **33**, 187–217, 1960; and p. 220 in F. Wendorf & R. Schild, "Archaeology and Pleistocene Stratigraphy of the northern Fayum Depression", in *Prehistory of the Nile Valley*, F. Wendorf & R. Schild (eds), 155–226 (New York: Academic Press, 1976).
10. See J. Stanley, M. D. Krom, R. A. Cliff, J. C. Woodward "Short contribution: Nile flow failure at the end of the Old Kingdom, Egypt: strontium isotopic and petrologic evidence", *Geoarchaeology: an International Journal* **18**(3), 395–402, 2003; K. W. Butzer, "Long-term Nile flood variation and political discontinuities in Pharaonic Egypt", in *From hunters to farmers*, J. D. Clark & S. A. Brandt (eds), 102–112 (Berkeley: University of California Press, 1984); and F. A. Hassan "Nile floods and political disorder in early Egypt", in *Third millennium BC climate change and Old World collapse*, H. Nuzhet Dalfes, G. Kukla, H. Weiss (eds), 1–23 (Berlin: Springer, 1997).
11. Calcrete, sometimes termed "duricrust", is the case-hardened crust of soil formed in semi-arid climates by the cementation of gravel and other residual deposits by calcium carbonate.
12. For more information on excavations of the loading ramps at Chephren's quarry and discussion about the vehicle used to transport statue blocks to the Nile, see E. G. Bloxam, "Transportation of quarried hard stone from Lower Nubia to Giza during the Egyptian Old Kingdom", in *Current research in Egyptology 2000*, A. McDonald & C. Riggs (eds), 19–27 (Oxford: Archaeopress, BAR International Series 909, 2000); also see I. M. E. Shaw & E. G. Bloxam "Survey and excavation at the ancient pharaonic gneiss-quarrying site of Gebel el-Asr, Lower Nubia", *Sudan and Nubia* **3**, 13–20, 1999.
13. See Bloxam & Storemyr (2002; *n.* 6 above).
14. E. G. Bloxam, P. Storemyr, T. Heldal, "Hard-stone quarrying in the Egyptian Old Kingdom (3rd millennium): rethinking the social organisation", in *ASMOSIA VII: Proceedings of the Seventh International Conference on Interdisciplinary Studies on Ancient Stone*, Thassos, Greece, 15–20 September 2003, Y. Maniatis (ed.), in press.
15. See p. 73 in C. V. Haynes, "Holocene migration rates of the Sudano–Sahelian wetting front, Arba'in Desert, eastern Sahara", in *Prehistory of arid North Africa*, A. E. Close (ed.), 69–84 (Dallas: Southern Methodist University Press, 1987); also p. 327 in W. P. McHugh, G. G. Schaber, C. S. Breed, J. F. McCauley "Neolithic adaptation and the Holocene functioning of Tertiary palaeodrainages in southern Egypt and northern Sudan", *Antiquity* **63**, 320–36, 1989; also p. 936 in H. J. Pachur & P. Hoelzmann, "Late Quaternary palaeoecology and palaeoclimates of the eastern Sahara", *Journal of African Earth Sciences* **30**(4), 929–39, 2000.
16. See Couyat & Montet (1912) and Goyon (1957) in *n.* 3 above.
17. See E. M. Abrams, "Economic specialization and construction personnel in Classic Period Copan, Honduras", *American Antiquity* **53**(3), 485–99, 1987; M. W. Spence, "The social context of production and exchange", in *Contexts for prehistoric exchange*, J. E. Ericson & T. K. Earle (eds), 173–97 (London: Academic Press, 1982); and M. W. Spence, J. Kimverlin, G. Harbottle, "State-controlled procurement and the obsidian workshops of Teotihuacan, Mexico", in *Prehistoric quarries and lithic production*, J. E. Ericson & B. A. Purdy (eds), 97–105 (Cambridge: Cambridge University Press, 1984).
18. The QuarryScapes project was designed by Elizabeth Bloxam, Tom Heldal and Per Storemyr, and further information about it can be obtained from the website: www.Quarryscapes.no.