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THE GEOLOGY AND ARCHAEOLOGY OF THE ANCIENT SILICIFIED SANDSTONE QUARRIES AT GEBEL GULAB AND GEBEL TINGAR, ASWAN (EGYPT)

Abstract

The ancient silicified sandstone quarries of Gebel Gulab and Gebel Tingar, covering an area of 12 km² on the west bank of the Nile at Aswan, were one of the major sources of this type of stone. A systematic geological and archaeological survey of the quarries concluded that the quarries were mainly exploited for utilitarian objects during the Pharaonic Period (New Kingdom) and to a lesser extent for elite status objects such as obelisks, statues and stelae. Previously undocumented obelisk extraction sites were recorded, as well as occurrences of hieroglyphs and rock art dating from the Predynastic Period. An examination of the extraction sites indicates an overwhelming use of fire-setting to extract the stone during the Pharaonic Period and to a lesser extent the wedging technique applicable to the Roman exploitation. The networks of quarry roads, mainly Pharaonic in age, indicate highly organised means to transport large objects from the quarries to the Nile. Small clusters of temporary shelters and minimal ceramic data imply that the labour force was relatively small and not permanently resident in the quarries.

keywords: Aswan, Egypt, New Kingdom, Roman Period, silicified sandstone, ancient quarries, fire setting, obelisk

1. Introduction: description of site and background

Production and consumption of silicified sandstone in antiquity spans several millennia between the 3rd millennium BC and 4th century AD. The ancient quarries of Gebel Gulab and Gebel Tingar, covering an area of 12 km² on the west bank of the Nile at Aswan, are known to be one of the major sources of the stone (Fig. 1). The quarry site was briefly studied by Klemm and Klemm 1993 and their generalised mapping identified that ancient quarrying occurred at several sub sites at and between the main stone extraction areas of Gebel Gulab and Gebel Tingar. It is important, however, to contextualise these west bank quarries within the greater Aswan region which in its totality constitutes a prodigious ancient industrial landscape. This industrial landscape includes the east bank red granite quarries and the recently surveyed (June 2004) silicified sandstone quarries, also on the east bank at Wadi Abu Aggag (Harrell forthcoming).

Gebel Gulab and Gebel Tingar constitute numerous ancient quarries in silicified Nubian sandstone (often termed quartzite), exploited from the Old King-

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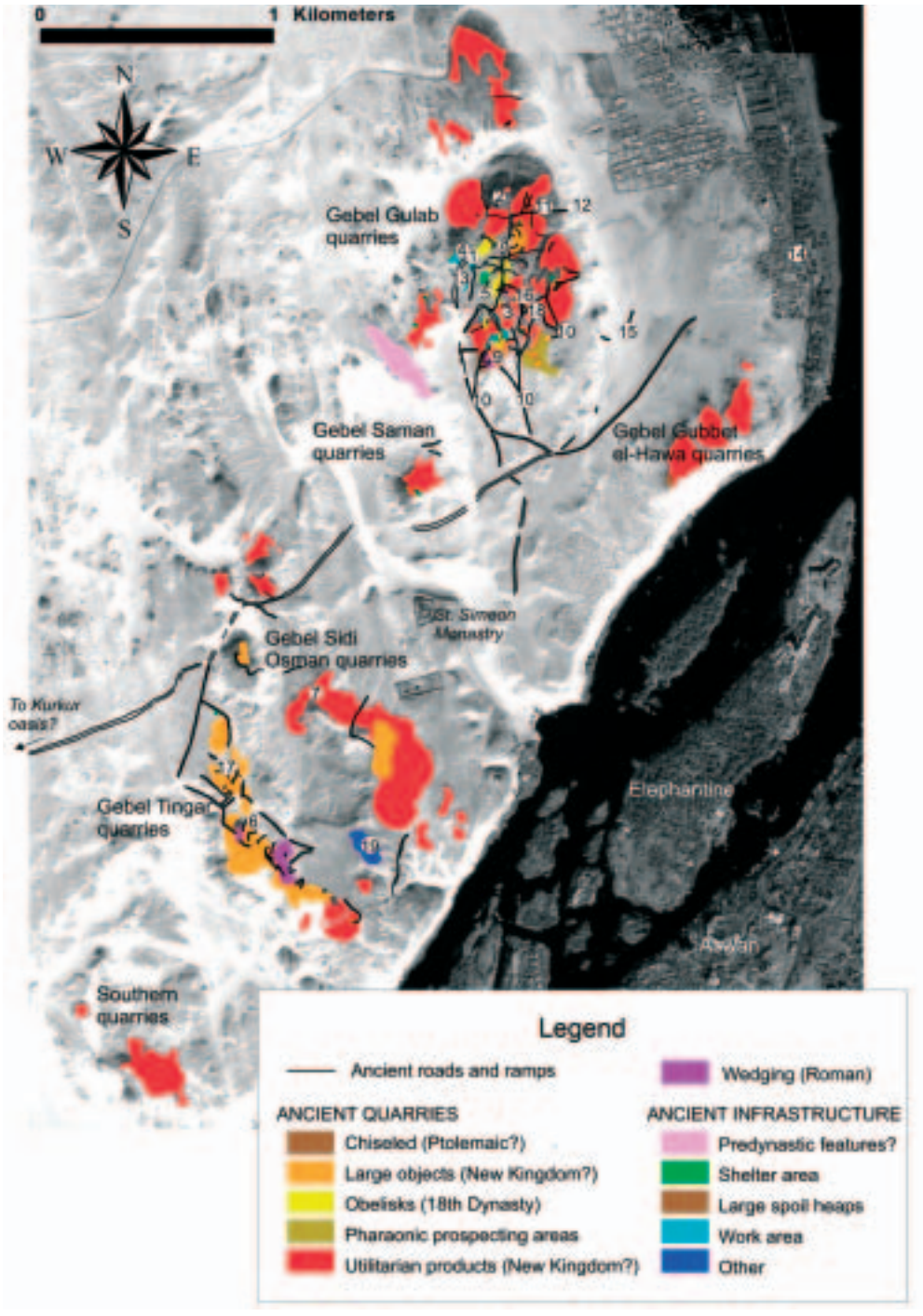

FIG. 1. Map of the Gebel Gulab quarry site with numbered references (see text).

dom, but predominantly between the New Kingdom and Roman Periods. In addition to the ancient quarries, there are roads, ramps and many other infrastructural features related to the ancient quarrying. The site also contains some Greek rock inscriptions and several newly discovered petroglyphs. To date the quarry site remains well preserved; however, it is now threatened by modern quarrying, building and urban expansion that is occurring at its southern and north-eastern borders.

This paper presents a description and preliminary interpretation of the extraction sites, archaeological infrastructure and epigraphic evidence surveyed at Gebel Gulab and Gebel Tingar by a joint Britsh-Norwegian-Egyptian team of geologists and archaeologists in March 2004. The survey was conducted under the auspices of the Supreme Council of Antiquities (SCA), the concession area (see Figure 1), which constitutes both Gebel Gulab and Gebel Tingar, is now regarded as one continuous archaeological site that still remains unregistered as a cultural heritage site.

The field mapping was carried out on IKONOS satellite image (2001) and supplementary on declassified US satellite images (1965), aided by GPS registrations. The maps were compiled in ArcView. Pottery was examined on site (EL-SENUSSI 2004), and other archaeological registrations/interpretations are based on investigations of superficial features only.

2. Uses of Silicified Sandstone ('Quartzite') in Antiquity

The use of *highly crafted* silicified sandstone objects from the Old Kingdom to Roman Period was almost exclusively by royalty and the elite. However, more utilitarian use of silicified sandstone, particularly as abrasive rubbers, grinding stones and borers to hollow stone vessels, is known in the archaeological record since the Neolithic (STOCKS 2003, 11-12). The first known use of silicified sandstone by royalty is in life-size statuary of 4th Dynasty Djedefre, which has been connected with the emergence of the title 'Son of Ra' during his reign, and continues into the 6th Dynasty (ASTON *et alii* 2000, 53-54; QUIRKE 2001, 122, 127). The stone did have a limited use in monumental architecture, particularly during the 5th and 6th Dynasties in the pyramid complex of Userkaf, e.g., as a false door, and as columns in Sahure's mortuary temple (ASTON, *op. cit.*; VERNER 2002, 370).

During the Middle Kingdom the stone was also used for stelae, statuary and in monumental architecture, such as wall linings and lintels (ASTON, *op. cit.*). New Kingdom use covered a wider range of objects such as pylons, obelisks, stelae, sarcophagi, small and large statues, including the Colossi of Memnon (STROSS *et alii* 1988, ASTON *et alii* 2000) (FIG. 2). Roman Period use, although much more limited, was also for statues, such as a large standing statue dating to the Roman Period in the Egyptian Museum in Cairo.

Silicified sandstone quarries are also known at Gebel Ahmar (now almost completely destroyed) close to Cairo (KLEMM and KLEMM 1993), and discussion still surrounds the question as to whether the most famous silicified sandstone objects, the Colossi of Memnon in Luxor, were extracted either from here or from Gebel Gulab/Gebel Tingar (KLEMM *et alii* 1984, STROSS *et alii* 1988, KLEMM and KLEMM 1993). This preliminary survey did not attempt to provenance such objects; however, it is clear that future research should include targeted petrographical and geochemical analyses.

3. The Geology of the Sandstones

The Cretaceous Nubian Sandstone Group dominates the bedrock geology of the

FIG. 2. The Colossus of Memnon (Luxor).

west bank of Aswan, covering the Precambrian granitic rocks, which are more exposed on the east bank. The sandstones of the west bank can be divided into two main sequences: a lower one, composed of sandstone beds intercalated by silt- and claystone, and an upper sequence, predominantly consisting of crossbedded arkosic sandstone and grit (FIG. 3). The upper levels are partly silicified, especially in the areas along the Nile River. The silification is caused by crystallization and cementation of silica (quartz) in the pores of the sandstone, due to infiltration of fluids from some yet unknown source (see also discussion in KLEMM and KLEMM 1993). The silification process made the sandstone much harder and more durable than the 'original' arkosic sandstone, and it is in technical properties comparable with metamorphic quartzites.

Being significantly harder and more resistant to weathering than ordinary sandstones, the silicified sandstone forms a resistant layer covering the upper part of the stratigraphy, *i.e.*, the hilltops in the area. Blocks and boulders from this layer are also found on the more low-lying terrain surface, having survived the weathering and erosion of the sandstones beneath. Thus, many of the silicified sandstone quarries are found as loose boulders, similar to boulder-quarry terrains typically found in igneous rocks in the region, such as the Aswan granite and the Chephren gneiss (Storemyr *et alii* 2002).

The silicified sandstone has generally a more crystalline, shiny appearance than the 'dull' arkoses, and displays a much more attractive range of colours, from purple red, via yellow to pure white (FIG.

4). Obviously, the aesthetic appearance of the stone has been of great importance for the selection of quarry sites, especially for prestige objects such as statues and obelisks. Thus, obelisk quarries are concentrated at Gebel Gulab, where the highest concentration of yellowish sandstone is found, and Gebel Tingar, which contains the most homogenous purple varieties, seems to have been a prime target for the quarrying of statues both during the pharaonic and Roman periods. However, in terms of volume of stone extracted, the most significant part of the ancient quarrying concerned exploitation for utilitarian and smaller objects, for which the physical properties (hardness) of the silicified sandstone, rather than visual appearance, seems to have been the prime concern, as discussed below.

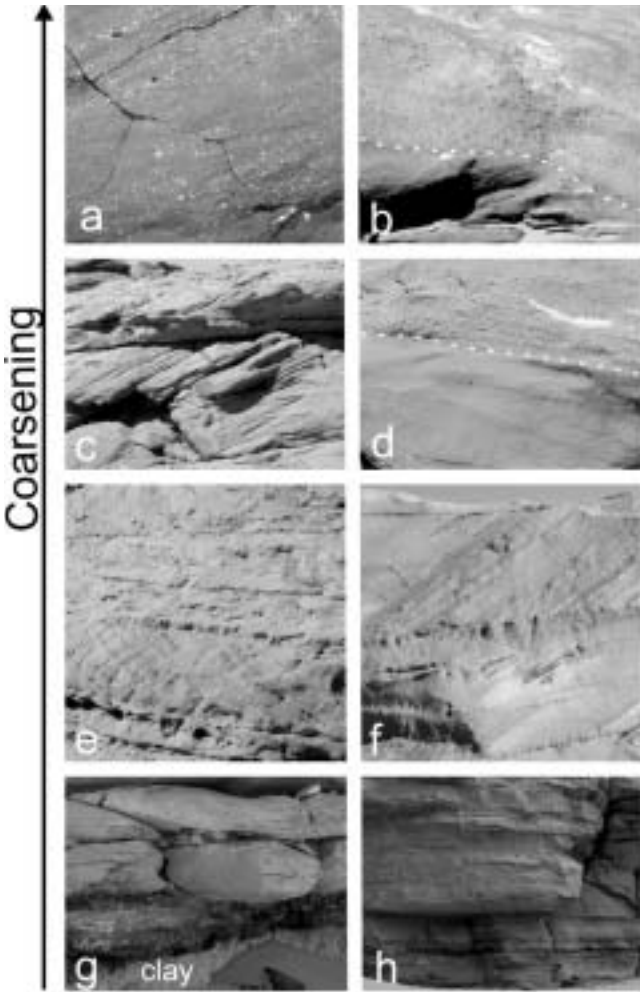

FIG. 3. Sandstone *facies* and variations from Nile level (lower photos) to top of the gebels (upper photos). a) grit/conglomerate; b + d) grit channel cutting cross-bedded sandstone; c + e + f) cross-bedded sandstone; g + h) horizontally bedded sandstone with clay-beds (see g).

4. THE QUARRIES AND EXTRACTION METHODS

The area as a whole is complex, in the sense that we are looking at a site with several periods of Pharaonic quarrying exploiting the stone for different purposes, overprinted by later (predominantly Roman) quarrying. During the survey, much effort was put into trying to characterise the quarries based on extraction techniques, tools and tool marks, waste rock characteristics and infrastructure around the extraction sites. Since the silicified sandstone is considerably harder than un-silicified varieties of the same, the extraction methods are quite similar to what is described from the Aswan granite quarries, such as the use of stone pounders in the Pharaonic period and wedge splitting in the Roman period (RÖDER 1965, KLEMM and KLEMM 1993, ASTON *et alii* 2000). Of great significance is the overwhelming evidence of fire setting in

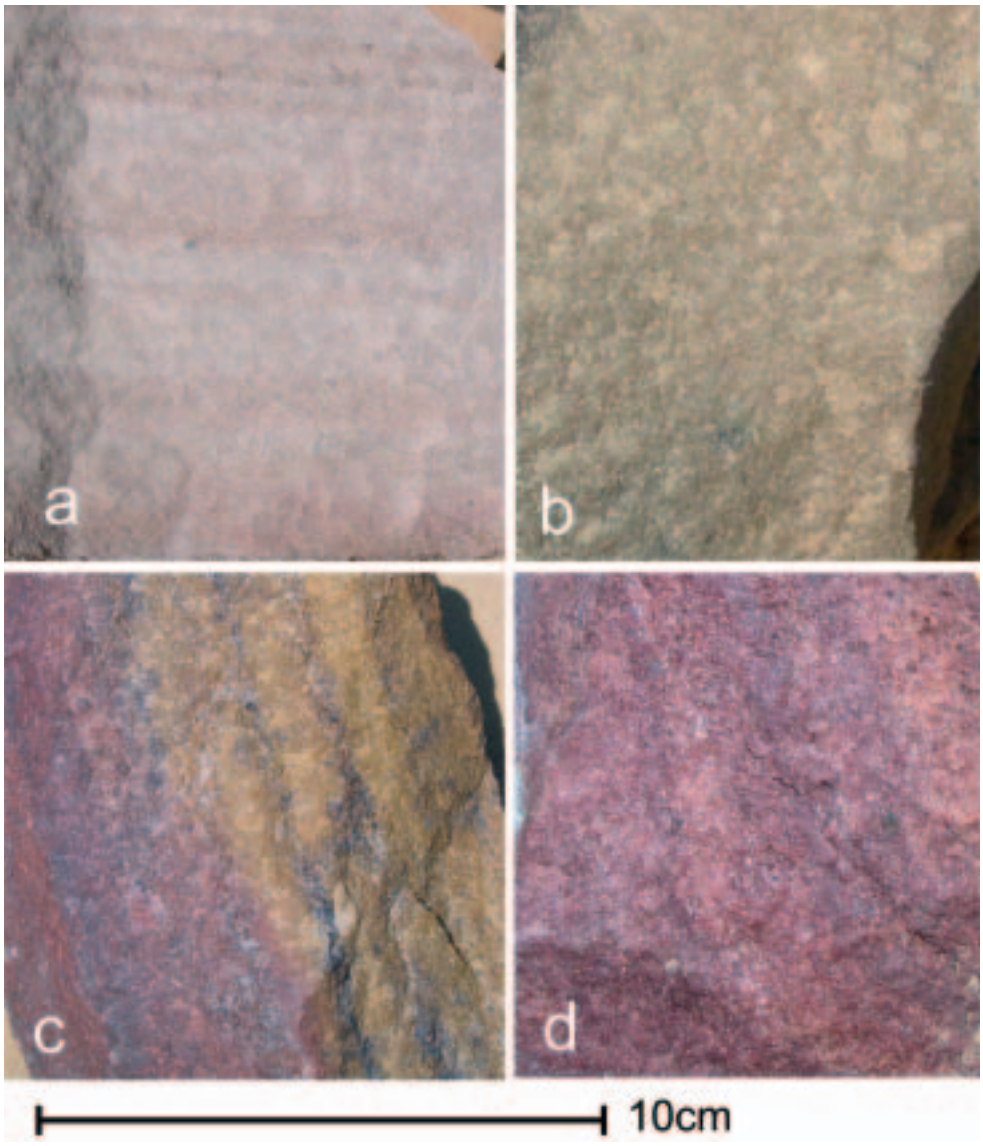

FIG. 4. Four characteristic types of silicified sandstone. a) white (Gebel Sidi Osman); b) yellow (Gebel Gulab); c) purple and orange (Gebel Sidi Osman); d) purple (Gebel Tingar).

the Pharaonic period, displayed by charcoal layers in the spoil heaps and broken quarry faces.

The quarrying has predominantly taken place on the hilltops and hillsides (FIG. 5), of which Gebel Gulab and Gebel Tingar compose the most prominent quarry areas (FIG. 6). In between these two sites, there are a number of small hills/quarries, such as the Gebel Saman hill and a group of hills collectively named Gebel Sidi Osman. Close to the Nile, quarrying has also taken place at Gebel Gubbet el-Hawa and there are also quite extensive quarry areas north of Gebel Gulab and south of Gebel Tingar. However, the quarries at Gebel

FIG. 5. Two different types of quarrying. Upper photo: Exploitation of bedrock-details to the right (Gebel Sidi Osman west); Lower photo: extraction of loose boulders, leaving a crater-like depression. Satellite image to the right.

Gulab and Gebel Tingar are so far the most interesting, displaying many phases of quarrying and the most attractive stone types. In particular, the Gebel Gulab quarries are of great value from a research perspective, being more or less undisturbed (although imminently threatened) by modern quarrying or development.

Due to the ransacking of Coptic Period burials in recent times (see below under heading *Burials*) the quarries at Gebel Tingar are generally more disturbed than those at Gebel Gulab (see Figure 1, map ref. 6). Determining a chronology of the quarries is therefore extremely difficult, as pottery, mainly dating between the Ptolemaic and Late Roman Period, now lies in disturbed contexts (EL-SENUSSI 2004). Although Late Period quarrying is clearly evident, perhaps more so than at Gebel Gulab, there was also a Pharaonic presence here, particularly between Gebel Tingar and the St. Simeon monastry, given the evidence of fire-setting and roads leading into these quarries. Hieroglyphic symbols are also present in some of the quarries (see more details under heading *Epigraphic Evidence*) and although very limited, sherds of a New Kingdom amphorae and a beer jar (EL-SENUSSI 2004). The purple silicified sandstone seems to have been most sought after at Gebel Tingar and objects, such as small statuettes, are known in museum collections dating to the Amarna Period (18th Dynasty) and into the Roman Period. The 'blank' of a standing statue was found in one of the nearby quarries

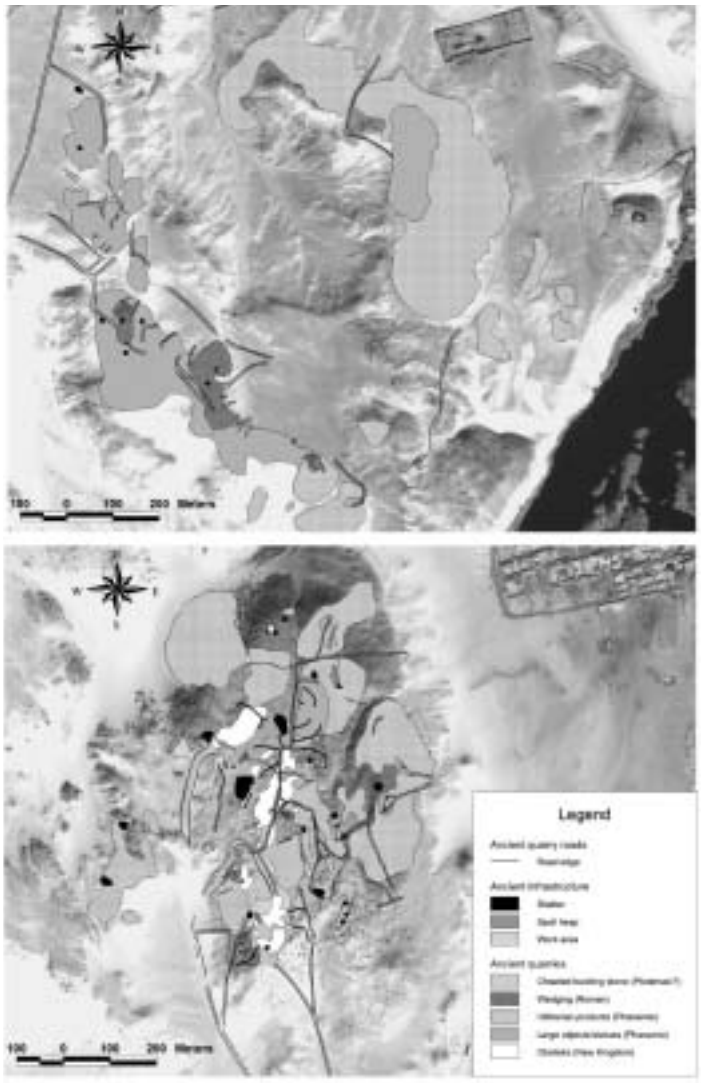

FIG. 6. Detailed maps of the Gebel Tingar area (upper) and the Gebel Gulab area (lower).

at Gebel Sidi Osman (see Figure 1, map ref. 7).

Based on the quarry characterisation, it is possible to differentiate between at least six groups of quarries.

4. 1. *Obelisk quarries*

Obelisk quarrying (only found on the western side of Gebel Gulab) is perhaps the most well known at the site, due to the presence of the inscribed (dating to Seti I) upper shaft of an obelisk block (FIG. 7a and b). This group of quarries is typically exploiting the massive outcrops of yellowish, rather weakly silicified sandstone, moving into the bedrock. There is ample evidence that fire-setting has been applied for the primary clearing of outcrops and faces, whilst stone pounders (predominantly granite and dolerite from the east bank of Aswan, but also very hard silicified sandstone from the site itself) have been used for leveling and channeling. Large ramps and causeways are associated with these quarries, most significant being the one in front of the Seti I obelisk. The upper shaft of the obelisk bears inscriptions on three sides dating to the reign of Seti I (19th Dynasty) with depictions of the king kneeling before manifestations of the Heliopolitan sun gods (HABACHI 1960, 227-230; BRAND 1997, 103). Pottery in this area of the quarry was very limited, however, sherds of Cananite amphorae dating to the mid-late 18th Dynasty were identified (EL-SENUSSI 2004). The height of the finished obelisk would have been approximately

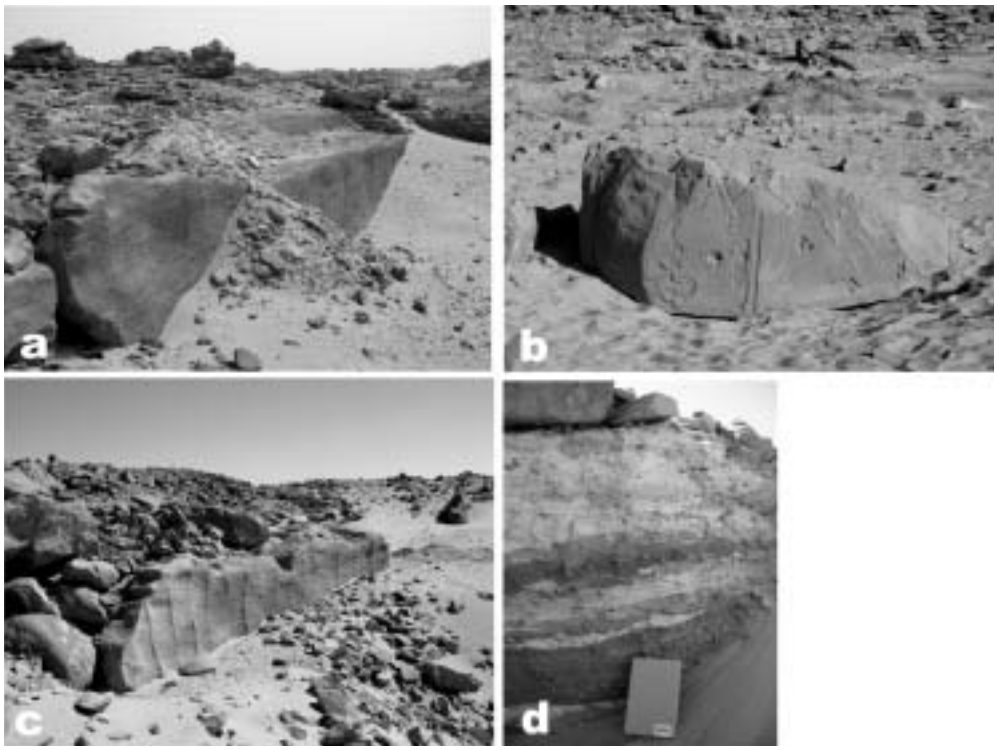

FIG. 7. Obelisk quarries at Gebel Gulab. a) Seti I quarry face, showing stone hammered surface; b) Seti I obelisk shaft; c) quarry face at southern Gebel Gulab displaying stone hammered surface and vertical shifts (possibly separating different workmen); d) stratified fine sand (spoil) from grinding and honing of sandstone, southern Gebel Gulab (A5 notebook for scale).

12 m, and was one of a pair, the second probably being underway when this one broke (BRAND 1997, 104). However, it remains unclear whether extraction of a second obelisk was actually from this quarry due to the discovery of five other clear obelisk extraction sites at Gebel Gulab, as well as numerous sites at which obelisk extraction might have taken place or at least have been planned.

At one of these other obelisk quarries (southern part of Gebel Gulab) there are indices of the extraction and removal of at least one large obelisk (FIG. 7c). Adjacent to the quarry, there are thick deposits of fine sand intermixed with pieces of waste rock (FIG. 7d), these being sand deposits from grinding and honing of sandstone. Considering the evidence that suggests the obelisks were almost finished in the quarries (e.g., the inscribed Seti I shaft), this suggests that at least one obelisk was finished in this southern quarry.

The most impressive of the newly discovered obelisk extraction sites is located approximately 500 m to the north of the Seti I obelisk quarry (FIG. 8) (see Figure 1, map ref. 2). The site is marked by two standing 'stela-shaped' rocks placed in close proximity, probably to demarcate the site to the quarrymen. The site is characterised by the familiar tool marks made from pounders and 'chocolate block' patterning on its surface, as seen in the granite quarries on the east bank at Aswan. The dimensions of the extraction

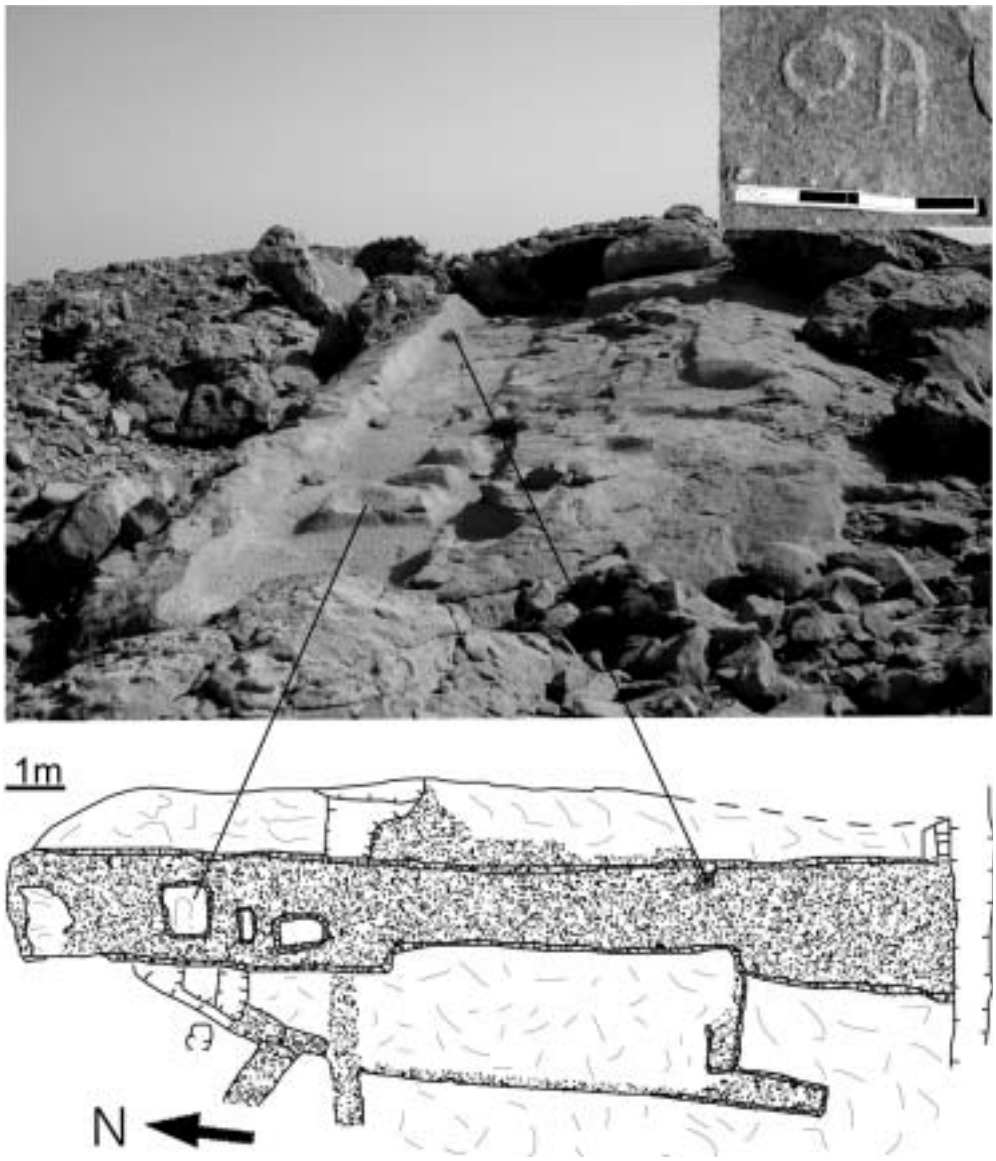

FIG. 8. Unfinished obelisk quarry at northern tip of Gebel Gulab. Upper right corner: inscription *mr - Ra*, translated as «beloved of Ra», found on outcrops around the quarry, possibly marking outcrops where extraction of obelisk sized blocks are possible (scale interval 5 cm).

site indicate that the obelisk would have been to a maximum height of 15 m and with a width at its base of approximately 2 m. However, the site was abandoned well before completion of the obelisk. Pottery scatters found in an ephemeral shelter close to the extraction site are of New Kingdom date (mid to late 18th Dynasty), however, Roman Period sherds were also found in the vicinity (EL-SENUSSI 2004).

There are several other extraction sites in the area, indicating attempts to extract

obelisks and/or prospecting activities (clearing of outcrops, test channels). However, it seems clear that none of the many small quarries actually produced any obelisks, with the exception of the Seti I site and the southern quarry.

4. 2. *Statue (large object) quarries*

A group of quarries were designated for extracting large objects, probably statues, from large, loose free-standing blocks and/or from the bedrock (Fig. 9). Signs of fire setting (ash/charcoal layers and cracked quarry faces) are frequently seen and in some instances pounded surfaces with scatters of pounders. Ramps and roads are also associated with these quarries. In several quarries, partially worked large blocks, some intended for seated statues, are found (see Figure 1, map ref. 5). Pottery scatters in the vicinity date these block quarries to the New Kingdom (mid-late 18th Dynasty) (el-Senussi 2004). Also other aspects indicate a close relationship in age with the obelisk quarrying; the extraction methods are identical, and the roads and ramps are of the same construction (see below).

4. 3. *Quarrying of utilitarian products*

The third group of quarries is by far the most widespread (see Figure 1), covering the major part of the ancient extraction area. Fire-setting has been im-

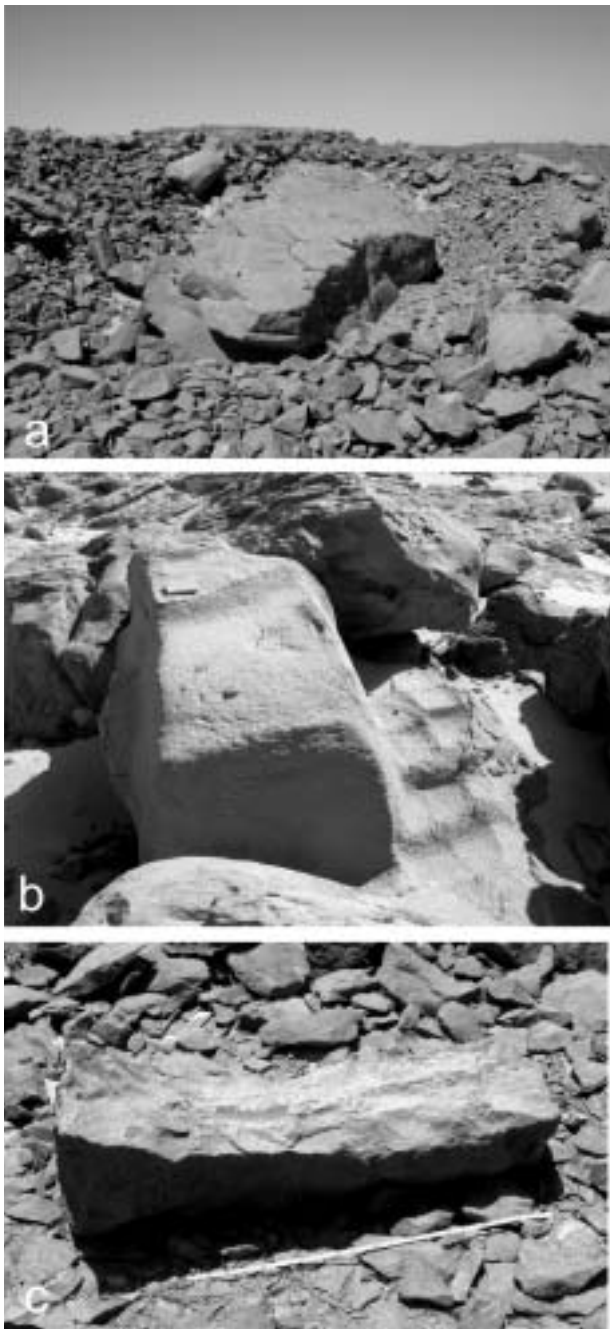

Fig. 9. Large objects/statue quarrying. a) huge sandstone block cleared for extraction; b) stone hammered cubic block, Gebel Gulab (A5 notebook for scale); c) stone hammered statue blank, Gebel Sidi Osman (feet of the statue to the left; scale 1 m).

portant for cracking blocks and flaking off smaller pieces of stone from quarry faces (Fig. 10a and b). Small amounts of pounders are also found in such quarries which seem to have been used for making crudely shaped blanks for smaller objects (see below) by spalling off small chips, similar to the method of making vessel blanks in the Chephren's Quarry (Heldal *et alii* forthcoming). Thus, this type of quarrying seems to have focused on reducing the block size instead of searching the largest and most massive pieces, as observed in the first two groups. This is further supported by the spoil heaps (which only contain small pieces of stone), the presence of many small work areas within the quarries, numerous blanks and almost complete lack of any roads or ramps for transportation of large blocks.

The blanks are generally oval in shape with a slightly concave pounded surface on their upper side, the lower side is 'humped' with signs of only rough working (Fig. 10b and c). The size of these objects ranges from 15 to 45 cm in length and between 10-25 cm in width. Identification of these objects as either grinding stones or querns, as found in significant quantities in the New Kingdom levels of Kom Rabi'a (Memphis) (Giddy 1999, 200-207), is a possibility. Their large numbers indicate a sizeable 'industry' for such objects that was occurring along side the elite stone production.

4. 4. *Stelae*

Quarrying for medium-sized stelae, in sizes ranging in length between 1 m and 1.2 m and with widths between 0.50 m and 0.7 m were observed at Gebel Gulab, especially in the northern part. These stele 'blanks' are characterised not only by their shape, comprising a rounded/oval top and square base, but by pounding marks on their surface (Fig. 11). These objects were not only a significant output from the quarries, but also as a possible by-product from quarrying for obelisks and other items. Re-working of abandoned obelisks into stelea can be suggested from two significant areas of stelae blanks located close to the unfinished Seti I obelisk extraction site (see Figure 1, map ref. 4). The proximity of these work areas to the inscribed obelisk block suggests that the quarrymen might have re-used the stone from the already abandoned obelisk. This situation might explain why only the inscribed block remains and further suggests a date post the reign of Seti I. There was no pottery in this vicinity, probably due to the collection of it by recent unsupervised visitors coming to view the obelisk block. Therefore, we have been unable to determine a more accurate date for these *stelae* work areas or indeed the Seti I obelisk extraction area itself.

4. 5. *Roman quarries*

While the four groups of quarries described above are all interpreted as Pharaonic (from the Old Kingdom to the Late Period), due to the use of stone pounders, the fourth group introduces wedges put in shallow channels made by heavy picks and/or chisels (Fig. 12), and is typical of Roman granite quarrying in Aswan (Röder 1965, Klemm and Klemm 1993) and elsewhere (especially in the Eastern Desert (Peacock and Maxfield 1997, Maxfield and Peacock 2001).

In the southern quarries of Gebel Gulab (see Figure 1, map ref. 9) there are scattered traces of Roman quarrying (Fig. 6, lower), particularly by reshaping older blocks from the Pharaonic quarrying intended for large statues. In addition, there are two small Roman quarries extracting solid bedrock, and containing remaining Roman infrastructure such as roads and shelters. Scatters of mainly of Roman

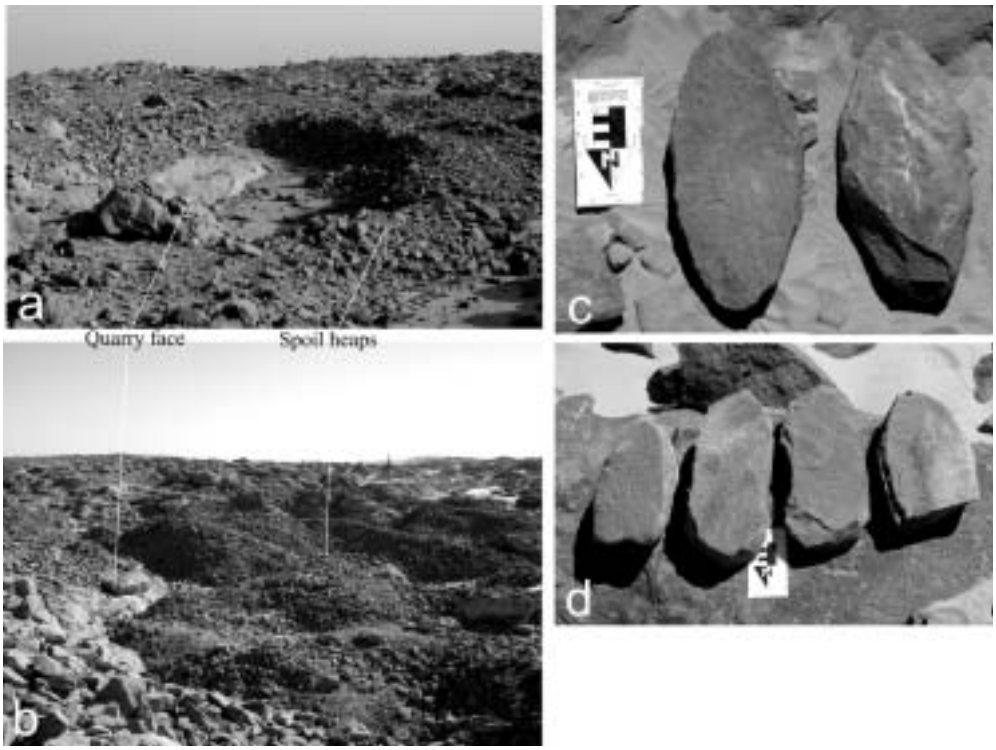

Fig. 10. Small object (predominantly utilitarian products) quarries. a + b) typical quarries with rough quarry faces; c + d) half-finished products (blanks; north arrow 10 cm for scale).

amphorae lie in these quarries (el-Senussi 2004), suggesting a Roman Period 'overprint' to these previously Pharaonic quarries. The largest Roman quarries are found in the Gebel Tingar area (Fig. 6, upper), exploiting the valuable purple variety of the silicified sandstone. Shelters, work areas, roads and even a smithy are found at these quarries. However, it should be noted that the Roman presence in the area is very limited as compared to Pharaonic working.

4. 6. *Building stone quarries*

A sixth group of quarries is somewhat atypical, being situated only in softer, less silicified varieties of the sandstone. The quarries display chiseled channels around blocks to be extracted (Fig. 13), similar features to what is described as Ptolemaic quarrying in Aswan and Gebel el Silsila (Klemm and Klemm 1993). Just below the largest of these sites, on the southern part of Gebel Gubbet el-Hawa, is located a column-capital (Fig. 13). There are also indications of several building stone quarries close to the monastery, although heavily covered with gravel and sand. However it is difficult to recognise such quarries from the many burials in the area carved into the sandstone. The area around the monastery is yet to be systematically surveyed.

5. The archaeological infrastructure at Gebel Gulab and Gebel Tingar

5. 1. *The Quarry Roads*

The most conspicuous infrastructure that

FIG. 11. Stelae blanks found at Gebel Gulab, worked with stone hammers.

remains well preserved at both Gebel Gulab and Gebel Tingar are the networks of quarry roads. Gebel Gulab has the most well-preserved roads and as the map (FIG. 6b) shows, arterial roads clearly lead from the numerous quarries, predominantly from where the larger blocks and obelisks were quarried, onto a more major road artery that traverses the centre of the gebel. The main road artery then changes character into more ramp-like structures that descend the eastern and southern sides of the gebels (see Figure 1, map ref. 10). The roads range in width range from 2.8 m to 3.5 m and are generally constructed by the laying a single level of flat stones directly onto the ground surface, securely butted into each other, hence explaining their remarkable preservation (FIG. 14). In some instances, more rounded cobbled stones are used and the ramps which traverse the eastern side of Gebel Gulab (see Figure 1, map ref. 11) are constructed from several layers of stones to overcome the topographical irregularities of the steep incline down to the desert plateau (see Figure 1, map ref. 12).

The causeway that leads from the main obelisk extraction site is a substantial structure (FIG. 14c), principally constructed to traverse a wadi, similar to the causeways constructed at intervals along the Hatnub quarry road (SHAW 1986 and 1987, 160) (see Figure 1, map ref. 13). Considerable labour and expertise was put into its construction, as amply demonstrated by its good preservation. At its widest the causeway is almost 20 m across with a depth of at least 3 m, then narrows to just 4.3 m, where it converges into a paved quarry road that heads in the direction of the Nile. This causeway was clearly constructed to facilitate the transport of obelisks from Gebel Gulab during the New Kingdom.

Dating roads to either the New Kingdom or Roman Period is difficult, as the ceramic evidence located on or beside these features is representative of both periods (EL-SENUSSI 2004). However, the overwhelming majority of roads do lead to large-block quarries in which there is no evidence of Roman extraction. This suggests that the roads are predominantly of Pharaonic age, although it has to be considered that during the Roman Period exploitation some of the New Kingdom roads were repaired (if necessary) and re-used (FIG. 14e). For example, the New Kingdom causeway from the obelisk quarry connects with a main road which is bordered, at regular intervals, with stone cairns which is highly characteristic of Roman Period quarry roads (PEACOCK and MAXFIELD 1997, MAXFIELD and PEACOCK 2001). Determining the chronology

of the road system is a future research aim that will involve producing a road typology from comparative quarry roads in datable contexts.

A substantial road, in the form of a 10 m wide cleared track, runs in the wadi to the West and South of Gebel Gulab and continues towards the southwest (see Figure 1). This road cuts the Pharaonic quarry roads and seems to be related to some of the Roman roads. Along it, shelters and lookouts containing Roman pottery sherds were found (EL-SENUSSI 2004). A minor part of the road has clearly been used for transporting stone during the Roman Period quarrying, but the road can be followed quite far to the southwest of the quarry areas.It is assumed that the road's primary use was as a major transport route – perhaps to the Kurkur Oasis in the Western Desert and used since the Old Kingdom (WEIGALL 1910, 438; JARITZ 1981). Harkhuf's well documented journeys into Nubia during the 6th Dynasty of the Old Kingdom are believed to have started at Gebel Tingar and such a road is referred to in his autobiography as the «Elephantine Road» (WEIGALL, *op. cit.*).

Beneath the eastern slope of Gebel Gulab, small fragments of a paved road are also found (FIG. 1, map ref. 15). These road fragments can be followed around the southern side of Gebel Gulab, linking with the assumed Pharaonic roads leading towards the top of the hill (FIG. 14a). This would indicate that the Pharasonic transport route to the Nile followed a more western path than interpreted by KLEMM and KLEMM 1993.

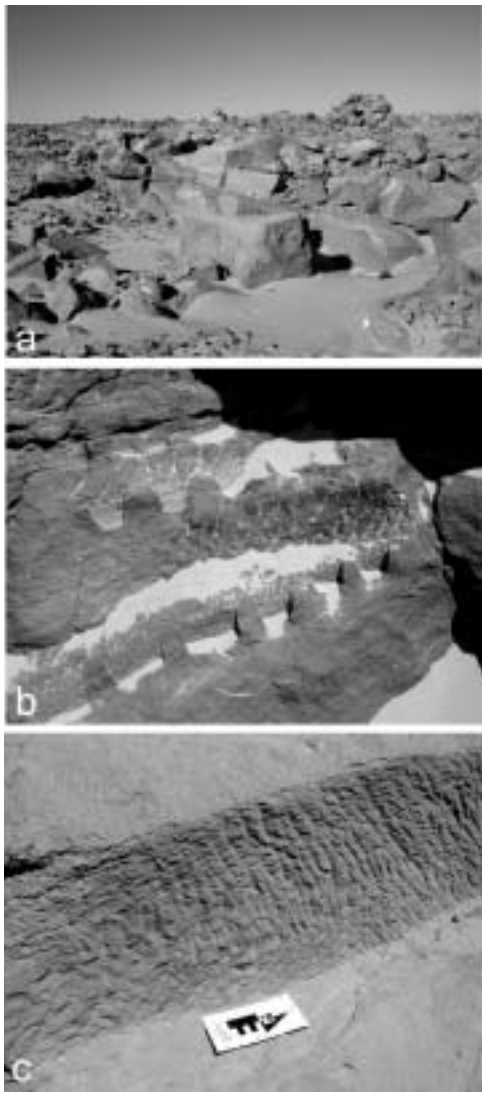

FIG. 12. Quarry in which wedging has been the primary method of extraction (assumed Roman Period). a) overview of stepped bedrock quarry, Gebel Gulab; b) detail of wedge-marks, Gebel Tingar; c) channel for levelling wedge-line, made by chisels and heavy picks, Gebel Gulab (north arrow 10 cm for scale).

5. 2. *Dry-stone Walled Features*

These exposed features usually comprise 1-5 courses of dry-stone walls, generally constructed in clusters of two or three around a natural rock outcrop and can be interpreted as temporary shelters for the quarrymen (FIG. 15) (see Figure 1, map ref. 8). These shelters are present in most of the quarries in a range of sizes up to 5 m in length and up to 4 m in depth, butted into the natural rock outcrop. At

Gebel Gulab pottery scatters dating both to the New Kingdom and Roman Period are present inside and outside the shelters (EL-SENUSSI 2004). Dating of these structures is therefore difficult, but it is probable that previously New Kingdom shelters were re-used in later periods. The ceramic data supports this hypothesis as there is evidence of periodic 'clearing out', whereby the later Roman pottery is found inside the shelter and the earlier New Kingdom pottery outside. At Gebel Tingar, however, the majority of sherds associated with the shelters dates from mainly the Ptolemaic Period to the 5th century AD (EL-SENUSSI 2004).

FIG. 13. Chiseled building-stone quarry in cross-bedded sandstone, Gebel Gubbet el-Hawa (assumed Ptolemaic Period). Upper left corner: capital of column found below the quarry. A5 notebook for scale.

There were several areas of shelter concentrations located over the entire concession area, most notable are those behind the New Kingdom obelisk extraction area, where up to five shelters are clustered in a small group (see Figure 1, map ref. 1), and in an area of predominantly Ptolemaic to Roman Period quarrying in the southern part of Gebel Gulab (see Figure 1, map ref. 9). In this latter site a hearth was also located, which provides, so far, the only evidence of food production occurring in the quarries. Amphorae from both the New Kingdom and Roman Period constitutes the bulk of the ceramic corpus, such vessels would have contained liquids (EL-SENUSSI 2004). The most notable absence in the ceramic corpus are cooking vessels and bread moulds and is indicative, along with the absence of substantial settlement evidence, that the labour force did not reside in the quarries. This situation is probably due to the proximity of permanent settlements at Aswan and Elephantine.

Clusters of shelters located in other parts of the concession area, yet to be studied in detail, are located to the east of Gebel Saman, in the southern part of Gebel Tingar (where there are many burials and inscriptions) and on Gebel Sidi Osman.

5. 3. *Burials*

At Gebel Tingar, and to a lesser extent at Gebel Gulab, burials are evident, although not specifically connected with periods of exploitation at the quarries. A possible Roman Period burial, located beside a quarry road at Gebel Gulab, is represented by a single stone mound 4 m in length by 2 m wide, with a 50 cm square entrance (see Figure 1, map ref. 16). The Gebel Tingar burials are, however, more numerous and located under the natural overhangs in the quarries which form cave-like entrances (see Figure 1, map ref. 17). Human bones and numerous frag-

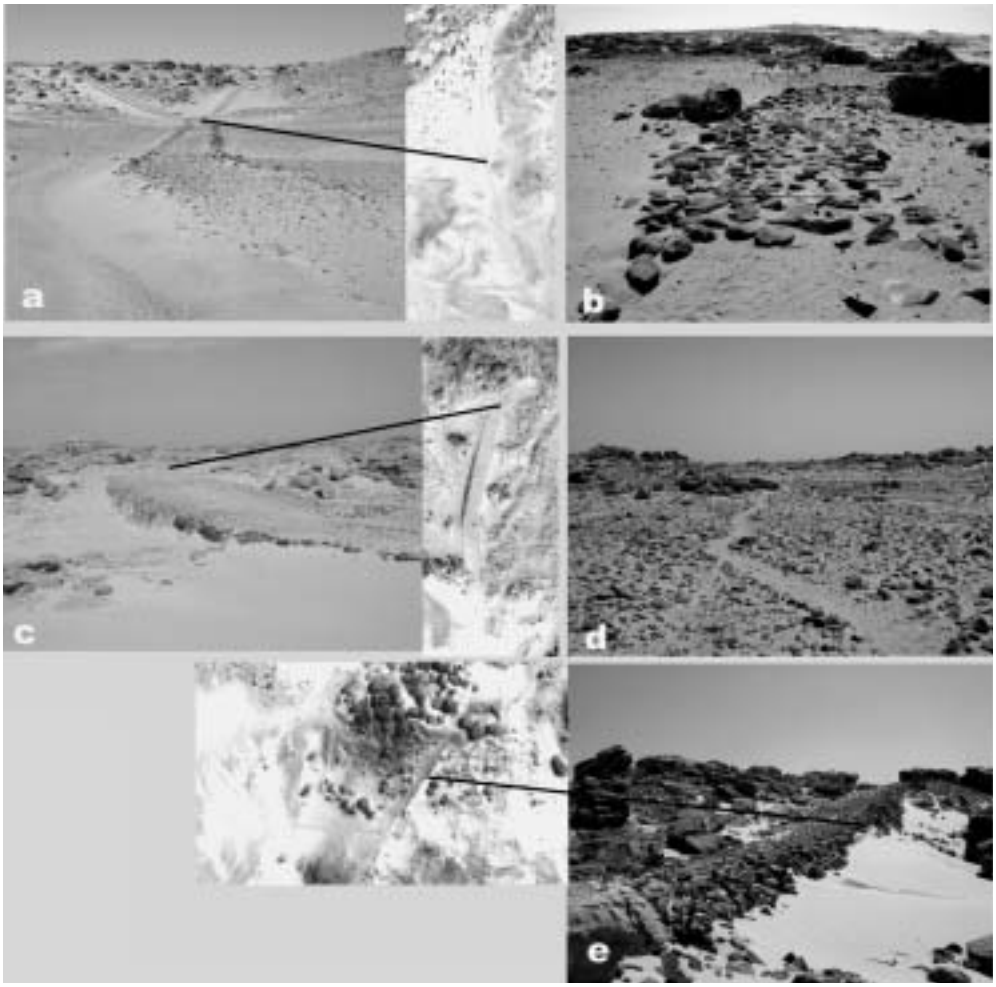

FIG. 14. Photographs of quarry roads and how they appear on satellite image. a) Y-shaped Pharaonic cleared track leading down from Gebel Gulab; b) paved Pharaonic road, Gebel Gulab; c) large ramp for transporting the Seti I obelisk, Gebel Gulab; d) donkey track, Gebel Gulab; e) ramp for transporting blocks from Gebel Tingar, assumed Roman Period.

ments of coffins lie scattered in the quarries due to their ransacking in recent times. The coffins were made from poor quality mud-brick type material which lies scattered in the quarries, some fragments having the impression of a face and arms. A sandstone coffin, found intact, was also located here. Coptic period pottery and inscribed 'crosses' in the rock above these burials suggest that they could represent a burial site connected with the nearby monastery of St. Simeon (EL-SENUSSI 2004).

5. 4. *Epigraphic Evidence*

Pharaonic period hieroglyphs at Gebel Gulab tend to be concentrated close to the two main areas of obelisk extraction (FIG. 16). The hieroglyphic symbols *mr - Ra*,

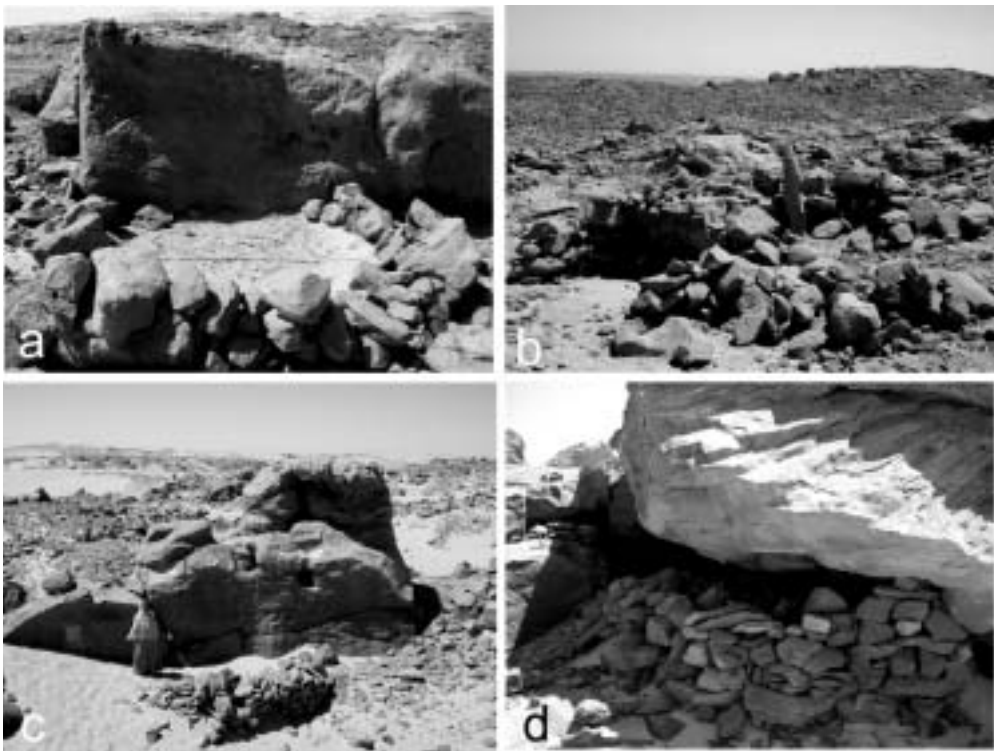

FIG. 15. Examples of shelters found in the quarries. a) Pharaonic shelter, Gebel Gulab; b) Pharaonic shelter related to the unfinished obelisk in Figure 8, Gebel Gulab. The standing stelae is probably for demarcation of the quarry; c) shelter close to Roman hearth, Gebel Gulab; d) shelter under a large stone in a Roman quarry, Gebel Tingar.

translated as «beloved of Ra» is a graffiti that occurs on many of the stones surrounding the easternmost part of the newly discovered obelisk extraction sites (FIG. 8). The occurrence of these hieroglyphs specifically in the area of an obelisk extraction could either suggest a marking of certain blocks for extraction or the name given to the obelisk and implies the connection between the stone and its symbolic association with the sun god Ra (see further discussion of this later). Other probably pharaonic depictions of birds occur in a group on the eastern approaches to Gebel Gulab (see Figure 1, map ref. 18), although due to weathering these are more difficult to interpret and date. Further depictions of birds and what appear to be ferns are also located in an overhang/natural shelter on the north-western tip of Gulab, although at this stage it is not possible to date these to any particular period.

The Greek inscriptions at Gebel Gulab, documented by MORGAN *et alii* 1894, tend to be concentrated in the mid-southern areas of the quarries (see Figure 1, map ref. 9), where Late Period/Roman quarrying is most evident. These can be interpreted as either names of individuals, stone cutters marks, or could suggest private ownership of certain parts of the quarry in this later period (DWORAKOWSKA 1983, 26-31). Greek inscriptions are well known in other quarries in this region, particularly at el-Hosh between Gebel

Silsila and Edfu, where there is often a mingling of both Greek and Egyptian characters (LEGRAIN 1906; LEGRAIN *op. cit.*, 18) has dated these inscriptions to the reign of Antoninus.

The natural rock landmark, representing a sanctuary, that demarcates Gebel Tingar is well known for its Pharaonic hieroglyphs (particularly 18th to 25th Dynasty) and possibly Early Dynastic votive stelae which surround this prominent feature (see Figure 1, map ref. 19). This place was clearly of symbolic importance, perhaps from the Early Dynastic period, and associated with its strategic position marking the commencement of several desert routes into the Western oases, e.g., Kurkur, and Nubia. These votive stelae and hieroglyphs have been previously documented (MORGAN *et alii* 1894, HABACHI 1960, JARITZ 1981). In addition to these inscriptions there are occurrences of Greek inscriptions in the quarries, similar to those at Gebel Gulab. Hieroglyphic symbols for the local deity of Elephantine, the ram-headed god Khnum, are also present in the quarries. There are also hieroglyphic signs in a shelter area in the quarries at Gebel Sidi Osman.

Ancient petroglyphs (rock art) are also of importance at the site. Apart from previously recorded rock art at the Berber site close to the Nile SE of Gebel Tingar (SCHWEINFURTH 1912) and to the north of Gebel Gulab (site nos. 53 and 54 in WINKLER 1939), a further 40 previously undocumented occurrences were recorded during the survey (Fig. 15). Considering that many petroglyphs will have been destroyed by stone quarrying, the area as a whole must be considered a significant rock art site. The newly discovered depictions range from animals such as cattle, gazelles, giraffes to anthropomorphic (human) figures, footprints and, most ubiquitous, boats. Dating of such occurrences is problematic, although HUYGE 2002 has attempted to devise a chronological seriation from rock art at nearby Elkab. Using this as a template, the rock art occurrences at Gebel Gulab and Gebel Tingar cover the date range from the Predynastic Badarian culture (*c.* 4000 BC) into the Graeco-Roman and Islamic periods (*op. cit.*, 195).

Boats, however, are the most numerously depicted and occur in various forms throughout the quarries, particularly at Gebel Gulab and Gebel Saman. They are usually located on flat, exposed slabs and bedrock. These can range from simple sickle boats and square boats with high prows from 10-30 cm long, to sickle boats with oars and a Pharaonic ship/cargo barge measuring 1.5 m (long) by 1 m (high)

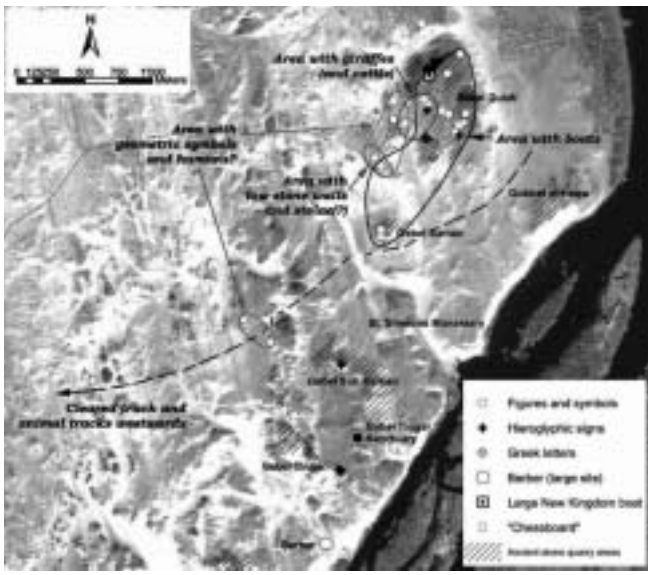

FIG. 16. Map showing the locations of rock-art sites and inscriptions found in the quarry area, ranging from Pre-dynastic to Graeco-Roman Periods.

by a newly discovered obelisk extraction site (FIG. 17) (see Figure 1, 204 map ref. 2). This exceptional engravings typical of New Kingdom iconographic depictions of such vessels found in many temples, although it remains questionable as to whether such an elaborate boat was used to transport stone from the quarries. All these boat depictions are of course open to interpretation, however, there are dangers in taking these literally as they can represent ideological constructs and idealised forms that are symbolic rather than narrative (HUYGE 2002, 204).

6. DISCUSSION

6. 1. *Quarrying Methods*

As previously mentioned, the quarrying methods used for silicified sandstone generally follow the techniques for hard stone boulder and bedrock quarrying in the Pharaonic Period, *i.e.*, fire-setting, the use of pounders, and in the Roman Period wedging with limited use of chiselling.

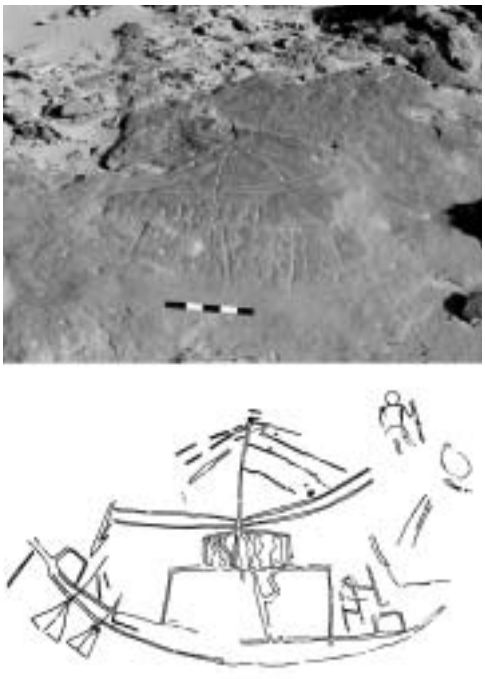

FIG. 17. Photograph and drawing of New Kingdom boat carved in an outcrop close to the unfinished obelisk in Figure 8. Scale interval on photograph 5 cm.

New discoveries during recent archaeological excavations in the Unfinished Obelisk quarry in the granite quarries in Aswan, points to a very widespread use of firesetting, in order to both remove the outermost weathered layers and possibly to help in softening the rock during, e.g., the making of extraction channels by pounders. The use of firesetting for removal of the outermost layers of weathered rock and perhaps to split larger pieces has also recently been found at Chephren's Quarry (STOREMYR *et alii* 2002, HELDAL *et alii* forthcoming). Our investigations at Gulab/Tingar confirm and widen the picture of widespread use of firesetting in the Pharaonic period. By practically every quarry face and quarried boulder, as well as in most spoil heaps from stone working, there is evidence of charcoal close to the surface – and there is also ample evidence of stone surfaces spalled and cracked by fire. Interestingly, such evidence is not only found in areas where large blocks were quarried, but also in the enormous amounts of quarries where small-scale objects were made on an 'industrial' scale.

With regard to quarrying of large blocks (either from boulders or bedrock), firewood must have been piled up against the face to be treated, in some cases probably enclosed by small stone or brick walls (as at the granite obelisk quarry in Aswan), and set to fire. The cracks developing in the stone would have made it easy to remove a significant proportion of the weathered and/or cracked surface. Although not yet investigated, it may well be that the silicified sandstone is very prone to cracking by fire (due to the quartz content as well as silica cement).

The same method seems to have been used for small-scale objects, but here it would have been the cracked-off pieces that were sought for. It is also likely that 'waste' from firesetting related to large-block quarrying was used for making small utensils and artefacts. For large- and medium-block quarrying there is also ample evidence for the levering up of the blocks to fireset them from below.

As for the distribution of the widespread small-scale quarrying, as opposed to large-block quarrying, this can be elucidated from the presence or absence of quarry roads. The quarry roads only seem to enter extraction sites where larger blocks were quarried, as evidenced by remaining, not yet finished large blocks in the quarries. Moreover, the mode of working in the small-scale quarrying areas is typically represented by many small work areas featuring very fine stone fragments (spoil) and sometimes destroyed pounders on and along the rim of waste of angular rock fragments, which develops over time around boulder extraction sites. Such work areas are not common in quarries for large-scale objects. The presence of this massive utilitarian production in the Gebel Gulab area not only suggests a considerable Pharaonic industrial activity, but also raises important questions about where and for what these products were used, as discussed below.

6. 2. *Silicified sandstone and solar symbolism*

Silicified sandstone has generally been termed the most «...solar of the stones of Egypt...» due to its colour ranges covering the spectrum from golden and white to purple-red (Quirke 2001, 76). The links with Iunu (Heliopolis), the principal sanctuary of the sun god are strong, not least, presumably, because the main source of the stone is the nearby silicified sandstone quarry of 'the Red Mountain', modern Gebel Ahmar (Aston *et alii* 2000, 53-55; Quirke 2001, 76, 79-80). The solar association between deities and building stone is also apparent from the inscribed relief on two silicified sandstone lintels dating to the Middle Kingdom reign of Senusret III of the gods Atum, Ra and the Powers of Iunu (Quirke 2001, 79).

The continuation of this symbolic use of silicified sandstone during the New Kingdom, particularly during the 18th Dynasty reigns of Amenhotep III and Akhenaten, is also characterised iconographically by the king as an incarnation of the sun god (Van Dijk 2000). This re-focussing of religious ideas in the 18th Dynasty to the sun god Ra-Horakhty and the Aten (or the sun disk), might be reflected in the increase in consumption of silicified sandstone at this time. Evidence for the coincidental renewal in the royal use of silicified sandstone can be observed in the archaeological record, most spectacularly with the Colossi of Memnon at Thebes, dating to the reign of Amenhotep III. Although the consumption evidence is fragmentary, due to re-use and loss, it is also notable from objects in the Cairo Museum (and in the Louvre) that a high proportion of silicified sandstone statues and statuettes seem to date to the Amarna Period. Both the yellow and purple colours of the stone were used, the most finely crafted of these being the magnificent head of Nefertiti.

Assigning this Pharaonic Period symbolic value to the Roman Period use of the stone is unlikely and it is more probable that other aesthetic attributes of the stone, such as its purple colour (this was sought after in the Roman Period) and hardness made it attractive to the Romans. The exploitation of purple porphyry from Mons Porphrityes (Maxfield and Peacock 2001) during this period is additional evidence to support such arguments.

6. 3. *Elite and non-elite stone procurement at Gebel Gulab and Gebel Tingar*

Quarrying at Gebel Gulab was to fulfil two objectives: first, elite exploitation of the stone for principally obelisks, statuary and stela; second, and most prodigiously, for utilitarian products such as grinding stones and querns. These two types of production were probably dual operations occurring during the same historical periods. Dating the quarries from the ceramic data alone is difficult, given that both New Kingdom (18th Dynasty) and Roman Period ceramics occur together in loose surface contexts in almost all the Gebel Gulab quarries. However, given the amounts of charcoal present it is envisaged that with future permission from the SCA samples can be collected to undertake C14 analysis. An assessment of the synchronic development of the quarries, in the absence of C14 dating has therefore been determined from the record of elite consumption of the stone and from production techniques, these sources of evidence suggest predominantly Pharaonic age quarrying, specifically during the New Kingdom (18th-19th Dynasties).

At Gebel Tingar, exploitation seems more focussed on the purple silicified sandstone, which as mentioned above was highly prized during the Roman Period. This might explain why the Roman presence at Gebel Tingar, as evident from the majority of the ceramics dating to this period, is the most significant 'over print' in these quarries.

Despite the royal and symbolic importance attached to silicified sandstone, dual use of it in both domestic and royal contexts is not unusual, because elite consumption and value is more often assigned to its final crafting and the distance the stone travels to its final destination (MELAS 1991; TYKOT 1996, 67, 70; BLOXAM 2003, 318-321). Hence utilitarian use tends to be for local consumption, such as the grinding stones which require little investment in human labour. Such objects are known to occur in a range of utilitarian contexts in Upper Egypt at Buhen and Amarna, in the latter associated with bread making (GIDDY 1999, 207). Silicified sandstone grinding stones are also associated with metal sharpening and possibly ore processing, suggesting that there might also be connection between this grinding stone production industry at Gebel Gulab and the explosion in gold mining by the 18th Dynasty in Nubia (MANLEY 1996, 68; SHAW 2000).

6. 4. *Logistics*

The means by which the stone blocks were moved across the quarry roads remains unknown. The roads show no signs of wear that would be expected if sledges or wagons were used, their narrowness also tends to preclude the use of wheeled vehicles. Furthermore, there are rather sharp standing stones in several places, suggesting that the roads were possibly not constructed for something to be sled on top of them, but rather on top of something lying on the road. Absence of wear marks is also a phenomenon on the Widan el-Faras quarry road and has presented similar problems of interpretation (HARRELL and BROWN 1995, 78-83; BLOXAM and STOREMYR 2002, 29-31).

The orientation of the major ramps which descend the eastern side of the Gebel and also the road to the south of it, imply that the quarried stone was transported towards the Nile, probably close to present Naq el-Gubba (see Figure 1, map refs. 10, 12, 14). The existence of ancient man-made harbour/quay structures in this vicinity remain unknown, due to poor preservation and over-building. However, it has to be considered that natural features could also have been

utilised to access the Nile. For example, a natural promontory that doubled as a quay is located within in a natural harbour on the ancient shoreline of Lake Moeris in the Fayum. The quay was the terminus of the Old Kingdom paved road from the Widan el-Faras basalt quarries to the lake and allowed for the transfer of basalt blocks from overland vehicles onto boats when the lake was at its highest level during the Nile flood (Harrell and Brown 1995, 86; Bloxam and Storemyr 2002, 30). Natural inlets and harbours can also be seen at the Gebel Silsila sandstone quarries, 50 km north of Aswan (Bloxam 2003, 221-222). Seasonal logistics can also be implied from epigraphic sources, such as Greek rock inscriptions at the sandstone quarries at El Hosh 30 km north of Aswan, which indicate that the Nile flood entered the quarries during July and August, enabling the flotation of the stone (Dworakowska 1983, 49). At present it remains unknown how close a flooded Nile would have come to the Gebel Gulab/Gebel Tingar quarries, hence sedimentary analysis from drill cores and geophysical analysis needs to be undertaken on the desert plateau between the Nile and the Gebels to determine if such a seasonal logistical framework can be applied.

6. 5. *The quarry labour force*

The social organisation of the quarry labour force, particularly the numbers of quarrymen, is difficult to determine due to the absence of settlement data or inscriptions that make any reference to numbers. The scatters of ephemeral stone shelters most likely functioned as work places and temporary shelters, but for a minimal number of people. The absence of food preparation areas and the minimal amounts of ceramic data, suggests that numbers of quarrymen were likely to have been quite limited and certainly not thousands.

The more industry based production at the quarries for utilitarian objects might be speculated as being on-going and organised at a local level. If this is considered, then perhaps a locally resident labour force was then simply conscripted for the elite procurement projects, rather than expeditionary forces being sent from elsewhere. However, it can be suggested from the 18th Dynasty inscription of Bak and Men at Aswan that elite stone acquisition could have been campaign/project driven as ordained by the king. Both Bak and Men have titles, «overseers of works» and «chief of the sculptors of the Red Mountain» which is the silicified sandstone quarry at Gebel Ahmar in Lower Egypt (Habachi 1965, 85-88). The inscription dates specifically to the reigns of Amenhotep III and Akhenaten and implies that they were sent to Aswan from Lower Egypt to oversee the quarrying of their monuments.

7. Concluding remarks

It is clear from this first systematic archaeological and geological survey of Gebel Gulab and Gebel Tingar, that these places are of enormous cultural and historical importance to our understanding of stone acquisition in antiquity. This site is extremely complex and presents many challenges, in particular, determining the chronology of stone extraction across the site as a whole and its relationship with the road system and the logistics of stone transport to the Nile. Determing the levels of the Nile in antiquity and whether stone extraction and transport were seasonally based activities are also crucial. As shown in this paper, the site adds significant information to our general understanding of stone extraction methods in antiquity, and the further investigation of such and the relationship between techniques and stone quality/geology is also an important subject in future field seasons. Furthermore, it

is important to establish the context of this quarry site within the prodigious ancient industrial landscape, which in essence, defines the Aswan region.

Similar to other quarry sites in Egypt, these places are often 'invisible' when it comes to land development which is due to them *not* being registered as archaeological sites. Protecting and managing the site is crucial if its integrity as an archaeological site is to be maintained. The wealth of material culture at the site is significant not only to our understanding of stone exploitation during the Pharaonic and Roman Periods in Egypt, but also because it provides a unique record of the continuous symbolic and ideological significance of this quarry landscape since the Predynastic period.

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Bibliography

Aston B., J. Harrell and Shaw I. 2000, *Stone*, in P. T. Nicholson and I. M. E. Shaw (eds.), *Ancient Egyptian Materials and Technology*, Cambridge, 5-77.

Bloxam E. G. and Storemyr P. 2002, *Old Kingdom Basalt Quarrying Activities at Widan el-Faras, Northern Faiyum Desert*, «Journal of Egyptian Archaeology», 88, 23-36.

Bloxam E. G. 2003, *The Organisation, Transportation and Logistics of Hard Stone Quarrying in the Egyptian Old Kingdom: A Comparative Study*, unpublished Ph. D. dissertation, Institute of Archaeology, University College London.

Brand P. 1997, *The "Lost" Obelisks and Colossi of Seti I*, «Journal of the American Research Center in Egypt», 34, 101-114.

Dworakowska A. 1983, *Quarries in Roman Provinces*, Wrocław.

el-Senussi A. 2004, *Report on Pottery from the Gebel Gulab/Gebel Tingar Archaeological and Geological Survey, 2004*, unpublished report.

Fournet J.-L. 1996, *Inscriptions grecques inédites de la rive ouest d'Assouan. Du nouveau sur le colosse chantant de Memnon?*, «BIFAO», 96, 143-170.

Giddy L. 1999, *Kom Rabi'a: the New Kingdom and Post-New Kingdom Objects*, Sixty-fourth Memoir ed. by Anthony Leahy, London, London Egypt Exploration Society («The Survey of Memphis», II).

Habachi L. 1960, *Dervnia Egipet*, Moscow, 224-235.

Habachi L. 1965, *Varia: from the Reign of King Akhenaten*, «Mitteilungen des Deutschen Archaologischen Instituts, Abteilung Kairo», 20, 70-91.

Habachi L. 1984, *The Obelisks of Egypt*, Cairo.

Harrell J. A. and Brown T. M. 1995, *An Old Kingdom Basalt Quarry at Widan el-Faras and the Quarry Road to Lake Moeris in the Faiyum*, «Journal of the American Research Center in Egypt», 32, 71-91.

Harrell J. A. 2002, *Ancient Egyptian Quarries*, website: http://www.eeescience.utoledo.edu/faculty/harrell/egypt/Quarries/Quarries_Menu.html

Harrell J. A. forthcoming, *An Ancient Quarry for Siliceous Sandstone Near Wadi Abu Aggag in Upper Egypt*, «Orientalia».

Heldal T., Storemyr P., Bloxam E. G., Shaw I. and Salem A. 2004 in press, *GPS and GIS Methodology in the Mapping of Chephren's Quarry, Upper Egypt: A Significant Tool for*

Documentation and Interpretation of the Site, in Y. Maniatis (ed.), *asmosia vii: Proceedings of the Seventh International Conference on Interdisciplinary Studies on Ancient Stone*, Thassos (Greece), 15-20 September 2003.

Huyge D. 2002, *Cosmology, Ideology and Personal Religious Practice in Ancient Egyptian Rock Art*, in R. Friedman (ed.), *Egypt and Nubia: Gifts of the Desert*. London, 192-206.

Jaritz H. 1981, *Zum Heiligtum am Gebel Tingar*, «Mitteilungen des Deutschen Instituts für Ägyptische Altertumskunde», 37, 241-246.

Klemm D. D., Klemm R. and Steclaci L. 1984, *Die Pharaonischen Steinbrüche des Silifizierten Sandsteins Ägypten und die Herkunft der Memnon Kolosse*, «Mitteilungen des Deutschen Archaologischen Instituts, Abteilung Kairo», 40, 207-220.

Klemm D. D. and Klemm R. 1993, *Steine und Steinbrüche im Alten Ägypten*, Berlin.

Legrain G. 1906, *The Inscriptions in the Quarries of El Hosh*, «Proceedings of the Society of Biblical Archaeology», xxvii, 17-26.

Manley B. 1996, *The Penguin Historical Atlas of Ancient Egypt*, London.

Maxfield V. A. and Peacock D. P. S. 2001, *The Roman Imperial Quarries Survey and Excavation at Mons Porphyrites 1994-1998*, vol. i, *Topography and Quarries,* Sixty-Seventh Memoir Edited by Anthony Leahy, London, Egypt Exploration Society.

Melas M. 1991, *Mediterranean Trade in the Bronze Age: a Theoretical Perspective*, in N. H. Gale (ed.), *Bronze Age Trade in the Mediterranean*, Josered («Studies in Mediterranean Archaeology», vol. xc), 387-398.

Morgan J., Bouriant U., Legrain G., Jéquier G. and Barsanti A. 1894, *Catalogue des monuments et inscriptions de l'Egypte Antique*, i série, *Haute Égypte,* 1, *De las Frontiére de Nubie à Kom Ombos*, Vienna.

Peacock D. P. S. and Maxfield V. A. 1997, *Mons Claudianus Survey and Excavation 1987-1993*, vol. i, *Topography and Quarries*, Le Caire, Institut Français d'Archéologie Orientale («Fouilles de l'ifao», 37).

Quirke S. 2001, *The Cult of Ra: Sun-worship in Ancient Egypt*, London.

Röder J. 1965, *Zur Steinbruchgeschichte des Rosengranits von Assuan*, «Archäologischer Anzeiger», 3, 467-552.

Schweinfurth G. 1912, *Über alte Tierbilder und Felsinschriften bei Assuan*, «Zeitschrift für Ethnologie», 44, 627-658.

Shaw I. M. E. 1986, *Survey at Hatnub*, in B. J. Kemp (ed.), *Amarna Reports iii*, London («ees Occasional Publication», 4), 189-212.

Shaw I. M. E. 1987, *Survey at Hatnub*, in B. J. Kemp (ed.), *Amarna Reports iv*, London («ees Occasional Publication», 10), 160-167.

Shaw I. 2000, *Egypt and the Outside World*, in Idem (ed.), *The Oxford History of Ancient Egypt*, Oxford, Oxford University Press, 314-329.

Stocks D. A. 2003, *Experiments in Egyptian Archaeology: Stoneworking technology in Ancient Egypt*, London.

Storemyr P., Bloxam E. G., Heldal T. and Salem A. 2002, *Survey at Chephren's Quarry, Gebel el-Asr, Lower Nubia: 2002*, «Sudan and Nubia Bulletin», 6, 25-29.

Stross F. H., Hay R. L., Asaro F., Bowman H. R. and Michel H. V. 1988, *Sources of the Quartzite of some Ancient Egyptian Sculptures*, «Archaeometry», 30, 1, 109-119.

Tykot R. H. 1996, *Obsidian Procurement and Distribution in the Central and Western Mediterranean*, «Journal of Mediterranean Archaeology», 9, 1, 39-82.

Van Dijk J. 2000, *The Amarna Period and the Later New Kingdom*, in I. Shaw (ed.), *The Oxford History of Ancient Egypt*, Oxford, Oxford University Press, 272-313.

Verner M. 2002, *The Pyramids*, London.

Weigall A. E. P. 1910, *A Guide to the Antiquities of Upper Egypt from Abydos to the Sudan Frontier*, London.

Winkler H. A. 1939, *Rock-drawings of southern Upper Egypt*, vol. ii, London, The Egypt Exploration Society.