Constructing a quarry landscape from empirical data. General perspectives and a case study at the Aswan West Bank, Egypt

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Ancient quarry landscapes are neglected, but important pieces of our common heritage, giving us insight into aspects of daily life throughout human history. As archaeological sites, quarry landscapes may, at first sight, appear insignificant, and contain layer upon layer of quarrying and other activities that can be difficult to interpret in a way that can help build a case for conservation. The present paper builds on the empirical data collected in the QuarryScapes project, and suggests a method for grouping such data into five main elements: the stone resource, secondary resources, material remains from production, logistics and evidence of social infrastructure. Moreover, how these elements can be analysed and provide a basis for revealing and visualising different quarrying activities and layers, as a tool for getting closer to assess the significance of a quarry landscape. The Aswan West Bank, Egypt, is used as a case study for illustrating the methodology. This particular quarry landscape contains multiple layers of quarrying, from the Lower Palaeolithic to at least into the Roman Period, displaying different uses of the same resource through millennia. When analysing the empirical data, collected through several years of surveying, a pattern of several short- or long-lived quarrying activities (or quarry complexes) comes to the surface. These can be viewed individually, each containing particular historical values, or collectively, as a rare landscape shaped by human engagement with a specific resource through several hundred thousand years.

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Introduction

Stone[1] quarries are found more or less everywhere where there has been human activity, from the earliest hominids into the present day. Hence, quarries can give us insights into important aspects of the daily life of our ancestors in terms of how they exploited and used natural resources. Quarries may provide important ’pools of knowledge’ of ancient technology, social organisation, trade and communications. Since many quarry landscapes were exploited over thousands of years, quarries can also be ’indicators‘ of important events or changes in society. Quarrying techniques and stone working have for a long time fascinated researchers and the lay audience, particularly in connection to the great monuments of Antiquity. In Egyptian archaeology, this fascination resulted in the important works by Petrie (1883) on the pyramid sites, Clarke and Engelbach’s interpretation of the Unfinished Obelisk quarry in Aswan and other work on Egyptian masonry (Engelbach 1922, 1923, Clarke and Engelbach 1930), the discovery and description of Chephren’s quarry (Engelbach 1933, 1938), the quarries in the Faiyum depression (Caton-Thompson and Gardener 1934) and, although much later, Röder (1965) on the quarrying of the Aswan granite. In the Graeco–Roman world, Ward-Perkins gained interest in marble quarrying quite early, summarised in Ward-Perkins (1971).

Ancient quarries have rightfully gained more attention of researchers during the last 25 years, lifting this subject significantly. The formation of ASMOSIA (Association for the Studies of Marble and other Stones used in Antiquity) was an important factor. The proceedings from these biannual conferences (Herz and Waelkens 1988, Waelkens et al. 1992, Maniatis et al. 1995, Schvoerer 1999, Herrmann et al. 2002, Lazzarini 2002) have made significant contributions to the understanding of ancient quarrying and in developing methods for linking quarries to their places of use. The excavations of two Roman quarry sites in the Western Desert of Egypt run by the University of Southampton (Peacock and Maxfield 1997, Maxfield and Peacock 2001) definitely demonstrated that quarry sites can contain a rich archaeological record, as did also several seasons of surveys and excavation at Chephren’s quarry in southern Egypt (Harrell and Brown 1994, Shaw and Bloxam 1999, Bloxam 2000, 2003, 2005, Storemyr et al. 2002, Shaw and Heldal 2003). Surveys of several quarries in the Faiyum area (Harrell and Bown 1995, Bloxam and Storemyr 2002, Heldal et al. 2009) continued the work initiated by Caton-Thompson and Gardener (1934). Survey work carried out by Harrell et al. (1996), Harrell (2002)[2], Harrell and Storemyr (2009) and Klemm and Klemm (1993, 2008) of quarries in Egypt through many years have added significant knowledge to understanding stone procurement in ancient Egypt, and also cleared numerous misinterpretations on stone sources and use. Furthermore, their work and active cooperation from Harrell made it possible for the Egyptian heritage authorities to make a comprehensive national inventory of ancient quarries, through the QuarryScapes project (Harrell and Storemyr 2009, Shawarby et al. 2009). Significant contributions to the understanding of ‘soft-stone’ quarrying in Antiquity, including experimental archaeology, has been made by Bessac (i.e., Bessac 1996).

Research of Neolithic and Palaeolithic quarrying has naturally been ‘nearer to the surface‘ due to the focus on origin, manufacturing and typologies of stone implements. Due to the development of more sophisticated geological methods of fingerprinting rocks, there has been an increasing focus on sourcing quarries and investigating artefact distribution patterns and trade (i.e., Bruen Olsen and Alsaker 1984, Bradley and Edmonds 1993). Some of the more recent works take a holistic view of quarries and landscapes (Cooney 1998, 1999, Bradley 2000, Edmonds 1999), viewing quarries as important places in ’social landscapes‘.

Another ’sector‘ of quarry research is related to millstones. Some of the largest industrial landscapes in Europe are made from millstone quarrying, and in recent years there has been an increasing cooperation among geologists, historians and archaeologists regarding millstone quarries (i.e., Vretto-Souli 2002, Anderson et al. 2003, Belmont 2006,; Belmont and Mangartz 2006, Grenne et al. 2008). An important meeting point is a biannual conference and a European millstone database on the web[3].

However, in spite of the positive contributions of the last few decades, research of quarry or production sites still remains compartmentalised into studies of either single periods (i.e., Neolithic, Classical Antiquity, Pharaonic Egypt, Medieval), commodity (i.e., millstones) and/or geographical region (i.e., Egypt). With ancient quarries disappearing at a high rate due to modern development and the lack of registration of such sites as cultural heritage (Storemyr 2009, Storemyr et al. 2007) the need for quarry researchers to come together and find ways of raising awareness of these important places has never been more pressing. The first step is to find ways where we can analyse the diversity of quarrying remains, across many time periods, and thus find a common ground between all aspects of production-site research. The basis for QuarryScapes was to thus design tools for better characterisation and valorisation of quarry sites as cultural heritage in terms of not only bringing researchers and professionals together, but as a crucial step in forwarding their significance to heritage authorities (see also Bloxam 2009).

The objectives of this paper are to look at quarries and quarry landscapes from a *micro-level* perspective in terms of their characterisation and interpretation from the geological resource, to mate-

[1]In this context, ‘stone’ is used as a collective term covering rocks that are used as more or less shaped and dressed blocks.
[2]See also Harrell’s web site http://www.eeescience.utoledo.edu/Faculty/Harrell/Egypt/AGRG_Home.html
[3]http://meuliere.ish-lyon.cnrs.fr/en/welcome.htm.

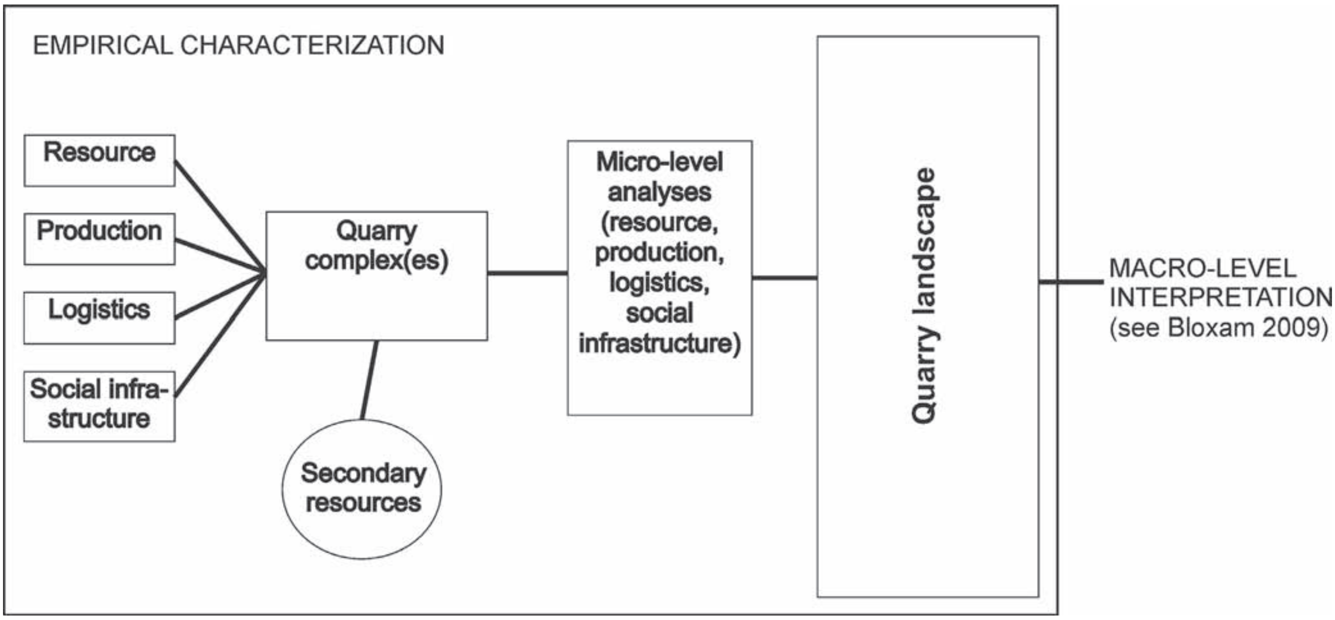

Figure 1. Proposed procedure for empirical characterisation of ancient stone quarries; from identification of features and elements to interpreting complexes.

rial remains from quarrying, to the 'construction' of quarry landscapes by sets of similar quarrying activities. Such analyses may be a useful way of structuring empirical data enabling interpretation of the bigger picture (*macro level*) (Figure 1). The present paper builds on a methodology presented in a QuarryScapes report (Bloxam and Heldal 2008), from which also several of the figures have been taken.

A general approach to quarry landscapes

All quarry landscapes, whether these are Neolithic chert quarries, Roman marble quarries or paving stone quarries from the Industrial Period, have aspects and features in common that can be examined and analysed in a systematic way, establishing a base of empirical characterisation for the assessment of their historical significance (Figure 1). A quarry site may be visualised from *the material remains* of the various processes involved in the exploitation of its resources, over one or several periods. These remains might include traces of the extraction of rocks (tool marks), deposition of excess rock (spoil), tools, semifinished and discarded products, work areas, ceramics, shelters etc. Collectively, they tell us something about the processes involved in the selection of stone to be quarried, the production of it, the logistics related to its transportation and the social context and organisation related to sustaining the people involved in the quarrying. The remains from quarrying may be characterised from a purely physical and descriptive perspective. However, when characterising quarries at a micro level, this analytical phase has to achieve a basic overview of the quarrying process in order to identify different quarrying activities within a quarry landscape, and as a tool for comparing one quarry landscape with another. A key problem is to address multiperiod and multifunctional quarrying, as seen in many quarry landscapes. This requires 'deconstruction' of quarry landscapes into connected activities, but without loosing the holistic perspective of the dynamics through time.

Stone resources—reading behind the quarries

One of the important aspects of resource characterisation is to find the link between the quarry and distribution of its products (provenance). Most of the studies involving ancient quarries have in fact investigated such aspects, as published in the ASMOSIA proceedings (op. cit.). But there are also other important aspects of the stone resources, less addressed, that can shed light on quarrying activities and stone procurement. These may be illustrated as a process. The selection of stone type to be quarried (commodity and quality in use), the physical landscape in which the stone resources occur (morphology and geometry of deposit) and the condition of the deposit (production quality) all count when choosing the place for quarrying (Figure 2).

One key aspect is the question of commodity. Why were the rocks desirable? At present time, as in the past, the exploitation of stone resources can originate from different needs, such as building material, valuable stone for decoration, and for high-quality rocks suitable

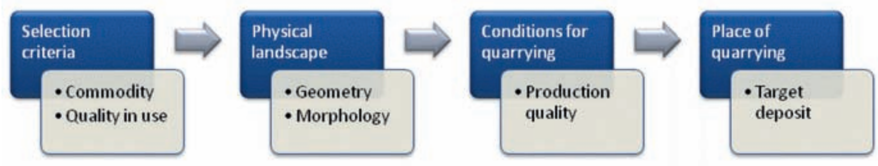

Figure 2. View of a stone resource—from selection to choice of place for quarrying.

for specialised tools. With these key aspects in mind, one may view stone resources from three extreme perspectives: building stone, ornamental stone and utilitarian stone (Table 1). From these perspectives we can then get closer to the reasons for quarrying; was the quarrying due to technical quality of the stone, its rareness or just that it was an available raw material? Visual appearance and even remoteness have been important in many cases of stone quarrying (i.e., Peacock 1992, Lazzarini 2004), in contrast to obtaining the 'everyday' building stone for a city, which often was extracted in the most available deposits of sufficient quality (Degryse 2007, Degryse et al. 2008, 2009, Abu-Jaber et al. 2009), or the high weight put on quality when applied to utilitarian stones. However, the city builders may have decided to go further away to obtain building stone of a particular quality and aesthetic appearance for prestige buildings, or for economic reasons they may have chosen to use the local, low-quality stone also for ornamentation. Thus, although the three perspectives are helpful, it is important to acknowledge that the divisions between them are not—and should not be—rigid.

The overall conditions for quarrying are decided by the exposure of stone resources in the landscape, as a result of multiple geological processes; from the formation of the rocks, through transformations of them to weathering and erosion. The geometry and outcropping pattern of the resource establishes the 'geometrical condition' of quarrying, to which quarrying methods to a large extent must be adapted. Consequently, it also represents the condition of how the morphology resulting from the transformation of the natural landscape by quarrying visually appears. Thus, it is valuable to reconstruct the situation before quarrying in order to interpret the size and spatial evolution of a quarry landscape. A simple division of stone resource geometries, as they appear in the bedrock, is given in Figure 3.

Production quality may be viewed as a result of the resources' (rocks') physical properties—their workability. Such issues can be viewed on different scales. On a *micro scale*, the mineral composition, texture and structure commonly decide the hardness, brittleness and preferred direction of splitting in rocks, properties that highly influence the quarrying techniques. On a *meso scale*, a key issue is the distribution and density of naturally occurring fractures, determining the obtainable sizes and shapes of stone blocks. Unsystematic and scattered spatial distribution of quarries can often reflect the movement of exploitation between places of favourable fracturing (see example in Kelany et al. 2009).

In many cases, quarrying requires input of other natural resources used in the production process. Defining the quarried resource as 'primary', we can collectively name the use of these other natural resources as 'secondary' resources (see Figure 1)[4]. These may be stone resources for use as tools, wood for smithies, stone for other constructions such as settlements, wells and roads, or grinding stones for food production. Secondary resources may be directly applied in the production process, or indirectly for sustaining the people doing it, such as housing for the workers and various utensils. Moreover, secondary resources may be imported or obtained locally.

Table 1. Stone commodities, use and important quality aspects.

	Commodity	Uses	Common rocks	Important aspects
Stone resources	Building stone (masonry stone)	Rubble walls Ashlar walls Architectural elements Roof Floor Paving	Sandstone Limestone Granite Gneiss Marble Schist Slate	Availability Workability
	Ornamental stone (decorative stone)	Sculpture Cladding Floor Columns Funerary	Marble Granite Misc. igneous rocks Porphyry Gneiss Quartzite	Aesthetic appearance Symbolic value Rarity Carving properties
	Utilitarian stone	Tools Weapons Grinding stone Millstone Whetstone Cooking vessels	Chert Volcanic rocks Quartzite Sandstone Schist Soapstone	Physical properties

Production evidence

Understanding the production process is a key aspect when it comes to characterising quarry landscapes. The stone resource, secondary resources and human resources are the 'inputs' to the production, the resulting products, finished objects or rough-outs, are the 'outputs'. The production process can be read from the marks on the quarry faces and blocks (tool marks), the composition and distribution of spoil rock, broken or half-finished products, remains from tools and the existence or not of designated work areas for different stages in the production. When compiling the empirical data from QuarryScapes, we found that a simple division of a production process in a quarry into four steps was useful, both for illuminating similarities and differences between these different activities (Figure 4). These are: 1) extraction from bedrock, 2) block reduction to 'cores', 3) semifinishing of cores to rough-outs or blanks, and 4) finishing to the final product.

The techniques involved in the extraction of blocks from the bedrock can be described as three fundamental principles—or combinations of them: levering, splitting and channelling. Le-

[4]Here, we will specifically address the secondary stone resources, not organic resources, water etc.

vering, being the simplest, involves the extraction of blocks bordered by natural cracks that are widened with the help of levers or inserted stones. Splitting involves the creation of cracks by percussion (stroke), inserting wedges of some kind in prefabricated holes or by heat. In a modern context, splitting is mainly done by detonating explosives in drill holes. Channelling is the third fundamental principle. Channels in the rock are made by removing the rock mass by chiselling, picking, sawing or heating. In most soft-stone quarries from the Bronze Age onwards, channelling is the most important extraction method. In most cases, channelling is combined with splitting (i.e., along bedding planes in limestone). Blade sawing of rocks, even basalt and granite, were applied since the Old Kingdom (Petrie 1883, Moores 1991). As a method in channelling, however, it may not have been applied until modern times, although sawn blocks are observed in Roman quarries (Harrell and Brown 2002).

When a stone block is obtained by extraction from bedrock, or collected from natural boulders or scree blocks, it is either reduced in size producing a core, or directly dressed to a rough-out or blank. Reduction of blocks may be described basically in the same way as extraction; e.g., splitting with percussion, splitting with wedges, splitting with heat (fire setting), sawing or carving/hewing. Dressing of semifinished products is essentially carried out by hewing and trimming, whilst finishing also can involve grinding and honing.

When analysing a quarrying process, it is important to address the start and end of the process, the number of steps involved and the techniques applied, based on the material remains. Did the process involve bedrock extraction, or just a collection of naturally occurring blocks? Did it involve few or several types of skilled labour? How far towards final finishing did it go? As will be shown in the case study, the presence (or absence) of these steps in a quarry site may reveal important information about the organisation of quarrying, which can be

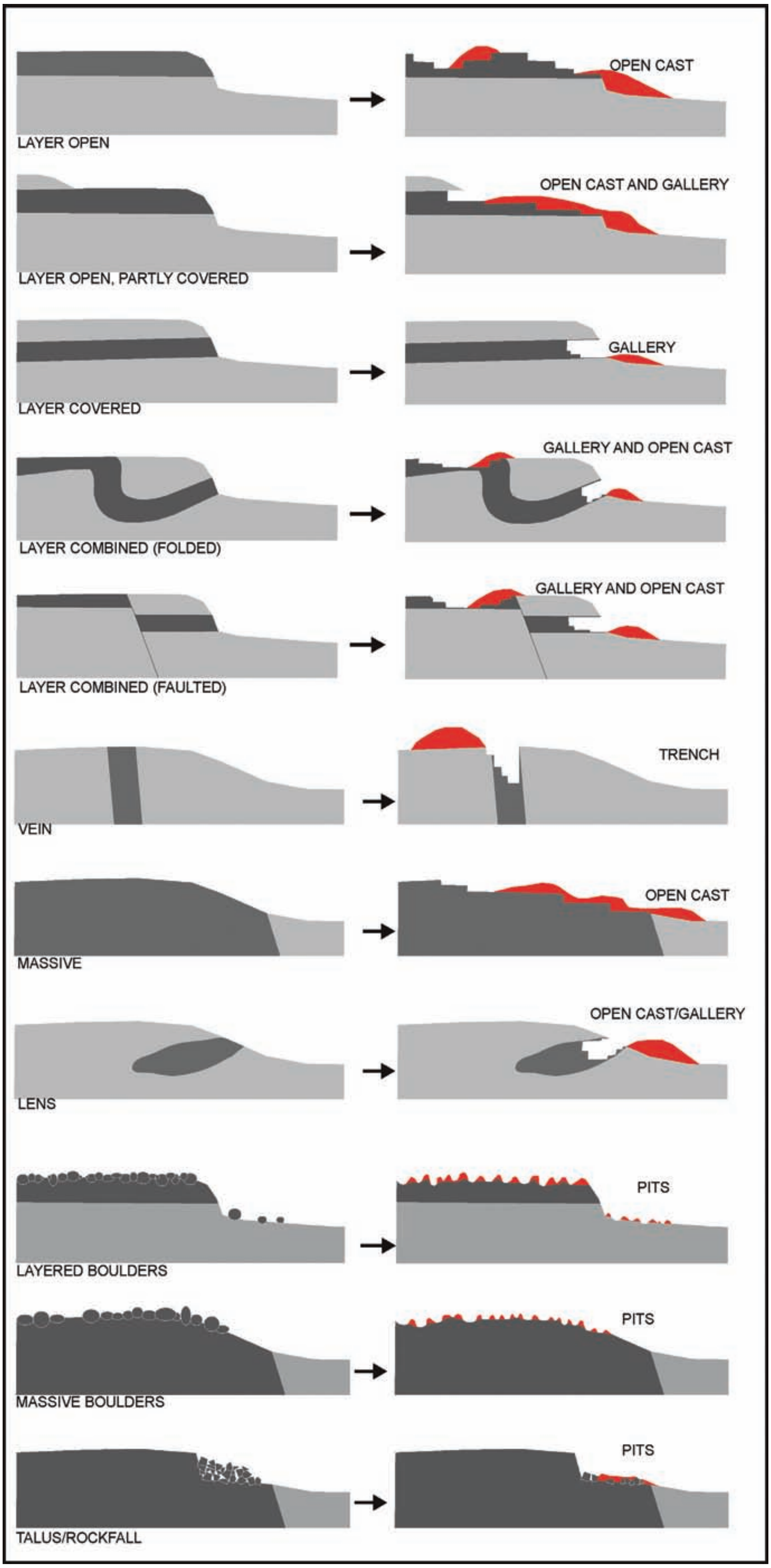

Figure 3. Various geological and morphological situations of stone resources and the resulting quarry landscapes. Stone resource=dark grey colour; spoil heaps=red colour.

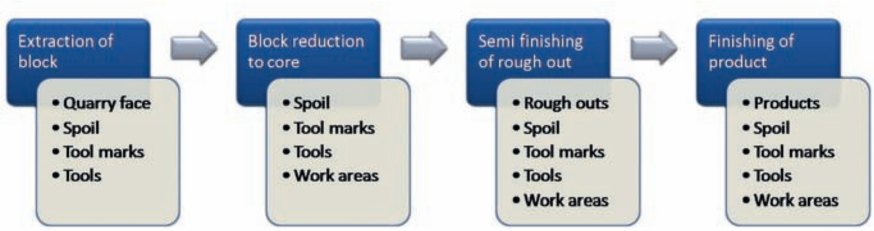

Figure 4. Production process in stone quarries and features defining each step.

valuable for assessing the broader social context of these operations.

Transporting the stone

The transport of stone blocks and products is an important element of all quarrying activities. Clearly, the production of small objects that can be carried by a man or a donkey requires less constructed infrastructure than huge obelisks. However, whatever the output of the quarrying was, the remains of features related to transport are important to characterise. Such remains may be constructed features such as ramps, roads and harbours, less visible features such as cairns (site lines) and worn paths, or other features such as fixingholes for ropes and postholes for fixing lifting devices. Also, stocked or lost stone products on the transport route are found in many cases, providing further evidence of the logistics.

Such remains can collectively give sufficient empirical information about the logistical process, the internal logistics (between the steps in the production process) and the transport of stone to other places for further processing and/or use, as illustrated in Figure 5. They may also provide evidence of how the transport was carried out. For example, the nature of the quarry roads may uncover the type of transport vehicle applied.

The logistics not only concern the transport of products out from the quarry, but also transport of people and resources into the quarry area. Examples are given in Maxfield and Peacock (2001, p. 96).

Social infrastructure

Written sources such as epigraphic data associated with quarrying, as well as historical texts that can relate to practice, are one key data source for extrapolating the social context through which ancient quarrying was expedited. Other sources are the built structures linked to dwellings for the work force, ceramics and other associated artefacts that comprise the social infrastructure of quarrying. Elements of this infrastructure that might be found across an ancient quarry landscape, vary from built features to epigraphic data, from which an assessment of the social context can be made.

The problem in visual terms is that easily recognisable large purpose-built settlements associated with ancient quarries, are the exception rather than the rule. The large purpose-built quarry settlements of Mons Claudianus and Mons Porphyrities in the Eastern Desert of Egypt are such an exception (Peacock and Maxfield 1997, Maxfield and Peacock 2001). Hence, in the search for dwellings for quarry labour forces, much emphasis has been placed on the ubiquitous 'stone circles' or 'stone enclosures' that occur in a number of ancient quarries in Egypt, as being places of habitation (see Shaw 1994, Harrell and Bown 1995). Such subtle remains are extremely difficult to interpret (see Heldal et al. 2009); for instance to separate temporary dwellings from storage, lookouts or later features not connected to quarrying at all. Thus, such remains must be combined with other evidence in order to make any inference on labour force and organisation (see Bloxam 2003).

Pottery is key in terms of indirectly determining periods when quarrying occurred, and when found associated with stone-built features in secure contexts, is important for dating such structures. Typologies of ceramics can indicate not only chronology, but can aid in characterising subsistence patterns of a labour force, particularly when associated with organic remains and/or other domestic artefacts. Epigraphic data—and of course written sources—may be key for understanding quarrying activities, where present. These can include inscriptions (i.e.,

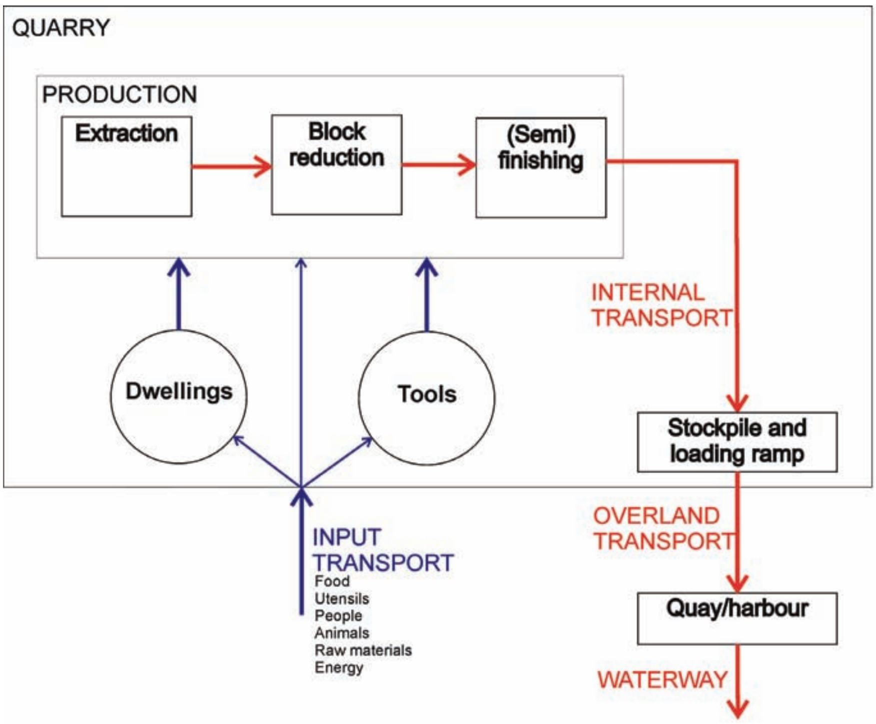

Figure 5. Schematic view of the logistical system in a stone quarry.

dedications), graffiti and rock art. Many of the large Roman and Dynastic Egyptian quarry sites are rich in epigraphic data, but in many other contexts such evidence is lacking or rare.

When analysing the empirical data in terms of making inferences into the social context of ancient quarrying, there are key questions that we need to ask of these data. For instance, the size of labour forces (did they reside permanently at the quarry?), levels of social organisation and the extent to which such activities may have been controlled by the 'state' or other type of centralised bureaucracy. We also need to contextualise these data historically, and compare with other ancient quarries. Moreover is the need to develop conceptual models through which we can gain fresh insights into the social context of quarrying, this being relevant where there are data gaps and an absence of written sources.

Quarry landscapes as constructions: evolution through time and space

Quarry landscapes are often composed of multiple layers of activities from more or less continuous activities through time. The different time layers do not form well-stratified layers, but rather a complex system of use, reuse and frequent relocation of material culture. Individual quarry sites were commonly revisited during several periods, spoil material was moved to make space for new quarrying, roads/other infrastructure may have been moved or reused. In addition, many quarry landscapes, particularly those that did not have permanent settlements for the work force, tend to have little dateable material culture. However, finding the time depth of a quarry landscape is one of the most crucial research questions when it comes to evaluating its significance. Naturally, the earliest phases of quarrying are less visible (and more difficult to identify) than the younger, but not less significant. Given such limitations, finding time depth in quarries can be achieved by several methods:

- Through *direct dating*: charcoal and other organic remains can be found in settlement areas and trapped in spoil heaps. Cosmogenic nuclides (particularly $^{10}Be/^{26}Al$) may prove useful in particular cases for dating of the time rocks have been exposed near or at the surface.
- Through *indirect dating*: ceramics, inscriptions and other epigraphic data.
- Through *consumption*: one of the most valuable methods of dating quarrying activities is through consumption of the rocks, being buildings in a city or other well-dated objects.
- Through *technology*: the interpretation of tool marks may reveal the use of specific tools and tool materials (stone, iron) that can be dated.
- Through *relative dating of events*: such as overlapping layers of quarrying activities, weathering of rocks.

Concerning direct dating by cosmogenic nuclides, the method seems to work best when rocks have become exposed at the surface by sudden events (such as quarrying). Obviously, this is particularly valid in bedrock quarries, where large volumes of stone have been removed (Wagner 1998). There may be more problems related to quarrying of small, scattered surface blocks, given that such blocks already have been exposed for a long time before they were worked. In spite of that, there is hope that the method may prove to work well on particular types of quarries. There have been some studies of rock artefacts from quarries with a certain success, such as dating of Lower Palaeolithic chert flakes in Egypt (Ivy-Ochs et al. 2001) and a study using ^{10}Be for separating Neolithic chert (brought from deep mines) from Palaeolithic (exploitation of surface blocks) (Verri et al. 2005).

Time depth alone does not get us much closer to understanding the evolution of quarrying at a given place. The micro-level data, as addressed above, must be drawn together and understood, allowing us to build a composite picture of the ancient quarrying process and its social context. From the case studies in QuarryScapes, it became useful to identify quarrying activities (or elements) that were connected to each other in time, space and/or function. Such a definition of *quarry complexes*, more than being a division into rigid classes, can aid in visualising similarities and differences in a quarry landscape. In a general view, a quarry complex may be visualised as in Figure 6, as a system of interconnected quarries sharing social infrastructure and logistics, input of labour force

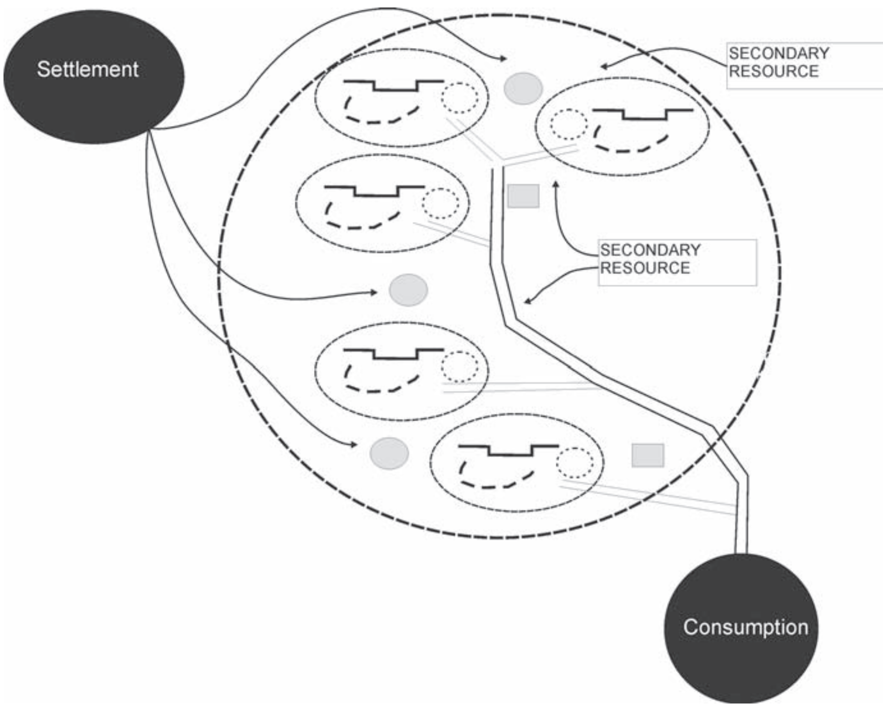

Figure 6. A quarry complex—as defined by a group of interconnected quarries sharing logistics, social infrastructure and secondary resources.

and secondary resources and output of products. Criteria used for identifying quarry complexes may be by time period ('historical complex'). But it may also be linked to the resource (as the 'arena' of exploitation), production/technology, consumption (i.e., parts of a city, or even a historical complex in a city) and function (which largely relates to commodity). The main reason for keeping an open view on the definition of complexes is that it is important to view quarry landscapes in perspectives other than the strictly historical. Although it is interesting to place quarry landscapes into historical 'slices' (and indeed in some cases this will be the most valuable perspective), one often faces problems in doing so, due to the above-mentioned lack of material culture. Moreover, in many cases the longevity of quarry activities is itself a major point to visualise and characterise. In the physical meaning of the term, a quarry landscape may thus be simply defined as the sum of its complexes.

The empirical data of the Aswan West Bank quarry landscape

The West Bank quarries

The ancient quarries at the West Bank of the Nile, at Aswan, cover an area of some 50 km² between the Old Aswan Dam in the south and Wadi Kubbaniya in the north (Figure 7). Some of the quarries, notably Gebel Tingar and Gebel Gulab (Figure 7), are known to be a major source of prestigious objects of silicified (hard, 'quartzitic') sandstone in ancient Egypt, together with deposits on the East Bank (Wadi Abu Agag, Harrell and Madbouly 2006) and Gebel el-Ahmar in Cairo (Klemm et al. 1984, Klemm and Klemm 1993, 2008). Such use of silicified sandstone is known from the 1st Dynasty to the Graeco–Roman Period, but peaked in the New Kingdom. See Bloxam (2007) for an overview of the use of silicified sandstone. Of particular interest in the West Bank quarries is the production of obelisks during the reign of Sety I (1294–1279 BC), which left an inscribed tip of an obelisk in the quarries (Habachi 1960, Brand 1997, 2000). Moreover, Klemm and Klemm (1993) suggested major exploitation of statue blocks (including the Colossi of Memnon) during Amenhotep III, and recognised Roman ornamental stone quarries. They also recognised and described several building stone quarries in the area in poorly silicified sandstone ranging from the Old Kingdom to the Coptic Period.

In Wadi Kubbaniya in the far north of the quarry landscape, Roubet (1989) discovered a quarry of grinding stones for food processing (hand querns), which she linked to a nearby Upper Palaeolithic (18,000 BP) settlement (Wendorf and Schild 1989), being so far evidence of the oldest production and use of such implements, certainly in Egypt and perhaps in the world. More recently, QuarryScapes surveys have revealed that such production of grinding stones in the Upper Palaeolithic and at least into the Roman Period, is the most extensive quarrying activity across the landscape (Heldal et al. 2005, Bloxam and Storemyr 2005, Bloxam et al. 2007). Furthermore, these surveys uncovered Palaeolithic production of tools in silicified sandstone, representing the earliest layer of quarrying in the landscape (Bloxam et al. 2007, Bloxam and Moloney 2009). Hence, the Aswan West Bank comes forward as a quarry landscape with high complexity, displaying many types and layers of quarrying operations through a vast period of time. In order to get closer to an assessment of historical significance, it is crucial to look closer at the empirical data and how these can contribute in deconstructing the quarry landscape into different elements.

Geology and stone resources at the West Bank

The sedimentary rock succession on the West Bank is part of the 'Nubian Sandstone' (Rüssegger 1847), which is a term used for the Upper Cretaceous in Sudan and Egypt (Zittel 1883). The term 'Nubian Series' (Sandford 1935) has also been in common use; however in more recent times the term 'Nubian Group', as introduced by Whiteman (1970), has been accepted by several authors (Klitzsch et al. 1979). The Nubian Group on the Aswan West Bank displays layers of claystones, mudstones and sandstones of Upper Cretaceous age (Turonian–Campanian, Klitzsch 1990). The lower part rests directly on top of Precambrian granitoid rocks ('Aswan Granite', see e.g., Ball 1907, Kelany et al. 2009), where the contact represents an irregular topographic surface formed by erosion of the Precambrian rocks prior to deposition of the sedimentary rocks.

The succession is divided into three formations as defined by Zaghloul (1970), and also used in some of the most recent papers, e.g., Klitzsch (1990) and Endrisewitz (1988), namely (from bottom to top): the Abu Agag Formation, the Timsah Formation and the Um Barmil Formation. In the present paper, some modification of the formation boundaries have been made, based on work by Bhattacharyya and Lorenz (1983) and van Houten et al. (1984). Most of the stratigraphic section is well displayed on the eastern slope of Gebel Gubbet el-Hawa (Figure 7, Heldal et al. 2007b), where the Tombs of the Nobles are situated. A log of the section is given in Figure 8, and a geological map showing the distribution of the three formations at the West Bank is shown in Figure 9.

The Abu Agag Formation displays a lower unit of cross-bedded sandstones and conglomeratic sandstones, resting directly on the Precambrian rocks. This unit is overlain by a unit of mudstones intercalated with thin sandstone and siltstone beds. In the upper part there is a several-metres thick point-bar deposit, which probably represents a meandering river channel (Heldal et al. 2007b). The uppermost few metres of the formation consist of shallow-marine sandstone beds locally containing oolitic hematite-goethite iron beds, subject to intensive ancient iron mining south of Gebel Gubbet el-Hawa. Most of the rock-cut tombs on the West Bank are found in the rocks of the Abu Agag Formation, and also several building stone quarries.

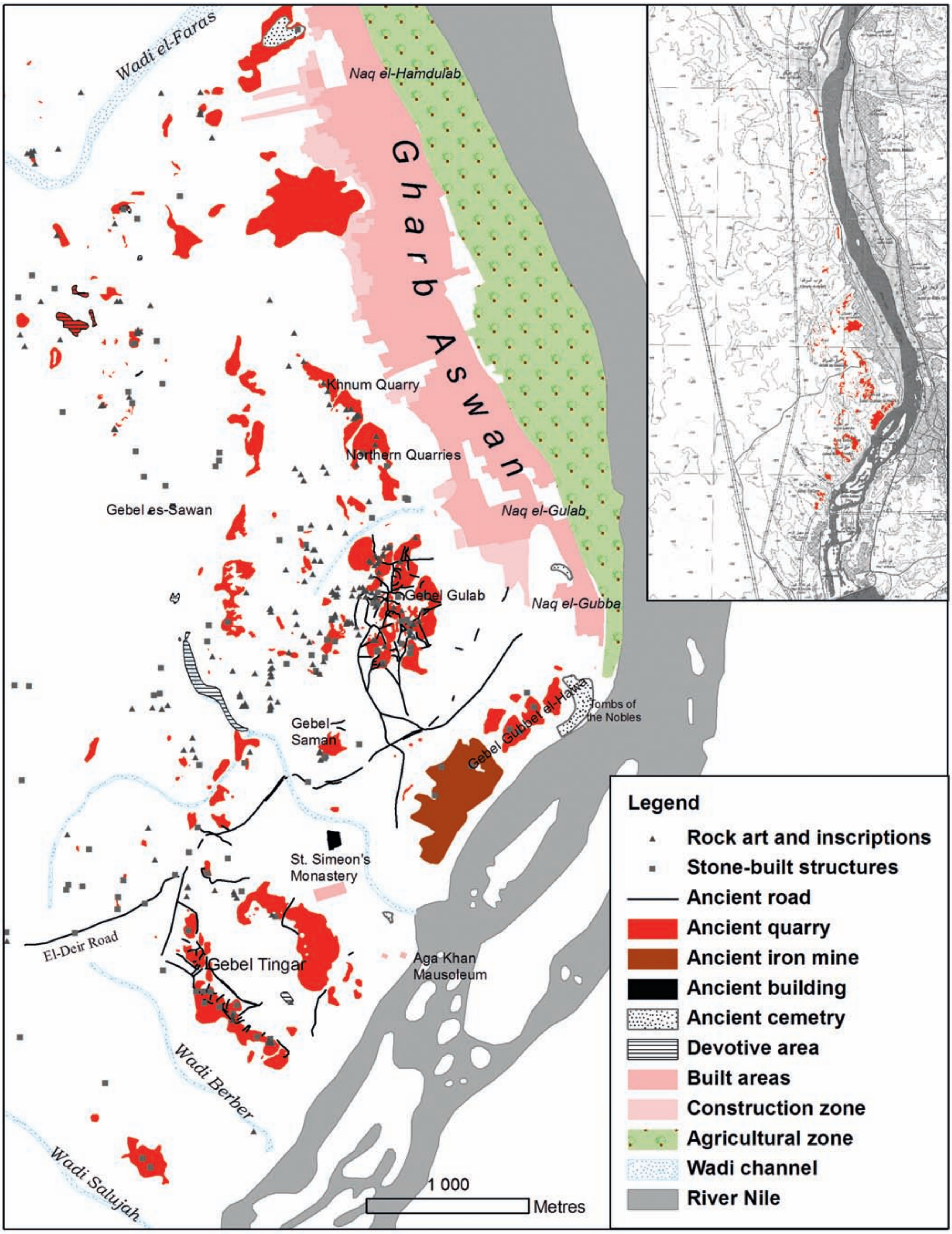

Figure 7. The central part of the Aswan West Bank quarry landscape and the main archaeological elements in the landscape.

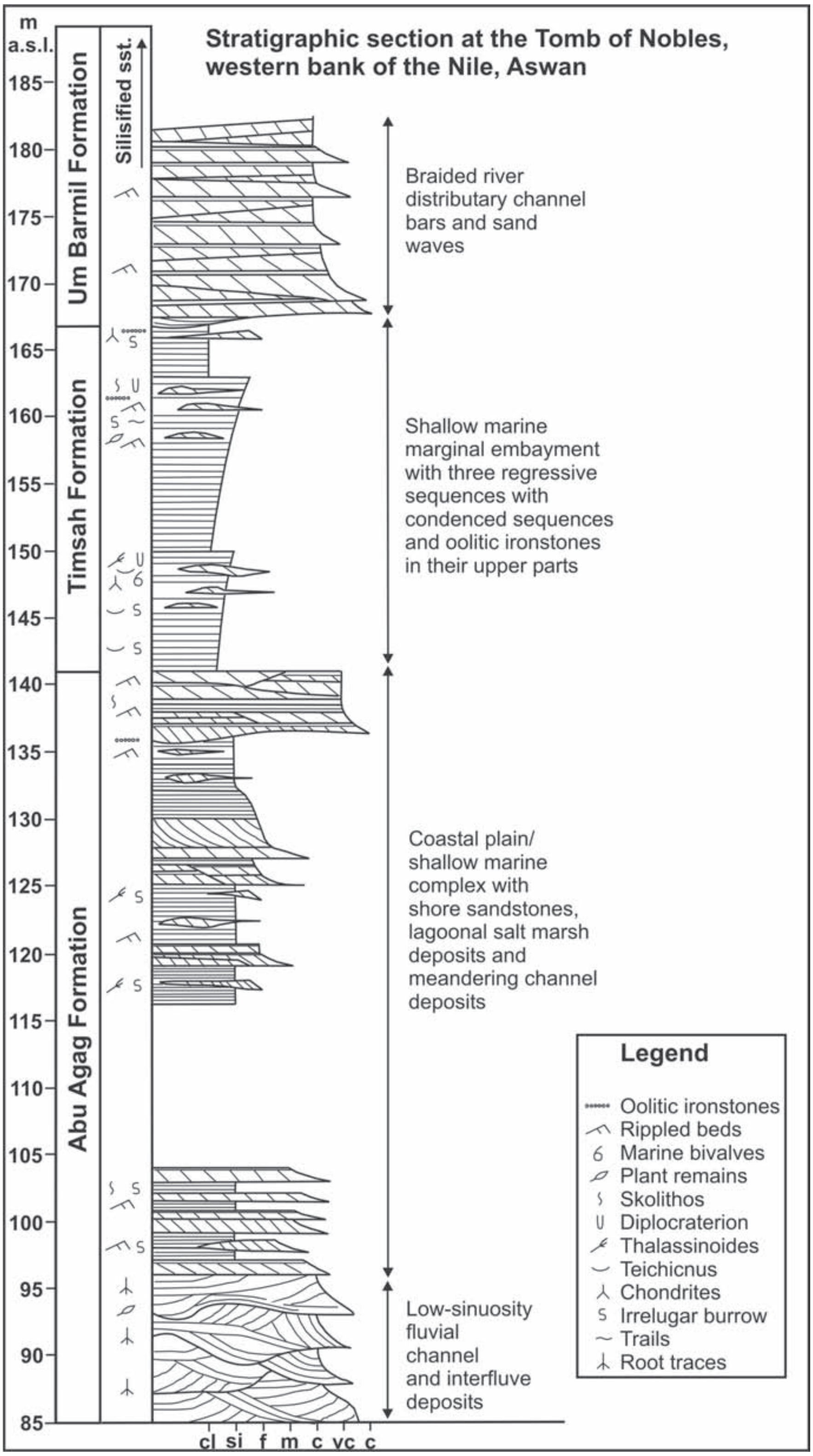

Figure 8. Stratigraphic section through the Nubian Group at the Tomb of Nobles, Aswan West Bank. From Heldal et al. (2007b). Drawing by Reidulv Bøe.

The Timsah Formation represents three shoaling-upwards sequences, each containing mudstones grading upwards to cross- and ripple-laminated sandstone beds. The Timsah Formation contains several thin layers of oolitic iron stone, predominantly occurring on top of the sandstone beds.

The Um Barmil Formation occupies the uppermost part of the topography within the concession area. It lies unconformably on top of the Timsah Formation, and locally, ferruginous conglomerate is developed along its base. It consists of two units of tabular cross-bedded sandstones and conglomerates interpreted as braided-river deposits. A 10 m-thick unit of mudstone, siltstone and rippled sandstone occurs between the two sandstone/conglomerate units. Parts of the fluvial sandstone beds have undergone extreme silica cementation so that they appear much harder than the bulk of the sandstones, and are thus termed silicified sandstone (or 'quartzite'). The first appearance of silicified sandstone is approximately 4–8 m above the base of the formation.

The degree of silicification varies considerably (Figure 10), from porous, poorly-cemented sandstone (target for building stone), to highly silicified sandstone, in which the spaces between the detrital quartz grains are almost completely filled with quartz cement (Figure 11). These variations can be observed both laterally and vertically, and even within single outcrops (Figure 10a). Silicification influences the hardness and the durability of the sandstones; the more silicified ones being extremely dense and durable, and displaying clear and bright colours. The colour is of particular importance when it comes to use of silicified sandstone for ornamental purposes, as will be described below.

The layered succession of mudstones, siltstones and sandstones defines the morphology of the area, with the more resistant, silicified sandstone beds capping hills and terraces, and escarpments formed where erosion has cut through sandstone beds and into underlying mudstones. The silicified sandstone is the most important target for stone extraction in the area, due to its mechanical quality (hardness) and/or aesthetic appearance. The hardness and low porosity has caused the silicified sandstone to be much more resistant to weathering than the other rocks, it thus occurs not only in layers capping the hilltops, but also as 'blocky remains' of the layers scattered across the area (Figure 12). In such

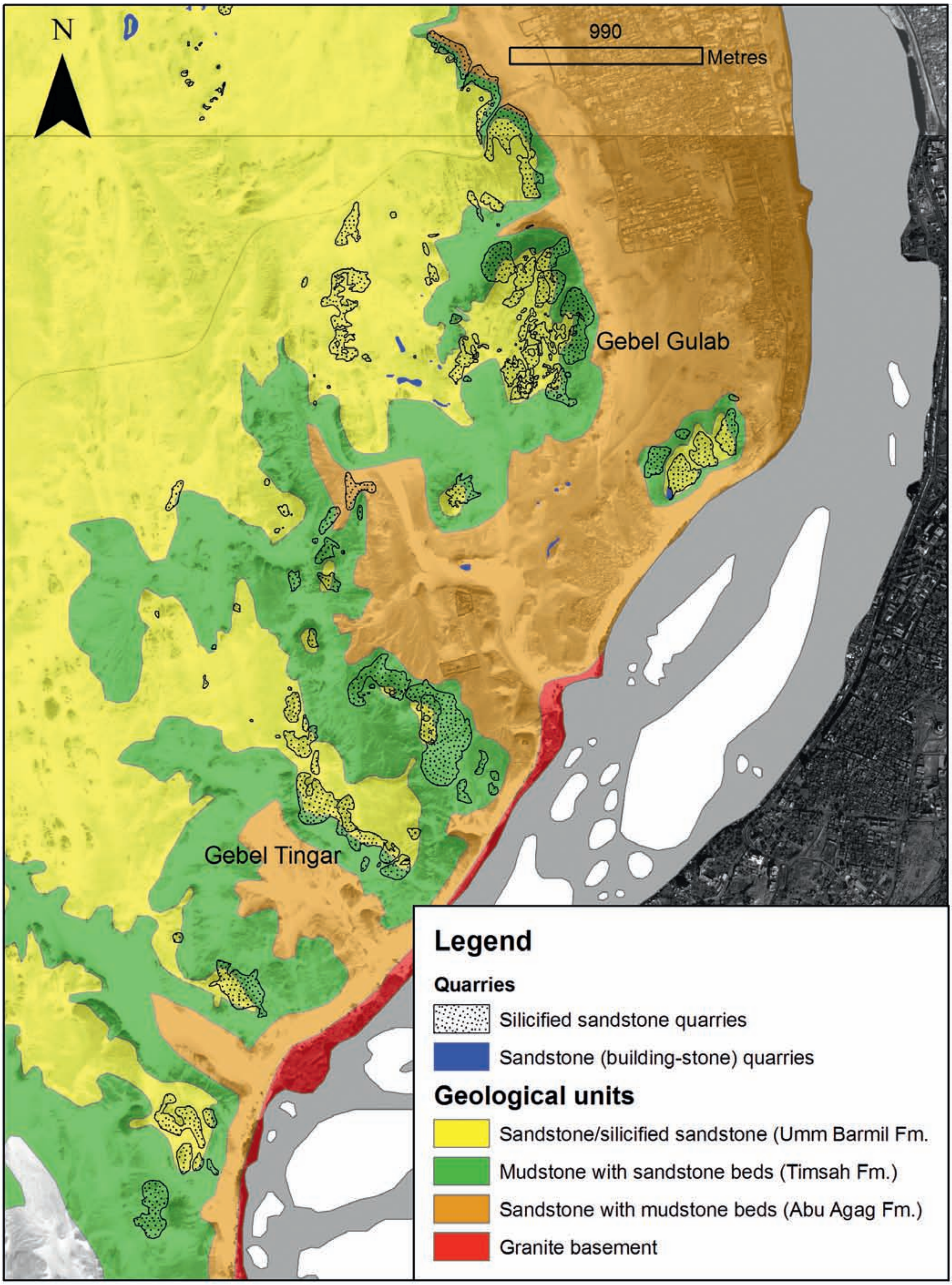

Figure 9. Geological map of the south-central part of the Aswan West Bank and location of main quarries.

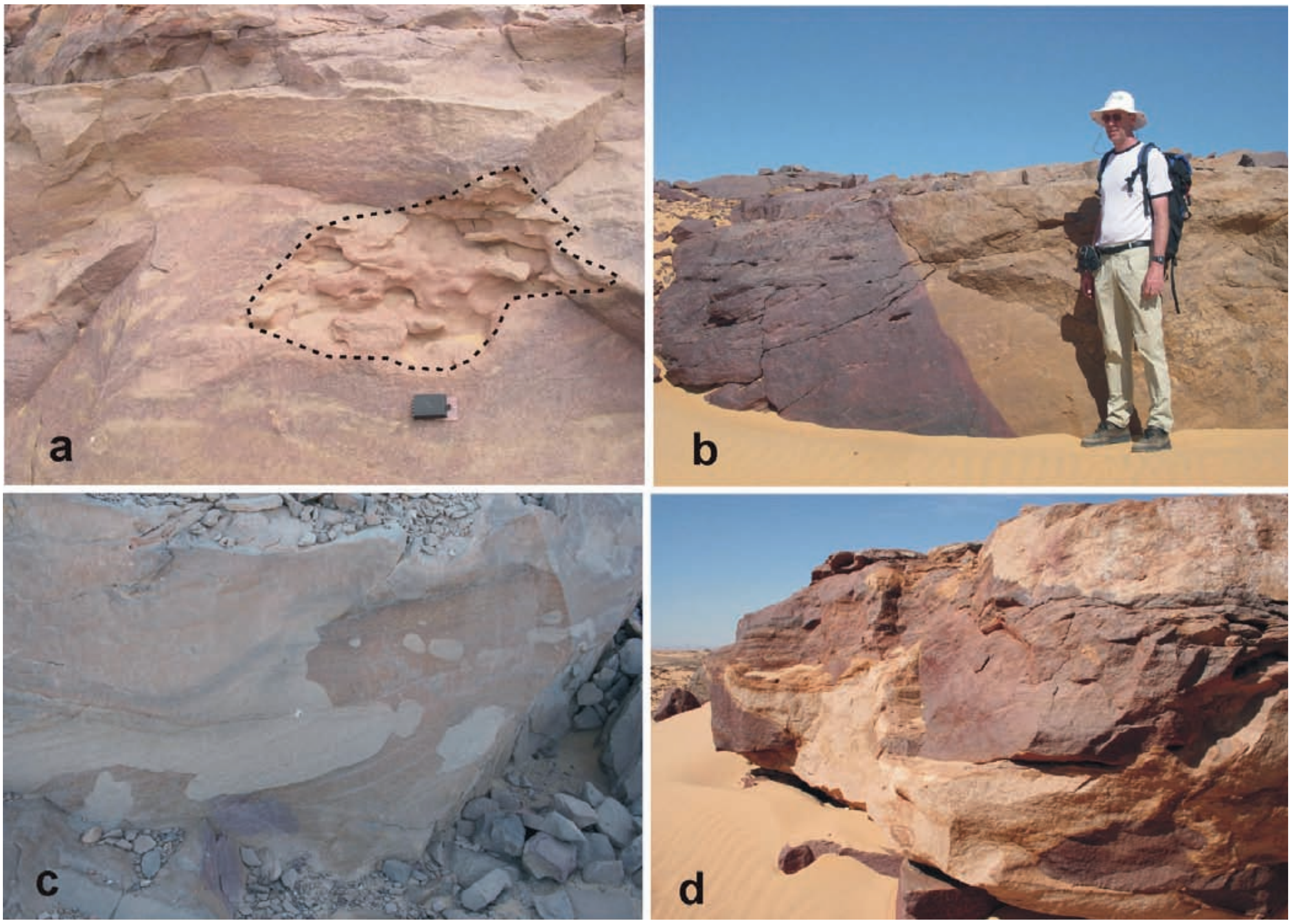

Figure 10. Aspects of silicification on a mesoscopic scale. (a) non-silicified spot in silicified sandstone, (b) border between purple and yellow silicified sandstone, (c) silicified sandstone (darker) in poorly silicified sandstone, (d) lenticular 'flame-structured' zones of purple silicified sandstone in yellow sandstone.

areas, silicified sandstones occur as collapsed, discontinuous block layers more or less in situ in the landscape. However, the farther away from their initial stratigraphic position the blocks are found, the smaller in size and more rounded they are. This aspect is important for interpretation of quarrying methods and chronology; it seems clear that the 'earliest' quarrying for tools and grinding stones targeted clusters of small, rounded blocks, whilst later mass production of grinding stones and ornamental stone quarrying focussed on the large blocks and the solid bedrock. Also 'softer' sandstone varieties have been exploited in the area, but to a smaller extent and mainly in the north, between Gebel el-Qurna and Wadi Kubbaniya. Oolitic iron stone and ferruginous sandstone layers occur in the sedimentary rock succession, and in the central part of the area these have been important sources of hematite and goethite; thus exploited at an early stage for ochre pigment and later for iron ore.

Hence, it is possible to 'deconstruct' the deposits in the area into qualities that fit the different commodities quarried; physical properties as important in the case of the utilitarian production (tools and grinding stone), workability in the case of the building stone quarries and 'rareness'/colour as key value regarding the ornamental stone production (Figure 13).

Finding production evidence

As key for understanding the layers of quarrying activity, the remains from the various steps in the quarrying process needed to be characterised. These include quarry faces/work areas, spoil heaps, tools and artefacts (rough-outs and discarded products). In the silicified sandstone, extraction and block-reduction techniques can be read from the tool marks on the quarry faces (for more detailed descriptions, see Heldal and Storemyr 2007). Simple techniques include levering by widening natural fractures and splitting with stone tools, which are particularly applied in grinding stone quarrying (Figure 14). Splitting with heating, leaving flaked quarry faces combined with large amounts of charcoal in the spoil heaps, are found both related to grinding stone quarrying and quarrying of large objects, such as statues (Figure 15). Channelling with stone tools, similar to the technique used in the Unfinished Obelisk quarry, Aswan (Röder 1965), is seen particularly connected to the obelisk quarrying at and near Gebel Gulab (Figure 16). Dressing of blocks with stone tools is commonly seen where there is evidence for quarrying large objects (Figure 15). Splitting with wedges, as typical for Roman granite quarrying, is found at Gebel Gulab and Gebel Tingar (Figure

17), overprinting previous quarries. In 'softer' sandstone varieties, extraction techniques (predominantly for ashlars) mostly involved channelling with chisels and wedging along the sedimentary layering, similar to methods described from various periods at Gebel el Silsila (Klemm and Klemm 1993) (Figure 18).

The discarded material from quarrying (spoil) can contribute much to the interpretation. The distribution of spoil heaps define the focal point of quarrying (such as concentric ones around extracted boulders), and their stratigraphy the number of quarrying cycles at one defined spot. The size distribution of spoil rock indicates the size of the products made; production of small objects leaves a uniform distribution of small-sized pieces, as in the case of the grinding stone quarries (Figure 19), whilst a variegated composition is found were large objects were targeted. Chips from trimming or dressing may be concentrated at specific spots (designated work areas) or more evenly distributed in-between larger fragments. The shape of the chips themselves gives inferences of whether the production involved trimming of small object blanks (such as grinding stones), dressing of surfaces (as statues and obelisks) or producing flakes (Palaeolithic tool production, Figure 20). At Gebel Gulab, there is also evidence of grinding of stone surfaces, leaving heaps of stratified sand mixed with tool fragments (Figure 17d).

Stone tools or fragments of such are found all over the area. They can basically be divided in three groups: quartz pebbles from ancient river beds in the

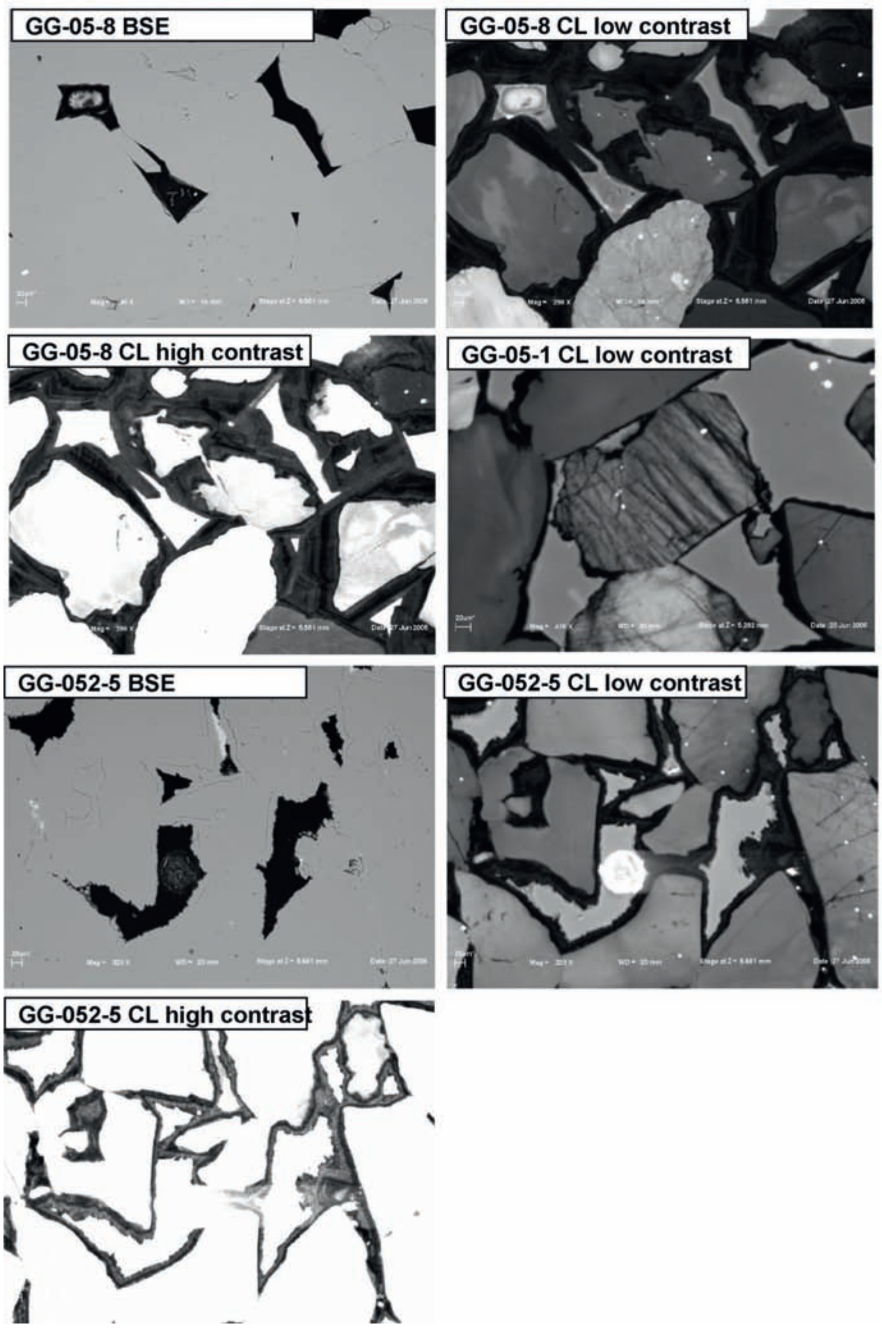

Figure 11. Silicification on a microscopic scale and diagenetic overgrowth patterns. Thick overgrowth (~40 µm) with internal planar zoning (GG–05–8), thin overgrowth (5–10 µm) without internal zoning (GG–05–1) and moderately thick overgrowth (~20 µm) with internal collomorph zoning (GG–052–5).

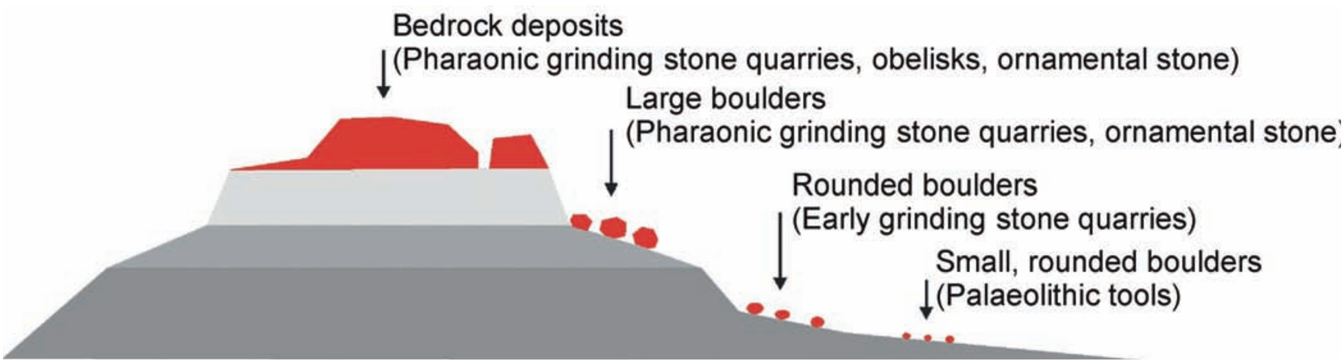

Figure 12. Simplified sketch of the morphology of the Aswan West Bank and occurrences of silicified sandstone deposits.

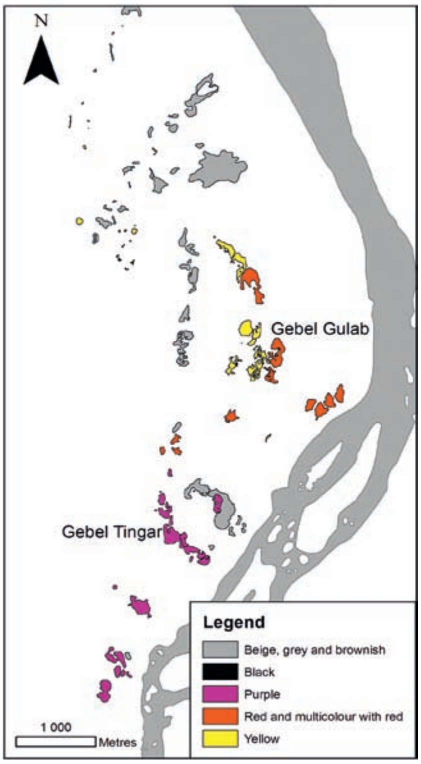

Figure 13. Distribution of colour in the silicified sandstone deposits.

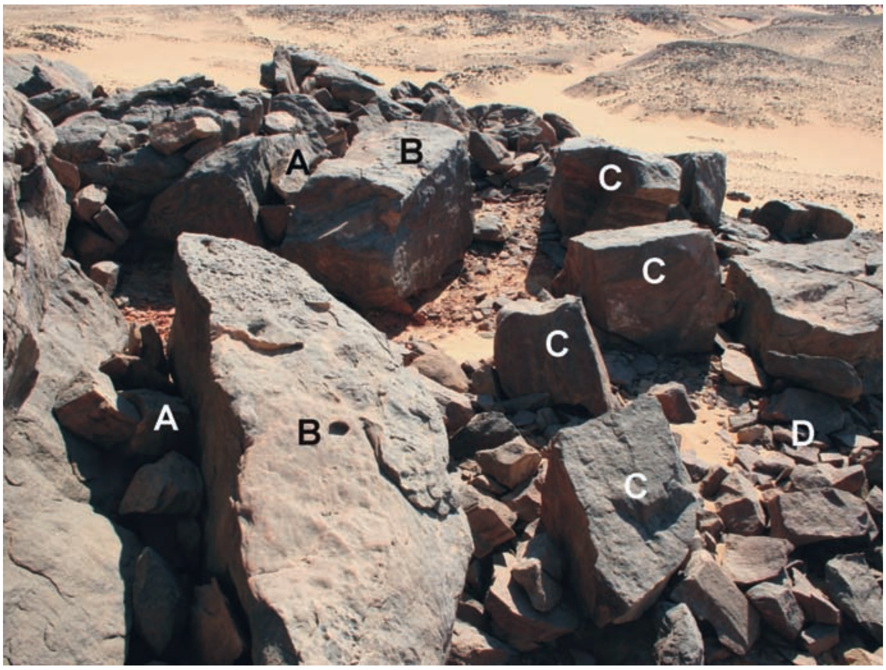

Figure 14. Grinding stone quarry showing different steps of block extraction and reduction. A: primary wedging with stones to open cracks. B: primary blocks. C: secondary split blocks. D: debitage from trimming of grinding stone blanks.

Figure 15. Pharaonic ornamental stone quarrying. (a–b) Area for extraction of large blocks, all removed from the quarry site. (c) Stages of producing statues or obelisks from large blocks. Right: splitting of surface-parallel flakes (by heating?). Left: dressing of surface by stone hammers. (d) Statuette blank made by trimming by stone hammers, similar method as production of grinding stones.

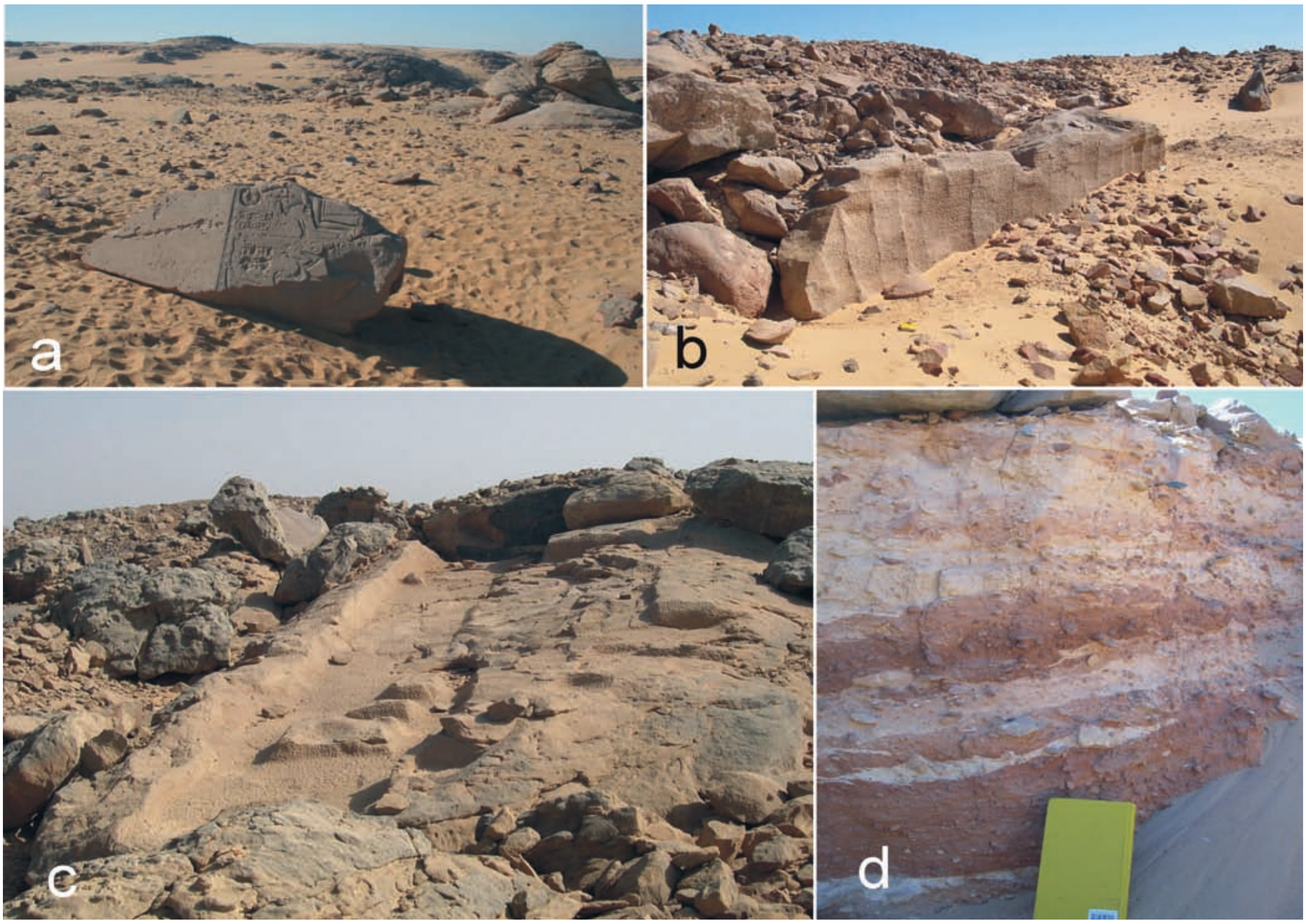

Figure 16. Obelisk quarries. (a) Sety I obelisk tip, (b) quarry face from extraction of obelisk block displaying tool marks from stone tools, (c) initiation of an obelisk quarry displaying initial levelling of the top of the obelisk surface, (d) stratigraphy of sand from grinding/polishing the surface of the obelisk mixed with tool fragments.

Figure 17. Traces of Roman Period quarrying of silicified sandstone. (a) Wedge marks, (b) work area, (c–d) wedges in shallow channels for extracting ashlar blocks.

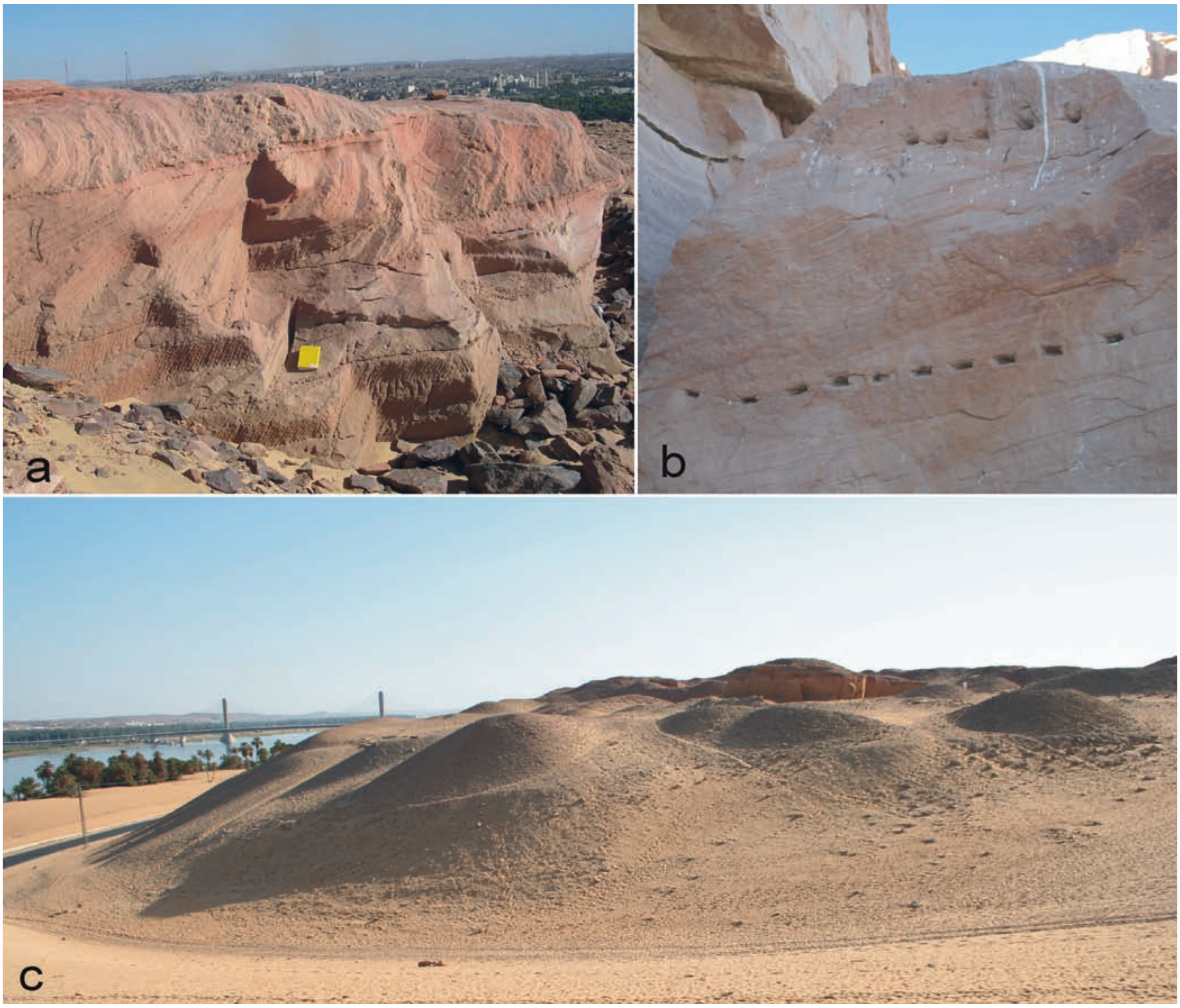

Figure 18. Building stone quarries in 'soft' sandstone. (a) Extraction of ashlar blocks by chiseling channels, (b) wedge marks along sandstone layering, (c) large building stone quarry (Naq el-Fugani quarry, Bloxam et al. 2007) and spoil heaps from production.

Figure 19. Grinding stone quarries. (a) Small and low-scale extraction site of grinding stone blocks, probably dating from the Upper Palaeolithic, (b) circular spoil heaps from quarrying of grinding stones from large boulders of silicified sandstone, (c) Middle Kingdom grinding stone quarry in bedrock, displaying evidence of the use of fire in the extraction, (d) typical grinding stone blanks.

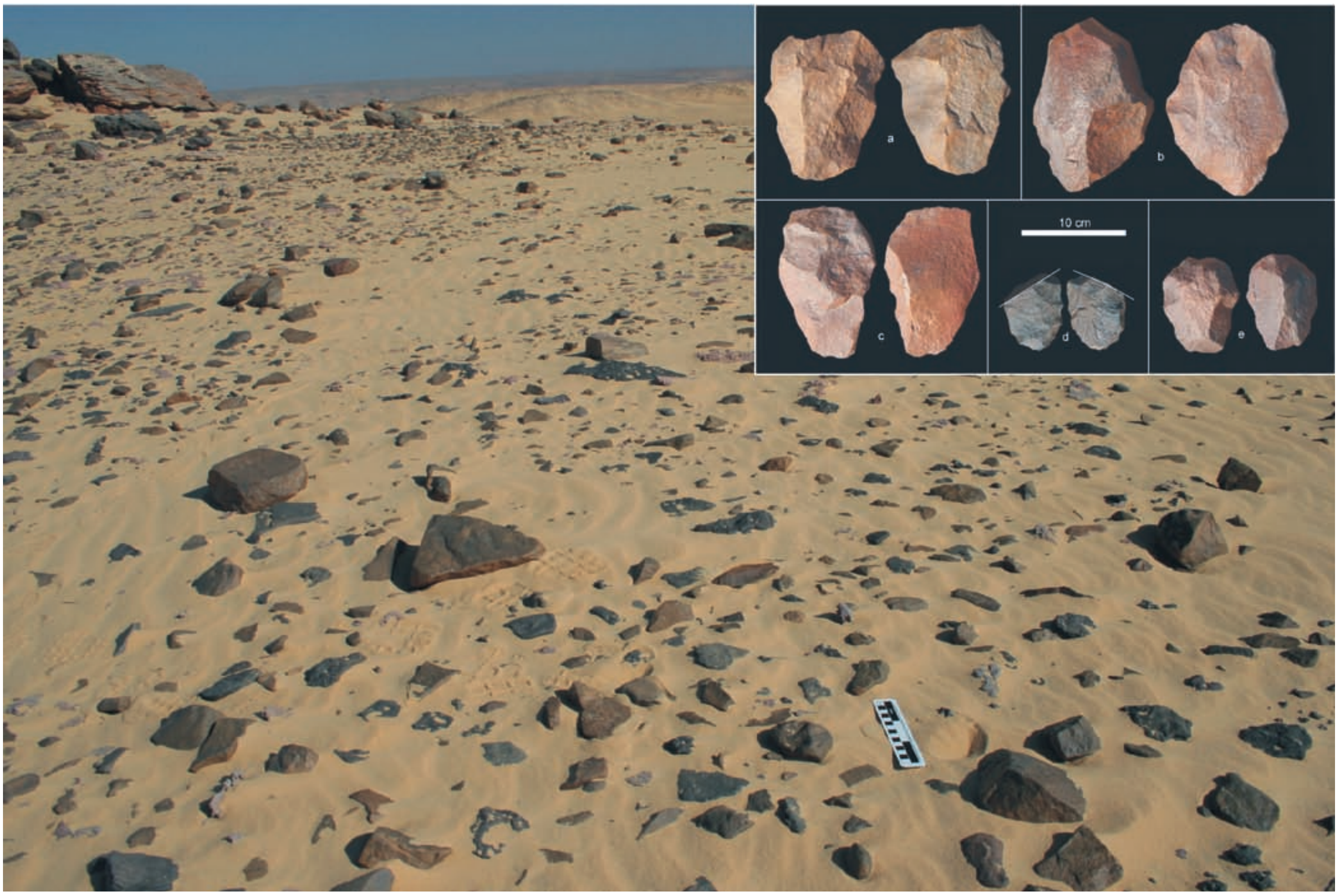

Figure 20. Debitage from production of tools from silicified sandstone cobbles, assumed Lower and Middle Palaeolithic.

Figure 21. Cobble of microgranite from the river bed used as a hammer stone (pounder) in the quarrying of silicified sandstone.

area (only in Palaeolithic tool quarries), cobbles of igneous rocks or silicified sandstone predominantly from the banks of the Nile, and pre-fabricated dolerite pounders, most likely originating from the East Bank (only in and near the obelisk quarries) (Figure 21). No metal tools have been found, although there are traces of slag from smithies connected with the Roman quarrying.

Finally, numerous semifinished or even finished products are recorded, providing evidence of what was produced in the quarries and how far the production went towards finishing. They include Palaeolithic tool rough-outs, oval to rounded grinding stone blanks, semifinished statues and obelisk bases, columns and capitals (from the Graeco–Roman Period), stelae or lintel blocks and ashlars. The well-known Sety I obelisk tip (Figure 17a) is so far the only evidence of finishing in the quarries, down to its inscriptions.

Collectively, the remains from production made it possible to interpret different production processes (Table 2). When such interpretations are combined with the spatial distribution of quarries, we get a picture of the size and distribution of different types of quarrying. For example, we see that the grinding stone quarrying in volume largely overshadows the other quarrying activities (85% of the quarrying area). Even in areas where there has been significant production of statue blocks, it turned out that most of the spoil was produced in the making of grinding stones.

As shown in Table 2, the remains from production can also aid in identifying evolutionary patterns. The earliest grinding stone quarrying involved just a few steps in the production process, exploiting clusters of naturally occurring blocks of silicified sandstone—up to one metre in size. At later stages, larger blocks and even bedrock were targeted and so production involved more steps of extraction and block reduction, but the semifinishing remained the same through thousands of years.

Quarry logistics

As the grinding stone production did not need any elaborate infrastructure, most of the remains of quarry roads are related to the movement of large objects from the quarries. Hence, the existence of road construction also provides evidence of where blocks actually were brought out of the quarries. Quarry roads are predominantly found in the Gebel Gulab (Figure 22) and Gebel Tingar areas. They include slipways and built-up ramps (for moving blocks from one level to another), causeways (built-up structures for evening out topographic features), paved roads, stone-

Table 2. Interpretation of the production processes for different quarry activities at the Aswan West Bank.

Activity	Extraction	Block reduction	Semifinishing	Finishing
Palaeolithic tools		Splitting of small boulders to cores, using quartz pebbles from riverbeds	Producing flakes (Acheulean, levallois) from cores with quartz pebbles	
Upper Palaeolithic grinding stone		Splitting scattered blocks with pounders into few cores	Trimming of cores to roughly shaped grinding stone bases with light pounders	
Predynastic(?) grinding stone	Extracting blocks by levering along natural fractures	Splitting blocks with heavy pounders to cores	Trimming of cores to roughly shaped grinding stone bases with light pounders	
Middle/New Kingdom grinding stone	Producing cracks on bedrock surface or large boulders by heating with fire and using heavy pounders, resulting in large flakes		Trimming of flakes to roughly shaped grinding stone bases with light pounders	
Pharaonic ornamental stone quarrying		Removing weathered surface of boulders and rough shaping of their perimeter by heating and trimming with pounders	Dressing with pounders	
Sety I Obelisk quarrying	Channelling in the bedrock by dolerite pounders, possible combined with heating		Dressing of surface with pounders	Honing of surface with grinding stones and inscribing
Roman ornamental stone quarrying	Splitting of blocks from bedrock by wedging (Roman style)	Splitting of blocks with wedges	Dressing of surface with mallet and chisel, producing roughly shaped columns and other objects	
Graeco–Roman building stone quarrying	Channelling by mallet and chisel, splitting loose blocks along sedimentary layering with wedges		Dressing of ashlar blocks with mallet and chisel	

aligned roads, cleared tracks and regular dirt roads. More detailed descriptions may be found in Heldal et al. (2007a).

By characterising the roads themselves and combining with production evidence, two recognisable logistical systems emerge (Figure 23): one from the Pharaonic Period (mainly New Kingdom) and one from the Roman. The Pharaonic system includes the wide causeway in front of the Sety I obelisk tip (Figure 24), slipways, ramps and paved or stone-aligned roads, most of them approximately two metres wide. The roads are similar to the 11 km-long, Old Kingdom quarry road from the Widan el-Faras basalt quarries (Caton-Thompson and Gardener 1934) and assumed New Kingdom quarry roads at the Aswan East Bank (Kelany et al. 2009), and were probably designed for supporting sledges

Figure 22. Pharaonic quarry roads, Gebel Gulab.

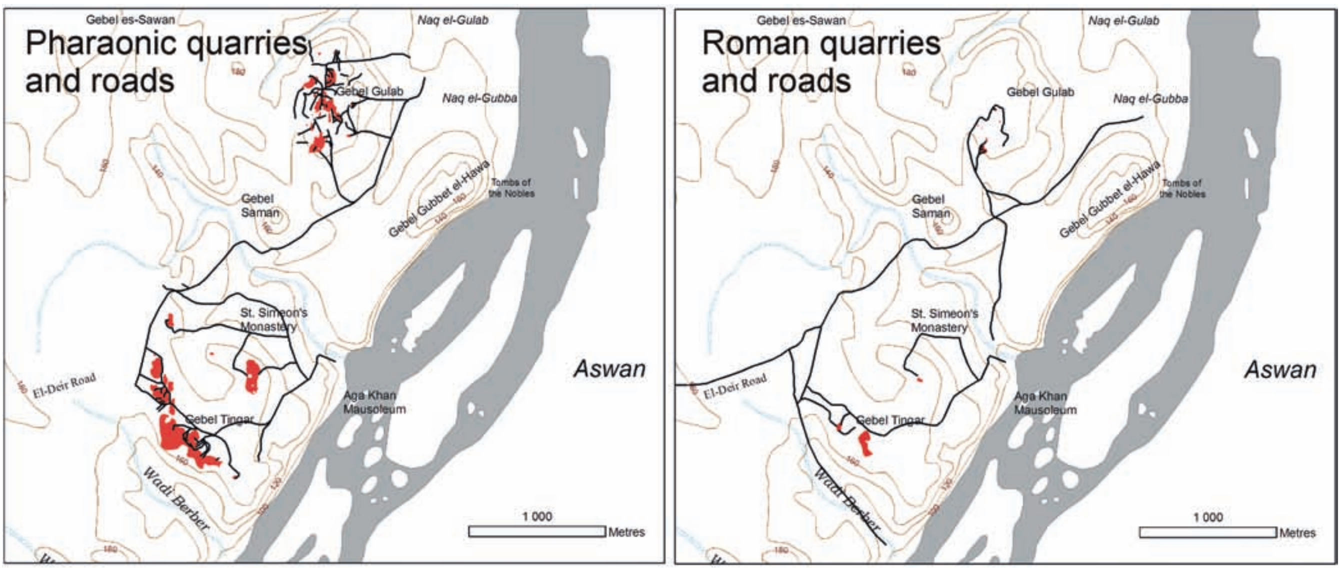

Figure 23. Interpretation of the quarry road systems at the Aswan West Bank linked to ornamental stone quarries. Quarries in red, associated roads shown as black lines.

running on top of a layer of logs. In the Roman Period, some of the routes were reused, but now in the shape of wider, cleared tracks and dirt roads, probably made for wagons. The Roman roads tend to climb downwards along the perimeter of the steeper hills, in order to minimise the inclination. In the Roman Period, a wide, cleared track went through the area. This was by Klemm et al. (1984) interpreted as a quarry road, but the track leads evidently westward into the desert (el Deir Road, see Storemyr 2007). However, the lower part of the road may have been used also as a quarry road.

Figure 24. Built-up causeway leading from the Sety I obelisk.

People in the quarries and in the landscape

The Aswan West Bank is a rich cultural landscape used for thousands of years, not only for quarrying. One of the key problems is therefore to distinguish between features related to quarrying and those linked to other use of the landscape (see descriptions and discussion in Bloxam and Kelany 2007).

Numerous stone-walled structures have been recorded (Figure 25). Most of these are ephemeral, reminiscent of simple shelters from the sun and wind (Figure 26). Some of them have a close, spatial connection to quarries, others to the road system (lookouts) but many may be related to other activities, such as hunting, the Coptic monastery, travelling along the desert routes and even modern contexts.

Similar ambiguity exists regarding the ceramic evidence. Are the ceramic remains found in the quarry areas actually related to such? In some cases, it is likely to assume a connection, due to the close spatial relationship between ceramics, shelters (connected to quarries) and production remains (ceramics found in work areas). Furthermore, the ceramic evidence tends to cluster in the main quarrying areas—Gebel Tingar and Gebel Gulab. Given such limitations, there are two main groups of ceramics—the New Kingdom and the Roman Period. In addition, there are more scattered findings of Predynastic, Old Kingdom and Middle Kingdom pottery.

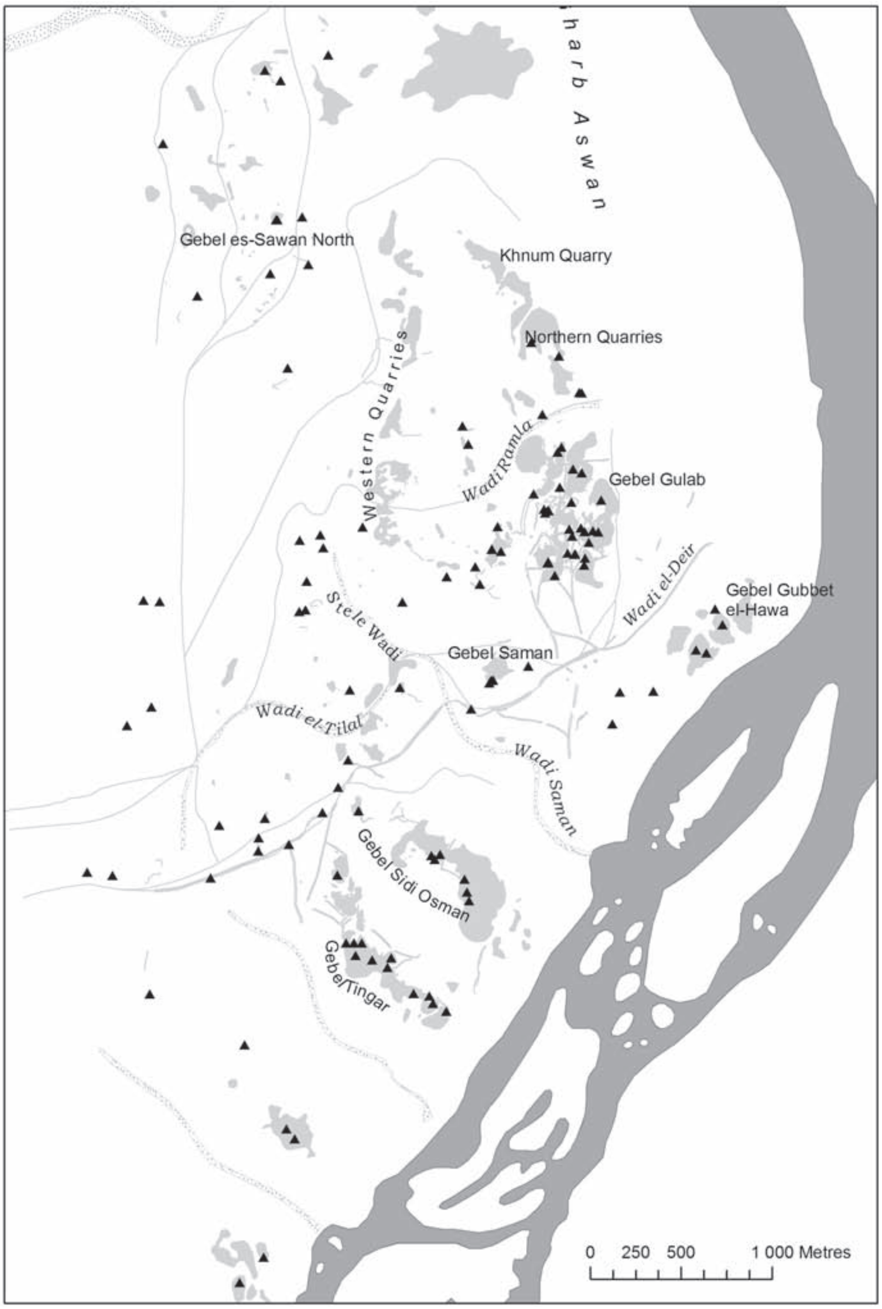

Figure 25. Distribution of stone-walled structures (triangles) and quarries (grey areas) at the Aswan West Bank.

Figure 26. A simple, stone-walled structure around natural outcrops by one of the obelisk quarries, probably a shelter for the quarrymen.

The area is rich in epigraphic data. Rock art from several periods are found all over the area (Storemyr 2007), but with few exceptions, the connection to quarrying remains unclear. Hieroglyphic inscriptions and graffiti are more evidently in context with quarrying, and in particular the 18th Dynasty of the New Kingdom (Bloxam and Kelany 2007). These include the hieroglyphic symbols for *mr-Ra* ('beloved of Ra') found on rock surfaces within the assumed Sety I obelisk extraction sites (Figure 27), in one case also directly associated to a cartouche of Sety I. An iconographic depiction of a Pharaonic Period boat, measuring 1.5 m long by 1 m high (Figure 28), was an important addition to the corpus of rock engravings that date specifically to the 18th–19th Dynasties of the New Kingdom. In the Khnum Quarries, north of Gebel Gulab, is a shelter/overhang between two large stones, on the internal faces there are many inscriptions in different types and size, with some graffiti of boats, ships, fish and images of men and women. Another *mr-Ra* sign was found beside the shelter area and also a rare incidence of the name of a person who could be the 'overseer' of the quarrying:

"Overseer of the Building Jw-Khnumw, true of voice."

Although there are more names that are still in the process of translation, these names give an indication about the

Figure 27. 'Beloved of Ra', one of the mr-ra *signs found near an obelisk quarry.*

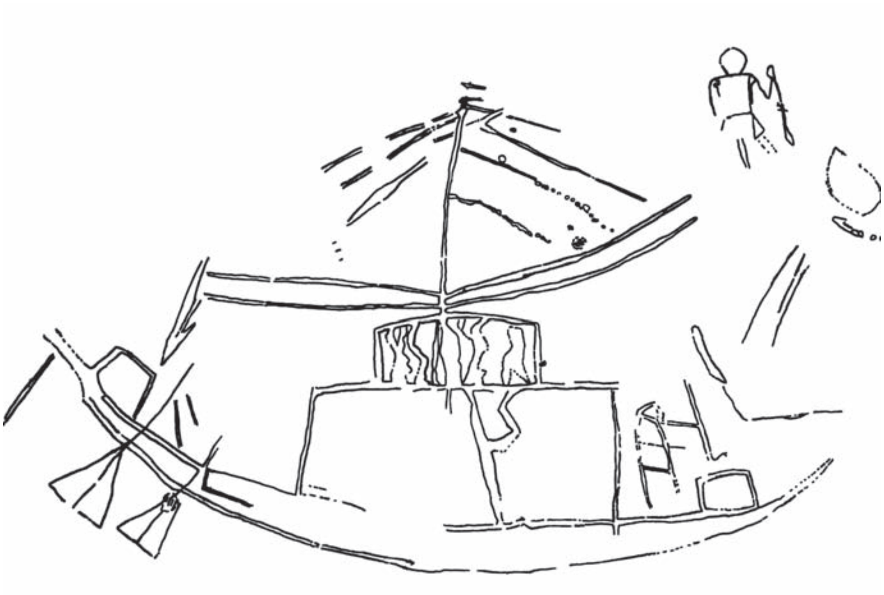

Figure 28. Depiction of a New Kingdom vessel found near an obelisk quarry, Gebel Gulab. Drawing by Adel Kelany.

titles and names of people working in the quarry in Dynastic times.

Several inscriptions have been recorded by other authors from the Graeco–Roman Period. Although many of these graffiti probably refer to the names of quarry workers, one is particularly interesting as it refers to an architect with the name 'Prepalaos son of Orestês forgeron of Memnon'. Fournet (1996, p. 144–146) suggests that Prepalaos may have been sent to the West Bank to quarry for silicified sandstone restoration blocks, on the orders of Roman Emperor Septimie Sévère, to repair the Colossi of Memnon between the end of 2nd century to early 3rd century AD.

Other man-made structures found at the Aswan West Bank include a large system of stone alignments (game drives, Storemyr 2007) and burials from different periods, often reusing quarries (Bloxam and Kelany 2007).

The Aswan West Bank quarry landscape in time and space

The Aswan West Bank comes forward as a quarry landscape of high complexity, with great time depth and exploitation of several stone commodities (utilitarian, building stone and ornamental stone), creating many layers of connected and less connected quarrying activities. Analyses of the material remains from the quarrying and the resource itself made it possible to identify and map such layers, thus separating grinding stone quarrying from ornamental, Roman quarrying from Dynastic times, etc. Consequently, the quarry landscape was 'deconstructed' into a number of complexes, each being a unique type of quarrying activity, targeting different parts of the resource, using different quarrying technology and producing different types of product (Figure 29). Some of them also have a recognisable logistical system (see Bloxam et al. 2007, Bloxam and Heldal 2008).

The oldest defined complex is the Palaeolithic tool quarries. Only small patches remains, others are either removed by erosion or overprinted by later quarrying. The oldest assemblages are Achuelean from the Lower Palaeolithic (between 150 and 700 ky) (Bloxam and Moloney 2009). Such production sites are rare, and definitely add to the overall importance of this quarry landscape. In addition, there are several Middle Palaeolithic tool quarries (op. cit.), frequently found in the same spots. In the Upper Palaeolithic, the use of silicified sandstone for sharp tools decreased, substituted by chert from slightly more distal sources and 'Egyptian Flint'. One exception is Sebilian assemblages (10,000–12,000 BP) in which particularly ferruginous sandstone is more common (Wendorf and Schild 1989).

The grinding stone complex is by area and volume the largest (approximately 85% of the quarrying area). Its time depth spans from the Upper Palaeolithic to at least the Roman Period. The earliest grinding stone quarrying, first described by Roubet (1989), involved quarrying of roughly shaped querns (lower grinding stones) for grinding roots. Although the evidence of the evolution of grinding stone production in the area yet remains fragmentary, clearly in Pharaonic times it involved mass production of ovalshaped lower grinding stones and 'loaf'-shaped upper ones for grinding cereals. The earliest quarrying involved few steps (Table 2), exploiting clusters of naturally occurring blocks of silicified sandstone, up to one metre in size. Block reduction involved splitting by percussion with stone tools. Thereafter, the resulting cores were trimmed by removing small scales from its surface until a more or less regular shape was produced. Finally, the perimeter of the grinding surface was 'retouched' with finer tools producing a grinding stone blank.

The semifinishing step of grinding stone production basically remained the same all the way up to the Roman Period. The blanks were never completely finished in the quarries, final fitting, and possibly smoothing the grinding surface, was carried out elsewhere. The first production steps, however, vary, most likely chronologically. It seems that in the Predynastic and Early Dynastic Periods, larger blocks were extracted from their in situ position in the silicified sandstone layers by levering, followed by at least two steps of block reduction (Figure 14). In the Middle and New Kingdom, some quarries display extraction of small blocks directly from the bedrock by heating (fire setting), each of these being worked to one grinding stone blank (Table 2). These are just some examples, but they illustrate the differences between the grinding stone quarries (more sophisticated extraction) and (not least!) the similarities—how the methods of

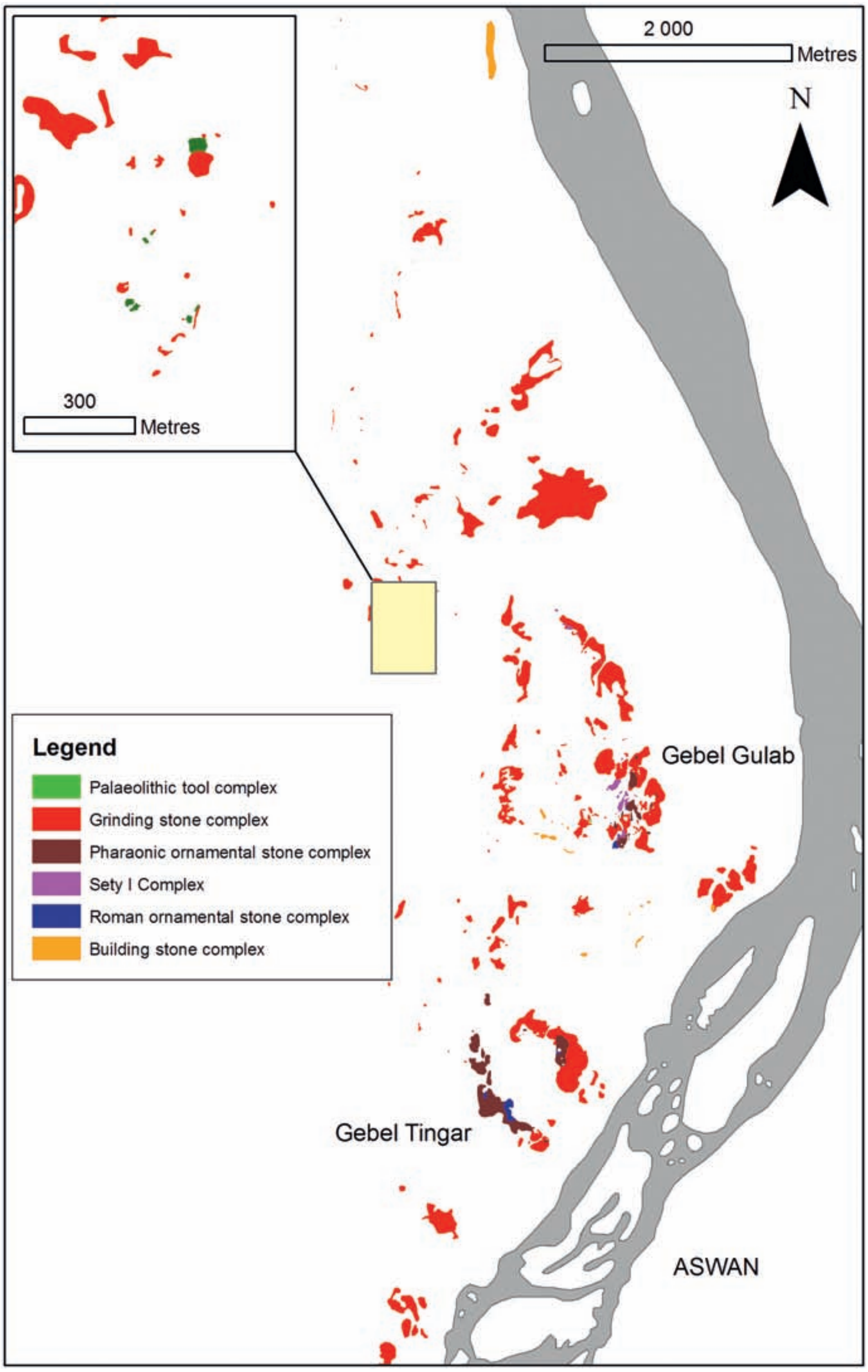

Figure 29. Spatial distribution of quarry complexes at the Aswan West Bank.

producing the blanks remain the same for thousands of years.

For ornamental purposes, silicified sandstone came into use during the 4th and 5th Dynasties of the Old Kingdom. During the Middle Kingdom use of the stone for monumental purposes, such as stelae, statuary, wall linings and lintels was maintained (Aston et al. 2000). However, it was during the New Kingdom that the use of silicified sandstone in monumental architecture, colossal and life-sized statuary, obelisks, lintels, stelae and small statuettes, reached its highest level. Historical sources suggest that this overwhelming use of silicified sandstone in the New Kingdom, particularly in the 18th Dynasty (1390–1352 BC) reign of Amenhotep III, was associated with a refocussing of religious ideas to solarise the major cults of Egypt in which the colours of the silicified sandstone played an important symbolic role (Bloxam 2007, p. 42–43, and references therein). By the following Amarna Period (1352–1336 BC), solarising of the royal cults reached its zenith. Hence silicified sandstone remained one of the principal hard stones used for royal statuary; in particular there seems to be a marked increase in the use of the purple variety. Moreover, it seems that there was a transformation from the monumental-scale use of the stone during the reign of Amenhotep III to generally smaller, highly crafted statuettes of the Amarna Period (op. cit.).

After a hiatus of approximately 80 years, the consumption record sees a short revival in the use of silicified sandstone for royal ornamental and monumental purposes during the reign of Sety I in the early 19th Dynasty (1294–1279 BC). Having modelled himself on Amenhotep III, the use of silicified sandstone for obelisks (including a truncated obelisk form that rests on a wider base) and colossi was again sought after (Brand 2000, p. 128, 360). It is important to note that a number of large building programmes, particularly in the Luxor Temple at Thebes (modern Luxor), were not completed due to Sety's early death (Brand 2000, p. 365, 384).

Seen from the quarries, Pharaonic ornamental stone production seems to have involved several activities. Firstly, in the areas where there are grinding stone quarries situated in the attractive red and purple varieties of the silicified sandstone (mostly the southern part of the area), there is evidence of production of small statuettes and possibly bowls and plates. From the consumption evidence, it is tempting to suggest that at least some of this activity is from the Amarna Period. Interestingly, this activity seems to have gone hand in hand with grinding stone production, displaying evidence of the use of the same tools and techniques for making the blanks (Figure 15d). Thus, blurring the 'boundary' between utilitarian and ornamental stone production.

A group of quarries situated in red, multicolour and purple varieties has collectively been defined as a Pharaonic ornamental stone complex. This quarrying involved production of large blocks, from in situ block layers or loose boulders. A few remaining blocks in different stages of production indicate that the first production step involved removal of the weathered surface by the use of heat and pounders. Next, the blocks were dressed with pounders before they were removed along the constructed ramps and roads. Klemm and Klemm (1984) suggest that much of this activity may be assigned to Amenhotep III.

One activity of Pharaonic ornamental stone production has been identified as a particular complex: the Sety I Complex, based on the famous obelisk tip. The targeted resource was yellow, moderately silicified sandstone, occurring only at Gebel Gulab and along an escarpment further to the north (Khnum quarries). The quarrying seems to mainly have involved production of obelisks, obelisk bases and possibly also truncated obelisks. Predominantly, the quarrying focussed on massive layers of sandstone, in which it was possible to obtain the large sizes needed for the obelisks. The technology involved was exactly the same as in the case of the Unfinished Obelisk quarry in Aswan: levelling of surfaces by shallow channels around 'pillows' of remaining rock, which then were split, probably aided by fire, and making wide channels around the attempted blocks leaving the same tool marks as in the granite quarries. Even the tools (pounders) were made of the same dolerite type found in the granite quarries, and seem to have been brought to the West Bank from the same source. Also, the Sety I Complex is the only one in the area displaying evidence of complete finishing in the quarries, down to honing of the obelisks and inscribing them. In contrast to the other Pharaonic ornamental stone quarries, there seem to be few objects that actually were brought away from the Sety I quarries, due to the many half-finished objects, quarries just in their initial phase and the lack of logistical infrastructure associated with some of them (particularly the Khnum quarries). In fact, it seems that work going on in many quarries simultaneously suddenly stopped. It is tempting to suggest that such a sudden halt in production was related to the death of Sety I.

The Roman ornamental-quarry complex in silicified sandstone involved the production of squared blocks for unknown purpose, columns and probably a range of medium-sized products. The quarrying technique is similar to other Roman Period hard-stone quarrying, in which splitting by wedges is primary. Designated work areas where the extracted blocks were brought for reduction and semifinishing are common. However, the Roman activity was rather small scale, and involved 'revisits' to previous quarry areas, particularly at Gebel Gulab and Gebel Tingar. As shown above, it also involved building of new roads and reworking of older ones more suitable for the period's means of transport.

The remains of building stone quarries (building stone complex) are found in the softer sandstone varieties all over the area, but particularly in the north. Most of them seem to belong to the Graeco–Roman Period, involving extraction of ashlar blocks (for yet unknown buildings/purposes) by chiselling channels around them and splitting along the base by wedging. But some of them may date back to the Old Kingdom (Klemm and Klemm 1993) and others as late as the Coptic Period (i.e., quarrying for the St. Simeon Monastery).

Back together: new perspectives of the Aswan West Bank

After such an exercise of deconstructing the Aswan West Bank quarry landscape into several complexes by interpreting their characteristic elements from the empirical data, the complexity of it becomes easier to understand. The different quarrying activities originating from different needs for raw materials through many periods resulted in layer upon layer of quarries. This can be visualised by defining such main activities as complexes, which can be seen as projections of different quarrying activities, needing different ways of evaluation when it comes to conservation. The Pharaonic ornamental stone quarrying may, for instance, be important projections of solar symbolism in the New Kingdom (Heldal et al. 2005), and of New Kingdom quarry logistics.

Even more important is that the analyses have changed the overall perception of the quarry landscape, in its totality, significantly. The 'old view' of the quarry landscape as being almost solely created by massive Pharaonic ornamental stone quarrying for the elite (as expressed by Klemm and Klemm 1993 and shared by ourselves in the beginning of the field work) has been replaced by the view of a huge landscape made by utilitarian stone production over tens of thousands of years, where the ornamental stone quarrying represents a relatively minor activity in time and space, superimposed on the utilitarian quarry landscape. Clearly, such a view must have impact on how we regard this particular quarry landscape. Although the ornamental stone quarrying, with its logistics, is an important feature of the landscape, its greatest significance may be found in its longevity—perhaps the most long-lasting quarry landscape in the world displaying human engagement with a specific resource throughout human history (Figure 30). In such a context, the importance of the more 'invisible' and less spectacular remains becomes more obvious. Furthermore, even though it can be argued that there may be better examples elsewhere of all of the individual complexes (i.e., the Unfinished Obelisk quarry in Aswan is 'better' than the ones at the West Bank), the fact that so many different periods and purposes of quarrying are found in one area, should in itself be considered as a major aspect of significance.

Conclusion

Features related to ancient quarrying may be described and characterised in a systematic way by dividing them into four main elements: the resource, the production, the logistics and the social infrastructure. This provides a useful method of connecting physical remains in quarries to processes, technology and organisation, by micro-level analy-

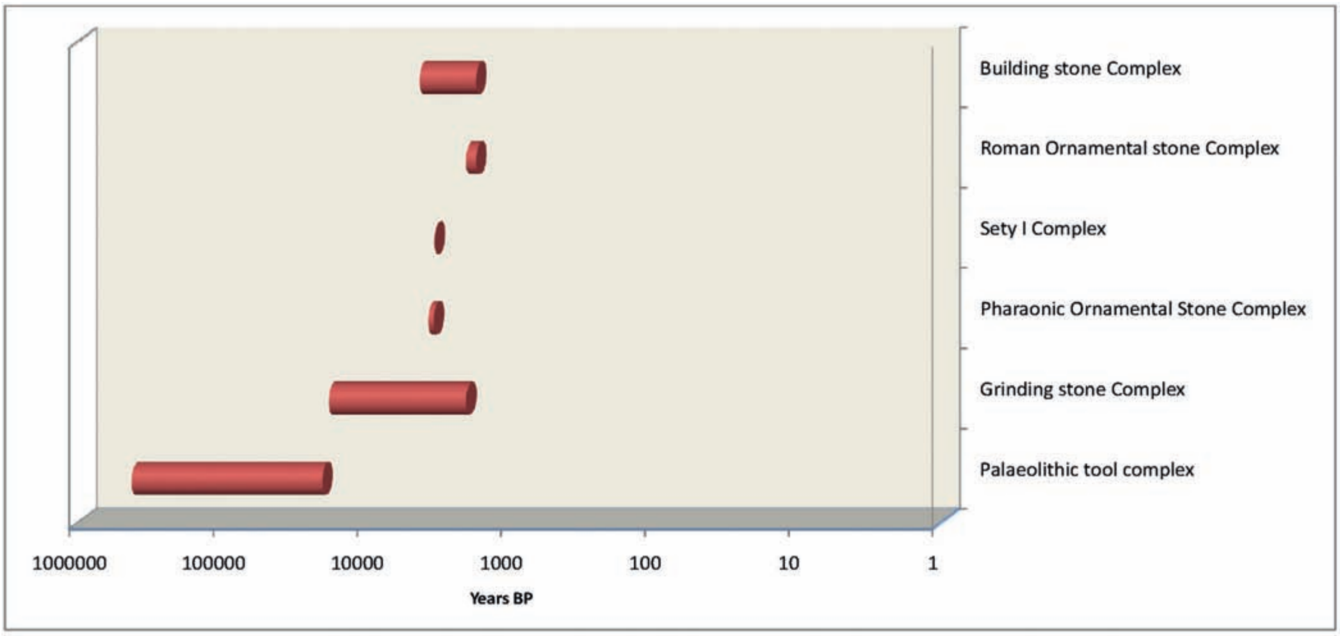

Figure 30. Time depth of quarry complexes at the Aswan West Bank. X-axis shows years, logarithmic scale.

sis. Finally, the term 'quarry complex' is introduced as a necessary tool of interpretation, in-between a quarry and a quarry landscape. We believe that defining such complexes helps in visualising complexities in quarry landscapes, and extracting individual characteristics that can aid the articulation of significance. The complexity of the Aswan West Bank quarry landscape was in itself one of the main reasons to develop a methodology that could separate one quarrying activity from another.

By using a characterisation method that on the one side is standardised enough to allow comparison between different places and different periods and 'open' enough to take heights of the individual characteristics, the evaluation of such landscapes can be made easier and more targeted—when the aim is to build a strategy for conservation and management. This method embraced new approaches in heritage management which have stressed the appropriateness of holistic landscape perspectives, and adopting 'characterisation' as a means to document and understand the distinctive characteristics (material remains) of a place (see discussion in Schofield 2008, p. 19, Fairclough 2008).

In the case of the Aswan West Bank, the characterisation of the resources and the material remains together with interpretation of production techniques and logistics lead to the identification of connected activities and finally to the reinterpretation of the quarry landscape. This also had an impact on how we evaluate the significance of such landscapes from a purely elite stone procurement, towards a composite system of quarrying through deep time. When deconstructing the quarry landscape into its complexes, it is also easier to point at particularly important places for future conservation that are good informational projections of the different activities.

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