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Summary:				
<p>Chephren's Quarry is one of the world's oldest hard-stone quarries. It is situated in the easternmost part of Sahara – covering nearly 100 km² of flat, hyper-arid desert, some 60 km west of Lake Nasser (River Nile) and the famous Abu Simbel temple in the extreme south of Egypt. Lately, it has been discovered that this unregistered, archaeological site of great importance, is seriously threatened by modern development – the canal and irrigation work related to the South Valley Development Project. An initiative to a Norwegian – British – Egyptian project aiming to provide accurate maps and documentation of the Chephren's Quarry site, was taken, and field work was carried out January 2003.</p> <p>The mapping and documentation work in January 2003 were carried out by the Geological Survey of Norway (NGU) with help from the Geological Survey of Egypt (EGSMA), supported by the Norwegian Directorate for Cultural Heritage (<i>Riksantikvaren</i>) and generous funding by the Norwegian Ministry of Foreign Affairs. Simultaneously, our partner, a British team of archaeologists undertook archaeological excavations in the area. This part of the project was funded mainly by the Egypt Exploration Society (EES) and University of Liverpool.</p> <p>In total, 5 ancient stone quarry areas, one ancient mine and an ancient road were mapped. This included approximately 700 ancient quarries (of these 40 large ones) and 2-300 features related to ancient infrastructure. The mapping was done with GPS and field computers. Several thematic maps were made, including accurate maps of the areas of interest for future protection. Maps and databases were handed over to the EAIS (Egyptian Antiquities Information System) project of the Supreme Council of Antiquities. In addition to these data, the project revealed a lot of new and interesting information about the ancient quarrying techniques.</p>				
Keywords: Archaeology		Chephren	Egypt	
Quarry		Natural stone		

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1. INTRODUCTION – CONFLICT BETWEEN MODERN DEVELOPMENT AND CULTURAL HERITAGE



Figure 1: Map of Egypt and location of Chephren's Quarry.

Chephren's Quarry is one of the world's oldest hard-stone quarries. It is situated in the easternmost part of Sahara – covering nearly 100 km² of flat, hyper-arid desert, some 60 km west of Lake Nasser (River Nile) and the famous Abu Simbel temple in the extreme south of Egypt (Figure 1). In the 3rd and 4th millennium BC, as the climate was more favourable than today, the quarry was used for extraction of stone for now world-famous sculptures and thousands of smaller funerary objects, especially vessels.

Discovered in the 1930s, Chephren's Quarry and its associated archaeological remains are extremely well preserved and offer a unique insight into the technology and life of Late Neolithic societies and during early Egyptian dynasties. Unfortunately this cultural heritage site of great international importance is now heavily threatened by the "South Valley Development Project" (also called the "Tushka Project"), one of the world's largest land-reclamation projects.¹ This project was initiated in order to gain land for agriculture and people now living in the overpopulated Nile Valley. With a population increasing by some 1 million people per year, Egypt has also started similar projects at other places, for instance in Sinai.

Chephren's Quarry is one, but far from the only example of the conflict that arises between modern development projects and environmental and preservation concerns in the deserts bordering the Nile Valley. From an economic and societal perspective these large projects are understandable and often necessary, but they have far-reaching and little known environmental consequences. In addition they destroy hundreds of known and unknown archaeological sites. Moreover, due to the economic importance and rapid advance of the

¹ See official Egyptian information on the web, e.g.: <http://www.sis.gov.eg>, <http://www.sis.gov.eg/calendar/html/cl090197.htm> and <http://www.toshki.com>. There is an enormous amount of websites related to the South Valley Project, try searching for "toshka" at Google.

land-reclamation projects on the one hand and the limited resources of the Egyptian environmental and cultural heritage authorities on the other, it is very difficult to achieve a balanced development, in which preservation concerns are being considered.

The cultural heritage authorities, represented by the Supreme Council of Antiquities, a directorate under the Ministry of Culture, have recently launched the "Egyptian Antiquities Information System" (EAIS) in order to be able to better cope with this situation.² EAIS is a GIS-based inventory of cultural heritage sites, but also a simple risk-assessment system, which is supposed to help the authorities in getting a better overview of endangered sites and also be used for planning purposes. EAIS is, however, completely dependent on foreign aid, as their resources are far too limited for undertaking necessary expeditions and fieldwork.

The 2003 fieldwork at Chephren's Quarry, which is described in this report, is a good example of foreign co-operation with EAIS, which basically need site maps compatible with their GIS systems and descriptions to be used in their databases (see appendix 1). The fieldwork was initiated after a short investigation in June 2002, during which it became clear that the South Valley project was about to completely devastate the site (see Storemyr et. al. 2002). It then also became clear that the site was not satisfactorily surveyed and archaeologically investigated. This matter was brought to the immediate attention in the form of a report to and meetings with the regional office of the Supreme Council of Antiquities (SCA) in Aswan, which later took action and designated the whole site for protection (Mapsheet 2003.025-06). It is, however, still unclear how far the work on permanently protecting the site has advanced.

Thus, the most important aim of the expedition described in this report was to make a detailed survey of the whole area, and produce accurate maps that can serve as decision-aiding tools in the on-going process of protecting the site. In addition, it was considered of high importance to collect geo-referenced information and images (photographs and detailed maps) of the large number of sub-sites in case the ancient quarries, or parts of them, will be lost. The work was carried out as scheduled between 4 and 29 January 2003, with permission from SCA and technical and scientific assistance from the Egyptian Geological Survey and Mining Authorities (EGSMA). According to technical descriptions agreed on during lengthy discussions with the EAIS project leaders in Cairo before and after the fieldwork, all information produced can and will be used by the EAIS.

The mapping and documentation work in January 2003 was carried out by the Geological Survey of Norway (NGU), with support by the Norwegian Directorate for Cultural Heritage (*Riksantikvaren*) and generous funding by the Norwegian Ministry of Foreign Affairs. Simultaneously, our partner, a British team of archaeologists undertook archaeological excavations in the area. This part of the project was funded mainly by the Egypt Exploration Society (EES) and University of Liverpool.

² See the EAIS Internet site: <http://www.eais.org.eg>

2. BACKGROUND

2.1 Historical significance of the site

Chephren's Quarry is the only known source in Egypt of the highly characteristic, bluish anorthositic to dioritic gneiss (the "Chephren Gneiss") used for elite funerary objects, particularly during the Old Kingdom. Furthermore, it was used for the famous 4th Dynasty life-size statues of Chephren (Figure 2) and thus represents one of the oldest stones used for statues worldwide. The most intensive period of exploitation took place during the late 2nd Dynasty into the early 4th Dynasty for stone vessel manufacture, as exemplified by the huge quantities of anorthosite gneiss vessels found in royal tombs. However, the stone has also been found in elite burial contexts as early as the Late Neolithic. The quarry thus has a long history of exploitation for elite status stone objects and specific work areas represented by boulder quarries scattered over the area can be related to these periods of use. It is clear that the region can provide significant insight into ancient hard stone quarrying methods and a framework for understanding the logistics and social organisation of these activities.



Figure 2: Statue of the 4th Dynasty King Chephren, performed in a banded variety of the Chephren Gneiss.



Figure 3: Rock fragments and spoil heaps in one of the ancient quarries.

2.2 Previous work

Engelbach (1933, 1938) and Murray (1939) made the first archaeological and geological investigations of Chephren's Quarry in the 1930's and designated the main workings into four areas: 'Khufu Stele Quarry', 'Quartz Ridge' 'Chisel Quarry' and 'Stele Ridge'. The first three areas are mainly Old Kingdom Chephren Gneiss quarries and 'Stele Ridge' an area of predominantly Middle Kingdom amethyst mining. More recent geological research was undertaken by Harrell and Brown in the early 1990's and archaeological survey and excavation was undertaken in 1997, 1999 and 2000, directed by Dr. Ian Shaw. During these seasons an area of settlement, bakery, two stone-built loading ramps and wells associated with the Old Kingdom exploitation were excavated (Shaw and Bloxam 1999, Bloxam 2000, 2001). This work further demonstrated that the region is still a significant source of archaeological and epigraphic evidence (including pottery from the Early Dynastic to the Roman period, and inscribed steles of the Old and Middle Kingdoms).

In spite of the previous research at the site, it was until now unregistered as an archaeological site, and there was a lack of a detailed survey of the area.

2.3 The threat to the site

Initially the survival of the site appeared to be threatened by the construction of the Aswan/Abu Simbel - Uweinat road, which was built across the area in the mid-1990s; this work partially destroyed the amethyst mining area at Stele Ridge with its associated infrastructure and the settlement area at Khufu Stele Quarry. However, this has now been entirely eclipsed by the South Valley Project that will engulf the entire region of Gebel el-Asr and Wadi Tushka and thus the quarry site. The South Valley Project will bring water from Lake Nasser via the 70 km long Sheikh Zayed Canal to four larger canal branches (see also Figure 5). Canal 4 is situated only 200 m from the newly discovered 'Pounder Quarry'.

The South Valley Project is managed and funded by the Egyptian Government with the help of international institutions (such as the World Bank and UNDP), international consortiums and private companies. Norway has also been involved in the project through a consortium led by Kvaerner Construction International, which was awarded the USD 425 million contract to build the huge pumping station – the largest on the African continent – at Lake Nasser.³ The pumping station is now more or less finished.



Figure 4: Mapping of ancient quarries in front of the workings at Canal 4 of the Tushka Development Project.

³ Information from the press release section of <http://www.kvaerner.com>

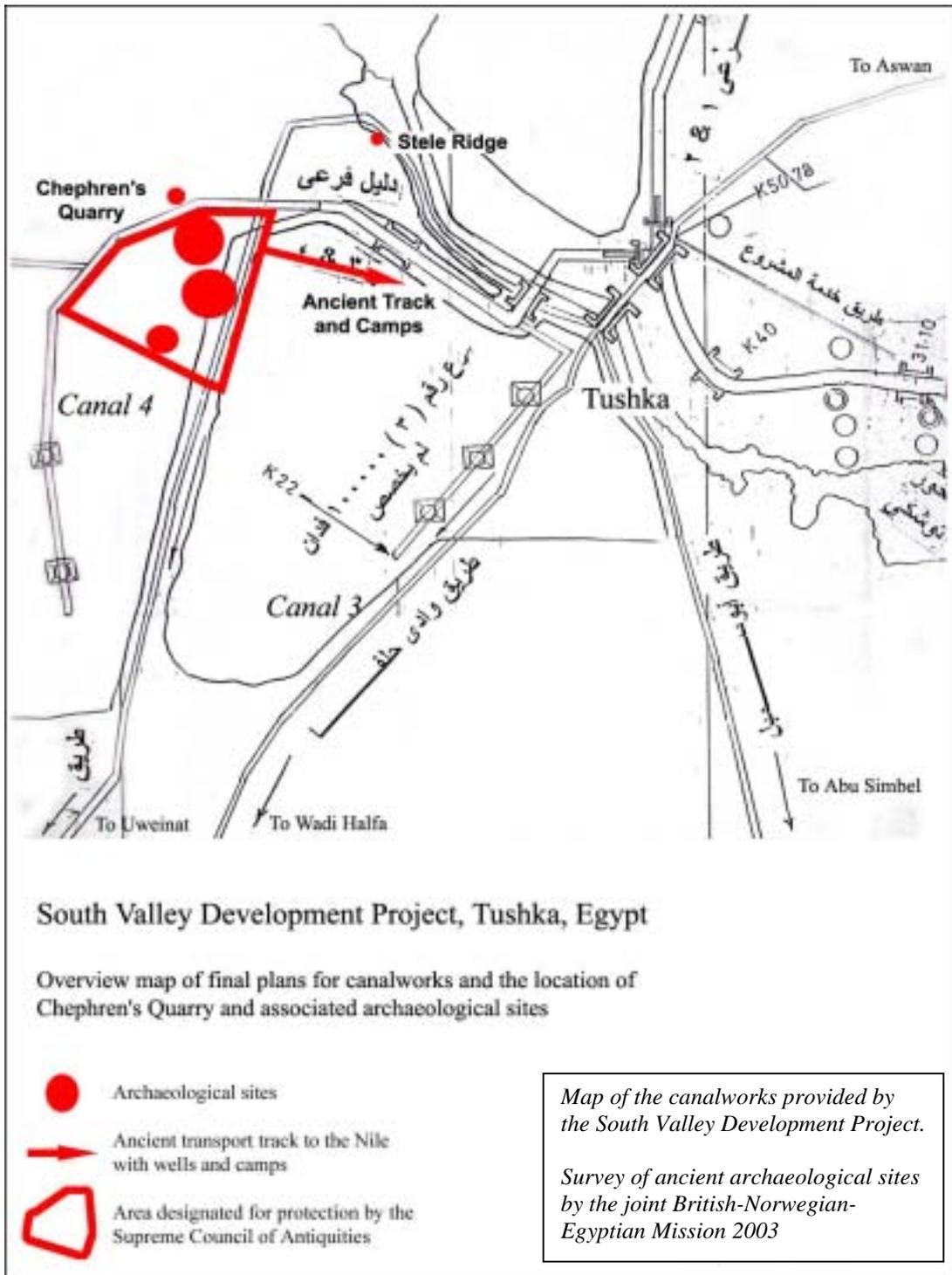


Figure 5: Map of the South Valley Development Project and location of the ancient sites of Chephren's Quarry.

3. DESCRIPTION OF THE 2003 FIELD WORK AND ITS RESULTS

3.1 Staff

Mapping and surveying team (Norwegian part of the project):

- ⌘ Tom Heldal (geologist, Geological Survey of Norway)
- ⌘ Dr. Per Storemyr (geologist, Expert-Center für Denkmalpflege, Switzerland, in this project with NGU)
- ⌘ Iver Schonhowd (conservator, Norwegian Directorate for Cultural Heritage)

Archaeological excavation team (British part of the project):

- ⌘ Dr. Ian Shaw (archaeologist, University of Liverpool)
- ⌘ Elizabeth Bloxam (archaeologist, research student University College London)
- ⌘ Richard Lee (archaeologist, Birmingham University Archaeological Unit)
- ⌘ In addition, two Liverpool MA/PhD students participated.

Co-operating Egyptian professionals and institutions

- ⌘ Adel Kelany (archaeologist, Inspector of Antiquities, Supreme Council of Antiquities – SCA, Aswan, the official Egyptian inspector of the project)
- ⌘ Abdou Salem (geologist Egyptian Geological Survey and Mining Authorities – EGSMA, Aswan, fieldwork specialist and co-ordinator of practical details)
- ⌘ Ashraf el-Senussi (archaeologist, Kom Aushim Museum, Fayium, pottery specialist)
- ⌘ Dr. Nagiub Amin, Ms. Azza. Shawarby and Ms. Marwa Talat (contact persons; project leaders and GIS specialists of the Egyptian Antiquities Information System, SCA, Cairo)
- ⌘ In addition, SCA and EGSMA provided drivers and workers, which were paid by the project.



Figure 6: Part of the 2003 team.

3.2 Mapping and surveying

Methodology

The area is a relatively flat desert with few hills, valleys, wadis and other significant terrain features. There were no detailed topographic or geological maps available, thus Corona satellite images⁴ from the 1960s with 2-5 metres resolution were used as background for the maps and geological interpretations.

The mapping itself was carried out with GPS (accuracy 5 metres). GPS point registrations and other observations/registrations were transferred to Excel tables (Table 1), which later were converted to map formats (ArcView GIS shape files). Geological observations and maps of larger features, such as large quarries and settlements, were drawn directly in the field on a Compaq Ipaq pocket computer connected to a GPS using ArcPad software (Figure 7).

Table 1: Overview of the registration types and GIS table structure.

Registrations of importance for the management of the site	
REG.NO	Unique registration number
DATE	Registration date
DATUM	Geographic projection (UTM WGS84)
ZONE	UTM zone
EAST	East coordinate in metres
NORTH	North coordinate in metres
ACCURACY	Estimated registration accuracy
SITENAME	Name of Archaeological site
REGTYPE	Main type of registration (e.g. Ancient quarry, ancient infrastructure)
REGSUBTYPE	Subtype of registration (e.g. Large quarry, Single extraction site)
SIZE DIAMETRE	Size of registration i diameters
MAPS	Link to detailed maps of the registration
POTTERY OBSERVATIONS	Findings og ancient pottery
PHOTOS	Photos of the site in the digital photo archive
ARCHAEOLOGICAL EXCAVATIONS	Year of excavation on the site
COMMENT	Short description
NAME	Name of person doing the registration
Other registrations	
ROCK TYPE	Main rock type (e.g. Chephren Gneiss, Granite)
ROCK SUBDIVISION	Subdivision of rock type (especially Chephren Gneiss)
BLANK COLLECTIONS	Findings of vessel blank collections at the site
EXOTIC TOOLS	Findings of tools of exotic rocks (non-Chephren Gneiss)
STATUE BLOCKS	Findings of worked statue blocks

All the map themes and point registrations were finally compiled to a series of thematic maps, including area coverage of important ancient sites.

⁴ Supplied by Prof. James Harrell, University of Toledo, USA



Figure 7: Ipaq pocket computer connected to a Garmin eTrex Venture GPS was used for mapping in the field.

Summary of achievements

Solid documentation was required for securing a proper management of the cultural heritage sites in the area. Therefore, the most important result of the fieldwork was the production of thematic maps and a geo-referenced database of the archaeological sites that can be used by the cultural heritage authorities, land use planners and the South Valley Project. In addition, the fieldwork has gained invaluable scientific results that can help us in the interpretation of ancient quarrying and infrastructure.

The study included GPS survey of approximately 700 small stone extraction sites, about 40 larger quarries and 100 ancient infrastructure sites (settlements, camps, huts/shelters, work areas and wells). In addition, geological observations and observations related to the South Valley Project were made. The thematic maps, which can be provided on different scales, include:

- ≠ Maps of the registrations grouped by type
- ≠ Maps of the ancient quarries grouped by size
- ≠ Maps of the ancient quarries grouped by rock type
- ≠ Maps of the area limitations (borders) of the ancient sites/infrastructure
- ≠ Map of the bedrock geology

Examples are given in Appendix 2: overview of registrations of ancient quarries and infrastructure (Mapsheet 2003.025-01), geological map (Mapsheet 2003.025-02), detailed map of the Northern Quarries (Mapsheet 2003.025-03), detailed map of the Central Quarries (Mapsheet 2003.025-04) and map of the limitations of the ancient sites (Mapsheet 2003.025-05).

New discoveries:

- €# Three previously unknown areas of ancient quarrying were discovered. These included sites that are very important for the understanding of the pattern and technology of the ancient quarrying.
- €# The ancient stone extraction sites and quarries mirror the outcrop pattern of the Chephren Gneiss in this flat desert environs. Virtually all gneiss boulders have been extracted or explored and only a small area in the newly discovered southern part have remaining, undisturbed outcrops/boulders.
- €# Three unfinished blocks designated for life-size statues were discovered (Figure 8).
- €# Large amounts of special stone axes, evidently used for the squaring and dressing of blocks, were observed (Figure 9). It also became clear that the use of pounders does not necessarily follow the same pattern as in other known quarrying sites of similar age (Aswan granite Quarries and the Widan el-faras Basalt Quarries in the Faiyum). Pounders used to split blocks seem to have been taken from the nearest possible source, such as diorite dykes by some quarries.
- €# Differentiation between quarrying areas mainly related to the production of vessels on the one hand, and mainly to statue blocks and other large objects on the other could be made.
- €# Discovery of many cairns along the ancient track give evidence of how ancient routes were marked.



Figure 8: One of the newly discovered statue blocks, partly finished. The broken pounders, found near the block, have been used for final shaping and dressing.



Figure 9: A collection of tools from one larger quarry. Broken pounders (top row) and hand-axes.

3.3 Archaeological excavations

Archaeological excavations were undertaken by the British team. These included sites such as ancient huts, shelters and large wells related to the quarrying sites as well as the ancient c.70 km long transport track between the quarries and Wadi Tushka/the Nile. In total, 11 archaeological sites were excavated, including two block extraction sites, one ancient loading ramp, two ancient wells, four shelters/huts and one work area.

Highlights of the findings made during these excavations were the following:

- ⚡ Many of the smaller extraction sites appear to be surprisingly deep (1,70 m or more), as evidenced by archaeological excavation (Figure 10).
- ⚡ Definite evidence for the use of fire setting as a vital part of the stone production technology was found.
- ⚡ Many shards of pottery were found at the excavation sites. Close examination of these revealed the predominantly Old Kingdom presence in the area.
- ⚡ Discovery and excavation of two very shallow, but large wells along the ancient track to the Nile gave evidence of the former, much wetter climate in the area, which is an important clue to the understanding of how this area was formerly inhabited (Figure 11).

21 Archaeological sites have been excavated in the area during recent years, which have resulted in very interesting and important findings. However, considering the extremely large size of the area, and the many newly discovered features, there is still a large potential for further excavations.



Figure 10: Deep hole left after the extraction of one, large single block. The Photograph is taken after Archaeological excavation.



Figure 11: Excavation of a shallow well by the ancient track, with building structures for watering animals.

3.4 Observations related to the progress of the South Valley Project

During meetings and discussions with responsible persons for the South Valley Project, we learnt that the plans for canal building and which areas that are to be used for agriculture have been changed several times over the last years and months. Thus, contrary to what we learnt during the investigations in June 2002, in January 2003 it was confirmed that Canal 3 of the South Valley Project will not enter Chephren's Quarry. Instead, it is Canal 4 that will remain most threatening to the site. The building of this canal is well underway (Mapsheet 2003.025-06). In addition, the agricultural area connected with Canal 4 may devastate the quarry areas situated to the west of the Uweinat road, whereas the agricultural area connected with Canal 3 may threaten the quarry areas to the east of this road, as well as archaeological sites along the ancient track to the Nile. Figure 5, which is based on the most recent plans of the South Valley project, gives an overview of the situation.

Devastation of the site is of course dependent on whether the Supreme Council of Antiquities is able to enforce its plans for protecting the site. Although it may seem that the area can be well protected, there are still difficulties, not least because several responsible people and companies working with the South Valley Project are not informed about the situation. This may seem strange, but given the huge site, far away from larger cities and the authorities in Cairo, and the fact that different people are responsible for different parts of the project, it becomes understandable.

4. BRIEF SCIENTIFIC INTERPRETATION BASED ON THE NEW RESULTS

4.1 Overview

According to the 2003 survey, Chephren's Quarry consists of 700 small stone extraction sites, about 40 larger quarries and 100 ancient infrastructure sites (settlements, camps, huts/shelters, work areas, wells, ramps etc.). These archaeological sites cover altogether approximately 12 km² within a rectangle of 11 x 7 km and are concentrated in three large and two small quarry areas (Mapsheets 2003.025-01 and 2003.025-06). In addition to the quarries, there is an 80 km long ancient track (with cairns, wells and settlements) for transporting stone eastward to the Nile. North of the stone quarry sites, there is an ancient gemstone mine (the Stele Ridge carnelian and amethyst mine). The latter, predominantly of Middle Kingdom age, has been registered, but will not be treated in any detail in the following text.

4.2 Geology

Chephren's Quarry is situated in Precambrian rocks, occurring as a "window" where younger rocks have been removed by erosion. The rock type that was subjected to quarrying is a light bluish, greyish to white gneiss with dark bands and spots – hereafter referred to as the Chephren Gneiss. It is predominantly composed of plagioclase feldspar (light coloured) and amphiboles (dark coloured), and will lithologically range from anorthosite gneiss to amphibolite gneiss (Figure 12).



*Figure 12:
Partly banded
and partly
speckled
Chephren
Gneiss.*

Chephren Gneiss occurs as large and small inclusions in granitic rocks, resulting in a highly irregular outcrop pattern, as shown in Mapsheet 2003.025-02. Almost all the outcrops of Chephren Gneiss have been exploited to some degree.

Surrounding the Chephren Gneiss are various intrusive granitoids, as well as some bands of black amphibolites. In the northwestern part of the area, the Precambrian rocks are intruded by a "swarm" of northeast-southwest oriented dykes of dioritic composition. These are very significant for the understanding of the quarrying, since the dyke rock was applied as tools

(pounders and hand-held axes). Deposited on top of the gneisses and granitoids occurs thick Mesozoic sandstones (Sandstone of the Nubia Group), predominantly exposed to the east of the ancient quarries. In the central quarry area, only small "islands" of sandstone occur, the rest of it is removed by erosion. Various sized "plugs" of Tertiary basalt occur at several places in the area.

4.3 The quarry areas

Five quarry areas have been recognised, as shown in Mapsheet 2003.025-01 and Table 2. The different areas are characterised by variations in rock type as well as production features. It seems that most of the quarries (with the exception of parts of the Central Quarries) have been exploited for vessels, probably through a considerable period of time (from the Late Neolithic Period to the end of the 5th Dynasty (until c. 2300 BC), a time-span of perhaps more than 1000 years. The statue quarrying (and quarrying for other large objects, such as big vases) is concentrated in the Central Quarries and southern part of the Northern Quarries. This activity was probably the result of one or a few campaigns (mainly in the 4th Dynasty, c. 2575-2465 BC), aimed at finding suitable blocks for a limited amount of sculptures.

Table 2: Characteristics of the quarry areas

Quarry area	Description	Gneiss variety	Main product
Northern Quarries	Large area with many single extraction sites and several large quarries. Many work areas, huts and shelters.	Mixed – both light speckled, light banded and dark banded types are common.	Predominantly vessel quarrying, but some quarries designated for large block extraction.
Northern Marginal Quarries	Very small area with some single extraction sites, north of the Tushka Project Canal 4.	Light speckled and light banded.	Vessel production
Central Quarries	Large area with several large quarries and smaller extractions.	Light banded	Both vessel and statue block production – eastern part only statues.
Chisel Quarry	One large quarry	Light speckled	Vessel production
Southern quarries	Several single extraction sites	Mixed – but most of the quarrying aimed at the light speckled variety	Vessel production

4.4 Infrastructure

Except for the Northernmost Quarries and the Chisel Quarry, the quarry areas have abundant traces of ancient infrastructure and settlements. In addition, along the re-discovered ancient track between the quarries and the Nile, huts, shelters, wells and larger well structures for animals have been discovered and excavated. This is summarized in Table 3.

Table 3: Characteristics of the ancient infrastructure

Area	Type of Archaeological site	Age (pottery)
Northern Quarries	Settlement, huts, shelters, loading ramps, well, cairns	Old Kingdom Middle Kingdom (re-use)
Central Quarries	Settlement, huts, shelters, loading ramps, well, cairns	Old Kingdom
Southern Quarries	Shelters	?
Ancient track	Huts, shelters, cairns, well, large well structures	Old Kingdom

The excavations at the sites clearly indicate the Old Kingdom predominance of the activity, partly opposing the interpretations by Engelbach (1933, 1938) and Murray (1939).⁵ Since all pottery has not yet been analysed, age interpretations may change. No certain Late Neolithic finds have been made in the quarries. However, objects made from Chephren Gneiss have been found in Late Neolithic burial contexts elsewhere. Thus, it is probable that Late Neolithic activity in the quarries has been obliterated by the massive Old Kingdom works.

4.5 Quarrying techniques

Before the quarrying was initiated, the outcrops of Chephren Gneiss occurred as *in situ* weathered boulders, a phenomena caused by spheroidal weathering, common in hot and arid climates. These boulders were sound and massive, but resting in a network of deeply weathered rock. The boulders on or close to the terrain surface were the targets of the ancient quarrying.

Most of the quarries are small extractions aimed at one or small groups of such boulders, leaving a concentric spoil heap around the boulder location after quarrying (Figure 14). The spoil heaps predominantly consist of weathered rock and soil, reflecting the depth of the trenches made around the boulders.



Figure 13: Small ancient extraction site showing remains of gneiss boulder in the centre and concentric spoil heaps around.

⁵ Engelbach and Murray proposed a predominantly Middle Kingdom influence along the ancient track

For the extraction of vessels, which was the most prominent and long lasting activity, the boulders were subdivided to rough blanks – cracking the blocks with heavy, rounded stone pounders (Figure 9). Rounded stones of sound quality, naturally shaped by weathering, were preferred. The dioritic dyke rock and sound granite were used where such rocks occur close to the quarries, whilst the Chephren Gneiss itself was used in other quarry areas. This reflects the observation that the pounders were used only a short time before they cracked – needing a readily available, local source for such tools.

The rough blanks were then worked with finer tools to semi-rounded vessel blanks, which defined the final stage of working in the quarries before transportation. In the northern part of the quarry areas, hundreds of such tools have been found – small hand-held axes made of dioritic rock and basalt (Figure 9). This activity took place in the margins of the quarries or in the close vicinity – frequently at places where rock outcrops forms natural shelters from the predominant northern winds (Figure 15). Piles of rock chips and vessel blank collections characterise such work areas.



Figure 14: Work area in front of a sheltering granite outcrop.

There are strong indications (e.g. from observations of finished vessels) that the light coloured, speckled variety of Chephren Gneiss was preferred for vessel production. This could be because this variety is more isotropic (less foliated) than banded types, and thus more technically suited for vessels. However, there could also be aesthetical reasons for these preferences.

The quarrying of large blocks for statues differed from the vessel production. The first stage of quarrying involved digging a deep trench around the large blocks, and also making space beneath the blocks, probably by letting them rest on smaller stones. There are several evidences that fire setting was used on these free-standing blocks in order to open potential cracks and flake off the weathered crust – leaving the sound and massive "core" of the blocks

for further treatment. After careful inspection, the finest blocks of suitable shape and size were hewn to "statue blanks" with pounders and/or hand-held axes. Still, several such hewn blocks were left behind, probably because they did not get through the final quality control. These leftover blocks have a drop-like shape, specially designed for the working of "sitting-farao" sculptures (Figure 16).

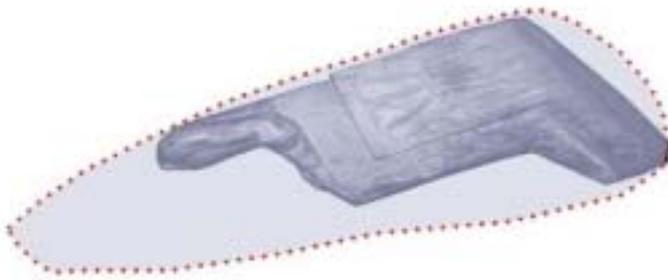


Figure 15: The hewn statue blocks are drop-shaped (above) designed to fit a sculpture of a sitting farao (below).

At places where large statue blocks were collected for transport, loading ramps were constructed (Figure 17). In front of the steep end, two parallel trenches, fitting a sledge-like transport vehicle, have been found during archaeological excavations (Figure 18).



Figure 16: One of the main loading ramps.



Figure 17: Parallel trenches in front of a small loading ramp, possible designed for a sledge-like transport media.

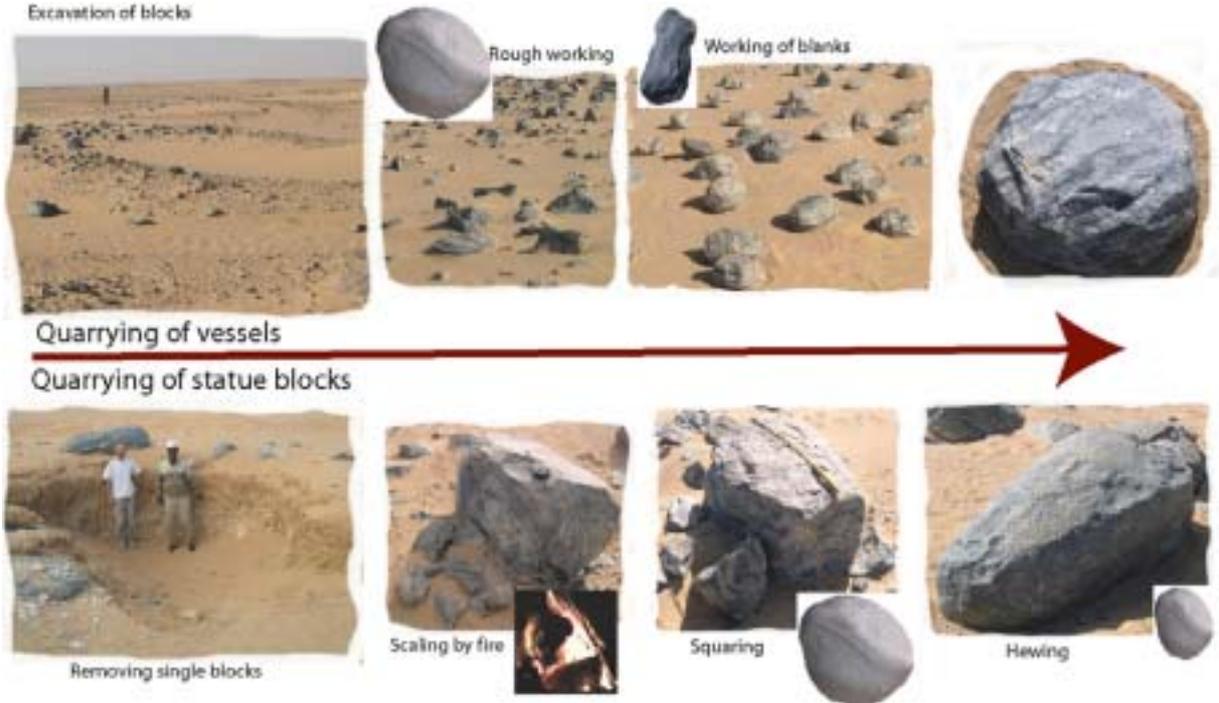


Figure 18: Summary of the quarrying process for vessels and statue blocks – from extraction to semi-finished products (vessel blanks and hewn statue blocks).

In contrast to the vessels, the banded – not the speckled – variety of Chephren Gneiss was preferred for statues. Either this variety was commonly occurring as large boulders, or there were aesthetical reasons for this choice.

5. CONCLUDING REMARKS

5.1 Will Chephren's Quarry be preserved?

As mentioned in chapter 1, Chephren's Quarry has been designated for protection following our work in June 2002. The survey in January 2003 has given a lot more detailed information about the location of previously known and newly discovered sites, some of the latter outside the designated area. In our opinion, the databases and reports submitted to the Egyptian cultural heritage authorities (SCA) and the Egyptian Antiquities Information System (EAIS) after the fieldwork are of sufficient quality for aiding the forthcoming process of for instance deciding which areas to be given special protection status. The response we got from SCA and EAIS supports this view. However, as described in chapter 2.3, we do of course not know how this process will end – if and how the quarry or parts of it will be preserved.

The project participants will follow the development by their contacts with the SCA and EAIS and are ready to aid these Egyptian authorities, preferably via the Norwegian Directorate for Cultural Heritage (*Riksantikvaren*), in their discussions and decisions, if needed.

In case the quarries will not be preserved, the project has generated a large amount of invaluable documentation helping the archaeological interpretation of the ancient quarrying and being an interesting source of information for the general public.

5.2 The mapping methodology and its implications

The state-of-the-art methods of mapping of Chephren's Quarry proved to be a highly efficient way of surveying a large area at risk in a short time. The use of GPS-aided digital data collection makes it possible to compile and finish maps and reports in the field, ready for integration directly into spatial land use management systems (in this case the EAIS-systems). The design of tables and templates especially applicable for ancient quarries also worked well, both for an efficient handling of a large amount of data and for the archaeological interpretation of the stone quarrying. Clearly, the methodology can be transferred to other sites in Egypt or elsewhere, especially to sites endangered by modern development projects and other risks and where time is limited. Plans for using the same methodology at endangered quarry sites in Aswan are underway.

5.3 Dissemination of results

By the end of the fieldwork, a field report (Bloxam et al. 2003) was submitted to the SCA, EAIS and EGSMA. In addition, a site report, based on templates from the EAIS, was delivered (enclosed). A CD-Rom with all the data from the fieldwork (tables, maps and digital images) was also delivered. These digital maps can, as mentioned earlier, be directly integrated in the Egyptian land management systems for archaeological sites (EAIS).

Other results from the fieldwork will be compiled and published in international scientific journals and at international congresses (especially the ASMOSIA Congress on Ancient Stone

in Greece in September 2003), and a "popular science" version will be published on the NGU websites.

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Appendix 1: Site Description for EAIS, based on EAIS templates



**Supreme Council of Antiquities
Egyptian Antiquities Information System**

Site Data			
Site Name	Chephren's Quarry		
Other names	Ancient	-	
	Classical	-	
	Biblical	-	
	Others	Chephren's diorite quarries	
Sub-Sites	7		
X, Y Coordinates	Khufu Stele in the Central Quarries (a subsite) : 316688/2518823 (UTM WGS 84)		
Site Location	65 km NW of Abu Simbel, along the Abu Simbel – Uweinat road		
Site Description	Ancient stone quarrying and mining area with associated infrastructure (settlements, camps, huts, shelters, wells, loading ramps, cairns etc.) located in a flat desert environment. The area was mainly utilized for the quarrying/-production of the famous, bluish Chephren's diorite/anorthosite gneiss, hereafter called "Chephren gneiss". The whole ancient quarrying and mining area covers approximately 100 square kilometers, and is situated within the canal works and planned agricultural area of the "South Valley Development Project"		
Historical Dating	Period	Dynasty	Ruler
	Prehistoric Predynastic Archaic Period Old Kingdom Middle Kingdom	Late Neolithic - 2 nd and 3 rd 4 th and 5 th 12 th	- - Khasekhemui Khufu, Djedefre, Khafre, Sahure, Niuserre Amenemhet II, Amenemhet III
Site History	From the Prehistoric period until the 3 rd Dynasty mainly stone vessels were made from the extracted stone at Chephren's Quarry. In the 4 th and 5 th Dynasty also statuettes and life-size statues, such as the famous statue of Khafre (Chephren), were made from the stone. In the 12 th Dynasty a sub site (Stele Ridge) was used for mining of carnelian and possibly amethyst. Limited exploitation of Chephren gneiss was in addition undertaken. The dating of the whole site has mainly been associated with the several inscribed steles discovered during early archaeological missions (1930s) and later.		
Archaeological Type <i>(See Table)</i>	Type	Subtype	
	Quarry Camp Road Mine (Well)	Workshop, Lithic scatter, Spoil heap, Block, Pottery scatter Wall, Lithic scatter, Pottery scatter Lithic scatter, Spoil heap, Pottery scatter Lithic scatter, Pottery scatter (Wall)	
Archaeological Description	The area has approximately 700 smaller and larger boulder extraction sites and quarries. Associated infrastructure is characterised by ruins of shelters, huts and settlements and shallow groundwater wells. All sites are easily visible.		

Mission History	1933: R. Engelbach and G.W. Murray 1938: R. Engelbach and G.W. Murray 1990: James Harrell, University of Toledo, USA 1997: University College London, Inst. of Archaeology (Dr. Ian Shaw) 1999: University College London, Inst. of Archaeology (Dr. Ian Shaw) 2000: University College London, Inst. of Archaeology (Dr. Ian Shaw) 2002: Joint British-Norwegian-Egyptian Expedition 2003: Joint British-Norwegian-Egyptian Expedition	
Other work on site	Archaeological Survey Mapping Project Excavation Rescue Excavation	
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Prod. & Rev.	Production: Per Storemyr & Tom Heldal Production:	Date:28.01.2003 Date:



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Risk Analysis		
Topography	Flat to undulating desert environment with scattered outcrops of Precambrian gneiss (boulders), to which the Chephren gneiss belong. To the SE is flat desert terrain on Nubian Sandstone, broken by scattered hills and sand dunes. The whole area is now engulfed by canal works of the “South Valley Development Project”, and agricultural works within the site is expected to commence shortly.	
Human Caused Risks <i>(See Table)</i>	Type	Subtype
	Construction Agriculture Neglect	Infrastructure Deep ploughing and draining Not registered by the SCA (until recently)
Environmental Risks <i>(See Table)</i>	Type	Subtype
	-	-
Protection regulations	Comment: The site appears to have been recently designated for protection by the SCA.	
Prod. & Rev.	Production: Per Storemyr & Tom Heldal Production:	Date:28.01.2003 Date:

Comments:

The main settlement area, situated within the Central Quarries (one of the sub sites) was destroyed by the construction of the Abu Simbel – Uweinat road in the late 1990s

Stele Ridge (one of the sub sites) was destroyed by road construction works connected with the Abu Simbel – Uweinat road in the late 1990s

Major amounts of fully intact, Middle Kingdom pottery vessels at Quartz Ridge within the Northern Quarries (one of the sub sites) was looted and destroyed in the late 1990s.



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Missions		
Site Name	Chephren's Quarry	
Institution	<p>The Joint British-Norwegian-Egyptian Mission 2003 (Gebel el-Asr (Chephren Diorite Quarries) Archaeological project at Tushka):</p> <p>Partners: University of Liverpool (UK) Geological Survey of Norway Egyptian Geological Survey and Mining Authorities (EGSMA) University College London, Institute of Archaeology (UK)</p>	
Country	UK, Norway, Egypt	
Contact Address	Dr Ian Shaw Department of Archaeology School of Archaeology, Classics and Oriental Studies University of Liverpool 12 Abercromby Square UK-Liverpool L69 3BX Tel: +44 (0)151 794 2452 Fax: +44 (0)151 794 2226 E-mail: ishaw@liv.ac.uk	Mr. Tom Heldal Geological Survey of Norway N-7491 Trondheim Tel: +47 73 90 40 00 Fax: +47 73 92 16 20 Tom.Heldal@ngu.no www.ngu.no
Person(s) in Charge	Dr. Ian Shaw and Mr. Tom Heldal (contact details: see above)	
Initial Permission No.		Date:
Type of Mission (See Table)	Archaeological Survey Mapping Project Excavation	
Internet links Max 5 links		
Prod. & Rev.	Production: Per Storemyr & Tom Heldal Production:	Date:28.01.2003 Date:



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Egyptian Antiquities Information System**

Sub sites Data (Chephren's Quarry)			
Sub site Name	Northern Quarries		
Other names	Ancient	-	
	Classical	-	
	Biblical	-	
	Others	Quartz Ridge, Quartz Ridge Quarries, Cairn Quarry, Pounder Quarry	
X, Y Coordinates	Quartz Ridge: 317808/2523151 (UTM WGS 84)		
Site Location	The northernmost part of the main stone extraction areas in Chephren's Quarry		
Site Description	Ancient stone quarrying area with associated infrastructure (camps, huts, shelters, wells, cairns etc.) located in an undulating desert environment. The area is cut by a wadi running approximately S-N. To the east of this wadi is Quartz Ridge, an ancient camp or settlement area on the top of a small hill. The main stone extraction sites, appearing as quarried boulders and depressions in the ground, are located to the west of the wadi, but there are also extraction sites north and northeast of Quartz Ridge. Canal 4 of the "South Valley Development Project" marks the north western boundary of the sub site.		
Historical Dating	Period	Dynasty	Ruler
	Prehistoric	Late Neolithic	-
	Predynastic	-	-
	Archaic Period	2 nd and 3 rd	Khasekhemui
Old Kingdom	4 th and 5 th	Khufu, Djedefre, Khafre, Sahure, Niuserre	
Middle Kingdom	12 th	Amenemhet II, Amenemhet III	
Site History	From the Prehistoric period until the 3 rd Dynasty mainly stone vessels were made from the extracted stone. It is possible that the site was also used for statues in the 4 th and 5 th Dynasty, as evidenced by the discovery in 2003 by unfinished statue blocks. At Quartz Ridge major amounts of large pottery vessels dating from the Middle Kingdom and possibly used as beer jars have been found.		
Archaeological Type <i>(See Table)</i>	Type	Subtype	
	Quarry	Workshop, Lithic scatter, Spoil heap, Block, Pottery scatter	
	Camp (Well)	Wall, Lithic scatter, Pottery scatter (Wall)	
Archaeological Description	The area has hundreds of smaller and larger boulder extraction sites and quarries. Associated infrastructure is characterised by ruins of camps, shelters and huts and shallow wells. All sites are easily visible.		
Prod. & Rev.	Production: Per Storemyr & Tom Heldal		Date: 28.01.2003
	Production:		Date:



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Egyptian Antiquities Information System**

Sub sites Data (Chephren's Quarry)			
Sub site Name	Northern marginal Quarries		
Other names	Ancient	-	
	Classical	-	
	Biblical	-	
	Others	-	
X, Y Coordinates	515957/2525378 (UTM WGS 84)		
Site Location	The north-westernmost part of the main stone extraction areas in Chephren's Quarry		
Site Description	Small ancient stone quarrying area along a small wadi running from Quartz Ridge (a sub site of Chephren's Quarry). The stone extraction sites, appearing as quarried boulders and depressions in the ground, are located to the north of Canal 4 of the "South Valley Development Project".		
Historical Dating	Period	Dynasty	Ruler
	Possibly Old Kingdom		
Site History	It seems that mainly stone vessels have been made from extracted stone at this sub site of Chephren's Quarry.		
Archaeological Type <i>(See Table)</i>	Type	Subtype	
	Quarry	Workshop, Lithic scatter, Spoil heap	
Archaeological Description	The area has only a few small boulder extraction sites and quarries. No associated infra structure has been discovered.		
Prod. & Rev.	Production: Per Storemyr & Tom Heldal Production:		Date:28.01.2003 Date:



**Supreme Council of Antiquities
Egyptian Antiquities Information System**

Sub sites Data (Chephren's Quarry)			
Sub site Name	Central Quarries		
Other names	Ancient	-	
	Classical	-	
	Biblical	-	
	Others	Khufu Stele, Khufu Stele Quarries, Unfinished Statue Quarries, Loading Ramp Quarries	
X, Y Coordinates	Main settlement area: 318384/2518925 (UTM WGS 84)		
Site Location	The central part of the main stone extraction areas in Chephren's Quarry		
Site Description	Ancient stone quarrying area with associated infrastructure (settlement, huts, shelters, wells, cairns etc.) located in a flat desert environment. The area is divided by the Abu Simbel – Uweinat Road, which has cut right through the main settlement area. To the west of the road are hundreds of stone extraction sites, and to the east smaller extraction sites, evidently used for extracting statue blocks. In this area there are also unfinished statue blocks and two special loading ramps.		
Historical Dating	Period	Dynasty	Ruler
	Prehistoric Predynastic Archaic Period Old Kingdom	Late Neolithic - 2 nd and 3 rd 4 th and 5 th	- - Khasekhemui Khufu, Djedefre, Khafre, Sahure, Niuserre
Site History	From the Prehistoric period until the 3 rd Dynasty mainly stone vessels were made from the extracted stone. The site also used for statues in the 4 th and 5 th Dynasty. It is uncertain whether the site was also occupied/used in the Middle Kingdom.		
Archaeological Type <i>(See Table)</i>	Type	Subtype	
	Quarry Camp (Well)	Workshop, Lithic scatter, Spoil heap, Block, Pottery scatter Wall, Lithic scatter, Pottery scatter (Wall)	
Archaeological Description	The area has hundreds of smaller and larger boulder extraction sites and quarries. Associated infrastructure is characterised by ruins of a settlement, shelters, huts, shallow wells and cairns. All sites are easily visible.		
Prod. & Rev.	Production: Per Storemyr & Tom Heldal Production:		Date:28.01.2003 Date:



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Egyptian Antiquities Information System**

Sub sites Data (Chephren's Quarry)			
Sub site Name	Southern Quarries		
Other names	Ancient	-	
	Classical	-	
	Biblical	-	
	Others	-	
X, Y Coordinates	313887/2515750 (UTM WGS 84)		
Site Location	The southernmost part of the main stone extraction areas in Chephren's Quarry		
Site Description	Ancient stone quarrying area with associated infrastructure (shelters) located in a flat desert environment. The area is characterised by shallow stone extraction sites and many untouched boulders, implying that that it must be regarded an exploration area, rather than a main quarrying site.		
Historical Dating	Period	Dynasty	Ruler
	Unknown, but possibly Old Kingdom		
Site History	It seems that the site was mainly used for extracting stone for vessels, possibly in the Old Kingdom.		
Archaeological Type <i>(See Table)</i>	Type	Subtype	
	Quarry Camp?	Workshop, Lithic scatter, Spoil heap,	
Archaeological Description	The area has some dozens of smaller boulder extraction sites. Associated infrastructure is characterised by ruins of stone shelters. All sites are easily visible.		
Prod. & Rev.	Production: Per Storemyr & Tom Heldal		Date:28.01.2003
	Production:		Date:



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Egyptian Antiquities Information System**

Sub sites Data (Chephren's Quarry)			
Sub site Name	Chisel Quarry		
Other names	Ancient	-	
	Classical	-	
	Biblical	-	
	Others	-	
X, Y Coordinates	314142/2520338 (UTM WGS 84)		
Site Location	The westernmost part of the main stone extraction areas in Chephren's Quarry		
Site Description	Large quarry appearing as a deeply cut pit, some 100 m across (diameter)		
Historical Dating	Period	Dynasty	Ruler
	Old Kingdom		
Site History	Chisel Quarry appears to have been used solely for the extraction of stone for vessels. A bronze chisel found in the quarry in the 1930s date from the Old Kingdom (4 th Dynasty).		
Archaeological Type <i>(See Table)</i>	Type	Subtype	
	Quarry	Workshop, Lithic scatter, Spoil heap, Pottery scatter	
Archaeological Description	The site only consists of the large quarry. No other quarries or associated infrastructure have been discovered nearby.		
Prod. & Rev.	Production: Per Storemyr & Tom Heldal Production:		Date:28.01.2003 Date:



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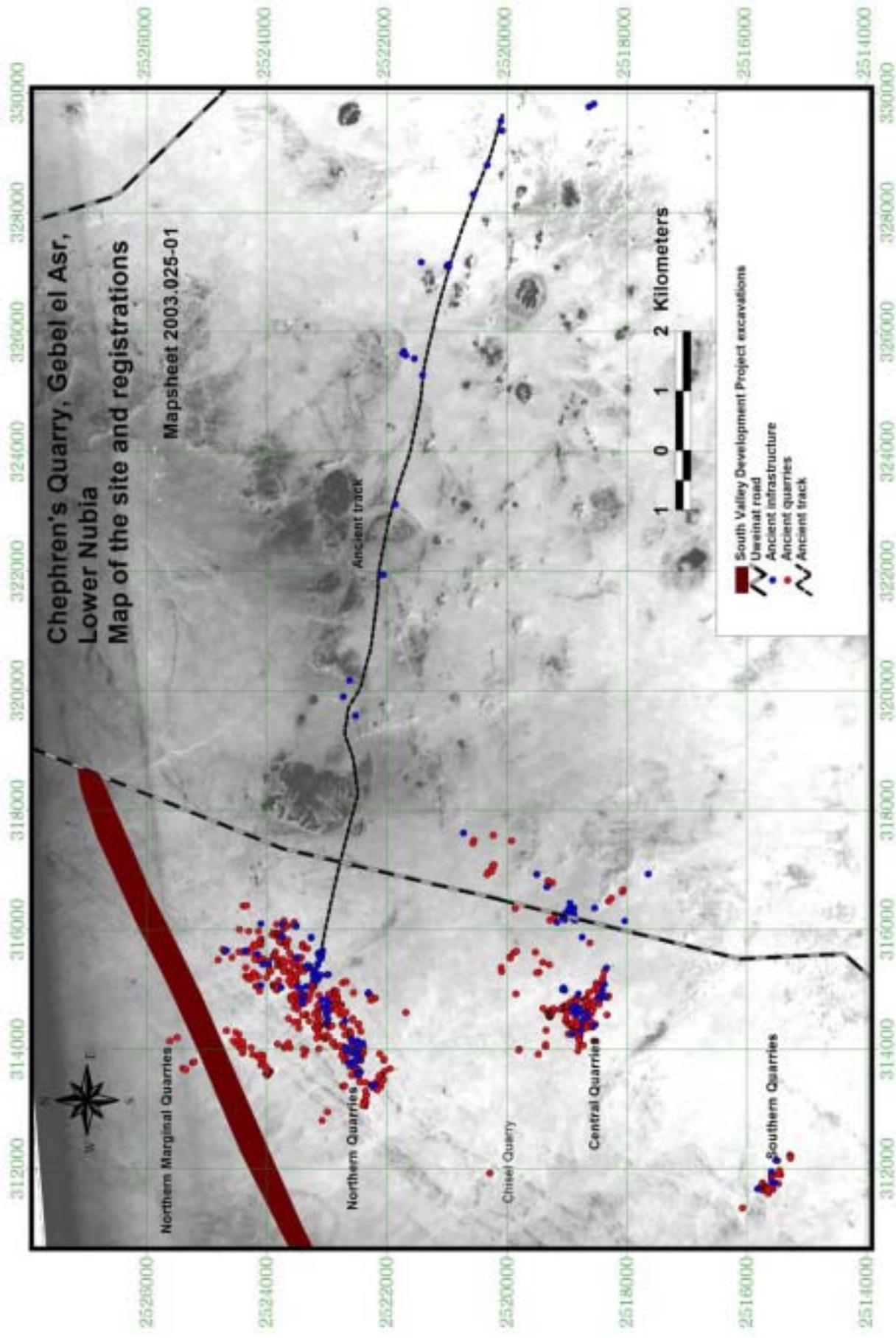
Sub sites Data (Chephren's Quarry)			
Sub site Name	Ancient Track		
Other names	Ancient	-	
	Classical	-	
	Biblical	-	
	Others	-	
X, Y Coordinates	Large well/camp: 327788/2521582 (UTM WGS 84)		
Site Location	Along a line starting at the northern quarries, oriented due east towards Wadi Tushka and the Nile.		
Site Description	Ancient track through desert terrain marked by cairns, along which there are large groundwater wells, camps and shelters. This was evidently the transport route to Wadi Tushka and the Nile for stone extracted in Chephren's Quarry. Only a fraction of the track has been re-discovered after the first discovery by Engelbach and Murray in the 1930s. At that time it was possible to follow the track, as well as possibly additional tracks, all the way from the Northern and Central Quarries to the banks of the Nile by Tushka. It is possible that the eastern part of the track has been destroyed by works associated with the "South Valley Development Project".		
Historical Dating	Period	Dynasty	Ruler
	Archaic Period Old Kingdom (Middle Kingdom)	- 4 th and 5 th (12 th)	
Site History	The ancient track appears essentially to have been a donkey track for transportation of vessel blanks from Chephren's Quarry and provisions to the people who worked in the quarries.		
Archaeological Type <i>(See Table)</i>	Type	Subtype	
	Road Camp (Well) (Cairn)	Lithic scatter, Spoil heap, Pottery scatter Wall, Lithic scatter, Spoil heap, Pottery scatter	
Archaeological Description	The track can be followed by inter-visible cairns for about 14,5 km from the Northern Quarries. Along the track there are at least two very large, shallow groundwater wells with associated camps. Moreover, there are several huts and shelters, as wells as scattered lithic remains and pottery along the track. All sites are easily visible.		
Prod. & Rev.	Production: Per Storemyr & Tom Heldal Production:		Date:28.01.2003 Date:

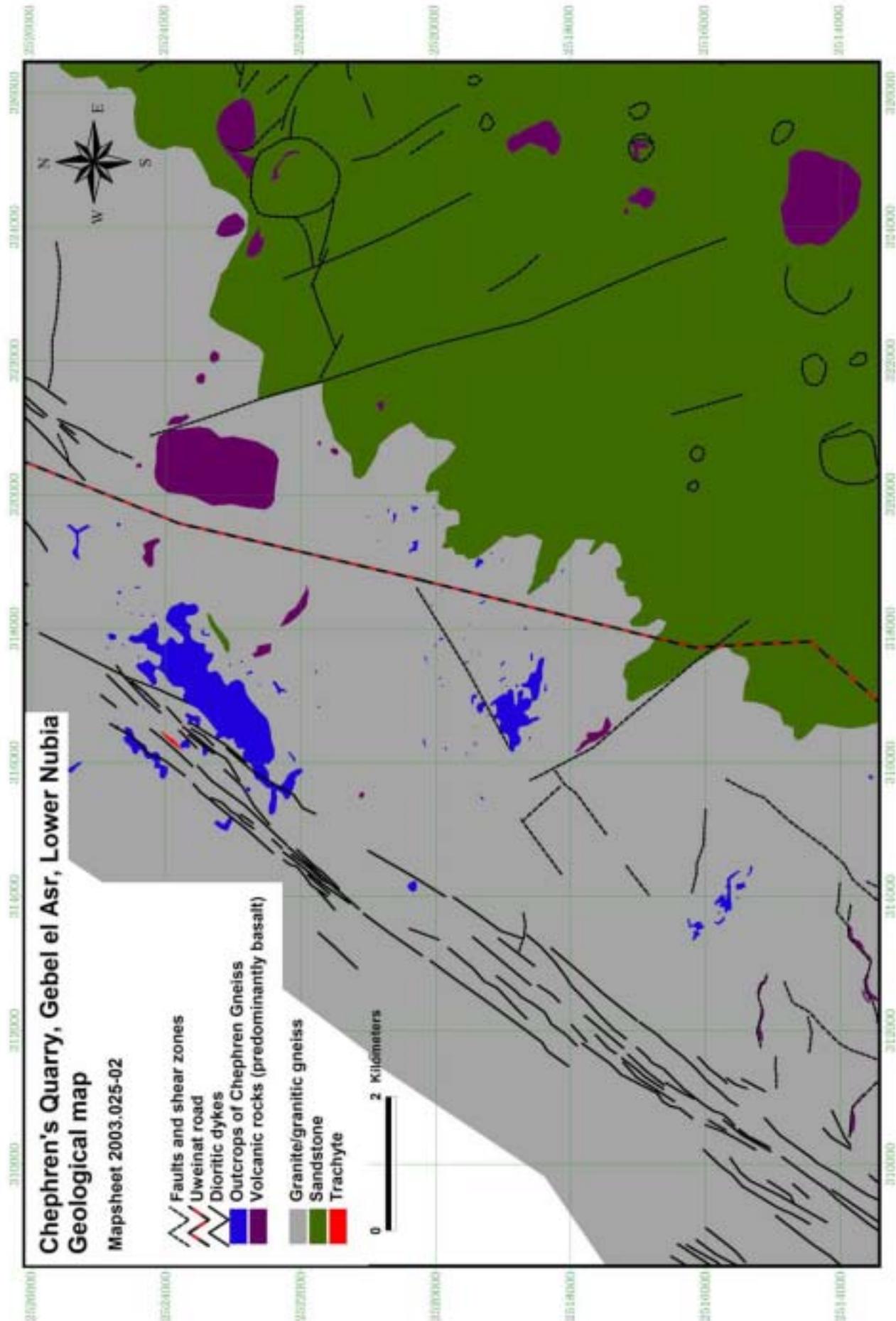


**Supreme Council of Antiquities
Egyptian Antiquities Information System**

Sub sites Data (Chephren's Quarry)			
Sub site Name	Stele Ridge		
Other names	Ancient	-	
	Classical	-	
	Biblical	-	
	Others	-	
X, Y Coordinates	327642/2533341 (UTM WGS 84)		
Site Location	By the northernmost bend of the Abu Simbel - Uweinat road, approximately 50 km NW of Abu Simbel.		
Site Description	Small ancient carnelian and possibly amethyst mining area, which may have been associated with Chephren's Quarry. The site has been completely destroyed by recent works associated with the Abu Simbel – Uweinat road, and is thus hard to describe. The site is famous for the numerous Middle Kingdom steles, which were mainly discovered in the 1930s.		
Historical Dating	Period	Dynasty	Ruler
	Middle Kingdom	12 th	Amenemhet II, Amenemhet III
Site History	The site appears to have been mainly mined for carnelian in the Middle Kingdom, but may possibly also have been used earlier and later (a little Roman pottery has been found in the area). Whether amethyst was mined has not yet been confirmed.		
Archaeological Type <i>(See Table)</i>	Type	Subtype	
	Mine	Lithic scatter, Pottery scatter	
Archaeological Description	The whole site has been churned up by the recent road construction works, but mining appears to have been undertaken by shallow workings along quartz or pegmatitic veins. Associated infrastructure has not been found.		
Prod. & Rev.	Production: Per Storemyr & Tom Heldal Production:		Date:28.01.2003 Date:

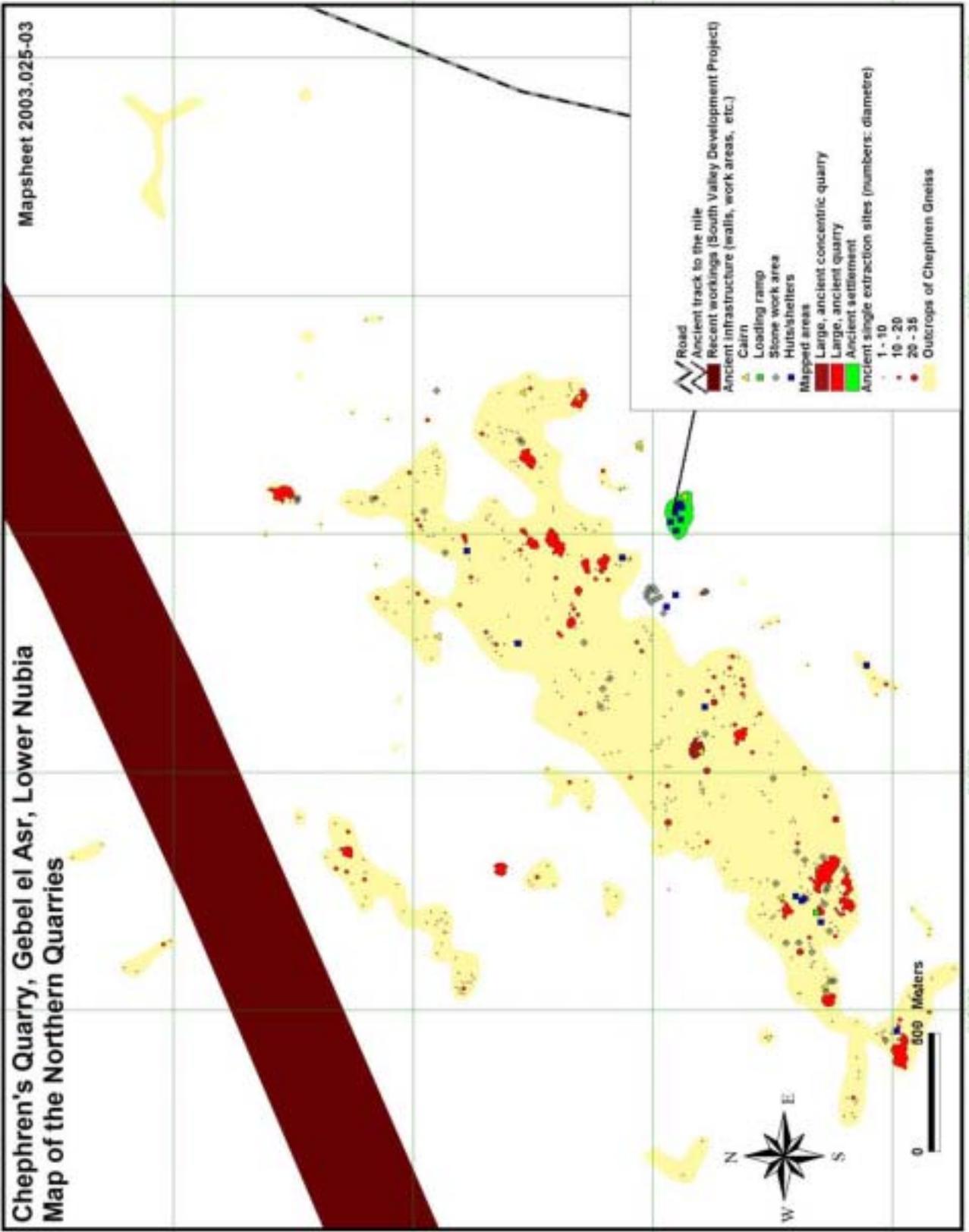
Appendix 2: Mapsheets





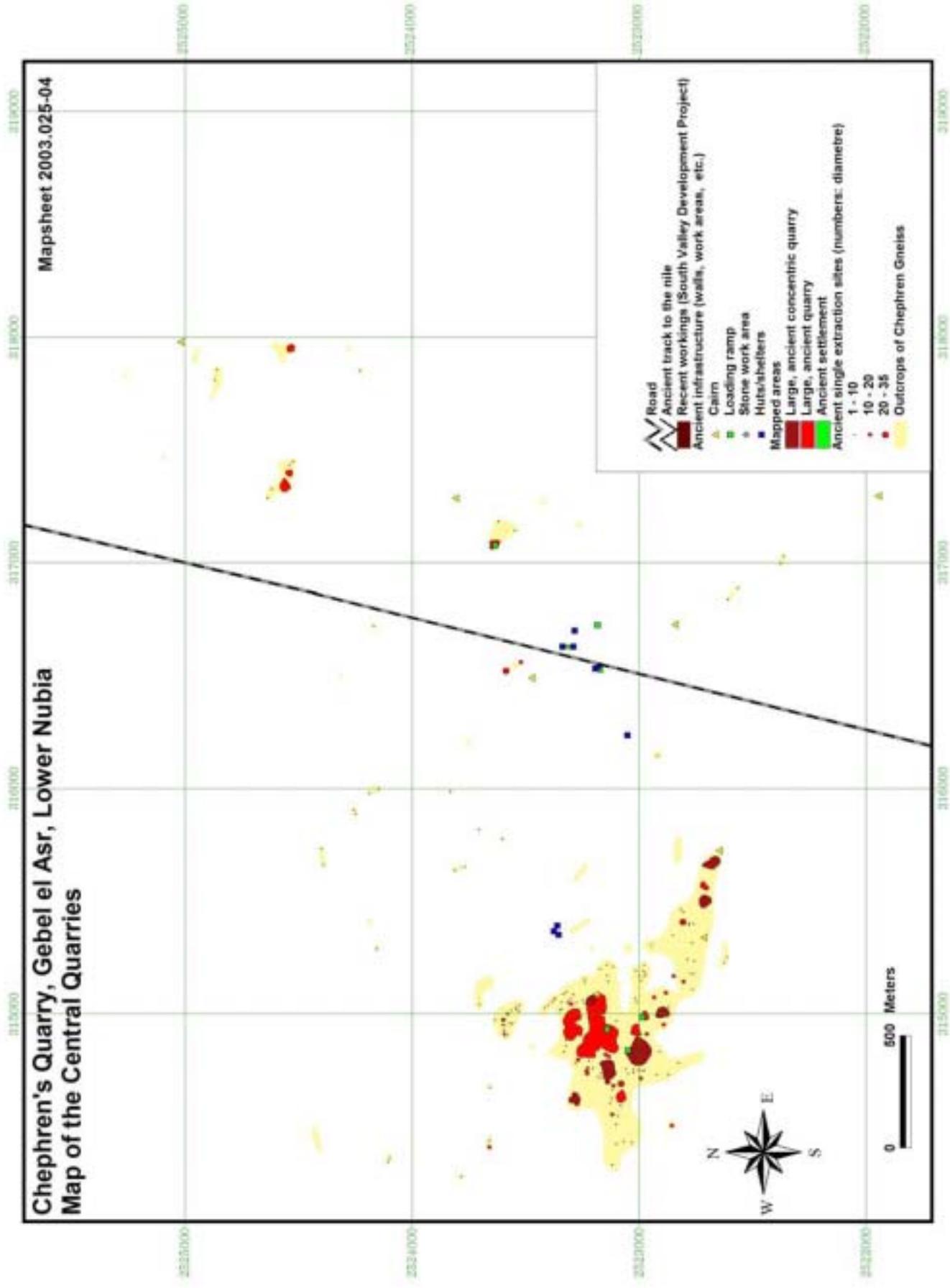
Chephren's Quarry, Gebel el Asr, Lower Nubia Map of the Northern Quarries

Mapsheet 2003.025-03



Chephren's Quarry, Gebel el Asr, Lower Nubia Map of the Central Quarries

Mapsheet 2003.025-04



Mapsheet 2003.025-05

