Archaeology and Geology of Ancient Egyptian Stones. Volume 1

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# Archaeology and Geology of Ancient Egyptian Stones

# Volume 1

## Archaeological and Geological Background; Building and Utilitarian Stones

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Cover: Slabs of some of the ornamental stones used in ancient Egypt and, at center left, the Khufu pyramid and ancient limestone quarry on the north side of the Khafra pyramid at Giza.



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*Dedicated to the memory of my parents*
*Marguerite Lee (née Sharp) (Harrell) Silliker*
*and Jesse Lyle Harrell*

# *On Writing a Reference Work*

'It is a difficult task to give novelty to what is old, authority to what is new, brilliance to the commonplace, light to the obscure, attraction to the stale, credibility to the doubtful... Accordingly, even if we have not succeeded, it is honourable and glorious in the fullest measure to have resolved on the attempt... Consequently by perusing about 2000 volumes, very few of which, owing to the abstruseness of their contents, are ever handled by students, we have collected in 36 volumes 20,000 noteworthy facts obtained from one hundred authors that we have explored, with a great number of other facts in addition that were either ignored by our predecessors or have been discovered by subsequent experience. Nor do we doubt that there are many things that have escaped us also; for we are but human, and beset with duties, and we pursue this sort of interest in our spare moments, that is at night—lest any of your house should think that the night hours have been given to idleness' (*Gaius Plinius Secudus*—a.k.a. *Pliny* the Elder—in the Preface (sections 15-18) to his *c.* AD 77 *Natural History*; translation from the original Latin by Rackham 1949: 10-13).

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# *Preface*

In late 1988 I visited the Toledo Museum of Art at the invitation of the then curator of ancient art, the late Kurt T. Luckner, who wanted me to identify the stones used for the museum's ancient Egyptian statuary and other carved objects. His invitation was prompted by what he described as great confusion among museum curators over what to call the many and varied Egyptian stones. This observation was the impetus for my embarking on a new research project. This originally had two simple objectives: to visit and sample the sources of the principal stones used in ancient Egyptian monuments and sculptures, and to do petrographical descriptions of these stones. Within a few months of first speaking to Mr. Luckner I was in Egypt. Initially I thought only four or five visits to this country would be sufficient to accomplish the research objectives. Over time, however, the objectives evolved to include a reconnaissance survey of all the ancient sources of rocks, minerals and metals in Egypt and northern Sudan, plus investigations of ancient extraction technologies and stone use. Now, thirty-two years and fifty trips later, this work has progressed far enough for me to attempt a comprehensive treatment of this multifaceted subject.

This undertaking would not have been possible without the assistance of numerous people. In the early years I was often accompanied in the field by geologist V. Max Brown (formerly of the University of Toledo, Toledo, USA), who co-authored several of my published papers. Geologists Thomas M. Bown (formerly of the United States Geological Survey, Denver, USA), Tom Heldal (Geological Survey of Norway, Bergen, Norway), Per Storemyr (Archaeology and Conservation Services, Hyllestad, Norway), and Aly A. Barakat, Mohamed I. Madbouly and Masoud S. Masoud (all formerly of the Egyptian Geological Survey and Mining Authority, Cairo, Egypt) were especially helpful with both my fieldwork and background research. The same assistance was also rendered by archaeologists Elizabeth G. Bloxam (formerly a research associate in the Institute of Archaeology at the University College, London, UK), Adel Kelany (Ministry of Antiquities and Heritage, Aswan, Egypt), Maria Nilsson (Lund University, Lund, Sweden), Barry Kemp (McDonald Institute for Archaeological Research at the University of Cambridge, Cambridge, UK), and Steven E. Sidebotham (University of Delaware, Newark, USA).

Descriptions and dating of surface pottery found at many of the sites visited were obligingly provided by ceramicists Sylvie Marchand (French Institute of Eastern Archaeology, Cairo, Egypt), Ashraf El Sennusi (Ministry of Antiquities and Heritage, Cairo, Egypt), and the late Roberta S. Tomber (British Museum, London, UK). Geological samples returned to the United States for analysis were exported from Egypt originally through the United States Embassy in Cairo and subsequently through the Egyptian Geological Survey and Mining Authority, and from Sudan through the Geological Research Authority of Sudan.

Of critical importance to my fieldwork was the late Ahmed Badawy, who served as my driver and logistics facilitator in Egypt for the first twenty years. He was later ably replaced by the late Karen van Opstal as the 'safari' organizer and Ahmed Saleh Hemaid as the driver. I also received welcome support and companionship in the field from fellow travelers Jiquan Chen, Colin M. Goepfert, James P. Harrell, Ronald E. Zitterkopf, and especially Robert E. Mittelstaedt. For nearly thirty years Sharon Gasser looked after my many cats while I was away, and no fieldwork could have been done without this assistance. Special thanks are due to my sister, Jacqueline Lee Harrell, who willingly proof-read an earlier draft of the manuscript and caught a multitude of punctuation and typographical errors, and missing accents on French words. Numerous scholars reviewed chapters related to their interests and expertise, and provided valuable feedback on the archaeological and geological content, including the aforementioned V. Max Brown, Tom Heldal and Per Storemyr, plus Brigitte Cech (University of Vienna, Vienna, Austria), Thomas Faucher (Center for Alexandrian Studies, Alexandria, Egypt), Elizabeth Hart (formerly of the Metropolitan Museum of Art, New York, USA), Jane Humphris (British Academy of Sciences, London, UK), Heidi Köpp-Junk (Institute of Mediterranean and Oriental Cultures PAN, Warsaw, Poland), Lorenzo Lazzarini (formerly of the Laboratory for the Analysis of Ancient Materials, University of Venice, Venice, Italy), Martin Odler (Charles University, Prague, Czech Republic), James Ross (University of Western Australia, Perth, Australia), and Lisbet Thoresen (formerly of the J. Paul Getty Museum of Art, Los Angeles, USA). Deserving of exceptional note is Leigh Bettenay (a Research Fellow at the School of Earth Sciences, University of Western

Australia, Perth, Australia), who critically read the entire manuscript and made a multitude of helpful suggestions. There are still others who provided some form of help over the years and their collective contributions are gratefully acknowledged.

James A. Harrell
The University of Toledo
(January 2024)

# Chapter 1

# Introduction

## 1.1 Why this Book?

The ancient Egyptian Civilization dominated the northeast corner of Africa—including modern-day Egypt and, at times, northern Sudan—during its Dynastic (or Pharaonic) through Greco-Roman phases from about 3000 BC to AD 642 (Table 1.1). Most of what it left behind consists of stones and these fall into five categories: (1) building stones for temples, pyramids, and mastaba tombs; (2) utilitarian stones for pigments, tools, weapons, and a wide array of mundane applications, including serving as the raw materials for faience, glass and pottery; (3) ornamental stones for decorative and structural elements in buildings, obelisks, statues, sarcophagi, stelae, vessels, shrines, offering tables, mace heads, cosmetic palettes, and other sculpted objects; (4) gemstones for jewelry, amulets, seals, and other small embellishments; and (5) other stones that were processed to extract their metals. These stone categories are not mutually exclusive. For example, two ornamental stones—granite and granodiorite from Aswan—were sometimes used as building materials, such as in the lower courses of the casing on the *Menkaura* pyramid and the walls of the *Khafra* valley temple in Giza. A similar duality existed for the two principal building stones—limestone and sandstone—which were also commonly employed for statuary. In this book, each variety of stone is assigned to an application category based on its primary use, but secondary uses are also noted. Thus, obsidian is grouped with gemstones because its importance in jewelry and the decorative arts outweighs its utilitarian application as a sharped-edge cutting tool.

Two persistent problems in Egyptology have been the geological identification of stones, and the recognition of their sources. The former has been exacerbated by frequent misidentifications, especially by archaeologists and other non-geologists, whereas the latter problem arises from a lack of appreciation by past scholars of the archaeological importance and richness of ancient mines and quarries. These problems are well illustrated by the greenish *bḫn* (*bekhen*-stone), one of ancient Egypt's most important ornamental stones. It has been variously referred to in the Egyptological literature as basalt, durite, graywacke, schist, siltstone and slate, all geologically very different materials. *Bekhen*-stone is actually best, although not perfectly, described as graywacke (or, more correctly, metagraywacke) as discussed in sections 2.8.2 and 19.2.3. While it has been known for over two centuries that *bekhen*-stone comes from the Eastern Desert's Wadi Hammamat, it has only been in the last decade, during a renewed interest in the source of this stone, that the full extent of the quarry workings has been recognized.

The primary objectives of this book are, therefore, to describe all the rocks and minerals employed by the ancient Egyptians using proper geological nomenclature, and to give an account of the sources of these stones in so far as they are known. The secondary objectives are to describe the multitudinous uses of the stones as well as the technologies employed to extract, transport, carve, or thermally treat them. With the exceptions of discussions of stone tools and weapons in connection with quarrying technologies and utilitarian applications (Chapters 4-5 and 11), the discipline of lithic analysis is not covered here. Also excluded are the purely archaeological considerations of the administration and organization of mining and quarrying enterprises, the lives of the workers involved and their settlements, the distribution of and trade in raw materials, and the construction methods for stone monuments. For these topics see: Arnold (1991), Clarke and Engelbach (1930), Laroze (2019), Laroze and Garric (2013), and Monnier (2023) on stone construction; and Bevan and Bloxam (2016), Bloxam (2005; 2007; 2009b; 2015; 2020; 2021), Bloxam *et al.* (2009), Goedicke (1964), and Shaw (1994; 1998; 2002; 2012) on mining and quarrying expeditions as well as the stone-working trade during the Dynastic Period, and Cuvigny (2005), Fitzler (1910), and Hirt (2010) for the Greco-Roman Period. Information on mine and quarry settlements and associated infrastructure during the Greco-Roman Period is provided by Sidebotham (2011), Sidebotham and Gates-Foster (2019), and Sidebotham *et al.* (2008), but no comparable overview yet exists for the Dynastic Period. Due to its length, this book has been divided into two volumes, based largely on the intrinsic value of the stones: Volume 1 on the archaeological and geological background (Part I), and the building and utilitarian stones (Parts II and III, respectively); and Volume 2 on the ornamental stones (Part IV), gemstones (Part V), and metals (Part VI).

The present work builds on the earlier studies of ancient Egyptian stones, especially those of Alfred Lucas (Lucas 1962: 41-79, 195-269, 386-428), Thierry De Putter and Christina Karlshausen (De Putter and Karlshausen 1992; revised 2022), Rosemarie Klemm

and Dietrich D. Klemm (Klemm and Klemm 1993; 2008; 2010; 2013), and papers by the present author and his collaborators (Aston *et al.* 2000; Harrell 2012a; 2012b; 2012c; 2012d; Harrell and Storemyr 2009). The four books published by the Klemms are particularly noteworthy in their scope, and so the reader may question the need for yet another book on ancient Egyptian stones. The present work differs significantly from that of the Klemms in several important respects. First, it is more comprehensive in its coverage in that it includes all the rocks, minerals and metals used by the ancient Egyptians and also all the sources for these stones. The Klemms were mainly concerned with building and ornamental stones and gold and, for the most part, excluded gemstones, utilitarian stones, and the other metals from their studies. Second, the present work documents nearly three times as many quarries for building and ornamental stones as the Klemms and does so in a more systematic manner. Third, it cites more of the relevant literature on ancient Egyptian mines and quarries. Fourth, the present work provides more and better maps of the mines and quarries, and supplies more accurate coordinates for their locations. Fifth, it is written mainly for archaeologists whereas the Klemms were more geological in their approach. And sixth, the present work provides a more focused and in-depth treatment of the ancient technologies for the extraction and transport of stones.

Apart from serving as a reference on ancient stones and their sources, this book also provides a record of mines and quarries that, in many cases, have already been damaged or destroyed, or are currently threatened with destruction from urban expansion and modern mining and quarrying. Ancient mines and quarries in Egypt are not protected unless they contain important antiquities, such as inscriptions and decorated tombs, or fall within a controlled archaeological zone like those around pyramid and temple complexes. The workings themselves, however, are not considered important archaeological sites by the Egyptian government and so are not accorded security. Even if the government felt differently, and there are many Egyptians in it who do, it lacks the financial resources (or perhaps only the will to allocate them) to provide its small army of antiquity inspectors with the means to patrol the threatened sites. The government can be partially excused for its negligence toward these sites because it is largely unaware that they even exist or can be rich sources of archaeological discovery. A preliminary database of ancient quarries was prepared by Egypt's Supreme Council of Antiquities (Shawarby *et al.* 2009) in order to inform decision makers about these sites, but work on this database stopped when the Western funding that paid for its creation ended. It is not evident that this brief experiment in enlightenment had any lasting effect. It is hoped that this book will serve as a more enduring reminder to those responsible for Egyptian antiquities of the existence and importance of ancient mines and quarries. A future goal, already attempted by Storemyr and Harrell (2013), is to have many of these declared UNESCO World Heritage Sites and so provide the Egyptian government with the rationale, if not also the resources, for protecting them. Another protection strategy is to develop more of the mines and quarries for tourism, which then provide them with funds for guards and other minders. This has already been successfully done for four sites: in the Nile Valley at the Unfinished Obelisk granite quarry in Aswan, and the Gebel el-Silsila sandstone quarries; and in the Eastern Desert at the Mons Claudianus tonalite gneiss quarries, and the Mons Smaragdus (or Sikait-Zabara) emerald mines. Many other sites would be of interest to tourists and, if made available to them with all the attendant amenities and infrastructure, would be an encouragement to visit Egypt and also increase this country's revenues from antiquity fees.

The question naturally arises: is the subject matter of this book to be considered as either 'archaeological geology' or 'geoarchaeology'? These terms do not have universally accepted definitions but, generally speaking, archaeological geology is geology in the service of archaeology whereas geoarchaeology is archaeology that employs geological concepts and methods, especially for the purpose of elucidating the environmental context of archaeological sites (Garrison 2003: 1-3; Hertz and Garrison 1998: 4-5; Rapp and Hill 1998: xi). Although the archaeological association of more specific terms like 'archaeomineralogy' and 'archaeogemology' have been accepted, geologists have appropriated the term 'archaeogeology' to refer to the geology of the earliest periods of Earth history. None of the available disciplinary names accurately describes the entirety of the present work, which employs roughly equal measures of archaeology and geology. If a label is needed, however, the one that will work best is archaeological geology.

## 1.2 Conventions and Approaches Adopted in this Book

### 1.2.1 *Mines vs. Quarries, and their Definitions*

There is no fundamental physical difference between a mine and a quarry. Both can be workings that are either open at the surface in the form of pits and trenches, or extend underground as adits, galleries, shafts, stopes, and tunnels. The former are termed open-cast, open-pit or open-cut excavations whereas the latter are closed excavations. However, it is conventional when referring to extraction sites to restrict the term 'quarry' to the rocks used in building, ornamental and utilitarian applications (and also for unconsolidated sediments

like sand and gravel), and the term 'mine' to metals, gemstones and other useful or economically valuable minerals. Another way of stating the difference is that whole rocks are extracted from quarries whereas mines produce specific minerals from rocks. This convention is followed in the present work. These distinctions are so widely accepted that even among non-geologists it would seem nonsensical to speak of granite mines or gold quarries.

Each named quarry may consist of one or, usually, multiple extraction cuts. The term 'quarry' is conventionally employed for both individual cuts and a group of associated cuts, but this leads to the terminological awkwardness of having quarries within a quarry. The approach adopted in this book is to identify a quarry with any group of contiguous (or nearly so) cuts that are well separated from other such groups, and apply the terms 'quarries' or 'quarry complex' to a collection of geographically associated cuts. All these entities will also be referred to by the more general term 'workings'. Thus, one can speak of the Giza quarries or quarry complex with its eight distinct areas of limestone workings, each a separate quarry, or the Nag el-Fuqani quarry with its single group of sandstone workings. In most cases the quarries within a given complex are separated by less than 1 km and are usually much closer. Some complexes, however, have more widely separated quarries, defined more by their geographic association and isolation than their mutual proximity. In a few cases, a long continuous series of workings has been arbitrarily split into contiguous complexes for the sake of convenience. In general, however, the recognition of named quarries agrees with past practice in the Egyptological literature. The same terminological approach is taken with mines where each site is viewed as either a single mine or a complex of multiple mines.

The above terminology is strictly morphological and geographical, but ancient mines and quarries also have an archaeological dimension. This notion is encapsulated in the term 'quarryscape' (a contraction of quarry landscape), which has been introduced and popularized for Egyptian sites by Norwegian geologists Tom Heldal and Per Storemyr, and British archaeologist Elizabeth Bloxam. They define quarryscape as 'a cultural landscape shaped by stone quarrying, consisting of groups of quarries... but also associated [with] infrastructure and other elements of material culture related to the exploitation of natural resources' (Bloxam *et al.* 2007: 6-7). By extension, a 'minescape' could similarly be defined for mining sites.

### 1.2.2 *Mine and Quarry Locations*

The locations of each ancient mine and quarry complex is provided by the latitude and longitude of a central point within it, and also by the outline of its excavation limits on a map. In most cases, the initial coordinates were determined in the field using a hand-held, 12-channel, Garmin GPS (Global Positioning System) receiver, but the final coordinates given in this book are those taken from orthorectified, high-resolution satellite imagery available through the Google Earth website (www.google.com/earth/). It is through this remarkable, open-access website that readers can virtually visit the mines and quarries. The horizontal positional accuracy of the Google Earth coordinates reported for Egyptian sites is usually within 10 m of the true position but occasionally is off by as much as 15 m.

### 1.2.3 *Transliteration of Arabic Place Names*

There are several transliteration systems that one can use to render Arabic words into English alphabetic characters. These are often supplemented with preferred spellings that do not conform to a particular scheme. The transliteration system adopted in this book closely follows the one employed in the *Cultural Atlas of Ancient Egypt* (Baines and Malek 2000), and for sites not included in this atlas, use was made of the largely homologous place-name transliterations from the topographic maps published by the Survey of Egypt in the early 1900s. Transliterations from both sources were simplified in some cases to avoid special characters and diacritical marks. Additional place names were taken from the more recent topographic maps of the Egyptian General Survey Authority. These follow a very different transliteration system and so the spelling of the place names was modified to conform to the system employed here. The surnames of cited Egyptian and other Arab authors are taken as published regardless of the system used.

### 1.2.4 *Transliteration and Spelling of Ancient Rock, Mineral and Personal Names*

The ancient Egyptian names of rocks and minerals reported in this book are the transliterated versions of the original hieroglyphic words as provided by Harris (1961). There are, however, two drawbacks to these transliterations. First, while most of the transliteration symbols are regular English letters, others are special characters that will not be meaningful to non-Egyptologists. And second, the ancient Egyptian words do not include vowels and so in their transliterated forms they appear as an unpronounceable string of consonants. Because of a lack of vowels in ancient Egyptian writing, it is not known how these words were spoken. Nevertheless, as a convenience to readers and listeners, Egyptologists render the transliterated words into a vocalized (pronounceable) form by replacing all transcription symbols with regular English letters of equivalent sound value and inserting the letter 'e' between some consonants (for good discussions of how

this is done see Allen 2014: 22-23 and Davies 1987a: 30-37). This practice is followed in the present work. The choice of where to place the e-vowels is arbitrary and dictated as much by tradition and personal aesthetics as anything else. It must be kept in mind, however, that these vocalizations do not necessarily coincide with the ancient pronunciations.

The Classical Greek and Latin names of rocks and minerals are provided in this book in their original unaccented scripts (which helpfully include both vowels and consonants). These are transliterated into regular English letters of equivalent sound value according to the schemes presented in any comprehensive English-language dictionary. The spellings of the Greek and Latin words are the conventional nominative (subjective) singular forms that appear in indices and dictionaries rather than the spellings used in the original texts. For modern rock and mineral names, standard geological terminology is used in accordance with North American practice as described in Chapter 2. The spelling of the names of Egyptian gods, rulers and other elite persons follows the system adopted in Shaw (2000c), but the names of Napatan and Meroitic rulers are spelled as in Welsby (1996).

### 1.2.5 *Chronology and Dating*

The ancient Egyptian and northern Sudanese chronologies employed in this book (Table 1.1) follow Shaw (2000c: 479-483) and Markowitz and Doxey (2014: 159), respectively. Other, slightly different chronologies are also in use by archaeologists but the ones employed here are widely accepted. The vast majority of the mines and quarries discussed in later chapters are poorly dated. Only a few have been studied by archaeologists and consequently have firmly established ages. The rest are tentatively dated based on surface pottery finds, inscriptions, tool marks, the stone's period of use, the age of nearby sites where the stone was (or might have been) used, and the type of grinding stone present in the case of gold mines. Future excavations or surveys at some of these mines and quarries will undoubtedly result in revised dating, especially for their earliest periods of activity which may be largely obscured by debris from later workings or natural sedimentation.

<table>
<tr><th colspan="3">EGYPT[1]</th><th>northern SUDAN[1]</th></tr>
<tr><th>Lower Egypt[2]</th><th>Middle and Upper Egypt[3]</th><th>Lower Nubia[3]</th><th>Upper Nubia[3]</th></tr>
<tr><td colspan="4">Predynastic Period (5300 to 3000 BC)</td></tr>
<tr><td>Late Neolithic (5300 to 4000 BC)</td><td>Badarian (4400 to 4000 BC)</td><td rowspan="5">A-Group Culture</td><td rowspan="5">Pre-Kerma Period</td></tr>
<tr><td rowspan="3">Maadi Cultural Complex (4000 to 3200 BC)</td><td>Naqada I or Amratian (4000 to 3500 BC)</td></tr>
<tr><td>Naqada II or Gerzean (3500 to 3200 BC)</td></tr>
<tr><td colspan="2">Dynasty 0 or Naqada III (3200 to 3000 BC)</td></tr>
<tr><td colspan="2">Dynastic or Pharaonic Period (3000 to 332 BC): Dynasties 1 to 31</td></tr>
<tr><td colspan="2">Early Dynastic or Archaic Period (3000 to 2686 BC): Dynasties 1 to 2</td><td rowspan="2">C-Group Culture</td><td rowspan="2">Early Kerma Period</td></tr>
<tr><td colspan="2">Old Kingdom (2686 to 2160 BC): Dynasties 3 to 8</td></tr>
<tr><td colspan="2">First Intermediate Period (2160 to 2055 BC): Dynasties 9 to early 11</td><td rowspan="2">C-Group Culture<br>Egyptian occupation</td><td>Middle Kerma Period</td></tr>
<tr><td colspan="2">Middle Kingdom (2055 to 1650 BC): Dynasties late 11 to 14</td><td>Classic Kerma Period</td></tr>
<tr><td colspan="2">Second Intermediate Period (1650 to 1550 BC): Dynasties 15 to 17</td><td colspan="2">Egyptian occupation</td></tr>
<tr><td colspan="2">New Kingdom (1550 to 1069 BC): Dynasties 18 to 20</td><td colspan="2">Egyptian occupation</td></tr>
<tr><td colspan="2">Third Intermediate Period (1069 to 664 BC): Dynasties 21 to 25</td><td colspan="2">independent Nubian cultures</td></tr>
<tr><td colspan="2">Late Period (664 to 332 BC): Dynasties 26 to 31</td><td colspan="2">Napatan Period</td></tr>
<tr><td colspan="2">Greco-Roman Period (332 BC to AD 395)</td><td colspan="2" rowspan="4">Meroitic Period</td></tr>
<tr><td>Macedonian Period (332 to 305 BC): Dynasty 32</td><td rowspan="2">Hellenistic Period (323 to 30 BC)</td></tr>
<tr><td>Ptolemaic Period (305 to 30 BC): Dynasty 33</td></tr>
<tr><td colspan="2">Roman Period (30 BC to AD 395)</td></tr>
<tr><td colspan="2">Byzantine, Coptic or Late Roman Period (AD 395 to 642)</td><td colspan="2" rowspan="2">Post-Meroitic Period</td></tr>
<tr><td colspan="2">Arab Conquest (AD 642)<br>Medieval Islamic Period (AD 642 to 1517)</td></tr>
</table>

[1] Egyptian chronology from Shaw (2000c: 479-483) and northern Sudanese chronology adapted from Markowitz and Doxey (2014: 159). Dates before the Late Period and temporal correlations between the two chronologies are approximate.

[2] Nile Delta.

[3] Nile Valley and adjacent deserts from the Delta's apex at Cairo to the First Cataract at Aswan (Middle and Upper Egypt), the First Cataract to the Second Cataract at the Egyptian/Sudanese border near Wadi Halfa (Lower Nubia), and the Second Cataract to the Sixth Cataract 70 km north of Khartoum (Upper Nubia). See maps in Figures 3.1 and 3.4.

Table 1.1: Ancient Egyptian and Sudanese chronologies.