

Archaeology and Geology of Ancient Egyptian Stones. Volume 1



ARCHAEOPRESS EGYPTOLOGY 49

Archaeology and Geology of Ancient Egyptian Stones

Volume 1

Archaeological and Geological Background;
Building and Utilitarian Stones

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ARCHAEOPRESS ARCHAEOLOGY



ARCHAEOPRESS PUBLISHING LTD

Summertown Pavilion

18-24 Middle Way

Summertown

Oxford OX2 7LG

www.archaeopress.com

ISBN 978-1-80327-581-9

ISBN 978-1-80327-582-6 (e-Pdf)

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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).

Contents

VOLUME 1

Archaeological and Geological Background; Building and Utilitarian Stones

On Writing a Reference Work

List of Figures and Tables..... viii

Preface 1

Chapter 1

Introduction

1.1 Why this Book?	3
1.2 Conventions and Approaches Adopted in this Book.....	4
1.2.1 Mines vs. Quarries, and Their Definitions	4
1.2.2 Mine and Quarry Locations.....	5
1.2.3 Transliteration of Arabic Place Names.....	5
1.2.4 Transliteration and Spelling of Ancient Rock, Mineral and Personal Names.....	5
1.2.5 Chronology and Dating.....	6

Part I

Archaeological and Geological Background

Chapter 2

Identification and Classification of Rocks and Minerals

2.1 Introduction	8
2.2 Minerals.....	8
2.2.1 Elements to Minerals	8
2.2.2 Mineral Properties and Identification	8
2.3 The Rock Cycle	11
2.4 Igneous Rocks	18
2.4.1 Origin of Igneous Rocks	18
2.4.2 Igneous Rock Properties and Classification	20
2.4.3 Igneous Rocks Used in Ancient Egypt	24
2.5 Sedimentary Rocks	25
2.5.1 Weathering, Sediments and Depositional Environments	25
2.5.2 Lithification	26
2.5.3 Sedimentary Rock Properties and Classification.....	26
2.5.4 Sedimentary Rocks Used in Ancient Egypt	30
2.6 Metamorphic Rocks.....	30
2.6.1 Origin of Metamorphic Rocks.....	30
2.6.2 Metamorphic Rock Properties and Classification	31
2.6.3 Metamorphic Rocks Used in Ancient Egypt.....	33
2.7 Gemstones and Metals Used in Ancient Egypt.....	33
2.8 Ancient Egyptian Origins of Some Common Rock Names.....	34
2.8.1 Alabaster	34
2.8.2 Basalt	35
2.8.3 Ophiolite and Serpentine	35
2.8.4 Porphyry	36
2.8.5 Syenite.....	36
2.9 Ancient Egyptian Knowledge of Rocks and Minerals.....	36

Chapter 3

Geology of Egypt and Northern Sudan

3.1 Introduction39

3.2 Geological Development39

 3.2.1 Precambrian Eon39

 3.2.2 Phanerozoic Eon39

3.3 Physiography45

 3.3.1 Nile River Valley45

 3.3.2 The Deserts46

3.4 Geological Hazards48

 3.4.1 Earthquakes48

 3.4.2 Floods50

 3.4.3 Landslides52

 3.4.4 Other Hazards54

Chapter 4

Tools and Methods for Extraction of Hard Stones

4.1 Introduction56

4.2 Hard-Stone Boulders versus Bedrock56

4.3 Hard-Stone Extraction with Stone Tools56

4.4 Hard-Stone Extraction with Iron Tools62

 4.4.1 Earliest Use of Iron Tools62

 4.4.2 Wedging Technique66

 4.4.3 Pointillé Technique67

 4.4.4 Sawing68

 4.4.5 Pick Work70

4.5 Fire-Setting71

4.6 Roughing-Out and Carving71

Chapter 5

Tools and Methods for Extraction of Soft Stones

5.1 Tools74

 5.1.1 Introduction74

 5.1.2 Chisels74

 5.1.3 Other Tools77

5.2 Quarrying Methods81

 5.2.1 Block Extraction81

 5.2.2 Changing Approaches to Block Extraction in Open-Cut Quarries86

 5.2.3 Block Extraction in Underground (Gallery) Quarries92

 5.2.4 Quarry Wastage93

 5.2.5 Distinguishing Between Ancient and Modern Quarries95

5.3 Chisel-Mark Chronology95

5.4 Other Features103

5.5 A Remarkable Quarrying and Transport Scene105

5.6 Architectural Depictions on Quarry Walls of Structures Built with the Quarried Stone106

5.7 Innovation and Conservatism107

Chapter 6

Stone Transport

6.1 Introduction109

6.2 Sledges109

 6.2.1 Surviving Sledges109

 6.2.2 Depictions of Sledges110

 6.2.3 Easing the Way112

 6.2.4 Loading Ramps115

 6.2.5 Continued Use into the Roman Period116

6.3 Boats116

6.4 Wagons116

6.5 Quarry Roads121

6.5.1 Dynastic Period	121
6.5.1.1 Widan el-Faras Quarry Road	121
6.5.1.2 Hatnub Quarry Road	122
6.5.1.3 Other Dynastic Quarry and Mine Roads	123
6.5.2 Roman Period	125

Part II Building Stones

Chapter 7

Overview of Building Stones

7.1 Introduction	128
7.2 Limestone and Sandstone	128
7.3 Lime Plaster and Mortar	132
7.4 Anhydrite and Gypsum	132
7.5 Gypsum Plaster and Mortar	133
7.6 Other Stones	134
7.7 Quarries	136
7.7.1 Distribution	136
7.7.2 Description	139

Chapter 8

Limestone

8.1 Introduction	140
8.2 Quarry Catalog	154
8.2.1 Mallahet Mariut Quarries	154
8.2.2 Abu Rawash Quarry	161
8.2.3 Gebel Moqattam Quarries	162
8.2.4 Giza Quarries	164
8.2.5 Tura-Masara Quarries	166
8.2.6 Zawyet el-Aryan Quarry	172
8.2.7 Abusir Quarry	172
8.2.8 Saqqara North Quarries	173
8.2.9 Saqqara South Quarries	174
8.2.10 Dahshur Quarries	175
8.2.11 Sadd el-Kafara Quarries	176
8.2.12 El-Lisht Quarries	176
8.2.13 Maidum Quarries	176
8.2.14 El-Lahun Quarries	176
8.2.15 El-Sawayta Quarries	181
8.2.16 El-Babein Quarry	182
8.2.17 Deir Gebel el-Teir Quarries	184
8.2.18 Tihna el-Gebel Quarries	186
8.2.19 El-Hawarta Quarries	189
8.2.20 Nazlet Hussein Ali Quarries	190
8.2.21 Nazlet Sultan Pasha Quarries	191
8.2.22 Zawyet el-Amwat Quarries	195
8.2.23 Nazlet Abu Ginah Quarries	196
8.2.24 Beni Hasan North Quarry	196
8.2.25 Beni Hasan South Quarries	197
8.2.26 Nag el-Arab Quarries	198
8.2.27 El-Sheikh Timay Quarry	198
8.2.28 El-Sheikh Ibada Quarries	200
8.2.29 Deir Abu Hennis North Quarries	201
8.2.30 Deir Abu Hennis South Quarries	201
8.2.31 Deir el-Bersha Quarries	202
8.2.32 Tuna el-Gebel North Quarries	206
8.2.33 Tuna el-Gebel South Quarries	206
8.2.34 Gebel Sheikh Said North Quarries	206

8.2.35 Gebel Sheikh Said South Quarries.....	209
8.2.36 Wadi el-Zebeida Quarries	209
8.2.37 Amarna North Tombs Quarries	212
8.2.38 Amarna South Tombs Quarry	214
8.2.39 Hatnub Quarries	215
8.2.40 Gebel Abu Foda North Quarry	217
8.2.41 Deir el-Quseir Quarries	217
8.2.42 Meir Quarry	218
8.2.43 Quseir el-Amarna Quarries	219
8.2.44 Deir el-Amir Tadros Quarries.....	221
8.2.45 Deir Abu Mina Quarries	222
8.2.46 Wadi el-Gabrawi Quarry	223
8.2.47 Deir el-Gabrawi Quarry.....	223
8.2.48 Arab el-Atiyat el-Bahariya Quarries	224
8.2.49 El-Ketf Quarries.....	227
8.2.50 Talet el-Hagar Quarries	227
8.2.51 Gebel Durunka West Quarry	227
8.2.52 Gebel Durunka East Quarries	229
8.2.53 Wadi Emu Quarry.....	231
8.2.54 Deir Durunka Quarries.....	231
8.2.55 El-Khawalid Quarries	232
8.2.56 Deir Rifa Quarries	233
8.2.57 Nazlet el-Mustagidda Quarry.....	236
8.2.58 El-Ruweigat Quarries	236
8.2.59 El-Zawya Quarries.....	236
8.2.60 El-Balayza Quarries	238
8.2.61 El-Iqal Bahari Quarries.....	240
8.2.62 El-Zaraby Quarry	240
8.2.63 El-Sheikh Isa Quarry	240
8.2.64 El-Iqal Qibli Quarry.....	243
8.2.65 El-Hammamiya North Quarries.....	243
8.2.66 Deir el-Ganadla Quarries	244
8.2.67 Qaw el-Kebir Quarries.....	246
8.2.68 El-Hammamiya South Quarries.....	247
8.2.69 El-Mashaya Quarries	250
8.2.70 El-Ghanayim Quarries.....	250
8.2.71 El-Qutna Quarries	253
8.2.72 el-Qarya Bil Diweir Quarry	253
8.2.73 El-Nawawra Quarries	254
8.2.74 El-Khazindariya Quarries	254
8.2.75 Nazlet Khatir Quarries	257
8.2.76 Nazlet el-Haridi North Quarries	257
8.2.77 Nazlet el-Haridi South Quarries	257
8.2.78 Nag Mubarak Quarry.....	260
8.2.79 El-Galawiya Quarry.....	262
8.2.80 Nag Abu Roda Quarry.....	262
8.2.81 Giheina Quarries	264
8.2.82 El-Salamuni Quarries	264
8.2.83 Wadi Abu Gilbana Quarry	265
8.2.84 Deir el-Abyad el-Bahari Quarry	266
8.2.85 Nag Hamad Quarry	268
8.2.86 Athribis Quarry.....	268
8.2.87 Nag el-Ahaywa Quarry.....	270
8.2.88 Gebel Tukh North Quarries	270
8.2.89 Gebel Tukh South Quarries	272
8.2.90 Gebel el-Alawaniya Quarries.....	273
8.2.91 Nag el-Ghabat Quarry	275
8.2.92 Gebel el-Gir Quarries.....	275

8.2.93 Nag el-Buza Quarry	277
8.2.94 Qurna Quarries.....	279
8.2.95 Four Possible Limestone Quarries in the Qena-Luxor Region.....	280
8.2.96 el-Dibabiya Quarry	282
8.2.97 el-Kula Quarry.....	284
8.2.98 Fatira Quarry	285
8.2.99 Siwa Oasis Quarries	286
8.2.100 Wadi el-Jarf Quarry	287
8.3 Use of Natural Limestone Blocks.....	287
8.4 Provenance Determination	287

Chapter 9 Sandstone

9.1 Introduction	297
9.2 Quarry Catalog	308
9.2.1 El-Mahamid Quarries	308
9.2.2 Shesmetet Quarries	309
9.2.3 Wadi el-Tarifa Quarries.....	310
9.2.4 El-Kejjal Quarry.....	311
9.2.5 Nag el-Dumariyya Quarry	313
9.2.6 Nag Hagar Abu Khalifa Quarry?	313
9.2.7 el-Buweib Quarries	313
9.2.8 Nag el-Raqiqein Quarry	315
9.2.9 Nag el-Hosh Quarries	316
9.2.10 Wadi el-Shatt el-Rigal Quarries.....	317
9.2.11 Nag el-Hammam Quarries.....	319
9.2.12 Gebel el-Silsila East and West Quarries.....	320
9.2.13 Nag el-Falalih Quarry	329
9.2.14 Nag el-Sheikh Garad Quarries	330
9.2.15 Gebel el-Hammam Quarry	331
9.2.16 Nag el-Fuqani Quarry.....	332
9.2.17 Hagar el-Ghorab Quarry	332
9.2.18 Gebel el-Qurna Quarry.....	334
9.2.19 Gebel Qubbet el-Hawa Quarry	335
9.2.20 Wadis Saman and el-Deir Quarries	336
9.2.21 Aswan Quarries	338
9.2.22 Dabod Quarries	339
9.2.23 Qertassi Quarries	339
9.2.24 Tafa Quarry.....	341
9.2.25 Kalabsha Quarries.....	342
9.2.26 Abu Hor/Murwaw Quarries	343
9.2.27 Qurta Quarry	343
9.2.28 Nag el-Agayba Quarry.....	343
9.2.29 Tumas Quarry.....	343
9.2.30 Qasr Ibrim Quarry.....	344
9.2.31 Nag Deira Quarry	344
9.2.32 Gebel Adda Quarry	344
9.2.33 Gezira Dabarosa Quarry.....	344
9.2.34 Buhen Quarries	345
9.2.35 Abdel Kadir Quarry.....	346
9.2.36 Sesebi Quarry	346
9.2.37 Khor el-Hawazawin Quarries.....	346
9.2.38 Other Quarries in the Karima Area and Beyond.....	349
9.2.39 Wadi el-Muweih Quarries.....	349
9.2.40 Bir el-Kanayis Quarry.....	350
9.2.41 Quarries in Wadis Allawi and Kharit, Eastern Desert?.....	350
9.2.42 Qaret el-Farargi Quarry in the Bahariya Depression	352
9.2.43 el-Muzawqa Quarry in the Dakhla Depression	353

9.2.44 Quarries in the Kharga Depression.....	353
9.2.45 Serabit el-Khadim Quarries.....	355
9.3 Provenance Determination	355

Chapter 10

Anhydrite, Gypsum, and Other Building Stones

10.1 Anhydrite and Gypsum.....	357
10.1.1 Introduction	357
10.1.2 Quarry Catalog	357
10.1.2.1 Umm el-Sawan Quarries.....	357
10.1.2.2 Deir Abu Lifa Quarries	359
10.1.2.3 Wadis Ibada/el-Amrani Quarries	361
10.1.2.4 Wadi el-Anba'ut Quarry.....	364
10.1.2.5 Ras Banas Quarry?.....	365
10.1.2.6 Other Potential Sources	367
10.2 Other Building Stones	368

Part III Utilitarian Stones

Chapter 11

Overview of Utilitarian Stones

11.1 Introduction	373
11.2 Stones for Tools.....	373
11.3 Stones for Weapons	376
11.4 Stones for Grinding	377
11.5 Glazed Stone Objects and Cooking Vessels	383
11.6 Pottery.....	384
11.7 Faience and Glass	385
11.8 Paint.....	386
11.9 Desiccants and Preservatives for Mummification.....	386
11.10 Other Applications and Materials	387

Chapter 12

Hard Utilitarian Stones

12.1 Chert	388
12.1.1 Introduction	388
12.1.2 Quarry Catalog	388
12.1.2.1 Wadi Warag Quarries	388
12.1.2.2 Wadi Sannur Quarries.....	390
12.1.2.3 Wadi el-Sheikh Quarries.....	395
12.1.2.4 Amarna Quarry	405
12.1.2.5 Other Predynastic and Dynastic Chert Quarries?	407
12.1.2.6 Palaeolithic and Neolithic Chert Quarries	407
12.2 Dolerite.....	408
12.2.1 Introduction	408
12.2.2 Quarry Catalog	408
12.2.2.1 Gebel el-Granite Quarry	408
12.2.2.2 Hod el-Rub North and South Quarries.....	411
12.2.2.3 Other Dolerite Sources in the Aswan Area?	411
12.3 Silicified Sandstone	412
12.3.1 Introduction	412
12.3.2 Quarry Catalog	412
12.3.2.1 North Aswan Quarries	412
12.3.2.2 Umm el-Sawan Quarry	414
12.3.2.3 North Kharga Quarries	415

Chapter 13

Soft Utilitarian Stones and Other Geological Materials

13.1 Steatite	418
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13.1.1 Introduction	418
13.1.2 Quarry Catalog	421
13.1.2.1 Wadi Saqiya Quarries	421
13.1.2.2 Wadi Mubarak Quarries	423
13.1.2.3 Wadi Abu Quraiya Quarries	426
13.1.2.4 Wadi el-Humra Quarries	428
13.1.2.5 Gebel Rod el-Baram Quarries	429
13.1.2.6 Wadi Umm Selim Quarries	431
13.1.2.7 Wadi Sikait Quarry	432
13.1.2.8 Wadi Kamoyib Quarries	433
13.1.2.9 Bir el-Hamr Quarries	434
13.1.3 Provenance Determination	435
13.2 Clay Minerals	435
13.2.1 Nile Mud	436
13.2.2 Desert Marl and Hiba	436
13.2.3 Kaolinitic Paleosoil	437
13.2.4 Mudrock	437
13.3 Alum	437
13.4 Natron	440
13.5 Mineral Pigments and Colorants	440
13.6 Quartz	442
13.7 Bitumen	443
13.8 Sulfur	444
Color Plates	446

List of Figures and Tables

Chapter 1

Table 1.1: Ancient Egyptian and Sudanese chronologies.....	6
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Chapter 2

Figure 2.1: The rock cycle	19
Figure 2.2: Spectrum of igneous rock occurrences.....	19
Figure 2.3: Visual comparator for porphyritic igneous rocks.....	20
Figure 2.4: IUGS mineralogical classification of plutonic (phaneritic) igneous rocks with the feldspathoid-bearing rocks omitted	23
Figure 2.5: IUGS chemical classification of aphanitic (extrusive volcanic and intrusive subvolcanic) igneous rocks with the feldspathoid-bearing rocks omitted	23
Figure 2.6: Spectrum of sedimentary depositional environments.....	25
Figure 2.7: Spectrum of metamorphic rock occurrences	31
Figure 2.8: Drawing of the 20th-Dynasty Turin papyrus map	37
Table 2.1: Relative abundances of elements in the Earth's crust	9
Table 2.2: Mohs hardness scale	10
Table 2.3: Minerals in ancient Egyptian stones.....	12
Table 2.4: Grain-size scale for igneous rocks	20
Table 2.5: Simplified IUGS classification of igneous rocks containing quartz and feldspar.....	21
Table 2.6: Miscellaneous igneous rock types	22
Table 2.7: Typical phenocryst assemblages in aphanitic (volcanic) igneous rocks.....	24
Table 2.8: Sediment deposits and their depositional environments	26
Table 2.9: Udden-Wentworth grain-size scale for siliciclastic sediments and sedimentary rocks	27
Table 2.10: Classification of siliciclastic sedimentary rocks	28
Table 2.11: Classification of carbonate sedimentary rocks.....	29
Table 2.12: Other common sedimentary rocks.....	30
Table 2.13: Classification of metamorphic rocks.....	32

Chapter 3

Figure 3.1: Generalized bedrock geology map of Egypt and northern Sudan	40
Figure 3.2: Generalized surficial geology map of Egypt and northern Sudan.....	41
Figure 3.3: Generalized topographical map of Egypt and northern Sudan	42
Figure 3.4: Geological map of cataracts and rapids along the Nubian reach of the Nile River in southern Egypt and northern Sudan.....	47
Figure 3.5: Rotated blocks caused by an earthquake in the unfinished 12th-Dynasty sandstone temple of Qasr el-Sagha in the northern Faiyum Desert	49
Figure 3.6: The northern <i>Memnon</i> Colossus at Kom el-Hetan (the <i>Amenhotep</i> III mortuary temple) on the Luxor West Bank	49
Figure 3.7: Wooden dovetail clamp joining two sandstone blocks in the 18th-Dynasty <i>Montu</i> temple at Karnak.....	49
Figure 3.8: Multiple mortises with wooden dovetail clamps in a pavement of sandstone blocks in the Ptolemaic Opet shrine in the Karnak temple complex.....	50
Figure 3.9: Luxor Temple with the lower halves of the columns in the Colonnade of <i>Amenhotep</i> III buried under sediment deposited by Nile floods.....	51
Figure 3.10: Damage by river erosion to the <i>Sobek</i> temple of Ptolemaic and Roman age at Kom Ombo	52
Figure 3.11: View of Deir el-Bahri from the top of the cliff that overlooks it	53
Figure 3.12: The Sheikh Abd el-Qurna slump block with the Theban escarpment, from where it slid, at left	53
Table 3.1: Stratigraphic succession and chronology of Egyptian rocks.....	43

Chapter 4

Figure 4.1: Broken dolerite pounder with a narrowed neck for hafting a wooden handle from the Predynastic-Early Dynastic section of the Wadi Hammamat quarry complex for metagraywacke.....	57
Figure 4.2: Scene from a relief in the 5th Dynasty tomb of <i>Ti</i> at Saqqara showing workmen using hafted stone pounders to sculpt a statue.....	57
Figure 4.3: Dolerite pounders from a New Kingdom granite quarry for a colossal Osirid statue in south Aswan.....	57
Figure 4.4: Pounders, as deposited by excavators, of mostly dolerite from the 18th-/19th-Dynasty section of the Unfinished Obelisk quarry for granite in Aswan	57
Figure 4.5: Dolerite pounder 30 cm across in the Middle Kingdom Wadi el-Hudi mining complex for amethyst.....	58
Figure 4.6: Scene from a painting in the 18th-Dynasty tomb of <i>Rekmira</i> in <i>Thebes</i> showing workmen using stone tools	58
Figure 4.7: Angular pounder of fine-grained granite from the New Kingdom section of the Wadi Abu Aggag quarry complex for silicified sandstone near Aswan.....	59
Figure 4.8: Angular pieces of pounder-size dolerite, as stockpiled in antiquity, in the Dynastic but otherwise undated Gebel el-Granite quarry for dolerite in south Aswan.....	59

Figure 4.9: Silicified sandstone bedrock that has been worked with pounders in the New Kingdom section of the Wadi Abu Aggag quarry complex near Aswan.....	60
Figure 4.10: Granite bedrock that has been worked with pounders to produce Aswan's Unfinished Obelisk of 18th- or 19th-Dynasty date.....	60
Figure 4.11: Crushing by a pounder along a natural fracture in volcanic tuff in the Early Dynastic Gebel Manzal el-Seyl quarry complex.....	61
Figure 4.12: Rod-like metagraywacke tools from a Predynastic-Early Dynastic section of the Wadi Hammamat quarry complex.....	61
Figure 4.13: Chisel-like marks on a cosmetic palette blank of metagraywacke from a Predynastic-Early Dynastic section of the Wadi Hammamat quarry complex.....	61
Figure 4.14: Chisel-like marks on metagraywacke bedrock in a Predynastic-Early Dynastic section of the Wadi Hammamat quarry complex.....	62
Figure 4.15: A series of pointillé pits in a block of metagraywacke in a Predynastic-Early Dynastic section of the Wadi Hammamat quarry complex.....	62
Figure 4.16: A series of pointillé pits in a block of metagraywacke in a Predynastic-Early Dynastic section of the Wadi Hammamat quarry complex.....	62
Figure 4.17: Tracks cut by an iron chisel in dolerite porphyry in the 30th-Dynasty to early Ptolemaic Rod el-Gamra quarry.....	63
Figure 4.18: Remaining halves of two primitive wedge holes cut for iron wedges in dolerite porphyry in the 30th-Dynasty to early Ptolemaic Rod el-Gamra quarry.....	63
Figure 4.19: Remaining half of a primitive wedge hole cut for an iron wedge in dolerite porphyry in the 30th-Dynasty to early Ptolemaic Rod el-Gamra quarry.....	63
Figure 4.20: Remaining half of a primitive wedge hole cut for an iron wedge in metaconglomerate in a probable 30th-Dynasty section of the Wadi Hammamat quarry complex.....	64
Figure 4.21: Remaining half of a primitive wedge hole cut for an iron wedge in tonalite in the Ptolemaic Wadi Abu Bokari quarry complex.....	64
Figure 4.22: Linear groove cut across a tonalite boulder in the Ptolemaic Wadi Abu Bokari quarry complex.....	64
Figure 4.23: Roman wedge holes in granite bedrock cut along the bottom of a shallow trough in Aswan's Unfinished Obelisk quarry.....	64
Figure 4.24: Wedge holes of probable Meroitic age cut along the bottom of a shallow trough in a granite/granodiorite gneiss boulder in quarry B of the Tumbos quarry complex in northern Sudan.....	64
Figure 4.25: Roman wedge holes cut in metaandesite/dacite porphyry bedrock in the West Quarries sub-complex at Mons Porphyrites.....	64
Figure 4.26: Close-up of wedge holes in Figure 4.25.....	65
Figure 4.27: Two Roman wedge holes cut into metagabbro in the Wadi Maghrabiya quarry complex.....	65
Figure 4.28: Wedging of Meroitic or early medieval Christian age in a granite/granodiorite gneiss boulder in quarry D of the Tumbos quarry complex in northern Sudan.....	65
Figure 4.29: V-shaped groove cut along the base of a block in the Roman Mons Claudianus quarry complex for tonalite gneiss.....	65
Figure 4.30: Close-up of the basal groove in Figure 4.29.....	65
Figure 4.31: Lever hole of Meroitic or early medieval Christian age cut on one side of a wedge-induced fracture in granite/granodiorite gneiss bedrock in quarry A of the Tumbos quarry complex in northern Sudan.....	65
Figure 4.32: Wedge holes and larger, roughly square Lewis holes for wooden posts in tonalite gneiss in the Roman Mons Claudianus quarry complex.....	66
Figure 4.33: Line of pointillé pits cut in tonalite in the Ptolemaic Wadi Abu Bokari quarry complex.....	67
Figure 4.34: Line of pointillé pits in tonalite cut along the bottom of a shallow trough in the Ptolemaic Wadi Abu Bokari quarry complex.....	68
Figure 4.35: Wedging and pointillé techniques used together in metagraywacke in a Ptolemaic or Roman section of the Wadi Hammamat quarry complex.....	68
Figure 4.36: Basalt block with saw cuts on two sides and one of many sawn blocks in the pavement of the <i>Khufu</i> pyramid temple at Giza.....	68
Figure 4.37: Flat saw cut in pegmatitic diorite in the Roman Wadi Umm Shegilat quarry complex.....	68
Figure 4.38: Saw cut in pegmatitic diorite in the Roman Wadi Umm Shegilat quarry complex.....	68
Figure 4.39: Chiseled grooves in pegmatitic diorite that are probably precursors to saw cuts in the Roman Wadi Umm Shegilat quarry complex.....	69
Figure 4.40: Last surviving section of the ancient Gebel Ahmar quarries for silicified sandstone in Cairo.....	70
Figure 4.41: Close-up of the tool marks on the quarry wall in Figure 4.40.....	70
Figure 4.42: Evidence of fire-setting in Aswan's Unfinished Obelisk quarry.....	71
Figure 4.43: Roughed-out colossal statue of a striding king of the 18th or 19th Dynasty found in the Gebel Ahmar quarry complex for silicified sandstone in the Nasr City district of Cairo.....	71
Figure 4.44: Roughed-out, tonalite gneiss columns of Roman date in the Mons Claudianus quarry complex as left in antiquity on the complex's main loading ramp.....	72
Figure 4.45: Three Early Dynastic vessel blanks in the Gebel Manzal el-Seyl quarry complex for metatuff and tuffaceous metalimestone.....	72
Figure 4.46: Roughed-out, dolerite porphyry <i>naos</i> of 30th Dynasty or, less likely, early Ptolemaic date in the Rod el-Gamra quarry.....	72
Figure 4.47: Broken tip (pyramidion) of a nearly finished (inscribed) obelisk for Sety I in the Gharb Aswan quarry complex for silicified sandstone.....	72
Figure 4.48: Nearly finished colossal statue of an unknown 25th-Dynasty king carved from granite/granodiorite gneiss in quarry B of the Tumbos quarry complex in northern Sudan.....	73

Chapter 5

Figure 5.1: Bronze bar chisel and wooden mallet from the Middle Kingdom	74
Figure 5.2: Scene from a painting in the 18th-Dynasty tomb of <i>Rekmira</i> in <i>Thebes</i> showing workmen using mallet-struck chisels to dress stone blocks.....	75
Figure 5.3: Large, partially extracted limestone block in an 18th-Dynasty section (quarry A) of the Qurna quarry complex.....	75
Figure 5.4: Segmented chisel tracks on the wall of a separation trench in a probable New Kingdom section (quarry B) of the Nag el-Hammam sandstone quarry complex.....	75
Figure 5.5: Segmented chisel tracks on the floor of a separation trench between two partially extracted sandstone blocks in a probable Middle Kingdom section (quarry B1) of the Wadi el-Shatt el-Rigal quarry complex	76
Figure 5.6: Chisel tracks on the wall of a separation trench in a probable 19th-Dynasty section (quarry A) of the el-Buweib sandstone quarry complex.....	76
Figure 5.7: Chisel tracks and natural stratification in sandstone in a probable New Kingdom section (quarry B) of the Nag el-Hammam quarry complex.....	76
Figure 5.8: (a) Bronze chisel of the 19th or 21st Dynasty from the el-Dibabiya limestone quarry complex near el-Gebelein and now in Cairo's Egyptian Museum; (b) Bronze chisel of the 18th Dynasty from Tell el-Amarna and now in Cairo's Egyptian Museum	77
Figure 5.9: Narrow separation trenches in a probable New Kingdom section (quarry B) of the Nag el-Hammam sandstone quarry complex	77
Figure 5.10: Partially extracted sandstone blocks in a 19th- or 20th-Dynasty (Ramesside) section of the Gebel el-Silsila East quarry complex	77
Figure 5.11: Narrow separation trenches and initial undercutting with chisels in an 18th-Dynasty section (quarry A) of the Qurna limestone quarry complex	78
Figure 5.12: Wide separation trenches in the 4th-Dynasty quarry E on the north side of the <i>Khafra</i> pyramid in the Giza limestone quarry complex near Cairo.....	78
Figure 5.13: Two partially extracted sandstone blocks in a probable Middle Kingdom section (quarry B1) of the Wadi el-Shatt el-Rigal quarry complex.....	78
Figure 5.14: Adze of 18th-Dynasty date from the tomb of <i>Ani</i> in Thebes, Egypt.....	79
Figure 5.15: Possible adze marks in a probable 18th-Dynasty section (quarry A1) of the Gebel Sheikh Said North limestone quarry complex	79
Figure 5.16: Pick-like chert pounder notched for hafting of Dynastic but otherwise uncertain date from the Wadi el-Sheikh chert quarry	79
Figure 5.17: Pick or adze marks and chisel marks in a Ptolemaic section (quarry B) of the <i>Shesmetet</i> sandstone quarry complex	80
Figure 5.18: Close-up of the pick or adze marks in Figure 5.17.....	80
Figure 5.19: Pick or adze marks in the Ptolemaic or Roman el-Keijal sandstone quarry near Edfu.....	80
Figure 5.20: Line of wedge holes parallel to bedding in the Ptolemaic or Roman Hagar el-Ghorab sandstone quarry	80
Figure 5.21: Line of wedge holes in sandstone oriented for vertical splitting in a Ptolemaic or Roman section of the Gebel el-Silsila East quarry complex.....	81
Figure 5.22: Saw cuts in a New Kingdom or later section (quarry A2) of the el-Sawayta limestone quarry complex.....	81
Figure 5.23: Rectangular blocks of sandstone, as stockpiled in antiquity, in a Roman section of the Gebel el-Silsila East quarry complex	82
Figure 5.24: Partially extracted column drum in a Middle or New Kingdom section (quarry C3) of the Wadi el-Shatt el-Rigal sandstone quarry complex.....	82
Figure 5.25: Footprint left by the extraction of a column drum in a Middle or New Kingdom section (quarry B) of the Nag el-Hammam sandstone quarry complex.....	82
Figure 5.26: Chisel holes along the base of a sandstone block in a probable Middle Kingdom section (quarry A) of the Wadi el-Shatt el-Rigal quarry complex	83
Figure 5.27: Chisel holes along the base of a sandstone block in a probable Middle Kingdom section (quarry A) of the Wadi el-Shatt el-Rigal quarry complex	83
Figure 5.28: White deposits of pulverized quartz sand produced by hammering chisels along the base of a now detached sandstone block in a 19th- or 20th-Dynasty (Ramesside) section of the Gebel el-Silsila East quarry complex.....	83
Figure 5.29: Lever sockets cut along bedding planes in a New Kingdom section (quarry B) of the Nag el-Hammam sandstone quarry complex.....	83
Figure 5.30: Wedge hole with the apparent remains of a wooden feather in an early Roman section of the Gebel el-Silsila East sandstone quarry complex.....	83
Figure 5.31: Holes cut, possibly with a hammer-drill, for the insertion of chisels along the base of a limestone block near the Queen <i>Tiy</i> gallery in an 18th-Dynasty section (quarry A) of the Wadi el-Zebeida quarry complex.....	84
Figure 5.32: Horizontal slots undercutting large limestone blocks in a Ptolemaic section (quarry B) of the Nazlet Sultan Pasha quarry complex.....	84
Figure 5.33: Drawing of an 18th-Dynasty relief carved on a limestone talatat block showing a workman carrying a talatat block	84
Figure 5.34: Partially extracted talatat and other larger blocks in an 18th-Dynasty section (quarry A) of the Wadi el-Zebeida limestone quarry complex.....	84
Figure 5.35: Partially cut separation trench in a probable New Kingdom section of the Gebel el-Silsila East sandstone quarry complex	85
Figure 5.36: Partially cut separation trench in the Ptolemaic or Roman el-Keijal sandstone quarry	85
Figure 5.37: Quarry wall produced by a descending platform in a Ptolemaic or Roman section of the Gebel el-Silsila West sandstone quarry complex	85
Figure 5.38: Close-up of the quarry wall in Figure 5.37.....	85

Figure 5.39: Typical aspect of an 18th-Dynasty section (quarry C1) of the Wadi el-Zebeida limestone quarry complex.....	86
Figure 5.40: Wide separation trench around an isolated block in a probable Middle Kingdom section (quarry C2) of the Wadi el-Zebeida limestone quarry complex.....	86
Figure 5.41: Small-scale, non-systematic block extraction near the Queen Tiy gallery in an 18th-Dynasty section (quarry A) of the Wadi el-Zebeida limestone quarry complex.....	87
Figure 5.42: Close-up of the quarry wall in Figure 5.41 showing the multi-directional, disorganized chisel marks and faint block outlines.....	87
Figure 5.43: Small-scale, non-systematic block extraction in a probable Middle Kingdom section (quarry B) of the Nag el-Hammam sandstone quarry complex.....	88
Figure 5.44: Close-up of the quarry wall in Figure 5.43 showing the multi-directional, disorganized chisel tracks and faint block outlines.....	88
Figure 5.45: Multiple-block extraction on descending platforms in a New Kingdom or later section (quarry A2) of the el-Sawayta limestone quarry complex.....	88
Figure 5.46: Descending platform in a late Ptolemaic or early Roman section of the Gebel el-Silsila East sandstone quarry complex	89
Figure 5.47: Close-up of the top of the descending platform in Figure 5.46.....	89
Figure 5.48: Walls produced by descending platforms in a probable Roman section (quarry B) of the Nazlet Hussein Ali limestone quarry complex.....	89
Figure 5.49: Close-up of one of the quarry walls in Figure 5.48.....	90
Figure 5.50: Walls produced by descending platforms in the New Kingdom or later Deir el-Abyad el-Bahari limestone quarry	90
Figure 5.51: Close-up of the quarry wall on the left side of Figure 5.50.....	90
Figure 5.52: Quarry wall created by a descending platform in the Gebel el-Silsila East sandstone quarry complex	90
Figure 5.53: Inward-sloping limestone wall produced by descending platforms in a New Kingdom or later section (quarry B) of the Beni Hasan South quarry complex	91
Figure 5.54: A ramp constructed with quarry debris below a descending platform in a late Ptolemaic or early Roman section of the Gebel el-Silsila East sandstone quarry complex	91
Figure 5.55: Small sandstone working of Ptolemaic or Roman age in the Nag el-Sheikh Garad sandstone quarry complex	92
Figure 5.56: Queen Tiy gallery in an 18th-Dynasty section (quarry A) of the Wadi el-Zebeida limestone quarry complex.....	92
Figure 5.57: Interior of the gallery quarry shown in Figure 5.56	93
Figure 5.58: Back wall of the 19th-Dynasty gallery (no. 2) in the el-Dibabiya limestone quarry complex.....	93
Figure 5.59: Horizontal slot cut at the top of a former gallery wall with the gallery subsequently quarried away in a probable 18th-Dynasty section of the Gebel el-Silsila East sandstone quarry complex.....	94
Figure 5.60: Close-up of the quarry wall on the left side of the gallery remnant in Figure 5.59.....	94
Figure 5.61: Lines drawn with red paint on the ceiling of a gallery in an 18th-Dynasty section (quarry A) of the Qurna limestone quarry complex	94
Figure 5.62: Quarry A in the Beni Hasan South limestone quarry complex showing the meticulously-cut ancient and ragged modern quarry walls.....	95
Figure 5.63: Modern tool marks left in the Gebel el-Silsila East quarry complex by the early 20th-century extraction of rectangular sandstone blocks for the Esna Barrage	95
Figure 5.64: Artisanal quarrying of sandstone at Gharb Aswan in an area of ancient sandstone quarries.....	96
Figure 5.65: Disorganized chisel tracks in a Middle Kingdom section (quarry A) of the Wadi el-Shatt el-Rigal sandstone quarry complex	96
Figure 5.66: Surfaces with two types of chisel marks in sandstone at the north end of the Gebel el-Silsila West quarry complex	96
Figure 5.67: Close-up of disorganized chisel tracks in Figure 5.66.....	97
Figure 5.68: Close-up of systematic chisel tracks in Figure 5.66.....	97
Figure 5.69: Partially extracted blocks and wide, deep separation trenches in a Middle Kingdom or 18th-Dynasty section of the Gebel el-Silsila East sandstone quarry complex	97
Figure 5.70: Wall on the hidden left end of the partially extracted blocks in Figure 5.69.....	98
Figure 5.71: Chisel tracks dating to the 18th-Dynasty's Thutmose period in glauconitic sandstone at the north end of the Gebel el-Silsila East quarry complex	98
Figure 5.72: Ramesside (19th or 20th Dynasty) chisel tracks in the Gebel el-Silsila East sandstone quarry complex.....	98
Figure 5.73: Block extraction in an 18th-Dynasty section of the Gebel el-Silsila East sandstone quarry complex.....	99
Figure 5.74: Close-up of the back wall of the quarry in Figure 5.73 showing a herringbone pattern of chisel tracks.....	99
Figure 5.75: Chisel marks from limestone extraction in the 4th-Dynasty quarry E of the Giza limestone quarry complex.....	100
Figure 5.76: Close-up of chisel marks in Figure 5.75.....	100
Figure 5.77: Disorganized extraction chisel marks on a limestone block at the 12th-Dynasty el-Lisht pyramid of <i>Senusret I</i>	100
Figure 5.78: Systematic extraction chisel marks on a limestone block at the 12th-Dynasty el-Lahun pyramid of <i>Senusret II</i>	100
Figure 5.79: Dressing chisel marks on a limestone block at the 12th-Dynasty el-Lisht pyramid of <i>Senusret I</i>	101
Figure 5.80: 6th-Dynasty tombs at Gebel Qubbet el-Hawa in Aswan	101
Figure 5.81: Courtyard of the 12th-Dynasty tomb of <i>Aku</i> at Gebel Qubbet el-Hawa in Aswan	101
Figure 5.82: Chisel tracks from sandstone extraction on the back wall of the courtyard of the 6th-Dynasty tomb of <i>Mekhu</i> at Gebel Qubbet el-Hawa in Aswan.....	102
Figure 5.83: Chisel tracks from sandstone extraction on the back wall of the courtyard of the 12th-Dynasty tomb of <i>Aku</i> at Gebel Qubbet el-Hawa in Aswan.....	102
Figure 5.84: Chisel tracks from sandstone extraction inside the courtyard trench of the 12th-Dynasty tomb of <i>Aku</i> at Gebel Qubbet el-Hawa in Aswan.....	102
Figure 5.85: Chisel tracks from sandstone extraction on the back wall of the courtyard of the 12th-Dynasty tomb of <i>Sarenput II</i> at Gebel Qubbet el-Hawa in Aswan.....	102

Figure 5.86: Chisel tracks from dressing activities on the back wall of the courtyard of the 12th-Dynasty tomb of <i>Sarenput II</i> at Gebel Qubbet el-Hawa in Aswan	102
Figure 5.87: Chisel tracks from dressing on the back wall of the courtyard of the 6th-Dynasty tomb of <i>Hekalb I</i> at Gebel Qubbet el-Hawa in Aswan	102
Figure 5.88: Roughed-out sandstone statue of a seated figure in the courtyard of the 12th-Dynasty tomb of <i>Sarenput II</i> at Gebel Qubbet el-Hawa in Aswan	103
Figure 5.89: 18th-Dynasty (probably reign of <i>Amenhotep III</i>) criosphinx carved from sandstone in the Gebel el-Silsila East quarry complex	103
Figure 5.90: 18th-Dynasty (Amarna period) roughed-out statue of a standing figure in siliceous crystalline limestone in the Hatnub quarry complex	104
Figure 5.91: Rope hole in the Ptolemaic Nag el-Fuqani sandstone quarry near Aswan	104
Figure 5.92: Early Roman chisel tracks and quarry marks in the Gebel el-Silsila East sandstone quarry complex	104
Figure 5.93: Late Ptolemaic to early Roman chisel tracks and quarry marks in quarry A of the Nag el-Hosh sandstone quarry complex	105
Figure 5.94: Early Roman (?) chisel tracks and quarry mark in the Nag el-Dumariyya sandstone quarry	105
Figure 5.95: Relief scene from the 19th-Dynasty rock-cut stela of <i>Hapy</i> (reign of <i>Rameses II</i>) in the Gebel el-Silsila East sandstone quarry complex	106
Figure 5.96: Partial remains of a gallery in quarry D of the Gebel Sheikh Said South limestone quarry complex	107
Figure 5.97: Temple plan drawn in brownish-red paint on a limestone pillar in the gallery shown in Figure 5.96	107
Figure 5.98: One of a few depictions of the monumental gateway in the Temple of <i>Montu, Raatawy</i> and <i>Harpocrates</i> in the village of Nag el-Madamud near Luxor as incised into a wall of an early Roman quarry in the Gebel el-Silsila East quarry complex	107
Figure 5.99: Remains of a monumental gateway erected by Roman emperor <i>Tiberius</i> at the Temple of <i>Montu, Raatawy</i> and <i>Harpocrates</i> in the village of Nag el-Madamud near Luxor	108

Chapter 6

Figure 6.1: Drawing of a wooden sledge of the 12th Dynasty found at Dahshur near the pyramid of <i>Senusret III</i>	109
Figure 6.2: Wooden sledge of the 12th Dynasty found at el-Lisht near the pyramid of <i>Senusret I</i>	110
Figure 6.3: Drawing of a relief scene in the 5th-Dynasty tomb of <i>Ti</i> at Saqqara showing men pulling a sledge carrying a shrine with a statue of <i>Ti</i>	110
Figure 6.4: Drawing of a relief scene in the 18th-Dynasty tomb of <i>Rekhmira</i> in <i>Thebes</i> showing men pulling a sledge carrying a block of stone	111
Figure 6.5: Drawing of a relief scene on the 18th-Dynasty stela of <i>Neferpert</i> in the Tura-Masara limestone quarry complex showing oxen pulling a sledge carrying a block of limestone	111
Figure 6.6: Drawing of a relief scene in the 8th-Dynasty tomb of <i>Shamay</i> at Kom el-Koffar near Qift showing men pulling a sledge carrying a block of metagreywacke	111
Figure 6.7: Drawing of a painted scene in the 12th-Dynasty tomb of the nomarch <i>Djehutihotep</i> at Deir el-Bersha near Tell el-Amarna showing men pulling a sledge carrying a colossal statue of <i>Djehutihotep</i>	112
Figure 6.8: One of the Roman slipways built for sledges carrying blocks of stone in the Mons Porphyrites (Gebel Dokhan) quarry complex for metaandesite-dacite porphyry	113
Figure 6.9: Close-up of the sledge slipway in Figure 6.8	114
Figure 6.10: Drawing of a painted scene in the 17th-Dynasty tomb of <i>Sobeknakht</i> at el-Kab showing oxen pulling a wheeled sledge (or proto-wagon) carrying a funerary barque or sarcophagus	114
Figure 6.11: Loading ramp 1 dating to the Old Kingdom in the Gharb Tushka quarry complex for anorthosite and gabbro gneisses	115
Figure 6.12: Drawing of a relief scene in the 18th-Dynasty tomb of <i>Rekhmira</i> in <i>Thebes</i> showing a boat with a large block of stone in its back end	115
Figure 6.13: Drawing of a relief scene on the interior wall of the temple causeway of the 5th-Dynasty pyramid of <i>Unas</i> at Saqqara showing a boat carrying granite palm columns	116
Figure 6.14: Drawing of a talatat relief scene from the 18th Dynasty showing a bull transported on a wagon	117
Figure 6.15: (A) Crude graffito of a two-wheeled cart from a 30th-Dynasty gallery in Wadi el-Nakhla, part of the Deir el-Bersha limestone quarry complex. (B) Lithograph of carts carrying blocks of limestone from the Tura-Masara quarries in the late 19th century	118
Figure 6.16: Monolithic column of tonalite gneiss in the Roman Mons Claudianus quarry complex	119
Figure 6.17: Close-up of the column in Figure 6.16	119
Figure 6.18: The early 2nd-century AD <i>Pantheon</i> in Rome with monolithic columns of tonalite gneiss from Mons Claudianus and one column of coarse granite from Aswan	120
Figure 6.19: Roman loading ramp near the mouth of Wadi Umm Sidri, which served the Mons Porphyrites quarry complex at Gebel Dokhan	120
Figure 6.20: Two pairs of Roman wagon-wheel tracks on the Naq' el-Teir Plain in the west-central Eastern Desert	121
Figure 6.21: Close-up of a section of the Widan el-Faras quarry road where the pavement is composed of slabs of soft sandstone	122
Figure 6.22: Widan el-Faras quarry road where the pavement is composed of logs of petrified (silicified) wood	122
Figure 6.23: Hatnub quarry road near travertine Quarry P where it crosses a small wadi	123
Figure 6.24: New Kingdom paved road on Gebel Gulab in the Gharb Aswan quarry complex for silicified sandstone	124
Figure 6.25: New Kingdom causeways descending from Gebel Gulab in the Gharb Aswan quarry complex for silicified sandstone	124
Figure 6.26: New Kingdom causeway descending from Gebel Gulab in the Gharb Aswan quarry complex for silicified sandstone	124

Figure 6.27: Roman road leading to the Wadi Umm Balad quarry complex for quartz diorite.....	125
Figure 6.28: Causeway built for a Roman road descending down a steep slope near the Wadi Barud quarry complex for quartz diorite.....	126

Chapter 7

Figure 7.1: Restored limestone tower of the early Ptolemaic Period at Abusir (ancient <i>Taposiris Magna</i>) on the Mediterranean coast west of Alexandria.....	128
Figure 7.2: Limestone pyramid, Great Sphinx, and temple wall in the <i>Khafra</i> funerary complex (4th Dynasty) at Giza near Cairo	129
Figure 7.3: Limestone mortuary temple of <i>Hatshepsut</i> (18th Dynasty) at Deir el-Bahari near Luxor	129
Figure 7.4: Sandstone <i>Isis</i> temple (Ptolemaic and Roman Periods) at <i>Philae</i> near Aswan.....	129
Figure 7.5: Sandstone pyramids at Nuri, near Karima in Sudan with the pyramid of <i>Taharqo</i> (25th Dynasty) at left and the pyramids of other, later kings of the Napatan Kingdom at center and right.....	130
Figure 7.6: Sandstone mortuary temple of <i>Rameses III</i> (20th Dynasty) at Medinet Habu near Luxor	130
Figure 7.7: Courtyard built with sandstone in the <i>Rameses III</i> mortuary temple in Figure 7.6.....	130
Figure 7.8: Limestone casing on the exterior of the rubble-filled Sadd el-Kafara dam (4th or 5th Dynasty) in Wadi Garawi near Helwan	131
Figure 7.9: Painted relief figure of <i>Khnum</i> on the wall of the portico in the 19th-Dynasty <i>Osiris</i> temple at <i>Abydos</i>	131
Figure 7.10: Gate in the exterior gypsum wall of the Abu Sha'ar fortress (late Roman Period) near Hurgkada.....	132
Figure 7.11: Gypsum Great Temple at <i>Berenike</i> (Ptolemaic to early Roman Periods)	133
Figure 7.12: Walls made from coral heads at <i>Berenike</i> (late Roman Period).....	133
Figure 7.13: Gypsum concrete foundation for the south pylon of the Great <i>Aten</i> Temple (18th Dynasty, Amarna Period) in ancient <i>Akhetaten</i> (modern Tell el-Amarna).....	134
Figure 7.14: Hut made from unworked, locally available granite boulders in a late Predynastic fluorite mine at Gebel el-Ineigi in the central Eastern Desert	135
Figure 7.15: The el-Hisnein East fort made from unworked, locally available granite cobbles and boulders in an 11th- or 12th-Dynasty gold mine in the Eastern Desert, 25 km southeast of Aswan.....	135
Figure 7.16: Close-up of the 2 m-high, outer wall of the el-Hisnein East fort in Figure 7.15	135
Figure 7.17: Huts made with unworked, locally available granite cobbles and boulders and dolerite porphyry rubble in the 30th-Dynasty to early Ptolemaic dolerite porphyry quarry at Rod el-Gamra in the central Eastern Desert	135
Figure 7.18: Buildings made with quarried slabs of aplite (or microgranite) in the late Roman settlement in Wadi Shenshef... 136	
Figure 7.19: Modern sleeping shelter built by a Ma'aza Bedouin camel herder in Wadi Hammamat in the central Eastern Desert	136
Figure 7.20a: Map of Egypt north of latitude 24° 41' N showing the locations of the ancient building-stone quarries.....	137
Figure 7.20b: Map of Egypt and northern Sudan south of latitude 24° 52' N showing the locations of the ancient building-stone quarries	138

Chapter 8

Figure 8.1a: Index and legend for the topographic contour maps in Figures 8.1b-8.1j showing the locations in the Nile Valley of ancient limestone quarries and free-standing monuments built largely or entirely of limestone	144
Figure 8.1b: (Cairo to el-Wasta).....	145
Figure 8.1c: (el-Wasta to Maghagha).....	146
Figure 8.1d: (Maghagha to Beni Khalid)	147
Figure 8.1e: (Beni Khalid to Asyut).....	148
Figure 8.1f: (Asyut to Juhayna).....	149
Figure 8.1g: (Juhayna to Farshut)	150
Figure 8.1h: (Balyana to Khuzam).....	151
Figure 8.1i: (Khuzam to Edfu).....	152
Figure 8.1j: (Edfu to Ballana)	153
Figure 8.2: Nummulitic limestone in quarry A of the Wadi el-Zebeida quarry complex	154
Figure 8.3a: Index for maps of the Mallahet Mariut district in Figures 8.3b-8.3d	155
Figure 8.3b: Eastern limestone quarries in the Mallahet Mariut district	155
Figure 8.3c: Central limestone quarries in the Mallahet Mariut district	156
Figure 8.3d: Western limestone quarries in the Mallahet Mariut district	156
Figure 8.4: Limestone quarries Q1, Q2 and Q3a-3b in the Mallahet Mariut district	157
Figure 8.5: Limestone quarries Q9-Q13 in the Mallahet Mariut district	157
Figure 8.6: Limestone quarries Q25-Q26 in the Mallahet Mariut district	158
Figure 8.7: Limestone quarries Q27-Q29 in the Mallahet Mariut district	158
Figure 8.8: Limestone quarry Q27 in the Mallahet Mariut district	159
Figure 8.9: Limestone quarry Q28 in the Mallahet Mariut district	159
Figure 8.10: Limestone quarries Q30-Q31 in the Mallahet Mariut district	159
Figure 8.11: Limestone quarries Q32-Q33 in the Mallahet Mariut district	160
Figure 8.12: Limestone quarries Q34-Q35 in the Mallahet Mariut district	160
Figure 8.13: Abu Rawash limestone quarry.....	162
Figure 8.14: Gebel Moqattam limestone quarries	163
Figure 8.15: An ancient gallery in the Gebel Moqattam limestone quarry.....	163
Figure 8.16: Giza limestone quarries	164
Figure 8.17: Quarry A1 in the Giza limestone quarry complex	165
Figure 8.18: North side of quarry E in the Giza limestone quarry complex	165

Figure 8.19: Quarry F in the Giza limestone quarry complex	166
Figure 8.20: Tura-Masara limestone quarries with an index to Figures 8.21a-8.21e	167
Figure 8.21: Maps of the Tura-Masara limestone galleries: (a) nos. 1, 2, 66 and 69; (b) nos. 3-34; and (c) nos. 35-53	168
Figure 8.21 continued: Maps of the Tura-Masara limestone galleries: (d) nos. 56-65; and (e) nos. 70-79	169
Figure 8.22: Limestone galleries 1-2 and 66-69 on Gebel Tura	170
Figure 8.23: Limestone galleries 36-38 on Gebel Hof	170
Figure 8.24: Entrance to an unidentified limestone gallery on Gebel Hof	171
Figure 8.25: Back end of a tunnel in an unidentified limestone gallery on Gebel Hof	171
Figure 8.26: Zawyet el-Aryan limestone quarry	172
Figure 8.27: Abusir limestone quarry	173
Figure 8.28: Saqqara North limestone quarries	174
Figure 8.29: Saqqara South limestone quarries	175
Figure 8.30: Dahshur limestone quarries	177
Figure 8.31: Sadd el-Kafara limestone quarries	178
Figure 8.32: Sadd el-Kafara dam and limestone quarry B	178
Figure 8.33: El-Lisht limestone quarries	179
Figure 8.34: Maidum limestone quarries	180
Figure 8.35: El-Lahun limestone quarries	181
Figure 8.36: Quarry A in the el-Lahun limestone quarry complex	182
Figure 8.37: El-Sawayta limestone quarries	182
Figure 8.38: Quarry A2 in the el-Sawayta limestone quarry complex	183
Figure 8.39: El-Babein limestone quarry	183
Figure 8.40: Long open-cut in the el-Babein limestone quarry	184
Figure 8.41: Bedrock outlier in the el-Babein limestone quarry	184
Figure 8.42: Deir Gebel el-Teir limestone quarries	185
Figure 8.43: Close up of portions of quarries A1 and A2 in the Deir Gebel el-Teir limestone quarry complex	186
Figure 8.44: Tihna el-Gebel limestone quarries	187
Figure 8.45: Quarry B with two small quarry cuts above on the middle slope in the Tihna el-Gebel limestone quarry complex	188
Figure 8.46: Large ('mega') blocks on the north side of quarry D in the Tihna el-Gebel limestone quarry complex	188
Figure 8.47: Partially excavated blocks at the north end of the trench in quarry D of the Tihna el-Gebel limestone quarry complex	189
Figure 8.48: El-Hawarta limestone quarries (A-D) and south end of the Tihna el-Gebel quarry complex	190
Figure 8.49: Nazlet Hussain Ali limestone quarries	191
Figure 8.50: Quarry A1 in the Nazlet Hussein Ali limestone quarry complex	192
Figure 8.51: Nazlet Sultan Pasha limestone quarries	193
Figure 8.52: Colossal statue block and mud-brick ramp in quarry A of the Nazlet Sultan Pasha limestone quarry complex	194
Figure 8.53: Quarry B in the Nazlet Sultan Pasha limestone quarry complex	194
Figure 8.54: Zawyet el-Amwat limestone quarries	195
Figure 8.55: Nazlet Abu Ginah limestone quarries	196
Figure 8.56: Beni Hasan North and South limestone quarries	197
Figure 8.57: Quarry B in the Beni Hasan South limestone quarry complex with workings at two levels	198
Figure 8.58: Nag el-Arab limestone quarries	199
Figure 8.59: El-Sheikh Timay limestone quarry	199
Figure 8.60: El-Sheikh Ibada limestone quarries	200
Figure 8.61: Deir Abu Hennis North and South (A-C) limestone quarries and north end of the Deir el-Bersha quarry complex	202
Figure 8.62: Interior of an unidentified gallery in the Deir Abu Hennis South limestone quarry complex	203
Figure 8.63: Deir el-Bersha limestone quarries (A-B) and south end of the Deir Abu Hennis South quarry complex	203
Figure 8.64: Gallery quarries dating to the 30th Dynasty (reigns of <i>Nectanebo I</i> and, to a minor extent, <i>Nectanebo II</i>) at the head of Wadi el-Nakhla in the Deir el-Bersha limestone quarry complex	204
Figure 8.65: Entrance to the <i>Nectanebo I-II</i> gallery quarry (Abu Gamusa) at the head of Wadi el-Nakhla in the Deir el-Bersha limestone quarry complex	205
Figure 8.66: Inside the entrance to the <i>Nectanebo I-II</i> gallery quarry (Abu Gamusa) at the head of Wadi el-Nakhla in the Deir el-Bersha limestone quarry complex	205
Figure 8.67: Late Roman or medieval Coptic crosses on the wall of the <i>Nectanebo I-II</i> gallery quarry (Abu Gamusa) at the head of Wadi el-Nakhla in the Deir el-Bersha limestone quarry complex	205
Figure 8.68: Tuna el-Gebel North and South (A-C) limestone quarries	207
Figure 8.69: Quarry A in the Tuna el-Gebel South limestone quarry complex	207
Figure 8.70: Gebel Sheikh Said North limestone quarries	208
Figure 8.71: Galleries in quarry A1 of the Gebel Sheikh Said North limestone quarry complex	208
Figure 8.72: Gebel Sheikh Said South limestone quarries	210
Figure 8.73: Wadi el-Zebeida limestone quarries	211
Figure 8.74: Central and western parts of quarry B in the Wadi el-Zebeida limestone quarry complex	212
Figure 8.75: Amarna North Tombs limestone quarries	213
Figure 8.76: Quarry B in the Amarna North Tombs limestone quarry complex	213
Figure 8.77: Amarna South Tombs limestone quarry	214
Figure 8.78: Amarna South Tombs limestone quarry	215
Figure 8.79: Hatnub limestone quarry complex	215

Figure 8.80: Quarry A in the Hatnub limestone quarry complex	216
Figure 8.81: Partially-worked limestone blocks in the Hatnub quarry complex	216
Figure 8.82: Gebel Abu Foda North limestone quarry	217
Figure 8.83: Deir el-Quseir limestone quarries	218
Figure 8.84: Meir limestone quarry	219
Figure 8.85: Quseir el-Amarna limestone quarries	220
Figure 8.86: A gallery in quarry I of the Quseir el-Amarna limestone quarry complex	220
Figure 8.87: Deir el-Amir Tadros limestone quarries	221
Figure 8.88: Deir Abu Mina limestone quarries	222
Figure 8.89: Quarry B in the Deir Abu Mina limestone quarry complex	223
Figure 8.90: Wadi el-Gabrawi limestone quarry	224
Figure 8.91: Deir el-Gabrawi limestone quarry	225
Figure 8.92: Deir el-Gabrawi limestone quarry	225
Figure 8.93: Interior of the largest gallery in the Deir el-Gabrawi limestone quarry	226
Figure 8.94: El-Ketf (A-B) and Arab el-Atiyat el-Bahariya (A-B) limestone quarries	226
Figure 8.95: Quarry B in the el-Ketf limestone quarry complex with the Sety II cartouche	227
Figure 8.96: Talet el-Hagar limestone quarries	228
Figure 8.97: Gebel Durunka West limestone quarry	228
Figure 8.98: Gebel Durunka West limestone quarry	229
Figure 8.99: Gebel Durunka East limestone quarries	230
Figure 8.100: Quarry G with two galleries in the Gebel Durunka East quarry complex	230
Figure 8.101: Wadi Emu limestone quarry	231
Figure 8.102: Wadi Emu limestone quarry	232
Figure 8.103: Deir Durunka limestone quarries	233
Figure 8.104: Quarry A in the Deir Durunka limestone quarry complex	234
Figure 8.105: El-Khawalid limestone quarries	234
Figure 8.106: Deir Rifa limestone quarries	235
Figure 8.107: Quarry A of the Deir Rifa limestone quarry complex	236
Figure 8.108: Nazlet el-Mustagidda and el-Ruweigat limestone quarries	237
Figure 8.109: Nazlet el-Mustagidda limestone quarry	237
Figure 8.110: El-Zawya limestone quarries	238
Figure 8.111: Quarry C2, with a prominent gallery entrance, in the el-Zawya limestone quarry complex	239
Figure 8.112: El-Balayza limestone quarries	239
Figure 8.113: Quarry B3 in the el-Balayza limestone quarry complex	240
Figure 8.114: El-Iqal Bahari limestone quarries	241
Figure 8.115: El-Zaraby limestone quarry	241
Figure 8.116: El-Sheikh Isa limestone quarry	242
Figure 8.117: El-Sheikh Isa limestone quarry	242
Figure 8.118: El-Iqal Qibli limestone quarry	243
Figure 8.119: El-Hammamiya North limestone quarries	244
Figure 8.120: Deir el-Ganadla limestone quarries	245
Figure 8.121: Galleries of quarry A3 in the Deir el-Ganadla limestone quarry complex	246
Figure 8.122: Gallery in quarry A3 of the Deir el-Ganadla limestone quarry complex that was converted to a Coptic church in the 7th/8th century AD	246
Figure 8.123: Monastery of Deir el-Adra Maryam built over the entrance of an ancient gallery in quarry B of the Deir el-Ganadla limestone quarry complex	247
Figure 8.124: Qaw el-Kebir limestone quarries	248
Figure 8.125: Quarries A2 with open cuts and A3 with galleries in the Qaw el-Kebir limestone quarry complex	248
Figure 8.126: Entrances to the easternmost gallery in quarry group B of the Qaw el-Kebir limestone quarry complex	249
Figure 8.127: El-Hammamiya South limestone quarries	249
Figure 8.128: South end of the el-Hammamiya South limestone quarries showing a gallery in quarry B and the ramp of <i>Amenhotep</i> III topped with mud bricks and leading up to quarry C	250
Figure 8.129: El-Mashaya limestone quarries	251
Figure 8.130: Quarry A and part of quarry B in the el-Mashaya limestone quarry complex	251
Figure 8.131: El-Ghanayim limestone quarries	252
Figure 8.132: Quarry A in the el-Ghanayim limestone quarry complex with rock-cut tombs below	252
Figure 8.133: El-Qutna (A-B) and el-Qarya Bil Diweir limestone quarries	253
Figure 8.134: El-Qarya Bil Diweir limestone quarry	254
Figure 8.135: El-Nawawra limestone quarries	255
Figure 8.136: Quarry A of the el-Nawawra limestone quarry complex	255
Figure 8.137: El-Khazindariya limestone quarries	256
Figure 8.138: Quarry B in the el-Khazindariya limestone quarry complex	257
Figure 8.139: Nazlet Khater limestone quarries	258
Figure 8.140: Quarry A of the Nazlet Khater limestone quarry complex	258
Figure 8.141: Nazlet el-Haridi North limestone quarries	259
Figure 8.142: Quarries I and J in the Nazlet el-Haridi North quarry complex	259
Figure 8.143: Quarry M in the Nazlet el-Haridi North quarry complex	260
Figure 8.144: Nazlet el-Haridi South limestone quarries	261
Figure 8.145: Quarry E in the Nazlet el-Haridi South limestone quarry complex	261

Figure 8.146: Nag Mubarak and el-Galawiya limestone quarries	262
Figure 8.147: Nag Mubarak limestone quarry	263
Figure 8.148: Nag Abu Roda limestone quarry	263
Figure 8.149: Nag Abu Roda limestone quarry	264
Figure 8.150: Giheina limestone quarries.....	265
Figure 8.151: El-Salamuni limestone quarries	266
Figure 8.152: Quarry A in the el-Salamuni limestone quarry complex	266
Figure 8.153: Entrance to a gallery in quarry D of the el-Salamuni limestone quarry complex.....	267
Figure 8.154: Wadi Abu Gilbana limestone quarry.....	267
Figure 8.155: Deir el-Abyad el-Bahari limestone quarry.....	268
Figure 8.156: Deir el-Abyad el-Bahari limestone quarry.....	269
Figure 8.157: Nag Hamad and <i>Athribis</i> limestone quarries	269
Figure 8.158: <i>Athribis</i> quarries with numerous Greco-Roman tombs on the slope below	270
Figure 8.159: Nag el-Ahaywa limestone quarry	271
Figure 8.160: Gebel Tukh North and South limestone quarries.....	271
Figure 8.161: Quarry A2 in the Gebel Tukh North limestone quarry complex.....	272
Figure 8.162: Quarry B in the Gebel Tukh North limestone quarry complex.....	272
Figure 8.163: Gebel el-Alawaniya limestone quarries	274
Figure 8.164: Quarry B in the Gebel el-Alawaniya limestone quarry complex.....	274
Figure 8.165: Quarry C in the Gebel el-Alawaniya limestone quarry complex.....	275
Figure 8.166: Enigmatic structure above quarry group B in the Gebel el-Alawaniya limestone quarry complex.....	276
Figure 8.167: Nag el-Ghabat limestone quarry	276
Figure 8.168: Gebel el-Gir limestone quarries	277
Figure 8.169: Eastern portion of the Gebel el-Gir limestone quarry complex.....	277
Figure 8.170: Nag el-Buza limestone quarry	278
Figure 8.171: Nag el-Buza limestone quarry	279
Figure 8.172: Qurna limestone quarries	279
Figure 8.173: Central portion of quarry A in the Qurna limestone quarry complex.....	280
Figure 8.174: Possible limestone quarry somewhere west of Armant.....	281
Figure 8.175: El-Dibabiya limestone quarries	282
Figure 8.176: Gallery 1 in the el-Dibabiya limestone quarry complex.....	283
Figure 8.177: Markings on the ceiling of gallery 2 in the el-Dibabiya limestone quarry complex	283
Figure 8.178: El-Kula limestone quarry	284
Figure 8.179: El-Kula pyramid and limestone quarry.....	284
Figure 8.180: Fatira limestone quarry	285
Figure 8.181: Fatira limestone quarry	285
Figure 8.182: Limestone quarries in the Siwa Oasis.....	286
Table 8.1: References on the geology of Egyptian limestones in or near the Nile Valley	140
Table 8.2: Formations quarried for limestones	141
Table 8.3a: Geochemical data for limestone from ancient Egyptian quarries (Delta ¹³ C to As)	289
Table 8.3b: Geochemical data for limestone from ancient Egyptian quarries (Ba to Lu)	292
Table 8.3c: Geochemical data for limestone from ancient Egyptian quarries (Mn to Ti).....	294
Table 8.3d: Geochemical data for limestone from ancient Egyptian quarries (U to Zr)	296

Chapter 9

Figure 9.1a: Index map and legend for the topographic contour maps in Figures 9.1b-9.1g showing the locations in the Nile Valley of ancient sandstone quarries and free-standing monuments built largely or entirely of sandstone	298
Figure 9.1b: (Khuzam to Edfu).....	299
Figure 9.1c: (Edfu to Nag el-Sheikh Garad)	300
Figure 9.1d: (Aswan to Dendur)	301
Figure 9.1e: (Gurf Hussein to el-Sebua).....	302
Figure 9.1f: (Kharaba to Nag Deira)	303
Figure 9.1g: (Abu Simbel to Wadi Halfa).....	304
Figure 9.2: Leaf impressions in sandstone of the Quseir Formation at Gebel el-Silsila West and dating to the Campanian stage of the Upper Cretaceous	306
Figure 9.3: Diagram illustrating planar bedding, and trough and tabular cross-bedding.....	307
Figure 9.4: El-Mahamid and <i>Shesmetet</i> sandstone quarries	308
Figure 9.5: Quarry A in the el-Mahamid sandstone quarry complex.....	309
Figure 9.6: Quarry B in the el-Mahamid sandstone quarry complex.....	309
Figure 9.7: Quarry A in the <i>Shesmetet</i> sandstone quarry complex.....	310
Figure 9.8: Quarry B in the <i>Shesmetet</i> sandstone quarry complex	310
Figure 9.9: Wadi el-Tarifa sandstone quarry complex	311
Figure 9.10: El-Keijal and Nag el-Dumariyya sandstone quarries	312
Figure 9.11: El-Keijal sandstone quarry	312
Figure 9.12: Nag el-Dumariyya sandstone quarry.....	313
Figure 9.13: El-Buweib sandstone quarries below the Late Byzantine el-Buweib fortress-town	314
Figure 9.14: Quarry A in the el-Buweib sandstone quarry complex	314
Figure 9.15: Nag el-Raqiqein and Nag el-Hosh sandstone quarries	315
Figure 9.16: South end of the Nag el-Raqiqein sandstone quarry.....	316

Figure 9.17: Quarry A in the Nag el-Hosh sandstone quarry complex	317
Figure 9.18: Wadi el-Shatt el-Rigal sandstone quarries	318
Figure 9.19: Quarry C3 in the Wadi el-Shatt el-Rigal sandstone quarry complex.....	318
Figure 9.20: Nag el-Hammam sandstone quarries	319
Figure 9.21: Quarry B in the Nag el-Hammam sandstone quarry complex	320
Figure 9.22a: Northern portion of the Gebel el-Silsila sandstone quarry complex plus quarry B of the Nag el-Hammam complex.....	321
Figure 9.22b: Southern portion of the Gebel el-Silsila sandstone quarry complex.....	321
Figure 9.23: Topographic maps of the Gebel el-Silsila area	323
Figure 9.24: Northern part of the Gebel el-Silsila West sandstone quarries.....	324
Figure 9.25: Central part of the Gebel el-Silsila West sandstone quarries	324
Figure 9.26: The so-called ‘Main Quarry’ of early Roman age in the central part of the Gebel el-Silsila East quarries	324
Figure 9.27: Early Roman workings in the central part of the Gebel el-Silsila East sandstone quarries and just south of the ‘Main Quarry’	325
Figure 9.28: Galleries of 18th-Dynasty date in the northern part of the Gebel el-Silsila East sandstone quarries	325
Figure 9.29: Inside the gallery shown in Figure 9.28	326
Figure 9.30: Nag el-Falalih and Nag el-Sheikh Garad sandstone quarries.....	329
Figure 9.31: Nag el-Falalih sandstone quarry	330
Figure 9.32: Quarry A in the Nag el-Sheikh Garad sandstone quarry complex.....	330
Figure 9.33: Gebel el-Hammam area with a now destroyed sandstone quarry.....	331
Figure 9.34: Nag el-Fuqani and Hagar el-Ghorab sandstone quarries	333
Figure 9.35: North end of the Nag el-Fuqani sandstone quarry	333
Figure 9.36: Roman or later (Meroitic?) relief cut into a wall at the north end of the Nag el-Fuqani sandstone quarry	334
Figure 9.37: Gebel el-Qurna sandstone quarry	334
Figure 9.38: South end of the Gebel el-Qurna sandstone quarry.....	335
Figure 9.39: Sandstone quarries in the Gebel Qubbet el-Hawa, and Wadis Saman and el-Deir areas.....	336
Figure 9.40: Tomb forecourts cut into the sandstone at Gebel Qubbet el-Hawa.....	336
Figure 9.41: Quarry A in the Wadis Saman/el-Deir sandstone quarry complex	337
Figure 9.42: Rough-out of a Corinthian column capital in sandstone near quarry B in the Wadis Saman/el-Deir sandstone quarry complex	337
Figure 9.43: Sandstone outcrops in the Aswan area with known sandstone quarries.....	338
Figure 9.44: Northern quarry in the Dabod sandstone quarry complex	339
Figure 9.45: The southern quarry in the Qertassi sandstone quarry complex.....	340
Figure 9.46: The southern quarry in the Qertassi sandstone quarry complex.....	340
Figure 9.47: Close-up of the rock-cut shrine in Figure 9.46.....	341
Figure 9.48: Northern quarry, in the foreground, in the Kalabsha sandstone quarry complex and the Kalabsha (Horus Mandulis) temple behind it	342
Figure 9.49: Gebel Adda sandstone quarry, with the citadel on top of the hill	345
Figure 9.50: Gezira Dabarosa sandstone quarry	345
Figure 9.51: Buhen sandstone quarries.....	346
Figure 9.52: Sesebi sandstone quarry.....	347
Figure 9.53: The main quarry in the Khor el-Hawazawin sandstone quarry complex	348
Figure 9.54: West side at the upper level of the main quarry in the Khor el-Hawazawin sandstone quarry complex	348
Figure 9.55: Wadi el-Muweih sandstone quarries	349
Figure 9.56: North side of quarry A in the Wadi el-Muweih sandstone quarry complex	350
Figure 9.57: Bir el-Kanayis sandstone quarry.....	351
Figure 9.58: Bir el-Kanayis sandstone quarry.....	351
Figure 9.59: Qaret el-Farargi sandstone quarry in the Bahriya Depression.....	352
Figure 9.60: el-Muzawqa sandstone quarry in the Dakhla Depression.....	353
Figure 9.61: Sandstone quarries and monuments in the northern part of the Kharga Depression	354
Figure 9.62: Sandstone quarry, now largely filled with wind-blown sand, near Qasr el-Lebekha in the northern part of the Kharga Depression	354
Figure 9.63: Serabit el-Khadim sandstone quarries	356
Table 9.1: References on the geology of Egyptian sandstones in or near the Nile Valley	297
Table 9.2: Formations quarried for sandstone.....	305
Table 9.3: Published petrographic descriptions of sandstone from the Gebel el-Silsila East and West quarries	327
Table 9.4: Other petrographic descriptions of sandstone from the Gebel el-Silsila and Nag el-Hammam quarries	328

Chapter 10

Figure 10.1: Umm el-Sawan gypsum (A-D) and silicified sandstone quarries.....	358
Figure 10.2: Quarry A in the Umm el-Sawan gypsum quarry complex	358
Figure 10.3: Gypsum blocks stockpiled in quarry A of the Umm el-Sawan gypsum quarry complex	358
Figure 10.4: Gypsum vessel roughouts as found in one of the workshops associated with quarry A in the Umm el-Sawan gypsum quarry complex	359
Figure 10.5: Deir Abu Lifa gypsum quarries (A-D).....	360
Figure 10.6: Cross-cutting gypsum veins in quarry A of the Deir Abu Lifa gypsum quarry complex	360
Figure 10.7: Wadis Ibada/el-Amrani gypsite quarries.....	361
Figure 10.8: Quarry B in the Wadis Ibada/el-Amrani gypsite quarry complex.....	362
Figure 10.9: Quarry C in the Wadis Ibada/el-Amrani gypsite quarry complex.....	362

Figure 10.10: Gypsite soil profile in quarry C of the Wadis Ibada/el-Amrani quarry complex	363
Figure 10.11: Topographic map and site plan of the Wadi el-Anba'ut anhydrite/gypsum quarry.....	364
Figure 10.12: Wadi el-Anba'ut anhydrite/gypsum quarry	365
Figure 10.13: <i>Anathyrosis</i> ashlar of anhydrite/gypsum in a 1st-century AD building in the Roman port city at Mersa Nakari	365
Figure 10.14: Putative Ras Banas anhydrite/gypsum quarry.....	366
Figure 10.15: Putative Ras Banas anhydrite/gypsum quarry.....	367
Figure 10.16: Veins of satin-spar gypsum in the limestone bedrock of the <i>Senusret</i> II pyramid complex at el-Lahun.....	368
Figure 10.17: Ruins of the late Roman settlement in Wadi Shenshef with aplite quarries	369
Figure 10.18: Aplite quarry on the south side of Wadi Shenshef.....	369
Figure 10.19: Aplite outcrop at the south edge of Wadi Shenshef exhibiting the cleavage that causes it to break into flat slabs.....	370
Figure 10.20: Quartz-muscovite schist quarry above Wadi Sikait, with the Roman ruins of the South Village in the wadi below	370
Figure 10.21: Quartz-muscovite schist quarry on Gebel Zabara	371
Figure 10.22: Walls of quartz-muscovite schist in the <i>Serapis</i> temple in Wadi Sikait's South Village	371

Chapter 11

Figure 11.1a: Map of known (or possibly) ancient Egyptian mines and quarries for utilitarian stones – northern section.....	374
Figure 11.1b: Map of known (or possibly) ancient Egyptian mines and quarries for utilitarian stones – southern section.....	375
Figure 11.2: Wooden sickle with serrated chert teeth (18th Dynasty). From <i>Thebes</i> , Egypt	375
Figure 11.3: Chert sickle insert with a serrated cutting edge (0th to 2nd Dynasty). Probably from Deir el-Ballas, Egypt	375
Figure 11.4: Chert bifacial knife (Middle Kingdom). From the Memphite region, Egypt	375
Figure 11.5: Chert bifacial knife with handle (2nd Dynasty). From the tomb of <i>Khasekhemui</i> at Umm el-Qaab in <i>Abydos</i> , Egypt.....	375
Figure 11.6: Chert fishtail knife (Predynastic Period). From Egypt (find site unknown)	376
Figure 11.7: Chert sculpture of a bird (Predynastic Naqada III or Early Dynastic Period). Probably from Dra Abu el-Naga in <i>Thebes</i> , Egypt	376
Figure 11.8: Chert bangle (1st Dynasty). From tomb M14 in the <i>Osiris</i> Temple precinct in <i>Abydos</i> , Egypt	376
Figure 11.9: Chert spear point (1st Dynasty). From the tomb of <i>Djer</i> at Umm el-Qaab in <i>Abydos</i> , Egypt.....	377
Figure 11.10: Chert arrow point (Predynastic Badarian Period). From Tomb 3083, BSAE/Brunton excavations of 1931 at Matmar, Egypt	377
Figure 11.11: Globular stone macehead (Predynastic Period). From Egypt (find site unknown).....	377
Figure 11.12: Discoidal andesite/dolerite porphyry macehead (Predynastic Period). From Egypt (find site unknown)	377
Figure 11.13: Boat-shaped, shallow saddle quern made of silicified sandstone and used to grind grain. From the Gharb Tuskha anorthosite/gabbro gneiss quarry complex in Egypt's western Nubian Desert and dating to either the Old or Middle Kingdom	378
Figure 11.14: Hopper-rubber quern with unmatched upper and lower stones made from coarse-grained Aswan granite and used for grinding grain. From <i>Karanis</i> in Egypt's Faiyum Depression and dating to the Roman Period.....	378
Figure 11.15: Rotary quern ensemble made from vesicular basalt and used for grinding grain. From Wadi Shenshef in the Eastern Desert and dating to the Roman Period	378
Figure 11.16: Horizontal rotary mill ensemble made from Aswan granite and used for grinding grain. From St. Simeon Monastery (Deir Amba Hadra) on Aswan's west bank and dating to the medieval Byzantine Period.....	379
Figure 11.17: Edge-roller mill stone made from limestone and used for pressing olives. From <i>Karanis</i> in the Faiyum Depression and dating to the Roman Period	379
Figure 11.18: Oval or dished reciprocating quern with accompanying rubber stone for grinding gold ore, a type typical of New Kingdom mines	380
Figure 11.19: Deep saddle quern for grinding gold ore, a type typical of Ptolemaic mines. This example comes from the Mueilha II gold-processing site in the Eastern Desert, and dates to the Ptolemaic Period	380
Figure 11.20: Part of a Ptolemaic edge-roller mill at the Compasi station in Wadi Daghab where ore from the Daghab and possibly other nearby gold mines was processed	380
Figure 11.21: Lower part of a rotary quern for grinding gold ore, a type typical of Roman and/or medieval Islamic mines. This example comes from the Gebel Atut gold mine in the Eastern Desert, and dates to the Roman or, less likely, the medieval Islamic Period	381
Figure 11.22: Lower part of a rotary quern for grinding gold ore, a type typical of Roman and/or medieval Islamic mines. This example comes from the Wadi Dabur gold mine in the Eastern Desert, and dates to the medieval Islamic or, less likely, the Roman Period.....	381
Figure 11.23: Upper part of a rotary quern for grinding gold ore, a type typical of Roman and medieval Islamic mines. This example comes from the Bokari I gold mine in the Eastern Desert, and dates to the Roman Period	381
Figure 11.24: Granodiorite anvil used for crushing gold-bearing quartz. From the Bokari I gold mine in the Eastern Desert and dating probably to the Ptolemaic Period.....	381
Figure 11.25: Granite pounder and anvil used for crushing gold-bearing quartz. From the Compasi gold-processing site in Wadi Daghab, Eastern Desert, and dating to the late Ptolemaic or early Roman Period.....	382
Figure 11.26: Granodiorite mortar used for crushing gold-bearing quartz. From the Bokari I gold mine in the Eastern Desert and dating probably to the Ptolemaic Period.....	382
Figure 11.27: Probably a New Kingdom dished quern for grinding gold ore that was reused during the Napatan Period at Hosh el-Guruf on the Nile River's Fourth Cataract in northern Sudan.....	382
Figure 11.28: Elongated mortar and pestle made from Aswan granodiorite (12th or 13th Dynasty). From Pit 885 in the Lisht North cemetery (MMA excavations 1920-1921) at el-Lisht, Egypt	382

Figure 11.29: Metagraywacke cosmetic palette in the shape of a fish (Predynastic Naqada III Period). From Tomb 23 in the Fort Cemetery, Hk 27 (MMA excavations 1934-1935) at <i>Hierakonpolis</i> , Egypt.....	382
Figure 11.30: Ceremonial metagraywacke cosmetic palette with a relief carving showing warriors hunting wild animals (Predynastic Naqada III Period). Possibly from <i>Abydos</i> , Egypt.....	383
Figure 11.31: Silicified sandstone rubbing stone used for smoothing sculptures carved from hard rocks (19th or 20th Dynasty). From the Lisht North settlement (MMA excavations 1906-1908) at el-Lisht, Egypt	383
Figure 11.32: Glazed steatite bowl (Ptolemaic Period). From Egypt	383
Figure 11.33: A well-used and repaired steatite baram formerly belonging to an Ababda Bedouin family and possibly dating to the early 1900s.....	384
Figure 11.34: Fragment of well-used steatite baram from the village of Shalatin on Egypt's southern Red Sea coast.....	384

Chapter 12

Figure 12.1: Wadi Warag chert quarries	389
Figure 12.2: Wadi Sannur chert quarries.....	390
Figure 12.3: Quarry bench cut into chert-bearing limestone at the edge of Wadi Umm Nihaybar.....	391
Figure 12.4: Concentrated chert workings consisting mainly of hillside benches in an unnamed tributary of Wadi Sannur.....	391
Figure 12.5: Chert blades from the knapping worksite beside the New Kingdom fort in Wadi Umm Nihaybar	392
Figure 12.6: Chert cores used to produce blades from the knapping worksite beside the New Kingdom fort in Wadi Umm Nihaybar	392
Figure 12.7: Wadi Umm Nihaybar section of the Wadi Sannur quarry complex with fort, settlement, and chert quarries.....	393
Figure 12.8: New Kingdom (Ramesside?) fort in the Wadi Umm Nihaybar section of the Wadi Sannur quarry complex for chert.....	393
Figure 12.9: Quarry trench cut into chert-bearing limestone 185 m east of the New Kingdom fort in Wadi Umm Nihaybar....	394
Figure 12.10: Thick blanket of chert debitage beside the New Kingdom fort and Wadi Umm Nihaybar	394
Figure 12.11: Chert nodules in limestone at the edge of Wadi Umm Nihaybar	395
Figure 12.12: Typical chert nodule with a freshly broken surface from Wadi Umm Nihaybar	395
Figure 12.13: Wadi el-Sheikh region where the areas with chert quarries (A-F) are shown as black patches.....	396
Figure 12.14: The main chert quarries (B-D) and peripheral areas (A and F) in Wadi el-Sheikh	396
Figure 12.15: Sand-filled bedrock trenches bordered by ridge-like spoil piles in area B2 of the Wadi el-Sheikh chert quarry complex	397
Figure 12.16: Area B2 in the Wadi el-Sheikh chert quarry complex consisting of trenches and shafts with most of the latter recently excavated by looters	398
Figure 12.17: Two bedrock adits in area B1 of the Wadi el-Sheikh chert quarry complex.....	398
Figure 12.18: Bedrock shaft in area B1 of the Wadi el-Sheikh chert quarry complex.....	398
Figure 12.19: Bedrock shaft in area B1 of the Wadi el-Sheikh chert quarry complex.....	399
Figure 12.20: Two types of surficial pits that are probably for halite: one irregular and the other circular in outline.....	399
Figure 12.21: Surficial pit for halite (and possibly also for anhydrite/gypsum) on the west side of Wadi el-Sheikh	400
Figure 12.22: Notched and un-notched chert picks from the Wadi el-Sheikh chert quarries	400
Figure 12.23: Stone shelter surrounded by spoil piles from bedrock trenches in area C1 of the Wadi el-Sheikh chert quarry complex	401
Figure 12.24: Knapping worksite in area B2 of the Wadi el-Sheikh chert quarry complex.....	401
Figure 12.25: Chert blade-core and trapezoidal blades from area B1 or B2 in the Wadi el-Sheikh quarry complex	402
Figure 12.26: Roughout of a chert bifacial knife without a tang from area B1 or B2 in the Wadi el-Sheikh quarry complex.....	402
Figure 12.27: Roughout of a chert spear point from area B1 or B2 in the Wadi el-Sheikh quarry complex.....	402
Figure 12.28: Fragment of a roughed-out chert bangle from area C1 of the Wadi el-Sheikh quarry complex	402
Figure 12.29: Typical appearance of chert from the lower terrace in area B1 of the Wadi el-Sheikh chert quarry complex	403
Figure 12.30: Typical appearance of chert from the upper terrace in area B3 of the Wadi el-Sheikh chert quarry complex.....	403
Figure 12.31: Chert nodules in area B1 of the Wadi el-Sheikh chert quarry complex	403
Figure 12.32: Tabular chert in area C1 of the Wadi el-Sheikh chert quarry complex	404
Figure 12.33: Amarna chert quarry	405
Figure 12.34: Amarna chert quarry	406
Figure 12.35: Close-up of the excavated bench on the north side of the Amarna chert quarry	406
Figure 12.36: Chert nodule in the Amarna chert quarry	406
Figure 12.37: Typical chert from the Amarna quarry	406
Figure 12.38: Dolerite quarries in the Aswan area.....	409
Figure 12.39: Part of the Gebel el-Granite dolerite quarry with modern piles of construction debris in the middle distance	409
Figure 12.40: Dolerite bedrock outcrop in the Gebel el-Granite quarry with a pile of extracted dolerite fragments	410
Figure 12.41: Dolerite boulder in the Gebel el-Granite quarry with a pile of extracted dolerite fragments.....	410
Figure 12.42: Primitive wedge hole in a slab of dolerite in the Gebel el-Granite quarry.....	410
Figure 12.43: Two dolerite dikes intruding granite in Aswan's Unfinished Obelisk Quarry	411
Figure 12.44a: Ordinary sandstone and silicified sandstone quarries just north of Aswan.....	413
Figure 12.44b: Ordinary sandstone and silicified sandstone quarries just north of Aswan.....	413
Figure 12.45: Gebel Sidi Osman in the Gharb Aswan quarry complex for silicified sandstone	414
Figure 12.46: Umm el-Sawan quarry for silicified sandstone, where the sand-filled pits produced grinding stones.....	414
Figure 12.47: North Kharga silicified sandstone quarries for grinding stones	415
Figure 12.48: North Kharga silicified sandstone quarries for grinding stones	416
Figure 12.49: Quarry A in the North Kharga silicified sandstone quarry complex for grinding stones	416
Figure 12.50: Lower, stationary part of a silicified sandstone grinding stone ensemble in North Kharga quarry A or B.....	417
Figure 12.51: Upper, sliding part of a silicified sandstone grinding stone ensemble in North Kharga quarry A or B.....	417

Figure 12.52: Three chert pounders used in North Kharga silicified sandstone quarry A or B for grinding stones.....	417
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Chapter 13

Figure 13.1: Suggested appearance of the short-handle pick-mattock used in the medieval Islamic quarries for steatite barams both to excavate blocks and carve the roughouts.....	419
Figure 13.2: Form variations in the steatite barams from quarries in the Eastern Desert.....	420
Figure 13.3: Wadi Saqiya quarries for talcose schist (A-C).....	421
Figure 13.4: Entrance to the adit in area A of the Wadi Saqiya talcose schist quarries.....	422
Figure 13.5: Scar left by the extraction of a vessel in area A of the Wadi Saqiya talcose schist quarries.....	422
Figure 13.6: Wadi Saqiya talcose schist quarries with area A in the distance and, in the foreground, a pit in area B.....	422
Figure 13.7: Trench in area B of the Wadi Saqiya talcose schist quarries.....	423
Figure 13.8: Wadi Mubarak quarries for steatite (A-B).....	424
Figure 13.9: Pits and trenches in area A of the Wadi Mubarak quarries for steatite.....	424
Figure 13.10: Channel cut into steatite in area A of the Wadi Mubarak quarries.....	425
Figure 13.11: Quarry face in area A of the Wadi Mubarak quarries where blocks of steatite were removed by hammering iron wedges into the bottom of cut channels.....	425
Figure 13.12: Typical steatite baram roughouts in area A of the Wadi Mubarak quarries.....	425
Figure 13.13: Wadi el-Humra (A-E) and Wadi Abu Quraiya (A-C) steatite quarries.....	426
Figure 13.14: Pits in area A of the Wadi Abu Quraiya steatite quarries.....	427
Figure 13.15: Tool marks left by a pick-mattock in the haphazard extraction of an irregular block of steatite in area A of the Wadi Abu Quraiya quarries.....	427
Figure 13.16: Typical steatite baram roughouts in area A of the Wadi Abu Quraiya quarries.....	427
Figure 13.17: Pits and trenches in area B of the Wadi el-Humra steatite quarries.....	428
Figure 13.18: Typical steatite baram roughouts in area A of the Wadi el-Humra quarries.....	428
Figure 13.19: Finished steatite baram roughout in area B of the Wadi el-Humra quarries.....	429
Figure 13.20: Gebel Rod el-Baram (A-E) and Wadi el-Selim (F) steatite quarries.....	429
Figure 13.21: Pits and trenches in area A of the Gebel Rod el-Baram steatite quarries.....	430
Figure 13.22: Hillside adits and pits in area A of the Gebel Rod el-Baram steatite quarries.....	430
Figure 13.23: The author posing in area A of the Gebel Rod el-Baram quarries with two steatite baram roughouts illustrating the large size range for these vessels.....	430
Figure 13.24: Finished steatite baram roughout in area A of the Gebel Rod el-Baram quarries.....	430
Figure 13.25: Scar left by the extraction of a steatite vessel directly from a quarry wall in area A of the Gebel Rod el-Baram quarries.....	431
Figure 13.26: Finished, unbroken steatite baram roughout in the Wadi Umm Selim quarries.....	431
Figure 13.27: Wadi Sikait steatite quarry.....	432
Figure 13.28: Block of steatite in the Wadi Sikait quarry with a line of pointillé pits above.....	432
Figure 13.29: Scar in the Wadi Sikait steatite quarry where a circular vessel was being extracted directly from the quarry wall.....	432
Figure 13.30: Wadi Kamoyib steatite quarries.....	433
Figure 13.31: Haphazard extraction of steatite blocks in the Wadi Kamoyib quarries.....	434
Figure 13.32: Unfinished steatite baram roughout in the Wadi Kamoyib quarries.....	434
Figure 13.33: Direct extraction of steatite vessels from a quarry wall in the Wadi Kamoyib quarries.....	434
Figure 13.34: Direct extraction of a steatite vessel from a quarry wall in the Wadi Kamoyib quarries.....	434
Figure 13.35: Modern adit and pit in the Bir el-Hamr quarries for talcose schist.....	435
Figure 13.36: Areas with alum mines in the northern part of the Kharga Depression.....	438
Figure 13.37: Roman alum mine near Qasr Umm Dabadid, northern Kharga Depression.....	439
Figure 13.38: Northernmost of two possibly ancient petroleum wells at Gebel Zeit on the shore of the Gulf of Suez.....	443
Figure 13.39: Larger of the two petroleum-fired kilns near the Gebel Zeit petroleum seep.....	445

Color Plates

Plate 1.....	447
Plate 2.....	448
Plate 3.....	449
Plate 4.....	450
Plate 5.....	451
Plate 6.....	452
Plate 7.....	453
Plate 8.....	454
Plate 9.....	455
Plate 10.....	456
Plate 11.....	457
Plate 12.....	458
Plate 13.....	459
Plate 14.....	460
Plate 15.....	461
Plate 16.....	462
Plate 17.....	463
Plate 18.....	464
Plate 19.....	465

Plate 20	466
Plate 21	467
Plate 22	468
Plate 23	469
Plate 24	470
Plate 25	471
Plate 26	472
Plate 27	473
Plate 28	474
Plate 29	475
Plate 30	476
Plate 31	477
Plate 32	478
Plate 33	479
Plate 34	480
Plate 35	481
Plate 36	482
Plate 37	483
Plate 38	484
Plate 39	485
Plate 40	486
Plate 41	487
Plate 42	488
Plate 43	489
Plate 44	490
Plate 45	491
Plate 46	492
Plate 47	493
Plate 48	494
Plate 49	495
Plate 50	496
Plate 51	497
Plate 52	498
Plate 53	499
Plate 54	500

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 Hemaïd 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
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(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 sharpened-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 *bhn* (*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.

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

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.