Identifying heritage values and character-defining elements of ancient quarry landscapes in the Eastern Mediterranean: an integrated analysis

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QuarryScapes: Conservation of Ancient Stone Quarry Landscapes in the Eastern Mediterranean

QuarryScapes is the first project of its kind for addressing the importance of ancient quarry landscapes and raising the awareness of the urgent needs for protecting such sites. QuarryScapes will develop scientific and practical methodologies for documentation, characterisation and conservation of ancient quarry landscapes, raise the awareness of their significance and vulnerability and contribute to legal protection measures and sustainable management. Through case studies in Egypt, Jordan and Turkey, the project will address development of theoretical and practical methods pertaining to the major steps in the process of conservation: from recognition, investigation and assessment of significance, to understanding the risks, developing sound conservation and monitoring concepts, and suggesting mechanisms for sustainable management. The project is subdivided in ten work packages.

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## CONTENTS

1. Introduction .......................................................................................................................... 1  
   Objectives ........................................................................................................................... 2  
   Scope of report ...................................................................................................................... 4  
   Case studies and data sources ................................................................................................. 5  
   Limitations ............................................................................................................................ 6  

2. Methodology: from empirical data to statements of significance ..................................... 7  
   Perspectives on ‘statements of significance’ ........................................................................ 8  
   Identifying heritage values ....................................................................................................... 9  
   Developing a methodology to draw up a ‘statement of significance’ of an ancient quarry landscape ......................................................................................................................... 12  
      Empirical characterization: identification of elements and complexes ......................... 13  
      Interpretation – the macro-level ......................................................................................... 14  
      Historical Value Assessment and Statement of Significance ........................................... 16  

3. Characterisation of ancient quarry landscapes: the empirical input from QuarryScapes case studies .............................................................................................................................................. 19  
   Identifying the elements of quarrying ..................................................................................... 20  
   The geological resource .......................................................................................................... 22  
      Characterizing the rock ........................................................................................................ 22  
      Stone as a commodity ........................................................................................................... 27  
   Stone resources, landscape and quarry morphology ................................................................. 34  
   Notes on fractures as a controlling factor in the resources .................................................... 41  
   Notes on weathering ............................................................................................................... 42  
   Analysing the resource ............................................................................................................ 43  
   Production ............................................................................................................................... 49  
      Extraction ........................................................................................................................... 50  
      Block reduction ................................................................................................................... 57  
      Semi-finishing and finishing ............................................................................................... 59  
   Notes on tool characterization ............................................................................................... 62  
   Spoil characterization ............................................................................................................ 64  
   Analysing the mechanics of production .................................................................................. 66  
   Logistics of quarrying ............................................................................................................ 74  
   Internal logistics .................................................................................................................... 74  
   Overland transport .................................................................................................................. 77
Quays, harbours and waterways ................................................................. 82
Analysing the logistics .................................................................................. 82

The Social Context: identifying and characterising the social infrastructure in ancient quarry landscapes ................................................. 85
Stone-built features ...................................................................................... 86
Other stone-built features ......................................................................... 101
Ceramics ..................................................................................................... 101
Epigraphic data ......................................................................................... 104

Interpreting the social context of ancient quarrying from micro-level data .................................................. 109
Secondary resources ............................................................................. 112

4. Constructing a quarry landscape ............................................................ 117
Defining simple units ........................................................................... 118
Defining complexes .............................................................................. 123
Quarry landscapes ............................................................................. 130

5. Historical Value Assessment and Statement of Significance .................. 135
Introduction ............................................................................................ 136
Socially Constructed Landscapes ............................................................. 136
Contact Landscapes ............................................................................. 139
Associative Historical Landscapes .......................................................... 143
Dynamic Landscapes ........................................................................... 146
Discussion ............................................................................................... 147

6. Conclusion: from significance to conservation and management ........ 149
Characterisation of quarry landscapes ..................................................... 150
Historical significance: building the case of conservation ..................... 151
The road to sustainable management ...................................................... 152

LIST OF TABLES

Table 1. Case studies in QuarryScapes ......................................................... 5
Table 2. Quarry landscape “case studies”, stone materials and periods .......... 20
Table 3. Elements of quarrying – main features/classes ............................. 21
Table 4. QuarryScapes case studies and their contribution to the empirical datasets... 22
Table 5. Main groups of rocks and examples ........................................... 23
Table 6. Scientific methods applied in different case studies for establishing provenance ... 26
Table 7. Stone resources divided by physical properties ................................ 28
Table 8. Three extremes principles of viewing stone resources as commodities .... 30
Table 9. Commodity view on our case studies ........................................ 31
Table 10. Resource geometry at QuarryScapes case studies ......................... 40
Table 11. Stone resource as an element and its features/classes .................. 44
Table 12. Subtypes of Chephren Gneiss and their application ....................... 45
Table 13. Silicified sandstone subtypes and application ................................................ 47
Table 14. Principles of extraction and associated process/features .............................. 51
Table 15. The production process in the Widan el Faras basalt quarries, Northern Faiyum quarry landscape ................................................................. 67
Table 16. The production process in Chephren’s Quarry, vessel production ............... 68
Table 17. The production process in Chephren’s Quarry, statue production ............... 68
Table 18. The production process in New Kingdom obelisk quarrying in the Aswan area .............................................................. 69
Table 19. The production process in Palaeolithic tool quarries, Aswan West Bank ...... 69
Table 20. The production process in Palaeolithic grinding stone quarries, Aswan West Bank ........................................................................................................ 70
Table 21. The production process in early stage of Dynastic grinding stone quarrying, Aswan West Bank .............................................................. 71
Table 22. The production process in New Kingdom grinding stone quarrying, Aswan West Bank ........................................................................................................ 70
Table 23. The production process in building stone quarries, Aswan West Bank ........ 71
Table 24. The production process in a Viking Period / Medieval Norwegian millstone quarry (Hyllestad, West Norway) .................................................. 72
Table 25. The production process in a 19th Century millstone quarry at Selbu, Central Norway ........................................................................................................ 72
Table 26. The production process in Sarcophagi quarries at Sagalassos ..................... 72
Table 27. Features of production in quarries .............................................................. 73
Table 28. Definition of road/track features in quarry landscapes ............................... 77
Table 29. Element of logistics and features/examples ............................................... 85
Table 30. Elements of social infrastructure, features and examples from several quarry landscapes ........................................................................................................ 86
Table 31. Examples of use of secondary resources in quarries .................................. 112
Table 32. Secondary resources at Chephren’s Quarry ............................................... 113
Table 33. Secondary resources at Widan el Faras .................................................... 114
Table 34. Secondary resources at Umm es Sawan, Northern Faiyum quarry landscape ........................................................................................................ 115
Table 35. The four macro-level concepts in short ..................................................... 136
Table 36. Keywords on the four macro-level concepts for each of the case study areas. ........................................................................................................ 147

LIST OF FIGURES
Figure 1. Steps in the process of making a statement of significance from an expert perspective (white area). Value assessments highlighted in yellow are those to be identified by stakeholders, managers and other decision-making frameworks to produce an integrated knowledge about values for the overall planning process ................................................ 12
Figure 2. Stone commodity groups as overlapping perspectives ....................... 30
Figure 3. Two extremes of use of local marble in the city of Aphrodisias. The rubble on the right photo probably comes from spoil heaps ....................... 32
Figure 4. Colours of silicified sandstone at the Aswan West Bank. a) only used for grinding stone, b) used for obelisks and statues, and c) – d) used for statues 33
Figure 5. Principle drawings of resource geometry and resulting quarry situations, layered deposits .......................................................... 35
Figure 6. Quarries in sandstone and limestone layers. a) tall steps in open cast quarry, Petra; b) tall and concave quarry face, Petra; c) Nabatean open cast quarry (foreground)
and Roman open cast quarry (background), Petra; d) open cast quarry at Gebel el Silsila, Egypt; e) open cast, low-stepped quarry in limestone, Jerash; f) Gallery quarry, Gebel el Silsila, Egypt.

Figure 7. The Widan el Faras basalt deposit (above the dotted line) .................................................. 36
Figure 8. Resource geometry for some types of non-layered deposits and resulting quarry situation .................................................................................................................. 37
Figure 9. Open cast quarry in massive granite (left – unfinished Obelisk, Aswan), trench quarry exploiting steep dyke of diabase (Neolithic quarry, Norway), lens shaped soapstone deposit containing small open cast quarries, Eastern Desert. Egypt. .......................... 37
Figure 10. Boulder deposits and resulting quarry situations ............................................................ 38
Figure 11. a) in situ, non quarried boulders of gneiss and granite, Chephren’s Quarry, Egypt; b) partially quarried boulders at Chephren’s quarry, concentric spoil heap around; c) series of circular spoilheaps resulting from exploitation of silicified sandstone boulders (grinding stones), Aswan West Bank; d) partially worked boulders of silicified sandstone, Aswan West Bank. ................................................................................. 38
Figure 12. Sketch illustrating the formation of boulder deposits, initiated by weathering along fractures. ................................................................................................................................. 39
Figure 13. Schematic illustration of a granite deposits with in situ boulders formed on top of it, and successive quarrying of boulders (middle) and later bedrock quarrying (lower). ................................................................................................................................. 40
Figure 14. “Pockets” of less fractured limestone (“good quality”) in essentially highly fractured limestone (“poor quality”), Sagalassos ................................................................. 41
Figure 15. Example of a situation where quarrying starts in a fractured part of the deposit (“easy target”) to the less fractured. ............................................................................................... 42
Figure 16. Some examples of weathering in the case study areas. a) karstic weathering (dissolution) on a limestone quarry face, Sagalassos, obliterating the tool marks, b) selective weathering on a sandstone quarry face, Petra, c) extreme weathering of basalt at Widan el Faras: blocks and spoil fragments have been transformed to rounded cobbles, d) strongly patinated and weathered Palaeolithic flake of silicified sandstone at the Aswan West Bank .............................................................................................................. 43
Figure 17. Features of stone resource characterization ...................................................................... 44
Figure 18. Varieties of Chephren Gneiss. A) dark banded, B) light banded (“statue type”), C) light speckled (“vessel-type”) and D) flamed (rare). To the right, statue of King Khafra and vessel. ............................................................ 45
Figure 19. Geological map of Chephren’s Quarry. Outcrops of Chephren Gneiss in blue colour. ................................. 46
Figure 20. Outcrop pattern in Chephren’s Quarry; the gneiss occurs as small and large inclusions in granite .......................................................... 46
Figure 21. Distribution of colour of silicified sandstone at the Aswan West Bank. ....... 47
Figure 22. The Aswan West Bank, Southern part. Distribution of silicified sandstone quarries and geology. The quarries plotting outside the upper sandstone unit (yellow) are boulder deposits. .......................... 48
Figure 23. A possible exploitation model for silicified sandstone quarrying.......................... 49
Figure 24. One way of viewing production of stone in steps from extraction to finishing. ..... 49
Figure 25. Three basic principles of extraction from bedrock. A) levering, B) splitting and C) channelling ................................................................................................................................. 50
Figure 26. Basalt quarries along the escarpment, Widan el Faras. The rocks are highly weathered and deteriorated. .............................................................................................................. 52
Figure 27. Extraction at Widan el Faras; initial situation (left) and situation after extraction of blocks along natural fractures (right) ........................................................ 52
Figure 28. Expanding cracks with stones (A) – example from grinding stone quarry on the Aswan West Bank. B) primary block, C) secondary blocks after size reduction, D) blanks and spoil from trimming of blanks ........................................................................ 52
Figure 29. Limestone quarry, Sagalassos, where extraction has been carried out predominantly along natural fractures.......................................................... 53
Figure 30. Splitting from bedrock using stone hammers. Left; attempt of splitting. Right: split quarry face from above. Arrows point at percussion marks ................. 54
Figure 31. Splitting with wedges, Roman period. Left: silicified sandstone, Aswan West Bank. Right: large blocks of granite, Aswan ........................................... 54
Figure 32. Flaked and cracked rock surface made from splitting by fire setting. Aswan West Bank, silicified sandstone ................................................................. 54
Figure 33. Examples of channelling in quarries. a) limestone in sagalassos (Roman), b) channels around sandstone blocks, Petra (Nabatean), c) channelling and levelling in granite, Aswan (New Kingdom) and d) channelling around the unfinished obelisk, Aswan (New Kingdom)................................................................. 56
Figure 34. Tool marks on quarry faces. a) stone hammer marks on quarry face, silicified sandstone, Aswan West Bank (New Kingdom), b) inclined chisel marks on inclined shifts, sidewall of a channel in sandstone, Aswan West Bank (Graeco-Roman), c) assumed pick marks (curved shifts and changing directions) on a sandstone quarry face, Petra (Nabatean), d) inclined chisel marks and horizontal shifts, marble quarry, Thassos (probably Byzantine) ...................................................................................................... 57
Figure 35. Principle of block reduction to core. ........................................................................ 58
Figure 36. Roman work area in silicified sandstone, Aswan West Bank, displaying remains from block reduction by wedging................................. 58
Figure 37. Chephren’s Quarry blanks. Statue blank (left), stockpile of vessel blanks (right) ........................................................................................................ 60
Figure 38. Aswan West Bank blanks and finished products. a) grinding stone blanks, b) Palaeolithic stone tool roughout, c) stele or lintel blank, d) statuette blank, e) statue blank and f) Seti I obelisk tip – finished in the quarries. ........................................ 61
Figure 39. a) column drums roughouts found in quarries near Jerash, Jordan, b) ashlars blocks in the Sarikaya quarry, sagalassos, c) a sizeable “blank” of a column at Mons Claudianus, Egypt, d) rotating millstone blank from Roman granite quarry, Aswan .... 62
Figure 40. Stone tools, Chephren’s Quarry. A) broken pounders and hand-axes/hammers, b) large diorite pounder, c) small pounder of the Chephren gneiss itself ................................................................. 63
Figure 41. Examples of pounders. Left: granite cobble stone from the river bed, Aswan West Bank. Middle: manufactured granite pounder, Chephren’s Quarry. Right: hafted stone hammer made of imported rock found in Widan el Faras Basalt quarries........ 63
Figure 42. Stone tools at the Umm es Sawan gypsum quarries. Left: crescent drill made of chert. Right: “hammer” made from chert and “chisel” made from silicified wood... 63
Figure 43. Spoil heaps in grinding stone quarry, Aswan West Bank. Note the uniform distribution of fragment sizes, which in itself indicates that small products of uniform size were targeted ................................................................. 64
Figure 44. Three situations of spoil heap development. a) simultaneous extraction along the full length of a quarry face, b) progressive extraction from a quarry face (first right side then the left), c) spoil heap around a central point of extraction................................. 65
Figure 45. Two examples of large quarries at Chephren’s Quarry; the Khufu stele Quarry (top), being predominantly for statue blocks, and the Chisel Quarry (below)
which was exploited for vessels only. The outer circle of spoil heaps in both cases is
detritus from soil and weathered rock, basically from excavating the boulders. The inner
circle of spoil consists of fragments from block reduction and trimming. 66
Figure 46. Ideal situation of the logistical system in a quarry. 74
Figure 47. Two examples of large quarries at Chephren’s Quarry; the Khufu stele
Quarry (top), being predominantly for statue blocks, and the Chisel Quarry (below)
which was exploited for vessels only. The first case shows internal, paved roads leading
towards a loading ramp, from which the statue blocks were transported to the Nile on
some sort of vehicle. The lower case shows no internal roads (due to the small size of
the products) but stockpiles of vessel blanks in the outskirts of the quarry close to a
track leading away from it. 75
Figure 48. Tall loading ramp at Chephren’s Quarry, Old Kingdom; the parallel tracks in
the foreground were artificially dug so that the top of the transport vehicle was level
with the top of the ramp. 76
Figure 49. The internal logistics of the Widan el Faras basalt quarries leading towards a
stockpile area. 76
Figure 50. Types of road constructions seen on the Aswan West Bank. 78
Figure 51. Quarry roads at the Aswan West Bank. Top: New Kingdom paved road with
edge alignments leading down from Gebel Gulab. Middle: New Kingdom built-up ramp
on a steep slope at Gebel Gulab. Lower: steep Dynastic ramp and Roman road, Gebel
Gulab. 79
Figure 52. Paved quarry roads, Egypt. Left: New Kingdom, Aswan West Bank. Right:
Old Kingdom, Northern Faiyum, leading from Widan el Faras to the ancient harbour by
Lake Moeris. 80
Figure 53. Left: Roman quarry road, carved in bedrock, displaying deep wear marks
from vehicles, Evia, Greece. Right: paved quarry road from the marble quarries at
Mount Pentellikon, Greece. 80
Figure 54. Ornamental stone quarries (red) and their logistics (black) at the Aswan West
Bank during the Pharaonic (left; predominantly New Kingdom) and Roman (right)
periods. 83
Figure 55. Proposed transport route from the Sarikaya Quarry to Sagalassos. 84
Figure 56. Remains of the largest settlement at Mons Porphyrites. 87
Figure 57. Life sized statue of King Khafra and vessel (lower photo). 88
Figure 58. Sand covered stone built features at Chephren’s Quarry. 89
Figure 59. Map of Chephren’s Quarry and distribution of stone-built features. 90
Figure 60. “Bakery” – excavated area displaying ash layers and small pits in which
intact Old Kingdom (3rd to 5th Dynasty) bread moulds were found. 90
Figure 61. Well – before excavation (left) and after (right). 91
Figure 62. Stone walls at Quartz Ridge. 91
Figure 63. Middle Kingdom storage vessels found at Quartz Ridge. Sherd of storage
vessels from the Old Kingdom found outside of this stone-built feature. 92
Figure 64. Camp and food production area along the transport route. Upper right corner:
close up of in situ bread moulds. 93
Figure 65. Walk-in well. Note pottery between the two stones in the lower right corner
93
Figure 66. Stone structure by a well along the transport route, probably a structure for
watering animals. 94
Figure 67. Widan el Faras with its “stone circle areas” 95
Figure 68. The large “stone circle area”. Most of the circles are weathered and disintegrated basalt blocks. The area was probably more likely a stockpile area during the basalt quarrying. ................................................................. 95
Figure 69. The small “stone circle area”. This served as an encampment. ............... 96
Figure 70. Basalt “stone circles” as seen on google earth at the quarry road terminus – the ancient quay (left part of image) ....................................................................................................... 97
Figure 71. Distribution of stone-built features across the Aswan West Bank .......... 98
Figure 72. Dry-stone wall enclosing an area between two natural outcrops at Gebel Gulab. Shelter for the quarrymen? ........................................................................................................ 99
Figure 73. Stone-built feature near a quarry road (in the background) on Gebel Gulab, may be a lookout. ................................................................................................................. 100
Figure 74. Stone enclosure with standing stela ........................................................ 100
Figure 75. New Kingdom and Roman pottery found together .................................. 102
Figure 76. Distribution of ceramics in the southern part of the Aswan West Bank quarry landscape. .................................................................................................................. 102
Figure 77. Old Kingdom ceramics found in Chephren’s Quarry a) pouring vessel (found in well), b) bread mould, c) beer/wine jar ................................................................. 104
Figure 78. Hieroglyphic inscription by the transport route leading from Chephren’s Quarry to the Nile, naming the “ overseer” of the craftsmen (left). Location – a landmark on the route (right). ................................................................. 105
Figure 79. Left: New Kingdom marks on sandstone outcrops naming mr-Ra (beloved of Ra), Aswan West Bank. Right: depiction of New Kingdom boat near obelisk quarries at the Aswan West Bank. ........................................................................................................ 105
Figure 80. Petroglyph on a worked quarry face at Gebel el Silsila, Egypt (left) and on a natural rock face at the Aswan West Bank (right)......................................................... 105
Figure 81. Multi-Period inscriptions at Wadi Hammamat – in this case from Dynastic Egypt to Graeco-Roman. Some of the inscriptions are made by people connected to stone quarrying. ........................................................................................................ 106
Figure 82. Left: the Khufu Stela, as found by Rex Engelbach in 1933, and Middle Kingdom stele from Stele Ridge carnelian mine, found in 2000 (right)...................... 107
Figure 83. Inscribed obelisk tip at the Aswan West Bank ......................................... 108
Figure 84. Selection of petroglyphs (rock art) from the Aswan West Bank ............ 109
Figure 85. Observation of stone tools (small circles), Chephren’s Quarry, made of diorite (dyke occurrences, black lines on the map). The use of this secondary resource for tools is decreasing the further away from the source one gets. ......................... 113
Figure 86. Rock types used as paving on the quarry road from Widan el Faras........ 114
Figure 87. Distribution of fragments from stone tools in a grinding stone quarry and an ornamental stone quarry. .............................................................................................. 115
Figure 88. Principle model of a quarry unit............................................................... 119
Figure 89. Part of the Chephren’s Quarry landscape, displaying numerous quarry units of different size ............................................................................................................ 120
Figure 90. Extremes of quarry units, Chephren’s Quarry. Left: small quarry, 5 metres in diameter, may have been only a prospecting site. Right: large quarry unit displaying concentric spoil heaps distributed around a central extraction/work area............. 120
Figure 91. “Crater” like depressions made from quarrying of boulders of silicified sandstone, Aswan West Bank grinding stone quarries ....................................................... 120
Figure 92. Quarry units and their internal logistics as defined in the Widan el Faras basalt quarry. Each unit may correspond with one pyramid complex..................... 121
Figure 93. Map of the quarry areas, gypsum workshops and “tool workshops” (secondary resources) at Umm es Sawan, Northern Faiyum quarry landscape. ........ 122
Figure 94. The Naq el Fugani quarry at the Aswan West Bank. The upper photo is taken from the southern edge of the quarry, the lower an overview of the quarry from the north, illustrating the sizeable spoil heaps. ................................................................. 122

Figure 95. Sagalassos limestone quarries. Left: limestone quarry in the city area, displaying quarry face (foreground), spoil heaps (blue coloured) and exit for transporting blocks (central part). Right: quarry face (red coloured) and area with spoil heaps and work areas (blue coloured) at the Sarikaya Quarry near Sagalassos. ......... 123

Figure 96. Simple model for visualising a quarry complex limited by the resource, as a number of connected quarries sharing common features of social infrastructure and logistics. ........................................................................................................................................ 124

Figure 97. The Widan el-Faras quarry complex; its elements and secondary resources. ........................................................................................................................................ 125

Figure 98. The main part of gypsum quarry complex in the northern Faiyum quarry landscape, Umm es Sawan, with its main elements and secondary resources. .......... 125

Figure 99. Quarries in local limestone in and in near vicinity of Sagalassos. .......... 126

Figure 100. Possible division of Chephren’s Quarry into a “vessel complex” and a “statue complex” – the latter overprinting the former. ......................................................... 127

Figure 101. Quarry complexes at the Aswan West Bank and their spatial distribution. All quarries in the upper centre. ............................................................................. 129

Figure 102. Illustration of time depth of quarry complexes at the Aswan West Bank (logarithmic scale, BP). .................................................................................................................. 129

Figure 103. Graphic illustration of functions and time depth of the quarry landscapes in the case studies (NB – not proportional sizes). ................................................. 130

Figure 104. Petra and its quarries, surrounding and integrated into the monumental city. ..................................................................................................................................... 131

Figure 105. Simple representation of the Jerash quarry landscape, as a simple complex of limestone quarries basically from one geological unit in the city’s surroundings... 131

Figure 106. The Northern Faiyum quarry landscape on a geological background. ..... 133

Figure 107. Chephren’s Quarry Landscape and its complexes. Landsat background. 133

Figure 108. Large house built of rubble situated in a limestone quarry. ................... 140

Figure 109. Left: free-standing sarcophagi in the southern Necropolis, Sagalassos. Right: rock-cut tombs with lids in the Eastern Necropolis, Sagalassos. ....................... 141

Figure 110. From recognition to management: cut from the QuarryScapes project proposal. Yellow = research activities, red = innovation activities. ......................... 150

Figure 111. A modified model (from Mason 2008) showing the process towards landscape management. The themes of the present report are shown in yellow. ........ 152
ABSTRACT

Drawing up ‘statements of significance’ from an expert perspective, in terms of articulating historical and informational values of an ancient quarry landscape, is a key stage in the conservation planning process. The objective of this report has been to analyse empirical quarry data, from the different case studies across the QuarryScapes region, and design a methodology to articulate historical and informational values in a statement of significance to decision-makers in an accessible way. To begin this process, a method has been designed to get at interpretation of quarry data from two perspectives: first, micro-level characterisation and interpretation, or ‘deconstruction’ of a quarry landscape; second, is ‘reconstruction’ by assessing values from macro-level concepts that view ancient quarry landscapes within their broader historical context.

Micro-level data across the project region has been examined and characterised through four main elements: the resource, the production, the logistics and the social infrastructure. The idea has been to interpret and characterise physical material remains in quarries through these main constructs as a means to identify and understand the technological and social organisational processes of quarrying in the past. The construction of ‘quarry complexes’, as an outcome of this micro-level interpretation, allows us to characterise and visualise where historical and informational values may be attached to specific material remains in a landscape.

The second interpretative stage takes a holistic view of an ancient quarry landscape in terms of its connection with other places or events of historical significance. ‘Socially constructed landscapes’, ‘associative historical landscapes’, ‘contact landscapes’ and ‘dynamic landscapes’ are four macro-level concepts that have been designed to articulate significance in a meaningful way to decision-makers of at worst the invisible, and at best, often confusing sets of material remains. In addition, to ‘best project’ where these historical and informational values may be attached to material remains within a quarry landscape as a key planning tool when landscapes are under pressure from modern development. The information that decision-makers, managers and stakeholders take away from a ‘statement of significance’ in relation to an ancient quarry landscape in terms of scale, importance, uniqueness and representativeness, would then be integrated into other frameworks of value assessment in their domain. Outcomes in this report suggest that such a method allows evaluation of ancient quarry landscapes to be made easier and more targeted and can form a baseline methodology to establishing a set of conservation guidelines.
1. Introduction
A landscape can be defined as “…an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.” (Council of Europe 2000). So how do we define a “quarry landscape”? We may use it as a loose term covering any physical landscape upon which stone quarrying has left a significant imprint. Or we may define it culturally, as a historical narrative of human interaction with specific stone resources. Whatever way we choose to define it, it is not absolute; we cannot draw a line where a quarry landscape ends and another landscape takes over on the basis of some quantitative measurements! As pointed out in recent discourse, there is also the impossibility of drawing a line between what is natural and cultural heritage, and so it is about taking a holistic view of landscape that is important (see Platcher and Rössler 1995; von Droste 1995; Jones 2003; Fowler 2004; Schofield 2008). Although there are parts of landscapes that are so transformed by quarrying that there is literally not a square meter left witnessing any other kind of activity, quarry landscapes are, as any landscapes, dynamic and display a range of human activities and natural processes. “Quarry landscapes” are thus more a perception (or perspective) of landscapes where such activities were important than an area with physical boundaries. Quarrying may even have been the trigger to a series of events that lead to the evolution of completely different landscape types; abandoned quarries re-used for burials, or rare ecosystems developing on ancient spoil heaps.

Within this analytical phase of the project, and with a view to establishing a set of conservation guidelines of ancient quarry landscapes, there is a key step in this process that requires us to identify from an “expert perspective”, historical value of the empirical data that comprise an ancient quarry landscape. Such perspectives are contained within a statement of significance which is the foundation from which a set of conservation guidelines (management and planning) can be drawn.

**Objectives**

The objectives for the present report were formulated as the following in the project proposal:

- *Perform a critical evaluation of the empirical results* from the case studies in the light of recent development in associated fields and with a view to conservation
- *Establish typologies* of quarry landscapes
- *Establish the scientific foundation* for practical conservation and management of ancient quarry landscapes

Furthermore it said about the work package:

*In essence, the analytical phase has to generate models that set baseline priorities of:* **recognition; investigation; significance; risks; conservation concepts; sustainable management**; which can be used as decision-making tools by such authorities. To make these guidelines ‘state of the art’ and also relevant globally, model building has to be developed within recent developments in landscape theory, conservation and with adherence to international conventions.*
In particular, this report puts heavy weight on the first three aspects (marked in bold). These are all related to how we identify and analyse the content of a given quarry landscape from which we can build a “case for conservation”. We believe this is an area where it is possible to construct a methodology that can be “relevant globally” as a “decision-aiding tool”. With respect to risks the WP 5 report (see Storemyr et al. 2007) presents evidence of an alarming rate of destruction of ancient quarry sites and equally troubling lack of protection measures on such sites. This again illuminates the need of applicable tools for deciding which quarry landscapes, and even more, which parts of quarry landscapes should be protected. The report furthermore introduced the “dynamic quarry landscape” as a perspective for viewing and analysing changes, also in modern terms, and this has been brought into the present report. Conservation concepts and sustainable management are enlightened by case studies in Egypt, and we believe these studies can provide ideas of “best practice” on how to protect on a local and national scale, which will be addressed in forthcoming publications.

About the methodology behind this report, it was said in the project description:

....typologies can be produced that can aid in the recognition of the basic characteristics which all ancient quarry sites, to a greater or lesser extent, share

Producing typologies which can be compared across the range of empirical data collected during the case studies is an analytical tool that can aid in characterising the archaeological record and for developing chronologies.

Rather than creating strict boxes to put quarries and quarry landscapes into, we have developed a view of providing a road for systematic characterisation of the empirical data for facilitating the extraction of important aspects of quarries. The aim is to enable the building of site characteristics that are more individually applicable to each quarry landscape, rather than a “global set of quarry landscape types”.

....comparative analysis of consumption vis-à-vis production across the region can also help identify trade networks that form the basis for understanding macro-level political and economic relations across the region.

Although consumption is a key aspect of quarry landscapes, we have experienced that it is also important to address other macro-level analyses. Quarry landscapes may also be of crucial importance to understand the social construction of landscapes in the past, as well as how some quarries can be a reflection of, or implicated in, historically significant events. As we will show below, we have extended macro-level interpretation also to these aspects.

In practical terms, it is clearly not possible to protect and conserve all ancient quarry landscapes....

However, without setting up a criteria of significance and values specific to ancient quarry landscapes, then it is impossible for cultural heritage authorities to make informed decisions about which elements of such generally prodigious sites should be specifically earmarked for protection. Therefore, guidelines need to be drawn up from the analytical steps taken above, to create a criteria of significance and values so that cultural heritage authorities can make informed decisions, when faced with local
developmental needs, as to which elements of an ancient quarry landscape take precedence for protection over others.

Again, the “statement of significance” is, in many ways, the centre of gravity for how to put forward a strategy for conservation. As the above paragraph from the project description underlines, this is not only for measuring importance related to other sites, but also how to treat such complex landscapes on a local level: which parts are most important? Thus, it was crucial to make an attempt to provide an integrated methodology where it is possible to “isolate” parts of a landscape and analyse its representation within a broader perspective. A crucial part of the development of a methodology is to test how such elements and landscapes play together.

We have, from the goals of the project description, tried to consequently keep a landscape perspective on our quarries. From our point of view, this has kept alive the “nature” of stone procurement as widespread exploitation of natural resources with a great time depth. In other words, in changing landscapes. Several of our case studies have shown that such perspectives lead to new avenues of interpretation as not only a source for a stone used in a specific context. This, we think, can contribute in broadening horizons on not only quarry landscapes, but landscapes of natural resource exploitation in general.

Scope of report

The report is built around “how to build a case for conservation” of quarry landscapes. From the case studies, we look at the elements that characterise quarrying, and how these can be identified and approached in a systematic way. Then we try to display how elements can be analysed on a micro-level and grouped together to form “systems of quarrying” – or quarry complexes, and how quarry landscapes can be defined from such. Finally, we use these “constructions” as input to macro-level analyses, which provide the input to articulating significance.

Chapter 2 presents a discussion of landscape values and how we extract a fresh methodology in how to characterise, interpret and make historical value assessment of empirical data, that leads to a statement of significance.

Using case study quarry landscapes, chapter 3 concentrates on how we identify and characterise elements of empirical quarry data as a basis for matching historical values to material remains.

Chapter 4 deals with how to put these elements together and build quarry complexes and landscapes.

Chapter 5 takes a macro-level perspective of all the quarry landscapes in the project region and discusses ways in which we can articulate historical and informational value of these places in terms of drawing up a ‘statement of significance’.

Chapter 6 concludes with a discussion on the report as a whole and summarises some of the key issues raised. It will also introduce the next step in the conservation and
planning process, in terms of how we can use ‘statements of significance’ in the drawing up of conservation guidelines.

**Case studies and data sources**

In essence, the case study areas in QuarryScapes provide the basis for what we present in this report (Table 1). In addition, we have also used examples from the literature and from other areas that we have knowledge of. As we will not repeat too much about each case study, the reader may find it useful to download case study reports from the QuarryScapes website (www.quarryscapes.no). Thus, examples from the case studies are used to illustrate points more than describing each of them.

<table>
<thead>
<tr>
<th>Case study</th>
<th>Country</th>
<th>Work Package</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jarash (Abu-Jaber et al. 2007b)</td>
<td>Jordan</td>
<td>WP1</td>
<td>Limestone quarries related to monumental construction in the ancient city of Gerasa, Northern Jordan. The case study sought to identify, survey and describe the quarries.</td>
</tr>
<tr>
<td>Petra (Al Saad et al. 2007)</td>
<td>Jordan</td>
<td>WP1</td>
<td>Sandstone quarries in and around the Nabatean city of Petra, Jordan. The case study sought to describe and characterise the quarries.</td>
</tr>
<tr>
<td>Al Jafr (Abu-Jaber et al. 2007a)</td>
<td>Jordan</td>
<td>WP1</td>
<td>Palaeolithic to Bronze Age chert quarries as raw material for stone tools. The case study sought to perform a geological characterization of the rocks, quarries and the landscape</td>
</tr>
<tr>
<td>Ankara Andesite (Caner-Saltik et al. 2007)</td>
<td>Turkey</td>
<td>WP2</td>
<td>Much of Old Ankara was built of Andesitic rocks, the case studies sought to identify the quarries</td>
</tr>
<tr>
<td>Ankara Marble (Topal et al. 2007)</td>
<td>Turkey</td>
<td>WP2</td>
<td>White marble is used in Roman monumental architecture in Ankara. The case studies sought to identify the source and the quarries for this marble.</td>
</tr>
<tr>
<td>Aksaray Tuff (Tavukçuğlu et al. 2007)</td>
<td>Turkey</td>
<td>WP2</td>
<td>Tuff quarries of Cappadocia exploited by Selçuks namely related to the Aşkıkarahan Caravanei in Aksaray. The case study aimed at identifying and characterising the quarries and rocks.</td>
</tr>
<tr>
<td>Hittite limestone (Akoğlu et al. 2007)</td>
<td>Turkey</td>
<td>WP2</td>
<td>Limestone quarries of the Hittites in Shapinuva-Ortaköy, near Çorum. The case study aimed at identifying and characterising the quarries and rocks.</td>
</tr>
<tr>
<td>Sagalassos (Degryse 2007a)</td>
<td>Turkey</td>
<td>WP3</td>
<td>Local and regional quarries used for the construction of the Antique city of Sagalassos, Anatolia. The case study aimed at characterising the quarries and bring forward new views on risks, conservation and promotion</td>
</tr>
<tr>
<td>Chephren’s Quarry</td>
<td>Egypt</td>
<td>WP5, 7</td>
<td>Old Kingdom gneiss quarry landscape in southern Egypt. The case study focused on risks and GIS, but the site will be much used in the report based on previous work.</td>
</tr>
<tr>
<td>Northern Faiyum</td>
<td>Egypt</td>
<td>WP5, 6, 7</td>
<td>Old Kingdom quarries of basalt and gypsum, north Egypt. The case study focused on risk and GIS.</td>
</tr>
<tr>
<td>Aswan West bank (Bloxam et al. 2007)</td>
<td>Egypt</td>
<td>WP4, 7</td>
<td>Complex quarry landscape composed of palaeolithic tool quarries, Palaeolithic to Roman Period grinding stone quarries, Dynastic and Gaeco-Roman building stone quarries and ornamental stone quarries.</td>
</tr>
</tbody>
</table>
The following QuarryScapes reports have provided the input to the present. They are all downloadable at www.quarryscapes.no.


Limitations

In this report, examples are used as illustrations for testing a methodological approach. We have no intention in making statements of significance for all of the case studies, because only a few of them were actually subject to full scale study. Each of the case studies was designed to illuminate one or a few aspects of quarry landscapes, but collectively they contribute as real examples of the diversity of such places and so enable us to build a general model that can be widely applicable.
2. Methodology: from empirical data to statements of significance
To draw up statements of significance in relation to ancient quarry landscapes, we have to analyse the empirical elements that characterise these landscapes in a way that is accessible across a range of interests and perspectives. The primary foundation to this process involves the formulation of a methodological framework, through which we can identify and analyse the material culture that defines an ancient quarry landscape. Although heritage values are constantly in flux and their articulation is context-specific in terms of local, regional and national politics and legislation, the aim here is to provide an expert, multi-disciplinary perspective into assessing the historical significance of this data. As several scholars have pointed out, heritage is multivalent and corresponds to different stakeholders and contexts that are not fixed (Lipe 1984: 2; Mason 2008: 100). Hence, it is important that significance statements do not collapse all values to form a whole, but rather identify the main themes of significance in the experts’ field and isolate these judgments from others outside the field (Mason 2008: 114, 119).

**Perspectives on ‘statements of significance’**

Articulating the significance of ancient quarry landscapes from an expert multi-disciplinary perspective1 in a ‘statement of significance’ is the primary step in the development of a set of ‘Conservation Guidelines’. In essence, as Aplin (2002: 18) points out, the ‘statement of significance’ has to provide the justification from an expert perspective, as to why a cultural resource should be conserved over other forms of land use or development. Yet, a ‘statement of significance’ is the end product of a process that requires the identification and analysis of the empirical data (material culture) that characterises an ancient quarry landscape, articulated through a theoretical screen to a scale of heritage values which will inform decision-makers.

At the broadest scale, key criteria that are important in the establishment of significance as forwarded by Aplin (2002: 20) have three dimensions:

1. **Scale**: something may be important to a local community, region, state, nation or globally;
2. **Importance**: how important is it at the appropriate scale and why;
3. **Either uniqueness or representativeness**: can be a unique case such as the last remaining, or it is a representative example of a type (comparative analysis)

As several commentators have remarked, there is the expectation that statements of significance will often be contradictory, for instance, historical value may often be in conflict with aesthetic value and so there is clearly no imperative for reflecting a universal view (Sullivan 1997: 19; Mason 2008: 119). Hence, it is important to articulate the significance of each value and the relative importance of that value with related sites. The steps necessary in how to draw up a ‘statement of significance’ as part of the conservation planning process tend to adhere to a specific methodology

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1 Within QuarryScapes these “expert perspectives” are from professionals working within archaeology and geology
(Sullivan 1997: 17; Aplin 2002: 133; Mason 2008: 120 see Fig.7.1 p. 108) the initial stage of which is gathering an expert perspective on the historical values of a resource from the documentation and characterisation of a site/landscape. The significance assessment is where values of the cultural resource are forwarded and formalised in a ‘statement of significance’ from an expert perspective. These initial stages of the planning process would also include an identification of stakeholders, or in other words those who would have influence over the management of the cultural resource (see Figs).

Mason (2008: 120) has developed a framework of the key phases in the processes involved in forwarding a significance statement that can be useful, in terms of how to develop a methodology from a landscape perspective: first, is making explicit the correspondences between specific values to specific physical resources (empirical data) and how each of these values is represented and delineated in the site. This might range from artefacts, to buildings to landscapes; second, key ‘complexes’ of (material) resources and (immaterial) values can then be identified. Hence, decision-makers can associate the values held with regard to the “site” to the actual physical resources that constitute it. In way of example of this method, Mason (2008: 120) identifies that the key historical complex for a historic building might associate the site’s most important historical events, narratives, and concepts with the arrangements of buildings on the site, or with the decoration of particular rooms or with landscape elements such as walls or hedgerows.

**Identifying heritage values**

In order to break down these steps in the process of drawing up statements of significance, we have to review and discuss a range of approaches in the assessment of heritage values. As a baseline, Lipe (1984: 2-8) developed what are still key terms of reference through which types of resource value, where these are related to some end use, can give meaning and importance to cultural materials of the past across a range of interests as summarised below:

*Associative/symbolic value* – the essence of physical cultural remains and their authenticity, even if re-used, that can transmit cultural information about the past. Powerful as symbols of the past that can also be bound up in ‘Communal value’ in terms of collective memory for those who relate to it by proximity but also in terms of society’s needs in general for continuity through time.

*Informational value* – emerges from formal ‘expert’ research, in particular from multi-disciplinary approaches and having to make ‘best projections’ of what kind of resources/elements will be most useful for future study

*Aesthetic value* – complex and culturally specific, there is power in aesthetics to symbolise and commemorate a past culture. These values can also relate to actions

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2 These approaches are still largely in a domain of Western value systems and so application in other cultural contexts has to be carefully considered. Such issues will be discussed in the forthcoming conservation guidelines.
from nature and man on a resource in how it looks today – its evolution through time that can also enhance its symbolic value.

**Economic value** – cultural resources have to compete with alternative uses of space and are not exempt from being reduced to costs and benefits in monetary terms. Hence, decisions re cultural resources to study, preserve, display, neglect and destroy all have an economic dimension. There are several pathways that resources enter the ‘market’ as: utilitarian value as a means to serve a present day need, modern quarrying, but also includes adaptive re-use but can these values conflict with symbolic/associative and aesthetic values that led to it becoming a cultural resource in the first place. Informational value may still be inherent in a cultural resource even if elements have been incorporated into another function, such as a park or farm. Destruction of the resource for more pressing economic uses, as long as detailed recording has been undertaken, means that some informational value can still be accessible.

**Associative and aesthetic value** in economic terms can be in conflict with associative/symbolic value if present day use means a severing of its power to evoke a remembrance of a past culture. Although any contemporary use of a resource will be different from its use in the past, there is need to assess the extent to which alternative uses will enhance or detract from associative and aesthetic values and degrees to which these are economically feasible.

Mason (2008: 105) has added further to assessing values of cultural resources that are also relevant to mention. Such as ‘social value’ that may not capitalise directly on the historical value of the cultural resource, but rather on use of the place for social gatherings and cohesion that may be related to special interest groups, community identities or on other feelings of affiliation to the place. Cultural resources may also have spiritual and religious value in terms of evoking wonder and awe. In addition, economic values may also be perceived in terms of ‘use’ and ‘non-use’ value. The former refers to goods and services that can flow from the cultural resource (market value) such as admission fees, cost of land, goods and services that flow from it (Mason 2008: 106-7). In the latter, non-use value refers to the way in which individuals are willing to allocate economic resources to acquire or protect cultural resources. This may be broken down into three sets of values that relate to the type of heritage consumption: (1) Existence value (individuals value the heritage for its mere existence); (2) Option value (that it might be consumed in the future); Bequest value (bequeathed as an asset for future generations).

‘**Outstanding universal value**: global significance, authenticity and UNESCO criteria for establishing World Heritage Status’

Three of the key criteria important in the establishment of significance, such as scale, importance, uniqueness or representativeness can also be articulated within the concept of ‘outstanding universal value’ - UNESCO’s criteria for assessing values of a cultural resource in terms of World Heritage Status (see UNESCO operational guidelines at [www.wch.unesco.org/archive/oguide08-en.pdf](http://www.wch.unesco.org/archive/oguide08-en.pdf)). Based on the concept of authenticity, it has taken some time and much debate into how these key criteria could be applied to cultural landscapes which are dynamic and comprise material culture that can represent several historical periods (von Droste 1995: 22-23; Cleere 1996: 228-9; Titchen 1996: 209).
After the Nara Conference on authenticity (UNESCO 1994) a more open and flexible approach to the concept of authenticity and cultural landscapes as representing the combined works of nature and man allowed for the distinctive character and components of a landscape across multiple periods to be recognised (von Droste 1995: 22-23; Mitchell 1995: 245; McBryde 1997a; Fowler 2004: 5; Jones 2003: 40). Such modification of this key criteria allowed for the inclusion of ‘industrial landscapes’, that may have evolved over several millennia, to be considered as World Heritage Sites.

The concept of ‘outstanding universal value’ has thus become an important method in terms of how we can articulate global values in a statement of significance. Such a method has recently been used in the assessment of significance of two ancient quarry landscapes: the Northern Faiyum (Bloxam and Heldal 2007) and the Aswan West Bank (Bloxam 2007). Key to this methodology was how we conceptualize the significance of the transformed landscape across time and its social construction. Theoretical approaches from social archaeology and landscape archaeologies (Ingold 1993; Ucko and Layton 1999; Ashmore and Knapp 1999; Barrett 1999; Thomas 2001) allows us to get at aspects of the ‘human experience’ of quarrying in the past and its significance in terms of time-depth. Practical and theoretical methods to get at time-depth and to characterise the historical significance of dynamic landscapes have also recently arisen from ratification of the European Landscape Convention in 2004.

The European Landscape Convention and Historic Landscape Characterisation

The European Landscape Convention has been a key instrument in recognising that ‘landscapes’ are the integration of both natural and cultural values, or in other words, “…an area, as perceived by people, whose character is the result of the action and interaction natural/or human factors.” (Council of Europe 2000). Some of the key aims of this Convention are to promote landscape conservation, management and sustainability by way of generating public participation in a common heritage (Fairclough 2008: 411). Viewing cultural resources within their broader context, rather than as ‘archaeological sites’ is a key advance to how we articulate landscape transformations as being long-term narratives rooted in social, political and economic processes over time. Historic Landscape Characterisation (HLC) has been a key methodology, developed as a means to practically implement some of the objectives of the European Landscape Convention, in terms of understanding the historic character of an area through its time-depth. In other words, a method for mapping and interpreting cultural resources in the way that earlier landscape change can be seen in the present-day landscape (Fairclough 2008). The principles of this method, particularly in terms of moving away from ‘site-based’ conservation, or ‘single-period’ focus, is relevant to how we assess multi-period transformations of landscapes by ancient quarrying. In essence, it is about finding a balance between continuity and change in a way that allows for the historical depth of a landscape to be preserved for future generations (Fairclough 2008:421).
Developing a methodology to draw up a ‘statement of significance’ of an ancient quarry landscape

Given the range of approaches that can be made in the assessment of values, as the basis for drawing up statements of significance, there is clearly a need for flexibility in building a methodology. As Aalen (2004: 13) points out, landscape studies in general are some of the hardest given their multiple meanings over time and the range of conceptual approaches across disciplines that can be applied. With no such multi-disciplinary studies of ancient quarry landscape being undertaken before the ‘QuarryScapes’ project, the key challenge is to build a methodology and tools from which a value assessment and statement of significance can be accessible to stakeholders, the non-expert and heritage managers.

In developing this methodological process to we have used perspectives and methods mainly based on the work of Lipe (1984) Mason (2008) and Aplin (2002). The main steps of this methodology are shown in Figure 1. The stages in this method that are contained in this report are the first three major areas that lead to the statement of significance from an expert perspective, these comprising: 1) Empirical Characterisation; 2) Interpretation; 3) Historical Value Assessment. Below is a summary of how we developed this methodology and how it can be applied to ancient quarry landscapes.

![Figure 1. Steps in the process of making a statement of significance from an expert perspective (white area). Value assessments highlighted in yellow are those to be identified by stakeholders, managers and other decision-making frameworks to produce an integrated knowledge about values for the overall planning process.](image-url)
**Empirical characterization: identification of elements and complexes**

Identifying the physical resources, or the empirical data, that comprises an ancient quarry landscape is the first step in how we can assess values of any ancient quarry landscape. Visualising this data is key and as with any cultural resource, the material culture that characterises an ancient quarry landscape is variable and fragmented. Yet, raw material acquisition or stone exploitation transforms landscapes in specific ways, although often difficult to visualise, that leaves traces and material culture that identify them from other cultural landscapes. For simplicity, we have designated four main categories of characterisation in which material culture related to ancient quarrying can be identified:

I. **Resource**: this refers to the actual stone deposit, or principal resource, that was sought after and exploited at some point in history. Expert analysis and identification of the ‘resource’ would involve the geological and technical characterization of rocks, how it occurs in the landscape and how exploitation characterises the landscape we see today.

II. **Production**: in quarries, “production” refers to the steps involved in removing rock from the deposit to working of the objects, either as rough-outs or completed pieces. Each of these steps – rock extraction, block reduction, semi-finishing and finishing, can be analyzed in a systematic way, aided by descriptions and characterization of the physical remains related to the process, such as, quarry face, spoil heaps, work areas, tool remains, semi-finished and broken products, etc. Also, manufacturing and maintenance of tools used in the production process (i.e. stone tool-making, smithing).

III. **Logistics**: some of the most visible features of quarrying are related to the transport of stone; internally in the quarries, and to the place of use/further treatment. Such features can be roads, ramps, remains from lifting devices, etc.

IV. **Social Infrastructure**: elements of material culture that relate specifically to the human presence associated with ancient quarrying. This can include built features (usually stone-built) such as purpose-built settlements, ephemeral dwellings, work places and other structures related to subsistence for the work force such as wells, hearths and places of food production and storage. Built features can also be associated with other activities that may be directly or indirectly associated with quarrying, such as rituals and hunting. Artefacts such as pottery (ceramics), food production tools, faunal and floral remains can all characterise domestic and subsistence activities related to provisioning of the work force. Epigraphic data found within an ancient quarry landscape such as inscriptions and petroglyphs (rock art) may be other traces that can inform about religion, ritual, organisational practices and other activities directly or indirectly related to quarrying.

**Micro-level Analysis**: drawing together and characterising the micro-level data, as categorised above, allows us to build a composite picture of the ancient quarrying process and its social context. Multi-disciplinary perspectives are clearly key in this analytical phase, given that the objective is to define and characterise all the empirical data in terms of how it constitutes the material resources that make up a quarry complex.
This phase of expert analysis needs to describe and characterise the empirical data in terms of what insights can be made into how quarrying was undertaken in the past. For instance, technologies of extraction, logistics and the social organisation/context of these activities. It uses methods that allows for empirical data to be visualised and understood in terms of identifying function, particularly in the absence of excavation. For example, stone-built features in quarries may often look similar, although location and nuances in construction may be key in identifying features such as wells from ephemeral shelters. Identifying and characterising such differences is important to understanding subsistence of a labour force, environment, and can aid in making assessments as to the size of a work force.

Assessing a chronology is an important part of this analytical phase, particularly in multi-period sites. Such assessments can be made from direct and indirect sources of evidence found in quarries. For instance, indirect dating can be made from identifying ceramic typologies and also from epigraphic data, in particular from inscriptions. Direct evidence may come from organic remains such as charcoal that may often be found in spoil heaps and from places of food production. Consumption of objects from a particular resource can also be valuable ways of assessing a chronology, especially if there is a total absence of any direct or indirectly datable material.

Given that empirical data is always fragmentary comparative analysis with other ancient quarry sites, along with indirect evidence, is also key to interpretation of the micro-level. For example, interpreting the technology used to extract a resource may often be built from analysing a range of data sets, often indirectly associated, particularly when the tools used in the quarrying process are absent. Tool marks on quarry faces, partially worked objects, the constituents of spoil heaps and comparative analysis, can be effective ways to interpret the production process. An analysis of micro-level data that informs about the logistics of how stone was transported from a quarry is key to visualising and delineating the boundaries of an ancient quarry landscape. In some instances purpose-built roads were necessary to even out the topography, yet in others, a transport route may only be indicated by cairns and sightlines. Analysing the presence/absence of such transport infrastructure is important in assessing environment, longevity of the production process and often the role of the state in such operations.

In most cases, quarry landscapes are multilayered and multifunctional. Thus, following the definition of elements related to quarrying and the micro-level analyses of them, such layers/functions need to be identified as groups or systems of quarries. The term quarry complexes can be defined as “a collection of quarry elements related to each other in time, space and/or function”. The identification of quarry complexes is an aid in visualising similarities and differences in a quarry landscape, acknowledging that there may be different ways of articulating significance for different quarry complexes. A simple way of viewing a quarry landscape is thus as a collection of quarry complexes.

**Interpretation – the macro-level**

Macro-level interpretation at this stage of the methodology aims to understand and isolate values of ancient quarry landscapes, in terms of their broader historical context. It has to formulate an analytical approach to how we can articulate historical values
from a diverse and fragmented range of empirical data. For instance, a quarry complex may only consist of a few traces of the resource and tool marks, with no evidence of social infrastructure. At the other end of the scale, an ancient quarry landscape may comprise several quarry complexes with rich and diverse material remains over multiple periods. Yet, does this mean that the quarry complex with fewer traces is less significant than the one with numerous traces? To grapple with such issues, in terms of articulating historical values of an ancient quarry landscape, we have to construct analytical approaches that can get at a range of ‘value contexts’ given such diversity. As Mason (2008: 120) describes, it is about how we identify and match immaterial values to the ranges of material resources of a given place. Hence, we have designed four concepts of ‘landscape’ through which we can articulate macro-level value contexts of ancient quarry landscapes. Characterising ancient quarry landscapes within such concepts, or ‘extended’ landscapes, is a way to identify significance and access historical values through a holistic approach that views these places in several different analytical ways. In essence, the idea is to find ways of articulating significance and value of an ancient quarry landscape, however diverse its material remains, within its broader geographical and historical context, or in other words, as having connections to other places and events of historical significance.

I. **Socially constructed landscapes**: this concept can be used to isolate values of multi-period quarry landscapes in terms of time depth of quarrying and also use and re-use of the landscape for other activities. Authenticity of cultural remains are key to assessing historical values, although often ancient quarry landscapes can lose ‘authentic’ remains of earlier quarrying from later quarrying and re-use. To get at the significance of these multiple traces of quarrying over time, and its connection to other activities occurring across the landscape, the concept of a ‘socially constructed landscape’ allows for the historical value context to be assessed in its totality. Stone working traditions, aspects of ancestry, and connection to a landscape, are key concepts to get at. Contributions from landscape archaeologies, ethnography and social archaeology are key theoretical sources that can aid in re-constructing the social landscape and from which historical values may be linked to specific material resources ((Ingold 1993; Ucko and Layton 1999; Barrett 1999; Cooney 1999; Knapp 1999; Bradley 2000; Thomas 2001; Grzymski 2004).

II. **Contact landscapes (consumption)**: ancient quarry landscapes do not exist in a vacuum but have connections with other places, sometimes over thousands of kilometres away, related to consumption of the material that came from the resource. In some instances these contacts may be extremely close to a quarry landscape and may be related to providing stone to a major city or monument of enormous historical importance. Hence, part of the historical significance of the ancient quarry, although this may be hard to visualise and attach to actual physical remains, is its connection to another more highly visible place. Consumption of stone from a particular resource over a wide geographical range can also be historically significant, in terms of identifying ancient trade patterns and values placed on particularly sought after resources over time. These contacts may also be significant in terms of identifying cross-cultural social relations between people, centred on the trade and consumption of a stone
resource, that places the ancient quarry landscape at the epicentre of these connections.

III. Associated historical significance: at a macro-level, some ancient quarry landscapes may be implicated in and provide additional evidence about significant events and transformations in history and prehistory. For instance, political and ideological change at key periods in history may provoke intensive production of a specific resource due to its symbolic association with an emerging religious cult. Quarries can be key places to identify changing social relations in the transformation of early states, particularly where monumentality and large-raw material procurement were key indicators of an emerging political elite. Explosions in quarrying for utilitarian objects from a specific resource, such as grinding stones, may tell us about major changes in diet and methods of food processing at key transformative stages in prehistory. Important insights into past environment may also be directly and indirectly evident at ancient quarries. For instance, methods of stone transport and types of infrastructure may provide evidence of once easy accessibility to water in now hyperarid environments. Technological changes in society over time can be reflected in quarries, for instance, the introduction of iron technology into quarrying.

IV. Dynamic landscapes: quarry landscapes, as with any type of landscape, are dynamic places that are not static in time. Although the concept of a ‘socially constructed landscape’ allows us to view multi-period transformations as adding new layers of historical significance, directly or indirectly related to quarrying, how do we articulate values of quarry landscapes where re-use for other activities may have completely or partially destroyed them? The aim is to view the landscape holistically from a perspective of how human agency into the present may have totally changed an earlier landscape and what threads of these past elements have been inherited and still survive (Fairclough 2008: 414). Aspects of this approach have been incorporated into methods relating to Historic Landscape Characterisation (op. cit. and see below) and form the basis of this macro-level concept. This is a particularly useful concept to use when a quarry landscape has been totally integrated into a modern city and where we need to assess historical and informational values through human agency as characterising the present-day landscape, rather than its past.

Historical Value Assessment and Statement of Significance

The key heritage value types that we will use in the historical value assessment are those forwarded by Lipe (1984) of associative/symbolic value and informational value from an expert perspective. This is where we have to assign these key values to the physical remains that project the meaning and importance of a quarry landscape and its components, as interpreted at a micro-level and macro-level, that will inform decision-makers. As described earlier in this chapter, associative/symbolic value refers to the essence of the material remains in terms of authenticity, even if re-used, that can transmit cultural information about the past. Informational value is where expert analysis can make ‘best projections’ of which cultural remains will be most useful for future study. Finally, in the statement of significance, we need to contextualise these values within key criteria as forwarded by Aplin (2002: 20) of scale, importance, uniqueness and representativeness. From such an assessment we can, for example,
draw out and advise that the values of an ancient quarry landscape may fall into all three categories of scale and could perhaps necessitate further defining values in terms of World Heritage criteria (see above).

There are of course many subsets to the two key values that we will use in this final analytical phase, these may touch on aesthetic value, educational, and social value. Yet, values such as the aesthetic, are culturally specific, complex and can often contradict with historical values (see Lipe 1984: 2-8; Sullivan 1997: 19). For instance, the aesthetic value of a cultural resource may become obscured by re-use, although multi-period re-use may be a key value linked to the rich and deep history of the place. Hence, some care needs to be taken here and only where appropriate will we touch on value subsets where it can aid in building an argument linked to our key value assessment criteria as stated above.

The aim is to achieve as balanced an assessment of values as possible, although in the realisation that we are only viewing significance through two value contexts. Economic value, social value, spiritual and religious value are also key assessment criteria in the conservation process. As these are subject to assessment by stakeholders, interest groups and heritage managers, given that such values are socially, politically and culturally specific at local, regional and national levels, we are only engaged in providing statements of significance prior to this phase of management assessment. In terms of conservation and management procedures, our aim is produce a statement of significance that should inform decision makers about which elements of a quarry landscape, when faced with modern development needs, best projects its historical values. Such projections are made with the understanding, as Fairclough (2008: 412) points out, that the expert approach should be made from the premise that change should not be stopped, but guided into ‘…sustainable historically sensitive directions’.
3. Characterisation of ancient quarry landscapes: the empirical input from QuarryScapes case studies
Ten quarry landscapes have been studied in the project (Table 2). In addition, a number of other quarry landscapes in and outside the region have been visited, or knowledge of them has been achieved from other sources/research. In this chapter, we will explore how the empirical data feeds into a general model that can be used in a cross-cultural context for characterizing quarry landscapes.

**Table 2. Quarry landscape “case studies”, stone materials and periods**

<table>
<thead>
<tr>
<th>QUARRY LANDSCAPE</th>
<th>COUNTRY</th>
<th>MATERIAL</th>
<th>KEY PERIOD(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aswan West bank</td>
<td>Egypt</td>
<td>Sandstone/silicified sandstone</td>
<td>Palaeolithic to Roman</td>
</tr>
<tr>
<td>Chephren’s Quarry</td>
<td>Egypt</td>
<td>Gneiss</td>
<td>Pre-Dynastic to Middle Kingdom</td>
</tr>
<tr>
<td>Northern Faiyum</td>
<td>Egypt</td>
<td>Basalt, Gypsum</td>
<td>Old Kingdom</td>
</tr>
<tr>
<td>Sagalassos</td>
<td>Turkey</td>
<td>Limestone</td>
<td>Graeco-Roman</td>
</tr>
<tr>
<td>Ankara</td>
<td>Turkey</td>
<td>Andesite, marble</td>
<td>Roman - Byzantine</td>
</tr>
<tr>
<td>Hittite cities</td>
<td>Turkey</td>
<td>Limestone</td>
<td>Hittite</td>
</tr>
<tr>
<td>Aksaray</td>
<td>Turkey</td>
<td>Tuff</td>
<td>Medieval (Celcuk)</td>
</tr>
<tr>
<td>Jerash</td>
<td>Jordan</td>
<td>Limestone</td>
<td>Roman</td>
</tr>
<tr>
<td>Al Jafr</td>
<td>Jordan</td>
<td>Chert</td>
<td>Neolithic – Chalcolithic</td>
</tr>
<tr>
<td>Petra</td>
<td>Jordan</td>
<td>Sandstone</td>
<td>Nabatean - Roman</td>
</tr>
</tbody>
</table>

First, we will take a closer look at features that are likely to be found in quarry landscapes, and that collectively define them; identifying the *key elements* of stone quarrying. Second, we will provide a model for how these elements can be used to identify and construct *complexes* of quarrying, i.e. quarrying activities with a specific purpose that are limited in space and/or time. A *quarry landscape* may then be conceptualized as the spatial merging of one or several complexes.

**Identifying the elements of quarrying**

A quarry site may be visualized as the remains from the various processes involved in the exploitation of its resources, in one or several periods. These remains include traces of the extraction of rocks, deposition of excess rock (spoil), tools, work areas, ceramics, shelters etc. Collectively, these physical remains tell us something about the processes involved: the selection of stone to be quarried, the production of it, the logistics related to transport of stone and the social processes related to sustaining the people involved in the quarrying.

The remains from quarrying may be characterized from a purely physical and descriptive perspective. However, when characterizing quarries at a micro-level, this analytical phase has to achieve a basic overview of the quarrying process. For instance, it is crucial to be able to characterise one heap of stone from another and one stone artefact from the other, in terms of function. Therefore, we have tried to develop a characterization procedure that groups material remains into key processes of quarrying, or elements, that can be defined as:
• Selection (of stone to be quarried); resource characterization
• Production; extraction of stone blocks, size reduction down to the unit to be further processed, shaping of the more or less finished product that will be brought away from the quarry site
• Logistics: transport of stone in the quarry and out from it
• Social processes: activities related to sustaining the work force and the “social life” around quarrying

Table 2 summarizes these elements and how they can be divided into characteristic classes of features.

Table 3. Elements of quarrying – main features/classes

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESOURCE</td>
<td>Rock</td>
</tr>
<tr>
<td></td>
<td>Commodity</td>
</tr>
<tr>
<td></td>
<td>Occurrence</td>
</tr>
<tr>
<td>PRODUCTION</td>
<td>Quarry morphology</td>
</tr>
<tr>
<td></td>
<td>Quarry face</td>
</tr>
<tr>
<td></td>
<td>Tool marks</td>
</tr>
<tr>
<td></td>
<td>Tools</td>
</tr>
<tr>
<td></td>
<td>Spoil</td>
</tr>
<tr>
<td></td>
<td>Work areas</td>
</tr>
<tr>
<td></td>
<td>Objects and object blanks</td>
</tr>
<tr>
<td>LOGISTICS</td>
<td>Road</td>
</tr>
<tr>
<td></td>
<td>Ramp</td>
</tr>
<tr>
<td></td>
<td>Causeway</td>
</tr>
<tr>
<td></td>
<td>Slipway</td>
</tr>
<tr>
<td></td>
<td>Track</td>
</tr>
<tr>
<td></td>
<td>Path</td>
</tr>
<tr>
<td></td>
<td>Stockpile</td>
</tr>
<tr>
<td></td>
<td>Harbours</td>
</tr>
<tr>
<td></td>
<td>Vehicle track</td>
</tr>
<tr>
<td></td>
<td>Stone feature</td>
</tr>
<tr>
<td></td>
<td>Carved feature</td>
</tr>
<tr>
<td>SOCIAL INFRASTRUCTURE</td>
<td>Stone built features</td>
</tr>
<tr>
<td></td>
<td>Ceramics</td>
</tr>
<tr>
<td></td>
<td>Epigraphics</td>
</tr>
<tr>
<td></td>
<td>Wells</td>
</tr>
<tr>
<td></td>
<td>Faunal/floral remains</td>
</tr>
<tr>
<td></td>
<td>Domestic artifacts</td>
</tr>
</tbody>
</table>

In addition to the elements above, there can be additional features that may or may not be linked to quarrying. Of particular importance are secondary resources, these can be stone, minerals, wood or others whose exploitation may be directly or indirectly linked to primary resource production. Such resources may have crucial importance in understanding the greater extent of quarrying activities. In the following subchapters, we will try to define the elements in Table 3, and use examples from the case studies and other quarry sites as illustrations.
Table 4. QuarryScapes case studies and their contribution to the empirical datasets.

<table>
<thead>
<tr>
<th>QUARRY LANDSCAPE</th>
<th>RESOURCE</th>
<th>PRODUCTION</th>
<th>LOGISTICS</th>
<th>SOCIAL INFRASTRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aswan West bank</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Chephren’s Quarry</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Northern Faiyum</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sagalassos</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankara</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hittite cities</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aksaray</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jerash</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al Jafr</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petra</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The geological resource

The stone resources that have been exploited define the natural arena in which quarrying took place – and, of course, the target of exploitation. In the past, there was clearly an importance attached to specific rocks at specific times and in specific places, and an important road to getting closer to why is to understand the resources. It is obvious that the technical quality of certain rocks for certain purposes was important: no doubt that chert, obsidian and quartzite became preferred materials for Stone Age tools due to their mechanical properties, that millstones tend to be made of rocks with a particular distribution of minerals and/or cavities, and that soapstone was used for cooking vessels due to its softness and heat capacity. But there are also other reasons for exploitation of specific stone resources. For instance, availability may be important. Instead of reaching for “the best quality”, one went for “the best within reach”, or “good enough for the purpose”. Some stone resources have been exploited because of other, non-practical reasons: being rare (Peacock 1992), aesthetically appealing or there may be symbolic values connected to the place where they occur (Bradley and Edmonds 1993). From the QuarryScapes case studies, we may be able to establish perspectives that can help us approach the purpose of quarrying – or in other words, why the resources were exploited.

Characterizing the rock

It is beyond the scope and efforts of this report to give any comprehensive overview of classification of rocks and minerals. The classification schemes made by British Geological Survey contain approximately 2700 rock names (Hallsworth and Knox 1999, Gillespie and Styles 1999, Robertson 1999), and still there are many controversies and different views on details of rock classification, although there are general agreements on main groups of rocks Table 5. But what we would like to point at, is the necessity of characterizing the rocks that have been exploited in a proper and scientific way. Wrong classification of rocks and in-proper description of them has unfortunately
led to many misinterpretations during research on ancient quarrying and stone consumption. One famous example is the Rosetta Stone, which was wrongly believed to be a basalt until Middleton and Klemm (2003) proved it to be a black granodiorite, most likely from the Aswan area. The confusion between basalt and other black rocks seems to be a tradition in Egyptian archaeology (Aston et al., 2000; see also Bloxam 2003).

<table>
<thead>
<tr>
<th>Main class</th>
<th>Subclass</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Igneous rocks</td>
<td>Volcanic (Extrusive)</td>
<td>Basalt, Dacite, Andesite, Rhyolite, Trachyte, Latite, Obsidian</td>
</tr>
<tr>
<td></td>
<td>Pyroclastic (Extrusive)</td>
<td>Tuff, Ignimbrite, Agglomerate, Lapilli, Pumice</td>
</tr>
<tr>
<td></td>
<td>Plutonic (Intrusive)</td>
<td>Gabbro, Diorite, Anorthosite, Granite, Granodiorite, Syenite, Tonalite, Monzonite, Aplitie, Pegmatite, Peridotite</td>
</tr>
<tr>
<td></td>
<td>Dyke (Intrusive)</td>
<td>Diabase (UK), Dolerite (US)</td>
</tr>
<tr>
<td>Metamorphic rocks</td>
<td>Thermal</td>
<td>Hornfels</td>
</tr>
<tr>
<td></td>
<td>Dynamo-thermal</td>
<td>Slate, Schist, Phyllite, Marble, Quartzite, Gneiss, Amphibolite, Serpentinite, Greenschist</td>
</tr>
<tr>
<td>Sedimentary rocks</td>
<td>Clastic</td>
<td>Claystone/mudstone, Siltstone, Sandstone, Conglomerate</td>
</tr>
<tr>
<td></td>
<td>Carbonates</td>
<td>Limestone, Dolostone/dolomite, Travertine, Tufa</td>
</tr>
<tr>
<td></td>
<td>Chemical and biochemical</td>
<td>Gypsum, Chert, Jasper, Phosphates</td>
</tr>
<tr>
<td>Fault rocks</td>
<td>Brittle</td>
<td>Fault breccias, Cataclasitane</td>
</tr>
<tr>
<td></td>
<td>Ductile</td>
<td>Mylonite, Phyllonite</td>
</tr>
</tbody>
</table>

Confusion may also arise from pure terminology use and/or changes in geological science. One of our case studies, Chephren’s Quarry, may serve as an example. This rock, used for the famous life-sized statues of Khafre found in the Giza Pyramid Complex, will from a non-genetic classification scheme be correctly identified as a plagioclase-hornblende-gneiss or hornblende-plagioclase-gneiss (depending on which mineral being the dominate in different part of the deposit). The terms anorthosite gneiss or meta-anorthosite may also be correct for the parts of the deposit containing more than 90% plagioclase, if using a genetic terminology (being an anorthosite transformed into gneiss) (Harrell and Brown 1994). Traditionally, however, before anorthosite was introduced as a geological term, the rock was called diorite or diorite gneiss, and later just anorthosite. Having four modern terms that all in their way are correct and three traditional, we started using Chephren Gneiss as a collective term not possible to misunderstand.

The need for scientific characterization is basically resting on two legs; first, is the importance of linking a stone resource with its consumption (rock provenance) as means to make inferences into selection criteria and technology in ancient quarrying activities. Second, the recognition of ancient quarry landscapes rests heavily on geological characterization and plays a significant role in the reconstruction of quarrying activities.

Obviously, the first step is the simple, visual inspection of the rocks (macroscopic examination). In many cases, rocks employed have unique and recognisable features
(minerals, structure and colour) visible to the eye that are sufficient to determine provenance. Examples in the region are Chephren’s Quarry (Engelbach 1933), the Aswan granite (Klemm and Klemm 1993), the Imperial porphyry (Maxfield and Peacock 2001) and a range of coloured marbles (Lazzarini 2004). In other cases, combinations of more sophisticated methods are needed. The mineral content is investigated by thin section microscopy, scanning electron microscope (SEM) and x-ray diffraction (XRD), and thin sections and SEM also give information about texture, microfossils etc. Whole rock geochemistry is investigated by x-ray fluorescence (XRF) and ICP-MS, mineral chemistry by the latter (laser ablation) or SEM. Stable isotopes (particularly $^{13}$C/$^{18}$O) have proved useful in the characterization of limestone and marble (Attenasio et al. 2006). Sr/Nd isotopes may “fingerprint” a range of intermediate, mafic and ultramafic igneous rocks (Jansen et al. in press). Cathode Luminescence may illuminate differences in certain minerals (i.e. quartz) that appear similar in thin sections (see example in Heldal et al. 2007). Other applied methods may include physical properties and petrophysics (e.g. sound velocity, magnetic susceptibility) and even colour analysis (Caner Saltik 2007).

Several of the case studies in QuarryScapes have aimed at identifying resources and finally confirming that these were used for specific purposes. To achieve that, a range of methods were applied (see summary in Table 6) with more or less success, reflecting that methods applicable for one rock type may not necessarily work for others.

A large part of Old Ankara is constructed of an andesitic volcanic rock (Sülüner 2007). Much of the bedrock in and around Ankara is composed of such rocks, and one of the questions in WP2 (Caner-Saltik 2007) was to identify quarries. Sampling and analysing (particularly thin section analysis, XRD and physical properties) of a range of deposits in the area revealed that the most likely source for the andesites in the Old Town (Citadel area) is the bedrock upon which it is built (Caner-Saltik et al. 2007). The quarries are no longer visible, but hidden beneath centuries of construction. Thus, the Ankara quarry landscape is deeply integrated into the built town itself. Interestingly, re-use of andesite (and marble) is a strong feature in the city (Sülüner 2007), illustrating another aspect of the use of stone.

In the Roman Period, marble was used for several purposes in Ankara, and one of the research questions was to identify the source and, if possible, ancient quarries. Thin section analysis aided by XRD and physical properties seems to confirm that the main sources were marble deposits in the near surroundings of the city. However, modern marble quarrying exploiting the same resources have had a large impact on the landscape and traces of ancient quarrying still remains to be found. Thus, the case study in Ankara identified resources, but the physical remains of the quarry landscape are completely obliterated!

Somewhat more successful was the identification of an ancient quarry that could be linked to Ağzikarahan, a 13th century caravanserai from the Selçuk Period, at Aksaray in Capadocia (Tavukçuoğlu et al. 2007). Not only petrographic analysis and physical properties, but also weathering studies and an investigation of “likeliness of match” of achievable block sizes in the quarry with those used in the building provide arguments for establishing a link between the two. Links were also made between limestone deposits/quarries and the monumental Hittite cities of Hatusa and Shapinuva (Akoğlu et al. 2007), by using petrography (including micro-fossils), XRD and physical properties.
An important case for constructing the Sagalassos quarry landscape has been the resource characterization (Degryse 2007b). The whole city, from the Hellenistic to Byzantine Period, is built from varieties of limestone. By detailed analyses of petrography and micro fossils, aided by $d^{13}C/d^{18}O$ isotopes relationships, the different buildings and building periods could be linked to specific quarries, revealing interesting patterns in the evolution of the city and different stone procurement strategies – particularly the difference between the Hellenistic and Roman Periods. At Sagalassos, there are still the visible remains of many quarries for further study. However, as in the case with the Ankara marble, the most remote of the stone resources within the city’s influential area (white crystalline limestone; Degryse 2007b) has been identified with analyses alone. Due to this rock’s “attractiveness” in our time (as well as in the Roman Period!) modern quarrying has most likely obliterated the old ones, and until now only vague traces of ancient quarrying are seen.

Limestone was also the key building stone in the Roman city of Jarash, Jordan (Abu-Jaber et al. 2007). By using simple classification schemes and petrographic examination the field surveys in the area revealed many quarry sites and linked them to the Roman buildings, thus uncovering a huge quarry landscape surrounding the city (Abu-Jaber op cit.). In this lies a tremendous potential for further research. Unfortunately, the survey also discovered the urgent need for protection of these sites, many of them being in acute danger of obliteration.

Leaving the limestones and the Romans for a while, to chert deposits in the Al Jafr area, Jordan, exploited from the Palaeolithic Period until the Bronze Age. In this case study, numerous quarries have been documented (Abu-Jaber et al. 2007b), as well as stone working sites and what appear to be ancient roads covered with debitage. Partly, the identification of the quarries came from the knowledge of the geological formations and the chert quality in different beds. Differentiation between the various beds was attempted applying SEM textural and trace element analyses. This study showed that while some overlap in texture and mineral inclusions exist between the various sources, it is possible to draw inferences that have not been reached before involving the sourcing of ancient chert in the region. Of course, this may have implications for future studies of artifacts.
Another important aspect of rock characterization is using scientific methods for understanding selection of resources and quarrying technology. Even subtle differences in composition may have been of crucial importance to the quarrymen. Although it is generally agreed that an important reason for quarrying the Chephren’s Gneiss may have been its aesthetic value, it may also be argued that the high-grade metamorphic fabric of the rock combined with the mineral composition made it extremely suitable for fine carving and polishing, thus being one of the most suitable raw materials that exists for the purpose of making decorative vessels and the life-sized sculptures of King Khafre (Heldal et al. 2007). Similarly, as pointed out by Grenne et al. (2008) textural differences in mica schist may have had “invisible” consequences for how millstones performed in a water mill, but learned from years of experience such differences may have caused a change of production from one part of a deposit towards another, or even to another and more remote deposit.

Summing up the rock characterization side of the case studies, it may be of general interest to draw some preliminary conclusions. The project has not generated any new methods on sourcing stone; this was not the intention anyway, there are numerous research projects going on covering this specific aspect of quarries, many of which come to the surface through the ASMOSIA. However, it has revealed some examples about how important the initial scientific characterization of the stone resources are for
identifying quarries (the source) and sheds light on the subtle but important variations within one quarry landscape and how rock characterization can contribute in constructing quarry landscapes. Even in cases where the characterization reveals a “non-existing” ancient quarry landscape – either because it is so deeply integrated in the buildings themselves or because it is obliterated by modern quarrying, it gives important input to the interpretation of stone production.

Stone as a commodity

When expressed as a commodity, “stone” (or “natural stone”) means any kind of rock that can be used as more or less shaped pieces, differing from other commodities of mineral resources where crushing and/or extracting key elements from the rock is a major task. The scientific characterization of the rocks, as described above, is useful for many reasons, but ancient as well as modern quarrymen were not particularly concerned about the geochemistry or origin of the rocks employed. Rather, what did concern them, was the workability and technical properties of the rocks. Hard or soft, brittle or less brittle, etc. Such properties are important to identify in order to understand how the resource itself impacts on the quarrying technology employed. As shown in Table 7, we can divide rocks into rather simple groups according to their working/quarrying properties. Although such a division is by no means standardized, it shines through most practical angled descriptions of modern stone production, and is fairly useful for interpreting ancient production as well.

**Massive stone** includes rocks that do not have closely spaced planar planes of weakness along which the rocks easily split into slabs. Thus, they are extracted as blocks of more or less uniform shape. We may subdivide them into hard rocks and soft rocks; basically, “hard rocks” are composed of minerals that are harder than steel, such as granite, quartzite and gabbro. “Soft rocks” are consequently composed of minerals softer than steel and/or poorly cemented rocks and include marble, limestone, porous sandstone, soapstone etc. In the present day stone industry, hard rocks are often collectively termed “granite”, whilst soft rocks, if polishable, are termed “marble”. Non-polishable soft rocks are usually termed with their geological names such as sandstone and limestone. Although confusing, particularly for geologists, this practical terminology reflects how rocks are viewed from the ones that are working and using them. As an example, the difference between silica-cemented and calcite cemented sandstone is (geologically speaking) minute. But regarding quarrying and processing, the contrast appears large, and will be displayed by completely different quarrying techniques. This aspect is striking in one of our case studies, the Aswan West Bank in Egypt (Heldal et al. 2007). Within the same geological formations, silicified sandstone not only differs from non-silicified ones in different quarrying methods, but also in having completely different applications.

**Cleavable stone** includes a variety of rocks that display closely spaced planar structures along which the rocks split easily. Thus, they are extracted as slabs, not blocks. Examples are roofing slate and flagstones for paving. **Rubble** basically includes any stone that is collected and used for any purpose without being further worked.
Table 7. Stone resources divided by physical properties

<table>
<thead>
<tr>
<th>NATURAL STONE</th>
<th>MASSIVE STONE (quarried as blocks)</th>
<th>“Hard” rocks</th>
<th>“Soft” rocks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Granite, gabbro and most other igneous rocks</td>
<td>Quartzite Chert Silica-cemented sandstone</td>
<td>Limestone Travertine Marble Calcite-cemented sandstone Gypsum (alabaster) Serpentinite Soapstone (steatite)</td>
</tr>
<tr>
<td>CLEAVABLE STONE (quarried as slabs)</td>
<td>Slate</td>
<td>True slate or any other thin-layered low grade metamorphic rock</td>
<td>Phyllite, schist, green schist or any other layered metamorphic rock displaying a spaced cleavage</td>
</tr>
<tr>
<td></td>
<td>Schist</td>
<td>Flagstone</td>
<td>Thin bedded sedimentary rock or thick-layered metamorphic</td>
</tr>
<tr>
<td></td>
<td>Flagstone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RUBBLE (collected)</td>
<td></td>
<td>Any available</td>
</tr>
</tbody>
</table>

Even more important to address, when it comes to practical perspectives on stone resources, is the question why the resources were selected in the first place. For what purpose was a specific rock quarried at a specific time? At present time, as in the past, the exploitation of stone resources can originate from different needs; of available building material, of particularly valuable stone for decoration, of high quality rocks suitable for specialised tools.

Again, there is no standardized terminology or set view on how to articulate such differences in a systematic way. However, it is not too controversial to establish some main “groups” – or rather perspectives, reflecting the purpose of use and consumption of stone resources, which can take us closer to articulate significance. From our point of view, this may be narrowed down to three such groups: building stone, ornamental stone and utilitarian stone (Table 8). It is important to underline that these categories are “extremes”, and that combinations may occur (Figure 2) as we will see from our case studies below, but even then this division may help us understand anomalies in the quarry landscapes.
We have used the term “Building stone” to include stone resources that were basically quarried to obtain construction materials for roads (paving) and buildings, i.e. the stone forms an integral part of the construction, and not primarily for decoration. “Masonry stone” is a term that is also used, but in a somewhat more narrow context (excluding for instance rubble for local housing) and “monumental building stone” even more restricted, to prestige buildings. A plausible model for describing why such resources were sought after may be found in a purely technical-economical perspective; easy available resources of “good enough” quality for the purpose. We may then argue that the “ideal” building stone is nearby, easy to quarry and work and sufficiently durable. Building stone quarry landscapes are thus often strongly linked to “cityscapes”.

“Ornamental” stone is, in a modern context, often defined as stone for decorative elements – or just decoration. It is important to note that the value of stone circulating in the international market has little to do with physical properties, but more with colour and structure. One may argue that this can be viewed solely as economical; supply and demand of more or less rare colours from a geological point of view. However, it is difficult to avoid the impression that the subjective value of “beautifulness” and thus fashion is a strong engine in today’s stone export. There is no reason to believe that such subjective values were not important also in ancient periods, and it seems fairly well established that colour was an important reason for the intensive trade of coloured and white marbles in Antiquity (Lazzarini 2004). Remoteness, or being difficult to obtain, may have been a value in itself, as also other aspects that made the stone unique or special compared with others (see Aston et al., 2000; Bloxam 2003). The key point is that such quarry landscapes are often disconnected in space with their consumption, and that much effort was often put into the exploitation of such important resources.

“Utilitarian” stone may be applied as the collective term for stone resources exploited for making domestic utensils, such as tools, weapons, grinding stones, millstones and whetstones. Such rocks were sought after basically because of their physical properties – e.g. their quality in production and use. It may be argued that in some cultures and periods symbolic values of utilitarian stone may have “overridden” the practical, thus blurring the difference between ornamental and utilitarian stone. Moreover, replicas of utensils may have been made of other stone materials, designed for display more than use (Cooney 1998). However, as a basic model, it seems valid to use “quality” as a key factor when investigating such quarries. Such quarry landscapes may have a wide variability; from local sources near settlements to huge “industrial” landscapes made from the exploitation of particularly important resources.

For funerary monuments, the choice of stone vary significantly according to cultural context, class/status and traditions. However, applying a commodity perspective may reveal such differences.
Table 8. Three extremes principles of viewing stone resources as commodities.

<table>
<thead>
<tr>
<th>Stone resources</th>
<th>Commodity (masonry stone)</th>
<th>Uses</th>
<th>Common rocks</th>
<th>Important aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building stone</td>
<td>Rubble walls</td>
<td>Sandstone</td>
<td>Limestone</td>
<td>Availability</td>
</tr>
<tr>
<td></td>
<td>Ashlar walls</td>
<td>Granite</td>
<td>Granite</td>
<td>Workability</td>
</tr>
<tr>
<td></td>
<td>Architectural elements</td>
<td>Gneiss</td>
<td>Gneiss</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roof</td>
<td>Marble</td>
<td>Marble</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Floor</td>
<td>Schist</td>
<td>Schist</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paving</td>
<td>Slate</td>
<td>Slate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(funerary)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ornamental stone</td>
<td>Sculpture</td>
<td>Marble</td>
<td>Marble</td>
<td>Aesthetic</td>
</tr>
<tr>
<td></td>
<td>Cladding</td>
<td>Granite</td>
<td>Granite</td>
<td>appearance</td>
</tr>
<tr>
<td></td>
<td>Floor</td>
<td>Div igneous rocks</td>
<td>Symbolic value</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Columns</td>
<td>Porphyr</td>
<td>Rarity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Funerary</td>
<td>Gneiss</td>
<td>Carving</td>
<td></td>
</tr>
<tr>
<td>Utilitarian stone</td>
<td>Tools</td>
<td>Chert</td>
<td>Physical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weapons</td>
<td>Volcanic rocks</td>
<td>properties</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grinding stone</td>
<td>Quartzite</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Millstone</td>
<td>Sandstone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Whetstone</td>
<td>Schist</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooking vessels</td>
<td>Soapstone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(funerary)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Stone commodity groups as overlapping perspectives.

How do these perspectives relate to our case studies? We have made an attempt of such classification in Table 9. Several of the case studies rest heavily into the building stone category, to the extreme in Ankara and central Sagalassos, where the quarries are located beneath the buildings which they provided stone for. But for other quarries at Sagalassos, these perspectives may contribute to diversifying the view of the evolution of quarrying activities. The strange location of the Ağlasun Dağları quarry (pink limestone) on the top of the mountain behind Sagalassos and thus logistically more challenging than similar “quality” but beige limestone in the city area (Degryse 2007b), may be explained by this resource being considered more desirable due to the colour and thus its “ornamental” features.
Similarly, why use stone from the “remote” (6 km) Sarikaya quarry (Heldal et al. 2007d) for building the Hellenistic temples, when the later Roman temples managed with the local limestone, although with decorative elements of other stones? Was it only due to a higher standard of technical quality (which is not obvious) or was the lighter colour of this limestone compared with the local one a key factor for its attractiveness? Also, the most remote stone source in the Sagalassos area, white recrystallized limestone from the Yarışlı quarry (Degryse 2007b) in the hills southwest of the plain of Burdur, were probably picked from its aesthetical "marble-like" appearance, and the white colour as well as the technical quality were probably the most important reasons for exploiting it (Waelkens et al., 2002). As this illustrates, the border between building stone and ornamental stone may be blurred, particularly when it comes to prestige buildings. Moreover, in some periods and cultural contexts the hunt for “rare” stone resources was less prominent than in others. During the Old Kingdom of ancient Egypt, the separation of stone resources used for different purposes was significant, as displayed in the Giza Pyramid Complex. Whilst local limestone resources were applied for the construction of the pyramids (“building stone”), “exotic” resources were brought from remote quarries for fulfilling the intended visual impact the complexes were meant to give (“ornamental stone”); the cladding of white Tura limestone and the red Aswan granite, the black basalt from Widan el Faras in the mortuary temple floors.

During later Dynasties, (e.g. New Kingdom and Ptolemaic Period) it seems that “ornamental” stone exploitation were mainly designated to sculptural elements in the architecture. Temples were made of local or semi-local limestone or sandstone, and decoration was added as inscriptions and reliefs on the masonry itself and not displayed by exotic stones. We may see a similar difference between Hellenistic and Roman use of stone. In the former case (as in Sagalassos) the merging of masonry and ornamental

<table>
<thead>
<tr>
<th>Building stone</th>
<th>Ornamental stone</th>
<th>Utilitarian stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jarash (Abu-Jaber et al. 2007b)</td>
<td>Masonry/ashlar</td>
<td>Decorative elements</td>
</tr>
<tr>
<td>Petra (Al Saad et al. 2007)</td>
<td>Masonry/ashlar</td>
<td>Decorative elements</td>
</tr>
<tr>
<td>Al Jaf (Abu-Jaber et al. 2007a)</td>
<td>Masonry/ashlar, rubble</td>
<td>Tools</td>
</tr>
<tr>
<td>Ankara Andesite (Caner-Saltik et al. 2007)</td>
<td>Masonry/ashlar, Decorative elements</td>
<td></td>
</tr>
<tr>
<td>Ankara Marble (Topal et al. 2007)</td>
<td>Masonry/ashlar</td>
<td>Decorative elements</td>
</tr>
<tr>
<td>Aksaray Tuff (Tavukçuoğlu et al. 2007)</td>
<td>Masonry/ashlar</td>
<td></td>
</tr>
<tr>
<td>Hittite limestone (Akoğlu et al. 2007)</td>
<td>Masonry/ashlar</td>
<td></td>
</tr>
<tr>
<td>Sagalassos (Degryse 2007a)</td>
<td>Masonry/ashlar</td>
<td>Decorative elements</td>
</tr>
<tr>
<td>Chephren’s Quarry</td>
<td>Masonry/ashlar</td>
<td>Vessels, sculpture</td>
</tr>
<tr>
<td>Aswan West bank (Bloxam et al. 2007)</td>
<td>Masonry/ashlar, rubble</td>
<td>Sculpture, decorative elements</td>
</tr>
</tbody>
</table>
quality seem to have been important, resulting in a quest for high quality white marble and “marble-looking” limestone. Although such marbles were still attractive in the Roman Period, rare stones with exotic colours were also highly valued for use in decorative elements.

Another obvious problem with such distinctive categories is the role of distance. A resource that is used as a local building material in a nearby city may be traded as “ornamental stone” throughout most of the Mediterranean region. The city of Aphrodisias in Anatolia, known for being a centre of marble sculpturing is largely built of white marble due to the simple fact that these valuable resources are the most available building stone in the area (Figure 3). Even more problematic is stone for funerary elements. In addition to historic and cultural context, the use of stone for such purposes strongly relates to class. To a larger or lesser extent, particularly desirable rocks were designated to the wealthy and/or powerful members of the society. This may be beautifully illustrated by the use of the Imperial Porphyry from the Eastern Desert in Egypt (Maxwell and Peacock 2001) for sarcophagi for the emperors. On a smaller scale, it is possible to see the same pattern in Sagalassos. Most of the sarcophagi scattered around the Necropoli in the city are made of limestone from onsite quarries (Heldal et al. 2007e), but a few are imported from more “valuable” marble quarries further away. However, one cannot directly correlate such import with status in the society, since this may have been expressed also by more elaborated funerary structures made of the local stone.

When it comes to Utilitarian stone, we have similar problems. When does a beautifully crafted stone tool made from prestigious stone move from being purely utilitarian to become an item of predominantly symbolic or “ornamental” value? What is the difference between the fantastically crafted hard-rock vessels of the Predynastic and the Old Kingdom primarily made for display and later periods soapstone cooking vessels? What is the difference between the production of grinding stone and statuette blanks in the silicified sandstone quarries at the Aswan West Bank (Bloxam et al. 2007)?

Thus, there are problems of simple commodity groups of stone resources, in some contexts more than others. However, using such divisions as perspectives when characterizing stone resources may still prove useful, due to the fact that the reasons for exploiting them show such large variability. Although many stone resources cannot be put solely in one group or the other, the three groups can be seen as the extreme, fundamental principles behind stone exploitation.
At the Aswan West Bank, we see these extremes well displayed. Silicified sandstone deposits have been exploited as tools in the Palaeolithic and as grinding stones from the Palaeolithic until the Roman Period (see Bloxam et al. 2007). The fundamental reason for this exploitation is utilitarian (domestic utensils). Thus, it is feasible to hook the quality aspects of the resource primarily, from a functional perspective, on its technical properties – suitability for the purpose. This provides an avenue to interpretation of the evolution of exploitation through time. Silicified sandstone was also (in some periods) exploited for prestige objects (statues and obelisks in the New Kingdom, columns and other small objects in the Roman Period). It seems clear that colour was an important driving force for these activities (Figure 4). In particular, yellow and purple varieties were quarried, while white, beige and rusty red were left in piece, even though the technical quality may have been similar. In the Dynastic periods, the “attractiveness” of these rocks was probably linked to solar symbolism (see later discussion and Bloxam et al. 2007). Viewing these resources as (periodically) particularly valuable (“ornamental”) due to their colour gives another entrance to interpret quarrying technology and logistics, and provide explanations to the differing quarrying methods. Not surprisingly, the obelisk extraction on the West Bank may have more in common with obelisk quarrying on the East Bank granites than with the other quarrying of silicified sandstone on the West Bank.

The few cases where there seems to be coexisting production of grinding stone and small ornamental objects made on the same technological platform provides yet another entrance to interpretation; the possible merging between the production of utilitarian and ornamental objects, blurring the separations between the two and raising the idea that the production of prestige objects on the Aswan West Bank had both “top down” and “bottom up” elements of social organization.

Parts of the sandstone deposits on the West Bank are not strongly silicified, and this minor geological difference from the silicified ones made them unattractive as utilitarian and ornamental stone, but highly usable as building stone, being much softer and easier to carve. From the Old Kingdom onwards, quarrying of such for monumental buildings in the area became an important part of the overall quarry landscape. Today, the same resources are being quarried as rubble for local housing.

Clearly, an early division of the sandstone resources at the West Bank into commodities became crucial for being able to characterise the quarry landscape. Although we here, as
in other places, see overlapping and differences in using strictly defined groups, the importance of continuously viewing the resources from different angles cannot be underestimated.

**Stone resources, landscape and quarry morphology**

The exposure of stone resources in the landscape is the result of multiple geological processes; from the formation of the rocks, through transformations of them through weathering and landscape forming processes. The geometry and outcropping pattern of the resource establishes the physical conditions of quarrying, to which quarrying methods to a large extent must be adapted. Consequently, it also represents the condition of how the morphology resulting from the transformation of the natural landscape by quarrying visually appears. Putting it on the edge, the human transformation of the landscape can be described as the morphology resulting from quarrying minus the resource’s occurrence in the landscape before quarrying was initiated.

Since quarrying is about removing pieces of rock from the landscape, being able to reconstruct the situation before quarrying is an important part of characterizing quarry landscapes. In the case of an underground quarry (gallery quarry) leaving a distinctive cavity in the resource, such interpretations may be easy to do. In many other situations, however, it is far more difficult. For instance, if the resource occurs as scattered blocks on the surface the resulting quarry landscape may be visualize as small, scattered heaps of debitage and spoil. Although the former may appear more visible and apparently larger, it is not necessarily more important or technically sophisticated. Numerous important quarries have been overlooked due to their invisibility.

A simple division of stone resource geometries, as appearing in the bedrock, is in five classes: layered (sedimentary, some metamorphic and volcanic rocks), massive (many plutonic rocks), veined (diabase and other dyke rocks, some travertine), lens (some metamorphic and igneous rocks) and irregular (not fitting the other categories). In addition, rocks can be exploited from superficial deposits, such as in situ boulder deposits, scree deposits and other deposits involving sediment transport (i.e. river beds). Depending on the initial situation, quarrying will develop differently, as shown in Figure 5 - Figure 11. In Table 10, we have related this to our case studies.
Figure 5. Principle drawings of resource geometry and resulting quarry situations, layered deposits
A simple case of a layered deposit is the basalt at Widan el Faras; this Oligocene lava flow, being more resistant to weathering than the underlying sedimentary rocks, caps the hills in the area as a distinctive layer (Figure 7). The Old Kingdom quarries occur as open cast quarries moving laterally into the layer from the edges of the escarpments. In a situation where the desirable layer is wholly or partly covered by other layers, one might see a situation where it is more convenient to move underground with quarrying (gallery quarries) than removing the cover, as seen in parts of the Gebel el Silila sandstone deposit (Figure 6f) and most limestone quarries along the Nile Valley (see Klemm and Klemm 1993). At Petra, one particular layer (or sandstone formation) was particularly sought for (Al Saad et al. 2007), and most quarries are situated in this. Several quarries have been initiated in the middle of steep cliff sides, creating overhangs (Figure 6b), and according to Rababeh (2005) this can be connected to the contact between the desirable layer and its cover: quarrying started at the contact and moved downwards and inwards.
Non-layered deposits can be put into four main groups: massive deposits are large bodies of exploitable rock, such as a granite intrusion. Typically, open cast quarries occur as clusters situated where the conditions for quarrying are best. The Aswan granite may serve as an example (Figure 9a). Vein shaped (or plate shaped) deposits are typically volcanic dykes (Figure 9b), but can also be sedimentary, such as some travertines. Lens shaped deposits usually occur in metamorphic terrains, and the soapstone deposits in the Eastern Desert of Egypt may serve as a good example (Figure 9c). The fourth group, irregular deposits, can be illustrated with Chephren’s Quarry, which will be described below.
Many quarrying activities have not exploited bedrock, but loose blocks made from weathering of the bedrock. Boulder deposits are formed in hard rocks by weathering over very long periods. Initiating along fractures, the weathering cycles gradually “peel off” shell by shell around the massive parts of the rock, “cut off” corners, and the result is in situ, rounded blocks loose from the rock mass (Figure 12). Particularly in igneous
rocks, this type of weathering creates easy exploitable deposits of stone. Also, boulder weathering may be described as natures’ own selection process, where the “surviving” boulders are made of the most sound parts of the rock. Chephren’s Quarry, Egypt, is a prime example of boulder deposits situated in irregularly distributed outcrops of anorthosite gneiss (Figure 11). The boulders formed a discontinuous layer on top of the bedrock surface, and during quarrying the working of them transformed the landscape to numerous pits made from circular spoil heaps around the empty space from which the boulders were extracted.

Boulder weathering is also common in the granite deposits in and near Aswan. The fact that they seem to be lacking in large areas, led Klemm and Klemm (1993) to assume that they may have been removed by quarrying, probably in the Old Kingdom. Later quarrying (New Kingdom) partly moved into the solid bedrock (i.e. unfinished obelisk quarry) perhaps due to improvement of quarrying techniques. Thus, the granite quarry landscape in that area may display an early layer of boulder quarrying and later ones in the bedrock as open cast quarrying (see sketch in Figure 13). The silicified sandstone on the West Bank also shows tendencies of boulder weathering, and there is evidence for assuming an evolution of quarrying starting (in the Palaeolithic) with exploitation of small boulders, then moving into larger ones and finally (in the Middle Kingdom) extraction from the bedrock.
Table 10. Resource geometry at QuarryScapes case studies.

<table>
<thead>
<tr>
<th>Layer</th>
<th>Vein</th>
<th>Massive</th>
<th>Boulders</th>
<th>Talus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jarash (Abu-Jaber et al. 2007b)</td>
<td>Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petra (Al Saad et al. 2007)</td>
<td>Open/covered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al Jaf (Abu-Jaber et al. 2007a)</td>
<td>Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankara Andesite (Caner-Saltik et al. 2007)</td>
<td></td>
<td>Thick layer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankara Marble (Topal et al. 2007)</td>
<td>Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aksaray Tuff (Tavukçuoğlu et al. 2007)</td>
<td>Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hittite limestone (Akoğlu et al. 2007)</td>
<td>Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sagalassos (Degryse 2007a)</td>
<td>Open</td>
<td>Thick layer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chephren’s Quarry</td>
<td></td>
<td></td>
<td>Massive</td>
<td></td>
</tr>
<tr>
<td>Northern Fayium</td>
<td>Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aswan West bank (Heldal et al. 2007a)</td>
<td>Open (sandstone)</td>
<td></td>
<td>Layered (silicified sandstone)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 13. Schematic illustration of a granite deposits with in situ boulders formed on top of it, and successive quarrying of boulders (middle) and later bedrock quarrying (lower).
Notes on fractures as a controlling factor in the resources

Another aspect of resource characterization is differences in quarrying quality within the resource itself. Independent of the other quality aspects described above, stone resources may be easy or difficult to extract at a given time employing a given technology.

Why was the basalt at Widan el Faras quarried for the Pyramid complexes, when there are similar basalt occurrences much closer? The most likely answer is the desire for rather large blocks, and most of the basalt deposits could not provide that due to dense fracturing. Thus, the chosen place may have been the closest possible were the density of the natural fractures was low and thus the block size sufficiently large (Bloxam and Storemyr 2002).

The spacing of natural fractures always defines the limit of potential block size. In cases where large blocks are desirable, like in the Widan el Faras case, the most massive part of the deposits is exploited while the fractured parts are left behind. However, fractures are also highly welcome boundaries of blocks, facilitating the quarrying by reducing the need of splitting, carving or other efforts of extraction. A fractured rock is thus simpler to quarry than a non-fractured. So depending on the aim of production and the available technology, fractures may be a friend or an enemy!

Fractures may help to understand the placement of quarries in Sagalassos. Due to the generally high degree of fracturing in the limestone deposits, there are few places where extraction of large pieces of rock is feasible, and the distribution of the quarries indicates that such “pockets” of massive rock were a prime target (Figure 14). Even within those most favourable places, there are few sites where the typical Roman extraction techniques in limestone (carving of channels) are seen, which most likely relates to the spacing of fractures being so dense that they became the boundaries of the extracted blocks.

Figure 14. “Pockets” of less fractured limestone ("good quality") in essentially highly fractured limestone ("poor quality"), Sagalassos
As said above, fractured rock can be an “easy” target of quarrying, but on the other hand the spacing of them limits the achievable block size. Thus, depending on the objective of quarrying and the technology involved quarrying may move in time from a fractured part of the deposit to the less fractured (see example in Figure 15), or vice versa.

Figure 15 Example of a situation where quarrying starts in a fractured part of the deposit (“easy target”) to the less fractured.

Notes on weathering

Rocks weather at different rates, depending on the nature of the rocks resistance to weathering, the local climatic conditions through various periods and exposure of outcrops to different types of weathering. And, of course, time. Characterization of weathering patterns in ancient quarries may be useful for several purposes. In the case of the Widan el Faras basalt quarries, the weathering after the Old Kingdom quarrying caused almost complete deterioration of the rocks (Figure 16c), leaving no visible traces of tool marks. Moreover, large blocks and even quarry faces are reduced to heaps of rubble. The pervasive weathering in the basalt makes the quarries difficult to recognise, and impossible to characterise tool marks and spoil heaps. Without the knowledge of the weathering processes these quarries are impossible to interpret.

Another aspect of weathering is relative dating; in some cases weathering may help in separating periods of quarrying, given that the exposure conditions and the rocks are comparable. At the Aswan West Bank, varying degree of weathering of silicified sandstone clearly aids the interpretation of relative age (Figure 16).
Analysing the resource

We have outlined the characterization of stone resources into aspects that we believe can aid the overall interpretation of quarry landscapes. The three main aspects are characterisation of the rocks, of the commodity and of the resource, as a controlling agent of quarry morphology and the transformation of the landscape. In short, Table 11 summarizes the features and classes, and Figure 17 illustrates how these aspects provide different avenues of interpretation. Below, we will walk through resource analyses for some of our Egyptian quarry landscapes, where detailed investigations of that have been carried out.
Table 11. Stone resource as an element and its features/classes.

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>FEATURES</th>
<th>CLASSES/EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESOURCE</td>
<td>Rock</td>
<td>See text</td>
</tr>
<tr>
<td></td>
<td>Commodity</td>
<td>Building stone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ornamental stone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utilitarian stone</td>
</tr>
<tr>
<td></td>
<td>Occurrence</td>
<td>Layered, open</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layered, covered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layered, combined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-layered, vein</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-layered, massive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-layered, lens</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irregular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boulders, layered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boulders, massive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scree/talus</td>
</tr>
</tbody>
</table>

As we have introduced above, the Chephren Gneiss is a hornblende-plagioclase gneiss which has been used for vessels found in funerary contexts and the statues of King Khafra. The provenance was quickly established after the location of the quarries in the 1930’s (Engelbach 1933, 1938). Not only does the gneiss appear attractive due to its colour and structure, but it is also very suitable for fine carving, having a granoblastic texture, low porosity and a low content of micro-fractures (Heldal et al. in press).

During mapping of the deposits and quarries, it appeared that the gneiss can be roughly divided into four subtypes (Table 12): Light speckled, light banded, light flamed and dark banded. The latter type remains unexploited, so obviously it was not found desirable. Concerning vessels, it seems that the most wanted type was the light speckled (Figure 18), while the statue quarrying targeted the light banded type. As we will see in a forthcoming chapter, the vessel quarrying thus focused in the western-central part of the deposit, and the statue quarrying in the eastern-central part.

So why these differences? If we view this from a purely geological/mechanical way, we may conclude that the speckled type was particularly favourable for thin delicate
vessels due to lack of a pronounced foliation which could more easily cause breakage of the vessels. Since the vessel quarrying started long before the statue quarrying, this leads to the conclusion that the statues had to be made from remaining large blocks in the area, which happened to be the ones not targeted for vessel quarrying. However, the difference may also be explained from an aesthetic point of view – that colour and structure played an important role for choosing subtypes of the gneiss.

Table 12. Subtypes of Chephren Gneiss and their application

<table>
<thead>
<tr>
<th>Rock subtype</th>
<th>Application</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light speckled gneiss</td>
<td>Vessels</td>
<td>Ornamental</td>
</tr>
<tr>
<td>Light banded gneiss</td>
<td>Statues, Vessels</td>
<td>Ornamental</td>
</tr>
<tr>
<td>Light flamed gneiss</td>
<td>Vessels</td>
<td>Ornamental</td>
</tr>
<tr>
<td>Dark banded gneiss</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

Figure 18. Varieties of Chephren Gneiss. A) dark banded, B) light banded (“statue type”), C) light speckled (“vessel-type”) and D) flamed (rare). To the right, statue of King Khafra and vessel.

The quarries at Chephren’s Quarry (more than 650 in number) are scattered over a wide area (roughly 60 km²)(Figure 19). This is controlled by the geological setting of the deposit: the gneiss occurs as inclusions in granite, thus the deposit occurs as numerous disconnected outcrops (Figure 20), of which most have been quarried. Only in situ boulders (as described above) have been exploited, and thus the quarry landscape appears as a large number of shallow pits spread out over a wide area. This is important as a background to the overall interpretation – the dynamics of quarrying and organization of it. What we see from the resource view is quarrying simultaneously over large areas.
The silicified sandstone of the Aswan West Bank has been exploited for Palaeolithic tools, grinding stones and statues/obelisks. Silicified sandstone occurs as irregular patches within a few layers of sandstone, essentially in the upper levels of the terrain. There are gradual transitions between silicified and non silicified sandstone. This, of course, had impact on quality and workability of the stone. The more silicified, the harder to work. For grinding stones, there seems to be a preference for intermediate types; not too soft and not too hard. This appears feasible; if the sandstone is too soft, it
will lose too many grains during grinding. At the opposite end, the hardest variety may have been too resistant, so that it was difficult to develop a smooth grinding surface. Thus, the degree of silicification seems to be the prime aspect for the location of grinding stone quarries, and not other properties, such as colour.

On the contrary, the ornamental stone quarrying (statues, obelisks, other) from the Pharaonic and the Roman Period seems to have been driven by colour, and the quarries are found in yellow, purple and multi-coloured varieties, some of them on the top end of silicification – being extremely tough to work. Thus, when viewing the distribution of quarries in silicified sandstone, the type of quarrying reflects the variation in the sandstones – mechanical properties targeted for grinding stone quarrying (no matter the colour), and colour in the ornamental stone quarrying (Figure 4, Figure 21, Table 13).

Table 13. Silicified sandstone subtypes and application

<table>
<thead>
<tr>
<th>Rock subtype</th>
<th>Application</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beige-white, weakly to moderately silicified</td>
<td>Grinding stone</td>
<td>Utilitarian</td>
</tr>
<tr>
<td>Red, moderately silicified</td>
<td>Grinding stone, (statues)</td>
<td>Utilitarian, (Ornamental)</td>
</tr>
<tr>
<td>Yellow, weakly to moderately silicified</td>
<td>Grinding stone, obelisks</td>
<td>Utilitarian, Ornamental</td>
</tr>
<tr>
<td>Multicolour, strongly silicified</td>
<td>Statues, grinding stone, Palaeolthic tools</td>
<td>Ornamental, Utilitarian</td>
</tr>
<tr>
<td>Purple, strongly silicified</td>
<td>Statues, (grinding stone)</td>
<td>Ornamental, (Utilitarian)</td>
</tr>
<tr>
<td>Black, strongly silicified</td>
<td>Palaeolthic tools</td>
<td>Utilitarian</td>
</tr>
</tbody>
</table>
When looking at the connection between the resource, morphology and quarry types, some interesting aspects may be seen. The geomorphology of the area reflects the varying resistance of the rocks to weathering. Silicified sandstone, being particularly resistant, caps the top of hills where present. In several areas, weathering and erosion have undermined silicified sandstones and removed the underlying strata. In such areas, silicified sandstones occur as collapsed, discontinuous block layers more or less in situ in the landscape. However, the further away from their initial stratigraphic position the blocks are found, the smaller in size and more rounded they are.

The areas with thick layers and large blocks of silicified sandstone can be defined as the "core area" for "high intensity" quarrying, including a substantial amount of bedrock quarrying and probably reaching its maximum during the New Kingdom. This is surrounded by a "marginal" resource area, containing smaller and more scattered occurrences of silicified sandstone and smaller blocks, which can be better described as "low intensity" or artisan type quarrying. These patterns may reveal chronological implications; small and distal boulders seem to have been the main target in the early days of quarrying (Palaeolithic to Predynastic?) while the later more intense quarrying activity focused on the central, large deposits. This, of course, has an important impact on how to forward significance for this quarry landscape, in that the least visible quarries are the oldest.

Figure 22. The Aswan West Bank, Southern part. Distribution of silicified sandstone quarries and geology. The quarries plotting outside the upper sandstone unit (yellow) are boulder deposits.
From these two examples and the others presented above, we may conclude that there are many more aspects of resource characterization than provenance studies; particularly, we believe that detailed investigation of the variability of quality and other properties within the exploited resource can provide crucial information to understanding the other features of quarrying. Moreover, the connection between resource, morphology and exploitation not only gives input to interpreting the process of quarrying, but also as a connection between the natural and cultural landscape.

**Production**

The resource/deposit is the input to a production process, and the more or less finished products being transported away from the quarry site is the output. In between there are one or more steps of work that can be described in a systematic way, particularly from the physical remains related to them.

In a previous report (Bloxam et al. 2007) we used “primary” and “secondary” extraction before the finishing process. This may be confused with “primary” and “secondary” production used in a range of contexts, from plant biology to business. Moreover, from the case studies it appears difficult to draw a border between the two that works for all of them. It thus seems more correct to use objective terms more directly related to the steps of production. We have tried to express that in Figure 24. Here, up to four steps (it may also be less) describe the quarrying process, moving from one step to another involves a change of method/technology.

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**Diagram Description**

- **Bedrock**
- **Large boulders**
- **Rounded boulders**
- **Small, rounded boulders**

**Figure 23. A possible exploitation model for silicified sandstone quarrying**

**Figure 24. One way of viewing production of stone in steps from extraction to finishing.**
The first step is here described as the extraction from bedrock applying various techniques, resulting in a block of stone, more or less shaped. The next step involves the reduction of stone blocks into a core, which may be defined as the “final” block from which the product(s) will be shaped. The core is further reduced into a semi-finished product (blank or roughout). Finally, the blank is finished.

It is important to take into consideration that in many quarrying situations there are less steps. For instance, in boulder and scree deposits, the quarrying process starts with the stone blocks (i.e. Chephren’s Quarry). Furthermore (for example Viking Age millstone quarrying in Norway; Grenne et al. 2008), the extraction actually involves direct carving of the blanks into the bedrock surface.

It is also important that in many cases the final finishing takes place far away from the quarries, and for characterizing the quarries it is important to establish how far the production went before the stones were taken to some other place. We know that the vessels or statues were not finished in the Chephren’s Quarry in the Old Kingdom, semi-finished blanks were transported to workshops (possibly at Giza) to be further worked there. In contradiction, the evidence is strong for final finishing of obelisks on the Aswan West Bank, down to the inscriptions on them, during the New Kingdom; such differences may tell us much about the social organization behind quarrying in different periods.

Below we will make an attempt of discussing each of these steps and how features in the quarries may define them.

**Extraction**

In all stone quarry situations the extraction phase is based on one or combinations of three fundamental principles (Figure 25, Table 14):

1. Levering; expanding open fractures by inserting levers, crowbars or stones
2. Splitting; creating fractures, preferable planar, by strokes (i.e. sledge hammer), wedging; heating or blasting with explosives
3. Channelling (carving); making channels in the rock by carving with hammer and chisel, pickaxe or stone tools, heating with fire, sawing or drilling

![Figure 25. Three basic principles of extraction from bedrock. A) levering, B) splitting and C) channelling.](image-url)
<table>
<thead>
<tr>
<th>Principle</th>
<th>Process</th>
<th>Tools</th>
<th>Toolmarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levering/extraction on fractures</td>
<td>Crack expansion</td>
<td>Logs, Crowbars, Stones</td>
<td>Hardly any</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Splitting</td>
<td>Percussion</td>
<td>Stone hammers/pounders, Chisel, Pick, Sledge hammer</td>
<td>Percussion marks, plumose marks on cracks</td>
</tr>
<tr>
<td></td>
<td>Wedging</td>
<td>Simple iron wedges, Plugs and feather wedges, Wooden wedges</td>
<td>Wedge marks of various shapes</td>
</tr>
<tr>
<td>Heating</td>
<td>Fire</td>
<td></td>
<td>Surface parallel flaking</td>
</tr>
<tr>
<td>Blasting (M)</td>
<td>Explosives</td>
<td></td>
<td>***</td>
</tr>
<tr>
<td>Channelling</td>
<td>Carving</td>
<td>Chisel, Pick, Stone tools</td>
<td>Straight parallel, Curved parallel, Pointed grooves</td>
</tr>
<tr>
<td></td>
<td>Sawing</td>
<td>Blade, Wire</td>
<td>Sawn surface, straight grooves, Sawan surface, curved grooves</td>
</tr>
<tr>
<td></td>
<td>Drilling (mainly modern)</td>
<td></td>
<td>****</td>
</tr>
<tr>
<td></td>
<td>Heating (mainly modern)</td>
<td>Fire</td>
<td>****</td>
</tr>
</tbody>
</table>

Levering may be described as the “simplest” way of extraction, involving the expansion of natural cracks or other planes of weakness (such as bedding planes) using various tools (Figure 26, Figure 27, Figure 28). Even though the basalt quarries at Widan el Faras are extremely deteriorated due to weathering, it is likely that the blocks were quarried by expanding natural fractures (Harrell and Bown 1995; Bloxam and Storemyr 2002) and that these rough blocks in essence were the products leaving the quarry site. Due to this type of extraction exploiting natural features of the rocks, quarries may be difficult to separate from the natural morphology (Figure 26, Figure 29).
Figure 26. Basalt quarries along the escarpment, Widan el Faras. The rocks are highly weathered and deteriorated.

Figure 27. Extraction at Widan el Faras; initial situation (left) and situation after extraction of blocks along natural fractures (right)

Figure 28. Expanding cracks with stones (A) – example from grinding stone quarry on the Aswan West Bank. B) primary block, C) secondary blocks after size reduction, D) blanks and spoil from trimming of blanks
Splitting may be defined as the act of generating new fractures for extracting rock. This may be done by percussion (stroke), inserting wedges of some kind in prefabricated holes or by heat\(^3\). In a modern context\(^4\), splitting is mainly done by detonating explosives in drillholes.

Although splitting from bedrock by percussion with heavy tools is rare to see (it is more common in block reduction) we have some examples in our case studies, particularly for extracting small pieces of rock (Figure 30). Wedging was a well introduced method in the Hellenistic Period (Chiotis and Papadimitirou 1995) and may have been introduced in Egypt as early as the Late Period. In the Roman Period, wedging was the predominant extraction method for hard rocks, and literally all Roman hard stone quarries display marks from wedging on the quarry faces (Figure 31, Röder 1965; Klemm and Klemm 1993; Maxfield and Peacock 2001; Peacock and Maxfield 1997).

Splitting by heating (fire setting) is a well documented method that was used already in the Mesolithic and Neolithic, primarily for generating shallow cracks sub-parallel to the quarry face (Figure 32). There is evidence of such quarrying both in granite and silicified sandstone quarries in Aswan (Heldal et al. 2007b).

\(^{3}\) Rocks expands to a different extent when heated, which causes the formation of cracks

\(^{4}\) In the Western world at least since the 17th century
Figure 30. Splitting from bedrock using stone hammers. Left: attempt of splitting. Right: split quarry face from above. Arrows point at percussion marks.

Figure 31. Splitting with wedges, Roman period. Left: silicified sandstone, Aswan West Bank. Right: large blocks of granite, Aswan.

Figure 32. Flaked and cracked rock surface made from splitting by fire setting. Aswan West Bank, silicified sandstone.
Although splitting techniques may be applied on most rock types, it is working best on hard siliceous (quartz-rich) ones. Partly because they in general display the most brittle behaviour, but also because it is a well documented fact (and experience among quarrymen) that siliceous rocks (granite in particular) have well defined preferred splitting directions defined by microfractures in quartz. Splitting by heating is caused by a combination of thermal expansion properties and brittle behaviour. To put this in short, brittle rocks that have a high linear expansion when heated crack. And again, quartz-rich rocks are considered to be the most willing, due to the well known but poorly understood change of mechanical properties of quartz when heated.

Channelling is the third fundamental principle. Channels in the rock are made by removing the rock mass by chiselling, picking, sawing or heating. In most soft stone quarries from the Bronze Age onwards, channelling is the most important extraction method. In most cases, channelling is combined with other methods. For instance, channels are made perpendicular to the natural layering of the rocks, and when the block is free on four sides, it is split with wedges (“trench and wedge” method; Walekens et al. 1988, 1990, 1992) or levers/crowbars inserted in chiselled grooves (“Minoan technique” according to Chiotis and Papadimitirou 1995) or by inserting wooden wedges in the channels themselves, creating shear stress along the block’s bases (Martin 1965, Rababeh 2005).

Evidence of channelling with stone tools is found in pre-iron age contexts in Egypt. During the New Kingdom this technique became particularly prominent in hard-stone quarrying. The most striking example is the Unfinished Obelisk in Aswan (Figure 33), where deep and wide channels are carved around the attempted obelisk block, still attached to the bedrock. The ruling idea about the extraction technique is that the channelling was carried out with dolerite stone hammers from the top of the block downwards (Röder 1965, Klemm and Klemm 1993). At the West Bank, we find basically the same tools and techniques applied on silicified sandstone extraction (Heldal et al. 2007). On the background of our own work in these quarry areas, we suggest that heating with fire may have played an important role in this hard stone channelling. The use of stone tools in channelling typically leaves a smooth surface with circular depressions on the quarry face, and corners tend to be rounded.
Figure 33. Examples of channelling in quarries. a) limestone in sagalassos (Roman), b) channels around sandstone blocks, Petra (Nabatean), c) channelling and levelling in granite, Aswan (New Kingdom) and d) channelling around the unfinished obelisk, Aswan (New Kingdom).

Quarrying of soft rocks by making channels using metal tools (chisel or picks) is described from numerous places and contexts. In Egypt it was commonly used since the Old Kingdom onwards (Klemm and Klemm 1993). On the Giza Plateau, the limestone quarries used for constructing the pyramids display a methodology which may be described as “trench and lever”; the channels are presumably made with bronze chisels (Aston et al. 2000, Arnold 1993) and asymmetric holes at the base of the limestone blocks seem to have been made for inserting logs for levering. Roman quarrying of limestone, sandstone and marble involved both the use of picks and/or chisels in the channelling, and then wedges were inserted to split the blocks loose. Such techniques are beautifully reconstructed by Bessac (1996). The final splitting may also be done by repeated blows with a chisel or pick along the base of the block until it cracks (see descriptions by Kozelj 1988).

Channelling with metal tools leaves parallel grooves on the quarry face that may differ in appearance depending on the rock type, tool and method of channelling (Figure 34). Parallel, curved grooves are often interpreted as pick marks, whilst parallel, straight grooves reflect the use of chisels (i.e. Klemm and Klemm 1993). Furthermore, the
inclination of the grooves tells us something about how the channels progressed; steeply inclined ones are worked from one side, horizontal ones are worked from the top, and “herringbone-pattern” reflects frequent change of position.

Figure 34. Tool marks on quarry faces. a) stone hammer marks on quarry face, silicified sandstone, Aswan West Bank (New Kingdom), b) inclined chisel marks on inclined shifts, sidewall of a channel in sandstone, Aswan West Bank (Graeco-Roman), c) assumed pick marks (curved shifts and changing directions) on a sandstone quarry face, Petra (Nabatean), d) inclined chisel marks and horizontal shifts, marble quarry, Thassos (probably Byzantine)

Blade sawing of rocks, even basalt and granite, were applied since the Old Kingdom (Petrie 1883, Moores 1991). As a method in channelling, however, it may not have been applied until modern times, although sawn blocks are observed in Roman quarries (Harrell and Brown 2002). Wire sawing was introduced in marble quarrying in the 19th century. Channelling by heating alone (jet burning) was common in quarrying of siliceous rocks from the 1950s until recently.

**Block reduction**

This stage starts with more or less shaped blocks extracted from the bedrock or natural blocks in boulder and scree deposits. Essentially, it is the process of transforming an initial block into one or several smaller blocks defining the “core” from which the final product will be shaped (Figure 35). Although sometimes extracted blocks are so close to the final product that none or only minor further working is needed. Reduction of blocks
may be described basically in the same way as extraction; e.g. splitting with percussion, splitting with wedges (Figure 36), splitting with heat (fire setting), sawing or carving.

Figure 35. Principle of block reduction to core.

Quarrying in Chephren’s Quarry starts with block reduction, from the natural boulders. The first stage seems to be removal of the outer shell of weathered rock on the block surface. This was done by hammering on the surface until shells fell off, or (particularly in the case of statue quarrying) lifting the blocks on top of a stone layer and fire set from below to initiate surface parallel cracks separating weathered from non-weathered rock. The next step was to divide the blocks and/or remove large pieces from the edges. This step was carried out by percussion with heavy pounders (up to 30 kg) to initiate cracks.

Figure 36. Roman work area in silicified sandstone, Aswan West Bank, displaying remains from block reduction by wedging.

Although not very spectacular, the process of block reduction is well illustrated in a small grinding stone quarry at Gebel es Sawan North, Aswan West Bank (Figure 28). After levering the primary blocks, they were split in two equal parts perpendicular to the
sedimentary layering. Each part was then turned and split again along the layering into cores of approximately equal thickness (the same thickness as the final grinding stone blanks).

**Semi-finishing and finishing**

The term “semi-finishing” may not, at first glance, seem very well chosen; why construct a division between that and finishing? However, in most cases the “products” leaving a quarry site are not ready to use. They are “blanks”, “roughouts” or “dressed blocks” (see examples in Figure 37, Figure 38, Figure 39) which in many cases are brought to a workshop or a building site where the completion of them takes place. An ashlar may be finished to the point of its dimensions and rough shape in the quarry, but the final working for fitting it with others and making a smooth surface was mostly carried out at the construction site (Aston et al. 2000). The degree and process of finishing (or lack of it) in the quarries clearly tells us a lot about the organization of stone production. If the products actually were finished to completion in the quarries, such as the obelisks in Aswan, it tells us that all the organisational layers of people involved in stone working were present at the site. The fact that other dynastic ornamental stone quarrying in the same area did not complete the object finishing in the quarries tells us that there is a difference in organization, perhaps within the same period. Was it a particular case of organization of obelisk quarrying in the New Kingdom that deviated from other contemporary quarrying activities, even for ornamental stone in the same resources?

The cases we have from the Old Kingdom, all of them in some way linked to the pyramid sites, witness that only roughouts or even rough blocks left the quarries. The vessel blanks and statue blocks of Chephren’s Quarry can be described as rough “containers” in which the shape of the final product fits (Figure 37). The basalt blocks brought away from Widan el Faras were not even that but irregular probably more shaped by the natural fractures in the rock than by man. No Old Kingdom quarry of the Aswan granite is preserved, but from the irregular surfaces of the granite blocks cladding the Menkara pyramid we may conclude that the blocks were not finished before they reached the pyramid complex 900 kilometres from the quarries. Jumping to the Roman quarrying in the Eastern Desert of Egypt, we find bathtubs and columns brought to a high level of finishing (Figure 39). It is known from large excavations that large settlements and infrastructure were associated to the Roman quarrying (Peacock and Maxfield 1997), whilst the Old Kingdom sites only display evidence of small groups of people in temporary camps (Bloxam 2003, Bloxam 2007a and see below). Combining this evidence, it is tempting to suggest that ornamental stone quarrying in the Old Kingdom was more a temporary activity to get suitable raw material for workshops, even if the location was as remote as the Roman desert quarries.

The question of finishing or not in the quarries thus depends on several factors that usually fall into the realm of economic and functional explanations: on the one hand it is important to avoid costly transport of excess stone and stone with failures that may break at a later stage of finishing (which lead Arnold (1991) to conclude that hard stones were mostly finished in the quarries). So, at least production in the quarries must
be brought to a level of good knowledge of the quality of the blanks. On the other hand, complete finishing in the quarries requires more skilled people and longer production time. The way this is balanced depends on the cultural context to which the quarries belong and to distance from infrastructure and permanent settlements.

The working of a core or block to a blank or roughout involves the removal of small pieces of rock, either by carving techniques (dressing) or flaking (trimming). In Chephren’s Quarry, the vessel blanks are made from cores by using small hammer stones or hand axes. Statue blocks are dressed by using pounders to level and smooth the rock surface.

Figure 37. Chephren’s Quarry blanks. Statue blank (left), stockpile of vessel blanks (right)
Figure 38. Aswan West Bank blanks and finished products. a) grinding stone blanks, b) Palaeolithic stone tool roughout, c) stele or lintel blank, d) statuette blank, e) statue blank and f) Seti 1 obelisk tip – finished in the quarries.
Notes on tool characterization

Stone tools were frequently used in quarrying, particularly of hard rocks, before the Iron Age. Fragments of discarded tools commonly occur in the quarries and they can provide important information about the production process. Pounders (or stone hammers) are found in most Egyptian hard stone quarries from the Dynastic and Pre-Dynastic Periods (Figure 40, Figure 41). These are usually spherical to sub-spherical pieces of varying size, depending on the purpose of use. Large, 20 kilos pounders may have been used for splitting in block reduction, and small ones for trimming or levelling surfaces. Pounders are made from hard rocks and it seems that the less brittle ones (quartz-poor) were most desired (dolerites, gabbro, metamorphic mafic rocks). In some instances other types of stone tools have been applied in the production process, including rod-shaped hand hammers (Figure 40a) chisels and drills (Figure 42). In addition to identifying types of stone tools and sizes, it is important to establish where they come from (provenance) and how they have been manufactured. We will discuss stone tool provenance (as secondary resources to the quarrying) in a forthcoming subchapter, so here we will just briefly show some examples from the Egyptian case studies. At these sites, many of the pounders found are collected from natural deposits of rounded cobbles or blocks, such
as river beds or weathered boulder deposits. Others have been manufactured, varying from roughly shaped discoid pounders to elaborate "sledge hammers" of stone.

Figure 40. Stone tools, Chephren's Quarry. A) broken pounders and hand-axes/hammers, b) large diorite pounder, c) small pounder of the Chephren gneiss itself

Figure 41. Examples of pounders. Left: granite cobble stone from the river bed, Aswan West Bank. Middle: manufactured granite pounder, Chephren's Quarry. Right: hafted stone hammer made of imported rock found in Widan el Faras Basalt quarries

Figure 42. Stone tools at the Umm es Sawan gypsum quarries. Left: crescent drill made of chert. Right: “hammer” made from chert and “chisel” made from silicified wood
Spoil characterization

Spoil (or rock waste) may be defined as the lithological leftovers from the quarrying. Each of the steps above leaves behind spoil material characteristic of that specific process. Ideally, a quarry that displays many steps of production involving changes of techniques will have a variegated “construction” of spoil heaps, while quarries with few steps and/or a single technique of working will have a uniform composition. Also, if all steps in the production are carried out in one place, the spoil will be mixed and perhaps display a cyclic vertical stratigraphy. Likewise, if movement from one step to the other involves physical movement of the blocks or cores, we may see a lateral separation of characteristic types of spoil – i.e. “extraction spoil” with large fragments and “work areas” containing fine debitage. Such perspectives have an important impact on the interpretation of the social organization of quarrying (Bloxam 2003).

Characterizing the spoil fragments includes describing fragment size, size distribution, shape and tool marks on them. In the ideal Roman limestone quarry, exploiting a massive resource with few natural fractures, carving would be the dominating rock-removing technique, leaving small fragments of spoil from all the steps involved. Likewise, a Roman granite quarry involving splitting in the extraction and block reduction and thereafter carving, will display extremely variegated spoil from the first two steps (including large block fragments) and fine debitage from the last. On the Aswan West Bank, spoil characterization gave us the first clue about the grinding stone production before we found the blanks; the uniform size of spoil from block reduction indicated that the quarrying targeted small objects and not statues or obelisks (Figure 43).

Figure 43. Spoil heaps in grinding stone quarry, Aswan West Bank. Note the uniform distribution of fragment sizes, which in itself indicates that small products of uniform size were targeted.
Characterization of the horizontal and vertical spoil stratigraphy is important for interpreting the evolution of a quarry and relative dating of events in it. When horizontal movement is a strong aspect of a quarry (for instance when quarrying a layer of valuable stone) the quarrying will leave behind a trail of spoil heaps, the oldest (beginning of quarrying) farthest away from the remaining quarry face. If the quarrying involves an overall downwards movement (level by level) the spoil heaps surrounding the quarry will display a cyclic vertical stratigraphy.

Spoil heap shapes and their relationship with the quarry faces are important to characterise. In Figure 44 three hypothetical situations are shown. The first one is a situation with contemporary extraction along a wide quarry face, resulting in an elongated spoil heap following parallel to the face. The second situation shows a similar long quarry face, but with quarrying one place along the face at the time. The result is half-moon shaped spoil heaps concentrically related to the focal point of quarrying. The last situation may illustrate well the one we see in Chephren’s Quarry (Figure 45) and many of the grinding stone quarries on the Aswan West Bank; a central focal point of quarrying (one or a cluster of boulders) resulting in a circular spoil heap around the quarry.

The spoil heaps in quarries are excellent places for the preservation of material culture; in an active quarry the deposition rate is much higher than any non-catastrophic geological process, which leads to capture and preservation of charcoal, ceramics, tools etc. The massive amounts of charcoal in New Kingdom silicified sandstone quarries was the first lead for suggesting the use of fire in the production process. In Dynastic contexts, the spoil heaps are also the places were one find fragments of tools, broken tools and of course unfinished and broken objects. By putting together observations of tools and object fragments it is possible to reconstruct what objects were produced in a quarry and which tools and technology were applied.
Figure 45. Two examples of large quarries at Chephren’s Quarry; the Khufu stele Quarry (top), being predominantly for statue blocks, and the Chisel Quarry (below) which was exploited for vessels only. The outer circle of spoil heaps in both cases is detritus from soil and weathered rock, basically from excavating the boulders. The inner circle of spoil consists of fragments from block reduction and trimming.

Analyzing the mechanics of production

Interpretation of the production processes and the elements related to it forms a basic platform of knowledge for “building” the larger concept of a quarry landscape and its significance. As we have seen, the production process can be broken up in several steps, and each of them, or how they group together, may be the key factor that makes a quarry unique or representative for a specific historical context. Although there are now “calibrated scale of technology” that provide an exact dating of a quarry on the basis of technology alone, there are distinguishing features in all cultural-historical contexts that are more or less diagnostic, as addressed by Klemm and Klemm (1993), Bessac (1999), Kozels (1988).

When combining the datasets into a schematic illustration of the production process, it is useful to look at some contrasting examples from our case studies, and a few from other places we recently have worked.
Regarding production, *Widan el Faras* is a rather simple case of basalt production Table 15, particularly when dealing with the Old Kingdom part of it. Here, the rough blocks of basalt, quarried with rather simple means by levering and exploiting natural fractures, were the “products” brought away from the quarries. This interpretation is partly made from studies of the actual basalt floor in front of the pyramids, being composed of well fitted irregular blocks. The final shaping andfitting must have taken place there. Due to the immense weathering in the quarries (all the blocks and quarry waste have disintegrated to small cobbles) we do not see tool marks or have any chance of performing studies of the spoil. In the table below, the simplicity of basalt production is visualised in that the whole production may be put in the “extraction” column. The most striking aspects of Widan el Faras are thus not the quarries themselves, but the logistics for transporting the blocks and the technology of fitting them at the pyramid complexes. This will be addressed later.

**Table 15. The production process in the Widan el Faras basalt quarries, Northern Faiyum quarry landscape,**

<table>
<thead>
<tr>
<th>Widan el Faras</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td>Levering, using natural fractures</td>
<td>No evidence</td>
<td></td>
<td></td>
<td>Irregular basalt blocks</td>
</tr>
<tr>
<td>Spoil</td>
<td>No evidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>Shafted hammer stones</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output from process</td>
<td>Irregular blocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In *Chephren’s Quarry*, it is convenient to separate the vessel quarrying from statue quarrying; even though these are largely contemporary, there are differences in the production which is important to identify. Both activities “start” with block reduction5, since the resource initially was clusters of loose boulders. In the vessel production Table 16, the blocks are first “cleaned” of the weathered crust, probably by simply hammering on the surface for releasing surface parallel flakes. For splitting the blocks, heavy hammer stones (pounders) were applied, probably repeatedly struck along the line of splitting. After producing a core roughly of the size of the vessels, this was shaped by trimming with small pounders and elongated “hand-hammers”, resulting in the vessel blanks.

---

5 Although after detachment from the soil
Table 16. The production process in Chephren’s Quarry, vessel production

<table>
<thead>
<tr>
<th>Chephren’s Quarry, vessels</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td></td>
<td>Flaking block surface, splitting</td>
<td>Trimming (percussion of edges)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spoil</td>
<td>Mixed, blocky</td>
<td>Chips and flakes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>Heavy stone hammers</td>
<td>Light stone hammers, hand axes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output from process</td>
<td>Core blocks for vessels</td>
<td>Vessel blanks</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the statue production (Table 17) the picture is rather similar, but deviates on the reduction side and the semi-finishing. There is some evidence of charcoal deposits beneath built-up statue blocks, and this seems to be the result of fire setting during the initial stage of quarrying. Most likely, the heating of the blocks helped remove loose weathered rock and to discover “hidden” cracks in them. A rough treatment, but it may have saved a lot of time consuming splitting and carving. After exposing the solid core of the blocks, splitting of edges and corners, they were further dressed with pounders to their final shape and size, in which the life sized statues would fit.

Table 17. The production process in Chephren’s Quarry, statue production

<table>
<thead>
<tr>
<th>Chephren’s Quarry, statues</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td></td>
<td>Flaking block surface, splitting</td>
<td>Dressing block surface, trimming edges</td>
<td></td>
<td>Statue blank</td>
</tr>
<tr>
<td>Spoil</td>
<td>Mixed, blocky, thin flakes</td>
<td>Small pieces ofdebitage and sandy powder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>Heavy stone pounders, fire setting</td>
<td>Light stone hammers/pounders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output from process</td>
<td>Core block</td>
<td>Statue blank</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The production process in the obelisk quarries in Aswan (both granite and silicified sandstone) appears completely different in our scheme (Table 18). Firstly, there is no reduction process at all, the extraction was all about making channels around the blocks until they could be broken loose from the bedrock. Thus, the output from the extraction was the “blank”, probably dressed on all sides before breaking it loose, except the lower. As mentioned above, the process of channelling is not completely understood, but clearly it involved the use of hand-held pounders. The massive amount of sandy powder from the channelling in the spoil clearly confirms this. It is furthermore interesting to note that at least some obelisks were mostly completed down to the
inscriptions on them before they were transported. Evidence of that is found on the West Bank – the inscribed tip of the Seti 1 obelisk at Gebel Gulab, used grinding stones in the quarries and stratified layers of fine powder from grinding.

Table 18. The production process in New Kingdom obelisk quarrying in the Aswan area

<table>
<thead>
<tr>
<th>Aswan obelisk</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td>Splitting, Channelling</td>
<td>Dressing</td>
<td>Grinding, inscriptions</td>
<td>Ground and inscribed obelisk</td>
<td></td>
</tr>
<tr>
<td>Spoil</td>
<td>Blocky from splitting, powder from channelling</td>
<td>Sandy Powder</td>
<td>Fine powder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>Stone pounders, fire</td>
<td>Stone pounders</td>
<td>Grinding stones, stone chisels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output from process</td>
<td>Obelisk blocks</td>
<td>Dressed obelisk block</td>
<td>Ground and inscribed obelisk</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Less spectacular (although extremely important) are small quarries – or “tool floors” from Palaeolithic tool production on the Aswan West Bank (Table 19), exploiting scattered small boulders and cobbles of silicified sandstone. These blocks were either used as “core” for further flaking as they occurred in nature, or bigger ones were split in smaller parts. The production process thus involved two steps; collecting natural “cores” or reducing the blocks to cores, and the flaking (mainly levallois) from cores to rough-outs of scrapers, handaxes, cleavers etc. The tools are quartz pebbles collected in nearby fossil riverbeds.

Table 19. The production process in Palaeolithic tool quarries, Aswan West Bank

<table>
<thead>
<tr>
<th>Palaeolithic tools</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td>Splitting, trimming</td>
<td>Flaking</td>
<td></td>
<td>Flake (tool roughout)</td>
<td></td>
</tr>
<tr>
<td>Spoil</td>
<td>Small flakes</td>
<td>Small flakes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>Quartz pebbles</td>
<td>Quartz pebbles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output from process</td>
<td>Core</td>
<td>Flake (tool roughout)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Grinding stone production on the Aswan West Bank shows interesting patterns of variation through time. The earliest grinding stone quarrying, first described by Roubet 1989, involved few steps (Table 20), exploiting clusters of naturally occurring blocks of silicified sandstone – up to one metre in size. Block reduction involved splitting by percussion with stone tools. Thereafter, the resulting cores were trimmed by removing small scales from its surface until a more or less regular shape was produced. Finally, the perimeter of the grinding surface was “retouched” with finer tools producing a grinding stone blank.

As shown in the tables below (Table 20, Table 21, Table 22), the semi-finishing step of grinding stone production basically remained the same all the way up to the Roman Period. The blanks were never completely finished in the quarries, final fitting and
possibly smoothing the grinding surface were carried out elsewhere. The first production steps, however, varies, most likely chronologically. It seems that in the Predynastic and Early Dynastic periods, larger blocks were extracted from their in situ position in the silicified sandstone layers by levering, followed by at least two steps of block reduction (Table 21). In the New Kingdom, some quarries display extraction of small blocks directly from the bedrock by heating (fire setting), each of these being worked to one grinding stone blank (Table 22). These are just some examples, but they illustrate the difference between the grinding stone quarries (more sophisticated extraction) and (not least!) the similarity – how the methods of producing the blanks remains the same for thousands of years.

Table 20. The production process in Palaeolithic grinding stone quarries, Aswan West Bank

<table>
<thead>
<tr>
<th>Palaeolithic grinding stone</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spoil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output from process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 21. The production process in early stage of Dynastic grinding stone quarrying, Aswan West Bank

<table>
<thead>
<tr>
<th>Early(?) Dynastic grinding stone</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spoil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output from process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 22. The production process in New Kingdom grinding stone quarrying, Aswan West Bank

<table>
<thead>
<tr>
<th>New Kingdom grinding stone</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td>Splitting of large flakes by percussion and heating</td>
<td>Trimming Retouching along edges</td>
<td></td>
<td></td>
<td>Grinding stone blank</td>
</tr>
<tr>
<td>Spoil</td>
<td>Blocky</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>Stone hammers, fire</td>
<td>Cobble hammer stones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output from process</td>
<td>Core</td>
<td>Grinding stone blank</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Many of the quarries in our case studies are “soft” stone quarries, either limestone or sandstone, and they display similar techniques of quarrying, namely channelling and wedging. We may use a building stone quarry at the Aswan West Bank to illustrate this (Table 23). The extraction is characterised by channelling (in this case with chisel) around the wanted ashlar blocks, before they are split loose with wedges along the sedimentary bedding plane. The ashlar blocks were almost ready to transport after extraction, but probably some minor dressing was carried out before they were.

Table 23. The production process in building stone quarries, Aswan West Bank

<table>
<thead>
<tr>
<th>Aswan sandstone</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td>Channelling and wedging</td>
<td></td>
<td>Dressing</td>
<td></td>
<td>Ashlar blanks</td>
</tr>
<tr>
<td>Spoil</td>
<td>Chips, flakes and some blocky</td>
<td></td>
<td>No evidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>Hammer/chisel wedges</td>
<td>No evidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output from process</td>
<td>Ashlar blocks</td>
<td>Ashlar blanks</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Similarly, far away from Egypt, we see channelling with picks displayed in a Viking Period millstone quarry in Hyllestad, Norway (Grenne et al. 2008); the channels were carved round the perimeter of the actual millstone blanks, and only minor work was needed after they were split loose (Table 24). Thus, in these two examples we see that the extraction process alone almost produced the more or less finished products. This is strikingly different from the later period Selbu millstone quarry (19th Century). Here, the extraction is done with the use of explosives (for extracting rough blocks). The blocks are reduced by wedging to the desirable size, and then carved in more or less the same way as the previous example, before the millstones are finished (dressed). Even though these two quarries have basically the same output (millstones) the Selbu production process involves more steps than the Hyllestad one, and most likely more specialisation towards one of the steps among the working team members.
Table 24. The production process in a Viking Period / Medieval Norwegian millstone quarry (Hyllestad, West Norway)

<table>
<thead>
<tr>
<th>Hyllestad rotating millstone</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td>Channelling and splitting by percussion</td>
<td></td>
<td></td>
<td>Dressing, carving centre hole</td>
<td>Millstones</td>
</tr>
<tr>
<td>Spoil</td>
<td>Chips and flakes</td>
<td></td>
<td></td>
<td>Chips</td>
<td>Hammer/chisel</td>
</tr>
<tr>
<td>Tools</td>
<td>Pick, Hammer/chisel</td>
<td></td>
<td></td>
<td>Hammer/chisel</td>
<td>Hammer/chisel</td>
</tr>
<tr>
<td>Output from process</td>
<td>Millstone blanks</td>
<td></td>
<td></td>
<td>Millstones</td>
<td></td>
</tr>
</tbody>
</table>

Table 25. The production process in a 19th Century millstone quarry at Selbu, Central Norway

<table>
<thead>
<tr>
<th>Selbu rotating millstone</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td>Drilling/Blasting</td>
<td>Wedging</td>
<td>Channelling and carving of millstones</td>
<td>Dressing, carving centre hole</td>
<td>Millstones</td>
</tr>
<tr>
<td>Spoil</td>
<td>Blocky, flakes</td>
<td>Chips</td>
<td>Chips</td>
<td>Hammer/chisel</td>
<td>Hammer/chisel</td>
</tr>
<tr>
<td>Tools</td>
<td>Hand drills, Explosives</td>
<td>Pick, Hammer/chisel</td>
<td>Hammer/chisel</td>
<td>Hammer/chisel</td>
<td>Hammer/chisel</td>
</tr>
<tr>
<td>Output from process</td>
<td>Blocks</td>
<td>Cores</td>
<td>Millstone blanks</td>
<td>Millstones</td>
<td></td>
</tr>
</tbody>
</table>

The last example is from Sagalassos (sarcophagi quarries near the necropolis). The local limestone is rather fractured and probably it took some efforts to get big enough blocks for producing sarcophagi. The extraction thus combined channelling with wedging and using natural fractures. The blocks were reduced primarily by wedging, and then dressed to roughouts (Table 26). Most likely, the sarcophagi were finished at the site of quarrying.

Table 26. The production process in Sarcophagi quarries at Sagalassos

<table>
<thead>
<tr>
<th>Sagalassos sarcophagi</th>
<th>Extraction</th>
<th>Block reduction</th>
<th>Semi-finishing</th>
<th>Finishing</th>
<th>Product (output from quarry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Process</td>
<td>Levering (natural cracks), Channelling and wedging</td>
<td>Splitting by wedges</td>
<td>Dressing</td>
<td>Carving</td>
<td>Sarcophagi</td>
</tr>
<tr>
<td>Spoil</td>
<td>Blocky</td>
<td>Blocky</td>
<td>Chips and flakes</td>
<td>Chips</td>
<td>Hammer/chisel</td>
</tr>
<tr>
<td>Tools</td>
<td>Hammer/chisel, pick, wedges</td>
<td>Hammer/chisel, pick, wedges</td>
<td>Hammer/chisel</td>
<td>Hammer/chisel</td>
<td>Hammer/chisel</td>
</tr>
<tr>
<td>Output from process</td>
<td>Rough blocks</td>
<td>Dimensioned block</td>
<td>Sarcophagi roughouts</td>
<td>Sarcophagi</td>
<td></td>
</tr>
</tbody>
</table>
As we have seen above, the production process varies much from quarry to quarry, and also in the quarrying of the same type of products in different periods. By splitting the production process into several steps, it is possible to visualise differences that have implications for the interpretation of the organization of quarrying. The number of steps involved in the production may indicate increased complexity of the organisation. Thus, in the case of Chephren’s Quarry (two steps with essentially the same tools) the production evidence points in the same direction as the material culture – namely that the quarrying was carried out by small teams (Bloxam 2003).

In Table 27, we have summarized the features and classes related to production characterization.

Table 27. Features of production in quarries.

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>FEATURES</th>
<th>CLASSES/EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODUCTION</td>
<td>Quarry morphology</td>
<td>Open cast</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gallery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trench</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pit</td>
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<tr>
<td></td>
<td>Quarry face</td>
<td>Collecting</td>
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<tr>
<td></td>
<td></td>
<td>Levelling</td>
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<td></td>
<td></td>
<td>Splitting</td>
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<td></td>
<td></td>
<td>Splitting by Wedging</td>
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<tr>
<td></td>
<td></td>
<td>Carved channels</td>
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<tr>
<td></td>
<td>Tool marks</td>
<td>Carving marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wedge marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trimming marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Retouch marks</td>
</tr>
<tr>
<td></td>
<td>Tools</td>
<td>Stone tools – pounders</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stone tools – axes</td>
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<tr>
<td></td>
<td></td>
<td>Stone tools – hammers</td>
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<tr>
<td></td>
<td></td>
<td>Metal tools</td>
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<tr>
<td></td>
<td></td>
<td>Wooden tools</td>
</tr>
<tr>
<td></td>
<td>Spoil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Work areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Objects and object blanks</td>
<td></td>
</tr>
</tbody>
</table>
Logistics of quarrying

The transport of stone blocks and products is an important element of all quarrying activities. Clearly, the production of small objects that can be carried by a man or a donkey does require less constructed infrastructure than huge obelisks. However, whatever the output of the quarrying was, the remains of elements related to transport are important to characterise. Again, we have chosen to categorize these remains by dividing them into processes: internal logistics (inside the quarry until finishing/semi-finishing), stockpiling and loading, overland transport and quay/harbours/waterways. As shown in Figure 46 this approaches a quarry as a logistical system composed of several steps.

**Figure 46. Ideal situation of the logistical system in a quarry.**

**Internal logistics**

The internal logistics in a quarry may be defined as all transport between the production steps described above, and from the final step to a place of stockpiling or specific loading area if that exists. Depending on the pattern of production and the outcome of it,
the internal logistics between the production steps may include constructed features or not. The need for less constructed infrastructure may indicate that products leaving the quarry were small, but may also indicate that the ground surface had natural load bearing potential.

Simple examples of internal logistics are found in Chephren’s Quarry (Bloxam 2003)(Figure 47). Statue blocks were dressed where they were found and then moved on sometimes roughly paved roads towards a loading ramp (Figure 48). The loading ramps are themselves made of spoil fragments, and in this particular case, constructed when it was clear that finished blocks actually would be produced. Vessel blanks, not needing internal road constructions or loading ramps, were placed in stockpiles outside the quarry where they were collected and loaded, probably onto animals for further transport. On the other hand, there are indications that the finishing of the blanks took place in specific work areas into which the “cores” were brought.

Figure 47. Two examples of large quarries at Chephren’s Quarry; the Khufu stele Quarry (top), being predominantly for statue blocks, and the Chisel Quarry (below) which was exploited for vessels only. The first case shows internal, paved roads leading towards a loading ramp, from which the statue blocks were transported to the Nile on some sort of vehicle. The lower case shows no internal roads (due to the small size of the products) but stockpiles of vessel blanks in the outskirts of the quarry close to a track leading away from it.
A slightly more complicated pattern is seen at the Widan el Faras basalt quarry. Each quarry is situated on the edge of an escarpment and it seems likely that the blocks were tumbled down the slope and brought further on a distributionary network of paved roads leading to a central stockpile, from which the blocks were loaded onto more permanent transport vehicles (Figure 49) (Harrell and Bown 1995; Bloxam and Storemyr 2002). Although not displayed well in our case studies, the lowering of blocks from tall quarry faces and the lifting of blocks from deep trench quarries may be important parts of the internal logistics. One author (Rababeh 2005) suggests that ashlar blocks made in steep quarries at Petra were tumbled down on sand pillows; more sophisticated lifting devices are described from several quarries from the Graeco-Roman Period and also in a number of other contexts.
Overland transport

In many quarry landscapes, the logistical system for the transport of heavy stone products can constitute the most visible features in the landscape, and could even have been the most effort-demanding side of the quarrying process. But even if the transport systems are less visible, such as for less heavy stone products, they are not necessarily less important, and may contribute with important information about the exploitation in general. In a few cases, even the complete lack of visible overland transport systems may prove significant in determining geomorphology and climatic conditions – such as transport of millstones from a remote quarry landscape in Norway; they were brought from the mountains down to permanent settlements on sledges on the snow in the winter time (Grenne et al. 2008) thus not leaving any trace on the terrain at all. At Chephren’s Quarry the absence of a purpose-built road to transport large blocks overland, perhaps over 20 km, suggests that the Old Kingdom ground surface had suitable load-bearing potential (see Bloxam 2003).

Characterization of roads and paths

Basic characterization of roads and paths can be done from how they are made; a road can be paved or not paved, built-up or not. The definitions as given in Table 28 may not cover all aspects of transport, but have proved useful in our case studies and will likely cover most quarry-related overland transport.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Classes</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>Paved road</td>
<td>Road with a surface of (stone) pavement</td>
</tr>
<tr>
<td></td>
<td>Non-paved road/earth road</td>
<td>Road with a cleared and/or smoothened surface on the natural soil</td>
</tr>
<tr>
<td></td>
<td>Hollow road</td>
<td>Road defined by a semicircular depression made by repeated use for transport of goods</td>
</tr>
<tr>
<td></td>
<td>Rock cut road</td>
<td>Road that is carved in the bedrock</td>
</tr>
<tr>
<td>Causeway</td>
<td></td>
<td>Built-up structure made for evening out topography</td>
</tr>
<tr>
<td>Slipway</td>
<td></td>
<td>A worn path made from sliding stone blocks down from one level to another</td>
</tr>
<tr>
<td>Ramp</td>
<td>Loading ramp</td>
<td>Built-up structure made for loading stones onto a vehicle of transport</td>
</tr>
<tr>
<td></td>
<td>Terrain ramp</td>
<td>Built-up structure that connects one level of topography with another</td>
</tr>
<tr>
<td>Path</td>
<td>Footpath</td>
<td>Single path resulting from repetitive use by people and/or animals</td>
</tr>
<tr>
<td>Track</td>
<td></td>
<td>Multiple paths resulting from repetitive use by people and/or animals along a route</td>
</tr>
</tbody>
</table>

On the Aswan West Bank, there are extensive road systems connected to Dynastic ornamental stone quarrying (including the Seti 1 obelisk quarrying). As shown in Figure 50 and examples in Figure 51 and Figure 52 (Bloxam et al. 2007) these can be characterized in a few groups. Paved roads constitute the major part of the dynastic
network. They are generally constructed by laying of a single level of stones directly onto the ground surface. The paving stones may be uneven or flat, depending on the local availability of materials. On the top of the hills (in and near the quarries) the stones used are predominantly quarry waste rock, and they are often angular and irregular in shape. In some of the wadis, more regular slabs of sandstone are applied where such resources are within the immediate vicinity of the road. The paved roads are most common on horizontal to weakly inclined surfaces, e.g. on the top of the hills, on terraces and in the wadis.

Cleared tracks of assumed dynastic age are found on some smooth and hard horizontal surfaces, presumably where paving was considered not necessary. Both the cleared and the paved roads may have an alignment of stones on the edges, the function of which is not clear. Several ramps which traverse the steeper slopes are constructed from several layers of stones to overcome the topographical irregularities of the steep incline down to the desert plateau. The causeway that leads from the main obelisk extraction site is a substantial structure, principally constructed to traverse a wadi. Considerable labour and expertise was put into its construction, as amply demonstrated by its good preservation. At its widest the causeway is almost 20 m across with a depth of at least 3 m, then narrows to just 4.3 m, where it converges into a paved quarry road that heads in the direction of the Nile. This causeway was clearly constructed to facilitate the transport of obelisks during the New Kingdom.

Collectively, the construction of Dynastic quarry roads of the Aswan West Bank provide an important input to the interpretation of how the transport of heavy stone blocks was carried out in these quarries. A puzzling aspect is the irregularity of the paved surface in many places (Figure 52), as well as the complete lack of wear marks on the surface; this may indicate that the paving primarily was made for stabilising the surface and not for providing a direct subsurface for transport vehicles (sledges). In other words, that “rails” or other “runners” were used in between the paving and the vehicles.

![Figure 50. Types of road constructions seen on the Aswan West Bank](image-url)
Figure 51. Quarry roads at the Aswan West Bank. Top: New Kingdom paved road with edge alignments leading down from Gebel Gulab. Middle: New Kingdom built-up ramp on a steep slope at Gebel Gulab. Lower: steep Dynastic ramp and Roman road, Gebel Gulab.
Figure 52. Paved quarry roads, Egypt. Left: New Kingdom, Aswan West Bank. Right: Old Kingdom, Northern Faiyum, leading from Widan el Faras to the ancient harbour by Lake Moeris

Figure 53. Left: Roman quarry road, carved in bedrock, displaying deep wear marks from vehicles, Evia, Greece. Right: paved quarry road from the marble quarries at Mount Pentellikon, Greece.

Similar aspects characterize one of the world’s oldest purpose-built paved roads, the 11 km Old Kingdom quarry road that links Widan el-Faras with Lake Moeris (see Harrell and Bown 1995: 79). It represents a major achievement in road building of the 3rd millennium BC using a range of locally available raw materials, such as fossilised wood, basalt, mudstone and sandstone (Harrell and Bown 1995: 78-83; Bloxam and Storemyr 2002: 29-31). (Figure 52). In the absence of any wear marks on the roads’ surface there is still much speculation as to the type of vehicle used to transport basalt along it. Although wear-marks on paved roads (or rock cut roads)(Figure 53) from the Greaco-Roman period are commonly seen and indicating use of wagons and/or sledges directly on the paved surface (e.g. Martin 1965). At the Aswan West Bank, the roads directly related to the Roman quarrying are not paved, but display wear suggestive of wheel marks.

As mentioned above, in Chephren’s Quarry the sizes of the statue blocks quarried during the Old Kingdom are comparable with those of Widan el Faras, but the logistics appear completely different; there are no traces of paved roads used in overland transport. This may be due to the natural surface being more suitable (no need for constructing roads) and/or different transport vehicles. The latter is supported by the observation of deep parallel grooves made in front of tall loading ramps (Figure 48), suggesting the use of rather tall, sledge like vehicles directly on the soil (Bloxam 2000; Bloxam 2003; Bloxam 2007a).
The quarrying of small objects may not require much built infrastructure as transport may be done using donkeys (as today in Egypt) or even by men. In the grinding stone quarries at the Aswan West Bank there are no roads directly connected to the quarries, but numerous fragments of footpaths that may or may not be remains of the transport system.

**Roads and topography**

Another aspect in the characterization of quarry roads is how the roads are situated in the terrain. Also this aspect is well illustrated at the Aswan West Bank; the Dynastic quarry roads tend to subside the “shortest route” down from the hills, involving built-up ramps down the steepest slopes. Consequently, the sloping of the roads was not a key factor for the means of transport used in that period, whatever it was. The Roman roads, however, climb sideways downhill, reflecting a need of reducing the slope angle, which again might indicate that wheeled vehicles were used (Figure 51).

**Cairns, wells and other features**

In addition to the roads and tracks there are many other features that may be directly related to stone transport. Often harder to see, but no less significant in terms of understanding stone transport logistics from quarries, are the man-made cairns that often demarcate unpaved tracks. For instance at Chephren’s Quarry, cairns located in prominent places on hill tops and at embarkation points in the quarries function as sightlines that demarcate the main stone transport route to the Nile. Hence, the location of such features is key to determining function. In some instances prominent landmarks with cairns that have additional material culture associated with them, such as votive objects and epigraphic data may additionally characterise a special place in a landscape. For instance at Stele Ridge in Chephren’s Quarry, cairns associated with votive objects and enclosures in a highly visible location characterises this area as a place where ritual practices may have been conducted as well as being an embarkation place (Engelbach 1933: 70-74; Bloxam 2006). Shelters may define resting places, and temporary dwellings and wells may define overnight stations. The scattered temporary settlements and wells between Chephren’s Quarry and the Nile make perfect sense when viewed as a part of the quarry logistic (see discussion below).

Particular features may be related to moving blocks or vehicles containing them; for instance, piles of stone found at regular intervals along some Roman quarry roads (Maxfield and Peacock 2001, Peacock and Maxfield 1997) and postholes in rocks along the roads as anchoring points.
**Quays, harbours and waterways**

Waterways are indeed important in stone transport, and in many cases the overland transport is following the shortest route to the nearest waterway. Key aspects to look for and characterize are quay constructions, fixing points for boats, remains of cranes and other lifting devices (Sodini et al., 1980; Peacock, 1997), lost objects and ballast stone. Although not very relevant in our case studies, the latter may provide important information about trade routes (provenance of the ballast stones).

In our case studies, the most visible structure of significance is the “dry” harbour downhill from Widan el Faras, where the basalt blocks were loaded onto ships during the Old Kingdom quarrying campaigns, leaving a “Quay” area with stockpiles of basalt blocks. This quay, now many kilometres inland from today’s shores of Lake Moeris, witnesses the higher level of the ancient lake (Harrell and Bown 1995; Bloxam and Storemyr 2002, Bloxam 2003).

**Analysing the logistics**

As pointed out above, one of the key questions of stone transport is how it was done. Thus, an important aspect of analysing the logistics is whether or not the logistic elements provide evidence of such. As we have shown, the Dynastic road systems at Widan el Faras and Aswan have features in common that do not give us an absolute explanation of the means of transport, but they give us some limitations of choice. From these observations, it seems likely to suggest that the kind of transport vehicle employed was not running directly on the paved surface (Harrell and Bown 1995). So, if wooden sledges were applied (as indicated by several depictions and described by numerous authors; i.e. Clarke and Engelbach 1930) they may have slid on wooden rails or runners. Likewise, although there are few preserved “roads” in Chephren’s Quarry, the loading ramps and the carved tracks in front of them say something important about the vehicle employed (Bloxam 2000; Bloxam 2003).

In other contexts, there are several studies of transport of stone, particularly from the Graeco-Roman periods. Carts transporting building blocks were probably a common view along the roads in the Roman Period. For more heavy stone products, sledges have been applied up to modern times, and were for instance applied for transporting marble from Mount Pentelikon to Parthenon (Martin 1965). Specially designed wagons may have been used for transporting giant columns through the eastern Desert in Egypt to the Nile (Peacock and Maxwell 1997, Maxwell and Peacock 2001).

The other key question is where the stone was transported. In the case of Widan el Faras, the question has a simple answer; we have a quarry, a paved road, a quay, and waterways to the Giza Plateau where the stone evidently was used (Harrell and Bown 1995; Bloxam and Storemyr 2002; Bloxam 2003). At the Aswan West Bank, however, quarries from different periods and for different purposes are overlapping each other and so the overall picture is complex. But when putting together the logistical elements that, through the detailed characterization, have been connected to each other, we see systems of logistics from different quarrying operations. This is illustrated in Figure 54. Here, we have separated the Pharaonic quarrying of ornamental stone (obelisks, statues) from that of the Roman Period. In the former case, we see a “draining” system of roads...
leading down to two harbours along the Nile. In the northern part of the area (“Khnum Quarry”) there are several quarries containing unfinished obelisk bases and statues. However, there is a complete lack of roads in this area, indicating that no large stone objects were taken away from the quarries. This halt of production (particularly obelisks) may coincide with the death of Seti 1.

The Roman quarrying was far less extensive and partly the old logistic system was reused. However, it seems that the Roman road system all points towards the southern harbour. However, a wide desert road (El-Deir road) from the Roman Period passes through the area, and part of this may also have been used for transport of stone.

In Sagalassos, one of the important aspects in analysing the logistics is the feasibility and costs of transporting stone from some of the sources involved. What was the difference in efforts in bringing stone from some of the more remote quarries compared to the local ones in the city? As pointed out above, the quarry in pink limestone at Ağlasun Dağları was considered desirable due to its colour. The quarry is situated high above the city, and apparently at a logistically difficult location. However, transport will not have posed too many problems. The quarry was located very close to existing infrastructure - the Roman road leading to the city from the north. Even if for the first hundred meters of this road the blocks had to be carried upslope, the rest of the way descended towards the city.

The stones quarried at Sarıkaya could also have been relatively easily to transport to the city over an earth track which probably connected it to Sagalassos (Waelkens et al., 1997). However, no traces of paved roads, ramps or tracks have been observed. Hence, drawing any conclusions as to the direction that the stone was transported from the
quarry is subject to some speculation. It is likely that dray animals would have probably hauled the loads and after survey a possible route (Figure 55) can be suggested that links to a pre-existing road into Sagalassos. Sarikaya is situated approximately 3.5 km as the crow flies from Sagalassos. The distance covered over the suggested route is approximately 5.8 km. The maximum altitude difference along this road is approximately 120m, Sagalassos being the highest point. This height difference of 120 m over a distance of ca. 5.8 km did not cause any major problems when it came to transporting normal sized building blocks over good roads. The larger distance and the differences in height to be conquered undoubtedly made the transport of the Sarikaya stone more expensive, but it will still have been rather modest when compared to the transport costs of some of the imported building stones. The ancient connection with the Burdur plain, furnishing the white recrystallised limestone to Sagalassos, covers a distance of almost 40 km through mountainous terrain (Waelkens et al., 2000). Even more prohibiting was the transport costs of the marble from Aphrodisias and Dokimeion (Waelkens et al., 2002).

Figure 55. Proposed transport route from the Sarikaya Quarry to Sagalassos.

This brings us to perhaps the most important aspect of logistical analysis, from a functional and economic perspective: efforts and costs. In Classical antiquity, overland transport of stone was costly. The huge cost of the transport of the products of Mons Claudianus and Mons Porphyrites in the Egyptian Eastern Desert, for example, made these stones the preserve of the emperors, not only socially, but also economically (Adams 2001). During the Roman Empire luxurious stones were transported over large distances as much as possible by ship, keeping transport costs as low as possible (Ward-Perkins, 1971; Ward-Perkins, 1980). The imperial price-edict of Diocletian (301 AD) makes clear that the cost of stone in the Roman world was mainly due to their transport, and not to their intrinsic worth. For example, Docimeian marbles, Turkey, which were quarried several hundreds of kilometres from the Mediterranean, cost five times as much (200 denarii per square foot) as a comparable stone quarried close to the sea (e.g. Proconnesian marble at 40 denarii per square foot; Waelkens et al., 2002). Similarly, we
may suggest that in our Old Kingdom sites, Chephren’s Quarry and Widan el Faras, the logistics were perhaps the most resource-demanding activity in the quarrying process, in the former case illustrated by that a large part of the material culture found in the quarry landscape relate to the transport of stone (see below).

Features and classes related to the logistic element of quarries are summarized in Table 29.

Table 29. Element of logistics and features/examples

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>FEATURES</th>
<th>CLASSES/EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOGISTICS</td>
<td>Roads</td>
<td>Paved road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-paved road/earth road</td>
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<tr>
<td></td>
<td></td>
<td>Rock cut road</td>
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<td></td>
<td>Hollow road</td>
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<td>Ramp</td>
<td>Loading ramp</td>
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<td>Terrain ramp</td>
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<td></td>
<td>Causeway</td>
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<td></td>
<td>Slipway</td>
<td></td>
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<td></td>
<td>Track</td>
<td></td>
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<tr>
<td></td>
<td>Path</td>
<td></td>
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<tr>
<td></td>
<td>Stockpile</td>
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<tr>
<td></td>
<td>Vehicle tracks</td>
<td>Carved</td>
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<tr>
<td></td>
<td></td>
<td>Wear</td>
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<tr>
<td></td>
<td>Harbours</td>
<td>Quay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Product remains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ballast</td>
</tr>
<tr>
<td></td>
<td>Stone features</td>
<td>Cairn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other stone structures</td>
</tr>
<tr>
<td></td>
<td>Carved features</td>
<td>Postholes</td>
</tr>
</tbody>
</table>

The Social Context: identifying and characterising the social infrastructure in ancient quarry landscapes

Extrapolating the social context through which ancient quarrying was expedited is key to understanding the extent to which transformations, particularly to large-scale exploitation of a resource, impacted on social relations. Written sources such as epigraphic data associated with quarrying at the source, as well as historical texts that can relate to practice, are one key data source. Other sources are the built structures linked to dwellings for the work force, ceramics and other associated artefacts that comprise the quarry infrastructure and for the purposes of this chapter will be termed the ‘social infrastructure’. The table (Table 30) shows key elements of the ‘social infrastructure’ that might be found across an ancient quarry landscape, from built features to epigraphic data, from which an assessment of the social context can be made.
The aim of this chapter is to discuss how we can visualise and characterise these datasets at a micro-level and develop methods to interpret this evidence.

Table 30. Elements of social infrastructure, features and examples from several quarry landscapes.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Class/examples</th>
<th>Eastern Desert, Egypt</th>
<th>Lower Nubia, Egypt</th>
<th>Northern Faiyum, Egypt</th>
<th>Aswan, Egypt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mons Porphyrites</td>
<td>Chephren’s Quarry</td>
<td>Widan el Faras</td>
<td>Umm es Sawan</td>
</tr>
<tr>
<td><strong>Stone-built features</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent settlements</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ephemeral dwellings/shelters/work places</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>?</td>
<td>X</td>
</tr>
<tr>
<td>Storage</td>
<td>X</td>
<td>X</td>
<td>?</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Wells</td>
<td>X</td>
<td>X</td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearths</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Ritual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defensive</td>
<td>X</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Domestic artifacts/organic remains</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ceramics</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Tools/grinding stones</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Faunal/floral remains</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Epigraphic data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inscriptions/graffiti</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rock art/petroglyphs</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Examples taken from ancient quarry landscapes in Egypt will illustrate key areas under discussion, derived from recent survey and excavation of key sites undertaken by members of ‘QuarryScapes’ before and during the project. As comparative analysis is important to interpreting empirical data, examples from ancient quarry landscapes across the Eastern Mediterranean and elsewhere will be used to highlight certain key points.

**Stone-built features**

Identifying and characterising the ‘social infrastructure’ within a quarry complex as a means to interpret the social organisation of quarrying can be problematic, given that such remains are usually fragmentary and difficult to visualise. The problem in visual terms is that easily recognisable large purpose-built settlements associated with ancient quarries, the key remains to make inferences into the social context, are the exception rather than the rule. The large purpose-built quarry settlements of Mons Claudianus and Mons Porphyrites in the Eastern Desert of Egypt are such an exception and which tend to be largely a phenomenon of the Roman Period (Peacock and Maxfield 1997; Maxfield and Peacock 2001) (Figure 56). Hence, in the search for dwellings for quarry labour forces prior to the Roman Period, much emphasis has been placed on the
ubiquitous ‘stone circles’ or ‘stone enclosures’ that occur in a number of ancient quarries in Egypt, as being places of habitation (see Shaw 1994, Harrell and Bown 1995).

Figure 56. Remains of the largest settlement at Mons Porphyrites

Occurring either as scatters of one to several levels of dry-stone walls, or as clusters built around natural rock outcrops, recent excavation of such features in a range of ancient quarries of the Egyptian Dynastic Period has led to a greater understanding of the variety of functions that can be attributed to these structures. In essence, functions that can be applied to these features can range from temporary dwellings to ritual features and so adding significant layers of information, previously unrecognised, as crucial to understanding the social context and construction of an ancient quarry (see Bloxam and Shaw 1999; Bloxam 2003; Bloxam 2007a; Bloxam et al., in press). Chephren’s Quarry in Lower Nubia, Widan el-Faras in the Northern Faiyum and the Aswan West Bank are key ancient quarry landscapes that show the visual diversity of these features and below are used as case studies to enable identification and determination of function.

A benchmark in how the function of these common stone-built features may be interpreted has come largely from excavations conducted at Chephren’s Quarry and have formed the basis for subsequent comparative analysis (see Bloxam and Shaw 1999; Bloxam 2003; Bloxam 2007). In addition, survey of the Aswan West Bank during QuarryScapes has added significantly to the identification of function, in the absence of excavation, through location and association with other material remains. Below, the diversity of these stone-built features will be discussed to build a broader framework in how the ‘social infrastructure’ of a quarry landscape can be characterised.
Chephren’s Quarry

Chephren’s Quarry defines an area of quarry workings that cover approximately 100 km² south of Wadi Tushka and 65 km northwest of Abu Simbel in the Western Desert of Upper Egypt (also known as Lower Nubia). Chephren’s Quarry is the source of the famous blue Chephren Gneiss used for royal statuary and vessels of the Old Kingdom (Figure 57). In the now hyper-arid conditions that prevail, the landscape is represented by flat deflated surfaces, interspersed with low-hills, with varying depositions of aeolian sand. Hence, the stone-built features relating to ancient infrastructure associated with quarrying at Chephren’s Quarry can usually be visualised on the surface. However, they can also be partially obscured by aeolian sand, particularly at low levels and where they are exposed to the prevailing north-west wind (Figure 58).

Figure 57. Life sized statue of King Khafra and vessel (lower photo)
The stone-built features of Chephren’s Quarry are largely concentrated within two main areas of Chephren gneiss quarrying at Khufu Stele Quarries and Quartz Ridge; and in two locations outside of the main quarrying complexes along the transport route that connects the quarries with the Nile (Figure 59). Khufu Stele Quarries represent a key area of Old Kingdom quarrying for large statue blocks linked to royal acquisition of Chephren Gneiss during the 3rd-4th Dynasties (see above). There is negative evidence of remains that may have characterised an extensive enclosed settlement in this area, despite road building in the area during the 1990s. Only partial remains of single-level stone-built features near the road can be visualised at Khufu Stele Quarries. Excavation of the undisturbed areas of these stone-built features that form a small cluster, revealed thick ashy layers with pits in which intact Old Kingdom (3rd to 5th Dynasty) bread moulds were found (El-Senussi 2003) (Figure 60). Hence, function associated with these stone-built features was mainly linked to food production, in particular bread baking. Nearby a stone-built feature exposed on the surface by a circular (single-level) stone wall (Figure 61) with a diameter of 1.75 m was excavated to reveal a meticulously constructed subterranean feature, 1.2 m deep, that was entered into by a sloping pathway. Comparative analysis revealed function to be connected with accessing shallow groundwater via two artificially-cut channels, 20 cm wide by 30 cm, in the base of the feature (Figure 61). The identification of this as a ‘walk-in’ well was key and also allowed for an immediate characterisation of this type of feature from other stone-circles seen in other parts of the quarry landscape (Bloxam 2003). The significant implications of this in terms of how we can re-construct the social organisation of ancient quarrying and gain insights into the climate and environment, will be discussed later.
Figure 59. Map of Chephren’s Quarry and distribution of stone-built features.

Figure 60. “Bakery” – excavated area displaying ash layers and small pits in which intact Old Kingdom (3rd to 5th Dynasty) bread moulds were found
It became clear from these observations that Khufu Stele Quarries and the stone features represented here did not characterise the key area of settlement we had been expecting. However, 4 km north at Quartz Ridge, another area of stone-built features, largely undisturbed, can be visualised as a scatter of circular and oval constructions. These features comprise between one and three courses of *ad hoc* dry-stone walls with diameters of no more than 4 m (Figure 62) (Bloxam 2003; Shaw and Bloxam 1999). These elements are highly visible and concentrated across an exposed quartzite escarpment rising 10 m above the desert plateau. Ceramics scattered inside and outside of these features, organic remains and other associated artefacts had suggested to previous researchers that this represented an area of ‘occupation’ during the Old Kingdom and Middle Kingdom (Engelbach 1933, 1938; Murray 1939).

After excavations were carried out here in 1999 and 2000 the archaeological expectations, in terms of specifying Quartz Ridge as the probable ‘main’ settlement, had to be revised. This was based on the absence of living floors in some of these features and scant evidence of domestic artefacts (Bloxam et al., in press; Bloxam 2003). Scatters of Old Kingdom ceramics from storage vessels outside an area of interconnecting rooms (later re-used in the Middle Kingdom) suggests these features may have functioned as storage places for provisioning the work force. This interpretation is also linked to the location of Quartz Ridge at the terminus of a main transport route, given that man-made cairns form the most visible landmark across otherwise flat desert plateau (Bloxam 2003; Shaw and Bloxam 1999) (Figure 63). (see map Figure 59). A sightline of cairns beginning at Quartz Ridge was key to identifying
a 10 km section ancient track along which, spaced at 4 km intervals, two camps comprising the most tangible evidence of habitation were located (Bloxam 2003; Bloxam 2007; Bloxam et al., in press).

Strategically placed about 500 m from the main track and discreetly nestled into the slopes of low hills, the construction of the camps varies significantly from the other stone-built structures observed at Chephren’s Quarry described above. Characterised by a semi-circular dry-stone wall 1.5 m high by 70 cm thick enclosing an area of approximately 50 m², partial excavation revealed that one-third of each camp was devoted to food production, in particular bread making (Figure 64). Bread-moulds embedded in a thick ashy layer and dating between 3rd to 5th Dynasties (El-Senussi 2004: 1) formed the bulk of the pottery, quantifiably the largest corpus found anywhere across the quarry landscape (Figure 64). Some other domestic equipment such as grinding stones, plates, bowls and deposits of faunal remains showed that these were key places where the labour force temporarily resided, but probably only a small number (less than 30) (Bloxam 2003; Bloxam 2007a; Bloxam et al., in press). Each camp is associated with one or more shallow walk-in groundwater wells, bearing similar diagnostics to that described at Khufu Stele Quarries (Figure 65). Another type of stone feature, unrepresented anywhere else, was constructed to facilitate the watering of animals (Figure 66). Hence, we have been able to deduce a significance difference between wells constructed for human use, as opposed to those for animals.
Figure 64. Camp and food production area along the transport route. Upper right corner: close up of *in situ* bread moulds.

Figure 65. Walk-in well. Note pottery between the two stones in the lower right corner.
In summary, the stone-built features at Chephren’s Quarry demonstrate the diagnostic range of such structures and variety of functions that may be attributed to them. Visualising the nuances in the construction of such stone-built features, their location and association with other artefacts and features, is key to interpreting function in terms of how we construct aspects of the social context from this evidence. At Chephren’s Quarry we see that individual stone walled features, usually meticulously constructed and located at the lowest ground levels are wells. Highly visible areas where there are stone-built features that often form inter-connecting rooms linked to a transport route can often represent storage places. Single large enclosure walled features, usually in sheltered and discreet places, tend to represent places of food production as well as temporary dwellings.

**Widan el-Faras**

The present ground surface at Widan el-Faras is highly deflated, due to the action of the constantly prevailing north-west wind, so the stone-built features of the site remain clearly visible on the desert surface. Two areas of stone-built features have been identified, each comprising a single-level basalt ‘stone circles’. The largest area is situated close to the basalt quarries at the base of the escarpment and the smallest is located 500 m to the south, close to the quarry entrance at Wadi Ghorab (Harrell and Bown 1995; Bloxam and Storemyr 2002) (Figure 67). As the largest area of stone circles, 275 m long by 11 m wide and spanning the ancient road is located close to the quarries, previous research had immediately assumed this to be the ‘Main Quarryman’s Camp’ (Harrell and Bown 1995: 77-8) (Figure 68). Estimates made in the early 1990s suggested that the Main Quarrymen’s Camp consisted of 160 stone circles, indicating that a substantial number of people, a few hundred, could have been accommodated here. However, reinvestigation identified only 24 circles and although consideration has to be given to the recent man-made disturbance of the site and periodic flash-floods, there was clearly a major discrepancy between these findings (Bloxam and Storemyr 2002: 31-3).
Figure 67. Widan el Faras with its “stone circle areas”.

Figure 68. The large “stone circle area”. Most of the circles are weathered and disintegrated basalt blocks. The area was probably more likely a stockpile area during the basalt quarrying.

When we compare these features with those of Chephren’s Quarry, we were able to determine other discrepancies connected with location, associated artefacts and diagnostics of these stone-circles that required a re-assessment of function. The position of the ‘Main Quarrymen’s Camp’ across a wadi and its exposure to the prevailing north wind poses many questions as to the function of this area, particularly as a settlement. Also, the now weathered basalt blocks would originally have been much larger than what is visible today and seemingly too large for tent footings. Trial
excavation of a section of one circle, to a depth of 40 cm, produced no evidence of a living floor level or discernible entrance. Furthermore, there were no post-holes to support a roof, which would be expected in such an exposed position, or any other artefactual evidence associated with the circle. This feature simply represented a loosely constructed stone circle surrounding a deep depression of medium to coarse grained gravel (Bloxam and Storemyr 2002: 31-3). With no evidence of hearths, charcoal or any artefact connected with food production, this absence of evidence made it very difficult to support previous suggestions by Harrell and Bown (1995: 77-8) that this was the quarrymen’s main settlement.

The smaller area of basalt stone-circles close to Wadi Ghorab at the entrance to Widan el-Faras, consists of just 6 basalt stone circles (Figure 69). Although these have also been subject to weathering, originally the blocks would have been much smaller than those observed in the larger area. The possibility that these blocks supported windbreaks, or were tent footings for temporary dwellings, is a much more feasible proposition. In addition, a hearth and plentiful amounts of charcoal were found here, which together with its more sheltered location, is generally more in keeping with it being a place of habitation or small encampment. Dense surface scatters of pottery sherds found across the site dating between the early 4th and 5th Dynasties (El-Senussi 2001) suggest only a single period of occupation in the Old Kingdom, consistent with the peak in exploitation of Widan el-Faras basalt. However, given the very small size of the encampment, we have estimated that only between 20-25 people could have been accommodated here (Bloxam and Storemyr 2002).

Hence, we are presented again with stone-built features which may initially look the same, but which on closer inspection and with comparative analysis can have totally different functions. Location and associated artefacts are key indicators in this case, given the more sheltered and strategic placement of the encampment. Moreover, recent investigations during QuarryScapes of the area surrounding the camp have revealed a possible association with quarrying of secondary resources (see above) such as silicified...
sandstone for grinding stones and also for materials connected with construction of the road. Although more research is necessary of the larger area of stone circles close to the basalt quarries, our preliminary observations may suggest this a storage place for blocks associated with the Old Kingdom and re-used during the Roman Period as perhaps the defining walls of wells. This hypothesis has yet to be tested, but the location of the circles above a wadi and with similar features located across the Old Kingdom quay at the road terminus, which also may have functioned as delimiting wells in the later Roman Period, is one possibility (Figure 70).

![Figure 70. Basalt “stone circles” as seen on google earth at the quarry road terminus – the ancient quay (left part of image).](image)

**The Aswan West Bank**

The dry-stone walled features or stone enclosures associated with quarrying across the Aswan West Bank have been described in detail (see Bloxam et al. 2007: 183-226) and so for the purposes of this report only key aspects of these will be summarised in terms of how these are visualised and how we assess function. In essence, the Aswan West Bank has the largest number of stone enclosures scattered across this 60 km² area (see map, Figure 71). Although unlike Chephren’s Quarry and Widan el-Faras, these span multiple periods from at least the Pre-dynastic to the Coptic Period. Diagnostically, the stone enclosures of the Aswan West Bank generally parallel those described at Chephren Quarry, i.e., occurring either as single features comprising one to several levels of dry-stone walls, as clusters around a natural rock outcrop and infrequently as small independent clusters (Figure 72).
The most visible concentrations of stone enclosures typically occur in the large ornamental quarry areas of Gebel Gulab, Gebel Tingar and Gebel Sidi Osman, but also along a main transport artery, the El Deir road. Determining a chronology of these features has been made indirectly via associated ceramic and epigraphic data, consumption and also by location within datable quarries (see Bloxam et al., 2007: 187-9; 192-5). Yet, there is often evidence of New Kingdom stone enclosures being re-used in later periods, given the periodic ‘clearing out’ whereby earlier (New Kingdom) pottery can be located outside the feature and later (Roman Period) pottery inside - a phenomenon which is also observed at Quartz Ridge in Chephren’s Quarry (Bloxam 2003; Shaw and Bloxam 1999).
Assigning function to these features has largely been made from their context in the landscape. For instance, as look-outs if they are located beside roads, wells if they occur at low-levels in or near wadis and perhaps work places/shelters if they are located in the quarries and have stone debitage and ceramics associated with them (Bloxam et al., 2007: 217) (Figure 73). In addition however, are the stone enclosures with standing stelae that are located only in a New Kingdom ornamental stone quarry at Gebel Gulab (site OE1 – see Heldal et al., 2005; Bloxam et al., 2007: 187-9) (Figure 74). Comparable features are only known in copper and gemstone mining contexts in Egypt where they have been associated with ritual practices (Petrie and Currelly 1906: 64-7; Bloxam 2006; Bloxam et al., 2007: 218). As the first known occurrence of such features in a quarrying context, this additional type of stone feature has been important in discussions that surround the connection between the solar symbolism attached to silicified sandstone and ritual practices conducted in the quarries (see Bloxam et al., 2007: 219).
There were no indicators of more permanent occupation associated with quarrying across the West Bank and any clusters of low-stone walled enclosures in the quarries, typically at Gebel Gulab and Gebel Tingar, would *not* suggest any form of permanent dwellings given the minimal amount of ceramics associated with them and their small size. Even in the one instance where there is a hearth, in an area of Late Ptolemaic to Early Roman Period shelters on the southern tip of Gebel Gulab, this would only suggest temporary habitations. In essence, unlike the large settlements that are associated with Roman Period quarrying in remoter parts of the Eastern Desert, as mentioned above, there are no known purpose-built settlements *specifically* linked to quarrying on the Aswan West Bank.
Other stone-built features

Of all the other types of man-made stone features found in quarries, it is those connected with the transport of stone that can characterise the most extensive and visible features in a quarry landscape (as described above). Less visible, although considerable stone structures in terms of volume of stone used, are the long lines of dry-stone walls termed ‘stone alignments’ that criss-cross the Aswan West Bank quarry landscape. Comparative evidence from similar features found across the Eastern Mediterranean, suggests their function as animal drives or traps since at least the Predynastic (see Storemyr 2007: 170 – 3). Such activities may have had an indirect connection with quarrying. The Aswan West Bank, given its multi-period transformations means that there are clearly many other highly visible stone-built features, such as the monastery of St. Simeon’s and other constructions linked to the Islamic Period. In general terms, these characterise significant stages in the social re-configuring or the ‘dynamics’ of the landscape that can also include re-use of features into the present, as discussed in detail in WP5 (see Bloxam 2007c: 119-125).

Ceramics

Pottery can be located in association with the social infrastructure, such as stone-built features and also in places of stone extraction. Such evidence is key in terms of indirectly determining periods when quarrying occurred and when found associated with stone-built features in secure contexts, is important to dating such structures. Typologies of ceramics can indicate not only chronology, but can aid in characterising subsistence patterns of a labour force, particularly when associated with organic remains. In addition, studies of ceramic fabrics can indicate whether pottery was locally made or imported to a quarry, this can have implications in determining the extent to which outside ‘agencies’ or a centralised bureaucracy were involved in the provisioning of a labour force.

Within the case study ancient quarry landscapes, ceramics are largely minimal and so difficult to visualise. Generally, the ceramics occur as small surface scatters both in the extraction sites as well as in association with some of the stone-built features described. A problematic, particularly across the multi-period Aswan West Bank, is the unreliability of this evidence in terms of dating features and quarries, given that both man-made and natural transformation processes can transport pottery out of its original context (see Bloxam et al., 2007: 203). Although the periods of intensive quarrying across the West Bank during the New Kingdom and Roman Period provide the largest corpora of ceramic evidence, these sherds can often occur together (Figure 75). As the pottery map shows, the highest concentrations of pottery of these periods are found where the most intensive quarrying occurred at Gebel Gulab and Gebel Tingar (Figure 76) (Bloxam et al., 2007: 203-6). It is only at site OE1, where stone enclosures and quarries associated with New Kingdom (18th - early 19th Dynasties) quarrying are largely undisturbed, can we make more secure dating inferences from ceramic evidence (see Bloxam et al., 2007: 192-3, 203).
Figure 75. New Kingdom and Roman pottery found together

Figure 76. Distribution of ceramics in the southern part of the Aswan West Bank quarry landscape.
At Chephren’s Quarry and Widan el-Faras, which are primarily single-period quarry landscapes, ceramic evidence has been a more reliable dating tool. Although ceramic data in both landscapes is relatively small, its association with stone-built features has been crucial to identifying function and subsistence of the labour force (Bloxam 2003). For instance, a pouring vessel of the Old Kingdom at the base of two wells (as described above) at Chephren’s Quarry was key to dating these features and determining function (Figure 77a). Ceramics found in secure contexts in the encampment at Widan el-Faras, dating to the Old Kingdom, were key to linking these features with the most intensive period of basalt quarrying at this time.

Ceramic typologies as a dating tool have been important at Chephren’s Quarry in terms of linking the main camps along the transport route with Old Kingdom quarrying. Bread moulds found in stone features at Khufu Stele Quarries and in the camps along the track are the classic ‘bell-shaped’ variety that are characteristic only of the Early Dynastic into the Old Kingdom (late 3rd to early 4th Dynasty) (Jacquet-Gordon 1981:12-3, El-Senussi 2003: 1, 3-4) (Figure 77b). Importantly, the clay used to produce these bread moulds would be locally acquired and shaped into the mould; called the ‘negative’ mould technique (Arnold and Bourriau 1993: 23). The clay was subsequently fired during the process of baking the bread and usually the moulds could only be used once, or at most twice, during this process (El-Senussi 2003: 1; 2004: 4; Arnold and Bourriau 1993: 173-4). The implications of this suggest not only the importance of bread as a basic food-stuff for the labour force, but also points to moister environmental conditions than we see today. It seems that clay and wood would have been locally available, given that firing and baking of the bread requires a temperature of over 500c. Moreover, even though the bread moulds are relatively numerous, their limited re-use does suggest that labour force numbers were small, probably under 50 individuals.

Of the other domestic ceramics found at Chephren’s Quarry that also date to the late 3rd and early 4th Dynasty, beer jars and wine jars have been relatively well represented (Figure 77c). The importance of alcohol in terms of labour force subsistence is highlighted here and is also known at other contemporary quarry sites, such as Umm es-Sawan in the Northern Faiyum (Caton-Thompson and Gardner 1934; Bloxam 2003; El-Senussi 2006). Moreover, the jars in which beer and wine were contained are of the same fabric and similar typology to those found in late 3rd Dynasty and 4th Dynasty contexts at Abydos and on the Giza Plateau (El-Senussi 2004: 3). These sites were places of elite burial and permanent settlement, hence one can argue that perhaps such ‘prestige’ goods, particularly wine, was imported to Chephren’s Quarry. The implications of this have been discussed in terms of determining the role that alcohol may have played in the organisational dynamics of quarry labour forces (Bloxam 2005). In effect, the ceramic data at Chephren’s Quarry gives us a direct correspondence between the camps and other stone-built features across the landscape with intensive quarrying (for statues and vessels) between the late 3rd – 4th Dynasties.
The pottery corpus at Widan el-Faras presents numerous similarities whereby the fabric and typology may represent both imported vessels, as well as those made locally. Of the imported pottery, parallels can be made with similar ceramics found on the Giza Plateau, dating between the 4th and 5th Dynasties (El-Senussi 2001). However, it is the distinctive fabric of locally made pottery (containing dark particles probably basalt) and also potters marks (Caton-Thompson and Gardner 1934: 99-100; 110-6, pl.lxvi.30; Bloxam 2003: 267; El-Senussi 2006) that have been key in making connections between quarrying of basalt at Widan el-Faras with gypsum at Umm es-Sawan and with the local settlements of Qasr el-Sagha and Kom IV during the Old Kingdom. Hence, in terms of understanding the extended quarry landscape and its social construction, ceramic data has been key (see Bloxam and Heldal 2007: 315-17).

**Epigraphic data**

Characterising and visualising epigraphic data across an ancient quarry landscape and assessing meaning, in terms of understanding the social context of quarrying, can be problematic to unravel. ‘Epigraphic data’ is a collective term we have used to define any type of man-made inscribing of an ancient quarry landscape. Such inscribing as known in an Egyptian quarrying context can be as inscriptions (usually hieroglyphic, hieratic and Greek) (Figure 78), graffiti (this can include usually single characters and/or geometric of unrecognisable symbols, masons marks) (Figure 79) rock art/petroglyphs (carvings on rocks of animals, humans, boats and symbols of often a religious nature and other pictorial, stylised and abstract art forms) (Figure 79).
This range of epigraphic data and how it occurs across an ancient quarry landscape is extremely variable. In most instances, epigraphic data is usually inscribed onto a natural rock face. These may be cut into a worked quarry face, so placed there after quarrying, such as those found at Gebel el-Silsila (Figure 80). Or, epigraphic data may occur on unworked rock faces close to an extraction site in a quarry complex, of which there are many examples across the Aswan West Bank (Figure 80). Sometimes epigraphic data may be located in places across a quarry landscape distant from the extraction sites, this can often be along transport routes or at key places of embarkation from the quarries (Figure 78). The most well-known and best preserved inscriptions that relate to ancient quarrying in Egypt are found along one of the main desert routes connecting the Nile Valley to the Red Sea; the Wadi Hammamat in the Eastern Desert (Couyat and Montet 1912; Goyon 1957) (Figure 81). Of the numerous dynastic period inscriptions found along the Wadi Hammamat and associated with Middle and New Kingdom quarrying of greywacke in the region, these written sources are the most frequently used to describe the social organisation of a quarry workforce (Bloxam 2007a; Bloxam et al., in press).
Figure 80. Petroglyph on a worked quarry face at Gebel el Silsila, Egypt (left) and on a natural rock face at the Aswan West Bank (right).

Figure 81. Multi-Period inscriptions at Wadi Hammamat – in this case from Dynastic Egypt to Graeco-Roman. Some of the inscriptions are made by people connected to stone quarrying

Epigraphic data can also occur, although more rarely in a quarrying context, on free-standing stelae. The majority of Old Kingdom inscriptions at Chephren’s Quarry were found in this way and probably related to the nature of the terrain where suitable in-situ natural surfaces are rare. Hence, there is only one known place where an inscription has been placed on a natural rock outcrop, this being beside one of the few key natural landmarks along the stone transport route (Figure 78). Usually at Chephren’s Quarry epigraphic data is found inscribed onto locally sourced rocks, such as basalt and trachyte, that have been roughly-shaped into stelae and strategically placed in the quarries (Figs). At Khufu Stele Quarries, the main stela that gave the quarries here their name (Engelbach 1933, 1938) was placed on top of a purpose-built platform, situated prominently within the main statue quarries (Figure 82). Free-standing stelae with inscriptions are also well represented in the northern reaches of Chephren’s Quarry at Stele Ridge and associated with Middle Kingdom carnelian mining here. These largely locally sourced silicified sandstone stelae were strategically placed at the terminus of the transport route near a series of highly visible cairns (see Engelbach 1933, 1938; Murray 1939; Bloxam 2006) (Figure 82).
In general terms, finding epigraphic data associated with ancient quarrying tends to be the exception rather than the rule. Poor preservation is a key factor that can be due to both natural and man-made factors. For instance, natural weathering and rock falls can obliterate epigraphic data. Ancient and modern quarrying can also remove epigraphic data, particularly from quarry faces, as well as vandalism and looting (see Storemyr et al., 2007 for an overview). At Widan el-Faras and Umm es-Sawan in the Northern Faiyum no epigraphic is known in the quarries. Although epigraphic data found in Old Kingdom quarrying contexts is extremely rare, its absence in these key quarries could also be due to natural and man-made interventions.

There is an enormous ambiguity that surrounds the characterisation and interpretation of epigraphic data in quarries. Hence, the boundaries between our definitions of inscriptions, graffiti, iconography and rock art are extremely blurred. Because of the sporadic nature and often poor preservation of this type of material culture, epigraphic evidence that can inform us about how quarrying was expedited, by whom and by how many, is rarely a written source found in quarries (particularly prior to the Roman Period) and unknown in the Egyptian case study quarries. In terms of identifying and characterising epigraphic data that we do find in the case study quarries, its significance is usually where it may provide additional evidence in terms of dating quarries (particularly as markers of presence connected to a specific ruler) determining symbolic associations between the resource and religious ideologies and sometimes as a means to understand past environment. For instance, inscriptions on the Khufu Stele in the statue quarry complex at Chephren’s Quarry suggests a wetter environment than the hyper-arid of today, as it is referred to as the ‘Place of Catching Birds’ and ‘Place-of-the Fisher’ (Rowe 1938: 394-5).
The Aswan West Bank is a key place where epigraphic data associated with New Kingdom quarries provides rare evidence from which we may suggest a connection between silicified sandstone and the solar religious cults. For instance, depictions of animals associated with the solar cults have been located in key New Kingdom ornamental stone quarries, particularly in Khnum Quarries (see Bloxam et al., 2007: 191, 209). In addition, the hieroglyphic symbols for \( \text{mr}-\text{Ra} \) (beloved of Ra) found most numerously at Gebel Gulab associated with a New Kingdom obelisk extraction, but also at Khnum Quarries, is further evidence of possible solar connections (op. cit) (Figure 79). It has been problematic determining whether these hieroglyphs could be a type of masons mark, or have more explicit ‘royal’ connections as are only known in the New Kingdom quarries. In terms of ‘royal’ inscriptions associated with quarrying across the West Bank these are unknown and only occur on the top of an obelisk dating the New Kingdom 19th Dynasty (Figure 83) (Habachi 1960: 227-30; Brand 2000; Bloxam et al., 2007: 207). Now removed from the quarries due to vandalism (see QuarryScapes website).

Epigraphic data of the Predynastic across the Aswan West Bank as petroglyphs (rock art) is usually strategic and often in highly visible locales. There are numerous occurrences of petroglyphs between Gebel es-Sawan North and Wadi Faras and near to grinding stone quarries which we tentatively date to Predynastic quarrying (see Heldal and Storemyr 2007: 78-91). The variety of petroglyphs in terms of subject matter across the West Bank can range from human figures and foot prints to depictions of giraffes, lizards, cattle and gazelle that date, given comparative instances in the region, to probably between the 5th and 4th millennium BC (see Storemyr 2007: 164-5) (Figure 84). More identifiable petroglyphs that depict Nubians, dating to both A-group and C-group, have allowed us to get a glimpse of the ethnicity of some of those who traversed and engaged with the landscape at certain times in the Predynastic and dynastic period (Figure 84d) (Storemyr 2007: 168; Bloxam 2007b: 20-21).

Figure 83. Inscribed obelisk tip at the Aswan West Bank
Interpreting the social context of ancient quarrying from micro-level data

When analysing the micro-level empirical data, in terms of making inferences into the social context of ancient quarrying, particularly during the Dynastic period in Egypt, there are key questions that we need to ask of this data. For instance, the size of labour forces, did they reside permanently at the quarry, levels of social organisation and the extent to which such activities may have been controlled by the ‘state’ or other type of centralised bureaucracy. We also need to contextualise this data historically, and also comparatively with other ancient quarries in Egypt, as well as cross-culturally. Moreover, is the need to develop conceptual models through which we can gain fresh insights into the social context of quarrying, this relevant where there are data gaps and an absence of written sources. Concepts drawn from social archaeology theory are key, particularly in cross-cultural contexts and across historical periods, where insights into the social context of ancient quarrying are often more developed. For instance, ancient quarries linked to some of the earliest monuments in the European Neolithic and to those of Classic Period Mesoamerica can provide useful conceptual frameworks to work with (Abrams 1982; Spence et al., 1984; Bradley and Edmonds 1993; Edmonds 1999; Bradley 2000).

Characterising dwellings from the range of stone-built features in quarries is one of the most problematic aspects in determining the size of a quarry labour force, in one given historical period. Yet, from the stone-built features described above, the archaeological expectations of the social infrastructure in terms of large labour forces being involved in
ornamental stone quarrying at Chephren’s Quarry and Widan el-Faras during the Old Kingdom is largely absent. Quantifying ceramic data can be important as an indirect indicator of labour force size, particularly when compared with other ancient quarries where such data is linked to less fragmented settlement data. Such an approach was used in the analysis of the camps and encampment at Chephren’s Quarry and Widan el-Faras, particularly given that these features are related to only a single historical period of quarrying. From this type of analysis linked to camp size and the minimal amounts of ceramic data associated with them, we could conclude that labour force size at quarries would probably have been under 100 people (Bloxam and Storemyr 2002; Bloxam 2003; Bloxam 2007a; Bloxam et al., in press).

In multi-period quarries such as the Aswan West Bank making such estimates is harder, given that stone-built features are more difficult to date to specific periods. Moreover, we cannot associate these features only with ornamental stone quarrying, as we can infer at Chephren’s Quarry and Widan el-Faras, given that utilitarian production for grinding stones was the main exploitative activity here since the Late Palaeolithic (see above and Bloxam et al., 2007). In addition, ceramics associated with stone-built features are often out of context and can be representative of multiple periods. Hence, estimates of labour force size in any given historical period could only be inferred within a New Kingdom quarry complex associated mainly with ornamental quarrying at Gebel Gulab (site OE1). Ceramic data, in relatively secure contexts associated with a few stone-built features, suggested low numbers of personnel linked to this extraction site, perhaps no more than 20 people (Bloxam et al., 2007: 222). The absence of ceramic evidence and features relating to food production here, also indicated, as opposed to Chephren’s Quarry and Widan el-Faras, that quarry workers did not reside in the quarries probably due to the proximity of permanent settlements at Aswan (op. cit).

Written sources that can aid in interpretation is problematic particularly as epigraphic data, as discussed above, does not provide evidence in the case study quarries of labour force size in any historical period. Sources of such data in other contexts, typically from the 2nd millennium BC (Middle Kingdom) quarry inscriptions in the Wadi Hammamat region of the Eastern Desert, have often been used as an indicator of labour force size and organisation. For instance, one such expedition records over 18,000 people being involved and organized along strict hierarchical lines (Couyat and Montet 1912; Goyon 1957). Yet, there are clear contradictions between these written sources and the archaeological data and hence, micro-level data and characterisation of the social infrastructure at the stone sources has been key in rethinking how quarrying was undertaken in the dynastic period (Bloxam 2003; Bloxam 2007a, Bloxam et al., in press). These indications suggest that ornamental stone quarrying was undertaken by small numbers of people at Chephren’s Quarry and Widan el-Faras. This may also be deduced in respect of ornamental stone quarrying on the Aswan West Bank. Hence, epigraphic data in a quarrying context may not be related to practice, but rather as an indicator of ideology and symbolism connected to quarrying activity that is still not fully understood (Bloxam 2006).

Ritual activities associated with ancient quarrying are also an important part of understanding the social context of these activities, not only between people who worked in the quarries, but as an indicator of links between specific places, people and religious ideologies that may all be attached to particular resources.
Such evidence, can be characterised, as described above, by stone features and epigraphic data. The Aswan West Bank where there is multiple inscribing of the landscape gives a strong indication, across a deep time-depth, of symbolism and ritual linked to the place and also the resource. During the New Kingdom, these links are more accessible for interpretation as the epigraphic data is more explicitly linked to contemporary solar cults, given their symbolic association with silicified sandstone at this time. Local deities were also venerated, this is particularly apparent from the New Kingdom into the Graeco-Roman Period and further indicates the local connection between people who worked in the quarries and place. Petroglyphs (rock art) into the prehistoric similarly suggest that inscribing of the landscape was key, and although making explicit connections between these incidences and quarrying is less clear, we can infer that marking of presence across the Aswan West Bank landscape has long cultural and historical antecedents attached to it (see Bloxam et al., 2007: 223-4; Bloxam 2007). Such an interpretation is important in how we can socially construct an ancient quarry landscape across deep time, particularly where multiple activities were undertaken.

Absence of social infrastructure remains may also be because the quarries are in such close proximity to where the resource was consumed, such as at Petra, Jerash, Ankara, Sagalassos and the Hittite quarries, that such elements were unnecessary. However, apart from Sagalassos, we have to take into account that project work in these other quarries was not focussed on identification of such features. So, we have a limited view at this stage and future research needs to investigate these aspects of a quarry complex. Although clearly at Ankara, due to the quarries being consumed by the modern city, such evidence is now totally destroyed. A similar situation is also seen at Sagalassos, particularly in the quarries closest to the city, whereby integration into the place of consumption occurred in antiquity. Investigations of the quarries surrounding the city showed no visible elements of social infrastructure, although at Sarakiya 4 km away from the city, ceramics and the remains of a structure in disturbed contexts as a consequence of later agricultural activity, may have been associated with quarrying here (Heldal et al., 2007d: 48).

We can build a picture of the social context of quarrying from the empirical data from stone-built features and associated ceramics, aspects of epigraphic data, location to permanent settlements and presence/absence of other features linked to food production. However, we cannot make inferences into the social context of ancient quarrying from the social infrastructure alone. Characteristics of production evidence, such as stone tools, spoil heap material and the extent to which objects were finished in the quarries are important additional sources of evidence from which can interpret the social context of quarrying. Interpretation has to be of the ‘quarry complex’ in its totality and from which we may establish links to not only other quarry complexes across the landscape, but perhaps with distant quarry complexes and landscapes that would hitherto be invisible. However, micro-level interpretation can only go so far in attaching historical values to such material remains. Hence, macro-level interpretation has to analyse this data, within the totality of a quarry complex and landscape, through value contexts constituted by their broader historical and geographical setting. Such approaches to interpretation being discussed in Chapter 5.
Secondary resources

In many cases, quarrying requires input of other natural resources used in the production process. Defining the quarried resource as the primary, we can collectively name such secondary resources\(^6\). These may be stone resources for stone tools, wood for smithies, stone for constructions and roads or grinding stones for food production. Secondary resources may be directly applied in the production process, or indirectly for sustaining the people doing it. Secondary resources may have been exploited elaborately, such as the building stones used in the construction of the fort and settlement at Mons Porphyritus (Maxfield and Peacock 2001), or modestly, and they may be imported or obtained locally. In principle, we separate between the use of secondary resources (as quarried or obtained for a specific purpose) and use of spoil material in the quarries for i.e. construction, but the border may be diffuse and should not be strictly drawn. Some examples of secondary resources and their use are given in Table 31.

Table 31. Examples of use of secondary resources in quarries.

| SECONDARY RESOURCE | Stone tools | Pounders/stone hammers
| | | Stone chisels |
| | Building stone | Houses
| | | Shelters
| | | Roads |
| | Domestic artifacts | Grinding stone/millstone
| | | Mortars
| | | Whetstone |
| | Clay | Ceramics
| | | Bricks |
| | Wood/charcoal | Smithy
| | | Fire setting
| | | Houses
| | | Lifting and transporting devices
| | | Wedges |

The characterization of secondary resources is important for understanding production technology as well as the organisation and logistics of quarrying.

In Chephren’s Quarry, the tools for working the gneiss are made from local resources (Table 32); pounders are made from diorite (a series of dykes occurring in the western part of the area), granite (occurrences all over the area) and the Chephren Gneiss itself. In addition, rod-shaped hand-hammers, made from diorite and basalt, were applied. When viewing the distribution of tools from these different sources, we see a clear pattern of use; the diorite was predominantly used near the source. Further away, granite and/or Chephren Gneiss were preferred. Thus, we may conclude that proximity was a more important aspect in the selection of tool materials than differences in quality (Figure 85). Other secondary resources, also obtained locally, include silicified sandstone for grinding implements and clay for ceramics.

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\(^6\) Here, we will specifically address the secondary stone resources, not organic resources, water etc.
Table 32. Secondary resources at Chephren’s Quarry.

<table>
<thead>
<tr>
<th>SECONDARY RESOURCE</th>
<th>PURPOSE/USE</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diorite (dykes)</td>
<td>Stone tools (pounder, hammers)</td>
<td>Local</td>
</tr>
<tr>
<td></td>
<td>Stela</td>
<td>Local</td>
</tr>
<tr>
<td>Granite</td>
<td>Stone tools (pounders)</td>
<td>Local</td>
</tr>
<tr>
<td>Basalt</td>
<td>Stone tools (hammers)</td>
<td>Local</td>
</tr>
<tr>
<td>Silicified sandstone</td>
<td>Grinding stone</td>
<td>Local</td>
</tr>
<tr>
<td>Sandstone</td>
<td>Shelters</td>
<td>Local</td>
</tr>
<tr>
<td>Clay</td>
<td>Ceramics (bread moulds)</td>
<td>Local</td>
</tr>
<tr>
<td>Wood</td>
<td>Domestic use,</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Fire setting</td>
<td></td>
</tr>
</tbody>
</table>

Figure 85. Observation of stone tools (small circles), Chephren’s Quarry, made of diorite (dyke occurrences, black lines on the map). The use of this secondary resource for tools is decreasing the further away from the source one gets.

Moving north to the more or less contemporary basalt quarrying at Widan el Faras (Table 33), we see a completely different pattern of stone tool use; the main type of tool found in the quarries are rather well fabricated pounders – most of them having contracted necks for the attachment of a haft. Interestingly, they all originate from the Precambrian rocks in the Eastern Desert and/or the Aswan area, far away from the quarries (Harrell 2002: 235; Bloxam 2003; Bloxam and Heldal 2007). Whether the reluctance of using local hard stone was related to quality, quarrying methods or social aspects is difficult to know, but certainly this contrast in the production and use of stone tools at two contemporary sites raises important questions about connections between quarry sites in the Old Kingdom. At Widan el Faras, local resources are, however, used to a large extent in the construction of the quarry road. As displayed in Figure 86, the construction material varies along the road, reflecting the most available resources near it. Notable, basalt rubble from scree deposits is used only in the uppermost part of the road.
Table 33. Secondary resources at Widan el Faras

<table>
<thead>
<tr>
<th>SECONDARY RESOURCE</th>
<th>PURPOSE/USE</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gabbro, diorite</td>
<td>Stone tools (shafted hammers)</td>
<td>Imported</td>
</tr>
<tr>
<td>Sandstone</td>
<td>Road construction</td>
<td>Local</td>
</tr>
<tr>
<td>Silicified wood</td>
<td>Road construction</td>
<td>Local</td>
</tr>
</tbody>
</table>

Figure 86. Rock types used as paving on the quarry road from Widan el Faras.

Not far away, in the Umm es Sawan gypsum quarries, the focus on local resources for tools is back (Table 34), still in the Old Kingdom Period. In the gypsum quarrying, the extraction has mainly taken place aided by stone pounders (semi-local basalt and silicified sandstone), chert nodules (semi-local sources) and rods of silicified wood (local sources). The latter two may have been used as “hammer and chisel” in quarrying of the soft rock. Chert was also used for making drilling and cutting implements for the manufacturing of gypsum vessels. However, in Umm es Sawan, there are also occurrences of imported rocks, from the Eastern Desert and even from Chephren’s Quarry 900 kilometres to the south (Harrell 2002; Bloxam and Heldal 2007). Whether or not these actually were imported as tools remains unclear, but the presence of them underlines again the connection between quarry sites. Near Umm es Sawan is one of the few examples we have a quite large scale quarry in a secondary resource; a peculiar variety of silicified sandstone that seems to have worked particularly well as a stone pounder in both gypsum and grinding stone production.
Table 34. Secondary resources at Umm es Sawan, Northern Faiyum quarry landscape

<table>
<thead>
<tr>
<th>SECONDARY RESOURCE</th>
<th>PURPOSE/USE</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chert nodules</td>
<td>Stone tools (pounders, crescent drills)</td>
<td>Local/semi-local</td>
</tr>
<tr>
<td>Silicified wood</td>
<td>Stone tools (chisels)</td>
<td>Local</td>
</tr>
<tr>
<td>Silicified sandstone</td>
<td>Stone tools (pounders)</td>
<td>Local and semi-local</td>
</tr>
<tr>
<td></td>
<td>Grinding stone</td>
<td></td>
</tr>
<tr>
<td>Basalt</td>
<td>Stone tools (pounders)</td>
<td>Semi-local</td>
</tr>
<tr>
<td>Chephren’s Gneiss</td>
<td>Stone tools (pounders)?</td>
<td>Imported</td>
</tr>
<tr>
<td>Mylonite</td>
<td>Stone tools (pounders)</td>
<td>Imported</td>
</tr>
</tbody>
</table>

At the Aswan West Bank, a study of secondary resources showed important differences between grinding stone quarries and ornamental stone quarries (both silicified sandstone). In the former case, most of the stone tools originate from cobbles of igneous and metamorphic rocks found on the riverbank and cobbles of the silicified sandstone itself. In the ornamental stone quarries, however, there were much higher proportions of stone tools of the same type of dolerite as found by the Unfinished Obelisk in Aswan East Bank (called “obelisk dolerite” in Figure 87). Surely, this indicates that tools were brought from the East Bank to the West Bank during the ornamental stone quarrying.

Figure 87. Distribution of fragments from stone tools in a grinding stone quarry and an ornamental stone quarry.
To sum up, defining and characterizing secondary resources may shed valuable light into the interpretation of stone production, and not at least, the connection and differences between various sites. However, a secondary resource to one type of quarry operation may be a primary in another; for instance, the Widan el Faras basalt, being a primary resource for the pyramid complexes, is a secondary to gypsum production (used as pounders). Grinding stone quarries found at both Widan el Faras and Umm es Sawan may have been exploited as a secondary resource to these quarrying operations, but they may also be later or earlier, and be a part of a different quarrying activity.
4. Constructing a quarry landscape
Quarry landscapes may be simple, composed of one single type of quarrying for one specific purpose, or they may be complex containing many different types of stone exploitation activities through long periods. This may raise considerable challenges in how to define historical values. Within the same physical landscape, one part may be significant for one reason, whilst the neighbouring part for another. Our case studies, particularly the ones involving detailed characterization of quarry landscapes, soon led us into a need of establishing tools for “deconstructing” quarry landscapes into “systems” with common features. Here, we will go the other way around, and try to “construct” quarry landscapes from simple models, illustrated with examples from the case studies. The building blocks of such constructions lie in the characterisation and analysis of the elements of quarrying as described in the previous chapter. In the next chapter we will suggest methods of how to use such constructions as a basis for macro-scale analysis of historical values that leads towards articulation of significance.

Defining simple units

Ideally, a “quarry” may be described as a unit of stone production, continuously exploited for a specific purpose in a specific period. Naturally, far from all quarries are ideal, some exhibit one or more hiatuses in the production, and some contain several layers of exploitation for different purposes. A quarry unit may be the result of one day’s work or tens of years. Individual quarries may start separate and later grow together into one large unit, in which the individual components remain invisible for us.

However, having in the back of our mind that the definition of quarry units is a floating size, depending on the characteristics of the resource, the level of details in the survey and many other factors, it is still valid to seek to identify such production units.

A quarry unit features (ideally) a stone resource (or part of such), remains from the various steps of production (quarry face, spoil heaps, work areas, unfinished products, tools, etc.), logistic features and remains of the social life around the quarrying (ceramics, shelters, etc.)(Figure 88). There may or may not be evidence of exploitation of secondary resources. There is an input of people and resources for sustaining the production, and an output of more or less finished stone products. To a smaller or larger extent, the unit is a part of a larger organisation and social context, which we will address in the next subchapter.
In Chephren’s Quarry, the resource occurs as scattered deposits over a wide area, and thus it is fairly easy to define single units; more than 650 of them were recorded (Heldal et al. in press), varying from very small, less than 3 metres in diameter, to more than hundred metres (Figure 89)(Figure 90). The smallest units are more correctly termed trial quarries or prospecting quarries, since the activity only involved testing of the stone to evaluate its workability. Nevertheless, Chephren’s Quarry appears as a wide, open quarry landscape with clearly defined quarry units; most of them circular in shape, with concentric circle(s) of spoil enveloping a central area where the boulders were worked. Many of the grinding stone quarries at the Aswan West Bank, also exploiting clusters of boulders, appears similar to the ones in Chephren’s Quarry – circular, crater-like structures with spoil heaps around the areas where the blocks were obtained (Figure 91).
Figure 89. Part of the Chephren’s Quarry landscape, displaying numerous quarry units of different size.

Figure 90. Extremes of quarry units, Chephren’s Quarry. Left: small quarry, 5 metres in diameter, may have been only a prospecting site. Right: large quarry unit displaying concentric spoil heaps distributed around a central extraction/work area.

Figure 91. “Crater” like depressions made from quarrying of boulders of silicified sandstone, Aswan West Bank grinding stone quarries
At Widan el Faras, the quarries are situated along an escarpment, defining swale-like features (Harrell and Bown 1995; Bloxam and Storemyr 2002). They define 4-5 quarry units, each containing their own logistical system leading towards the stockpile of blocks on the plane below (Figure 92). The number of units roughly corresponds with the number of pyramid complexes the basalt has been used in, and analyses carried out by Bloxam and Storemyr (2002) show that the correspondence between the volume extracted in each and the basalt use in the pyramids indicate a progressive development of quarrying from the east towards the west.

![Figure 92. Quarry units and their internal logistics as defined in the Widan el Faras basalt quarry. Each unit may correspond with one pyramid complex.](image)

In the Umm es Sawan gypsum quarries, the main quarrying activity in the largest outcrops of the gypsum deposits have grown together, and so it is difficult to define units and from that make interpretations about organisation and progressive development of the quarrying. As shown in Figure 93, we were left with defining “units” based on the degree of quarrying – more or less exploited, giving an idea of key extraction areas.

Moving to building-stone quarries, we display some examples from the Aswan West Bank and Sagalassos. In the former case, the Greaco-Roman Naq el Fugani quarry (first described by Klemm and Klemm 1991) is a good example of a large quarry unit that has been active for a long time, visualised by the fact that most of the rock exploited has been “transformed” to spoil heaps, and only a small part of the actual rock faces are still seen (Figure 94). The quarry displays most features described above, such as extraction areas, work areas, block remains, quarry roads and built structures, possibly for sustaining the people working there.

On a smaller scale, some of the limestone quarries at Sagalassos also show such “classic” distribution of extraction areas, spoil heaps, work areas and roads/exit areas for transporting blocks (Figure 95).
Figure 93. Map of the quarry areas, gypsum workshops and “tool workshops” (secondary resources) at Umm es Sawan, Northern Faiyum quarry landscape.

Figure 94. The Naq el Fugani quarry at the Aswan West Bank. The upper photo is taken from the southern edge of the quarry, the lower an overview of the quarry from the north, illustrating the sizeable spoil heaps.
Defining complexes

Rarely are quarry landscapes simple in the way that they consist of one single time layer of exploitation of one type of stone resource for one purpose. In most cases, quarry landscapes are multilayered and multifunctional. Thus, the definition of elements related to quarrying and the micro-level analyses of them, soon leads to a need of making groups or systems of quarries, for being able to extend interpretations on a macro-level into the fields in which one may get closer to assess historical values. For example, two different layers of quarry systems within one quarry landscape may need different approaches to get to their significance.

We have chosen to define quarry complexes; in the general sense, a “complex” can be defined as “a collection of interrelated units forming a whole”. In our meaning, we define a quarry complex as: “a collection of quarry elements related to each other in time, space and/or function”. It is important to underline that in our meaning, a “quarry complex” cannot be defined strictly and universally into a tight scheme, but is more an aid in the methodology of visualising similarities and differences in a quarry landscape. We will try to enlighten this further through some of our case studies.

In a general view, a quarry complex may be visualised as in Figure 96, as a system of interconnected quarries sharing social infrastructure and logistics, input of labour force and secondary resources and output of products.

The criteria on which a complex is defined depend on many factors, and may be one or combinations of the following:

- Time/period (“Historical Complex”)
- Resource (rock/commodity)
- Production (technology)
- Function/consumption (products)
Obviously, a division by time/period requires control and knowledge of the chronology, which may have been achieved directly by exact dating techniques or indirectly through i.e. consumption patterns (see subchapter on social infrastructure). This is often not the case, and an indirect way of approaching chronology may be by defining complexes from production technology.

![Figure 96. Simple model for visualising a quarry complex limited by the resource, as a number of connected quarries sharing common features of social infrastructure and logistics.](image)

The basalt quarries of Widan el Faras may serve as an example of a rather simple quarry complex predominantly defined within a limited period (4th and 5th Dynasties, Old Kingdom) with a simple and well known consumption pattern (mortuary floors for pyramid complexes), but with minor overprints from the Middle Kingdom (based on consumption) and the Graeco-Roman Period (based on ceramics, analysis of quarry technology and consumption). Thus, we may say it is mainly defined as a “time-resource-complex” by indirect (consumption) and direct (ceramics; Bloxam and Storemyr 2002) methods. In Figure 97 we have summarised the elements and secondary resources of that complex.

A similar pattern is seen at Umm es Sawan, also in Northern Faiyum (Figure 98). The dating of the gypsum quarrying is predominantly Old Kingdom (Caton-Thompson and Gardner 1934), but with a small Graeco-Roman overprint (Bloxam and Heldal 2007). So again, the main elements compose a “time-resource” complex predominantly from the Old Kingdom.

In both Widan el Faras and Umm es Sawan, there are grinding stone quarries nearby (Bloxam and Heldal 2007). These may have been used primarily by the quarry work forces (secondary resource), but may also represent a third quarry complex in Northern Faiyum independent of the other two; until more knowledge is achieved about these, the question remains open.
In the Sagalassos case study, complexes may be defined as resources (types of limestone used in the building of the city as shown in Figure 99) for the local limestone resource. However, some of these fit well into a definition as historical complexes, since
they have a limited period of consumption in the city. Concerning the local limestone, this appears more difficult, due to these resources having been used most of the lifetime of the city, and it is difficult to date each quarry. As seen in Figure 99, there are several quarries situated in the necropolis areas of the city and it is likely that the production of funerary monuments were their main function. So, with some further research into this, it may be plausible to separate the quarries for funerary elements from those for the buildings, thus defining “funerary” and “building stone” quarry complexes.

In Chephren’s Quarry, most of the quarry units are linked to the production of vessels for funerary (elite) purposes, from the Predynastic Period well into the Old Kingdom. In some of the areas, there is evidence for the production of statue blocks, i.e. the famous statues of King Khafra. Whilst the former is a long lasting activity, the latter seems to represent shorter campaigns in a limited period. Thus, we may say that the statue quarrying overprints the vessel quarrying in parts of the area, and is also exploiting a slightly different variety of the Chephren Gneiss. Although it is impossible to separate the material culture of one from the other, the statue quarrying clearly displays productional and logistical features which the vessel quarrying does not. When defining these as different complexes (Figure 100) we see some spatial relationships that may shed more light on the chronology and technology of quarrying and transport, and highlight (from a conservation view) how different parts of the quarry landscape represent different historical values. However, as it is likely that both activities lived side by side for a period, and could even have been carried out by the same people, we must not fall into the trap of building impermeable walls between the complexes.
Moving to the Aswan West Bank, the picture is (as already stated several times) more complex. The Aswan West Bank is truly a multi-layered, multi-resource and multi-functional quarry landscape. This makes the establishment of quarry complexes even more useful, in order to reach some kind of interpretation and understanding of its many facets. From slightly different angles, five complexes were defined from the survey data (Figure 101):

- Palaeolithic tool complex (silicified sandstone; period, production)
- Grinding stone complex (silicified sandstone: resource (commodity), production)
- Dynastic ornamental stone complex (silicified sandstone: production, period)
- Roman ornamental stone complex (silicified sandstone: production, resource (commodity))
- Building stone complex (sandstone: production, resource (commodity))

The Palaeolithic tool complex comprises the oldest layer of quarrying in the area and is probably to a large extent overprinted by the younger complexes. These interpretations are made from production technology (flake technology), nature of product remains (flake type) and weathering (surface loss and patina on flakes compared with the other complexes).

The largest complex is the grinding stone complex, and there is evidence for more or less continuous production of such since the Late Palaeolithic (Bloxam et al., 2007) up to the Roman Period. Since production technology only shows small changes through
time and the amount of datable material culture is small, it is difficult to divide the
complex into time layers; thus we defined grinding stone production as a commodity-
production complex, although spanning through a period of 16,000 years.

Dynastic ornamental stone complex is found in the central part of the area, and
constitutes production of statue blocks and obelisk, mainly confined to the New
Kingdom, but also with possible contributions in the previous Dynastic periods. The
major part of the quarry road system on the West Bank belongs to this complex. The
complex is defined from production (quarrying method, comparable analysis with other
sites), consumption (general Dynastic consumption of silicified sandstone as ornamental
stone), dating of inscriptions and ceramics.

Similarly, the Roman ornamental stone complex is defined mainly from production
(quarrying technology) and dating of ceramics/inscriptions.

The last complex comprises scattered building stone quarries in the area; although this
kind of production likely has been carried out since the Old Kingdom onwards, most of
the quarries seem to be from the Graeco-Roman Period. Production (quarrying
technology and comparison with other sites) and resource (commodity – sandstone
building stone) were the key aspects for defining the complex.

When viewed together on a timeline (Figure 102) we see how some of these complexes
define short time intervals, others (particularly the utilitarian ones) reflect almost the
whole human history. Moreover, when we look at the periodical and spatial distribution
together, the grinding stone quarrying clearly had a leading role in transforming the
landscape of the West Bank. The ornamental stone and building stone quarrying may be
highly visible in the small areas they occur in, but represents short lived campaigns.
Thus, when uniformly focus the ornamental “elite” stone quarrying one may seriously
misinterpret the quarry landscape as a whole, in filtering away the largest complexes.
Consequently, quarrying in ancient Egypt may be viewed as a solely elite exercise. The
recognition of the utilitarian complexes, however, leads to another view: a large,
“living” quarry landscape that was already there when the first “elite” production
started, implicating possible integration between the two. This recognition of the
various complexes also strongly underlines the need for following several avenues
towards assessing historical values, as we will discuss in the next chapter.

As we have been through in this exercise of defining complexes from our empirical
data, there are several ways leading to it which may vary from person to person. In other
fields, landscape characterization often focuses on “historical complexes” as key
elements for value assessment and conservation (Fairclough 2008). Ideally, we may say
that such perspectives should also apply for quarry landscapes. However, such
landscapes rarely constitute the material culture needed for dividing them into historical
complexes, particularly in the case of the less visible “non-elite” quarrying.
Furthermore, stone quarrying is often multi-period and the longevity of such production
is one of the key aspects in value assessments.
Figure 101. Quarry complexes at the Aswan West Bank and their spatial distribution. All quarries in the upper centre.

Figure 102. Illustration of time depth of quarry complexes at the Aswan West Bank (logarithmic scale, BP).
Quarry landscapes

Finally, in our efforts of “deconstructing” our datasets and then “reconstruct” them into a methodological approach, we get back to the title of our project: quarry landscapes.

In our project description, we had the following definition of quarry landscapes:

“The archaeological record in the quarries comprises rare evidence of stone extraction sites, roads, harbours, settlements, ceramics and inscriptions, which collectively constitute an ‘ancient quarry landscape’”

In the previous chapters, we have tried to show how we can approach our data systematically by characterising and analysing elements and features of stone quarrying, and how this can aid us in constructing complexes. Logically, a quarry landscape can thus be defined as a landscape containing one or several quarry complexes. As we have seen, several complexes may serve the same main purpose (function) such as providing building stone to Sagalassos. Or, they may display several functions on the same resource, and/or on different resources (Aswan West Bank). Moreover, the complexes may display quarrying for a long time or within a single period (time depth). So, an overall characterization and definition of a quarry landscape may, in short, be based on the function and time depth of its complex(es) (Figure 103).

Several of the case studies (Ankara, Sagalassos, Hittite quarries, Petra (Figure 104) and Jerash (Figure 105)) had one main function - supplying cities with stone. Their time depth is linked to the time depth of the cities. Such “extended city landscapes” have of course much in common, and the baseline for interpretation lies in the change of consumption, resources, logistics and technology over time, as reflected in the cities’ construction. The consumption of the stone is predominantly found in the city, which is the “epicentre” of the quarrying activity. The quarry landscape may expand as the city grows, and/or become more deeply integrated in the city’s infrastructure.
Figure 104. Petra and its quarries, surrounding and integrated into the monumental city.

Figure 105. Simple representation of the Jerash quarry landscape, as a simple complex of limestone quarries basically from one geological unit in the city’s surroundings.

Some of the case studies are even more specific in function - designated to one or few monuments/buildings, such as the Aksaray Tuff quarry (Tavukçuoğlu et al. 2007) and the building stone complex at the Aswan West bank (local temples/monasteries). Such quarry landscapes may be seen as ‘extended monument landscapes’. The Northern Fayum Quarry Landscape (basalt from Widan el Faras and gypsum vessels from Umm es Sawan; Figure 106) and Chephren’s Quarry landscape (Figure 107) both feed into the pyramid complexes together with other quarry landscapes (Aswan granite and Tura limestone). Partially or completely, the pyramid complexes are thus the epicentres for these remote quarrying activities. While these quarry landscapes may be seen isolated as
such (as we have done above), it is important to analyse them also as parts of a greater social organisation and logistic system.

Similar approaches can be made to many other quarry landscapes, particularly of “ornamental stone” where rarity or uniqueness have been an important aspect of their exploitation. Mons Pophyrites (Maxfield and Peacock 2001) and Mons Claudianus (Peacock and Maxfield 1997) as part of the Roman Imperial resource procurement, and many of the marble quarries around the Mediterranean as part of an extensive marble trade system in Classical Antiquity. However, these examples were not designated to one or few specific purposes, but had wider applications due to the “ornamental quality” of the stones involved.

Quarry landscapes involving utilitarian stone production can vary from “modest” procurement of local resources for tools or other “everyday” stone products, to extensive “industrial” production of such over a great time depth. The Al Jafr chert quarries in Jordan and parts of the grinding stone quarries on the Aswan West Bank illustrate the latter. Across Europe and the Middle East, there are numerous such quarry landscapes, and apart of some aspect of Neolithic Stone production, they are indeed poorly studied. Yet, these may have tremendous research value concerning the “everyday life” in the past, revealing trade patterns but also as indicators of food production technology and changes of such over time. For example, a millstone quarry landscape that has been continuously exploited for millennia up to the 20th century, gives unique insights into transitions of the society.

Having been through some fundamental views of quarry landscapes, it is necessary to underline that many of them have different functions changing over time. Quarrying of a specific stone resource may be initiated by the building of a monument, and later the purpose of quarrying changes when the monument is finished. Or, knowledge of a utilitarian resource may trigger use of the same material for other functions. In a class of its own among our case studies, the Aswan West Bank appears as a multi-functional quarry landscape containing a large time depth (Figure 101, Figure 102); this complexity makes it challenging to interpret, but as we will see in the next chapter the complexity also adds several perspectives for viewing significance.
Figure 106. The Northern Faiyum quarry landscape on a geological background.

Figure 107. Chephren’s Quarry Landscape and its complexes. Landsat background.
5. Historical Value Assessment and Statement of Significance
Introduction

The next step in expert analyses of historical values is to articulate them through a theoretical screen in terms of scale (see Chapter and Mason 2008: 114). As the previous two chapters have shown, quarry landscapes present extremely diverse micro-level data, some of these remains ranging widely in terms of visibility and most often extremely mundane and fragmented. So, how do we go about projecting historical values of these landscapes in a statement of significance to decision-makers in a meaningful way? To do this, we have designed four macro-level interpretative concepts that could be used in an expert value assessment of ancient quarry landscapes (see Chapter 2)(Table 35). These concepts have been developed as a means to articulate historical values of ancient quarry landscapes in two ways: first, in a holistic way in terms of how a quarry landscape may have connections with other places and/or events of historical significance; and secondly, as a means to isolate where across an ancient quarry landscape material remains best characterise these values. In the realities of modern development needs we have to be able to ‘best project’ areas of a landscape that may, from our expert perspective, be the most significant to protect.

To test these macro-level concepts this chapter will use, were appropriate, case studies from the project region that may best exemplify how these approaches may aid in articulating historical values in an accessible way. It is important to point out that in some instances an ancient quarry landscape may have connections with other places and/or events of historical significance; and secondly, as a means to isolate where across an ancient quarry landscape material remains best characterise these values. In the realities of modern development needs we have to be able to ‘best project’ areas of a landscape that may, from our expert perspective, be the most significant to protect.

Table 35. The four macro-level concepts in short

<table>
<thead>
<tr>
<th>Socially constructed</th>
<th>Traditions, other use of landscape, ancestry, re-use</th>
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</thead>
<tbody>
<tr>
<td>Contact</td>
<td>Consumption, trade, exchange</td>
</tr>
<tr>
<td>Associated historical</td>
<td>Connections to political, ideological and technological changes and evolutions</td>
</tr>
<tr>
<td>Dynamic</td>
<td>Transformations of landscape, re-use, present day situation</td>
</tr>
</tbody>
</table>

Socially Constructed Landscapes

As explained in Chapter 2, this concept has been designed to allow for macro-level interpretation to get at historical values of a landscape, in its totality, over deep time. Moreover, it allows for historical values to be articulated, even when authenticity of some material remains may be compromised by re-use for other activities. Within the project region, the Aswan West Bank presents us with a key case study to test the feasibility of the concept of a ‘socially constructed landscape’ to get at significance in a holistic way. As described in the previous chapter, five quarry complexes can be
identified according to the types of products produced, these often overlying each other across 60 km² covering a time depth of up to one million years. The material remains in these complexes varies greatly, in terms of visibility and authenticity, across time and space. Moreover, within most of these complexes we have material remains that authenticate other activities and re-use over time, such as burials, monasteries, game drives and desert routes (see Storemyr 2007: 163-181). Or in other words, across time we have periods when the landscape was socially re-configured for other activities, particularly after large-scale quarrying ceased to be the core activity. Hence, in creating a statement of significance applicable to the West Bank we have to find a way to assign historical values to these diverse remains in a balanced way that does not rank or consign them, but provides a plural assessment.

As time depth is key to the ‘story’ of the Aswan West Bank, we need to find ways to view how this landscape transformation through time and can be characterised in terms of social and political change to get at the bigger picture. Such approaches have also been key within the methodology of Historic Landscape Characterisation (see Chapter 2) and are also part of conceptual approaches in social archaeological theory, in particular landscape archaeologies (Ingold 1993; Barrett 1999; Cooney 1999; Knapp 1999; Bradley 2000; Thomas 2001; Grzymski 2004). Hence, ‘socially constructed landscapes’ is a method of macro-level interpretation that blends together a range of these concepts to create a theoretical framework that can be flexible and allow for significance of multi-period landscapes to be visualised.

A recent report on significance of the Aswan West Bank (Bloxam 2007) applied these methods to get at the ‘narrative’ of this landscape to make connections between people and places over time, even though we may have data gaps. For instance, the grinding stone complex has its origins in the Wadi Kubbaniya, associated with Late Palaeolithic semi-permanent settlements. Here, however, we have difficulty in directly determining a chronological sequence of how this quarrying evolved over the intervening periods from these earliest producers into the Predynastic. Of course this is an archaeological problem that would be encountered in any cultural landscape transformed over deep time. Yet, we can argue, if we compare cross-culturally similar instances where production of a single object such as a grinding stone had long cultural antecedents and where production methods attest to little technological change (see Chapter 3 and Bloxam et al., 2007) we can make important inferences. Such evidence is known and archaeologically attested over deep time in Australian aboriginal culture, research has shown how social relations were mediated through production of grinding stones. Over time, these places of production became incorporated into ‘dreaming tracks’ and were continually revisited over time as special places in the landscape (McBryde 1997).

In effect, such a model can help in forwarding the historical significance of an extensive grinding stone complex, in its totality, as authenticating a rare perspective that links quarrying of a single object into the dynamics of social life on the West Bank across deep time. When grinding stone complexes lie side by side with ornamental quarrying in the Dynastic period, such as at Gebel Gulab and Khnum Quarries, we can use such a perspective to view the extent to which changes to large-scale object quarrying may have impacted on these social relationships locally. Key to such changes would be indications from material remains that characterise the hand of the ‘state’ and ideas of monopoly of the resource (see Chapter 3). Although we see a significant enhancement in production techniques linked to large object quarrying and also logistical
infrastructure being laid down, as discussed in Chapter 3, we cannot attest from micro-
level social infrastructure that these transformations impacted significantly on the social
counter of quarrying at this time. In addition, we see no indicators of ownership or
restricted access to the resource. Yet, we can identify a continuity in inscribing of the
landscape, particularly related to local gods and those that attest to symbolic links
between silicified sandstone and the solar cults.

In essence, we get a sense of continuity even through periods when resource
exploitation transformed quite significantly. We may be able to visualise this continuity
through the inscribing of the landscape and from grinding stone production as key
activities that linked people, in kin groups, with these places through ancestry. We may
consider that restriction of access to this resource, rather than materially visible, was
socially constructed via such groups over time (see Bloxam 2007: 13). As suggested,
perhaps ‘social restriction’ may be embodied in the fact that the grinding stone
production methods, their shape and other attributes implies this continuity with little
change over time, something that would not be expected if procurement was open to
‘outsiders’ or transformed into a monopolised industry.

The concept of a socially constructed landscape allows us to include all material
remains of a landscape, even if authenticity has been compromised by later activities, to
be historically significant. Today, artisan quarrying for local house building attests to
these resources still being important places and although such low key activities today
may continue to impact on authenticity, it helps us see the dynamics of this landscape
into the present as significant. In essence, historical and informational value lies in its
totality that has no clear boundaries because it authenticates a rare ‘storied’ landscape,
which at its core, tells us about human engagement with its natural resources from the
earliest tool makers of the Lower – Middle Palaeolithic into the present.

Statement of significance: the Aswan West Bank

If we are to draw up a statement of significance of the Aswan West Bank, we would
have to forward this value assessment at the broadest level of criteria in terms of scale,
importance, uniqueness/representativeness using comparative analysis. Viewed in its
totality as a socially constructed landscape we can present a strong case for the Aswan
West Bank being of ‘global’ significance, as it represents a unique case in being the last
known ancient quarry landscape where exploitation of a single resource can be
characterised through deep time from the earliest tool makers. We would then isolate
key places across the landscape that characterise this longevity, as discussed above. If
global historical and informational values can be attributed to an ancient quarry
landscape, then a statement of significance would project the view to decision-makers
that there is a strong case for World Heritage nomination through UNESCO criteria of
‘outstanding universal value’ (see Chapter 2 and Bloxam 2007: 15-18 where this is
discussed further).

Value assessments by decision-makers and stakeholders would be urged to take further
this holistic view in terms of assessing economic, aesthetic and other values that fall in
their domain. Moreover, in terms of the Aswan West Bank, World Heritage sites
already exist in the locality to the south and east (see Storemyr et al., 2007: 179). So,
we would need to stress the importance of making efforts to expand these already
existing boundaries to the north up to the Wadi Kubbaniya. Although viewing the
landscape in its totality is key to getting at global significance, we would also need to take a perspective in a statement of significance that can isolate key areas within the landscape where material remains characterise historical and informational value in their own right. Certainly, given the extent of the Aswan West Bank (60 km²) we need to inform and make ‘best projections’ to decision-makers about where and how these places are significant. As mentioned in the introduction, we do not prescribe only one macro-level concept to be applied in an historical and informational value assessment as there has to be some flexibility that would need to take into account many external factors. The above has only demonstrated how one concept may be applied to an ancient quarry landscape of such complexity over time and space. Later in this chapter, a specific area of the Aswan West Bank will be looked at through a different macro-level concept.

Contact Landscapes

This concept has been designed to get at historical values of an ancient quarry landscape holistically due to its connections, via consumption of its products, with other places of historical significance (see Chapter 2). More than many other products, stone can be traced revealing ancient trade patterns. The fact that stone provenance has been so much the focus of research over the last tens of years, in many ways underlines the importance of such knowledge: the quarry landscapes can be important sources of information about their “contact landscapes”. This concept would, however, only be applicable if expert analyses can provide secure provenance, between the resource and consumption of its products, in secure depositional contexts of a given historical period. These depositional contexts may be in close proximity to the resource, such as a city of major historical significance, or may have been incorporated into important monuments distant from the resource. If the function of a quarry landscape has been to provide building stone for a city, its significance must necessarily be strongly connected to that: the quarries adding informational value to the cities. Moreover, many quarry landscapes of antiquity became sources of stone that were distributed widely across the ancient world and so we may say that they were at the epicentre of great trade systems. As an example, articulating significance for the quarries in “cippolino” marble from the Greek island of Evia must include the distribution of the marble to almost every corner of the Roman Empire. Similarly, the concept of contact landscapes will also be important in the case of utilitarian stone production, were distribution patterns provide some of the most fruitful ways of understanding exchange and trade patterns.

The concept also takes a holistic approach to a quarry landscape and is particularly applicable when it is difficult to make a strong case for historical and informational values to be attached to specific material remains therein: the contact landscape as an “extended” quarry landscape. For instance, there may be scant if any remains that characterise the social context of quarrying and logistics. Or in other words, as opposed to the Aswan West Bank, the quarry landscape may not stand comparatively well in terms of scale, importance and representativeness in its own right in a statement of significance.

In many of the case studies, the concept of contact landscapes provides perhaps the most useful perspective to get at significance. As we have seen, studies of the quarries
at Sagalassos and their chronological use for building the city has provided new perspectives for interpreting the city’s evolution. Similarly, the case study in Jerash, Jordan, has revealed the existence of a large limestone quarry landscape surrounding the city, and there is clearly a rich research potential in these that can add informational value to this Roman city. Similar conclusions can be drawn in the case of Petra, Ankara and the Hittite cities. The Aksaray tuff quarry (one monument – one quarry), makes a simple but interesting case; the historical significance of the quarry depends on its contact landscape – the monument, and vice versa, the quarry may add value to the latter. Thus, the concept of contact landscapes is the key tool for analysing the interconnectivity between the stone resources and their use, for enhancing historical values at both ends of this dynamic.

Quarry landscapes in direct proximity to historically significant cities of antiquity, or monuments, are key examples where, in some cases, the quarries may almost completely lose their identity and authenticity as they were almost entirely incorporated into the fabric of the city. The quarries in the city of Sagalassos are typical examples where the often few remains of the resource have been re-used as foundations of later buildings and/or as structural walls (Figure 108). Here, the extent that these resources were consumed to create the city goes as far as incorporating even spoil heap material into the construction of buildings (see Degryse 2007a) contributing further to the almost complete invisibility of some of the quarry complexes surrounding Sagalassos. Significantly, the resource was also consumed for an entirely different purpose, given that these quarries are also incorporated into the necropoli that surround the city (Figure 109). The burials are either directly into the resource, or, sarcophagi were quarried from extracted blocks, used and deposited almost in the same context (op. cit.).

Figure 108. Large house built of rubble situated in a limestone quarry
**Statement of significance: Sagalassos**

Within the concept of a ‘contact landscape’ we can make an historical and informational value assessment of the scant remains of the quarry complexes of Sagalassos within their broader context as integral to the city. Importantly, such a statement would focus historical values where ‘contact through consumption’ has almost entirely consumed a stone resource. Hence, the scant material remains of the quarry complexes that surround the city authenticate and provide key historical and informational value as to how building of an ancient city, and burial of its dead, profoundly impacted on local resources over a relatively short time depth (appr. 1000 years).

Assessing historical and informational values in terms of scale, importance, uniqueness and representativeness the task is less easy. At the time of writing, there is little comparative data from other quarry landscapes in Turkey, although we know of several Roman period cities that also heavily exploited local resources for buildings and burials, such as Termessos (Roos 1985; Pekridoui 1985). Hence, these quarry complexes are not unique on a national or global scale, although they are representative of a specific type of ‘contact through consumption’ quarry landscape that is important at local and regional levels. It would be important to include the Sarakiya quarries, that are part of the ‘greater’ Sagalassos quarry landscape, located 5 kms from the city, into any significance statement. Characterised by one large remaining quarry face (see Chapters 3 and 4) these quarries are also part of this ‘contact landscape’ given that consumption included stone from this resource. In terms of informational value, these quarries are key in determining the ‘internal’ logistics within the greater Sagalassos quarry landscape that are largely unknown.
Other applications of ‘contact landscapes’

The concept of ‘contact landscape’ would also be one of several approaches to conceptualise the Widan el-Faras basalt quarry complex within the greater pyramid landscape of the Memphite necropolis (this includes the Giza plateau and Abu Sir pyramid mortuary landscapes) during the Old Kingdom. Basalt from Widan el-Faras can be provenanced to several ‘royal’ pyramid complexes here of contemporary age. Similarly, in an Old Kingdom context, Chephren’s Quarry is an important contact landscape because Chephren gneiss as life-sized statues were found associated with at least one of the Old Kingdom pyramid complexes. As the resource has only one source in Lower Nubia, it means we can track its distribution through deposition of products that can be significant in connecting a quarry landscape to a range of other places. For instance, products from the statue and vessel quarry complexes of this landscape occur across a wide of range ‘royal’ depositional contexts of enormous historical significance, both inside and outside Egypt in the Old Kingdom, at the pyramids of Saqqara and the Giza Plateau and royal contexts in Byblos in the Levant (Scandone-Matthiae 1988; Bevan 2001; Bloxam 2003). We can therefore forward connections between Chephren’s Quarry into an international trading and/or prestige gift giving arena at a key stage in the early Egyptian state.

As opposed to Sagalassos, the quarry complexes of Widan el-Faras and Chephren’s Quarry consist of material remains that characterise logistical, production and social infrastructure and hence we can also use other macro-level concepts together with ‘contact landscape’ to get at historical and informational values (see below). The aim is to recognise that in a statement of significance, one would try to articulate these values through as many of the macro-level concepts as possible and project where these can be assigned to material remains in the quarry complexes. For instance, ‘contact landscape’ is also a useful concept to get at significance of more mundane elements of production, such as stone tools, particularly when depositional context in another contemporary quarry complex far from the source, means they were used as a secondary resource (see Chapter 3). At the Umm es-Sawan gypsum quarry complex in the Northern Fayyum, imported secondary resources to be used as tools from distant sources, such as Chephren’s Quarry, is a key characteristic of production evidence unknown in any other quarry landscape in Egypt. There is key informational and historical value attached to the importation of stone tools from distant sources at times of intensive and contemporary quarrying that can illuminate and give rare insights into social contacts, either directly or indirectly, between those who worked at these places that are 800 km apart.

We may also apply the concept of ‘contact landscape’ to some of the earliest quarry complexes of the Neolithic and Chalcolithic, such as the chert quarries of Al Jafr in Jordan (Abu-Jaber et al., 2007a, see also Chapter 3) in a statement of significance. Provenance studies at the Al Jafr quarry landscape attests to it being at the epicentre of a wide distribution of chert tools from this one source. In a statement of significance, decision-makers need to be informed that informational value is of at least national importance in terms of future research into understanding some of the earliest trade networks in the Eastern Mediterranean. In addition, there is key informational value linked to production remains and other material elements of this quarry complex that are still under investigated. For instance, assessing historical values that may be attached to technological aspects that may be unique to this quarry complex.
Associative Historical Landscapes

Described in Chapter 2, this concept is particularly useful when we can contextualise quarry landscapes, or complexes within them, to key events of historical significance. Hence, we need to have secure datable contexts related to material remains in a quarry landscape and in addition, other sources of information (from written sources) and research that gives us the contemporary historical backdrop. This information having been used during micro-level interpretation (see Chapter 3).

In the Northern Faiyum (the basalt and gypsum quarry complexes) and at Chephren’s Quarry, these extensive quarry landscapes largely dated to the Old Kingdom are key places where we can associate the transition to the early Egyptian state, characterised by monuments of global significance (the pyramids) with a revolution to almost ‘industrial’ scale quarrying at these places (see Bloxam and Heldal 2007). In the Northern Faiyum and associated with the basalt quarrying complex at Widan el-Faras, we can authenticate the impact of this revolution in terms of logistical infrastructure (characterised by the first paved ‘quarry road’ see Figure 52). Also, across the greater landscape at the Great Pyramid Complex of Khufu on the Giza plateau, another technological ‘first’ from evidence for sawing of basalt in the laying of the mortuary temple floor (Petrie 1883: 174-5, Moores 1991; Bloxam and Heldal 2007: 314). In addition, primary resource extraction led to an exponential use of local secondary resources and also the importation of stones for tools from other quarry complexes in Egypt, to expedite extraction and transportation of this product.

At Chephren’s Quarry, authentic remains from production, in particular block reduction to statue rough-outs, characterise the Chephren’s Quarry Statue Complex’. Logistical infrastructure and the social infrastructure linked to transportation of these products can be authenticated in the Chephren’s Quarry transport route (see Chapter 4, Figure 107) Across time and space, we can link and characterise both complexes as integral to royal acquisition of a resource for ornamental purposes as constituting the first appearance of life-size statuary known. The intensity of production for these products and for other ornamental objects such as small vessels, is what characterises the quarry landscape we see today.

Within this concept, we may also raise some questions concerning the other case study areas, even though detailed studies which may provide answers were not carried out in the project. For instance, are there features in the Hittite quarries which are unique to this cultural context? Do the tall sandstone quarries at Petra reflect a particular technology and organisation of the Nabateans that stands out in the greater picture of the evolution of stone production technology?

Statement of significance: Widan el-Faras (Northern Faiyum) and Chephren’s Quarry

In a statement of significance, in terms of scale, importance, uniqueness and representativeness, we would first articulate historical and informational values on a
scale relative to the complexes that best characterise and authenticate these historically significant transformations. At Widan el-Faras, the logistics of large-scale basalt transport to the Giza plateau and the construction of the world’s first paved quarry road is of global significance, as it has no other comparison. At Chephren’s Quarry, the statue quarry complex is of global historical value as its material remains authenticate the world’s first known statue quarry. Hence, we could ‘best project’ and isolate global historical values at these two complexes within these quarry landscapes.

In the case of such extensive landscapes as the Northern Faiyum and Chephren’s Quarry that cover areas in excess of 100 km² and with the knowledge that both these landscapes are under high risk from modern development, as assessed and monitored during the QuarryScapes project (see Storemyr 2007: 68-88) a statement of significance would need to make such projections. Although we should provide a holistic perspective, given these landscapes’ significance are more than the sum of their parts. For instance, the transport system may not compare logistically with Widan el-Faras at a global level, however, with its additional social infrastructure, sight-lines and evidence relating to climate in the Old Kingdom (see Chapter 3), a complex of this type is unique certainly to Egypt, and perhaps globally in terms of historical and informational values relating to the social organisation (particularly in terms of stone transport) and subsistence of an Old Kingdom labour force.

Transformations to intensive production of a resource set in motion other activities across time and space that are directly related to primary resource production. Although these may not be of global significance as isolated complexes, together they make up the whole. In addition, both landscapes include quarry (and mining) complexes that authenticate exploitation of other primary resources. For instance, gypsum at Umm es-Sawan in the Northern Faiyum and carnelian (in the Middle Kingdom) at Stele Ridge at Chephren’s Quarry (see Chapter 4, Figure 107). Hence, we would need to present historical and informational values also on a holistic scale. This is particularly difficult, given that at a national level we are comparing both landscapes also with the Aswan West Bank. Arguments for global significance would have to be carefully measured and take into account other macro-level assessments of significance (some discussed above). Then, be further assessed through World Heritage criteria of ‘outstanding universal value’ – such an assessment was recently forwarded in relation to the Northern Faiyum (see Bloxam and Heldal 2007).

The Aswan West Bank

The Aswan West Bank articulated through the concept of socially constructed landscapes allowed for its global significance to be forwarded to decision-makers from an expert perspective. However, as a landscape under pressure (see Storemyr et al. 2007) as recognised during QuarryScapes survey work, we should also be looking at where we can ‘best project’ historical and informational values at specific places across this extensive landscape. There are several key areas where we can do this, although we need to think about where material remains best authenticate and can be contextualised with historically significant events. The Dynastic ornamental quarry complex at Gebel Gulab and Khnum Quarries is one area where we can demonstrate this, through the concept of associated historical landscapes, because they provide additional indirect evidence towards understanding a key transformative stage in Egyptian history.
At the beginning of the New Kingdom in the 18th Dynasty and particularly during the reign of Amenhotep III, solarising of the major cults of Egypt and the king identifying himself with the sun god Ra became the key religious orthodoxy of this period (Kozloff et al., 1992: 76, 110). The implications of this has a direct connection with the explosion of silicified sandstone quarrying for ornamental purposes, due to its identification with the solar cults, characterised by material remains particularly at Gebel Gulab and Khnum Quarries (see Chapter 3 and Bloxam et al., 2007). In terms of authenticity, Gebel Gulab and Khnum Quarries are currently quite well-preserved, although at medium to high risk from local village expansion and looting (see Storemyr et al., 2007: 86). Production evidence of partially finished large objects, ceramic data, transport infrastructure and epigraphic data related to solar cults, characterises these New Kingdom quarries (see previous chapter and also Bloxam et al., 2007).

After a brief hiatus, Seti I of the 19th Dynasty reinitiated silicified sandstone quarrying for ornamental objects in his desire to model himself on Amenhotep III (Brand 2000: 128, 360). However, his ambitions to remove large objects from Gebel Gulab and Khnum Quarries were never realised, given his early death after only 11 years as king. The remains left from this last episode of New Kingdom ornamental quarrying, particularly at Khnum quarries where an obelisk base and two partially worked statues and/or obelisks remain unfinished, lie as testament to these unfulfilled ambitions.

Although this period of large-scale exploitation is only a minor blip (80 years) in the history of quarrying across the Aswan West Bank, it tells us about key historical changes that led to the laying down of the most highly visible infrastructure across the landscape. In terms of scale, importance, uniqueness and representativeness in a statement of significance, we need to identify where these criteria can be best assigned to specific types of material remains within this dynastic ornamental quarrying complex. For instance, historical and informational values would be specifically connected with the networks of quarry roads on and near Gebel Gulab. In terms of scale they would be of global importance, as they probably represent the best preserved examples of an ancient road system linked to quarrying from this period of the 2nd millennium BC. In addition, they form the most visible aspects of this quarry landscape. Hence, we could argue for global historical value and also informational value in what they would yield about still poorly known aspects of overland transportation at this time. The quarries and social infrastructure however have comparable, and in some cases better, material examples locally. Hence, historical values may only be at a local scale of importance, although as informational value where direct connections between stone properties, symbolism and royal consumption in antiquity can be characterised, this would be at least of national importance.

The above has tested this macro-level concept in a quarry landscape where quarrying covers multiple periods. It has best projected where historical and informational values can be attached to a specific place/s within a quarry complex and how they may be put across in a statement of significance. This can aid the planning process when an extensive landscape is under pressure and can also be used as method to isolate other key areas in a landscape that may also authenticate and be connected with other key historical events. However, it has also shown how, in terms of the Aswan West Bank, that such multi-period and multi-faceted sites can lose much of their ‘global significance’ when not interpreted holistically.
Dynamic Landscapes

This concept is described in Chapter 2 and is an approach to how we articulate historical and informational values of a quarry landscape where authentic material remains are almost completely integrated into modern developments, such as a city. Hence, the quarry landscape is characterised through elements linked to other purposes, such as buildings and how they occur across a ‘cityscape’. We could of course apply this concept to places such as Sagalassos as described above, and at the other end of the scale to the Aswan West Bank in terms of past and more recent re-use (see Storemyr et al., 2007). We are aware that there are of course many contradictions in how we evaluate acts of destruction and re-use as significant (see Bloxam 2007: 119-131). So, what we need to think about in terms of macro-level interpretation of quarry landscapes, where authentic remains are almost totally compromised, is to articulate and project historical and informational values onto the ‘living’ cultural landscape that may have completely obliterated these early landscapes.

The quarry complexes surrounding Sagalassos were part of such dynamics in the past so we see that integration into the city ‘frozen’ in time, given that they are under protection by the antiquities organisation (see Degryse 2007a). So, we use the concept of ‘dynamic landscapes’ as a way of seeing such processes almost in action in places such as modern cities today that are still evolving. In some instances the way that buildings are located, sometimes irregularly topographically across a city skyline, may indicate their placement inside disused quarries. For instance in Ankara, creation of the city over time has completely obliterated practically all traces of the andesite quarries that were the main sources of building stone here (Caner-Saltik et al., 2007). In Old Ankara, andesite bedrock formed the foundations of the Citadel area, hence the quarries after use became part of the fabric of the city we see today.

The question is how would we assign historical and informational values to quarry landscapes when there are no material remains at all? In the case of Ankara, historical value would be placed on how the use of resources reflects human agency over time, in terms of how utilisation of the local resources it sits upon characterise the fabric of the city we see today, even down to colour. Arguably, this would be an expert value in terms aesthetics. In addition, historical values should also reflect ingenuity over past generations of builders who recognised ‘extinct’ quarry complexes as valuable foundations for the buildings we see today. As mentioned above, we can have some contradiction here in terms of placing ‘values’ onto destructive actions of historical remains, as would be expected in such circumstances. Yet, what we have in Ankara, as opposed to places such as Sagalassos, is perhaps a vision of what may have happened to a quarry landscape (in a contact landscape perspective) where consumption of a primary resource in close proximity to a city, if the city was not abandoned. Hence, we also have informational value in terms of how we compare cities of the past that were abandoned, with cities of today. In terms of scale, importance and representativeness, Ankara as a major capital is of global significance, but in terms of integration of quarry complexes into its fabric in a present-day cityscape then this is not unique, but rather representative at a national level of importance. Moreover, we have to articulate that ‘lost’ quarry landscapes of the past make up far more of our modern cities and towns.
than realised, and in some instances their layout may be directly attributed to the extinct quarries they may lie on top of.

Table 36. Keywords on the four macro-level concepts for each of the case study areas.

<table>
<thead>
<tr>
<th>Case study</th>
<th>Socially constructed landscapes</th>
<th>Contact landscapes</th>
<th>Associated historical landscapes</th>
<th>Dynamic landscapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jarash (Abu-Jaber et al. 2007b)</td>
<td>No applicable information</td>
<td>City of Gerasa</td>
<td>Roman technologies?</td>
<td></td>
</tr>
<tr>
<td>Petra (Al Saad et al. 2007)</td>
<td>No applicable information</td>
<td>City of Petra</td>
<td>Nabatean industries/technologies</td>
<td>Integration of quarries and monuments (tombs)</td>
</tr>
<tr>
<td>Al Jaf (Abu-Jaber et al. 2007a)</td>
<td>--</td>
<td>Pre-historic</td>
<td>No applicable information</td>
<td>--</td>
</tr>
<tr>
<td>Ankara Andesite (Caner-Saltik et al. 2007)</td>
<td>--</td>
<td>City of Ankara, Citadel</td>
<td>--</td>
<td>Integration into the constructed city, re-use</td>
</tr>
<tr>
<td>Ankara Marble (Topal et al. 2007)</td>
<td>--</td>
<td>Roman monuments, Ankara, re-use in the citadel of Ankara</td>
<td>--</td>
<td>Consumed by modern quarrying</td>
</tr>
<tr>
<td>Aksaray Tuff (Tavukçuğlulu et al. 2007)</td>
<td>No applicable information</td>
<td>Caravanei</td>
<td>Selçuk industries?</td>
<td>Modern quarrying</td>
</tr>
<tr>
<td>Hittite limestone (Akoğlu et al. 2007)</td>
<td>No applicable information</td>
<td>Hittite cities</td>
<td>Hittite industries/technologies?</td>
<td>No applicable information</td>
</tr>
<tr>
<td>Sagalassos (Degryse 2007a)</td>
<td>--</td>
<td>City of Sagalassos</td>
<td>Roman technologies?</td>
<td>&quot;Frozen&quot; quarry landscape</td>
</tr>
<tr>
<td>Chephren’s Quarry</td>
<td>Traditions of stone procurement</td>
<td>Pyramid complexes, Northern Fayum</td>
<td>First statue quarry, Old Kingdom industries</td>
<td>Modern land reclamation</td>
</tr>
<tr>
<td>Northern Fayum</td>
<td>Traditions of stone procurement</td>
<td>Pyramid complexes (consumption), Chephren's Quarry and Aswan (tools)</td>
<td>First paved road, first hard rock sawing, Old Kingdom industries</td>
<td>Modern quarrying</td>
</tr>
<tr>
<td>Aswan West bank (Bloxam et al. 2007)</td>
<td>Time depth of Utilitarian stone production, hunting, inscribing of the landscape</td>
<td>Wadi Kubbaniya settlement, Elephantine, West Bank monuments</td>
<td>Palaeolithic grinding stone production, New Kingdom ornamental stone quarrying (&quot;authentic remains&quot;, particularly logistics) Food production technology</td>
<td>Modern development, ancient re-use</td>
</tr>
</tbody>
</table>

Discussion

We have aimed to test four macro-level concepts as a way to articulate historical and informational values in a statement of significance, in a meaningful way to decision-makers. These concepts have been designed as a way to aid decision-makers and stakeholders visualise at worst the invisible, and at best, often confusing sets of material remains within their broader historical context. The information that decision-makers, managers and stakeholders take away from a statement of significance in relation to an ancient quarry landscape in terms of scale, importance, uniqueness and representativeness, would then be integrated into other frameworks of value assessment in their domain. The approach has been from both a holistic view of an ancient quarry landscape and also to ‘best project’ where historical and informational values may be attached to material remains within a quarry complex. Best projections being a planning tool for decision-makers when landscapes are under pressure from modern development needs.
We do not subscribe to ‘squeezing’ quarry complexes into just one type of macro-level assessment but have discussed ways in which experts may be able to articulate significance, from various macro-level perspectives, relevant to the material remains they may be dealing with. The quarry landscapes from the project region provided a good sample of the ranges of material remains that can constitute a quarry landscape and how one may go about articulating significance with even the most fragmentary and barely visible remains. Macro-level perspectives can also help experts recognise historical and informational values in ways that may not have previously been realised and so enabling a feedback mechanism onto the micro-level remains. A methodology for macro-level interpretation always needs to be reassessed and should be flexible if it aims to be globally transferable. This has been a start to gathering a consensus on how we put quarry landscapes on the conservation agenda by making them significant to decision-makers and stakeholders in a meaningful and accessible way.
6. Conclusion: from significance to conservation and management
Characterisation of quarry landscapes

In this report we have attempted to collect and analyse the empirical data from the different case studies in QuarryScapes and design a methodology that may be an effective way to articulate historical and informational values in an expert statement of significance. We have tested this method through various case studies from the QuarryScapes project region that reflect the great diversity of material remains that constitute and characterise an ancient quarry landscape. The aim has been to find ways of drawing up a statement of significance that can be accessible and meaningful to decision-makers in the initial stages of conservation planning of quarry landscapes.

In the project proposal, we outlined the “road to conservation” from the recognition (of a quarry landscape) to sustainable management of it (Figure 110). The work packages and the case study areas were collectively designed so that each of the six steps would be explored.

The case studies have each contributed to shedding light on different aspects of quarry landscapes. The work packages focusing on “recognition” of quarry landscapes have truly raised interesting “eye-opening” questions, of which the following are some examples; the importance of a (physically) non-existing quarry landscape in Ankara (integrated into the city), recognized through provenance studies has opened new ways of viewing the evolution of the city; recognition and investigation of a huge quarry landscape around the ancient city of Jerash has added value to the city and presents a large research potential, but also revealed how these sites are gradually changed and partially destroyed by agriculture; recognition of Hittite quarries in Turkey has put stone acquisition on the agenda for further research on their cultural remains. These cases most of all show how doors to new perspectives open when stone and quarries are put in focus, and once again underline the need of awareness-raising.

The case studies involving deeper investigation of their material remains first of all have shown how complex such sites may be, but also how they are deeply under-investigated and carriers of huge informational values for the future research. The Aswan West Bank, which previously was seen as a rather simple and modest New Kingdom ornamental stone quarrying site, has developed into a deeply rooted and complex cultural landscape around human interaction with specific resources through huge time depths. An interesting potential for similar approaches is found in the Al Jafir Quarry landscape, Jordan. In Sagalassos, the quarries have aided the interpretation of the city’s
development, and appears as a rather typical example of use of stone in growing cities of Classical antiquity.

The investigations of the various sites have also, as we have seen, provided an empirical basis for a systematic approach to features related to quarrying. We have proposed a way of describing and characterizing such features by grouping them into four main elements: the resource, the production, the logistics and the social infrastructure. In our opinion, this provides a useful method of connecting physical remains in quarries to processes, technology and organization, by micro-level analysis. Finally, we have introduced the term “quarry complex” as a necessary tool of interpretation, in between a quarry and a quarry landscape. We believe that defining such complexes helps in visualizing complexities in quarry landscapes, and extracting individual characteristics that can aid the articulation of significance.

When dealing with quarry landscapes in different cultural and historical contexts, it is of course difficult to tie them to a uniform scheme of characterization. However, many such landscapes tend to be multi-period, the resources are re-visited several times, with different purpose, organization and technology. Therefore, we think it is vital to be able to get to holistic views of such landscapes, even though they extend out of the “most interesting”, or most highly profiled, historic context. It is challenging to characterise and analyse a quarry landscape that has been more or less in continuous production from Antiquity, through the Medieval Period and into modern times!

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

Historical significance: building the case of conservation

As we pointed out in Chapter 2, the assessment of values of cultural landscapes is complicated, and there are ranges of different values that on equal terms have to provide the input for management strategies. What we have done, is to separate between “expert values” (historical and informational values) and others (see Figure 111). Not because we think expert values\(^7\) are more important than the others, but because we think that it is actually regarding these expert perspectives that we, in QuarryScapes, can propose a methodology that may work “in a range of cultural contexts”, as we said in the proposal. Naturally, this is more difficult to achieve regarding economic, social and aesthetic values, that belong in the domain of decision-maker (management) and stakeholder interests.

\(^7\) In addition to experts in archaeology and geology, as focused in this report, other experts in different fields may also input where relevant
Acknowledging that, we have constructed a model for macro-level analysis resting on four concepts: the social construction of the landscape, contact landscapes, associated historic landscapes and dynamic landscapes. After testing such analysis on our case studies, we believe that these concepts work as instruments for enlightening aspects that are important to quarry landscapes (and perhaps production landscapes in general?) and which can provide different roads to a statement of significance. Furthermore, we think this methodology is not only useful for comparing different quarry landscapes, but also for going back to their elements to find which of them are the “best projections” of the historical and informational values assessed, recognising that such selection often has to be done. As already stated, we think this road towards articulating significance is vital for building a case for conservation of a quarry landscape. Remembering our introduction to the report, about how “quarry landscapes” can be a relevant perspective of any cultural landscape where quarries are present, it might even be desirable to use such methodology independently from other value assessments, and that the specific “quarry values” may arise as one of many “competing” landscape values.

![Figure 111. A modified model (from Mason 2008) showing the process towards landscape management. The themes of the present report are shown in yellow.](image)

**The road to sustainable management**

Although the present report centres around an expert statement of significance (“what is important to conserve from a historical and informational perspective”) QuarryScapes has also been studying other aspects of quarry landscapes closer to the management of them. WP5 covered an inventory and evaluation of risks to quarry landscapes in Egypt (the “conditions”; Figure 111, Storemyr 2007). This work showed how it is possible to assess risks to such sites on a national or regional scale in a comprehensive way in a
short time, and identify the main active mechanisms of threats to the sites. Moreover, Storemyr et al. (2007) shows how to assess risk patterns and evolutions for several case study quarry landscapes. Such analyses can easily be integrated with the historical value assessment – and interact with a dynamic landscape concept.

Two work packages focused the implementation of actions concerning quarry landscapes in Egypt. WP 6 aimed at building a concept for conservation of the Northern Faiyum Quarry Landscape (NSCE 2008), involving stake holders and legal issues in the analyses, thus bringing one of the case studies one step further into practical site management. This has been an interesting exercise, revealing many interest groups and potential conflicts. However, it also reveals how important it is to clarify a statement of historical significance on solid grounds as an input to a site management process.

The same applies for the integration of empirical data on quarry landscapes (basically maps) into a national heritage management system. Three Egyptian quarry landscapes were “delivered from researchers” and “processed” through the Egyptian Antiquity Information System into GIS databases that can be applied for future site management. The question of “which parts are most important” soon arose, and although the researchers, including ourselves, did make priorities, these surely would have benefited from being processed through the analytical framework we have presented here. WP7 also included a national inventory of quarry landscapes, and a comprehensive national map of Egypt was constructed from several data sources. The datasets include not only information about features of these quarry landscapes, but also their legal status. Thus, the inventory should be displayed as a “school example” on how a national inventory can be carried out in a short time.

In QuarryScapes, we have strongly leaned on a landscape perspective as key to conservation of quarries. It may on the surface seem a bit exaggerated to make a landscape out of one quarry. But, as we have seen, the historical significance of quarries will often rest strongly on their connections to other physical elements in the landscape, to their use and to various extensions of the metaphysical landscape. Hence, we are, through the case studies, strengthened in our view of the necessity of using landscape perspectives. On the other hand, we think the methodology presented can also be used as a tool for “reducing” a landscape to one or more ‘sites’ if this proves to be the best (or most realistic) way towards conservation.

The fact that quarries are not where they are without reason but are initiated and driven by some other, close or remote, processes in society, also underlines the point of not seeing them isolated – but as a part of…something else. Therefore, they are often adding value to other historical sites or processes more than standing alone. This is reflected in how they are mostly protected (or not!) in the world today – as part of other sites or protected landscapes. The stone quarries within the Jurassic Coast natural WHS, United Kingdom (www.jurasiccoast.com), are adding value to the geological landscape as human interaction with the “protected” geology, and the quarries of Petra add value to the city site.

Although QuarryScapes intends to raise awareness about the importance of quarry landscapes, we realize that such connections are vital for future management, protection

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8 Prof. James A. Harrell must in this context be gratefully acknowledged, having contributed with extensive data.
and promotion. Without doubt, the Pyramid (mortuary) landscape of the Giza Plateau in Egypt stands well in its own right as a site of global significance, but they would appear even greater when extended to the resources of which they were made and the efforts to get them?

The present report and methodology is part of the baseline for making conservation guidelines for quarry landscapes. Such guidelines will present a possible road from identification and analyses of quarries and complexes, via statements of historical significance to “best practice” examples of assessing other values, risks and measures for sustainable management.
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