The definition of cyclopean: An investigation into the origins of the LH III fortifications on mainland Greece

Nancy Claire Loader

Loader, Nancy Claire (1995) The definition of cyclopean: An investigation into the origins of the LH III fortifications on mainland Greece. Doctoral thesis, Durham University.

The Definition of Cyclopean: An Investigation into the Origins of the LH III Fortifications on Mainland Greece.

Vol. I of II

Nancy Claire Loader

Submitted to the Department of Classics, University of Durham
for the Degree of Doctor of Philosophy
1995

Abstract

Cyclopean masonry, used to construct the LH III fortifications on mainland Greece, has been broadly defined as being of large irregular-shaped blocks, commonly of local limestone, unworked or roughly dressed and assembled without mortar, but with small stones set in interstices. Unfortunately, this is the extent to which this masonry has been defined, leaving unanswered questions concerning building style, engineering techniques, and the amount of labour invested in the projects. The heavily fortified palatial/residential complexes of Mycenaean Greece have often been considered the result of an unsettled and aggressive society; however, an investigation into the types and location of the various structures suggest that the walls were designed to conspicuously display wealth. Cyclopean stonework is not confined to the citadels, but includes the elaborate drainage project of the Copaïs and a system of road networks, both which would suggest a high level of cooperation between communities. Indeed, calculations made in considering resource availability demonstrate that fortifications exceeded all defensive requirements and were probably constructed in their initial form as part of a programme promoting and strengthening the status of the state through a display of its wealth in large scale building programmes.

These monumental fortifications are often believed to have their origins elsewhere in the Aegean, Cyprus, or the Near East; however, the evidence points to an independent development on mainland Greece. Features of the fortifications are analysed and compared to earlier and contemporary forms of Aegean, Cypriote, and Near Eastern structures in order to understand similarities and/or differences in construction, with a particular emphasis on those structures outside the Greek mainland that have been labelled as "Cyclopean". The conclusion reached is that in each geographical region the fortifications form a distinct group.

In order to determine the origins of Cyclopean masonry on the Greek mainland, Cyclopean structures other than fortifications are studied and the masonry style is classified into a typology for an understanding of differences in regional work or date. This information is then used to understand Mycenaean social complexity, defined as the resultant behaviours of individuals or groups functioning within a larger collective assembly whose attitudes and actions, either directly or indirectly, affect the larger community, and to show how previous notions of an aggressive and warring society may be inaccurate. Although the Mycenaean culture may have been competitive, its means for competition and displays of wealth could only have been achieved through cooperative measures.

No part of the material contained in this thesis is based on joint research nor has previously been submitted for a degree in this or any other university.

Table of Contents

Appendices.

Abbreviations

AA	*Archaeologischer Anzeiger.*
AAA	*Athens Annals of Archaeology.*
AD	*Arkhaiologikon Deltion.*
Aegaeum	Aegaeum. Annales d'archéologie égéenne de l'Université de Liège.
AI	Ben-Tor, A. (1992) *The Archaeology of Ancient Israel.* The Open University of Israel.
AJA	*American Journal of Archaeology.*
AM	*Mitteilungen der deutschen archaeologischen Instituts: athenische Abteilung.*
AR	Society for the Promotion of Hellenic Studies, *Archaeological Reports.*
AS	*Anatolian Studies.*
ASOR	*American School of Oriental Research.*
BAR	*British Archaeological Reports.*
BASOR	*Bulletin of the American School of Oriental Research.*
BCH	*Bulletin de correspondance hellénique.*
BSA	*Annual of the British School at Athens.*
EG	Marinos, P. G. & Koukis, G. C. (1990) *The Engineering Geology of Ancient Works, Monuments and Historical Sites.* Proceedings of an International Symposium Organized by the Greek National Group IAEG, Athens, 18-23 September 1988. Rotterdam: Balkema.
Ergon	*Ergon tes Arkhaiologikes Hetaireias.*
GAC	Hope Simpson, R. & Dickinson, O. T. P. K. (1979) *A Gazetteer of Aegean Civilisation in the Bronze Age, Vol. I: The Mainland and Islands*, SIMA 52.
Hesp	*Hesperia.*
IEJ	*Israel Exploration Journal.*
JHS	*Journal of Hellenic Studies.*
L'Habitat Egéen Prehistorique	P. Darcque & Treuil, R. (1990) *L'Habitat Egéen Prehistorique. Actes del la Table Ronde Internationale Organisée par le Centre de Recherche Scientifique, l'Université de Paris et l'École Française d'Athènes. Athènes, 23-25 Juin 1987.* BCH Supp. XIX.
MAGE	Institute of Civil Engineers (1976) *Manual of Applied Geology for Engineers.* London: HMS.
MME	McDonald, W. & Rapp, G. R. (1972) *The Minnesota Messenia Expedition.* Minneapolis: University of Minnesota Press.
PAE	*Praktika tes en Athenais Arkhaiologikes Hetaireias.*
PPS	*Proceedings of the Prehistoric Society.*
RB	*Revue Biblique.*
SIMA	*Studies in Mediterranean Archaeology.*
SJA	*Southwestern Journal of Archaeology.*
USDI	United States Department of the Interior.
Zeitschrift	*Zeitschrift des Deutschen Palästina-Vereins.*

List of Figures.[1]

---

[1] Figures have been numbered according to the chapters within which they first appear.

List of Tables.[2]

---

[2] Tables have been numbered according to the chapters within which they appear.

Acknowledgements.

There are many groups and individuals who have made this study possible; each has contributed to my knowledge and understanding of prehistory and, in particular, prehistoric engineering, and each has offered much support.

A special note of thanks is extended to those individuals who assisted my research with additional reading materials, letters in answer to various questions, and personal time: Roland Adams, Timber Technologist and Specialist; Dr. John Bintliff, University of Durham; Robert Boothby, P. Eng.; Dr. Hector W. Catling, University of Oxford; Dr. Joost Crouwel, Archaeologisch-Historisch Instituut Amsterdam; Jim Crow, University of Newcastle upon Tyne; Professor Pascal Darcque, École Française d' Athènes; Professor Pierre De Miroschedji, Recherche Français de Jerusalem; Dr. Oliver T. P. K. Dickinson, University of Durham; Dr. Elizabeth B. French, British School at Athens; Hope Grau, University of Toronto; Professor Sinclair Hood, University of Oxford; Dr. Catherine Morgan, Royal Holloway, University of London; Guy Sanders, British School at Athens; Dr. Metaxia Tsipopoulou, Ayios Nikolaos Archaeological Museum; Dr. Jonathan N. Tubb, The British Museum; Dr. Brian R. Turner, University of Durham; Elisabeth Waywell, British School at Athens; Dr. James Whitley, University of Cardiff Wales; and Professor James Wright, Bryn Mawr College.

I am grateful to the British School at Athens, the American Institute of Archaeology at Athens, l'École Française d' Athènes, Deutsches Archäologisches Institut Athen, Dr. Hector W. Catling, Dr. William D. E. Coulson, Professor Pascal Darcque, Dr. Katie Demakopoulou, Dr. Elizabeth B.French, Professor K. Fittschen, and Dr. Spyros Iakovidis for granting me permission to visit many of the sites in this study. I am most grateful to Dr. Christina Vlassopoulou of the Acropolis Museum in Athens who kindly granted me permission in 1993 to view the remains of the Cyclopean walls. Dr. Vlassopoulou personally escorted me to the section behind the Acropolis Museum and off-limit to visitors, and gave me the chance to explore the Erechtheum. The staff at the Delphi Museum were also most helpful; permission was granted to me to study the terrace walls outside the tourist boundaries. I am also appreciative of the assistance, knowledge, and guidance provided by Dr. John Bintliff both in Boeotia and in Durham. His encouragement has been most generous. Rayna Andrews of the University of Birmingham kindly granted me access to the Mycenae photo archive.

This work could not have been completed without the generous support of the University of Durham: I was granted a University of Durham Research Studentship in 1992-93 and 1993-94, which included a research trip to the mainland of Greece, as well as a grant from the University of Durham Council Fund for Students Travelling Abroad. In 1992, Victoria College in the University of Toronto kindly presented me with a Professor D. O. Robson Graduate Scholarship for Study Abroad. At the same time, my first trip to Greece was handsomely sponsored by a Swan Hellenic Scholarship. A recent research trip to Crete and Turkey was generously aided by the Mortimer and Tessa

Wheeler Fund and a British Institute of Archaeology at Ankara Travel Grant. I extend a special thank you to all awarding bodies.

Dr. Oliver T. P. K. Dickinson of the Department of Classics, University of Durham agreed to supervise this study, offered suggestions as to the approach of the study and guidance throughout its progression.

Encouragement has been found in family and friends, especially Oliver, Hobbes, and Roland, and I am particularly grateful to my family for their consistent and unyielding support, and to Pudding for having to contend with my absence in her life. The Department of Classics at the University of Durham has indeed been most supportive; a special thank you is extended to Professor Martin Smith and Professor Peter Rhodes for their kindness and constant encouragement.

Finally, I wish to thank Professor Joseph W. Shaw for introducing me to archaeology and the prehistory Greece in my undergraduate years at the University of Toronto, Dr. Edward B. Banning of the Wadi Ziqlab Project for providing me with the "field experience" in Jordan, and Dr. Oliver T. P. K. Dickinson for continuing to foster my love of the subject.

This dissertation is dedicated to the memory of

Max Higgins
1899-1988.

Technological innovation takes root in the inquisitive mind.

Chapter 1. Introduction.

The inaccurate and subjective application of "Cyclopean" in early and recent reports is the consequence of the masonry style being ill-defined. The style was labelled as early as the second century AD, by Pausanias in his ‘Ελλαδος Περιηγησις, when recalling the legend of building the fortifications of Mycenae and Tiryns by the Cyclopes (II.xvi.5-6, II.xxv.8). Apollodoros (II.ii.1) and Strabo (VIII.vi.11), and later travellers and geographers have also recounted the legend, labelling the architectural style as the work of the Cyclopes; hence the term "Cyclopean". This label, however, distinguished this style from other types of masonry by its use of large blocks, and did not consider the composition of the masonry itself, which the term has now come to define.

Schliemann, in his 1876 excavations, described the circuit walls of Mycenae as resembling those of Tiryns: "Limestone blocks only slightly hewn or even quite unhewn are heaped one on another..." (Schuchhardt 1965: 136). Wace, who carried out subsequent excavations at Mycenae (1921-23; 1949; 1953; 1954; 1955), further defined the masonry as being "constructed of huge blocks of limestone, shaped only roughly, if at all, and packed together with small stones and yellow clay in the interstices" (Wace 1949: 49). However, this is the full extent to which the style was defined. Robertson (1943: 4, n. 3), in his book on architecture, defines Cyclopean in a footnote of his introductory chapter, although he in fact devotes an entire chapter to "Mycenaean Greece and Homeric Architecture". Of Cyclopean, he writes: ""Cyclopean" walls are characteristic of Mycenaean fortifications: they are built of unshaped stones, large and small...". Even Dinsmoor (1950: 390) avoids isolating the style by defining it simply as "the rude but massive masonry employed by the Aegean peoples and by the early Greeks in the walls of their cities and citadels." It has been assumed that an understanding of the term is met with images of the familiar LH IIIB fortifications of Mycenae and Tiryns, and this has therefore resulted in its inaccurate identification elsewhere. Even so, a definition of Cyclopean masonry is found in *A Dictionary of Ancient Near Eastern Architecture*:

> Composed of very large, irregular, and only roughly dressed stone blocks. It was used mainly in Anatolia and West Iran for fortifications (Luck 1988: 58).

Scoufopoulos' *Mycenaean Citadels* (1971) is the first serious attempt to discuss all excavations and evidence of Mycenaean fortifications and to present some of the earlier defensive walls on the mainland and the Cycladic and Eastern Aegean islands, with the intention of tracing the development of Bronze Age fortifications and the use of Cyclopean masonry. The evidence is presented first and then analysed comparatively by shared and distinct features of fortifications and building technique, primarily relying on the evidence of the major citadel centres--Mycenae, Tiryns, Midea, Athens, and Gla. Scoufopoulos concludes that there are two types of Mycenaean citadel, "political centres" (Mycenae, Tiryns, and Athens) and "military headquarters" (Midea and Gla), which have their origins of building style in Anatolian architecture. However, Scoufopoulos does not consider the possibility that variations in building technique may indeed represent earlier or later developments of the Cyclopean style or may be the result of local materials or regional differences and readily accepts tenuous links to the Near East, based in part on mythic tradition and the acceptance that Ahhiyawa mentioned in Hittite texts can be equated with Mycenaean Greece, which has remained a very controversial question.

Wright, in his PhD dissertation (1978), attempts to place the Cyclopean building technique in the context of Mycenaean masonry techniques as a whole. As with Scoufopoulos, he focuses on the major citadel centres that employ Cyclopean masonry, but also notes its use for bridges and terrace walls. He argues that the masonry is the result of a desire to construct monumental structures, citing block size and wall width, but represents a long development in defensive architecture. He suggests that the move from small rubble walls to massive structures may have been influenced in part by the Cyclades and that the offset construction of Gla may have links to the Near East; however, he sees the origins of Cyclopean masonry in Mycenaean Greece with roots in the MH and early LH period.

Iakovidis (1983) picks up Wright's argument, that the masonry style may symbolise the strength of the ruling power, and argues that the major sites were, in fact, capitals and form a distinct group from other fortified and unfortified settlements at this time. He argues that Mycenae and Tiryns may have been built first as a symbol of power, but that by the final building phase, LH IIIB2, the walls served a defensive function, being clearly impregnable and securing a water supply. Iakovidis does support Scoufopoulos in arguing that elements of construction were borrowed from Hittite building techniques, but differs in his argument that these elements were adopted and transformed into independent features that continued to evolve on the mainland.

Field (1984) returns to the earlier argument of Scoufopoulos, that the Mycenaean sites are military in character, and classifies sites into fortified citadels, fortified towns, and forts or look-out posts. Variations in technique are attributed to a regional grouping of structures rather than building materials or differences in date and, in complete contrast to Wright, it is argued that "there is nothing obviously antecedent on the Greek mainland in the way of military architecture or stratego-tactical concept" (1984: 349). Field does update the available data on Mycenaean fortifications in his PhD thesis (1984), which is essentially a site survey of the material and is the most complete body of evidence available to date. Field's work, along with my own personal observations in 1993 and 1994, provides the background evidence for the research herein.

In 1993, the following mainland sites where Cyclopean masonry is reported were visited:

Achaea	Araxos: Teikhos Dymaion
Argolid	Argos: Aspis and Larissa, Kandia: Kastro, Kazarma: Arkadiko bridge and tholos tomb, Midea: Palaiokastro and Dendra, Mycenae and environs, Nafplion: Ancient Nauplia, Prophitis Ilias (near Mycenae), Prophitis Ilias (near Tiryns), Prosymna: Argive Heraion, Tiryns and environs
Attica	Athens
Boeotia	Ayia Marina, Ayios Ioannis, Ayios Vlasis: Ancient Panopeus, Chaeronea, Eutresis, Gla, Haliartos, Kastro, Khantsa, Larymna: Kastri, Mytikas, Pyrgos, Stroviki, Thebes, Vristika
Corinthia	Isthmia, Perdikaria
Laconia	Geraki: Ancient Geronthrae
Phocis	Amphissa forts (north and south of Gravia), Khryso: Ancient Krisa

In 1994, during a combined research trip to Crete and Turkey, the following sites where Cyclopean masonry is reported were visited, but as in 1993 only selected sites were visited due to time constraints resulting from a restricted field budget and my intention to visit sites not reported as Cyclopean and museums for a comparison of building techniques and study of tools.

Crete	Ayia Triada, Gortyn, Juktas
Turkey	Boğazköy, Miletus: Kalabaktepe, Troy

As a result of the foregoing limitations and being restricted to note-taking and general photographs once on site, I have relied upon various reports, plans, and photographs in addition to that information provided by Field (1984). The latter source, along with Wright (1978), proved invaluable for the measurements that I was prohibited from taking on site. Where comments in this thesis are made from personal observations these are noted throughout, either in the text or by footnoting the particular site concerned.

A detailed description of citadel centres has been avoided, as the foregoing studies, in particular Iakovidis (1983), thoroughly discuss the layout of the citadels, including the palatial complexes and associated housing, cult centres, water supplies, fortifications and their development over time. Rather, the study herein focuses on the engineering aspects of building in Cyclopean masonry and provides an investigation into the extent of local and foreign influence.

Little attention has been given to how the walls were engineered and less notice to the large amounts of time invested in building fortifications, which suggest a function other than that servicing immediate defensive needs, and for these reasons one aim of this study is to define Cyclopean masonry by its constituent parts, in order to understand why the masonry varies between sites and how the masonry was constructed. It is not until more recent times, with the recognition of the wide application of Cyclopean masonry in buildings, bridges, and dams, in addition to its known use in fortifications, that Cyclopean has become defined as a stonework of large irregular-shaped blocks, commonly of local limestone, unworked or roughly dressed and assembled without mortar, but with small stones inserted into the chinks between them. Even this definition, however, leaves much room for misinterpretation and leaves unanswered the question of how the walls were engineered and the amount of time that would have been invested in building structures, and thus these engineering aspects have been considered in this study.

Chapter 2 sets out to define Cyclopean masonry in terms of its total composition, discussing foundations, wall faces, and fill, and considers that the variations in construction methods were often the result of location, local materials and available time, yet the major inconsistencies are sometimes the consequence of structural deformations. It arrives at the conclusion that the aim of Cyclopean masonry was to provide great structural and mechanical strength, and suggests that its popularity was consequential on a desire to build strong monumental walls, not only to secure administrative and religious centres but to display the wealth and domination of the ruling power.

Chapters 3, 4, and 5 examine how Cyclopean fortifications were built, with consideration to quarrying, transportation, and labour resource. Ancient quarry and transportation methods have been somewhat neglected because of the proximity of outcrops to LH III building sites and the assumption that difficulties were only encountered over long distances. Yet, it is unlikely that men, even in numbers, pushed, pulled or carried the blocks from quarries to building site (some stones well exceed 100 tons), and thus another means to convey the building materials was necessary. The construction of the walls required a large labour force and a fairly sophisticated transportation technique, as surely it was no easy task to move massive blocks from quarries to building sites and then to positions in the wall; the precipitous citadel slopes would have further hindered transportation.

Chapter 6 is an analysis of the features of the LH III fortifications intended to assess the extent, if any, of foreign influence and whether the walls were built for defensive purposes. The Near East, particularly Hittite Anatolia, is the most commonly cited source for the origin of the Cyclopean style, and Crete, the Greek islands, Cyprus, and Southern Europe have also been suggested, but all arguments rely on the size of building stones used in construction. For this reason, structures other than fortifications built in Cyclopean masonry have been studied and the mainland fortifications classified by type. In Chapter 7, each of these structures is discussed to determine if the masonry type is specific to any one structure and if this can therefore suggest its possible origins.

Origins of the masonry style are also examined in Chapter 8, "Foreign influence". Reports of Cyclopean structures and defence systems outside the mainland are studied to assess the extent of influence that foreign connections may have made on the Mycenaean builders.

In Chapter 9, all examples of Cyclopean masonry are typologically classified to examine any regional or functional differences in the stonework, which are then used to determine the origins and spread of the architectural style. Difficulties are encountered in determining whether a structure is Cyclopean when reported structures have since collapsed, through other external forces or internal deformations, walls have been strengthened by additions or have been repaired, or when walls have been entirely reconstructed by later generations. Furthermore, it must be noted that misinterpretations occur when natural outcrop is mistaken for Cyclopean masonry. Admittedly, unless on site, it is sometimes difficult to distinguish the two at a distance, particularly if it is a short stretch of wall. In some instances, unworked blocks that appear to have naturally eroded and fallen downslope have been suggested to be isolated Cyclopean blocks, and elsewhere natural outcrops have been mistaken for sections of masonry. Finally, few measurements of the stones have been reported, making the comparison of block size problematic. Labels such as "massive", "huge", "large", "medium", and "small" have been applied. Unfortunately, these definitions are not impartial and cannot be adequately relied upon by other archaeologists, but neither can they be easily avoided. It is agreed that the blocks of the citadels are massive, but size labels imposed upon the archaeological record do not aid in evaluating what are highly disputable structures. Partly as a result of this, a typology of Cyclopean masonry has been established in Chapter 9.

1.1. Conventions.

1.1.1. Site names.

I have attempted to be consistent in the transliteration of Greek site names and geographical regions; however, for ease in recognition I have adopted the more widely used English spelling in some instances. Cypriot names most often follow Fortin (1981). Near Eastern and Southern European site names borrow the common designations, although other recognised names are indicated in footnotes.

The year that each site was visited is recorded throughout, either in the text or as a footnote when the site is first introduced in the text, and thereafter where comments are based on the author's impression as the result of personal observation. This is also recorded in Appendix 5. It should be noted that where no year is given, the author has not visited the site.

1.1.2. Dating.

The following abbreviations for relative dates have been used throughout this study:

EBA, MBA, LBA	Early, Middle, Late Bronze Age
EC, MC, LC	Early, Middle, Late Cycladic
EH, MH, LH	Early, Middle, Late Helladic
EM, MM, LM	Early, Middle, Late Minoan
ECyp, MCyp, LCyp	Early, Middle, Late Cypriote

Absolute dates are in years BC, unless otherwise stated.

Chapter 2. Defining Cyclopean.

Since supposedly Cyclopean masonry has such a widespread geographical distribution, reported to occur in Crete, the Cyclades, the Ionian islands, the Dodecanese, Cyprus, Syria-Palestine and the Transjordan, Anatolia, and Southern Europe (see fig. 2.0.), and incorporates a variety of distinctly different techniques, the stonework is not easy to define. The traditionally simple definition has had the unfortunate consequence that the term has been misapplied, where it refers to nothing more than the size of the stones used in construction.

Wright (1978) and Iakovidis (1983) present the best studies of the masonry, moving away from the more traditional and simplified definition of Cyclopean as a stonework of large, irregular-shaped blocks, commonly of local limestone, unworked or roughly dressed, and assembled with the aid of interstice stones, and examine the overall building technique and variations between major Mycenaean fortified centres. Yet the importance of foundations in building practices has not been fully explored in the published literature, nor are structural deformations, which produce building variations, discussed, and the questions of how the walls were engineered and the amount of time that would be invested in building structures remains to be considered.

2.1. Foundations.

It is surprising and most disconcerting to find that both excavation reports and studies of Cyclopean walling provide little information about the foundations on which walls were raised. Iakovidis (1983) provides the most detailed information on foundations; however, in other literature, explanations of the relationship between support structure and superstructure are generally lacking, and differences in foundation techniques within the same structure and between other units are not always indicated.[3]

Foundations determine a structure's strength, height, and longevity by sustaining the weight of the superimposed masonry, and therefore are the most essential components in the building process. If the support is weak, through either faulting of natural rock, uneven or ill-prepared surfaces, or settlement motions of unconsolidated soils, the superstructure may collapse. In addition, external factors such as location, building material, and structural composition of the wall must be taken into account, and it is precisely these factors that Mycenaean builders would have considered when constructing their walls.

The nature of the foundations was not dictated by the type of masonry, but rather created in response to variations in land forms. Where bedrock was available it provided a natural support upon which to set courses, used, for instance, in the construction of the first fortification at Mycenae (Iakovidis 1983: 27; fig. 2.1.), but when it was impossible to reach an even and solid mass, support was achieved by either hammering or cutting the

---

[3] Shaw's study of Minoan architecture provides the most detailed account of Bronze Age building practices, examining foundation techniques in his chapter on stone (1973: 75-7).

rock, infilling with earth and/or small stones, or by means of a plinth set on alluvial deposits.

Bedrock not only relieves building weight but helps to secure the fill between wall faces. The walls of the terrace constructions of Vasiliko: Malthi and Sparta: Menelaion[4] are founded on bedrock and, as a result, building weight is transferred directly to the ground, helping to stabilise the fill (Wright 1980: 61). It is possible that a lower course placed between the fill and the ground will experience differential pressure through the disturbance of fill settlement and may result in shifting. Instead, when bedrock is used for foundations, tensions resulting from settling processes are directly released to the ground (fig. 2.2a.).

By contrast, a rough foundation surface causes an uneven transfer of weight from the superstructure to the support, increasing tensions exerted on neighbouring stones. Each stone within a structure experiences stress through the physical forces of gravity and friction, and excessive stress occurs within courses when they become burdened with overlying masonry. The contact surface between the uneven foundation and superimposed blocks is reduced and consequently exerts pressures, resulting in a deformation of the wall (see fig. 2.2b.).

The most common deformity is toppling, the collapse of a wall as a result of the forward sliding motion of upper courses (Rodrigues 1988: 1004). Not only do poorly laid courses stimulate collapse, but poor adhesion between the lower courses and the foundation often provokes this deformity. The isolated and piled Cyclopean blocks at Nafplion: Ancient Nauplia,[5] Vari: Kiapha Thiti,[6] and Koropi: Ayios Christos, noted by Field in his site survey (1984: 54, 140, 142), are in all probability the consequence of toppling. In time, all rubble walls collapse from constant and increasing stresses, the length of time varying proportionally with the mechanical strength and durability of the wall. Likewise, the so-called "gappy" construction at Salamis (see Field 1984: 146) has certainly been affected by internal structural deformities. The wall, running north to south and parallel to the eastern side of the mound, was not approached any closer than 150 m by Field; thus, this author finds his observations, of a structure with unfilled spaces in the wall face and well-founded on bedrock, questionable; it is difficult to accept that Mycenaean engineers would build a circuit wall in which intervening gaps would have been left unfilled. Indubitably, such a construction would have been easily penetrated by marauders. Therefore, until a thorough analysis is undertaken, the Salamis wall can neither be ruled out nor confirmed as Cyclopean.

A further problem in building is rock fracturing, where excessive pressures result in breaks within the stone. When these cracks are joined, structures experience rupture

---

[4] Visit in 1993.

[5] Visit in 1993.

[6] From the reported evidence, it appears that Vari Kitsi and Kiapha Thiti are the same site (Field 1984: 140-1). In recent reports the site is called Vari: Kiapha Thiti (see *AR* 1988-89). See Chapter 9 for a discussion on the appropriateness of Cyclopean as a label for this site.

(Nicolas 1984: 25). Although evidence of fracturing has not been reported, excessive building stress must have been of foremost concern to prehistoric engineers. The builders of Pylos, Gla, and Tiryns[7] employed an architectural style where foundations and walls are built along a zigzag line so that each wall section is set back from its adjacent unit, reducing such pressures and increasing the stability of the wall (Wright 1980: 66, 68, 81; figs. 2.3.-2.5.). This system provides a greater number of contact points, thus distributing the weight much more evenly.

Although hammering provides a means to eliminate projections of the exposed rock, cavities would break up flat surfaces and thus required infilling. By using small stones to fill depressions, readily available either on the ground surface, from hammering off projections of the bedrock, or as chips from quarrying large blocks for the *enceinte* walls, masons were able to modify planes. The cavities at Khryso: Ancient Krisa[8] were filled with interstice stones (Field 1984: 211), as were those in the bedrock of the first citadel of Tiryns (Iakovidis 1983: 5). The foundations of the preserved southern limit of the fortification at Eutresis were similarly filled (Goldman 1931: 70; fig. 2.6.).[9] At Mycenae,[10] however, the problem of gaps in the bedrock surface was effectively solved by differing means; the north fortification foundation employed interstice stones, whereas the west wall was built on earth and stones overlying bedrock (Mylonas 1966: 19, 21; Iakovidis 1969: 470, 1983: 29). The earth was used to level the surface and the small stones helped secure the lowest course by providing several contact surfaces (see fig. 2.2c.). This construction provides a similar support to that of a projecting stone socle; the thrust of weight is expelled outwards to the ground by way of the platform (see fig. 2.2d.). Such a stone socle is found at Thebes (Aravantinos 1986: 61),[11] and at Tiryns several parts of the lowest course of the first fortification are wider than the raised courses (Field 1984: 42). A similar protruding lower course was found in the south-west circuit at Nea Epidhavros: Vassa (Field 1984: 61).

The purpose of the foundation courses, the nature of each being determined by local physiography, is ultimately to provide the strength necessary to counterbalance the weight of the superimposed courses. The purpose of the protruding lower course of the so-called detached bastion at Khryso: Ancient Krisa (see Field 1984: 215)[12] is to counteract excessive forces exerted by the slope of the land upon which the bastion is constructed. Similarly, the preserved Mycenaean fort north-west of Amphissa is built to adapt to the grade of the land (Field 1984: 220-21). However, sloping ground at Athens has been treated differently by dressing the ground into horizontal steps (Iakovidis 1983: 88).[13] The lower faces would have been raised to a greater height to account for its low

---

[7] Gla and Tiryns were visited in 1993.

[8] Visit in 1993.

[9] Visit in 1993.

[10] Visit in 1993.

[11] Visit in 1993.

[12] Visit in 1993.

[13] Visit in 1993.

placement on the slope and, structurally, to counteract the thrust of the upper face; elsewhere, however, hammer-dressed bedrock was a sufficient support for the fortification. This stepping arrangement uses the same principle as the cut-and-terrace technique, where a deep horizontal cut is made into the hillside and a wall is constructed upon it. The Cyclopean retaining walls south of Gravia[14] and near the modern villages of Prosilion and Kouvela are founded in this cut-and-terrace fashion (Kase 1973: 76-7, but see n. 194). Retaining walls at Athens further demonstrate the variety of techniques used to dress bedrock. Due to the extremely uneven surface, pitted with numerous cavities, the west wall of terrace III is founded on a layer of earth and small stones set in a shallow trench, whereas the north wall of terrace IV is set exclusively on a layer of stones (Iakovidis 1983: 88; fig. 2.7.).

Architects of Mycenae's second *enceinte* (see fig. 2.1.) had the difficulty of designing and extending the wall over the soft hardpan below the summit, but by cutting a foundation trench into the hardened clay and filling it with small stones and *plesia* they constructed a successfully secure foundation (Iakovidis 1983: 34). It has been argued that the use of the clay is an innovation of Late Helladic IIIB (Mylonas 1966: 21) and its use in foundations is to safeguard against rain and groundwater (Mylonas 1966: 21; Iakovidis 1983: 34; Field 1984: 16). Certainly a water resistant clay would decrease the weakening effect of the infiltration of ground water; however, the argument is weakened by the fact that *plesia* is not reported to have been employed in this manner elsewhere at this time nor in subsequent constructions. It would appear that this does not necessarily reflect a widespread development, but rather a technique employed to strengthen and bind the foundation with the lowermost courses at Mycenae.

It is equally difficult to build above earlier remains, but it can be done, providing foundations are solid and level. For example, the builders of the Cyclopean Terrace Building at Mycenae had to overcome an uneven surface and often soft ground created by earlier strata. They erected the east terrace wall and south wall on a layer of earth and stone, whereas the west wall was founded solely on earth (Wace et al 1953: 16, 1954: 268-69). Similarly, the engineers of the first citadel at Tiryns had to meet the challenge of building walls on earlier deposits and where bedrock could not provide a natural support, walls were sunk in trenches cut through former deposits (Iakovidis 1983: 5).

One of the difficulties in an analysis of ancient building practices is to determine if prehistoric masons were aware of the physical properties of building materials: mechanical strength, durability, stress and deformity. Or, on the contrary, did they simply borrow methods from elsewhere? It is unlikely that foundation techniques were copied from sources outside the mainland, as great variations in wall foundations also occur throughout the Aegean and Near East, and often the diversity in these techniques is a result of the great variations in land.

---

[14] Visit in 1993.

On Crete, the sloping ground beneath the buildings of EM II Vasiliki was horizontally levelled by a stepped plinth and the south-west side of the Late Palace at Phaistos was constructed on a large platform (Shaw 1973: 75, 76; fig. 2.8.). On the other hand, the Neopalatial building at Petras provides a good example of ancient builders making ready use of available resources: the natural rock was levelled with earth and Prepalatial sherds (Tsipopoulou 1991: 30). On Cyprus, the lower course of the L Cyp IIC fortification at Enkomi was placed directly on bedrock except at the junction of the north wall and the Level IIB building, where trenches were cut into early deposits (Dikaios 1969: 68, 69, 512; Åström 1972 IC: 39). Similarly, the two towers set against the exterior face of the second fortification wall were founded on an early deposit (Dikaios 1969: 125). At Kourion: Bamboula the south-east section was partly founded on bedrock and elsewhere on a layer of earth over the rock; the LBA tower was set exclusively on bedrock (Weinberg 1983: 29; fig. 2.10.). At Boğazköy in Anatolia,[15] foundations also vary. At the point where the city wall joins the citadel wall, stone foundations are employed; however, the steep ground dictated the use of soil to artificially level the land and support the walls (Bittel nd.: 12, 13; see also fig. 2.11.). At Troy,[16] foundations of successive fortifications use differing techniques. Troy I and part of VI were built on bedrock, but IIa and IIb used stone substructures to support brick courses and the north section of IIc was sunk through earlier deposits (Blegen 1963: 43, 61, 62, 122; fig. 2.12.). It would therefore seem that Mycenaean foundation techniques did not derive from a common Aegean or Near East practice, nor did Late Helladic stone-workers have consistent practices; rather, as equally apparent elsewhere in the Aegean and Near East, individual solutions were used to solve individual problems.

2.2. Wall faces.

Cyclopean walling has been broadly defined as having faces of large irregular blocks, generally of local limestone, unworked or roughly dressed and assembled without mortar, but with small stones inserted into the chinks between them. The core was commonly a dense fill of earth and stones. However, variations resulting from differences in available resources, workers, and local preferences do occur and, although walls differ in structure and purpose, Cyclopean masonry appears to have been favoured because of its strength and the monumental appearance created by its massive blocks and great width.

This stonework is well-suited to fortifications; not only did the thickness of the wall and its large stones make it difficult to penetrate, but the impression created by its intimidating appearance could enhance its value in defence. In bridge building, Cyclopean masonry is advantageous in distributing the weight of the carrying load over a large surface area. Equally, retaining walls were strengthened, being able to absorb great thrusts of weight from the retained mass.

---

[15] Visit in 1993.

[16] Visit in 1993.

Outer faces were built with the largest available blocks, often roughly dressed and fitted so as to appear solid and monumental. Sometimes the blocks of the inner face were smaller than those of the exterior face, but were positioned in a similar manner. The two faces supported a substantial fill, increasing the width and consequently the capacity to support a considerable number of courses. Wall width is proportional to wall height; wide structures distribute stress over larger areas, reducing the risk of collapse, whereas thin walls of great heights will readily topple. Walls of the Cyclopean Terrace Building average a width of 2.70 m (Wace 1921-23: 403), while in comparison those of the fortification at Mycenae average 5.00 m, having certainly supported a greater number of courses required for defence. Protection was not only sought in the height, but also in the breadth of the structure. Although exceeding necessary defensive requirements, the walls of the mainland citadels would have undoubtedly proved most difficult to penetrate. This would appear to be in part the consequence of the monumentalising phenomenon in architecture in the latter part of LH IIIA, which gives way to a greater focus on defence in LH IIIB2 where walls are generally of lesser widths, and there is a higher proportion of smaller and less elaborately fortified sites. However, as shown in Table 2.2., this is not always the case; monumental walls continue to be erected in LH IIIB at Athens and Khyrso: Ancient Krisa whilst less eleborate structures are built at Chaeronea, Kandia: Kastro, Ktouri, and Mycenae: Prophitis Ilias.[17]

	Date	Average Width[18]
Vari: Kiapha Thiti	LH I-IIB	3.75
Ayios Ioannis	LH III	2.50
Ayia Marina	LH III	2.00
Eutresis	LH III	4.70
Haliartos	LH III (*t.p.q.*)	3.00
Thebes	LH III	5.00
Gla	LH IIIA2-B1	6.00
Mycenae	LH IIIA2, IIIB1, IIIB2	5.00
Tiryns	LH IIIA2, IIIB1, IIIB2	7.50
Midea: Palaiokastro	probable early LH III (see pp. 155-56), IIIB2	6.25
Araxos: Teikhos Dymaion	LH IIIA(-B) (see p. 164)	5.30
Athens	LH IIIB	5.20
Chaeronea	LH IIIB	2.50
Kandia: Kastro	LH IIIB	3.00
Khryso: Ancient Krisa	LH IIIB	5.35
Ktouri	LH IIIB	2.40
Mycenae: Prophitis Ilias	LH IIIB	2.00
Isthmia[19]	LH IIIB-C, post-Mycenaean	5.00
Pyrgos Kieriou: Ancient Arne	post-Mycenaean	2.25

Table 2.2. Cyclopean wall widths.

---

[17] All sites, except Ktouri, visited in 1993.

[18] This table reflects those sites where Cyclopean masonry is confirmed by the author (see Chapter 9) and the average reported, often approximate, measures only.

[19] This author does not believe that the various wall sections of the Isthmian wall belong to the same structure; see pp. 166-67.

The substantial wall widths provide further security by supporting ramparts. Although it is argued that no material remains are preserved to suggest how the top of walls were formed (Iakovidis 1978: 30), uppermost parts may have provided platforms on which defenders could position themselves as needed. The upper course readily lent itself as a platform of ample width where defenders could easily manoeuvre, and provided a quick means of communication between towers. Normally embrasures would provide both a lookout and a protective space from which weapons could be hurled against an approaching enemy; however, apart from the possible arrowslits in the Lower Citadel at Tiryns (Field 1984: 43; fig. 2.5.), such splayed recesses are not to be found in Late Helladic walls. A wall-walk, with or without a stone parapet, would be the only point of defence, since retaliation from behind the massive walls would have been most difficult as attackers could not be seen.

Widths are proportioned to the structure's purpose, monumentality, defence, and location being of concern. The citadel fortifications were considerably wider than those of forts or posts. Wall widths at Haliartos, Ayios Ioannis, and Ayia Marina, 3.00 m, 2.50 m, and 2.00 m respectively, appear to indicate that less priority was placed on monumentality than at Gla, Mycenae, Tiryns, Midea: Palaiokastro, Araxos: Teikhos Dymaion, and Athens, but rather that, as suggested by their location, they were part of a strategic defence network built to protect the Copaïs and principal centre of Gla.[20]

The appearance of monumental walls is a deterrent against attack. The large blocks of the citadel walls would have been perceived as being impossible to disrupt and, indeed, their massive size must have kept them immovable. Filled interstices further reduce the possibility of attackers using the spaces as footholds to scale the wall. In addition, care was taken to conceal weak spots in the exterior face. At Mycenae, breaks in the north wall are, in fact, well-bonded sections of overlapping courses that adhered behind the faces, whereas the section south of the sally-port is uninterrupted by using a smooth curve (Scoufopoulos 1971: 37). Massive gateways also gave a powerful appearance. The well-dressed ashlar courses of the Lion Gate and the large blocks flanking the sides of the entrance at Khryso: Ancient Krisa (Field 1984: 210) suggest impregnability.

The move to dressed stone would have demanded greater precision and time of quarry techniques, and appears to have been simply the product of available time, labour, and necessity. Wright (1989: 177) has convincingly argued that ashlar was used at Mycenae as a symbol of power; nevertheless, this ashlar has been used in the most accessible and thus most vulnerable areas of the fortification. The ashlar blocks provided a protective cover over the structural support of the Cyclopean core, and because of their size and neat surfaces the stones would be difficult to dislodge (Lawrence 1979: 232). Elsewhere, the Cyclopean masonry received additional protection from the acropolis height and the Chavos ravine; the boulders, fitted together with wedges, provided a quicker building

---

[20] Visits in 1993.

method as compared to the carefully shaped ashlar stonework and, as such, were suited to areas not easily reached by the enemy.

Although Cyclopean faces are of undressed blocks, those in corners and where the walls terminate have been deliberately shaped to increase strength. Square stones, aligned with those in immediate positions below, bind the junction of two walls, being most distinct in the fortifications of Tiryns, Gla and Mycenae's Prophitis Ilias (Field 1984: 21). This tight arrangement cannot be made with undressed corner stones. Often corner stones are considerably larger than those used elsewhere. For instance, the Cyclopean and Epano Phournos tombs have large stones in the corners of the *dromos* but smaller stones in the tholos proper (Wace 1921-23: 290, 1953: 81).[21] Large immovable blocks were required to absorb the stress of adjoining walls and to secure junctions. At Geraki: Ancient Geronthrae corner stones were also squared but stepped back slightly (Wace & Hasluck 1904-05: 94-5; Field 1984: 89), perhaps to curtail additional thrusts from the wall being set on the hillside.[22]

Significant differences in block dimensions are attributed to variations in building materials. The hard limestone of the citadel walls is difficult to quarry, but has the advantage of durability and large block size. The wide distribution of joints in bedding planes would have helped to facilitate quarry production (Bell 1990: 1868; see below, pp. 33 and 43) and produce massive blocks. At Tiryns, blocks of the first citadel have an average size of 0.60-0.70 m, but the most massive stones do reach dimensions of 1.25 m by 1.20 m. By the final building phase, advances in quarry techniques enabled quarriers to cut some blocks with lengths of 3.25-4.00 m (Iakovidis 1983: 5, 12).[23]

Advanced coursing is not a feature particular to Cyclopean masonry, but rather seems to have been dependent on labour and building materials. The first citadel walls at Tiryns are built of local limestone blocks laid in horizontal courses, giving a smooth appearance (Scoufopoulos 1971: 48; Iakovidis 1983: 5; Field 1984: 42), but in the second building phase, two different architectural styles can be noted. The first style uses smaller stones than those of the first citadel and courses are uneven, whereas the second style, also uncoursed, alternates between large and small blocks (Scoufopoulos 1971: 49-50; Field 1984: 42). The abandonment of coursing may be attributed to the enormous amount of time required to build the enclosure walls, which was significantly increased when quarriers had to cut blocks of equal heights.

---

[21] Visit in 1993.

[22] Visit in 1993.

[23] Although this is highly speculative, the dressing of corner stones, the squaring of angles and smoothing of surfaces, may represent an initial stage in the development of *anathyrosis*, the contact between dressed outer edges of masonry joints. The well-finished ashlar blocks of the Lion Gate show a further, but basic, development of this technique where vertical joints meet only at the outer edges of faces; in true *anathyrosis* the rear of each block would also be dressed. See Coulton (1977: 169 n. 73) for a definition of *anathyrosis*.

Strength in a wall is increased when blocks are shaped, as the smooth joints enable the weight to be distributed across even surfaces, and because of these neat surfaces fewer wedges, if any, were required to fill interstices.

> Well-finished parallelepipedic blocks arranged in layers with adequate interlocking increase the contact surface, reduce the chances of block rotation and, thus, they can be regarded as ideal procedures for making stable and steep dry-stone structures (Rodrigues 1988: 1002).

However, well-built, yet uncoursed, Cyclopean walls with oblique joints also provide a favourable construction. Blocks are arranged so that they are best fit, gaps being secured with chinking stones and sometimes with earth or clay, which often help to square polygonal stones, aiding to transmit stress between large blocks and thus reducing excessive pressure and possible collapse.

Structurally, the stones helped counterbalance the weight of large boulders through a number of contact points which increase the safety and durability of the structure (Rodrigues 1988: 1002). Wedges increase the number of contact points between stones, transmitting and distributing the weight of upper courses, thus diminishing torques, that is, forces causing rotation, and lessening shear forces, which occur when block surfaces laterally shift against one another. When torques and shears are in equilibrium, a stable dry-stone wall arrangement results. The inclinations of the tholos walls of the Cyclopean and Epano Phournos tombs were initially secured by balancing the weight of the limestone slabs on the inner face with stone wedges (Wace 1921-23: 290, 388).

Interstice stones also permit greater structural flexibility and elasticity. Although stones are tightly wedged into crevices, there will ultimately be minute unfilled spaces which provide security against slight shifts of ground movement and settlement pressure, whereas a dense packing of earth between stones does not provide for excess space and hence, flexibility. Moreover, limestone chinks have better durability than sediment fills, which are easily dispersed by elements of weathering or long-term settlement processes. This may have happened at Larymna: Kastri, where characteristic interstice stones are lacking and breaches west of the central section are found (Field 1984: 163).[24]

The relative number of interstice stones varies between structures. In the circuit wall at Midea: Palaiokastro, Cyclopean blocks are closely fitted and minimum use is made of wedges (Iakovidis 1983: 22; fig. 2.13b.). Very few interstice stones have been used in the wall at Aetos: Ayios Dimitrios. Field attributes this to the nature of local stone and local building practices (Field 1984: 108), but even so builders may have simply felt that a fairly smooth appearance could be achieved with the abundant use of rectangular blocks.

---

[24] Visit in 1993.

2.3. Deformities.

Variations in construction methods are often the result of location, local materials and available time, yet major inconsistencies should be viewed as the consequence of structural deformities. Deformities may be either the result of internal changes within the property of the stone or external pressures acting upon the structure. "Rock properties are governed by the reaction of the rock to the forces acting on it; forces induce a state of stress which results in deformation, i.e., a state of strain" (Winkler 1975: 42). When a stone is placed under a heavy load for a long period of time, slow changes within the rock occur; the stress acting on constituent particles of calcite cause internal deformities (Prentice 1990: 34) and are, unfortunately, not recognised until stress is so intensified that cleavages result.

2.3.1. Toppling.

Toppling, discussed in relation to foundation inconsistencies (p. 19), can seriously distort the appearance of stonework, of which the extreme result is a pile of blocks as, for example, at Vari: Kiapha Thiti. Lateral motions between shifting stones cause fractures in lower courses which, in turn, affect the balance of upper levels (see fig. 2.14a.).

Toppling may have caused the courses in the wall at Perdikaria[25] to appear set back on each other so that the wall is on an angle (see Field 1984: 64). It is possible that this is the result of earth movements or settlement processes but, more probably, it is a structural response to the use of rounded boulders, making for few contact points between stones. The problem with this deformity is that it is often perceived as a local variation of the usual masonry style, therefore misleading in interpretation and comparative analyses.

2.3.2. Bulging.

Similar misinterpretations are made with structures that have experienced bulging. Bulging, like toppling, occurs when courses experience a forward shift, but protrude out from the walls in a convex curve (see fig. 2.14b.). This deformation is critical, in that structures may stand for a long time after having experienced shifting and then suddenly burst open (Rodrigues 1988: 1001-02). The unusual curving in the revetment wall at Ayia Marina (Field 1984: 166) may represent the critical moment of bulging induced by pressures of placing the wall on the slope of the south side of the hill, and the wall collapse evident elsewhere along the trace may be the final product of this deformation.[26]

2.4. Discussion.

The inaccurate and subjective application of Cyclopean in early and recent reports is the result of it being ill-defined. Cyclopean masonry is comprised of large blocks, frequently of local limestone, completely unwrought or roughly hammer-dressed, and fitted with interstice stones. The stone is commonly the hard blue to white *epichoros lithos* readily available in mainland outcrops. Occasionally, weak conglomerates are used, but because they take a good polish and are more easily worked than the compact limestone they are

---

[25] Visit in 1993.

[26] Visit in 1993.

employed for their aesthetic value, being used at main entrances and for structures requiring monumental appearances.

Blocks are generally not shaped except in corners and gateways. Shaped stones gave strength to potentially weak spots by uniformly absorbing the stress of two walls placed at junctions and by binding walls where they terminated. Elsewhere, blocks were used as extracted at quarries, with an average length of 0.70 m and 1.20-1.50 m, height of 0.80 m, and thickness of 0.80-1.00 m, headers being in excess of 1.00 m (Wright 1978: 159-60).

Features of Cyclopean masonry helped safeguard against natural destruction. Interstice stones secured blocks, breaking vertical and horizontal joints up into oblique planes which increase the number of contact points through which stress is distributed to the ground, and the strong compact limestone offers strong mechanical properties which aid in minimising fractures, increasing long term stability and durability.[27] Builders of the gate at Athens further reduced the risks of internal stress and damage by building transverse walls which secured and stabilised the inner fill, therefore decreasing the force of the load against the wall faces (Iakovidis 1969: 471). Similar compartmentalisation was used in the terrace constructions of Vasiliko: Malthi and Sparta: Menelaion (Wright 1980: 61), being structurally necessary to counter the imbalance of pressures resulting from the use of small blocks in the supportive outer face at Vasiliko: Malthi and the rounded, water-worn boulders at Sparta: Menelaion.

Chinking stones are not invariably small; vertical slabs have been noted. It would appear that their size is determined in part by the size of the intervening space and by what is immediately available to fill it with. Occasionally clay is used as a binding agent, although this is infrequent and when used is often combined with small chinking stones.

Inclining faces at an angle to the vertical was another means to reduce pressures that were compounded when building on slopes. All constructions are subjected to forces of both gravity and friction, but when a wall is built on a slope, an additional frictional force is imposed at the point where the slope meets the wall. However, by slanting wall faces to the direction of the hill, the area affected by this friction is reduced. Araxos: Teikhos Dymaion provides the best example of wall inclination, where cambering is still well-defined, having been achieved without affecting the smooth appearance of the wall (Field 1984: 120).[28] It must be noted, though, that the three degree inclination noted by Field in the LH IIIB walls at Larymna: Kastri (Field 1984: 163) hardly deviates enough from the vertical to be considered a conscious building technique.

Further problems of recognition result when characteristic Cyclopean stonework has been interrupted by stretches of differing masonry. At Midea: Palaiokastro, the *enceinte* wall is

---

[27] By contrast, the fragmentary conglomerate remains at Kakovatos: Nestora suggest collapse, a result of pressures on the conglomerate's inherently weak planes.

[28] Visit in 1993.

interrupted with stretches of smaller stones and consequently it has been rejected as being Cyclopean by Scoufopoulos. She argues that the stones used are flatter and smaller than those in the walls at Mycenae and Tiryns (Scoufopoulos 1971: 98), but Field suggests that the smaller stones may have withstood shock better and made the walls much easier to repair in the event of disturbance. He also suggests that these stretches represent repairs of previously vulnerable areas (Field 1984: 36).

Continuous reconstructions by different masons, different techniques and successive generations may alter masonry completely from its original appearance. The wall in the south-west at Ano Lekhonia: Nevistiki is of characteristic Cyclopean masonry, but towards the south-east the wall progressively changes to well-dressed polygonals (Field 1984: 238-39).

> Nevistiki is, with Chaeronea, the classic example of the puzzling phenomenon where a wall, apparently acceptable as Mycenaean, deteriorates progressively along its course until finally it retains little or nothing of its initial character (Field 1984: 239).

Sites such as Ano Lekhonia: Nevistiki and Chaeronea,[29] where a Cyclopean classification is queried because of later reconstructions (Field 1984: 192-93, 238-39, 312), and Ayia Marina, where much of the structure has collapsed, may indeed be Cyclopean constructions that have undergone later repairs or experienced rupture, and therefore indicators of stress, both internal and external forces, must be considered.

Likewise, extensive repairs have resulted in variations in the wall at Geraki: Ancient Geronthrae: dressed polygonals and rough boulders have been used in different sections.[30] Nonetheless, differences in construction do not inevitably suggest differing dates. The north-east part of section Ge of the Isthmian wall[31] is of irregular-shaped stones with small stones fitted in interstices but, by contrast, stones of the south-west face are smaller, the larger stones being used sparingly and placed at greater distances (Broneer 1968: 27-9). This suggests that the massive stones were used conservatively with a greater reliance placed on local field stones.

Iakovidis (1969: 470; Field 1984: 310) suggests that Cyclopean can be further defined as being founded directly on bedrock that was, in most instances, prepared by hammer. However, foundations, although important in construction, do not aid in defining Cyclopean as they vary greatly between structures, the variations being solutions to cope with differing land forms.

It seems that the initial aim of Cyclopean masonry was to provide great structural and mechanical strength. Its popularity was the consequence of a desire to build strong monumental walls, not only to secure later administrative and religious centres but to

---

[29] Visit in 1993.

[30] Visit in 1993.

[31] Visit to Isthmia in 1993.

display the wealth and domination of the ruling power. Although the size and structural arrangement presupposes that Cyclopean masonry was used for its strength, its appearance also suggests that it provided a means by which to convey wealth and prosperity of the territory within which it was based. This does not imply that defence was not a consideration of the Mycenaeans, but that danger was by no means imminent. Cyclopean walls afforded good protection from potential assailants; however, they would have required many working hours and a large number of labourers to quarry, transport, and lay the stones, costs being inflated when stones were imported, such as the Mycenaean conglomerate stone used in the monumental gate at Tiryns (Iakovidis 1983: 7) and the limestone blocks in the wall at Sparta: Menelaion (Catling 1982: 39-40). Wright (1987: 174) proposes that it would have taken ten men approximately ten days to dig Shaft Grave V at Mycenae, and the same ten men almost one year to build the Aegisthus tholos. Certainly a longer period of time, not to mention a greater workforce, was required to build the circuit walls. The dressing of stone also increased the time and labour necessary for accurately fashioning it, and detailed ornamentation, such as found in the Lion Gate relief, required speciality craftsmen. All this added to the great expense of time, labour and resources (see pp. 62-68). Lawrence argues that eastern influence is widely apparent in the LH III walls; however, if this is to be accepted, and this author will only entertain possible stylistic adaptations and not actual construction techniques, then this suggests that overseas contacts and possible foreign masons were only acquired by some form of wealth.

Chapter 3. Quarrying.

Reconstructing the activities in a Bronze Age quarry is difficult, as indeed few quarries can be dated to this time and investigations of tooling and stone quarrying, which provide the majority of recovered evidence, have focussed on Crete. Remains of activities can be noted in later Greek quarries with partly hewn columns and blocks, but it is less easy to locate *in situ* remains of Bronze Age activities. In many instances, stones were wedged from beds, being left unshaped so that dressing areas were not always required at the quarry. Other blocks were dressed or neatly cut, but their origin is often difficult to determine; many quarries are worked continually for centuries and consequently later quarry activity may have obliterated any Bronze Age remains. Evidence must therefore be sought not only in the way the quarry surface has been cut, but in any artifactual information associated with the site.

The aim of quarrying was to cut large, roughly rectangular blocks to create structurally sound masonry, using minimal effort and resources. Thus, the ability of the stone to resist damage was important in determining its suitability. Favoured qualities would be its strength and durability, its ease in quarrying and overall appearance, yet economic expense was by far a greater determinant, involving time, availability, and distance to transport. Due consideration would have been given to the characteristics of building stones, each selected with desirable qualities in mind, although availability would be the determining factor.

3.1. How to identify a quarry.

Several factors need to be considered when dating a quarry to the Bronze Age:

3.1.1. Petrological determination.

Analyses of the petrological composition of building stone may suggest probable locations of the stone's source.

3.1.2. Artifactual information.

Tools, including a range of hammers, chisels, and picks, may suggest the method of quarrying and help to establish a date for the working of the quarry.

3.1.3. Physical evidence of quarrying.

Observations of the stone surfaces of a probable location will help to determine the extent to which an area was utilised and the method employed, and consequently suggest a probable date for the working of the quarry. Observations should include the way in which the stone has been taken from the beds, any evidence for channelling, wedging, or quarrying in steps, deposits of waste debris, and suggestions of stone dressing areas.

3.2 Resource location: Greek mainland (see fig. 3.0.).

Thessaly, Euboea, Boeotia and Attica consist of broad plains separated by limestone mountain masses making up the Pelagonian and sub-Pelagonian geological structural zones of Greece. The Pelagonian zone comprises sedimentary and igneous rock and igneous minerals, mainly schist varieties, which split easily into thin sheets, but are unsuitable for blocks of great height, length and width, as demanded by Cyclopean masonry. However, an abundance of Upper Miocene and Lower Pliocene limestone and marl of the sub-Pelagonian zone, including the Isthmus of Corinth and parts of Boeotia, and the Triassic and Palaeocene limestones of the Argolic Parnassus zone proved advantageous (Marinos 1990: 2189). Pure limestones have low porosity levels, since the pores have been filled with calcite which has been deposited during diagenesis, the conversion of sediments into sedimentary rock, helping to resist weathering processes that occur through the infiltration of air or water, and thus offer good mechanical strength (Dermentzopoulos 1988: 623; Papageorgakis & Mposkos 1988: 651; Prentice 1990: 47). On the other hand, with poros limestones the movement of water within the cells, resulting from high porosity, encourages solution and stress in the rocks, reducing their overall strength (Bell 1983: 112; 1990: 1871). They are more likely to contribute to wall deformations and subsequent collapse than geologically older rock.

Athens and its surrounding area comprise solid and compact limestone (Wycherley 1978: 269) with strength well-suited to large scale building projects as evident on the acropolis. The summit of Athens rises more than 35.00 m[32] above the plain and is largely of limestone, know by the ancients as *epichoros lithos*, literally "stone above the region" (Wycherley 1978: 9). It is a blue-grey rock with small traces of red colouring, laid horizontally in thick beds (Wycherley 1978: 268; Dermentzopoulous 1988: 620). These beds are strong and solid, as they have few cavities where water can penetrate, causing calcium carbonates to precipitate into a solution and weaken the mass (Bell 1983: 109-11). Although the stone is very hard and difficult to shape once quarried, and was inappropriate for shaped ashlar blocks or even later well-fitted polygonal masonry, it was suitable for Cyclopean building.

Western Greece comprises solid Mesozoic limestone (Marinos 1990: 2189), which is difficult to work (Dinsmoor 1950: 154-55), but good for undressed blocks of Cyclopean construction. It is within this region that the palace of Pylos and the massive walls of Kato Samikon: Klidi and Araxos: Teikhos Dymaion are located.

Marble was quarried in Attica, in the south-east of the Pelagonian region. Marbles are varieties of limestone that have undergone metamorphic changes in the Mesozoic era. The underground spring at Athens employed a variety of marble which Broneer suggests came from Euboea, as it is not common to Athens (Broneer 1939: 345). If this is indeed true then the cost in transporting the marble would suggest that the spring may not have been built to secure the water resource as a result of an immediate danger, for if this were

---

[32] Iakovidis (1983: 73) gives an elevation of 35.00-40.00 m above the plain.

the case, local stone would have provided a quicker and easier means of supply procurement.

In Classical Athens poros limestone was quarried from beds at Kara in south-east Attica and it is likely, although not certain, that the quarry was also in use in the Bronze Age. The Kara beds provide a grey-white stone, much easier to cut and dress than the compact rock of the acropolis (Wycherley 1978: 270; Dermentzopoulos 1988: 619). Priphtiane: Magoula (modern Monastiraki), also appears to have been a centre of quarry production. Wace has pointed to this as the area that the poros stones of Mycenae originated (Wace 1949: 137), and the remains of a Mycenaean settlement and cemetery may indicate that the function of the Bronze Age settlement was related to this quarry's production. Poros would have been much favoured because it cuts easily, splitting along natural rock cleavages. In Minoan architecture it was frequently used for ashlar blocks (Shaw 1973: 12-3). However, the city walls of Mycenae were built of local limestone quarried perhaps from the citadel or nearby at Prophitis Ilias and Zara (Wace 1949: 136; Iakovidis 1983: 24). The solid acropolis rock may have been preferred because of its low porosity levels and hence increased strength, not to mention proximity to the citadel.

Limestones not only have low porosity and thus high values of mechanical strength and weather resistance, but have an agreeable characteristic of well-defined cleavage, making quarries easier to work by allowing stones to be manipulated in a number of directions (O'Neill 1965: 77; Bell 1990: 1868). Limestone is generally a thick, well-jointed stone that breaks easily into oblong slabs, but as beds result from changes in the laying of sediments (Tucker 1982: 48) this is not always the case, as is evident in many of the Cyclopean walls. At Midea: Palaiokastro, the hard blue limestone acropolis blocks break into polyhedrons of moderate sizes, averaging lengths of 1.00 m, heights of 0.80 m, and widths of 0.80-1.00 m (Wright 1978: 173), whereas the blocks at Araxos: Teikhos Dymaion are much more rectangular-shaped, the result of the natural splitting of the rock (Field 1984: 121).

Joints are fractures in bedrock which form an arrangement of intersecting lines and determine the size of the stones when quarried (*MAGE* 1976: 293; Bell 1990: 1868). They are not uniformly distributed throughout a bed and as a result, separate into blocks of different sizes; hence the variety in shapes and sizes of Cyclopean boulders.

Hard limestones, as opposed to other sedimentary structures, tend to have widely spaced joints, producing large slabs and thus were favoured in quarrying. The redeposited calcites help to decrease their bedding discontinuities which result from open pores. Rather the rhombohedral cleavage of calcite minerals helps to assure that the rock cuts equally in all directions (Prentice 1990: 46-7).

> The presence of joint sets oriented more or less at right angles in limestones and sandstones was one of the factors which meant that these rock masses were those most

> commonly quarried in ancient times and indeed they still are at the present day (Bell 1990: 1868).

On the other hand, soft limestones are more likely to rupture through the joining of small fractures (Tucker 1982: 111; Nicolas 1984: 25).

The advantage of hard limestones were also recognised by the Minoans. At Knossos, Tripolis limestone and dolomite were quarried at the northern edge of Prophitis Ilias and on the hill of Kakon Oros, being used for pavements, jamb bases, and thresholds of the palace (Papageorgaki & Mposkos 1988: 651).

Conglomerate stones were not as easily extracted from quarries as limestones were and when shaped they had to be sawn, hammered or abraded (Mylonas 1957: 22; Shaw 1973: 27), giving them a small role in the Late Helladic walls. Conglomerates are clastic rocks, composed of rounded pebbles of various lithologies and differing sizes set in a sandy or muddy matrix (Winkler 1975: 13). They are unreliable as building stones because of their wide petrographical composition, which results in uncertain strength properties. In essence, their diverse compositions create numerous planes of weakness (Turner, pers. comm.). At Mycenae, conglomerate was readily available on the Panagia and Kalkani ridges (Wace 1949: 136; Wright 1978: 229, 242-43 n. 227; 1987: 177) and blocks of it were used in the Lion Gate, North Gate and south-east projection of the wall (Iakovidis 1983: 24). Its use at Mycenae was, as Wright has convincingly argued, a means to convey power and wealth through aesthetic and monumental effects (see also pp. 67-8, 178). Limestones dull readily and their surfaces discolour when they come in contact with water that has reacted with carbon dioxides or sulphur oxides or nitrogen (Bell 1990: 1871). Conglomerates, however, maintain a polished appearance over time. In any case, little was used because of its unreliable nature and the time required to shape the stone. In fact, conglomerate was not commonly used as a building stone outside of Mycenae, probably because a sufficient source of it had not been found elsewhere.

It has been argued that the red stone blocks of Tiryns were used for aesthetic reasons, being capable of taking a good polish (Wace 1949: 137). Nevertheless, this should not be considered equivalent to the use of conglomerate at Mycenae; rather the stone was used for its durability. This red stone is a close-grained limestone capable of resisting weathering processes, retaining its original appearance over a long period of time, unlike conglomerates which suffer weathering processes at much faster rates due to their coarse-grained composition (see Bell 1990: 1870).

The Argolid lies in the Parnassus zone, another predominantly limestone region (Marinos 1990: 2189). This area provided white to grey limestones, similar to those found in Attica and Boeotia, as well as hard blue limestone in the region surrounding Midea (Wright 1978: 173) and red limestone, mentioned above, near Tiryns (Wace 1949: 137). For the most part, the fortification walls at Mycenae and Tiryns are constructed of the solid white-grey limestone cut from the citadels. The limestone at Mycenae is cream-coloured with shades of yellow and blue that have resulted from weathering. The same stone is also found nearby at Prophitis Ilias (Wace 1949: 136). At Tiryns, much of the first citadel wall is of white-grey limestones, but with the construction of the second citadel the close-grained red limestone came into use. Both limestone types can be found in the vicinity of Tiryns (Wace 1949: 137; Wright 1978: 205, 215-16; Iakovidis 1983: 5).

The south-central Peloponnese did not produce structurally good building stone, rather beds of Triassic to Upper Eocence limestone are interbedded with Upper Eocene-Oligocene clastic sediments of flysch (Koukis 1990: 2218; Marinos 1990: 2188). Such poor availability of good outcrops may have been a factor contributing to the few LH III megalithic constructions. The district of Olympia is composed of a course shelly limestone (Dinsmoor 1950: 151) unsuitable for quarrying large, roughly rectangular blocks with only a nominal quarrying technology. At Sparta: Menelaion builders mainly used water-worn stones from the Eurotas bed; the large limestone blocks were transported a considerable distance (Catling 1980: 157), making the time and labour required to secure the blocks costly.

3.3 Tools.

It cannot be disputed that some tools were needed to assist the extraction of blocks from quarry beds, and indeed a number of stones bear signs of quarrying activity. For example, picks leave curved marks in the stone, which are wider at the end where an initial blow is made to the stone and narrower where the point has penetrated its depth. Marks overlay one another, the number of impressions depending upon the number of strikes needed to split the rock from its bed. In the Rods of Digenis, an ancient marble quarry in east Crete, pick marks have been preserved in area 2 and indicate that the pick had a point 1.50 cm wide which produced concave, arcuate cuts. Similar marks have been noted on blocks at the Bronze Age sites of Phaistos, Ayia Triada, Tylissos, and also in the quarries at Phaistos, Ayia Irini, and Zakro (see Shaw 1973: 33, 35, 49).

Wedges undoubtedly played a significant part in the quarry, being used either in what is commonly termed wedge-and-feather extraction (see below) or inserted into slots that were chiselled beneath the stone and used to force the rock up from its bed. Wedges are not reported in the Bronze Age mason's tool-kit, and thus it is assumed that they were of wood. As has been suggested for the later Greek quarriers, these would have been soaked in water, so that when they expanded they would have exerted enough pressure on the stone to crack it along cleavages in the rock.

With the development and specialisation of quarrying, tools became task-specific, increasing work potential and decreasing time and labour input (Torrence 1986: 181-82). The tool-kit of the Bronze Age mason likely comprised saws, axes, hammers, chisels, borers, and picks; however, it is probable that picks were used to assist in the excavation of Cyclopean blocks whilst hammers and chisels were used to achieve well-cut and dressed stones. There was not necessarily an abundance of all tool types because of their expense, and thus those tools that could have performed several functions would have been favoured. Unlike stone operations, the exploitation of metal deposits did not occur locally, rather it was limited to a few profitable sources, namely the Laurion and Cypriot mines, and operated by specialised labour (Stos-Gale & Gale 1990). In terms of trade, the limited and controlled access to the mines may have made the commodity costly, and may explain why so few tools have been recovered on the mainland. However, stone tools would have been cost-efficient, using local materials and a known and evolved technology.

3.3.1. Saws.

Saws were used as early as the EBA and continued in use through MB and LBA (Branigan 1974: 26). Although saws have been found on Levkas and at the Argive Heraion at Prosymna,[33] respectively (Van Horn 1976: 324, 390), most examples come from Minoan sites and of these, fifteen large saws have been dated between MM III and LM I (see Shaw 1973: 55). Saws would have been wide bronze sheets, of uniform thickness, with upper straight-edges and triangular teeth, and shaped by hammers, as the length of the tools were too great to mould (Shaw 1973: 55). Although used to cut stone, it is unlikely that saws were used to finish blocks; evidence suggests that large blocks were chiselled and surfaces were ground smooth, possibly by another stone (Shaw 1973: 55-8, 59; Van Horn 1976: 349). Examples from Zakro, nos. 2613 and 2600, and the villa at Ayia Triada, no. 701 (now in the Herakleion museum), have been pierced at either end, suggesting that they were used by more than one man (Shaw 1973: 58; Adams, pers. comm.). The squared ends of the Zakro saws provide sufficiently large areas to which wooden handles could be fitted, but the opposite and rounded ends would not as easily take a handle; sometimes this end is pierced with only one hole as opposed to the usual three of the squared end. (It should be noted that a single rivet would not have secured the handle to the blade as securely as several rivets.) The single hole may have been used to tie a cord, or something similar, which was pulled forward, drawing the saw across the stone; the shafted end, being pulled back along the stone, would perform the cutting action of the saw (Adams, pers. comm.).

Shaw believes that saws were used to cut small soft stones (Shaw 1973: 62), and in decoration they may have been used to even edges and smooth surfaces. However, if indeed saws were used to cut the shaped blocks used at entrances of Mycenaean fortifications and elsewhere they should have been over 1.00 m, in length, the average length of a Cyclopean block, so that a relatively even face could be obtained during cutting. Only the toothed examples of Minoan Crete surpass 1.00 m lengths; the two examples from the mainland are less that 0.25 m long. Moreover, neither copper nor bronze would have been sufficiently strong to cut through hard limestone and dolomite. Saws would need to be straight edged with small teeth, otherwise the cutting edge would be crushed (Van Horn 1976: 324).[34] With continual stress acting upon the cutting edge,

---

[33] Site visit in 1993.

[34] Saws nos. 701 and 2613 from Ayia Triada and Zakro respectively, have small teeth appropriate for stoneworking as compared to the longer and more prominent teeth of no. 2600 from Zakro, which were certainly used for wood working, where deep gullets are required to cut against the grain of the wood (Adams, pers. comm.).

the saws would need repetitive refinements to bend the tool back to its former shape.[35] It would have been much easier, and probably more common for Cyclopean stonework, to simply strike the rock, fracturing it along lines of natural cleavage. Any necessary shaping of the stone could be done once the block had been extracted from the bed, before its sap dried and hardened its overall composition.

3.3.2. Axes.

Bronze Age axes have been extensively defined typologically (see Shaw 1973; Branigan 1974; Van Horn 1976), but for the purpose of Cyclopean quarrying they have been grouped into double axes, flat axes, and lugged axes.

The double axe was made up of two blades and central shaft-hole with either side of the axe tapering to thin cutting edges, which were parallel to the shaft. More than ten double axes have been found in mainland contexts, no functional example dates earlier than LH III, although a gold foil example from Shaft Grave IV at Mycenae and LH I and II decorative motifs on vessels and seals suggest its use as a ritual symbol, or perhaps as a tool, dates much earlier (Van Horn 1976: 319). Thirty-four examples come from Minoan Crete, the earliest dating to EM II (Branigan 1974: 21-2).

The double adze was like the double axe except that its blades were positioned at right angles to the handle to which it was commonly lashed, as opposed to being socketed. Its horizontal blade was designed for woodwork, but could easily have been used to excavate trenches about blocks when surface deposits had to be deep channelled (Shaw 1973: 49), thereby more likely having a greater function in the quarry. As with the double axe, its two blades would decrease the number of times that the tool required sharpening (Shaw 1973: 46).

The axe-adze would also have been useful, having both functions of cutting and chopping. Unlike the double axe/adze, examples on the mainland date to both the EH and LH, demonstrating a continuous use throughout these periods. The earliest example comes from Eutresis, dating to EH II. Later types have been located at Athens and Vaphio (Van Horn 1976: 384).

Flat, or plain, axes have only one cutting edge. They are characterised by a flat blade tapering from the shaft-hole to a thin cutting end. Again Eutresis provides the earliest examples, being found in EH I and EH II contexts. However, the MH flat axe from Lerna and two LH III types from Prosymna (Van Horn 1976: 316) illustrate its continuity.

One example of a lugged axe comes from LH III Asine (Van Horn 1976: 317). Its shape is like a flat axe except that, instead of being socketed to a shaft, it has two lugs on either side of a shaft, both lashing the head to the handle. The type is more common in Syria-

---

[35] Folded saws, found for example at Zakro, are suggested by Adams (pers. comm.) to be no longer usable tools, having been bent and put aside until they could be melted and recast.

Palestine, and numerous examples having been found associated with the Ulu Burun shipwreck (Pulak 1988: 14-5).

Axe-hammers are known from EH II/III contexts at Thebes (Branigan 1974: 23). This tool has a central shaft-hole with a sharp, thin and convex cutting edge at one end while the opposite end is wide and blunted, forming the hammer.

It is difficult to determine the extent to which axes were used in the quarries. They certainly had no role in deep channelling, unless used at the adze end, which could be treated much like a pick, nor in wedge-and-feather excavation (see below). They may have been used in stepped quarrying (see below) to cut blocks from the steps, but this too was likely accomplished by picks or a combination of chisels and hammers to detect natural fractures that were manipulated to split the rock. Perhaps their function in the quarry was to dress the blocks, shaving surfaces smooth and evening edges, much as a chisel would have done.

3.3.3. Hammers.

Hammers were important tools in ancient building and stone-cutting: they were used to level the foundations upon which buildings were raised, helping to uniformly distribute stress, in combination with chisels to wedge blocks from their beds, and to dress ashlar blocks. Hammers could be as simple as small rough stones found lying on the ground, or of a more sophisticated variety, such as the sledge-hammer.

Although not widely reported, evidence of this tool type is known from Neolithic occupations; early levels at Nea Nikomedeia have produced ground stone tools (Warren 1975: 59). "In fact, the hammer-stone may well be man's oldest tool since rocks suitable for hammering may be selected, held in the hand, and used without any modification" (Van Horn 1976: 322). And, because of their durability, stone hammers were an integral part of the Bronze Age mason's tool-kit. Admittedly, the mainland provides little evidence for stone hammers; circular- and rectangular-shaped ones from Asine (Van Horn 1976: 322) and pounders from Ayios Stephanos (Taylour 1972: 211) are reported and others are unpublished. Surely the stone hammer was widespread, as it required little effort to manufacture and could be easily manipulated. However, familiarity with hammers is undoubtedly suggested by their presence in other Aegean contexts. At least eight hammering tools, hammer-stones and pounders, have been associated with the Period IV settlement on Keos: Ayia Irini.[36] On Melos, hammer-stones have been noted at the quarries of Sta Nychia and Demenegaki, apparently used in the production of chipped-stone tools (Torrence 1986: 184-85); they have also been uncovered in LBA deposits at Phylakopi (Renfrew 1985: 356). Although these latter tools have been found associated with food production (Renfrew 1985: 349), they may in fact have had numerous functions, as similarly suggested by the excavator of Ayios Stephanos for the MH/LH stone pounders (Taylour 1972: 211).

---

[36] See catalogues of stone tools in Overbeck 1989: 45, 83, 142, 167, 168, 169.

The shaft-holed hammers and hammer axes are other likely tools used to create even surfaces.[37] Where simple hammer-stones could not be used to apply great mechanical forces, the socketed shaft enabled the user to apply a sizable power by swinging the tool in a downward motion from shoulder height to striking platform. Early examples of shaft-hole tools have been located in EH III contexts at Lerna (Van Horn 1976: 301), and others have been found at Ayia Irini on Keos (Davis 1986: 96) and Ayia Triada on Crete (Shaw 1973: figs. 41-42). The latter site has produced sledge hammers which would have been a valuable contribution to quarrying, as their weight and large, blunt striking edges would have struck the surface with much force. Both examples have rough hammered surfaces suggestive of stoneworking; if used to work metal their blunt ends would be much smoother (Shaw 1973: 53-4).

Wood mallets could have similarly been used to dress and smooth surfaces, or struck chisels into stone, but they have left no trace in the archaeological record (Shaw 1973: 52). Wood, however, would have been well-suited to the dressing of conglomerates, which are susceptible to fracture or crumble under excessive stress. These mallets would have had a weight less than that of stone or metal, and would thus be easier to use to deliver delicate blows.

Finally, metal hammers have been reported, but only in LH IIIA-B contexts at Mycenae and Athens (Van Horn 1976: 320, 384). Their relative scarcity suggests that the stone hammer was never replaced in the Bronze Age with a metal counterpart, its strength being greater than the hardest bronze (Van Horn 1976: 322). Moreover, stone hammers would have been readily available on the ground surface, whereas metal hammers were dependent upon available materials and the rate of manufacture and repair by smithies. Nevertheless, it remains possible that, once damaged, bronze tools were melted and cast into other forms, and it is likely that future excavations will yield other metal hammers.[38]

3.3.4. Chisels.

Chisels comprise the greatest number of any one tool recovered in the Aegean Bronze Age. More than 200 examples are known (Branigan 1974: 25-6), of which 21 were found in the Argolid (Van Horn 1976: 326). The Kynthos hoard is the best know group from the early period, having been assigned a date of EC II (Fitton 1989: 31-40). Middle Bronze Age examples come from Levkas, Lerna, and Troy (Branigan 1974: 25) and two LH III bronze chisels were found at Mycenae (Wace et al 1955: 236).

A chisel is characterised by its narrow, sometimes butt, end which tapers into a wider bevelled blade. Most are flat in section (Shaw 1973: 70), but they can also be squared, as with the two LH III Mycenaean examples. The style, however, is likely the result of function. Some chisels were used by hand, but those with well-defined butt-ends were

---

[37] The hammer proper would pummel small surface protrusions of foundation bedrock, whereas the sharper edge of the hammer-axe would enable larger projections to be cut off.

[38] See above, n. 35.

probably struck by hammers (Shaw 1973: 70). The use of this tool for stone-cutting would certainly require the force of a hammer to direct strong blows, fracturing the rock.

The deep-bar chisel would have been suited to the wedge-and-feather technique (see below). The blade of this chisel type is set at a right angle to the broad face of the shaft, and in quarrying its broad face is used to wedge the stone, but its shank, being the thickest and strongest part of the tool, receives the applied force. LH III deep-bar chisels have been found at Prosymna and Thebes (Van Horn 1976: 330, 383).

3.3.5. Borers/punches.

Borers and punches may have cut the holes necessary in wedge-and-feather extraction (see below). Both tool types have narrow pointed ends and flat, butt ends, which were probably struck by hammers. The two differ only in section, borers being circular and punches being square. Most, however, have been recovered from the islands, particularly at Thermi on Lesbos, and others are noted from Troy. Only a few EH and MH types were found on the mainland at Eutresis, Vasiliko: Malthi and Thebes.[39] Lerna has produced four retouched chipped stone borers with sharp and narrow points. Van Horn argues that the few stone examples suggest the relative unimportance of this type (Van Horn 1976: 181); however, as with stone hammers, the type may have been disregarded in early investigations as a result of little knowledge of stone-tool assemblages.

3.3.6. Picks.

Although only a few picks have been found in Aegean Bronze Age contexts, and only from Crete and Anatolia (see Branigan 1974: 22-23), their role in quarrying cannot be underestimated. The pick was pointed at one end of a slightly curved blade, which terminated in a flat sharp chopping edge. The centre was pierced by a shaft-hole, sometimes offset from centre, and fitted with a wooden handle. The pick point may have served to mark out channels while the chopping edge may have been used to cut and shape them. And either end would have provided a device by which blocks could be pried from their beds.

Evidence of pick marks has been found in the Minoan quarries of Phaistos and Ayia Triada, and on the western wall of the settling basin of House C at Tylissos. In the Phaistos quarry, one side of an abandoned limestone block has marks suggestive of a pick. At Ayia Irini, near Knossos, the scars are much more visible. Here, marks indicate that the tool used was pointed at one end and flattened at the other, having a breadth of 2.50 cm (Shaw 1973: 33, 35, 39, 49).

3.4. Physical evidence.

The physical evidence for systematic quarrying in the Bronze Age is slight, yet the number of stone-built structures, the range of recovered tools, and a list of twelve

---

[39] See the catalogue of tools in Branigan (1974).

masons, literally translated as "wall-builders", in Pylos tablet An35, suggests that quarrying was extensive, forming a particular craft specialisation (Chadwick 1976: 138).

Several factors would have influenced the extent of quarry activities. First, the ease of working the stone would have been partly determined by the bedding planes which depend upon their lithological composition, yet conglomerates, which have weak compositions, take a high polish making them most attractive in places of decoration. On the mainland conglomerates were not used extensively, but generally reserved for places where attractiveness was a desirable feature. Indeed, the appearance of the stone was a factor of great significance, as was the strength and durability of the stone when used as a building block. Its location and eventual use of the stone also helped to determine the type used.

The depth of the quarry was also a factor, being determined in part by the water table of the area and by the difficulties incurred when transporting stones out of the quarries. If blocks could not be extracted easily out of the area, then another quarry site would have to be sought. In other words, "...where the amount of overburden which has to be removed is or becomes excessive, then this is likely to prohibit quarry operations" (Bell 1990: 1867). Certainly, the economic factors implied in transport and extended quarry activities would have been considered, reducing inefficiencies in supply and the size of the workforce.

3.4.1. Greek evidence.

Although the Rods of Digenis in east Crete, fully investigated by Durkin and Lister (1983), is an ancient Greek quarry, it has been thoroughly studied and reported, and offers the best information for ancient quarry activity (fig. 3.1.). Quarry methods are often in use for long periods of time, and probably techniques used here have a long tradition. The Rods of Digenis was a marble quarry, worked in steps in three areas. Steps were irregularly oriented in areas 1 and 2 and blocks were not hewn into precise rectangles; this was due in part to the uneven bedding planes of the rock. Channels were cut about the desired mass and separated by undercutting the stones. In area 2, pick marks have been clearly noted, producing arcuate cuts that have marked the stone at a 45° angle, and it is argued that the pick was used to dig the channels (Durkin & Lister 1983: 74, 80). Area 3 has been worked systematically and regularly, with blocks cut parallel to the outer edges of the mass. "It involved the cutting of vertical channels, outlining the shape of rectangular block, and the subsequent raising of the blocks by insertion of wedges in a plane perpendicular to that of the channels" (Durkin & Lister 1983: 75). Lines of lunate marks indicate wedge-slots, probably cut by chisels, for the insertion of wedges at the base of the desired stone. These were soaked with water to promote expansion, causing the rock to split from its bed.[40] Once the blocks were cut they were dressed and then transported out of the quarry; the quarry site was located

---

[40] There is no evidence for vertical wedging, as in wedge-and-feather technique (Durkin & Lister 1983: 82), see below.

150 m above a river, which is suggested to have provided the necessary transport route (Durkin & Lister 1983: 71, 84).

3.4.2. Bronze Age evidence.

Although quarrying has been suggested at Mycenae, on the Panagia and Kalkani ridges and the south-west slope of Prophitis Ilias (Wace 1949: 36; Iakovidis 1983: 24), and quarry marks have been noted in front and to the left of the east gate at Midea: Palaiokastro (Demakopoulou 20-4-1994), the majority of evidence of Bronze Age quarrying comes from Crete.[41]

In East Crete, the Pelekità quarry provided the sandstone used in the constructions at Zakro (fig. 3.2.). It was worked downhill in steps and each block was extracted by cutting channels on all sides and wedging it out from underneath. This is not dissimilar from the method used in the Rods of Digenis. The quarry area at Pelekità was small, measuring 30 m by 50 m, but its high cliffs would have yielded a substantial amount. MM III sherds were located in the quarry channels, and as no sherds later than MM III have been found, it is believed that quarry activity was limited to this period (Shaw 1973: 31).

Likewise, Ta Skaria, near Palaikastro in east Crete, is suggested to have been worked for its calcareous sandstones as early as MM III (fig. 3.3.). The quarry was composed of five smaller quarries, located in shallow beds close to the coast, totalling an area of 2500 m^2. Each was worked by channelling about the blocks and detaching the stone underneath with the use of wedges, starting at the top of each quarry and working both outwards and downwards.

North-west of the palace at Mallia, several sandstone quarries have also been noted. One of these quarries has been excavated, the Point du Moulin, and indicates a similar method of extraction by cutting channels about the blocks; however, the stone was worked on the flat (Shaw 1973: 35-6: fig. 3.4.).

A small quarry just offshore from Nirou Khani has produced similar channels crossing at right angles to one another, showing the pattern of extraction. However, as at Trypiti, west of Herakleion, where channels approximately 15 cm wide divide the limestone into square blocks, no date can be suggested for quarry activities. Although it is probable, no sherds have been reported to confirm that either of the quarries at Amnisos or Arkhanes: Phourni, or the underground quarry at Ayia Irini were worked during the Bronze Age.

3.5. Techniques.

The variety of materials used in building fortifications was not extensive; nonetheless, the immense projects demanded large quantities of those resources that were used. Methods naturally varied between quarries having "...to be modified to take account of different

---

[41] Study of the quarries at Mycenae is currently being undertaken and may produce further insight into quarry activities.

properties of matrices [and] variations in jointing structure..." (Torrence 1986: 179), and thus different sources would have been tested until a deposit was found to offer a suitable work potential (Wright 1987: 177).

3.5.1. Deep channelling.

Sixth century techniques involved the cutting of deep channels about the desired block of stone to a suitable depth, so that wedges could be inserted at such an angle as to pry the stone from its bed when sufficient force was applied. Evidence of deep channelling is scarce in the Bronze Age. Either quarries were continued to be worked in later times so that any former indication of Bronze Age working has been obliterated, or at present they simply escape archaeological detection. However, Cretan examples have been located, namely the MM III sandstone quarries of Pelekità and Point du Moulin (Shaw 1973: 31-4, 35-6; figs. 3.2., 3.4.). At Pelekità the channels are still quite clear, being c. 7.00-11.00 cm wide, the depth being intentionally for easy block removal (Shaw 1973: 32, 33-4).

It has been suggested by Shaw that channels were made by hammers striking the rock along predetermined lines. These "guide lines", having been cut into the surface, provided the quarriers with the limits of the desired stone (Shaw 1973: 63). At Gla, a number of long-saw cuts have been noted in the threshold (Shaw 1973: 68, n. 2), however, little evidence of the use of saws can be found elsewhere. Rather small holes may have been drilled into the stone to guide fractures. A number of borers and punches have been recovered in the Aegean and are found throughout the Bronze Age periods, whereas only a few saws have been located, likely because of the expense to fashion them. In Egypt, channels were made by pounding the rock mass with stone hammers or pounders. The Aswan obelisk was cut out of its bed after channels were sunk nearly one metre around the stone by pounding the rock with dolerite balls (Bromehead 1979: 569). It is more probable, however, that channels were cut with picks, being time-saving tools. As Cyclopean masonry indicates, block uniformity was not a prescribed rule, rather massive irregular blocks of varying shapes and sizes were used, and thus it was unnecessary to use precision in mapping out quarry surfaces.

3.5.2. Wedge-and-feather.

This technique splits sedimentary rock masses along the joints of the bedding plane. As limestones are laid in thick beds this method is efficient, making use of the natural stone structure. With wedge-and-feather, also known as plug-and-feather, a series of holes is drilled into the stone along a predetermined line. Two feathers are inserted into the holes and a wedge is hammered between them. As the wedge is driven in, the feathers are forced apart and stress is transferred to the rock. Pressures are increased with each successive blow of the hammer until the stone splits under force (O'Neill 1965: 70; Winkler 1975: 62; Bell 1990: 1868). This technique, however, would have been time-consuming, and like deep channelling would have required the mapping out of the quarry surface. Moreover, a supply of wedges, feathers and hammers would have been required, and yet relatively few tools have been recovered although it must be noted that they may have been made of wood; but wood feathers would probably have cracked under the sheer stress applied by the wedge and hammer.

3.5.3. Stepped quarrying.

As the depth of the quarry increased, it would have been more difficult to lift the blocks out of the pit, and thus working in tiers became advantageous. The rock mass would have been quarried in steps and worked downhill, each block also being removed downhill as work progressed (Shaw 1973: 34). Such a technique would have offered an attractive method to the Mycenaean masons, as steps could have been cut along the natural cleavages, facilitating the extraction of the blocks, which also could have been cut of approximately similar sizes without exacting precision. The Minoan quarry of Pelekità was worked in steps as such, following the natural layers of sandstone (Shaw 1973: 31-2). This surely was not a method limited to the Minoan world, but one which was practised widely over generations because of its effective and easy technique, as evidenced in the sedimental limestone and marl admixture of the Klenies quarry, near Nemea, which was worked in the 5th-3rd centuries (*AR* 1990-91: 17). Of Minoan architecture, Shaw suggests that hard limestones may have been simply pried loose from sources (Shaw 1973: 30); however, the amount of limestone used in the walls and the hilltop locations of the known Late Helladic quarries[42] would suggest that this quarrying method would have been best suited to mainland geology, quarry faces being oriented along natural lines of cleavage to assist excavations.

The method, although simple, was surely a systematic operation based on efficiency and organisation, resulting from the need for much stone. With sufficient labourers to cut and remove blocks, good use could be made of the whole bed by quarrying first the cliff face and then moving inwards, wasting little of the stone. Several blocks could have been cut across steps simultaneously, working not only the lengths of tiers but also several steps at once. And with the introduction of regular cut blocks, this method would also have proved to be of benefit to masons.

The move to uniform blocks would have demanded accurate measurements and greater precision in the cutting of the stone. Tiered quarrying would have sped up the operation, providing each step was of equal dimensions to those above and below it. By working across each step the stone could be sliced out from its bed. A cut at the rear of a step, down the face of its successor, to its depth and a second cut across the tier to the desired breadth of the block, would have enabled a quarrier to remove a block by slicing under and across it. As the practice developed, stones gradually became more uniform in size and shape making for walls of neat courses and squared corners. Masons not only learned how to dress individual blocks but entire wall surfaces, and by LH IIIB2 they were able to effectively fashion walls into smooth continuous curves.

---

[42] Kara, Mycenae: Prophitis Ilias, the Panagia and Kalkani ridges at Mycenae, and the citadel summits of Mycenae, Tiryns, Gla, Midea: Palaiokastro, and Araxos: Teikhos Dymaion.

The use of cut stone for wall building on the mainland can be traced back to LH I at Vari: Kiapha Thiti, but it is more common by LH IIIA, occurring at Tiryns and Araxos: Teikhos Dymaion, and in LH IIIB at Mycenae, Geraki: Ancient Geronthrae, Midea: Palaiokastro, Gla, and Larymna: Kastri.[43] In the Cyclades, well-hewn stones appear in the archaeological record as early as MM IB/IIA at Keos: Ayia Irini and continued to be hewn in the Late Bronze Age, as evident in the walls of Melos: Phylakopi. In Crete, walls of well-cut stones seem to have appeared by MM IB and continued on through LM III (Shaw 1973: 30). However, the technique would have required careful extraction and dressing, both of which necessitated a lot of time, and additional expense for defensive structures. It appears that the use of well-hewn blocks in fortifications was an exception stimulated by wealth and the social organisation of available labour (Hult 1983: 62), and may be the reason why dressed stones were reserved for special or non-utilitarian walls, as shown by their almost complete abscence from dams, bridges and terraces.

3.6. Reconstruction of quarry activity.

There is no indication that quarriers were systematically organised into supervised work groups, save that the Ta Skaria quarry was worked in five different parts (see fig. 3.3.), by perhaps five different groups of labourers; no evidence exists to suggest that these areas were worked at different times. Surely, a mason responsible for building projects approved the stone, particularly that used for its aesthetic value, but whether that was done at the building site is not known. It would seem plausible that some sort of overseer organised the workers, ensuring that quarry production was continuous, but this is purely speculative.

It would be improbable that any one individual was responsible for all aspects of stone production: quarrying, dressing, and transporting the stone. Depending on the type of stone to be worked and, as a consequence, the size of blocks, men probably worked in teams, where groups were responsible for cutting the stone, transporting the stone to dressing areas when necessary, lifting the stone onto transport vehicles, and conveying the stone to building sites (see pp. 62-8).

In general, it would appear that those responsible for cutting the stone in Crete favoured the method of heavy quarrying, where channels were dug and each block was extracted by using either wedges or picks to pry up the stone at its base, although it is probable that many stones of less importance, i.e., fill stones, were loose pieces collected from the ground surface. However, the Mycenaeans seemed to simply pry stones free from their beds and used them as they appeared; stepped quarrying may have been used for large dressed stones, such as those found in the Lion Gate at Mycenae.

Where necessary, stone dressing, particularly of limestone, was probably done at the quarry site, immediately following the extraction of the blocks. In the case of limestone, it is easier to shape blocks immediately after their extraction before the quarry sap, or the pore water, within the stone dries and consequently hardens the stone (Bell 1990: 1868).

---

[43] Visits in 1993.

At the Rods of Digenis a large amount of debris was noted on the slope immediately north of the uppermost quarried level, and has been suggested to have been a stone dressing area (Durkin & Lister 1983: 79).

Transportation was yet another problem for the quarrier to contend with; how were stones moved out of quarries to building sites? It is difficult to determine if sufficient numbers of men were available to transport stone, and thus draught-power would seem favourable as it greatly reduces the number of men required to haul a load. Unlike the coastal quarries on Crete where it has been suggested that boats transported stones out of the quarries, the majority of mainland sites are not coastal (see p. 69) and thus water transport is unlikely. It should be noted that the available number of men to cut, load, and transport blocks would be proportionate to the size of the blocks and the difficulties of extracting them, and time would be related to the speed at which the blocks were cut and the number that could be cut and transported simultaneously. Therefore, it seems that land transport was probably by pack animal for small loads, and ox-driven carts and sledges for larger weights.

Chapter 4: Transportation.

Ancient transportation methods have been somewhat neglected because of the proximity of outcrops to LH III building sites and the assumption that difficulties were only encountered over long distances.[44] Yet, it is unlikely that men, even in numbers, pushed, pulled or carried the blocks from quarries to building sites (lintel and jamb stones easily weigh 120 tons each, Heizer 1966: 821), and thus another means to convey building materials was necessary. The construction of the walls required a large labour force (see Chapter 5) and a fairly sophisticated transportation technique, as surely it was no easy task to move massive blocks from quarries to building sites and then to positions in the wall. The precipitous citadel slopes and deep gullies and ravines, as well as the size of the blocks, would have hindered transportation.

4.1. Wagons.[45]

Cyclopean blocks were transported by wagons--four-wheeled vehicles each with central draught-pole, extending below the length of the car, to which a draught-team was yoked. Piggott distinguishes between wagons and carts by the number of wheels--a wagon has four wheels whereas a cart has two (Piggott 1977: 4)--and I have accepted the same division, used herein, to differentiate between the two types of vehicles.

Wagons would have been built of timber as were their wheels, but it is uncertain if the latter were single disc-shaped pieces cut from logs and trimmed of soft outer layers or, indeed, if they were tripartite units of three vertical planks, two of which were one-half the width of the third, being shaped on one long edge into a convex curve and fastened to either side of the third plank by cross struts. The upper and lower edges of the central plank were rounded so that the three pieces formed a disk when joined together (Hodges 1970: 84; Littauer & Crouwel 1979: 18; see fig. 4.0.). Childe suggests that a lack of trees able to produce planks with large diameters may be one explanation for the origin of the tripartite wheel (Childe 1954a: 207). Excavations at Ur and Susa have produced preserved wooden wheels, dating to c. 2500, made in this tripartite fashion (Childe 1954a: 208; Hodges 1970: 84, fig. 73). In fact, the evidence of wheels prior to c. 2000 demonstrate that the majority were of tripartite construction[46] and those of the second millennium examples are mostly this type (Childe

---

[44] Wright (1978: 159, 229) contends that because building materials were locally available they did not pose a transportation problem. Shaw (1973: 43) makes a similar argument for the materials of the Minoan palaces.

[45] It is not my purpose to trace the origin of the wagon as done by Childe (1951, 1954a, 1954b) nor to provide a detailed discussion of all types of wheeled vehicles (Littauer & Crouwel (1979), Crouwel (1981) have presented most convincing accounts), rather the following is intended to link the possible use of wagons to the transportation of the Cyclopean boulders. In addition, there is little evidence in the Aegean for transport vehicles and therefore the attempt herein to reconstruct them relies on evidence, albeit also limited, outside the Aegean.

[46] Littauer & Crouwel (1979) cite many examples from the third millennium where tripartite wheels were favoured.

1954a: 206-07). On the other hand, the concentric circles painted on the disks of the early MM Palaikastro model (see Childe 1954b: fig. 518b; Crouwel 1981: pl. 49) suggest that wheels are of one piece; the characteristic concentric arrangement of tree rings would be broken when several pieces of wood were joined together. Unfortunately as this is the only Aegean wagon to date, this suggestion is far from conclusive. It must be recognised that the concentric design may not have been a means to convey the material of the wheels, but rather was a stylistic preference.

Spoked wheels were not used with heavy transport wagons as such light frames would have collapsed under the excessive weight of the car and its load. Rather, spoked wheels were suited to speed and the sharp, easily controlled movements demanded in driving chariots (Childe 1954a: 211). Solid wheels of the third millennium likely proved suitable for slow transport and, being economically viable, they continued to be made into the next millennium. From this early period, a terracotta model from Szigetszentmarton, Hungary shows wheels mounted upon cylindrical axles protruding beyond the width of the car, which enabled the vehicle to turn easily; otherwise they would rub against the wagon, limiting its ability to turn (Littauer & Crouwel 1979: 17). The wheels are solid single-unit disks; spokes and tripartite constructions are suggested neither by crosshatching, incising nor painting. Similarly a bovid-drawn wagon model from south-east Anatolia, also dating to the third millennium, has solid disk wheels.[47] Although spokes first appeared in the Aegean, approximately with the advent of the second millennium (Littauer & Crouwel 1979: 48; Crouwel 1981: 90), evidence of wagons elsewhere suggest that solid wheels were employed for heavy loads. For example, the water-logged wagons from the Lchashen tombs at Lake Swan, Armenia, c. 1500 and later, had solid tripartite wheels (Piggott 1976: 6; Littauer & Crouwel 1979: 73).

The centre of each wheel was pierced by the axle and, in most instances, secured with linchpins. Examples from Kish and Susa have linchpinned wheels (Childe 1954a: 207; Littauer & Crouwel 1979: 17), but the south-east Anatolian wagon mentioned above had hubs on its wheels projecting on inner and outer surfaces, suggesting that nuts were used to secure the wheel to the axle instead of the more commonly used linchpins. The hub's function was to reinforce the point where the axle past through the wheel, securing the wheel at right angles to the axle and steadying it on the ground (Littauer & Crouwel 1979: 18). If wheels were not secured to axles by some means they would have easily slipped off the rod when the vehicle was jarred crossing rough ground.

It is likely that wheels were not made especially large, so that if damaged or separated from the axle they could be easily and quickly replaced; the load and remainder of the vehicle would have been unaffected, as the car height, gauged by the size of the wheels, would not have been great. Furthermore, large wheels that heightened the car would have made it more

---

[47] See Crouwel (1981: 54-5, pl. 116a-b, pl. 117) for a general description of the Hungarian and Anatolian models and illustrations.

difficult to load and unload. Childe provides diameter measurements for early wheels showing that most were indeed small (1954a: 209).

Two axles, connecting wheels on either side of the wagon, were attached to the undersurface of the car providing the balance necessary for maintaining stability. Childe and later Hodges suggest that the axles of the Mesopotamian vehicles were not fixed to cars, so that they could be dismantled when travel became treacherous (Child 1954b: 717-8; Hodges 1970: 86). However, the distances over which the limestone blocks had to be transported were short, being repeated over well-travelled routes, and thus did not require the dismantling of the wagons. Moreover, the vehicle was strengthened when the axles were attached directly beneath the floor of the wagon and the draught-pole was secured along the length of the car's underside (Crouwel 1981: 90). The pole and axles were not only fastened to the car but also to each other, reducing the risk of separation between the car and its wheels if axles were, in fact, not well-secured and excessive pull was imposed upon the pole. And if axles were fixed to floors the chance of damage to the wagon was reduced when one of the wheels collapsed.

A yoke, fastened to one end of the draught-pole, was placed over the heads of oxen, resting against their shoulders. Prior to the use of the yoke, oxen were attached by their horns and provided traction only for non-wheeled vehicles, particularly the plough. However, with its introduction the draught-team were kept level and the yoke, maintained at right angles to the pole, evenly distributed the stresses from pulling the load forward between the animals (Burford 1960: 131; Littauer & Crouwel 1988: 195). Not only was farming facilitated once the yoke became part of the plough equipment, but the yoke provided the steady traction necessary for the development of wheeled transport vehicles.

> Tractive power was transmitted to the wheels by the pole, and to the pole by the wooden yoke. At its centre, the latter was pegged to the pole; it sat comfortably on the shoulders of the oxen, which pressed against the yoke and so pushed the pole and the vehicle forward (Childe 1954b: 720).

The wagon with central draught-pole makes it improbable that one ox hauled the load, as the pole would have hindered both the animal's free movement and the balance required to cross rough ground. Large loads, however, may have required the strength of more than a single draught-team. And as narrow paths and steep slopes would have made it impossible for ox-pairs to be yoked to separate poles, a yoke-bar would have been used. This long bar with several attached yokes was added as an extension of the draught-pole.[48] If made excessively long, however, the vehicle would be too rigid to contend with uneven ground, resulting in placing much strain on the oxen, pole and wagon (Littauer & Crouwel 1979: 20). Burford persuasively argues that the yoke was well-suited to the physical structure of the ox;

---

[48] Burford (1960: 13) first suggests the use of the yoke-bar, citing a reference to it by Xenophon.

its neck provided a thick ridge of bone and muscle which supported the yoke when the wagon was pulled forward (Burford 1960: 10). The long neck and low shoulder blades of the horse or donkey were unsuitable for early yoking; in order to have used the equipment it would have been necessary to place a collar about the animal's throat and a girth around its body just to secure the yoke on the upper quarters, and even then the result would have choked the animal when under much strain (Hodges 1970: 87; see also Crouwel 1981: 99). It is only with the development of the chariot's yoke saddle that horses were secured effectively and hence efficiently. The inverted Y-shaped saddle was placed above the withers of the horse, its ends passing over either shoulder. The end of each leg curved upwards and was pierced to receive harness straps. This saddle provided the means to adapt the ox-yoke to the shape of equines (Crouwel 1981: 99), but even so they did not offer the slow and steady strength of oxen.

Donkeys were also harnessed, but it is improbable that they were used for heavy transport, as the strength of the donkey is not enough to move large loads. Rather, donkeys were used as pack animals to move baskets of clay (for example from beds at Plesia to Mycenae) or, when harnessed, to haul small carts. It is thus apparent that only oxen provided the strength and surefootedness necessary for transporting heavy or awkward goods which could not be easily conveyed by man or pack animal.[49]

The oxen terracotta figurines found at the EBA site on Tsoungiza Hill, Ancient Nemea provide the earliest examples of domesticated bovines in the Aegean. Of the three figurines, the preserved EH I/II yoked ox has been suggested to be one-half of a draught-team; its partner, painted in mirror-image, was found in a later deposit (Pullen 1992: 49-52). The third figure (Pullen's second figure) has a small additional piece attached to the back of its horns, possibly indicating it too was under yoke (Pullen 1992: 52). Outside the Aegean, early examples of ox-driven wagons are found in an Early Dynastic I burial at Susa, an Early Dynastic III King's Grave at Ur (Childe 1951: 179; Hodges 1970: 84) and the previously cited south-east Anatolian model (see above, p. 48).

4.2 Carts.

Although carts have been found in Mesopotamia, Syria, Assyria, Armenia, Turkey, Central Asia and the Indus Valley (Childe 1951: 179; Piggott 1979: 6), they are under-represented in the archaeological record and in the ancient artist's repertoire. The cart functioned much like a wagon, in that it enabled goods to be hauled by a draught-team yoked to a central pole; nevertheless, evidence does not suggest that carts were used to convey heavy loads, as they were not structurally suitable.

---

[49] This conclusion corresponds with those reached by Burford (1960), Hodges (1970), Piggott (1979), Pritchett (1980), and Crouwel (1981: 32).

The placement of a cart's axle determined the balance of the car. If the rod and wheels were placed at either the front or back end of the vehicle then the opposite end of the car would tip towards the ground. In contrast, if centrally placed the unit would attain an appropriate equilibrium, but only if the draught-pole were kept at right angles to the car. And yet, the vehicle would tilt in any case when the draught-team suddenly changed pace or whenever it was jarred on the rough terrain.

Balance was also determined by the size of the load and its position in the car. Again, if materials were placed too far forward or towards the rear, not only would they cause the vehicle to tip, but they would put excessive force on one part of the structure. It was important to maintain the balance of the load so that the extreme pressures exerted by the boulders on the cart were equally distributed over the whole vehicle; a concentration of stress on one part of the cart could result in sudden collapse. It would thus appear that if carts were used in the Aegean Bronze Age they played no role in the transportation of the massive Cyclopean stones, but rather conveyed goods of much lower weight.

4.3. Sledges.

Evidence from the Near East suggests that sledges were used for heavy transport. Wall decoration, c. 2400, from a tomb at Saqqara, Egypt shows a colossus transported on sledge, and a similar scene, c. 1800, is found in the Twelfth Dynasty tomb painting at El Bersheh, Egypt. The seventh century Assyrian bas-reliefs from the palace at Nineveh, depicting the transportation of a massive bull statue roped and hauled on a sledge by slaves, indicate that sledges continued to be used after the introduction of wheeled vehicles.[50] Although all of these representations show sledges moved by manpower, it is probable that oxen were also used. In fact, Cole states that oxen were yoked to both sledges and carts as early as the Jemdet Nasr phase in Mesopotamia (Cole 1954: 710). Although no evidence has been retrieved, it remains possible that sledges were used as well on the mainland. Their wide application in a variety of periods throughout the world shows an ability to adapt to differing types: grass, soil, marsh and snow (Cole 1954: 707). The runners provided a smooth surface against the ground, reducing the amount of resistance (Cole 1954: 707, 710), and protected the cargo from the damage it would have received if dragged along the ground without any sort of intervening support. Road surfaces would need to have been firm and smooth to reduce friction and risk of damage which, because of the sledge's direct contact with the surface, would have been subject to the impact of rough terrain. However, evidence for levelled roads between quarries and building sites is lacking, which may suggest that sledges, if in use in the Late Bronze Age, were very rarely used, perhaps for the massive 120 ton lintel and jamb stones which would have easily crushed any transport wagon.

---

[50] See Cole 1954: fig. 511; Heizer 1966: figs. 9 and 10; Hodges 1970: fig. 4.

4.4. Roads.

Prepared road surfaces would facilitate transportation by reducing the tensions generated by projections, lumps and indentations of uneven ground which are characteristic of Greek terrain. There has been much discussion about Mycenaean road building with evidence cited from the Argolid, Messenia and Phocis,[51] and yet it is still to be determined whether these roads were used for pack animals, people or wheeled-vehicles, chariots or transport wagons.[52]

The best preserved roads are in the vicinity of Mycenae (see fig. 4.1.); noteworthy is the road which runs from the Lion Gate along the north Cyclopean wall, past the Perseia spring, and circles around the south side of Agrilovounaki where Cyclopean retaining walls support it on the south-east slope (Steffen's "Road 1"[53]). The road is constructed of an earth and small stone layer, averaging 0.25 m thick, and was supported on a foundation fill of larger stones and earth whose depth was proportioned to the slope's grade. The surface was of packed earth, clay, sand, and pebbles, and including its retaining walls appears to have averaged a width of 3.50 m (Mylonas 1966: 86; Crouwel 1981: 30). Roads were carefully laid so that slopes were not steep; however, this necessitated the building of bridges and the laying of the pass along the longest of possible routes, in order to avoid sudden drops and steep inclines. Even so, the road was forced to cross the Chavos ravine west of Agrilovounaki and this was accomplished with a Cyclopean bridge. Just east of the hill a second bridge, also of Cyclopean construction, was required (fig. 4.2a.).

The bridges and retaining walls were pierced with culverts at 3.00-6.00 m intervals which allowed for the free drainage of rain- and groundwater from hill slopes. These were necessary to maintain well-drained and smooth road surfaces (Mylonas 1966: 86; Crouwel 1981: 30). All of the retaining wall culverts were of simple trabeated construction, where massive lintel stones capped the spaces through which water flowed. In contrast, those of the Dragonera and Lykotroupi bridges are arched.[54]

Road 1 is intersected just west of the Dragonera bridge by a second road whose course ran about and north of Prophitis Ilias. To its west, approximately 0.50 km, is another road of parallel course, and a fourth route runs south of Mycenae in the direction of Prosymna, crossing at the Ayios Yeoryios bridge (fig. 4.3.). The construction, bridges, and locations of these latter roads strongly resemble Mycenaean techniques like those of Road 1, although the Ayios Yeoryios bridge may in fact be a very late construction (see below, p. 104, 118). An

---

[51] McDonald & Hope Simpson 1961 & 1964; McDonald 1964; Mylonas 1966; *MME* 1972; Kase 1973; *GAC*; Hope Simpson 1981.

[52] Current work on the road systems at Mycenae may produce further information.

[53] Labelled "Road 1" by Steffen in *Karten von Mykenai* (1884), a usage followed by later scholars. Visit in 1993.

[54] Visit in 1993.

earlier Cyclopean bridge of limestone boulders below the south-west corner of the citadel has also been located (Mylonas 1966: 87), and this may suggest a distinctly different route from that of Road 4, or the abandoning of this route in favour of the new Road 4.

Extensive work has been done to recover road remains in Messenia.[55] Although evidence of a Late Helladic roadway in Messenia can only be traced from Karpophora to Chilia Choria (McDonald 1964: 236), McDonald argues that the system followed the modern highway from Neromilos to Kazarma (McDonald 1964: 227-37). The road, 4.80 m wide, was built in the cut-and-terrace technique where deep horizontal cuts are made into the slope and Cyclopean walls are erected to support the lower sides; it is only the Cyclopean technique of the retaining walls' lower sides that provides a Late Helladic date.[56] The surface was levelled with fine shale gravel and pebbles (McDonald 1964: 220, 227-37; *MME* 1972: 27; Crouwel 1981: 31). It climbs gradually up steep slopes by using switchbacks whose ascents and descents had low gradients, averaging 5.9% (Crouwel 1981: 31). These S-curves make the road longer, but more manageable than a direct up-slope climb. McDonald argues that this road was intended to carry wheeled traffic (McDonald 1964: 229), but with no culverts to relieve excess water it would be difficult to move vehicles along when wet.

Traces of Cyclopean retaining walls and posts in the mountains north of Amphissa and also west of Elaion provide further evidence of Mycenaean road systems. A road is thought to have run between the Malian Gulf and Gulf of Itea enabling the settlements in Phocis to communicate with one another (Kase 1973: 76; fig. 4.4.). The road was more than 2.00 m wide and built using cut-and-terrace technique.[57]

Roads are built according to the terrain and thus mostly conform to the land's contours. Often this necessitates longer routes in order to circle about summits or gently climb upwards by a series of curves, but the effect is a fairly even route with grades at a minimum, avoiding deep ravines and gullies.[58] Near the Arkadiko bridge, the Mycenaean road is relatively level, following the land contours which wind along a uniform land elevation, much like the modern road (Iakovidis 1978: 127; fig. 4.5.).[59]

Of the road systems recovered, it appears that many were located in mountainous regions where centres were located on summits. Although this proved advantageous for security

---

[55] McDonald 1964; McDonald & Hope Simpson 1964; *MME* 1972.

[56] McDonald & Rapp (*MME*: 245) argue that the Late Helladic date was derived from dating nearby occupation sites and tombs, but the Cyclopean masonry, as part of the road proper, also provides a relative date based on comparison with like stonework.

[57] This cut-and-terrace construction was not noted in 1993. See n. 194.

[58] The study of the Neromilos-Kazarma highway by the Minnesota-Messenia Expedition provides the only measured Mycenaean road gradient, which averages 5.9% (*MME* 1972: 25; Crouwel 1981: 31; see above).

[59] Visit in 1993.

with hilltop lookouts lining either side of the road (the four forts near Amphissa providing the best example) it also proved most laborious to engineer and construct in the requisite cut-and-terrace fashion. Excavations into hillsides and the construction of Cyclopean support walls on the lower sides of roadways would have been an expense in terms of time and labour, and demonstrates the care and effort builders took to maintain even surfaces. This technique is characteristic of most hillside structures, being favoured most by the Neromilos-Kazarma highway and the northern passes near the villages of modern Prosilion and Gravia (McDonald 1964: 229; Kase 1973: 76); it allows builders to lay relatively flat surfaces on sloping ground. If natural even surfaces could be found, however, then the switchbacks and bridging were unnecessary and building was facilitated through these naturally occurring and ideal building conditions. For example, a section of the Mycenaean road just west of Elaion used neither cuts nor terraces, but was simply laid on flat ground (Kase 1973: 76), and the road from Mycenae to Corinth maintains gentle grades, without horizontally cutting into the hillside, and being supported only by terraces on the downhill side (*MME* 1972: 25).

Road building suggests that a level of cooperation existed between settlements within the road network and that some degree of authority oversaw the completion of these ambitious projects. Such amiable political relationships and civil administrative hierarchies were presumably long-term, so that roads were properly maintained. If indeed these roads carried wheeled vehicles, which they were certainly wide and sufficiently strong enough to have done, then they were required to be kept smooth and well-drained (*MME* 1972: 25). Although culverts allowed for free drainage, not all sections of the roads were equipped with these underground channels and in the case of the Neromilos-Kazarma highway no drainage facilities whatsoever are evident. Fant and Loy argue that it was unlikely that the Neromilos-Kazarma road supported wheeled traffic; the lack of drainage facilities would have made it difficult to maintain the surface, but perhaps it was the duty of road engineers to maintain the surfaces by reapplying dressings of gravel after flooding or excessive wear.

The remarkable amount of ingenuity, skill, and resources, both in terms of labour and materials, needed to engineer, design, and construct Mycenaean roads presupposes a sophisticated level of organisation and some motivating force initiating the projects. Whether roads determined the growth of settlements, or settlements determined connecting routes, is not clear. Presumably as settlements were founded and expanded, routes were established directly between sites and with increasing numbers of habitations more paths were developed eventually forming intersecting networks. Sanders and Whitbread, in applying a network analysis graph theory to the Roman road system of the Peloponnese, concluded that road and sea links help to determine central places (Sanders & Whitbread 1990), and certainly in the Late Helladic period the construction of roadways would have opened up greater means of communication during the LH III period. However, problems occur with the application of relative dating. For example, two structures of LH IIIB date may appear to have been built within the same period, but really may have been works of two distinct generations. And in dating road systems, the road really provides no way of distinguishing early or late dates within the Mycenaean period; thus, dates must be derived from bridges and culverts associated with carriageways. It is interesting to note that it is during the LH IIIB expansion of Mycenaean settlements that the bridges, culverts and retaining walls were built. The Mycenaean road system in Phocis is dated by the construction of the LH IIIB Amphissa forts (see p. 53 and n. 57, 139) and notably by what seems to have been the building of the fortification at Khryso: Ancient Krisa (Hope Simpson 1981: 77). The LH IIIB Arkadiko bridge was built on the pass connecting the Gulf of Argos to the Saronic Gulf. The settlement at Nea Epidhavros: Vassa was probably connected to the harbour site of Palaia Epidhavros: Panayia, and the route upon which cargo goods were transported from the harbour to Nea Epidhavros: Vassa was probably guarded by Palaiochori, as suggested by LH IIIB finds. The Dragonera and Lykotroupi bridges presumably enabled residents of Mycenae to communicate with other Argolid sites north and east of it. And clearly these communications continued to the end of LH IIIB as shown by the construction of the Ayios Yeoryios bridge on Road 4. This bridge is not of the same masonry technique as that of the Dragonera or Lykotroupi bridges, nor those on the northern pass (Road 2); the structure was alternately coursed with rows of rectangular- and square-shaped stones.[60] But on the grounds that the blocks are of Cyclopean size, it has been assigned a Mycenaean date by Hope Simpson (Hope Simpson 1981: 17; fig. 4.3.; but also see below, pp. 104, 118).

These LH IIIB roads date later than the initial Cyclopean fortifications and thus appear not to have been constructed out of an influence of heavy transport needs. The Dragonera, Lykotroupi, and Arkadiko bridges employ arches of more advanced masonry, which were not engineered by the time that the first Cyclopean fortifications of Mycenae and Tiryns were built. It must also be noted that extensive road networks were unnecessary for transporting building materials, as the resources were obtained locally, though to some extent the routes used must have been smoothed to reduce the friction between the transport vehicle and ground.

Wooden rollers, such as those used to transport the colossal statues of ancient Egypt, may have provided the even ground that the Mycenaeans required. Heizer suggests that logs were placed beneath and on a parallel course to sledge runners (Heizer 1966: 826). This lengthwise laying of logs would be more cost efficient than their perpendicular placement which would have required a greater number of logs.[61] Ideally such a surface would have been useful for a sledge, but not for wagons; wooden planks would have been more effective in counteracting the uneven surface, as the wheels avoided slipping on rounded edges of parallel placed logs. The rough land would have required some amount of levelling even

---

[60] Visit in 1993.

[61] Cole (1954: 710) suggests that the line of logs parallel to the direction of runners is the result of problems encountered by Egyptians in trying to render perspective and that, in fact, the logs were placed perpendicular to the direction of the runners.

before logs were set down and this, in itself, may have provided a suitable surface, as it appears to have been for the later LH IIIB2 roads.

Roads with smoothed surfaces were already constructed prior to building the fortification walls at Tiryns and Mycenae, and presumably at Gla and Athens. At Tiryns, Early Helladic citadel structures indicate that the summit was in use before the first fortification and would have required some type of access route. At Mycenae, the earliest path to the citadel is reported to have been built in the Middle Helladic and predates the first enclosure.
It was constructed of a layer of large limestone blocks set over a packed earth fill which, in the subsequent Late Helladic period, was reinforced with harder surfaces to withstand its increased traffic (Mylonas 1966: 26-7).

4.5. A theoretical Aegean transport model.

Without some sort of vehicle, an enormous amount of manual labour, distinct from that necessary to quarry and build, would have been required to transport materials from their source to the site (see Chapter 5). Nevertheless, some amount of manpower was required to load and unload stones to and from transport vehicles and to help position stones in the walls. There are no indications of mortises to receive braces or clamps used to move Cyclopean blocks, and it can only be suggested that stones were somehow moved short distances by men to the vehicles. If quarries were cut in steps, blocks could be pushed up on to each successive ledge to the top of the slope and from there moved to vehicles. A rope lashed about the width of the stone and tugged by a team at the top of the hill would have also aided in its movement, especially when it is remembered that the deeper a stone is bedded the more difficult it is to get it out. Alternatively, stones may have been placed on litters and either manually carried out of the quarry or lifted by ropes. And although possible, litter transport would have been most difficult and cumbersome. Heizer notes the difficult, yet successful, movement of 1.5 ton basalt columns in La Venta, Mexico; by the use of shoulder poles and ropes, 35 men were able to move the stone. Similar litter transports were used in Colombia, Madagascar and in the Himalayan regions (Heizer 1966: 825). However, conveyance of the Cyclopean blocks by litters would have been made difficult by the highly uneven ground, and thus another means of heavy transport was required.

The greatest problem in reconstructing a suitable heavy transport vehicle is to determine if it was sufficiently stable to endure the excessive weight of its load and if a suitable draught-power could haul the load. It has been calculated that to move a four-ton wagon across the Australian outback a draught power of 920 N per ton is required (Cotterell & Kamminga 1990: 37). For this same wagon plus a load of one average size Cyclopean block, a weight just under two tons, a draught-team of 14 oxen would have been needed, or 8 oxen for a one-ton sledge and same size load.[62] Wagons are known to support even greater weights, but would require an appropriate increase in draught-power proportionate to the increase in weight of the load. Indeed, Burford (1969: 253) cites a record from Eleusis for the transport of 6.5-8 ton column-drums from the Pentelic quarry to Eleusis by vehicle, although the structure of the vehicle may have differed from the wagon. Coulton (1977: 141) argues that four-wheeled wagons and oxen provided the usual method of transport in Ancient Greece, but that very heavy blocks would have exerted much pressure on the wagon's axles and much pressure on the road surface. He suggests that six- or eight-wheeled wagons would help to counteract the stress involved and the use of wide wheels would lessen the effect on the road, but problems were encountered in trying to steer a wagon with more than four wheels and that sledges were probably used for very heavy blocks.

The advantage of the wagon over the sledge is that the wheels would have raised the stones off the level of the ground surface so that the points of contact between wheels and ground surfaces were fewer than those of sledge runners; thus, the resistant force was reduced, facilitating the movement of the vehicle. In addition, the raised load is protected from the damage which would result if it was dragged along rough ground; this would have been an important consideration when moving ashlar blocks, which were probably shaped at quarries (see above, p. 45). However, massive blocks would have subjected the wagon axles to much stress and possible collapse and in order to move such large blocks sledges may have been used (Coulton 1977: 141).

It is likely that Aegean transport wagons that were used were built long and narrow like the Irish wheel-car (see Fox 1931), enabling the vehicle to adapt to mountain terrain and narrow paths. However, the Irish vehicle had a central axle fixed above the main beam of the car, front bumpers, and, in contrast with ancient four-wheeled models, the wheel-car combined both the runners of a sledge, located at the front of the vehicle, and the wheels of a cart. The angling of the car would have pushed the load down and forward on the runners, securing it in place against the front wall of the car and taking pressures off the rear wheels. The runners absorb the initial shocks and vibrations of the ground and smooth the route for the wheels situated midway along the car.[63] The poor representation of vehicles as a whole in the archaeological record makes casual dismissal of this possible transportation method in the context of the Aegean Bronze Age difficult.

---

[62] Based on a 410 N draught-power of an ox, cited by Cotterell & Kamminga (1990: tab. 2.5), the draught-power of nine oxen is required for the four ton wagon, and for the same wagon plus an average size Cyclopean block the number of oxen is increased to thirteen. However, as it is believed that oxen would have been yoked in teams (see above), ten and fourteen oxen are required, respectively. For a one ton sledge and load, seven oxen are needed, yet when yoked in pairs, it becomes necessary to use eight oxen.

[63] See Fox (1935: 185-86, fig. 1) for a complete description of the Irish wheel-car and diagrams.

The hypothetical Aegean model is a lengthy wagon that enables the load's weight to be distributed over its length, reducing the concentration of pressures which cause wheels to buckle and collapse. Axles and draught-pole are attached to the car's underside to provide additional support and to secure the load when a draught-team pulled the load forward. As the axle is fixed, the small wheels rotate freely. It cannot be determined if wheels were made from single disks or of tripartite construction, but in any case they were not spoked, as their solid and heavy construction would have been adequate for this type of transportation. Mesopotamian and Elamite wheels were studded to protect rims from wear (Child 1954a: 208), and perhaps those of the Aegean were similarly made; a nail-studded wheel would have provided wagons with better traction on the rough slopes. Again, though, evidence is lacking.

Stress was further reduced by constructing wagons low to the ground, as in the Palaikastro model (see above, p. 48), where the gravitational force is weaker. Although sledges greatly reduce gravitational pull, they have far more points of friction which are compounded by uneven ground. It is the long, low-bodied wagon that would have been structurally able to deal best with the Greek landscape.

4.6. On site.

Little consideration has been given to how the blocks were placed in positions in the wall. The sheer size and weight of individual blocks would have made the task of raising stones to heights of 7.50 m and 8.00 m , at Tiryns and Mycenae respectively, very difficult (Mylonas 1966: 12, 17). Many of the stones average lengths of 0.70 m and 1.20-1.50 m, heights of 1.00 m, and thicknesses of 0.80-1.00 m, each weighing several tons (Wright 1978: 159-60). And undoubtedly it would have been essential to have some sort of transport system to aid in moving blocks into their respective places.

The size of the Cyclopean blocks can be compared with stones used in the Great Pyramid at Giza, Egypt, where each block weighs close to 2.50 tons and was moved into position with the aid of earthen ramps (Heizer 1966: 824; Hodges 1970: 118). As each successive course was completed additional earth was added to raise the ramp to a level where the next course could be added. Once the structure was complete the ramp was dismantled and the pyramid revealed. Similar building platforms were used by the Incas in Peru (Heizer 1966: 824) and ramps were sometimes used in the 6th century (Coulton 1977: 48). But were the same kind of building aids used in the construction of the LH III fortifications?

The citadels of Mycenae, Tiryns, Midea: Palaiokastro, Athens, and Gla are each set on substantial elevations, the lowest being Tiryns at 18.00 m above the plain, as compared with an elevation of more than 171.00 m at Midea: Palaiokastro.[64] If earthen ramps were in fact

---

[64] The highest point at Mycenae is approximately 40.00 m, at Athens 35.00-40.00 m, and Gla 20.00-40.00 m above the plain (Iakovidis 1983: 3, 23, 73, 91).

used, they would have needed to have been raised to the height of the citadel and continually heightened until the desired wall height was achieved. As ramps were heightened they too would have been lengthened so that a suitable gradient was achieved, enabling wheeled vehicles to travel across it surface; the steep 20% gradient of Mycenae's Great Ramp, stretching from the Lion Gate to the palace would have been suitable only for pedestrian traffic (Iakovidis 1983: 39-40). A gradual incline would have been less stressful than a steep slope, as to carry and set blocks in their positions would have demanded much upon vehicles and labourers. Even so, a ramp placed at a right angle to the ground and required to reach a height of 10.00 m with a 20% gradient would come close to 50.00 m in length. In all likelihood a gentler gradient was required, proportionally increasing the length of the ramp and requiring much space, which was not readily available at the citadels. At Mycenae, for instance, to reach the top of the acropolis a 20% graded ramp would need to have run 0.50 km, and at Midea: Palaiokastro close to 1.00 km in length! On the other hand, ramps could have been constructed on top of the acropolis, which was accessed by routes possibly present from earlier occupations. However, this hypothesis is also problematic. First, at each of the major Late Helladic citadel centres buildings predate the first fortifications. Difficulties would have been encountered in building a ramp to help construct the LH IIIB2 west and south-west walls at Mycenae, because of the presence of Grave Circle A and buildings of the earlier citadel. Neither could ramps have been built on the exterior of the fortification walls unless they were extended down the acropolis slope to the plain below; as the walls were constructed along the brow of the rock, there would have been insufficient space to erect a ramp.

If a ramp were possible to construct, it would probably have been built of small stones and well-packed earth much like the original Great Ramp of Mycenae (Iakovidis 1983: 40). Stones and soil would have been continually added to the ramp, so that its height could be increased as dictated by the successive courses of stone. However, it must be considered that much earth would be required to pack a ramp to endure the weight and movement of the stones.

It could be suggested that a wooden ramp would alleviate any problem of poor soil availability, but again the ramp would have been long, requiring additions, extensions or even reconstructions to raise it to the appropriate height for each course. Its advantage, however, would have been its portability; it could be shifted along the length of the circuit, whereas an earthen ramp would have to be constructed, presumably in sections, across the entire length of the wall. If a wooden ramp were constructed of rollers, as opposed to planks, the movement of the stone would be facilitated; and if sufficient strength were available to haul the blocks (say that of a draught-team placed on the far side of the wall), the gradient of the ramp would be of lesser consequence. Logs could be placed side by side closely fitted, but not so tight as to stop free rotation, and set within a frame which would keep the timbers together, much like a primitive conveyor belt (fig. 4.6.). As stones were hauled up the platform each log would rotate in the direction of the movement of the stone, helping to push the blocks forward on to the next roller and eventually to the top of the wall (fig. 4.7.). The unit could either be set on a earthen ramp when space allowed for it or, if the logs were set in a frame with a solid floor, it could conveniently rest against the wall on an angle which was proportioned to the walls' height. At the top of the ramp, struts, fastened together, could have been laid along the flat length of the wall, so as to keep the ropes connecting the blocks to a draught-team both taut and level and reduce their shear on the already positioned stones. A simple wooden square of four struts meeting at right angles and secured on the wall would have been adequate. It is possible that a timber horse, centrally placed with legs straddling either side of the wall, was used to hoist the stones up and into place. But it is unlikely that the ropes and horse would have withstood the heavy loads for a long period; shear stress would eventually cause the cord to fray and the wooden frame to collapse. The strength of a code with 7.5 cm circumference is insufficient to lift a weight great than 82 kg (Atkinson 1961: 293), a fraction of the weight of a Cyclopean boulder, and one with a larger diameter could not be easily grasped by hand nor attached to an animal harness. However, the force required to pull on a rope is decreased with the use of pulleys. For instance, Vitruvius' trispast (X.ii.3), a compound system of three pulleys and a winch, which would have held the block, decreases the force necessaary to lift a load by one-third (Cotterell & Kamminga 1990: 91). Yet there is no evidence for a pulley system prior to the end of the 6th century BC (Coulton 1977: 48), and blocks have not been reported to have holes suggestive of having taken the ends of a winch (see also Appendix 1). It would have been a more effective system to combine the draught-team and timber horse assemblage with a portable wooden ramp. Ropes would have been fastened at one end encircling the width of the block to be lifted,[65] and at the other end attached to a draught-team whose forward pull on the rope would hoist the block up the rollers and to the height of the horse. A team of oxen would provide the strength to lift the blocks and the horse the height necessary to swing the block into position, thus avoiding the problems of building an earthen ramp, its maintenance and sheer size.

It has been suggested that massive stones were raised to their appropriate heights in stages with the aid of levers and platforms. As each end of the stone was raised a block was inserted between the stone and the ground, so that when the mass was raised up on either end the intervening and surrounding space between it and the ground could be filled with several other blocks, making a platform upon which another could be built. This system continued until the block reached its determined height, from which it could be levered into position. Although effective and perhaps a desirable option for raising some massive stones, this system would have been most ineffective in fortification building. Experiments conducted with the Easter Island statues show that eleven men using levers were able to re-erect a 25-ton statue in 18 days (Cotterell & Kamminga 1990: 82-3), but elsewhere experiments have

---

[65] As neither mortises nor dowel holes are evident in the stones it must be assumed that rope was used to hoist the blocks, much like it was used to haul sledges as depicted in Egyptian art, cited above.

shown that a 2.5 ton load can be raised by four men taking less than 35 seconds per cycle of leverage--raising the load, inserting packing to raise the height of the block, and lowering the block on to the packing (Hodges 1989: 139). Yet when one considers the number of blocks required for building a Mycenaean fortification, a more efficient system would surely have been necessary. At Gla, for instance, well over 2000 blocks were required to construct one course of one face of the circuit (see Appendix 2).[66]

If oxen were used to transport blocks from the quarries to citadels, depositing their loads outside the enclosure, and blocks were hoisted up a series of rollers and into position by another ox, as suggested, then in one day a minimum of eight blocks per building team could be transported from quarries and placed in the wall, and this number would be compounded by the number of work teams employed. And when one compares the useful power of a bullock to that of a human, the power of the bullock is found to be approximately 3.5 times greater than that of a human,[67] suggesting that no more than one-two oxen would be required to hoist a Cyclopean block up the rollers into the wall.

Although the Mycenaeans would have taken full advantage of local resources, it would not have been without intense labour and economic expense organised by some authoritative power, which saw to it that quarrymen cut limestone blocks, craftsmen built wagons, and general labourers pushed, pulled and aided the loading and unloading of boulders to and from the vehicles and helped to position blocks in the walls. Who these workers were is, at this point, an archaeologically irretrievable question. The fact that there is nothing to suggest slave labour in Mycenaean contexts indicates, perhaps, that quarrying, transportation, and building of the LH IIIB fortifications may have been a cooperative effort by the citizens of one or several communities, much like the extensive road building projects, or a form of corvée labour. What is provided here is a theoretical model which may, perhaps, prove inaccurate in application, but as a model, it illustrates the problems encountered not only by the Mycenaean builders, but also by applying the accepted theories of monumental building practices to fortification building.

---

[66] Although raising blocks with a rocker, where a load placed on a rocker is raised to the appropriate height by the insertion of beams at either end of the unit as it is rocked (Coulton 1977: 48) , would require less time to that of levers, the number of blocks required for circuit building makes suggests its unlikely use as a building tool.

[67] An approximate figure based on Cotterell & Kamminga (1990: tabs. 2.5 & 2.7).

Chapter 5. Labour resource and working hours.[68]

The time required to build a structure in Cyclopean masonry would have been proportionately related to the number and size of blocks required, as well as the available number of men and equipment to quarry, load, transport, unload, and place the blocks in position. Time would further be decreased with experience, and it is assumed that a minimal amount of skilled labour would have been required to organise and instruct workers, increasing the overall efficiency of production.

The projects required a substantial amount of effort. The circuits at Midea, Tiryns, and Gla[69] would have taken well over 1.0, 5.5, and 12.0 years, respectively, to complete two faces only (see Appendix 2), which also illustrates, however, the unlikelihood that experienced masons could find enough work for a lifetime's support in one project, and consequently travelled distances to jobs. During the 4th-3rd century, masons moved between projects to maintain an existence; only Athens, Corinth, and to a lesser extent Argos supported stone workshops, and even then the masons that were employed from these shops were expected to travel a distance (Burford 1969: 199-200). Others may have been from the local population who sustained themselves by performing whatever jobs were available to them. However, both of these situations assume that workers were indeed employed, receiving some form of payment in return for their labour. It is equally possible though that religious or political circumstances influenced the local population into contributing some amount of time and effort towards monumental building.

There is no evidence for a slave population nor a specialised mason group, save for a few skilled workers to train and organise the others, and thus it is difficult to determine the source from which labour was supplied for constructing monumental works.[70] Labour was, in all probability, found within the local population, individuals working either part-

---

[68] Fortifications are generally equated with defence and often an imminent threat; however, this author believes that Cyclopean fortifications only assumed a defensive function after they had been built. The costs of labour and time to erect such monumental works, not to forget administration of such projects, would have been enormous. Of the Tomb of Aegisthus, Wright (1987: 174) writes:

> Its construction required the gathering of suitable rubble stone, their transport and dressing, and the technical skills of specialised masons in the construction of the dromos walls and corbelled vault. Also massive bloc[k]s of conglomerate had to be quarried and set in place over the jambs of the stomion of the tomb. Such an operation may have taken as much as a year to complete and have required the administration of skilled masons and a large workforce.

Surely, the circuit walls would have taken even longer. This chapter sets out to prove Chadwick's (1976: 135) statement that "...a walled citadel like Mycenae must have taken a generation to construct, unless its builders had inexhaustible supplies of manpower."

[69] These sites offer the only available data upon which to calculate an estimate for the number of years to build two faces of the circuits.

[70] Population estimates of Mycenaean sites are most difficult to determine, and thus whether a local population could have supplied a sufficient labour force is most problematic to ascertain. See Kardulias (1992) for the most recent discussion.

time or seasonally, either out of religious coercion or as a form of corvée labour. It has been suggested that the Egyptian and Mesoamerican pyramid builders were from local populations, working when, in the Delta, the Nile flooded making cultivation impossible, and at Teotihuacan recruited as casual volunteers (Heizer 1966: 828). Moreover, local labour would alleviate the difficulties in having to house and feed a slave population which would indeed prove to be troublesome if resources were limited (particularly when cultivated goods were out of season) and the problem of what to do with the men once the projects were finished.

5.1. Quarrying.

Using the overall average of Wright's estimated block sizes (see above, p. 28, below, p. 70), so that l=1.025 m, w=0.90 m, and h=0.80 m, where l is the length, w is the width, and h is the height of the average block, each average-sized Cyclopean block weighs 1.845 tons.[71] It it is assumed that a man can raise and carry a weight of 80 lbs, or 36.29 kg (Hodges 1989: 10), then 51 men are needed to lift an average size Cyclopena block. Since it would be difficult to arrange the 51 men around the block, some other mechanism for raising stones from the quarry bed would be required. If quarries were worked on the flat, levers and platforms might have been used to raise blocks up and onto wagons; however, if stone was quarried in steps and worked downslope, blocks could be dragged or pushed downwards and either hauled or pushed up a ramp into a wagon. Atkinson, in estimating the workload for the Neolithic megalithic builders of Britain (1961; 297), suggests that each man can haul a weight of 0.5 tons on a sledge on level ground, i.e., two men per ton, but that the sledge reduces the number in the hauling party by 56%; therefore, without the sledge seven men are needed to haul one Cyclopean block. However, for a 9% gradient, Atkinson argues that a 450% increase in labour is needed (Atkinson 1961: 297),[72] and so an average-sized Cyclopean block would require a minimum of 26 men to haul the block up a 9% graded ramp and into a wagon. It is more likely that levers were used to raise the blocks into the wagons. Through experimentation, Hodges (1989: 133f) has demonstrated that by using four levers, one man to each, a 2.5 ton weight could be raised. "The force required to lift a 2.5 ton load at each of four lever ends would be 28 kg - well below the possibility of any fit man, especially as the effort is only required in short bursts, and in rhythm" (1989: 139).

---

[71] The only recorded dimensions and weight are of the lintel block of the Treasury of Atreus, c. 120 tons (Wace 1921-23: 346; Heizer 1966: 821; Mylonas 1966: 121); the interior lintel block of the Peristeria tholos is reported to be 3.70 m long by 2.80 m wide, and estimated to be 22 tons, but no width is given (Pelon 1976: 208), and the threshold and lintel blocks of the Lion Gate at Mycenae are 4.60 m by 2.40 m by 0.85 m and 4.50 m by 2.10m by 1.00 m, respectively, but the weight is only guessed as being "in excess of 20 tons" (Iakovidis 1983: 30). Using the lintel dimensions of the Treasury of Atreus, l=8.00 m, w=5.00 m, and h=1.20 m, volume, V, is 48.00 m^3; thus each cubic metre of stone weight 2.50 tons. Using the dimensions of the average-sized block and the weight per cubic metre of stone, the average Cyclopean block is estimated to have a weight of 1.845 tons. This however does not account for the fact that the lintel is of conglomerate stone whereas most Cyclopean blocks are of hard limestone, which is in fact a fraction greater in weight per cubic metre than conglomerate stone. Yet, the weight per cubic meter corresponds to that calculated for a large limestone block of Temple 1 at Bogazköy, measuring 5.75 m by 1.40 m by 1.80 m and weighing 36 tons.

[72] That is, an increase from two men on the flat to nine men on the slope.

The amount of time required to quarry blocks is proportionate to the time it took for each load to be transported to the site and for the return journey, and for the number of loads that could have been moved simultaneously. It is impossible to determine how much time was needed to cut, lift, and load blocks, but if it is assumed that this was dictated by the necessary time it took to transport the blocks from the quarry to the site, to maintain a steady and continual production rate, no additional time to that of transportation was required. Indeed, it is equally possible that quarriers worked fewer hours than the transporters, a day's work being determined by a prescribed number of blocks to be cut.

5.2. Transportation.

Studies of and experiments in megalithic transport[73] suggest that much time and energy were invested into moving the stones. In the Colombian mountains, it has been demonstrated that 35 men were required for one week to transport a one ton statue, by litter, over a distance of seven kilometres (Heizer 1966: 825; Müller 1990: 14). In the Yucatan, it has been calculated that a lone man could carry a 50 kg load, but that it would take one hour to transport it one kilometre (Müller 1990: 12-13). And in antiquity, Burford (1961: 247) has calculated that to transport and polish a geison of poros for the Temple of Aphaia at Aegina would have taken one man three months' worth of work. Atkinson, through experimentation and an evaluation of Neolithic transportation (1979), noted that with the use of a sledge and rollers the number in the hauling party was cut by 56%, as the friction imposed upon the blocks was reduced (Atkinson 1979: 114-15). With this in mind he calculated that a minimum of 16 men was needed to haul each ton of Stonehenge bluestone, to man the guide-ropes used to help steer the sledge, and to shift the rollers (Atkinson 1979: 115) and 22 men per ton of sarsen stone were required for the same tasks (Atkinson 1979: 120). In the calculations that follow, those tasks other than hauling the sledge and load have not be accounted for, and thus the figures provided for man-power herein are indeed greater.

As noted, on level ground 4 men would have been needed to haul one average-sized Cyclopean block on sledge from quarry to site; however, transporters often had a minimum of two slopes to contend with. The first was between the quarry and chief transportation route, and although not often more than one kilometre from the sites, all traces of likely quarries indicate that they were located on hills. The second grade commenced at the point where the route climbed up to the citadel. At Mycenae, the Great Ramp to the upper part of the citadel had a 20% gradient (see p. 59), so using Atkinson's figures, where a 450% increase in labour is needed to haul blocks up a 9% gradient, a single block would require 40 men to move it up the ramp on sledge or 63 men without a sledge. Moving a stone downslope would have been as problematic as manoeuvring it up (Atkinson 1979: 119): although the stress induced by gravitational forces would have to be coped with on the upslope, the passage downslope would involve maintaining a steady pace and control of the direction of the load.

---

[73] See Atkinson (1961; 1979: 105-22), Burford (1960), Erasmus (1965), Heizer (1966), Startin & Bradley (1981), and Müller (1990).

Again using Atkinson's measures to haul blocks on sledge,[74] and assuming men indeed provided the energy for the transportation of the blocks on sledges then to move a Cyclopean block on the flat one kilometre, the approximate and equivalent distance between the quarry and citadel, would have taken the 4 men 11.19 hours per block. Therefore the time taken to transport the blocks for one face only of the circuits at Gla, Tiryns, and Midea: Palaiokastro would have been more than 195, 55, and 14 years, respectively (see Appendix 3). It is unlikely that those massive stones which greatly exceed the average block dimensions were moved in this fashion. For instance, the weight of the 120 ton lintel block in the Treasury of Atreus (Wace 1921-23: 346; Heizer 1966: 821; Mylonas 1966: 121)) would have required a hauling party of at least 480 men to transport it on the flat by sledge or 749 men without a sledge, and with any sort of incline the number of men would necessarily have been increased. Given the uncertainty of whether such a massive labour force was available, the economical constraints of organising and maintaining such a force, and the sheer amount of time, it is reasonable to assume that the Mycenaeans capitalized upon the traction offered by oxen.[75] This would have reduced even the most massive hauling party to a minimum of one man guiding the draught-team, with perhaps one or two others monitoring the load from the sides and rear. As noted above (p. 56), a draught-team of fourteen oxen would be required for a four ton wagon and average size Cyclopean block or eight oxen for a one ton sledge and same size load.

The walking speed of an ox under load is c. 1.8-2.5 km per hour (Piggott 1983: 90). As the quarries were, in most cases, within one kilometre of the building site[76] a return trip from the quarry would have taken just under one hour,[77] so that in an eight-hour work day eight trips could have been made from the quarry to the site. At this rate the time required to move a sufficient number of blocks to Gla and Midea: Palaiokastro to build one face of the circuits would have been approximately 16.5 years and 1.25 years, respectively, and for the entire circuit at Tiryns close to 5 years, not allowing for massive blocks, second face, or internal fill (see table 5.2.). However, Burford reports that it took 2.5 to 3 days for oxen to travel 22 miles (35.398 km) from the Pentelic quarries to Eleusis (1969: 189 n. 1), which is a rate less than one half that given above, assuming an eight hour work day. Therefore, the number of blocks moved per day may indeed be less than this estimate, to account for varying sizes of loads and the ability of a draught-team to sustain the work.

---

[74] It takes 22 men nine hours to move a one ton block 0.5 miles (Atkinson 1979: 120-21; Müller 1990: 14), where one mile equals 1.609 kilometres.

[75] *qo-u-ko-ro* are known from the Pylos tablets (see Palaima, T.G. (1989), Perspectives on the Pylos Oxen Tablets: Textual (an Archaeological) Evidence for the Use and Management of Oxen in Late Bronze Age Messenia (and Crete). *Studia Mycenaea (1988).* Antiquite Vivante Monographies, No. 7. T. G. Palaima, C. W Shelmerdine, and P. H. Ilievski, eds. Skopje). It does not seem unreasonable that someone was responsible for oxen much in the same manner as cattle.

[76] The terrace wall at Sparta: Menelaion is an exception, since its limestone blocks were transported over long distances.

[77] 0.930 hours.

	Manpower	Draught-team
1 Average Cyclopean Block, t=8-hour days (d)	2.50	0.125
One face of circuit wall, t=years (365 d)		
Gla	195.62	16.44
Tiryns	55.26	4.94
Midea: Palaiokastro	14.16	1.27

Table 5.2. Time (t) required to transport blocks from quarry to building site.

This rate, however, makes several assumptions. First, it is assumed that the modern working day of eight hours was the same in prehistory when, in fact, the day may have been either longer or shorter than the present day, or rather, a work day may have been set by some other formula other than time: i.e., a predetermined number of trips made to the site or a requirement to transport all blocks cut in the quarry during the day.

Second, it is presumed that labourers worked each day between the start and completion of the project. "We do not know what the mason's working week was, or how many days were knocked out by festivals, how much more limited he was by the quality of the light and by the weather." (Burford 1969: 247).

Finally, this rate does not account for the possibility, and likelihood, that more than one vehicle was used to transport blocks.

5.3. On site.

Although there is considerable support for the theory that earthen ramps were used in monumental building in Egypt, Mesoamerica, and Peru (see Heizer 1966: 824; Atkinson 1979: 119), it is improbable that the Mycenaeans used them other than to load blocks into wagons or onto sledges at the quarry, because of the difficulties of constructing them (see p. 59) and the great number of men required to push the blocks up the slope. Even when aided by draught-teams, it would not have been possible to avoid using 18 men on a 9% grade, as they would have been needed to push the block up the remaining part of the slope from the point where the vehicle and team, having reached the top, would have been forced to halt. For this same reason, a similar number of men would have been required for a portable wooden ramp. However, if blocks were pulled up a wooden ramp by draught-teams on ground level, as has been suggested (see p. 59-60) the number of men required would be greatly reduced. At minimum, one man would have been required to guide the draught-team and perhaps two other men would have been stationed on top of the wall, and at either end of the raised block, ensuring the correct placement of the block; however, the number of men required to move the wooden ramp would have been greater.[77] To build to the 12.50 m height of the Lower Citadel wall at Tiryns, the maximum reported height of any Cyclopean wall, and allowing for the average length of a Cyclopean block, 1.025 m, 30 men would have been needed to move and position a wooden ramp, no more than one metre from the base of the wall as there would have been insufficient room to extend the ramp further out. Furthermore, the weight of the stone, when hauled upwards, would have secured the ramp against the wall so that no further effort was expended by securing its base on or into the ground.

5.4. Discussion.

Since in any task, it is human nature to conserve as much energy as possible (Trigger 1990: 122-23), the use of the draught-team to haul loads and manoeuvre blocks into position would have conserved individual and group manpower, and increase the rate of progress for each building project. If men were the only available power used to quarry, load, transport, unload, and build the walls, an absolute minimum of 56 men would have been required: four men to lever one average Cyclopean block into a wagon or onto a sledge, 18 men to transport the block from the quarry to the citadel,[78] and another 34 men to unload and position the blocks and move the wooden ramp. However, draught-power would have greatly reduced this figure to a minimum of 39 men, four men to lever the block onto the transport vehicle, one man to guide the team between the quarry and building site and at the site, and another 34 men to unload, position the blocks and move the wooden ramp. Both methods of stone transport, nevertheless, would have demanded many more labourers than this absolute minimum, to allow for blocks greater than the average size and the probability that more than one vehicle transported loads.

Any calculated measure of time is inaccurate as it makes several assumptions. First, it assumes a uniform block dimension. Where the circuit length is known, it has been divided by this average size to determine the number of stones used to construct one face of the wall. Yet Cyclopean boulders are not of equal dimensions, but rather of irregular sizes and shapes; therefore any calculation using the average value immediately imposes an error into the estimated number of blocks .

Second, by using the average block size it has been assumed that the number of courses in the circuit is uniform, but as the block dimensions vary, the number of courses also differs throughout the length of the wall. In most examples of Cyclopean masonry, the only discernible coursing appears in the corners, where attention was given to the shaping and laying of the stones in header-and-stretcher construction. Furthermore, it is not certain that a uniform height was achieved throughout the walls; some parts of the circuit may have been raised to levels higher or lower than adjacent sections, perhaps because of

---

[77] Atkinson suggests that 6-8 men were necessary to carry a hardwood roller 10 feet long with a one foot diameter (a softwood would not have been able to withstand the continuous stress induced by the weight of the blocks). Calculations have been based on the ability of seven men to carry this 3.048 m^3 of hardwood.

[78] That is providing a gradient not more than 9% was encountered; otherwise the number of men would have had to be increased.

changes in the elevation of the land upon which the walls were built, to obscure views from the surrounding hills, to increase the ability to command good views from within, or to emphasise a particular monumental feature, for example, a gate tower. The predicted wall heights further assume that the wall was entirely stone built; preserved heights exceeding 8.00 m at Mycenae, Tiryns, Athens, and Araxos: Teikhos Dymaion (see Appendix 2) and the lack of evidence for a mudbrick superstructure do not suggest otherwise.

In addition, the above estimates do not account for any supplementary features, such as towers, gateways, platforms, staircases, and parapets, nor for possible architectural embellishments which may have required additional time to shape and decorate. Certainly the relieving triangle of the Lion Gate would have required a greater amount of time. Its relief would have required extra time of a sculptor, and many labourers to manoeuvre it into position. It must be recognised that the calculated labour force may have in fact been much larger to allow for the transport of such massive blocks, with dimensions and weight which surpass the average block. Likewise, the hammer-dressing of the ashlar blocks would have absorbed extra time in the quarry as would the preparation of the foundation upon which walls were raised. Furthermore, differences in the amount of work achieved have not been allowed for; it has been assumed that production was not variable and that the rate of activity was consistent between workdays. Nor have figures been adjusted for differences in speed between individuals or groups of labourers.

Nevertheless, these calculations suggest the magnitude of the building projects, and although somewhat incomplete, the foregoing estimations serve to show the minimum, yet large, amounts of time invested in building structures in Cyclopean masonry. The reported circuit lengths and areas of other large settlements (see Appendix 2) would suggest that similar amounts of time would have been invested into building their fortification walls. Even with the most conservative estimate of building time, it is difficult to accept the hypothesis that the LH III fortification walls were built for an immediate defensive need; rather, they can be viewed as part of an offensive programme where authorities visually displayed their sovereignty over the surrounding territories. Once constructed, however, the walls would have served defensive requirements, which would have inevitably become necessary through such a display of the region's wealth.

Chapter 6: Features of the LH III fortifications.

6.1. Location.

The distribution of Late Helladic fortified sites suggests that the placing of major settlements was determined in relation to agricultural practices; only 19% of the total number of mainland sites are coastal, whereas 22% and 33% are located in the Argive and Copaïc plains, respectively. In the Argolid, they lie within a 20 x 15 km area (Field 1984: 318), and in Boeotia they ring Lake Copaïs, suggesting that both regions were tied to the plains for subsistence. The remaining 26% is distributed as 4% in the remainder of the Peloponnese, excluding the Argolid and Corinthia, 7% in Attica, and 15% in Phocis and Thessaly (see fig. 6.0.).

The preferred site for a fortified Mycenaean settlement was a flat-topped, steep-sided hill of considerable height, although positioned near to or adjoining higher ground (type I). More than 60% of LH III fortified sites accepted in this study and in Field's (1984: 314), can be placed in this category. Approximately 26% are hilltop sites, type II, having been built on the highest available ground. In the Argolid, sites are equally distributed between the two types, so that a specific type is not particular to the region. Mycenae and Tiryns conform to type I, whereas Argos: Larissa and Midea: Palaiokastro are type II sites.[80]

In Boeotia, type I sites are preferred; there are only two type II sites, Chaeronea and Ayios Vlasis: Ancient Panopeus.[81] Sites were probably selected because of their proximal locations to the canals and their function within the system.[82] Each site was placed at a point commanding a particular view over the Copaïs, which would otherwise have been remote from observation at any other site in the plain (fig. 6.1.). Furthermore, they were positioned so as to take advantage of land passages and trade routes between the north and the south, to exploit agricultural lands, to guard against any opposition, and to make necessary repairs to parts of the system.

A further 11% of the sites are located on the flat ground, their location selected in respect of the sites' functions. Larymna: Kastri, located between the two bays of Larymna harbour, presumably controlled harbour activity; Eutresis was positioned on the trade route between Boeotia and Attica, and Isthmia, whether a frontier site or trans-isthmian wall, separated the Peloponnese from Central Greece.[83]

---

[80] Visits in 1993.

[81] Visits in 1993.

[82] Although Ayia Marina occupies a high point on the north-west end of a chain of hills stretching along the east side of the Copaïs, it has been grouped as a type I site, being distinct from the ridge but connected to it by a saddle.

[83] The Isthmian wall was founded on both flat and elevated land, but cannot be classified as either a type I or II site. In fact, the masonry varies throughout the length and would seemingly belong to more than one structure. See also pp. 166-7.

6.2. Block size.

Although the largest blocks quarried by the Mycenaeans occur in the post-and-lintel construction of gates and the entrances of tholos tombs, large limestone blocks often one metre or more in length, height, and width were commonly used in building the fortification walls. Wright (1978: 159-60) has determined the average block dimensions to be:

length = 0.70 m and 1.20-1.50 m,

width = 0.80-1.00 m, with headers exceeding 1.00 m and upright blocks at 0.40-0.60 m,

height = 0.60 m and 1.00 m, and an average course height of 0.60-0.80 m.

In general, walls of a late date employ larger blocks than earlier ones, but this is not invariably the rule, and various sizes of stone are used in all phases of building. At Gla, stones vary between 0.50 m and 1.00 m in length and 0.40 m and 0.60 m in height, but a number of blocks have been noted to be 1.00 by 1.20 by 1.40 m, and other long slabs have lengths measuring 1.50-2.00 m (Wright 1978: 181). All reported block dimensions have been recorded in Appendix 2.

6.3. Analysis of wall structure.

Cyclopean masonry is specific to mainland Greece, being a stonework composed of two wall faces, separated by an inner fill of earth and small stones which is unbroken throughout the circuit length. In some instances, wall sections have been built independent of others and when connected form a setback, but the core fill between sections is unbroken. The type has often been labelled as compartment, casemate, or shell-wall construction; however, these terms have been inappropriately applied.

6.3.1. Compartment construction (see fig. 6.2a.).

The earliest example of compartment construction is to be found at Lerna III, where in its final phase the fortification consisted of two independent and parallel stone walls, separated by a space of 2.00-3.00 m, but connected at 4.00 m intervals by crosswalls, dividing the wall into a series of rectangular spaces (Themelis 1984: 342; fig. 6.3.).[84] Field suggests that the wall at Raphina was also compartmented;[85] however, from the plan this does not appear to be a uniform construction (see fig. 6.4.) and the wall has since been covered over (Scoufopoulos 1971: 19), so it is difficult to confirm such a conjecture. Moreover, the superstructure is, according to the excavator, of mud-brick (Scoufopoulos 1971: 19) reducing any similarity to Lerna's stone wall. It must be remembered, however, that the wall at Lerna was the result of several reconstructions. In

---

[84] Visit in 1993.

[85] Field (1984: 351) calls the construction method "casemate". For casemate construction see below.

its first phase, it was a single stone wall, believed by the excavator to have retained a fill which supported a terrace platform (Caskey 1958: 133). It is not until after Room Q-R had been built and the horseshoe-shaped tower, U, had been demolished, being replaced by tower V, that the wall was in fact doubled and compartmented into a number of rectangular spaces, being P-Q-R-S in the southern sector, A-B-C-D and building EV in the west (Caskey 1958: 134-35). Compartmentalisation is achieved by constructing crosswalls to separate the fill into a number of confined spaces, whilst maintaining a relatively straight line of the wall. Crosswalls were intended to increase the safety of the structure by securing against possible shifts of sediments and, as buttresses, by providing additional support for wall faces. This building practice has been called the *Kastenmauer* technique, a term often used to define central Anatolian fortification walls, and appropriately applied to walls encasing and separating the fill.

The only other known EBA examples are found at Thermi V on Lesbos and at Alaca Hüyük, level 5M, in central Anatolia. The wall at Thermi V, with crosswalls positioned at irregular intervals (Themelis 1984: 343; fig. 6.5.), is architecturally closer to Lerna's compartment construction than the wall at Alaca Hüyük, where inner and outer walls, separated by 4.00-5.00 m, are not compartmented with crosswalls, but appear to have been constructed in units set slightly offset from each other (Van der Osten 1937: 4; Bittel 1970: 49; Themelis 1984: 342). Well-developed compartment construction does occur in Hittite Alaca Hüyük and in the Late Bronze Age sites of Alalakh (Scoufopoulos 1971: 103), Bogazköy (Parr 1968: 37; Bittel 1970: 49; und.: 13), and level VII of Mersin: Yümüktepe (Garstang 1953: 237-38). From excavation reports and corresponding plans, these LBA fortifications appear to have been constructed of two walls joined by crosswalls, the resulting spaces being filled with rubble. Offsets do occur, but these do not necessarily correspond with the inner walls, as in unit-building (see below), but seem to be used to alter the direction of the circuit's course (figs. 2.11, 6.6, 6.7.). Indeed, the crosswalls and jogs, independent of one another, recall the earlier, LC I, fortification at Phylakopi on Melos and the south-west section of walling at Mirou: Peristeria, the latter the only LBA mainland example.[86] In addition, the interior plans of Anatolian towers have been sub-divided into rectangular cists, imitating adjacent wall lengths. The enclosure wall at Tilmen Hüyük was also constructed with crosswalls, but where cells were rubble filled in the other Anatolian examples, these were made into rooms only accessible from the area within the enclosure (*AS* 1971: 23). The only other instance where rooms have been built within the thickness of the wall occurs in the earliest enclosure at Mersin: Yümüktepe, level XVI: here windows slits, measuring 0.20 m. by 0.50 m (Scoufopoulos 1971: 103), may suggest casemate construction, but its Chalcolithic date makes a comparison with LBA Tilmen Hüyük rather dubious.

6.3.2. Casemate construction (fig. 6.2b.).

Casemate construction has often been assumed to be synonymous with the *Kastenmauer* technique, and so the term has been misapplied. Casemate architecture is a defensive

---

[86] Field calls this casemate construction, but for reasons cited it has been labelled as compartment construction (1984: 100-02). See casemate construction below.

form of architecture where chambers are built within the thickness of the fortress walls and embrasures, splayed inwards, are cut in the outer wall. Presently, there is no evidence for such openings in the *Kastenmauer*-type walls cited above (with the possible exception of the Chalcolithic wall at Mersin: Yümüktepe), nor can the label casemate be accurately applied to the walls of 18th century BC Carchemish in modern Syria (Parr 1968: 30), the numerous Palestinian examples,[87] and the so-called casemates at Nitovikla on Cyprus (Åström 1972 IB: 5; Fortin 1981: 490). Its use in these examples is clearly a misnomer for what is more appropriately labelled as compartment or unit-built construction. Nor can the term be applied to the later Mycenaean fortifications: the space between the two faces of the Cyclopean walls is solidly filled with earth and/or stone, crosswalls not being employed. Moreover, the walls at Mycenae, Midea: Palaiokastro, Kandia: Kastro, Geraki: Ancient Geronthrae, Araxos: Teikhos Dymaion, Athens, Gla, and Khryso: Ancient Krisa have well-preserved heights (see Appendix 2), so that any use of embrasures, through the thickness of the walls, would be readily apparent.[88] It may indeed be suggested that embrasures were part of the mudbrick superstructure of Levantine or Anatolian fortifications, that are no longer preserved, but any similar suggestion cannot be made for the rubble walls of mainland Greece.

6.3.3. <u>Shell-wall construction</u> (fig. 6.2c.).

As with casemate construction, shell-walls cannot be considered characteristic of the Mycenaean fortifications. Fortin defines shell-wall construction as a double-wall separated by a rubble fill and not connected by crosswalls (1981: 505), and suggests that in Cyprus only M Cyp III-L Cyp I Nitovikla used this technique (fig. 6.9.), whilst other Cypriot fortifications at this time were single-walled (Fortin 1981: 486).[89] Karageorghis and Demas (1984: 23) also define the east wall at Pyla-Kokkinokremos as "standard shell construction" (fig. 6.10.). If these examples are to be regarded as shell-walls, then some Cyclopean walls must also be considered as examples of this construction. However, shell-walls, by definition, are self-supporting outer walls placed over stone or timber structural members, to provide additional strength to the structure.[90] In Cyclopean walls, the interior is a fill of earth and/or stone, not arranged as a self-supporting structure but rather contained by the wall faces, so that the strength of the entire structure, faces and fill, was increased through its substantial width and consequently could be built to great heights. Only the detached bastion at Khryso: Ancient Krisa appears to have had a true

---

[87] The Syro-Palestinian LB I-II western wall Ras Shamra (Hult 1983: 21); Area A-A2 Tel Balâtah-Shechem (Wright 1957: 15, 17); MB IIC-LB I Tell Ta'annek (Lapp 1969: 22); Tell es-Sa'diyeh (Tubb 1988: 41, 44); Tel Yarmut (*Excavations and Surveys* 1988/89: 187). Wright notes that the casemate spaces were used as living quarters at Tel Balâtah-Shechem, similar to those of Tilmen Hüyük (Wright 1957: 15); however, as at Tilmen Hüyük, no suggestion of embrasures has been put forward by the excavator.

[88] The Lower Citadel wall at Tiryns may indeed be an exception, employing arrowslits, according to Field (1984: 43); however, the rooms and corridors built with the thickness of the wall, characteristic of casemate construction do not occur here. Site visits in 1993.

[89] LCypr IIC-III fortifications are double-walled.

[90] See "shell" or "stressed-skin construction" in J. Fleming, H. Honour and N. Pevsner's *The Penguin Dictionary of Architecture*.

shell-wall construction.[91] The shell proper is approximately 2.00 m in breadth and provides a facade for an inner wall, c. 1.00 m thick, within which was a fill of large stones (Field 1984: 215).[92] The pseudo-ashlar, conglomerate stone used at Mycenae in the Lion Gate, North Gate, and the south-east bastion are other examples of the use of shell-walls on the mainland, designed to be aesthetically pleasing and monumentalising: "this material was only used as a facing of the main core, which was built in the usual cyclopean manner" (Iakovidis 1983: 26). Structurally, however, the Cyclopean core required no additional support, as evidenced elsewhere in the circuit, and thus the outer conglomerate facing cannot be considered a shell-wall proper.

6.3.4. Unit-building (fig. 6.2d.).

This type of building involves erecting self-contained units adjacent to and abutting one another. Each unit is stepped either forward or backwards from its neighbouring unit so that the straight line of the wall is broken by a series of offsets.[93] It is not to be equated with *Kastenmauer*, casemate, or shell-wall construction, but is a separate architectural solution, having been developed to stabilise those structures built on slopes and cliff edges, and to accelerate the process of building.

Wright has defined the type as particular to Mycenaean terrace and palatial constructions.

> The advantage of the terrace compartments was that each was a solid and independent structural unit. They easily resisted the destructive action of water seepage, which caused fill to slip downward against a terrace wall: large single-walled terraces would not have withstood this pressure. This manner of construction also allowed each compartment to settle and shift independently of any other (Wright 1980: 81).

However, as the outer walls of palatial complexes at Tiryns, Mycenae, and Gla are also part of the circuit wall, it must be considered whether unit-building is an appropriate label for the building style of the fortification walls.[94]

The walls of Tiryns are the result of the several phases of construction, where unit-building appears first in the earliest phase, LH IIIA1, although it is somewhat obscured by the successive building periods (see fig. 2.5.). The walls of the south part of the

---

[91] The horseshoe-shape fort at Amphissa, located by Field (1984: 220), is not an example of stressed-skin construction. Here only one wall, 0.60-0.70 m thick, supports a solid stone fill; there is no outer shell facing reinforcing the wall.

[92] The location of the detached bastion could not be confirmed in 1993; a large rubble pile was noted, but it could not be determined if this was the bastion referred to by Field (1984: 215).

[93] In architectural studies, "offset" is defined as "the part of a wall exposed horizontally when the portion is reduced in thickness" (J. Fleming, H. Honour, N. Pevsner. *The Penguin Dictionary of Architecture*). Here "offset" is taken to be synonymous with "set back" or "set forward", meaning that the wall either projects forward or backwards from its adjacent unit and a well-finished corner with vertical joints is apparent.

[94] Wright does make brief mention of the circuit walls at Tiryns as proof of unit construction (Wright 1980: 78).

Upper Citadel measure 3.00 m thick and the blocks set at offset corners were dressed into rectangular shapes to strengthen and finish corners (Wright 1980: 75). Offsets along the outer face do not cut through the width of the wall and connect with those of the inner face, but are positioned at oblique angles to one another, and the westernmost outer jog of the south wall is not matched by any inner indentation. This would suggest that the stretch of the south trace was indeed continuous throughout its length. On the other hand, the north walls were retaining walls, as indicated by the absence of an inner face and the fill, whose depth varied according to the shape of the rock (Iakovidis 1983: 5). The outer wall faces of upper structures correspond with the offset line of the terraces and it would seem that the north sector of the citadel was planned following the line of the lower terracing (Wright 1980: 75-80).

The Middle Citadel additions, made directly south of the storerooms extending over the slope and those built within the confines of Citadel 1, were created by unit-building. The south-west corner was separated from the south-east by a stepped passage and postern gate, and the south and east walls can be distinguished by their abutting, yet offset ends. The north extension was also constructed in separate, abutting units, with the south-west unit being constructed first, followed by the west unit, then the north and east units (Iakovidis 1983: 6). The outer faces were marked by a number of offsets, but these were not matched on the inner face; rather, the inner face was a straight wall line enclosing a roughly quadrangular space. On the east side, a new section of wall with three vertical offsets was built between the upper palace area and the new north extension. It increased the overall width of this part of the wall, narrowed the approach to the citadel, and strengthened the wall itself.

Offsets occur in the Lower Citadel, but unlike those in the Upper and Middle Citadels these do not result from constructing the wall on a plan determined by a terrace, nor can the technique be called unit-building. The Lower Citadel wall construction differs from the previous two building periods in that the exterior jogs do not correspond with those on the interior, suggesting that the wall length was continuous and well-bonded (Wright 1978: 218). It has been suggested that these jogs were dictated by the massiveness of the limestone slabs, which are not suited for curving architecture (Iakovidis 1983: 12); however, the sinuous curves evident in the Cyclopean walls at Mycenae and Midea: Palaiokastro, the north wall at Araxos: Teikhos Dymaion, and the west wall at Tiryns, period 3, illustrate that curving lengths could indeed be met with such massive blocks (see figs. 2.5, 2.13, 6.11.). Rather, it would seem that the jogs were employed to deal with irregularities and changes in the height of the underlying bedrock foundation and enabled builders to have greater control over the placement of the wall (Wright 1978: 26, 270).

A number of rectangular niches were set within the Lower Citadel wall and further distinguish its construction from that of the earlier citadel walls. They measure 3.05-3.25 m wide, c. 2.00 m high, and have a depth of 3.35-3.70 m. Thirteen recesses are found in the east wall and twelve in the west wall, and the distance between them is

4.20-4.40 m. Another two are positioned in the wall south of the west gate (Iakovidis 1983: 12). Kilian suggests that these were cult rooms (1988: 148), but Iakovidis' suggestion that these openings may have been storage rooms (Iakovidis 1983: 12) is an attractive explanation, considering that what has been excavated shows this lower area to have been rather crowded. Their purpose remains unclear, since they have not been identified in any other Mycenaean fortification wall, nor has the relationship between the Lower Citadel buildings and the enclosure wall been ascertained.

Field reports that each niche has an "arrowslit" (Field 1983: 43). If this is indeed so, then perhaps we can see this third period of building as one inspired by a defensive need. The wall construction still maintains its Cyclopean technique, but the use of corbelled vaults enabled small chambers to be built within the wall, and the splayed embrasures, through which a potential enemy could be viewed and fired upon, provided additional security.

It has been suggested that the three rooms built within the north Cyclopean wall at Mycenae are analogous with the Lower Citadel niches (Iakovidis 1983: 27). However, in contrast with Tiryns, the rooms differ in size, two communicate with each other, and no other chambers have been uncovered elsewhere in the circuit. The LH IIIB-early IIIC date of the rooms is contemporary with the construction of the North-east Extension and underground cistern, and also with the chambers of the Lower Citadel, suggesting that if defensive considerations stimulated the third phase of building at Tiryns, it is likely that they were responsible for this development at Mycenae also.

Mylonas suggests that the southern section of the original circuit at Mycenae was also built with a series of setbacks (1962: 175, 197; Field 1984: 14), but now, after a succession of building periods, the enclosure at Mycenae has only two recognisable offsets in its outer wall (see fig. 6.11.). The first is located in the north Cyclopean wall, just west of the North Gate, so that the stretch of wall between this offset and the North Gate is stepped towards the south, resulting in a narrowing of the passage just beyond the gate. Another offset occurs at the point where the south and east walls intersect and form the south-east bastion. In both instances, the offsets occur only where the circuit alters its direction. A similar technique was used in the north-west part of the north Cyclopean wall. Three straight wall sections, east of the point where the circuit dips into a U-shaped section, overlap and bond behind the wall face (Scoufopoulos 1971:37). This was possibly a means of linking together walls that were built as separate sections and strengthening the masonry where it altered its course; however, the offset, located near the North Gate, was perhaps the result of a change made to the location of the postern gate and construction of the North Gate proper. The north Cyclopean wall was cut at the point where it dipped south-east and the north part of the wall was extended eastwards, creating a gate passage with its entrance facing east. Likewise, the jog created by the south-east bastion was the result of a change in the building plan. At this point, the wall retained a fill and provided a terrace for the east wing of the palace area (Wace 1949: 91; Iakovidis 1983: 33). The south wing of the House of Columns was situated on this south-east corner, its basement rooms being built within the fill of the terrace (Iakovidis 1983: 65).

Other buildings on the summit were also supported by artificial terraces. The west terrace distinctly employs a number of offsets, suggesting that the wall was not only built in sections but also adapted to the shape of the land (Iakovidis 1983:56). On the terrace the various buildings and courts of the palace complex were raised, their plan dictated by the shape and size of the summit and the terraces, which were built to increase and support the available building area. Associated pottery indicates that the Pillar Basement, located west of the megaron and below a courtyard, was constructed in LH IIIA (Iakovidis 1983:61), which suggests that at least this portion of the west terrace had been constructed by this time.

At Midea: Palaiokastro, on the north-west slope below the east gate, a similar terrace wall, built in what appears to be unit-built construction, has been located (Field 1984: 34; see also fig. 2.13.). Iakovidis reports that MH and LH sherds have been found associated with the terraces over the site's slopes and this would suggest that unit-building was a solution well known to the engineers at Midea: Palaiokastro by the time the circuit wall was built. Terracing is also apparent on the east and north sides of the summit, and pottery finds provide a LH date for the buildings erected on the platform (Iakovidis 1983: 22). However, the fortification wall at Midea: Palaiokastro does not conform to this style of construction, but rather is a sinuous circuit wall following the natural line of the rock.[95]

The fortification at Gla was indented with offsets which appear to have cut through the width of the wall, so that the vertical projections of the outer face have corresponding inner indentations (fig. 2.4.). Offsets are positioned along the entire circuit at intervals of 6.00-12.00 m, averaging 9.00-10.00 m, and project out from the outer face 1.10-0.60 m, most being 0.25-0.40 m (Wright 1978: 181; Iakovidis 1983: 92). However, study of the south wall indentations and careful examination at those points where blocks have been dislodged has shown that the vertical joints of both the outer and inner faces do not continue through the width of the wall but are stopped by the wall fill. Moreover, the inner fill is uninterrupted throughout the entire length of the fortification and, in some instances, blocks extend through what would appear to be two distinct wall sections (Iakovidis 1983: 93).[96] By contrast, the vertical joints of the north and east terrace offsets of the residential building do cut deep into the fill. "At many places a masonry face is detectable running through the width of the circuit wall and terminating at offsets in the interior and exterior faces" (Wright 1980: 69).

Superimposed buildings were also constructed in successive rectangular units, beginning with the outermost units and working inwards until the walls met each other (Wright 1980: 71). This same system of building occurs in the south-western building at Pylos,

---

[95] Visit in 1993.

[96] Visit in 1993.

where rectangular compartments, offset and abutting each other, were not only built to retain the fill of the terrace, increase the overall structural stability, and to support walls of the building proper (Wright 1980: 66-8; fig. 2.3.), but once the walls had been constructed made it possible to assemble the core with little effort (Wright 1978: 270). It would seem that the technique used for the terraces at Gla differed from that used for the fortification.

Iakovidis has suggested, as with the Lower Citadel at Tiryns, that the indentations served to break the curving length of the circuit into straight sections, a plan made necessary by the large rectangular limestone blocks (1983:93) Field reiterates this point and suggests that the construction method may have been the result of several groups working simultaneously, or a means to deal with uneven ground (1984: 37, 183); however, he also cites the curving lengths at Araxos: Teikhos Dymaion as a way to contend with the rough ground (Field 1984: 119; below). Furthermore, as noted above, curves have been satisfactorily constructed elsewhere with blocks of equal and larger dimensions than those used at Gla.[97]

The regular use of offsets, inherent in the wall at Gla, is not found in the circuit wall at Araxos: Teikhos Dymaion;[98] rather the use of sinuous curves and offsets, and variations in style throughout the course, suggest that the builders used various means to solve problems such as building on uneven ground, manipulating changes in the direction of the course, and connecting walls that have been assembled by more than one work party. For instance, the curving length that occurs along the north side for a stretch of 190.00 m was intended to solve the difficulties of building on uneven ground (Field 1984: 119), and the variations suggest that several sections of the wall were built separately with offsets being formed when walls were connected together, and being more pronounced when the circuit changed its direction.[99]

Lawrence correctly notes that the stability of the wall was increased by repeated changes in the circuit direction as walls buttressed one another at right angles (1979: 5). Scranton also observes the structural value of offset walls; if a fault were to have occurred in the wall, or if the wall should have collapsed, it would have little effect on adjacent offset sections (1941: 151). Scranton further suggests that the indentations at Gla had an aesthetic function.

> The effect, so far as the faces are concerned, is to give the wall the appearance of having been built in block like sections, each block being the entire height of the wall and as long as the distance between the offsets (Scranton 1941: 150).

---

[97] Blocks at Gla average lengths of 0.75 m, whereas those from Midea: Palaiokastro are 1.00 m long, from Araxos: Teikhos Dymaion 1.30 m long, and those in the curving wall of the west bastion at Tiryns are not reported to be distinctly smaller in size than those in the Lower Citadel, averaging a 1.00 m length (see Appendix 2).

[98] Little has been reported on the wall at Araxos: Teikhos Dymaion and indeed on the offset construction.

[99] Visit in 1993.

A similar argument has been made for the offsets of the main building at Pylos, which are believed to have been employed to interrupt a long stretch of straight walling (Blegen & Rawson 1966: 51).[100]

It does indeed seem that its the appearance created was of utmost concern. First, the jogging of the wall at Gla imitates that of the residential/palatial complex,[101] the latter having been dictated by terracing, and so the whole circuit presents a uniform appearance. Second, when the enclosure was viewed from the surrounding plain, it would have been impossible to detect where the residence/palace was located within the circuit, thereby providing additional security for the complex.

6.3.5. Cyclopean construction.

Cyclopean walls must be viewed as a distinct style of fortification found only in the Aegean and particular to mainland Greece. The style does not make use of crosswalls nor embrasures, and thus cannot be classified as compartment nor casemate construction. Rather, fortification walls were, as noted above (p. 22), composed of an inner and outer face, separated by a core of earth and stone. The average width was approximately 4.30 m, but many exceed 5.00 m, as compared with those just over 2.00 m on Crete and Cyprus. The wall at Melos: Phylakopi, 6.00 m wide (Atkinson et al 1904: 31), is the only structure with a comparable width, but its technique of construction differs. Although the LC I wall had an inner and outer face, separated by a fill of rubble, and was built of large undressed or roughly dressed blocks, it must be classified as compartment construction. The two walls, each c. 2.00 m wide and separated by c. 2.00 m, were connected by crosswalls, of varying thicknesses, which divided the interior space into a number of rectangular cists, also of differing dimensions (Atkinson et al 1904: 31). Nor can the LH IIIB1 wall, built to reinforce the earlier wall, be considered Cyclopean; it too was built in a compartment technique (Field 1984: 271). At Keos: Ayia Irini, the Great Fortification was not compartmented, except where later additions had been built, and a rubble and earth fill separated wall faces; however, the alternation of small stone pieces, filling horizontal joints, with courses of large rectangular slabs creates a pseudo-ashlar appearance that is not characteristic of Cyclopean masonry (fig. 6.13, 6.14.). A similar style of masonry occurs in the walls at Paros: Koukounaries and Siphnos: Ayios Andreas, measuring 1.66 m and c. 3.50 m in breadth (Field 1984: 330; Barber 1987: 68); the difference in width was probably a result of their function. The wall at Paros: Koukounaries functioned as a terrace wall which blocked the direct route into the site, so that the approach was stepped (Barber 1987: 68-9; 234), whereas that at Siphnos: Ayios Andreas was a fortification proper with eight rectangular towers (Field 1984: 275; Barber 1987: 68; figs. 6.15-16.).[102] Neither can be considered to be of a Cyclopean style.

---

[100] Vertical offsets appear at regular intervals at Troy VI (Blegen 1963: 111) and elsewhere in Anatolia. Although their construction differs, it seems that appearance was also an important concern in the Near East when constructing fortification walls.

[101] Iakovidis (1983) calls this group of buildings the "Residential Complex", whereas Wright (1980) labels the same structure a "palace".

[102] Also see p. 134.

It is interesting to note that, from the reported measurements of wall widths, those widths exceeding 2.00 m belong to sites where the Cyclopean wall was clearly a fortification, whereas those 2.00 m or less belong to terrace walls. The only exception is Mytikas, but here the wall width has been estimated by Field and not, in fact, measured, and the site is suggested to be a guardpost (1984: 188).[103] Similarly, the so-called Cyclopean walls in Crete appear to vary in wall breadth according to function. The massive wall at Juktas is 3.00-3.50 m thick and has been suggested to be a fortification wall, being constructed of large blocks averaging more than 1.00-1.50 m in length, assembled in irregular courses and fitted together with small interstice stones (Hayden 1988: 11; fig. 6.17.).[104] At Kastrokephala, west of Herakleion, the LM IIIA-B[105] fortification wall is 2.10-2.20 m wide (Hayden 1988: 4; fig. 6.18.). The remains of the fortification at Ayia Photia in eastern Crete, built during the first phase of construction and contemporary with the rectangular building, suggest that the wall width measured 1.30-1.50 m (Tsipopoulou 1990: 309), but the width is by no means uniform (fig. 6.19.). The north wall was a substantial width, being buttressed with three or more semi-circular bastions set close together, the west wall was also wide and may have been strengthened by a bastion on its south end, but the east wall was thinner, appearing to have been one-half the width of the other two walls. It is likely that the wall surrounded the building on all sides: clear remains can be seen on the north, east, and west sides; only slight traces and a possible entrance are apparent on the south side.[106]

A fortification thought to be built in the Cyclopean technique was located at the base of the hill at Petras, on the Gulf of Siteia (*AR* 1988-89: 106; Tsipopoulou 1990: 319; 1991: 20-1). Unfortunately, the width of the wall cannot be determined because of the modern road that runs over it; however, the preserved height to c. 3.00 m and the large rectangular towers suggest that it would indeed have had a substantial width. Another wall of LM I date, not exceeding more than 1.10 m in width, was located on the slopes of the hill: its function was to support the fill of the terrace upon which the buildings of the settlement were built (*AR* 1988-89: 106).

The walls on Cyprus and in the Near East display a similar pattern, with walls in excess of 2.00 m,[107] although Kourion: Bamboula is an exception, measuring 0.75-1.45 m (Weinberg 1983: 29). In contrast the retaining walls, F2083 and F2084, located at Hala

---

[103] In 1993, no evidence for a Cyclopean wall was located at Mytikas. On the south side, a terrace wall was noted cutting across a cleft in the rock, but its masonry was not Cyclopean; rather, it is similar to modern rubble walls. At the top of the hill a pile of large blocks, many of Cyclopean size, was noted; however, it is difficult to confirm if this ever formed a structure, as the hill is very rocky and much of it is covered in similar blocks. At the base of the cliff were the remains of a modern stone house.

[104] Visit in 1994.

[105] Dated by Hayden to LM IIIA-B, see below, p. 129.

[106] Also see below, pp. 131-2.

[107] Sinda at 2.00 m (Fortin 1981: 537; Karageorghis & Demas 1984: 30), North wall of Enkomi III at 3.50-4.00 m (Fortin 1981: 537), south wall of Enkomi III at 2.50-3.50 m (Åström 1972: IC: 40; Fortin 1981: 537), Kition at 2.40 m (Karageorghis 1973: 11; 1976:60; 1982: 90-1; Fortin 1981: 537), and Maa: Palaiokastro at 3.50 m (Fortin 1981: 537; Karageorghis 1982: 91).

Sultan Tekke measure c. 1.30 m and 1.20 m (Åström et al 1983: 107). Massive fortification walls measure c. 9.00 m wide in the Büyükkale at Bogazköy (Bittel 1970: 49; fig. 2.11.), 4.50 m at Troy VI (Blegen 1963: 62; fig. 2.2.), and 5.00-6.00 m at Alaca Hüyük (Van der Osten 1937: 4; fig. 6.6.). In Palestine, however, massive fortifications were often reinforced with either a single or double glacis and additional outer walls, and covered over with a layer of earth, *hamra* and/or *kurkar*. At Tel Yarmut, Wall B is a retaining wall, its inner fill supported massive rectangular platforms increasing the usable area of the hilltop. It measures 2.60 m in width (De Miroschedji 1990: 57; fig. 6.20.).[108]

It would appear that although walls vary in widths between regions, probably a result of their differing construction technique, in all reported instances the breadth of the structure seems to have been determined by the function of the wall. This is not only limited to fortifications and terraces: dams appear to be constructed sufficiently wide to retain enormous amounts of water and divert river flows. The dam at Tiryns varies between 50.00 m and 80.00 m in width,[109] a massive thickness to withstand the pressures of water and increase the stability of the structure (fig. 6.21.). Two dams have been located at Pseira, eastern Crete, of which one has been excavated, and measures 2.90-3.10 m wide. Its breadth is comparable to the fortification walls in Crete, but unlike these it was constructed of three stone walls separated by an earth and stone fill (*AR* 1990-91: 76). In Anatolia, a dam approximately one kilometre from Alaca Hüyük measures 14.45 m wide. It was responsible for stopping the water from a number of surrounding hills (Arik 1937: 10-13) and so was constructed to be quite substantial.

It seems that differences in Cyclopean construction were the result of the structure's purpose and the locality within which it was built. Fortifications were necessarily wide structures, enabling a substantial height to be achieved. Walls at Mycenae, the Lower Citadel at Tiryns, Araxos: Teikhos Dymaion, and Athens are preserved to heights well over 8.00 m (see Appendix 2). Dams were also broad structures, since stabilility was required to stop flow water. On the other hand, terrace walls were not required to be so wide: the massive Cyclopean blocks and the wall's elastic nature were sufficient to retain and support pressures of the fill.

Further differences in the way in which the wall was built are often related to where the wall was located. Offsets were used to connect and strengthen sections that were built as separate units. At Khryso: Ancient Krisa, the wall was thickened at points where the circuit altered its course, strengthening what might otherwise have been a weak spot (Field 1984: 212). Offsets were also used in unit-built terraces, again as a strengthening device, but also because those on rocky summits dictated their form. Likewise, offsets

---

[108] Also see below, p. 143.

[109] Balcer (1974: 147) does not provide any measure of wall width, but notes that the channel over which the dam was built was more than 8.00 m across. Hope Simpson (1981: 23) notes that although a precise measurement of width cannot be obtained, the north section measures c. 80.00 m in width and the south part is c. 50.00 m.

occur on Crete, at Ayia Triada and Knossos (see figs. 6.22-23.).[110] Those in area A at Ayia Triada appear to have been used to connect a number of sections to form one long wall. Smaller walls, positioned at right angles and on either side of the main wall, do not suggest unit-building, nor do they indicate that the wall length had any aesthetic function. On the other hand, the offsets of the south wall of the lower court were seemingly used aesthetically, since the sections of the eastern half of this wall are of similar lengths. Offsets are also found along the outer wall of the magazines and facing onto the court; these may also have had an artistic value, but with the piers located at the storeroom entrances they also functioned as supports for upper storeys.

Cyclopean walls did not require crosswalls, as sufficient strength was provided by the massive boulders and flexibility created by the minute spaces between blocks and interstice stones. Moreover, the fill increased the wall width and consequently the capacity to support a number of superimposed blocks. The construction method is unlike of that used for structures located on Cyprus and in the Near East, using neither a mudbrick superstructure, crosswalls, casemates, nor vertical offsets that extend through the core fill; rather, it appears to have been a local and independent building technique.

6.4. Gates.

The most common type of gate found on the mainland, also favoured elsewhere in the Aegean, on Cyprus, in Syria-Palestine, and in Anatolia, is the axial entry. The axial approach can take the form of a simple-entry, a single-entrance gate, a two-entrance gate, a three-entrance gate, or a double gate. Each has a path of direct access through the fortification wall. A second type, the L-shaped entry, is not as prevalent as the axial type; nonetheless, it too is found in the Cyclades, on Cyprus, and in the Near East.

6.4.1. Simple-entry (fig. 6.24a.).

The simple-entry is a gate type that provides direct access into the settlement interior by means of a small passage cut through the wall. On the mainland, this type does not appear to have been used for gates of primary importance during the Late Helladic period, but rather was commonly employed for simple postern gates. The west gate in the Lower Citadel at Tiryns offers, at present, the best example of the simple-entry (see fig. 2.5.). The passage interrupts the wall in the south-west, at a point just before the circuit turns in a north-west direction to form the roughly elliptical shape of the Lower Citadel. At this point, the wall width is c. 8.00 m (Iakovidis 1983: 10). The passage has a uniform 2.20 m width (Iakovidis 1983: 10) except where a frame would have once secured a door, as indicated by sockets set 0.22 m and 0.26 m out from the side walls and 0.02 m and 0.17 m deep into the stone threshold (Iakovidis 1983: 10). At a height of 2.75 m above the passage floor, the side walls incline inwards, suggesting that the corridor was roofed with a stone vault. There may have been another passage in the north part of the the Lower Citadel wall; however, Iakovidis (1983: 10) rejects this possibility on the basis of its awkward arrangement. Like the west gate, the north passage was also 2.20 m wide with a length of 7.00-8.00 m and was roofed by a corbelled vault. Its floor, however, is

---

[110] Visits in 1994.

2.75 m above the ground, thus making it inaccessible except by ladder (Iakovidis 1983: 10) or earthen ramp. But, its similarities in dimensions and construction to the west gate, despite its height above the ground, makes the possibility not easy to dismiss.

Another passage of similar construction has been located in the North-east Extension at Mycenae (see fig. 6.25.). It runs the breadth of the wall, 7.10 m, and is of a uniform width, 1.05 m. The passage is 2.45 m high and roofed with a corbelled arch (Iakovidis 1983: 35). Other than providing access to the south terrace of the extension, and thus a dominating position to view the Chavos ravine (Iakovidis 1983: 35), the purpose of the passage remains obscure. Surely, if it were simply to allow for a view over the valley, the vault would not have been necessary, as a simple passage cut through the wall would have sufficed. If, however, the purpose of the archway was to provide a continuous wall-walk, the passage would have been unnecessary, for the same view could be had from on top of the wall.[111]

Other simple entries of LBA date were not as well constructed, and appear to have been nothing more than unroofed spaces between wall ends. The passage through the west gate at Midea: Palaiokastro is flanked on the left of entry by the circuit wall and on the right by the natural rock of the hill (fig. 2.13.). Likewise, the enclosures of Juktas[112] and Kastrokephala on Crete have openings cut through the breadth of the walls (figs. 6.17-18.). The passage at Juktas is 3.00-3.50 m deep, but the collapse of wall sections (Hayden 1988: 11) may account for some of the passage length. The possible entrances at Kastrokephala are, in comparison, 2.10-2.20 m deep (Hayden 1988: 4). Likewise, the Cypriot entrances of Maa: Palaiokastro and Idalion, period 1, provided direct access to the sites through simple openings in the walls (figs. 6.27-28.).

As with the LBA simple-entries, earlier passages do not conform to specific dimensions of depth and width, construction technique nor plan, other than being direct access approaches positioned at right angles and through the circuit wall. At Lerna, the entrance passage, on the left of the semi-circular tower and more than 3.00 m deep, cut directly through the inner and outer enclosure walls (fig. 6.3.). At Syros: Kastri, two of three gates also cut through the enclosure which, unlike Lerna, was a single wall, 1.20-1.90 m thick (fig. 6.29.). However, the north gate between Towers G and D does, in fact, closely resemble that found at Lerna. A small room was built immediately behind the entrance with a passageway cut through its south wall which led into the settlement area; it was built on the same axis as the first entrance and was of a similar width, 0.45-0.50 m.[113] The east gate at Syros: Kastri, on the other hand, resembles the EB II entrances of Palestinian Arad and the period IV entrance at Keos: Ayia Irini, where

---

[111] Visit in 1993.

[112] A LM III date has been assigned by Hayden (1988: 11) to the wall at Juktas; however, the more usual MM IA date is preferred by this author. See pp. 128-9.

[113] Doumas (1972: 161) reports an entrance width of 0.45-0.50 m and from the plan the inner doorway would appear to be the same.

passages, cut through one wall only, are located within proximity of semi-circular towers (figs. 6.13, 6.30.).[114]

6.4.2. Single gates (fig. 6.24b.).

The single-entrance gate has a depth greater than the width of the enclosure, created by projecting its side walls inwards beyond the line of the fortification wall. As demonstrated by Mycenae, Tiryns, Gla and Ayia Marina, this type is favoured for the monumental entrances of LH IIIA2-B fortifications. But, in no way do they succeed the simple-entry type which, as mentioned above, continued to be used for gates of secondary importance.

The simplest form of the single-entrance gate is found at Ayia Marina where the south gate has been formed between two sections of walling, which each turn perpendicular to the circuit wall (fig. 6.31.).[115] This same form appears at the Late Cypriot sites of Kition and Sinda, and in a slightly more developed form at Idalion, period 3 (figs. 6.28., 6.32.).[116] The second building phase of the east gate of Citadel 1 at Tiryns is similarly formed, but protrudes slightly outwards as well (fig. 2.5.). However, both the Lion Gate and North Gate at Mycenae extend well beyond either side of the fortification line.[117]

The approach to the Lion Gate is 14.80 m long from the end of the so-called bastion to the west Cyclopean wall and through a small courtyard immediately placed before the gate. The breadth of the threshold adds another 2.40 m to the length of the gate passage and a second courtyard, found immediately inside the gate, contributes a further 4.00 m (Iakovidis 1983: 30-1). The entire gate passage thus exceeds a length of 21.00 m (fig. 6.33.). The North Gate followed a similar plan to that of the Lion Gate, yet was of smaller dimensions; the projecting north wall extended outwards 6.50 m, the threshold breadth has been measured at 1.50 m (Iakovidis 1983: 33), and just inside the gate was a courtyard 4.00 m wide (Iakovidis 1983: 33). From these measurements it is determined that the passage through the North Gate did not exceed 12.00 m (fig. 6.34.).
Both the Lion Gate and the North Gate were closed by doors, probably constructed of wood, indicated by sockets and buttresses projecting 0.10 m and 0.09 m out from the sides of doorposts and framing the doors of the Lion Gate and North Gate, respectively (Iakovidis 1983: 30, 33). It is also certain that there were doors at the single-entrance gates at Tiryns and Gla (Iakovidis 1983: 93-6).

---

[114] The gate at Naxos: Panormos has also been typologically classified as a simple entrance, although the wall has been reinforced by triangular-shaped structures at either side of the entrance. Because of its variable wall thickness, ranging between 1.00-2.00 m (Doumas 1972: 90), and the construction of rooms within the circuit, it cannot be classified as any other gate type other than simple-entry, but it may indeed need to be viewed as distinct from other Bronze Age gates discussed herein.

[115] Visit in 1993.

[116] The north-east gate at Keos: Ayia Irini could also be classified as a single-entrance gate. Inner walls create an enclosed space off of which other streets and rooms can be accessed.

[117] Visit in 1993.

The west gate at Gla resembles the gate plans at Mycenae (fig. 6.35.). The side walls of the gate were projected forward to form two rectangular towers and to enclose a forecourt, 5.30 m by 6.00 m (Iakovidis 1983: 93). At the rear of the court was a gateway, beyond which lay a second court. On the north side of the second court was a small room, 3.00 m by 3.00 m (Iakovidis 1983: 95). It is comparable to the gate niches at Mycenae, in that they also lie on the left side of entry; however, its smaller dimensions[118] and entrance above ground suggests, if not a separate function, then clearly a change of plan by the time the gate at Gla was constructed.

The north and south gates at Gla also have rooms to the left of entry. That of the south gate was planned like that of the west gate, but instead of being square is rectangular. At the north gate, however, it was left open, so that it forms a large courtyard as opposed to a separate room. The main difference between these gates and the west gate is that each of them contained another room to the right of the passage, across from that on the left. Apart from the south-east gate at Gla[119] this type of plan has not been found elsewhere on the mainland and appears only in the three-entrance systems of Syria-Palestine.

The west gate of the Upper Citadel of Tiryns is another variant of this type, combining the single-entrance gate with the simple-entry postern (fig. 6.36.). The postern, 7.50 m long, interrupts the wall at an oblique angle. Immediately inside the gate, a staircase, 45.00-50.00 m long ascends to a single-entrance gate which is no wider than the width of the staircase, 1.50-2.30 m (Iakovidis 1983: 8-10). Beyond the gate was a larger space, somewhat like the courtyards at Mycenae and Gla.

6.4.3. Two-entrance gates (fig. 6.24.).

Like the single-entrance gate, the two-entrance gate is a passage of depth; however, instead of one doorway, this type has two distinct thresholds separated by an inner chamber. Its appearance on the mainland is limited to the left (west) entrance of the south-east double entrance at Gla and the east gate of the second citadel at Tiryns. The western half of the gate at Gla is 11.10 m deep and 4.90 m wide (Iakovidis 1983: 95; fig. 6.35.). The first threshold was set more than halfway into the passage, and the second doorway was located at the far end of the chamber created immediately beyond the first door. This part of the gate is, in plan, similar to the other three gates at Gla and it would not be surprising if evidence were found to suggest that these gates were also closed by two successive entrances, particularly in the south gate where the northernmost wall protrudes into the passageway approximately equal to the width of the buttresses of the known entrance.[120]

---

[118] The Lion Gate niche, 1.85 by 1.80 by 1.50 m, is accessible through an opening, 0.70 by 1.05 m, set 0.75 m above floor level (Iakovidis 1983: 31). The North Gate niche is accessible through a 1.30 by 1.47 m opening, 0.30 m above the ground (Iakovidis 1983: 33).

[119] See double gates below, p. 87.

[120] Visit in 1993.

A two-entrance system was constructed along the east side of the Upper Citadel of the second period at Tiryns (fig. 6.36.). It restricted access into the settlement with its large buttresses on either side of the doors, which effectively narrowed the entrance. At this time, the approach to the citadel had also been confined within two walls, one along the west face of the already present wall and a second on the outer and eastern side of the ramp.

The only other Bronze Age two-entrance systems known have been located in the east gate at MB IIA Akko and Hittite Alaca Hüyük. The plans, of two successive doorways separated by an inner chamber, are the same as the two mainland examples, and like the Tiryns gate, the eastern gates did not have rooms that were accessible from the inner chamber.

6.4.4. Three-entrance gates (fig. 6.24d.).

The three-entrance gate has three sets of inner projecting buttresses which proportionately narrow and lengthen the passage, and create two distinct inner chambers. The entire length of the gate was flanked by two massive, rectangular towers. Of the two-entrance systems, only the Anatolian example from Alaca Hüyük can boast towers flanking the entire length of the gate passage; the left tower (west) of the west section of Gla's south-east double gate flanks the length of the forecourt only, and the entrance at Tiryns was positioned between the flanking walls of the ascent ramp. The origins of this type are to be seen in Syria, from where it later spread to Palestinian fortifications of Middle Bronze Age date (Gregori 1988: 98).

Many of the gates offer only one possible route, a direct passage, although made somewhat indirect by successive doorways. However, the north-west gate at Shechem and north-east gate at Alalakh did provide alternatives to the straight passage. Immediately beyond the first doorway of the gate at Shechem, two passages at the left and right of the direct route provided access into the towers. Inside the right (east) tower a staircase was built parallel to the axis of the gate entrance, and presumably led to an upper storey. The interior plan of the left tower is similar and is assumed to also have been a stairwell. The south-west gate at Alalakh was also constructed on this plan, but provided access into only one of its towers, the right (left) tower (fig. 6.38b.). It was entered through an opening located approximately halfway between the first and second doorways and accessed a stairwell, parallel to the main passage. Beyond the stairwell are two inaccessible rectangular cells characteristic of the so-called casemate construction of Anatolian and some Syro-Palestinian fortifications. The division of large internal spaces into smaller cells by crosswalls was probably intended to support upper storeys, which are suggested by the remains of staircases at Shechem and Alalakh. This system of dividing the inner tower space by crosswalls also occurs in the water gate at Carchemish, the east gate at Yavneh-Yam, the south gate at Beth Shemesh, and the gate at Tell el-Far'ah south. One further example is known outside the Near East at Melos: Phylakopi, where a stairwell, parallel to the city wall, and two rectangular cells were enclosed by an outer wall.

One further interesting feature of Alalakh's north-east gate is the small room located at the rear of the east tower. It could not be reached from inside the gate, but was accessible only through the small opening from within the citadel. A similar room was built in the left (east) tower at Beth Shemesh.

There was an opening immediately inside and to the left of the first doorway at Beth Shemesh, but rather than leading to a stairwell, it provided entry into a small, approximately square, room (fig. 6.39.). Its only other eastern parallel is to be found in the north-east gate of the lower city at Hazor, stratum 3 (fig. 6.38.). Here both flanking towers have rectangular rooms extending over the length of the towers which themselves are of almost equal dimensions, with east and west walls buttressed at midpoints by projecting walls. The plan at Beth Shemesh resembles, rather, the gates at Gla where the rooms are roughly square[121] and occupy less than one half of the available inner space of the tower. That a stairwell was found within the tower at Beth Shemesh, quite distinct from the room to the left of the main passage, indicates that these gate rooms had some function other than providing access to upper levels, even by means of wooden ladders, as suggested by Scoufopoulos of the south gate at Gla (Scoufopoulos 1971: 85); of course, this assumes that these gates can be compared with a lone example from Palestine of Middle Bronze Age date. Perhaps Scoufopoulos is correct in applying the term guardroom to these rooms (Scoufopoulos 1971: 85), although Charitonides' suggestion of gate shrines for the niches found at Mycenae, Tiryns, Athens and Troy VI (Charitonides 1960: 1ff.) could also be applied to the gate rooms at Gla, Midea: Palaiokastro, and Beth Shemesh. However, any suggestion of their function remains speculative in the absence of associated remains.

This three-entrance gate has been argued to be a Syrian innovation, appearing throughout north and central Syria in the early MBA, and introduced thereafter in Palestine during a period of renewed urbanisation in MB IIA which followed after a time of complete abandonment in EB II-MB I. This redevelopment of urban centres did not occur in Syria, but rather continuous growth and change throughout the later EBA-early MBA period (Gregori 1988: 95). Not only does the historical account suggest Syria's influence over Palestine, but the Palestinian three-entrance gates date no earlier than MB IIB, whereas Tell Mardikh and Tell Tuqan in Syria date to MB I (Gregori 1988: 95).

Syrian influence does not appear to have had widespread effects in Anatolia. In fact, only one example of this type has been recognised, namely the south gate of the Hittite *Unterstadt* at Bogazköy. In plan, it resembles the north and south gates of Alaca Hüyük with the interior of the towers subdivided by crosswalls and the rear doorway placed on the same line as the back wall of the gate tower. The only difference is that instead of two successive doorways it has three. The north gate of the lower city and the King's Gate and Lion Gate of the the upper city are, however, of the the two-entrance type.

---

[121] The rectangular shape of the room in the south gate at Gla is more pronounced by the niche, 0.90 by 1.50 m (Iakovidis 1983: 95), in its south wall.

6.4.5. Double gates.

Only two examples of double gates are known from Mycenaean Greece; the south-east gate at Gla and the north-west gate of Araxos: Teikhos Dymaion. Both plans show two distinct entrances, one being significantly larger than the other, and separated by piers which may have once been used as free-standing towers. At Gla, the pier, c. 6.00 m wide, does not exceed the limits of the gate's depth, 11.10 m, by projecting forward from the line of the fortification (fig. 6.35.). The west gate is the larger of the two, with an opening 4.90 m wide and a two-entrance system, discussed above. The passage of the smaller gate is 3.90 m wide and, because the right (east) tower does not project as far back into the citadel as do the pier and the westernmost wall of the gate, the depth of the passage is smaller than the west passage at 10.50 m (Iakovidis 1983: 95). The plan of the tower is like that of the central pier, with a small room[122] to the right of the passage, immediately beyond the doorway. The arrangement at Araxos: Teikhos Dymaion is similar, with its gates, 4.00 m and 2.20 m wide, separated by a central pier c. 6.80 m wide (Field 1984: 124). At Gla each passage provides access to different parts of the citadel, while at Araxos: Teikhos Dymaion both passages access the same part of the citadel. Field suggests that the wider entrance was used for wheeled vehicles and the smaller entrance for pedestrian traffic; however, this does not explain why wheeled traffic was banned from the eastern tip of the citadel at Gla. Vehicles could easily have accessed the citadel through one of the other three gates which would have been of sufficient width for wheeled traffic; indeed, the width of the west gate at Gla exceeds that of the south-east gate. Furthermore, wheeled vehicles would have experienced difficulty in travelling up the steep paths, of gradients exceeding 20 degrees,[123] to the citadel. These double gates lack other parallels and thus it is difficult to arrive at suggestions for their original function. The fact that in neither instance were the gates remodelled and that they were located at two citadels dating not earlier than LH IIIA2-B suggest that this was a later type.[124]

6.4.6. L-shaped Entry (fig. 6.24e.).

The L-shaped entry is not axial, but is an approach that turns abruptly at 90 degrees immediately beyond the threshold. The earliest examples of this gate type date to EB III at Syros: Kastri, Aegina: Kolonna V, and Tell Yarmut. The L-shaped passage at Syros: Kastri is considered to be the principal entrance into the site (fig. 6.29.). It is entered only after passing through the outer curtain wall and turning left, staying on the east side of Tower G. Tower B projects into the space between the two walls and its gate is immediately visible, facing in a westward direction in front of the approach. The gateway is substantially larger than either the other north gate or west gate, having a width of 1.15 m (Doumas 1972: 159) and a depth created by the passage into the tower turning right through the wall. Other L-shaped entrances that turn right inside the

---

[122] 2.40 by 3.00 m as compared to 3.10 by 3.00 m of the central pier (Iakovidis 1983: 95).

[123] This figure is based upon the dimensions of the ramp leading up to the south gate, 100 m long rising to a height of 24 m above the plain (Iakovidis 1983: 93). Calculating from the plan, the slopes of the paths climbing up to the other three gates would have been not less than this 20 degree grade.

[124] Visits in 1993.

gateway have been found in the Phylakopi III city wall and in the outer city wall, Wall B, at Tell Yarmut, although this may indeed have been dictated by the route up to the citadel, the large corner tower existing from the earlier fortification, Wall A, and the stone terracing between Walls A and B (fig. 6.8., 6.20.). In all other examples the turn is to the left of entry, which would have forced the shielded side of an enemy against the outer limit of the path, thus exposing their unprotected side to any defenders who may have been stationed in adjacent towers or along inner walls. At Syros: Kastri, however, an unprotected side was equally exposed to attack from Tower G and the inner fortification wall. The passageway cutting through a semi-circular tower only has a parallel at Aegina: Kolonna, where similar plans are found in the outer city wall built in City V, 2200-2050 BC (Walter 1983: 64; fig. 6.40.), and later appears as part of the inner defence system of City VII, 2000-1900 BC (Walter 1983: 94). In further contrast with the other two gates, this entrance was closed by a door, whereas the others appear to have remained open.

The gate at Syros: Kastri does not share any features with later L-shaped gate types other than its indirect approach. The rightward turn of its passage through the tower is a feature found only in the other EBA L-shaped gates, although neither Tell Yarmut nor Aegina: Kolonna have been noted to possess both features, and it is uncertain if the passage at Melos: Phylakopi cut through both an outer and inner city wall or what may have once served as a tower.

The mainland types have been located only at Athens, Midea: Palaiokastro, and at Tiryns, Citadel 3. In the latter two cases, the L-shaped passage results from their location in the east where the natural outcrop of the citadel of Midea: Palaiokastro and the inner wall of the ramp of the second citadel at Tiryns force a turn to be made. At Athens, however, the L-shaped layout of the west gate appears to have been a conscious decision taken by the builders. The direct passage through the entrance was blocked by a Cyclopean wall set at a right angle to the entrance and fortification wall, forcing one to turn left to enter the citadel area (fig. 6.41.).

The east gate at Tiryns became a well-developed entrance, having evolved through all types set out above (see fig. 2.5.). When the citadel was first constructed in LH IIIA2 a simple-entry, reinforced by the thickening of wall ends and c. 2.84 m wide, provided access through the east wall into the citadel. Shortly after its construction, the gate was reinforced inside the doorway by two towers (Iakovidis 1983: 3), thus making a single-entrance gate passage. During the following period of reconstructions, approximately one century later (Iakovidis 1983: 5), the plan of the gate was completely rebuilt. The gate itself was demolished and the area to the east of where it stood was made into an enclosed courtyard. At the north-east corner of the courtyard a two-entrance gate was constructed (see above, p. 84) at the top of a narrow approach which was bounded by two walls of equal thickness (Iakovidis 1983: 5). The citadel underwent a third period of major alterations at the end of the 13th century (Iakovidis 1983: 6), and the east gate was yet again reconstructed. Access was through a simple L-shaped entry, 4.70 m wide, constructed because the east end of the new Lower Citadel fortification effectively closed the former passage to the Upper Citadel (Iakovidis 1983: 7). A left (south) turn after entering through the first gate gave access to the Upper Citadel, and a right turn directed the entrant to the Lower Citadel. The latter was easily entered with no further thresholds to cross. However, the ascent to the palatial complex was hindered by three further gates, two encountered along the straight access and the third at a right angle to these. The first gate was newly constructed between the retaining walls of the approach, built in period 2, and resembles none of the former gates. It is, in fact, similar to the Lion Gate at Mycenae, being built of massive, dressed blocks well in excess of the average size Cyclopean boulder. The threshold block, 1.45 m deep and more than 4.00 m across, supported equally large doorposts and the buttresses projecting from the doorposts reduced the 3.20 m wide entrance to 2.86 m (Iakovidis 1983: 7). Immediately inside the doorway was a narrow chamber which opened into a wider space, and beyond which was a second gate dating from the preceding phase. The only alterations made to this gate at this time were to reinforce the side walls to the south and east which in no way changed any of its dimensions (Iakovidis 1983: 7). The courtyard from Citadel 2 was also retained, although a gallery running north-south and seven small storage rooms were added onto its east side (Iakovidis 1983: 7). Finally, a gate of similar plan and location to that of Citadel 1 was built at a right angle to the passage ascending from the first gate to the upper courtyard, and through this one entered into the Upper Citadel.[125]

The gates at Aegina: Kolonna also exhibit a long period of redevelopment, although it seems that the L-shaped entry was favoured, occurring in the north and south gates of the City V wall and later in the inner wall of City VII. During City VI, a simple entry was cut through the City V wall, midpoint between the south gate and adjacent tower, and the new inner wall employed deep single-entrance gates. With changes to the defence system of City VII, the L-shape entry of the south gate was sealed off and a simple entrance built along its side. This was probably intended for a second tower needed to defend the approach. The axial entries of the inner wall were now altered into the L-shaped gate type previously preferred and which continued to develop in depth along this plan in the succeeding cities. The type was easy to defend, funnelling pedestrian traffic through narrow paths which broadened towards the settlement (Walter 1983: 94, 101). Although not as deep nor intricate, the east gate at Midea: Palaiokastro also had a funnel-like approach, widening from 2.00 m on the outside to 2.30 m on the inside (Iakovidis 1983: 22).

6.4.7. Discussion.

The approaches to the citadels were well protected by placing monumental gateways immediately at the top of the ascent and by forcing an entrant to expose his unshielded side as he climbed upwards. Nevertheless, it seems that the single-entrance gate developed out of the simple-entry type not so much for security as for appearance. Main entrances were carefully built of massive blocks, tightly fitted, and often dressed. As such, they provided monumental appearances conveying an impression of power. Entrances were lengthened by projecting walls in and out from the fortification at right

---

[125] Visit in 1993.

angles. More than one-half of this type restricted the passage width with buttresses positioned at midpoints along the corridors. At Mycenae, the Lion Gate was formed out of an original simple-entry by projecting the north end of the west Cyclopean wall forward so that the approach into the citadel was forced around it and into the forecourt of the gate.[126] And as gate plans were altered, so were construction techniques which now employed massive, dressed blocks and lintel decoration as found at Mycenae with the Lion Gate and its relief and in the east gate of Tiryns, Citadel 3.[127]

The single-entrance gate served defensive requirements better than simple-entries with its towers and deep, restricting passages which made the entrant vulnerable to defenders throughout the length of the gate. However, if security were a foremost concern, single-entrance gates would surely have evolved into deeper two- or three-entrance types where defence in depth was possible and an enemy could have been easily trapped within the confines of the gate by sealing off its exits. The door of the single-entrance gate would only lock an enemy out of, or into, the citadel, leaving him to escape back down the outer ramp or through a different exit within the citadel; by no means could an enemy have been trapped within the gate passage. In fact, only one two-entrance gate has been located, at Gla, and no three-entrance gates are known anywhere in Greece. L-shaped gates were also used in the Late Helladic period, although less frequently constructed, being a result of the configuration of the citadel; only that at Athens seems to have been built with a desire to force a left turn immediately inside the gateway. For these reasons, and because the single-entrance gates constitute the prevalent gate typology during the Late Bronze Age on the mainland, this type must be regarded as an important and characteristic feature of the LH III enclosure walls.

What can be concluded from this typology is that LH III builders did not follow an established gate plan as the builders of the Syro-Palestinian enclosures did, nor can types be established as having any chronological associations. It is certain that the entrances of the LH III citadels did not copy the earlier forms of the Near East. The three-entrance gate type found in EBA and MBA Syro-Palestinian is in no way like those gates on the Greek mainland; the only remote similarity detectable is the construction of rooms to one or both sides of the main gate chamber at Gla, but by the time the entrances were built at Gla, the Syro-Palestinian gates had long been abandoned.

Anatolia offers no evidence that the Mycenaean gates might have evolved out of a tradition of Hittite architecture. Their two-entrance axial system is closer in plan to the three-entrance type of Syria-Palestine than to the one example found in the west part of the double entrance at Gla, and their casemate building tradition reflects in no way the building tradition on the mainland.

---

[126] Although the original gate of Citadel 1 is difficult to reconstruct (Iakovidis 1983: 28), it does appear to have been planned as a simple-entry at the point where the west Cyclopean wall turns north-west and again north into what is labelled as the north Cyclopean wall.

[127] Even if no relief can in fact be claimed to have decorated the gate at Tiryns, the importation of conglomerate from the region of Mycenae suggests the additional expense which the builders were willing to undertake to dress the structure.

Cypriot gates are also mixed typologically. Simple-entries have been noted at Maa: Palaiokastro and Idalion and L-shaped gates existed at Sinda, Nitovikla, and Enkomi, where the north gate of the latter actually took two turns, one to the left followed by an immediate turn to the right.

The reported gates of Crete and the Cyclades are all of the simple-entry type, except the later gates at Keos: Ayia Irini, Period V, and Phylakopi III, which have been suggested to be a single-entrance type (see n. 116) and a L-shaped entry (see above, p. 87), respectively. The simple-entry also occurred at Lerna and Aegina Kolonna VII. This type is the simplest form of a gateway, and should certainly be seen as having no specific origin, for without even a simple opening no enclosed space could have been accessed.

Although the function of the simple-entries changed from principal entrances to passages of secondary importance, their occurrence in mainland contexts appears relatively unchanged from the Early to the Late Bronze Age. From the present evidence, it appears that the LH III builders did prefer the single-entrance gate, although a few L-shaped gates and equal numbers of simple-entries and double gates were also constructed at this time. Only the two-entrance gate and double gate make their first appearance in the Late Bronze Age, but, as noted above, these are relatively rare among Bronze Age gate forms, and their relatively small number can hardly be seen as a significant architectural trend. Rather, the gates were engineered to relate to their function. Simple-entries were used in their earliest form as main doorways, but by the LH IIIB2 fortifications they were used for postern gates, where they would have drawn as little attention as possible. Principal entrances were built in depth with massive, well-dressed and closely fitted blocks, giving an appearance of impregnability. Entrants were admitted into the citadels through gates that would have appeared well guarded with their flanking towers and massive doors. Finally, the approaches to the third citadel at Tiryns and at City VII at Aegina: Kolonna suggest that some sort of defensive measure was required, but whether this reflects an international or national threat to these two sites only cannot be determined from the nature of the gates alone.

6.5. Towers.

Towers appear to have undergone significant changes in their development, rarely appearing as part of the circuit wall in the LBA on the mainland, but rather incorporated into gate plans. But whether towers continued to be defensive structures, as were Aegean and Near Eastern walls of the Early and Middle Bronze Ages, is something which remains to be considered.

Often "bastion" and "tower" have been used as interchangeable terms; however, the true bastion was introduced by Italian engineers at the end of the fifteenth century AD, being a protrusion of the fortification, "designed so that its faces were elongated from the flanks of its adjoining bastions and it was therefore fully protected by flanking fire" (Hughes 1974: 17). Towers, on the other hand, are tall structures, distinctly projecting beyond the width and height of the wall with interior rooms often, but not necessarily, on ground level. However, what has been preserved in the archaeological record does not often provide sufficient evidence of the height of a tower nor its internal arrangement with possible upper storeys upon which a definition can be based, and thus, for the purpose of this discussion, a tower is defined as a distinct structure, clearly perceptible in plan, protruding at a length beyond the limits of the wall; a bastion is simply distinguished as a protuberance in the course, positioned so that its wall forms an angle with the circuit greater than 90 degrees. Both a tower and a bastion have been found in the north-west corner of the Middle Citadel at Tiryns: during the second building period a tower proper was built, and in reconstructions of the succeeding phase, a wall was added to the south-west corner of this tower, curving along the west side of the citadel to form a bastion (Mylonas 1966: 12, 14; Iakovidis 1983: 8).

6.5.1. Semi-circular towers.

Towers were built as semi-circular or horseshoe-shaped, i.e., with rounded projecting faces, or alternatively as square or rectangular-shaped structures. From the present evidence, it appears that the former type are generally to be associated with the Early Bronze Age. They were constructed of small, local stones and placed at intervals along the length of the circuit wall. Their function seems to be one of defence as suggested by their shape and position. They provided defenders with unobstructed views in all directions whereas square units would have restricted the range of view with blind spots created by their angular walls. They appear first as bastions at EC II Naxos: Panormos and as towers at Delos: Kynthos[128] and Lerna III. Shortly thereafter, in EC IIIA, horseshoe-shaped towers were added to the circuit at Syros: Kastri. In the east, rounded towers held less favour, appearing only at Demirchi Hüyük, phase F, and Jericho, stage XXXXIV, but their construction is somewhat different, having stone foundations and a mudbrick superstructure (*AS* 1978: 16; Korfmann 1983: 242). And following soon after, still within the EBA, and presumably at the time when the first fortifications with projecting square towers were built at Troy, their rounded towers were replaced by rectangular ones.

Those sites where a substantial part of the fortification has been recovered show that towers were spaced at regular intervals along the length of the wall.[129] In ancient military architecture, towers were designed and positioned to support each other, the distance between them being determined by the range of the defenders' weapons. The further forward a tower was projected, the greater was its problem of security; however, a systematic spacing of towers meant that when one was under siege adjacent units could rally to its defence (Vitruvius i.v.4; Hughes 1974: 17). Was the intention the same on these EBA walls?

---

[128] Doumas argues that the thickness of huts Π and Ψ, 0.80 m and 1.40 m respectively, and their location at the outermost part of the settlement suggest that the walls formed parts of an enclosure wall (1972: 162-63; see also Barber 1987: 56), and because of uncertainties of the fortification's plan they have been classified here as towers.

[129] At Aegina: Kolonna semi-circular towers are regularly spaced along the circuit, but with each building phase these develop as part of elaborate gate plans relying on defence in depth (see gates, above, and rectangular towers, below).

At Syros: Kastri, the five preserved towers of the inner wall are set facing north at 4.50-8.00 m intervals; a sixth tower was positioned at its west end (Scoufopoulos 1971: 25; fig. 6.29.). However, the semi-circular towers are EC IIIA additions made to an already existing structure (Barber 1987: 54), perhaps inspired by the EB II walls of Naxos: Panormos and Lerna, where bastions and towers, respectively, were also systematically spaced along the walls.

Unlike the enclosure wall and bastions of Panormos, which were constructed as part of the same building programme, the towers at Lerna were added independently to successive rebuildings of the wall. When the horseshoe-shaped tower U was built, it was constructed as part of a new fortification plan, its foundation being bonded with that of room Q-R. However, in the third building phase, tower U was destroyed and a new tower, tower V, was built, extending as a square projection 2.50 m southwards which, after several building sub-phases, returned to its previously rounded form, although it was not hollow as the earlier tower was (see fig. 6.3.). At this time another similar tower was built to the east of the entrance with segment S-T (Caskey 1958: 134), and more than likely another one would have existed in the west, although further excavation is needed to confirm this.

The preference for rounded towers continued into the early MBA as suggested by those at MM IA Ayia Photia in eastern Crete (*AR* 1988-89: 102; fig. 6.19.) and at Keos: Ayia Irini, where the period IV fortification has a horseshoe-shaped tower, located north of building CJ; however, these are the only examples of projecting semi-circular towers, as square or rectangular-shaped towers were to become the norm.[130] In addition, the spacing of towers along the trace lost favour in the Aegean, excepting the walls at Isthmia,[131] Siphnos: Ayios Andreas, Melos: Phylakopi, and Keos: Ayia Irini, but their positions adjacent to entrances were to increase in importance as defensive and monumentalising features.

6.5.2. Rectangular towers.

The period V fortification with rectangular towers at Keos: Ayia Irini replaced the earlier system with its horseshoe-shaped tower, and at Melos: Phylakopi and Siphnos: Ayios Andreas squared towers were also constructed. They have been found on the mainland at all of the major citadel sites--Tiryns, Mycenae, Midea, Athens, and Gla--and at many of the other Late Helladic sites, including the five towers at Ktouri and those projecting northwards along the stretch of the Isthmian wall.[132] However, these are all LBA examples as, in fact, evidence of MBA towers is scarce, having been reported only at

---

[130] Evans & Renfrew's (1968: 22-3) cautious proposal that the rounded LH III corner at Saliagos, was a bastion (Evans & Renfrew 1968: 22-3), must remain a suggestion until further evidence can elucidate the relationship of the rectangular building and the "bastion". And at Tiryns, the west bastion added to the Middle Citadel during the third period was a necessity rather than a preference, resulting from building on the limited space and uneven slope of the citadel.

[131] That is assuming that the four towers of section Pe are indeed part of the same structure as the other reported remains. See pp. 166-7.

[132] See n. 128 and n. 131.

Troy IV-V (Blegen 1966: 111-23), at Lesbos: Thermi (Lamb 1936: 211) and Demirchi Hüyük (Korfmann 1983: 242). Middle Helladic fortification walls, let alone towers, have yet to be reported, and although it has been proposed that Vasiliko: Malthi and Geraki: Ancient Geronthrae were fortified at this time (Scoufopoulos 1971: 20, 65; *GAC*: 174), the evidence points to a later date.

The enclosure at Vasiliko: Malthi is not characteristically Cyclopean: its outer face was not constructed with large blocks, its fill was composed of differing sized stones, and the wall width was variable. The towers were not simply a protective arrangement flanking gates, but rather were part of an elaborate entrance system where passages opened within the wall then turned into the settlement, as at Aegina: Kolonna (Field 1984: 190-12). In addition, the excessive number of entrances for the small settlement size, 138.80 m by 82.40 m (Field 1984: 109), the twisting passages and associated towers (noted particularly in the east gate), and stairways at two of the entry points are reminiscent of the architectural style of early LBA Kolonna. The only other staircases reported are also of LBA date. At Melos: Phylakopi a gate tower with a staircase was built flanking the passage for what is believed to have been a postern gate, having access only from within the settlement (Atkinson 1904: 25, 34; Field 1984: 270; Barber 1987: 68). Tower ne, added to the circuit of Keos: Ayia Irini in period VI, was likewise accessible by a staircase (Davis 1977: 20; 1986: 12 n. 5).

During late MBA-early LBA, enclosures with square towers begin to appear, at Keos: Ayia Irini and Petras in eastern Crete. The towers appear to have been single-roomed units, constructed with large blocks of local stone, faced outermost and laid in a semblance of coursing. This was to become the basic structure upon which later towers were modelled. Such towers were not limited only to Greece and the Aegean, but have been found, for example, in Cyprus at Enkomi, Kition, Nitovikla, and Sinda, and in Anatolia at Troy; however, it is certain that these did not influence the Aegean structures. The eastern towers had an internal arrangement of two rooms with equal dimensions (except Nitovikla which had one room only), each enclosed on three sides by the tower walls and on the fourth side by an internal crosswall. Although the mudbrick superstructures would suggest a limited supply of building stones, the plan was too regular a feature in the east to be considered a method for conserving supplies, and thus must be viewed as a structural solution whereby the crosswall would have helped to support walls and possible upper floors. The construction is similar to the compartmentalised, or *Kastenmauer*, technique used to build the fortifications. There is only one parallel, the south-east tower of the third building period at Tiryns. But one example can hardly represent the infusion of an idea from the east; rather, this is probably the result of an independent building plan.

One wonders why squared towers replaced the EBA/MBA rounded structures, as their angular walls certainly obstructed views and efforts were required to reinforce the corners. Did these new forms actually provide a greater structural defence, or was it that their shape and size imposed a strong psychological impact upon a threatening foe, or was this new construction even dictated by a change in construction materials? Local outcrops of hard limestones and an ability to quarry them provided builders with the means to erect more monumental structures than previously. However, because of the massive size and naturally rectangular shape of the stones, and the difficulty of working them, it was problematic to achieve curved walls, although not impossible. In contrast, the EBA builders were not using large dressed blocks, but rather small stones tightly fitted together, so that walls could be made to curve easily. This gave a defensive advantage over squared towers, for the latter could be destroyed easily by driving a wedge between their corners where the joints are connected (Vitruvius i.v.5). However, the LH III architects were able to achieve mechanical and defensive strength at corners by shaping blocks and laying them in an arrangement of alternating headers and stretchers, so that the joints alternated and evenly distributed the stresses from superimposed blocks. At Gla, gate towers were constructed of local limestone blocks laid in headers and stretchers, with occasional small interstice stones. The stonework is comparable to Flemish bond masonry, where each course consists of alternating headers and stretchers; each header was surrounded on its four sides by stretchers, and likewise each stretcher was enclosed by headers. This style was much adhered to in corners, but there was less concern for uniformity in the lengths. This type of construction was certainly not unknown elsewhere at this time: at Troy, towers VIg and VIh were also built of large limestone blocks with corners of alternating headers and stretchers (Blegen 1963: 117; Scoufopoulos 1971: 105).

This construction allowed architects to build to great heights, as required for the erection of towers. The headers bonded with the inner wall fill, strengthening widths while the stretchers supported lengths, and thus stresses were transferred evenly throughout the wall. It is worth noting here that the EBA semi-circular towers also required defensive support, to protect the weak point where the walls abutted each other, which an enemy would likely attempt to use to bring the structure down; where they have been added on to the trace, the existing wall has been reinforced. After Lerna's tower V was rounded, its outer face was reinforced by a screen of stones which also stretched eastwards. In the following phase, the spur-wall of Q-R was added (Caskey 1958: 134-35) to support the east side of the tower, while the wall already existing between rooms P and Q would have reinforced the west side of the tower. In the east, where the wall can no longer be completely traced, a spur-wall between S and T once reinforced another tower similar to tower V.[133] At Syros: Kastri, variations in the inner wall thickness of 1.30-1.80 m suggest that the circuit was later reinforced (Doumas 1972: 159), and the buildings crowded up against the fortification would also have helped to support the addition of six new semi-circular towers. The reinforcing spur walls of the detached horseshoe-shaped bastion at Khryso: Ancient Krisa, however, call into question whether reinforcements, at either corner of the flat end, solved a structural problem as opposed to a defensive one. Did building pressures concentrate in these two ends, as they would have in corners of a rectangular-shaped tower, and as such require extra support? If this was the case we should expect to find spur walls on the flat ends of the isolated Amphissa forts, but the

---

[133] Visit in 1993.

literature makes no mention of these and so, until further evidence is found, reinforcements as a whole must be viewed as a defensive measure, with Khryso: Ancient Krisa perhaps an exception.

Late Helladic engineers were aware of building principles and the risks involved in building structures too high, but the higher a tower was raised, the better the chance to outrange potential assailants (Hughes 1974: 17). Differing structural features were adapted to towers, so that they could be erected to required heights without placing excessive pressures on the lower load-bearing courses. The massive gate tower at Athens was constructed with an internal crosswall which was intended to secure and release pressures of its massive internal stone core (Iakovidis 1983: 88); if not relieved, this would have caused the western wall to collapse down slope, in due time. Even at period V Keos: Ayia Irini, the builders seem to have been concerned with the load-bearing ability of towers x and e and thus increased the width of their walls (Davis 1986: 101); a further mechanical feature was employed with the setting back of successive courses, at 15-20 cm, of tower e. Such stepping of the tower sides would have enabled builders to have achieved a substantial height; the walls would have eventually converged, each supporting the others and distributing stresses downwards on a slope.

Probably, however, this setting back of courses was also for aesthetic reasons. When walls with even surfaces are built to great heights, even though they are structurally secure, they will appear to an observer to be leaning forward, as if about to collapse. However, if walls are built with a slight inward inclination, to the observer they appear optically correct. This refinement was well-known in Classical architecture, characterised most thoroughly in the Parthenon,[134] and imparted to buildings an appearance of strength and monumentality, without the sense of weightiness of the massive stones. Perhaps the setting back of courses represents a similar practice of refinement in the Bronze Age, though developed to a lesser extent.

Monumentality was a desirable feature for aesthetic as well as defensive qualities, being, as mentioned above, most evident in Mycenae's Lion Gate and south-east tower. Their use of conglomerate has already been noted, but here it is the construction technique which proves most interesting. Like the gate towers at Gla, the Lion Gate tower is of header-and-stretcher construction which imparted a sense of greater strength and stability to the conglomerate face. This same type of construction is also evident in the south-east tower, constructed in Mycenae's second building period, which was built of well-fitted ashlar conglomerate blocks, and protected a large drain through which groundwater from the buildings of the eastern sector was conducted. For defensive purposes the tower's height would not only have provided a good view of the Chavos Ravine but a south-west view around and past the southernmost tip of the settlement, which otherwise would have been obscured.[135] It has been argued, however, that its purpose was to strengthen this section of the wall, lending additional support to the palace and buildings of the eastern

---

[134] See Dinsmoor (1975: 165-67) for a discussion of optical refinements in the Parthenon.

[135] Visit in 1993.

sector (Iakovidis 1983: 33: Field 1984: 15, 337). The new structures and additional fill certainly would have imposed greater stress on the wall, particularly at the corner where the trace changes direction from south-east to north-east; however, one wonders why a terrace wall constructed in Cyclopean masonry could not have been used for such a purpose. It would seem that monumentality and defence capabilities went hand-in-hand in the LH III period, and probably monumentality peaked in popularity in LH IIIA2-B. The massive gate towers at Midea: Palaiokastro and Athens also seem to have been expressions of monumentality through their size and massiveness of the stones. It appears that the tower and its use of ashlar conglomerate were in keeping with a desire to achieve a monumental effect communicating the strength and wealth of the citadel to those who approached from the south.

There was a preference for placing at least one tower beside an entrance, a defensive design which proved effective by protecting the most accessible and hence vulnerable part of the circuit. At Mycenae and Tiryns, both main and postern gates were secured by towers and bastions as were principal entrances at Gla, Athens, Midea: Palaiokastro, Mesopotamos: Xylokastro, and probably, although less certainly, at Vari: Kiapha Thiti, Kandia: Kastro, Geraki: Ancient Geronthrae, and Kakovatos: Nestora.[136] Iakovidis believes that the use of a tower[137] flanking a gate is a "typically Mycenaean innovation in fortification tactics" appearing first at Gla, being accepted and used in the second building phases of Tiryns and Mycenae, and later adopted at Athens (Iakovidis 1983: 108). This, however, is not confined to the Greek mainland at this time, but occurs in Cypriot, Anatolian, and Syro-Palestinian fortifications. Furthermore, this tower placement is not new, but occurred at Syros: Kastri the principal entrance passage was through Tower B in the main entrance at Avenue A of period V Keos: Ayia Irini, whilst at Naxos: Panormos the thickening of the wall end at the entrance is suggestive of a bastion. Even at Lerna III, the horseshoe-shaped tower, although not immediately connected to the entrance, was positioned near enough to have provided protection.

With the exclusion of the Isthmian wall,[138] mainland citadel fortifications did not have towers placed at regular intervals along the trace as was done in some of the Cycladic and Near East walls. As mentioned above, the rounded towers and bastions of Syros: Kastri and Naxos: Panormos and the square units of EBA Troy II and its succeeding cities project outwards at regular distances. Likewise, the eight rectangular towers of LH IIIB Siphnos: Ayios Andreas (Field 1984: 275) and the level VII towers of Mersin: Yümüktepe (Garstang 1953: 237) are systematically spaced along the walls. Such ordered placement, however, is not a uniform feature of all Bronze Age fortifications and appears to be more a result of a need to reinforce and mask points where the walls altered directions. In the aforementioned examples, excepting Syros: Kastri, all towers and bastions built in addition to those at entrances were placed wherever the fortification

---

[136] At Geraki: Ancient Geronthrae and Kakovatos: Nestora these may in fact have been later additions (Field 1984: 89, 114).

[137] Iakovidis calls the towers at Gla "bastions", but for reasons already cited these are considered to be towers proper.

[138] See n. 83, n. 131, and n. 132.

changed its course. Similarly, the rectangular towers placed along sections St, Ro, and Pe of the Isthmian wall, the latter with four rectangular towers projecting c. 0.70 m northwards from the wall face and separated at intervals of 7.90-9.50 m (Broneer 1966: 351; fig. 6.42.), would have strengthened those points of the wall where its course altered.

During LH III several centres reinforced their fortifications with additional towers, indicated by their abutting, as opposed to bonded, walls; although consistent in their pleasing monumental effect, their construction as supplementary structures suggests the importance of defence. As indicated above, it is within this period that the south-east tower was added to the circuit at Mycenae, and at Tiryns a rectangular tower was added onto the north-east corner of the Middle Citadel. It was also at this time that the gamma-shaped tower was constructed at the main entrance of Araxos: Teikhos Dymaion. Certainly monumental in character, it projected 9.40 m out from the circuit and was faced with large blocks, some averaging more than 1.50 m long (Field 1984: 123). Also, at Gla, Field observed a protrusion, c. 6.00-6.50 m thick, in the north-east circuit which may have been a tower (Field 1984: 178). Its Cyclopean technique is "superior" to that of the enceinte, the entire unit having been constructed as a distinct structure abutting the circuit (Field 1984: 179), which suggests that it was built some time after the settlement wall. Its position on the highest point of the circuit, overlooking the north-east end of the Copaïc basin (Field 1984: 178-79) made it an excellent strategic post. Nevertheless, the placement of towers or bastions at places other than entrances in Mycenaean citadel fortifications is unusual, and lends credibility to the hypothesis that their function was purely monumental. Perhaps the Mycenaeans felt that security was sufficiently met by the height and sheerness of the citadels, which would have proved most difficult for any attacker to scale.

6.5.3. Forts and isolated towers.

Many LH III citadel towers were positioned so as to command views of the surrounding plains. Mycenae and Gla have been mentioned above, and at Midea: Palaiokastro gateways, and therefore gate towers, were placed to view the Argive plain and the Gulf of Argos. According to Field, however, citadels and fortified towns were only part of a range in fortifications and auxiliary forts, detached towers or lookout posts, provided further tactical defence (Field 1984: 322 f); they enabled a greater range of view over the plains and could signal the approach of an enemy to the principal settlements, which could then amply prepare themselves and their people for an assault.

Probably, the number of surrounding forts was the result of the functions of the main settlements. In Phocis, Khryso: Ancient Krisa appears to have dominated northern trade routes stretching from Kirrha, in the south, northwards to the interior (Kase 1973: 775), with, it is reasonable to assume, the assistance of the Amphissa forts. These latter forts were semi-circular and circular-shaped outposts positioned along the passes in the mountains north of Amphissa. The best preserved structure is semi-circular with an approximate diameter of 6.00 m, located near the modern village of Prosilion. Preserved to c. 2.00-2.50 m, remains indicate that the level of the structure was raised to the rear and that, at least on the lower level, the unit was filled solidly with stone (Kase 1973: 76-7; Field 1984: 219-21).[139] Similar measurements and method of construction have been reported in another fort approximately 700 m to the south-east of the former (Kase 1973: 77). These remains resemble those of the detached tower at Khryso: Ancient Krisa where the horseshoe-shaped tower, with its uncoursed face fronting a fill of large stones, sloped upwards so that its top was raised parallel to the line of the hill slope. At Khryso: Ancient Krisa, however, the tower's diameter reaches almost 9.00 m. (Field 1984: 215, 220-21).[140]

In Boeotia, the small site of Mytikas was situated on the peninsula north of the Bay of Kardhitsa, at one end of the dyke that cut across the bay. Although not large, the site is suggested to have served as a watch post guarding this part of the canal and communicating signals between Kokoretsa and Vristika, the latter labelled by Fossey as a military outpost (1990: 82). However, Vristika's location in the valley between two spurs of Mt. Ptoion (Fossey 1990: 82) and the absence of any reported fortification suggests that if it were a settlement it was a small one, aided perhaps by the secure arrangement of Kastro, Gla, and Ayia Marina across the neck of the north-easternmost end of the Copaïs.[141]

North of Gla and situated on the northern edge of the bay on the centre of three peninsulas, was the fortified site of Ayios Ioannis (fig. 6.43.). It was a substantial settlement, ringed with a fortification more than 700 m in length (Field 1984: 160). It was first settled well before the building of the fortification walls and continued to be occupied, as indicated by the extensive sequence of sherds and presence of MH and LH tombs (Fossey 1988: 287; 1990: 79-81). Ayios Ioannis was strategically situated to view the drainage exit in the east, but its view of the remaining northern Copaïs would have been blocked by Khantsa hill to its west, and thus a small post stationed on the peak of Khantsa hill was essential.[142] In fact, a Cyclopean trace has been reported along the ridge of the hill (Field 1984: 157-59; Fossey 1990: 81-2), and its small size and rocky

---

[139] I was unable to view the fort in 1993, as road works prohibited travel from Amphissa to Prosilion.

[140] The association of the detached tower and fortified citadel at Khryso: Ancient Krisa may not be a lone exceptional example as has been assumed (Field 1984: 215); a similar arrangement may, in fact, have occurred at Nea Epidhavros: Vassa, where blocks have been found arranged in a roughly square structure, situated east and downslope from the preserved wall in the south-west on what originally may have been a path up to the citadel. (For a description of the blocks see Field 1984: 64.) However, before this can be ascertained, an investigation into the relationship of these blocks to the fortification wall is required.

[141] Field suggests that a road fort existed at Vristika; however, the remains of this structure suggest a modern date. Walls are of small to medium size stones held together by mortar, and not wider than any modern house wall. It is somewhat like the farm houses of modern Stroviki, but stylistically similar to the structure at the base of the cliff at Mytikas where concrete cement was spread across one inner wall face. There is no convincing evidence to suggest either Mytikas or Vristika were involved in the Bronze Age drainage system nor occupied for any length of time. (See pp. 171-2.) Visits in 1993.

[142] Visit in 1993.

surface suggest that during Mycenaean times it could not have been anything more than a post (Field 1984: 158-59). Indeed, its gateway was positioned to face Ayios Ioannis, indicating perhaps their affinity with one another.[143]

Similar defensive systems are suggested to have been used along roads in Protopalatial Crete, with administrative buildings and guardposts were spaced along communication routes, often at the junction of two or more roads. The "administrative posts", enclosed with circuits, were of dressed, white limestone blocks and positioned on flat and easily accessible ground, whereas the "watchtowers" were small, and well placed to view the roads from their higher and rocky grades (Tzedakis et al 1989:60-3).

Networking of auxiliary posts was seemingly a Mycenaean tactic, which perhaps had its foundations in Crete but, equally conceivably, was an independent plan developed to protect the wealth and economic claims of the Mycenaean centres.

6.6. Water resource.

Secured water supplies are reported only at Athens, Mycenae, Tiryns, and Araxos: Teikhos Dymaion, and have been assumed to have been built as part of a programme of increased defensive measures taken in the later part of LH IIIB (Broneer 1939: 337; *GAC*: 379). However, their rare occurrence, comprising only 12% of the citadel sites, raises the question whether such defensive measures were indeed needed and if so, why they were not taken elsewhere.

6.6.1. Athens (fig. 6.44.).

A natural reservoir occurs on the north side of the acropolis at Athens, at the bottom of a fissure in the rock. It was cleared and a stairwell constructed (Iakovidis 1983: 82). Eight flights of stairs ran "alternately" from east to west and descended to a depth of 34.50 m, at which point slope waters collected and formed a pool. Both wood and marble were used in the construction; however, little wood was used in the lower part of the passage where there was much moisture (Iakovidis 1983: 89). The beginning of the passage cut below the fortification wall and is believed to have been roofed in corbelled construction (Iakovidis 1983: 84), similar to that at Mycenae. Pottery finds confirm that both the passage and fortification were part of the same building programme and date to LH IIIB (Broneer 1939: 423-24; Iakovidis 1983: 86).

6.6.2. Mycenae (fig. 6.45.).

In the third period at Mycenae, an underground cistern was constructed and accessed from within the confines of the North-east Extension by means of a staircase. Water was conveyed from the Perseia spring, east of the citadel, to the base of the stairs by clay pipes. At the mouth of a small shaft, built in the roof of the cistern, through which the spring water emptied into the pool, were a number of small stones spaced so as to filter

---

[143] On the south side of the hill, scant traces of a wall were noted in 1993. However, it was difficult to establish if this was indeed Cyclopean; very little of the wall remains, and the area had been recently cleared and an electricity tower erected. Grouped and isolated blocks were noted to be of dimensions appropriate to Cyclopean work.

the incoming water (Iakovidis 1983: 37). By contrast, at Athens, water was separated from impurities by means of a pit sunk in the middle of the pool to collect mud and debris (Iakovidis 1983: 82-4). The passage into the cistern was accessed from within the confines of the fortification, cutting through and below the wall, and descends to the resource by three flights of stairs; it can thus be dated to LH IIIB2, when the North-east Extension was added.

6.6.3. Tiryns (fig. 6.46, 1.).

The relatively high water table of the surrounding plain at Tiryns provided a natural catchment area to the west of the citadel (Balcer 1974: 142; Iakovidis 1983: 12). Pottery taken from the foundations of the Lower Citadel fortification wall provide a *terminus post quem* of LH IIIB (Iakovidis 1983: 12-3), and likewise a LH IIIB date should be assigned to the underground passages and cisterns. Two passages, separated by 9.00 m and on parallel courses, were cut into the rock and below the west side of the Lower Citadel. They were dug to a depth of c. 20.00 m, probably built of both stone and wood, and covered over with corbelled vaults (Iakovidis 1983: 12).

6.6.4. Araxos: Teikhos Dymaion.

The possibility of a hidden water source at Araxos: Teikhos Dymaion was noted by Field in 1984; an opening, 0.45 by 0.45 m, was located 15.10 m north of the middle gate. It lead to twelve descending stairs which were roofed over by flagstones (Field 1984: 127). The high water levels of the surrounding plain would have allowed for the easy construction of wells, perhaps accessed by similar subterranean passages as at Athens, Mycenae, and Tiryns.

6.6.5. Elsewhere.

Elsewhere in the Aegean, the method of procuring water differed. On Crete cisterns were used to collect rain-water, wells were dug, and conduits conveyed water from springs into palaces.[144] In the Cyclades, Barber suggests that cisterns and large pithoi collected rainwater, the latter also being used for its storage (Barber 1987: 44). At Keos: Ayia Irini, however, a chamber and covered passage enclosed and protected the site's water resource in period V. The source was located outside the enclosure wall, in a natural cavity in the north-west sector. It was accessed by a passage with 13 stone steps, which is suggested to have cut through the fortification. The passage walls were stone built of blue marble and roofed with slabs of schist (Davis 1986: 9). As at Athens, marble was presumably favoured for its durability and resistance to moisture.

In Palestine, reservoirs were used as early as EB II at Ai, Arad, and Tell Yarmuth, having been built at the lowest part of the towns to collect runoff from the hill slopes (Ben-Tor 1992: 84, 104). Plastered cisterns have been noted in the MBA at Hazor, Ai, and Raddanah, but elsewhere in Palestine the supply of water depended upon the wealth of the springs (Mazor 1992: 289). Water systems, similar to those of the Greek

---

[144] See Graham (1987).

mainland,[145] developed out of these simpler forms, with stepped and covered passages descending through the citadel rock to outside springs; but this did not occur until the 12th century BC, or Iron Age II-III (Barkay 1992: 332-34) and may have been influenced by the few examples in Hittite and early architecture of Anatolia and north Syria.

In Anatolia, several sites had elaborate constructed systems to retrieve water. At Bogazköy clay pipes directed spring waters to the sites where cisterns were protected within the confines of the enclosure walls. Pipes were either completely conical, 0.20-0.22 m in diameter, or tapered so as to fit one pipe into the other. The latter was probably a later type of construction, as suggested by the pipes of Zinçirli, which are the earliest water pipes in north Syria and which were constructed like the former type with a constant width.[146] At Troy VI-VII, Tell Halaf, and Ras Shamra deep shafts were cut for wells and at Eflâtun Punar a sea dam was built to block and redirect water into the site.[147] However, as most sites had no access to springs, cisterns and basins were often used to collect rainwater.

6.6.6. Discussion.

The water systems of the four mainland sites are similar to those noted at Keos: Ayia Irini, Troy VI-VII, Tell Halaf, and Ras Shamra, and the use of clay pipes at Mycenae to direct water from the Perseia Spring to the underground cistern parallels that at Boğazköy and Zinçirli. In Hittite Anatolia, it is suggested that the bringing of water to areas within enclosure walls is suggestive of military precautions (Naumann 1955: 181), and a similar argument can be made for the mainland constructions. However, the fact that security of water appears to have been a concern at only four sites must be explained by the sites' differing physiography. In no region is a particular method of water retrieval preferred, each being developed with the resources at hand and suited to the needs of the site: Athens had a fountain occurring naturally as the result of the cleft in the limestone on the north side of the Acropolis, Mycenae had the nearby resources of the Perseia and other springs to utilise and channel to the site's cistern by clay pipes, and Tiryns and Araxos: Teikhos Dymaion were positioned in regions where there was a high water table and thus

---

[145] At Tell es Sa'idiyeh, the water system of stratum 12 was a plaster-lined conduit accessed by means of a staircase. The source was a group of continually productive "perennial springs", opposite the north side of the higher tell, and suggested to have provided enough water for a population of more than several thousands (Pritchard 1985: 1; Tubb 1988: 72; Miller 1988: 84-5). Similarly, at Gibeon a stepped passage was cut through solid rock to provide access to a cistern from the citadel. It was constructed in three stages, but generally assigned a 12th century BC date (Pritchard 1961: 2-6, 22). At Tell Ta'annek a 1.45 m square shaft was cut and at its base an entrance to a descending staircase was constructed to access water, but the plan was abandoned and the structure plastered over to "serve as a reservoir" (Lapp 1969: 31-2). This has been assigned a LB I date by Lapp (1969: 31), in opposition to Barkay's position that no structure similar to the Mycenaean constructions dates earlier than Iron Age II-III (1992: 332-34). Regardless, if it is of LB I date, it is too early to offer any likeness to the Greek mainland structures some 100 years later.

[146] Pipes also taper into each other at Knossos. For a full description of the water systems at Boğazköy and Zinçirli see Naumann (1955: 181-84).

[147] The date of Eflâtun Punar is disputed. See Naumann (1955: 188) for a discussion of its date.

wells could be dug. Midea: Palaiokastro, 171.00 m above the plain (Iakovidis 1983: 21), may have been deemed far too high above the water table to dig a shaft. Elsewhere, nearby streams may have been sufficient, and sites may not have felt sufficiently threatened to secure the resource, or the supply of water from collection in basins and storage in pithoi or jugs may have been sufficient for settlement sizes.

Outside the citadels, wells and springs surely were sufficient. The protection of the water supplies at Athens, Mycenae, Tiryns, and Araxos: Teikhos Dymaion suggests the importance of these sites and the need to defend them in the later part of LH IIIB.

Chapter 7: Cyclopean structures other than fortifications.

In discussions of Cyclopean stonework, little attention has been given to structures other than fortifications, yet the masonry type has been used to construct dams, bridges, terraces, and tholos tombs. It first appears in the LH IIA Cyclopean and Epano Phournos tombs at Mycenae and possibly in the tholos tomb at Kazarma, and as a variant of the stonework in the LH IIB-IIIA1 tholos tomb at Midea: Dendra. Thereafter it is evident as a fully developed type in the palatial terraces at Mycenae.

The stonework was functional, that is, it was a means by which a specific building type could be constructed, but at the same time care was given to emphasise areas of visual importance. At Mycenae, the outer faces of bridges, exposed on approach to the citadel, were built of large stones carefully laid in a semblance of coursing; less care, however, was given to inner faces. The opening in the outer wall of the Lykotroupi bridge was neatly built to meet at a sharp point, but was of simple flat-arch construction on the inner face and across its length. Similar arched openings exist in the North-east Extension of the fortification wall, forming an inverted V-shape on either wall face, but within the passage it is of keystone construction; a comparable technique is found at Tiryns in the niche on the east side of the passage to the lower city. Attention was also given to gateways and towers of fortifications, and entrance passages and facades of tholos tombs, generally those parts of constructions readily visible. But retaining walls and the walls of the Tiryns dam exhibit no evidence of such attention, having been built for the purpose of securing fills and, in the case of the latter, diverting water.

There seems to be little correlation between the dates of structures and the use of Cyclopean versus ashlar stonework; both occur within the same building phases. However, where ashlar blocks have been used they appear in more conspicuous positions than Cyclopean ones, and an increase in the use of ashlar work can indeed be noted with time. The relationship appears to have resulted from a concern to emphasise particular features, creating a visual impression of power or prestige. The increasing refinements of details in relation to dating may reflect an increase in resources, knowledge of building techniques, and available time. It is possible that earlier Cyclopean structures were reconstructed at a later date to fit into such a programme of monumental display. The Ayios Yeoryios bridge, seemingly late in date, may indeed reflect a rebuilding of the structure incorporating an impressive facade; it is likely that this route was in use before LH IIIB2, and thus the pass from the south would have required bridges to span the depressions of the Chavos Ravine. But it cannot be assumed that a structure built entirely in the Cyclopean technique is earlier than a work incorporating ashlar blocks; function and location of the structures must also be considered. As noted above, no attempt at visual refinement was incorporated in the dam at Tiryns.

7.1. Tholos tombs.

A true style of Cyclopean stonework appears in only a few tholos tombs, and then it is most commonly reserved for the inner walls of the *stomion* and tholos chamber. As the entrance would have been viewed by the public during and immediately after its construction, its appearance would have been of greater value than that of the interior of the chamber. That is not to say that the chamber was of little importance, as it must have held some value for the engineers to design such enormous vaults, but to the onlooker, who never saw the interior of the tomb, the prestige and wealth of the dead within and that of his community could be measured by the monumentality of the tomb and ornamentation of its facade. Such large tombs exceed practicality and were likely constructed to promote and strengthen the social position of those individuals buried within and that of their people (Persson 1931: 26; Trigger 1990: 122).[148] Perhaps the monumental form of the Cyclopean technique was first introduced to convey this wealth, becoming proportionately more refined with the increasing prosperity of the community. Like all monumental architecture, "these structures testify to the ability of powerful individuals or the state to deploy skilled craftsmen, material resources, and massive amounts of labour" (Trigger 1990: 122). For instance, the entire structure of the Treasury of Atreus at Mycenae was constructed in ashlar courses with blocks of more or less similar sizes. The interior of the chamber was dressed so that no block appeared to jut out from the wall, but effected a well-finished, smooth, and continuous curve of the vault.[149] The facade was elaborately decorated with half-columns flanking either side of the door, each supporting another half-column approximately one-half of the former's dimensions. All columns and the space found directly above the lintel were carved with a variety of zigzag and spiral patterns. In fact, greater attention to detail and laying blocks in rough courses first appears in tholos tombs some time in the LH II period, continuing into LH III. The LH IIA Tomb of Aegisthus favours uniformity (Pelon 1976: 161), with slabs more regular in size and assembled into rough courses.[150] Likewise, the walls of the *dromos* and *stomion* of the LH IIA tholos tomb at Prosymna are neatly coursed, although wedges are noted to have been inserted to keep blocks level. The tholos tombs at Berbati and Midea: Dendra also employ rudimentary coursing; however, as with the tomb at Prosymna, the appearance in the chambers is rougher than that of the *dromos* or *stomion*. The stonework in the Midea: Dendra tomb's *dromos* resembles Cyclopean masonry, although the blocks are of smaller dimensions.[151] In fact, of all reported mainland tholos tombs, only six employ a masonry that reflects some aspect of a

---

[148] Boyd (1993: 18) suggests that the burial monuments in Messenia were constructed in response to an "ancestor tradition" with the corpse having become a symbol related to the need of the people "to assert their position by means of conspicuous control of the corpse through an elaborate funeral." Although this reinforces my own view of promoting individual and state power, caution must be exercised in accepting this sociological perspective; from the evidence at hand, we cannot reconstruct the rules pertaining to the inclusion or exclusion of individuals in funerary activities, in fact all levels of the entire community may have been involved in the ceremonial rites and/or only a priest or ruler allowed access to the chamber and "control over access to skeletal material".

[149] Visit in 1993.

[150] Visit in 1993.

[151] Visit in 1993.

Cyclopean style and thus comprise the bulk of the following analysis: the Cyclopean and Epano Phournos tombs at Mycenae, the tholos tombs at Midea: Dendra and Kazarma, and, with some hesitation, the tombs at Medeon, A.1 and T.239.[152]

Nevertheless, having stated that megalithic building was a means to exert power and exhibit prosperity, Voutsaki (1992) and Mee and Cavanagh (1984) argue that status could be expressed by other means, such as grave furnishings, and that each region must be considered as an independent entity in such analyses. In the Argolid, however, it cannot be disputed that the introduction of the tholos in LH IIA presented a new feature of monumentality in mortuary practice in the Argolid (Voutsaki 1992: 71) and, whether it symbolised state wealth or a level of competition between groups, I would suggest that, although the tholos tomb ceased to be built after LH IIIA2, this aspect of monumentality continued as an intrinsic part of the building activity until the collapse of Mycenae; extensive building continues into LH IIIB2 and included the North-east Extension of the fortifications, the roofed passage and underground cistern, the east wing of the palatial complex, a number of new and enlarged buildings both within and outside the citadel walls, and the construction of an elaborate road system.

7.1.1. Dromos.

Where stonework has been used in the construction of the *dromos*, it is more common that blocks are rectangular in shape, although they can vary in size, and laid in rough courses, as for example in the *dromos* walls of the tholos tombs at Berbati, Tiryns,[153] and Prosymna, and, similar but slightly neater in appearance, the Panagia Tomb.[154] On the other hand, the *dromos* walls of the Cyclopean and Epano Phournos tombs were left unfaced, so that the bedrock was exposed.[155] The Tomb of Aegisthus also reveals the bedrock of the hill, with its *dromos* being only partly stone-lined; the lower part of the walls were of the bedrock into which the *dromos* was excavated, whereas the upper half was cut and stepped back from the face of the lower section so that its rubble facing was supported on a ledge. The blocks of the stonework are small and seemingly have been packed to support the earth of the hillside. Its uncoursed masonry, comprising various size stones, can be likened to the work of the Tomb of the Genii, where walls have been constructed of blocks of various sizes and wedged together with smaller stones; however,

---

[152] The two tombs at Medeon are not tholoi proper, but rather are large, stone-built tombs intended for multiple burials (Dickinson 1977:60). T.239 is circular in plan, measuring 3.00 m in diameter, and was cut into bedrock to a depth of 2.00 m. The chamber was entered by descending five stone steps built in the *dromos* passage. In the centre of the chamber is a large quadrangle, 1.00 m by 0.80 m, in which were found the bones of three individuals. Cut in the wall on the east side was a rectangular niche within which was found the skeletal remains of a child (Vatin 1969: 29-30; Pelon 1976: 240). The stonework appears at first glance to have been built in the Cyclopean technique, but the characteristic earth and stone fill between the wall faces is missing, rather massive blocks seem to have been used through the width of the wall, and no attention has been given to the laying and shaping of corner stones. The chamber of tomb A.1 is similarly constructed and neither can be labelled as true Cyclopean work.

[153] Visit in 1993.

[154] Visit in 1993.

[155] Visits in 1993.

the number of chinking stones in the construction of the Tomb of the Genii is excessive as compared with the Tomb of Aegisthus.

The only *dromos* stonework that can be compared to the Cyclopean technique is that of tomb A.1 at Medeon (but see n. 152) and the tholos at Kazarma. The walls of tomb A.1, measuring 4.70 m in length, were built of massive, irregular-shaped limestone blocks assembled with the aid of smaller interstice stones. At Kazarma, the *dromos* measures 2.50 m wide and has been preserved to a length of 5.60 m, but is believed to have been originally longer (Pelon 1976: 182; fig. 7.1.). Its preserved measurements, however, correlate with the shorter and wider proportions of tomb A.1. The walls have been described by Pelon as constructed of large blocks and assembled in the Cyclopean technique (Pelon 1976: 182); however, as only the foundation course is preserved, a Cyclopean label cannot be confirmed.[156] Similarly, the walls of the Midea: Dendra tholos are rubble-lined and constructed with large stones, of dimensions comparable to Cyclopean blocks; however, the stonework is rough and has been assembled with large amounts of clay (fig. 7.2.).[157]

It is impossible to view the *dromos* walls of either the Medeon or Kazarma tombs as part of a possible architectural or chronological development progressing from undressed walls to a masonry type; the Kazarma tholos dates to the same time as or perhaps slightly earlier than the Cyclopean and Epano Phournos tombs, and the Medeon tomb dates well after the time that ashlar stonework became the preferred form of masonry. In fact, it is difficult to identify any sort of architectural difference in *dromos* construction as being directly related to a development over time. As noted above, the stonework in the *dromos* of the LH IIB-IIIA1 Tomb of the Genii is comparable to the earlier LH IIA Tomb of Aegisthus, and that of the LH IIA Panagia tomb and the LH III tholos tomb at Tiryns are similar to the work in the LH IIA tholos tomb at Berbati. That skill and technique improve with time is clear, but the relationship may have been indirect, resulting from either the imitation of earlier and successfully engineered works and/or modifications as a consequence of a failed structure, and therefore a later structure may indeed resemble an earlier work, rather than a stage in an architectural progression.

7.1.2. Stomion.

The Cyclopean and Epano Phournos tombs are the only examples where the Cyclopean technique has been used in the construction of the *stomion*; large, unshaped blocks have been assembled without any regard to coursing but secured by chinking stones (figs. 7.3-4.). These are the largest blocks used in the constructions, the most massive ones reserved as lintel stones. The lintel nearest the *dromos* of the Epano Phournos tomb measure 2.20 ± 0.05 m and 2.40 ± 0.05 m,[158] and do not exceed much more than the width of the *stomion*, being 2.00 m. Likewise, the largest lintel block of the Cyclopean

---

[156] Visit in 1993.

[157] Visit in 1993.

[158] Measurements have been obtained from published plans and therefore assume drawings are accurate within a 0.05 m error margin.

tomb, excluding the interior lintel stone, measures 1.70 ± 0.05 m and just covers the *stomion* width of 1.40 m (Pelon 1976: 157, 161, pl. LVII 1-2). Corner stones are also large, not as massive as lintel blocks but seemingly bigger than those used elsewhere. The wedges of the Cyclopean tomb are indeed chunkier than those of the Epano Phournos tomb and a greater amount of earth has been used to additionally secure blocks. The stonework of the *stomion* of the Epano Phournos tomb exhibits more of the characteristic features of Cyclopean work: irregular-shaped blocks fitted with small chinking stones, large hammer-dressed blocks in corners forming more or less right angles, and a substantial wall width backed by a mixed fill of earth and stone. The Cyclopean tomb seems to have shared these features, although the blocks of the interior wall are larger than those of the Epano Phournos tomb, but it must be noted that its poor state of preservation makes any further comparison difficult.[159]

7.1.3. Chamber.

Of the six tombs only the chambers of the Cyclopean tomb and the tholos tomb at Kazarma use a stonework resembling Cyclopean masonry but, even so, it does not reflect a true Cyclopean technique, being reserved for the lowermost courses only. In both instances, these blocks are unshaped and of Cyclopean dimensions; however, block size decreases with height and the stones in the Kazarma chamber become more slab-like. The number of chinking stones also increases in relation to height, several often being piled together in place of a larger stone. Although the preservation of the Kazarma tholos tomb is poor, it permits an observation of the fill backing the chamber wall. Larger blocks are again noted to occur in the lowermost levels, but, those of the face are larger than those in the fill. The wall is one to two metres thick and retains the earth of the hill into which it has been cut. Where it was possible to observe, it appears that the Cyclopean tomb was similarly constructed.[160]

7.1.4. Dating.

Cyclopean masonry appears at Mycenae in LH IIA, in the Cyclopean and Epano Phournos tombs. This is indeed the first appearance of this stonework at Mycenae; the first fortification wall has been assigned a LH IIIA2 date, and the earliest known terraces and the road network are dated to LH IIIB. The only other Cyclopean work at this time is that of the tholos tomb at Kazarma, presently preserved in the lowermost courses of the chamber wall and, as noted by Pelon, in the *dromos* (1976: 182). Why Cyclopean masonry was used here is not clear; elsewhere at this time tholos tombs were constructed of a coursed masonry employing smaller blocks. Perhaps the use of large blocks was a result of the bedding characteristics of the stone, although large lintel stones are not unknown in other regions. It may be that this tomb type was seen by the people of the

---

[159] Visits in 1993.

[160] Visits in 1993.

Argolid as a means to monumentally display the prestige of the dead, and therefore was adopted from Messenia[161] and the stonework modified with such intentions.

The fact that Cyclopean stonework is limited to the Argolid would initially suggest the limitations of resources elsewhere. For example, one would think that the marls, weak conglomerates and marly limestones of Laconia would have made the quarrying of large blocks difficult; but that the three lintel blocks of tholos A at Arkines each measure 1.45 m long (Pelon 1976: 185) and the interior lintel block of tholos A at Analipsis is reported to have dimensions of 1.75 m by 1.45 m by 0.35 m (Pelon 1976: 186) indicates that massive stones were not completely out of the range of the builders. Moreover, limestone occurs in the south-west Peloponnese, Attica and north Greece, where a number of tholos tombs have been reported, but these too are constructed of relatively small blocks. It would seem that the use of massive stones to create megalithic structures was a regional preference of the Argolid and in particular to Mycenae; "...the tholoi are exclusive signs of power and prestige, relying on the mobilisation of social force and special craftsmanship; briefly, they belong to the elite." (Voutsaki 1992: 94).[162] The impetus to build monumental tombs in Cyclopean masonry would seem to have been the result of a desire to express wealth; the technique thereafter offered a similar means of expression through elaborate fortifications.

7.2. Dams.

Cyclopean walling is used in dams because of its ability to support a substantial earth embankment, withstand excessive pressures, and deal with structural and mechanical problems specific to dam construction. Although the evidence at present is limited to the dam west of Tiryns and to the Lake Copaïs drainage system, enough of the remains survive to suggest how the structures were built and for what purpose.

The dam at Tiryns is situated 4.00 km due east of the acropolis and approximately 700.00 m north of Ayios Adrianos (Verdelis 1963: 5; Hope Simpson 1981: 21; fig. 6.21.), in an area of poor land drainage and consequently high water table, and poor soil conditions caused by alluvial silts, sands and gravels.[163] The dam was constructed at a point where three streams flowed from the eastern mountains, converged, and flowed west towards Tiryns (Balcer 1974: 145, 147). Just west of the confluence an earth and gravel embankment was erected, retained on each side by two Cyclopean walls. The east Cyclopean wall was deliberately curved to deflect the stream south-south-west and to obstruct any water seeping around the dam and flowing west again. The river was then forced to flow south of Profitis Ilias[164] before turning towards the Gulf of Argos, where it was discharged (Balcer 1974: 147). Although the dam is reported to have exceeded

---

[161] See Hood (1960: 176), Branigan (1970: 139-60), Dickinson (1977: 61-2, 108; 1983: 116-17; 1994: 224-27), Korres (1983: 148-49) and Taylour (1983: 70) for some of the arguments as to the origin of the tomb type.

[162] Conspicuous display was not only limited to burials of the tholos type, but exhibited in other burial assemblages (see Voutsaki 1992); however, this is beyond the scope of this thesis.

[163] Visit in 1993.

[164] Visit in 1993.

100.00 m in length and close to 10.00 m in height (Hope Simpson 1981: 21),[165] very little of it could be noted in 1993. The best preserved section is to the north, by the modern road, where the line of the inner and outer face of the eastern Cyclopean wall and traces of wall fill are still visible. It appears that the north end was the widest part of the wall, perhaps intended as an abutment to provide lateral support for the remainder of the wall, which would have been exposed to the pressures of the diverted river. To the west of this wall, several blocks of differing size and loose gravel cover the slope of the north bank and river bed, having once been part of the original fill of the dam. Traces of the west Cyclopean wall were noted between either bank, though very slight. The wall was founded on intrusive igneous rock, which rises sharply above the level of the bed and slopes against the original course of the river (fig. 7.5.). This dyke, evidenced in the stratigraphy of the south bank, cut the sedimentary layers from midpoint of the dam's south side to a point just beyond the west wall, and extended over much of the floor between these two points.[166]

In Boeotia, the Kephissos and Melas rivers, to the west of Lake Copaïs, and the Herkyna, Phalaros and Lophis streams, on its south, emptied into the basin flooding the plain (Kalcyk & Heinrich 1989: 56; fig. 6.1.). Water was channelled from the west by a system of canals and dykes constructed along the north and east sides of the basin. Canals were cut approximately 40.00 m wide and banked on either side by dams, c. 30.00 m wide. The north canal, however, required only one artificial embankment, that on its south side; the higher ground on the north provided a natural bank for this side of the canal. The canal collected the water of the Kephissos and Melas rivers, channelled it across the south side of the north barrier mountains, cutting through the headlands at Stroviki and Kastro,[167] and discharged it through a number of sink-holes, *katavothres*, in the north-east (Kalcyk & Heinrich 1989: 56-61). The principal outlet was through the *katavothra* at Spitia, located at the end of the canal and immediately below Ayios Ioannis (Kalcyk & Heinrich 1989: 61). Additional conduits, branching off of the main waterway, also conducted water to other *katavothres*. Between Kastro and Ayia Marina a canal diverges from the main system east of Gla, turns south and empties into the Phtelia *katavothra* (Kalcyk & Heirich 1989: 62; fig. 7.6.). North-east of Kastro a dam blocked water issuing from the mountains and directed it to the Palaiomylos *katavothra*. In fact, both sides of the canal in the north-east bay were lined by dams, each estimated to be 2.50 m in height[168] and average 30.00 m in width (Kalcyk & Heinrich 1989: 62). Another dam, south of the Tourloyannis hill, has been argued to have been built to recover some land lost from the inundated canal (Kalcyk & Heinrich 1989: 62); it

---

[165] Bintliff (1977: 281) reports a height of at least 30 feet.

[166] Visit in 1993.

[167] Visits in 1993.

[168] Kalcyk & Heinrich (1989:61) provide a measure of 2.50 m for the depth of Lake Copaïs, but this author wonders if the same 2.50 m as an estimate for the dam height is indeed sufficient to withstand heavy rainfall and flooding of the system. The height of the dam is generally influenced by local drainage conditions, land, safety and resource availability (Hill 1984: 48), and it would seem that the measure of height equivalent to the measure of the lake's depth would not support an overflow of water.

demarcated an area of land south of the north canal. Certainly, if the concern was only to channel water across this area to a discharge point, this dam would not have been necessary and a smaller parcel of land would have been secured. The dam is narrower than the others, probably because the canal to the north sufficiently dyked and channelled the runoff from the mountains, and thus a bank was only needed on the south side of the polder to dam the waters of the lake.

Further south on the east side of the basin, a small canal has been located between Boeotian Medeon and Prophitis Ilias, measuring 41.00 m wide with a dam on its west side, 19.00 m wide. It is uncertain whether another dam existed on the east side of the waterway or, as in the north section, it was deemed unnecessary because of the higher land level at this point (Kenny 1935: 193; Hope Simpson 1981: 67). In any case, a polder of c. 2.00 km^2 was created in the bay (Kalcyk & Heinrich 1989: 62), and perhaps was intended for a pass between the south approach to Lake Copaïs and Prophitis Ilias, eliminating travel through the mountains. North of this polder a number of *katavothres* would have discharged underground water possibly to Lake Likeri, which was stream-fed from the north-west, and the Gulf of Euboea.

The investigations by Fossey (1988) and Kalcyk and Heinrich (1989) argue that the Copaïc system was built to recover cultivatable land. The continuous silting of the land created a highly fertile soil (Fossey 1988: 10), and so the 90.00 km^2 available from recovered lands enabled farmers to work year round (Kalcyk & Heinrich 1989: 62). The enclosed polder south of the Tourloyannis hill would have created 8.00 km^2 of arable land. North-east of Kastro another 8.00 km^2 has been noted. The polder of Gla, closed by a dam blocking the small bay by Phtelia and that extending between Mytikas and Kastro, provided 9.00 km,^{2} and the polder of Davlosis Bay provided an additional 2.00 km^2. Further land reclamations increase this total to 45.00 km^2, and with another 45.00 km^2 recovered around the area of Orchomenos,[169] a total area of 90.00 km^2 could have been farmed (Kalcyk & Heinrich 1989: 62). A flood channel constructed west of Romaïkon, to divert the overflow of the Kephissos south into the plain lying towards the Herkyna River (Kalcyk & Heinrich 1989: 61), ensured that the canals did not overflow into the recovered land areas of the north.

Canals and dykes were probably constructed in summer months when seasonal flooding did not occur, as a result of low precipitation and water levels. At Tiryns, the dam was constructed across the original path of the westward flowing river, and an artificial channel, 8.00 m deep (Hope Simpson 1981: 21), diverted the original stream in a south-west direction connecting it with another stream further south. The soil removed from the channel was used to construct the earth core of the dam across the former streambed

---

[169] Orchomenos was protected from the lake to its east by a dam (Kalcyk & Heinrich 1989: 62).

(Bintliff 1977: 281; Hope Simpson 1981: 21).[170] The dam was founded on bedrock, which suggests that a temporary embankment was required to block the existing flow of water so that an appropriate depth for the foundations of the dam could be excavated. Once the dam was completed, the temporary blockade would have been dismantled. Similarly, when constructing the overflow channel, on the west side of Lake Copaïs and west of Romaïkon, the Kephissos was likely dammed until the junction between this river and the overflow channel was dug.

Although Hope Simpson was unable to measure the exact width of the Tiryns dam when he conducted his 1981 survey of Mycenaean sites, he noted that there was an apparent difference in the breadth of the north and south sections; the north section measuring 80.00 m wide and the south section 50.00 m (Hope Simpson 1981: 23). The wider north section was positioned at the point where the river, flowing west, was blocked and diverted south, and thus at the point where the force of the river exerted the greatest thrust against the structure. A dam's vertical line of thrust, which defines where pressures act on joints,[171] becomes oblique when it experiences a sideways thrust, such as the compressive load of impounded or diverted water (Gordon 1978: 181). The wider north section of the Tiryns dam would have ensured that this vertical thrust was kept well inside the structure; otherwise the unit would have cracked and burst open. By tapering the dam from bottom to top there is a greater chance of confining the oblique angle of the vertical thrust (Gordon 1978: 181-2). Although the state of preservation of the Tiryns dam does not permit such an observation, it has been noted that the uppermost stone courses of the dam located along the north canal of the Copaïc Basin, near Anderas, slope inward so that the entire wall tapers towards the top (Hope Simpson 1981: 67). It is unlikely that the Mycenaean engineers understood the importance of keeping the vertical thrust line within the confines of the structure, but perhaps as a result of experience they recognised where the greatest thrust would have been exerted against the dams.

Dams fail most often from a lack of stability (Gordon 1978: 184), and so the structure must be first stable under its own weight and then under the pressures of water (Sowers 1962: 253). Foundations must not only provide a support for the embankment, by resisting both vertical and horizontal pressures, but resist the seepage of water below the embankment (Sowers 1962: 5). All of the Aegean dams known were founded on bedrock. The channel at Tiryns was dug through the alluvium down to a flysch substratum, and consequently the dam walls were supported by the flysch beds (Bintliff 1977: 282). The walls flanking the canals of the Copaïc Basin were built both on flysch and the compact and poros limestone bedrock, common of the region (Rolland 1989: 27).

---

[170] Balcer (1974: 147) suggests that the channel was the result of land eroded at the point where the streams merged. However, Bintliff (1977: 281) and Hope Simpson (1981: 21) have demonstrated that the channel runs across the natural land contours and not down the fall of the land, which would be the case if the channel were in fact eroded naturally.

[171] In a symmetrical wall, where squared blocks are closely fitted, the line of thrust is directed down the centre of the wall (Gordon 1978: 181).

It is critical to maintain the structural stability of dams by securing against sliding of the structure, shifting of sediments, and water pressures. Sliding occurs when the structure shifts over or beyond the limits of the foundation, and generally results when the embankment is unable to resist shear stress, often caused by the weight of the soil and angle of embankment slope (USDI 1965: 191). However, as the dams were not of substantial heights and the embankment was supported by two Cyclopean retaining walls, the extent of sediment slippage was somewhat limited.

A structure can experience a large amount of shifting without resulting in damage and, in fact, settlement does continue for up to three years after building has ceased (Sowers 1962: 254; Bintliff 1977: 31). Nevertheless, as a result of the continuous shifting of sediments during and after this time, stress may compound within the structure and possibly result in some form of structural deformity. This is a greater problem of rockfill dams than of earth embankments; the movement of sediments between rocks and their points of contact can cause the stones to reorient themselves, and excessive stress induced by the weight of the embankment can cause the rocks to shift, finding new points of contact with other stones (Sowers 1962: 254). Thus, this was a problem capable of affecting the Cyclopean retaining walls, with the weight of the supported bank having exerting pressure against its inner face, but of less concern for the earth core of the dam. Even so, settlement motions of the core do exist and they weaken the structure when soil distortion occurs, the outcome of either swelling, caused by water saturation, or desiccation of the earth (Sowers 1962: 134). The soils of the Lower Argolic plain and Copaïc Basin are poorly developed because of the scarcity of clay in both regions, but because of their aggregate and noncohesive nature they suffer little soil deformation which would have helped to increase the stability of the embankments (Bintliff 1977: 88; Rolland 1989: 28).

> Embankments of granular or noncohesive materials are more stable than those of cohesive soils, because granular materials have a higher frictional resistance and because their greater permeability permits rapid dissipation of pore-water pressures resulting from compressive forces (USDI 1965: 191).

The great width of the Tiryns dam is a response to the ability of the water to penetrate the soil,[172] so that a deep channel was not only necessary, but a sufficient amount of soil was required to block the path of the original stream. "A thin core will dissipate pore pressures more rapidly than a thick one..." (Sowers 1962: 199); however, a thick core is much more resistant to erosion (Sowers 1962: 199), forcing water to permeate a greater surface area. Water seepage can cause internal erosion and settlement shifting, and the friction of this internal pressure can decrease soil strength, resulting in possible deformations or structural failures through shear stress (Sowers 1962: 91; USDI 1965:

---

[172] In modern earth and stone dams, the earth core is an impervious zone (Sowers 1962: 5, 194), and it is here that water seepage and erosion must be checked. However, because of the arrangement of particles in the Argolic soil, spaced so that air and water can be circulated, the core of the Tiryns dam is in fact pervious.

162). In some cases, an open conduit is cut into the embankment and allows water to flow through the dam (Sowers 1962: 91).

If water does flow into and through the embankment, the rate at which it seeps into the soil must be equivalent to the rate at which it leaves the soil (Sowers 1962: 70), otherwise it increases pressure within the soil, which in turn increases the potential of damage. If the pressure build-up is substantial, it can lift the soil mass vertically and overturn the dam (Sowers 1962: 91; Gordon 1978: 185); therefore, overflow and underground waters can be hazardous if not immediately relieved. The east Cyclopean wall of the Tiryns dam not only retained the earth core, but was also designed to discharge the potential overflow of water, particularly when the streams were flooded from heavy rain and erosional debris from the mountains. It directed the river to a new route that ran much steeper than the previous course (Bintliff 1977: 282), increasing the efficiency of water run-off and decreasing the potential of flooding and streambed overflow. Lake Copaïs was fed not only by the rivers in the west, but also by underground waters that issued from the north barrier mountains (Fossey 1988: 10). The dams are approximately one-half the width of that at Tiryns, and prevented overflow by directing the water to the *katavothres*, rather than being built to block and redirect the flow of a waterway, as was that at Tiryns. In the west, spillways disposed of excess floodwaters of the Kephissos River, diverting them to the south-west part of the lake.

Instability can also be a result of the type of building material, the speed at which the structure was built, and any climatic changes that may have occurred during construction (Walters 1962: 31). However, the blocks used in Cyclopean walling were of a stone with much durability and resistance to weathering, and any climatic changes in the arid environment would have been slight, making little, if any, difference to the stone. Moreover, the limestone soils are generally not affected by climate (Bintliff 1977: 91). Finally, the speed at which the structures were built was of little consequence, as projects would not have been immediate solutions, rather the amount of time would have been dependent upon the available manpower.

The greatest investment of time and human labour would have resulted from the excavation of the canals and construction of the earth embankments, rather than the building of the Cyclopean retaining walls. As with the construction of the fortifications, oxen would have transported limestone blocks to the building site, and an estimate of time can be calculated from the available data (see Appendix 4). For instance, at Tiryns the minimum number of average-size Cyclopean blocks[173] required for the east and west Cyclopean walls is 4684, and to transport them by a draught-team of 14 oxen,[174] making eight trips per day (see p. 56 and 65), would have taken 1.60 years. The stone used in the walls of the dams lining the canals of the Copaïc Basin, would have taken the same

---

[173] Based on Wright's average size for a Cyclopean block. See pp. 27 and 70.

[174] Or eight oxen if using a sledge and rollers. See Cotterell and Kamminga (1990: tab. 2.5) for the draught-power of animals.

draught-team over 3 years to transport.[175] This figure accounts for the walls of only one dam, as no more than a single dam was required on the north part of the canal and along that near Davlosis. However, it is known that part of the canal was bordered on its two sides by dams and that no fewer than three dykes flanked and separated the double canal, located north of Gla. Nor have those dams that were constructed to recover agricultural lands been included in this figure.[176] However, this figure assumes that the entire 25 km channel was lined with dykes, and although this is likely it must yet be confirmed.[177] Furthermore, calculations have assumed that only one draught-team hauled blocks, but if more than one transport vehicle was used the amount of time required to move the stones would be greatly decreased.[178]

The removal of earth to construct the channels would have increased the amount of time invested into building these works, not so much a result of the weight of the earth, but because of the sheer volume of it. The dam at Tiryns had an earth embankment estimated at 52,000 m^3, whilst the embankments in the Copaïs are estimated to have used 300,000 m^3. Wright has estimated that one man could excavate no more than one cubic metre of soil per day (Wright 1987: 174),[179] and accepting this figure, it would take one man over 142 years[180] to excavate a sufficient amount of earth for the dam at Tiryns. In the Copaïc Basin, close to 822 years[181] were required to dig 300,000 m^3 of earth. But it is unlikely that only one man was responsible for excavating the earth and much more probable that a number of men worked together, being positioned in a line along the path of the proposed channel. As the channel was dug, the soil was pitched on to a mound that formed the earth embankment of the dam. If it is assumed that men were spaced at 5.00 m intervals,[182] so that 20 men worked simultaneously at Tiryns and 500 men worked in the Copaïs, then the time to excavate the channels would have been decreased to just over 7 and 1.5 years at Tiryns and the Copaïs, respectively.[183] Where canals were flanked by dykes, men may indeed have been placed in facing pairs, each excavating the same channel and each pitching soil behind himself, thus forming two distinct dams. Such pairing of labourers would further decrease the time expended by 50%. Whether

---

[175] 3.34 years.

[176] The dams of the north-east bay, including that north-east of Kastro and leading to Palaiomylos, the dam south of the Tourloyannis hill, and the dam near Orchomenos have not been accounted for.

[177] Those sections of the drainage project that have been uncovered are flanked by dykes, and thus it is assumed that all channels of the project were similarly constructed.

[178] For example, if 5 draught-teams were used, then the time would be decreased to 0.32 and 0.668 years at Tiryns and the Copaïc Basin, respectively .

[179] Hawkins (1966: 89) suggests that one man can excavate one cubic yard (0.9144 m) of chalk, in the Salisbury Plain, in a nine-hour work day.

[180] 142.47 years.

[181] 821.92 years.

[182] This is an arbitrary value.

[183] The depth and height of the channel and dam at Tiryns exceed that of the works in the Copaïc Basin.

the soil was pitched directly from the channel to the mound by the excavator himself or men filled baskets with earth and other labourers emptied these onto the mound, has little effect on the time calculated herein. No estimate can be made for the time to transport the soil to the mound, as the size of loads cannot be calculated and may have varied.

7.2.1. Dating.

Mycenaean pottery dates the dam at Tiryns to the Late Bronze Age (Slenczka 1975: 71; Bintliff 1977: 281); whether the dam was early or late LBA remains problematic, the only clue coming from those constructions built in the old stream bed or flood plain. It can be confirmed that the dam dates well before the Geometric period, as a number of sub-Mycenaean and early Geometric graves were located within the alluvial deposits of the original river (Balcer 1974: 145; Hope Simpson 1981: 21) and Mycenaean graves have been located south of the citadel in the path of the old stream bed (Balcer 1974: 145), where it is believed to have flowed between the north slope of Prophitis Ilias and Kophini to the Gulf of Argos, flooding the Lower Citadel of Tiryns (Verdelis 1963: 5; Balcer 1974: 145). Certainly, the dam would have been built sometime prior to the construction of this Lower Citadel, dated to LH IIIB2, having diverted the river successfully and drained the plain.

In the Copaïc Basin the similarity of style between the masonry of the dykes of the north-east bay and the circuit wall of Gla provide a provisional date of LH IIIB. Stones are of the rough polygonal shape, characteristic of Cyclopean, but are relatively uniform in size and set in rough courses. This neater style of Cyclopean is specific to early LH IIIB, known from the circuit walls of Gla and the first citadel of Tiryns. However, pottery has been claimed in excavations near a section of walling at Anderas. Unfortunately, the exact provenience of the finds are unknown and so its relation to the drainage system cannot be established (Hope Simpson 1981: 67). The Cyclopean wall, however, is similar to those in the north-east bay and to that at Gla (Kenny 1935: 195). In fact, the style differs only from the fortification in its width, resulting from its function as a retaining unit for a massive earth embankment. The wall widths in the drainage system average 2.50 m and are comparable to the Cyclopean terrace walls, built elsewhere, which also supported substantial earth fills[184] and date no earlier than LH IIIB. The only stretch of walling that differs from this Cyclopean technique is a small section stretching east from Kastro. It is a single stone wall, measuring 2.20 m wide and built of large, roughly shaped blocks (Hope Simpson 1981: 67). In fact, this wall dammed the north-west angle of the 8.00 km^2 polder surrounding Gla. The drainage works and dams around Gla must date prior to the construction of the citadel's fortification, being LH IIIA2-B1, as it would have been necessary to clear the plain to transport blocks to build the circuit and other buildings of the site. There are traces of a road leading into the south gate and a second road approaches the double or south-east gate across the plain from the direction of Mt. Ptoön (*AR* 1959-60: 13; Hope Simpson 1981: 64). Neither road could

---

[184] The terrace walls of Prophitis Ilias and the House of the Oil Merchant at Mycenae measure 2.00 m wide, and that supporting the Mansion on Aëtos hill at Sparta: Menelaion is 1.20 m wide.

have been built without those dams which enclosed the polder of Gla having been constructed first.

The only other reported dams have been located at Pseira, on Crete, one of which has been given a LM I date by finds of associated pottery. This was the largest of the two dams, bridging a ravine 15.50 m across, and constructed of three walls of large stones. The walls were separated by inner fills of earth and small stones. Where it could be measured, the dam attains a breadth of 2.90-3.10 m and has a preserved height of 3.62 m (*AR* 1990-91: 76). The second dam was also built across a ravine, and is preserved to a c. 3.00 m height and c. 3.00 m width (*AR* 1989-90: 76; 1990-91: 76). The only similarity with the mainland structures is the use of large stones, averaging 1.50 m or more in length. Even the function of the structures was not to divert the water elsewhere; they were part of artificial reservoirs, the purpose of which is believed to have been agricultural (*AR* 1989-90: 76). These dams offer little clue as to the origin of the construction method of the mainland dams.

The Mycenaean dams can not be dated more specific than early LH IIIB. Based on appearance, the Lake Copaïs structures should be dated prior to the construction of the fortification walls of Gla and during the time of the first citadel walls of Tiryns. The dam at Tiryns should be viewed as earlier than LH IIIB, the time of the construction of the third citadel. Finds of Mycenaean pottery in the upper courses of the dam walls (Bintliff 1977: 281) and 14th-13th century sherds found in the streambed (Slenczka 1975: 71) would support such a date.

7.3. Bridges.

Although Late Bronze age road systems have been argued for in central Greece (Kase 1973; Field 1984) and Messenia (McDonald & Hope Simpson 1961 & 1964; McDonald 1964; McDonald & Rapp 1972), evidence for bridges is at present only identifiable in the Argolid, in the vicinity of Mycenae, and at the base of the Kazarma hill west of Ayios Ioannis, near the modern road that leads to Nafplion. The prehistoric road systems of the Argolid, which have been determined by the location of these bridges, suggest that there must have been some system of organisation and cooperation between Mycenaean centres for their construction to have occurred. Mycenae provides the greatest evidence for such an argument, with traces of four roads extending from the citadel towards Corinth, Prosymna, and Berbati (fig. 4.1.).

Road 1 leaves the Lion Gate on the north, turns east, running below the north side of the citadel, past the Perseia spring, across the Chavos Ravine, turning south around the Agrilovounaki hill before resuming its eastern course. At the point where the road crosses the ravine the Dragonera bridge was built to avoid carrying the road down into the depression. A second bridge, the so-called Lykotroupi bridge, was located just beyond the Agrilovounaki hill. Here the roadway is estimated to be c. 5.20 m wide, including the retaining walls of the bridge; however, the surface of the road is estimated at c. 2.40 m (Hope Simpson 1981:15). The bridges were constructed in Cyclopean fashion, where two faces of massive blocks were assembled together with the aid of smaller interstice stones. However, the intervening space was not filled with earth and small stones as normal; rather, large blocks were corbelled to form an arch, above which a row of coursed blocks supported a road of earth and stone. The arch of the Lykotroupi bridge is just over 1.20 m wide at its base and narrows to a point, c. 2.00 m high (fig. 4.2.), and the arch of the Dragonera bridge appears to be similar; however, the west face of the arch of this latter bridge is flat with a large lintel stone laid across a c. 1.00 m opening. It does appear that the bridge has experienced some shifting of blocks, but much of the structure has survived and indicates that it would have had a total length of 8.00-10.00 m.[185]

Road 2 joined Road 1 just west of the Dragonera bridge in the area of the Ayios Vasilios valley. From this point it runs north in the direction of Corinth, past the west side of Prophitis Ilias. The road runs a parallel course to Road 3; the purpose of two roads with identical courses is as yet unknown, although Hope Simpson suggests that they may have served as two one-way traffic routes (Hope Simpson 1981: 17). This explanation seems unlikely, because the routes terminate in two different areas: Road 2 joins with Road 1, and Road 3 presumably ends at the Lion Gate, as suggested by its placement close to 0.50 km west of Road 2 and in line with the north-west corner of the citadel. Moreover, one would have to question the feasibility of and the mechanisms used to control one-way traffic routes. It would seem more likely that Road 3 turned west beyond the northern limit of Prophitis Ilias, its northward course the result of avoiding the sharp rise and fall of the land and the numerous streams that would have to be crossed.

Road 4 leaves the Lion Gate and turns south in the direction of Prosymna. At least five bridges have been located along this route (Hope Simpson 1981: 17), but only two have been described. The first was located c. 200.00 m south-west of the citadel, and was constructed of large limestone blocks. It is believed to have been constructed in Cyclopean masonry; however, very few of its blocks remain *in situ*. In 1993, a section approximately 7.00 m of this bridge was noted on the north side of the Chavos Ravine. The style is Cyclopean-like, being of moderately large blocks and using interstice stones, but has experienced collapse. Further down the slope several smaller blocks were observed and were likely part of the stone fill. An an isolated block on what appears to be the east line of the bridge was found in the ravine.[186] The second bridge is located below the chapel of Ayios Yeoryios, approximately 1.00 km south of the citadel. Like the Dragonera bridge, it was built to enable travel over the Chavos Ravine. Only one half of the bridge survives, with a width c. 4.40 m and a preserved height of 3.79 m. It appears to have been built largely of conglomerate and some limestone blocks, its south face arranged in almost horizontal courses of alternating rows of rectangular and square stones (fig. 4.3.). The fill is a dense packing of earth and small stones with larger blocks piled on the top. On the basis of this construction Mylonas and Hope Simpson have assigned it a late date, although they still consider it Mycenaean (Mylonas 1966: 87; Hope Simpson 1981: 17); Wace, on the other hand, suggests a Classical date (1949: 27).

---

[185] Visit in 1993.

[186] Mylonas notes that no blocks are *in situ* (1966: 28).

However, if this is to be dated on stylistic grounds, then an arrangement of coursed square and rectangular blocks should be likened to the second citadel wall at Tiryns and the tholos tomb at the same site, although these are built of blocks with much smaller proportions. On the other hand, stonework of large square blocks whose interstices are filled with small slabs is characteristic of section Pe of the Isthmian wall. The neat stonework of the Ayios Yeoryios bridge occurs only on its south face; the north face provides a semblance of coursing without the alternating rows of square and rectangular shaped blocks, but with rougher and variable shaped ones. This would suggest that the south face was visually more important than the north face, being immediately viewed if approaching the citadel along the road leading from Prosymna. Structurally, the preserved east section is similar to the north part of the east Cyclopean wall of the Tiryns dam, being wider at its easternmost end and narrowing at the point where it crossed the ravine. The eastern edge of the bridge is more than 9.50 m wide, narrowing to approximately 5.50 m midpoint of the preserved section, and just over 4.00 m at the westernmost edge of this east section. Although, its lack of similarity with the other bridges at Mycenae does make the determination of its date somewhat problematic, it does find affinities with LH III structures.[187]

The remains of four other bridges have been located at Kazarma (Hope Simpson 1981: 27); however, only the Arkadiko bridge has been described.[188] It spans a small ravine and supports the road running from the Argolic Plain to the Saronic Gulf by means of a corbelled arch (Wright 1979: 223; Hope Simpson 1981: 27; fig. 4.5.). The height of the arch is c. 2.35 m, its width is not more than 1.50 m, and it imitates the arched culverts on the south side of the Agrilovounaki hill (*GAC*: 51; Hope Simpson 1981: 27).[189] The corbelled arch enabled rivers or valleys to be bridged without altering the intended course of the road or obstructing the flow of the rivers. All of the bridge arches at Mycenae and Kazarma are reportedly of the corbelled type, with stones projecting slightly beyond those below. The corbelled arch enabled greater distances to be bridged than would have been possible with simple post-and-lintel construction, but more importantly the compressive thrust is less than that of a flat arch (Gordon 1978: 201; Hill 1984: 63), and this was probably one reason for its use in structures bridging ravines and rivers. In addition, post-and-lintel arches experience an increase in pressure at the mid-point of the lintel. They were used in the construction of some culverts of Road 1, but none appear to have exceeded more than c. 0.50 m in breadth. Their purpose was to enable the runoff from the Agrilovounaki hill to be dissipated without flooding and consequently damaging the roadway, and the c. 0.50 m openings, positioned 3.00-6.00 m apart (*MME* 1972: 25), would have been sufficient for such drainage. By contrast, where it has been reported, arches are c. 1.00 m wide at the base, reaching more than 2.00 m in height.

---

[187] Visit in 1993.

[188] This author has only visited the Arkadiko bridge.

[189] Visit in 1993.

7.3.1. Dating.

In 1966, Mylonas (1966: 87) published a LH IIIB date for the construction of Road 1 at Mycenae and this has since been the accepted date for the entire road network.

> It is virtually certain that the roads were constructed at a time late in the LH IIIB period, since Mylonas found sherds of this date in his two trial trenches dug to determine the nature of the construction of Steffen's Road 1 (Hope Simpson 1981: 15).

Mylonas, however, only sank two trenches into Road 1, and it is from the sherds in the trenches that a tentative date was suggested.

> Very few sherds, of which only two were painted, were found in these two trenches. Both of these sherds belong to late LH IIIB times. We hope to be able in the future to test the road further and perhaps obtain more material that would make possible a definitive chronological conclusion for the construction of the road (Mylonas 1966: 87).

Thus, in absence of subsequent published dates, the assigned LH IIIB date remains tentative. Moreover, if the claimed Late Helladic highway located near Mylos Cheliotou, on the route to Corinth, is dated by LH IIIA2 sherds (*GAC* 62; *AD* 1966: B121) and can be shown to be connected to the Mycenaean network, this LH IIIB date may need to be reconsidered.

The construction of the Dragonera and Lykotroupi bridges of Road 1 resembles that of the Arkadiko bridge at Kazarma. Rough courses of irregular-shaped blocks supported the roadway, but in turn were supported by a corbelled arch, which was built to a height approximately two times the distance it spanned. The walls of the arch did not meet, except on the outer face exposed to public view; arches of the inner faces and passage lengths were closed by keystones.[190]

There is no evidence that corbelled vaults were used in the citadel construction at Mycenae prior to building the Lion Gate in LH IIIB1. The gate was framed by two large doorposts surmounted by an equally massive lintel block. Above this, stone courses have been corbelled to frame a relieving triangle which was blocked on the facade by a thin triangular slab in relief (Iakovidis 1983: 30-1; fig. 6.33.). The North Gate, constructed at the same time as the Lion Gate, is a flat arch, consisting of doorposts and lintel, above which two large rectangular slabs were positioned on the lintel (Iakovidis 1983: 33; fig. 6.34.). Corbelling appears next in the LH IIIB2 North-east Extension and reconstructions. In the extension, two galleries run north and south through the wall. The north gallery is of trabeated construction, roofed by horizontal stone slabs; the south gallery, however, was roofed in corbelled construction. The gallery was cut through the fortification at a right angle so that its length is equivalent to the thickness of the wall, being 7.10 m. The side walls were built straight and parallel to each other, being

---

[190] Pointed arches occur on the east face of the Lykotroupi bridge of Road 1 and the south face of the Arkadiko bridge at Kazarma.

separated by a space of 1.05 m (Iakovidis 1983: 35). The vault was effected by side walls, constructed of Cyclopean blocks, inclining inwards in corbelled courses, narrowing to a sharp angle on the outer faces but roofed by keystones throughout its length (fig. 6.25.).[191] Similar arch construction occurs in the passage extending from the North-east Extension to the underground cistern. The passage has been divided into three sections (fig. 6.45a.).[192] The first section is formed by a descending stepped passage that was cut through the north wall. Its length was covered by a corbelled vault, spanning a 1.60-2.00 m width and rising to a 4.00 m height. This part of the passage terminated at a doorway, designed like the Lion Gate with jamb stones, lintel and relieving triangle, which opened onto a rectangular platform. The second section is also a stepped passage, descending in a westward direction, more or less at a right angle to the landing. The passage, measuring 2.00 m wide and 2.00 m high, was roofed by flat slabs laid horizontally across the corridor. The third section descends to the north-east from the landing between it and the second section of the passage. This is the longest of the three sections, and also the narrowest, being 1.40 m wide. Like the first section the corridor is roofed in part by corbelling. Where corbelled, the top of the arch was pointed, so that in section the arch is triangular. This same type of construction was evidently also used to roof the small room located immediately beside the north Cyclopean wall and adjacent to the three rooms cut within the core of the wall. Its construction also dates to LH IIIB2.

At Tiryns, this type of arch also makes its appearance in LH IIIB2, with the construction of two galleries in the Upper Citadel wall and a niche cutting through the Lower Citadel wall. The first gallery of the Upper Citadel connected the seven rectangular rooms of the forecourt to the upper gate. The corridor measures 1.65 m wide with walls rising vertically 1.75 m to the point where the vault was sprung in a corbel technique. The second gallery was created by the addition of a section of the new fortification along the south end of the existing wall. This new wall was not connected with the previous wall, but rather was placed 1.50-1.70 m out from the wall, thus creating a gallery which exceeded 1.80 m. in height. Like the gallery of the forecourt, the purpose of this passage was to communicate with the rooms built within the thickness of the wall. Both passages have similar measurements, corresponding to an approximate 4:5 ratio of width to height, but the ability to span even greater distances with this type of vault is evident in the Lower Citadel niches, where a like technique of roofing spans a distance almost two times that of the gallery widths.

The difference in vault construction between bridges and arches elsewhere cannot be directly related to the height nor span of the arch. The height of the Lykotroupi bridge at Mycenae and the Arkadiko bridge at Kazarma reach heights that are comparable to that of the arched passages at both Mycenae and Tiryns, and the span of the former bridge is comparable to the width of the south gallery of the North-east Extension at Mycenae (the span of the Arkadiko bridge is unreported). But what the difference does suggest is

---

[191] Visit in 1993.

[192] See Iakovidis (1983: 35-7) and Mylonas (1966: 31-2) for full descriptions of the underground passage and cistern.

perhaps a difference in date, with the pointed arch dating after the simpler corbelled or keystone arch. If it is accepted that the bridges were constructed slightly earlier than the North-east Extension at Mycenae and the galleries and Lower Citadel niches at Tiryns, then the visual similarities of construction are easily recognised. At Mycenae, the rough courses of irregular, unworked blocks in the Dragonera and Lykotroupi bridges imitate the walls of the first and second citadel constructions, but not that of the North-east Extension where the blocks were less carefully laid. The Ayios Yeoryios bridge differs, however, being coursed with massive and relatively well-shaped stones. It may indeed be later in construction than either of the bridges of Road 1, suggesting perhaps that Road 4 is later in date; but, as noted above, its construction can be likened to the second citadel walls and tholos tomb at Tiryns. Its distinct construction could perhaps be explained by a different technique employed by a different group of workers, or by its importance in a building programme designed to display the prosperity and power of Mycenae. Whilst on Road 4 anyone approaching the citadel is immediately faced with the imposing south face of the Ayios Yeoryios bridge, the Treasury of Atreus on the right, and the massive citadel walls. From what can be observed, the north face was constructed in a rougher and less visually impressive fashion. Similarly, the exposed faces of the Dragonera, Lykotroupi and Arkadiko bridges were constructed with visually more impressive arches than those faces not readily seen. However, only intensive field study of the bridges and road systems will establish their dating within the framework of the Mycenaean building programme.

7.4. Retaining Walls.

Retaining walls have been noted in connection with road works, being constructed to first secure the fill and second, where the road could not have been placed on level ground, support a terrace. Remains of retaining walls of Road 1, at a point just below and south-west of the Agrilovounaki hill, have been measured at c. 1.20 m and 1.35 m, on the north and south sides of the road respectively (Hope Simpson 1981: fig. 2). They were built of large blocks, although appear somewhat smaller than those used for the construction of the Dragonera and Lykotroupi bridges, but the style is no different than the latter works.[193] They supported a fill of earth and stones overlain by another thin layer of earth and smaller stones, c. 0.25 m , which was then covered by a road surface of well-packed earth, clay and pebbles (Mylonas 1966: 86).

Where ground levels were such that they did not permit a road to be laid on the flat, terraces were constructed. Cut-and-terrace road construction (see p. 53) was employed in the pass running northwards from Amphissa. Horizontal cuts were excavated into the hillside and the road, supported by retaining walls, was constructed. These were noted by Kase (1973: 76-7) near the village of Prosilion, on the north side of the road near

---

[193] These comments are based on the notes and plans published by Hope Simpson (1981). When I traced Road 1 in 1993, I noted a much poorer state of preservation than what appears in photos published in 1981.

Kouvela, and on the west slope south of Gravia, and reported as Cyclopean.[194] Similar road terraces and retaining walls have been reported on the north-west side of the Livadostro Valley (*GAC*: 251; Hope Simpson 1981: 75) and beyond the Agrilovounaki hill, on the north side of the Koutzoyanni hill, a terrace wall was noted in 1993 two-thirds up the height of the slope (fig. 7.7.). It is preserved in two sections, not more than one metre in height, and separated by a space close to 7.00 m. Section 1 is more than 7.00 m long and is constructed of medium and large boulders and some small interstice stones. Section 2 is approximately c. 4.50 m, and is built of several large boulders, close to one metre in length, as well as the more characteristic medium size blocks of section 1. The walls support a well-packed fill of earth and small stones of which the surface resembles the preserved sections of Road 1, to the west of Koutzoyanni. Whether this terrace is indeed Mycenaean is difficult to determine stylistically. The stones used are more boulderish in appearance than the bridges of Road 1; however, this could be a factor related to the quality of the limestone, and interstice stones are not abundant, although some were indeed noted in both sections. Unfortunately, this terrace appears to have no connection with Road 1, which cuts through the Mavroneri pass on the west and south side of this hill and leads to Berbati. Furthermore, its position on the upper edge of the hill is unusual; if a route was indeed required to circle the hill on the north, it would have been easier to construct it lower down the slope. Even so, the aforementioned reasons and the lack of any sherds by which to date the wall make a Mycenaean date difficult to confirm.[195]

Although the outer faces of the retaining walls are reportedly of Cyclopean construction, in which characteristic large, rough boulders were fitted with small chinking stones and supported a fill of earth and small stones, the composition differs from fortification walls in that there is often no internal wall face. Rather, where possible, the fill has been supported by bedrock, so that the minimum amount of work was performed without forfeiting the structural stability of the wall. The east wall, just inside the entrance of the Lion Gate was constructed more than 4.00 m out from the natural rock of the hill and the intervening space was rubble and earth filled. This section has been reported to be 12.00 m in length and has been situated on the same line as another wall to its east, but separated by a gap of c. 2.00 m. This latter wall was built closer to the rock and likewise retained a fill of small stones. It is believed that it may have formed part of the east wall of the Great Ramp (Iakovidis 1983: 39) and, like the former, supported the hillside and provided an artificial terrace for structures built on higher ground (Wace 1921-23: 62; 1949: 54-5). Similarly the palatial terrace at Mycenae, planned according to the configuration of the bedrock, used the rock as a support for the inner face of the fill and consequently minimised the amount of work. The terraces were built at differing levels as a result of the uneven summit and the buildings that they supported, tracing the summit

---

[194] In 1993, travel to Prosilion from Amphissa was blocked because of road works and thus the retaining wall near Kouvela could not be viewed. The forts north and south of Gravia were noted, and their doubtful Mycenaean construction makes the terrace wall reported by Kase on the west slope dubious. This cut-and-terrace construction was not noted in 1993.

[195] A number of terraces have been documented by the Berbati-Limnes archaeological survey (Wells et al 1990).

on the north-west, west and south sides. On the south-east, the fortification wall doubled as a retaining wall, supporting the rock filled terrace upon which the Megaron was built (Wace 1921-23: 246).

The construction of the artificial terrace of the House of the Columns, located in the south-east corner of the summit, provides insight into how the palatial terraces were constructed. The artificial terrace, bounded on the east and south by a large retaining walls, has been measured to be 20.50 m by 27.00 m, and attains a maximum height of 6.00 m above the rock. It was built of large stones covered by a 0.10 m layer of *plesia*, over which another layer, 0.70 m thick, of *belitsa* was laid. Above this, the floor of the house was laid (Mylonas 1968: 14-5; Iakovidis 1983: 64). By contrast, the house walls of the House of Sphinxes, outside the citadel and to the south of Grave Circle B, were founded directly on bedrock.

The retaining wall of the House of the Oil Merchant, adjacent to the House of Sphinxes, shows a similar technique of construction to the wall located on the east side of the House of Sphinxes. The wall of the House of the Oil Merchant has a width of c. 2.00 m and height of 2.00-3.00 m, and supported the basement rooms of the house. To the north of the house a second similar Cyclopean retaining wall supported a terrace of earth and gravel upon which the House of Shields was built (Wace 1953: 9; 1954: 238; Wright 1980: 62). Likewise, the Cyclopean Terrace Building, located north-west of the Lion Gate, was supported by a terrace of large stones and earth retained by a Cyclopean wall (Wace 1954: 238-9). It appears to have been terraced on all sides and supported by massive walls more than 2.50 m wide (Wace 1921-23: 403; 1954: 268-9). The west wall was built on earth and the south and east walls on both earth and bedrock (Wace 1954: 269),[196] and elsewhere the building reused the existing walls as a foundation level (Wace 1953: 16; 1954: 273). On the other hand, the retaining wall of the House of Sphinxes was founded in a shallow trench and supported a fill of large stones, which were used to level the area between the house and terrace wall; there were no basement rooms (Wace 1954: 238-39; 1955: 185).

The foundation of a retaining wall is the most important part of the structure, for it is at its base that failure may develop, causing the retained fill to exert pressure against the masonry and possibly induce collapse. At Athens, the manner in which the retaining walls have been bedded differs. For instance, the north wall of terrace IV was founded on a support of small stones, whereas the west wall of terrace III was sunk into a trench with a maximum depth of 0.35 m and its surface levelled with mud and small stones (Iakovidis 1983: 88). The difference in technique is due to the configuration of the acropolis rock. The north wall of terrace IV was situated on the edge of sloping rock. The small stones served to level this edge, so that a wall could be constructed to retain the terrace fill with less effort than that which would have been required to excavate and dress the hill slope. On the other hand, the wall of terrace III was positioned on the summit which, although of uneven surface, was on a similar plane. Hammering the surface free

---

[196] The north wall has not been preserved (Wace 1954: 268-69).

of any projecting rock would have created the shallow trench and evened the rock, which was further levelled by filling the cavities with small stones and earth. Once the wall was securely founded, the remainder of its stability resulted from its masonry weight and ability to counteract the pressure of the fill that it retained.

The size of the retaining wall and type of fill are proportionate to the height and function of the terrace. The terrace wall of the House of Columns supports a substantial platform of large stones and consequently the height of the wall reaches c. 6.00 m in places. In contrast, remains of Road 1 suggest that retaining walls were no more than 1.00-2.00 m in height,[197] and contained an earth and stone fill c. 2.10-2.40 m wide (Hope Simpson 1981: 15).

7.4.1. Dating.

Retaining walls provide little useful information in terms of dating the beginnings of Cyclopean masonry, most having been built during LH IIIB, after the construction of the first citadel at Mycenae and Tiryns. The techniques and style of these walls do not differ from the Cyclopean masonry of the fortifications, apart from the absence of an inner wall face, with the exception of the house walls of the Cyclopean Terrace Building, where the blocks used are much smaller in size, recalling those in the *stomion* of the LH IIA Epano Phournos tombs. The terrace of the House of Columns has been dated by Mylonas to the later part of LH IIIB, on the basis of a number of sherds found in the fill (Iakovidis 1983: 64), and earlier palatial terraces have been dated to LH IIIA, likewise confirmed by sherd evidence (Wright 1980: 62). The east wall, located inside the Lion Gate, post-dates the gate suggested by its construction, abutting the so-called gate shrine, and placement over an earlier drain that was initially built to serve the gate (Iakovidis 1983: 39). Retaining walls outside of the enclosure and situated on the lower slopes of the hill, the terraces of the houses south of the tomb of Clytaemnestra, the Cyclopean Terrace Building, and Road 1 have also been assigned LH IIIB dates based on artifactual finds (Wace 1950: 222; 1954: 291; Mylonas 1966: 80, 87; Hope Simpson 1981: 15).

At Athens, the terrace walls have been dated by sherds to LH IIIB, prior to the construction of the fortification (Iakovidis 1983: 79), and the style is not unlike the terraces noted at Mycenae. Although the section of retaining wall located below the bastion of the north-west corner of the acropolis, and to the left of the visitor's approach, appears to have been partially restored, it should also be dated to LH IIIB on the basis of its similar construction. The blocks are unworked, many exceeding 1.00 m in length, height, and width, with intervening spaces filled with small stones.

The massive retaining wall of large, undressed blocks, reported to have separated the upper and lower terraces of the Aëtos hill, south of Sparta: Menelaion, has also been suggested to be of LH IIIB date (Catling 1982: 35, 40). It measures 1.20 m wide and is believed to have been 2.00 m in height; only the lowest course remains *in situ* (*AR* 1979-80:19; Catling 1979-80: 18; 1980: 157; 1982: 40).

---

[197] See plans by Hope Simpson (1981: fig. 2).

Likewise the wall at Perdikaria has been dated to LH IIIB, on the basis of sherds found within the settlement area (*GAC*: 64; Hope Simpson 1981: 34). The Cyclopean section was reported to be located on the upper part of the north side of the hill, preserved to a length of 30.00 m with a maximum height noted as c. 3.00 m (*GAC*: 64; Hope Simpson 1981: 34; Field 1984: 64). In 1993, I was unable to locate this section; newly planted olive and lemon groves have necessitated extensive ploughing of the slopes, and likely the clearing of the wall. Lower down the slope, I noticed a pile of Cyclopean-size boulders that appear to have been cleared to one side by the farmers, and to the east of this pile, I noted the remains of a possible terrace wall constructed in Cyclopean stonework, approximately 9.50 m long. Several grouped and isolated blocks indicate that it may be three times greater than this length, but this was difficult to confirm, since it was obscured by overgrowth. In view of the little that is preserved, it is difficult to establish a precise date; however, there is no reason to doubt its placement within Late Helladic. This section bears very little similarity to the remains of the Isthmian wall, where both the blocks and interstice stones have been dressed into neat rectangular shapes, and which is suggested by its appearance to be of a late Mycenaean date at the earliest. Rather, the Perdikaria section uses many variable-shaped stones, reminiscent of the LH IIIB terrace walls at Athens.

The terrace wall at Delphi is also problematic. Excavation reports do not record the wall, and therefore no artifactual information is known by which to date the wall. The wall is located on the north slope, above and to the east of the theatre, and forms the foundation of the Classical retaining wall. The preserved section is not unlike the masonry at Khryso: Ancient Krisa or the acropolis of Chaeronea. Blocks are large and unhewn, fitted together with small, angular chinking stones; only in those sections that have been repaired has earth been used to bind the joints. The section is not more than c. 1.00-1.50 m in height; its breadth and fill could not be determined because of the later wall. Other possible stretches of Cyclopean stonework were noted south and west of the Roman Agora, to the south of the Argive monument, and to the south-west of the large, semi-circular niche; however, as with the north retaining wall, the extensive building of the site makes it difficult to establish with any certainty that this work was indeed Mycenaean.

7.5. Discussion.

The only evidence for true Cyclopean work dating prior to the fortifications is to be found in the LH IIA Cyclopean and Epano Phournos tombs at Mycenae. However, it is difficult to dismiss the possibility that the work was used in earlier architectural forms and was destroyed and in some instances rebuilt at a later date, as suggested of the bridge of Road 1 at Ayios Yeoryios (see pp. 104, 118). The structural collapse of these early tholos tombs may indeed suggest that earlier Cyclopean structures could have also suffered structural failure, and ultimately necessitated some sort of replanning and reconstruction. For example, the Cyclopean tomb could not have remained intact for long, as it would have been unable to withstand the stress of the lintel blocks. Indeed, Wace notes (1949: 289) that the interior lintel stone had in fact "fallen in, owing to the collapse of the inner jamb on the north." With other types of buildings, such as terraces or bridges, the structures may have been completely demolished after having experienced collapse and then later rebuilt, a sequence which can not be traced in the archaeological record. On the other hand, an increasing emphasis on appearance may have been responsible for a programme of rebuilding. No matter what may have been the impetus for rebuilding structures, the probability that other earlier Cyclopean works existed cannot be rejected because of their absence in the present record, recognising of course that such absence can not confirm their existence, either.

Chapter 8: Foreign Influence

Cyclopean fortifications are reported in Crete, the Greek islands, Cyprus, Syria-Palestine and the Transjordan, Anatolia, and Southern Europe; however, their description as "Cyclopean" is a misnomer, referring to nothing other than the size of the stones. The masonry technique of the fortifications is not the same as that of the Greek mainland. Generally, Cycladic fortifications form a homogeneous style of stonework of large, roughly rectangular blocks and small thin slabs used to level courses; however, variations do occur. Cypriote walls are generally composed of stone socles and mudbrick superstructures. Levantine fortifications are similarly built, but positioned on top of an earthen rampart or glacis construction. EBA Anatolian walls also employ mudbrick, and in some instances ramparts, but many of the Hittite walls are stone built. However, the compartment technique of the Hittite walls are not analogous with true Cyclopean stonework. Finally, apart from the use of large blocks, the masonry in Southern Europe is considerably different from that of the Greek mainland.

Each geographical region has been studied independently for a homogeneous building technique and similarities to the Greek mainland Cyclopean masonry; those walls reported as Cyclopean are discussed first and each site is treated independently of the others. Other fortifications are studied for similarities with the reported Cyclopean structures to determine if there is any regional style. A discussion follows of the the appropriateness of the term Cyclopean as applied to each region.

8.1. Crete.

8.1.1. Reported Cyclopean walls.

Cyclopean masonry has been reported at several sites in Crete, but in no instance is the stonework the same as that on the mainland. Rather, the term seems to be a convenient word used to describe the size of the stones in the construction and not related to the way in which the wall was built.

A so-called Cyclopean wall, 735 m in length, is reported on the north, south, and east slopes of Mt. Juktas, enclosing the sanctuary (*AR* 1980-81: 43; 1988-89: 99; 1989-90: 99; Rutkowski 1986: 75-6). It is preserved to a 2.50-3.60 m height, with a width measuring 3.00-3.50 m. The stonework is a dry-stone technique, where courses are not regular and very few interstice stones have been used to wedge blocks that average 1.00-1.50 m long, and the fill is of smaller stones than those of the faces (Hayden 1988: 11). Today, only the north side of the wall is in a relatively good state of preservation. Here the wall does not appear to have been laid to form a smooth face but rather is irregular, with little regard for uniformity. In fact, much of the so-called wall is natural outcrop, but where sections are indeed man-made it would appear that they were less carefully constructed than the walls of the mainland, being seemingly a mere piling of stones; the great variations in wall width support this. In a true Cyclopean stonework both the horizontal and vertical planes are relatively flat, although various sizes and shapes of blocks are used. Furthermore, it appears that the builders at Juktas have laid a large proportion of the stones as headers; in Cyclopean structures this more commonly occurs at gates and where the wall terminates. In fact, Hayden does report that headers do occur at angles (Hayden 1988: 11-2); however, their frequent use throughout the wall length is not characteristic of a Cyclopean style.[198]

Evans assigned the wall at Juktas a MM IA date, based on pottery found within the wall, but Alexiou redated the wall on stylistic grounds to LM III.[199] Karetsou (1981: 145) supports a MM IA date for the site's establishment, but notes that monumental architecture dates to MM III. In support of the LM III date, Hayden likens this wall to that of Kastrokephala, west of Herakleion, although she does note the use of smaller stones in its construction (Hayden 1988: 12). In view of the artifactual evidence and differences in construction from LH III stonework, a MM IA date is preferred by this author.

On the flat summit of Kastrokephala a Cyclopean enclosure, approximately 480 m in length, is reported on the east, west, and north sides. The wall is 2.10-2.20 m thick, and varies between 2.00 and 3.50 m in its preserved height; the thickened west and east ends of the wall, which project forward from the line of the fortification, have been interpreted as towers (Hayden 1988: 5). It was built in a dry-stone technique of both small and large unhewn limestone blocks, up to 1.00 m in length, and small stones were used in chinks (Kanta 1980: 19; Hayden 1988: 4). The frequent use of small stones and the lack of concern for placing the largest stones in the lowest courses are not characteristically Cyclopean, nor is the frequent laying of large blocks as headers (Hayden 1988: 4). The wall has been dated to LM IIIA-B by Alexiou and LM IIIB-C by Kanta.[200]

On the south part of the saddle-shaped hill of MM Kharakas at Monastiraki traces of Cyclopean masonry, preserved in places to 2.00 m in height, have been reported (Hood et al 1964: 76). However, no further account has been given and no photos of the wall have been published.

At Stilos, another Cyclopean wall was reported in 1962, with LM III sherds in an area 100 m to the north; however, as with Kharakas, little has been reported and in 1965 no further remains could be traced at the site (Hood 1965: 111).

A LM wall at Vasiliki, above the MM I Gamma house, has also been described as Cyclopean (Hayden 1988: 14), yet its construction, apart from the average block length of 1.00-1.50 m, bears little resemblance to a true Cyclopean style.[201] Very little of this wall remains, which causes further difficulties in accepting its Cyclopean label. In the central section of the remains, where the wall is preserved to a height of 0.60-1.80 m, the wall only measures 2.00 m wide, and from the plans it appears to narrow towards the

---

[198] Visit in 1994.

[199] *AR* (1981-1982: 54) reports that there is no evidence by which the wall can be dated.

[200] Kanta reports LM IIIB pottery (1981: 19). See also Hayden (1988: 3).

[201] Reported in *AR* (1972-73: 32) as a "Mycenaean fortification".

north, after which it turns west. No evidence for dressed blocks or header-and-stretcher construction can be noted at this corner. Furthermore, part of the wall is built of small stones packed with mud (Hayden 1988: 15), which is a technique quite different from Cyclopean.[202]

A Geometric wall at Gortyn, that runs under and south from the south-west corner of the temple, has been called Cyclopean (Hayden 1988: 12). Its width of 0.80 m is certainly not characteristic of true Cyclopean technique in either a defence wall, as claimed by Di Vita (1984: 111), or a terrace wall. As Hayden correctly notes, the wall cuts across the summit; "it is not placed to take maximum advantage of the terrain...There is relatively level ground for several meters on either side of this north-south wall section, and it is more probable that a defensive wall would encircle the hill top." (Hayden 1988: 12-3) Although little of the wall has been preserved, it is clearly constructed in a distinctive Geometric manner, where blocks are tightly fitted together, some with straight edges, and there is little need for interstice stones.[203]

Recent investigations at Praisos in east Crete (*AR* 1992-93: 77-9) have produced substantial walls. On the first acropolis, on the north-west, wall 2 has been tentatively labelled as Cyclopean (*AR* 1992-93: 79) and likened to the walls at Palaikastro[204] and Kato Zakro. From a section plan of the wall,[205] wall 2 does indeed present the Cyclopean characteristic of large blocks wedged with interstice stones, specifically the left half of the wall. However, the right half is of neater construction, in which blocks, c. 0.50 m long, have been placed in three distinct courses, above the bedrock. A roughly vertical joint divides the wall into two distinct sections, suggesting perhaps a rebuilding of the right half.[206] Walls 3 and 6, on the south and east sides of the first acropolis, are said to be similar (*AR* 1992-93: 79) to wall 2, yet in neither case does the plan seem to suggest a Cyclopean technique. Blocks are certainly massive, particularly in the mid-section of wall 6A, but many are dressed into square or rectangular shapes. The use of interstice stones is infrequent and in places blocks are closely fitted together. Moreover, wall 6A uses much bonding clay throughout the structure. This wall is suggested to be very similar to the LM I enclosure wall at Petras in Siteia (*AR* 1992-93: 79); the attempt made to lay stones in courses is similar to the wall at the foot of the Petras hill, rather than

---

[202] An EM III fortification has also been suggested at the site; however, its defensive function is questionable and it appears rather to have been a boundary wall delimiting the area of the sanctuary (*AR* 1991-92: 69).

[203] Visit in 1994.

[204] Although the line of the supposed fortification wall at Palaikastro: Roussolakkos can be traced, not enough of it survives to judge its construction technique. The watch-tower at the south-west entrance to the town does provide a likeness to the left part of wall 2, yet the wall does appear to have been of a neater construction.

[205] I am grateful to Dr. James Whitley, Director of the 1992 Praisos excavations, and Mr. Howard Mann, project draughtsman, for copies of the plans of walls 2, 3, and 6A.

[206] The suggestion that the right portion was reconstructed is also argued on the basis of its neater construction, and the way in which the stone, second from the bottom and closest to the left side of the wall, is partly balanced by the left wall, as is the small stone used to balance the uppermost stone in the same vertical plane.

the more haphazard construction of the terrace wall on the summit, yet the use of so many squared stones throughout the length of the wall is not similar to the Petras walls, where squared blocks are used only at angles.

At the north-west foot of the hill on the seaward side at Petras an "almost Cyclopean" LM I fortification wall with square towers has been reported (*AR* 1989-90: 106). It has been preserved to a length of 20.00 m and an average height of 3.00 m;[207] it is impossible to measure the width because of the modern road that cuts across it (Tsipopoulou 1990: 319). Of all reported Cyclopean structures in Crete, this wall appears to be the closest Cretan parallel to the mainland Cyclopean walls, yet corners are not neatly squared nor do they use header-and-stretcher construction, and in places the wall presents a somewhat gappy appearance. A second wall, c. 280 m long and 1.10 m wide, is situated on the north crest of the summit and is constructed of small and large stones, some measuring 2.50-3.00 m, or a size that the excavator calls Cyclopean (Tsipopoulou 1991: 12). However, this wall cannot be called Cyclopean; it does not appear to be carefully assembled, there is no attempt to maintain a level wall surface or lay blocks in courses, nor does consideration seem to have been given to placing of the largest blocks in the lowest part of the wall. The wall uses many small stones and appears to have reused several well-shaped blocks, which themselves suggest a late date.

8.1.2. Other reported Cyclopean structures.

At Akhladia, in the district of Siteia, a LM IIIB tholos tomb has been reported as Cyclopean: "It is built of big stones giving an impression of "Cyclopean" masonry" (Kanta 1980: 178). Although the blocks in the chamber are large and unhewn, and wedged with a great number of interstice stones, and massive blocks have been used to construct the *stomion*, the term Cyclopean refers to nothing more than the size of the stones; the technique used here, where interstice stones are large and used excessively, differs from true Cyclopean work.

8.1.3. Fortifications in stonework other than Cyclopean.

A fortification wall has been identified in the Roussolakkos area at Palaikastro in east Crete, along the approach from Patema and Zakro (Catling 1982-3: 21; *AR* 1983-4: 66; MacGillivray, Sackett et al 1984). The wall is situated along the north-east approach to the settlement and has preserved the foundations of two rectangular towers. However, because of its location on the flat, the defensive nature of the wall has been questioned (MacGillivray, Sackett et al 1984: 137). At the south-west, a watch-tower built of large irregular-shaped blocks guarded the entrance to the town (MacGillivray, Sackett et al 1984: 136).

At Ayia Photia, near Siteia, an enclosure wall with four towers is also suggested to be a fortification. It is preserved on three sides of the summit, measuring 1.30-1.50 m thick, enclosing a large rectangular building, dated to c. 2000 BC. It was built in the same

---

[207] Tsipopoulou in1991 (30) reports a 2.50 m height, in 1990 (319) reports a 3.00 m height, and in*AR* 1989-90, reports a 3.50 m height.

technique as the house walls of the settlement, but using much larger stones (*AR* 1988-89: 102; 1989-90: 102; Tsipopoulou 1990: 307, 309).

Defence walls have also been suggested to the north-west of Kato Zakro,[208] enclosing the palace at Mallia (Tzedakis et al 1989: 63; *AR* 1991-92: 67), and at the prepalatial site of Kouphonisi (*AR* 1983-4: 67).

8.1.4. Other forms of defence.

Another system of defence in east Minoan Crete seems to have relied upon the placement and networking of towers and guard posts along roadways. East of the bay of Ayia Varvara, Tzedakis et al (1989) have identified a number of administrative buildings and watchposts, the latter often enclosed with walls (p. 100). Although it is difficult to date the construction of the road, traces of MM remains have been noted and dated to the first palace period (*AR* 1989-90: 75; Müller 1991: 551, 558). The style of masonry used in construction is rather homogeneous: large, well-cut, rectangular blocks of white limestone are used in the rectangular-planned administrative centres, and large, irregular-shaped, grey limestone blocks are used for guard posts (Tzedakis et al 1989: 63).

Investigations in the area around Kato Zakro have also produced possible guard posts (Tzedakis et al 1989: 55; MacGillivray, Sackett et al 1984: 136-7). It is suggested that these road structures are to be associated with a system of defence (MacGillvray, Sackett et al 1984: 157; Tzedakis et al 1989: 60, 74). Likewise, towers have been noted in east and central Crete; for example, three towers are suggested at Praisos (Catling 1992-3: 28) and the structure at Matala has been identified as another (*AR* 1989-90: 72).[209]

A defence system has also been suggested for the Oreino valley in the west Siteia mountains. At both Kastri and Petrokopia, defence walls cut across the accessible sides of the sites, enclosing lookouts for settlements within the valley. The post at Kastri formed the "Upper Town" of the settlement, enclosed on its south-east and south-west sides. The enclosure wall is preserved in parts to 1.70 m in height, with an average width of 1.20-1.40 m (Nowicki 1990: 171). At Petrokopia, the defence wall runs across the south-east side of the knoll, but it is not continuous; rather, where openings existed between the rock of the summit, a wall was constructed to fill in the space. The site is suggested to have defended the southern approach to the settlement at Ellinika (Nowicki 1990: 173).

8.1.5. Discussion.

Defence seems to have been a concern in the MM period to judge from a defence wall reported at Myrtos-Pyrgos (MacGillivray, Sackett et al 1984: 137), the wall at Ayia Photia enclosing the rectangular building, and the east Cretan roads and guard posts, constructed not only to connect urban centres and move supplies, but possibly to defend

---

[208] Field was unable to trace these walls in 1984 (355).

[209] A tower has been noted on Kephala hill, north-east of Knossos, but may in fact date to the third century rather than any time earlier (Hood & Smyth 1989: 20).

territories. Posts are generally located at the junction of two or more passages, being built close to the routes or near town entrances, and in many cases within view of each other (Tzedakis et al 1984: 60).

There is an increase in the number of enclosure walls in late LM III and the Geometric period, however, many of the walls were not built as defensive structures, but were used to mark the limits of sanctuaries. Rutkowski (1986: 75) argues that it was common practice to use a mound of stones or a large boulder to indicate boundaries, and massive walls to surround more important enclosures, although these may have also served as refuge centres in times of trouble. The sanctuaries of Juktas, Kophinas, Krasi, and Mallia: Prophitis Ilias were defined by man-made walls, whereas at Prinias the north rock formed a natural boundary wall.[210] Likewise, at Kato Symi Viannou, a peribolos wall built of well-hewn stones enclosed a cult area of 1225 m^2 on the west; the area appears to have been in use from neo-palatial to post-palatial times (*AR* 1989-90: 100).

Most defence systems occur in the east part of Crete in the Lasithi district, or in central Crete, at and near Ayia Varvara. Apart from Juktas, Monastiraki: Kharakas, and Vasiliki, all so-called Cyclopean structures date late in LM III and therefore are not helpful in determining the origins of the masonry. Equally, the earlier walls provide little aid as they differ greatly in construction and are in fact not Cyclopean in technique.

8.2. Cycladic Islands

8.2.1. Reported Cyclopean walls.

Although Cyclopean stonework has been reported in the Cyclades, the masonry is distinct from that of the mainland, partly owing to the nature of the building material, but more notably because of the technique of construction.

A Cyclopean fortification wall has been reported at Koukounaries on Paros, running east to west across the south side of the acropolis, and dating to LH IIIC (*Ergon* 1989: 119; 1990: 105; *AR* 1988-89: 90; 1989-90: 68). The wall, which also was a retaining wall for the terrace upon which the main buildings were constructed, appears to have been founded on bedrock, but in those areas where the rock sharply drops, a strong foundation wall, with a height of 0.57 m, was constructed to support the wall (*Ergon* 1988: 131). The wall has been described as consisting of well-cut granite blocks, laid lengthwise and forming two faces, which enclosed a rubble fill (Schilardi 1979: 159; Field 1984: 278). In 1988, the wall was reported to have been preserved to a 3.05 m height, but the excavator suggests that it may have once reached a height of 8.00-9.00 m (Field 1984: 279; *Ergon* 1988: 132). Barber likens the masonry technique to that at Siphnos: Ayios Andreas, where two stone walls, built of large and approximately squared stones, support a rubble fill (1987: 69). On the south side of Koukounaries, a section of walling, measuring c. 16.00 m in length, is noted to have been founded on bedrock and is of large polygonal blocks, roughly coursed with the aid of interstice stones (Field 1984: 279).

---

[210] See Rutkowski (1986: 75-6, 96, 97, 98).

The site was entered from the south-west, but at some point the approach was blocked by a wall of medium size blocks running east to west.

Two defence walls at Siphnos: Ayios Andreas encircle the site; the outer wall is c. 1.20 m thick and has been assigned a Geometric date, the inner wall is c. 3.50 m wide, has eight towers along its length, and is dated to LH IIIB on the basis of associated pottery (*AR* 1972-3: 25; 1975-6: 23; Philippaki 1973: 102-03; Field 1984: 273-5; Barber 1987: 68). The space between the two walls was filled with small stones, presumably immediately after the outer wall was constructed. The stonework of the LH IIIB wall recalls that of Keos: Ayia Irini and Tenos: Akrotirion Ourion, and has been likened to that at Paros: Koukounaries (Barber 1987: 69). Blocks are large rectangular slabs, seemingly undressed and laid in a semblance of coursing, and small thin slabs were used to help keep courses level and to fill gaps between blocks.

The Third City wall at Melos: Phylakopi is described as Cyclopean (*GAC*: 314), and is built on bedrock, with a c. 6.00 m thickness, offsets, and larger blocks used in the construction of its outer face as compared with the inner face (Field 1984: 269-70; Barber 1987: 68). The west section of the wall seems closer to mainland Cyclopean stonework than the site's LC I wall; however, a great number of small stones have been used to fill the wide gaps found between the larger stones. Moreover, crosswalls, not a characteristic of Cyclopean stonework (rather, see compartment construction, pp. 70-1),[211] were used to join the wall faces. The east part of the LH IIIB wall differs from that of the west; faces are constructed of large boulders widely separated, many of which are water-worn, and intervening spaces appear to have been filled with clay.

Davis argues that the outer face of the earlier fortification wall at Melos: Phylakopi is similar to the period V wall at Keos: Ayia Irini (1977: 181; 1986: 104), where the wall was built with an inner and outer face, which supported a fill of small stones and earth, and was founded on bedrock. Both schist slabs and blue-grey limestone blocks, up to 1.50 m long and 0.70 m wide, were used to construct the walls, the joints being filled with interstice stones and earth. Stones used were local, some having been dressed into rectangular shapes and others used as extracted from quarry beds (Davis 1977: 4; 1986: 9; 1986: 8). The wall cannot be assigned a single date, as it was constructed in sections and then reconstructed over time (Caskey 1964: 321; 1970: 373, 376). The west side, Area D, has been described as a "massive wall with cyclopean masonry" (Caskey 1962: 277); however, nothing other than the size of some stones suggests that the wall was really Cyclopean. The wall by the lime kiln is similarly constructed to that in Area D, where a great number of small slabs have been used to level blocks and maintain courses (Caskey 1971: pl. 70g). This is also the technique used for the outer face of the wall in Area J (Caskey 1971: pl. 72a & b). The masonry recalls that at Tenos: Akrotirion

---

[211] Field contends that the compartmentalisation of the wall is not dissimilar to the mainland constructions (1984: 272); however, compartmentalisation is not a feature of the mainland nor is this construction to be equated with unit-building. For compartment and unit-building see above.

Ourion, except the later does not seem to use as many levelling and interstice slabs and it has also been repaired at a later date.

8.2.2. Fortifications in stonework other than Cyclopean.

The wall at Tenos: Akrotirion Ourion has also been likened to the early defence wall at Melos: Phylakopi (Field 1984: 267) and may be contemporary with it as well as that at Keos: Ayia Irini (Renfrew 1972: 398; Davis 1977: 181). On the south side of the hill a wall, built of roughly cut blocks laid in courses and a small projection, 1.40 m wide, has been located. A shorter stretch of similar stonework has also been noted on the west (Scholes 1956: 13; Field 1984: 266).

At Naxos: Grotta-Khora a fortification wall built of mudbrick on a stone foundation defended the site on the seaward side (*AR* 1985-6: 75; 1990-91: 63; Barber 1987: 63).

8.2.3. Other forms of defence.

To the northwest of Keos: Ayia Irini, positioned on the Troullos hill, a so-called watchtower has been reported, with sides measuring c. 13.00 m. It was built within sight of Ayia Irini, and is suggested by Caskey (1966: 376) to have been placed to communicate signals to the Bronze Age settlement.[212]

8.2.4. Discussion.

The fortification walls in the Cyclades form a distinct group in their style of construction, which, apart from the size of some stones, bears little resemblance to the Cyclopean stonework of the mainland. Blocks are roughly rectangular slabs levelled by small thin slabs in an attempt to course the masonry. Paros: Koukounaries, Siphnos: Ayios Andreas, Keos: Ayia Irini, and Tenos: Akrotirion Ourion are stylistically similar. Keos: Ayia Irini is the earliest of the group, having been built in the late Middle Cycladic period, but was repeatedly reconstructed and repaired. This later wall was built of flat schist slabs of irregular sizes assembled in the same dry stone technique as that of the earlier Period IV wall and semi-circular tower (Barber 1987: 47, 68). Tenos: Akrotirion Ourion has been suggested to be contemporary with the Great Fortification at Keos: Ayia Irini,[213] and indeed its construction is similar. Siphnos: Ayios Andreas and Paros: Koukounaries were built in LH IIIB and LH IIIC, respectively.

The west section of the wall at Melos: Phylakopi presents a style similar to that of mainland stonework, but the abundant use of small stones surrounding each stone and its compartment construction are not consistent with a true Cyclopean style.

Naxos: Grotta-Khora is an anomaly in this group of fortifications, and recalls the Cypriot and Near East fortifications where mudbrick superstructures are supported on stone socles.[214]

---

[212] Although undated, its relation to the site implies a Bronze Age date.

[213] See Field (1984: 267) for a discussion of the date of Tenos: Akrotirion Ourion.

[214] Barber (1987: 229) notes that the site is "largely unpublished".

8.3. Ionian Islands

8.3.1. Reported Cyclopean walls.

The only reported Cyclopean wall on the Ionian Islands is that at Aëtos on Ithaka, which has been assigned a 13th century date on the basis of its style of construction (*AR* 1985-6: 55; 1986-7: 32). No further information has been reported, nor photographs published.

8.3.2. Fortifications in stonework other than Cyclopean.

No other prehistoric fortifications have been reported on the islands.

8.3.3. Discussion.

The siting of Ithaka: Aëtos is unusual in that it is not geographically positioned to favour direct contact with southern Italy and Sicily nor with the hub of Mycenaean activity on the mainland; the site is hidden from the west by Kephalonia and from the Greek mainland by its south-west position on the island, and one wonders why a Cyclopean wall, if indeed it is Cyclopean, was constructed here. Regardless, a 13th century date does not aid in determining the origins of the technique.

8.4. Dodecanese

8.4.1. Reported Cyclopean walls.

There is no reliable evidence from the Dodecanese to suggest that any of the walls are Cyclopean; Hellenistic terrace walls at Khorio: Kastro and Telos: Megalokhorio-Kastro have been erroneously reported as Cyclopean (Hope Simpson & Lazenby 1970: 66; 1973: 157), at Leros: Xerokambos the defence wall is suggested to be Cyclopean construction, but the earliest sherds associated with it are dated to the fourth century (Hope Simpson & Lazenby 1970: 54), and an early report of Cyclopean stonework at Kastellorizo: Vigla could not be confirmed in 1970 because of its poor state of preservation (Hope Simpson & Lazenby 1970: 75).

At Kos: Amaniou-Palaiopyli, the wall on the north and north-west slopes has been labelled as Cyclopean (Hope Simpson & Lazenby 1970: 59; *GAC*: 362; Hope Simpson 1981: 201), but in a more recent study by Field it has been argued that the wall is not Cyclopean, although he believes that it was probably a Late Bronze Age structure. The blocks used are generally more rectangular than polygonal, and larger blocks have been placed in the uppermost courses, where they have been closely wedged together with little use of interstice stones (Field 1984: 281-2).

Cyclopean walls cutting across the landward side of Rhodes: Kallithies-Erimokastro have also been reported (Hope Simpson & Lazenby 1973: 154; *GAC*: 357; Hope Simpson 1981: 199). However, they measure only c. 1.70 m thick and there is little evidence from which to date the walls (Mee 1982: 77).

8.4.2. Fortifications in stonework other than Cyclopean.

At Symi: Kastro a roughly coursed wall, built of polygonal hammer-dressed stones, and a tower have been noted on the south side of the hill (Hope Simpson & Lazenby 1970: 63). Only one Mycenaean sherd is associated with the construction, making a date for the structure unreliable.

8.4.3. Discussion.

The term Cyclopean has been used inappropriately in the Dodecanese. At Khorio: Kastro and Telos: Megalokhorio-Kastro it is clearly a misnomer, having been applied to walls dating to the Hellenistic period, and the same is suggested by the sherd evidence at Leros: Xerokambos. Evidence is equally lacking at Kastellorizo: Vigla and Rhodes: Kallithies-Erimokastro. In the case of Kos: Amaniou-Palaiopyli, the technique of construction differs from Cyclopean.

8.5. Cyprus

8.5.1. Reported Cyclopean walls.

As with the fortification walls of the Cyclades, those of Cyprus form a distinct group. Fortin (1981: 520) correctly notes that the M Cyp III-L Cyp I walls bear no similarities to the Greek mainland Cyclopean walls, Aegean fortifications generally, or the defence systems in the Levant. However, of the L Cyp IIC-III walls, he applies the term Cyclopean to Sinda: Siri Dash, Enkomi, Kition, and Maa: Palaiokastro (1981: 193, 218, 288, 363, 527-8, 538); but, although Mycenaean influence is suggested (Fortin 1981: 553), this appears to be nothing more than a convenient term to describe the massive socle blocks that sometimes have been fitted with interstice stones, and is a usage common among other Cypriot archaeologists.[215]

The L Cyp IIIA wall at Enkomi has been reported as being Cyclopean in technique (Karageorghis 1982: 90). The socle, c. 1.50 m high and founded partly on bedrock and elsewhere on a layer of flat stones, is of two parallel rows of large undressed sandstone blocks, some of which have been reported to measure 1.40-1.90 m high, 1.00-1.30 m thick, and 2.00-3.00 m long. The stones in the outer face are larger than those used to construct the inner face, and both retain a rubble fill so that total width measures 2.50-3.50 m.[216] Interstice stones and small boulders were used to chink the blocks. However, it differs from Cyclopean stonework in having a superstructure of mudbrick, towers spaced at regular intervals, and reportedly casemates (Dikaios 1969 Vol. 1: 68-70; Vol. 2: 517; Åström 1972 IV IC: 40; Fortin 1981: 214-23; Karageorghis 1982: 69, 90; Courtois et al 1986: 2-4). Indeed, Dikaios (1969 Vol. 2: 512) notes that the method of construction is dissimilar from that of mainland Greece.

The second fortification wall at Kition has also been called Cyclopean and dated to L Cyp IIIA. It measures c. 2.40-2.50 m wide and, as at Enkomi, is composed of a stone socle,

---

[215] See individual sites discussed below.

[216] Fortin (1981: 214, 219) reports the L Cyp IIB wall as measuring 2.00-2.30 m thick, but when strengthened in L Cyp IIIA the total thickness measure 3.50-4.00 m.

c. 1.25 m high, with a mudbrick superstructure; in the precinct area it was also the north wall of several temples.[217] The socle is said to be constructed of two rows of large conglomerate stones, the inner face being composed of smaller stones than the outer, and separated by a rubble fill. Some of the blocks are indeed massive, having lengths reported at more than 3.00 m, but in places along the internal face very small stones were piled together to form the wall. However, the wall is not always of two distinct faces; many of the blocks cut across the entire width of the structure, so that there is no internal fill. The fortification was reinforced by large rectangular towers with ashlar foundations of calcareous sandstone and mudbrick superstructures (Karageorghis 1973: 8, 11; 1976: 59-60; 1982: 69, 90-1; Fortin 1981: 277-88). Defence is further suggested by the report of casemates, rooms 63, 64, and 65 (Dikaios 1969: 70), but the plans do not show embrasures cutting the width of the stone wall; they could only have been cut through the mudbrick, which was not reported to have been preserved at this point.

The city and fortification wall at Sinda: Siri Dash were built at the same time as the second wall was erected at Kition, L Cyp IIIA. It too has been reported to resemble Cyclopean construction, recalling the stonework of Enkomi and Kition, with two rows of large blocks forming the socle, which measures 2.00 m wide (Åström 1972: 41; Karageorghis 1982: 88, 91; Fortin 1981: 193-6; Karageorghis & Demas 1984: 30). From the plans it appears that all blocks have been laid lengthwise.

At the end of L Cyp IIC the site of Maa: Palaiokastro, situated on the south-west coast, was fortified by a so-called Cyclopean wall cutting across the north or landward side of the promontory. The wall, measuring c. 70.00 m long and c. 3.50 m wide, is a double row of large upright slabs separated by a rubble fill, and supporting a mudbrick superstructure. It is not continuous across the neck of the promontory, but rather the west segment overlaps the east part by c. 2.50 m, creating an entrance 4.00 m wide. This is not an isolated feature; the gateway of L Cyp Lara was also constructed by overlapping two wall segments (Fortin 1981: 389). Sometime thereafter, the entrance at Maa: Palaiokastro was blocked and another entrance, 3.60 m wide and axial in plan, was built 20.00 m west of the former entry (Åström 1972 IV IC: 42; *AR* 1980-81: 57; 1986-87: 71; Fortin 1981: 361-78; Karageorghis 1982: 86, 87, 91; 1983: 28; Karageorghis & Demas 1988: 50-52). The wall blocking the earlier entrance is not of uniform width, but is wider where it abuts the east wall than where it joins the west segment, and it is built of very small stones.

Another wall was situated on the seaward side of the site and, like the north wall, it was constructed of two overlapping wall segments. This south wall measures 4.00 m wide and was built with two faces of large unworked stones separated by an inner rubble fill. The blocks used to construct this wall are smaller than those of the north wall, and indeed the fill appears to have used blocks of similar sizes to those of the faces (Åström 1972 IV IC: 42; *AR* 1980-81: 57; 1986-87: 71; Fortin 1981: 527, 528; Karageorghis 1982: 86,

---

[217] From the plans it can be seen that the fortification wall is no wider than the remaining walls of the temples.

87, 91; 1983: 28; Karageorghis & Demas 1988: 50-52). From what is preserved of this wall, it is difficult to discern its masonry technique and therefore a Cyclopean label is difficult to accept; indeed, the inner face appears to have been much more neatly constructed than the outer face, but much of the latter appears to have been water worn. "Cyclopean" is also a misnomer for the north wall, where most blocks have been laid lengthwise, interstice stones are infrequent, and no attention has been given to laying the larger square stones at wall-ends. Moreover, the superstructure of mudbrick presumed for both the north and south walls is not a feature found in the walls of mainland Greece.

The settlement at Korovia: Nitovikla dates to M Cyp III, but was enclosed in L Cyp IIA. The site is not a fortified town, but has been labelled as a fortress (Hult 1983: 15), comprising a rectangular building and open courtyard, surrounded by an enclosure wall. Åström (1972 IV IB: 4-5; IV IC: 34-5) describes the enclosure walls as "broad shell-walls of Cyclopean", built of medium and large sandstone blocks, laid in courses without mortar;[218] however, the north and east walls differ from Cyclopean stonework in that the core is generally comprised of medium size stones. The west wall has been described as constructed throughout of medium size sandstone blocks (Fortin 1981: 157-61).

The walls in trenches F2083 and F2084 at Hala Sultan Tekke have also been interpreted as Cyclopean shell-walls. Other large blocks of Cyclopean size have been noted, but not found *in situ*. The wall in F2083 has a preserved length of c. 4.80 m, a height of c. 0.30 m, and a width of c. 1.30 m. Wall faces are of irregular-shaped limestone and conglomerate blocks, supporting an earth and small stone fill. That in F2084 is similarly constructed, but with a preserved length of c. 2.20 m, a height of c. 0.20 m, and a width of c. 1.20 m. It is suggested that these walls are part of a former defence work (Åström 1983: 107).[219] Not much of the construction has been excavated, and the little that has been uncovered does not appear convincingly Cyclopean; however, until further excavation is undertaken judgment should be reserved.

8.5.2. Fortifications in stonework other than Cyclopean.

At Ayios Sozomenos: Barsak a double enclosure wall of M Cyp III date encircled an area 250 m by 200 m. Both walls extend between either edge of the scarp and are separated by only a few centimetres. The line of the outer wall turns to follow the contour of the plateau. The walls are mudbrick structures set on stone socles, of which only the lowest course has been preserved (Fortin 1981: 41).

Similarly, two walls fortify the south side of M Cyp III-L Cyp I Eylenja: Leondari Vouno; the north, west, and east slopes were naturally defended by precipitous sides. One wall is 24.00 m long and additionally defended by two large rectangular towers. Approximately 26.00 m north of this line is another fortification wall (Fortin 1981: 97-9).

---

[218] Shell-walls are not synonymous with Cyclopean walls, see pp. 72-3.

[219] See also Fortin (1981: 293).

There are also two walls at Krini: Merra which defend the north side of the site, each 2.00 m wide and constructed of uncoursed local limestone blocks of various sizes and believed to have supported a mudbrick superstructure. The distance between the walls varies from 4.00 m in the east to 11.50 m in the west (Fortin 1981: 121-3). The M Cyp site, located on the south side of the Kyrenia mountains, is suggested to have been a refuge site (Karageorghis 1982: 53). This technique of building mudbrick walls on socles of two parallel lines of stone, of which the core and interstices are earth and rubble filled, also appears in the circuit wall at Ayios Sozomenos: Nikolides, Dhali: Kafkalia, Yeri: Phtelia, Eylenja: Nifkia, Episkopi: Bamboula, Karpasha: Stylomenos (Fortin 1981: 46, 52, 91, 105, 328-32, 418), and Lythrangomi: Troulia, although this latter site is reported to use large well-cut orthostat slabs (Fortin 1981: 147-50).

The west wall at Yeri: Vrysi tis Pantelous, dating to M Cyp III-L Cyp I, is a single wall with many stones covering its entire width of 0.80-1.00 m (Fortin 1981: 88), and so differs in construction from the usual double-faced wall and rubble fill.

The L Cyp II fortification wall at Kourion: Bamboula comprises a stone socle, constructed of field stones and rough undressed blocks, founded on bedrock, uncoursed, and fitted together with small chinking stones, and a superstructure of mudbrick. Unlike the walls of Enkomi, Kition, and Sinda: Siri Dash, the fortification wall at Kourion: Bamboula is not reported to have two stone faces; north-west of the tower it only measures 0.90 m wide, being wider in the south-east, 0.75-1.40 m, where it also functioned as a terrace wall (Daniel 1938: 264; Weinberg 1952: 178; 1983: 29-30; Benson 1970: 25-6; Åström 1972 IV IC: 38).

At Pyla: Kokkinokremos the fortification and rooms built up against it[220] were constructed as an integrated system. The wall has been exposed in two excavated areas and is composed of a low socle of two rows of undressed rectangular-shaped calcarenite, limestone, and conglomerate blocks, supporting a presumed mudbrick superstructure (Fortin 1981: 311; Karageorghis & Demas 1984: 23, 29). Parts of the enclosure are considered to be of shell-wall construction, that in contact with Complexes A, B, and C, and casemates are reported along the west (Fortin 1981: 317; Karageorghis & Demas 1984: 23). The width of the east wall measures 0.60-0.70 m, but is much wider along the west side of the site (Karageorghis & Demas 1984: 23); however, no where does the boundary wall appear much wider than walls of the complexes.

Idalion[221] was fortified first in L Cyp IIIA, with a mudbrick wall set on flat limestone blocks, 0.20-0.30 m long and arranged in courses. The wall has a total width of 1.60-2.00 m, each face measuring 0.40 m. In L Cyp IIIB a new wall was built, measuring 1.40-1.75 m wide and preserved to heights of 0.50-2.50 m. This later wall was also a mudbrick structure set on a stone foundation, but the stones of the faces were more

---

[220] Karageorghis & Demas (1984: 24, 31) call these casemates, but for reasons cited above, pp. 70 f., these should be viewed as a form of compartment construction.

[221] Also known as Dhali: Ambeleri.

regular, some being roughly dressed, and corners were constructed in header-and-stretcher technique (Åström 1972 IV IC: 35; Fortin 1981: 74). The wall continued to be used in the succeeding L Cyp IIIC phase, with modifications to its gateways; the two west gates were blocked, the north gate made narrower, and a postern gate added (Fortin 1981: 76-9).

Other fortifications have been noted at Eylenja: Kafzin, Dhikomo: Orisia, Dhikomo: Pamboulos, Bellapais: Kapa Kaya, Ayios Thyrsos: Vikla, Rizokarpaso: Syla, Asomatos: Patemata, and Sinda: Harman Tepe (Fortin 1981: 103, 113, 115, 126, 183, 187, 208, 413); however, either their preservation is poor and/or little has been reported on them.

8.5.3. Discussion.

It would appear that the term Cyclopean has been applied to Cypriot walls to convey nothing more than the size of blocks. In most instances, two stone walls are laid parallel to one another and separated by a rubble fill, and infrequently interstice stones are used; however, the mudbrick superstructures at all sites, the use of compartments at Enkomi, Kition, and Pyla: Kokkinokremos, the so-called shell-wall construction of Korovia: Nitovikla, Hala Sultan Tekke, and Pyla: Kokkinokremos, and the use of massive stones cutting the width of the wall at Kition do not suggest a mainland Cyclopean technique. Rather the earlier M Cyp III-L Cyp I fortifications foreshadow the L Cyp IIC building technique;[222] they have low socles of two rows of local limestone or sandstone separated by an earth and rubble fill, except Yeri: Vrysi tis Pantelous, as noted above. The only real changes in the stonework of L Cyp IIC are the use of much larger building stones, which are more consistently placed in the outer face while smaller stones are used for the inner face (Fortin 1981: 537-8), the addition of casemates, and an increase in wall width; the average wall width is only 1.00-1.30 m (Fortin 1981: 523), comparatively less than the widths of the L Cyp III fortifications.

8.6. Syria-Palestine and the Transjordan

8.6.1. Reported Cyclopean walls.

Fortifications of Syria-Palestine and the Transjordan can be divided into two groups: rampart construction and wall-and-glacis systems. A rampart is an earthen structure with a stone, brick, and earth core, sloped on both sides and topped by a free-standing wall, generally of mudbrick. On the other hand, the line of the glacis of wall-and-glacis construction slopes on the outer side only, from the top of the mound out to ground level. Often the lower slopes of the rampart or glacis were reinforced with retaining walls, described at Tel Yarmut as Cyclopean, as have the lower courses of several mudbrick walls, for example Shechem.

---

[222] This is in contrast to Fortin (1981: 553) who believes that the later L Cyp IIC walls bear little resemblance to the M Cyp II-L Cyp I walls, and to Karageorghis (1989: 94) who writes: "The prototype may be found in Hittite Anatolia from where the Mycenaeans borrowed this element of defensive architecture probably via Miletus, and we find it in Cyprus and elsewhere. In Cyprus, where there was no such tradition in earlier periods, the 'Cyclopean' walls may have been introduced from the Aegean."

The early fortification wall at Shechem,[223] wall A, has been reported as Cyclopean (Wright 1957: 14; Albright 1960: 88; Mazar 1968: 91-2; Aharoni 1982: 100; Ussishkin 1989: 42). However, apart from the use of large blocks and interstice stones, the construction bears little resemblance to a true Cyclopean technique; the wall is not composed of two distinct faces separated by an internal fill, but rather the stones are laid in courses, with chinking stones larger than those of the mainland, and well-packed with much earth. The wall was also strengthened by the addition of a glacis and thereafter by a second wall, B2, which cut into the slope of the glacis. The intervening space between walls A and B2 was divided by crosswalls, used to help support the fill. In the succeeding phase, wall B2 was rebuilt as B1 and a postern gate added (Wright 1957: 15, 16-7; Toombs & Wright: 3-11; Dever 1974: 31-40).

There seems to be little agreement whether the fortification system was conceived and built in a single operation or was the result of several modifications to an existing structure. Albright (1960: 88) notes that "an older sloping wall" stood behind the "great battered wall." Wright (1957: 15) also believes in distinct dates for the erection of walls A and B, with wall B increasing the strength of the fortification in the later part of MB IIC. On the other hand, Ussishkin (1989: 49) argues that the system was planned and executed as one unit. If this were the case, the crosswalls and glacis would certainly distinguish it from mainland Greek fortifications.

The final plan and construction of the wall at Jericho[224] is said to resemble that at Shechem (Kempinski 1992: 199), having evolved through many phases of rebuilding. The initial EBA wall, consisting of a foundation of one stone course set in a shallow trench that supported a mudbrick superstructure, was rebuilt in the succeeding two phases, B and C, was strengthened by an additional wall in phase D, the whole of which was rebuilt in phase E, was widened in phase F and G, and was again rebuilt in phases H and J. Another wall, wall K, was built 8.00 m downslope from that wall built in phase J. The end result was a fortification system where a stone wall and crosswalls supported a glacis, above which stood a free-standing brick wall measuring 2.00-2.80 m wide (Kaplan 1975: 6; Kenyon 1981: 97-101, 373-4; Ussishkin 1989: 41). "Cyclopean boulders" are reported to have been used for the base of the revetment wall (Kempinski 1992: 199), however, here the term refers to nothing more than the size of the stones. Of the walls of Jericho and Shechem Albright (1960: 88) writes:

> The masonry of these walls was of the polygonal type known as cyclopean, in which great boulders of irregular outlines were fitted to one another and the chinks were filled in with small stones, after which the outside face was roughly hammer-dressed.

---

[223] Shechem = Tel Balatah.

[224] Jericho = Tell el-Sultan.

But there is no sign that Cyclopean walls were ever hammer-dressed once assembled; the shaping of Cyclopean boulders was reserved for the corners and points of termination of walls.

The fortification system of Tel Yarmut is like that of Shechem and Jericho, originally consisting of an inner city wall which was then enlarged and covered by an earthen glacis. In the succeeding construction phase, an outer city wall was erected. It is this phase IIA wall, wall B, that has been characterised as having been constructed of Cyclopean masonry. It retained a fill of medium and large stones which were piled against either a natural slope or a glacis that had been cut by the foundation trenches of the wall. Where it could not be built as a retaining wall, it was built as a free-standing structure (Aharoni 1982: 59; Pommerantz 1982: 113; 1984: 195-6; 1988-89: 187; *RB* 1985: 395-7; De Miroschedji 1988: 225; 1990: 52-7). It was built of stones with height and widths averaging 0.60 m, and lengths not exceeding 2.60 m (De Miroschedji 1990: 57; pers. comm.). Corners and wall-ends of roughly shaped blocks laid in header-and-stretcher construction and characteristic of Cyclopean stonework are not regular features at Tel Yarmut; only one example of header-and-stretcher construction has been noted, in the ends of the walls which form the indirect entrance (pers. comm.). In addition, the stone fill of the wall at Tel Yarmut differs from the mainland walls, which generally have earth and small stone fills. Furthermore, the abundant use of interstice stones in the Tel Yarmut wall is uncharacteristic of Cyclopean proper: although chinking stones do occur in the mainland walls, to fill the spaces between blocks and secure against slight shifts of ground movement and structural settlement, the blocks of the mainland walls were much more tightly fitted, appearing more solid and monumental. Perhaps less care was taken to fit the blocks together at Tel Yarmut because the entire length of the outer wall was covered over with a thick layer of lime plaster, and so a smooth monumental appearance was indeed effected. Such plastering has been reported elsewhere, for example at Tel Akko and Hazor. Indeed, the excavator at Tel Yarmut has noted that the use of "Cyclopean" is a commonplace term used to describe nothing more than a masonry of large undressed stones assembled together with the use of smaller interstice stones (pers. comm.), and the differences in construction demonstrate that this is clearly a misnomer.

A Cyclopean wall is also reported at Gezer, dating to the final stage of the fortifications (Aharoni 1982: 100). This outer wall measured c. 4.00 m wide and has been reported to be preserved up to 6.40 m in height. It was constructed of large roughly dressed stones, secured with small chinking stones, and founded on bedrock (Dever 1986: 9, 13-5). However, stones have been roughly coursed, joints are widely spaced, averaging 5 cm wide, and mud has been used throughout as a mortar (MacAlister 1912: 245). The wall was set into a glacis that was part of the MB II fortification system which included a well-dressed and coursed inner wall, also c. 4.00 m wide (Dever 1986: 29).

The fortification at Tel Akko was begun in MB IIA. The system consisted of a sloping rampart, 3.50-4.00 m wide, founded on bedrock and above which a later mudbrick wall, c. 2.50 m wide and up to 4.00 m high, was erected (Pommerantz 1984: 113, 189-90).

This mudbrick wall was built on top of a stone wall, whose large stones are Cyclopean in size but whose technique is not, and reinforced by a new rampart (Pommerantz 1984: 1).

The excavations at Tell Rumeideh[225] in area H1 revealed an MB IIC wall[226] which the excavator has also called Cyclopean. It was reported as 3.00 m wide with a preserved height of 5.00 m, set on bedrock foundations. In area F large boulders were found and appear to have belonged to the same wall in H1 (Pommerantz 1984: 95; Finkelstein 1988: 48). However, apart from the possible offset in area F (Pommerantz 1984: 95), nothing other than the size of the stones recalls a Cyclopean technique.

Mazar (1968: 92) reports further Cyclopean walls at MBA Bethel[227] and Beth-zur,[228] level V of Beth Shemesh, and levels VIII-VII at Lachish,[229] but again the use of large stones is the only feature shared with Cyclopean masonry.

8.6.2. Fortifications in stonework other than Cyclopean.

The glacis type of fortification begins in the EBA at Tell Ta'annek and Tel el-Far'ah North (Kempinski 1992: 176).[230] Albright (1960: 89) believes that the battered wall and glacis came to Palestine from Asia Minor, being first found at Alalakh and Ras Shamra[231] in North Syria. Most Palestinian fortifications date to the EBA, MBA, or Iron Age, although Dever (1986: 29) does suggest a possible LBA date at Gezer, a rampart was added to the MBA structure at Hazor[232] in late MBA-early LBA (Aharoni 1982: 125), and LBA defences were built after the MBA system was destroyed at the end of the period at Achzib (Prausnitz 1975: 207). In the Transjordan an EB IV fortification is reported at Khirbet Iskander (Richard & Borass 1982-85: 110; Richard 1983-87: 36), fortifications at Tel Safut and the citadel of Amman date to MB IIB-C (Dornemann 1983: 19; Greene, 'Amr et al 1992: 125-8), and a LBA I/II wall, W9, at Tell Abu al-Kharaz may represent a possible enclosure wall (Fischer 1991: 69, 76, 81), as might the EBA wall, W3, at Tell esh-Shuna (Baird & Philip 1992: 71). Most fortification systems were altered by new phases of building or reconstructions, but the usual form is a mudbrick wall with a stone substructure built on an earthen glacis, often retained by a wall or scree of stones at its base. The MB IIA fortifications at Tel Poleg, Tell Burga, and Tell Kabri have wall and glacis systems (Parr 1968: 27; Kochavi et al 1979: 133, 141, 151; Pommerantz & Hurowitz 1988: 59; Kempinski 1992: 166), Tell el-Far'ah and Tell el-Far'ah North also have inner stone walls, glacis constructions, angled at 30° at the former site, and low retaining walls (de Vaux 1955: 573; 1962: 215-6; Parr 1968: 23, 41), and at

---

[225] Tell Rumeideh = Hebron.

[226] The wall was originally dated to EBA (Pommerantz 1984: 95), but since has been redated to the MBA (Pommerantz 1986: 93; Finkelstein 1988: 48).

[227] Also known by the name of the modern village Beitin.

[228] Beth-zur = Khirbet et-Tubeiqah.

[229] Located at Tell ed-Duweir.

[230] Tell el-Far'ah North = Tirzah.

[231] Ras Shamra = Ugarit.

[232] Located on Tell el-Qedeh.

Yavne-Yam[233] the rectangular enclosure was faced with a glacis of a clayey soil, 0.60-0.70 m thick, over which was a cover of 0.50 m of crushed *kurkar* (Kaplan 1975: 6; see p. 80). Ramparts are known from Khirbet el-Umbashi and Sweyhat (Weiss 1994: 125, 139).

The fortification wall at Megiddo was built in two phases. In level XIIIA the wall was built in segments, forming offsets (Kenyon 1969: 55). This suggests that different groups of labourers constructed their sections independently, thereafter joining them together; Ben-Tor (1992: 99) notes that this is similar to the technique used to construct the walls at Jericho. In the succeeding construction phase, XII, the city wall at Megiddo was widened by the addition of a second wall with a mudbrick superstructure (Parr 1968: 25-6; Kenyon 1969: 55; Kempinski 1992: 166). In level XI, the wall was extensively rebuilt and buttressed on its inner face. It was built on the same line as the former wall, but on an earth bank which sloped at a 45° angle (Mazar 1968: 84; Kenyon 1969: 56). Buttresses also occur at Tel Dan,[234] projecting c. 1.50 m out from the c. 4.00 m wide stone and mudbrick wall (Pommerantz 1989-90: 87-8).

The fortification system at Tell Beit Mirsim was also built in several phases. The level G wall, c. 3.25 m wide, was further widened in phase F, and in level E an earthen rampart was surmounted by a sloping wall (Aharoni 1982: 99, 100).

The wall at Ai (et-Tell) was first erected late in EB I, enclosing an area of 27.5 acres, and subsequently strengthened in succeeding phases (Callaway 1965: 28-31; 1969: 10; Ben-Tor 1992: 97). The wall has a 6.00 m width and has been preserved to a height of 7.00 m (Aharoni 1982: 59). It was built of large stones, as at Tel Halif, where large boulders were used to construct the city wall, c. 3.50 m wide, retain fills, and form the base of the EBA glacis (Pommerantz 1983: 38; 1986: 46; Seger 1983-87: 10) and it has been likened to the wall at Shechem (Ussishkin 1989: 42). The site of Ai was uninhabited from the end of the EBA until Iron Age I (Finkelstein 1988: 69).

The fortification at Tel Kinrot is also of EB date. A 14.00 m long section of the wall was located in area A of the site and is believed to have surrounded all sides of the settlement. It was of stone, founded partly on hewn bedrock and partly on a packing of small stones and pebbles, and is suggested to have had a mudbrick superstructure, of which nothing has been preserved. As at Arad, Ai, Megiddo, and Jericho, it has been suggested that the wall was built in sections and as in Megiddo, level XI, where buttresses provide additional support, the wall at Tel Kinrot is not free-standing, but is suggested to have been additionally supported by dry masonry walls and low embankments (Pommerantz 1984: 65, 191; Gonen 1992: 218). Similar defences have been reported at the lower city of Tell Mardikh, consisting of an artificial mudbrick embankment, measuring c. 50.00 m at its base, topped by a wall. At intervals the embankment is secured with stone retaining walls on its inner side (Parr 1968: 33).

---

[233] Yavne-Yam = Minat Rubin.

[234] Tel Dan = Laish.

Tell Ta'annek was first fortified in EBA, with four consecutive phases of construction in this period. In its earliest form, the wall was built of stone with a mudbrick superstructure, c. 4.20 m wide, and had a tower. A second wall was constructed on top of this earlier wall, 3.77 m thick and c. 2.40 m high. In the third phase a massive fill was then heaped up against this wall. Indications of a fourth building period are suggested by the possible location of a gate to the west of the tower (Lapp 1964: 10-2; 1967: 3, 5, 7, 9, 19; Parr 1968: 42; Ben-Tor 1992: 97). The site was refortified in MB IIC, employing three distinct phases of glacis construction (Lapp 1964: 14-5; 1969: 16).

Arad was first fortified in EB II. The city wall, 2.00-2.50 m wide, was built to enclose the settlement. It is not a continuous wall, but has been constructed in many segments of straight lines, which where joined form wide angles (Aharoni 1982: 62; Callaway 1982: 74). Callaway (1982: 74) likens the technique to that of Ai where wall sections have been offset to each other, and it also recalls the section building of Megiddo and Jericho. No occupation is known after EB II until Iron Age I (Aharoni & Amiran 1964: 145; Finkelstein 1988: 39).

Me'ona appears to have been a free-standing wall, measuring c. 2.80 m thick and built to follow the natural line of the land. Later a terrace wall was constructed north of the wall and the space between the two filled with earth and large stones (Pommerantz & Hurowitz 1988-89: 126-7). Semi-circular towers project from the fortification, similar to those at Arad.

Two systems are known at Tel Qahish. The first is similar to that at Abd[235] and dates to EB I, consisting of stone foundations, with a width 2.50-3.00 m and preserved to a height of 1.00 m. In MBA a new wall, 2.00 m wide, was built directly on top of the earlier wall. On its outer face a glacis of earth and small stones was erected (Pommerantz 1987-88: 106-7).

The system at Tel Shalem also had an inner and outer wall, 4.50 m and 2.80 m thick respectively. The outer wall was built 9.50 m north of the inner wall and on a parallel line to it; the intervening space was filled with debris (Pommerantz 1986: 97; Pommerantz 1988-89: 166).

At Tel Gerisa[236] three fortification systems have been reported. The first wall was mudbrick, measuring 2.20 m in width, preserved to a 1.20 m height, and dates to MB IIA. In front of the wall a glacis with a 20° slope was built. A second wall was built 1.00 m out from the second wall. It too was mudbrick, measuring 1.70 m wide (Pommerantz 1984: 56; Pommerantz & Hurowitz 1988-89: 61). The third wall was also mudbrick, 3.00 m wide, having been constructed on top of the earlier two systems and dates to MB IIB (Kaplan 1975:3; Pommerantz 1984: 56; Pommerantz & Hurowitz 1988-89: 61).

---

[235] See Weiss (1994: 116) for a description of the wall at Abd.

[236] Tel Gerisa = Tell Jerishe.

The MB IIA city wall at Tel Aphek has a uniform width of 1.20 m and was built with stone foundations and mudbrick superstructure (Aharoni 1982: 59; Pommerantz 1983: 3-4).[237] Likewise the walls at Tel 'Erani and Beth Yerah[238] were mudbrick, although much more massive; each measures 8.00 m in width (Aharoni 1982: 58, 59). The mudbrick wall uncovered at Tell el-Hammah may also have been a fortification wall (Pommerantz 1989-90: 135).

Tel Batash[239] was fortified in MB II by a 2.00 m wide wall, preserved to a 3.00 m height, and fronted by a plastered earthen rampart, 2.70 m high, with a 25° slope, extending 5.70 m out (Kelm & Mazar 1981-83: 93, 103; 1982: 5; Pommerantz 1986: 7-8; 1989: 108). Similar to Tell el-Ajjul, Tel Zeror, and Tel Haror[240] the site was not only surrounded by a fortification system but by a moat (Kochavi et al 1979: 160; Aharoni 1982: 102; Kelm & Hazar 1982: 5). A LBA defence wall was also noted in stratum VI, consisting of three stone courses and a mudbrick superstructure, of which one course was preserved (Kelm & Mazar 1982: 9).

The MB IIC city wall at Tel Shiloh was built of large stones and founded on bedrock, and is preserved to 8.00 m high. In Area D, the wall is built with a number of offsets, and a possible inner fortification line was noted to limit the north sector of the tell. The wall was faced with a glacis, 25.00 m long and c. 6.30 m wide, within which another wall was located, c. 2.00 m from the fortification wall. At the foot of the glacis was a retaining wall of large boulders (Pommerantz 1983: 95, 99, 100; Finkelstein 1988: 208-22). Similarly, a brick wall with stone foundations, 3.00 m wide, was protected by a glacis at MB IIA Tel Yoqne'am (Pommerantz 1987-88: 104-5; Pommerantz & Hurowitz 1988-89: 195) and a comparable construction plan was used at Tell en-Nagile.[241] Along the inner face of the north part of the fortification wall at Tel Shiloh a number of rooms were built against the fortification wall, and associated finds have led the excavator to suggest that these were used as storerooms (Finkelstein 1988: 216).

The c. 5.00 m wide fortification wall reported at Tell es-Sa'idiyeh, in area EE, was constructed in compartment technique;[242] mudbrick crosswalls, 1.10 m wide, divide the interior space into compartments but these were filled with brick rubble (Tubb 1988: 44). Similar compartment construction has been noted in the east section of the wall at Hazor (Aharoni 1982: 101; Kempinski 1992: 198), the inner north and east sides of the town

---

[237] An earlier EB wall has been reported lower down the slope (Kochavi et al 1979: 128).

[238] Beth Yerah = Khirbet Kerak.

[239] Tel Batash =Timnah.

[240] Tel Haror = Tell Abu Hureireh = possibly Gerar.

[241] See Kaplan 1975: 4.

[242] The excavator calls this "casemate" construction; however, for reasons cited (pp. 70 f.) the wall has been classified as compartment construction.

wall at Carchemish (Parr 1968: 30; Aharoni 1982: 101),[243] at Qatna (Aharoni 1982: 101), and at Afis (Weiss 1994: 148).

8.6.3. Discussion.

It is easy to see how one can call many of the constructions Cyclopean on the basis of massive unworked boulders and small chinking stones, but the overall building technique renders the label of Cyclopean inappropriate. It is obvious that the wall-and-glacis constructions are something that do not appear on the mainland at all, but even the walls, i.e., foundations of city walls or retaining walls, are not true Cyclopean. In some instances, two distinct faces are not found separated by an internal fill,[244] or where there is a fill it differs little from the faces, using stones of similar size.[245] Some of the walls have widely spaced joints, apply much mud mortar,[246] or have an excessive amount of interstice stones.[247] In other instances crosswalls have been employed, with the spaces thus created being either used as rooms[248] or filled with debris and used to strengthen the construction.[249] In other cases again, lime plaster was used to cover the outer face of the walls.[250] These are all features that do not occur in mainland Cyclopean building, but only in other fortification systems in Syria-Palestine and the Transjordan[251] and in Anatolia.

8.7. Anatolia

8.7.1. Reported Cyclopean walls.

Like the fortifications of Syria-Palestine and the Transjordan, defence walls of Anatolia are sometimes mudbrick walls with stone substructures; however, their compartmentalisation recalls the walls at Enkomi, Kition, and Maa: Palaiokastro on Cyprus, except that in Anatolia the cells have been regularly offset to one another, producing a zig-zag appearance. Elsewhere walls are completely stone built. Large blocks and interstice stones are used, but applied in the constructions differently than on the Greek mainland. In many instances a Cyclopean label is inappropriate: for example, it has been applied to the 7th century BC terrace wall on the acropolis at Sardis (*AR* 1989-90: 96), seeming to indicate nothing more than a stonework of large unworked blocks.

---

[243] Carchemish is located in modern Turkey, being one of the last villages before the Syrian border, but is more commonly referred to in discussions with sites of ancient Syria than Anatolia.

[244] For example, Shechem.

[245] The fill at Tel Yarmut is of medium and large stones.

[246] The so-called Cyclopean wall at Gezer was built with wide joints and used mud mortar.

[247] An abundant number of chinking stones were used in the construction of the outer wall at Tel Yarmut.

[248] At Tel Shiloh a complex of MBA rooms were built up against the city wall in Area F.

[249] Crosswalls were constructed between walls A and B2 at Shechem and in the final stage of fortification building at Jericho.

[250] For example, Tel Yarmut.

[251] For example, compartment building has been noted above at Tell es-Sa'idiyeh, Hazor, Carchemish, and Qatna.

Stretches of Mycenaean walling have been reported at the south-west part of the temple of Athena at the Kalabaktepe at Miletus[252] and, although there is much disagreement over its date and setting on the site, it is suggested to have formed the east-west alignment of a defence structure (Mee 1978: 133-5) and has been compared to the wall at Enkomi and Bogazköy, on the basis of its so-called *Kastenmauer* construction (*AR* 1978-79: 63; 1989-90: 104).

Compartment construction was also used to build the walls of Tilmen Hüyük. The fortification system consists of an inner and outer wall, both built in the compartment construction technique (Alkim 1969: 218; 1973-6: 33-7; RA *AS* 1971: 23; 1973: 63; Sinclair 1990 Vol. IV: 94-6). The inner enclosed only the upper rim of the mound and was of brick set on well-dressed stone foundations with independently constructed units, offset at 20.00-40.00 m (Alkim 1973-6: 33, 34) and reminiscent of mainland unit-building. The outer wall surrounded the entire mound and had three main gateways, on the east, west, and north. The east gate was constructed in two phases, of which the second one has been suggested to have sidewalls constructed in Cyclopean masonry (Alkim 1973-6: 33), but again this refers to the size of the stones only.

Although the substructure of the terraces on the east and west sides of the the north part of Boğazköy and the back wall of the niche in the north-east corner of the Yazilikaya have been reported as Cyclopean (*AS* 1968: 24; Bittel 1970: 73), the walls, including those ringing the plateau of the Büyükkale and running along the south-east edge of the lower city, bear little resemblance to mainland constructions apart from the use of massive stone blocks.[253] Rather, much of the construction is of the compartment technique, where two walls are connected by crosswalls, dividing the interior space into rubble-filled cells. The total wall width measures 8.00-9.00 m (Bittel 1970: 36, 49, 74-6; und. 13).[254] The lower city wall, built during the extensions of the late 14th-early 13th centuries, at the time when the walls on the ridge above the Büyükkaya-deresi in the east and the area of the Yerkapi in the west were also built, was positioned on an earthen rampart, of which the outer slope was plastered (Bittel 1937: 13; und. 12; Parr 968: 37).[255]

Cyclopean masonry has been reported at Alaca Hüyük, occurring on either side of the main gateway (Alkim 1969: 214) and in the walls and vault of the north-west postern gate (Arik 1937: 9). The postern is constructed of large blocks, but interstice stones are less frequent than in the north or south sally-ports of the North-east Extension at Mycenae or in the niches and galleries at Tiryns. Furthermore, the curve of the vault begins immediately above ground level, whereas the mainland vaults spring at a point approximately two-thirds of the height of the passage. Similarities cannot be denied, i.e., the use of large blocks, the corbelled technique, and the use of keystones to cap the

---

[252] Visit in 1994.

[253] See also Burney 1977: 142.

[254] The earlier wall surrounding the Büyükkale is reported to measure 8.00 m (Bittel 1970: 49) and the lower city wall measures 9.00 m (Bittel 1970: 74-6).

[255] Visit in 1994.

roof,[256] and it may indeed be suggested that this type of structure was an Anatolian development; however, it is equally possible that the type may have been conceived independently in both regions, and variations in form support this. Only the south sally-port at Mycenae and the niche on the right of the entrance to the Lower Citadel at Tiryns are capped by keystones; at Mycenae, the north sally-port is of trabeated construction (see p. 121), and the corbelling of the sidewalls of the underground cistern and the galleries at Tiryns meet at a sharp point.

8.7.2. Fortifications in stonework other than Cyclopean.

The wall at Hacilar is one of the earliest reported fortification walls, dating in its earliest phase to the second half of the sixth millennium. At this time the wall was a mudbrick structure, 1.50-3.00 m thick, without stone foundations. In the succeeding phase, early Chalcolithic, the wall was rebuilt on a different plan, being that of a fortress, incorporating a larger area and serving as the rear wall for the houses built against it. In places, the walls measure 4.00 m (Alkim 1969: 70; Mellaart 1970: 25, 77; Yakar 1991: 156).

The earliest fortification at Mersin: Yümüktepe, c. 4000 BC, was a brick structure, c. 1.50 m wide, with a stepped stone foundation set on a steep revetment wall (Garstang 1953: 237-40; Parr 1968: 38; Yakar 1991: 132-5). The wall was a true casemate wall, compartmented by crosswalls, and arrowslits have been reported (Yakar 1991: 135).[257]

The walls at Troy were built in successive stages, allowing for the expansion of the settlement and strengthening of the fortification system. The earliest wall dates to c. 3000 BC and is a free-standing stone wall, c. 2.50 m thick and built on bedrock, with a 60° batter, which is also characteristic of the succeeding walls at Troy.[258] A new fortification wall, of mudbrick on stone foundations, was built 6.00 m out from the earlier wall. This was replaced by another mudbrick wall built 2.50-5.00 m out from the previous wall and set on an earth and clay embankment (Blegen 1963: 43-6; Parr 1968: 38). Three successive fortifications were built during Troy II, each with a stone foundation and brick superstructure, built increasingly further out and enlarging the available building space (Blegen 1963: 59-62). Troy VI also had three successive fortified phases, each with carefully dressed surfaces, employing the distinctive vertical offsets of this period (Blegen 1963: 100, 111-6; Alkim 1969: 146). As the wall of Troy VIIA dates to the LBA it is most often compared with the mainland structures, being solidly built but not as well-

---

[256] Indeed the keystones are not as neatly positioned as those in the vaults of the mainland; in places more than one stone is used to close the space. A corbelled vault, roofed with keystones, has also been noted in the underground construction at Hüyük Tepe (Alkim 1973-6: 51-2).

[257] The wall at Poliochni II-IV on Lemnos was also a true casemate construction; arrowslits have been reported (Burney 1977: 123).

[258] Battering also occurs at Maltepe (Sinclair 1989 Vol. III: 362).

constructed as those of Troy VI; Blegen suggests that this was because the wall was possibly built in haste (1963: 149).[259]

Three successive fortifications were built at Arslantepe. In EBA II a wall was built to encircle the previously unfortified settlement, and in EBA III a wall was built at the base of the mound to revet the earlier inner stone wall. In the MBA a Hittite city was established at the top of the mound and enclosed by a city wall (RA *AS* 1984: 208; Sinclair 1989 Vol. III: 13-15).

The fortification at Demirchi Hüyük, in north-west Anatolia, also dates to the EBA. It was a battered mudbrick structure built on stone foundations, further protected by a glacis built against its outer face and a fosse at its foot. The wall was 3.00 m thick and constructed in the compartment technique, where cells were filled with rubble and offset to one another (*AS* 1975: 36; 1979: 192; French 1977: 23-61; 1978: 16; Korfmann 1983: 242; Kull 1988: 76). Other EBA walls have also been noted at Gedikli (Alkim 1969: 94; Sinclair 1990 Vol IV: 97), Çinis (Sinclair 1989 Vol. II: 221), Maltepe (Sinclair 1989 Vol. II: 362), Hakim Tepe (*AS* 1973: 64), Norsuntepe (Sinclair 1987 Vol. I: 71-2), Kurban Hüyük (Sinclair 1990 Vol. IV: 149), Khabuba Kabira (Millard 1991: 197), and a bastion in the south-west part of the EBA site at Tepecik suggests defence (Sinclair 1989 Vol. III: 108). A Chalcolithic-EBA wall has been reported at Tülintepe (Alkim 1973-6: 18; Sinclair 1989 Vol. III: 109) and a Late Chalcolithic-EBA wall at Hassek Hüyük (Alkim 1973-6: 197; Sinclair 1990 Vol. IV: 137).[260] A Late Neolithic enclosure wall is reported at Kuruçay Hüyük (*AS* 1988: 201; Yakar 1991: 168).

A MBA fortification on a stone foundation and rectangular towers are reported at Korucutepe (*AS* 1974: 40; Sinclair 1989 Vol. III: 111), a defence wall, c. 1.80 m thick and towers at Lidar Hüyük (RA *AS* 1980: 226; 1983: 255; Sinclair 1990 Vol. IV: 141), and city walls are reported at Tarsus (Alkim 1969: 83). A MBA town wall, c. 5.00 m wide, encloses a palace at Beycesultan (Mellaart & Lloyd 1965: 3-4, 47) and a recently detected level of MB I date at İmikusagi has produced a fortification (Sinclair 1989 Vol. III: 422).[261] A city wall has been located in squares C20/IV3 and D1/IV3 at Ikiztepe (Alkim & Bilgi 1988: 153-4) and an enclosure wall surrounds an oval courtyard at Karatas-Semayük (Alkim 1969: 117).

The Hittite fortification at at Alishar Hüyük was of compartment construction with units offset to one another forming a zig-zag alignment, except in the north-east, and is similar to the construction technique at Mersin: Yümüktepe VII and V, Tilmen Hüyük (*AS* 1973:

---

[259] Certainly nothing other than the size of some stones and offsets can be compared to the Greek mainland Cyclopean stonework. Although not published as a Cyclopean structure, the Troy VI walls have been reported as Cyclopean in personal communication. Visit in 1994.

[260] Sinclair suggests a Chalcolithic-EBA date for the wall at Tülintepe, but Alkim records an EBA date only. Similarly, Sinclair notes Late Chalcolithic construction at Hassek Hüyük, but Alkim reports an EBA date.

[261] A MBA II wall (12th level) has been reported in *AS* 38 (1988): 198.

63), and Degirmentepe (*AS* 1987: 184).[262] The wall, which followed the contour of the mound, was 5.00-6.00 m wide and of mudbrick, *kerpic* set on stone foundations of large and medium unworked blocks, fitted together with small chinking stones and *kerpic* (Van der Osten 1937: 4; Alkim 1969: 146, 183). A narrow wall was positioned 1.50 m in front of the city wall, and is suggested by the excavator to have been a retaining wall possibly used to support the embankment found immediately in front of the city wall (Van der Osten 1937: 5). Similarly, at Carchemish a mudbrick city wall is supported on an earthen embankment which is in turn supported by a sloping revetment (Sinclair 1990 Vol. IV: 163).

A section of walling at Hüyük Tepe has been suggested to be part of a Hittite fortification (*AS* 1973: 64; Alkim 1973-6: 51). A Hittite city wall also occurs at Kültepe. It has been shown to have been built of large stones set in two parallel rows in the south-west sector, indicative of compartment technique. Near the palace it is preserved to a 3.00 m height (Lloyd 1967: 42; Alkim 1973-6: 42-3). Massive Hittite fortifications also occur at Songrus Hüyük (Sinclair 1990 Vol. IV: 94) and Keferdiz Hüyük (Sinclair 1990 Vol. IV: 94). A city gate at Alalakh, contemporary with the c. 1450 BC palace of Niqme-pa (Sinclair 1990 Vol. IV: 288) suggests a possible defence wall.

8.7.3. Discussion.

The method of fortification construction in Anatolia is similar to the unit-building technique of Gla, where exterior and interior offsets are matched, suggesting that offset walls not only cut through the entire width of the structure, but separate individual boxes from those adjacent. However, at Gla this is not the case: vertical joints do not continue through the width of the wall but are stopped by the wall fill, which is continuous throughout the entire length of the fortification. In Anatolia units are roughly equivalent in size, with offsets occurring at more or less regular intervals, so that the line of the wall assumes a zig-zag course, and the wall is broken into a series of compartments. However, unit-building does not occur elsewhere on the mainland except, as suggested in the Middle Citadel constructions at Tiryns (see pp. 73-4), where the units are not regular and appear to be the result of additions made to an already existing structure, and may reflect groups of labourers working on different sections of the wall. It is difficult to accept that this building technique was influenced by an Anatolian compartment tradition, which is already known in Chalcolithic levels and had matured by the time the Hittite cities were built; unit-building is not widespread and, apart from the use of offset corners, is very different in technique. Moreover, the use of mudbrick and sloping earthen ramparts is not known on the Greek mainland.

8.8. Southern Europe

8.8.1. Reported Cyclopean walls.

Cyclopean masonry was not a style of stonework used in southern Europe, and any application of the term should be understood as referring to the size of the stones used in the construction under discussion. For example, at Borg in-Nadur on Malta, the defence

---

[262] The earlier 18th century wall was also compartmented (Bittel 1970: 49).

wall that blocks the accessible side of the promontory has been described as Cyclopean (Coles & Harding 1979: 193), but from the plan this would seem to refer to the size of the stones only.

In Sardinia and Corsica, *nuraghi*, towers, first appear in the second millennium;[263] to date 6000-7000 of them are known. They average 10.00-12.00 m in diameter[264] with heights up to 15.00 m or more. Although each differs, the general plan is circular with a central chamber roofed by a corbelled vault, side niches, and a staircase that leads up to a second, and sometimes third, storey (Coles & Harding 1979: 421; Balmuth 1984: 25-9). Walls are constructed of rubble without mortar, and have been labelled Cyclopean (Contu 1990: 63; Belli 1992: 235). Balmuth (1984: 29), in discussing the vault construction, further likens the constructions to mainland Greece:

> ... covered passages between the towers that flank the central tower are so reminiscent of stone construction in Mycenaean Greece, that along with the corbelled vaults, these galleries have been considered to be examples of ideas and techniques borrowed from the East Mediterranean.

However, as in the vault of Alaca Hüyük in Anatolia (see above, p. 149), the walls incline immediately at ground level as opposed to the Greek mainland examples where a vault springs at a point two-thirds the height of the passage. Moreover, most of the so-called Cyclopean stonework is coursed, with many rectangular-shaped and well-fitted blocks.

8.8.2. Other reported Cyclopean structures.

At Pantalica in Sicily, "a truly Cyclopean palace (*Anaktoron*) has been excavated" (Coles & Harding 1979: 421), but here the term implies the size of the building as opposed to any construction technique.

8.8.3. Fortifications in stonework other than Cyclopean.

In Sicily an early Copper Age[265] defence wall has been noted at Piano Vento (AR 1986-87: 128) and enclosure walls of Sicily's Castelluccian Culture[266] occur at Branco Grande, Melilli, and Thapsos. At Gaffe a similar enclosure wall has been partly cut into the rock and partly built (*AR* 1986-87: 129). On the island of Ustica, LBA walls have been reported and are preserved in places to a 3.00 m height (Holloway 1991: 36).
At Beltojë, in the district of Shkodër in Albania, a Bronze Age wall has been reported on the south side of the site. It is built of medium size unshaped stones, fitted together with smaller stones (*AR* 1991-2: 71). Similarly, a LBA circuit wall has been identified at Marqëlliç, in the Fier district of Albania (*AR* 1983-4: 109). In addition, at Badhra, in the

---

[263] Coles & Harding provide a c. 1500 date (1979: 193).

[264] Coles & Harding (1979: 421) report a diameter of 10.00 m whereas Balmuth (1984: 25) reports 12.00 m.

[265] Ridgway dates the Copper Age to 2000-1700 BC (*AR* 1979-80: 57).

[266] On the Castelluccian Culture see Holloway (1991: 20).

Saranda area of Albania, a fortification wall, built of unworked stones and assembled without mortar, has been associated with LBA pottery (*AR* 1983-4: 116).

In the former Yugoslavia, southern Serbia, Croatia, and Bosnia, and in parts of central Italy defence relied on a network of hill-forts (Alexander 1972: 94, 97; Coles & Harding 1979: 196, 418, 443).

8.8.4. Discussion.

Nothing in southern Europe can be suggested as a forerunner to developed Cyclopean stonework of mainland Greece and, as demonstrated by the differing plans and masonry technique of the *nuraghi* of Sardinia and Corsica, notable variations occur within regional groups, so that many structures are indeed unique. Large blocks are used to build many structures, but there is no other resemblance to Cyclopean stonework.

8.9. Summary

Defence was certainly a consideration in the Aegean, Near East, and parts of southern Europe, but systems varied between regions: hill-forts were common to Albania and the former Yugoslavia, the distribution of *nuraghi* in Sardinia and Corsica suggest a defensive function (Balmuth 1984: 48), mudbrick walls with stone foundations are known in Cyprus, and wall-and-glacis constructions, ramparts, and mudbrick walls occur in the Near East. Perhaps mudbrick was used because it offered a quicker means for building the fortification walls; with clays readily available less time and effort would be required to fashion, handle, and place bricks in position than it would be to cut and transport massive stones.[267] Similar defensive considerations may explain why the Lower Citadel wall at Tiryns was first built in mudbrick and replaced with stone.

It would seem that Cyclopean masonry is a building style particular to the Greek mainland; the only affinities in technique to the other regions under discussion are block size, use of chinking stones, and some details of vault construction, yet enough differences exist for it to be a distinct type of stonework. In contrast to its wide application on the mainland, its reported use in other areas is minimal: only ten examples have been noted on Crete, of which one is dated to the Geometric period and two are structures other than fortifications; five examples are found in the Cyclades; one example in the Ionian islands; six examples in the Dodecanese, three of which are of Hellenistic date. In the Near East 16% of Syro-Palestinian and Transjordanian sites and 16% of Anatolian sites are reported to have Cyclopean stonework, and 24% of the sites in Cyprus have so-called Cyclopean walls.[268] Nevertheless, outside the mainland Cyclopean is simply used to denote the size of blocks employed in construction and therefore the origins of this masonry must be sought on the mainland.

---

[267] Stone was available, as indicated by foundations and retaining walls, and thus any argument that there was an insufficient supply of stone to build fortifications is unfounded.

[268] Percentages are based on sites discussed in this study.

Chapter 9: Conclusions. The origins of the LH III fortifications.

A total of 132 Cyclopean walls have been reported (see Appendix 5), yet it has been established in Chapter 8 that 47 of these reported sites, found on the Greek islands, the Near East, Cyprus, and Southern Europe, are in fact not Cyclopean. The remaining 85 are those reported from mainland Greece, but not all fit the definition of Cyclopean that has been established in Chapter 2; as with those structures in areas outside the mainland, many of the walls have been labelled as Cyclopean because they use large stones, but show no construction technique similar to a true Cyclopean stonework, and others are so poorly preserved that no architectural classification can be made. This has resulted in only 27 of the reported 85 structures being accepted as Cyclopean.

These 27 walls have been studied typologically for similarities and differences in construction, date, and location in order to determine the origin of the masonry technique. Similar types have been compared to determine if an architectural style is favoured in a certain period or region, and different groups have been contrasted for architectural developments over time. The result is a typology where the structures divide into five distinct groups.

9.1. Wall typology.

9.1.1. Type I (fig. 9.0a.).

This type is generally boulderish in appearance, resulting from the way in which the local blue-grey limestone and conglomerate fractures naturally into uneven, curving lines. Stones are large and crude, being unhewn and more often rounded than blocks used in Types II-V; interstice stones are smaller but equally boulderish. Often there is no attempt to lay the blocks in courses, and the result resembles a mere piling of stones. In all examples, foundations are set on bedrock.

The type is best known from Geraki: Ancient Geronthrae in Laconia, where the circuit wall combines Type I with Type III construction (see below). The north sector of the fortification takes on this boulderish appearance and smaller stones, equally rounded, are used to fill in the chinks. Much of the east wall is similarly built, but here Type III building and modern reconstructions are also apparent (fig. 9.2.). In several sections, blocks appear to have been reassembled, possibly in response to a deterioration or collapse of parts of the wall; elsewhere they serve as foundations for modern walls.[269]

Midea: Palaiokastro also combines the features of Type I and III construction. The west face of the West gate tower is certainly closer to Type I construction, whereas the north-east wall is certainly Type III construction, recalling the stonework at Mycenae (fig. 9.3.). It has been noted that the circuit has been repaired over time (see p. 28), resulting in variations of the masonry technique, yet such differences do not automatically exclude it as a form of Cyclopean stonework, as Scoufopoulos suggests of the south section of the west wall (1971: 55). Rather, the architectural evidence would suggest a date slightly

---

[269] Visit in 1993.

earlier than LH III, or at least in the early part of LH III, for its initial construction, and remodelling and repair thereafter.[270]

The wall at Larymna: Kastri, located on the headland between the two bays of the Larymna harbour in north-east Boeotia, is also of Type I construction; however, it recalls the rough coursing apparent in Type IV (see below). It has been classified as Type I because of its boulderish appearance, and although few interstice stones are used and blocks are more tightly fitted in the well-preserved north-west sector than at Geraki: Ancient Geronthrae, it does indeed bear closest resemblance to the stonework of Type I. Remains of the wall can be traced about the headland, the best preserved section being on the north-west, but shorter segments are also preserved along the north and north-east; the south is cut by the modern village. Slight differences in construction may in fact be due to some reconstruction, which is not at all surprising considering the amount of ancient and modern day activity at the harbour and settlement, and the rounded shape of boulders may result from the way the conglomerate stone fractures, although a few limestone blocks have also been noted.[271]

The wall at Vari: Kiapha Thiti is also tentatively labelled as Type I construction. Although stones are closely fitted, its overall appearance is boulderish, somewhat like the work at Geraki: Ancient Geronthrae, yet interstice stones are rather angular. Its categorisation is indefinite because it appears in some ways much like the stonework of Type III and may indeed be better categorised as a variant or prototype of the more developed Type III form. However, in *AR* (1988-89: 19) the wall is described as "all but cyclopean".

9.1.1.i. <u>Location</u> (see table 9.1.).
Type I masonry is not geographically specific and the number of sites using this stonework is relatively small, comprising 14.8% of the total accepted Cyclopean sites: Argolid (1),[272] Attica (1), Boeotia (1), and Laconia (1).

---

[270] Visit in 1993.

[271] Visit in 1993.

[272] Enclosed numbers refer to the number of sites within the given area (also used in "Location" of Types II-IV).

Type	% of total no. of sites	Location	No. of sites per location
Type I	3.7	Argolid	1
	3.7	Attica	1
	3.7	Boeotia	1
	3.7	Laconia	1
	14.8		4
Type II	11.1	Boeotia	3
	3.7	Thessaly	1
	14.8		4
Type III	3.7	Achaea	1
	7.4	Attica	2
	25.9	Argolid	7
	22.2	Boeotia	6
	7.4	Corinthia	2
	3.7	Laconia	1
	3.7	Phocis	1
	11.1	Thessaly	3
	85.1		23
Type IV	3.7	Argolid	1
	11.1	Boeotia	3
	7.4	Corinthia	2
	22.2		6
Type V	3.7	Corinthia	1

Table 9.1. Geographical Distribution of Types.

9.1.1.ii. Average Dimensions.

Of the Type I sites, an average block size is reported only for Midea: Palaiokastro, being 1.00 m long by 0.80 m wide by 0.90 m high, and is comparable to the average size of a Cyclopean block (see pp. 27 and 70). Those in the circuits at Geraki: Ancient Geronthrae and Larymna: Kastri have been viewed by the author and appear to be of similar size,[273] but those used in the circuit at Vari: Kiapha Thiti cannot be commented on.

9.1.1.iii. Date.

Dating is problematic at Geraki: Ancient Geronthrae as no artifactual evidence is associated with the walls. Hope Simpson and Waterhouse have noted MH sherds at the site, but suggest that the architectural style is Mycenaean (1960: 85-6; 1961: 164, 170-3). Later Hope Simpson and Dickinson (*GAC*: 111) suggest a LH III date, concurred with by Field (1984: 89-90). Conversely, Scoufopoulos suggests a MH date (1971: 65). The Type I stonework does seem to be earlier than Type III; the latter figures prominently in the circuit construction, seemingly used to replace earlier work. Much of the Type I work occurs in lowermost courses of the circuit with either modern reconstructions, Type III stonework, or further Type I construction above it. Yet until artifactual evidence from systematic excavations at Geraki: Ancient Geronthrae produce a firm date, this type is considered earlier than LH III solely on the basis of architectural evidence. On the other hand, Field suggests Vari: Kiapha Thiti was built in LH I-IIB (1984: 140), but offers no evidence for such a date; however, since his 1984 study, the fortification has indeed been reported as a late MH-early LH fortification (*AR* 1988-89: 19) and more recently, associated layers date the wall to LH I-II. However, Type I stonework cannot be considered particular only to a time prior to or early in LH III, as sherds from the West gate at Midea: Palaiokastro suggest a LH IIIB2 and early LH IIIC date (Field 1984: 308) and the work at Larymna: Kastri has been assigned a LH IIIB date, but perhaps the type represents the earliest form of Cyclopean masonry and continued to be used throughout LH III.

9.1.2. Type II (fig. 9.0b.).

Like Type I construction, the Type II wall does not use shaped stones, but stone which appears to cleave naturally into square and rectangular blocks, and fewer interstice stones are used, yet where used they are angular. Blocks are not coursed and their arrangement is rather random. Limestones, commonly local blue-grey varieties, are favoured, although some conglomerates and dolomites have been noted. Bedrock is used for surface foundations.

Although the gates at Gla combine Type II construction with Type IV (see below), only Haliartos provides a clear example of this masonry type (fig. 9.5.). The site is approximately 25 km south of the town of Levadhia, positioned on the acropolis found east of the Thebes-Levadhia highway. The wall is best preserved on the south side of the acropolis, but other segments are still preserved on the north-west and south-west sides,

---

[273] Visits in 1993.

and in places serve as a foundation course for the later Classical stonework. Preserved blocks are large, but appear somewhat smaller than the Cyclopean blocks of Mycenae or Tiryns, except in corners, and generally are rectangular in shape, albeit undressed. Interstice stones are not abundant, but where noted they are usually angular. The wall is substantial, with two faces and fill, and averages a c. 3.00 m thickness; it is preserved to a 2.00 m height (Field 1984: 190).[274]

Ayia Marina, on the south-west corner of the north-east bay of Lake Copaïs and above the junction of two canals, provides another example of Type II construction, but as a result of the sparse remains it can only be provisionally labelled. In 1993 parts of the trace were noted, but much of the remaining masonry is terracing on the south slope (fig. 9.6.). The best preserved section is near the south gate, where it appears that the west side of the gate would have projected further forward than its eastern counterpart, so that the entrance was not of the simple-entry type but a guarded single-entry construction. Here a number of large, unhewn yet square-shaped stones have been assembled and secured by smaller chinking stones. A number of other square-shaped blocks lie downslope, having fallen either from the supposed fortification or from a collapsed terrace wall. Although many blocks appear to be of correct size and dimensions for Cyclopean stonework, a Cyclopean label cannot be distinctly applied. In places, blocks appear rough and unhewn, characteristic of Type III construction, but more commonly they appear like those of Haliartos. On the basis of this similarity with Haliartos, the smaller angular stones noted amongst the larger blocks, which may have once filled interstices, and the construction of the gate, Ayia Marina has been classified as a probable Type II construction.

9.1.2.i. <u>Location</u> (see table 9.1.).

Type II stonework is specific to Boeotia (3), although Ktouri in Thessaly also employs squared blocks. However, here both Type II and Type III stonework are distinct in the wall.

9.1.2.ii. <u>Average Dimensions</u>.

The average block at Gla is smaller than the average Cyclopean stone, measuring 0.75 m long and 0.50 m high.[275] However, blocks used in corners are generally larger and more carefully worked; indeed, many are massive measuring 1.50-2.00 m in length (Wright 1978: 181). Similarly, corner blocks are larger in the north-west corner of the circuit at Haliartos than can be seen elsewhere in the remains of the trace.

The wall at Gla is substantially wider than either of the walls at Haliartos or Ayia Marina, being an average of 6.00 m wide as compared to 3.00 m and c. 2.00 m, respectively. Such a considerable width occurs in all of the sites built in the early part of LH III, generally becoming less favoured for smaller sites in LH IIIB (see below).

---

[274] Visit in 1993.

[275] Wright (1978: 181) notes that the blocks at Gla vary in size with lengths 0.50-1.00 m and heights 0.40-0.60 m. I have reported the average of these dimensions.

9.1.2.iii. Date.

A LH III sherd found in the wall at Haliartos provides a *terminus post quem* for Type II construction (*GAC*: 242). At Gla, pottery from the construction phase has been assigned to the transition between LH IIIA2 and LH IIIB by Iakovidis (1983: 105; Field 1984: 173-86). At Ayia Marina, no artifactual evidence can be associated with the wall, although LH III sherds are reported from the settlement area and Kilian suggests a LH IIIB1 *terminus ante quem* (1988: 133).

9.1.3. Type III (fig.9.0c).

Type III is similar to Type II, but stones are of irregular shapes and chinking stones are common, being small and used to fill in spaces, sometimes aided by earth. Foundations are generally bedrock, but sometimes layers of small stones and/or earth are used to level rough ground. The major citadel sites--Mycenae, Tiryns, Midea, Araxos: Teikhos Dymaion, Athens, and Gla--make extensive use of this type of construction.

The first fortification at Mycenae, constructed no later than LH IIIA2, typifies Type III construction. Two faces were built of large limestone blocks of various sizes, sometimes laid as headers or stretchers, but not in any regular order nor set in courses (fig. 9.7.). Chinking stones were used to fill spaces between stones, and a fill of smaller stones and earth separated the faces.[276] The entire system was founded directly on bedrock. This same masonry style was employed in the succeeding LH IIIB1 fortification and LH IIIB2 North-east Extension, but at this time *plesia* was also used for foundation beds and joints in the faces (Iakovidis 1983: 29, 34).[277]

The LH IIIB terrace walls and bridges are also built in developed Type III stonework; however, the Cyclopean and Epano Phournos tombs provide the earliest example of it at Mycenae, dating to LH IIA (figs. 7.4. and 7.4.). In the *stomion* of both tholos tombs, massive blocks have been fitted together with interstice stones and earth, with little regard for coursing or maintaining an even surface. It is presently impossible to tell if an inner face supported the fill behind the visible outer surface without excavating a portion of the wall, but it would have been structurally unnecessary and an inner face is not known to have been used in the later terrace walls.[278] This, however, is the only difference from the fortification walls.[279]

Two types of construction exist at Tiryns, Type III and Type IV (see below). Although Type III construction is readily apparent in the walls of the first construction phase and parts of the Middle and Lower Citadel fortification, the stonework appears somewhat

---

[276] Visit in 1993.

[277] Sections of the original stonework remain on the south, north, and north-east of the extension; much of the *anastylosis* is along the east.

[278] Hershenson, in her paper for the 95th Annual Meeting of the Archaeological Institute of America, reports that Early Minoan terrace walls had two faces and that "The discovery that a finished interior face was unnecessary on a terrace wall for the purpose of either strength or aesthetics seems not to have been made until MM I at the earliest" (*AJA* 1994: 307).

[279] Visits in 1993.

neater than that at Mycenae, forming relatively smooth faces. The first building period has been assigned an early LH IIIA1 date (Iakovidis 1983: 5, 108). Blocks are large, averaging 0.60-0.70 m heights (Iakovidis 1983: 5), and secured by chinking stones. As with the second and third phases of building at Mycenae, clay was used in joints and in the stone fill. The whole was secured on foundations of bedrock or in trenches cutting through earlier settlement materials (Iakovidis 1983: 5). The Middle Citadel walls are a mixture of small and large limestone blocks of highly irregular shapes, laid without any uniformity, yet at other points the fortification appears neat with many stones having been dressed and massive blocks, with dimensions 1.25 m by 1.20 m, placed at intervals (Iakovidis 1983: 6; fig. 9.8.). For the most part, blocks of the Lower Citadel wall are of variable sizes and shapes, some reaching lengths of 3.25 m and 4.00 m; dressed stones and attention to coursing occur only at offset corners.[280]

A similar technique is argued for the dam located nearby at Nea Tiryns; although not much remains today, it probably was also a Type III construction. The section to the north of the modern road shows large unworked blocks and chinking stones reminiscent of Type III stonework, and large unworked blocks have been noted along the bank and in the river bed.[281]

To the east of Nea Tiryns, on the side of the road leading from Nafplion to Epidhavros, is the Arkadiko bridge, built in Type III construction (fig. 4.5.). The bridge is built of two distinct faces with large, unhewn stones, the majority of which exceed 1.00 m heights, widths, and lengths, and roughly packed with the aid of interstice stones. Each face well exceeds 1.50 m and the total bridge width surpasses 10.00 m, being wider at either end and narrowing towards the middle. The overall appearance is closer to that of the north-east wall of Midea: Palaiokastro, where blocks assume a slightly boulderish appearance (compare with fig. 2.13.); however, the difference compared with the stonework at Mycenae or Tiryns is not distinct enough to assign it to a separate category. On the other hand, the construction of the arch recalls the key-stoned vaults in the south sally-port and underground cistern at Mycenae and the gate niche at Tiryns, dating to LH IIIB2.[282]

The Type III stonework at Midea: Palaiokastro, as noted above (also see fig. 9.3b.), is probably later than the more boulderish Type I masonry found in much of the circuit length and in the West gate and guardhouse.[283] A LH IIIB2 date for the West gate has been supplied by a thick destruction layer found not only in the entrance but generally noted in the west sector of the site as a whole (Demakopoulou 20-4-94). A large Cyclopean wall of similar technique is found to the north and lower down the slope; it appears to be part of the lower terraces excavated in 1993.

---

[280] Visit in 1993.
[281] Visit in 1993.
[282] Visit in 1993.
[283] Visit in 1993.

Similarly, the Type III wall at Araxos: Teikhos Dymaion has been assigned a LH IIIB date (*GAC*: 196; fig. 9.9.). The circuit surrounds the north, west, and east sides of the Araxos promontory; the south was sufficiently protected by a sheer cliff face. Stones are large but of a rough, sometimes rectangular, shape and probably result from local bedding planes. They recall the masonry in the circuit at Gla, where the Type III technique occurs in the stretches of wall running between offsets and wall ends (fig. 6.12.), but Type IV construction is used near and at corners. Yet the overall technique at Araxos: Teikhos Dymaion, of rough uncoursed blocks secured with chinking stones, is characteristic of Type III stonework.[284]

This same technique was used on the complete circuit at Athens, but today this is preserved only below the Temple of Athena Nike, opposite the south-west corner of the Parthenon, behind the Acropolis Museum, and reassembled on one side of the visitor approach to the Acropolis, and indications of the trace have been noted in the north-east in front of the North porch of the Erechtheum (see Iakovidis 1983: 79-82).[285] Terrace IV is also partly visible on the north-west, below the later Turkish building; although it is difficult to confirm its Cyclopean appearance, it does appear that the wall used large unhewn boulders and chinking stones, and was founded on bedrock.[286]

Type III work is not limited to these major centres but appears elsewhere on the Greek mainland. In the Argolid, Type III construction is apparent in the south-west sector at Nea Epidhavros: Vassa, where the circuit is preserved c. 4.00 m high, but appears to have suffered some structural deformation; the wall, set on a protruding socle, is somewhat loosely fitted and inclines slightly backwards (Field 1984: 61). A well preserved section at Prophitis Ilias near Mycenae is found on the north-east slope, stretching c. 30.00 m long, with a 2.50 m height and c. 2.00 m width. The site of Kandia: Kastro has also been provisionally labelled as Type III stonework, on the basis of the photo in Gebauer's 1940 publication. However, the photo is not clear and the location in Gebauer's figure and Field's figure (of which the latter is the same location visited by the author in 1993) do not appear to be the same site,[287] and the location of the wall could not be confirmed during a visit in 1993. Therefore the acceptance of a fortification at Kandia: Kastro is uncertain.

In Boeotia, at Pyrgos and Chaeronea (fig. 9.10.) some of the blocks are square-shaped, but the overall stonework is of the Type III form; many stones are polygonal and

---

[284] Visit in 1993.

[285] I am most grateful to Dr. Christina Vlassopoulou and the Acropolis Museum staff for granting me permission in 1993 to view the remains of the Cyclopean walls. Dr. Vlassopoulou kindly gave me the opportunity to view those sections off-limit to visitors, namely behind the Acropolis Museum, and the chance to explore the Erechtheum.

[286] Visit in 1993.

[287] See Field (1984) for both photographs. It is clear that the chapel in Gebauer's figure is not the same building appearing in Field's figure, unless, of course the chapel was rebuilt some time between 1940 and 1984; I have not been able to locate any information in support of such a possibility.

interstice stones are of various shapes. As with the Type II stones, squared blocks are not hewn, but result from regular cleavage lines in limestone beds from which the stones are obtained; however, the difference here as compared with Type II stonework is a more consistent use of chinking stones.[288] Similarly, in Thessaly, Ano Lekhonia: Nevistiki recalls the masonry found at Pyrgos and Chaeronea, where stones are not necessarily coursed, but many are square-shaped. However, its overall appearance with unhewn blocks and the regular use of interstice stones, is certainly more in line with Type III stonework than the commonly squared stones and angular wedges of Type II construction or the systematic coursed masonry of Type IV.

Thebes and Kastro have also been tentatively labelled Type III constructions on the basis of scant remains and similarities to nearby sites. The Proitides Gate is one of the best preserved sections of the presumed fortification at Thebes (fig.9.11.). There is little on which to firmly establish its character, but the few large blocks and chinking stones that do remain suggest a probable Type III classification;[289] however, elsewhere a mudbrick superstructure is used. At Kastro, a portion of a wall by the chapel of Ayia Paraskevi was noted by Field (1984: 155) and isolated blocks to the north-east were noted by the author during a visit in 1993. Nevertheless, as with Thebes, an insufficient amount has been preserved; yet what does remain shows blocks shaped and fitted similar to those at Pyrgos. On this basis a Type III classification has been assigned, but is tentative at best. Likewise, several large, unhewn boulders and chinking stones which make up the scant remains preserved on the south-east slope of Ayios Vlasis: Ancient Panopeus (fig. 9.12.)[290] and the north-east sector of the wall at Pyrgos Kieriou: Ancient Arne have been classified as Type III structures, although this is a speculative conclusion.

Type III in Phocis is represented by the remains of the circuit at Khryso: Ancient Krisa. Here the stonework is distinctly of large, unhewn boulders carefully fitted with interstice stones. The detached bastion noted by Field cannot be grouped with this type; it appears to be nothing more than a solid mass of piled boulders, none of which rival Cyclopean size.[291]

9.1.3.i. Location (see table 9.1.).

Although the greatest number of sites occur in the Argolid and Boeotia, Type III masonry is not specific to a geographical region. The type is found in 23 of the 27 accepted sites (more than 85%): Achaea (1), Attica (2), Argolid (7), Boeotia (6), Corinthia (2), Laconia (1), Phocis (1), Thessaly (3).

9.1.3.ii. Average Dimensions.

The reported block dimensions of Type III walls conform to the average block size, and many of those at Mycenae, Tiryns, and Nea Epidhavros: Vassa exceed this standard.

---

[288] Visits in 1993.

[289] Visit in 1993.

[290] Visit in 1993.

[291] Visit in 1993.

Where reported, Type III walls are wide. Mycenae, Tiryns, Midea, Araxos: Teikhos Dymaion, Athens, Gla, Thebes, and Khryso: Ancient Krisa have the most substantial widths, averaging more than 5.70 m. Those walls where smaller widths have been reported, Mycenae: Prophitis Ilias, Kandia: Kastro, Chaeronea, Ktouri, and Pyrgos Kieriou: Ancient Arne, were constructed in LH IIIB or later and seem to have ringed less substantial settlements. Although Athens and Khryso: Ancient Krisa are also dated to LH IIIB, the increasing number of smaller sites at this time could be linked to part of an increasing emphasis on defense in later LH III; less effort would be required to enclose a small settlement with a thinner wall.

9.1.3.iii. Date.

Type III masonry is clearly a LH III form, appearing first in the period at Tiryns and Mycenae and manifesting itself over a wide geographical area by LH IIIB; the wall at Vari: Kiapha Thiti is the earliest example of Type III masonry, yet it is not fully developed and may be, as noted above (p. 156), a variant of this later mature form. At Tiryns, it was first used for the fortification of Citadel 1, earlier than that at Mycenae, and continued to be the favoured type for the succeeding citadel walls, although some Type IV construction also occurs in the final phase of the fortification.

The wall at Araxos: Teikhos Dymaion has been suggested by the excavator to be of LH IIIA date (Field 1984: 308) and described as an early form of Cyclopean stonework by Wright (1978: 168). Hope Simpson and Dickinson assign it to LH IIIB (*GAC*: 196; Hope Simpson 1981: 155), yet the frequently used rectangular blocks and the double entrance plan of the north-west gate suggest an architectural link with LH IIIA2-B1 Gla, and thus this earlier date is preferred. Likewise, Thebes has been suggested to have been fortified in LH IIIA (Kilian 1988: 133). On the other hand, the stonework at Isthmia is late LH III. Field suggests that sections Sk and St should be dated to the transitional period between LH IIIB and LH IIIC (1984: 67); however, Sk is architecturally similar to Pe which is argued to be very late, if Mycenaean at all (see below, p. 166-7). The evidence at Midea: Palaiokastro also suggests a late LH III date; LH IIIB2 sherds have been located near the East gate, LH IIIC sherds have been found in a trial trench, also near the East gate, and LH IIIB2 and early LH IIIC sherds are noted from the West gate (Field 1984: 308; *AR* 1989-90: 15). Yet, as noted above (p. 29 and 155), the wall was probably an earlier work, having been reconstructed over time.

Scoufopoulos argues for a LH IIIB date for the wall at Kandia: Kastro (1971: 56); however, as noted above, it is difficult to clearly assess the wall structure. Similarly, Kastro and Ayios Vlasis: Ancient Panopeus are suggested to be of LH III date, but there is insufficient evidence upon which to base a firm conclusion.

The remaining sites that can be clearly dated have been assigned to the LH IIIB period. The Arkadiko bridge near Kazarma should also be considered as a LH IIIB structure, on the basis of architectural similarities with the North-east Extension and bridges of Road 1 at Mycenae (see p. 120).

9.1.4. Type IV (fig. 9.1a.).

As in Type III, the blocks of Type IV are unshaped and wedged together with small stones and earth; however, an attempt is made to lay blocks in courses and interstice stones are often used to maintain such levels. Both limestone and conglomerate are used. Foundations are often bedrock, but as with Type III, may employ a layer of small stones and/or earth to smooth the bedrock surface. The type seems to be a development of Type III masonry, formalising it into distinct courses with a degree of regularity and uniformity. It is most distinct in the LH IIIB2 additions and reconstruction of the fortification at Tiryns, but is also noted in section Sp at Isthmia and the remains of a wall at Perdikaria, although in not nearly as developed a form as at Tiryns.[292]

The Isthmian section and wall at Perdikaria should be classified somewhere between Type III and Type IV. The builders have attempted to course the walls, yet other parts look more like the haphazard type of Type III (fig. 9.13.). Some of the blocks are squared, perhaps hammer-dressed, while others are completely unworked. There is not enough of the remains of Perdikaria to register a satisfactory classification; however, what does remain recalls section Sp of the Isthmian wall, which seems to be a combination of these two typological classes.[293]

The fortification wall at Ayios Ioannis has been tentatively labelled a Type IV structure on the basis of the preserved west section (Field 1984: fig. 66); however, recent roads and the erection of a monument on the site appear to have destroyed what little was preserved. Although, it was difficult to trace the remains during a visit in 1993, the west side being easier to follow than the east, it was apparent that some enclosure wall once existed, as traces of foundations were noted, which seem to follow the contour of the hill. The preserved west sector, noted by Field (1984: 159-60, fig. 66), is neat, showing attempts to lay the blocks in courses and employ some small chinking stones. However, the spacing between blocks is smaller than elsewhere, for instance at Tiryns, and causes one to wonder if the stonework has indeed been reconstructed; therefore, it is only tentatively classified as Type IV.

9.1.4.i. Location (see table 9.1.).

22% of the total accepted Cyclopean sites indicate Type IV construction and include sites in the Argolid (1), Boeotia (3), and Corinthia (2).

9.1.4.ii. Average Dimensions.

The dimensions of Type IV walls are the same as those reported of Type III; blocks conform to the average block size and wall widths are substantial. However, the wall at Ayios Ioannis differs in that it is only c. 2.50 m wide, yet rings an area that is comparable to Athens and Tiryns. Its width may be a consequence of the suggested late LH III defensive measures, as the structure has been dated to LH IIIB, but this is doubtful since the wall at Athens, measuring 6.00 m wide, was also constructed in LH IIIB. It can only

---

[292] Visits in 1993.

[293] Visits in 1993.

be suggested that perhaps measures for defense, although increasingly being perceived as necessary, were not yet perceived to be urgently necessary, so that, although precautions were being taken, displays of wealth as exhibited in monumental fortifications continued to pervade Mycenaean society.

9.1.4.iii. Date.

Type IV masonry occurs later in LH III, found first during the transition between LH IIIA2-B1 at Gla, a date also suggested by sherds at Ayios Ioannis (GAC: 241) and Perdikaria (Blegan 1920: 7; Hope Simpson 1981: 34), and used in the LH IIIB2 Lower Citadel fortificaton at Tiryns, LH IIIB-C work at Isthmia, and as the main method of building at Larymna: Kastri in LH IIIB.

9.1.5. Type V (fig. 9.1b.).

Type V is distinct from the previous four types in that walls are constructed of dressed blocks laid in courses. Chinking stones have been used to maintain and secure these courses, but many appear as small flat slabs. The type is advanced stonework, seemingly late in date. Only one instance of Type V construction has been noted, being section Pe (fig.6.42.), and possibly, although not certainly, section Sk of the wall at Isthmia. As this is a more advanced type of work, moving away from a true Cyclopean style, it is tempting to place it later in date than the foregoing examples.[294] Since section Sp appears to represent an architectural development on Type III and is similar to the late LH IIIB2 stonework at Tiryns, it would seem reasonable to date the Type V work no earlier than Sp, tending towards a LH IIIC or most probably post-Mycenaean date. Indeed, the large square stones and architectural style recall the wall at Goulas on Crete that Evans called Cyclopean, but was thereafter determined to be Hellenistic by the French school. Unfortunately, as no artifactual evidence has in fact been recovered from the wall, dating can only be surmised architecturally. Apart from the pottery found in section Ge, Sk, and St, all pottery presented in the findings was located on the surface or in test trenches sunk near the faces of the wall. Section St offers the most reliable evidence for a Mycenaean date, with sherds found in the wall (Broneer 1966: 349), but sections Ge and Sk have produced less reliable evidence. Mycenaean sherds found in the wall section Ge "come from an accumulation of earth which contained Roman roof tiles and some pieces of Late Roman ware"; it is believed that the interior wall fill was removed during one of the Roman periods (Broneer 1968: 28). Mycenaean sherds were noted in the lowermost stratum of the trench sunk at the south end of section Sk, where small stones of the original fill of the wall were also noted, and in a trench dug along the north face (Broneer 1966: 347-9); "the few sherds found in contact with section Ro were undatable" (Broneer 1966: 351). Of section Pe, which I believe to be Geometric on the basis of its architectural style, Broneer (1966: 351) writes:

---

[294] Visit in 1993.

> There was very little earth close to the wall, and the sherds found on the surface are mostly small pieces of undatable coarse fabrics. Two undecorated pieces might be Mycenaean.

Section Sp is argued to be the "most typically Cyclopean stretch", yet after digging a trench along the face of the wall and a cross trench in the hopes of finding an inner face, Broneer found no Mycenaean sherds; rather, "some Late Roman combed ware" and "small fragments of Hellenistic roof tiles, but not stones or cuttings in stereo from the southeast, inner face" (1966: 351). "In any case there is but slight ceramic evidence for the date of this section" (1966: 352). Bronner also writes (1966: 353):

> To determine the date we are dependent on two factors, the construction of the wall itself and the pottery found in contact with it. The sherds from our trenches are admittedly few; no one would expect to find an abundance of pottery inthe fill of a fortification wall so far removed from a settlement. Only the two areas Sk and St in the plain produced enough pottery to be chronologically important. In both places some classical and some very late sherds were found in the shallow earth above and alongside the two faces of the wall. Two small areas of the interior in which the fill seems to have remained undisturbed yeilded only Mycenaean and some nondescript sherds.

9.1.5.i. Location (see table 9.1.).

Only section Pe and possibly section Sk of the Isthmian wall display Type V construction.

9.1.5.ii. Average Dimensions.

As the function of the Isthmian wall is presently unknown, and the remains are suggested by this author to represent sections of more than one structure, comment on its dimensions must be limited. The blocks used in sections Pe and Sk are Cyclopean in size and the wall width of 4.60-5.75 m can be paralleled at the major citadel centres, yet the building technique differs; blocks are well dressed and tightly fitted with thin rectangular slabs.[295]

9.1.5.iii. Date.

Type V masonry is probably no earlier than LH IIIC and possibly dates much later.

9.1.6. Not classified.

There is another group of mainland structures that have been labelled as 'Cyclopean' on the basis of the large blocks used in their construction, but do not conform to the definition of Cyclopean established herein. For instance, a straight line of walling cutting across the east end of the ridge at Kionia: Ancient Stymphalos has been reported to resemble Cyclopean stonework, although a Mycenaean date is doubtful (Field 1984: 82), yet nothing other than the size of the stones is similar. The arrangement of the blocks is

---

[295] Visit in 1993.

haphazard and interstice stones do not appear to have been used. A similar argument can be made for the preserved inner wall face located in the north-east sector of Thisbe: Palaiokastro; in fact, the lowermost blocks seem to be natural rock and the arrangement of blocks cannot be said to form part of a wall with certainty. Indeed, there is a group of structures that have been called Cyclopean on the basis of the size of stones used in construction, yet have been dated to later ancient times; they include the Hellenistic wall at Khorio: Kastro in Chalki (Hope Simpson & Lazenby 1973: 157), the Geometric temple terrace wall at Prosymna: Argive Heraion (Scoufopoulos 1971: 54), and the Hellenistic wall at Palairos: Kekropoulos, whose position above Greek stonework makes it impossible that it should be Mycenaean (Field 1984: 254-5), and the section of walling at Nestani: Paniyiristra, measuring 10.00 m long by c. 2.00 m high, dated to post-Mycenaean times on the basis of its neater construction and association with later masonry (Field 1984: 85-6). On the other hand, the wall north of the village of Aetos: Ayios Dimitrios and that at Mirou: Peristeria cannot be classified as being of Cyclopean construction; both have been constructed of small stones merely piled together, with little use of interstice stones to secure blocks. Moreover, the compartmentalisation of the latter is not characteristic of Cyclopean masonry (Field 1984: 100-2).

The wall reported by Papadimitriou (1956) on the south-east side of the hill at Ancient Brauron: Ayios Yeoryios is of similar construction. Along the north side stones are generally small and, although larger stones have been used elsewhere, they have been carelessly piled with little regard for placing the largest ones in lowermost courses (Field 1984: 143).[296]

The remains of what has been labelled a defence tower (Field 1984: 25) and fortification wall have been located on the north side of the high hill overlooking the Mesolonghi plain at Ancient Kalydon (*GAC*: 103; Hope Simpson 1981: 96). Although only the lowermost courses are preserved, the remains show dressed stones that have been tightly fitted together. Hope Simpson and Dickinson query a possible late LH date (*GAC*: 103) but Field accepts a probable Mycenaean classification (1984: 252); however, if a Mycenaen date is indeed accepted, this author would speculatively argue for a date very late in LH on the basis of an architectural definition that would fall beyond Type V stonework, but perhaps slightly earlier than the clearly Geometric work found at Argos: Aspis (see below).

A LH date for the wall and tower at Mouriatadha: Elliniko is equally difficult to confirm. A mixture of polygonal, square, and rectangular blocks has been used, although the last shape predominates. The blocks recall those of the Archaic wall at Prosymna: Argive Heraion, and the large, vertical interstice slabs recall the Type V stonework of section <u>Pe</u> and <u>Sk</u> at Isthmia. Although much LH IIIB pottery has been located on the site, the wall should be considered, at earliest, very late in the Late Helladic.

---

[296] Admittedly, the assessment of this structure is based on published photographs (see Papadimitriou 1956: pl. 23a), as the wall has been long covered over with backfill.

None of the walling at Argos: Aspis can be called Cyclopean; rather, much of the stonework is of the polygonal construction favoured in the Geometric period, recalling the masonry at Asine and at the fort north of Gravia. Towards the south there is some stonework of unhewn blocks; yet most stones are of medium size and have been laid as headers, interstice stones are rare and there is no distinct inner face.[297]

It is equally hard to accept that Argos: Larissa was once ringed by a Cyclopean circuit, and there has indeed been much debate over this (see *GAC*: 44; Hope Simpson 1981: 24; Field 1984: 27). Several massive blocks reused in the later Venetian wall, including a threshold and jamb blocks and a possible lintel stone (see Volgraff 1928: figs. 11 & 13), are argued to be Mycenaean, and the original excavator claims to have seen sections of Cyclopean walling. However, foundation courses bear little resemblance to Mycenaean work and therefore do not suggest its reuse, nor could any Cyclopean masonry be perceived by the author on site during a visit in 1993. The jamb and lintel stones are certainly reused blocks, but this is insufficient evidence upon which to base conclusions in favour of a Cyclopean circuit wall. Moreover, although the location on the Larissa affords an excellent view of the plain stretching between Nafplion and Mycenae, taking in Tiryns and Midea, it is exceptionally high: an enormous amount of time and effort would have been required to build a circuit at such a height,[298] and nearby hills would have been more suitable. Although the appearance of massive stones in a structure built mostly of small squarish blocks does imply their reuse from some earlier construction, this need not have been a fortification wall, nor can they be used to establish the masonry type. Likewise, the dating of the wall at Nafplion: Ancient Nauplia is difficult to confirm because of continuous ancient and historical building activity. It too has a commanding view of the harbour and plain stretching northwards from the bay, and massive blocks can indeed be noted throughout the length of the Frankish enclosure wall, but no other indication of a Cyclopean technique can be discerned.[299] Similarly, several large stones comparable in size to Cyclopean blocks have been noted to have been incorporated into a modern terrace wall at Ayios Andreas: Palaiokastro in Thessaly, yet this is insufficient evidence to suggest that the hill was once surrounded by a circuit wall.

Megara has long been considered to have been a fortified site; yet modern building has obscured much of the circuit. Fimmen first reported the wall, and since then isolated blocks of Cyclopean dimensions have been located on the upper parts of the hill (see *GAC*: 73; Field 1984: 144). The position of the site, commanding the coastal plain and valley towards the north-east, and recovered artifacts do not suggest that the site was unimportant, yet there is little evidence of the fortification wall and, as a result, the structure can not be typed.

---

[297] Visit in 1993.

[298] The height of Argos: Larissa is comparable to Midea: Palaiokastro, which is suggested to have taken approximately 14 years to build by manpower or 1.25 years by draught-power).

[299] Visit in 1993.

It is equally difficult to support a Cyclopean label for the wall at Salamis: The Arsenal, as the site is now within the confines of an army base and cannot be approached, and photographs have been taken at a distance and thus provide very little useful information. Field does indeed note some differences in technique:

> The face is more gappy than in better quality Mycenaean fortification walls and the not infrequent interstice-stones are more irregular and rough than usual (Field 1984: 146);

however, this could also be a possible result of structural deformation (see above, p. 27). Therefore, until a thorough investigation can be undertaken, a Cyclopean label must be withheld.

The plausibly late MH/early LH wall at Vasiliko: Malthi has been called Cyclopean (Wright 1978: 163, Iakovidis 1983: 1), yet its construction technique falls outside the definition of Cyclopean. The frequency of rectangular blocks recalls Type II stonework, but the masonry does not suggest an early variant of Cyclopean, as blocks are not very large, none exceeding 1.00 m (Scoufopoulos 1971: 21), and interstice stones are infrequent. Indeed the stonework recalls the upper section of the wall at Tolophon: Mathiou, where blocks, many of rectangular shape, have been fitted with little use of interstice stones.

There are a number of other reported fortification walls that cannot be classified as Cyclopean because of insufficient evidence. Reports of the walls at Pyrgos Kieriou: Makria Magoula and Stephanovikeio: Petra in Thessaly, Dramesi, Khelonokastro, Livadostro, Lophos Vlikha, and Vathy: Nisi in Boeotia, Gyphtokastro: Ancient Pleuron in Aetolia, Iklaina: Traganes, Kalamata: Kastro, and Kambos in Messenia, Pikernis: Gourtsouli in Arcadia, Kakovatos: Nestora in Elis, Korakou and Xerokastelli in Corinthia, Las: Passava in Laconia, and Prophitis Ilias near Tiryns[300] do not contain enough information to obtain a clear understanding of the walls' masonry, and physical evidence is conspicuously lacking. At Thorikos in Attica, Ayios Stephanos and Ayios Vasilios in Laconia, Anthokhorio: Levendi and Sores: Moustaphades-Neokhoraki in Boeotia, and Psakhna: Gliphas in Euboea traces of ancient walling cannot be established as Cyclopean. Claims for a fortification at Dimitra: Troupes in Arcadia rest solely upon a photograph published by the excavator (Syriopoulos 1973: pl. 45d), which shows neat rectangular blocks not fitted in the characteristic Cyclopean manner. Equally, the walls reported at Kato Samikon: Klidi, 70.00 m north of the cemetery and on the hill top (*AR* 1990-91: 32), cannot be confirmed as Cyclopean; there is nothing resembling Cyclopean masonry other than large stones, and associated sherds of MH and early LH date put it too early for well defined Cyclopean work. Similarly, a Cyclopean label for the crosswall noted by Scoufopoulos on the south-east side of the Frankish castle at Mezzapo (Scoufopoulos 1971: 66) is doubtful; although large blocks are used for the inner and outer facings and the intervening space filled with smaller stones, no mention has been made of chinking stones nor associated sherds by which to date the structure. Moreover,

---

[300] Visit in 1993.

the three or four towers reported to project from the line of the wall (Scoufopoulos 1971: 66) are not in keeping with the usual plan of a Mycenaean defence system. Therefore, until the site is investigated, judgement must be reserved.

Likewise, the claimed Mycenaean fort at Mytikas in Boeotia is doubtful. A wall is reported by Field to cut across the cleft in the rock and is preserved three courses high, with an estimated 2.00 m width (Field 1984: 187-8), yet what has been photographed appears to be mostly outcrop and naturally eroded stones. During a visit in 1993, a sort of terrace wall, backed by much loose rubble, was noted two-thirds of the way up the hill, but it appears to be modern and probably was built as a temporary measure to secure the eroding rubble. At the top of the hill, a large heap of rubble with some very large blocks was noted; this may indeed have once been some structure but is today an incomprehensible mass. Finally, no reported evidence which might suggest a date is reported.

Similarly, Kerinthos: Kria Vrisi, Stroviki: Tourloyannes, and Khantsa, also in Boeotia, cannot be confirmed as Cyclopean because of inconclusive evidence. The former site has been reported in Hope Simpson and Dickinson (*GAC*: 269) as Cyclopean, built with the aid of chinking stones, and having a c. 3.00 m thickness, yet the wall has not been since been located (Field 1984: 234) and no photographs of the wall have been published. No evidence exists for a circuit at Stroviki: Tourloyannis, except for its favourable position, overlooking part of the Copaïc system and at a point where a polder of land was recovered for agricultural purposes.[301] On the other hand, Khantsa appears to have once been surrounded by an enclosure wall, possibly Type III, like nearby Pyrgos or Kastro, but more probably a Type IV work, to judge from its closeness to Ayios Ioannis; however, no classification can be made with certainty because of sparse remains. In the south sector of the site, traces of walling were noted by this author and elsewhere grouped or isolated blocks were noted to be of Cyclopean size, yet the recent erection of a electricity pylon and further clearing of the area have made investigations difficult.[302]

Equally difficult to type is the fortification at Stephania: Lekas, Panayiotis in Laconia. The existence of a circuit wall was first suggested by Hope Simpson and Waterhouse (1960: 95) and confirmed by Field (1984: 92-4); however, the building technique cannot be typed, let alone classified as Cyclopean. Much of the structure is buried beneath an earth embankment and until the structure can be investigated, it cannot be called Cyclopean and can only be suggested to be a possible circuit wall.[303]

---

[301] Visit in 1993.

[302] Visit in 1993.

[303] Field did note a heavy wall foundation, c. 2.00 m thick, and the presence of Mycenaean sherds (1984: 93-4), yet this is not enough to establish its Cyclopean character.

Khoni in Boeotia has been likened to Field's road fort at Vristika, being a rectangular form, measuring 25.00 m by 30.00 m.

> On the basis of certain similarities with Vristika, for example--namely those of size, wall thickness, wall coursing and slope technique--Choni was presumed to be Mycenaean (Field 1984: 169).

However, the structure at Vristika bears no resemblance whatsoever to Cyclopean stonework; small to medium size stones have been used in its construction, the walls are no wider than ordinary house walls, and much clay mortar has been used to bind the courses together. Indeed, the stonework is similar to that used in the ruined houses in the village of Stroviki, and thus may be of similar date.[304] It can also be likened to the ruined farm house and pen at the base of the Mytikas hill, where modern cement has been used to smooth the surface of an inner wall of the house.[305] Therefore, there is no reason to suppose that Khoni, any more than Vristika, was ever a Mycenaean structure; there is no supporting sherd evidence, the masonry style does not fit with Bronze Age work, and the locations on the flat are incongruous with other Mycenaean sites.

Of the three circuit walls at Mesopotamos: Xylokastro, only the outermost wall has been suggested to be Mycenaean; the uppermost is a Hellenistic structure and the middle is mostly post-Geometric (Field 1984: 258). However, small to medium stones and its overall construction technique are not of Cyclopean work. Indeed, Field suggests that any Mycenaean association is "marginal" (1984: 260).

Nothing more than a marginal association can be made for the wall at Soules. It is uncertain whether the preserved remains indicate one wall that has been widened over time, or two distinct circuits; regardless, both walls are built mostly of small stones, many of which are rectangular in shape. Isolated blocks of Cyclopean size have been noted, however, a Cyclopean circuit cannot be deduced on this basis (Field 1984: 228-9).

Grouping the foregoing sites as non-classified is not intended to imply that they were unimportant settlements or had only a small function in Mycenaean society, but simply that there is no evidence that they had walls constructed in Cyclopean technique. That the major citadel centres used Cyclopean masonry in fortification building may indicate a shared or similar site function, whereas sites using a different building technique might reflect a local preference, perhaps based on a quality of sufficiency rather than grandeur, and unfortified sites might have had a function altogether distinct from that of the enclosed settlements. What can be deduced from the analysis is that very few fortified sites are in fact built in Cyclopean masonry: only 27 of the 85 reported mainland Cyclopean circuits (32%), or of the total 132 reported circuits from the Mediterranean, Aegean, and Near East (20%), can be confirmed as Cyclopean.

---

[304] Visits in 1993.

[305] Visit in 1993.

9.2. Geographical distribution.

Cyclopean masonry is specifically a mainland building technique, not limited to any particular region, but is more common to the Argolid and Boeotia than elsewhere.

Region	No. of sites
Achaea	1
Argolid	7
Attica	2
Boeotia	10
Corinthia	2
Laconia	1
Phocis	1
Thessaly	3
Total No. of Cyclopean Sites	27

Table 9.2. Site distribution.

Of the 27 accepted sites, all but four Boeotian sites are entirely or partly built in the Type III technique; Ayia Marina and Haliartos are Type II constructions and Ayios Ioannis and Larymna: Kastri employ Type IV stonework, but the latter site also has the boulderish characteristics of Type I work. As the first two sites do not appear to differ in date, their difference in style probably results from the nature of the local rock, where bedding planes, positioned roughly at right angles, cause the rock to split naturally into rectangular shapes. The only other example of Type II stonework is at Ktouri in Thessaly, where it is combined with the Type III technique. This site lies in a region of both hard and poros stone, so that bedding planes are variable depending on the type of stone cleaved. On the other hand, the neater Type IV construction of Ayios Ioannis and Larymna: Kastri would suggest a development of the Type III technique, as at Tiryns, where the stonework becomes more ordered and carefully assembled, and thus a date slightly later than Type III masonry is proposed.

The Argolid, Attica, Boeotia, and Laconia also have evidence of Type I work, yet the number of walls of this type is few and no preferred locality can be deduced. Indeed, by the time Type III is fully developed, the technique is widespread, appearing in Achaea, Attica, Corinthia, Laconia, Phocis, and Thessaly, but predominates in the Argolid and Boeotia. Further development on this style, is only to be found in the Argolid, Corinthia, and Boeotia, and a possible further development, Type V, is confined to Corinthia.

9.3. The origins of the LH III fortifications.

It is difficult to establish the precursor to the LH III fortifications on mainland Greece. Apart from Vari: Kiapha Thiti and possibly Geraki: Ancient Geronthrae, Cyclopean fortifications fall within LH III, and although it has been proposed that these Type I walls may represent the earliest form of Cyclopean fortifications, it cannot be overlooked that Type III stonework was also in use in early Late Helladic, but appearing in the LH IIA Cyclopean and Epano Phournos tholos tombs at Mycenae. However, as with Type II stonework, the remaining Type III structures date to LH III; several date to early LH III, but the type is more common in LH IIIB. Type IV walls also date to the later part of LH III, apart from Gla which has been assigned a LH IIIA2-B1 date for the entire wall, and the one Type V construction dates, at the earliest, to the end of the Late Helladic.

Although contact with the Near East cannot be disputed, the style and technique of fortification building differ sufficiently from those currently known in the Near East to argue that Cyclopean stonework was not a borrowed form. It is often suggested that the technique originated in Hittite Anatolia, being transmitted directly to the mainland or via Cyprus (see Scoufopoulos 1971: 106; Fortin 1984: 471-472). But support for this stems from the acceptance that the state of Ahhiyawa mentioned in some 25 fragmentary Hittite texts refers to Mycenaean Greece (see Gurney 1952: 46-56; Ünal 1991). Gurney (1952: 54) calls attention to the controversy:

> ...the Mycenaeans cannot have failed to come into contact with the Hittites, and the few facts that we can glean from the texts about the people of Ahhiyawa tally very well with what is known of the Mycenaeans. Much depends on the general problem of Hittite political geography, which is still far from an agreed solution.

However, debate over whether Ahhiyawa should be equated with Mycenaean Greece still persists. Scoufopoulos (1971: 46) argues the connection on mythic tradition:

> [Tiryns] was admired by Homer in The Catalogue of Ships and characterised there as the kingdom of Diomedes. Earlier in the tradition there is a quarrel between the two brothers, Akrisios and Proitos, over Argos and the latter is expelled. The exiled Proitos goes to Lycia and there marries the king's daughter. Whe he returns to the Argolid with the backing of the Lycian monarch he gains possession of Tiryns...The subsequent fortification of Tiryns is attributed to the Cyclopes; and for this reason the walls built of huge blocks are often referred to as Cyclopean and are a characteristic of the Mycenaean period. Proitos' return from Lycia and his building of Cyclopean fortifications suggests and supports an eastern origin of this building technique.

Yet the fortifications of Anatolia differ significantly in form and building technique from those on the Greek mainland. Gates follow the compartment technique of the fortification walls and are gates of depth, generally built as two-entrance types. Likewise, towers are compartmented and rubble filled. Details of building stone, its shape and dressing to fit in available spaces and corners, and the infrequent use of interstice stones differ significantly from the mostly unshaped blocks and regular use of chinking stones, and the header-and stretcher corner technique of Mycenaean constructions. It could be suggested that the unit-building at Gla may have been inspired by Hittite walls, thereafter being adopted and modified elsewhere on the mainland, but this does not explain differences with the circuits at Mycenae and Tiryns, nor the similarities to the already existing circuits at Vari: Kiapha Thiti or Geraki: Ancient Geronthrae. Moreover, the theory does not explain the very different construction at Troy, which the evidence for international contact would suggest to be a plausible site for the transmission of ideas and techniques. The argument that Troy VI may have flourished because of its advantageous position on the Dardanelles, enabling it to control trade and exact levies on foreign traders, is persuasive, but this does not necessarily suggest that Mycenaean traders returned to Greece bringing with them new methods of building. The very different techniques evident in the Trojan walls--a battered wall, regular and stylistic use of false offsets, and coursed stonework of rectangular and shaped blocks--show no likeness to the Mycenaean works.[306]

Fortin accepts the Hittite and Mycenaean architectural connection proposed by Scoufopoulos and goes on to further the theory by arguing that Cyclopean masonry originates in Hittite Anatolia and makes its way to Cyprus via Greece.

> ...these Cyclopean city walls were not designed and engineered by the people of Cyprus alone. They had never used such a technique before...They were obviously helped by foreigners, most likely Mycenaeans, whose presence on the island is asserted by a fairly good body of evidence, but the original design apparently came from Anatolia at the same time it reached Greece, presumably by way of Miletus (1981: 553).

The argument is also accepted by Karageorghis (1990: 28). However, this relation of Cypriot to Hittite architecture again relies on the transmission of the style from Anatolia to Greece, for which there is very little substantiated evidence.

Arguments for the transmission of architectural techniques from Crete to the mainland and from Melos: Phylakopi to the mainland are equally problematic. Those structures in Crete suggested to have been built in a Cyclopean technique differ from a true Cyclopean style; in some cases a large proportion of the stones in the walls are laid as headers, elsewhere blocks are dressed into rectangular shapes, and in other places stones are smaller than the average size of a Cyclopean block. In east Crete, buildings are built in a common style: the preferred form for administrative centres is a masonry of large rectangular blocks of white limestone, and for guard posts large irregular-shaped blocks of grey limestone (Tzedakis et al 1989: 63). The technique of wall construction at Melos:

---

[306] Visit in 1994.

Phylakopi differs significantly from the more homogeneous building technique of the other Cycladic fortifications and would seem to be closer to a mainland style, and the earlier fortification wall at Melos: Phylakopi, wall 661, is closer to a true Cyclopean stonework than the later city wall. It has large unworked boulders arranged with little regard for coursing, except in corners, yet differences, such as the exceptionally frequent use of small stones to surround large blocks and the significant amount of clay, distinguish it from mainland work. Rather, the evidence seems to suggest that the Cyclopean technique was a style specific to and originating on mainland Greece.

Although the EH wall at Lerna is the earliest example of a mainland fortification built with an inner and outer face, and the plausibly late MH/early LH wall at Vasiliko: Malthi is the first mainland example of large blocks used in circuit construction, the first use of a double face of massive irregular blocks secured by interstice stones, separated by a fill and forming a fortification wall of substantial width does not occur until LH III. It has been said of the EH and MH sites that

> The walls enclosing them were low and thin, made of rubble, and totally incapable of withstanding determined and sustained attacks, and throughout their entire life there is no sign of any substantial modification in either the internal plan or the construction methods employed in them. These settlements, that is to say, did not exhibit any evolution (Iakovidis 1983: 1).

And yet, the origins of Cyclopean masonry cannot be determined from these later circuit walls themselves; generally, the method of construction is similar and there is no difference in block size between types. Nor can stone size be considered to be a variation based on date, as block size is similar and the majority of Cyclopean circuits date within LH III. Therefore, perhaps the origins should be sought in structures other than fortifications.

If Cyclopean masonry is understood as being a technique first devised to convey grandeur, its earliest appearance in the tholos tombs at Mycenae is acceptable. The style appears to have originated in the Argolid, in the LH IIA tholos tombs at Mycenae, yet may have formed structures that were rebuilt, as suggested of the Mycenaean bridges (see pp. 104 and 127), or that have long since been destroyed. Likewise, the destruction of Grave Circle B's wall, suggested by Mylonas (1966: 98) to be built in a "primitive Cyclopean" technique, makes it difficult to confirm because of insufficient remains. What can be reconstructed from notes and photographs seems to suggest that only the block size is similar; the setting of stones erect and levelling of the first course with smaller stones and clay does not seem to be a common practice. "Of its circular wall only a small segment and a few stones" were visible when Mylonas published his investigations (1966: 97). "A good deal of the eastern side was destroyed in Late Helladic IIIB times when the so-called Tomb of Klytemnestra was constructed" and

> a good part of the western section of the circular wall was destroyed [possibly] when the modern road to the citadel was constructed...The southern half of the circular wall, standing on the slope, apparently collapsed at an early period and only very few of its stones can be detected below the slope to the south. As a matter of fact, its southwestern arc must have been ruined before the Historic Era had set in since a Geometric round structure was found built over that area. At the southeast section we have only the three blocks that revealed the existence of a circle (Mylonas 1966: 97).

Regardless, the style of the stonework in monumental structures, whose basic function could have been achieved in a technique that demanded less effort, indicates that it was conceived out of a desire for a conspicuous display of wealth. However, as suggested by the rise in the number of fortified sites in LH IIIB, such exhibited wealth would have invited hostilities.

In the fortification walls, Cyclopean masonry appears first in LH IIIA1 and 2, in the walls at Tiryns and Mycenae, respectively, and other circuit walls that have been simply dated to LH III, such as Thebes, might be equally dated early in this period. Although reported sherds date sections of the wall at Midea: Palaiokastro to LH IIIB2, earlier material is known from the site and the Type I masonry would suggest that the site is also part of this earlier citadel group. These earlier fortifications are also the longest circuits, enclosing larger areas than those built in LH IIIB. Moreover, they show evidence of greater attention to readily visible areas, such as gates, than do the later structures; this later group does not seem to have had additional ashlar facades, elaborate gates, nor architectural embellishments and thus, coupled with a smaller area to enclose, required the expenditure of less effort in terms of labour and time. What this implies is that the proportionately greater number of fortifications built in LH IIIB marks a defensive response, perhaps partly precipitated by the display of wealth and power by the larger citadel centres and increased national and international contacts, both of which would have invited hostilities. It has been already observed that wall widths are more often reduced in the later circuits (p. 22), and it is also in the later part of LH IIIB that the extensions at Mycenae and Tiryns were built to enclose a greater area and to protect valuable water resources.

Unfortunately, Geraki: Ancient Geronthrae and Vari: Kiapha Thiti do not fit this hypothesis. The Type I walling at Geraki: Ancient Geronthrae could be explained as terracing, as it appears only on the north side of the site where some sort of artificial terracing would be needed to support structures built on this side of the hill, and the Type III stonework as part of a defensive programme built in the LH III period; however, the suggestion that this site is the only fortified site in this area begs further questioning. It must be recalled that of 85 reported Cyclopean walls on mainland Greece, only 27 have been accepted in this study as true Cyclopean; but there is a distinct possibility that those sites rejected as Cyclopean because of insufficient evidence or poor preservation may indeed have once been ringed by a Cyclopean circuit wall. In the case of Laconia, Geraki: Ancient Geronthrae may have formed part of a system with Ayios Stephanos and Ayios Vasilios, or alternatively have been defending itself from them. On the other hand, the classification of Vari: Kiapha Thiti is uncertain (see p. 156). Nevertheless, it is certain that Cyclopean masonry is a style of stonework specific to mainland Greece, being distributed over a wide area but predominating in the Argolid and Boeotia.

The preferred site for a major Mycenaean settlement was a hill of considerable height, although positioned near to or adjoining higher ground, with the so-called palace or chief residential complex built on the highest point of the settlement area. The area was enclosed by massive fortification walls, built in Cyclopean masonry, that traced the outer line of the summit and which, in some instances, enclosed an area that exceeded practical needs. For instance, at Gla in Boeotia, only one-third of the enclosed space seems to have been utilised. Moreover, the circuit walls themselves well exceed the limits of defence. On average, fortifications are 5.00 m wide and preserved to 8.00 m in height. They do not make use of embrasures, apart possibly from the Lower Citadel wall at Tiryns, and therefore defendants could only have protected the site against an enemy by positioning themselves on top of the walls, consequently exposing themselves to missiles. It is possible that a parapet once existed, perhaps built of mudbrick, but is no longer preserved; certainly, once the walls were built they were not only a means to display wealth, but served as protection. Yet the projects required a substantial amount of effort; quarrying, transporting, and raising blocks that weigh close to two tons or more, would have demanded a large number of labourers and many working hours and suggests that the fortifications were not initially built as a response to an immediate defensive need.

The Late Helladic site distribution, concentrating in the Argolid and Boeotia, suggests that settlements were selected in relation to agricultural practices rather than for defence. An early change would have occurred with a movement in the Middle Helladic from low-lying coastal sites to hill sites, effecting a shift to agrarian practices. Only 19% of the sites in this study are coastal, and thus their locations were likely selected because of their function. For instance, in Boeotia, sites ring the Copaïc plain, likely having been selected because of their proximal locations to the drainage works and functions in the system. Each site has been placed at a point commanding a view over the Copaïs which was otherwise shut off from other sites in the plain. Moreover, sites were positioned to take advantage of the land passages and trade routes, and agricultural lands, and to make necessary repairs to parts of the system, and the draining of Lake Copaïs, to retrieve the fertile plains, would have required an enormous amount of labour to build and maintain the drainage system. Equally, the construction of the dam east of the acropolis of Tiryns would have demanded a large investment of time, labour, and cooperation, and suggests a level of organisation and instruction, but what is not known is who delegated the authority and trained the workers.

Not only did a level of cooperation exist within the community but, as suggested by drainage and road projects, between neighbouring settlements over an extended period of time. It seems that more than twelve settlements participated in the drainage of Lake Copaïs and the upkeep of the system, and profited in the agrarian activities as a result of the recovered lands. And roads radiating out from Mycenae leading to Prosymna, Berbati, and possibly as far north as Corinth, and the bridge at Kazarma and four others within the vicinity provided connections between various settlements and could not have been built if tensions were rife.

This further suggests a degree of interaction between communities where communication was possible for economic reasons or perhaps because of kinship ties. The evidence in Boeotia suggests a strong economic relationship tied to the production and distribution of grain, resulting in the conspicuous display of this wealth. Gla with its granaries, immense space, and central location amongst the reclaimed lands, appears to have been the central point for collection, and possibly distribution of grain. Its conspicuous place in the plain and position to oversee the surrounding land, its massive 3 km Cyclopean fortification with monumental gateways, and the palatial/residential complex situated on the highest point of the acropolis argue for its importance within the system. Kinship relations, whether the result of members moving out of a pressured population to establish new communities or the consequence of marriage ties, may also have been partly responsible for cooperative efforts between various communities or states; however, this is conjecture and admittedly cannot be substantiated on the basis of the architectural remains.

Regardless of the intensity of site interaction, there does seem to be a degree of competition in statements of power and wealth. Mycenae proves to be the best example of this because of the amount of preserved evidence, resulting from extensive investigations of the citadel and surrounding area. All architecture viewed on approach to the citadel was monumental: outer faces of bridges were constructed of massive, often hammer-dressed stones, with arches corbelled to neat points; terrace walls were built with the largest available stones; the citadel walls, elevated on the acropolis, were equally massive, conveying the impression of impregnability, which is further emphasised at entrances with neat arrangement of large ashlar blocks. Today, approaching Mycenae from the east along Road 1, one is still impressed by the massive citadel walls and truly monumental North Gate, and from Road 4, by the massive stone course of the Ayios Yeoryios bridge, the monumental facade of the Treasury of Atreus on the left, and the citadel walls and Lion Gate in front. But this is not an isolated example; other Late Helladic sites were enclosed by massive Cyclopean walls with monumental entrances. The cooperative efforts that enabled fortifications, drainage projects, roads, tholos tombs, and massive terrace walls are not suggestive of immediate defensive measures; rather, the time and effort required to build these structures suggest power and prosperity. Furthermore, these works inform us of the level of engineering competence. Quarrying, transporting, and laying stones, some in excess of 100 tons, were achieved by builders. Roads, where attention was given to maintaining dry surfaces and low gradients, and bridges that crossed depressions in the land suggest wheeled vehicles; wet surfaces and relatively steep slopes would not prohibit the movement of people on foot.

With the collapse of the Mycenaean society, monumental projects were no longer undertaken. If it is accepted that such projects were carried out by local populations, were they over-extending themselves and consequently affecting resources? Or, if it is accepted that specialised masons and labourers were employed, could the economies no longer afford to sustain such workers? Certainly the projects would have affected the population, demanding many workers, yet at present there is insufficient evidence to determine the population of the Mycenaean states and the stress that such projects would place on the community.

Appendix 1. Ropes and Pulleys

Ropes were certainly used to transport stones, either as leads attached to sledges or as lashes about the stone securing it to the transport vehicle. Near Eastern tomb paintings depict massive stone sculptures secured on sledge and transported by teams of men hauling ropes. Four teams of men are shown to pull the alabaster statue of Djehutihetep in a 12th Dynasty tomb painting at El Bersheh, Egypt. Another four teams move a winged-bull statue in an Assyrian 8th century BC limestone panel from Nineveh. In a 5th Dynasty tomb at Thebes an inscription is reported to mention the twisting of ropes (Gilbert 1979: 453). The earliest reported evidence of rope in fact comes from Egypt: it is made of reed and dates to c. 4000 BC (Gilbert 1979: 451). Fibres from palm, flax, grass, halfa, papyrus, and camel-hair have also been reported (De Camp 1960: 34; Gilbert 1979: 451-52; Cotterell & Kamminga 1990: 225; Edwards 1991: 246) and handmade ropes of palm fibre have been noted in modern Egyptian villages (Cotterell & Kamminga 1990: 225). Rope-making appears to have been a specialised skill, perhaps demanding its own workshop space. An 18th Dynasty painting in the tomb of Rekhmire depicts the manufacture of rope: a seated man is shown to feed fibres into a rotating yarn whilst a second man spins a yarn tool to form the yarn (Gilbert 1979: 453). The next stage in manufacture would be to stretch the yards so that the tension is even throughout. Finally, the yarns are formed into strands, which in turn are twisted into rope (Gilbert 1979: 453-54). The Rekhmire tomb painting shows an animal hide hanging against the wall, which suggests that leather was also used in the manufacture of rope, and leather is suggested to be the preferred material for rope-making in Neolithic Britain. Leather thongs and animal hair were twisted or plaited into ropes used to haul the Stonehenge blocks. Atkinson is skeptical about the use of vegetable fibre for rope-making because of its unavailability and insufficient breaking strain (Atkinson 1961: 293; 1979: 120). Leather on the other hand has an ultimate breaking strength of ca. 1815 kg per square 2.5 cm[1] (Atkinson 1961: 293), or a safe working load of close to 82 kg for a rope with an approximate circumference of more than 7.5 cm[2] (Atkinson 1961: 293).

> Since a rope of more than 6 inches in circumference is difficult to grip, it follows that the largest Neolithic ropes would have a working strength of about one third of a ton, and that where heavy stones had to be moved, weighing up to several dozens of tons, the number of ropes required would be correspondingly large (Atkinson 1961: 293).

When blocks are being hauled on a sledge, the tension in the rope must be resolved. Cotterell and Kamminga (1990: 30-1) have shown that a wooden sledge and load, totalling 250 kg, pulled over an unlubricated wooden track, requires a tension in the rope of 870 N in order that the vehicle be kept in motion. Assuming the same circumstances and data as derived by Cotterell and Kamminga from the Egyptian bas-relief in the tomb of Sheshonq at Abusir, so that the rope is pulled at a 40° angle to the horizontal, and

---

[1] Atkinson suggests the ultimate braking strength of ca. 4000 lbs per square inch.

[2] Atkinson gives a safeworking load of 180 lb for a 3 inch circumference.

accounting for perpendicular contact force,[3] friction force, and the force of gravity acting on the mass, the horizontal component of tension in the rope is expressed by

$$T\cos 40 - F_f = 0,$$

where T = horizontal tension in the rope, F_f = the friction force, and a value of 0 recalls Newton's first law, which states that for a motion of uniform equilibrium the total force must be equal to zero.

According to Cotterell and Kamminga, when the frictional force is constant, it will be equivalent to 0.35 F_c, where F_c is the perpendicular contact force (Cotterell & Kamminga 1990: Table 2.4).[4] Therefore, $T\cos 40 - F_f = 0$ can be expressed as $F_c = 2.19T$.

For the vertical component of tension

$$F_c + T\sin 40 = mg,$$

where T = vertical tension in the rope, m = mass and g = gravity.

For an average Cyclopean block and sledge m = 5.275 tons,[5] and the conventional value of g = 9.81 N.

By substitution,

$$T=18{,}629.14 \text{ N}$$

Therefore, a tension of more than 18, 500 N must be produced in the rope to maintain the load. However, as noted above, the breaking strain of a 7.62 cm circumference rope is 82 kg; thus, if one rope were indeed used, as depicted in the Egyptian bas-relief, it would have had a circumference of 1.7145 m and a corresponding diameter close to one-half meter![6] It is likely that a number of ropes were used to haul a load of one average Cyclopean block on a sledge, for example 11 ropes, each with a tension of 1,693.56 N, providing that each does not exceed a 15.24 cm diameter.[7]

---

[3] Perpendicular contact force is the force created between the vehicle and surface; in this instance the sledge and the wooden track.

[4] The coefficient of friction, μ, is expressed by F_f/F_c, where F_f=frictional force and F_c=perpendicular contact force. Therefore $F_f=F_c\mu$, where m=0.35 for a wooden vehicle travelling over a dry wood surface (Cotterell &Kamminga 1990: Table 2.4).

[5] This figure is based on Atkinson's estimate of 35 lbs. per cubic inch of pine wood and a sledge, 9 ft. x 4 ft. , which weighs approximately 3.43 tons (Atkinson 1979: 111, 114-15), and the average Cyclopean block weight of 1.845 tons.

[6] The diameter of a 7.62 cm cord is approximately 2.1 cm., and thus for a 171.45 circumference cord the corresponding diameter is 47.25 cm.

[7] Recall Atkinson suggests that a rope with a circumference more than 6 inches would be most difficult to grasp (Atkinson 1961: 293).

The stress in each of these ropes is comparable with that measured for palm fibre cord and by experiments conducted on rope made from ivy, being 16 MPa and 12 MPa respectively (Cotterell & Kamminga 1990: 225). Cotterell and Kamminga have expressed stress as

stress = N/cross-sectional area of specimen,

where N = force in Newtons and stress is expressed in MPa.

Therefore, the stress in each rope used to haul a sledge and average Cyclopean block is equivalent to

stress = 1693.56/(116.1288 cm^2 x l) = 14.58 l MPa,

where l = the length of the rope.

Similar problems are encountered when lifting a block to any height. As with hauling a load, the number of the ropes used to vertically lift a block is proportionate to the load's weight (Cotterell & Kamminga 1990:90). However, the use of pulleys decreases the force required to pull on the rope; the amount of energy is decreased proportionately with the use of pulleys. For instance, the force necessary to lift the load by the *trispast*, described by Vitruvius (X.ii.3) as a compound pulley with two pulleys in the upper portion of the assemblage and a third pulley just above the winch which would have held the raised block, is one-third of the force required to raise the weight (Cotterell & Kamminga 1990: 91). However, the breaking strain of the rope must be considered. Assuming Atkinson's safe working load of a rope with a 7.62 cm circumference, 23 ropes would be needed to raise one average Cyclopean block. One rope could be used, but this would place the rope at its ultimate breaking point. The rope diameter could have been greater and the number of ropes fewer, but, the ability of the rope to pass over the pulley and be easily grasped in the hand must be considered. Evidence does not suggest that ropes were in fact thicker that the safe value given by Atkinson. In the Tura caves, located outside of Egypt papyrus ropes have been reported to be close to 6.5 cm in diameter (Gilbert 1979: 453; Cotterell & Kamminga 1990: 225 n.12). Moreover, there is no evidence for any sort of pulley system in Late Bronze Age contexts, nor have any blocks been reported to bear dowel holes which would have taken the ends of a winch.

Appendix 2. Amount of Stone Required for Circuit Building.

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
Achaea												
Araxos: Teikhos Dymaion	1.30 (a)		1.00 (m)		9500	10.00	4.20-5.20, 5.90 (m)	13				
Aetolia												
Ancient Kalydon							1.70					
Gyphtokastro: Ancient Pleuron							2.00					
Arcadia												
Dimitra: Troupes												
Kionia: Ancient Stymphalos												
Nestani: Paniyiristra												
Pikernis: Gourtsouli												
Arcarnania												
Palairos: Kekropoulos												

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
Argolid												
Argos: Aspis							3.00					
Argos: Larissa												
Asine												
Kandia: Kastro							3.00					
Kazarma: Arkadiko bridge												
Midea: Palaiokastro	1.00	0.80	0.90 (a)		33000		5.50-7.00					
Mycenae												
Citadel 1						8.25	7.50 (a)					
Citadel 2	1.40		0.80			8.25	8.00 (m)					
Citadel 3	2.20		1.275 (a)		38500	8.25	8.00 (m)					
Lion Gate Threshold	4.60	2.40	0.85		30000							
Lion Gate Lintel	4.50	2.10	1.00									

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
North Gate Threshold	3.62	1.50	0.32 (a)									
North Gate Lintel	2.99	1.41	0.585 (a)									
North Gate Jamb stones	1.40	0.475 (a)	2.30									
North Gate Inner Stone over Lintel	2.15	0.44 (m)	0.90									
North Gate Outer Stone over Lintel	2.09	0.71 (m)	1.63									
Nafplion: Ancient Nauplia					100000							
Nea Epidhavros: Vassa	2.15		0.45		24000							
Prophitis Ilias, Mycenae						2.50	2.00					

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
Prophitis Ilias, Tiryns					2400							
Prosymna: Argive Heraion												
Tiryns Citadel 1	1.15		0.65	274	4690	7.50	3.00	12		2859	28410.048	3208
Citadel 2		1.25 (m)	1.20 (m)		7690 (m)	7.50	6.00	12[5]				
Citadel 3 Upper				725		7.50	4.5-17.00	12			75169.728	8488
Citadel 3 Lower	1.00 (a)		0.80 (a)	380	7800	12.50	7.50	16		6080	70045.056	5932
Gate to 3-Upper Threshold	4.00	1.45										
Attica												
Ancient Brauron: Ayios Yeoryios							2.90					
Athens				793	24568	10.00	6.00					

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
Ayios Kosmas												
Koropi: Ayios Christos												
Thorikos												
Vari Kiapha Thiti					8000	2.50-5.00						
Boeotia												
Anthokorio: Levendi												
Ayia Marina					7500 (m)		2.00					
Ayios Ioannis				+700	25000 (m)		2.50					
Ayios Vlasis: Ancient Panopeus					20000	2.00						
Chaeronea						2.50	2.00					
Dramesi												

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
Eutresis	1.50				200000[6]	2.00	4.70 (a)					
Gla	0.75 (a)		0.50 (a)	3000	200000	6.00	6.00 (a)	12		48000	311040.43	35122
Haliartos					37500		3.00					
Kastro												
Khantsa												
Khelonokastro												
Khoni												
Larymna: Kastri												
Livadostro												
Lophos Vlikha							2.50					
Mytikas							2.00					
Pyrgos					37500	1.75						

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
Sores: Moustaphades-Neokhoraki												
Soules												
Stroviki					30000 (m)							
Thebes					480000 (m)		5.00					
Thisbe: Palaiokastro												
Vathy: Nisi												
Vristika												
Corinthia												
Isthmia	1.625 (a)		0.75				4.00-4.60, 5.75 (m)					
Korakou					225000							
Perdikaria	1.60		1.00		6000 (m)							

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
Xerokastelli												
<u>Elis</u>												
Kakovatos: Nestora												
Kato Samikon: Klidi					15000 (m)							
<u>Euboea</u>												
Kerinthos: Kria Vrisi					120000 (m)		3.00					
Psakhna: Glyphas												
<u>Laconia</u>												
Ayios Stephanos												
Ayios Vasilios												
Geraki: Ancient Geronthrae						4.00						
Kambos												
Las: Passava												
Mezzapo												

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
Stephanis: Lekas, Panayiotis						2.00						
Megarid												
Megara												
Messenia												
Aetos: Ayios Dimitrios						2.30						
Iklaina: Traganes												
Kalamata: Kastro												
Mirou: Peristeria												
Mouriatadha: Elliniko												
Vasiliko: Malthi				420	10000		1.60-3.55					
Phocis												
Amphissa forts												
Khryso: Ancient Krisa	2.45 (a/m)	1.90 (a)	0.90		105000 (m)	5.00	4.50-6.50, 6.90 (m)					

Site	Avg. Block Size (m)[1]			Circuit Length (m)	Area (m^2)	Height (m)	Width (m)	Approx. No. of courses[2]	Approx. Metres of Stone for One Face[3]			
	l	w	h						Given Size		Wright's Size[4]	
									m^3	No.	m^3	No.
Tolophon: Mathiou						2.25	3.60 (a)					
Salamis												
Salamis: The Arsenal					37500 (m)	1.75						
Thessaly												
Ano Lekonia: Nevistiki	2.10 (m)											
Ayios Andreas: Palaiokastro												
Ktouri		2.475 (a)					2.50 (a)					
Pyrgos Kieriou: Ancient Ame							2.25					
Pyrgos Kieriou: Makria Magoula					126000 (m)							
Stephanovikeio: Petra				5000	1000000		5.00					
Thesprotia												
Mesopotamos: Xylokastro				1120	67500		6.50 (a)					

---

[1] Where (a) or (m) have been used, they indicaite the <u>average</u> measurement for two or more reported dimensions and a <u>maximum</u> dimension. All measurements listed have been obtained or calculated from the available reported data.

[2] The height of the wall has been divided by the average block height and rounded off to the nearest whole number.

[3] This does not inculde a second face, i.e., not an inner <u>and</u> outer face, nor the stones used in the fill between faces.

Calculcation for the amount of stone in cubic meteres: Total amount of stone (m^3) = V x no. of blocks in circuit length x no. of courses, where V is the volume of the average block, and the average block is determined from the measures given under "Avg. Block Size" or by Wright's average block size (see n. 4).

[4] Wright (1978) has determined the average block dimensions to be:

length (l) = 0.70 m and 1.20-1.50 m,
width (w) = 0.80-1.00 m,
height (h) = 0.60 and 1.00 m.

I have made calculations based on the <u>average</u> of his suggested figures so that l = 1.025 m, w = 0.90 m, and h = 0.80 m.

[5] Reconstructions of Citadel 2 indicate additions to the Middle Citadel and entrance approach; there is no indication of increased height and thus I have retained the height of the former citadel, although it is recognised that courses may have, in fact, been added to the existing structure.

[6] Per Darque (1992: 14), although Goldman (1931: 70) and others report a smaller enclosed area.

and Midea: Palaiokastro in the Argolid.

Site	Average block size (m)			Circuit length (m)	Area (m^2)	Height (m)	Approx. no. of courses	Width (m)	Approx. amount of stone for one wall face
	l	w	h						
Gla									
Reported	0.75		0.50	3000	200000	6.00	12	6.50	48000/ **195.62**years
Average	1.025	0.90	0.80						35122/ **139.53** years
Tiryns: Upper									
Reported				725		7.50	12	17.00 (max.)	
Average	1.025	0.90	0.80						8488
Tiryns: Lower									
Reported	1.00		0.80	c.380	7800 (max.)	12.50	16	7.50	6080
Average	1.025	0.90	0.80						5932 Total= **55.26** years
Midea									
Reported	1.00	0.90	0.80	462	33000	6.50	8	7.00	3696/ **14.16** years
Average	1.025	0.90	0.80						3606/ **13.82** years

Appendix 4. Time to Construct Mycenaean Drainage Works[1]

Dam	Dimensions						Volume of Earth Dug from Canal (m³)	Time for One Man to Dig Canal[2]	% Stone for Cyclopean Facings					Time to Build in Stone[3]	Total Time for Dam to be Built by One Man[4]
	Length	Width (m)			Total Height of Wall & Dam (m)	Depth of Canal (m)			No. of Blocks			Volume (cubic metres)	% of Total Dam Volume		
		Walls	Dam	Canal					Avg. Length (m)[5]	No. of Courses	Total No. of Blocks				
Tiryns	100 m.	East: 3.50-4.00	N Half: 80.00 S Half: 50.00		9.572 [6]	8.00	52 000	142.47 years	1.025	12	1171 per face Total= 4684	3456.79	6	1.60 years	144.07 years
Copaïs															
Avg. Data	250 km		30.00	40.00	c. 2.50	3.00	300000	821.92 years	1.025	4	9756 per face	7199.93	2.3	3.34 years	825.36 years
N Dyke, W Part		3.00	30.00	40.00	2.50	3.00			1.025	4					
N Dyke, E Part			30.00	40.00		3.00			1.025						
Double Canal N of Gla	20.00 m														
N Canal & Dam		2.00	35.00	40.00-45.00	2.00	3.00	2550	6.99 years	1.025	2.	39 per face Total= 156	115.128	4.3	19.5 days	7.04 years
Central (inner) Dam		2.00	30.0 0		2.00				1.025	2.	39 per face Total= 156	115.128		19.5 days	

S Canal & Dam	2.00	30.00	30.00 0	2.00	3.00	1800	4.93 yeasr	1.025	2	39 per face Total= 156	115.128	6	19.5 days	4.98 years
<u>Canal from point where canals merge to Binia Kata.</u>			80.0					1.025						

Time Using Kalcyk & Heinrich's Averages (Dam width = 30.00 m., Canal width = 40.00 m., Stone Wall Height = 2.50 m. 1022.39 years[7]

---

[1] The above data have been derived from Bintliff (1977), Hope Simpson (1981), Kalcyk & Heinrich (1989).

[2] Based on Wright's estimation that one man can excavate one cubic metre per day and that ten men could excavate Shaft Grave V in ten days (Wright 1987: 174). No estimate can be given for the transportation time as the size of loads cannot be calculated and may have been variable. More likely, the soil was pitched from the channel onto a mound which formed the earth embankment of the dam.

[3] Based on a 1.845 ton stone transported by oxen making 8 trips per day.

[4] This includes the time to excavate the earth by one man only.

[5] No data have been reported on block size. Calculations have been made on the average of Wright's average block sizes, where length=1.025 m., width=0.90 m., and height=0.80 m.

[6] Bintliff (1977: 281) reports a height of 30 ft. (9.144 m). Hope Simpson (1981: 21) suggests a minimum height of 10.00 m. The average of both measurements is 9.572 m., as reported in the chart above.

[7] Only one retaining wall has been considered because the northern part of the system is retained by only one wall and the section on the east, at Davlosis, is retained by one wall only.

Appendix 5. Classification and Date of Reported Cyclopean Walls.

Map Reference Figure 2.0.	Reported Cyclopean Wall[1]	Type[2]	Date[3]
	<u>Mainland</u>		
1	Aetos: Ayios Dimitrios (Messenia) D 227[4]	N	LH(?)
2	Amphissa forts (Phokis)*[5]	N	?
3	Ancient Brauron: Ayios Yeoryios (Attica) F 38	N	late MH
4	Ancient Kalydon (Aetolia) B 100	N	late LH(?)
5	Ano Lekonia: Nevistiki (Thessaly)	III	LH III
6	Anthokorio: Levendi (Boeotia) G 59	U	
7	Araxos: Teikhos Dymaion (Achaea)* E 47	III	LH IIIB
8	Argos: Aspis (Argolid)* A 8	N	Geometric
9	Argos: Larissa (Argolid)* A 8	U	
10	Asine (Argolid) A 20	N	Geometric(?)
11	Athens (Attica)* F 1	III	LH IIIB
12	Ayia Marina (Boeotia)* G 10	II(?)	LH III
13	Ayios Andreas: Palaiokastro (Thessaly)	U	

14	Ayios Ioannis (Boeotia)* G 12	IV	LH III
15	Ayios Kosmas (Attica) F 16	N	end LH
16	Ayios Stephanos (Lakonia) C 17	U	LH III(?)
17	Ayios Vasilios (Lakonia) C 7	U	LH III
18	Ayios Vlasis: Ancient Panopeus (Boeotia)* G 48	III	LH III
19	Chaeronea (Boeotia)* G 46	III	LH IIIB
20	Dimitra: Troupes (Arcadia) B 33	N	LH
21	Dramesi (Boeotia) F 64	N(?)	
22	Eutresis (Boeotia)* G 33	U	LH III
23	Geraki: Ancient Geronthrae (Lakonia)* C 12	I, III	LH III(?)
24	Gla (Boeotia)* G 9	II, III, IV	LH IIIA2-B1
25	Gyphtokastro: Ancient Pleuron (Aetolia) E 1	N(?)	
26	Haliartos (Boeotia)* G 17	II	LH III *t.p.q.*
27	Iklaina: Traganes (Messenia) D 46	N(?)	LH III
28	Isthmia (Corinthia)* A 58	III-IV, V	LH IIIB-C, end of LH III or post-Mycenaean
29	Kakovatos: Nestora (Elis) B 94	N(?)	
30	Kalamata: Kastro (Messenia) D 142	N(?)	

31	Kambos (Lakonia) D 146	N(?)	
32	Kandia: Kastro (Argolid)* A 21	III(?)	LH IIIB
33	Kastro (Boeotia)* G 8	III(?)	LH IIIB-Geometric
34	Kato Samikon: Klidi (Elis) B 92	N	
35	Kazarma: Arkadiko bridge (Argolid)* A 25	III	LH IIIB2
36	Kerinthos: Kria Vrisi (Euboea) G 92	N(?)	LH III
37	Khantsa (Boeotia) G 11	U	LH III
38	Khelonokastro (Boeotia)	N(?)	LH IIIB
39	Khoni (Boeotia)	N	
40	Khryso: Ancient Krisa (Phokis)* G 56	III	LH IIIB
41	Kionia: Ancient Stymphalos (Arcadia) B 35	N	LH III
42	Korakou (Corinthia) A 50	N(?)	LH III
43	Koropi: Ayios Christos (Attica) F 40	N(?)	
44	Ktouri (Thessaly) H 51	II, III	LH IIIB
45	Larymna: Kastri (Boeotia)* G 22	I, IV(?)	LH IIIB *t.p.q.*
46	Las: Passava (Lakonia)	N(?)	
47	Livadostro (Boeotia) G 38	N(?)	

48	Lophos Vlikha (Boeotia)	N(?)	LH
49	Megara (Megarid) A 93	U	
50	Mesopotamos: Xylokastro (Thesprotia) K 1	N	
51	Mezzapo (Lakonia)	N	
52	Midea: Palaiokastro (Argolid)* A 6	I, III	LH IIIB2
53	Mirou: Peristeria (Messenia) D 200	N	early LH
54	Mouriatadha: Elliniko (Messenia) D 201	N	end of LH (at earliest)
55	Mycenae (Argolid)* A 1	III	LH IIIA2, LHIIIB1, LH IIIB2
56	Mytikas (Boeotia)*	N	
57	Nafplion: Ancient Nauplia (Argolid)* A 18	U	
58	Nea Epidhavros: Vassa (Argolid) A 30	III	LH III
59	Nestani: Paniyiristra (Arcadia) B 19	N	post-Mycenaean
60	Palairos: Kekropoulos (Acarnania) E 8	N	Hellenistic
61	Parori: Goritsa (Phocis)[6]	N	
62	Perdikaria (Corinthia)* A 59	III-IV	LH III
63	Pikernis: Gourtsouli (Arcadia) B 18	N(?)	
64	Prophitis Ilias, Mycenae (Argolid)	III	LH IIIB

65	Prophitis Ilias, Tiryns (Argolid)* A 24	N(?)	LH IIIB
66	Prosymna: Argive Heraion (Argolid)* A 4	N	Geometric
67	Psakhna: Glyphas (Euboea) F 72	U	
68	Pyrgos (Boeotia)* G 4	III	LH IIIA-B
69	Pyrgos Kieriou: Ancient Arne (Thessaly) J 8	III(?)	post-Mycenaean
70	Pyrgos Kieriou: Makria Magoula (Thessaly) J 9	N(?)	
71	Salamis: The Arsenal (Salamis) F 10	U	
72	Sores: Moustaphades-Neokhoraki (Boeotia)	U	
73	Soules (Boeotia) G 24	N	
74	Stephanis: Lekas, Panayiotis (Lakonia) C 19	U	LH III
75	Stephanovikeio: Petra (Thessaly) H 17	N(?)	
76	Stroviki (Boeotia)* G 6	N(?)	LH III
77	Thebes (Boeotia)* G 23	III(?)	LH III
78	Thisbe: Palaiokastro (Boeotia) G 35	N	
79	Thorikos (Attica) F 25	N	
80	Tiryns (Argolid)* A 7	III, IV	LH IIIA2, LH IIIB1, LH IIIB2
81	Tolophon: Mathiou (Phokis)	N	

82	Vari: Kiapha Thiti (Attica) F 22	I(?), III(?)	LH I-IIB
83	Vasiliko: Malthi (Messenia) D 222	N	probably late MH/early LH
84	Vathy: Nisi (Boeotia) F 65	N(?)	
85	Vristika (Boeotia)*	N	
86	Xerokastelli (Corinthia)	N(?)	
	<u>Crete</u>		
87	Akhladia	N	LM III
88	Ayia Triada†	N	
89	Gortyn†	N	Geometric
90	Juktas†	N	MM IA
91	Kastrokephala	N	LM IIIB
92	Monastiraki: Kharakas	U	MM
93	Petras	(?)	LM I
94	Praisos	N	LM
95	Stilos	U	LM III
96	Vasiliki	N	LM
	<u>Cycladic Islands</u>		
97	Keos: Ayia Irini	N	MC III/LC I

98	Melos: Phylakopi	N	LC I, LH IIIB
99	Paros: Koukounaries	N	LH IIIC
100	Siphnos: Ayios Andreas	N	LH IIIB
101	Tenos: Akrotirion Ourion	N	LM IB(?)
	Ionian Islands		
102	Ithaka: Aëtos E 19	N(?)	LH IIIB
	Dodecanese		
103	Chalki: Khorio-Kastro	N	Hellenistic
104	Kastellorizo: Vigla	N(?)	
105	Kos: Amaniou-Palaiopyli	N	LH
106	Leros: Xerokambos	N	4th century
107	Rhodes: Kallithies-Erimokastro	N(?)	
108	Telos: Megalokhorio-Kastro	N	Hellenistic
	Cyprus[7]		
109	Enkomi	N	L Cyp IIC-IIIA
110	Hala Sultan Tekke	N	L Cyp III
111	Kition	N	L Cyp IIC-IIIA
112	Korovia: Nitovikla	N	L Cyp IIC-IIIA
113	Lara	N	L Cyp IIC-IIIA

114	Maa: Palaiokastro	N	L Cyp IIC-IIIA
115	Sinda: Siri Dash	N	L Cyp IIC-IIIA
	<u>Syria-Palestine and the Transjordan</u>		
116	Beth Shemesh	N	level V
117	Beth-zur	N	MBA
118	Bethel	N	MBA
119	Gezer	N	end MB II
120	Jericho	N	EBA
121	Lachish	N	level VIII-VII
122	Shechem	N	MB II
123	Tel Akko	N	MB IIA
124	Tel Yarmut	N	phase IIA
125	Tell Rumeideh	N	MB IIC
	<u>Anatolia</u>		
126	Alaca Hüyük	N	Hittite
127	Bogazköy†	N	Hittite, 14th-13th century
128	Miletus: Kalabaktepe†	N	LH IIIB
129	Sardis: Acropolis	N	7th century

130	Tilmen Hüyük	N	Hittite
131	Troy[†]	N	Troy VI
	<u>Southern Europe</u>		
132	Malta: Borg in-Nadur	N	
133	Sicily: Pantalica	N	

---

[1] * visited by the author in 1993, † visited by the author in 1994.

[2] Abbreviations used:
N - not Cyclopean
N(?) - probably not Cyclopean, physical evidence is lacking
U - unable to classify because of insufficient evidence
? - questionable classification, requiring on-site evalutation
(?) - tentative classification

[3] Where a date is not given, this indicates that no date has been reported for the wall

[4] *GAC* reference number where applicable.

[5] In 1993, the forts north and south of Gravia were visited, the fort at Oiti was not located, and a visit to the fort north-west of Amphissa was prevented by road works.

[6] Parori: Goritsa is reported in *AR* (1993-94: 33) but, as the foregoing statistics were compiled before the publication of *AR* 1993-94, the site has not been included in the total number of reported Cyclopean walls.

[7] Dates of Cypriote sites have been derived from Fortin's (1984) classification of sites into M Cyp III-L Cyp I and L Cyp IIC-IIIA.

Bibliography.

Adam, S.
1966 *The Technique of Greek Sculpture in the Archaic and Classical Periods*. London: Thames & Hudson.

Aharoni, Y.
1973 *Beer-Sheba I. Excavations at Tel Beer-Sheba 1969-1971 Seasons*. Vol. I. Tel Aviv University.

1982 *The Archaeology of the Land of Israel*. A.F. Rainey, trans. London: Bloomsbury.

Aharoni, Y. & Amiran, R.
1964 Excavations at Tel Arad. Preliminary Report on the First Season, 1962. *IEJ* 14: 131-47.

Albright, W. F.
1960 *The Archaeology of Palestine*. 4th ed. Middlesex: Penguin.

Alexander, J.
1972 *Jugoslavia Before the Roman Conquest*. London: Thames & Hudson.

Alexiou, S.
1979 Τειχη και Ακροπολεις στη Μινωικη Κρητη. *Kretologia* 8: 41-56.

Alin, P.
1962 *Das Ende der mykenischen Fundstätten auf dem griechischen Festland*. SIMA 1.

Alkim, H.
1973-76 Explorations and Excavations in Turkey in 1970, 1971 and 1972. *Anatolia* 5: 7-140.

Alkim, U. B.
1969 *Anatolia I*. J. Hogarth, trans. London: Barrie & Rockcliff.

Alkim, U. B., H. Alkim, & Bilgi, O.
1988 *Ikiztepe I. The First and Second Seasons' Excavations (1974-1975)*. Ankara.

Amiran, R. et al
1978 *Early Arad. The Chalcolithic Settlement and Early Bronze City I. First-fifth Seasons of Excavations, 1962-1966*. Jerusalem: Israel Exploration Society.

Antonaccio, C. M.
1992 Terraces, Tombs, and the Early Argive Heraion. *Hesp* 61: 85-105.

Aravantinos, V. L.
1986 The E.H.II Fortified Building at Thebes. Some Notes on Its Architecture. *Early Helladic Architecture and Urbanization*. R. Hägg & D. Konsola, eds. SIMA 76:57-63.

Arik, R. O.
1937 *Les Fouilles D'Alaca Höyök*. Ankara: Société D'Histoire Turcque.

Arnold, D.
1991 *Building in Egypt. Pharaonic Stone Masonry.* Oxford University Press.

Åström, P.
1972 *The Swedish Cyprus Expedition.* Vol. IV-IB, IC. Lund.

1987 A Late Helladic IIIB2 Deposit from the Acropolis of Midea. *Schriften des Deutschen Archäologen-Verbandes IX. Kolloquium zur Ägäischen Vorgeschichte Mannheim, 20-22 February 1986*, 152-154.

Åström, P. et al
1976 *Hala Sultan Tekke. Excavations 1897-1971.* Vol. 1. SIMA 45.

1983 *Hala Sultan Tekke. Excavations 1971-1979.* Vol. 8. SIMA 45.

Atkinson, R. J. C.
1961 Neolithic Engineering. *Antiquity* 35: 292-99.

1979 *Stonehenge.* 2nd ed. London: Penguin, 102-141.

Atkinson, T. D. et al
1904 *Excavations at Phylakopi in Melos.* Society for the Promotion of Hellenic Studies. London: MacMillan.

Austin, R. P.
1925-26 Excavations at Haliartos, 1926. *BSA* 27: 81-91.

1926-27 Excavations at Haliartos, 1926. Part II. *BSA* 28: 128-40.

1931-32 Excavations at Haliartos, 1931. *BSA* 32: 180-212.

Baird, D. & Philip, G.
1992 Preliminary Report on the First (1991) Season of Excavations at Tell esh-Shuna North. *Annual of the Department of Antiquities of Jordan* 36: 71-88.

Balcer, J. M.
1974 The Mycenaean Dam at Tiryns. *AJA* 78:141-49.

Balmuth, M. S.
1984 The Nuraghi of Sardinia: An Introduction. *Studies in Sardinian Archaeology.* M.S. Balmuth & R.J. Rowland Jr., eds. University of Michigan Press, 23-52.

Barber, R. L. N.
1987 *The Cyclades in the Bronze Age.* London: Duckworth.

Barkay, G.
1992 The Iron Age II-III. *The Archaeology of Ancient Israel.* A. Ben-Tor, ed. The Open University of Israel.

Bell, F. G.
1983 *Engineering Properties of Soils and Rocks.* 2nd ed. London: Butterworths.

1990 Engineering Geology and Buildings Stones of Historical Monuments: construction materials; geological origin; quarries. *EG*: 1867-74.

Belli, P.
1992 Aegean Architectural Links with the Central Mediterranean: Sardinian Sacred Wells and Lipari's Thermal Tholos. *Sardinia in the Mediterranean: A Footprint in the Sea. Studies in Sardinian Archaeology Presented to Miriam S. Balmuth.* R. H. Tyhot & T. K. Andrews, eds., Sheffield Academic Press, 235-42.

Ben-Tor, A.
1992 The Early Bronze Age. *The Archaeology of Ancient Israel.* A. Ben-Tor ed. The Open University of Israel.

Benson, J. L.
1970 Bamboula at Kourion. The Stratification of the Settlement. *Report of the Department of Antiquities of Cyprus*, 25-30.

Benton, S.
1931-32 The Ionian Islands. *BSA* 32: 213-46.

Bienkowski, P.
1986 *Jericho in the Late Bronze Age.* Wiltshire: Aris & Phillips.

Bintliff, J.
1977a The History of Archaeo-Geographic Studies of Prehistoric Greece, and Recent Fieldwork. *Mycenaean Geography.* J. Bintliff, ed. Cambridge: British Association for Mycenaean Studies.

1977b *Natural Environment and Human Settlement in Prehistoirc Greece.* BAR Supp. 28.

Bittel, K.
1937 *Die Ruinen von Boğazköy.* Berlin: Walter de Gruyter.

1970 *Hattusha. The Capital of the Hittites.* Oxford University Press.

1972 *Guide to Boğazköy.* Ankara.

Bittel, K. & Naumann, R.
1952 *Boğazköy-Hattusa. Vol. I Architeckture, Topographie, Landeskunde und Siedlungsgeschichte.* Germany: Kohlhammer Stuttgart.

Bittel, K. et al
1957 *Boğazköy III. Funde aus den Grabungen 1952-1955.* Berlin: Verlag Gebr. Mann.

Blegen, C. W.
1920 Corinth in Prehistoric Times. *AJA* 24: 1-13.

1954 An Early Tholos Tomb in Western Messenia. *Hesp* 23: 158-62.

1963 *Troy and the Trojans.* London: Thames & Hudson.

Blegen, C. W. & Rawson, M.
1966 *The Palace of Nestor in Western Messenia.* Vol. I. University of Cincinnati: Princeton University Press.

Bosanquet, R. C.
1901 Excavations at Petras. *BSA* 8: 282-85.

Bowden, F.P. & Tabor, D.
1950 *The Friction and Lubrication of Solids*. Oxford: Clarendon.

Boyd, M. J.
1993 The Middle and Late Bronze Age in Messenia. *Archaeology* New York. 1: 11-24.

Branigan, K.
1970 *The Tombs of Mesara*. London: Duckworth.

1974 *Aegean Metalwork of the Early and Middle Bronze Age*. Oxford: Clarendon Press.

Bromehead, C. N.
1979 Mining and Quarrying. *A History of Technology*. Vol.1. 2nd ed. C. Singer et al., eds. Oxford: Claredon Press, 558-71.

Broneer, O.
1933 Excavations on the North Slope of the Acropolis in Athens. *Hesp* 2: 327-417.

1935 Excavations on the North Slope of the Acropolis in Athens, 1933-1934. *Hesp* 4: 109-88.

1939 A Mycenaean Fountain on the Athenian Acropolis. *Hesp* 8: 317-433.

1956 Athens in the Late Bronze Age. *Antiquity* 30: 9-18.

1958 The Corinthian Isthmus and the Isthmian Sanctuary. *Antiquity* 32: 80-8.

1966 The Cyclopean Wall on the Isthmus of Corinth. *Hesp* 35: 346-62.

1968 The Cyclopean Wall on the Isthmus of Corinth, Addendum. *Hesp* 37: 25-35.

Broshi, M. & Gophna, R.
1986 Middle Bronze Age II Palestine: Its Settlements and Population. *BASOR* 261: 73-90.

Burford, A.
1960 Heavy Transport in Classical Antiquity. *The Economic History Review Second Series* 13: 1-18.

1969 *Temple Builders at Epidauros*. Liverpool University Press.

Burney, C.
1977 *From Village to Empire. An Introduction to Near Eastern Archaeology*. Oxford: Phaidon Press.

Cadogan, G.
1977-78 Pyrgos, Crete, 1970-77. *AR* 24: 70-84.

Callaway, J. A.
1965 The 1964 'Ai (et-Tell) Excavations. *BASOR* 178: 13-40.

1969 The 1966 'Ai (Et-Tell) Excavations. *BASOR* 196: 2-15.

1970 The 1968-1969 'Ai (et-Tell) Excavations. *BASOR* 198: 7-31.

1980 *The Early Bronze Age Citadel and Lower City at Ai (et-Tell).* ASOR.

1982 Review of Arad I. *BASOR* 247: 71-79.

Caskey, J. L.
1958 Excavations at Lerna, 1957. *Hesp* 27: 125-144.

1962 Excavations in Keos, 1960-1961. *Hesp* 31: 266-83.

1964a Excavations in Keos, 1961. *Mycenaean Studies*. E. L. Bennett Jr., ed. University of Wisconsin Press, 193-94.

1964b Excavations in Keos, 1963. *Hesp* 33: 314-35.

1966 Excavations in Keos, 1964-1965. *Hesp* 35: 363-76.

1968 Lerna in the Early Bronze Age. *AJA* 72: 313-6.

1971 Investigations in Keos. Part I: Excavations and Explorations, 1966-1970. *Hesp* 40: 359-96.

Casson, S.
1933 *The Technique of Early Greek Sculpture.* Oxford: Clarendon.

Catling, H. W.
1972-73 Archaeology in Greece, 1972-73. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1973-74 Archaeology in Greece, 1973-74. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1975-76a Archaeology in Greece, 1975-76. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1975-76b *British School at Athens Annual Report.*

1976-77 Excavations at the Menelaion, Sparta, 1973-1976. *AR* 23: 24-42.

1977-78a Archaeology in Greece, 1977-78. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1977-78b *British School at Athens Annual Report.*

1979-80 *British School at Athens Annual Report.*

1980 Sparta: Menelaion. *AD* 35B: 153-7.

1980-81 Archaeology in Greece, 1980-81. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1982 Excavation and Study at the Menelaion, Sparta 1978-1981. *Ανατυπον εκ των Λακωνικων Σπουδων* τομ. 6, 28-43.

1982-83 *British School at Athens Annual Report.*

1983 Study at the Menelaion 1982-1983. *Ανατυπον εκ των Λακωνικων Σπουδων*. τομ. 7, 23-81.

1983-84 Archaeology in Greece, 1983-84. *Archaeological Reports*. Society for the

Promotion of Hellenic Studies.

1984-85 Archaeology in Greece, 1984-85. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1985-86 Archaeology in Greece, 1985-86. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1986-87 Archaeology in Greece, 1986-87. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1987-88 Archaeology in Greece, 1987-88. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1988-89 Archaeology in Greece, 1988-89. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

Cavanagh, W. G. & Laxton, R. R.
1981 The Structural Mechanics of the Mycenaean Tholos Tomb. *BSA* 76: 109-40.

1988 Problem Solving and the Architecture of Tholos Tombs. *Problems in Greek Prehistory*. E. B. French & K. A. Wardle, eds. Bristol Classical Press, 385-95.

Chadwick, J.
1976 *The Mycenaean World.* Cambridge University Press.

Childe, V. G.
1951 The First Waggons and Carts--From the Tigris to the Severn. *PPS* 17: 177-94.

1954a Rotary Motion. *A History of Technology*. Vol. I. C. Singer et al., eds. Oxford: Clarendon Press, 187-215.

1954b Wheeled Vehicles. *A History of Technology*. Vol. I. C. Singer et al., eds. Oxford: Clarendon Press, 716-29.

Cole, S. M.
1954 Land Transport Without Wheels. Roads and Bridges. *A History of Technology*. Vol. I. C. Singer et als., eds. Oxford: Claredon Press, 704-15.

Coles, J. M. & Harding, A. F.
1979 *The Bronze Age in Europe*. London: Methuen.

Contu, E.
1990 Il nuraghe. *La Civiltà Nuragica*. Milan: Electra, 35-99.

Cotterell B. & Kamminga, J.
1990 *Mechanics of Pre-industrial Technology*. Cambridge University Press.

Coulton, J. J.
1977 *Greek Architects at Work. Problems of Structure and Design*. London: Elek.

Courtois, J. et al
1986 *Enkomi et le Bronze Récent à Chypre*. Nicosia: Leventis.

Crouwel, J. H.
1981 *Chariots and Other Means of Land Transport in Bronze Age Greece.* Amsterdam: Allard Person.

Dabney, M. K. & Wright, J. C.
1990 Mortuary Customs, Palatial Society, and State Formation in the Aegean Area: A Comparative Study. *Celebrations of Death and Divinity in the Bronze Age Argolid. Proceedings of the Sixth International Symposium at the Swedish Institute at Athens, 11-13 June, 1988.* R. Hägg & G. C. Nordquist, eds. Stockholm.

Dacari, S.
1976 'Ανασκαφη στο Νεχυομαντειο του 'Αχεροντος. *PAE*: 149–52.

Daniel, J. F.
1938 Excavations at Kourion. The Late Bronze Age Settlement-Provisional Report. *AJA* 42: 261-75.

1942 Review of 'Problems of the Late Cypriote Bronze Age'. *AJA* 46: 286-93.

Darcque, P.
1987 Les Tholoi et L'Organisation Socio-Politique du Monde Mycénien. *Aegaeum* 1: 185-205.

1992 Les Fortifications Mycéniennes. *Les Dossiers D'Archéologie* 172: 12-19.

Davis, J. L.
1977 *Fortifications at Ayia Irini, Keos: Evidence for History and Relative Chronology.* PhD diss. University of Cincinnati.

1986 *Keos V. Ayia Irini: Period V.* Mainz: Philipp von Zabern.

De Camp, L. S.
1963 *The Ancient Engineers.* New York: Ballantine Books.

De Miroschedji, P.
1985 Tel Yarmuk (T. Yarmouth)--1981-1984. Chronique Archaeologique. *RB* 92: 394-403.

1988 Khirbet Yarmouk (Tel Yarmouth), 1986-1987. Chronique Archaeologique. *RB* 95: 217-25.

1990 The Early Bronze Age Fortifications at Tel Yarmut--An Interim Statement. *Eretz-Israel* 21: 48-61.

De Vaux, R.
1955 Les fouilles de Tell El-Far'ah Pres Naplouse. *RB* 62: 573-4.

1962 Les Fouilles de Tell El-Far'ah. *RB* 69: 215-53.

Demakopoulou, K.
1990 Palatial and Domestic Architecture in Mycenaean Thebes. *L'Habitat Egéen Prehistorique*, 307-317.

Dermentzopoulos, T. et al
1988 Building Stones of Ancient Monuments in Attica: An Outline. *EG* 2: 619-29.

Dermitzakis, M. D. et al
1990 Petrological and geological study of the building material from the underground pit of Gortys area, Crete island. *EG* 4: 2049-56.

Dever, W. G.
1974 The MB IIC Stratification in the Northwest Gate Area at Shechem. *BASOR* 216: 31-52.

1986 Late Bronze Age and Solomonic Defenses at Gezer: New Evidence. *BASOR* 262: 9-34.

1993 Further Evidence on the Date of the Outer Wall at Gezer. *BASOR* 289: 33-54.

Dickinson, O. T. P. K.
1977 *The Origins of Mycenaean Civilisation.* SIMA 49.

1983a Cist Graves and Chamber Tombs. *BSA*: 55-67.

1983b Cretan Contacts with the Mainland During the Period of the Shaft Graves. *The Minoan Thalassocracy. Myth and Reality. Proceedings of the Third International Symposium at the Swedish Institute in Athens, 31 May-5 June 1982.* R. Hägg & N. Marinatos, eds., 115-8.

Dieter, A.
1991 *Building in Egypt. Pharonic Masonry.* Oxford University Press.

Dietz, S.
1991 Site and Settlement Patterns in the Argolid. *The Argolid at the Transition to the Mycenaean Age. Studies in the Chronology and Cultural Development in the Shaft Grave Period.* Denmark: National Museum, 281-94.

Dikaios, P.
1953 Recent Excavations at Enkomi by the Department of Antiquities of Cyprus. *AJA* 52: 106.

1969 *Enkomi. Excavations 1948-1958.* Mainz: Philipp von Zabern.

Dinsmoor, W. B.
1950 *The Architecture of Ancient Greece.* London: Batsford, 3rd ed.

Dornemann, R. H.
1983 *The Archaeology of the Transjordan in the Bronze and Iron Ages.* Wisconsin: Milwaukee Public Museum.

Doumas, C.
1972 Notes on Early Cycladic Architecture. *AA* 87: 151-70.

1990 Weapons and Fortifications. *Cycladic Culture. Naxos in the 3rd Millennium BC.* L. Marangou, ed. Athens: Goulandris Foundation, 90-2.

Dry Stone Walling Association of Great Britian
nd. a *Specifications for Simple Retaining Walls.*

nd. b *Technical Specifications for Dry Stone Walls.*

Durkin, M. K. & Lister, C. J.
1983 The Rods of Digenis: An Ancient Marble Quarry in Eastern Crete. *BSA* 78: 69-96.

Edwards, I. E. J.
1991 *The Pyramids of Egypt*. rev. Penguin Books.

Erasmus, C. J.
1965 Monument Building: Some Field Experiments. *SJA* 21: 277-301.

Evans, J. D. & Renfrew, C.
1968 *Excavations at Saliagos near Antiparos*. BSA Supp. 5. London: Thames & Hudson.

Felton, F.
1986 Early Urban History and Architecture of Ancient Aigina. *Early Helladic Architecture and Urbainzation*. R. Hägg & D. Konsola, eds. SIMA 76: 21-28.

Field, D.
1984 *Mycenaean Fortifications on the Mainland of Greece*. PhD diss. University of Cambridge.

Finkelstein, I.
1988 *The Archaeology of the Israelite Settlement*. Jerusalem: Israel Exploration Society.

1991 The Central Hill Country in the Intermediate Bronze Age. *IEJ* 41: 19-45.

Fischer, P. M.
1991 Tell Abu Al-Kharaz. The Swedish Jordan Expedition 1989 First Season Preliminary Report from Trial Soundings. *Annual of the Department of Antiquities of Jordan* 35: 67-104.

Fitton, J. L.
1989 Esse Quam Videri: A Reconsideration of the Kythnos Hoard of Early Cycladic Tools. *AJA* 93: 31-40.

Forbes, R. J.
1965 *Studies in Ancient Technology*. Vol. 2. Leiden: E.J. Brill.

Fortin, M.
1981 *Military Architecture in Cyprus During the Second Millennium BC*. PhD diss.University of London.

Fossey, J. M.
1988 *Topography and Population of Ancient Boiotia*. Vols. I-II. Chicago: Ares.

1989 *Papers in Boiotian Topography and History*. Amsterdam: Gieben.

Fossey, J. M. & Gauvin, G.
1985 Les Fortifications de l'Acropole de Chéronée. *Actes du Troisième Congress International sur la Béotie Antique*. J. M. Fossey & H. Giroux, eds. Amsterdam: Gieben, 41-69.

Fox, Cyril
1935 Sleds, Carts and Waggons. *Antiquity* 5: 185-99.

Fraser, P.M.
1970-71 Archaeology in Greece, 1970-71. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

French, D. H.
1971 Recent Archaeological Research in Turkey. *AS* 21: 5-58.

1973 Recent Archaeological Research in Turkey. *AS* 23: 13-68.

1974 Recent Archaeological Research in Turkey. *AS* 24: 17-59.

1975 Recent Archaeological Research in Turkey. *AS* 25: 15-24.

1976 Recent Archaeological Research in Turkey. *AS* 26: 21-68.

1977 Recent Archaeological Research in Turkey. *AS* 27: 23-61.

1978 Recent Archaeological Research in Turkey. *AS* 28: 9-37.

1979 Recent Archaeological Research in Turkey. *AS* 29: 181-210.

1980 Recent Archaeological Research in Turkey. *AS* 30: 301-228.

1983 Recent Archaeological Research in Turkey. *AS* 34: 203-235.

1984 Recent Archaeological Research in Turkey. *AS* 33: 231-264.

1987 Recent Archaeological Research in Turkey. *AS* 37: 179-223.

1988 Recent Archaeological Research in Turkey. *AS* 38: 191-208.

French, E. B.
1989-90 Archaeology in Greece, 1989-90. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1990-91 Archaeology in Greece, 1990-91. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1991-92 Archaeology in Greece, 1991-92. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1992-93 Archaeology in Greece, 1992-93. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1993-94 Archaeology in Greece, 1993-94. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

Garner, L.
1984 *Dry Stone Walls*. Shire Publications 114.

Garstang, J.
1953 *Prehistoric Mersin*. Oxford: Claredon Press.

Gebhard, E. R. & Hemans, F. P.
1992 University of Chicago Excavations at Isthmia, 1989: I. *Hesp* 61: 1-77.

Gilbert, K. R.
1979 Rope-Making. *A History of Technology*. Vol. 1, 2nd ed. C. Singer et

al, eds. Oxford: Clarendon, 451-4.

Goldman, H.
1931 *Excavations at Eutresis in Boeotia.* Harvard University Press.

Gonen, R.
1992 The Late Bronze Age.*The Archaeology of Ancient Israel.* A. Ben-Tor, ed. The Open University of Israel.

Gophna, R.
1984 The Settlement Landscape of Palestine in the Early Bronze Age II-III and Middle Bronze Age II. *IEJ*: 24-31.

1992 The Intermediate Bronze Age. *The Archaeology of Ancient Israel.* A. Ben-Tor, ed. The Open University of Israel.

Gordon, J. E.
1978 *Structures or Why Things Don't Fall Down.* Penguin Books.

Gough, M. R. E.
1967 Recent Archaeological Research in Turkey. *AS* 17: 25-36.

1968 Recent Archaeological Research in Turkey. *AS* 18: 21-44.

Gregori, B.
1986 'Three-Entrance' City-Gates of the Middle Bronze Age in Syria and Palestine. *Levant* 18: 83-102.

Greene, J. A., 'Amr, K. et al
1992 Deep Sounding on the Lower Terrace of the Amman Citadel: Final Report. *Annual of the Department of Antiquities of Jordan* 36: 113-44.

Greenfield, J. C. et al
1983 Notes and News. *IEJ.*

1984 Notes and News. *IEJ.*

1985 Notes and News. *IEJ.*

1986 Notes and News. *IEJ.*

1987 Notes and News. *IEJ.*

1988 Notes and News. *IEJ.*

1989 Notes and News. *IEJ.*

1990 Notes and News. *IEJ.*

Hawkins, G. S.
1966 *Stonehenge Decoded.* London: Souvenir Press.

Hayden, B. J.
1988 Fortifications of Postpalatial and Early Iron Age Crete. *AA* 1-21.

Heizer, R. F.
1966 Ancient Heavy Transport, Methods and Achievements. *Science* 53: 821-30.

Herr, L. G. et al
1991 Madaba Plains Project: The 1989 Excavations at Tell el'Umeiri and Vicinity. *Annual of the Department of Antiquities of Jordan* 35: 155-79.

Heyman, J.
1972 *Coulomb's Memoir on Statics*. Cambridge University Press.

1977 *Equilibrium of Shell Structures*. Oxford: Clarendon.

1982 *The Masonry Arch*. Chichester: Elis Horwood.

Hill, B. H.
1966 *The Temple of Zeus at Nemea*. Princeton: American School of Classical Studies at Athens.

Hill, D.
1984 *A History of Engineering in Classical and Medieval Times*. London: Croom Helm.

Hodges, H.
1970 *Technology in the Ancient World*. New York: Knopf.

Hodges, P.
1989 *How the Pyramids Were Built*. J. Keable, ed. Wiltshire: Aris & Phillips.

Holloway, R. R.
1991 *The Archaeology of Ancient Sicily*. London: Routledge.

Hood, M. F. S.
1959-60 Archaeology in Greece, 1959-60. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1960 Tholos Tombs of the Aegean. *Antiquity* 34: 166-76.

1961-62 Archaeology in Greece, 1961-62. *Archaeological Reports*. Society for the Promotion of Hellenic Studies.

1965 Minoan Sites in the Far West of Crete. *BSA* 60: 99-113.

1987 Mason's Marks in the Palaces. *The Function of the Minoan Palaces. Proceedings of the Fourth International Symposium at the Swedish Institute in Athens, 10-16 June, 1984*. R. Hägg & N. Marinatos, eds. Stockholm.

Hood, M. F. S. & Smyth, D.
1981 *Archaeological Survey of the Knossos Area*. 2nd ed.

Hood, M. F. S. et al
1964 Travels in Crete, 1962. *BSA* 59: 50-99.

Hope Simpson, R.
1981 *Mycenaean Greece*. New Jersey: Noyes Press.

Hope Simpson, R. & Dickinson, O. T. P. K.
1979 *A Gazetteer of Aegean Civilisation in the Bronze Age, Vol. I: The Mainland and Islands*. SIMA 52.

Hope Simpson, R. & Lazenby, J. F.
1970 Notes from the Dodecanese II. *BSA* 65: 47-76.

1973 Notes from the Dodecanese III. *BSA* 68: 127-79.

Howell, R.
1970 A Survey of Eastern Arcadia in Prehistory. *BSA* 65: 79-127.

Hughes, W.
1974 *Military Architecture*. London: Hugh Evelyn.

Hult, G.
1983 *Bronze Age Ashlar Masonry in the Eastern Mediterranean*. SIMA 66.

Iakovidis, S.
1969 Cyclopean Walls. *AAA* 3: 468-72.

1978 *Mycenae-Epidauros*. Athens: Ekdotike Athenon S.A.

1983 *Late Helladic Citadels on Mainland Greece*. Leiden: E.J. Brill.

Immerwahr, S. A.
1971 *The Athenian Agora. The Neolithic and Bronze Ages*. Vol. 13. Princeton: American School of Classical Studies.

Institute of Civil Engineers
1976 *Manual of Applied Geology for Engineers*. London: HMS.

Jantzen, U.
1975 *Führer Durch Tiryns*. Deutsches Archäeologisches Institut Athen.

Jaros, K.
1976 *Sichem*. Universtätsverlag Freiburg Schweiz.

Kalcyk, H. & Heinrich, B.
1989 The Munich Kopais Project. Boeotia Antiqua I. *Papers on Recent Work in Boiotian Archaeology and History*. J. M. Fossey, ed. Amsterdam: Gieben, 55-71.

Kanta, A.
1980 *The Late Minoan III Period in Crete. A Survey of Sites, Pottery and Their Distribution*. SIMA 58.

Kaplan, D.
1963 Men, Monuments, and Political Systems. *SJA* 19: 397-410.

Kaplan, J.
1975 Further Aspects of the Middle Bronze Age II Fortifications in Palestine. *Zeitschrift* 91: 1-17.

Karageorghis, V.
1969 *Cyprus*. London: Barrie & Rockliff.

1973 *Kition: Mycenaean and Phoenician*. Proceedings of the British Academy, Vol. 59. London: Oxford University Press.

1976 *Kition: Mycenaean and Phoenician Discoveries in Cyprus*. London: Thames & Hudson.

1982 *Cyprus. From the Stone Age to the Romans.* London: Thames & Hudson.

1983 *Annual Report of the Department of Antiquities for the Year 1982.* Nicosia

1989 The End of the Late Bronze Age in Cyprus. *The Civilizations of the Aegean and their Diffusion in Cyprus and the Eastern Mediterranean, 2000-600 BC.* V. Karageorghis, ed. Larnaca: Pierides Foundation, 93-4.

1990 *The End of the Late Bronze Age in Cyprus.* Nicosia: Pierides Foundation.

Karageorghis, V. & Demas, M.

1984 *Pyla-Kokkinokremos. A Late 13th-Century BC Fortified Settlement in Cyprus.* Cyprus: Department of Antiquities.

1985 *Excavations at Kition V. The Pre-Phoenician Levels.* Cyprus: Department of Antiquities.

1988 *Excavations at Maa-Palaeokastro 1979-1986.* Cyprus: Department of Antiquities.

Kardulias, P. N.

1992 Estimating Population at Ancient Military Sites: The Use of Historical and Contemporary Analogy. *Antiquity* 57: 276-87.

Karetsou, A.

1981 The Peak Sanctuary of Mt. Juktas. *Sanctuaries and Cults in the Aegean Bronze Age. Proceedings of the First International Symposium at the Swedish Institute in Athens, 12-13 May 1980.* R. Hägg & N. Marinatos, eds., 137-53.

Kase, E. W.

1971 A Study of the Role of Krisa in the Mycenaean Era. *AJA* 75: 205-6.

1973 Mycenaean Roads in Phocis. *AJA* 77: 74-7.

Kelm, G. & Mazor, A.

1981-83 Tel Batash (Timnah) Excavations.Second Preliminary Report (1981-1983). *Preliminary Reports of ASOR-Sponsored Excavations 1981-83.* W.E. Rast, ed. BASOR Supp. No. 23, 93-120.

1982 Three Season of Excavations at Tel Batash-Biblical Timnah. *BASOR* 248: 5-6.

Kempinski, A.

1992 The Middle Bronze Age.*The Archaeology of Ancient Israel.* A. Ben-Tor, ed. The Open University of Israel.

Kenny, C. R. J.

1935 Ancient Drainage of the Copais. *LAAA* 22: 189-206.

Kenyon, K. M.

1969 The Middle and Late Bronze Age Strata at Megiddo. *Levant* 1: 55-7.

1981 *Excavations at Jericho. Vol. III. The Architecture and Stratigraphy of the Tell.* T.A. Holland, ed. London: British School of Archaeology in Jerusalem.

Kilian, K.

1987 Altere Mykenische Residenzen. *Schriften des Deutschen Archäologen-Verbandes IX. Kolloquium zur Ägäischen Vorgeschichte Mannheim, 20-22 February 1986*, 120-4.

1988a Mycenaean Architecture. *The Mycenaean World: Five Centuries of Early Greek Culture, 1600-1100 BC*. K. Demakopoulou, ed. Athens: Greek Ministry of Culture, The National Hellenic Committee, ICOM, 30-4.

1988b Mycenaeans Up to Date. Trends and Changes in Recent Research. *Problems in Greek Prehistory*. E. B. French & K. A. Wardle, eds. Bristol Classical Press, 115-52.

1990 Mykenische Fundamentierungweisen in Tiryns. *L'Habitat Egeen Prehistorique*, 95-113.

Kochavi, M. et al

1979 'Aphek-Antipatris, Tel Poleg, Tel Zeror and Tel Burga: Four Fortified Sites of the Middle Bronze Age IIA in the Sharon Plain. *Zeitschrift* 95: 121-65.

Konsola, D.

1990 Settlement Size and the Beginning of Urbanization.*L'Habitat Egeen Prehistorique*, 463-471.

Korfmann, M.

1983 *Demirchihüyük. Die Ergebnisse der Asgrabungen 1975-1978*. Vol.I. Mainz: Philip von Zabern.

Korres, G.

1983 The Relations between Crete and Messenia. *The Minoan Thalassocracy. Myth and Reality. Proceedings of the Third International Symposium at the Swedish Institute in Athens, 31 May - 5 June 1982*. R. Hägg & N. Marinatos, eds., 141-52.

Korres, M.

1988 The Geological Factor in Ancient Greek Architecture. *EG* 3: 1779-93.

Kosay, H. Z.

1938 *Alaca Höyük hafriyati: 1936 daki çalismalar ve kesiflere ait ilk rapor*. Ankara: Türk Tarih Kurumu.

Koukis, G.

1990 Peloponnesus: History, geology and engineering geology aspects. *EG* 4: 2213-34.

Kull, B.

1988 *Demirchihüyük. Die Mittelbronzezeitliche Siedlung*. Vol. V. M. Korfmann, ed. Mainze: Philip von Zabern.

Lamb, W.

1936 *Excavations at Thermi in Lesbos*. Cambridge University Press.

Landels, J. G.

1978 *Engineering in the Ancient World.* London: Chatto & Windus.

Lapp, P. W.

1964 The 1963 Excavation at Ta'annek. *BASOR* 173: 4-44.

1967 The 1966 Excavations at Tell Ta'annek. *BASOR* 185: 2-10.

1969 The 1968 Excavations at Tell Ta'annek. *BASOR* 195: 2-49.

Lawrence, W. A.
1979 *Greek Aims in Fortification.* Oxford: Clarendon Press.

1983 *Greek Architecture.* 4th ed. Pelican History of Art.

LeBrun, A.
1984 *Fouilles Recentes à Khirokitia (Chypre) 1977-1981.* Paris: Editions Recherche.

Littauer, M. A. & Crouwel, J. H.
1979 *Wheeled Vehicles and Ridden Animals in the Ancient Near East.* Leiden: E. J. Brill.

1988 New Light on Priam's Wagon? *JHS* 108: 194-6.

Lord, L. E.
1939 Watchtowers and Fortresses in Argolis. *AJA* 43: 78-84.

Loud, G.
1948 *Megiddo III Seasons of 1935-39.* University of Chicago Press.

Luck, G.
1988 *A Dictionary of Ancient Near East Architecture.* London: Routledge.

MacAlister, R. A. S.
1902 *Reports on the Excavation of Gezer.* Palestine Exploration Fund.

1912 *The Exploration of Gezer.* Vol. I. Palestine Exploration Fund.

MacGillivray, J. A.
1980 Mount Kynthos in Delos. The Early Cycladic Settlement. *BCH* 104: 3-45.

MacGillivray, J. A. & Driessen, J.
1990 Minoan Settlement at Palaikastro. *L'Habitat Egeen Prehistorique*, 395-412.

MacGillivray, J. A., Sackett L. H. et al
1984 An Archaeological Survey of the Roussolakkos Area at Palaikastro. *BSA* 79: 129-60.

Machule, D.
1990 Tall Munbaga. Die Spätbronzezeitlich Stadtanlage und die Häuser. *Resurrecting the Past. A Joint Tribute to Adnan Bounni.* P. Matthiae et al, eds., Istanbul: Nederlands Historisch-Archaeologisch Instituut, 199-214.

Mallet, J.
1987 *Tell el-Far'ah II. Le Bronze Moyen.* Vol. I. Paris: CNRS Editions Recherche sur les Civilisations.

Marinos, G. P.
1990 Greece. *EG* 4: 2187-90.

Mastrokostas, E.
1963 'Ανασκαφη του Τειχους Δυμαιων. *PAE*: 93-8.

1964 'Ανασκαφη του Τειχους Δυμαιων. *PAE*: 60-2.

Mazar, B.
1968 Middle Bronze Age in Palestine. *IEJ* 18: 75-92.

1992 The Iron Age I.*The Archaeology of Ancient Israel.* A. Ben-Tor, ed. The Open University of Israel.

McCown, C. C. et al
1947 *Tell en-Nasbeh I. Archaeological and Historical Results.* Palestine Institute of Pacific School of Religion & ASOR.

McDonald, W. A.
1964 Overland Communications in Greece During LH III, With Special Reference to Southwest Peloponnese. *Mycenaean Studies.* E.L. Bennett Jr., ed. University of Wisconsin Press, 217-40.

McDonald, W. & Hope Simpson, R.
1961 Prehistoric Habitation in Southwestern Peloponnese. *AJA* 65: 221-60.

1964 Further Exploration in Southwestern Peloponnese: 1962-1963. *AJA* 68: 229-45.

1969 Further Exploration in Southwestern Peloponnese: 1964-68. *AJA* 73: 123-78.

McDonald, W. & Rapp, G. R.
1972 *The Minnesota Messenia Expedition.* Minneapolis: University of Minnesota Press.

McNicholl, A.
1986 Developments in Techniques of Siegecraft and Fortification in the Greek World ca. 400-100 B.C. *La Fortification dans l'Historie du Monde Grec. Actes du Colloque International, La Fortification et sa Place dans l'Histoire Politique, Culturelle et Sociale du Monde Grec. Valbonne, Décembre 1982. Centre de Recherches Archéologiques.* P. Leiriche & H. TrézIny, eds., 305-13.

Mee, C.
1978 Aegean Trade and Settlement in Anatolia in the Second Millenium BC. *AS* 28: 121-56.

1982 *Rhodes in the Bronze Age.* Warminster: Aris & Phillips.

Mee, C. & Cavanagh, W. G.
1984 Mycenaean Tombs and Social Organisation. *Oxford Journal of Archaeology* 3: 45-64.

Megaw, A. H. S.
1962-63 Archaeology in Greece, 1962-63. *Archaeological Reports.* Society for the Promotion of Hellenic Studies.

1963-64 Archaeology in Greece, 1963-64. *Archaeological Reports.* Society for the Promotion of Hellenic Studies.

Mellaart, J.
1967 *Çatal Hüyük. A Neolithic Town in Anatolia.* London: Thames & Hudson.

1970 *Excavations at Hacilar.* Occasional Publications of the British Institute of Archaeology at Ankara No. 9.

1978 *The Archaeology of Ancient Turkey.* London: The Bodley Head.

Mellaart, J. & Lloyd, S.
1965 *Beycesultan.* Vol. 2. London: British Institute of Archaeology at Ankara.

Mendelssohn, K.
1975 *The Riddle of the Pyramids.* London: Thames & Hudson.

Millard, A. R.
1991 Archaeology and Ancient Syria. *Essays on Ancient Anatolian and Syrian Studies in the 2nd and 1st Millennium BC.* Bulletin of the Middle Eastern Culture Center in Japan. Vol IV. H. I. H. Prince Takahito Mikasa, ed. Germany: Harassowitz.

Muhly, J. D.
1985 The Late Bronze Age in Cyprus: A 25 Year Retrospect. *Archaeology in Cyprus 1960-1985.* V. Karageorghis, ed. Nicosia: Leventis.

Müller, J.
1990 Arbeitsleistung und gesellschaftliche Leistung bei Megalithgräbern. Das Fallbeispiel Orkney. *Acta praehistorica et archaeologica* 22: 9-35.

Müller, S.
1991 Routes Minoennes en Relation avec le Site de Mallia. *BCH* 115: 545-60.

1992 Delphes et sa region à l'époque Mycénienne. *BCH* 116: 445-96.

Mylonas, G.
1934 Excavations at Hagia Kosmas. *AJA* 38: 258-79.

1957 *Ancient Mycenae.* London: Routledge and Kegan.

1966 *Mycenae and the Mycenaean Age.* Princeton University Press.

1968 *Mycenae's Last Century of Greatness.* Australian Humanities Research Council. Occasional Paper 13. Sydney University Press.

1970 *Mycenae. A Guide to its Ruins and its History.* 2nd ed. Athens.

Naumann, R.
1955 *Architektur Kleinasiens.* Tübingen: Deutsches Archäologisches Institut.

Nicolas, A.
1984 *Principles of Rock Deformation.* S. W. Morel, trans. Paris: Masson.

Nowicki, K.
1987 Settlements of Refuge in Crete. *Schriften des Deutschen Archäologen-Verbandes IX. Kolloquium zur Ägäischen Vorgeschichte. Mannheim, 20-22 February 1986,* 83-87.

1990 The West Siteia Mountains at the Turn of the Bronze and Iron Ages. *Aegaeum* 6: 161-82.

O'Neill, H.
1965 *Stone for Building*. London: Heinemann.

Ohata, K.
1966 *Tel Zeror I. Preliminary Report of the Excavation First Season 1964*. Japan: Society for Near Eastern Studies.

Oldfather, W. A.
1916 Studies in the History and Topography of Locris. *AJA* 20: 32-61.

Orton, A.
1992 *Structural Design of Masonry*. 2nd ed. London: Longman.

Overbeck, J. C.
1989 *Ayia Irini: Period IV. Part I: The Stratigraphy and the Find Deposits*. Mainz: Philipp von Zabern.

Papadopoulos, T.
1990 Settlement Types in Prehistoric Epirus. *L'Habitat Egeen Prehistorique*, 359-367.

Papageorgakis, J. & Mposkos, E.
1988 Building Stones of the Minoan Palace of Knossos. *EG* 3: 649-59.

Parr, P. J.
1968 The Origin of the Rampart Fortifications of Middle Bronze Age Palestine and Syria. *Zeitschrift* 84: 18-45.

Pelon, O.
1976 *Tholoi, Tumuli et Cercles Funéraires. Recherches sur les monuments funéraires de plan circulaire dans l' Egée de l' âge du Bronze*. École Française d' Athènes.

Pendlebury, J. D. S.
1939 *Archaeology of Crete*. London: Methuen.

Persson, A. W.
1931 *The Royal Tombs at Dendra Near Midea*. Oxford University Press.

1942 *New Tombs at Dendra near Midea*. Oxford University Press.

Philippaki, B.
1978 'Ανασκαφη ακροπολεως 'Αγ. 'Ανδρεου Σιφνου. *PAE*: 192-4.

Piggott, S.
1979 The First Wagons and Carts: Twenty-five Years Later. *University of London Institute of Archaeology Bulletin* 16: 3-17.

1983 *The Earliest Wheeled Transport*. Thames & Hudson.

Pommerantz, I.
1982 *Excavations and Surveys in Israel*. Jerusalem: Archaeological Newsletter of the Israel Department of Antiquities and Museums, 1 (78-81).

1983 *Excavations and Surveys in Israel*. Jerusalem: Archaeological

Newsletter of the Israel Department of Antiquities and Museums, 2 (82-83).

1984 *Excavations and Surveys in Israel.* Jerusalem: Archaeological Newsletter of the Israel Department of Antiquities and Museums, 3 (84-85).

1985 *Excavations and Surveys in Israel.* Jerusalem: Archaeological Newsletter of the Israel Department of Antiquities and Museums, 4 (86-87).

1986 *Excavations and Surveys in Israel.* Jerusalem: Archaeological Newsletter of the Israel Department of Antiquities and Museums, 5 (88-89).

1987-88 *Excavations and Surveys in Israel.* Jerusalem: Archaeological Newsletter of the Israel Department of Antiquities and Museums, 6 (90-91).

Pommerantz, I. & Hurowitz, A.
1988-89 *Excavations and Surveys in Israel.* Jerusalem: Archaeological Newsletter of the Israel Department of Antiquities and Museums, 7-8 (92-93).

1989-90 *Excavations and Surveys in Israel.* Jerusalem: Archaeological Newsletter of the Israel Department of Antiquities and Museums, 9 (94-95).

Prausnitz, M. W.
1975 The Planning of the Middle Bronze Age Town at Achzib and its Defences. *IEJ* 25: 202-10.

Prentice J. E.
1990 *Geology of Construction Materials.* Topics in Earth Sciences 4. London: Chapman & Hall.

Pritchard, J. B.
1961 *The Water System at Gibeon.* University of Pennsylvania: The University Museum.

1985 *Tell es-Sa'idiyeh: Excavations on the Tell, 1964-1966.* University Museum Monograph 60. University of Pennsylvania.

Pritchett, W. K.
1980 *Studies in Ancient Greek Topography. Part III.* University of California Press.

Pulak, C.
1988 The Bronze Age Shipwreck at Ulu Burun, Turkey: 1985 Campaign. *AJA* 92: 1-37.

Pullen, D. J.
1992 Ox and Plow in the Early Bronze Age Aegean. *AJA* 96: 45-54.

Reimbert, M. & Reimbert, A.
1974 *Retaining Walls. Anchorages and Sheet Piling. Theory and Practice.* Vol. I. Germany: Trans Tech Publications.

Renfrew, C.
1972 *The Emergence of Civilisation. The Cyclades and the Aegean in the Third Millenium BC.* London: Methuen.

1973 Monuments, mobilization and social organization in neolithic Wessex. *The Explanation of Culture Change.* C. Renfrew, ed. London: Duckworth, 539-58.

1978 The Mycenaean sanctuary at Phylakopi. *Antiquity* 52: 7-15.

1982 *Bronze Age Melos. An Island Polity. The Archaeology of Exploitation in Melos.* C. Renfrew & M. Wagstaff, eds. Cambridge University Press, 35-43.

1985 *The Archaeology of Cult. The Sanctuary at Phylakopi.* BSA Supp. 18. Oxford: Alden Press.

Richard, S.
1983-87 The 1987 Expedition to Khirbet Iskander and its Vicinity: Fourth Preliminary Report. *Preliminary Reports of ASOR-Sponsored Excavations 1983-87.* BASOR Supp. No. 26, W.E. Rast, ed. ASOR, 33-58.

Richard, S. & Boraas, R.
1982-85 The Early Bronze IV Fortified Site of Khirbet Iskander, Jordan: Third Preliminary Report, 1984 Season. *Preliminary Reports of ASOR-Sponsored Excavations 1982-85.* BASOR Supp. No. 25, W. E. Rast, ed. ASOR, 107-130.

Robertson, D. S.
1964 *Greek and Roman Architecture.* 2nd ed. Cambridge University Press.

Rodrigues, J. D.
1988 Dry-stone Wall Monuments--Structural behaviour, disturbing mechanisms and conservation procedures. *EG* 2: 1001-6.

Rolland, N.
1989 Observations on the Pre-Neolithic Human Occupation in the Kopais Basin. Boeotia Antiqua I. *Papers on Recent Work in Boiotian Archaeology and History.* J. M. Fossey, ed. Amsterdam: Gieben, 23-53.

Rutkowski, B.
1986 *The Cult Places of the Aegean.* Yale University Press.

Rutter, J. B.
1974 *The Late Helladic IIIB and IIIC Periods at Korakou and Gonia in the Corinthia.* PhD diss. University of Pennsylvania.

Sanders, G. D. R. & Whitbread, I. K.
1990 Central places and major roads in the Peloponnese. *BSA* 85: 333-61.

Schilardi, D. U.
1975 'Αρχαιολογικαι ερευναι 'εν Παρω. *PAE*: 175-211.

1979 The Destruction of the LH IIIB Citadel of Koukounaries on Paros. *Papers in Cycladic Prehistory.* J. L. Davis & J. F. Cherry, eds. California: Institute of Archaeology, 158-79.

1984 The LH IIIC Period at the Koukounaries Acropolis, Paros. *The Prehistoric Cyclades*. J. A. MacGillivray, & R. L. N. Barber, eds. Edinburgh: Department of Classical Archaeology, 184-206.

1987 'Ανασκαφη Παρου. *PAE*: 217-40.

1988 'Ανασκαφη Παρου. *PAE*: 184-207.

Schlanger, N.
1987 Untersuchungen zur Prähistorischen Topographie im Aussersten Südosten Kretas: Zakros bis Xerokampos. *Schriften Deutschen Archäologen-Verbandes IX. Kolloquium zur Ägäischen Vorgeschichte Mannheim, 20-22 February 1986*, 64-77.

Schliemann, H.
1967 *Mycenae*. 2nd ed. New York: Benjamin Blom.

Scholes, K.
1956 The Cyclades in the Later Bronze Age: A Synopsis. *BSA* 51: 9-40.

Schoder, R. V.
1974 *Ancient Greece from the Air*. London: Thames & Hudson.

Scoufopoulos, N.
1971 *Mycenaean Citadels*. SIMA 23.

Scranton, R. L.
1941 *Greek Walls*. Harvard University Press.

Seger, J. D. et al
1983-87 The Bronze Age Settlements at Tell Halif: Phase II Excavations, 1983-1987. *Preliminary Reports of ASOR-Sponsored Excavations 1983-87*. BASOR Supp. No. 26, W. E. Rast, ed. ASOR, 1-32.

Shaw, J. W.
1973 *Minoan Architecture: Materials and Techniques*. Annuario della Scuola Archeologica di Atene 49. Roma: Instituto Poligrafico dello Stato.

1983 The Development of Minoan Orthostats. *AJA* 86: 213-16.

1993 The Monumental Ashlar Buildings. Excavations at Kommos (Crete) During 1986-1992. *Hesp* 62: 161-188.

Sinclair, T. A.
1987 *Eastern Turkey: An Architectural and Archaeological Survey*. Vol. I. London: Pindar Press.

1989 *Eastern Turkey: An Architectural and Archaeological Survey*. Vol. II. London: Pindar Press.

1989 *Eastern Turkey: An Architectural and Archaeological Survey*. Vol. III. London: Pindar Press.

1990 *Eastern Turkey: An Architectural and Archaeological Survey*. Vol. IV. London: Pindar Press.

Slenczka, E.
1975 Damm und Kanal bei Kofini. *Führer Durch Tiryns*. U. Jantzen, ed. Deutsches Archäeologisches Institut Athen.

Sowers, G. F.
1962 *Earth and Rockfill Dam Engineering*. Bombay: Asia Publishing House.

Spence, Y.
1990 Was There a Guarded Southern Entrance Way to the First Palace at Mallia? *BSA* 85: 369-74.

Sperling, J.
1942 Explorations in Elis, 1939. *AJA* 46: 77-89.

Startin, B. & Bradley, R.
1981 Some notes on Work Organisation and Society in Prehistoric Wessex. *Astronomy and Society in Britain during the period 4000-1500 BC*. C. Ruggles & A. Whittle, eds. Oxford: BAR 88, 286-96.

Steffen
1884 *Karten von Mykenai*. Berlin: Dietrich Reimer.

Stevens, G. P.
1946 Architectural Studies Concerning the Acropolis of Athens. *Hesp* 15: 71-106.

Stos-Gale, Z. A. & Gale, N. H.
1990 The Role of Thera in the Bronze Age Trade in Metals. *Thera and the Aegean World III. Vol. 1. Proceedings of the Third International Congress, Santorini, Greece, 3-9 September 1989*. D. A. Hardy et al, eds. London: The Thera Foundation, 72-92.

Summers, G. D.
1993 *Tille Höyük 4. The Late Bronze Age and the Iron Age Transition*. British Institute of Archaeology at Ankara. Monograph No. 15.

Taylour, W. D.
1972 Excavations at Ayios Stephanos. *BSA* 67: 205-70.

1983 *The Mycenaeans*. rev.ed. London: Thames & Hudson.

Themelis, P.
1984 Early Helladic Monumental Architecture. *AM* 99: 335-51.

Toombs, L. E. & Wright, G. E.
1963 The Fourth Campaign at Balatah (Shechem). *BASOR* 169: 1-60.

Torrence, R.
1986 *Production and Exchange of Stone Tools. Prehistoric Obsidian in the Aegean*. Cambridge University Press.

Touchais, G.
1977 Chronique des Fouilles. *BCH* 101: 513-666.

1978 Aspis. Rapports sur les Travaux de l'École Française en Grèce. *BCH* 102: 798-802.

1984 Aspis. Rapports sur les Travaux de l'École Française en Grèce en 1983. *BCH* 108: 850-1.

Trigger, B. G.
1990 Monumental Architecture: a thermodynamic explanation of symbolic

behaviour. *World Archaeology* 22: 119-132.

Tsipopoulou, M.
1989 *Archaeological Survey at Aghia Photia, Siteia*. SIMA Pocketbook 76.

1990 Νεα Στοιχεια για τη Μινωικη Κατοικηση Στην Περιοχη τηςΠοληςτης Σητειας. Πεπραγμενα του Στω Διεθνους. Chania.

1991 Ερευνα Στον Πετρα Σητειας 1987. *AAA*.

Tubb, J.
1988 Tell es' Sa'idiyeh. Preliminary Report on the First Three Seasons of Renewed Excavations. *Levant* 20: 23-88.

1991 Preliminary Report on the Fifth (1990) Season of Excavations at Tell es-Sa'idiyeh. *Annual of the Department of Antiquities of Jordan* 35: 181-9.

Tucker, M. E.
1982 *The Field Description of Sedimentary Rocks*. Geological Society of London Handbook.

Tufnell, O. et al
1958 *Lachish IV. The Bronze Age*. Oxford University Press.

Tufnell, R.
1991a *Better Dry Stone Walling*. I. Deward, ed. Dry Stone Walling Association of Great Britain.

1991b *Building and Repairing Dry Stone Walls*. Dry Stone Walling Association of Great Britain.

Tzedakis, Y. et al
1989 Les Routes Minoennes: Rapport Préliminaire. Defénse de la Circulation ou Circulation de la Defénse. *BCH* 113: 43-75.

Ünal, A.
1991 Two Peoples on Both Sides of the Aegean: Did the Achaeans and the Hittites Know Each Other? *Essays in Anatolian and Syrian Studies in the 2nd and 1st Millennium BC*. HIH Prince Takahito Mikasa, ed. Wiesbaden: O. Harrassowitz, 16-44.

United States Department of the Interior
1965 *Design of Small Dams*. 3rd ed. Washington: Government Printing Office.

Ussishkin, D.
1985 Level VII and VI at Tel Lachish and the End of the Late Bronze Age in Canaan. *Palestine in the Bronze and Iron Ages. Papers in Honour of Olga Tufnell*. J. N. Tubb, ed. London Institute of Archaeology, 213-30.

1989 Notes on the Fortifications of the Middle Bronze II Period at Jericho and Shechem. *BASOR* 276: 29-53.

Van Der Osten, H.
1937 *The Alishar Hüyük Season of 1930-32. Part II*. University of Chicago Press.

Van Horn, D. M.
1976 *Bronze Age Chipped Stone Tools from the Argolid of Greece and Their Relation to Tools Manufactured from Other Materials*. PhD diss.

University of Pennsylvania.

Vatin, C.
1976 *Médéon de Phocide*. Paris: École Française d' Athènes.

Verdelis
1963 Neue Geometrische Gräber in Tiryns. *AM* 78: 1-5.

Vermeule, E.
1964 *Greece in the Bronze Age*. University of Chicago Press.

Vita-Finzi, C.
1969 *The Mediterranean Valleys. Geological Changes in Historical Times.* Cambridge University Press.

Voigtländer, W.
1973 Tiryns. Unterburg--Kampagne 1972. *AAA*: 28-39.

Voutsaki, S.
1992 *Society and Culture in the Mycenaean World: An Analysis of Mortuary Practices in the Argolid, Thessaly and the Dodecanese.* PhD Thesis, University of Cambridge.

Wace, A. J. B.
1949 *Mycenae. An Archaeological History and Guide.* Princeton University Press.

Wace, A. J. B. & Hasluck, F. W.
1904-05 Laconia II. Geraki. *BSA* 11: 91-9.

Wace A. J. B. & Thompson, M. S.
1912 *Prehistoric Thessaly*. 2nd ed. Cambridge University Press.

Wace A. J. B. et al
1921-23 Excavations at Mycenae. *BSA* 25: 1-434.

1953 Mycenae 1939-1952. *BSA* 48: 3-93.

1954 Mycenae 1939-1953. *BSA* 49: 231-98.

1955 Mycenae 1939-1954. *BSA* 50: 175-250.

Wagstaff, M. & Cherry, J. F.
1982 Settlement and Resources. *An Island Polity. The Archaeology of Exploitation in Melos.* Cambridge University Press, 246-63.

Wallace, P. W.
1973 Gla and the Kopaic Drainage System--Mycenaean Cooperative Projects? *AJA* 77: 230-1.

1974 Herakles and the Dikes. *AJA* 78: 182-3.

Walter, H.
1983 *Die Leute im alten Ägina 3000-1000 v. Chr.* Stuttgart: Urachhaus.

Walters, R. C. S.
1962 *Dam Geology*. London: Butterworths.

Wardle, K. A.
1972 Two Notes from Knossos. *BSA* 67: 283-4.

Warren, P.
1969 *Minoan Stone Vases*. Cambridge University Press.

1975 *The Aegean Civilizations*. Elsevier Phaidon.

1994 The Minoan Roads of Knossos. *Knossos. A Labyrinth of History. Papers Presented in Honour of Sinclair Hood.* D. Evely et al, eds. The British School at Athens. Oxford: Oxbow, 189-210.

Waterhouse, H. & Hope Simpson, R.
1960 Prehistoric Laconia: Part I. *BSA* 55: 67-107.

1961 Prehistoric Laconia: Part II. *BSA* 56: 114-75.

Watrous, L. V.
1974 Review of the 'The Minesota Messenia Expedition'. *AJA* 78: 84-6.

Weinberg, S.
1983 *Bamboula at Kourion: The Architecture.* Pennsylvania: University Museum.

Weiss, H.
1994 Archaeology in Syria. *AJA* 98: 101-58.

Wells, B. et al
1990 The Berbati-Limnes Archaeological Survey. The 1988 Season. *Opuscula Atheniensia* 18: 207-38.

Wiener, M. H.
1990 *The Isles of Crete? The Minoan Thalassocracy Revisited. Thera and the Aegean World III. Vol. I. Proceedings of the Third International Congress, Santorini, Greece, 3-9 September 1989.* D. A. Hardy et al, eds. London: The Thera Foundation, 128-61.

Whittle, A.
1988 Megaliths and monuments: the uses of privacy. *Problems in Neolithic Archaeology*. Cambridge University Press, 164-85.

1993 The Neolithic of the Avebury Area: Sequence, Enviornment, Settlement and Monuments. *Oxford Journal of Archaeology* 12: 29-53.

Wildgoose, M.
1991 The Drystone Walls of Roystone Grange. *The Archaeological Journal* 148: 205-40.

Wilkie, N. C. & McDonald, W. A.
1984 How the Mycenaeans Buried Their Dead: New Evidence from the Nichoria Tholos. *Archaeology* 37: 40-7.

Winkler, E. M.
1975 *Stone: Properties, Durability in Man's Environment.* 2nd ed. Wien: Springer-Verlag.

Winter, F. E.
1971 *Greek Fortifications*. University of Toronto Press.

1972 Review of Niki Scoufopoulos' "Mycenaean Citadels". *AJA* 76: 334.

Wolff, S. R.
1994 Archaeology in Israel. *AJA* 98: 491-519.

Wright, G. E.
1956 The First Campaign at Tell Balatah (Shechem). *BASOR* 144: 9-20.

1957 The Second Campaign at Tell Balatah (Shechem). *BASOR* 148: 11-28.

Wright, J. C.
1978 *Mycenaean Masonry and Techniques*. unpub. PhD diss. Bryn Mawr College.

1980 Mycenaean Palatial Terraces. AM 95: 59-86.

1982 The Old Temple Terrace at the Argive Heraeum and the Early cult of Hera in the Argolid. *JHS* 102: 186-201.

1987 Death and Power at Mycenae: Changing Symbols in Mortuary Practice. *Aegaeum* 1: 171-84.

Wycherley, R. E.
1978 *The Stones of Athens*. Princeton University Press.

Xidakis, G. S. et al
1988 Building Stones and Geological Environment in Three Ancient Cities of the Aegean Thrace, Greece. *EG* 2: 607-18.

Yadin, Y.
1955 Hyksos Fortifications and the Battering-ram. *BASOR* 137: 23-32.

1975 *Hazor. The Rediscovery of a Great Citadel of the Bible*. Jerusalem: Weidenfeld & Nicolson.

Yakar, J.
1991 *Prehistoric Anatolia. The Neolithic Transformation and the Early Chalcolithic Period*. Jerusalem: Institute of Archaeology of Tel Aviv University.

Young, J. H.
1948 Cyprus. *AJA* 52: 530-3.

Zangger, E.
1994 Landscape Changes Around Tiryns During the Bronze Age. *AJA* 98: 189-212.