

Meditations on the Diversity of the Built Environment in the Aegean Basin and Beyond

Proceedings of a Colloquium in Memory
of Frederick E. Winter

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RODNEY D. FITZSIMONS

An Energetic(s) Approach to Late Helladic Tomb Construction: Funerary Architecture and State Formation at Bronze Age Mycenae

Introduction¹

Prior to the appearance of the first palatial structures on the acropolis of Mycenae toward the end of the 15th century B.C. (LH IIIA1), the most impressive architectural manifestation of elite authority was not the palace, or even the house, but rather the tomb, specifically the shaft grave and the tholos tomb. The former, which appears to have developed from earlier Middle Helladic burial practices, dominated the funerary landscape around Mycenae during the 18th and 17th centuries B.C., while the latter, a form borrowed from the mortuary traditions of southwest Messenia, rose to prominence in the 16th and 15th centuries B.C.² Not surprisingly, the funerary data supplied by these graves have long served as the primary means by which scholars have approached the study of Early Mycenaean state formation.³ For the most part, however, such studies have tended to focus almost exclusively on the grave goods that were deposited in the tombs, rather than on the tombs themselves. Indeed, while almost all

¹ I am grateful to Professor David W. Rupp and Jonathan Tomlinson, the Director and Assistant Director of the Canadian Institute in Greece, for the opportunity to participate in the conference at which this paper was first presented, and for the opportunity to contribute to this volume. Thanks also to Catherine Georgana for her help with my presentation.

² Cavanagh and Mee 1998.

³ For recent discussions and summaries of the early Mycenaean period, see, for example, Graziadio 1988, 1991; Dietz 1991; Voutsaki 1995, 1999, 2001, 2010a, 2010b; Wright 1995, 2004, 2008a, 2008b; Cavanagh and Mee 1998; Rutter 2001, pp. 124-143; Shelmerdine 2001, pp. 352-353; Shelton 2010.

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discussions of Early Mycenaean state formation provide some sort of qualitative description of the tomb structure that served to house the artifacts being examined, there has been little systematic research conducted on the funerary architecture itself from a quantitative perspective, an approach that has been dubbed “architectural energetics.”⁴

This paper seeks to expand upon some early research conducted by the author on monumental architecture and early state formation at Mycenae by applying an energetics approach to the shaft graves and tholos tombs that were constructed at the site of Mycenae in the Early Mycenaean Period.⁵ The research presented here is still in its formative stages, and any observations and interpretations offered below are admittedly tentative and preliminary in nature. The goals of this paper are therefore modest, but twofold: to demonstrate the enormous potential that an energetics approach can provide to the study of Early Mycenaean state formation, and to highlight two new avenues of approach that such a line of inquiry opens up.

Architectural Energetics

The central assumption behind the theory of architectural energetics is that the quantity of labor expended upon any particular architectural project correlates more-or-less directly with the socio-political complexity of the society that produced it.⁶

⁴ Indeed, while it has been widely observed that architecture can be studied from a variety of perspectives (Blier 1987; Abrams 1989, pp. 48-52; Abrams and Bolland 1999, pp. 263-264), rarely have these perspectives been fully explored and exploited (Oliviera 1986, p. 103; Gilman 1987, p. 538; Abrams 1989, pp. 48-49).

⁵ Fitzsimons 2006, 2007, 2011.

⁶ Udy 1959; Abrams 1987, 1989, 1994; Mathewson 1987, pp. 321-322; Carmean 1991; Webster 1991, p. 840; Abrams and Bolland 1999. For similar arguments based upon labor investment in other artifactual categories, see Price 1982. For labor investment and transport costs, see Adams 1978; Hammond 1978; Tourtellot 1978; Drennan 1984a, 1984b. For energetics studies based upon caloric intake, see Shimada 1978; Drennan 1984a.

Using this approach, individual structures, discrete portions thereof, or even widespread and durative building programs, can be analyzed on a sort of piece-work basis, thus generating precise calculations for the amount of time and manpower required for their execution, and rough estimates of the size of the population pool that supplied the necessary labor force. Since one aspect of social and political power is defined by differential access to human labor resources,⁷ the values generated by such studies serve as quantifiable and easily comparable measures of the power and status of those individuals or groups responsible for their undertaking.⁸

Although the term “architectural energetics” was only coined in 1987,⁹ the notion that monumental buildings and landscape modifications served as direct reflections of the socio-political systems that produced them dates back to the very end of the 18th century.¹⁰ In 1799, the Prussian geographer, Alexander von Humboldt, embarked on a five-year expedition through northern and western South America, Cuba, central Mexico and the northeastern United States, bringing with him a keen interest not only in the standing monuments left behind by the prehistoric cultures that inhabited these regions, but more importantly in understanding the social, political and economic contexts in which such building programs were executed.¹¹ This interest found its clearest expression in the volumetric estimates he made of the Pyramid of the Sun at Teotihuacan in 1803 and the conclusions about labor investment that he derived from them.¹² Similar quantitative approaches to the built environment appeared

⁷ Fried 1967, pp. 186, 189-190, 207-213; Wright 1978; Haviland 1982; Price 1982; Renfrew 1984; Hayden 1995; Oliveira 1986, p. 105; Abrams 1987, 1989, 1994; Trigger 1990; Carmean 1991; Earle 1991a, 1997, pp. 85-86, 156-157, 177-179; Chase and Chase 1992; Abrams and Bolland 1999, pp. 267, 268; Clare 2010.

⁸ Abrams and Bolland 1999, p. 271.

⁹ Abrams 1987.

¹⁰ For a brief summary of the history of architectural energetics studies, see Abrams 1994, pp. 5-6; Abrams and Bolland 1999, pp. 269-272.

¹¹ For a discussion of von Humboldt's contributions to the fields of architectural study and landscape archaeology, see Mathewson 1986, 2006.

¹² Mathewson 1986, p. 54, 1987, pp. 324-325.

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sporadically over the next century and a half,¹³ but despite the obvious potential of such studies it was not until the 1950's that the relationship between the built environment and socio-political organization began to be explored in any systematic fashion. This renewed interest was prompted, in part, by the efforts of modern civil engineers working on Third World developmental projects following the end of the Second World War that produced a wealth of data on digging rates under a variety of conditions and employing a variety of excavation, lifting and transportation devices.¹⁴ Around the same time, a number of ethnographic studies on the constructional capabilities of pre-industrial societies began to appear,¹⁵ as did a variety of experimental investigations into the construction of earthen mounds, stone temples, and other ceremonial structures,¹⁶ which themselves prompted further, "second generation" studies that served to establish architectural energetics as a viable approach to understanding socio-political development.¹⁷

Perhaps the most important study on labor investment in architecture is that published in 1965 by Charles Erasmus,¹⁸ who hired a group of local Mayan workers in Sonora, Mexico, to perform a variety of building tasks, such as excavating and transporting earth and rock using various tools, and facing and sculpting stone walls. Using the figures he derived from these experiments, Erasmus proceeded to calculate the number of

¹³ See, for example, Squier and Davis 1848; Andrews 1877; Morris, Charlot and Morris 1931.

¹⁴ Indian Ministry of Irrigation and Power 1965, cited in Mathewson 1987, p. 323.

¹⁵ See, for example, Barrau 1958, 1961; Redfield and Villa Rojas 1962; Pospisil 1963; Lerche and Steensburg 1973; Gorecki 1985; Blier 1987.

¹⁶ See, for example, Atkinson 1961; Coles 1973, pp. 131-158.

¹⁷ See, for example, Puleston 1977; Turner 1983; Erickson 1985; Turner and Denevan 1985, pp. 15-16; Abrams 1994, pp. 41-52. For a recent selection of energetics studies, see, for example, Arnold and Ford 1980; Folan et al. 1982; Renfrew 1983; Cheek 1986; Abrams 1987, 1989, 1994; Muller 1986, pp. 99-93, 99-103, 200-204; Mathewson 1987; Carmean 1991; Earle 1991b; Webster 1991; Kolb 1994, 1997; Webster and Kirker 1995; Abrams and Bolland 1999; de Haan 2009; Erickson 2010.

¹⁸ Erasmus 1965.

workmen, the quantity of foodstuffs and the amount of time it would have taken to construct the Mayan ceremonial center at Uxmal. Given the number of environmental, technological, temporal and demographic variables that limit the accuracy and efficacy of these sorts of data,¹⁹ it is perhaps not surprising that Erasmus' conclusions have not received universal acceptance.²⁰ Experimental analyses conducted by Turner on Mayan raised field systems,²¹ and by Golson and Steenburg on agricultural practices in New Guinea,²² for example, have produced figures that vary by as much as a factor of ten or more from those published by Erasmus.²³ Nevertheless, numerous subsequent studies, such as Puleston's experimental work on raised field agriculture in Belize and McEwan's investigation of building practices in the Andean state of Pikillacta,²⁴ have yielded data very similar to those produced by Erasmus, thus providing strong support for their general reliability.²⁵

Energetics Studies in the Bronze Age Aegean

Somewhat surprisingly, it has only been fairly recently that scholars have begun to apply an energetics approach to the

¹⁹ Abrams 1987, pp. 487-488; Mathewson 1987, pp. 322-328.

²⁰ For reference to the difficulties involved in such calculations, see for example, Arnold and Ford 1980; Folan et al. 1982; Haviland 1982; Abrams 1994, pp. 54-55; Abrams and Bolland 1999, pp. 265-267.

²¹ Turner 1983.

²² Golson and Steenburg 1985.

²³ See also Erickson 1985.

²⁴ Puleston 1977; McEwan 2005.

²⁵ Webster and Kirker 1995, pp. 379, 380. Indeed, Erasmus' figures still serve as the foundation for most energetics studies, as for example, those conducted by Abrams (1987, 1989, 1994; Abrams and Bolland 1999), Arnold and Ford (1980), Carmean (1991), Erickson (2010), Kolb (1994), Mathewson (1987), Muller (1986), Topic (1991), Webster (1991), and Webster and Kirker (1995), to name but a few. Note, however, that such calculations of labor expenditure are, by design, intended to represent estimates, rather than absolutes (Abrams 1987, pp. 490-491; Webster and Kirker 1995, pp. 379-380; Abrams and Bolland 1999, pp. 265, 283).

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architectural remains of the Bronze Age Aegean. A relatively early attempt to incorporate energetics into the study of Early Mycenaean state formation was made in 1987 by Wright, who drew upon Atkinson's study of megalithic architecture in Neolithic Britain²⁶ to estimate the number of man-days required for the initial stages of construction of Shaft Grave V and the Tomb of Aigisthos at Mycenae.²⁷ Despite the enormous potential offered by the approach advocated by Wright, however, the first such study published in any detailed fashion did not appear until over a decade later, with Cavanagh and Mee's calculation that 20,000 man-days were required for the construction of the Treasury of Atreus at Mycenae.²⁸ Aside from observing that a similar figure was yielded by Burford in her study of the Temple of Asklepios at Epidauros,²⁹ however, and suggesting that the tomb had been built for the *wanax* of Mycenae,³⁰ the authors could do little with the figures they generated in the absence of similar studies on comparable Bronze Age constructions. This lacuna is now beginning to be filled, however, with the work of Devolder, who has undertaken labor cost analyses on a number of Minoan structures, both palatial and 'vernacular', and from them drawn several, tentative, yet insightful, conclusions regarding the social, political and demographic nature of the local communities,³¹ and the author, whose research into Early Mycenaean architecture forms the basis for this paper.³²

²⁶ Atkinson 1961.

²⁷ Wright 1987.

²⁸ Cavanagh and Mee 1999.

²⁹ Burford 1969, pp. 246-251; Cavanagh and Mee 1999, p. 99.

³⁰ Cavanagh and Mee 1999, p. 100.

³¹ Devolder 2008, 2009a, 2009b, forthcoming.

³² Fitzsimons 2006, 2007, 2011.

The Shaft Graves

Of the 33 graves contained within Grave Circles A and B,³³ 27 (6 cist graves and 21 shaft graves) were preserved well enough and/or published in sufficient enough detail to allow their subjection to an energetics study, which included calculations for the time required for the excavation and removal of the topsoil and bedrock, the facing of the exposed bedrock, the procurement of the building materials (including stone, wood, pebbles, and water [for mudbrick], where appropriate), the manufacture and laying of the mudbrick, the transport and laying of the masonry elements, and the filling of the shaft (Table 1).³⁴ Preliminary examination of these calculations yields some interesting observations, the first of which is perhaps the least surprising: the amount of labor investment required for the construction of a shaft grave almost always exceeded that required for the excavation of a cist grave (Chart 1). What is perhaps surprising, however, is the magnitude of the difference. For example, while a gang of five men could have built the largest cist grave, A², in slightly less than three days (14 man-days of labor), that same team of laborers would have had to spend 22 days to finish Grave Γ (106 man-days of labor), and just over 97 days (485 man-days of labor) to complete Shaft Grave IV. While more demanding projects such as these may well have taken longer to bring to completion than the excavation of smaller graves, it is difficult not to conclude that their execution would also have involved much

³³ In addition to the canonical list of 25 graves usually associated with Grave Circle B, Mylonas (1957, pp. 148, 153) mentioned two additional burials (one (SOMA located between Graves A and Δ, the other between Graves Ξ and Π) that were not provided with any physical descriptions. Grave P was also excluded from the study because of its unique form and late (LH IIA) date (Mylonas 1957, pp. 158-165; Dietz 1991, pp. 130-131; Fitzsimons 2006, pp. 55-57).

³⁴ The basic data for these various construction activities was taken from Erasmus 1965, and supplemented with additional data from Abrams 1989, table 2.1; Webster and Kirker 1995, pp. 370-371; McEwan 2005, pp. 73-74. The measurements and description of built elements were drawn from Gates 1985, pp. 272-274; Graziadio 1988, 1991; Dietz 1991, pp. 106-132, 247-250. See, also, Fitzsimons 2006, pp. 61-66.

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larger workforces. If such is the case, then it is also reasonable to conclude that one significant aspect of the power and status held and exercised by the new elite class for which these tombs were being constructed was its ability to acquire, direct and presumably reward substantial pools of laborers.³⁵

Grave	Type	Man-Days for Excavation	Man-Days for Construction Elements	Total Man-Days
A	shaft	86	3	89
A ²	cist	12	2	14
B	shaft	25	4	29
Γ	shaft	99	7	106
Δ	shaft	34	3	37
E	shaft	52	3	55
Z	cist	7	3	10
H	cist	3	1	4
I	shaft	40	3	43
K	shaft	19	2	21
Λ	shaft	22	3	25
Λ ²	cist	2	3	5
M	shaft	26	2	28
N	shaft	43	6	49
Ξ	shaft	15	5	20
O	shaft	94	6	100
Π	shaft	9	1	10
Σ	cist	8	3	11
T	shaft	13	3	16
Y	shaft	13	1	14
Φ	cist	4	3	7
I	shaft	243	14	237
II	shaft	64	7	71
III	shaft	135	8	143
IV	shaft	467	18	485
V	shaft	317	11	328
VI	shaft	79	7	86

*Table 1. Labor investment for graves in Grave Circles A and B
(organized in alphabetical order)*

A second observation concerns the difference in scale between the graves in the two Grave Circles (Chart 2). Again, while it is perhaps not surprising that the more expensive tombs are to

³⁵ Fitzsimons 2006, pp. 83-86, 2007, p. 99, 2011, pp. 82-83.

be found in Grave Circle A, which is after all slightly later in date and which did produce a much richer selection of grave goods, the magnitude by which the three largest examples exceed their counterparts in Grave Circle B is nevertheless striking. One explanation for this phenomenon is that what we are seeing is the product of a reorganization of the socio-political landscape that occurred during the transitional period when both Grave Circles were in use, a reorganization that resulted in the appearance of new, larger elite factions formed (at least in part) through the absorption of the members of older factions who gradually emerged as unsuccessful competitors in the ongoing struggle for power and status.³⁶ The leaders of these newer factions, having assumed positions of authority over larger segments of the population, would then have been able to draw upon greatly expanded supplies of human labor for their construction needs.

Some support for this competitive scenario can be found by examining the data for labor investment in Grave Circle B from a diachronic perspective. Despite the fact that these tombs have yielded a large quantity of complete and partial vessels, it has proven extremely difficult to establish a firm sequence for the deposition of the individual burials.³⁷ Indeed, as a comparison of three frequently-cited sequences demonstrates (Table 2), it is clear that the establishment of a widely, or even generally, accepted order of construction remains elusive, and as a result, interpretations of the social and political implications indicated by the diachronic use of the Grave Circle are similarly varied.³⁸ Thus, while Dickinson envisioned a steady and gradual increase in the wealth and prosperity of the occupants of Grave Circle B over time (Chart 3), culminating in the appearance of the burials in Grave Circle A,³⁹ Graziadio imagined an initial rise and a subsequent drop

³⁶ This notion parallels the Principle of Competitive Exclusion, drawn from economic theory (see Carneiro 1967, 1978).

³⁷ Dietz 1991, p. 106; Fitzsimons 2006, pp. 48-52, 2011, p. 85.

³⁸ Dietz (1991, pp. 25-26, 243-246) did not comment explicitly on this issue.

³⁹ Dickinson 1977, pp. 42-44.

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in their status and prestige (Chart 4), with their elite position being usurped by those interred in Grave Circle A.⁴⁰

<i>Grave</i>	<i>Type</i>	<i>Dickinson (1977)</i>	<i>Graziadio (1988, 1991)</i>	<i>Dietz (1991)</i>
A	shaft	late	late 1	MH IIIB
A ²	cist	early	early	
B	shaft	middle	late 1	MH IIIB
Γ	shaft	late	late 1	LH IA
Δ	shaft	late	late 1	MH IIIB
E	shaft	late	late 1	LH IA
Z	cist	early	early	MH IIIB
H	cist	early	early	MH IIIB
I	shaft	middle	early	MH IIIB
K	shaft	middle	late 2	LH IB
Λ	shaft	middle	late 1	MH IIIB
Λ ²	cist	middle	early	MH IIIA
M	shaft	late	late 2	LH IA
N	shaft	late	late 1	MH IIIB
Ξ	shaft	middle	early	MH IIIB
O	shaft	late	late 2	LH IA
Π	shaft	late	late 2	LH IA
Σ	cist	early	early	
T	shaft	early	early	
Υ	shaft	middle	late 1	MH IIIB
Φ	cist	early	early	MH IIIA

*Table 2. Labor investment for graves in Grave Circle B
(organized in alphabetical order)*

Despite their conflicting order, close examination of both proposed sequences leads to two significant observations (Table 3).⁴¹ The first is that even after the appearance of the first shaft graves, cist graves continued to be constructed and utilized by certain segments of the population, as is demonstrated by the presence of the “late” Cist Graves Φ and Λ², thus indicating that they were apparently an acceptable alternative for those who

⁴⁰ Graziadio 1988, 1991.

⁴¹ Fitzsimons 2006, pp. 48-52, 2011, p. 85.

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were to be interred in Grave Circle B.⁴² The second observation is that, while there is a general trend towards increased energy expenditure, the amount of labor investment did not increase directly with time, as small and relatively simply built tombs continued to appear throughout the Circle's history, thus supporting the argument for emerging, competitive factions put forth above.⁴³

<i>Grave</i>	<i>Type</i>	<i>Dickinson (1977)</i>	<i>Grave</i>	<i>Type</i>	<i>Graziadio (1988, 1991)</i>
A ²	cist	early	A ²	cist	early
Z	cist	early	Z	cist	early
H	cist	early	H	cist	early
Σ	cist	early	Σ	cist	early
T	shaft	early	T	shaft	early
Φ	cist	early	Φ	cist	early
B	shaft	middle	I	shaft	early
I	shaft	middle	Λ ²	cist	early
K	shaft	middle	Ξ	shaft	early
Λ	shaft	middle	B	shaft	late 1
Λ ²	cist	middle	Λ	shaft	late 1
Ξ	shaft	middle	Υ	shaft	late 1
Υ	shaft	middle	A	shaft	late 1
A	shaft	late	Γ	shaft	late 1
Γ	shaft	late	Δ	shaft	late 1
Δ	shaft	late	E	shaft	late 1
E	shaft	late	N	shaft	late 1
M	shaft	late	K	shaft	late 2
N	shaft	late	M	shaft	late 2
O	shaft	late	O	shaft	late 2
Π	shaft	late	Π	shaft	late 2

*Table 3. Labor investment for graves in Grave Circle B
(organized in alphabetical order)*

⁴² This interpretation is supported by the fact that none of the cist graves was disturbed by the construction of the peribolos wall encircling the Grave Circle (Fitzsimons 2011, p. 85).

⁴³ This phenomenon is perhaps not surprising, considering the frequent juxtaposition of “rich” and “poor” graves documented elsewhere in the Middle Helladic period (Fitzsimons 2011, p. 85), itself likely an early manifestation of elite competition.

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Further support for this scenario emerges from analysis of the distribution of burials within the Circle (Figs. 1-3).⁴⁴ In both Dickinson's and Graziadio's chronological schemes, the earliest burials appear to fall into three distinct groupings located in the northeast, northwest and southeast quadrants, each of which might be seen as an early manifestation of one particular faction within this elite community, with Graves E and Γ representing the appearance of a new faction sometime after the establishment of the Grave Circle.

The Tholos Tombs

A comparable set of calculations for labor investment was produced for the nine tholos tombs located around the site of Mycenae (Fig. 4),⁴⁵ with values expressing (where appropriate) the time required for the excavation of the burial site, the quarrying, transport, and laying of the walls, the facing of the exposed bedrock and masonry elements, and the quarrying, transport,

⁴⁴ Fitzsimons 2006, pp. 48-52, 2011, pp. 87-88.

⁴⁵ The nine tholos tombs are: Cyclopean Tomb (Wace 1921-23, pp. 287-293; Pelon 1976, pp. 157-158; Fitzsimons 2006, pp. 109-111); Epano Phournos Tomb (Wace 1921-23, pp. 292-296; Wace and Hood 1953; Pelon 1976, pp. 158-159; Fitzsimons 2006, pp. 112-114); Tomb of Aigisthos (Wace 1921-23, pp. 296-316; Taylour 1955, pp. 207-209; Pelon 1976, pp. 159-162; Fitzsimons 2006, pp. 114-119); Panaghia Tomb (Wace 1921-23, pp. 316-320; Pelon 1976, pp. 162-163; Fitzsimons 2006, pp. 119-121); Kato Phournos Tomb (Tsountas and Manatt 1897, pp. 124-126; Wace 1921-23, pp. 320-325; Pelon 1976, pp. 163-164; Fitzsimons 2006, pp. 121-124); Lion Tomb (Tsountas and Manatt 1897, pp. 124-126; Wace 1921-23, pp. 325-330; Pelon 1976, pp. 164-166; Fitzsimons 2006, pp. 124-127); Tomb of the Genii (Wace 1921-23, pp. 376-387; Pelon 1976, pp. 166-167; Fitzsimons 2006, pp. 127-130); Treasury of Atreus (Tsountas and Manatt 1897, pp. 117-122; Wace 1921-23, pp. 338-357; Wace 1956, pp. 116-119; French 1964, pp. 243-261; Ellis et al. 1968; Pelon 1976, pp. 171-175; Cavanagh and Mee 1999; Fitzsimons 2006, pp. 130-137); Tomb of Klytemnestra (Tsountas and Manatt 1897, pp. 122-124; Wace 1921-23, pp. 357-376; Wace 1953, pp. 5-7; Taylour 1955, pp. 209-236; Wace 1955; Pelon 1976, pp. 167-171; Fitzsimons 2006, pp. 138-144).

laying, and finishing of the lintel blocks (Chart 5).⁴⁶ A complete discussion of the results produced through analysis of these data is unfortunately beyond the scope of the current paper, but two observations merit inclusion here. The first concerns the status of the two grandest examples, the Tomb of Klytemnestra and the Treasury of Atreus, which Wright and the author have suggested elsewhere stand quite apart from the socio-political system embodied by the other tholoi, and belong instead to the fully developed palatial administration of the 14th and 13th centuries B.C.⁴⁷ Indeed, the enormous values for the labor investment necessary for their construction as compared to that required for the other structures do seem to support this argument, serving as a strong indication of the existence of a correspondingly more complex organizational system that was capable of attracting, organizing and directing labor resources on a far more expansive scale.⁴⁸

The second observation involves the size of the workforce employed in these projects and the nature of the socio-political system that demanded their construction. At first glance, these topics may seem impenetrable given the fact that virtually nothing is known, for example, about the status of Mycenaean workmen, the length of a Mycenaean work day or the number of days of the year that Mycenaean workers were free (or forced) to engage in non-utilitarian and non-subsistence activities.⁴⁹ The key,

⁴⁶ Note that these calculations likely underestimate the total labor investment required, as activities such as clearing vegetation to prepare the burial site (see Erickson 2010, pp. 628-630), heaping earth above the burial chamber to create the tumulus (the precise, original dimensions of which are almost impossible to reproduce), excavating the burial pits (which would have required comparatively little effort), and backfilling the *dromos* (which may, or may not, have been standard practice) were not included.

⁴⁷ Wright 1987, pp. 176-184; Fitzsimons 2006, pp. 190-191, 2007, pp. 113-114, 2011, pp. 110-111.

⁴⁸ Fitzsimons 2006, pp. 297-303, 2011, pp. 93-94.

⁴⁹ Mathewson 1987, p. 325. For reference to the difficulties involved in calculating the number of laborers on the basis of the number of days of labor, see, for example, Sidrys 1978a; Abrams 1987, p. 490, 1989, p. 66-68; Abrams and Bolland 1999, pp. 273, 284-286.

however, may lie in the characteristics of a single stone: the lintel block.⁵⁰ Indeed, the most expensive use of simultaneous manpower in the construction of a tholos tomb was the transportation from the quarry to the building site of the massive lintel blocks that capped the *stomion* passage. Unfortunately, it is almost impossible to locate accurate data concerning the capacity of pre-industrial societies to transport megalithic stones, despite the fact that numerous experiments have been conducted over the past two centuries.⁵¹ In 1815, for example, Giovanni Battista Belzoni, the great Italian explorer and Egyptophile, succeeded in transporting a 7-ton fragment of a statue of Ramses II (the so-called ‘Young Memnon’) from the Ramesseum to the Nile River, a distance of roughly one kilometer, using ropes, rollers and a team of 130 men.⁵² This endeavor consumed 17 days, meaning that it required 19 men to move one ton 60 meters per day. In the 1950’s, Thor Heyerdahl organized a team of 180 Easter Islanders who managed to move a 10-ton *moai* using ropes, a sledge and natural lubricants.⁵³ The figure of 18 men per ton yielded by Heyerdahl’s experiment, though comparable to that achieved by Belzoni, may be a bit high, as more recent experiments, such as those conducted by Chevier at Karnak⁵⁴ and Lehner at Giza,⁵⁵ suggest that ratios as low as 8 or 6 (or fewer) men per ton can be achieved.⁵⁶ In any event, while precise accuracy may never be achieved, a ratio of ten

⁵⁰ Abrams and Bolland, drawing upon the Theory of Constraints proposed by Goldratt (Goldratt and Cox 2012) and Dettmer (1997), dub features that limit the production flow of a construction project, “bottlenecks” (Abrams and Bolland 1999, p. 273).

⁵¹ For reference to the transport of massive stones using ancient technology, see, for example, Croon 1925; Naumann 1955, pp. 34-37; Mulloy 1970; Velson and Clark 1975; Coulton 1977, pp. 141-144; Sidrys 1978b; Landels 2000, pp. 183-185; Arnold 1991, pp. 57-107; Edwards 1991, pp. 254-257; Flenley and Baun 2003, pp. 122-133.

⁵² Time-Life Books 1993, pp. 47-48.

⁵³ Heyerdahl 1958, pp. 148-152.

⁵⁴ Chevier 1970; Arnold 1991, p. 63; Edwards 1991, pp. 256-257.

⁵⁵ Lehner 1997, pp. 202-225.

⁵⁶ For similarly low figures, see, for example, Atkinson 1961; Mohen 1980; Edwards 1991, pp. 256-257; Lehner 1997, pp. 209, 224; Flenley and Baun 2003, p. 127; Clare 2010, pp. 249-250.

men to one ton for the transport of the lintel blocks seems reasonable, and indeed, such a figure was also cited by Cavanagh and Mee in their study.⁵⁷

Assuming such a ratio, multiplying the mass of the heaviest lintel block in each tomb by ten produces a relatively realistic estimate for the total size of the workforce employed for each project, values which range from 51 for the Cyclopean Tomb to 368 for the Lion Tomb (Table 4).⁵⁸

<i>Tomb</i>	<i>Date</i>	<i>Largest Lintel Block (tons)</i>	<i>Estimated Work Force</i>	<i>Total Man-Days</i>	<i>Project Time</i>
Tomb of the Genii	LH IIB-III A:1	20.23	203	6423	32
Lion Tomb	LH IIA-B	36.79	368	14496	40
Panaghia Tomb	LH IIA-B	11.25	113	4670	42
Epano Phournos Tomb	early LH IIA	13.31	134	5858	44
Kato Phournos Tomb	LH IIA-B	11.66	117	5705	49
Cyclopean Tomb	early LH IIA	5.07	51	2802	55
Tomb of Aigisthos	early LH IIA	8.81	89	9596	108

Table 4. Estimated size of labor force and duration of building program for the tholos tombs at Mycenae (organized in ascending order)

Dividing the number of man-days required for the completion of each tomb by the resulting size of its estimated workforce, then, produces an approximate figure for the number of days required for the completion of each monument (Table 4). With the exception of the Tomb of Aigisthos, whose score may be skewed because of the small size of its lintel blocks,⁵⁹ the estimated

⁵⁷ Cavanagh and Mee 1999, p. 96.

⁵⁸ Note that the figures used here do not include the energy invested in the remodelling of the Tomb of Aigisthos that saw the addition of the ashlar parastades, since this activity post-dated the original construction of the tomb (Fitzsimons 2006, pp. 116-118).

⁵⁹ The largest lintel block in the Tomb of Aigisthos weighs ca. 8.8 tons, much less than those in the Panaghia Tomb (11.3), the Kato Phournos Tomb (11.7), the Epano Phournos Tomb (13.3), the Tomb of the Genii (20.2 tons), and the Lion Tomb (26.8 tons). The largest lintel block in the Cyclopean Tomb is actually smaller (5.1 tons), but represents a larger percentage of the total labor investment for the overall project (ca. 3.8%) than that required for the largest lintel block in the Tomb of Aigisthos (ca. 1.9%).

duration of each building project is remarkably consistent (Chart 6), with an average length of 43.3 days, despite the wide variation in their overall labor investments (Table 4).⁶⁰

Interestingly, and perhaps significantly, based on the work of Hogbin in New Guinea,⁶¹ this figure falls precisely into the range of the minimal number of days per year that families were expected to contribute labor in chiefdom-level societies. Concluding that Early Mycenaean society was governed by chiefdoms based on the rough calculations presented here for tholos tomb construction is of course both premature and meaningless, especially given the ongoing discussion amongst anthropologists over the precise definition of that and similar terms for the various stages of socio-political development.⁶² Nevertheless, the remarkable consistency in the values produced for the construction times of these monuments, together with their similarity to data derived from ethnoarchaeological studies, is perhaps too coincidental to ignore.

Architectural Energetics and Social Network Analysis

As has been demonstrated not only here, but in the host of similar studies that have appeared in the literature over the last few decades, architectural energetics can contribute greatly to our understanding of the processes of early state formation as they

⁶⁰ It is perhaps notable that even the relatively large value of 108 days produced for the Tomb of Aigisthos fall within the temporal limits of 60-120 days for non-subsistence activities suggested by ethnographic studies (Redford and Villa Rojas 1964, pp. 80-81; Abrams 1987, pp. 490-491; Blier 1987, p. 19; Mathewson 1987, pp. 326-327; Abrams and Bolland 1999, p. 284), although it is perhaps likely, given the social and political significance of these building activities, that their duration may well have been extended through conscious and deliberate choice (Doolittle 1984; Turner and Denevan 1985; Mathewson 1987, p. 324).

⁶¹ Hogbin 1939, p. 148; Erasmus 1965, p. 280.

⁶² See, for example, Service 1964, pp. 143-177, 1975; Fried 1967, pp. 109-242, 1978; Sahlins 1968; Pasternak 1976, pp. 17-21; Wright 1977, 1978; Claessen and Skalník 1978a, 1978b; Cohen 1978; Cohen and Service 1978; Khazanov 1978; Price 1978; Sanders and Webster 1978, pp. 268-275; Haas 1982; Earle 1991a, 1997; Feinman and Marcus 1998; Marcus and Feinman 1998; Grinn et al. 2004.

unfolded in the late Middle and early Late Bronze Age Aegean. Yet it is by combining this approach with social network analysis that its true potential is revealed, as two avenues for future research will illustrate.

The first involves exploring further the correlation between workforce size and socio-political complexity. Since the former can be understood as proxies for the number of households that contributed labor (through whatever means) to form a pool of adequate size,⁶³ and that therefore owed some form of obligation to those responsible for any particular construction project, they serve, in essence, as fractional representations of the total membership of each factional group.⁶⁴ Using the suggested models for labor recruitment offered by Webster and Kirker,⁶⁵ for example, produces estimates for factional population ranging from 128 members, with each family of 5 contributing 2 laborers for the construction of the Cyclopean Tomb, to 3680,⁶⁶ with the work force representing 10% of the total membership of the faction responsible for the construction of the Lion Tomb (Table 5). Sociological and economic theory demonstrates that, as the

⁶³ For reference to labor forces being organized along kinship lines, see Mosely 1975; Sanders and Webster 1978, p. 274; Abrams 1987, pp. 494, 495-496; Abrams and Bolland 1999, pp. 286-287. For a summary of various models of labor recruitment and organization, see Abrams 1994, pp. 96-108.

⁶⁴ For calculations of overall population pools based upon labor estimates, see, for example, Cook 1947; Sidrys 1978a, p. 8; Webster and Kirker 1995, pp. 374-379.

⁶⁵ Webster and Kirker 1995, pp. 374-379. Abrams (1987, p. 493) offers a comparable estimate of 20-33% for the percentage of the total population represented by the work force, and his ethnographic study suggests that most households contributed one laborer to construction projects (1994, p. 42).

⁶⁶ While there is no direct information concerning the size or composition of pre-historic households in the Bronze Age Aegean, most anthropological studies appear to assume a family size of 5 individuals (e.g., Webster and Kirker 1995, pp. 374-379; Clare 2010, p. 250), a value supported to some extent by ethnographic research into pre-industrial families (Redfield and Villa Rojas 1962, p. 91; Erasmus 1965, p. 294; Laslett 1971, p. 66; Beauroy 1986, p. 27; Blier 1987, p. 142; see Pospisil 1963, p. 59 and Cohen 1975, however, for larger family sizes, and Ruggles 2009 for a review of recent discussions on the pre-industrial family). In the end, however, it is not the particular composition of any individual household which is important, but rather the number of laborers of adequate ability that each could supply.

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size of a particular population group increases, direct contact between individuals within that group becomes more and more difficult to maintain, eventually reaching a point at which the social and political ties between its members begin to break down.⁶⁷

<i>Tomb</i>	<i>Estimated Work Force</i>	<i>2 Laborers per family of 5</i>	<i>1 Laborer per family of 5</i>	<i>30% of non-elite population</i>	<i>10% of non-elite population</i>
Cyclopean Tomb	51	128	255	170	510
Tomb of Aigisthos	89	223	445	297	890
Panaghia Tomb	113	283	565	377	1130
Kato Phournos Tomb	117	293	585	390	1170
Epano Phournos Tomb	134	335	670	447	1340
Tomb of the Genii	203	508	1015	677	2030
Lion Tomb	368	920	1840	1267	3680

Table 5. Estimated size of population pool accessible by tomb builders

Consequently, in order to maintain the integrity of such a system once the population level has surpassed a certain threshold, a dramatic reorganization of the horizontal and vertical connections within the network is required, and as a result, a corresponding increase in the complexity of the socio-political hierarchy is produced.⁶⁸ In this light, it is important to note, as has often been observed, that large-scale, community-building construction programs such as those that produced these tholos tombs is frequently associated with times of political and/or social stress.⁶⁹ Combining an architectural energetics approach with social network analysis, then, should allow for the identification of more discrete stages in the process of early state formation at Mycenae, the examination of the transitions between them in more detail, and the production of a much more nuanced picture

⁶⁷ See, for example, Simon 1962; Ember 1963; Carneiro 1967, 1978; Bernard and Killworth 1973; Johnson 1978, 1982; Kosse 1990, 1994; Feinman 1998.

⁶⁸ Population thresholds of around 500 and 2500 are often cited (e.g., Carneiro 1978; Feinman 1998, pp. 104-109; Kosse 1990, 1994, p. 38), although Kosse (1994, p. 38) suggests the existence of even smaller thresholds on the order of 10-12 and 125-175 group members.

⁶⁹ See, for example, McGuire and Schiffer 1983; Oliveira 1986, p. 106; Abrams 1989, p. 63, 1994, p. 92; Trigger 1990, p. 127; Adams 1992, p. 216; Kolb 1994, pp. 521, 527-532, 533, 1997, p. 279; Clare 2010, p. 250; Fitzsimons 2011, p. 100.

of the dynamic period that culminated in the appearance of the Mycenaean palace state.

The second avenue involves expanding this research onto a wider, regional scale, and bringing into the discussion energetics analyses for the other monumental tombs that were constructed throughout the Argolid (Fig. 4).⁷⁰ The presence of funerary structures of comparable scale and labor investment at sites such as Kazarma,⁷¹ Kokla,⁷² Tiryns,⁷³ Berbati,⁷⁴ Dendra,⁷⁵ and Prosymna⁷⁶ suggests a similar rise in the size of elite factions at independent sites throughout the region. It is reasonable to postulate, then, given the increasingly high demands for labor investment and the limited supply of workmen available locally, that such factions would attempt to increase their pools of potential labor (and thus their regional status) by seeking to forge alliances with and/or absorbing the members of non-local population groups. The culmination of this process of competitive exclusion,⁷⁷ now expanded beyond the level of the individual site, ultimately resulted in the emergence of a single, elite faction, the consolidation of its authority throughout the region, and the establishment of the Mycenaean palatial state.⁷⁸ Incorporating the funerary monuments from throughout the Argolid into the same sort of energetics study carried out for the tombs at Mycenae, then, seems to be a natural means by which to begin accessing and analyzing this new and dynamic socio-political landscape.

⁷⁰ For preliminary research along these lines, see Fitzsimons 2006, pp. 144-192, 2007, pp. 100-106, 2011, pp. 89-100.

⁷¹ Protonariou-Deilaki 1968, 1969; Fitzsimons 2006, pp. 145-148.

⁷² Demakopoulou 1990, 1993, 1997; Fitzsimons 2006, pp. 148-151.

⁷³ Dragendorff 1913; Fitzsimons 2006, pp. 151-153.

⁷⁴ Wace 1936; Pelon 1976, pp. 177-178; Santillo-Frizell 1984; Fitzsimons 2006, pp. 158-161.

⁷⁵ Persson 1931, pp. 8-70; Pelon 1976, pp. 178-180; Fitzsimons 2006, pp. 154-157.

⁷⁶ Stamatakis 1878; Wace 1921-23, pp. 330-333; Pelon 1976, pp. 176-177; Fitzsimons 2006, pp. 161-165.

⁷⁷ Carneiro 1967, 1978.

⁷⁸ Fitzsimons 2011, p. 107.

Conclusion

The data and interpretations presented here are admittedly preliminary and tentative in nature, but it is hoped that they have nevertheless served the two purposes outlined at the beginning of this paper: to demonstrate the vast potential that an architectural energetics approach offers to the study of Early Mycenaean state formation, and to set the stage for further research strategies, the pursuit of which will not only underline the still as-of-yet untapped potential of architectural energetics analysis, but also re-energize (if you will) the study of early state formation in the Mycenaean world.

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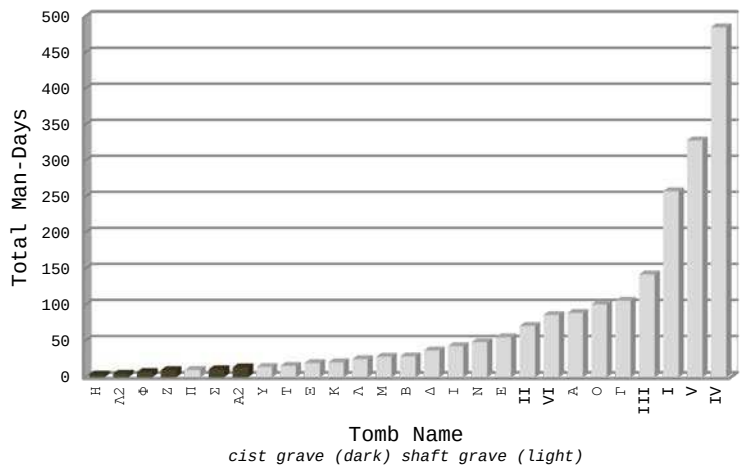


Chart 1. Labor investment for graves in Grave Circles A and B (organized in ascending order)

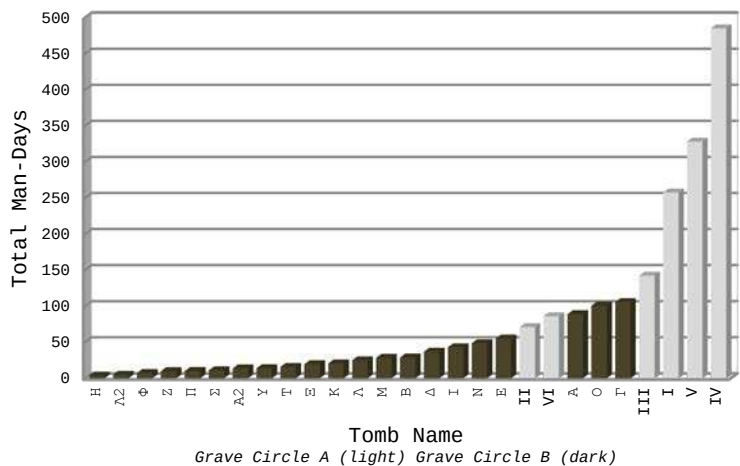


Chart 2. Labor investment for graves in Grave Circles A and B (organized in ascending order)

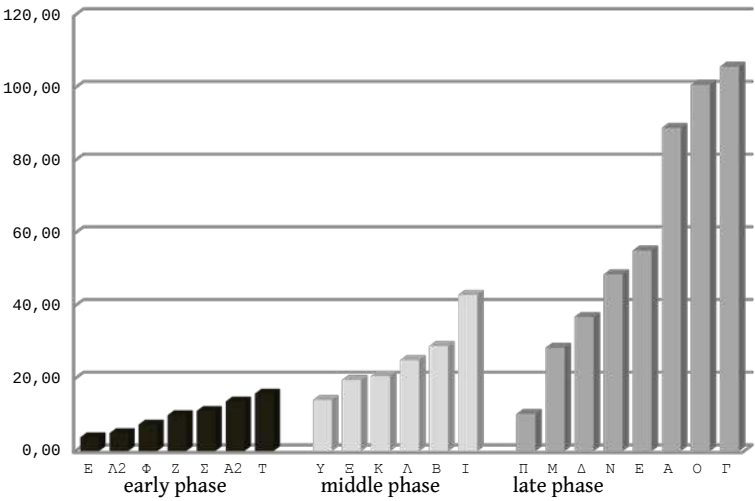


Chart 3. Labor investment for graves in Grave Circle B (according to Dickinson's chronology)

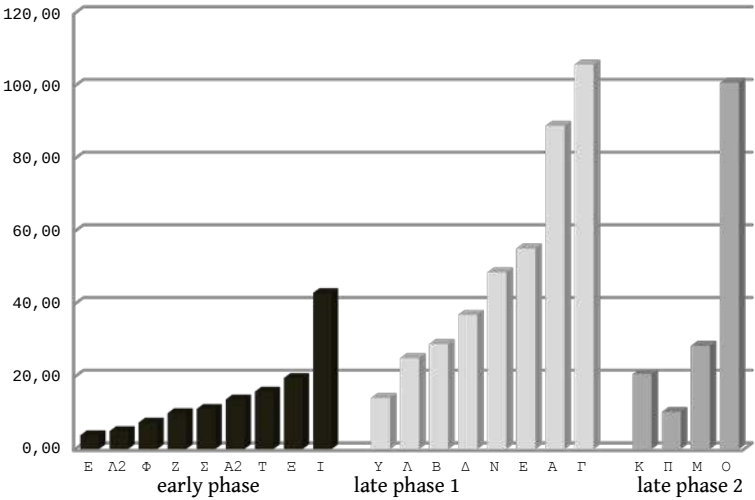


Chart 4. Labor investment for graves in Grave Circle B (according to Graziadio's chronology)

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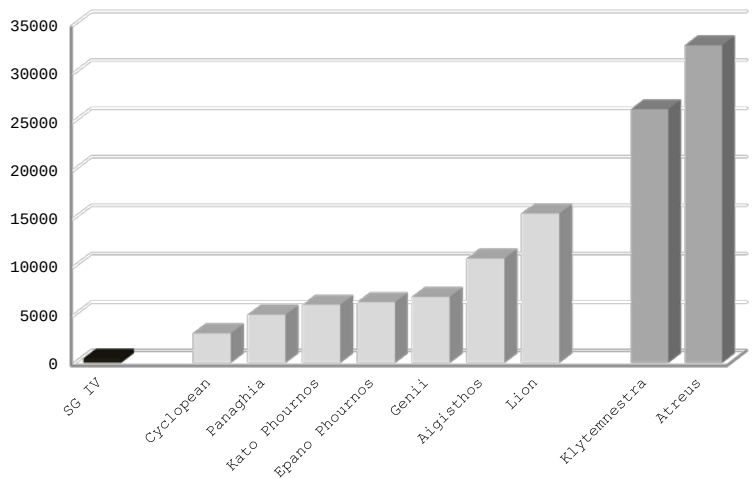


Chart 5. Labor investment for the tholos tombs and largest shaft grave at Mycenae (organized in ascending order)

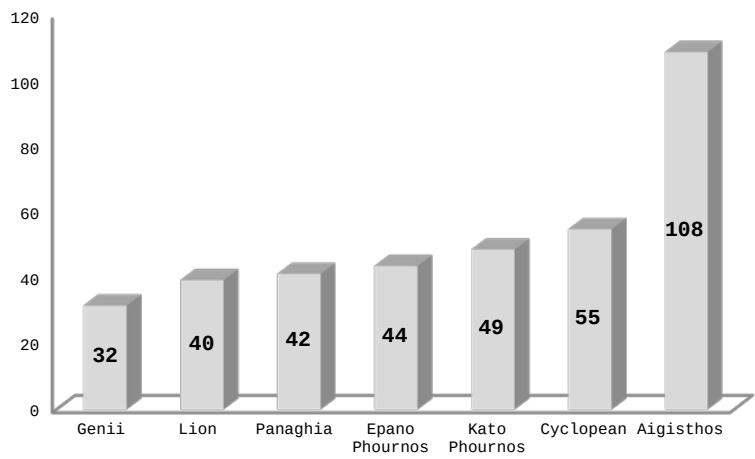


Chart 6. Estimated number of days for the completion of the tholos tombs at Mycenae

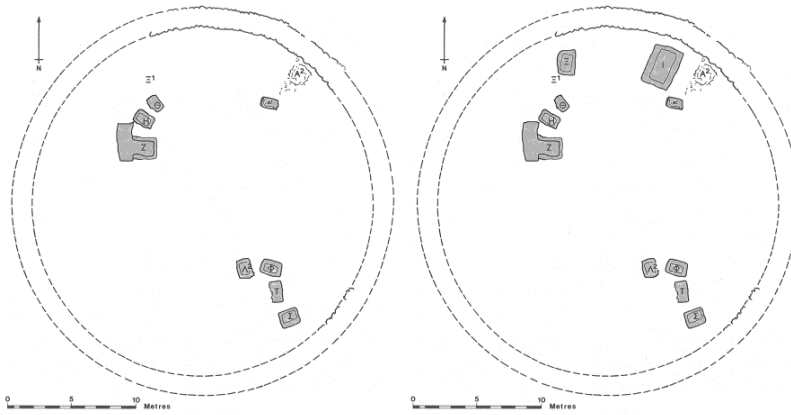


Figure 1. Plan of Grave Circle B at Mycenae, showing graves of Dickinson's Early Phase and Graziadio's Early Phase (after Fitzsimons 2011, fig. 5.5)

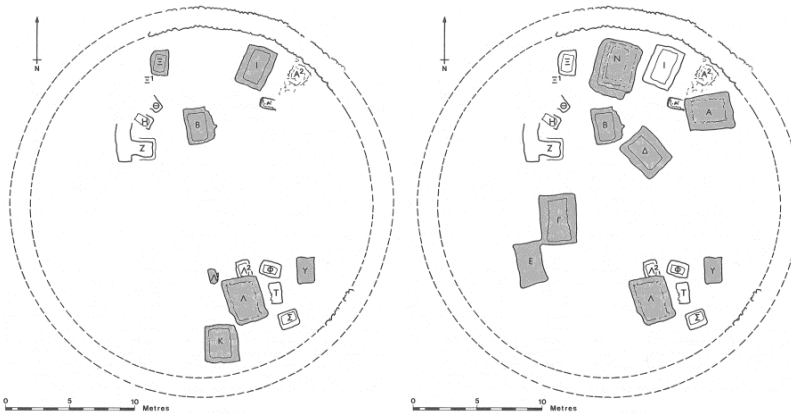


Figure 2. Plan of Grave Circle B at Mycenae, showing graves of Dickinson's Middle Phase and Graziadio's Late Phase 1 (after Fitzsimons 2011, fig. 5.6)

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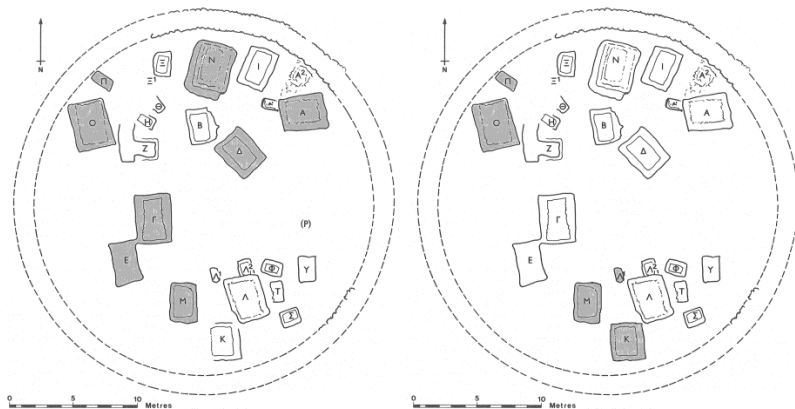


Figure 3. Plan of Grave Circle B at Mycenae, showing graves of Dickinson's Late Phase and Graziatio's Late Phase 2 (after Fitzsimons 2011, fig. 5.7)

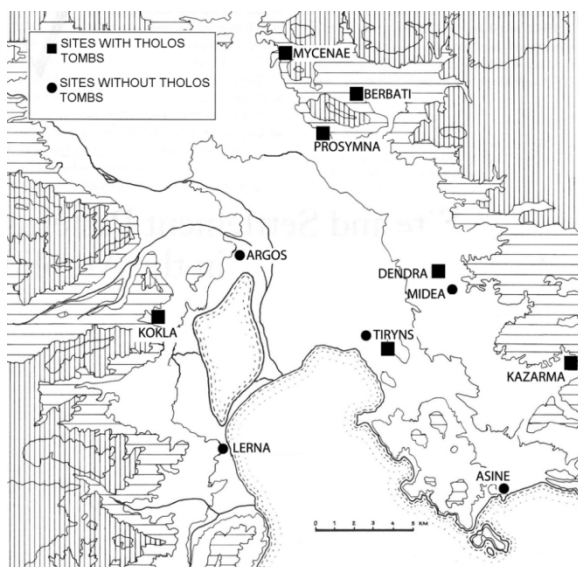


Figure 4. Map of the Argolid, showing the location of tholos tombs (after Fitzsimons 2011, fig. 5.9)