Rethinking the Sacred Landscape

Minoan Palaces in a Georitual Framework of Natural Features on Crete

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ABSTRACT The present work diverges from visual *extension* relationships between architecture and landscape features as described in Scully's *The Earth, the Temple, and the Gods* (1962). In contrast, symbolic landscape frameworks on Minoan Crete are investigated as an *a priori* means of locating ceremonial "palaces," a process here called *intension.* Using custom software called *Geopatterns,* several remarkably accurate geometric patterns among natural and built points in the landscape are identified and described. The computer application allows these actual patterns to be compared to those generated by large numbers of sets of equivalent random points. Statistical analyses demonstrate the high probability of design. The formalized landscape structure of highest mountains and most prominent caves that creates the geometric context for the four major palaces—Knossos, Mallia, Zakros, Phaistos—appears to have evolved from an earlier pattern created coincidentally by natural features alone. The orientations of the four palaces integrate with this original framework.

KEYWORDS sacred landscape, Minoan culture, social integration, georitual landscapes

INTRODUCTION

Vincent Scully's (1962) discussion of the orientation of Greek and Minoan temples to conical or horned peaks still stands in design fields as a formal model of landscape-architecture relationships. Classical scholars, however, doubt such a convention because it is not mentioned in Greek accounts of surveying (Thompson 1963). Even if the relationship had been important, temples could have been located anywhere within a considerable peak viewshed, thus diminishing the design constraint *per se,* and accommodating other siting requirements such as adjacencies to agricultural fields, water sources, healthy air, military camps, or territorial boundaries (Osborne 1987, 166–171). According to Scully, the symbolic effect of temple alignment to peaks does not come from any precise geometric restriction of the landscape itself, but from the formal *extension* of the architectural context usually as site axis to the natural feature. It is the power of architectural site geometry that creates the illusion of a special integration with a natural peak.

Scully subsequently investigated the topic in *Pueblo: Mountain, Village, Dance* (1989) describing ritual dances in the Southwest Pueblo plazas and their symbolic linkage to an ordered structure of ranked sacred sites located in the surrounding landscape (ethnographically described in Ortiz, 1969, and Doxtater 1978). The most sacred are four mountain tops with ritual openings, *sipapu,* as thresholds for ancestral spirits. Although an isomorphism exists between the ceremonial subterranean chamber, *kiva* (the closest thing to temple architecture) and the landscape framework, the most effective locus of ritual power lies in the latter. Here participants make contact with multiple spiritual beings associated with nodes of the framework. These natural sites, including the sacred mountain peaks themselves, are not seen from any viewpoint of the subterranean *kiva,* or even from specially constructed features of the organic form of the plaza. In spite of the far greater ritual and geometric framework of the Puebloan landscape compared to that of the Greeks, Scully made no theoretical distinction. One had the sense that the pueblo and *kivas* were built first, and then the ritual framework structured symbolically around them (though not related to a specific architecturally framed viewshed).

Archaeologists, such as Graves (1990), investigating true pueblo forms that began around the 14th century agree with Scully's assumptions. Out of the collapse of a larger scale, more organized Anasazi "world" in the 13th century, territorial-like regions coalesced, eventually becoming the historical Hopi, Zuni, and Tewa. Theoretically, these cultures' use of space and landscape was different than their prehistoric predecessors. Archaeologists now accept that the pueblo-like "great houses" and great *kivas* of Chaco Canyon were pilgrimage destinations from distant areas of a large region, not domestic communities as in the Historical Pueblos. Nevertheless, most still assume that the location of the Chaco Canyon center was determined primarily by politically powerful chiefs and priests without regard to any larger-scale natural framework. It is assumed that ritual processes such as Scully describes might have existed in the landscape around Chaco Canyon, but their organization came after the establishment of the center by some elite clan.

Landscape Journal 28:1–09 ISSN 0277-2426

If Scully had focused on the Anasazi landscape (though more difficult because of a lack of ethnographic data and lack of ready computer technology at the time of his work), he might have discovered a profound theoretical contrast with that of Classical Greece in the relationship between architecture and landscape. There exists an ethnographic description, though not in the Southwest, of an extreme of this contrasting condition. The Warao of Venezuela's Orinoco Delta (Wilbert 1993, 11) constructed an accurate geometric framework of north-south and east-west axes close to 200 km across and with no architectural elements at the center, only a sacred tree. Most accounts of the religious power of Chaco Canyon focus on the great houses and their great *kivas,* e.g. Pueblo Bonito or Chetro Ketl. But if one takes the size of great *kivas* as an expression of religious importance, the largest, Casa Rinconada, uniquely has no above-ground great house architectural component. It sits clearly apart and in possible symbolic opposition to the great houses across the Chaco wash. Was this the most powerful of thresholds relating to some large landscape framework, not unlike the sacred tree of the Warao?

Hypothetically, a formalized "georitual" landscape framework existed prior to the building of great houses (Doxtater 1991, 2002, 2003, 2007). It structured the entire southern Colorado Plateau with vertical and cross axes organized in what Witherspoon and Peterson (1995) describe among the Navajo as "bipolar" and "bilateral" symbolic oppositions (not unlike the Tewa or Hopi). The meridian relationship with Mount Wilson in southern Colorado, the highest mountain in the region, locates Chaco Canyon. Lekson's book the *Chaco Meridian* (1999) posits a hypothetical 700 km north-south axis, but as a prolongation of the Chaco Canyon center (first north to Aztec, then south to Casas Grandes in Northern Mexico). Here power comes from the politics of the elite family that established Chaco rather than from the gods in the highest mountains.

Perhaps fundamental cultural differences exist between societies that build large, impressive temples emphasizing a formal *extension* out into the visible landscape—whether to horned peaks or the better documented sunrise points on the birthdays of the gods—and those using large-scale ritual landscapes to condition, constrain, and locate their ceremonial structures. The latter can be called *intension,* i.e. coming or originating from the landscape as distinct from *extending* out into it. While this paper's primary focus is to provide a solid cultural example of *intension* on the ancient Minoan island of Crete, the described layouts will also be seen to include elements of *extension* as well.

The Social Meaning of Classical Greek and Minoan Landscapes

Current studies of Greek society are strongly influenced by territorial or hegemonic ideas of landscape (Alcock, S. and Osborne 1994). In contrast to these studies, though far less mainstream, even obscure, is Richer's volume on the sacred Greek landscape (1994). Contemporaneous with Scully's ideas, Richer is inspired by Plato's ideal *zodiac* structure of the landscape (see also Thompson 1963) and seeks to discover multiple large-scale examples that created temple location. Surveying at such distances might not be surprising considering Aeschylus' description in *Agamemnon* of signal fires between Athos and Macistus, 177 km apart. Unfortunately, Richer was working in a pre-computer era and his thesis remains untested. Even if the Greeks had laid out temple locations according to zodiac geometry, such might have been a less ancient phase of landscape expression compared to ritually integrating frameworks. Zodiacal patterns are determined by establishing a center point and then prolonging lines out into the landscape, not unlike the radiating lines, or *ceques,* of the Incas (Bauer 1992). They *extend* rather than *intend.*

Going back to Minoan Bronze Age times, evidence exists of approximately 25 "peak sanctuaries" on Crete. Several natural caves were also used ritually (Tryee 1974). Both created contact points with gods possibly prior to and even including the most intense palace building period from 2000 to 1700 BCE (see overview in Jones 1999, 28–38).[1] Except for the small architectural features on the few later sanctuaries directly associated with palaces, evidence of these locations is minimal, e.g. seashells, pieces of pots, and the depositions of small figurines. Peatfield (1994) suggests visibility relationships between cult sites on higher topographic locations and lower areas where ritual participants lived. Like Scully, the religious effect is again one of viewshed though no formal architecture is involved in the farms below.

Other classical archaeologists, however, dispute Peatfield's limited spatial constraint on the relationship between natural and architectural places. Briault (2007) finds the same kinds of ritual objects being used in non-peak sanctuary locations, even in the two palaces of Phaistos and Mallia. She believes the landscape offers no special component to organized Minoan cults, emphasizing the bodily experience of symbols in a context of practice. Religious practice in traditional societies, however, most often includes symbols, the movement of bodies, *and* a cognitive spatial structure articulated by oppositions, orientations, thresholds, and homologues that can create social effect (Doxtater 1991).[2] The large-scale patterns of the present study involve at least three kinds of sites where cult artifacts occur: peak sanctuaries, caves, and palaces.

One initial clue about differences between Classical Greek and Minoan religious space comes from the less rhetorical, exterior facade architecture of Minoan palaces on Crete. The presumed ritual emphasis of these sites focuses on the interior central courtyard with its altar features. This is in contrast to the elaborate exteriors, but non-participatory interiority of the Greek temple and its residing deity. The siting of the four most prominently discussed Minoan palaces, e.g. Warren (1985), contributes to the lack of façade formality: Knossos sits on a seemingly arbitrary slope in a hilly region providing limited view of the site from the surrounding area; Mallia, though sited on a large plain near the north shore of the island, at ground level remains unremarkable from any distance; and Zakros, the smallest palace, huddles in a tight ravine immediately adjacent to the sea. Only Phaistos commands any rhetorical or phenomenological presence, but only from its southeast side, opposite its entrance. Thus one may ask whether the Minoan palaces reflect the myths of earth-mother Bronze Age periods (Campbell 1964, Goodison and Morris 1998), in contrast to the heroic, male, competitive culture and architecture of the Classical Greeks.

Even Scully's ideas of orientational motives of monumental structures common to both Crete and Classical Greece can be more finely evaluated. Shaw's (1974) theodolite measurement of the four principal Minoan palace courtyard orientations offers no firm conclusions—climatic, symbolic, or otherwise—about the widely varying axes. He describes but ultimately dismisses two "improbable" large-scale hypotheses, one that the palaces' north-south axes pointed to a location on the coast of Africa, and the second that a geographic rectangle of palaces existed with two palaces yet to be discovered.

While most researchers view Minoan palaces in a more modern, territorial context as competitive spaces controlled by elite authorities, we know that most "pre-Western" or "traditional" people used formal, symbolic layouts at small scales of architecture and settlement (e.g. Turner 1968; Ingham 1971; Cunningham 1972; Gossen 1972; Bourdieu 1973; Meletinskij 1973; Kamau 1976; Paul 1976; Doxtater 1981; Levy 1990). It would not have been technically difficult for some of these cultures to also, or perhaps even first, understand and construct larger geometric frameworks on the landscape.

Technical Considerations of the Argument

This research requires an easily used, relatively inexpensive computer application, *Geopatterns,* to accurately describe and test large-scale geometries of lines on the surface of an elliptical earth.[3] Beyond present software capacity, one must question Minoan surveying abilities. Certainly they had extensive contact with Egypt, which for its part was highly regarded for its surveying and related mathematical expertise (Dilke 1971). Dilke says nothing about Minoan abilities, but in Roman times most surveying occurred at smaller scales of town, cities, and farms. Some roads and aqueducts have longer aligned elements, but only at a scale of a few kilometers. The one exception is an 80 km alignment of 12 Roman

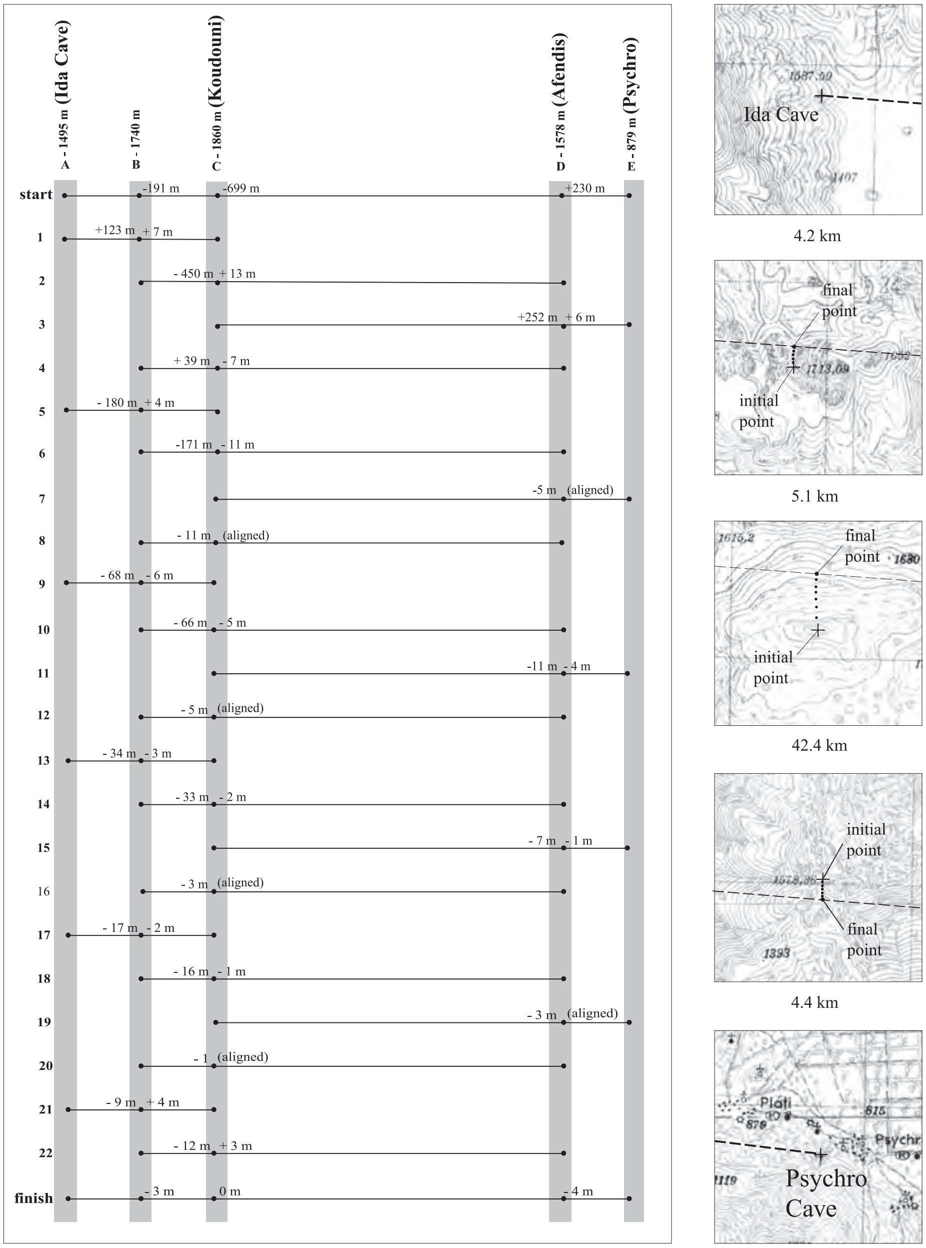


Figure 1. A trial and error simulation to establish an accurate line between Ida and Psychro caves. Three interim sites were selected for their intervisibility. (Left) Sequence of 22 adjustments to initial points through backsighting technique; (right) the location of the initial points in relation to the final points and line. (Figure by author)

watchtowers in Germany along diverse topography (Söderman 1989). The greatest deviation of any particular tower from this line along the Neckar River is 2 m (deviation of about 0.016°). The "instrument" used might have been threesomes of "range poles" (Gallo 2004, 14) aligned across the landscape. Given poles of 0.10 m in diameter, an accuracy of visual acuity or 0.017° can be achieved when the poles are about 300 m apart.[4]

Establishing a line of watchtowers is easier than creating an accurate line between two natural features separated at large distances by obstructing topography. Figure 1 illustrates a trial and error method of achieving this end. Priest surveyors might have first set up a number of approximate points between two very distant features, each interim point being visible from its two neighbors. Three teams can move back and forth along the line as illustrated, or there can be a team on each interim point.

The most difficult technical issue, however, is a statistical "proof" that landscape patterns are intentionally designed. Given the far greater number of studies and mainstream acceptance of archaeoastronomy, keynoters in this field such as Ruggles (1999) offer the best advice. One needs to place such studies in a cultural context, and cannot rely solely only upon comparisons using normal distribution curves of random sets.

One possible solution lies in a Bayesian procedure that includes a contextual dimension (Ruggles 1999, 160). Perhaps the only mainstream Southwest archaeologist to adapt statistical analyses to landscape geometry is Swanson, who studies view corridors among signal-fire features on Cerro Moctezuma, northern Mexico (2003). Using GIS software, Swanson investigated 10 sets of randomly distributed points on the mountain, and using standard statistical methods, concluded that the existing signal-fire points were intentionally aligned with each other for intervisibility. This author's study of Chaco patterns (Doxtater 2007) used standard Z-score comparisons to show that some number of existing three-point alignments, bisects, and cardinal relationships were designed. Also included were simple numerical probabilities of several complex patterns. In the present study, the number of sites was too small to get reliable standard comparison curves. Opportunities do exist, however, to examine sets of random patterns in greater detail.

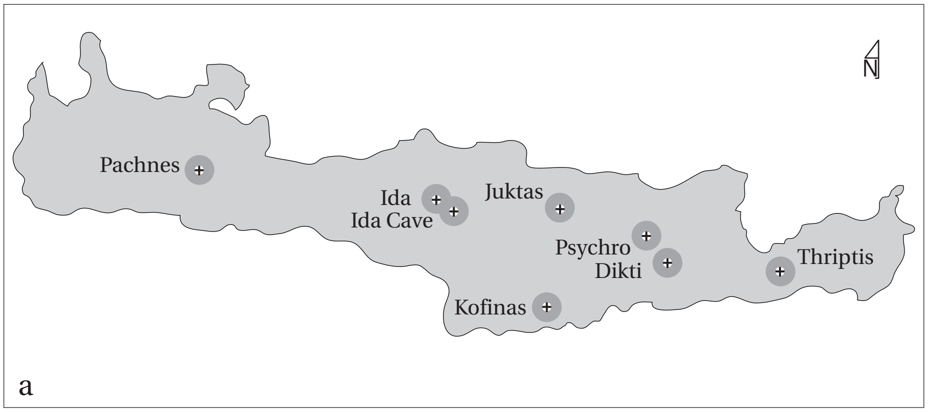
One final technical footnote regards the cessation of US government scrambling of GPS satellite data only a month or so pior to our work on Crete, enabling us to use a common Garmin GPS 12 receiver. For the most remote sites that we could not visit, e.g. the highest peaks, the Greek military provided precise latitude and longitude benchmark figures. At two sites, I obtained both GPS and military survey figures by which the accuracy of the Garmin instrument could be measured. The GPS reading at the Juktas benchmark was off by approximately three tenths of an arc second (about 9 m) of latitude, and its longitude was off by about the same amount. At the monument at Vrysinas peak, the latitude and longitude were off by about two tenths of an arc second (about 6 m). At the analysis scale of the entire island these inaccuracies do not significantly alter hypotheses about designed landscape patterns.

Pattern Probability among Eight Natural Points on Crete

The goal of this georitual research is to show that Minoan palaces were located in a geometric context with the most significant natural features on the island, i.e. to demonstrate *intension.* The first step in this process was to identify the most significant natural features, which in this case included eight sites. A paradox, however, exists in this selection. Hypothetically, the most prominent natural features on the island were revered by the palace builders and used as an integrating georitual context. Some earlier, wholly natural symbolic framework built upon coincidental patterns may have predated the palaces. Thus if one chooses these significant natural features, many with associated mythological or archeological evidence, does this bias the analysis? To dispel the illusion of pre-selection for geometric pattern one can show that the eight features, even with their cultural associations, are very ordinary in comparison to the large numbers of multiple sets of eight random points.

After this exercise, four random points representing the four most prominent palaces were added to the sets. The random occurrence of patterns in these sets of 12 can first be compared to the patterns generated by the 8 (natural) points. Most importantly, however, the existing pattern between the four palaces and the eight natural features is compared with the best random patterns of the 12 point sets.

Illustrated in Figure 2 (a and b) are the eight selected natural sites. One logically begins with the two equally highest mountains on Crete: Mount Ida and Mount Pachnes to the far west. The highest mountain on the eastern end of Crete is Mount Thriptis, while the highest mountain to the south is Mount Kofinas. This peak has two sanctuaries, one just below the peak on an accessible bench, and one on the precipitous peak itself (Figure 3). One begins to see a spatial dualism, a frequent characteristic of more integrated traditional social space. Mythically, Mount Ida had its partner, Mount Dikti opposed in the east. Only a few visible kilometers from this peak is Psychro Cave, a "grotto long associated with the legendary Diktaean cave" (Tryee 1974, 14).[5] Mount Dikti's opposite, Mount Ida, also has a large cave at its base, Ida Cave, though it has less ritualistic importance than Psychro. There is no prominent



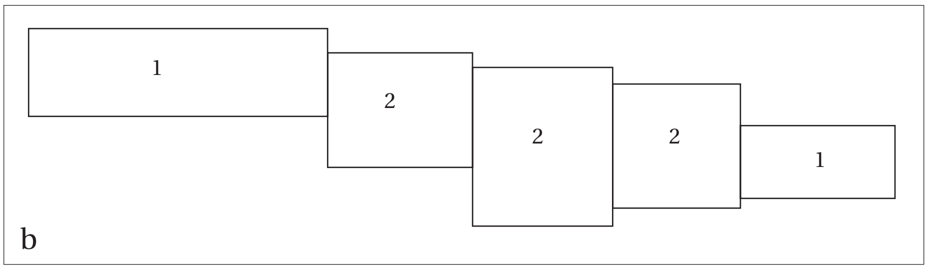


Figure 2. (a) Location of eight most significant natural features on Crete; (b) diagram of test areas and numbers of random points each used in the analysis. (Figure by author)

Figure 3. Summit of Mount Kofinas, the highest peak in south central Crete. (Photograph by author, 2000)

mountain to the north as a possible opposite to Mount Kofinas, but the phenomenological and cultural feature of Mount Juktas makes a logical eighth point. The peak of Juktas is *the* remarkably singular natural feature of north central Crete (Figure 4). It has one of the most architectural peak sanctuaries—one of the few used during the period from 2000 to 1700 BCE—right at its summit and has been clearly linked to the palace at Knossos by archaeologists (Peatfield 1990, 1994). Jones's review of cult artifacts identifies several archaeologists who believe Mount Juktas was one of the first natural sanctuaries on Crete (1999, 29).

In spite of their apparent oppositional structure, these eight natural points create only one pattern with a minimal angular deviation, an alignment between the two highest mountains, Pachnes and Ida, and the sacred cave of Psychro. The line from the Pachnes benchmark on its peak to the GPS point at the entrance to Psychro Cave misses the benchmark on Ida by about 21 m. From Mount Pachnes, 67.608 km away, Ida lies 1.01 arc minutes off; while from Psychro Cave, 61.835 km away, Ida is off 1.15 arc minutes. The average of these two deviation figures is 1.10′ or 0.018°. This figure is right at nominal visual acuity of the unaided eye, 0.017°.

To find out how often patterns occur among eight random points substituted for the eight natural ones, test areas can be created corresponding to the geography of the island as shown in Figure 2b. With each

Figure 4. Mount Juktas peak and sanctuary, looking north over Knossos. (Photograph by author, 2000)

pattern to be tested, a tolerance or range of deviation from the exact was set: alignments (A) = 0.02; bisects (B) = 0.071; cardinals (C) = 0.06; equal angles (E) = 0.032; and nineties (N) = 0.108. These deviations are those of patterns to be shown below that exist among the eight natural points and four palaces.

Two capacities of *Geopatterns* can be applied to sets of eight (natural) random points on the Crete diagram. One can search a modest number of sets, 100 in the present study, for the occurrence of individual patterns (A, B, C, E, N). At present, the software cannot record economically multiple sets where each set generates a number of simple patterns. Each random set must be evaluated by itself. However, millions of sets can be quickly considered when the search is for a relatively rare combination patterns, e.g. A + C(2) + N(2) + N(3) + B (2). (The numbers in parentheses indicate the number of points overlapping in each pattern added to the string.) In the 100 sets of random points, the total data are small enough that all combinations of simple patterns can be observed. Each of these combination patterns, along with those of the existing sites, can be individually tested for probability. However, because of the large number of total combinations possible, even from this small number of points, one cannot firmly place more interesting combination patterns within the larger universe of all geometric possibilities.

The list of all individual patterns from 100 sets of 8 random points each is shown in Figure 5. In 20 of the 100 sets, no pattern occurs in spite of the much larger frequency of bisects (13.3 in 100). An additional 59 sets have one or more bisects but no other patterns. The rest of the sets contain 7 alignments, 10 cardinals, no equal-angles, and 8 nineties; several of these occur with bisects. Figure 5 also shows the predicted frequency of these patterns as derived from larger numbers of random sets where only the particular pattern is being tested.

It is the strategy of this analysis to disregard the presence of bisects because of their much greater random frequency. Furthermore, the focus will be less on individual patterns than on their combination into connected and possibly designed layouts. In the test group of 100 sets, only 2 have combinations of individual patterns, numbers 10 and 51. Set Number 10 is a three-point alignment of which two are in a cardinal relationship to each other [A + C(2)]. When tested as an individual compound pattern, it occurs about 1 in 1000 (0.001). Set number 51 at first appears similar, but because of the higher tolerances of cardinal lines (0.06) than alignments (0.02), it is just [C + C(1)]. The three points have cardinal east-west relationships to each other, but do not comprise a three-point alignment. This combination pattern occurs also about 1 in 1000 sets. The fact that 2 combination patterns of this frequency occurred in our test list of 100 sets confirms that there is some number of combination patterns which cannot yet be predetermined with precision. We do not know how many there are, and therefore, how rare it is that 2 such occur in a test of 100 sets. Nevertheless, the single pattern of the existing eight points—the alignment between Mounts Pachnes and Ida, and

1. B	21. 2B	41. B	61. 2B	81. 2B
2. B	22. B	42. 3B	62. —	82. 4B
3. B	23. —	43. A, B	63. B	83. 2B
4. —	24. —	44. B	64. —	84. B
5. 2B	25. 3B	45. —	65. B	85. 4B
6. B	26. 2B	46. N	66. —	86. 2B
7. —	27. 2B	47. 3B	67. A, 4B	87. N
8. B	28. —	48. 4B	68. B	88. 2B, N
9. B	29. 2B	49. 2B	69. 2B	89. 2B
10. A, B, C	30. A, B	50. B, N	70. B	90. B
11. N	31. C	**51. 4B, 2C**	71. —	91. —
12. B	32. 2B	52. 2B	72. N	92. 2B, C
13. 2B, C	33. B	53. —	73. B	93. A, B
14. 2B, C	34. A, 3B	54. B	74. —	94. —
15. —	35. 2B	55. B	75. B	95. —
16. B	36. 2B	56. 2B	76. 4B	96. —
17. 2B	37. 2B	57. 2B	77. B	97. 2B
18. 6B	38. 2B	58. B	78. B, C	98. A, B
19. B, C	39. B	59. 2B, N	79. B, C	99. —
20. 2B, N	40. —	60. —	80. B	100. B

A = 7 (predicted = 3.8)
B = 133 (predicted = 113)
C = 10 (predicted = 7.4)
E = 0 (predicted = 0, 0 in 1,000,000)
N = 8 (predicted = 6.3)

No pattern = 20
B only = 59
A + C = 1
2C = 1

[EXISTING 8 SITE POINTS: A only]
(A = 0.02, B = 0.071, C = 0.06, E = 0.032, N = 0.108)

Figure 5. Patterns occurring in 100 sets of 8 random points; underlines indicate multiple base patterns excluding bisects. (Figure by author)

Psychro Cave—is not very unusual. It does not even have a bisect in its set. At least 23 of the 100 sets are more complex, including the 2 compound examples, 20 singles that pair up with 1 or more bisects, and 1 set with 2 non-connected patterns. Even though the 8 natural points have apparent oppositional properties in the Crete landscape, within the angular tolerances of the study, they are ordinary random phenomena.

Pattern Probability Among Twelve Random Points on the Crete Landscape

Now four random points are introduced to the analysis, one in each of the four palace areas (Figure 6). The analysis can be simplified by not distinguishing between natural and built points. At large scales, no geologic or climatic forces across the entire island would create more than random geometry, nor would palaces be located in large scale patterns for non-symbolic reasons. Figure 7 gives the patterns that occur in each of the 100 sets, now of 12 each.

The increase of 4 points produces 11 alignments, 962 bisects, 23 cardinals, 0 equal angles, and 27 nineties. Every set has a pattern, but 51 sets only have 1 or more of the frequently occurring bisects. As highlighted in Figure 7, 10 of the 100 sets have multiple single patterns (not including bisects). Out of these 10, the single patterns in 3 of the sets do not combine. Figure 8 examines three of the seven sets where they do combine.

Clearly the most design-like combination pattern is the double ninety with an alignment (set 63). The probability of this pattern occurring among 12 random points is about 3 in 10,000 or 0.0003 (runs on *Geopatterns* are done in units of 1, 10, 100, 1000, etc.). One in 3,333 seems like a possible indication of design intention yet this is a random phenomenon. Again there must be some number of seemingly rare, different complex patterns which might occur in a group of 100 sets. The other 6 examples that combine occur at somewhat greater frequencies ranging from 11 in 10,000 for a simple three-point alignment (set 81), to 6 in 100 for 2 nineties connected at 1 point (set 99).

The combined patterns created by the existing eight natural and four palace points are shown in Figure 9. First, this combination (bisects excluded) has 5 individual pattern components, compared to 3 in number 63 of the 100 random sets. Most rare, however, is the equal angle with its predicted probability of 3 in 100,000 (0.00003), *and* the integration of the other 4 individual

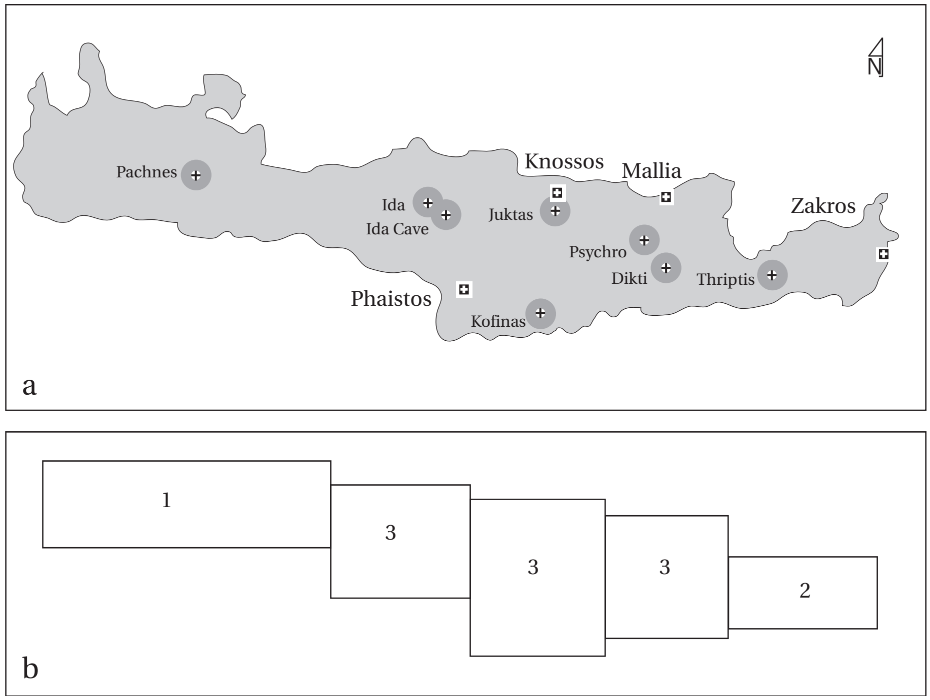


Figure 6. (a) Location of the four most recognized Minoan "palaces:" Phaistos, Knossos, Mallia, and Zakros; (b) diagram of test areas with numbers of random points in each. (Figure by author)

patterns with it. What does it mean if the best random compound pattern of the 100 occurs about 1 in 3,333 sets, while the existing compound pattern occurred 1 in 10,000,000? Without understanding the frequency of all the possible variations of compound patterns, from two to five individual patterns each, however, one cannot say that this exercise statistically "proves" design intention. It is, however, a good indication of such, and can now be considered together with a more contextual landscape or architectural historical perspective.

The Sacred Triangles of Juktas and Knossos

In addition to the rare occurrence of an equal angle among 12 existing points, the fact that its apex is at the palace of Knossos adds to the sense of a ritual layout. This is the largest and assumed most powerful palace connecting equal angles to the end points of the one coincidental alignment among the eight natural points (Pachnes-Ida-Psychro), and the end points of a new three-point alignment formed with Zakros's position and the Psychro and Ida caves. From the center of Knossos's courtyard, the angle to the ends of the West axis (Pachnes and Psychro) is 149.808°, and to the ends of the East axis (Ida Cave and Zakros) is 149.839°, or a variation between the two angles of 0.031 (visual acuity = 0.017°). These two east-west lines appear to be integrated with each other via their equal angle relationship to Knossos. Mount Ida is the central point of the coincidental West axis, while Dikti related Psychro Cave forms its opposite on the palace-created East axis.

Knossos is not described traditionally in integrative terms as suggested by its mediating position between West and East axes. Even though Sir Arthur Evans's popular interpretation of Knossos as the residential palace of King Minos has been modified recently to include somewhat separate religious and economic functions (Warren 1985, 94), it is still considered as a center of hegemonic, territorial power. Based upon Evans's domestic finds on the site that date to Neolithic times (5,000 to 3,000 BCE), the assumption remains that Knossos was the seat of some sort of "family" power for a very long period of time. The site has been rebuilt many times and Evans could find no religious architecture in the earliest layers. Furthermore, when Goodison and Morris discuss the figurines from the deepest strata, only one has a possible religious context (1998, 114). Could it not be that the georitual location of Knossos occurred coincidentally at one of many small domestic settings from earlier periods?

Again, the typical territorial view of Knossos does not in itself invalidate Scully's (or Evans's) idea of visual linkage with Juktas, 6.7 km away (Figure 10). If Juktas as peak sanctuary was a kind of acropolis for the rich surrounding agricultural area, a very large number of landscape locations would have been in its politico-religious viewshed. The only aspect of a territorial view that

1. 11B
2. 7B
3. 6B, N
4. 11B
5. 11B
6. 6B
7. 8B, N
8. 10B
9. 9B
10. 3B, N
11. A, 4B
12. 10B, C
13. 8B
14. 12B, N
15. 7B, C
16. 10B
17. 9B
18. 5B
19. 12B, C
20. 11B, C
21. 10B, C
22. 12B
23. A, 11B, C, N
24. 20B, C
25. 10B
26. A, 15B
27. 11B
28. 11B, C, N
29. 4B
30. 7B, N
31. 7B, C, N
32. B, N
33. 13B
34. 8B
35. 12B
36. 9B
37. 11B, N
38. 7B
39. 3B, C
40. 18B, N
41. 8B
42. 8B, C
43. 11B
44. 14B, C
45. 10B, N
46. 9B
47. 7B
48. A, 3B, C
49. 9B
50. 11B, 2C
51. 9B
52. 7B
53. 12B, N
54. A, 5B
55. 6B
56. A, 9B
57. A, 10B
58. 8B
59. 12B
60. A, 15B, C
61. 8B, N
62. 10B
63. A, 8B, 2N
64. 8B, N
65. 12B, N
66. 12B, N
67. 14B, C
68. 12B, N
69. 11B
70. 6B
71. 7B
72. 14B
73. 6B
74. 5B, C
75. 12B
76. 8B
77. 8B, C
78. 8B
79. 15B, N
80. 15B
81. 2A, 11B
82. 11B
83. 5B
84. 11B
85. 16B, N
86. 8B, C
87. 4B
88. 12B
89. 5B
90. 13B, 2N
91. 4B
92. 19B
93. 16B, C
94. 16B, C
95. 8B
96. 7B, N
97. 7B
98. 13B
99. 10B, 2N
100. 11B, C

A = 11 (predicted = 11)
B = 962 (predicted = 520)
C = 23 (predicted = 12)
E = 0 (predicted = 0, 3 in 100,000)
N = 27 (predicted = 38)

B only = 51
A + C = 2
C + N = 2
A + C + N = 1
2A = 1
2N = 2
3C = 1
A + 2N = 1

[EXISTING 12 SITE POINTS: 2A + C + N + E]
(A = 0.02, B = 0.071, C = 0.06, E = 0.032, N = 0.108)

Figure 7. Patterns occurring in 100 sets of 12 random points; underlined sets indicate multiple base patterns excluding bisects. (Figure by author)

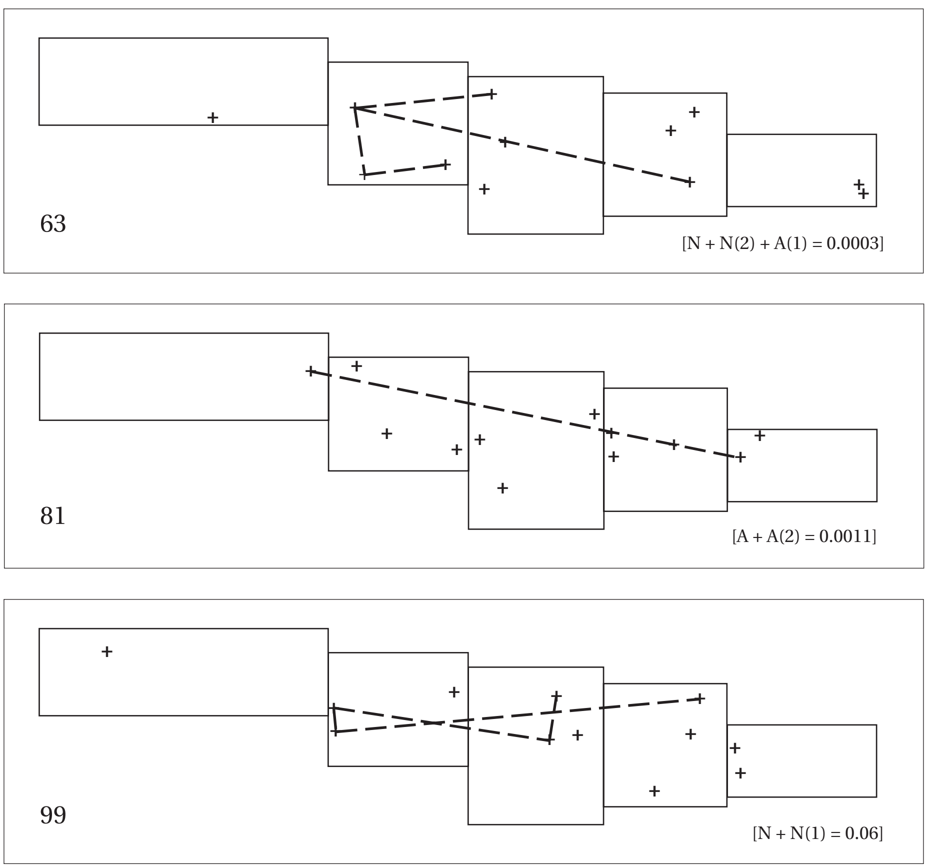


Figure 8. Most complex combinations of base patterns among 100 sets of 12 random points. (Figure by author)

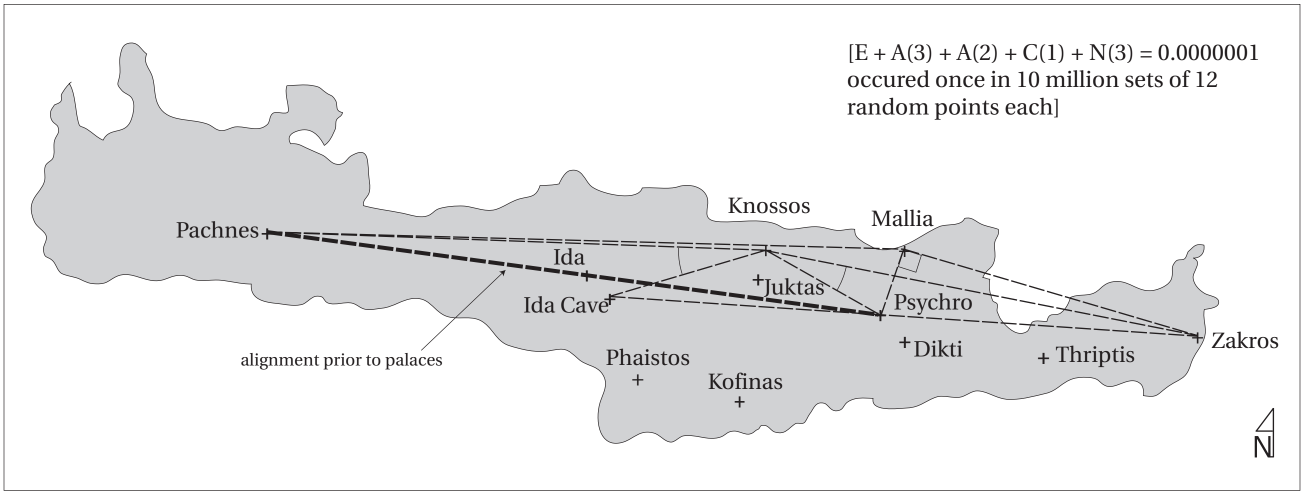


Figure 9. Existing combined base patterns among 12 natural and palace points on Crete. (Figure by author)

could distinguish the Knossos palace from other sites in the area is the orientation of its courtyard axis to Mount Juktas. Yet it misses the peak by over 5°.

There exists one additional, wholly coincidental natural pattern on the landscape beside the Pachnes-Ida-Psychro alignment. Its geometry is not within *Geo-patterns* capacity, nor is the pattern part of the existing patterns used in the statistical analysis. It is an isosceles triangle or pyramid between Ida Cave (Figure 11) and Psychro Cave as base points, and the Juktas peak as vertex (Figure 12). The difference in the two angles (11.990°, 12.048°), divided by two, gives a deviation of 0.029°, or a number again in the range of visual acuity. The lengths of the two sides of the triangles are 28.873 km and 28.735 km. The three points cannot be seen from each other.

This dualistic, triangular relationship between the Ida and Psychro caves, with Juktas as a symbolic mediator, could have been important in Minoan religion. The location and building of palaces now can be seen as evolving from natural patterns. Given the dualism between the sacred caves of the triangle, and the attachment of the Pachnes-Ida-Psychro line to its east base point, it may have behooved Minoan priests to construct an equivalent axis in the east, extending to the triangle's west base point at Ida Cave (Figure 12a).

Once an East line was prolonged from Ida Cave and Psychro, an opposite to the more ancient natural West line, the locations of both Zakros and Knossos must have been created in concert. One possible scenario begins with Juktas as the most sacred central mediator, establishing a bisect angle to both ends of the West axis as shown in Figure 12b. The precise bisector

Figure 10. View of Knossos's axis toward Mount Juktas. (Image is Figure 1 from Scully 1962; axis added by author)

from the existing Knossos point on this path misses the data column on Juktas 6.666 km away by about 8.13 m, an average deviation of 0.070° (the difference in the angles divided by two). Even though random bisect patterns occur with great frequency and are immediately suspect, this was not primarily a bisect in itself, but the creation of a Juktas-inspired total angle from the developing Knossos point to the ends of the West line, i.e. Pachnes and Psychro.

As shown in the Figure 12c, the next step in the process of palace location might have been the establishment of a line between the tentative Knossos point

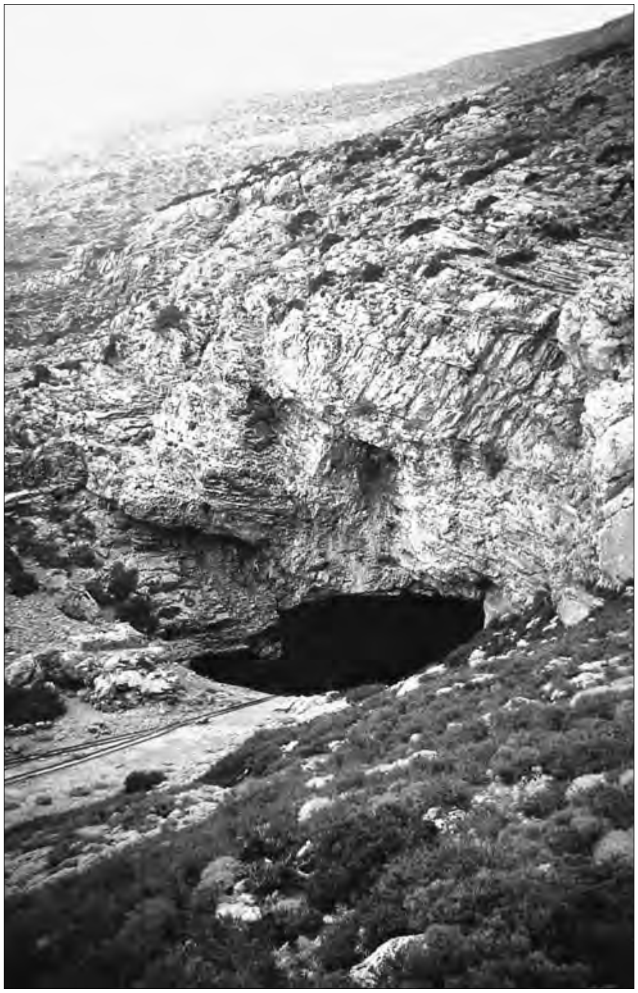


Figure 11. Ida Cave. Opening is approximately 50 feet high. (Photograph by author, 2000)

and the west terminus of the East line, Ida Cave. Then the angle between this line and Pachnes-Knossos can be measured and duplicated to the east to create a Zakros position on the prolonged East line. Trial and error reiterations must have been necessary to achieve the remarkable accuracy of the final layout. While unit measurement probably could not have created such accurate lengths of lines, as in the distances from Knossos to Pachnes (102.877 km) and Zakros (102.421 km), angular surveying could.

Thus Knossos' location intimately connects to that of the smallest of the palaces, Zakros, excavated in the 1960's. Unlike the three other palace sites, it has no surrounding agricultural area. According to Warren (1985, 94) "Zakros is difficult to reach by land . . . and makes sense only as a major port for traffic from the east and southeast." This could mean Egypt. The palace site forms a visually interesting threshold between the "gorge of the dead," a Minoan funerary area inland to the west, and Crete's eastern shore.

Palace Orientations and the Locations of Mallia and Phaistos

People at Knossos used the peak sanctuary on Juktas and may have originated the positioning process with Juktas's bisect relationship to the ancient West line of Pachnes-Ida-Psychro. Given the precision of their surveying, the eventual Knossos palace axis (Figure 13) could not have been directed to Juktas, again over 5° off. What Shaw (1974) did not consider in his analysis of palace orientations were possible contexts with distant sacred natural features. Had he done so, the relationship of Knossos's orientation to the highest central peak of the island, with two peak sanctuaries on it, would surely have become interesting. The azimuth from the central point in Knossos' courtyard to the benchmark on Mount Kofinas is 168° 27′ 16″. Shaw measured Knossos's axis as 11° 37′ 08″ (168° 22′ 52″). This is an angular deviation of 0.073°, very accurate compared with the 5° angle from Knossos to Juktas. Why Kofinas might have been considered as more powerful than Juktas will follow the discussion of the other two palaces, Mallia and Phasitos.

Returning to the existing compound pattern among natural features and palaces one finds two individual patterns connected to the Knossos equal angle and its two alignments (Figure 9). The first is Mallia's 90° pattern (89.892°) with Psychro Cave and Zakros, and the second is its cardinal (90.044°) with Pachnes. The two patterns together could have created an intersection point to become Mallia's central courtyard (Figure 14). Symbolically, the lines from the Mallia point to Pachnes and Zakros emulate Knossos's lines to the same end points of its revised great sacred triangle. But Mallia, located just north of the focus of the East axis mid-points of Dikti and Psychro would logically be linked to one of these points, rather than Kofinas and Juktas as in the case of Knossos. Thus one focuses on the 90° angle between Mallia, Zakros, and Psychro. Both of these latter points are those of the "new" East axis prolonged from

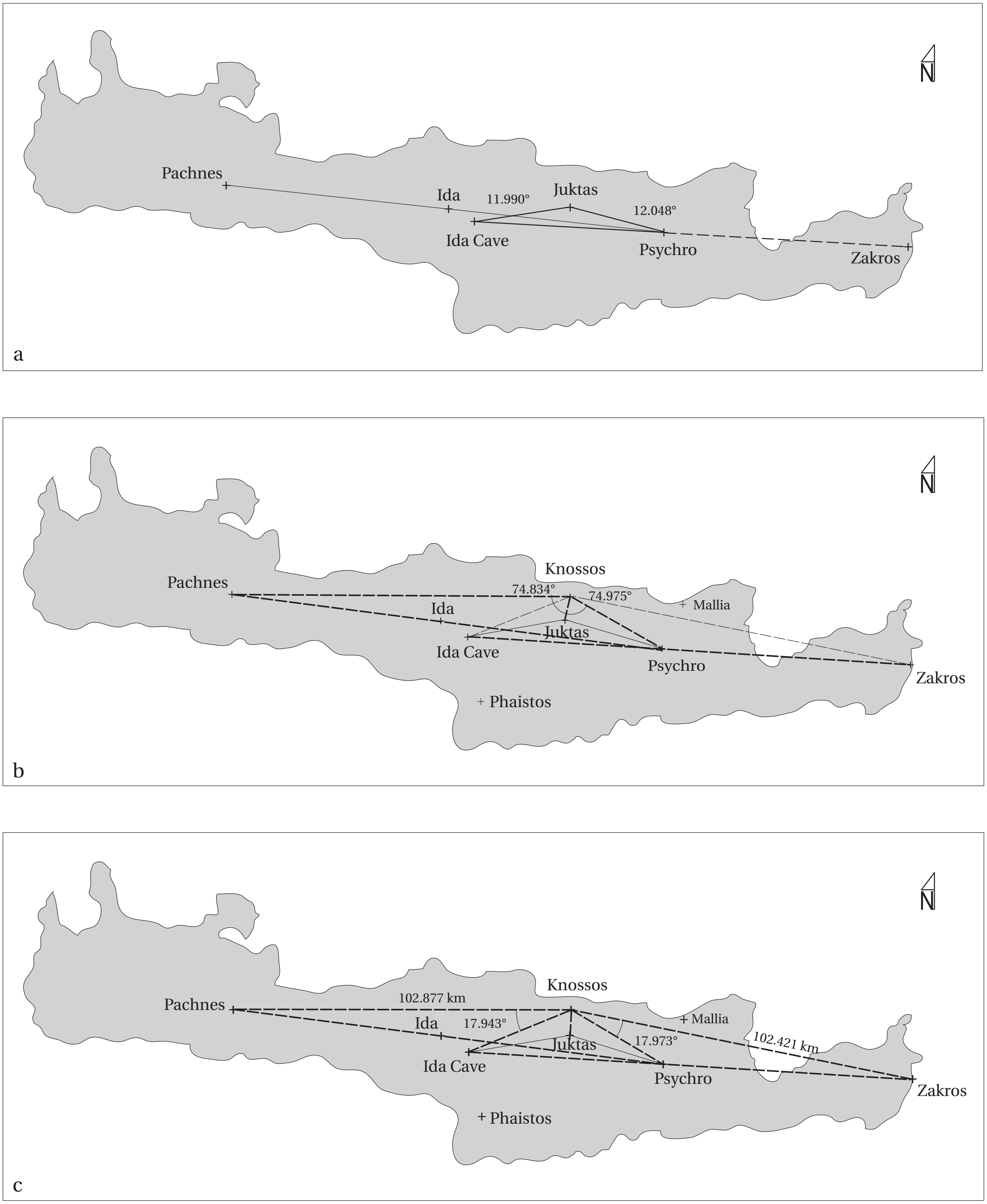


Figure 12. (a) Sacred triangle of Juktas and extension of base to the eastern tip of the island; (b) possible bisect from approximate Knossos position to Mount Juktas (Pachnes-Psychro) as first step in layout of equal angle relationship; (c) equal angles struck from Knosses position to create oppositional East axis and Zakros position. (Figure by author)

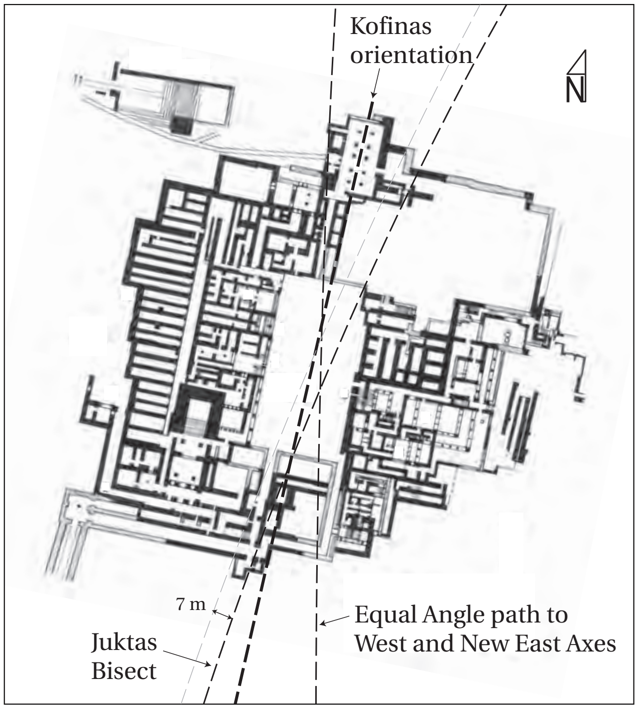


Figure 13. Plan of Knossos showing axis to Mount Kofinas and intersection of equal angle path and Mount Juktas bisect. (Figure by author)

the base of the Juktas triangle (Ida Cave and Psychro Cave) and part of the Knossos equal angle.

Shaw's determination of Mallia's orientation now reinforces its possible georitual context. His figure of 17° 1′ 48″ compares with the azimuth from Mallia to Psychro of 16° 50′ 20″. While this deviation of 0.191° is less accurate than that between Knossos and Kofinas, given the 15.061 km distance from Mallia to Psychro, the line is only off 50.18 m. The deep ravine entrance to Psychro is much less prominent than that of Ida Cave, and some question exists as to which point Minoan surveyors would have used (the author's GPS reading was from its small entrance). In view of Mallia's 90° relationship between the East line midpoint of Psychro and the East line terminus (or origin) of Zakros, it can be noted that Knossos's angular relationship with its orientation focus of Kofinas and Zakros is close to 90° at 89.366°. Its deviation of 0.64° suggests it was not intentionally laid out at the accuracies of described georitual patterns, but was perhaps a coincidental byproduct. Mallia's surveyors might nonetheless have emulated the 90° pattern, but much more accurately (0.108°).

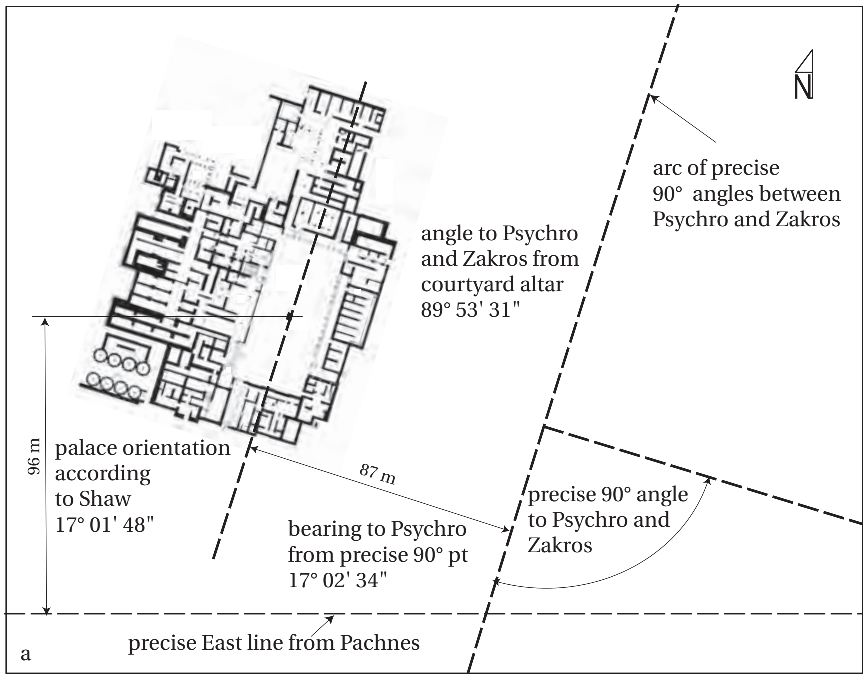
Phaistos's context in the developing scheme is less immediately apparent. Having seen interesting associations between Knossos's and Mallia's palace orientations and natural features, one begins by looking to where Phaistos points (Figure 15). Here Shaw (azimuth) and Scully (visual) both agree on the horned mountain of Mawri. Shaw's determination is 2° 35′ 38″, compared to *Geopatterns* azimuth of 177° 23′ 15″ (2° 36′ 45″). Accuracy of 0.019° is almost right at visual acuity (0.017°). Unlike Kofinas and Psychro as axis referents, Mawri is directly visible from Phaistos (14.623 km). Thus we have a second palace orientation focus, in addition to Kofinas, that does not connect to the Knossos equal angle with its equal West and East axes.

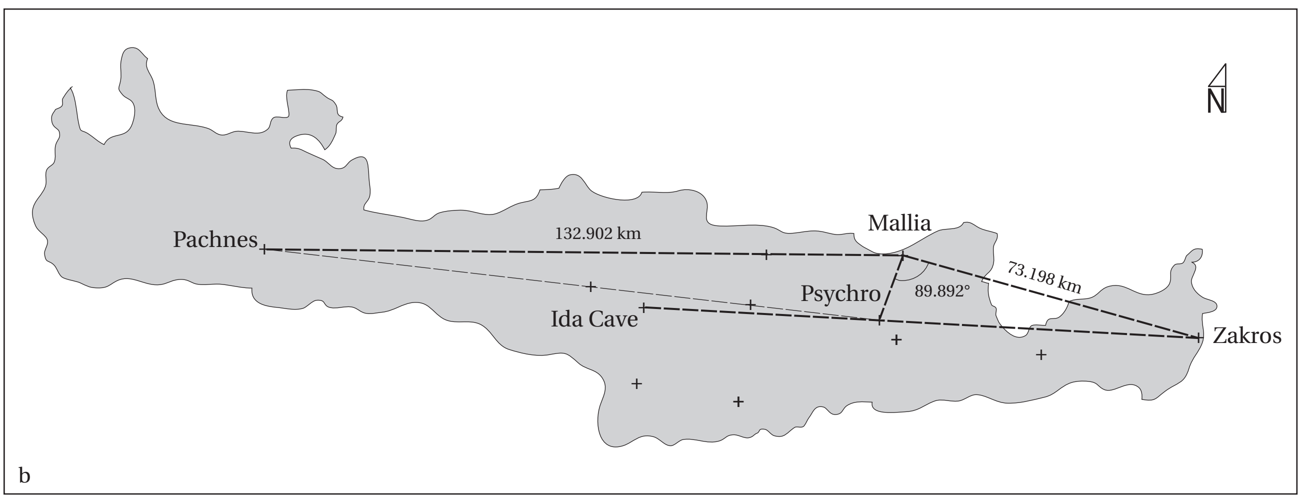
One way the Minoans might have linked Mawri and Phaistos to the Knossos great triangle was to strike a cardinal line east from Mawri (Figure 16). The point where it intersects the base of the Juktas sacred triangle (Ida Cave-Psychro) creates a three-point alignment between Phaistos and Mallia courtyard points. From the precise intersection point, the line from Phaistos to Mallia is off by about 19 m (0.035°) at the distances to the two palaces of 32.785 km and 30. 865 km.

A Hypothetical, Earlier, Wholly Natural Framework on Crete

Why was Mawri considered the important western feature in relation to the palace landscape organization, and not Mount Ida itself, also visible from Phaistos, about 14° farther west? Why does Knossos orient accurately to Kofinas? First, the latitude/longitude figures used for the horned mountain Mawri, which works so well in terms of Shaw's azimuths, did not come from either a given Greek benchmark, or a GPS reading. The visual focus of the mountain is not its peak, but the valley between the two "horns." This position was first approximated from a 1:50000 map of the area. It was then realized that this tentative point aligned with Mount Ida and Mount Kofinas. It also appeared to be the western terminus of a line from Mount Dikti and Mount Thriptis. It is this precise intersection point that has been used in the calculations of azimuths from Phaistos and the creation of the Phaistos/Mallia intersection point. This possible georitual point has not been field investigated.

Figure 14. (a) Mallia plan and relationship to ninety degree angle and cardinal; (b) georitual layout. (Figure by author)





Considering the close to parallel relationship between the ancient Pachnes-Ida-Psychro or West line and this southern Mawri-Dikti-Thriptis line (azimuths of 262° 02′ 24.8″ and 263° 32′ 32.5″) as shown in Figure 17, one can speculate about an earlier relationship between them. Symbolically, the midpoints of these two axial oppositions would have been the two most prominent mountains, Ida and Dikti. How then did Juktas and Kofinas integrate into this layout? These two clearly sacred features of central Crete form a relatively accurate central axis of a bisect to the two great western and eastern mountains of Ida and Dikti. This coincidental bisect has an accuracy of 0.101°, meaning that the precise bisector will miss the monument on Juktas, 31.428 km away, by about 55 m. It is also true that one can see the well known volcanic island of Thera (Santorini) from the peak of Kofinas (1231 m), particularly if it is venting or erupting as it did famously during the Minoan palace period at about 1700 BCE. If prolonged by 162.742 km, the Kofinas-Juktas axis hits Thera about 2 km from the small volcanic island in the present day caldera.

The final diagrams of Figure 17 show the possible evolution of dualistic georitual patterns beginning sometime prior to the palace periods. Based upon the geometry of the Juktas sacred triangle, the palace system might reconstitute the old East axis as the

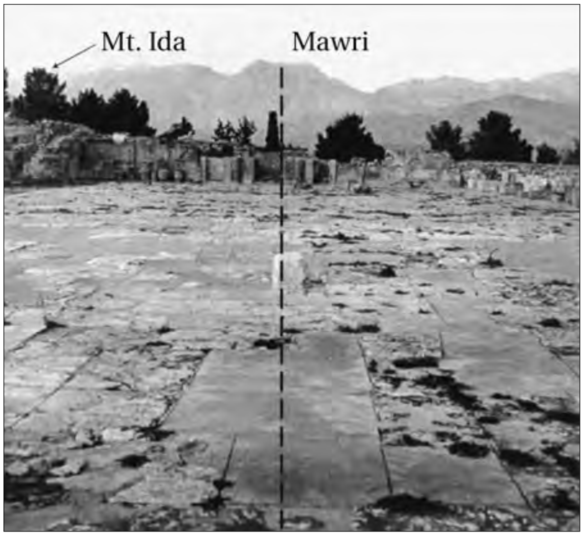


Figure 15. View of Phaistos's axis toward Mawri. (Image is Figure 11 in Scully 1962; axis and mountain identification added by author)

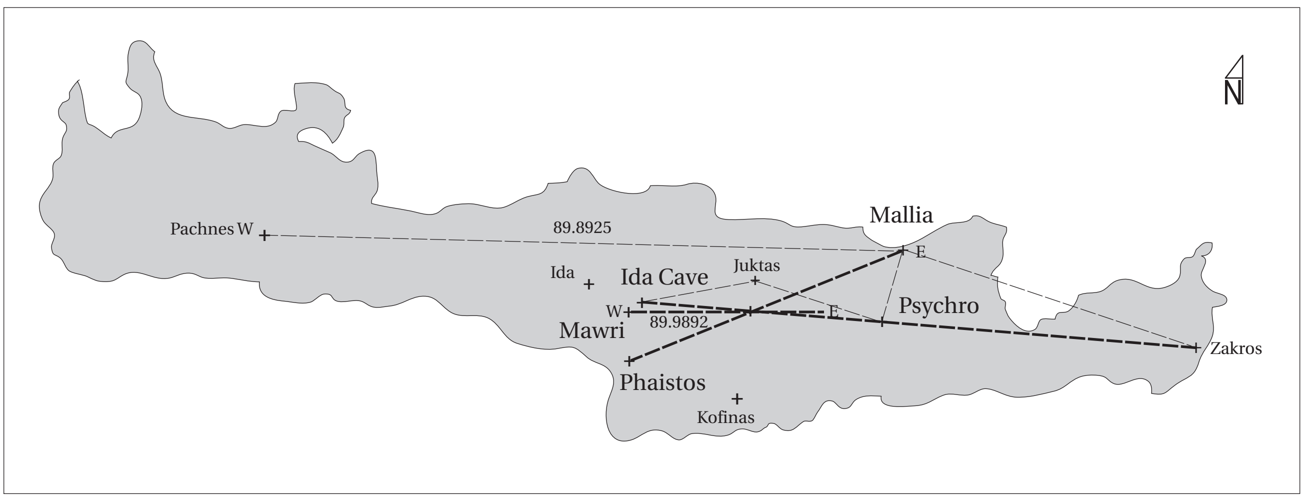


Figure 16. Hypothetical means of positioning Phaistos (West) in relation to Mallia (East) via a cardinal line from Mawri to the Juktas triangle base. (Figure by author)

prolongation of the triangle to Zakros. Given the equal angle relationship of Knossos to both ancient West and new East axes, its central or mediating ritual power is clear. The positions of the east and west palaces of Mallia and Phaistos might well have been laid out from this new construct. What is most interesting, however, as shown in Figure 18 is the apparent fact that the orientations of the new palaces did not focus on the revised georitual layout, but the earlier one. Knossos aligned to Kofinas, the base of the Ida-Juktas (Thera)-Dikti bisect. In addition to the central palace's equal angle location, it may have participated in some ritual relationship to the Kofinas-Juktas-Thera line. Knossos's entrance faces the line some 489 m to the west. Considering the early pattern and Knossos' link to its central base Kofinas, the orientations of Mallia and Phaistos may have been symbolically logical. Neither orients to the central mountains of the two old axes, Ida and Dikti, but to the associated ends of the opposite axis: Mallia to Psychro (eastern terminus of the West axis) and Phaistos to Mawri (western terminus of the East axis).

Shaw's figures for the orientation of Zakros, 37° 33′ 10″, remain an enigma in terms of either early or revised georitual framework on Crete. This azimuth does not align with any of the lesser peaks with benchmarks, or with the best known peak sanctuaries on the tip of the island (Figure 19). To a large extent, there are no singularly important natural features in the general

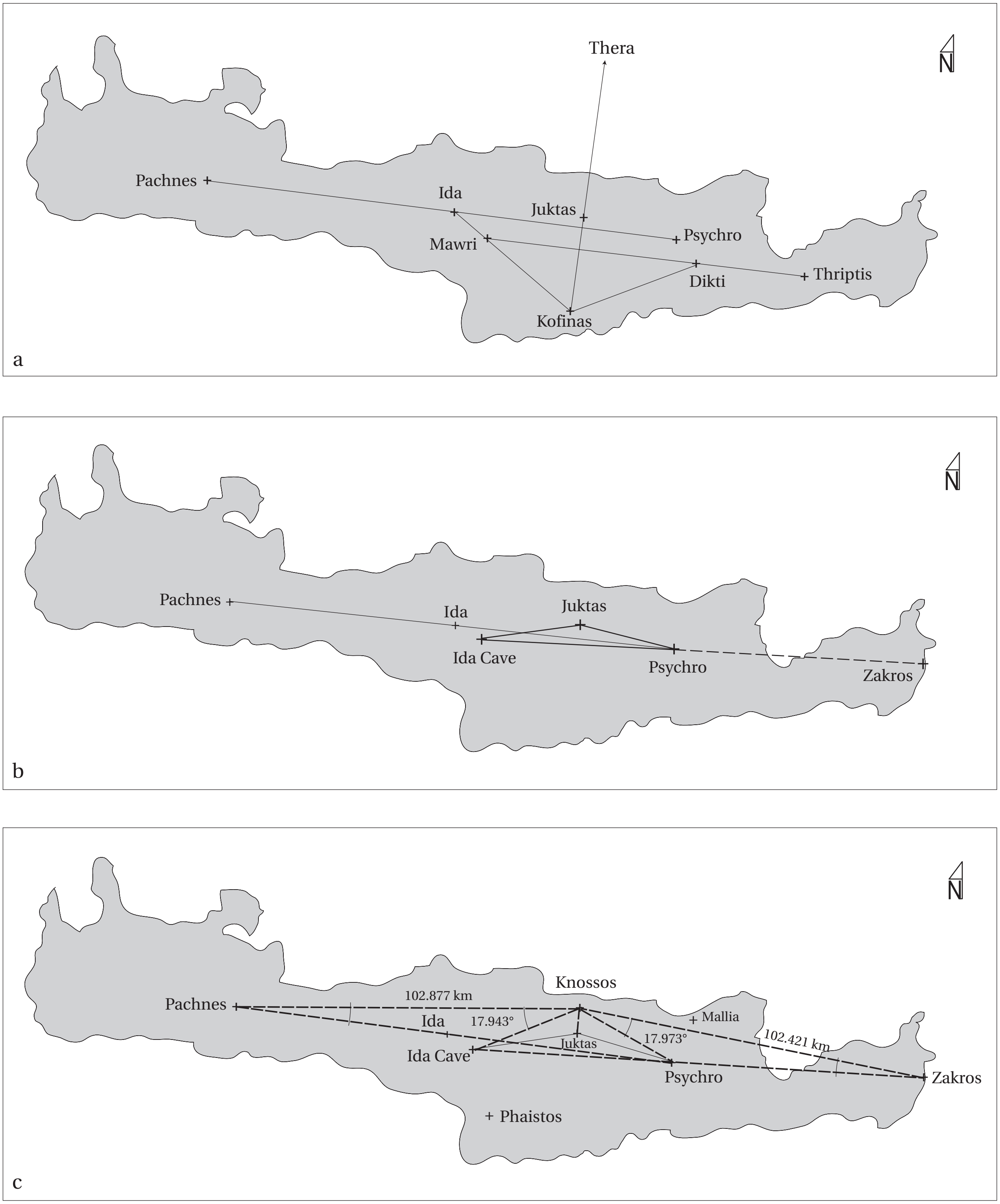


Figure 17. (a) Georitual evolution beginning with pre-palace framework of West and East axes with a bisect from Kofinas to Mount Ida and Mount Dikti, central axis from Kofinas through Juktas to Thera; (b) sacred triangle of Juktas and extension of base to the east; (c) Knossos triangle and equal angles to West and new East axes. (Figure by author)

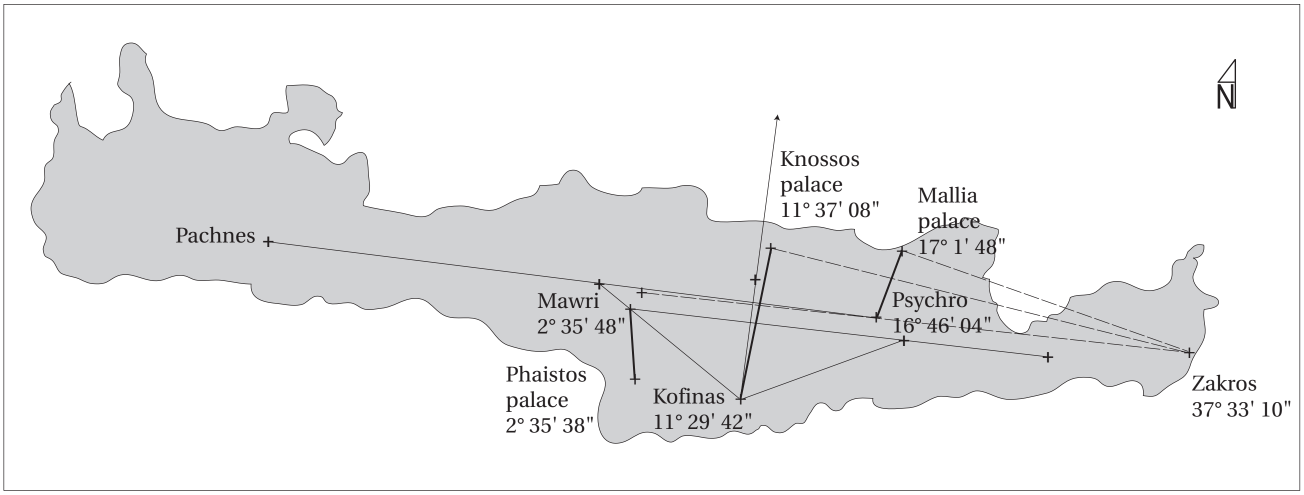


Figure 18. Orientation of three palaces to three of the natural framework points. [Palace azimuths from Shaw (1974, 56); figure by author]

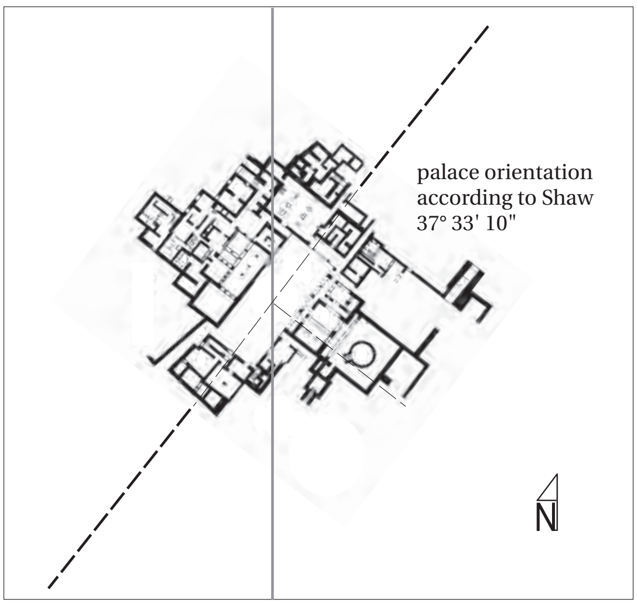


Figure 19. Zakros palace plan and orientation. (Figure by author)

north-south orientation of the palace axis. The palace's relationship to Egypt, land of expert surveyors and sailors, is tantalizing.

Toward Future Georitual Research and the Distinction between *Intension* and *Extension*

In this study, eight most significant natural sites were selected. An analysis of 100 sets of 8 random points in an island diagram showed no unusual geometric patterns among the 8 existing sites. Four random points were then added, representing the 4 acknowledged most prominent palaces, producing a second group of 100 12–point sets. The best compound patterns produced by this second analysis were somewhat more complex than those of the eight-point test, but not radically so. The primary aim was to compare the best random sets of the 12–point analysis to the compound patterns created by the 8 natural feature points together with the 4 palace locations.

Geopatterns' ability to test particular strings of up to 5 combined individual patterns tells us that the best pattern with the lowest probability of the 100 sets (12 random points each) is about 1 in 3,333. Only 7 of the 100 sets have any combined pattern at all. Consider if building palaces had been a sacred lottery, winning connective power with the spirits if coincidental configurations were created. There would have been only one ticket sold, i.e. the construction of four expensive palaces in random locations. Builders would have had a 93 percent chance of creating no combined pattern at all, and over 50 percent of the time would have gotten only the frequent bisect patterns without any alignments, cardinals, nineties, and especially the rare equal angles. If they were really fortunate they might get a combination of three individual patterns. The fact that the particular disposition of the 4 palaces creates a very complex compound pattern, which occurs randomly about 1 in 10,000,000, speaks clearly. The builders were not fantastically lucky, but rather designed the patterns and laid them out with good surveying. The design probability of this compound pattern is reinforced by graphic suggestions of a formally related earlier framework on the island. The clear, logical orientations of the four palaces to this framework provide final evidence of ritual (and design) intention.

Figure 20. "Horns of Consecration" at Knossos, aligned with palace orientation to Kofinas and possible dualistic expression of the ancient West and new East axes. (Image courtesy of Richard Ishida, 2006)

This work does not come from a discourse in classical archaeology with its emphasis on the dating and interpretation of objects, but from design research into the relationship between landscape and architecture. As such, the author can make little informed speculation about what an evolution from an earlier framework to a Knossos-focused layout implies in terms of religion or society. There is, however, a growing subfield of archaeology called "landscape archaeology" in which the interpretation of objects is given a larger context, both in terms of geographic scale and complexity of influences. It may be here that interdisciplinary work between design research and archaeology can be advantageous.

The danger of archaeologists extending their investigation of artifacts, however, lies in the assumptions, made also by architects, that design formalities essentially occur first at the scale of architecture and then are *extended* out into the natural landscape, as seen in Scully. Georitual research and the use of tools like *Geopatterns* attempt to reverse this assumption in certain cultural landscapes. In the case of the archaeology of Chaco Canyon, the author has proposed that the first geometric formalities of intentionally designed layout occurred in the large scale landscape prior to the development of palace or temple-like great house architecture. These structures were first located by *intension* relationships to landscape frameworks, which then were integrated into formal buildings along with more easily created *extension* to other great houses, astronomical phenomena, and perhaps also natural features. It is true that virtually all simple domestic dwellings in very traditional societies are formally microcosmic, i.e. with ritual layouts that emulate some larger cosmos. But these structures are not intentionally designed, as such, just built as people had always built them. Evolutions in these societies do occur, but not as specific, formal design layouts as discussed in the present paper.

Research has not yet determined whether Greek temples were positioned by georitual frameworks. With the possible exception of Pan-Hellenic sites like Delphi or Delos, their architecture seems in ways thoroughly modern. They sit as monumental, competitive icons expressing the power of the territorial city or city state. The Minoan palaces, on the other hand, seem less interested in impressive exterior facades, or interior rooms for residing gods. Even the layout of the building is less formal, primarily emphasizing the courtyard and its orientation to a distant natural feature. Where these buildings eventually stand on the possible continuum of *intension-extension* can only be determined by future work (Figure 20).

Intuitively, from a design research perspective, the differences between these two kinds of ceremonial buildings, together with a glimpse into their relationships with the larger landscape suggest an association of social integration with *intension,* and greater territorial power with *extension.* If, as interdisciplinary researchers we can prove that essentially modern, territorial structures of space and religion did not grow out of “indeterminate sacred space” as Sourvinou-Inwood (1993) has termed the period preceding Classical Greece, but radically diverged from fundamentally different kinds of cultural landscapes, then our view of the Classical Greeks, and our Western selves may require some revision. Earlier landscapes may not have been just visually captured by architectural formality, as Scully proposed, but were far more symbolically and ritually structured. Religiously, the gods were still in the mountains rather than temples, landscape was still dominant over architecture, and integrative social modes still had an edge over the authoritarian.

NOTES

1. The term “palace” originated with early archaeologists and is still widely used even though the actual function of these largest of multi-room buildings remains to be completely understood.
2. For additional categories of experience in landscapes, see Doxtater 2008.
3. For a detailed description of the custom application *Geopatterns,* see Doxtater 2007.
4. Curiously, the watchtowers need not be aligned to watch the activities of the river, or pass signals to each other. Accuracies in a similar range can be obtained by backsighting using pairs of tall tripods with plumb bobs about 6 m from each other (Doxtater 2002).
5. Tyree gives more text to Psychro’s archaeology than any other cave.

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