

## **On Middle Minoan Sites and Sight Lines: Communication Strategies in the Bronze Age Mediterranean**

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The fact that so many views from hill-top Middle Minoan sites interlock in multiple directions suggests that these sites were picked deliberately not only for their views but also for intercommunication among sites. The uniqueness of some of these multiple vistas suggests the same. Analysis (on the basis of communication theory and practical experiments) of the possibilities for sending message signals shows that the Minoans would have been restricted to fire signals at night, and that such a system would be highly limited in content but effective within those limits. The analysis also makes predictions about the existence of a small number of additional, connecting sites — predictions that have been and can be used to test the hypothesis.

### **Sight-Lines**

Balancing in the wind atop the oval walls of the isolated Minoan building “of uncertain use” at Khamaízi in East Crete, one bright May morning, we found ourselves astounded at the view. Not only could we see the eastern panorama of the Siteía valley and the great ridge beyond, crowned by peak sanctuaries on Módi and Priniás and stretching out to the northeast tip of the island at Cape Síderos, but with a turn of the head to the west we could also see straight through a small notch in the hills to the peak sanctuary on Thýlakas, just above Agios Nikólaos more than 30 km away along the north shore of Crete.

Might the key purpose of placing a lone building up on this isolated hillock, then, be for communication — to provide a permanently tended lookout for relaying signals quickly along the island from one area to the next? Recall the opening of Aeschylus’ *Agamemnon*, where the tired watchman on the roof recounts the passing of many seasons of stars and finally hails with joyous relief the beacon that announces the fall of Troy. Clytemnestra answers explicitly the chorus’s

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demand to know what messenger could possibly come in a single night from Troy to Mycenae:

“Hephaistos, sending forth a bright blaze from [Trojan] Ida!  
 And beacon sent it to beacon from the courier flame  
 hither: Ida first to the Hermaean crag  
 of Lemnos; and the precipice of Zeus on Athos  
 took up the great torch from the island third:  
 the power of the traveling flare o’erleaping,  
 in joy to cross the back of the sea,  
 the gold-flamed pine log like some sun  
 transmitting the sign to the lookouts of Makistos;  
 which, not delaying nor senseless in sleep,  
 victorious passed onward the role of messenger;  
 afar the beacon’s light across the streams of Euripos,  
 moving on, signaled to the watchmen of Messapion.  
 These lit up in answer and passed the relay onwards,  
 touching fire to a mound of withered brush.” [lines 281-295]

And on and on the signal flies through the night, till it reaches the lookout above Mycenae.

I take no stand as to whether this signal ever *actually* announced the fall of Troy. But I would point out that the inhabitants of Greece millennia ago were quite capable of both thinking up and producing such a system. Hence it seems reasonable to explore the possibilities on Minoan Crete. For the record, Aeschylus’ stages vary enormously in length: Trojan Ida to Lemnos 150 km, Lemnos to Athos 75 km, Athos (which is over 2000 m high) to Makistos 135 km (if it is indeed to be identified as lofty Pelion), 85 km more to Messapion in Opuntian Locris, Messapion to Kithairon 50 km, Kithairon to Aigyplanktos (now Geraneia) 25 km, and a final 40 km to Arakhnos above Mycenae (Map 1). All but one of these stages is longer than the distance from Khamaizi to Thylakas.

The excavators of Khamaizi — Xanthoudídes in 1903 and Daváras in 1971 — had found the rooms and their MM I furnishings sufficient for the living needs of one or two families — all that maintaining a signal tower would require. Perhaps the rather heavy substructure and nearly unique ovoid shape once supported an upper platform for the requisite flare, much as in a lighthouse today. A bit of added height would only improve the double view, as well as the visibility from the next post. Indeed, the ancient Anasazi at Chaco Canyon, New

Mexico, when erecting signal-relay towers to enhance communication among their shrines, had to choose the emplacements very carefully, and occasionally even add extra height to the tower to make intervisibility possible (Hayes and Windes 1975: 153-155).



MAP 1: Greece and the Aegean, showing stages Aeschylus claimed for fire-signal sent from Troy to Mycenae (also position of peak sanctuary at Agios Georgios, Kythera).

We had noticed the views at Khamaizi because we had got in the habit of looking up (instead of always down at the excavated soil), while checking sight-lines from sites in the

Mesará to the “horns” of Psiloríti — Cretan Mt. Ida. That the central courts at Phaistós and Knossós are aligned on Psiloriti and Ioúkhtas, respectively, is well known. But we had found that other kinds of sites, too, were referenced to the sacred horns of Ida and the Kamáres Cave just below:<sup>1</sup> certain sightlines were clearly important to and carefully noted by the Minoans.

### Intervisibility

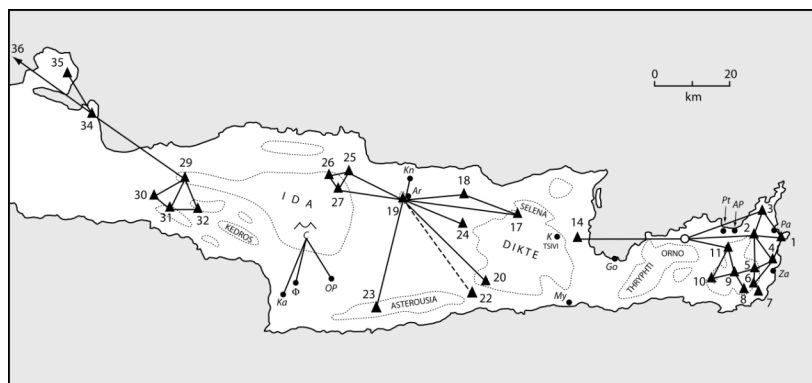
It has long been established that the known peak sanctuaries are always prominently visible from the surrounding agricultural land (observations summarized, e.g., by Peatfield 1983: 274-276). What we found in addition, with much map work and hiking, was that from these known and agreed-upon peak sanctuaries one could also see at least one and usually several other peak sanctuaries and peak sites (see Maps 2-4).<sup>2</sup> For example, from the sanctuary atop Módi you can see the peak sanctuaries of Petsophás (6.5 km E), Traóstalos (8.5 km SE), Vígla Zákrou (9.5 km S), and Kalamáki (8.5 km N), as well as Khamaizi (18 km W), not to mention the important Minoan coastal sites of Palaíkastros, Petrás, and Agia Photiá, and the next islands to the east (see also Map 1).<sup>3</sup>

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<sup>1</sup>At Kamilari, for example, we could not see Psiloriti and its horns as we approached, but only when actually standing on the site. If the round charnel house of Kamilari had been moved even a few meters in any direction except up the hill — and who wants to drag the dead any farther uphill than absolutely necessary? — the apparently sacred view would not have been achieved.

<sup>2</sup>In the term “peak sites” I will include those sites that were clearly frequented by Minoans and resemble peak sanctuaries in their prominently visible placement, but that are not yet proved or agreed upon as cultic. Cult and ritual are not the central issues of this paper. In Map 2, note how the intervisible sites fall into three primary networks. (Cf. Soetens *et al.*, 2008, 155.)

<sup>3</sup>At 539 meters, Modi is not so much high — rising pyramidally only 90 meters from the high ridge sloping out to Cape Sideros — as conveniently visible from many sites on either side of the ridge. The knoll at Agia Photia with Minoan house foundations is the only shoreline spot in the area from which you can see Modi — and that includes the largish Hellenistic site of Tripytos two ridges farther west. (Hellenistic Greek concerns in picking a site apparently did *not* include being able to see the best lookout around.) Similarly at Petras, where large Minoan buildings are being excavated on a hillock just east of Siteia: Petras is easily identifiable from Khamaizi, but Modi is not visible from Petras until one gets right up on the knoll where the most monumental edifice sits. These experiences suggest that being able to see



MAP 2: Sight lines between various Minoan sites on Crete (solid and dashed lines). Contours of tallest mountain massifs indicated with dotted lines. See Map Key for symbols and names of sites.

KEY TO MAPS 2, 3, and 4

- ▲ Peak sanctuary previously known **and** identifiable on contour maps
- △ Suggested peak site, or known sanctuary whose location had to be surmised
- Confirmable sight lines
- Highly probable sight lines
- ... Contour lines (above roughly 600 m within the circles)

PEAK SITES (listed as peak sanctuary — by Peatfield \*, by Kyriakidis +):

1. Petsophás* +	(215 m)
2. Módi* +	(539 m)
3. Kalamáki* +	(150+? m)
4. Tragóstalos* +	(515 m)
5. Vígla Zákrou* +	(714 m)
6. Korphí tou Máre*	(750+ m)
7. Ampelos* +	(500+? m)
8. Plagiá* +	(819 m)
9. Xyképhalo* +	(810 m)
10. Etianí Kephála* +	(615 m)
11. Priniás* +	(725 m)
12. Aphéntis Stavroménos, S spur	(~1000 m)
13. Xylogournes	(824 m)
13'. Katalímmata	(802 m)
14. Thýlakas* +	(521 m)

Modi had indeed been important somehow — perhaps just as a view of a sacred place, but perhaps also to hook into an informational pipeline.

My thanks to Philip Betancourt for arranging entry to the site of Agia Photia, to Sarah Rudofsky for pointing out the need, and to Paul Barber for trekking with me in 1994.

15. Stavroménos Anatolí	(951 m)
16. Táppes*	(750+ m)
17. Karpí* +	(1158 m)
18. Mazá* +	(456 m)
19. Ioukhtas* +	(811 m)
20. Roussos Détis*	(1160 m)
20'. Koupa	(1187m)
21. Sykológos	(698 m)
22. Demáti* +	(180 m)
23. Kóphinas* +	(927 m)
24. Lilianó +	(~400 m)
25. Pýrgos* +	(685 m)
26. Philiórimos/Goniés* +	(797 m)
27. Keriá* +	(1160 m)
28. Kopída	(973 m)
29. Vrýsinas* +	(858 m)
30. Karavéllas	(560 m)
31. Atsipádes* +	(736 m)
32. Spíli at Voritzi* +	(878 m)
33. Akoúmia	(853 m)
34. Drapanokephála	(528 m)
35. Sklókhas	(528 m)
36. Agios Geórgios, Kythera +	(350 m)

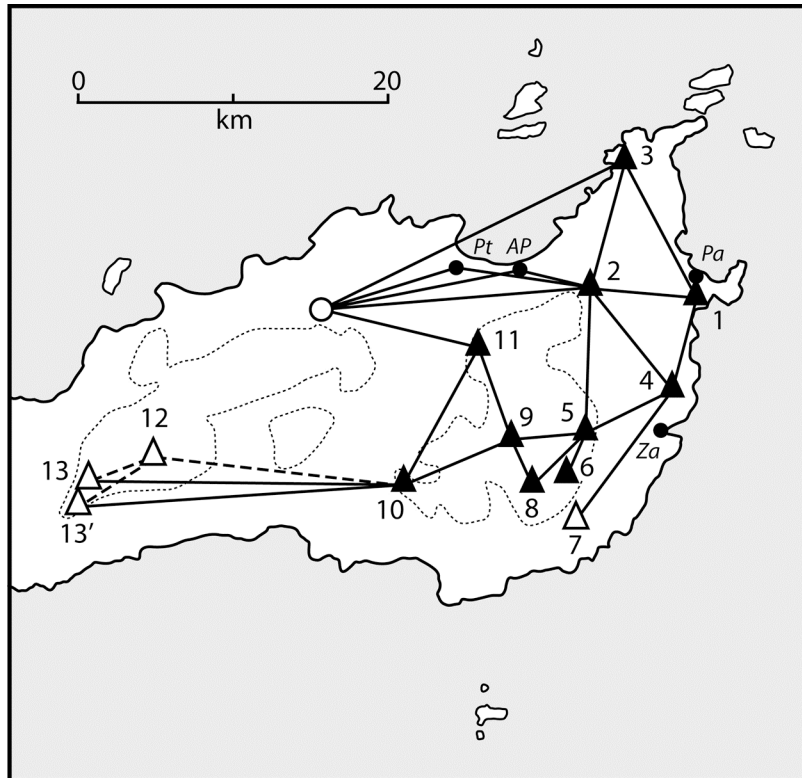
## OTHER SITES:

O	Khamaízi (520 m)
C	Kamáres Cave (~1550 m)
∩	“Horns of Psiloríti” (Ida) (1981 m)

AP	Agia Photiá	OP	Orthí Péttra
Ar	Arkhánes	Pa	Palaíkastro
Go	Gourniá	Pt	Petrás
Ka	Kamilári	Φ	Phaistós
Kn	Knossós	Za	Zákros
My	Myrtós		

From Traostalos, according to Peatfield, “at least six other peaks can be seen: Petsophas to the north, Modhi to the northwest, Vigla Zakrou, the tip of Plagia, and Korphí tou Máre, all to the southwest, and Ambelos to the south” (Peatfield 1983: 276), and to this list one can now add Korakomouri (Chryssoulaki 2001, pl. XII), making seven. From Ioukhtas one can see the peak sites of Mazá (19 km ENE), Karpí (30 km ESE), Liliano (above Galatas to the east: Kyriakidis 2005, 20), Roussos Détis (29 km SE), Kóphinas (30 km SSW), Pýrgos and Keriá (15.5 km NW), and possibly Demáti (26.5 km SSE), as well as the major Minoan remains at Arkhánes and Knossos; while from Vrýsinas one can see,

among others, Atsipádes, Karavéllas, and Spíli/Voritzi to the south and all the way to the Minoan colonial peak sanctuary at Agios Geórgios on the island of Kýthera far to the northwest (Kyriakidis 2005: 19; see Map 1).

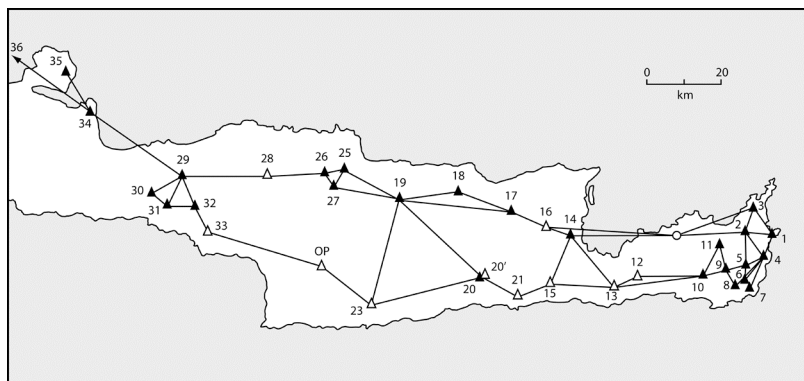


MAP 3: Enlargement of East Crete, where peak sites (see Map Key) are densest.

The available contour maps alone, however, proved insufficient to determine some of the actual sight lines from peak to peak.<sup>4</sup> Again and again, as we scrambled the last few meters up a “Minoan peak” we found that additional peaks that

<sup>4</sup>I used the excellent hiking maps published by Harms Verlag, at scales of 1:100,000 and 1:80,000, with 50-meter contour lines. The exceedingly slim margins of error for intervisibility and the remarkable personal experience of seeing some of these vistas appear make me wonder whether even the new GPS systems are entirely adequate unto the task of discovering intervisibility. One need not think to calculate every unlikely angle: one has only to turn around and look.

we had not expected to see were rising majestically into view through some convenient little gap in the surroundings, just as at Khamaizi (cf. Kamilari: note 1). This happened, for instance, on Thylakas, above Agios Nikolaos.<sup>5</sup> Just visible through a convenient notch loomed the peak of Stavroménos Anatolí (951 m), 13 km SSW of us near the south coast, on the far side of Crete's long, central, mountainous spine. As at Khamaizi, we discovered that this *particular* placement of the sanctuary — on this bump rather than on the other one a few hundred feet away — gave a unique view of another peak, although the surrounding lowlands and coast were equally visible from both. Seeing that peaks were of interest, our hiking guide turned and pointed northwest, where above the north shoulder of massive Katharó Tsívi peeped another distant peak: Mákhaira, at 1487 meters the easternmost and second highest pinnacle of the four-peaked Seléna range.



MAP 4: Chains of “peak site” sight lines across Crete. (See Map Key for symbols and site names. For site 36, see Map 1.)

<sup>5</sup>P. Demargne (1901: 286) suggests that the name *Thylakas* is a mutation of *Phylakas*, from *phylak-* “guard”. Several of the relevant peaks have names suggesting lookouts of some sort, such as *Vigla* (from Latin *vigil*), named from the perspective of above. Others have names based on the visual prominence of the site from below: *kephal-* “head”, *koryph-* “head, peak”, etc.

My thanks to Donald Haggis for encouragement, for contour maps, and for climbing Thylakas with me; and to Georgos Aphordakós of the Greek Hiking Club for cheerfully volunteering at a moment's notice to guide us up the steep, rocky, and trackless mountainside, sharing with us his bananas (“For energy!”) and his wide knowledge of every Minoan wall and fragment of Minoan road along the way. My thanks also to Ann Peters, Sharon Touton, and Aleda Winget for trekking with me that season (2001).



Studies of the Minoan peak sanctuaries carried out by Alan Peatfield, Krzysztof Nowicki, Bogdan Rutkowski, and others demonstrate that these prominent sites do not occur above about 1200 meters, the approximate limit to good pasturage on Crete.<sup>6</sup> Since both Makhaira and Katharo Tsivi topped that limit by several hundred meters and hence were very unlikely to belong to a Minoan system, I was led to wonder if there might be another, lower peak site to the north linking Thylakas with the peak sanctuaries farther west.

Peatfield's list from 1992, I found, added a sanctuary above the village of Tápapes — that is, precisely on the north shoulder of Tsivi that blocks the view west from Thylakas. Finding and climbing that promontory indicated that Tápapes indeed completes the chain: not only could we clearly see Thylakas to the east (along with the entire gulf of Mirabéllo, Ornó, the Kha gorge, Thryphtí, and a bit of Gourniá), but the villagers claimed emphatically that Karphi was also visible to the west.<sup>7</sup> Map work also indicated that, like Thylakas and

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<sup>6</sup>Summarized by Peatfield 1983: 276 and 1990: 120. See also Faure 1963: 493-508; Rutkowski 1986: 73ff. The explorations of Faure and Davaras and the syntheses of Rutkowski and Peatfield are what have made much of my analysis possible. Earlier, Nikolas Platon (1951) made a major study of peak sanctuaries. It is interesting, however, that Peatfield rejected almost all the sanctuaries listed by Platon! The 25 known by 1992 that Peatfield found acceptable are marked with \* in the Map Key, while the 22 accepted by Kyriakidis in 2005 are marked with +. This paper, however, considers Minoan peak sites more broadly, not exclusively the sanctuaries. While hiking peak sites, I have taken nearly 200 photos — some film, some digital; some are enhanced digital, some ID'd with GPS location and compass readings to distant features. They do not reproduce well in black and white, but I am happy to share both them and my notes with other researchers.

My thanks to Alan Peatfield, Krzysztof Nowicki, Tim Cunningham, and others for encouragement and for directions on finding several of the known sites.

<sup>7</sup>Tápapes villagers assured us repeatedly that one could see Karphi from the north side of the Kastellos, although I have trouble squaring that with the contour map. (On the other hand, the "excellent" contour map is not infallible: Petsophas, for example, is marked on the wrong peak of the right promontory.) There are actually 3(!) peaks NW of Tápapes that people call Karphi ("nail"), and what one could see was definitely not the northernmost, which is part of the Selena range, its view being blocked by Selena itself. Apparently what *is* visible (through a visible notch not noticeable on the contour map) is the 1117-meter northern spur of 1148-meter "Karphi proper", a few hundred meters north of where the peak sanctuary is thought to have been (although that exact spot, too, seems to be in doubt). What we *can* say is that, once one is up on Karphi and Kastellos, it wouldn't take much

massive Katharo Tsivi, Tappes should be visible directly from Khamaizi.

In that case, one could send a message by light-signal from Petsophas, on the east coast above Palaikastro, all the way to the peak sanctuary on Ioukhtas, near Knossos, in only five hops using six stations: Petsophas-Modi-Khamaizi-Tappes-Karphi-Ioukhtas. To reach the Mesará or the Týlissos area would require only one more leap.

Given how much the shepherds wandered these hills, we can safely surmise that the Minoans would have had little trouble identifying precisely those spots that gave them the optimal views, if they once conceived the idea of intercommunication. “Peak sanctuaries are part of the pastureland,” as Soetens et al. (2008, 159) so succinctly put it, and slowly-grazing sheep leave one much time to contemplate the world. What struck us over and over was that these sites so persistently have the greatest *intervisibility*, when one considers the many surrounding hilltops that don’t qualify quite so well. Granted this was not the only possible chain, but it was one of the very few most efficient chains, and its very efficiency raised interesting possibilities.

### **Predictability**

Plotting the known peak sites and their *intervisibility* on a map suggested that, if the intercommunication theory were correct, it would predict yet other site locations completing the chains, as it had at Tappes (Map 4). Farther west, for example, a relay post connecting Philióremos above Goniés and Pyrgos above Týlissos (both visible from Ioukhtas to the east of them) with Vrysinas to the west of them would allow the signal to continue a very great deal farther, since, as we noted, one can see from Vrysinas (above Réthymnon) all the way to the peak sanctuary of the Minoan colony on the island of Kythera, just off the southern tip of the Greek mainland. Within Crete itself, the signal could continue west to Drapanokephála and Sklokhas beyond Khaniá (disputed as “peak sanctuaries” but certainly classifiable as Minoan “peak sites” well placed for sight-lines<sup>8</sup>), and also south to Atsipades

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jockeying to establish *intervisibility*.

<sup>8</sup>Both were flagged by Faure as peak sanctuaries but not accepted by Peatfield in his careful reassessment of this category of sites (Peatfield 1992: 59-61). Although Minoan locales, they were not well explored and one is now

Korakias, Karavellas, and Spili/Voritzi. A relay between Spili and the Mesara would then connect the west to the south-central group.

Map work suggested that the only possible connector between the Spili area and the Mesara — virtually the only site of appropriate type that would visually turn the corner between the valley running south from Rethymnon past Vrysinas to beyond Spili and the southeast/northwest corridor running from the Mesara to Akoúmia — was the 853-meter promontory above and to the west of Akoumia itself, midway along the east slope of Asideroto (Map 4). So up we went,<sup>9</sup> finding Minoan potsherds like those on Vrysinas strewn liberally across a 50-meter-wide area on the saddle (around a modern dump replete with bed-springs and plastic bottles) and on the rock terraces above it. From there one can see the great bluff above Spili NNW (although Atsipades is apparently hidden behind a hill WNW) and — beyond the south end of massive Kédros — the huge panorama of the Mesara to the southeast, including Kophinas in the Asterousia Mountains and Orthí Pétra overhanging the sacred site of Gortýna.<sup>10</sup>

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destroyed. They may have been only message stations, but their positions suggest they were set down strategically. To boot, Sklokhas is visible from many parts of the next peninsula yet farther west.

There are, of course, additional possible reasons for establishing a peak site on this or that location. As an anonymous reader commented, “those near the sea could have provided beacons for incoming boats at night or have functioned as watches for schools of tunny.” But beacons to offshore boats do not require *inter*visibility. This particular research simply investigates the ramifications of *this* aspect of peak sites.

<sup>9</sup>Easiest from the village of Vryses, whence a paved farm-road starts up to the south from behind the spring in the plateia. After a kilometer, a dirt road goes off sharply uphill to the right: follow this to a two-wheel track leading gently left to the saddle and rocks. My thanks to Alan Knoerr for accompanying me on this and other long, arduous hikes in 2005 (with cameras, GPS, bananas, and *vysino*); to Hrysoula Iliadou and Georgos Hrystides of the Rethymnon branch of the Greek Hiking Club for their very useful information and encouragement; to Georgia Kordatzaki for accompanying us up Vrysinas and to Iris Tzachili for sending her to guide us; and to Georgos Roussakis of Agios Mamas for his help, hospitality, and hiking canes as we tackled Kopida.

<sup>10</sup>The very tip of that bluff, where the Greeks later placed a temple of Athena, is the only spot at the ultra-sacred site of Gortyna from which one can see the horns of Psiloriti and the Kamares Cave; it is also apparently the only spot in the area with Minoan sherds. The many later accretions at Gortyna mean we will probably never see the Minoan sanctuary there — which is doubly too bad, since it is the most likely site for the myth-mentioned *Minoan* stone law

Maps also showed that the only reasonable candidate to link up the chain *east* from Vrysinas was a 973-meter rockpile called Kopída, above Agios Mamás (Map 4). Up we went again: not only can you see Vrysinas due west, but due east you can see both Gonies and Pyrgos. We spotted Minoan sherds on the slightly lower terraces to the east and north of the summit, while in a pleasant saddle to the west lay the ruins of a relatively recent stone summer hut and threshing floor.<sup>11</sup>

With these connecting sites confirmed as visited by Minoans, we wondered whether the Mesara might also be linked to the east end of the island via the south coast. The most likely post to investigate, according to the map contours, seemed to be Sykológos. There we found a few sherds and a tremendous view: northeast to Stavromenos Anatoli (the peak just behind/above Myrtos that we had seen from Thylakas), eastward 28 km to Xylogournes and Katalímmata on the south spur of Thryphti just beyond Ierápetra, and far westward along the south coast and coastal range.<sup>12</sup>

So, tackling the chain from the other end, we hiked up Etianí Kephála, a 615-m promontory in the eastern highlands known to have a peak sanctuary and having views to the knolls of Plagiá and Xyképhalo (both of whose sanctuaries are now destroyed), and to Prinias. One could also easily pick out Xylogournes (820 m) and Katalimmata (802 m) 23 km WSW, as well as the 1470-meter peak of Ephéndis Stavroménos due

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code, if it existed. Given the slot-in-frame syntactic construction of laws, such a document or even a piece of it would be our best shot at deciphering Minoan (cf. Barber 1974: 24-25, 223).

<sup>11</sup>Not permitted to excavate, of course, we can vouch only for potsherds, not figurines, both above Akoumia and on Kopida; so we will label these merely “peak sites”. Both, however, have the typical topography of appearing prominent from the valley below, having a steep front side and a much gentler approach from the back (including some rather flattish pastureland close by), having some of the best panoramic views to be found, and being rather windy.

<sup>12</sup>Unfortunately, the visual determination of sightlines from Sykologos to the west was hampered by haze and by insufficient clarity in the then available literature of the precise location of Roussos Detis. One can, however, see Koupa (the 1187m promontory directly between Martha and Viannos) and its WSW flank from the southern end of the Sykologos heights; and Koupa in turn is intervisible with many sites N and W, including Ioukhtas, Kophinas, and Orthi Petra (above Gortyna).

My thanks to Teresa Perez, Kellyn Adams, Connie Law, and Erin Bassie for climbing peaks with me in 2005.

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west (Map 3).<sup>13</sup> Links here could complete a southern chain, tied in several places to the chain across the north (see Map 4).

### Uses of Peaks

Note that we are not claiming that peak sanctuaries were used *only* as signal stations, or even that this was their primary use, merely that their exact placement suggests such a use. Intervisibility was clearly very important for *some* reason. The little clay models of people, animals, dung-beetles, limbs, and so on, found among the rocks at some of the peak sites, attest to some strong religious or cultic associations up there, as do the few Minoan representations of steep, rocky sanctuaries that have come down to us (all discussed by Peatfield 1983: 273-274). These ties clearly have to do with the health and fertility of the agricultural and pastoral communities of both people and livestock (cf. Haggis 1999: 77-78). But just as medieval cathedrals had multiple functions as markets, museums, and meeting places as well as locations for religious rituals, so might the peak sanctuaries have served their communities in several, including secular, ways.

Furthermore, apparent alignments with key celestial events, observed at several peak sanctuaries,<sup>14</sup> raise the possibility that peak sites had a third important use, as observatories. As Macrobius put it so long ago, “Time is a fixed measure obtained from the turning of the heavens” — that is,

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<sup>13</sup>Unfortunately, we did not have time to check for Minoan sherds on Katalimmata and Xylogournes, although we saw some on the saddle between. Vance Watrous has noticed evidence of a peak sanctuary somewhere on Ephendi Stavromenos (pers. com. 2005). My thanks to Steven Soetens via Tim Cunningham for information on how to approach Etiani Kephala.

<sup>14</sup>Paul Faure repeatedly noted special features apparently aligned on the summer solstice sunrise — e.g., at Traostalos (Faure 1963: 495), Prinias (Faure 1967: 119), and at Keria and Gonies (Faure 1969: 184). Some of the highest sites would be nearly impossible to reach at the winter solstice because of snow; yet Faure says of Vrysinas (at 858 m, not the highest): “quand on se place dans l’espèce de corridor supérieur plein de tessons de vases, on aperçoit les deux cornes de l’Ida.....à 27 km au Sud-Est, selon un angle de 21° 30’ par rapport au parallèle (35° 18’38”) du mont Vrysinas. On voit le soleil se lever dans ce croissant lunaire deux jours par an avant et après le solstice d’hiver.” (Faure 1963: 506.) Thus one could easily calculate the winter solstice from these twin observations atop Vrysinas. Is this the sort of “calculation” that large *kernoi* were for? (*Calculate* comes from Lat. *calculus* “pebble” for a practical reason.)

before modern clocks and wall-calendars, the heavenly bodies marked the passage of time, and somebody needed to keep an eye on their motions.<sup>15</sup> In addition, some of these peaks with their cycloramic views and low horizons could well have served as ideal school grounds for teaching at night the star knowledge useful for navigation, exactly as in Polynesia (Kyselka 1987; see also Ovenden 1966).

On the other hand, signal-sending itself does not require sanctuaries, merely appropriate viewsheds: a few sites like Khamaizi and Sykologos could have served simply to link up the system. The peak sanctuaries, for their part, *could* be so used when placed where they had views of several other key sites (as they almost always were). So it will be useful to explore both the possibilities and the problems of employing peak sites for this practical purpose.

### Signal Systems in Theory and Practice

If, as the sight-lines show, a signal relay was *physically* possible, then two further questions need exploration, and they are interconnected. What kind of information might Minoans have wished to send each other over such distances, and what kinds of systems, within the world of signals, could they have used to achieve that mission from these stations?

The simplest information system is binary — yes or no, blip or no blip. This is the easiest possible signal to send with fire, and Aeschylus represents Clytemnestra's mechanism as of this type. But this also means that the *question* to be answered — all the complex information — *must be known in advance*. If the Minoan system involved merely lighting a flare, what question would be both simple and perennial enough for the Minoans that they would bother to set up such a relay for it? Sighting enemies? The arrival of a trading fleet safely from the East Mediterranean? Heliacal star-risings marking the start of a key festival or of a new calendrical cycle?

Or had their system reached greater linguistic sophistication?

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<sup>15</sup>Macrobius, *Saturnalia* 1.8.7. For prehistoric Mediterranean knowledge of the skies for both time and navigation, see Barber and Barber 2005, chapter 16. For a comparison to the Anasazi intervisibility system in Chaco Canyon: "The clear view of distant eastern and western horizons would make the [shrine] usable for a sun-watcher's observations of the equinox, and the results could be quickly signaled for miles in all directions." (Hayes and Windes 1975: 149)

If all you have to work with is a bonfire, it is hard to proliferate symbols. But Paul Revere, according to Longfellow's well-memorized lore, entered the next stage of complexity by requesting *patterns* of lantern flashes in the distant belfry: one if by land and two if by sea, if and when the enemy invaded. Thus, as in human language, he made use not only of a meaningful element but also of a meaningful pattern of arrangement. Such a system can expand easily: three if by helicopter, four if by space shuttle, and so on. But the brain loses track of counting pretty soon, and you still have to know what initial question is being answered: have the British arrived, has Troy fallen.

So Samuel Morse took his famous code in another direction by introducing the variables *long* vs. *short*. Arranging anywhere from one to four long and/or short elements together into arbitrary symbols gave him enough higher-order elements to send any message, in any language, in any of a variety of media (light, sound, electricity, visible marks, tangible bumps, and so on) — but only because he equated each of his symbols with a letter of an alphabet.

The Minoans did not have an alphabet. Undeciphered though they may be, Minoan Linear A, Cretan hieroglyphics, and even the Phaistos Disc script can be demonstrated mathematico-linguistically to be at base simple-syllabic scripts like Linear B, containing on the order of 60-100 syllabic signs (Mackay 1965: 14-25; Barber 1974: 93-96; Duhoux 1998: 4).<sup>16</sup> Could the Minoans have assigned a unique flash-pattern to each sign of such a script? A theoretically possible system — but so unwieldy as to be unlikely in the extreme. Alternatively they would have to have used, at best, one flash-pattern (or smoke-pattern) *per assigned message*, as in, for example, telegraph codes: say, three short flashes for “the fleet is coming” and two long ones for “the king is dead” or whatever else might be of moment. And that is assuming that they used an occludable light source to be able to produce all these differences, and differences that were distinguishable at the necessary distances.

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<sup>16</sup>Archaeological data show that the northeast Mediterranean cultures began developing their own family of scripts somewhat before 2000 BC (jump-started by ideas demonstrably from Egypt), so the *possibility* of a script-based signal system is systematically explored here, even though I think such a system can be totally ruled out on the basis of the logic given below.

Practical experiments carried out in 1991 and 1993 by Richard Lange in the Arizona desert give us a better fix on the relation of signal sources to distances:

“Various types of signals and environmental variables were tested with multiple listeners and observers to average out differences in hearing or visual acuity. In the experiments, the participants creating the messages yelled, blew whistles and a shell trumpet; waved dark and white flags against dark backgrounds and skylighted them against the horizon; flashed mirrors, small flashlights, and cigarette lighters; and made small bonfires.” (Lange 2001: 72)<sup>17</sup>

Sound carried the least far. To hear voices or a shell trumpet blast from more than half a kilometer required that the producers use a cliff as a backboard to direct the sound and that the observers know exactly when the sounds would be made, in which case one could detect their existence from 3.2 km (2 miles) but not distinguish modulations like words (Lange 2001: 73). On Crete, Kyriakidis (2005: 19) reports: “Weather permitting, the bells of Arkhanes can be clearly heard at Youkhtas, and voices from Youkhtas can easily be heard at Arkhanes” directly below. But that is a barely a kilometer as the crow flies, or rather, plummet.

Visual signals in daylight included “flags” (swatches of fabric “the size of a small bath towel”) and mirrors:

“A waving flag, held at one corner, is visible to about 1.6 km (1 mile), but the viewer’s ability to distinguish motion, such as moving it in a circle, side-to-side, or up-and-down, is largely lost by this point. If the flag is stretched as a banner, increasing the visible surface area, it can be seen at nearly 3.2 km (2 miles), but again, distinguishing motions is not possible.” (Lange 2001: 73)

Flashing a bright piece of metal as a mirror “was not effective over 2.4 km (1.5 miles),” but a better mirror could be seen as far as 6.4 km (4 mi). “Beyond this point, aiming the flash at the observers became a problem” (Lange 2001: 74). Another experimenter in New Mexico obtained results of the same order of magnitude (max 7.6 km) using slabs of selenite and

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<sup>17</sup>My thanks to Alan Ferg for acquainting me with the Southwest literature.



lenses.<sup>18</sup> (Historical information — cited by Lange — exists on the use of smoke as a daytime signal on the Great Plains, but the conditions of extreme windiness and frequent haze that we find in Crete make smoke signals an unlikely candidate there.)

Light signals at night, on the other hand, carry much farther, and Lange's team concluded that "the size of the fire ultimately determines the distance it can be seen" (Lange 2001: 75). Even

"a very small light, such as from a cigarette lighter, is readily visible at 2.4 to 2.8 km (1.5 to 1.75 miles), and is visible at 3.2 km (2 miles) if you know exactly when and where to look. The modern military's concern with soldiers' lighting cigarettes at night is well known..." (Lange 2001, 74)

Indeed, Billy the Kid was caught that way, and the danger of advertising one's position to snipers may be the origin of the belief that three on a match is bad luck.

Larger fires, such as a burning rag or "a small, dry Christmas tree" set alight, were "easily visible" at 11 to 12 km. Lange continues:

"We could not test greater distances due to insufficient radio capabilities, but...our observers told us that the small fires we used were as bright or brighter than the headlights on our vehicles... Measuring on a highway one night, we were able to see headlights easily at 24.1 km (15 miles)."

He also reports anecdotally that "an observer in New England was able to see a...burning barn from 48.3 km (30 miles)

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<sup>18</sup>Ellis 1991: 63, cited by Lange. Mica was tested to 4 miles: the diffuseness of its reflection actually made its beam much easier to control than that of a modern glass mirror (Riddle 2001).

The Mongols waved flags by day and torches by night, in the manner of semaphores, to send simple messages quickly across vast tracts of Eurasia, but the signalers must have been quite close together to perceive the motions. For more detailed messages than this channel would carry, they sent relays of horse-riders (well organized into a system called *yam*). See Chambers 1979: 61. My thanks to C. Scott Littleton for acquainting me with this tradition.

The Persians also used signal systems in Classical times, according to Xenophon, while the legend of Theseus and some of the Pylos tablets suggest lookouts as a technology used in the Aegean Bronze Age.

away.” (Lange 2001, 75)

On Crete, the distances between the suggested relays fall mostly in the range of 5-18 km, and seldom more than 32 km (20 mi.): see Table 1. These data show that sound would not work, but a small burning bush or rag would suffice for all but the longest jumps, such as those between Khamaizi and Thylakas or Tappes, and from Ioukhtas to Kophinas. For those leaps, a good-sized bonfire — an Aeschylean “mound of withered brush” or pile of “gold-flamed pine logs” (as in the film of Tolkien’s “Return of the King”) — would do the trick; no barns are needed. (Some sort of fire-pit, enclosing the fuel and designed to shoot the flame upward, would of course improve control and visibility — and guard from starting a wild-fire.)

Reports from many of the peak sanctuaries mention ash layers, which are generally interpreted as the remains of “sacrificial bonfires” (cf. Peatfield 1983: 275-276; although the deduction that the soil actually contained ash has been disputed in some cases<sup>19</sup>). Note two points. The ash, where truly present (as on Ioukhtas), could very well be the remains of fires used simultaneously for sacrifice and signaling, or at times for just one of these purposes. Second, since so little fuel is needed for signaling across the typical short hops, we would not necessarily find the ashy remains of occasional small signal-fires up on these windy summits. Both these points indicate that — unfortunately — we are not going to get *either* real proof or disproof of the signal-fire hypothesis from ash.

Note, too, that Minoan folk were well placed both to send and to receive information, should they wish to, from a wide variety of important coastal and non-coastal living-sites along the way. They had only to beam it up to the nearest high-

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<sup>19</sup>Layers of ash and charcoal, usually thick, are said to have been found, for instance, at Petsophas, Ioukhtas, Modi, Tragostalos, Vigla Zakrou, Plagia, Xykephalo, Prinias, Pyrgos, Roussos Detis, Kophinas, Keria, and Vrysinas. See Rutkowski 1986: 96-98, for numerous references to the peak sanctuaries in the literature, and Kyriakidis 2005: 190-196 for further bibliography site by site.

Peatfield (1992: 66) says that in excavating Atsipades Korakias he was surprised that they found no ash “apart from a small deposit on a rock shelf on the Upper Terrace”. On the other hand, Lange’s experiments show that a small fire the size of a burning rag would be “easily visible” to the neighbors on Spili/Voritzi and even Vrysinas (cf. Peatfield 1992: 63), only 9 and 11.5 km away respectively, so Peatfield’s ash-shelf may have sufficed — depending on the view from where it sat.

station, or observe it from below (from the roof, like Clytemnestra's palace watchman?) as the signals passed by up above, if it occurred to them to do so.

**Table 1:** Distances between some of the key sites; those greater than 24 km—15 miles—are marked with \*. Distances and contours were measured using Harms Verlag's *Kreta 1:100,000 Touristikkarte* (1997) and Section 5 (Sitia) of their 1:80,000 version (1992), both with 50 m contours.

Petsophas to	Modi	6.3 km
	Traostalos	6.5
	Vigla Zakrou	11.3
Modi to	Traostalos	8.5
	Vigla Zakrou	9.5
	Agia Photia	5
	Petras	8.3
Traostalos to	Vigla Zakrou	6.5
	Korphi tou Mare	9.5
	Plagia	12.5
Etiani Kephala to	Plagia	7.5
	Xykephalo	7
	Prinias	9
	Xylogournes	22
Khamaizi to	Modi	17
	Thylakas	30.5 *
	Tappes	35.5 *
	Agia Photia	12.5
	Petras	9.5
Thylakas to	Tappes Kastello	5
	Stavromenos Anatoli	13
Tappes Kastello to	Xylogournes	24.5 *
	Karphi	13.8
Karphi to	Ioukhtas	30.3 *
Joukhtas to	Kophinas	~30 *
	Roussos Detis	~29 *
	Pyrgos	15.5
	Knossos	6.8
Kopida to	Pyrgos	20.5
	Philioremos	13.5
	Vrysinas	25 *
Vrysinas to	Drapanokephala	27.5 *
	Atsipades	11.5
	Spili Voritzi	12
Spili Voritzi to	Atsipades	9
	Akoumia	7.3
Akoumia to	Orthi Petra	34 *
	Kophinas	~50 *
Sykologos to	Koupa	13
	Xylogournes	28 *

### Message Contents

However that may be, *complex* communication this way was still not a reasonable possibility. Even with periodic occlusion to form discrete bursts of light, the system would at best carry only a small number of pre-arranged messages, of the yes/no type, signaling such things as the arrival of boats, danger, prey (such as schools of fish), and/or the moment for some important communal activity. Such, in fact, was the system of signal fires that European explorers found when they first reached the Florida coast. They learned that “the fire might mean the stranding of a whale or the approach of a boatload of strangers, and the watchers in the distant village at once prepared for either emergency, according to their expectation.” (Hodge 1911: 565)<sup>20</sup> This is truly remarkable, since it implies that for one message they should run down to the shore and for the other perhaps run away and hide!

Details of more general sight-line research on Crete have implied not unsimilar simple messages, namely ones concerning a) enemies<sup>21</sup> or other such emergency, b) commerce, c) political jockeying, d) communal rituals, e) astral events, and/or f) some combination thereof. Any effort to link together the three clusters — east, central, and west — would suggest that the messages held a *common* interest for all three areas (ruling out, for example, enmity toward each other). The placement of so many peak sites above coastal habitations suggests connections with boats and boating (see note 3), whether inimical or friendly, as do the placements and viewsheds of several other Bronze Age peak sites elsewhere in the Aegean, such as on the islands of Kythera,

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<sup>20</sup>Cited also by Lange 2001. In the Southwest, where smoke- and fire-signals were more developed, Hodge (1911: 566) says further that “the fire, after having been lighted, was first allowed to burn for some time without hindrance until it was evident or probable that it had attracted the attention of those at a distance for whom it was intended. The signaler then proceeded with the message by throwing his blanket over the smoldering pile” to produce long or short beams or puffs of smoke, and/or a desired number of such.

<sup>21</sup>There is a series of “guard posts” running south from the slopes of Traostalos, but these clearly belong to a completely different system with different intent. Their small, square, stone foundations are set at 1-2 km intervals and at middle height along the valleys, just high enough to overlook the cultivable slopes and see each other, and low enough to be easily accessible, but not perched *agrimi*-like on the tops of the dominant high-points. See Tzedakis et al., 1990.

Kea, Naxos, and Rhodes (Sakellarakis 1996: 91-98). Yet some of the peak sanctuaries are inland. The alignments of Phaistos and Knossos and the placement of Kamilari, on the other hand, suggest that some sight-lines marked religious events, possibly or sometimes relating to the dead (see note 1). The thick cluster of early sites near the *east* coast, for its part, suggests observing and announcing either boats arriving from the east (and/or north, given the early ties of the east end with the Cyclades), or the rise of key celestial bodies above the sea to the east, which would be the earliest possible moment for any of these to be visible from Crete. Heliacal risings have traditionally pegged the major phases of agrarian calendars, which are necessarily sun-based, while celestial bodies have commonly been viewed as connected with religion, and the stars often connected with departed souls (see Barber and Barber 2005: 176-217).

We are not yet in a position to assess astral usage, but we do know that long-distance trade by ship was becoming increasingly important around 2000 BC when the peak sanctuaries were being set up (cf. Watrous 1995: 395). Not only do we see more metal and other imports from the east, but we also see strong evidence of Minoan exports to Egypt in particular, where Middle Kingdom noblemen were becoming fond of ornate Minoan textiles (Barber 1991: 311-357). We can also surmise that building and sending out a ship to far-away places to obtain useful metals was not something an individual did. It required the pooling of resources from a whole community (quite possibly voluntarily for the common good, i.e., from economic incentives, rather than coerced by “elites”) in order both to build and man that ship and also to stock it with food, water, oars, sails, and things to trade. Whether a Minoan trade ship simply sailed to the Levant and back, or whether it whisked over to Egypt on the strong southerly summer tradewinds and returned via the long coastal route, it would first reach Crete at the east end, as the currents carried it past Rhodes, Kápathos, and Kásos straight to Zakro or Palaikastro. It is not hard to imagine both the economic and the emotional importance to the Minoans back home of the safe return of their trade ships — an event that would have been visible from Modi, Traostalos, and the other eastern peaks long before the boats actually touched shore, let alone before they had time to sail west along the Cretan coasts to

other home ports. (Don't forget Aegeus anxiously waiting atop Cape Sounion for a first glimpse of Theseus's returning ship.) The amount of effort required to set up so many intervisible peak sites suggests they were used more than once a year, and also that they were deemed useful enough to spread westward through Crete early in the Middle Bronze Age.<sup>22</sup> Yet the lack of permanent living quarters on virtually all these high places indicates that the communication was not needed 365 days a year. This fact militates against defense as the prime motive.

Which of the various message-questions, then, were of greatest importance to the Minoans? Without readable Minoan texts, we not only don't know how to choose, but don't even know if we *should* choose one. As with the early people of Florida, they may have set themselves up to communicate on more than one issue.

### Obsolescence

As the archaeological evidence now clearly shows, the rise of the new palaces correlates with the demise of Khamaizi and most of the peak sites, only those few peak sanctuaries under the direct control of major power-centers continuing.<sup>23</sup> And as the number of peak sanctuaries declined, those remaining became larger, richer, and enhanced with actual cult-related buildings, as though non-ritual uses had become unimportant. And as Soetens *et al.* remark (2003: 485), "the hierarchy of the sanctuaries (in terms of richness and architecture) ...coincides with a hierarchy in intervisibility" in the New Palace period: one can see many sanctuaries from Ioukhtas, for example, but mostly only Ioukhtas from its satellites. This is also the time of widespread Minoan use of Linear Script A, which could encode much more — and much more exact — information than a simple yes/no system. Is this correlation an accident? As the society rapidly grew more complex, the positioning of literate

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<sup>22</sup>If, as some bits of evidence suggest, matrilineal groups existed in early Crete, peak sanctuaries dominating chunks of land passed down through the matrilines could have served for convenient communication between a man's natal family and his conjugal family, since, as anthropological data show, the men in matrilineal/matrilocal systems had to fulfill duties to *both* families, which involved traveling between them as needed.

<sup>23</sup>Liliano and possibly Kophinas, however, spring up as new peak sanctuaries in the New Palace period, during the time when Ioukhtas — visible from both these sites — outstrips all the remaining peak sanctuaries in richness and influence.

people in numerous locales around the island could have made it more satisfactory to send a runner to the next town or villa with a detailed document than to signal with a crude yes/no flare concerning severely limited questions. And if the greater centralization of power meant much wider control over the surrounding seas, watching for enemies may have been no longer a concern. At that point the remaining use for peak sites — the religious one — could be centralized into those few peak sanctuaries controlled directly by the palaces while the rest dropped out of use.

Some 3500 years later, however, the Venetians set up a beacon system that used some of these same peak sites and that “entirely encircled the coast of Crete” (Chryssoulaki 2001: 63, with references). As the geologists say, what did happen, can happen (Smith’s Law): what the Venetians did, the Minoans can have done too, if they wished.

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