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ENVIRONMENTAL CHANGE AND MINOAN SACRED LANDSCAPES

by Jennifer Moody

This paper explores the links between changes in Minoan natural landscapes and Minoan sacred landscapes from the end of the Early Minoan (EM) IIB period to just after the Minoan eruption of Santorini.¹ This dynamic, roughly 700-year period includes a number of significant climatic and cultural events, including the 3rd-millennium aridity event, the 2nd-millennium Little Ice Age, the Minoan eruption of Santorini, the development and proliferation of peak and cave sanctuaries, and the construction of Minoan “palaces.” The nature of the evidence and the vagaries of dating make it necessary, in this study, to discuss earlier and later periods to some extent. It is suggested in this paper that the development and initial proliferation of peak and cave sanctuaries is linked to the 3rd-millennium aridity event dated ca. 2200–2000 B.C.

EARLY AND MIDDLE BRONZE AGE CRETAN ENVIRONMENTS

CLIMATE

Local climate data for Early and Middle Bronze Age Crete are moderate but improving. They consist largely of a new deep-sea core (LC21; Fig. 20.1), two pollen cores (one old, one new), and a few flood deposits. Especially exciting about this data is its recent yielding of details of seasonal differences in temperature and rainfall over the last 10,000 years.

DEEP-SEA CORE LC21

The fossil record from a deep-sea core off the northeast coast of Crete, analyzed by Rohling et al., shows that warm-water foraminifera have dominated this part of the Aegean for the last 10,000 years (Fig. 20.2:A).²

1. This paper has benefited from many conversations with other scholars. I would like to thank especially Heinrich Hall, Loeta Tyree, Roy and Rita

Harris, Sandy MacGillivray, Anna Lucia D'Agata, Lucia Nixon, George Harrison, Jane Francis, and of course Gerry Gesell for discussing various

ideas with me, either in person or via email.

2. Rohling et al. 2002, p. 588, fig. 1:d.

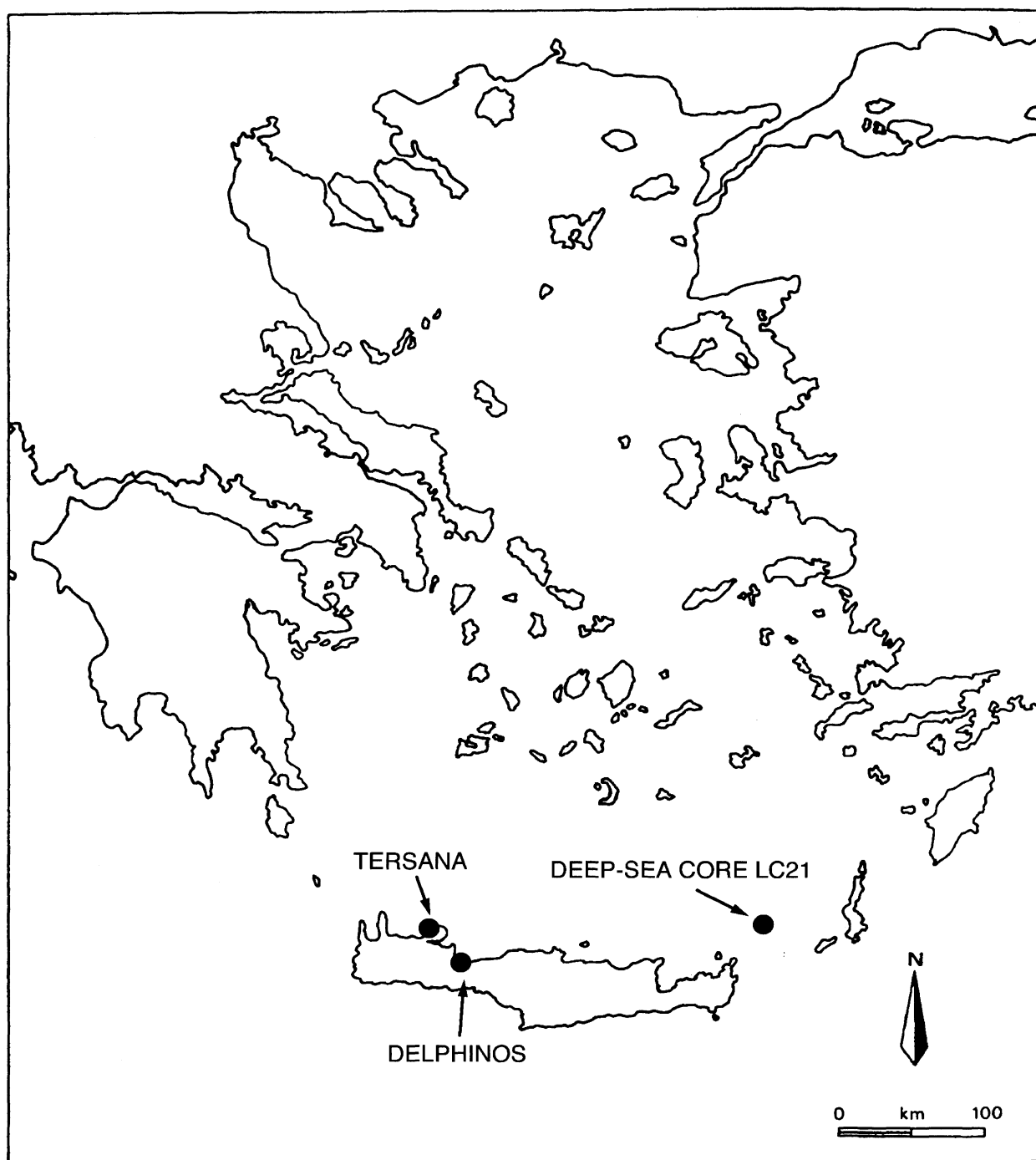
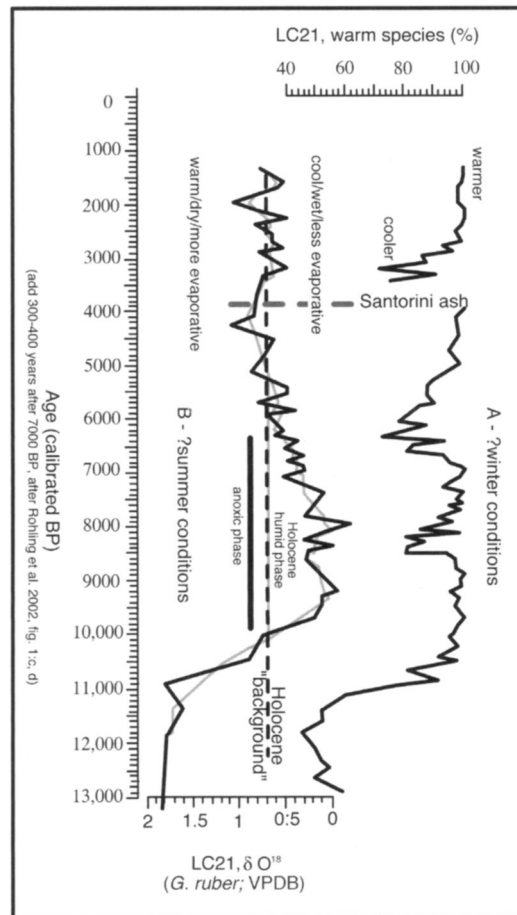


Figure 20.1. Map of environmental sites mentioned in the text: deep-sea core LC21, pollen cores at Tersana and Delphinos. J. Moody

Figure 20.2. Core L21: (a) percent of warm water foraminifera; (b) δO^{18} values for *Globigerinoides ruber*. Thin gray line is a 3-point running average. VPDB = Vienna Pee Dee belemnite (standard). Rohling et al. 2002, p. 588, fig. 1:c, d, courtesy Springer Science and Business Media



For 6,000 or more years they formed 95%–100% of the species in this core. These warm periods date roughly to ca. 8400–6500 B.C., 5900–4400 B.C., 2800–?1650 B.C. (gap in data), and 600 B.C.–A.D. ?1000 (gap in data).³

There are, however, four periods when the number of warm-water species drops by 20%–30%. These cooling events date roughly to ca. 6500–6200 B.C., 4300–3600 B.C., ?–1150 B.C., and 900 B.C. They total approximately 1,000 years, indicating that such cold spells in the south Aegean are exceptional events for the Holocene.

Rohling et al. propose that the declines in warm-water foraminifera were the result “of long-term (multi-decadal) periods of increased intensity, duration, and/or frequency of the winter-time northerly air outbreaks, causing winter conditions that today are restricted to the northern sector of the basin to intensify and expand southward over the Aegean Sea.”⁴ In short the authors suggest that winters were significantly cooler.

They then go on to say: “Our inference that the Aegean cooling events were predominantly winter phenomena is corroborated by the very muted responses in the stable oxygen isotope record of the summer mixed-layer dweller *Globigerinoides ruber*.”⁵ Although that may be true, close inspection of Rohling et al.’s figure 1:c reveals that the running 3-point average they use masks important fluctuations in the δO^{18} values of this little animal (Fig. 20.2:B).⁶ For example, the highest δO^{18} value for the last 10,000 years

3. Rohling et al. (2002, pp. 590–591) state that there is an offset of 300–400 years in their chronology after ca. 7000 B.P., which they blame on the reventilation of the Mediterranean at the end of the Neolithic humid phase. To arrive at the dates given in my text, I have therefore added 300–400 years to the dates indicated in their fig. 1. Note that this adjustment has not been made to the dates in Fig. 20.2, which retains the dates indicated in Rohling et al. 2002, p. 588, fig. 1:c, d.

4. Rohling et al. 2002, p. 590.

5. Rohling et al. 2002, p. 590.

6. Rohling et al. 2002, p. 588, fig. 1:c.

corresponds nicely with the 3rd-millennium aridity event: 2200–2000 B.C. (see below).⁷

Their analyses show that from about 6000 B.C., summer temperatures were on the increase, no doubt due to the development of the so-called Mediterranean summer drought for this interglacial.⁸ But this was not a gradual process—the summer drought developed in fits and starts.

Summer evaporation levels first exceed the Holocene average ca. 3400/3300 B.C., recover, and then soar again between about 3100 and 2900 B.C.—that is, during a late phase of the Final Neolithic. Then, between ca. 2700 and 2200 B.C., summer evaporation decreases and hovers around the Holocene average. This “honeymoon” period is roughly contemporary with late EM I–IIB. Finally, as mentioned above, summer evaporation soars to an interglacial high between ca. 2200–2000 B.C., which according to a number of chronologies is roughly contemporary with EM III–Middle Minoan (MM) IA.⁹

Conditions then begin to improve. Between about 2000/1900 B.C. and 1800/1700 B.C., summers cool off, though they remain substantially more evaporative than the Holocene average. Winters, however, continue to get warmer at least up to ca. 1650 B.C. The onset of cooler summers is roughly coincident with the onset of the 2nd-millennium Little Ice Age (see below). Frustratingly, there is then a short gap in the winter data, followed by a stratum of ash from the Minoan eruption of Santorini, followed by another gap. When the winter record in the core resumes ca. 1150 B.C., warm-water species have fallen by 25%; that is, winters have become significantly colder.¹⁰

POLLEN CORES

The two Cretan pollen cores that cover this period come from the west: Tersana (near Khania) and Delphinos (near Lake Kournas) (see Fig. 20.1). The Tersana core, published in detail elsewhere, is briefly summarized here.¹¹ The extrapolated aggradation rate suggests that the top surface of the uppermost stratum of the pollen-bearing strata in this core dates to the Middle Bronze Age. Furthermore, in light of the clear deposit of pumice from the Minoan eruption of Santorini in the Delphinos core, ca. 20 km southeast of Tersana, the absence of such a deposit in the Tersana core suggests that the top of the pollen-bearing strata dates earlier than this event—that is, earlier than late Late Minoan (LM) IA. Thus the increase in wildwood seen at the top of the pollen-bearing strata in the Tersana core is likely to date to the Middle Bronze Age. I would suggest that the increase is connected to cooler summer temperatures, which—on the evidence of the deep-sea core LC21, discussed above—began after 2000 B.C.

Also significant are the fluctuations in, and final disappearance of, *Tilia* tree pollen from the Tersana core. *Tilia* pollen first disappears during the evaporative phase between 3100 and 2900 B.C. As noted above, this is the first period in the Holocene during which winters as warm as those of today are combined with summer evaporation that substantially exceeds the Holocene average. During a reprieve from these conditions in a phase of less evaporative summers ca. 2600–2200 B.C., *Tilia* pollen reappears in

7. A high δO^{18} value in marine sediments equals more evaporation, which can be caused by either high temperatures, low rainfall, or a combination of both.

8. Grove and Rackham 2001, pp. 144–146.

9. Watrous 2001b, pp. 221–223.

10. According to this data, winter temperatures rise from ca. 1150 to 1050 B.C., which is contemporary with a 20-year period of unusually wide tree rings from Anatolia and the eruption of Helka 3. See Kuniholm 1990, pp. 653–654; Kuniholm et al. 1996, pp. 781–782; Moody 2005b.

11. Moody, Rackham, and Rapp 1996.

the Tersana core, albeit in tiny quantities, suggesting that it survived the Final Neolithic aridity event on the island in a more favorable location. By ca. 2000 B.C. the tree disappears entirely from the diagram, probably a casualty of the 3rd-millennium aridity event.

The compression of the Delphinos pollen core, recently published by Bottema and Sarpaki,¹² restricts specific chronological observations. Nevertheless, according to the aggradation rate and radiocarbon calibrations, spectrum 26 is roughly contemporary to the 3rd-millennium aridity event. The decline in all tree species at this time, while grass pollen, including *Cerealia*-type, increased, has been interpreted by the authors as an increase in cultivation;¹³ but given the stable isotope analyses from Rohling et al.'s deep-sea core LC21, it is equally likely to be the result of increased summer temperatures, or some combination of the two.

On the whole, the Delphinos core parallels the developments seen in the deep-sea core and at Tersana, with an interesting exception: *Tilia* pollen, making its first appearance in approximately 2,000 years, occurs in the Delphinos core *above* the layer of Santorini pumice.¹⁴ It is possible, given the wet microclimate of Lake Kournas—which even today is home to wild grapes, elms, and deciduous oaks!—that the area was a refugium for this tree until later in the Late Bronze Age, when it vanishes from this core, too.¹⁵

FLOOD DEPOSITS

A number of flood and debris flow deposits identified on Crete seem to date to the MM period.¹⁶ These kinds of deposits are typically associated with intense episodic rainfall, such as that associated with summer thunderstorms. It seems likely that the increase in summer drought for the period from EM III to MM IA/B was accompanied by intense episodic summer rain.

THE 3RD-MILLENNIUM ARIDITY EVENT AND CRETE

According to a number of studies, much of the eastern Mediterranean became suddenly more arid around 2300/2200 B.C.¹⁷ Although the climatic effects of this aridity event may have been less intense in Crete than in the Near and Middle East and Egypt—due to the ameliorating effects of the sea—Crete was not immune. The new evidence for a sharp increase in summer evaporation ca. 2200–2000 B.C. in the deep-sea core taken off the northeast coast of Crete indicate that the island did indeed experience the aridity event directly. Given the island's topography and weather patterns, it seems likely that East Crete and the Mesara were hardest hit.¹⁸ The

12. Bottema and Sarpaki 2003.

13. Bottema and Sarpaki 2003, p. 737.

14. Moody 2005a, pp. 458–459.

15. *Tilia* pollen does not seem to occur at all in the nearby Kournas core, which spans the period from the Late

Bronze Age to the near present (Bottema and Sarpaki 2003).

16. Moody 2001.

17. See Dalfes, Kukla, and Weiss 1997.

18. Moody 2005a; Moody and Watrous 2009.

new evidence supports the suggestion that the destruction horizons seen throughout the island at the end of the EM II period may not have been entirely due to peoples displaced from the eastern and southern Mediterranean, but that internecine conflict may also have played a part.¹⁹

THE 2ND-MILLENNIUM LITTLE ICE AGE AND CRETE

Following close on the heels of the 3rd-millennium aridity event is the 2nd-millennium Little Ice Age, defined by the Lössen glacial advance in the Alps between about 1870/1800 and 1370/1230 B.C. and other contemporary advances in Scandinavia, New Brunswick, the Rocky Mountains, Alaska, and New Zealand.²⁰ Jean Grove suggests that this advance was the most extensive of the Holocene in Central Europe.²¹ It is associated with two proposed sunspot minima, 1870 B.C. (Silver Lake) and 1370 B.C. (Egyptian), and with several volcanic eruptions, including the Minoan eruption of Santorini (16th/15th century B.C.) and the eruption of Mt. Etna in Sicily (ca. 1320 B.C.).²² Sunspot minima and volcanic eruptions have been credited with triggering cold maxima during the “medieval” Little Ice Age,²³ and they may have also done so in the 2nd millennium B.C. In Crete, the Lössen advance is contemporary with MM IB/II–LM IIIA/B.²⁴

Although it may seem odd that in the south Aegean this phase of alpine glacial advance was not associated with colder winter temperatures until late in its development—according to the data from the deep-sea core LC21—it is clearly associated with cooler summer temperatures.

TECTONICS

It has long been noted that ca. 3000 B.C. the Aegean, and perhaps most of the world, entered a phase of increased tectonism.²⁵ Thus, throughout the Early Bronze Age the people of Crete grew accustomed to periodic earthquakes and tsunamis. It has been suggested that a period of even more heightened tectonism developed in the MM II–III period and resulted eventually in the catastrophic Minoan eruption of Santorini in LM IA.²⁶

MINOAN ERUPTION OF SANTORINI

The Minoan eruption of Santorini remains a contentious topic for Aegean archaeologists; there is not enough space here to deal with it in any detail. Nevertheless, two observations can be made in light of the environmental data discussed above. First is that the absolute date of the event still cannot be fixed. The ash deposit found in the deep-sea core off Crete can be

19. Manning 1997.

20. Grove and Grove 2004.

21. Grove 1997, p. 96.

22. Stuiver and Kra 1986. Also see <http://www.geo.arizona.edu/palynology/geos462/20climsolar.html#hallstat>.

23. For a summary, see Grove and Rackham 2001, pp. 138–139.

24. Rehak and Younger 2001, p. 391; Watrous 2001b, p. 222.

25. Thommeret et al. 1981; Moody 1987.

26. Driessen and Macdonald 1997.

dated no more precisely than between 1650 and 1150 B.C. Second, it is becoming increasingly clear that the eruption, or this eruption along with several others, did impact the climate.²⁷ This is demonstrated by the possible onset of cooler winter temperatures suggested in deep-sea core LC21 and by the reappearance of *Tilia* pollen above the deposit of Theran ash and pumice in the Delphinos core.

CONCLUSIONS

EM II: We can reconstruct a climate for EM II Crete that was fairly stable, with slightly cooler winters and markedly less evaporative summers than the preceding Final Neolithic/EM I period. The presence of *Tilia* pollen and that of other Central European trees no longer native to Crete indicate a climate less evaporative overall than the present. Since δO^{18} levels approximate the modern, there must have been greater year-round rainfall.

EM III/MM I: Winters became slightly warmer and summer evaporation soared. These changes happened fairly rapidly, probably within a generation or two, and plant-growing seasons would have been constrained by summer drought. The sudden drying up of summer vegetation would have been quite a shock to a culture not used to it. It probably encouraged people to move to higher elevations during the dry season, if not permanently, much as is done by some Cretan shepherds today.

MM I/II to the Minoan eruption of Santorini: Summer temperatures became progressively less evaporative, but winter temperatures remained as warm. This circumstance suggests that seasonal differences became increasingly less marked than they were in the previous period, and that plant-growing seasons were less constrained by summer drought.

SACRED LANDSCAPES IN EARLY AND MIDDLE MINOAN CRETE

As old data for Minoan cult are reexamined and new evidence is discovered, our understanding of Minoan sacred paradigms becomes more and more elaborate.²⁸ Nevertheless, few would disagree that Middle Minoan religion reveled in Nature. The imagery is everywhere. Reconstructions of Minoan frescoes, with Disney-like exuberance, demonstrate this vividly.²⁹ The Middle Minoans had shrines in towns and in "palaces," but also on hilltops, peak-tops, and in caves.³⁰ There were sacred enclosures, sacred trees, sacred pillars, and sacred rocks.³¹ Birds, bulls, and snakes were imbued with special meaning and power. Cult paraphernalia included "horns of consecration," human and animal figurines of all shapes and sizes, pebbles, and a panoply of ceramic objects decorated with floral motifs, including libation tables, rhyta, cups, and jugs.

The contrast to the sacred paradigms of the Early Minoan period are pronounced. In EM II, tombs were the most visible focus of cult in the Minoan landscape.³² According to Peatfield and Tyree, no peak sanctuaries,

27. Moody 2005a, p. 461.

28. For example, Branigan 1998a; Hall 1999; Tyree 2001; Morris and Peatfield 2002; Adams 2004.

29. Marinatos 1984.

30. Rutkowski 1986.

31. Warren 1988.

32. Peatfield 1987, p. 90; Murphy 1998.

nor indisputable cave sanctuaries—that is, caves in which ritual activity was unrelated to human burial—can be securely dated to this period.³³

The earliest Minoan peak and cave cults date to EM III.³⁴ By MM IA both types of sanctuaries proliferate, as do shrines attached to tombs.³⁵ Why? Certainly the general observation that increased religious fervor is often connected to increased cultural stress³⁶ helps to explain the sudden boom in sanctuaries in EM III/MM I—a period of cultural upheaval throughout the Eastern Mediterranean³⁷—but it does not account for their location on peak-tops and in caves. What caused the stress? What changed?

As we have seen, at least one circumstance that changed was the climate.³⁸ And it changed in such a way that the Minoans had to reassess their landscape and the way they related to it. As noted above, Crete and most of the eastern Mediterranean experienced a dramatic increase in summer evaporation ca. 2200 B.C. This would have dried up lowland summer pastures, and it would have driven herders and their flocks to higher elevations. Rutkowski and others have eloquently noted the connections between peak sanctuaries and pastoralism, but they have never satisfactorily explained *why* or *why then*.³⁹ As our understanding of the 3rd-millennium aridity event has improved, the obvious associations of mountaintops with the sky and rain, which would have been attractive to a drought-stricken people, have suddenly become relevant.⁴⁰ In this light the common occurrence of beetle images on peak sanctuaries may also be relevant, as they may share the same symbolism as the Egyptian beetle *kheper*, which was associated with water cycles including the annual flooding of the Nile.⁴¹

Although perhaps the association is not as obvious, almost all Minoan sacred caves are associated with water.⁴² Tyree notes that “the presence of water is another distinctive feature of Minoan sacred caves and one that warrants emphasis.” According to her, Minoan sacred caves “are deep and damp, usually with copious amounts of water within, either dripping and/or in pools.”⁴³ The water associated with caves would be that which

33. Peatfield 1990, p. 125; Tyree 2001, p. 40. The few Final Neolithic/EM I sites that have been called hilltop shrines show no chronological continuity with Minoan peak sanctuaries; one of these (Atsipades) is a recently investigated, well-excavated Minoan peak sanctuary (Peatfield 1992). Contra Tyree, Hall argues that some Neolithic caves are neither burial caves nor habitations. He proposes that they had a broader cultural significance, some part of which was religious (Hall 1999, pp. 197–212). There was, nonetheless, a qualitative change in the use of caves between EM IIB and MM IA.

34. Peatfield 1990, p. 125; Tyree 2001, p. 40.

35. Soles 1992, p. 238; Tyree 2001, p. 40.

36. Johnson 1982, pp. 405–406.

37. Dalfes, Kukla, and Weiss 1997.

38. The development and proliferation of cave and peak sanctuaries has also been linked to the “rise of the state” in Minoan Crete (see Cherry 1986). Because of space limitations and the specific focus of this paper, I do not address this complex social issue here, but refer the reader to a recent reappraisal by Barrett and Halstead (2004). I would point out that the 3rd-millennium aridity event and the initial foundation of the sanctuaries predates the construction of the palaces that are considered the hallmark of the Minoan state in Crete. I would also note that the conditions that lead to the development of a cult need not be the same as those that result in its proliferation,

maintenance, and demise. Caves in particular have a myriad of spiritual associations that will fluctuate in individual importance depending on the concerns of the period.

39. Rutkowski 1986, p. 94.

40. Given the lack of continuity between the Final Neolithic/EM I hilltop shrines and the Minoan peak sanctuaries, and the association of both with periods of markedly more evaporative summers, I wonder if similar arguments might also apply to the establishment of the earlier hilltop shrines.

41. Watrous 1995, p. 399.

42. The association of cave cults with water is not unique to the Mediterranean; see Steele 1997.

43. Tyree 2006.

“originates” from the ground rather than from the sky. Both types of water sources would be critical in a suddenly arid environment, such as occurred at the end of the 3rd millennium B.C. The 3rd-millennium aridity event, then, not only helps to explain the cultural stress that led to the development and proliferation of sanctuaries in EM III/MM I, but it rationally explains their locations in the landscape: peak-tops for rain and summer pasture; caves for groundwater.⁴⁴

Another aspect of the natural landscape that might have been associated with caves is tectonism, but this is harder to get at. Nevertheless in MM III–LM I—a period that is known to have been especially tectonically lively—activity in sacred caves increased while the number of peak sanctuaries declined; perhaps there is a connection. The Neopalatial decline in peak sanctuaries has been attributed to a centralization of the “peak” cult by the “palaces,”⁴⁵ but perhaps the amelioration of the summer climate due to the development of the 2nd-millennium Little Ice Age had something to do with it.

Limitations of space do not permit these ideas to be presented more fully here. Nevertheless, it is becoming increasingly clear that the traditionally observed cultural changes in Minoan Crete are connected with the newly documented environmental changes, and that such changes richly reward further exploration.

44. Dedicated spring sanctuaries such as Kato Syme seem to be slightly later in date (Watrous 2001b, p. 217).

45. Peatfield 1987, pp. 92–93.