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DATING THE VOLCANIC ERUPTION AT THERA

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ABSTRACT. The eruption of the volcano at Thera (Santorini) in the Aegean Sea undoubtedly had a profound influence on the civilizations of the surrounding region.The date of the eruption has been a subject of much controversy because it must be linked into the established and intricate archaeological phasings of both the prehistoric Aegean and the wider east Mediterranean. Radiocarbon dating of material from the volcanic destruction layer itself can provide some evidence for the date of the eruption, but because of the shape of the calibration curve for the relevant period, the value of such dates relies on there being no biases in the data sets. However, by dating the material from phases earlier and later than the eruption, some of the problems of the calibration data set can be circumvented and the chronology for the region can be resolved with more certainty.

In this paper, we draw together the evidence we have accumulated so far, including new data on the destruction layer itself and for the preceding cultural horizon at Thera, and from associated layers at Miletos in western Turkey. Using Bayesian models to synthesize the data and to identify outliers, we conclude from the most reliable ^{14}C evidence (and using the INTCAL98 calibration data set) that the eruption of Thera occurred between 1663 and 1599 BC.

INTRODUCTION

The question of the date of the eruption of Thera (or Santorini) is of great importance because it defines the relationship between different cultural developments in the east Mediterranean in the middle of the 2nd millennium BC (Manning 1999). Dating of the eruption has been determined by "traditional" archaeological techniques through the study of trade links, particularly to Egypt (see Bietak 2003 for a summary of this evidence; previously, Warren and Hankey 1989), linking it into the Egyptian historical chronology, which is thought to be secure for this time period because of the extensive documentary evidence (e.g. Kitchen 2000).

Radiocarbon dating since the mid-1970s has suggested a date for the eruption some 100–150 yr earlier than the traditional archaeological ("conventional") chronology (e.g. Michael 1976; Betancourt 1987; Manning 1988; Friedrich et al. 1990; Housley et al. 1990; Manning and Bronk Ramsey 2003). In the 1980s, it was suggested that tree-ring and ice-core evidence also suggested similarly "early" dates in the mid- to later-17th century BC (LaMarche and Hirschboeck 1984; Hammer et al. 1987; Baillie and Munro 1988).

But recent work has seriously questioned the case from ice-core evidence for a Thera eruption about 1645 BC (argued for by Hammer et al. 2003); there was a major volcanic eruption, just not it seems of Thera, given critical review of the currently available geochemical characterization data (Pearce et al. 2004a,b; Keenan 2003). Similarly, the case for a dendrochronologically-derived date has only ever been based on a hypothetical and suggestive proxy linkage. There is as yet no positive evidence for a causal association.

Thus, attention turns ever more centrally and critically to the ^{14}C evidence since at present this alone offers direct and independent science-based dating evidence for the great and archaeologically pivotal Thera eruption in the mid-2nd millennium BC. In this paper, we report on further ^{14}C measurements which we have recently made on material from Thera and from a related Aegean site. These add important new elements to the ^{14}C picture.

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STRATEGY

One of the main problems with the dating of material from the eruption at Thera is the form of the calibration curve in the period from about 1675 cal BC to 1525 cal BC. In this period, there is an approximate plateau in the curve, which means that the ^{14}C dates do not differ by more than about 50 yr (see Figure 1). Thus, with the usual levels of precision obtainable, it is difficult to distinguish between the 2 main contending dates for the eruption: a mid- to later-17th century BC date (proposed variously from ^{14}C, ice-core, and tree-ring evidence: LaMarche and Hirschboeck 1984; Baillie 1995; Zielinski et al. 1994; Manning 1999; Manning et al. 2001; Hammer et al. 2003), or one about 100–150 yr later (the "conventional" position based on interpretation of archaeological linkages between the Aegean and Egypt: e.g. Warren 1984, 1998; Warren and Hankey 1989; Bietak 2003). However, the calibration curve in periods preceding and postdating this plateau does show considerable variation and, therefore, allows more precise calendar dating.

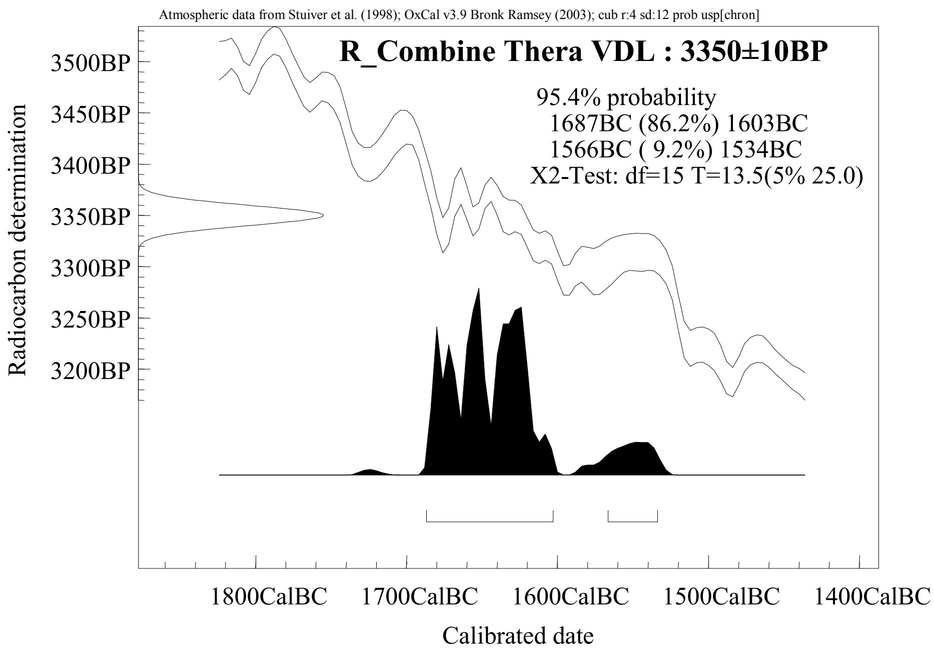

Figure 1 This shows the combined result from the 16 measurements, using standard pretreatment methods, run at ORAU on charred seeds from the final volcanic destruction layer at Aktrotri. This evidence, on its own, suggests that a 17th century cal BC date for the eruption is more likely by a factor of 10 than a date in the mid-16th century cal BC. However, on its own, the result is not conclusive.

The aim of this dating program (see Manning et al. 2002 and Manning and Bronk Ramsey 2003 for previous reports) has, therefore, been to date material from throughout the Late Minoan I period (from the end of the Middle Bronze Age) and to the close of the Late Minoan II period. If the chronology is shifted in the way that has been suggested by, or argued from, the ice-core evidence, tree-ring evidence, and past ^{14}C analyses from Thera, then these periods should show compatible offsets. Where possible at other sites, we have used wiggle-match dating (see Galimberti et al., these proceedings) to achieve the highest precision currently possible. In the analysis, we have also included normally pretreated data from measurements previously obtained at Oxford on material from Thera (Housley et al. 1990).

In addition to these measurements, we have also conducted multiple high-precision accelerator mass spectrometry (AMS) measurements on short-lived material from the volcanic destruction level at Akrotiri (Thera) to see if this can help to resolve the date of the eruption itself.

In terms of sample selection, we have concentrated on short-lived material, identified to species, which is sealed in secure contexts (architectural features, storage jars, etc.) and labeled "secure" in this paper. In previous publications, these have been the samples on which our conclusions have been based. However, such material is not easy to find in many sites and periods. We have, therefore, also dated a range of bone and charcoal samples from well-defined stratigraphic contexts. Because the bones are not articulated and the charcoal is from wood of unknown age, we can only use this material as a *terminus post quem* for the phases, and, since there is always the possibility of intrusion from higher levels, even this cannot be done with complete certainty. These samples will be labeled "phased" here. In this paper, we will present all of the results from "secure" and "phased" samples.

THE ^{14}C MEASUREMENTS

The ^{14}C dates considered in this paper are all listed in Appendix I. The results cover the whole range from the Middle Bronze Age to Late Minoan II:

- From Kommos, Akrotiri, and Trianda, we have long-lived wood charcoal samples which are from early Late Minoan IA (LM IA) levels. These either derive from this period or an earlier one. One Trianda sample has 30 visible rings and 3 decades have been measured in duplicate in order to try to wiggle-match the sequence. From Miletos, we also have bone samples from Middle Bronze Age (MBA) phases.
- From Miletos, we have wiggle-matched 7 decades (each measured twice) from a 72-yr-long tree-ring sequence from an oak timber that had been quartered and stripped of bark before being fashioned into an ornate chair. This chair burned in a fire dated by the excavator, Wolf-Dietrich Niemeier, to late in the LMIA period, and as excavated was covered in Theran ash (Niemeier, personal communication, September 2003). The last ring of the sample, present around the entirety of the preserved circumference, appears to indicate the presence of the waney edge, i.e., the last ring before the tree was cut down (Peter Ian Kuniholm and Maryanne Newton, personal communications, December 2002, February 2004; they note that this is their best interpretation of what is visible on the basis of their experience, but also that it cannot be regarded as certain given the absence of the morphological features that in oak wood might indicate sapwood—color change, filled tyloses in the earlywood vessels). Though this chair is from late in the LM IA level, it could, in principle, have been manufactured earlier. This wiggle-matched dendrochronological sequence is, thus, best considered in our Bayesian-modelled scenarios (below) as being bounded on the most recent end by the Volcanic Destruction Level (VDL) at Thera.
- From the VDL at Thera itself, there is short-lived material in the form of charred seeds. The original series of these seeds (submitted by A Sarpaki, OxA-1548 to -1556) were from pithoi in the West House. The new series also comprises seeds from storage jars from the 2000–2001 excavations at Akrotiri (M10/23A N012 from pithos A15, M2/76 N003 from vase A12, M31/43 N047 from pithos A105, and M7/68A N004 from basket M05). We also have material from the LMIA levels of other sites which should be contemporary (or earlier if residual). Such material includes samples from Tsoungiza, near Nemea, in mainland Greece, which is from what is interpreted as its LHI phases.
- From the LMIB destruction levels of Chania and Myrtos-Pyrgos in Crete, we have more seeds (i.e. short-lived material, originally submitted by Hallager and Cadogan [see Housley et al.

1999] and re-dated for this project). These should date the period towards the end of LMIB and should be roughly contemporary. More charcoal from Kommos should also relate to this period, as should LHI/II charcoal from Tsoungiza.

- For LMII, we have dates on charred seeds from the destruction layers at Knossos (originally submitted by M Popham and re-dated for this project).

OVERVIEW OF ^{14}C EVIDENCE FROM THIS PROJECT

As the principal purpose of this paper is to examine the dating of the eruption of the volcano at Thera, we will first look at the results on samples from the volcanic destruction layer itself. All 16 measurements on the short-lived material (cereals and pulses) pass a χ^2 test (Figure 1). They suggest a 17th century cal BC date for the eruption with a lower probability (by a factor of about 10) for a date in the mid-16th century cal BC.

Later in the paper, we will consider a wider statistical analysis of these results, but first we will examine the calibrated results for each of the other periods.

- The secure context long-lived samples from early LMIA (which may very well date to during the Middle Bronze Age) are apart from one (OxA-11252) earlier than 1700 cal BC. OxA-11252 could be anything between about 1520 cal BC and 1750 cal BC. These samples suggest that the early part of LMIA might lie from about 1700 cal BC, but it could be later given the nature of the material. The material taken from contemporary phases gives a more mixed picture, on average being a little later. Two samples are particularly late (OxA-10618 from Kommos and OxA-10623 from Trianda, marked "?" in Figure 2).
- For the later LMIA (Figure 3), the individual calibrations are not very specific, except in the case of the wiggle-matched sample from Miletos, which could, in principle, be residual. However, note that the sample 65/N001/I2 combined date must be later than about 1683 cal BC and M4N003 must be earlier than 1625 cal BC (both samples from Akrotiri). The short-lived material from the VDL itself (as discussed above) is most likely to be from the mid-later 17th century cal BC. Again the samples from contemporary phases give a very mixed picture. Early dates can be explained as being residual within context, but the 3 LHI dates from Tsoungiza seem later as does one of the bone samples from Miletos (OxA-11952—this sample and the almost similarly late looking OxA-11953 have, subsequent to the initial writing of this text for submission, now been recognized as later, probably Mycenaean, intrusive material from a pit cut into the LMIA stratum [Wolf-Dietrich Niemeier, personal communication, December 2003]; they may, therefore, be discounted).
- For the LMIB destruction layers (Figure 4), the dates cluster around about 1500 cal BC, but with considerable scatter because of the calibration. Given that these dates are meant to be very similar in age, the only date consistent with all of the measurements is about 1520 cal BC, where there is a steep fall in the INTCAL98 calibration curve (Figure 1), which explains the range in values obtained for the 2 sites. But we might also note that 1 sample from Chania (of peas: OxA-2517, 10322) is perhaps significantly older than the other samples from this site (and the set of data from the Chania LMIB destruction horizon fails a 95% χ^2 test with this sample included—it passes without them) and without this sample the need to include the older 16th century BC calibration curve segment is reduced; we might also note that the steep slope in the INTCAL98 calibration curve relies on the effect of a Belfast bi-decadal datum centered at 1510 BC—significantly different from the surrounding Seattle data—without this datum, the "slope" in the calibration curve moves more to about 1500–1490 BC (cf. analysis of Housley et al. 1999 main text based on the Seattle 1993 data set). Thus, an initial date range of possibly

about 1520–1490 BC might be considered. The sample from LMIB levels at Kommos is compatible with the Chania and Myrtos-Pyrgos ages. The samples from LHI/II at Tsoungiza are much earlier.

- The LMII samples from Knossos (Figure 5) show a similar pattern with all of the calibrated dates scattering about 1420 cal BC.

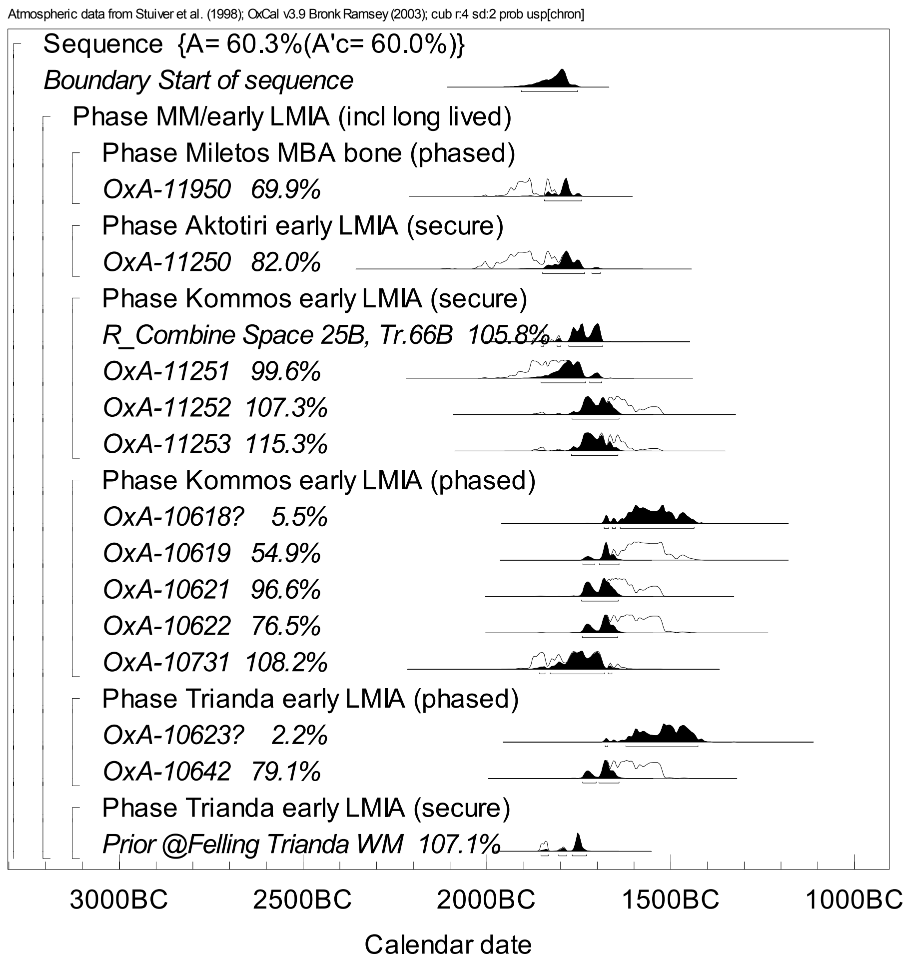

Figure 2 This figure shows the results of the calibrations (in outline) of the samples dated from the MM and early LMIA levels. The solid black distributions are the result of applying Model 3 to the data using a Bayesian analysis. The ^{14}C dates marked with a "?" have been excluded from the analysis in this model and the distributions for those samples are for a simple calibration. The figures in percentages are the agreement indices for the samples. Where the sample is excluded from the model (those marked "?"), the figure gives the probability that the sample is in the context specified in the model.

What is immediately clear is that the dates from stratigraphic phases give more mixed results than those from the secure contexts with short-lived material. This is not very surprising.

Because we can always account for early dates through likely instances of residuality, it is useful to look in more detail at the 6 later dates mentioned above. Three of these samples are from LHI levels at Tsoungiza. Two of the samples (OxA-11312 and -11313) come from contexts also dated using

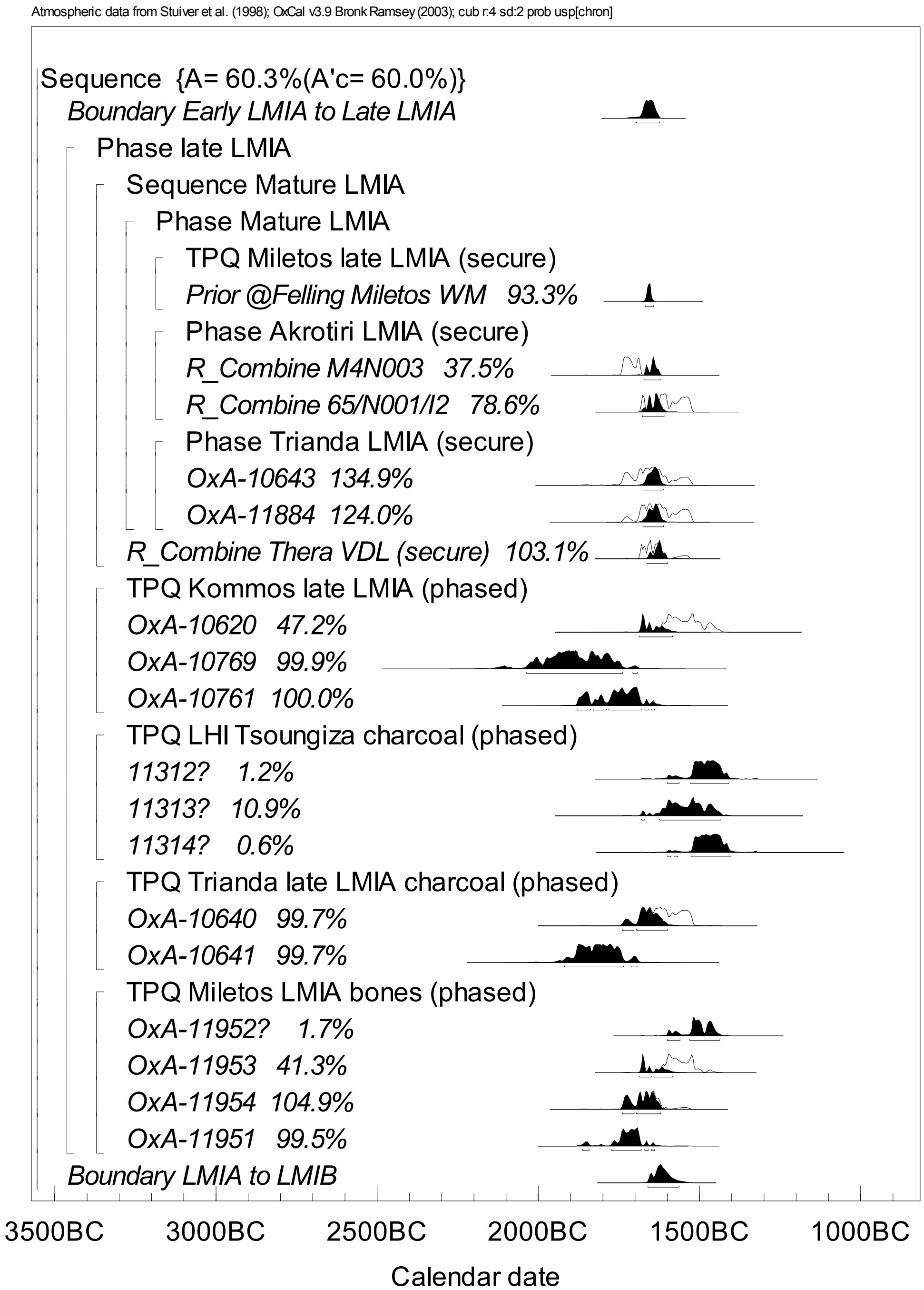

Figure 3 This shows the results from the late LMIA phase; see Figure 2 caption for details.

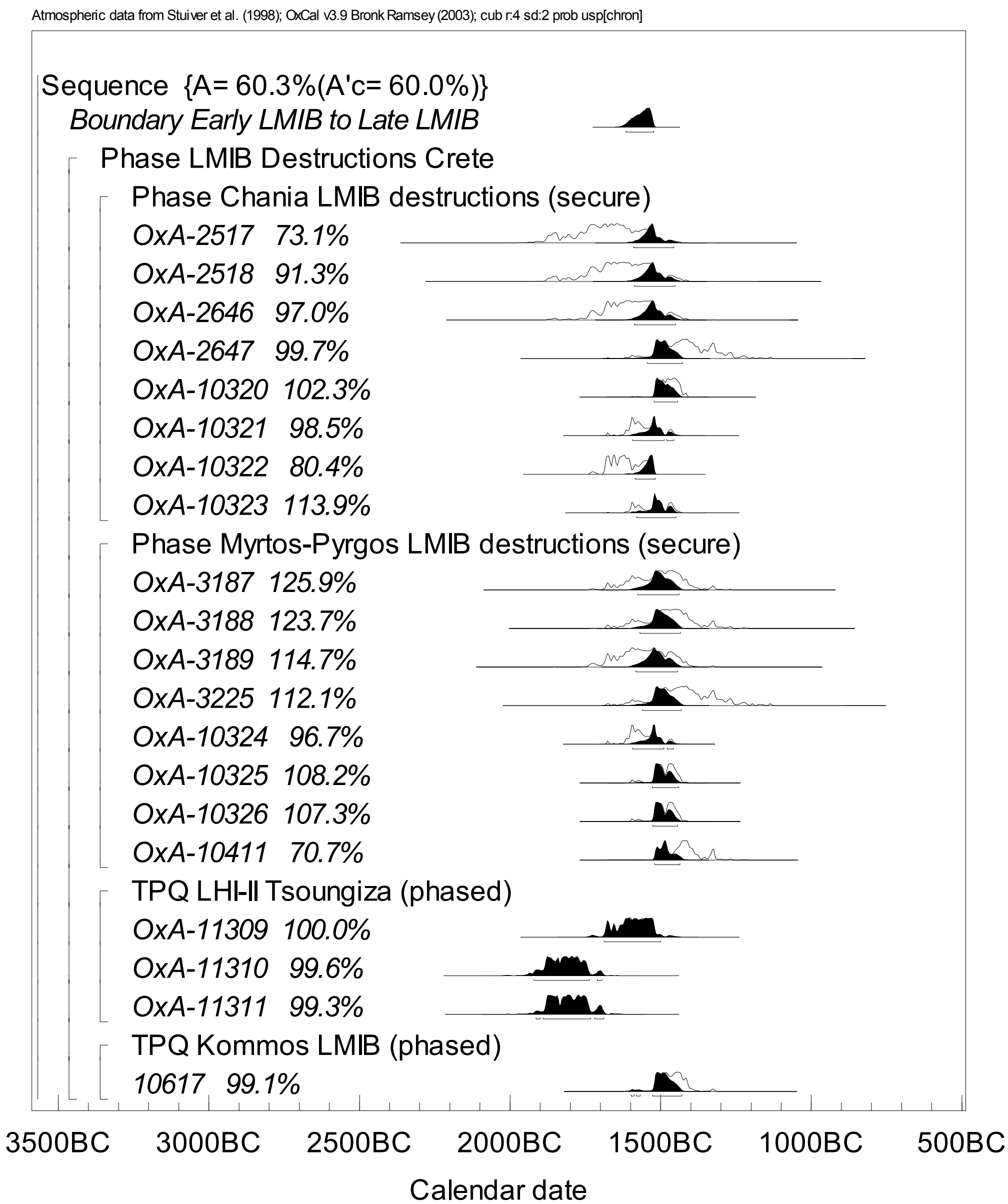

Figure 4 This shows the results from the LMIB phase; see Figure 2 caption for details.

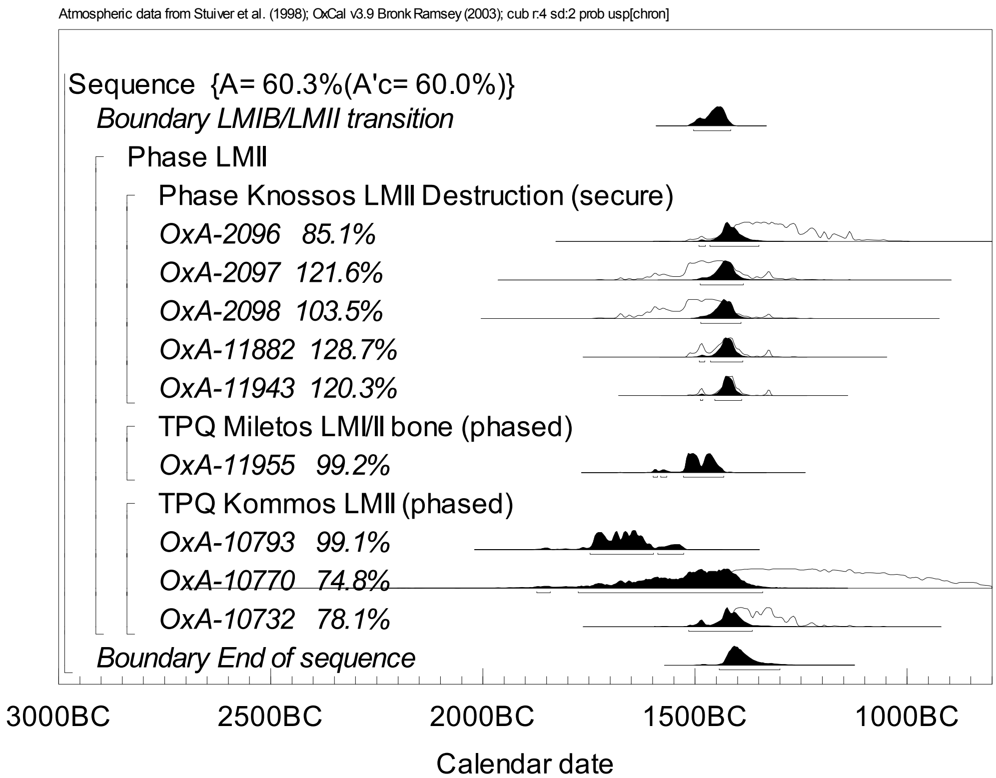

Figure 5 This shows the results from the late LMII phase; see Figure 2 caption for details.

other charcoal fragments by the Arizona ^{14}C lab to 3322 ± 54 BP (AA-10816) and 3317 ± 55 BP (AA-10818)—earlier dates which suggest that the material from these contexts is mixed in age. A third sample (a grape seed, *vitis vinifera*) from this site, 3308 ± 39 BP (OxA-11309), matches well with another sample on charcoal fragments from the same context, 3313 ±5 5 BP (AA-10820). Of the other 3 samples that seem later than the majority, two are un-identified charcoal fragment samples (one from Kommos and one from Trianda) and one is a bone sample from Miletos. In the case of the Trianda sample, subsequent analysis of the archaeological record suggests that the context may be disturbed (Toula Marketou, personal communication, 2002).

From this information, several points emerge. Firstly, the dates from the LMIB period point strongly to the period of the destruction of the sites/palaces in Crete being around 1520 cal BC (INTCAL98), where there is a strong shift in the ^{14}C calibration curve (see Section 6 and Table 2 for discussion of calibration data sets). This is about 50–100 yr earlier than the conventional archaeological chronology would suggest (e.g. a date of about 1425 BC is given in Warren and Hankey 1989:169; Warren 1999:902 suggests a date of "around 1430 B.C."). If we accept such a shift, then 6 samples (none of them in the "secure" context category) from the preceding LMIA period seem to be too late for their context as they lie on the young side of this same rapid ^{14}C concentration shift and, therefore, date to later than 1520 cal BC (INTCAL98). All of the dated "secure" samples from LMIA are consistent with a volcanic eruption date in the mid- to later-17th century cal BC, and with a much lower probability in the mid-16th century cal BC.

BAYESIAN ANALYSIS USING OXCAL

In order to be more numerically specific, we have constructed a Bayesian model for the analysis of these dates using OxCal (Bronk Ramsey 1995, 2001). This takes all of the material together and uses it to constrain a basic model for the chronology of the region. In this model, we have taken the following transitions:

- early LMIA to late LMIA,
- late LMIA to early LMIB,
- early LMIB to late LMIB,
- late LMIB to LMII,

as the major transitions in the chronology. We have then fitted all of the dates within this framework, assuming, for example, that the volcanic destruction at Thera occurs in the late LMIA period. Where material is long lived, we have defined it merely as a *terminus post quem* (TPQ), which will constrain the model to be later than these dates. We have also treated any material which is taken from stratigraphic phases, as opposed to secure contexts, as being a TPQ for the end of the relevant phase. If anything, this should make the chronology later rather than earlier; it allows for residual material but not for intrusion from higher levels.

In order to test for intrusion and outliers, we used the OxCal agreement index (Bronk Ramsey 1995, 2001). This is a calculation of the overlap of the simple calibrated distribution with the distribution after Bayesian modelling. If the overlap falls below 60%, it is equivalent to a combination of normal distributions failing a χ^2 test at 95% level. In this case, we have over 100 ^{14}C dates, so we would expect some samples (5%) to fail this test but not by much. An extension of this method tests the model as a whole to see if the overall agreement is acceptable or not. In this case, we decided to include all relevant dates in the analysis and then remove the most extreme outliers in a sequential fashion. The characteristics of the 6 models considered are shown in Table 1. We have used INTCAL98 in this exercise.

Table 1 Models 1 and 2 are not acceptable in terms of internal consistency. By removing 6 (all from non-secure contexts) out of the 102 samples dated, the agreement becomes acceptable and the model converges on conclusions that are fairly robust. The best agreement (Model 6) is with only the secure context samples included.

	Excluded samples	Reason	Overall agreement	
Model 1	None	—	26%	Very poor
Model 2	Tsoungiza charcoals OxA-11312, 11313, 11314	Very low agreement and AA comparisons	43%	Poor
Model 3	+ OxA-10618 (Kommos), 10623 (Trianda), 11952 (Miletos)	Low agreement and contexts not secure	60%	Marginal
Model 4	+ OxA-10619 (Kommos), 10620 (Kommos), 11953 (Miletos)	Low agreement and contexts not secure	81%	OK
Model 5	+ M4N003 (Akrotiri) combination	Low agreement despite secure context	96%	OK
Model 6	All non-secure contexts (M4N003 included)	M4N003 agreement now OK	100%	OK

Model 1 includes all measurements; Model 2 excludes the 3 most extreme outliers, which are the 3 measurements from LHI (as discussed above). Model 3 excludes the next most extreme outliers (also as discussed above), which are from non-secure contexts. The full details of Model 3 are given in Appendix II and the results of the analysis are given in the Figures 2–5. This is the first model where the overall agreement is acceptable (just over 60%). In Model 4, we have then examined the effect of removing the remaining 3 samples from non-secure contexts where the agreement index is lower than 60% (even though these may simply be statistical outliers). Model 5 removes 1 "secure" sample (M4N003) which has been dated 5 times because its agreement index is still just below the 60% threshold.

Given that almost all of the anomalous measurements come from the "phased" rather than "secure" contexts, it seems better simply to consider the "secure" material on its own and exclude all "phased" elements from the model. If we do this, all of the agreement indices are above the 60% threshold (including M4N003) and this is what we have considered in Model 6.

The results of all of the analyses are summarized in Table 2. It shows the dates for the main archaeological transitions as estimated from the Bayesian models under the different assumptions outlined above. Models 1 and 2 are not acceptable because they are internally inconsistent—the anomalous dates discussed in the previous section are, in ^{14}C terms, clearly too late to fall before the early/late LMIB transition which must pre-date 1520 BC. All of the models give a very consistent picture of the chronology of the middle of the LMIB phase. All models, except 1 and 2, constrain the date of the eruption at Thera to be in the 17th century BC. The 6 dates that are inconsistent with this date are fragments (five of charcoal, one of bone) from "phased" contexts. Given the very large number of dates measured in this project (over 100), this inconsistency is not too surprising.

Table 2 This shows the date ranges for key transitions inferred from the different models. Note that the date for early LMIB to late LMIB is fairly sensitive to the model and is always earlier than 1520 BC. Models 1 and 2 are the only ones consistent with a 16th century BC date for the Theran eruption, but suffer from very low levels of internal consistency (as measured by the agreement index—see Table 1). However, given that the start of the LMIB destruction events must be earlier than 1520 BC (see this table), Models 1 and 2 would have to require a very short end to LMIA and a very short LMIB phase. Between each of Models 3 and 6, only the date of the early to late LMIA transition is significantly affected by the assumptions made. The "conventional" dates are taken from Warren (1999). All data marked * are based on the INTCAL98 calibration curve (Stuiver et al. 1998). The last model, marked †, has been calculated on the basis of the University of Washington decadal calibration data set (UWTEN98: Stuiver, Reimer, and Braziunas 1998).

	LMIA early/ LMIA Late		VDL		LMIA/LMIB		LMIB early/ LMIB late		LMIB/LMII	
	From	To	From	To	From	To	From	To	From	To
Model 1*	1677	1625	1632	1600	1593	1533	1575	1520	1510	1423
	1586	1546	1587	1536						
Model 2*	1678	1624	1638	1598	1624	1532	1591	1520	1508	1420
	1579	1549	1587	1537						
Model 3*	1696	1623	1663	1599	1660	1563	1615	1523	1504	1416
Model 4*	1709	1628	1662	1611	1661	1595	1620	1524	1503	1416
Model 5*	1698	1613	1661	1601	1661	1577	1618	1523	1504	1416
Model 6*	1747	1643	1662	1608	1661	1581	1621	1522	1507	1416
Model 6†	1743	1639	1663	1605	1662	1577	1621	1516	1501	1421
Conventional			~1520/1500		~ 1500				~ 1430	

POSSIBLE FLAWS IN THE ANALYSIS

There are various possible flaws in the ^{14}C dating program presented here. They center on 4 main issues:

- *Certainty of association*: We have considered this in some detail previously in this paper. If we rank the samples in terms of their certainty of association with the archaeological phases into the 2 categories "secure" and "phased," all of the outliers are in the second category and one of these is now known to lie in a disturbed context. The most secure context samples (the charred seeds from storage vessels at Akrotiri) all give a perfectly consistent set of results and imply a date for the eruption in the 17th century BC.
- *Regional offsets in ^{14}C concentration*: This is an area that has been much discussed and studied (e.g. Kromer et al. 2001; Manning et al. 2001; Manning and Bronk Ramsey 2003). There is little to add here, except to point out that the wiggle-matched sample from Miletos (Galimberti et al., these proceedings) confirms that material from the eastern Mediterranean does match well with the general Northern Hemisphere calibration curve in this particular period. Even if one discounts the material from Thera itself on the grounds that it may have been cultivated near some volcanic vent (and this is very unlikely for all samples from different crop types), such an explanation will not hold for the LMIB material from Crete, nor the LMIA data from Rhodes.
- *Laboratory offset in measurements*: All of these measurements have been measured in conjunction with known-age material from tree-rings. These average <10 ^{14}C yr offset from the INTCAL98 values (see Bronk Ramsey et al., these proceedings, for the latest measurements on this). The results on the short-lived material from Thera have also been measured over a very long timeframe, with the first measurements being made in the 1980s and then the more recent dates on 2 different accelerators. The fact that all of the dates are in good agreement at least shows strong internal consistency. They are also in good agreement with the Copenhagen dates on fully charred short-lived material from the destruction level (Friedrich et al. 1990).
- *Calibration curve*: We have employed what is, at the time of writing, the standard internationally recommended ^{14}C calibration curve (INTCAL98: Stuiver et al. 1998). This curve is, of course, far from definitive (and a new revised and more robustly-based INTCAL04 calibration will appear soon). We have noted, for example, the issue of the reality of the steep slope in the curve ~1520 BC, and how this relies largely on 1 Belfast datum that is perhaps an outlier from the general trend at this time. Ignoring this datum would place the relevant slope more about 1505–1485 BC. Thus, statements in this text referring to the 1520 BC slope and age divide would have to be modified, and might be lowered to about 1490 BC (compare Housley et al. 1999 which used only the Seattle data set in its main text). However, overall, such issues of relatively minor differences between the underlying calibration data sets have little significant impact on the analysis of the entire sequence of data. See, for example, the 2 rows of Table 2 for Model 6 (Model 6* and Model 6†), where the results of using INTCAL98 may be compared with the outcome of calibration employing just the Seattle data on German oak (UWTEN98: Stuiver et al. 1998); the differences are very small and insignificant.

The Bayesian analysis performed has explored a number of possible interpretations of the data set presented, and provides some measure of the sensitivity of the analysis to different assumptions. All of the models that which acceptable levels of internal consistency (i.e. Models 3–6 inclusive) provided very similar conclusions about the chronology of this period, despite the different underlying assumptions.

CONCLUSIONS

The first conclusion we draw from the data presented here is a recurrent theme in publications on ^{14}C dating: that where high-precision work is to be undertaken, high-quality samples of short-lived material and with very secure contexts are critical. In this case, we do have quite a few measurements which do not fit this category, and in the end, they do not add much to the analysis. We have 102 ^{14}C measurements to consider here and, of these, six are inconsistent with the others; all come from phases of sites but do not have the same certainty of context as the samples from secure architectural contexts, storage jars, etc.

By looking at the calibrated ^{14}C dates, it is clear that the chronology, particularly of the late LMIB period, must be earlier than the conventional archaeological chronology. We can also see from the secure short-lived material from Akrotiri and other related sites that the eruption of Thera is much more likely (by a factor of about 10) to be in the mid-later 17th century cal BC than a 100 yr (or more) later.

If we combine this information in a Bayesian model and take only those models that are internally consistent, we can see that 4 different analyses (Models 3–6) all give dates for the eruption of Thera in the range of about 1663–1599 BC. This is consistent with suggestions from the mid-1970s onwards of a mid- to late-17th century BC date for the Thera eruption. We emphasize that this dating is direct on the context of interest; it is not a proxy (as current tree-ring evidence) nor subject to debate over the provenance of the tephra-derived glass shards/acidity spike in Greenland ice cores (e.g. Zielinski and Germani 1998a, 1998b; Manning 1998, 1999: 288–307; Hammer et al. 2003; Keenan 2003; Pearce et al. 2004a, b). Following our conclusions above, we think that Model 6, which discards all evidence from fragmentary charcoal and bone found in stratified contexts, is likely to give us the most accurate results. Figure 6 shows the resultant distribution for the volcanic destruction layer material from Akrotiri.

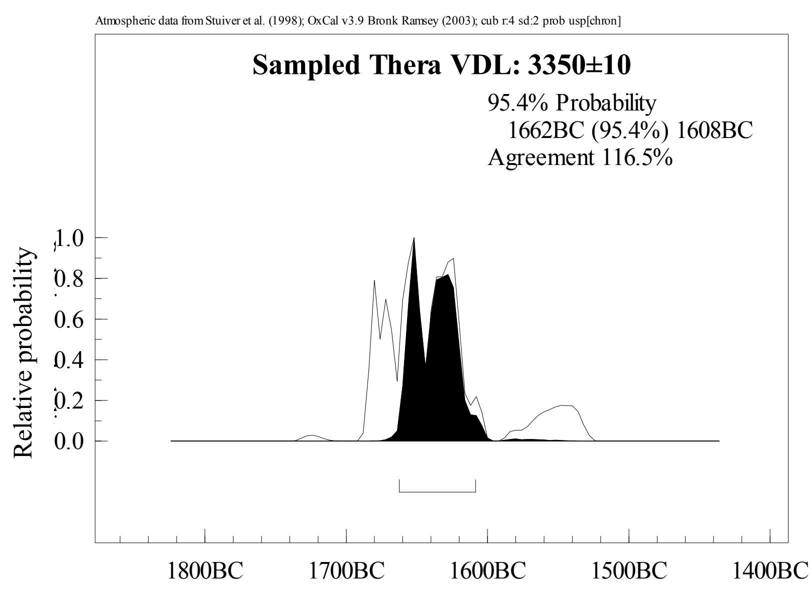

Figure 6 This shows in outline the ^{14}C calibration for the samples from the volcanic destruction layer at Thera (cf. Figure 1, but now after Bayesian analysis using Model 6*, in which only the samples from "secure" contexts are used).

We conclude that if the ^{14}C evidence is considered in isolation, one would deduce that the eruption of Thera took place sometime between 1663 and 1599 BC with 95% confidence. However, there is other archaeological evidence and specific interpretations of this, which clearly need to be taken into account (see Bietak 2003). Ultimately, one's conclusions will depend on how much weight is given to the alternative evidence and especially its interpretation. If, for example, after considering the archaeological evidence, it is concluded that a mid-16th century BC date for the eruption of Thera is 10 times as likely as a 17th century BC date, then this will lead to a different final conclusion. Others, meanwhile, have argued that the archaeological evidence is potentially consonant with a 17th century BC date for Thera (Kemp and Merrillees 1980; Betancourt 1987, 1998; Manning 1988, 1999).

Perhaps most interesting of all is that new evidence is now beginning to suggest that the historical-numerical chronology of Egypt in this period may not be as secure as had been supposed (see Kutschera et al., submitted). Such evidence might open the way for the reconciliation of archaeological linkages with Egypt to the ^{14}C evidence.

ACKNOWLEDGEMENTS

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Appendix I List of all samples and dates (108) used in this study. The six samples shown in grey are not considered further because they are either too early to be relevant, or TPQ for late periods and, therefore, would have no impact on the chronology considered here.

Site	Submitter's reference	Material	Species	OxA	BP	±	$\delta^{13}C$	Period	Context
Akrotiri, Thera	M31/67 N069	charred seed		11819	3768	32	–25.5	<LM	secure
Akrotiri, Thera	M31/67 N069	charred seed		12173	3788	29	–25.2	<LM	secure
Akrotiri, Thera	M31/67 N069	charred seed		12174	3745	29	–25.5	<LM	secure
Miletos, Turkey	AT 98.196	bone		11950	3549	24	–19.8	MM	phased
Kommos, Crete	TP-KE-32	charcoal		10621	3359	39	–25.5	MMIII	phased
Kommos, Crete	TP-KE-32	charcoal		10622	3330	45	–25.3	MMIII	phased
Miletos, Turkey	AT 99.915	bone		11951	3423	23	–19.5	LMIA[a]	phased
Miletos, Turkey	AT 99.729	bone		11952	3243	22	–20.1	Intrusive into LMIA	phased
Miletos, Turkey	AT 99.779	bone		11953	3279	26	–20.0	Intrusive into LMIA[a]	phased
Miletos, Turkey	AT 99.811	bone		11954	3377	24	–19.4	LMIA	phased
Trianda, Rhodes	Trianda 4	charcoal		10640	3338	40	–25.4	LMIA	phased
Akrotiri, Thera	M54/2/VII/60/δε>247	charcoal	*Olea europaea*	11250	3550	45	–23.4	LMIA(early)	secure
Kommos, Crete	Space 25B Tr.66B	charcoal	*Chamaecyparis sp.*	3429	3350	70	–27.8	LMIA(early)	secure
Kommos, Crete	Space 25B Tr.66B	charcoal	*Chamaecyparis sp.*	11883	3485	33	–25.3	LMIA(early)	secure
Kommos, Crete	Space 25B Tr.66B	charcoal	*Olea europaea*	11944	3435	25	–24.4	LMIA(early)	secure
Kommos, Crete	TP-KE-30	charcoal		10618	3270	45	–22.6	LMIA(early)	phased
Kommos, Crete	TP-KE-30	charcoal		10619	3295	45	–22.8	LMIA(early)	phased
Kommos, Crete	K85A/62D/9:92	charcoal	*Quercus sp.*	11251	3505	40	–23.6	LMIA(early)	secure
Kommos, Crete	K85A/66B/4:22+23	charred twig		11252	3375	45	–23.6	LMIA(early)	secure
Kommos, Crete	K85A/62D/8:83	charcoal	*Quercus sp.*	11253	3397	38	–23.2	LMIA(early)	secure
Kommos, Crete	38/TP-KC-22	charcoal		10731	3450	45	–24.1	LMIA(early)	secure
Trianda, Rhodes	Trianda 1	charcoal		10623	3245	45	–23.5	LMIA(early)	phased
Trianda, Rhodes	Trianda 9	charcoal	*?Olea sp.*	10642	3333	39	–25.2	LMIA(early)	phased
Trianda, Rhodes	34/AE1024/A	charcoal	*Quercus sp.*	10728	3455	45	–25.3	LMIA(early)	secure
Trianda, Rhodes	34/AE1024?B	charcoal	*Quercus sp.*	10729	3410	45	–25.9	LMIA(early)	secure
Trianda, Rhodes	36/AE1024/C	charcoal	*Quercus sp.*	10730	3490	45	–25.5	LMIA(early)	secure
Trianda, Rhodes	34/AE1024/A	charcoal	*Quercus sp.*	11945	3473	24	–24.9	LMIA(early)	secure
Trianda, Rhodes	34/AE1024/C	charcoal	*Quercus sp.*	11946	3474	24	–26.1	LMIA(early)	secure
Trianda, Rhodes	36/AE1024/C	charcoal	*Quercus sp.*	11948	3526	25	–25.2	LMIA(early)	secure

[a]Two bone samples from Miletos were received and dated on the basis of being from Late Minoan IA contexts. Subsequent to this work, the excavator of the site, Wolf-Dietrich Niemeier (personal communication, December 2003), has informed us that these 2 samples derive from what is now recognized as a later (probably Mycenaean) pit cut into the LMIA stratum. These 2 dates may therefore be dismissed as relevant to LMIA. The analysis (see text) had already identified these 2 data as outliers.

Appendix I List of all samples and dates (108) used in this study. The six samples shown in grey are not considered further because they are either too early to be relevant, or TPQ for late periods and, therefore, would have no impact on the chronology considered here. *(Continued)*

Site	Submitter's reference	Material	Species	OxA	BP	±	$\delta^{13}C$	Period	Context
Akrotiri, Thera	F/65/N001/I2	charcoal	*Tamarix sp.*	10312	3293	27	–24.0	LMIA(late)	secure
Akrotiri, Thera	G/65/N001/I2	charcoal	*Tamarix sp.*	10313	3353	27	–24.1	LMIA(late)	secure
Akrotiri, Thera	H/65/N001/I2	charcoal	*Tamarix sp.*	10314	3330	27	–24.5	LMIA(late)	secure
Akrotiri, Thera	A/M4N003	charcoal	*Olea europaea*	10315	3446	39	–24.0	LMIA(late)	secure
Akrotiri, Thera	B/M4N003	charcoal	*Olea europaea*	10316	3342	38	–24.4	LMIA(late)	secure
Akrotiri, Thera	C/M4N003	charcoal	*Olea europaea*	10317	3440	35	–24.1	LMIA(late)	secure
Akrotiri, Thera	D/M4N003	charcoal	*Olea europaea*	10318	3355	40	–24.2	LMIA(late)	secure
Akrotiri, Thera	E/M4N003	charcoal	*Olea europaea*	10319	3424	38	–24.4	LMIA(late)	secure
Kommos, Crete	TP-KE-31	charcoal		10620	3269	38	–22.4	LMIA(late)	phased
Kommos, Crete	40/TP-KC-20	charcoal		10761	3440	38	–24.3	LMIA(late)	phased
Kommos, Crete	39/TP-KC-21	charcoal		10769	3555	60	–24.8	LMIA(late)	phased
Miletos, Turkey	1:C-TU-MIL-1/RY1000-1010	charcoal	*Quercus sp.*	12301	3439	30	–25.4	LMIA(late)	secure
Miletos, Turkey	1:C-TU-MIL-1/RY1000-1010	charcoal	*Quercus sp.*	12302	3386	31	–26.0	LMIA(late)	secure
Miletos, Turkey	2:C-TU-MIL-1/RY1010-1020	charcoal	*Quercus sp.*	12303	3467	31	–25.5	LMIA(late)	secure
Miletos, Turkey	3:C-TU-MIL-1/RY1020-1030	charcoal	*Quercus sp.*	12304	3404	31	–25.5	LMIA(late)	secure
Miletos, Turkey	3:C-TU-MIL-1/RY1020-1030	charcoal	*Quercus sp.*	12305	3459	31	–25.7	LMIA(late)	secure
Miletos, Turkey	4:C-TU-MIL-1/RY1030-1040	charcoal	*Quercus sp.*	12306	3416	31	–25.7	LMIA(late)	secure
Miletos, Turkey	4:C-TU-MIL-1/RY1030-1040	charcoal	*Quercus sp.*	12307	3425	31	–25.6	LMIA(late)	secure
Miletos, Turkey	5:C-TU-MIL-1/RY1040-1050	charcoal	*Quercus sp.*	12308	3361	31	–26.0	LMIA(late)	secure
Miletos, Turkey	5:C-TU-MIL-1/RY1040-1050	charcoal	*Quercus sp.*	12309	3397	31	–26.0	LMIA(late)	secure
Miletos, Turkey	6:C-TU-MIL-1/RY1050-1060	charcoal	*Quercus sp.*	12310	3345	32	–26.3	LMIA(late)	secure
Miletos, Turkey	6:C-TU-MIL-1/RY1050-1060	charcoal	*Quercus sp.*	12311	3397	32	–26.3	LMIA(late)	secure
Miletos, Turkey	7:C-TU-MIL-1/RY1060-1070	charcoal	*Quercus sp.*	12312	3388	30	–26.3	LMIA(late)	secure
Miletos, Turkey	7:C-TU-MIL-1/RY1060-1070	charcoal	*Quercus sp.*	12313	3352	31	–26.1	LMIA(late)	secure
Miletos, Turkey	2:C-TU-MIL-1/RY1010-1020	charcoal	*Quercus sp.*	12407	3385	34	–25.8	LMIA(late)	secure
Trianda, Rhodes	Trianda 8	charcoal		10641	3498	39	–24.4	LMIA(late)	phased
Trianda, Rhodes	Trianda 13	charred twig	*Quercus sp.*	10643	3367	39	–26.3	LMIA(late)	secure
Trianda, Rhodes	Trianda 13	charred twig	*Quercus sp.*	11884	3344	32	–26.0	LMIA(late) LHI(late)	secure
Tsoungiza, Nemea	Tsoungiza 4	charcoal		11312	3215	38	–24.2	(LMIA(late)) LHI (late)	phased

Appendix I List of all samples and dates (108) used in this study. The six samples shown in grey are not considered further because they are either too early to be relevant, or TPQ for late periods and, therefore, would have no impact on the chronology considered here. *(Continued)*

Site	Submitter's reference	Material	Species	OxA	BP	±	$\delta^{13}C$	Period	Context
Tsoungiza, Nemea	Tsoungiza 5	charcoal		11313	3261	39	–24.1	(LMIA(late)) LHI (late)	phased
Tsoungiza, Nemea	Tsoungiza 6	charcoal	*Allium sp.*	11314	3202	38	–22.7	LMIA(late)	phased
Akrotiri, Thera	M2/76 N003	charred seed	*?Lens. sp.*	11817	3348	31	–22.9	LMIA(V)	secure
Akrotiri, Thera	M7/68A N004	charred seed	*Hordeum sp.*	11818	3367	33	–25.8	LMIA(V)	secure
Akrotiri, Thera	M10/23A N012	charred seed	*Hordeum sp*	11820	3400	31	–25.2	LMIA(V)	secure
Akrotiri, Thera	M31/43 N047	charred seed	*Hordeum sp*	11869	3336	34	–22.8	LMIA(V)	secure
Akrotiri, Thera	M2/76 N003	charred seed	*?Lens. sp.*	12170	3336	28	–22.9	LMIA(V)	secure
Akrotiri, Thera	M7/68A N004	charred seed	*Hordeum sp*	12171	3372	28	–25.7	LMIA(V)	secure
Akrotiri, Thera	M31/43 N047	charred seed	*Hordeum sp*	12172	3321	32	–23.1	LMIA(V)	secure
Akrotiri, Thera	M10/23A N012	charred seed	*Hordeum sp*	12175	3318	28	–24.7	LMIA(V)	secure
Akrotiri, Thera	1	charred seed	*Lathyrus sp.*	1548	3335	60	–26	LMIA(V)	secure
Akrotiri, Thera	1	charred seed	*Lathyrus sp.*	1549	3460	80	–26	LMIA(V)	secure
Akrotiri, Thera	2	charred seed	*Lathyrus sp.*	1550	3395	65	–26	LMIA(V)	secure
Akrotiri, Thera	4	charred seed	*Lathyrus sp.*	1552	3390	65	–26	LMIA(V)	secure
Akrotiri, Thera	8	charred seed	*Lathyrus sp.*	1553	3340	65	–26	LMIA(V)	secure
Akrotiri, Thera	8	charred seed	*Lathyrus sp.*	1554	3280	65	–26	LMIA(V)	secure
Akrotiri, Thera	9	charred seed	*Lathyrus sp.*	1555	3245	65	–26	LMIA(V)	secure
Akrotiri, Thera	11	charred seed	*Hordeum sp.*	1556	3415	70	–26	LMIA(V)	secure
Tsoungiza, Nemea	Tsoungiza 2	charred seed	*Vitis vinifera*	11309	3308	39	–23.4	LHI-II (LMIA/ LMIB)	phased
Tsoungiza, Nemea	Tsoungiza 3	charcoal	*?Quercus sp.*	11310	3503	38	–24.5	LHI-II (LMIA/ LMIB)	phased
Tsoungiza, Nemea	Tsoungiza 3	charcoal	*?Quercus sp.*	11311	3487	38	–22.7	LHI-II (LMIA/ LMIB)	phased

Appendix I List of all samples and dates (108) used in this study. The six samples shown in grey are not considered further because they are either too early to be relevant, or TPQ for late periods and, therefore, would have no impact on the chronology considered here. *(Continued)*

Site	Submitter's reference	Material	Species	OxA	BP	±	$\delta^{13}C$	Period	Context
Chania, Crete	15/TR10, Rm E	charred seed	*Pisum sativum*	2517	3380	80	–25.6	LMIB	secure
Chania, Crete	13/TR17, 1984, Rm C	charred seed	*Vicia faba*	2518	3340	80	–24.9	LMIB	secure
Chania, Crete	14/TR17, 1984 Rm C	charred seed	*Hordeum sp.*	2646	3315	70	–23.9	LMIB	secure
Chania, Crete	16/TR24, 1989, L6, BA1	charred seed		2647	3150	70	–25.1	LMIB	secure
Chania, Crete	13/TR17, 1984, Tm C	charred seed	*Vicia faba*	10321	3208	26	–22.8	LMIB	secure
Chania, Crete	14/TR17, 1984, Rm C	charred seed	*Hordeum sp.*	10321	3268	27	–22.1	LMIB	secure
Chania, Crete	15/TR10, Rm E	charred seed	*Pisum sativum*	10322	3338	26	–23.9	LMIB	secure
Chania, Crete	16/TR24, 1989, L6, BA1	charred seed		10323	3253	25	–23.3	LMIB	secure
Kommos, Crete	TP-KE-29	charcoal		10617	3190	40	–24.2	LMIB	phased
Myrtos-Pyrgos, Crete	17/K5,2,1	charred seed	*Hordeum sp.*	3187	3230	70	–22.2	LMIB	secure
Myrtos-Pyrgos, Crete	18/K5,2,4	charred seed	*Hordeum sp*	3188	3200	70	–26.5	LMIB	secure
Myrtos-Pyrgos, Crete	19/K5/K6,2,1	charred seed	*Vicia ervilia*	3189	3270	70	–26.0	LMIB	secure
Myrtos-Pyrgos, Crete	20/K5/L6,2,2	charred seed	*Vicia ervilia*	3225	3160	80	–23.6	LMIB	secure
Myrtos-Pyrgos, Crete	17/K5,2,1	charred seed	*Hordeum sp.*	10324	3270	26	–22.4	LMIB	secure
Myrtos-Pyrgos, Crete	19/K5/K6,2,1	charred seed	*Vicia ervilia*	10325	3228	26	–23.4	LMIB	secure
Myrtos-Pyrgos, Crete	20/K5/L6,2,2	charred seed	*Vicia ervilia*	10326	3227	25	–22.4	LMIB	secure
Myrtos-Pyrgos, Crete	18/K5,2,4	charred seed	*Hordeum sp.*	10411	3150	40	–26.5	LMIB	secure
Miletos, Turkey	AT 99.787	bone		11955	3233	23	–17.8	LMIB/II	phased
Knossos, Crete	LMII	charred seed	*Hordeum sp.*	2096	3070	70	–23.3	LMII	secure
Knossos, Crete	LMII	charred seed	*Hordeum sp.*	2097	3190	65	–23.6	LMII	secure
Knossos, Crete	LMII	charred seed	*Hordeum sp.*	2098	3220	65	–22.9	LMII	secure
Knossos, Crete	LMII	charred seed	*Hordeum sp.*	11882	3156	33	–22.7	LMII	secure
Knossos, Crete	LMII	charred seed	*Hordeum sp.*	11943	3148	23	–23.0	LMII	secure
Kommos, Crete	TP-KE-28	charcoal		10793	3382	37	–23.7	LMII	phased
Kommos, Crete	43/TP-KC-17	charcoal		10732	3095	45	–22.2	LMII	phased
Kommos, Crete	42/TP-KC-18	charcoal		10762	7440	50	–23.4	LMII	phased
Kommos, Crete	41/TP-KC-19	charcoal		10770	3040	190	–26.9	LMII	phased
Kommos, Crete	45/TP-KC-27	charcoal		10734	3185	45	–24.1	LMIIIA1	phased
Kommos, Crete	44/TP-KC-26	charcoal		10733	2930	45	–24.2	LMIIIA2	phased

Appendix II Bayesian OxCal Model 3 used in this analysis.

```
Plot
{
 D_Sequence "Trianda WM"
 {
  First;
  R_Date "OxA-10730" 3490 45;
  R_Date "OxA-11948" 3526 25; Gap 10;
  R_Date "OxA-10729" 3410 45;
  R_Date "OxA-11946" 3474 24; Gap 10;
  R_Date "OxA-10728" 3455 45;
  R_Date "OxA-11945" 3473 24; Gap 5;
  Event "Felling Trianda WM";
 };
 Page;
 D_Sequence "Miletos WM"
 {
  First;
  R_Date "OxA-12301-2" 3413 22; Gap 10;
  R_Date "OxA-12303, 407" 3430 23; Gap 10;
  R_Date "OxA-12304-5" 3432 22; Gap 10;
  R_Date "OxA-12306-7" 3420 22; Gap 10;
  R_Date "OxA-12308-9" 3379 22; Gap 10;
  R_Date "OxA-12310-11" 3371 23; Gap 10;
  R_Date "OxA-12312-3" 3371 22; Gap 5;
  Event "Felling Miletos WM";
 };
 Page;
 Sequence
 {
  Boundary "Start of sequence";
  Phase "MM/early LMIA (incl long lived)"
  {
   Phase "Miletos MBA bone (phased)"
   {
    R_Date "OxA-11950" 3549 24;
   };
   Phase "Aktotiri early LMIA (secure)"
   {
    R_Date "OxA-11250" 3550 45;
   };
   Phase "Kommos early LMIA (secure)"
   {
    R_Combine "Space 25B, Tr.66B"
    {
     R_Date "OxA-3429" 3350 70;
     R_Date "OxA-11883" 3485 33;
     R_Date "OxA-11944" 3435 25;
    };
    R_Date "OxA-11251" 3505 40;
    R_Date "OxA-11252" 3375 45;
    R_Date "OxA-11253" 3397 38;
   };
   Phase "Kommos early LMIA (phased)"
   {
    R_Date "OxA-10618" 3270 45?
    R_Date "OxA-10619" 3295 45;
    R_Date "OxA-10621" 3359 39;
    R_Date "OxA-10622" 3330 45;
    R_Date "OxA-10731" 3450 45;
   };
   Phase "Trianda early LMIA (phased)"
   {
    R_Date "OxA-10623" 3245 45?
    R_Date "OxA-10642" 3333 39;
   };
   Phase "Trianda early LMIA (secure)"
   {
    Prior "@Felling Trianda WM";
   };
  };
  Page;
  Boundary "Early LMIA to Late LMIA";
  Phase "late LMIA"
  {
   Sequence "Mature LMIA"
   {
    Phase "Mature LMIA"
    {
     TPQ "Miletos late LMIA (secure)"
     {
      Prior "@Felling Miletos WM";
     };
     Phase "Akrotiri LMIA (secure)"
     {
      R_Combine "M4N003"
      {
       R_Date "OxA-10315" 3446 39;
       R_Date "OxA-10316" 3342 38;
       R_Date "OxA-10317" 3440 35;
       R_Date "OxA-10318" 3355 40;
       R_Date "OxA-10319" 3424 38;
      };
      R_Combine "65/N001/I2"
      {
       R_Date "OxA-10314" 3330 27;
       R_Date "OxA-10313" 3353 27;
       R_Date "OxA-10312" 3293 27;
      };
     };
    Phase "Trianda LMIA (secure)"
    {
     R_Date "OxA-10643" 3367 39;
     R_Date "OxA-11884" 3344 32;
    };
   };
```

Appendix II Bayesian OxCal Model 3 used in this analysis *(Continued)*.

```
 R_Combine "Thera VDL (secure)"
 {
  R_Date "OxA-11817" 3348 31;
  R_Date "OxA-11818" 3367 33;
  R_Date "OxA-11820" 3400 31;
  R_Date "OxA-11869" 3336 34;
  R_Date "OxA-12170" 3336 28;
  R_Date "OxA-12171" 3372 28;
  R_Date "OxA-12175" 3318 28;
  R_Date "OxA-12172" 3321 32;
  R_Date "OxA-1552" 3390 65;
  R_Date "OxA-1555" 3245 65;
  R_Date "OxA-1548" 3335 60;
  R_Date "OxA-1549" 3460 80;
  R_Date "OxA-1550" 3395 65;
  R_Date "OxA-1553" 3340 65;
  R_Date "OxA-1554" 3280 65;
  R_Date "OxA-1556" 3415 70;
 };
};
TPQ "Kommos late LMIA (phased)"
{
 R_Date "OxA-10620" 3269 38;
 R_Date "OxA-10769" 3555 60;
 R_Date "OxA-10761" 3440 38;
};
TPQ "LHI Tsoungiza charcoal (phased)"
{
 R_Date "11312" 3215 38?
 R_Date "11313" 3261 39?
 R_Date "11314" 3202 38?
};
TPQ "Trianda late LMIA charcoal (phased)"
{
 R_Date "OxA-10640" 3338 40;
 R_Date "OxA-10641" 3498 39;
};
TPQ "Miletos LMIA bones (phased)"
{
 R_Date "OxA-11952" 3243 22?
 R_Date "OxA-11953" 3279 26;
 R_Date "OxA-11954" 3377 24;
 R_Date "OxA-11951" 3423 23;
 };
};
Boundary "LMIA to LMIB";
Page;
Boundary "Early LMIB to Late LMIB";
Phase "LMIB Destructions Crete"
{
 Phase "Chania LMIB destructions (secure)"
 {
  R_Date "OxA-2517" 3380 80;
  R_Date "OxA-2518" 3340 80;
  R_Date "OxA-2646" 3315 70;
  R_Date "OxA-2647" 3150 70;
  R_Date "OxA-10320" 3208 26;
  R_Date "OxA-10321" 3268 27;
  R_Date "OxA-10322" 3338 26;
  R_Date "OxA-10323" 3253 25;
 };
 Phase "Myrtos-Pyrgos LMIB destructions (secure)"
 {
  R_Date "OxA-3187" 3230 70;
  R_Date "OxA-3188" 3200 70;
  R_Date "OxA-3189" 3270 70;
  R_Date "OxA-3225" 3160 80;
  R_Date "OxA-10324" 3270 26;
  R_Date "OxA-10325" 3228 26;
  R_Date "OxA-10326" 3227 25;
  R_Date "OxA-10411" 3150 40;
 };
 TPQ "LHI-II Tsoungiza (phased)"
 {
  R_Date "OxA-11309" 3308 39;
  R_Date "OxA-11310" 3503 38;
  R_Date "OxA-11311" 3487 38;
 };
 TPQ "Kommos LMIB (phased)"
 {
  R_Date "10617" 3190 40;
 };
};
Page;
Boundary "LMIB/LMII transition";
Phase "LMII"
{
 Phase "Knossos LMII Destruction (secure)"
 {
  R_Date "OxA-2096" 3070 70;
  R_Date "OxA-2097" 3190 65;
  R_Date "OxA-2098" 3220 65;
  R_Date "OxA-11882" 3156 33;
  R_Date "OxA-11943" 3148 23;
 };
 TPQ "Miletos LMI/II bone (phased)"
 {
  R_Date "OxA-11955" 3233 23;
 };
 TPQ "Komos LMII (phased)"
 {
  R_Date "OxA-10793" 3382 37;
  R_Date "OxA-10770" 3040 190;
  R_Date "OxA-10732" 3095 45;
 };
};
Boundary "End of sequence";
};
};
```