Beyond the Santorini eruption:
some notes on dating the Late Minoan IB period on Crete, and implications for Cretan-Egyptian relations in the 15th century BC (and especially LM II)

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Introduction

While much attention over the last couple of decades has been directed towards the impacts of, and absolute date for, the great Minoan eruption of Santorini/Thera, and associated debates, very interesting things have been happening in the archaeological study of the subsequent Late Minoan (LM) IB period. When these archaeological developments are combined with an assessment of the recent direct absolute (radiocarbon) dating evidence from LMIB contexts (available from three sites on Crete), an important new perspective for mid-second millennium BC Aegean-east Mediterranean chronology starts to become available. This finding in turn has implications for other debates and syntheses, and especially for the synchronization of Aegean-Egyptian linkages in the 15th century BC. Importantly, the LM IB radiocarbon case is free from the potential ambiguities that (are argued to) attend the absolute dating of the previous LM IA period and especially the volcanic destruction level at Akrotiri on Thera (*by itself*). Whether these are due to the mid-16th century BC wiggle in the radiocarbon calibration curve – and hence the need for a seriated sequence analysis of multiple radiocarbon sets through the period for satisfactory calendar dating resolution;[1] or, as repeatedly suggested (though not substantiated in any case), from unusual contaminant issues/effects because of volcanic CO_2 or other proposed causes that some suggest may have affected samples from Thera;[2] and so on.

The key advance is that the overall scope of, and internal phasing of, the LM IB period on Crete is now becoming clear, and here I particularly adopt and employ the wonderfully thorough and incisive analysis of Jeremy B. Rutter (forth.) based on his exhaustive work at Kommos, and the wider linkages he proposes across a number of sites on Crete (of course not everything is universally agreed, some sites remain to be studied and included – notably Khania from where one set of radiocarbon data come – but his assessment is set to become more or less standard). No longer can the LM IB period be considered just a (very) short cultural episode (relatively homogenous and perhaps the work of one or two generations) based on just a very select group of finewares from a few destructions,[3] as was standard up until the end of the 1980s. Popham was the most severe final proponent of the short phase: "I would allot only one generation to this stage – 25 years".[4] Instead, the case for a long LM IB period that began to be voiced by several scholars over the last two decades has become clear, and thus replaces the old orthodoxy of one to two generations, or standard temporal allowances in many scholarly chronologies in the second half of the 20th century AD of *c.* 50 years down to Popham's 25 years.[5]

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[1] Manning 1992, 249; Bronk Ramsey *et al.* 2004; Manning *et al.* 2006a, 2009.
[2] See *e.g.* Wiener 2007, 29–39; 2009.
[3] Popham 1967; Page 1970, 1–8; Betancourt 1985, 140–8.
[4] Popham 1990, 27.
[5] *E.g.* Furumark 1941; Hankey & Warren 1974; Cadogan 1978; Warren 1984; 1985; Warren & Hankey 1989; Eriksson 1992.

Site	Context	Sample	Species	Lab ID/No.	^{14}C Age BP	SD	Archaeological Date
Khania	15/TR10,Rm E	charred seed	*Pisum sativum*	OxA-2517	3380	80	LMIB Early to Late?
Khania	13/TR17,1984,Rm C	charred seed	*Vicia faba*	OxA-2518	3340	80	LMIB Early to Late?
Khania	14/TR17,1984,Rm C	charred seed	*Hordeum sp.*	OxA-2646	3315	70	LMIB Late?
Khania	16/TR24,1989,L6,BA1	charred seed		OxA-2647	3315	70	LMIB Late?
Khania	13/TR17,1984,Rm C	charred seed	*Vicia faba*	OxA-10320	3208	26	LMIB Early to Late?
Khania	14/TR17,1984,Rm C	charred seed	*Hordeum sp.*	OxA-10321	3268	27	LMIB Late?
Khania	15/TR10,Rm E	charred seed	*Pisum sativum*	OxA-10322	3338	26	LMIB Early to Late?
Khania	16/TR24,1989,L6,BA1	charred seed		OxA-10323	3253	25	LMIB Late?
Myrtos-Pyrgos	17/K5,2,1	charred seed	*Hordeum sp.*	OxA-3187	3230	70	LMIB Late
Myrtos-Pyrgos	18/K5,2,4	charred seed	*Hordeum sp.*	OxA-3188	3200	70	LMIB Late
Myrtos-Pyrgos	19/K5/K6,2,1	charred seed	*Vicia ervilia*	OxA-3189	3270	70	LMIB Late
Myrtos-Pyrgos	20/K5/L6,2,2	charred seed	*Vicia ervilia*	OxA-3225	3160	80	LMIB Late
Myrtos-Pyrgos	17/K5,2,1	charred seed	*Hordeum sp.*	OxA-10324	3270	26	LMIB Late
Myrtos-Pyrgos	19/K5/K6,2,1	charred seed	*Vicia ervilia*	OxA-10325	3228	26	LMIB Late
Myrtos-Pyrgos	20/K5/L6,2,2	charred seed	*Vicia ervilia*	OxA-10326	3227	25	LMIB Late
Myrtos-Pyrgos	18/K5,2,4	charred seed	*Hordeum sp.*	OxA-10411	3150	40	LMIB Late
Mochlos	B.kiln.2910	olive stone		85991	3240	50	LMIB Final
Mochlos	A.2.212	olive stone		85992	3180	40	LMIB Final
Mochlos	B.kiln.2801	olive stones		115890	3170	60	LMIB Final
Mochlos	B.9.1705	olive stone		129765	3220	40	LMIB Final
Mochlos	A.pit.2315N	olive stone		151768	3270	40	LMIB Final
Knossos	MUM	charred seed	*Hordeum sp.*	OxA-2096	3070	70	LMII Advanced
Knossos	MUM	charred seed	*Hordeum sp.*	OxA-2097	3190	65	LMII Advanced
Knossos	MUM	charred seed	*Hordeum sp.*	OxA-2098	3220	65	LMII Advanced
Knossos	MUM	charred seed	*Hordeum sp.*	OxA-11882	3156	33	LMII Advanced
Knossos	MUM	charred seed	*Hordeum sp.*	OxA-11943	3148	23	LMII Advanced

Table 1. Radiocarbon Dates on (i) short-lived samples from Late Minoan IB contexts at Khania, Mochlos and Myrtos-Pyrgos (after Housley *et al.* 1999; Bronk Ramsey *et al.* 2004; Manning *et al.* 2006a; Soles 2004b); and (ii) radiocarbon dates on short-lived samples from the Advanced LM II destruction at the Minoan Unexplored Mansion at Knossos (after Housley *et al.* 1990, 214-215; Hedges *et al.* 1990, 227; Bronk Ramsey *et al.* 2004; Manning *et al.* 2006a, b). All are AMS dates except sample 115890 from Mochlos listed as radiometric (*i.e.* routine ^{14}C dating); Mochlos samples 85991 and 85992 were run at Oxford after pretreatment at Beta Analytic (Soles 2004b, table 40), the others at Beta Analytic itself or at other unnamed laboratories following pretreatment at Beta Analytic (Soles 2004b, 145). All the other (OxA) samples were pretreated and run at the Oxford Radiocarbon Accelerator Unit. The Oxford samples come from a lab with published pretreatment regime and with published known age test results indicating good accuracy and precision (information relevant to the Khania and Knossos and Myrtos-Pyrgos samples can be found in the Manning *et al.* (2006a) paper – see Supporting Online Material, Manning *et al.* 2006b). We do not have the same level of information for the pretreatment procedures for the Beta dates, nor for the un-named other laboratories/accelerators. We do not have published information on the performance quality of the Beta radiometric dates (re sample 115890).

This change has been a long time coming. Starting with the report on the excavations at Kastri on Kythera,[6] numerous excavators and specialists have noted the multiple phases of LM IB activity and material at sites on Crete or the southern islands within what seem to be substantial or long overall LM IB periods. This could be noted already by the late 1980s,[7] and again and more widely in the late 1990s,[8] and for over a decade early and late phases of LM IB have been recognized at Kommos,[9] but many chose nonetheless to downplay the significance in terms of the temporal duration of the period – LM IB was still inherently thought of as a relatively "short" period.[10] Thus even when confronted by this increasing stratigraphic and ceramic evidence from excavations on Crete pointing to what was most plausibly a longer LM IB period (and recognition of earlier and later stylistic phases within just the later LM IB groupings),[11] and even with the beginnings of evidence and arguments for additional temporal components of LM IB entirely beyond, and temporally extending, the original conception of the period by Popham and others working through to the 1980s,[12] LM IB nonetheless somehow remained a "short" period for many scholars – with even very recent reassessments by several prominent scholars only offering it at most 70 or 80 years duration (of course this is already a substantial change from the previous 25 and/or 50 years).[13]

It is time now to break with the "short" timeframe assumption/orthodoxy in light of the clear evidence for a long LM IB period from a number of sites, and especially Kommos and Mochlos (but also Hagia Triada, Khania, Malia and Pseira, and with more to come).

Furthermore, the overall (long) LM IB period can now be plausibly divided into at least three, and perhaps four, distinct phases:

"Late Minoan IB Early"

"Late Minoan IB Developed" (this tentative phase is unclear at present)

"Late Minoan IB Late"

"Late Minoan IB Final"

following the analysis of Rutter (forth.), which develops the Kommos sequence into a co-ordinated scheme across central-east Crete incorporating (so far) 16 sites. If we accept the general Rutter scheme (which I here do without further discussion of various details and subtleties which undoubtedly will engage ceramic specialists over the next few years), then this "new" LM IB period, and especially its phases, become very important when we assess the radiocarbon evidence.

LM IB and radiocarbon chronology

Three sites on Crete, each from a very distinct area of Crete (west, northeast and southeast) offer sets of modern radiocarbon (AMS) dates on short-lived sample matter from LM IB find contexts: Khania, Mochlos and Myrtos-Pyrgos (see Table 1). Short-lived samples found in secure use or storage contexts should offer ages contemporary with their use give or take a year or so at most, and thus they should offer dates for the specific archaeological context in which they are found. Hence I focus on these data.

Two of these sets of data may be tentatively phased within LM IB following the Rutter scheme: the Myrtos-Pyrgos destruction context likely belongs to (the end of) Late Minoan IB Late; and the Mochlos data from the destruction of the Artisan's Quarter belongs to the (end of) Late Minoan IB Final.[14] In other words: there is a sequence, with the Myrtos-Pyrgos data stratigraphically/cerami-

[6] Coldstream & Huxley 1972.

[7] So Warren & Hankey 1989, 79–80

[8] So Housley *et al.* 1999, 169.

[9] Van de Moortel 1997; Rutter 2006.

[10] *E.g.* Driessen & Macdonald 1997, 23 following Warren & Hankey 1989; but note critique of Warren 2001 re vigorous LM IB period.

[11] Rutter forth. exploiting the work of Müller 1997.

[12] See especially Barnard & Brogan 2003.

[13] *E.g.* Warren 2006; 2007; Wiener 2006a.

There were of course exceptions: those who espoused the Aegean "High" chronology starting with Kemp and Merrillees 1980 and especially Betancourt 1987 and Manning 1988; and some others who were looking either at radiocarbon evidence and/or their own site's long LM IB phases, such as Marketou *et al.* 2001, 25; or Soles 2004b, 148.

[14] Soles 2004b, 147 comments that the "charred olive stones [...] belonged to olives that were probably harvested shortly before the Artisans' Quarter destruction".

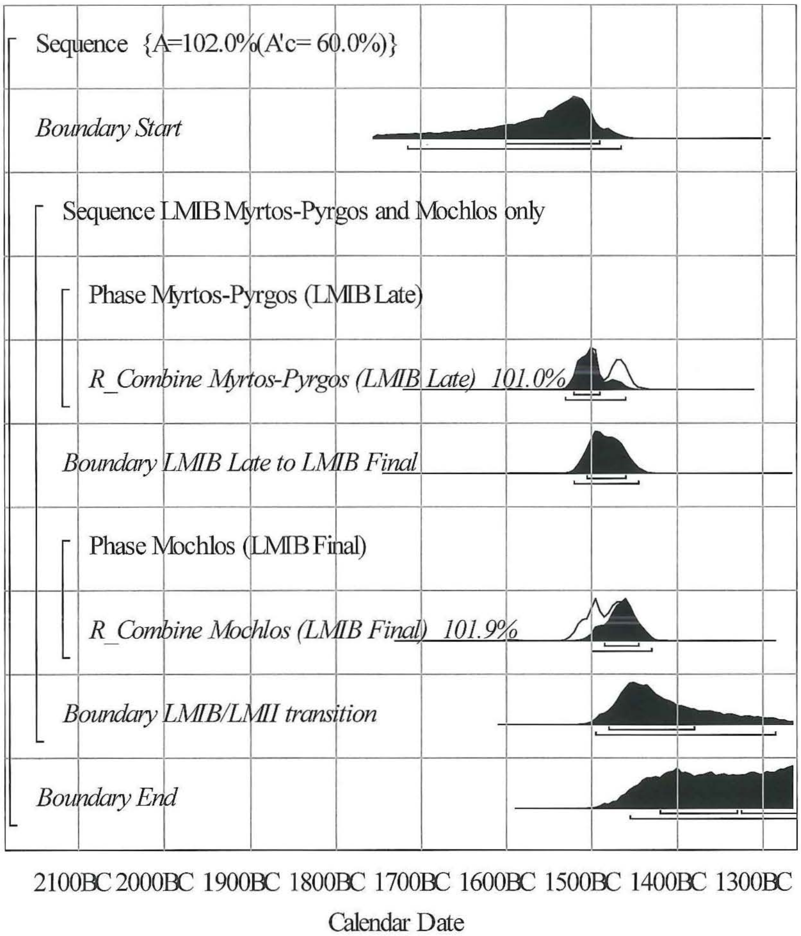
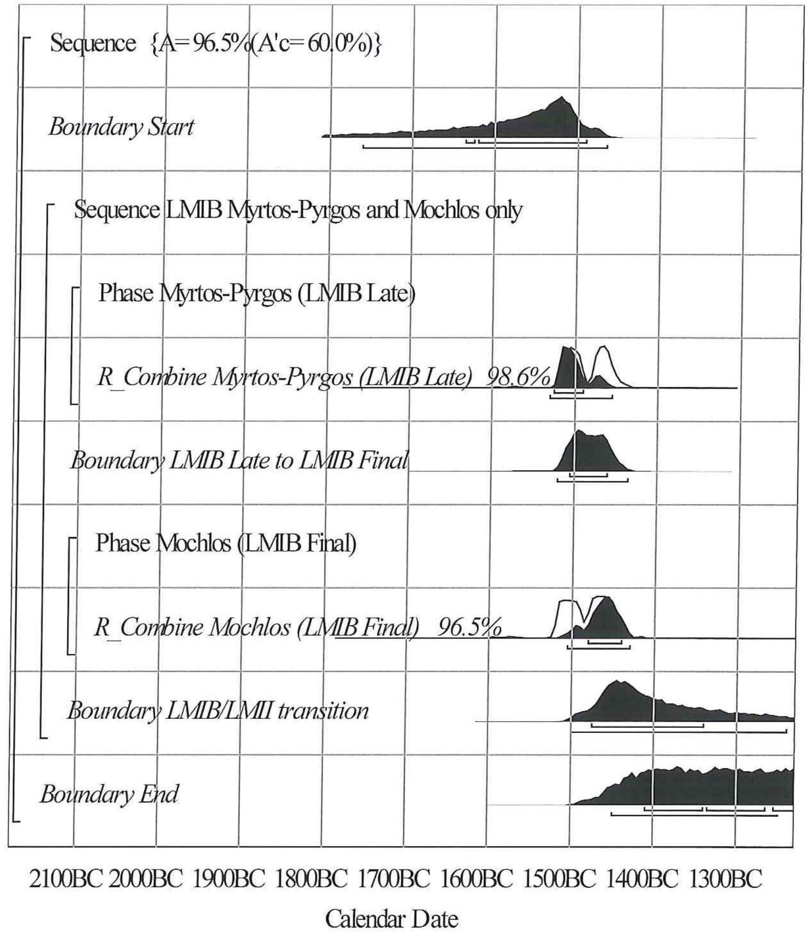


Fig. 1. Myrtos-Pyrgos and Mochlos, LM IB Late and LM IB Final, sequence analysis in isolation. OxCal (Bronk Ramsey 1995; 2001; 2008a) with IntCal04 (Reimer *et al.* 2004). The hollow distributions for each individual date show the calibrated calendar age probabilities in isolation (no model), and the solid distributions show the reduced probability distributions after applying the sequence analysis model shown. The upper and lower lines under each distribution show the respective 1σ (68.2 % confidence) and 2σ (95.4% confidence) calibrated age ranges (for the modeled results): see text for details. The agreement index compares the final (posterior) distribution calculated (the solid histogram) against the original distribution (the calibrated age probability for the individual sample in isolation: the hollow histogram). If the former is unaltered the index value is 100. The value rises above 100 where the final distribution overlaps only with the very highest part of the prior distribution. In contrast, an agreement index below 60 indicates disagreement with the model (and insufficient overlap of the distributions) at about the 5% level of a chi-squared test. The overall agreement index for each sequence is also stated – again a score greater than the stated test statistic indicates that the model surpasses an approximate 95% confidence level. See postscript.

cally *prior* to the Mochlos data. This archaeological sequence information can thus be employed in a Bayesian radiocarbon analysis to gain greater resolution and precision for the dating of the LM IB period. This paper employs the OxCal software[15] and the IntCal04[16] and IntCal98[17] radiocarbon calibration datasets (with curve resolution set at 5 and rounding – to nearest 5 years – "on"). Further, the sets of short-lived data from Myrtos-Pyrgos and Mochlos each seem to represent the same time horizon at their respective sites at 95% confidence (thus same year or year two of growth for the seeds in question): yielding weighted averages of (i)

[15] Bronk Ramsey 1995; 2001; 2008a. Plots and data from version 3.10, current when this paper was first written. See Postscript.
[16] Reimer *et al.* 2004.
[17] Stuiver *et al.* 1998.

Fig. 2. As Fig. 1 but employing IntCal 98 (Stuiver *et al.* 1998).



Myrtos-Pyrgos (n=8) of 3229±13 BP with a χ^2 test statistic of 7.6 < 14.1 the 95% confidence value for 7 degrees of freedom, and (ii) Mochlos (n=5) of 3220±20 BP with a χ^2 test statistic of 3.4 < 9.5 the 95% confidence value for 4 degrees of freedom.[18] This is nicely consistent with the idea that these short-lived samples come from (*i.e.* were harvested and stored/used shortly before) the respective destruction contexts. The weighted average of each set of data thus offers the best estimate for the relevant year(s) of growth for the samples from each destruction level.

Let us begin by considering just these two phased data sets: Figs 1 and 2. We find that the Myrtos-Pyrgos destruction set (that is a Late Minoan IB Late *destruction*) is placed (i) from IntCal04: 1525-1490 BC (1σ, 68.2% confidence) and the Mochlos destruction (that is a Late Minoan IB Final *destruction*) is placed 1485-1445 BC (1σ) (2σ, 95.4% confidence: 1530-1460 BC and 1500-1430 BC respectively); or (ii) from IntCal98: the Myrtos-Pyrgos LMIB Late destruction is placed 1525-1490 BC (1σ) and the Mochlos destruction (that is a Late Minoan IB Final *destruction*) is placed 1480-1440 BC (1σ) (2σ, 95.4% confidence: 1530-1455 BC and 1505-1430 BC respectively).

The whole/majority of Late Minoan IB Late is therefore *before c.*1525-1490 BC (or at 2σ before 1530-1460/55 BC). And all of Late Minoan IB Early lies *before* this. How long is the LM IB Final phase? How long is the LM IB Late phase? How long is LM IB Early? We do not know (and, note to excavators: we urgently need Late Minoan IB Early radiocarbon data). But it seems highly unlikely that these phases are to be measured in terms of less than a few decades each, and one or more could well represent several decades to a half-century of time. Rutter (forth.) suggests at least a couple of decades but probably no longer than 50 years for either of each LM IB Late and LM IB Final, so maybe 50-

[18] Ward & Wilson 1978.

100 years here. And then there is LM IB "Developed", if we include this phase, and LMIB Early – so maybe another half century of time to insert. This all makes "Low" Chronology positions[19] for the start of Late Minoan IB unlikely, and in conflict with the radiocarbon evidence and archaeology (and there are no major wiggles in the radiocarbon calibration curve, or volcanic CO_2 issues at play for LM IB). Indeed, the radiocarbon evidence we have would suggest *c.* 40 years for the interval between the destruction of Late Minoan IB at Myrtos-Pyrgos to the destruction of Late Minoan IB Final at Mochlos. So, if we (arbitrarily) allowed 40 years for each of the three earlier phases, then this would imply a *start* for LM IB *c.*1645-1610 BC. If we allow only 25 years each, or leave out the (less than clear) Late Minoan IB Developed phase, then this might be 1605/00-1570/65 BC, *etc.* The numbers are flexible – but any reasonable estimate will necessarily yield a minimum date well *before* the (most recent, and rising seemingly every year!) Low Chronology start dates of *e.g.* 1480 BC[20] or 1500 BC[21] or 1520/1510 BC.[22] In other words: the data point more or less to a version of the "High" Aegean chronology, with a *long* overall LM IB period.

But we have two additional pieces of evidence to further test and refine our analysis. First the Khania LM IB destruction data, and second some short-lived samples from the LM II destruction at Knossos which can act as a nice *terminus ante quem*, or lower limit, for the date of the overall LM IB period.

The Khania data cannot yet be placed in terms of the Rutter phasings for LM IB, and the individual contexts at Khania are not necessarily all equivalent. The samples come from several contexts at the large overall site and the assemblages have not yet been published and fully analysed. They were submitted as from the final LM IB destruction horizon at the site, and the associated material for some of the samples appears to indicate a LM IB destruction with typical mature LM IB finds (including elements of "Special Palatial Tradition" ceramics in the Marine and Alternating Styles) typical of LM IB Late contexts elsewhere as defined by Rutter.[23] But we can also note, however, that the Khania data do not form a consistent set – some data are older/younger than others. This may reflect some differing real ages of the contexts of the samples. All eight data can be treated as a Phase in OxCal and an Event summarizing the entire group in isolation (no other evidence considered as constraining before or after) offers an overall calibrated calendar range of 1610-1470 BC (1σ) and 1710-1390 BC (2σ) (data from IntCal04): Fig. 3. In general terms, different elements of the Khania set cover the whole 16th century BC. Being arbitrary, we might argue that four Khania dates on two samples (OxA-2646 & 10321, OxA-2647 & 10323) offer a coherent "later" grouping (weighted average 3257±17 BP) and these data lie more towards (but still somewhat earlier than) the LMIB Late range of the Myrtos-Pyrgos set (above), with a calibrated range in isolation of (1σ) 1610-1590 BC (7.8%) and 1540-1490 BC (60.4%), and (2σ) 1610-1490 BC (92.2%) and 1480-1460 BC (3.2%) (IntCal04). This might suggest a placement for some of the set as during Late Minoan IB Late (*i.e.* from contemporary with to a bit older than the Myrtos-Pyrgos destruction assemblage within this overall phase); whereas the older dates perhaps hint at some earlier part of the LM IB Late phase or before this in the LM IB Developed or LM IB Early phases. (Especially OxA-2517 & 10322 on the same sample; whereas OxA-2518 is more questionable as it was not exactly replicated by the repeat on the same sample: OxA-10320. The large error on OxA-2518 nonetheless allows the two dates to be satisfactorily combined, weighted average 3221±25 BP, T=2.5 <3.8 for df1.) Alternatively, if it is maintained that the samples and their different contexts really are all equivalent and all from the same final LMIB destruction at the site (as the excavators believed on submission), then one or more of the radiocarbon data might be considered as a possible outlier for some (unknown) reason. In which case, if we apply

[19] *E.g.* 1480 BC: Warren & Hankey 1989, 169; Bietak & Höflmayer 2007, 17; or 1500 BC: Warren 2006, 901; or 1520/1510 BC: Warren 2007, 498.
[20] Warren & Hankey 1989.
[21] Warren 2006, 901.
[22] Warren 2007, 498.
[23] Housley *et al.* 1999, 160.

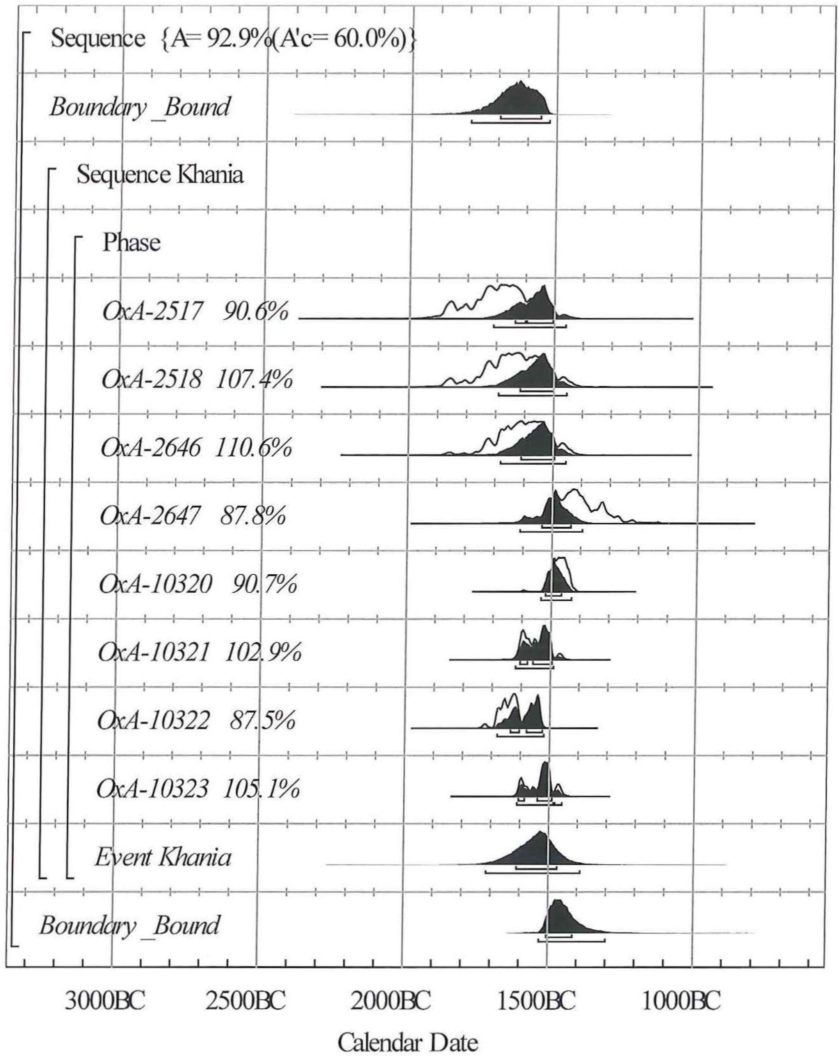


Fig. 3. A Phase (a group of data for which we have no information about their respective relative ages vis à vis each other, but which we can define as a grouping vis à vis other information – in this case the data all come from LM IB destruction contexts at Khania and are assumed to form a time horizon – LM IB – at Khania) analysis of the eight radiocarbon data from LM IB contexts at Khania (employing IntCal04 and OxCal). An Event (see OxCal manual: http://c14.arch.ox.ac.uk/oxcalhelp/hlp_contents.html) describing the Phase comprising the eight radiocarbon dates from Khania LM IB destruction contexts is shown – this attempts to define the data within the phase (inside the boundaries). The date ranges calculated for the Event are cited in the text. The spread reflects the range of older through later ages within the Khania set evident in the eight individual calibrated age ranges shown above. For general description of how to read the plot, see caption to Fig. 1.

a minimum exclusion criterion to yield a set with a weighted average which satisfies a Chi-squared test at the 95% confidence level,[24] then excluding just OxA-10320 allows the other seven dates to yield a weighted average of 3293±14 BP (T=8.2 <12.6 for df6). This would place the Khania set as rather older than the Myrtos-Pyrgos LM IB Late destruction or Mochlos LM IB Final destruction sets.

I consider Sequence analyses below with three options: (i) Khania treated as one overall set and thus as one OxCal Phase (n=8) = Model 1, (ii) Khania treated as the minimum coherent set of seven data with a weighted average of 3293±14 BP = Model 2, and (iii) Khania treated as two groups,

[24] Ward & Wilson 1978.

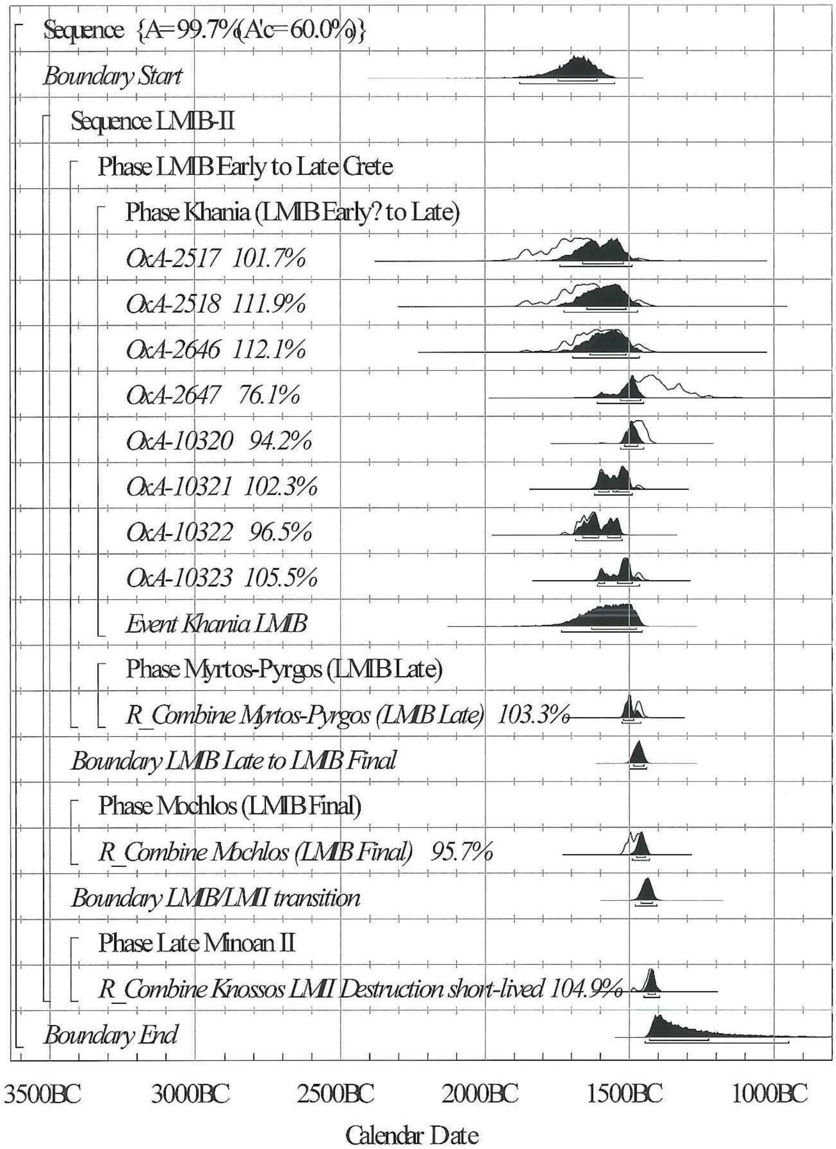


Fig. 4. Model 1 with IntCal04. The Model 1 LM IB to LM II sequence treats the Khania dates simply as a Phase. For general description of how to read the plot, see caption to Fig. 1.

an "Older" group (OxA-2517, 10322), and a "Later" group (OxA-2646, 10321, OxA-2647, 10323) (n=6 and excluding the somewhat divergent ages on the sample determined by OxA-2518 and 10320) = Model 3.

Finally, as an important constraint on the latest possible placement of the LM IB data, we have a set of data on barley samples from the Advanced LM II destruction of the Minoan Unexplored Mansion (MUM) at Knossos (Popham 1984): see Table 1. This context is (by an unknown amount) later than all the LM IB contexts.

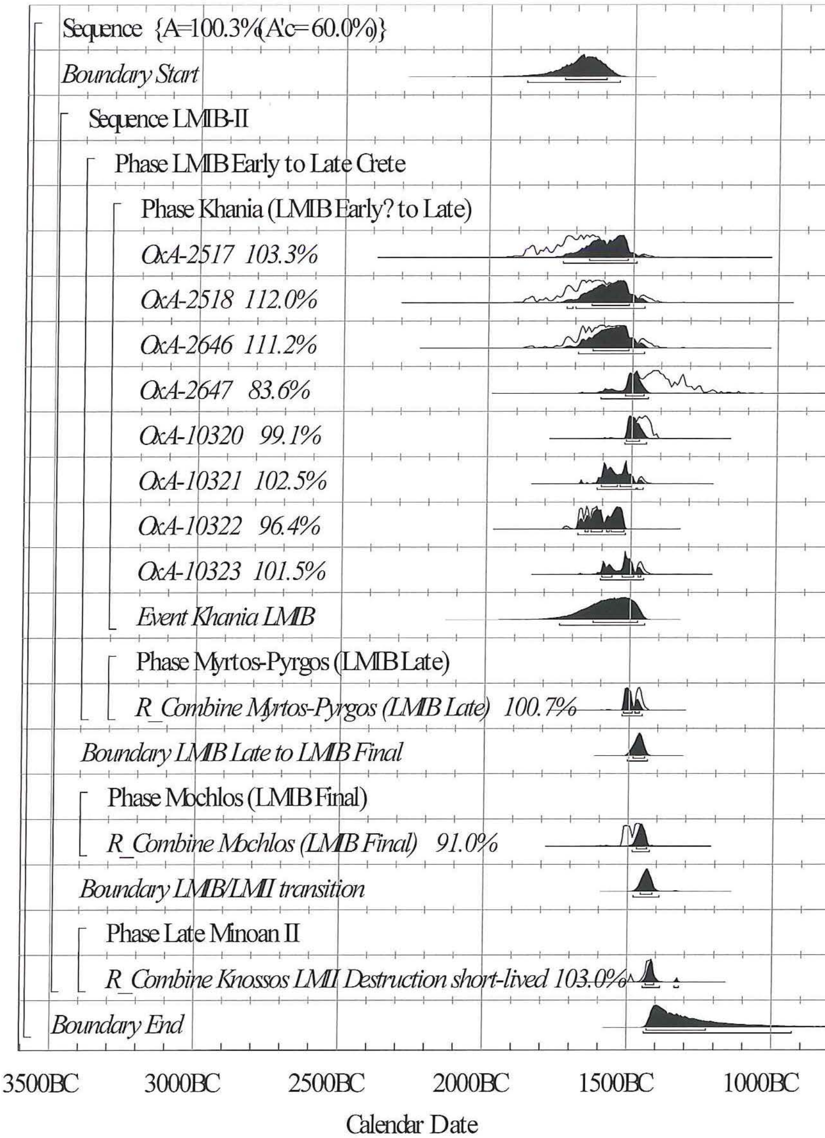
We therefore have a Late Minoan IB to Late Minoan II sequence of:

Khania destruction data (or Khania "Older" > Khania "Later") ≥ Myrtos-Pyrgos destruction data > Mochlos destruction data > Late Minoan II destruction data.

This sequence comprises samples from four different sites from all over Crete. No special circumstances apply (like claims of possible volcanic CO_2 effects, *etc.*, unusual wiggles/plateau in the radiocarbon calibration curve, *etc.*).

We may use this archaeological sequence to inform a Bayesian analysis of the likely calendar calibrated age ranges for the data. Figs 4-9 show the calibrated age range analyses for this overall LM IB-II sequence (given the three options for treating

Fig. 5. As Fig. 4 but using IntCal98.



Khania described above, and considering both the IntCal04 and IntCal98 calibration datasets). The date ranges calculated are shown in Table 2.

We see from Figs 4-9 and Table 2 that the radiocarbon data form a good analysis with the clear archaeological Myrtos-Pyrgos > Mochlos > Knossos sequence consistent with the radiocarbon evidence (good agreement index values). The Khania data are less constrained, but are also compatible, and provide further evidence for some parts of the LM IB period likely lying through much if not all the 16th century BC. (The Khania LM IB "Older" dates offer radiocarbon ages contemporary with those from the LM IA volcanic destruction level at Akrotiri on Thera – but, since we know archaeologically that they must be later, this implies that the mid-16th century BC "wiggle" that creates a degree of ambiguity in the dating of the Santorini/Thera evidence is perhaps the cause of these LM IB dates which seem rather similar in radiocarbon age to those from late in the LM IA period. If so, we might speculate that the Khania "Older" dates lie on the wiggle in the radiocarbon calibration curve *c.* 1575-1535 BC.[25] These data from Khania LMIB destruction contexts, although labeled "Older" here – versus the other Khania dates – do not seem

[25] See previously Manning 1992; Housley *et al.* 1999.

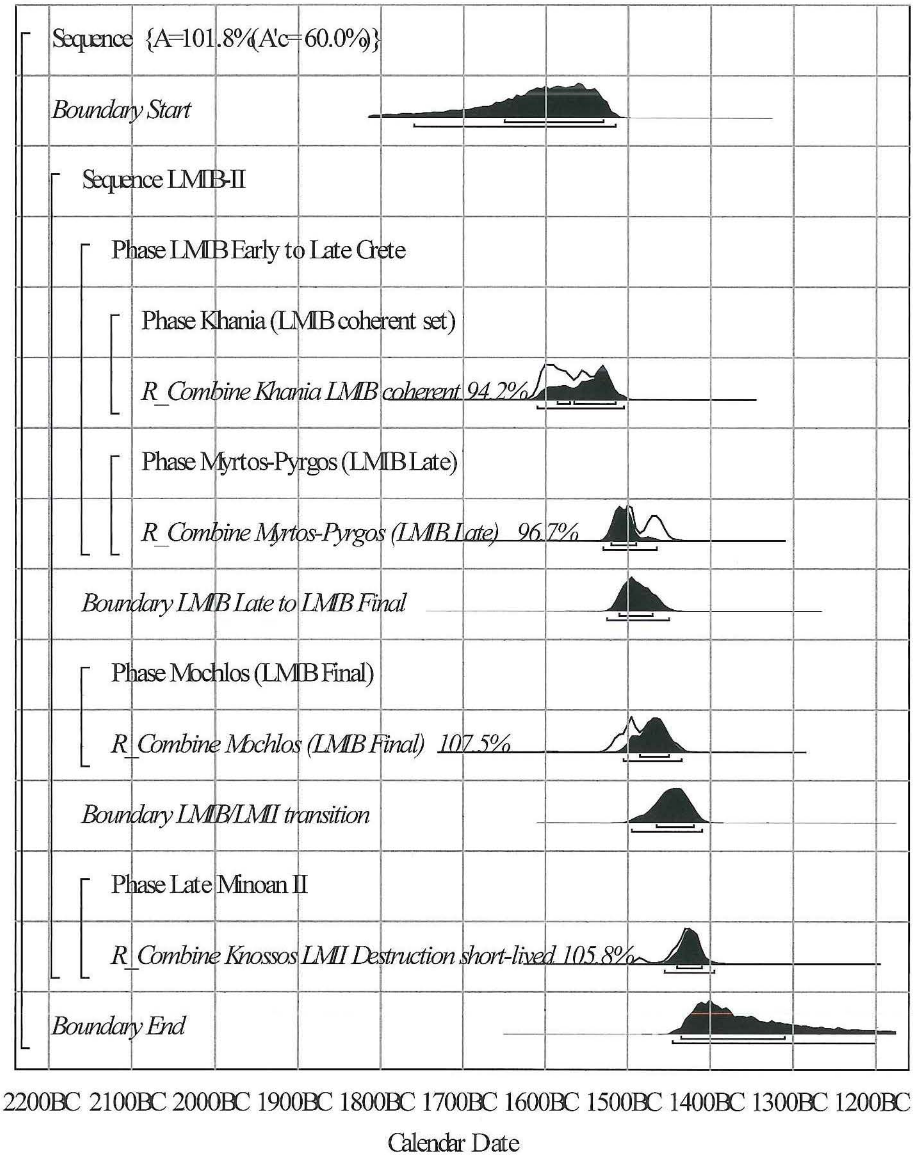


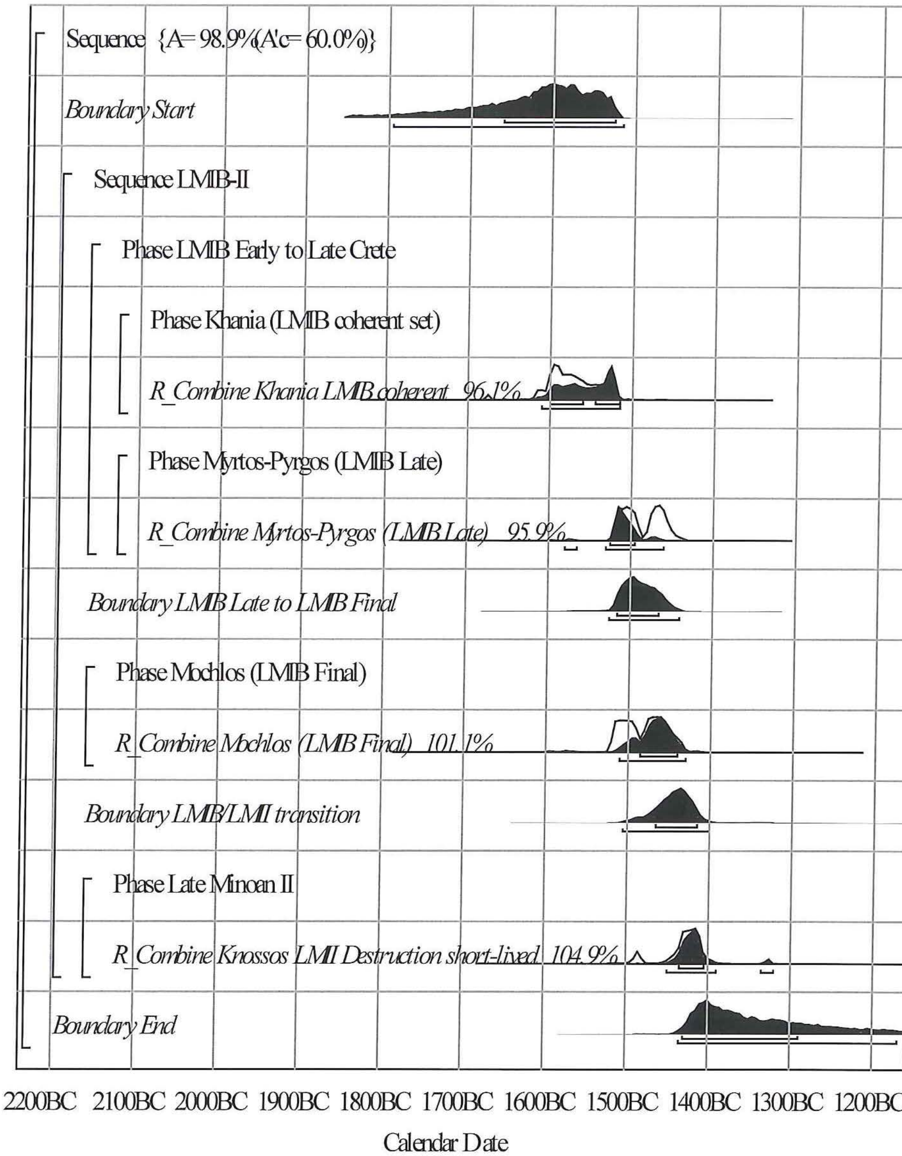
Fig. 6. Model 2 with IntCal04. The Model 2 LM IB to LM II sequence treats the Khania dates as a weighted average from the 7 of the 8 Khania dates which can combine satisfactorily (see text). For general description of how to read the plot, see caption to Fig. 1.

to come from the LM IB Early phase defined by Rutter – they were submitted as final LM IB destruction. We might assume that at least the LM IB Early Phase, and maybe even LM IB Developed, lie *before* the Khania "Older" set – likely in the first half of the 16th century BC.)

The *terminus ante quem* for the LM IB period from the Advanced LM II destruction at the MUM at Knossos is clear and specific taking the most likely 1σ ranges from Table 2: between *c.* 1440/1435 to 1411/05 BC. Moreover, we must also allow for the fact that much (or most) of the LMII period lies *before* the (Advanced LM II) destruction event dated by these samples – making the effective likely *terminus ante quem* for the end of LM IB or the start of LM II older. This implies, even if the LM II period is considered relatively short, an earlier to mid-15th century BC start date for LM II (and the end of LM IB).

The dates of the Mochlos LM IB Final *destruction*, and the Myrtos-Pyrgos LM IB Late *destruction*, contexts are very consistent across all the scenarios in Figs 1-2 and 4-9. Taking the 1σ ranges (or main range therein) as the most likely indicative reality: the very end of LM IB Final (Mochlos) lies between *c.*1500/1485/81/80/75/70 to 1455/49/45/44/40/35 BC. The whole LM IB period (that is each of the Early, "Developed", Late, and Final phases) lies before this. The destruction context of LM IB Late at Myrtos-Pyrgos is various-

Fig. 7. As Fig. 6 but using IntCal98.



ly placed *c.* 1525/21/20/19/15 to 1498/95/90/85 BC. Again, most of LM IB Late (before this close of phase destruction), LM IB "Developed", and LM IB Early lies beforehand.

I note that the above are date *ranges* encompassing the most likely 68.2% of a 100% probability. It is *not* legitimate to glance at them and then to choose to pretend that the last year of the range is a reasonable number to use. Indeed, years more within the range are more likely (depending on the exact shape of the probability distribution: see these – the solid histograms – in Figs 1-2, and 4-9). One must consider the *range*. In the previous two paragraphs I cited the 1σ ranges. These are the most likely 68.2% of the dating probability. But of course there is the other 31.8%. One could therefore be more conservative and cite just the 2σ ranges – the most likely 95.4% of the total probability. These numbers are given in Table 2 or in the text above. Thus the Mochlos LM IB Final *destruction* dates *c.* 1515/10/08/05/04/1500/1490 to 1440/38/35/30/25 BC and the Myrtos-Pyrgos LM IB Late *destruction* dates *c.* 1530/29/27/25 to 1466/65/61/60/55 BC. In each case, these 2σ ranges widen the overall *range* both up and down. They do not change the clear indication to be drawn from these data. Seeking to cite the very end of the 2σ range and ignoring the rest of the range – and especially the most likely 68.2% part – is misleading (just as if one cited just the very top end of any of these ranges).

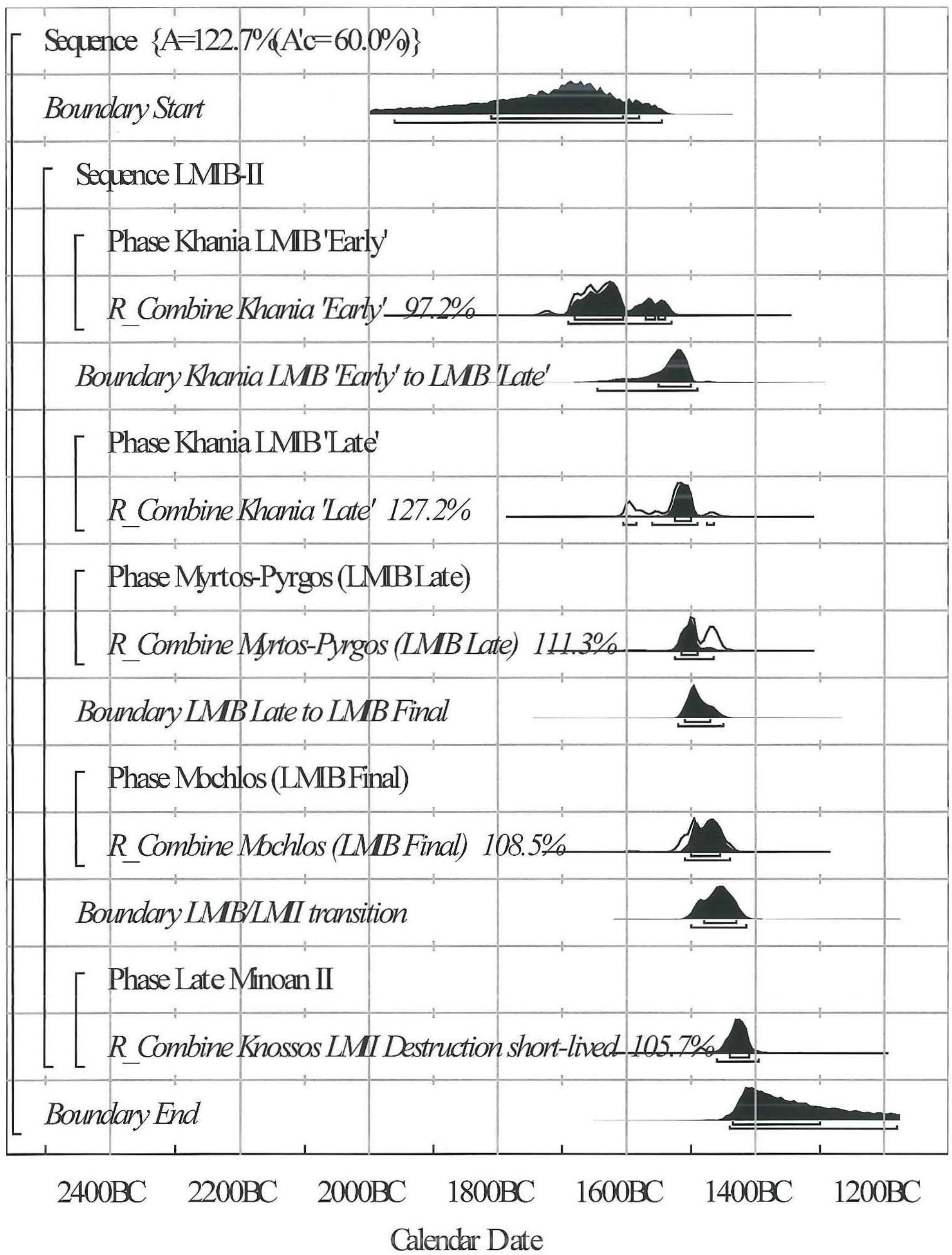
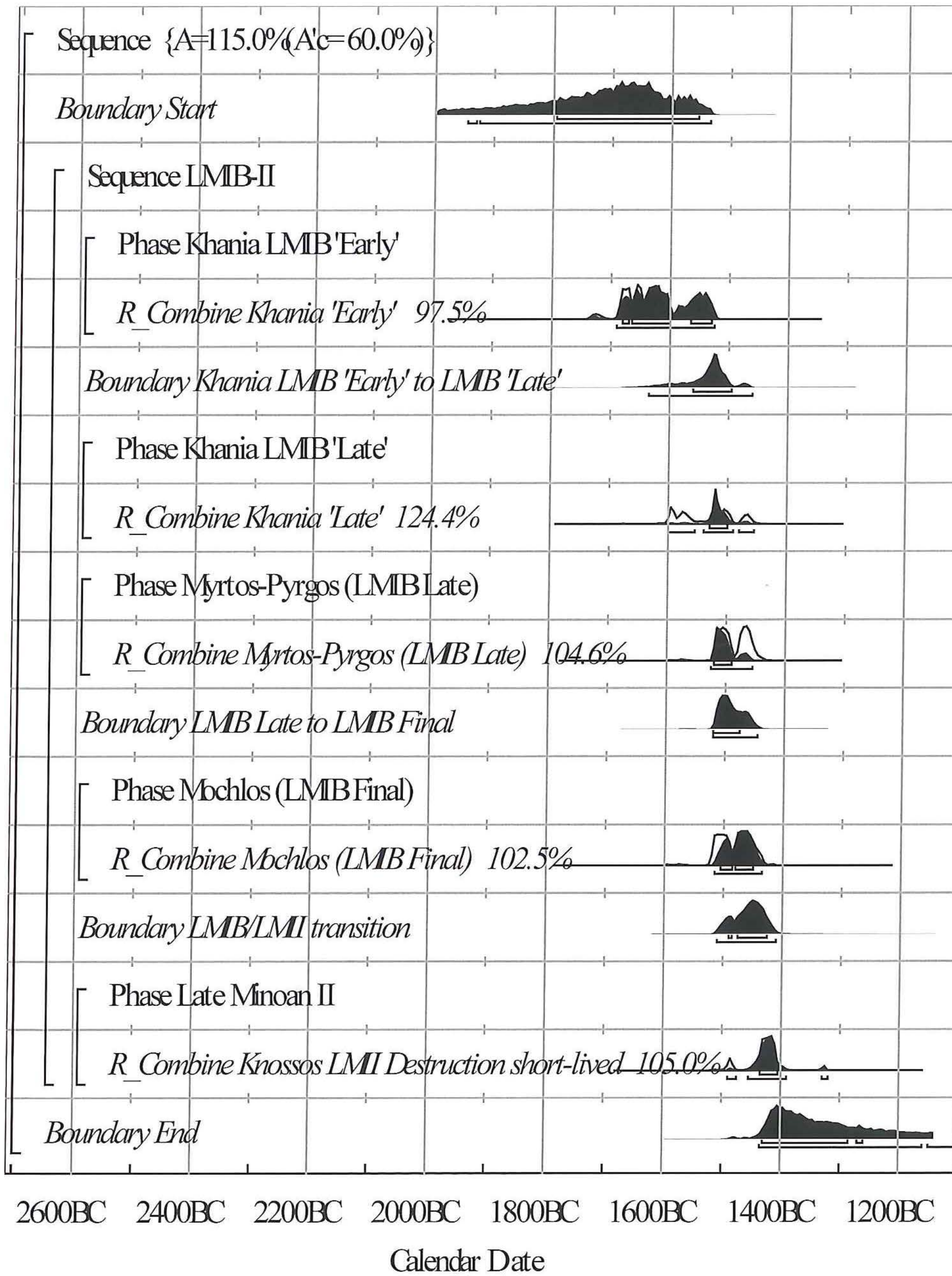


Fig. 8. Model 3 with IntCal04. The Model 3 LM IB-II sequence treats the Khania data as two separate groups, Khania "Older" and Khania "Later" (see text for discussion). For general description of how to read the plot, see caption to Fig. 1.

All the data in Table 2 indicate a very similar message, and there is only a little difference between using IntCal04 or IntCal98. IntCal04 includes additional data and was constructed with a rigorous statistical procedure compared to the *ad hoc* approach employed for IntCal98.[26] The approach in IntCal04 slightly smoothes some of the "ragged" nature of IntCal98 – as a result occasionally it may lose a little sensitivity for tree-ring radiocarbon wiggle-matching exercises. But for general purposes, and for archaeological situations like our LM IB-II case, all the evidence points to IntCal04 being the best most appropriate radiocarbon calibration dataset presently available (there will of course be further revisions to the international radiocarbon calibration curve in the future). From the archaeological perspective, there are Model 1, Model 2 and Model 3 in Table 2. Models 2 or 3 provide narrower dating estimates for the Khania contexts.

[26] See Reimer *et al.* 2004; Buck & Blackwell 2004; Blackwell *et al.* 2006.

Fig. 9. As Fig. 8 but using IntCal98.



Of these, Model 2 offers the wider and somewhat earlier overall range, but its peak probability in the modeled analysis (Fig. 6) lies *c.* 1531/1530 BC, not really that far from the 1525-1500 BC range for the "Late" Khania subset employed in Model 3. On the basis that choosing as *late* a date as possible for the Khania context is appropriate given this involves then no favouritism towards a "High" chronology (and instead deliberately favours a minimum chronology), we might estimate a date of *c.* 1530-1500 BC for at least the later part of the Khania LM IB destruction evidence. This date range, and as indicated by at least the later group of radiocarbon dates, and the ceramics from the LM IB destruction at Khania, is assumed to be relevant roughly to some part of the LM IB Late phase in terms of the Rutter scheme.

Thus, for a best (current, working) rounded approximation of the dates of our contexts, we might cite an amalgamation of the Model 2 and 3 IntCal04 1σ results, thus:

Model 1 – Khania as One overall Phase (Figs 4-5)

Site-context	1σ IntCal04 BC	2σ IntCal04 BC	1σ IntCal98 BC	2σ IntCal98 BC
Khania LM IB destruction	1630-1470	1740-1450	1640-1470	1750-1450
Myrtos-Pyrgos LM IB Late destruction	1520-1485	1525-1460	1520-1490 (60.1%) 1480-1465 (8.1%)	1525-1455
Mochlos LM IB Final destruction	1475-1440	1490-1430	1470-1435	1490-1425
Knossos LM II destruction	1435-1405	1450-1390	1435-1405	1450-1390 (88.7%) 1340-1320 (6.7%)

Model 2 – Khania as weighted average (7 of 8 dates – see text) (Figs 6-7)

Site-context	1σ IntCal04 BC	2σ IntCal04 BC	1σ IntCal98 BC	2σ IntCal98 BC
Khania LM IB destruction	1593-1588 (3.8%) 1583-1575 (6.3%) 1561-1518 (58.1%)	1609-1510	1597-1561 (31.8%) 1542-1518 (36.4%)	1611-1516
Myrtos-Pyrgos LM IB Late destruction	1519-1495	1529-1466	1521-1498	1577-1569 (1.7%) 1527-1461 (93.7%)
Mochlos LM IB Final destruction	1485-1449	1504-1438	1481-1444	1508-1435
Knossos LM II destruction	1437-1411	1452-1399	1434-1406	1449-1390 (92.3%) 1332-1322 (3.1%)

Model 3 – Khania treated as Khania "Early" and Khania "Late" (see text) (Figs 8-9)

Site-context	1σ IntCal04 BC	2σ IntCal04 BC	1σ IntCal98 BC	2σ IntCal98 BC
Khania LM IB "Early"	1680-1600 (59.3%) 1570-1530 (8.9%)	1690-1530	1690-1600 (49.8%) 1570-1530 (18.4%)	1690-1520
Khania LM IB "Late"	1525-1500	1600-1580 (1.5%) 1560-1490 (93.9%)	1530-1495	1600-1550 (8.6%) 1540-1490 (79.5%) 1480-1460 (7.3%)
Myrtos-Pyrgos LM IB Late destruction	1515-1490	1525-1465	1520-1490	1525-1455
Mochlos LM IB Final destruction	1500-1455	1510-1440	1505-1485 (16.9%) 1480-1445 (51.3%)	1515-1435
Knossos LM II destruction	1440-1410	1460-1395	1435-1405	1490-1480 (1.6%) 1460-1390 (92.6%) 1330-1320 (1.2%)

Table 2 (opposite). Calibrated calendar age ranges from Figs 4-9 for the LM IB-II contexts according to the different models (see text) and different use of IntCal04 (Reimer *et al.* 2004) and IntCal98 (Stuiver *et al.* 1998). Radiocarbon calibration employs OxCal (Bronk Ramsey 1995; 2001; 2008a with curve resolution set at 5 and cubic interpolation "on"). Where there are much more likely sub-ranges within the overall quoted ranges, these are underlined. Note: each run of such analyses produces very slightly different outcomes (typically within 0 to a few years). As elsewhere in this paper, OxCal 3.10 is employed, as current when this paper was initially written; some small variations may occur if OxCal 4 is employed instead. See postscript.

Khania LMIB	
"Late" *destruction*	1530-1500 BC
Myrtos-Pyrgos LMIB	
Late *destruction*	1520/15-1495/90 BC
Mochlos LMIB	
Final *destruction*	1500/1485-1455/50 BC
Knossos LMII	
Advanced *destruction*	1440-1410 BC.

Thutmose III comes to the throne as king of Egypt conventionally – in scholarship of the last decade or so – in (or very close to) 1479 BC.[27] Or, in a very recent proposed revision, his accession date might even be reduced to 1468 BC.[28] Using the indicative central 1σ (or main) intervals cited above (in all cases but one – and there only by ignoring the main 60.1% subset), Thutmose III only becomes king *after* the LM IB Late destruction at Myrtos-Pyrgos! Taking even the very ends of the ranges this is by 19+, 16+, 11+ or 6+ years – and taking something like the mid areas of the *ranges* as more indicative, his accession could be 20-odd years later than the Myrtos-Pyrgos destruction (and another 11 years more distant again, so *c.* 30-odd years – if the 1468 BC accession date is accepted). Only the LM IB Final phase really potentially overlaps with the beginning of the reign of Thutmose III (*i.e.* in reality Hatshepsut) – and even this Final LM IB phase may well end more or less as Thutmose III came to the throne (though equally it may offer one to a few decades of overlap).

Advanced LM II ends (MUM destruction) *c.* 1440-1410 BC, and much or all of the LM II period thus occurred *before* this date range. LM II is clearly a major period with much development at Knossos – if not already by later LM IB, with LM II (following the LM IB destructions at other major sites), the Knossos elite was entirely dominant in Crete (and recent research indicates this was a home-grown Knossian elite, and not a new mainland Mycenaean stratum),[29] and, as clearly seen in the mortuary record, this Knossian elite engaged in conspicuous status display including use of overseas symbols and items.[30] Driessen and Langohr note that the palace at Knossos at this time "was ... embellished on a scale surpassing earlier investments".[31] They note the extensive use of gypsum at this time, including for the "Throne Room", and the decoration of the palace façades with fine limestone rosette friezes.[32] And then there is of course the extant major wall-paintings that seem to date to this period (LM II or LM II-IIIA)[33] and not earlier (though some were repeating earlier compositions), notably the Griffin fresco, the Procession Fresco, and bull-leaping scenes[34] including the famous Taureador Fresco[35] and probably the (later LM IB to) LM II scene from West Magazine XIII.[36] The period must have lasted a few decades at least. In turn, a start date for LM II after *c.* 1450 BC seems unlikely, and the period could easily have begun a decade or two earlier. We might suggest somewhere in the 2nd quarter of the 15th century BC as an approximation. This is not too revolutionary: Warren gives 1440/1430 BC for the end of LM IB, and we are thus only raising these dates by one to a few decades.[37] The real "change"

[27] Krauss 2007, 181–2; Kitchen 2007, 169; 1996; Beckerath 1997.
[28] Krauss & Warburton this volume.
[29] Nafplioti 2008.
[30] Preston 1999; 2004a; 2004b.
[31] Driessen & Langohr 2007, 181.
[32] Driessen & Langohr 2007, 181.
[33] Hood 2000; 2005.
[34] Also Driessen & Langohr 2007, 183–4.
[35] Also Macdonald 2005, 223.
[36] Macdonald 2005, 211.
[37] Warren 2007, 495.

is that LM IB is now a very much longer overall period (and this really is potentially *key* to overcoming/resolving the long-running debates between the "High" and "Low" Aegean Chronologies for the mid second millennium BC). In sum, this all means that the reign of Thutmose III (or the majority thereof) likely corresponds with LM II (and *not* LM IB).

Late Minoan IB dates and Egypt

The conclusion that the reign of Thutmose III at most overlaps only with the last part of the very end (last phase of three/four) of Late Minoan IB, and in fact is most likely contemporary primarily with LM II,[38] works well with the archaeological evidence securely tied directly to his reign. The LH IIB (= LM II time period) squat jar from the Tomb of Maket at Kahun[39] from the reign of Thutmose III and not the end of his reign, indicates the prior existence of this Aegean ceramic phase around or before *c.* 1440 BC.[40] This works nicely with the radiocarbon date for the LM II phase. In addition, one can immediately observe that the kilts of the Keftiu (Cretans) from the Menkheperraseneb and Rekhmire tombs from later in the reign of Thutmose III with their LM II-IIIA decorative motifs fit perfectly with this Thutmose III-LM II correlation.[41] These Egyptian representations also compare to the likely LM II wall paintings of the Procession Corridor at Knossos.[42] Dynamic and royal Knossos of LM II (-IIIA early) was a state-level entity of inter-regional significance. LM II-IIIA2 early was the time of Knossos' greatest dominance on both Crete and in the Aegean, and the time of clear significant international links to Egypt[43] – with extraordinary contexts like the Isopata "royal tomb" standing out.[44]

This linkage of Thutmose III with LM II means that some of early Dyn. XVIII to Thutmose III contexts with LM IB vessels or LH IIA vessels must now be reconsidered (if they are not regarded as LM IB Late and especially LM IB Final and from the early part of Thutmose III's reign). Whereas Warren and Hankey[45] choose to interpret these as primarily evidence of a LM IB – Thutmose III link, now we must see some of these as either: (i) contexts which do in fact relate to material from the earlier part of the possible Egyptian date range (so early Dyn. XVIII before Thutmose III – and a scenario more as proposed by Kemp & Merrillees 1980, and various scholars since), or (ii) some of the (relatively few) items must be considered heirlooms of a generation or so. On the other hand, some other finds, like the late LH IIA ring-handled cup from Saqqara,[46] from a context Warren suggests as Thutmose I to Hatshepsut[47] (and others have suggested could be a little earlier also), are perhaps nearer contemporary when deposited.

The LM IB radiocarbon dates also have considerable relevance for the attempts to link the finds and especially the Aegean-style wall paintings at Tell el-Dab^ca with the Aegean, most recently the beautifully produced book of Bietak *et al.*[48] The wall-paintings derive likely from the early part of the reign of Thutmose III (or perhaps some decade earlier – Thutmose I – but Thutmose III makes the best sense as Bietak suggests).[49] The dates found for LM IB (above) indicate that the Egyptian context can overlap at most with the very end of LM IB and in fact is more likely coeval with LM II. Such a very late LM IB and likely Monopalatial (Knossian) LM II association for the Aegean iconography – and *not* attempts to link directly with the prior LM IA and LM IB tradition (and thus contra the line of argument taken by Bietak)[50] – in fact makes much better sense in several ways.

This is a point recognized by Bietak — where

[38] And perhaps even overlaps with the start of LM IIIA1: something Warren 1996, 288; 1998, 326, 328 accepted as possible a decade ago; see Betancourt 1998, 293; Rehak 1996, 36–7.
[39] Warren 2006, 316.
[40] As Warren suggests towards the end of Warren 2006, 316.
[41] Manning 1999, 209–17.
[42] *E.g.* Hood 2000; 2005.
[43] Phillips 2003; Driessen and Langohr 2007, 185–6; Manning 1999, 219–20.
[44] Evans 1906, 136–172.
[45] Warren & Hankey 1989, 138–44; Warren 2006, 310–7; Bietak & Höflmayer 2007, 17.
[46] Warren 2006, 311–3.
[47] Warren 2006, 311.
[48] Bietak *et al.* 2007.
[49] Bietak *et al.* 2007, 39–40.
[50] Bietak in Bietak *et al.* 2007, 67–8.

he comments that the best Knossian parallels are "late" – *i.e.* LM IIB [*sic*] to LM IIIA.[51] But, whereas Bietak wonders if the paintings were perhaps done earlier – *e.g.* LM IA – and still on the walls in LM IIIA, the more plausible and satisfactory reading is to reverse the logic, and to wonder if the short-lived horizon of the Tell el-Dabᶜa paintings instead correlates to when the best Knossian parallels occur and the historical context appears most appropriate: in/from LM II. For example, the putative throne room reconstruction of Tell el-Dabᶜa Palace F[52] – looks like the likely LM II Knossos Throne Room,[53] the inter-locking designs at Tell el-Dabᶜa and in the (contemporary) Senmut tomb[54] link best to those on the kilts in the Knossos Procession fresco of LM II(-IIIA), and of course the wonderful Taureador wall painting at Tell el-Dabᶜa, links best with the famous likely LM II Taureador Fresco from Knossos (the spread of the bull-leaping iconography from Knossos is at earliest *late* LMIB and the comparison seems best with the likely LM II Taureador Fresco), *etc.*[55] All these sorts of indicators provide a case for earlier Thutmose III (onwards) linking with LM II Knossos.

The further arguments adduced by Bietak and colleagues for the linkages in royal imagery between Tell el-Dabᶜa and Knossos[56] again link best to LM II for the specific materialization. Although there were earlier uses of the rosette motif, its implementation in palatial contexts and especially in a "throne room"[57] setting at Knossos (and then mainland palaces) is LM II(-IIIA).[58] Critically, we need to note that LM II Monopalatial Knossos was the new super-site, and state, of Crete and perhaps the whole southern Aegean. This was a special time. As noted above, there is much increased evidence for elite level contacts with Egypt in LM II to LM IIIA – with a vessel with the cartouche of Thutmose III even found at Katsambas Tomb b on Crete near Knossos.[59] It makes sense that this is the time Knossos was a player on the international stage, and that this is when a royal alliance, maybe a marriage occurred (and the associated sharing of royal ideology as Marinatos argues).[60] This in turn might best explain the rash of Aegeanizing elements seen in the reign of Thutmose III.

An obvious question is: what about the more LM I style vessels carried by the Keftiu in the earlier paintings, especially the Senmut scenes? The radiocarbon evidence suggests this context could at the earliest be very late LM IB, and it is likely LM II.[61] There are several potential explanations.[62] First, even if seen as LM IA, the prestige vessels may well have been heirlooms used into late LM IB[63] and indeed the types usually could date through LMIB and usually even into LM II (noting the overall range observed);[64] second, few of the types illustrated are so specific and could well be LM I-II; third, the source of the illustrations in the early tombs might well stem from a LM IB visit/contacts before new "royal" linkages with Thutmose III (post co-regency) in LM II.

The evidence for a long LM IB period from both the stratigraphic record on Crete[65] and from the radiocarbon evidence (above) is of course in contradiction to the Low Chronology interpretation for the later 16th century BC.[66]

A variety of arguments based on archaeological linkages and/or artefact and stylistic similarities

[51] *E.g.* Bietak in Bietak *et al.* 2007, 82.

[52] Bietak *et al.* 2007, fig. 36.

[53] *E.g.* Hood 2000, 204; Macdonald 2005, 116; Driessen & Langohr 2007, 183–4.

[54] Bietak *et al.* 2007, figs 38 and un-numbered figure bottom of p. 43.

[55] For a detailed review of the Bietak *et al.* 2007 volume which also finds that this material is better associated with LMII/IIIA, and at earliest later LMIB – or later Neopalatial – Crete, see Shaw & Younger 2009.

[56] *E.g.*, the shared use of the rosette – see Bietak *et al.* 2007, 50–2, 145–6.

[57] Or sacred situation, see Marinatos in Bietak *et al.* 2007, 145–150.

[58] See summary in Driessen & Langohr 2007, 181.

[59] Warren & Hankey 1989, 137.

[60] Marinatos in Bietak *et al.* 2007, 149–50.

[61] Indeed – this question somewhat affects even the latest "Low" Chronology position: since Warren 2007 starts LM IB 1520/1510 BC and ends it 1440/1430 BC, there is only an overlap of the last half of LM IB with Thutmose III.

[62] See also Manning 1999, 209–20.

[63] See Driessen & Macdonald 1997, 62–70.

[64] *E.g.* Matthäus 1995, 182, 184 and and see this also in light of the discussion of Manning 1999, 216–7.

[65] Rutter forth. and the large body of work he summarizes.

[66] *E.g.* Warren & Hankey 1989; Warren 2006; 2007; Wiener 2003a; 2006a; 2007; 2009; Bietak 2003b; Bietak & Höflmayer 2007; *etc.*

have been vigorously proposed over the last decades claiming to support or require the Low position. Few of these are really solid cases, and I suggest that the radiocarbon evidence (above) should take priority for LM IB: it is direct evidence on short-lived samples, it is independent evidence free from the assumptions and the other step-wise logic transfers inherent in archaeological-artefact-style-exchange syntheses, and there is no obvious reason that the LM IB radiocarbon data cannot be taken at face-value (*i.e.* no ambiguities in the calibration curve, no issues of possible effects from volcanic CO_2, *etc.*, *etc.* as sometimes argued – but not demonstrated – as relevant to the radiocarbon evidence from Santorini/Thera). It is beyond the scope of this present paper to devote an exhaustive critique (and there is a sense of *déjà vu*),[67] and, more fundamentally, it is unnecessary, as the good, strong, clear LM IB dating case (above), and the good LM II–Thutmose III archaeological association, means that one must now instead question the contradictory hypotheses built on assumptions and prior convictions. To address just a few examples:

i The finds of Santorini/Theran Minoan eruption pumice in contexts dated specifically to the Thutmoside period in Egypt and the time of Thutmose III at Tell el-Dab^c^a[68] occurs in LM IB Late and LM IB Final and LM II in Aegean terms (long, long after the eruption – even for recent assessments of the Low Aegean Chronology[69] these finds are many decades after the eruption). They are thus utterly irrelevant to the discussion of the date of the Minoan eruption of Santorini. (The finds could relate either to use of pumice recovered from the shores of the east Mediterranean in later decades and centuries, or to a possible trade in LM IB-III times of Santorini pumice from the Aegean to the east Mediterranean for craft purposes.)

ii Warren[70] argues that a stone vase from Mycenae Shaft Grave IV is Egyptian and specifically of Dyn. XVIII date (and the main comparison is to the time of Thutmose III).[71] Warren also notes a vessel from Akrotiri.[72] Hence the argument is that LH I/LM IA must overlap into Dyn. XVIII (and so continue after *c.* 1540 BC), and, given the specified Thutmose III parallel, perhaps even later. If the Egyptian types can really only be dated from Dyn. XVIII then I admit this would be a problem or contradiction between different types of evidence.[73] However, although not a student of Egyptian stone vases like Warren, I find it difficult to regard the case for an exclusively Dyn. XVIII dating as demonstrated. A central problem is circularity; because we have a good number of Dyn. XVIII assemblages, and especially ones linked to Thutmose III, these provide the available parallels, whereas we know much less for earlier Dyn. XVIII and very especially for the SIP. No demonstration against an SIP date is really possible. If the radiocarbon evidence prevails, then one should be considering manufacture also perhaps in the Delta region through southern Levant in the SIP.

iii Bietak and Höflmayer[74] state that the Canaanite jars found at Akrotiri on Thera are LB I (and hence LM IA does not end until after LB I begins), but they could very well be (and others would say are more likely to be) late MB, as others have suggested.[75]

iv Bietak and Höflmayer[76] state that Manning suggests a northern Cypriot origin for the Theran White Slip I bowl "without a detailed typological treatment and material analysis" – but there are published discussions of parallels.[77]

And so on.

If scholars choose simply to reject, or to try to undermine to worthlessness, the radiocarbon evidence, then the counter-case has immediate merit.

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[67] Most recently Manning 2007, with literature.
[68] Bietak & Höflmayer 2007, 17 and refs., fig.2.
[69] Such as Warren 2007.
[70] Warren 2006, 305–10; 2007, 498; also Bietak & Höflmayer 2007, 17.
[71] Warren 2006, 308.
[72] Warren 2006, 310.
[73] Warren 2006, 205–310 argues that the vessels are Egyptian, but others might differ or wonder at Nile Delta – that is Hyksos/Second Intermediate Period (SIP) manufacture – or southern Levant manufacture in the SIP.
[74] Bietak & Höflmayer 2007, 17.
[75] *E.g.*, Manning 1999, 113–4 n. 510 and literature cited.
[76] Bietak & Höflmayer 2007, 17.
[77] See *e.g.*, Manning *et al.* 2006c, 482–5 (also Manning 2007, 118–9) which details such a case.

But, if the archaeological case for a long multi-phase LM IB period is accepted, and/or if the radiocarbon evidence – notably coherent – for LM IB is accepted, then one must re-think past convention/orthodoxy. In support, there is a good case for a compatible Thutmose III linkage primarily with LM II, and for upgrading the importance/perception of (especially Knossian) LM II into the appropriate time-period for the most obvious royal and aristocratic Egyptian-Cretan linkages we know about (those of the reign of Thutmose III). And, as I have deliberately avoided mentioning to this point, there is of course a large body of LM IA radiocarbon evidence from several sites in the Aegean which offers an entirely compatible and coherent analysis also requiring a re-thinking of the Low Chronology.[78]

Conclusion

The evidence for a long multi-phase LM IB period on Crete (Rutter forth.), and the evidence of the LM IB radiocarbon dates (above), clearly undermine the Low Aegean Chronology. A start for the period no later than the early to mid 16th century BC seems necessary (ignoring any other evidence). A start at the end of the 17th century/start 16th century BC would seem entirely reasonable from the evidence summarized in Table 2 (remembering the dates there are for LM IB Late and LM IB Final *destructions* and therefore that much or all of the overall LM IB period lies *before* these date ranges). The need to re-think the LM II period appears entirely in accord with – and indeed more compatible with – the archaeological evidence linking the reign of Thutmose III to LM II (to LM IIIA). The Late Minoan IB radiocarbon data are entirely compatible with, and in support of, the large body of Late Minoan IA radiocarbon evidence which places the late LM IA period in the later 17th century BC to around 1600 BC.[79] Together, the Aegean radiocarbon evidence from good contexts and high-quality samples (either short-lived samples, or tree-ring samples which can be wiggle-matched) offers a coherent absolute chronology for the period *c.* 1700–1400 BC.[80]

We might think along the approximate (rounded) lines of:

LM IA	*c.* 1700 to 1600 BC
LM IB	*c.* 1600 to 1470/60 BC
LM II	*c.* 1470/60 to 1420 BC

Acknowledgements

I thank Jeremy Rutter for information and comments, the editor David Warburton, and Erik Hallager.

[78] Manning *et al.* 2006a; 2009; Friedrich *et al.* 2006; 2009; and papers in this volume with W. Friedrich as an author.
[79] Manning *et al.* 2006a; 2009; Friedrich *et al.* 2006; 2009; and papers in this volume with W. Friedrich as an author.
[80] Manning *et al.* 2006a; and with LM IB-II as further elucidated in the present paper. Note: there is some definitional variation over whether what was termed LM IA early at Kommos should instead be referred to as MM IIIB (Girella 2007). If so, this "new" MM IIIB might run down to around 1685-1680 BC give or take (see Manning & Bronk Ramsey this volume).

Postscript

Each run of an OxCal Sequence analysis produces slightly different outcomes. Data in the paper represent average or typical values from several runs from OxCal 3.10. The main likely ranges remain fairly stable across different runs, but the break-points where there are possible sub-ranges, especially, can vary, and also when compared to the outputs from the subsequent OxCal 4, where some minor differences in the revised software also affect exact outcomes. For example, considering and comparing Fig. 1 above, if OxCal 4.11 is employed (with IntCal04) now as proofs returned (AD 2009), the Myrtos-Pyrgos date range (rounded to 5 years) is more typically 1520-1490 BC (56.3%) and 1480-1465 BC (11.9%) at 1σ and 1520/1525-1460 BC at 2σ (whereas the text above reports respectively 1525-1490 BC and 1530-1460 BC); and the Mochlos date range is more typically 1500-1450 BC at 1σ (but sometimes 1500-1490 at 18.4% and 1485-1450 at 49.8%) and 1510-1440 BC at 2σ (whereas the text above reports respectively 1485-1445 BC and 1500-1430 BC). The overall 2σ ranges are very similar; and the most likely part of the 1σ ranges are very similar, give or take about 5 years, but there is some difference in how the finding (or not) of sub-ranges and (related) occurs in OxCal 4, linked to the better delineation of the surrounding boundaries. To also give one example from Table 2, if we consider and compare Model 2 employing OxCal 4.11 with IntCal04: Khania coherent set 1559-1512 BC at 1σ and 1601-1502 at 2σ (versus Table 2 above: 1592-1588 BC, 3.8%, 1583-1575 BC, 6.3%, and 1561-1518 BC, 58.1% at 1σ and 1609-1510 BC at 2σ); Myrtos-Pyrgos 1518-1494 BC at 1σ and 1527-1467 BC at 2σ (versus Table 2 above: 1519-1495 BC at 1σ and 1529-1466 at 2σ); Mochlos 1498-1491 BC, 11% and 1481-1453 BC, 57.2% at 1σ and 1506-1441 BC at 2σ (versus Table 2 above: 1485-1449 at 1σ and 1504-1438 BC at 2σ); and Knossos 1445-1415 BC at 1σ and 1494-1476 BC, 8.1% and 1461-1404 BC, 87.3% at 2σ (versus Table 2 above: 1437-1411 BC at 1σ and 1452-1399 BC at 2σ). Again there are some slight variations, but the overall 2σ ranges, and the 1σ or most likely 1σ sub-ranges, are very similar, typically within about 0-10 years. The approximate age ranges and estimates offered in the text above can therefore be regarded as sound, but with allowance for the sort of small possible variations just illustrated.