RADIOCARBON DATING AND CALIBRATION AND THE ABSOLUTE CHRONOLOGY OF LATE NEOLITHIC AND EARLY MINOAN CRETE

by Peter Warren

I Early Minoan Absolute Chronology

In the determination of Aegean and thus, to some extent, south-east European chronology Minoan Crete has always played a crucial part. This has been so because, through Egyptian and Near Eastern links, Minoan chronology is fairly secure from the beginning of Middle Minoan around 2000 B.C.

But the dating of the period before 2000 B.C., the Early Minoan or pre-palatial period, has been subject to much discussion. The writer, among others 1, has argued for a long chronology, based chiefly on two independent classes of evidence, the many links between Early Minoan I pottery and that of the Troy I and immediately preceding north-west Anatolian cultures 2 and imported and imitated Egyptian stone vases in EM contexts 1.

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A date of c. 2800 B.C. for the beginning of Troy I would be accepted by most archaeologists today on the basis of south-east European, radiocarbon-dated ceramic links and imported Early Helladic II or contemporary Early Cycladic painted fragments in middle and late Troy I contexts. EH II will have begun around or somewhat before the middle of the third millennium on the evidence of the calibrated EH II dates from Eutresis and Lerna. Accordingly, with Troy I beginning around 2800 B.C. and some EM I links being with pre-Troy I material, the beginning of full EM I (ceramically pattern-burnished and the earliest red-on-buff and white-on-red painted wares) may be set around 3000 B.C.

The second line of evidence, imported and imitated Egyptian stone vases, gives some confirmation of the length of the EM period. A pyxis of Chephren diorite (therefore probably VIth Dynasty or earlier) from the large circular tomb at A. Triadha, which was in use from EM II-MM I B/II, and a fragment of an early Dynastic or Old Kingdom diorite bowl from EM II houses at Knossos demonstrate by their contexts links between Crete and Egypt during the island's Early Bronze Age. Next there is the evidence of


8. Warren, MSV 106, 110 no. C 1. It is possible that the thirty-one other Predynastic-VIth Dynasty stone vases from Crete (op. cit. 108-12) arrived at the time of their floruit in Egypt, i.e. throughout EM, rather than later when the types had long passed out of use.

9. On certain Egyptian stone vases from Crete two important negative points must be noted. The famous I11rd Dynasty syenite bowl found in the South Propylaeum at Knossos (Evans, PM I 65 & fig. 28. Warren, Kr. Kohon. IO' (1965) 36. MSV 109 no. A 7) has been used as evidence for the approximate contemporaneity of the IIIrd Dynasty with the subneolithic of Crete (F. Matz, Zur ägäischen Chronologie der frühen Bronzezeit, Historia 1 (1950) 192-4. Cf. F. Schachermeyr, Die orientalisch-mittelmeeri-
two Egyptian miniature stone vase forms popular in the VIth Dynasty (c. 2347-2182 B.C.), through the VIIth and VIIIth Dynasties (2182-c. 2160 B.C.) and First Intermediate Period to the end of the Xth Dynasty (c. 2160-1991 B.C.) \(^{10}\) and early Middle Kingdom. These two forms are imitated contemporaneously in Crete during later EM II to MM I \(^{11}\). Hence later EM II, EM III and MM I A must run roughly parallel with the VIth Dynasty through the First Intermediate Period into the early Middle Kingdom. Since the VIth Dynasty ended c. 2182 B.C. and the F.I.P. began c. 2160 B.C. EM III may have begun about this time. Approximately 2170 B.C. is a reasonable date for the transition from EM II to EM III.

A new piece of evidence has recently been published by V.E.G. Kenna which seems to give another fix to the chronology at a slightly earlier point. A silver cylinder from Mochlos Tomb I, where the pottery and other datable

schen Grundlagen der vorgeschichtlichen Chronologie, *Prähistorische Zeitschrift* 34-35 (1949-50) 24-6, for the similar argument, that no Egyptian stone vessels in Crete are earlier than the IIIrd Dynasty, which may be roughly synchronized with the subneolithic of Crete. This argument rests on Reisner's analysis of the stone vessels (*Antiquity* 5 (1931) 200-12). But there are now three times as many stone vases as were available to Reisner, and the earliest are certainly predynastic. See *MSV* 106-12. Recently the IIIrd Dynasty bowl has been used again, with untypical obtuseness, by V. Mijočić, Die absolute Chronologie der Jungsteinzeit in Südosteuropa und die Ergebnisse der Radiocarbon — (C 14) — Methode, *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 14 (1967) 16-7). From this starting point the entire EM and subsequent Aegean absolute chronology has been constructed (cf. Mijočić, *ibid.*). It must therefore be stated emphatically and, I hope, finally (see Warren, *Kr. Khron.* 19 (1965) 36. *MSV* 109 no. A 7. The Early Bronze Age Chronology, *supra* n. 2, 609) that this piece had no stratigraphical context whatever (cf. J.D.S. Pendlebury, *The Archaeology of Crete* (1939) 54), nor was any claimed for it by Evans. The bowl was found "on the borders of the Neolithic and Subneolithic clay deposit" (*Evans, PM* I 65), not in the deposit. If one were to guess at its original context it was probably part of the rich deposit of complete stone vessels from the Central Shrine deposit near the South Propylaeum, forming part of the Palace final destruction material (*Evans, PM* II 820 sqq.).

Secondly there are the three fragments of stone vessels from the latest Neolithic houses just below the Central court at Knossos (*Evans, PM* II 15-17 & figs. 6, 7a, 7c. Warren, *MSV* 105-6, 108-12 nos. A 5, A 10, G 6. For the houses see now J.D. Evans, Neolithic Knossos; the Growth of a Settlement, *PPS* 37 Part II (Contributions to Prehistory Offered to Grahame Clark) (1971) 110-3 & pl. VII). They are highly problematical and I think one must finally (in *MSV ibid.* I had inclined towards accepting them as Egyptian) conclude that they are valueless as chronological evidence. Two cannot now be found and studied, the material of the third is not certainly Egyptian and the context of the two from the upper house is far from pure final Neolithic (or earliest EM) (see *MSV* 109 n. 1).

\(^{10}\) W.C. Hayes, Chronology. Egypt - To End of Twentieth Dynasty, *CAH* I\(^3\) Part I (1970) 174, 179.

objects are EM II, is considered by him Akkadian and dated c. 2300 B.C. by the evidence of the Akkadian period. 2300 B.C. for a point in EM II fits well with the chronology presented above and later (p. 212-214) from the radiocarbon evidence.

Finally there are the imported XIth-XIIth Dynasty scarabs, whose earliest clear contexts are MM I A, showing that MM I A has begun by 2000 B.C. Definite Minoan features among the silver cups of the Tòd treasure confirm the sequence since the cups themselves, if they are Minoan, or the imitated features, elaborate arcades and grooves, cannot be earlier than MMIB. This indicates a beginning for MM I B or MM II A before 1903 or 1895 B.C. (death of Amenemhat II, with whom the treasure was buried).

Other evidence for the length of the Early Minoan period comes from the stratigraphical sequence and that of homogeneous deposits each distinct from one another and present on the same site, particularly at Knossos.

II The Early Minoan Sequence: a Summary

The sequence of EM I, II and III set out by Sir Arthur Evans and followed by Pendlebury has been confirmed and amplified by excavations in the last twenty years. The Kyparissi cave west of Kanli Kastelli contained EM I burials, lasting into early EM II. St. Alexiou’s Tomb II at Lebena produced a thick burial deposit with many EM I vases on the floor, merging to EM II and MM I above. Tomb II A was built against Tomb II.

12 V.E.G. Kenna, Ancient Crete and the Use of the Cylinder Seal, AJA 72 (1968) 322-4 & pl. 105 figs. 1-2. The cylinder does not necessarily date the close of EM II, as Kenna suggests (ibid. 324), but a point anywhere in the period.


14 For references see Warren, MSV 185 n. 1. Amenemhat III there should read Amenemhat II. With the EM III-MM I chronology proposed in the present article cf. M.S.F. Hood, The Relative Chronology of the Aegean in the Early and Middle Bronze Ages, Actes du VIIe Congrès International des Sciences Préhistoriques et Protobistoriques, Prague, 21-27 août 1966 I (1970) 605-6, who comes to a very similar dating, arguing back from MM I ceramic connexions.

15 Evans, PM I 56-126.

16 Pendlebury, The Archaeology of Crete (1939) 46-93.

17 St. Alexiou, Protominoikoi taphoi para to Kanli Kastelli Herakleiou, Kr. Kbron. Ε’ (1951) 275-94.

It contained an EM II level on the floor, a sand level above and an MM I stratum on top. M.S.F. Hood's excavations at Knossos in 1957-61 produced a well below the north-east part of the Palace with a large EM I deposit containing much pattern-burnished and painted ware, while stratified deposits of EM II, III and MM I A were recovered alongside the Royal Road northwest of the Palace. More recently J.D. Evans has obtained further stratigraphical evidence from the West Court of the Palace, an EM II A house with a floor deposit stratified over a Late Neolithic-EM II pit (mainly EM I), with Late Neolithic levels below the pit. In 1972-3 the writer excavated an EM II A building on the south side of the Royal Road.

In western Crete the cave of Platyvola, though unstratified, contained classic pottery of EM I, II and III dates in central Cretan terms. In 1971 the writer excavated, jointly with J. Tzedakis, an Early Minoan I-II open settlement with two stratified phases at Debla, a summit of one of the foothills of the White Mountains of western Crete, south-west of Khania. In the east of the island useful deposits of EM III and MM I A were found by L.H. Sackett and M.R. Popham at Palaikastro in 1963. Lastly the settlement at Myrtos on the south coast west of Hierapetra, excavated in 1967-8, is datable to EM II, phases A and B, and was destroyed at the end of that period. In summary there seems no doubt that Evans' traditional phases are correct in substance, though needing modification in details. Therefore the virtual abolition of the Early Bronze Age by D. Levi seems unjustified.

24 L.H. Sackett and M.R. Popham, Excavations at Palaikastro VI, *BSA* 60 (1965) 250-1, 269, 272, 277-8 & pl. 72 b-d.
Phaistos in fact has material of all EM periods, though it was for the most part unstratified. Of particular importance is the emerging evidence for the prehistory of western Crete, through the many discoveries of caves by P. Faure, the excavations by J. Tzedhakis at Khania and the caves of Platyvola and the Mamaluke’s Hole at Perivolia, and by the writer and Tzedhakis at Debla (see above, and n. 23). Apart from the links of Platyvola with central and east Crete (see n. 22) another class of pottery is particularly common there and on other west Cretan sites. This is scored, wiped, brushed or combed ware, where the monochrome red or red/brown surface is wiped or combed over with brushwood or something similar. It occurs on jugs and bowls at Debla and at Platyvola again on jugs and on a type of bowl closely parallel in shape to one in the EM I deposit at Kyparissi. The close, vertical red-on-buff pattern of the Kyparissi bowl produces a surface appearance very similar to that of the scored Platyvola vessel. Equally good evidence for the date of this ware comes from Knossos where it is common in the Late


Neolithic and on jugs (cf. Debla and Platyvola) in the EM I well. Hence it is of particular interest that this was the type of pottery accompanying the charcoal in the Ledaka Cave at Melidhoni Apokoronou, which has provided the first radiocarbon date from western Crete.

III Radiocarbon Dates and Calibration

The evidence presented above for Early Minoan chronology, absolute and relative, is reliable but not as sufficient as could be hoped. The north-west Anatolian ceramic links suggest a date for the start of EM I around 3000 B.C.; but no one would dispute that there is room for more evidence for the absolute date of Troy I. The Egyptian stone vase links are sound, but cannot be demonstrated by context any earlier than EM II at the earliest. Moreover the imitating types in Crete mostly come from rather widely dated communal burial contexts. The scarabs give no help before c. 2133 B.C. (beginning of the XIth Dynasty). The stratigraphical sequence, particularly from Knossos, Lebena, Myrtos, Palaikastro and Vasilike, is secure, but no single site has all the EM periods superposed level by level. There is therefore ample scope for radiocarbon dates to strengthen the chronology.

It is only from very recent excavations that the first results have become available. We have three Middle-Late Neolithic transition dates from Knossos, one date from a Final Neolithic-EM I scored ware context in the Ledaka Cave at Melidhoni Apokoronou, seven from Myrtos for the end of EM II, one from Knossos from an EM II-MM I A context and one from

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37 The pottery is called subneolithic by Faure, BCH 89 (1965) 57, and it included black polished and scored ware, BCH 85 (1962) 43; the scored ware is again taken as subneolithic, BCH 93 (1969) 201 n. 2, where its distribution is set out.
38 Evans, PPS 37 (1971) Part II 117. Stratum II represents a transitional phase from Middle to Late Neolithic at Knossos (Evans, BSA 59 (1964) 182, 225).
40 V.R. Switsur, M.A. Hall and R.G. West, University of Cambridge Natural Radiocarbon Measurements IX, Radiocarbon 12 (1970) 597 for Q-950 and Q-953. See also addendum. For full publication and discussion see Warren, Myrtos. An Early Bronze Age Settlement in Crete (1972) Appendix XV.
41 Evans, Anatolian Studies 22 (1972) 118 n. 2.
an EM III/MM I A context (the immediately pre-palatial level) at Mallia. The dates are tabulated in Fig. 1.

<table>
<thead>
<tr>
<th>Site and context</th>
<th>Laboratory number</th>
<th>C-14 Age b.c. (5568 half-life)</th>
<th>Archaeological or expected date</th>
<th>Historical (calibrated) date B.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knossos: Middle/Late Neo. Strats III/II</td>
<td>BM-571</td>
<td>3686 ± 94</td>
<td></td>
<td>4600-4300</td>
</tr>
<tr>
<td>Knossos: Middle/Late Neo. transition (Stratum II)</td>
<td>BM-585</td>
<td>3638 ± 145</td>
<td></td>
<td>4600-4360</td>
</tr>
<tr>
<td>Knossos: Middle/Late Neo. transition (Stratum II)</td>
<td>BM-579</td>
<td>3584 ± 76</td>
<td></td>
<td>4450-4370</td>
</tr>
<tr>
<td>Ledaka Cave: Late Neo.-EM I</td>
<td>Sa-241</td>
<td>2550 ± 300</td>
<td>Later 4th millennium — c. 2600 BC</td>
<td>3660-2950</td>
</tr>
<tr>
<td>Myrtos: end of EM II</td>
<td>Q-953</td>
<td>2192 ± 80</td>
<td>c. 2600-2170 BC (EM II)</td>
<td>2960-2530</td>
</tr>
<tr>
<td>Myrtos: end of EM II</td>
<td>Q-1002</td>
<td>2015 ± 80</td>
<td>»</td>
<td>2750-2230</td>
</tr>
<tr>
<td>Myrtos: end of EM II</td>
<td>Q-1003</td>
<td>1957 ± 80</td>
<td>»</td>
<td>2520-2200</td>
</tr>
<tr>
<td>Myrtos: end of EM II</td>
<td>Q-951</td>
<td>1885 ± 80</td>
<td>»</td>
<td>2500-2150</td>
</tr>
<tr>
<td>Myrtos: end of EM II</td>
<td>Q-950</td>
<td>1855 ± 85</td>
<td>»</td>
<td>2480-2150</td>
</tr>
<tr>
<td>Knossos: EM II-MM IA</td>
<td>BM-578</td>
<td>1791 ± 137</td>
<td>c. 2600-1900 BC</td>
<td>2480-2080</td>
</tr>
<tr>
<td>Mallia: EM III/MM I A</td>
<td>Gif-254</td>
<td>2080 ± 300</td>
<td>c. 2170-1900 BC</td>
<td>3100-2140</td>
</tr>
</tbody>
</table>

**Figure 1.**

Cretan Middle/Late Neolithic and Early Minoan Radiocarbon Dates and Calibrations.

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With the publication of Dr Hans Suess's latest calibration curve, given here as Fig. 2, the historical date ranges can be established. The calibrations are done as follows: to make proper allowance for the range of years in the standard deviation in the radiocarbon dates conversion has been done on the upper and lower limits of the dates and the maximum range thus calculated. For example, Sa-241: first 2850 (2550 + 300) is converted, giving an upper limit of c. 3650 B.C. Then 2250 (2550-300) is converted, giving a lower limit of c. 2950 B.C. Thus the true age range is approximately 3650-2950 B.C., i.e. the true or calendrical date of the sample is likely to fall somewhere within this range. If 2550 itself were converted a rather narrower age range would result, though allowance would not have been made for the standard deviation. It must also be emphasised in these early days of the application of dendrochronology to archaeology that the curve should only be taken as a rough guide to true dates. The suggested maximum and minimum calibrations make some allowance for this.

The results of the calibrations appear in the final column of Fig. 1. It is at once apparent that the EM calibrated results, though producing a rather wide date range, nevertheless fit well with the Early Minoan absolute chronology determined from archaeological and other radiocarbon evidence (see n. 4 and ns. 48 and 49) in section I above. Secondly, the C-14 evidence, though consisting as yet of only 3 Middle/Late Neolithic and 9 Early Minoan determinations, shows good internal consistency. This is clear from the sequential list in Fig. 1, while behind this list lies the earlier Neolithic range of Knossos, again in good sequence (see n. 38).

A chronological table may therefore be presented, combining all the evidence for the Late Neolithic and Early Minoan, Fig. 3.

Further confirmation of the correctness of the table at the lower, younger end comes from a group of seven thermoluminescent dates from Myrtos. All are from sherds in final destruction contexts in the settlement (end of EM II). The sherds were from pots made at some time in the life of the settlement (EM II, c. 2600-2170 B.C.), and in all probability from pots

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43 W.F. Libby, Radiocarbon Dating, in Philosophical Transactions of the Royal Society of London, A, Mathematical and Physical Sciences vol. 269 no. 1193 (1970) (A Symposium on the impact of the natural sciences on archaeology) 8 fig. 3, and R. Berger, op. cit. 31 fig. 2. In each of these figures the 2000-500 B.C. column is unfortunately numbered 200-500 B.C. Permission to use the curve was kindly granted me by Dr Suess at the Symposium. For his own publication of it see H.E. Suess, Bristlecone pine calibration of the radiocarbon time scale 5200 B.C. to the present, in I.U. Olsson (ed.), Radiocarbon Variations and Absolute Chronology (1970) 303-12.

44 Conversions are done with Figure 2 on the B.P. dates, i.e. 1950 is first added to the C-14 dates (on the 5568 half-life).

45 S. Fleming in Warren, Myrtos, supra n. 40, Appendix XIV.
FIGURE 2. The Suess radiocarbon calibration curve. The figures on the left sides are radiocarbon years before present (B.P.), on the right calendrical or historical dates B.C. Radiocarbon dates are expressed as B.P. (the number of radiocarbon years before A.D. 1950) or b.c. Thus 4000 B.P. = 2050 b.c. (4000-1950). For example, to calibrate a C-14 date of 4000 B.P. (2050 b.c.) follow the 4000 B.P. line to the point where it cuts the curve, then read off, perpendicularly, to the figures on the right side, which produces a calendar or historical date of c. 2500 B.C.
<table>
<thead>
<tr>
<th>BC</th>
<th>Chronological Table</th>
<th>Calibrated C-14 and other dates</th>
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</thead>
<tbody>
<tr>
<td>3300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3200</td>
<td>Late Neolithic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pre-4000 - 3000/2900 B.C.</td>
<td></td>
</tr>
<tr>
<td>3100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2800</td>
<td>Early Minoan I</td>
<td></td>
</tr>
<tr>
<td>2700</td>
<td></td>
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</tr>
<tr>
<td>2600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2400</td>
<td>Early Minoan II</td>
<td></td>
</tr>
<tr>
<td>2300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2100</td>
<td>EM III? EM III</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>MM I A MM I A MM I A MM I A MM I A MM I A</td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td>MIDDLE MINOAN I B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SOUTH CENTRE EAST</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3. Late Neolithic and early Minoan chronological table.**

made in EM II B (c. 2400-2170 B.C.), the second period, at the end of which the site was destroyed. The preferred ages of the seven samples range from 2580-2170 B.C., six out of the seven from 2430-2170 B.C. They therefore fit extremely well with the archaeological and calibrated radiocarbon chronology.
Conclusions

The combined absolute and relative chronological evidences allow the dating of the Late Neolithic and Early Minoan 4th-3rd millennium sequence to be considered fairly secure. This being so a few brief comments may be made on the wider importance of the chronology.

1) The approximate contemporaneity of Early Minoan II with the Keros-Syros or Early Cycladic II culture is known from many links in pottery, metalwork, figurines and stone vases. The Keros-Syros culture also has close connexions with Early Helladic II. It is therefore instructive that the EM II chronology, archaeological and calibrated radiocarbon, fits well with calibrated C-14 dates for EH II Eutresis and late EH II Lerna and that EM II and EH II thus combine to date absolutely the rich Early Bronze 2 of the Cyclades. The approximate contemporaneity of EH II and EM II may now be even more clearly seen with the discovery of imported EH II sauceboats in the EM II A house at Knossos recently excavated by the writer (see n. 21). The beginning of EB 2 in the Aegean must be about 2600 B.C. or earlier (note Eutresis especially), while all evidence (Lerna C-14, Myrtos C-14 and thermoluminescence, and the well-dated Egyptian stone vase forms imitated from late EM II to MM I) combines to suggest a date no later than c. 2170 B.C. for the end of the period through the Aegean. Then in Crete EM III-MM I A dates from c. 2170 - pre-1900 B.C., again fitting well the radiocarbon sequence from Lerna, with imported MM I A pottery in the earliest Middle Helladic levels.

2) For the earlier periods, Late Neolithic and Early Minoan I, many more dates are needed. But already the C-14 evidence from Knossos and western Crete and the Troy I connexions suggest a transition from Late Neolithic to Early Minoan in the centuries on each side of 3000 B.C. The EM I period is roughly contemporary with the EB 1 of Greece and the

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49 P-300, P-299, P-303A (Ralph and Stuckenrath, *Radiocarbon* 4 (1962) 150), calibrating to a range of c. 2510-2120 B.C. From the Greek mainland cf. also a thermoluminescent date of 2070 ± 400 B.C. from Lefkandi Phase I (M.J. Aitken, in *Philosophical Transactions, supra* n. 43, p. 85). Lefkandi I is contemporary with EH III.
50 J.L. Caskey, Excavations at Lerna, 1955, *Hesperia* 25 (1956) 159-60 & pl. 43
Cyclades. The contemporaneity is now beginning to be confirmed by the calibrated C-14 evidence. Late Neolithic Kephala on Kea has a calibrated date of c. 3680-3530 B.C. 51; Early Helladic I Eutresis dates within c. 3410-2980 B.C. 52, Troy I period Emborio in Chios within c. 2940-2230 53 and late Troy I period Karataş within c. 3330-2520 B.C. 54.

3) For the Late Neolithic of Crete calibration of the three dates recently available from Knossos indicates, surprisingly, that full Late Neolithic must have been under way before 4000 B.C., in that the transitional Middle-Late Neolithic phase lies a few centuries earlier. The three dates are likely to be highly reliable in that they are the last in a consistent sequence of thirteen now published for the whole Knossian Neolithic (see n. 38). The calibrated date for Late Neolithic (late in the period), pre-Grotta-Pelos Kephala on Kea confirms the length of the period in the Cyclades, as do the dates for the earlier site of Saliagos 55. Later still, and again in sequence, comes the Ledaka Cave from western Crete. Clearly therefore we have a Late and Final Neolithic development in Crete (and the Cyclades) of at least a thousand years. Equally clearly there is much more to be learnt about these numerous Cretan Late Neolithic communities 56, especially their dating. The Phaistos phases 57, the earliest material from the Eileithyia Cave at Amnisos and perhaps the many west Cretan caves will date to the second half of the 4th millennium. The long transition to full EM I is still not clearly defined but the important Partira group will have come around 3200-2900 B.C. because of its close pattern-burnished links with Lebena and other EM I groups 58.

4) Finally, and most importantly, a long chronological sequence best accords with the great economic and social developments from the predomin-
ently troglodytic people of the Cretan Late Neolithic and incipient Early Minoan to the great builders and craftsmen at the dawn of the Palatial Age.

ADDENDUM

After the above text was submitted for publication the results of two more C-14 determinations for Myrtos were communicated to me by Dr V.R. Switsur from the Cambridge Laboratory. These results complete the Myrtos list and they should be inserted into Fig. 1 above, Q-952 before and Q-1004 after Q-953. The two dates, like the five in Fig. 1, are from samples in the final, burnt destruction of the settlement, which is at the end of EM II. They confirm the chronology of the five Myrtos dates in Fig. 1. The site has produced, from six different final destruction contexts, seven consistent dates within a C-14 range of 2292-1770 B.C. at one standard deviation (average 2023 B.C.) and within 2960-2150 B.C. after calibration. The conclusion may be presented more firmly than in the article above, that the final destruction of the Myrtos settlement, which equals the end of Early Minoan II, lies before (and perhaps at least fifty years before) 2150 B.C. 59

<table>
<thead>
<tr>
<th>Site and context</th>
<th>Laboratory number</th>
<th>C-14 Age B.C. (5568 half-life) or expected date</th>
<th>Historical (calibrated) date B.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myrtos: end of EM II</td>
<td>Q-952</td>
<td>2222±70 c. 2600-2170 B.C. (EM II)</td>
<td>2960-2570</td>
</tr>
<tr>
<td>Myrtos: end of EM II</td>
<td>Q-1004</td>
<td>2036±80 »</td>
<td>2760-2420</td>
</tr>
</tbody>
</table>

ADDENDUM ULTIMUM

This paper was submitted for publication in December 1971 and accepted in January 1972. The text and references have been brought up to date at proof stage (November 1975), but to avoid major disruption the addendum has been retained since the place of the additional dates in figure 1 is clear.

It was also not practicable at proof stage to take full account of a recently published paper by Professor Keith Branigan, The Absolute Chronology of the Aegean Bronze Age, Kr. Kbron. KE' (1973) 352-74, a paper largely initiated by the appearance of the Myrtos dates. While I have found much of value in Branigan's

59 For all the Myrtos dates see P. Warren, Myrtos. An Early Bronze Age Settlement in Crete (British School at Athens Supplementary Volume 7) (1972) 344-5. See also n. 40 above for Q-950 and Q-993. For the remaining samples see V.R. Switsur and R.G. West,
discussion, which concludes for a somewhat shorter chronology than that proposed here, I am unable to accept his rejection of dendrochronological calibration (with a preference for historical dates approximating to the 5730 C-14 half life). I consider calibration firmly established by the radiocarbon and tree ring scientists, whatever minor adjustments to the curve may yet have to be made.

Branigan's actual reason for his rejection and his 5730 preference (and on this reason the whole of the rest of his discussion depends) is that an average of the seven Myrtos dates (2220-2062, on 5730 half life) corresponds best to his date for the end of EM II, 2150-2100 B.C. But this latter date depends on a too precise correlation between Cretan miniature stone amphoras, which begin within EM II, and Egyptian First Intermediate Period (beginning c. 2170 B.C.) and Middle Kingdom forms. The type imitated in Crete goes back at least to the Vth Dynasty (MSV 72 and P 355), so that in fact EM II could end no later than c. 2350 B.C. (end of Vth Dynasty). See also below.

On the other hand Branigan is certainly right to emphasize the problem that even within the wide date range produced by calibration three out of the seven Myrtos dates have lower limits which are roughly 220-370 years earlier than the conventional date of their context, 2200/2170 B.C. (end of EM II), while it is hard to believe that this conventional date can be vastly in error.

Secondly, Professor William Ward has rendered me the courtesy of a very thorough and critical examination of the two Minoan miniature stone forms imitating Egyptian miniature stone forms (see above pp. 206-207 and n. 11) in his book, *Egypt and the East Mediterranean World* 2200-1900 B.C. (1971) 97-105. A careful reading of his text will show that his conclusions finally emerge as similar to my own, which he sets out to criticize. I had perhaps put a little too much chronological weight on the First Intermediate Period parallels, but I did nevertheless show that the Egyptian miniature amphora with high shoulder occurs from the Vth Dynasty onwards (MSV 72 and P 355) and the cylindrical jar with everted rim and disk base from the VIth Dynasty onwards (Kr. Khr. (1965) 35. MSV 75). For the former type Ward (op. cit. 104-5 and fig. 19) simply amplifies my evidence and shows that the series begins with a single example in the IVth Dynasty, while for the latter type, the specific miniature form with everted rim and disk base, he simply confirms my VIth Dynasty evidence (op. cit. 102, 104 and fig. 17, where it can be clearly seen that it is precisely the VIth - Xth Dynasty examples (Ward's nos. 8-23, cf. MSV D 230 - D 234) which provide the parallels for the Minoan imitations).

In conclusion then we may agree that we have two Minoan forms, beginning in EM II and in contexts down to MM I, copying Egyptian forms whose floruit is from the Vth Dynasty onwards (2492 B.C., Hayes) in one case, miniature amphoras, and the VIth Dynasty onwards (2347 B.C., Hayes) in the other, cylindrical jars with everted rim and disk base. This suggests an approximate contemporaneity between the Egyptian Vth - XIIth Dynasties and somewhere in EM II to MM I. This is entirely in harmony with the radiocarbon and thermoluminescent chronology presented in this article.