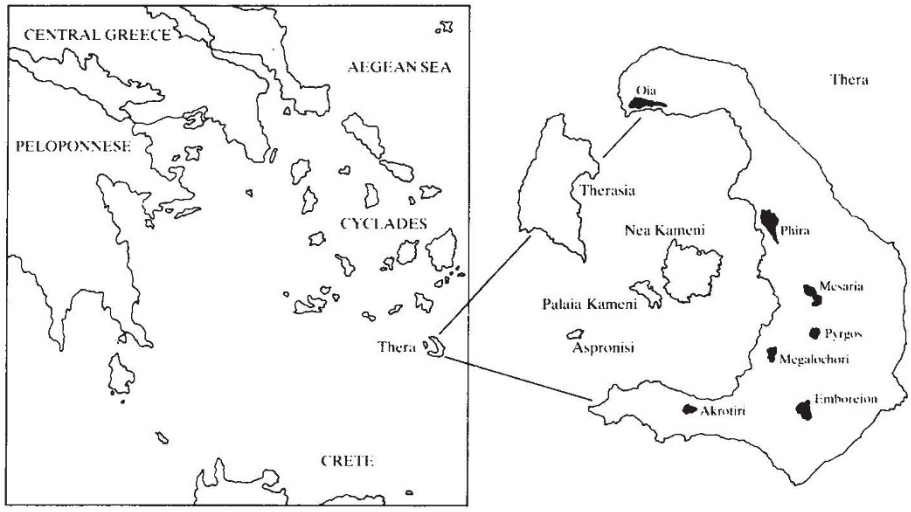
Archaeology

Unsteady date of a big bang

Gerald Cadogan

APPROXIMATELY 3,500 years ago, a catastrophic volcanic eruption on the Aegean island of Thera (Santorini) engulfed the town of Akrotiri (see map). There has been lively debate on several issues concerning Thera since 1967, when Spyridon Marinatos began excavating Akrotiri. A dramatic and perplexing development in this debate is reported on page 517 of this issue by C.U. Hammer *et al.*[1] who report an independent dating of the eruption, obtained by studying acidic fallout trapped in the Greenland ice core. This result, together with other recent datings, throws studies of the period into a quandary.

Akrotiri, often called 'Thera', is rightly known as a prehistoric Pompeii. Its rich culture preserved by the volcanic fallout shows a blend of the Middle Bronze Age traditions of the Cyclades with new ideas from Minoan Crete, notably in buildings, daily paraphernalia of life and iconography. It is an important marker in the assessment of the growth of Aegean and east-Mediterranean civilizations.



Map showing the position of the Thera island group, whose culture combined the traditions of the Cyclades with new ideas from Minoan Crete. The enlargment shows the location of Akrotiri and the other main archaeological sites on the island of Thera.

The civilization belongs in archaeological terms to the Late Cycladic I and the Late Minoan IA cultural phases. The 'Minoan' system for dating the Aegean Bronze Age, with Early, Middle and Late Minoan, each with three main divisions and further subdivisions, follows that of the Old, Middle and New Kingdoms of Egypt. This Minoan model was copied for the Helladic and Cycladic cultures, which have more or less parallel sequences.

The conventional archaeological date[2,3] for the volcano's destruction of Akrotiri is 1500 BC (on the assumption that this happened as or immediately after the town was finally abandoned), and for the whole cultural phase 1550–1500 BC.

The ice-core date is an independent check of the archaeological date, which depends on a complex group of correlations with the calendrical chronology of pharaonic Egypt, and of radiocarbon dates from Thera. The date 1645 BC obtained by Hammer *et al.* in this issue falls within the two standard deviations (2σ) average range of the calibrated radiocarbon dates (1675–1525 BC) from short-lived material (mostly seeds). Their range is also close to Aitken's[4] average range of 1670–1520 BC. Both Aitken and Hammer *et al.* use the new high-precision calibrations of Pearson and Stuiver[5].

But 1645 BC does not agree with the independent date of LaMarche and Hirschboeck[6], who dated frost damage in Californian bristlecone pines to 1628–1626 BC. These authors tentatively ascribe the damage to the effect of cold winters brought on by the release of volcanic dust into the stratosphere by the eruption of Thera. The frost-ring date falls well within 2σ, and almost within 1σ, of the radiocarbon dates of Hammer *et al.* and of Aitken, but is two decades younger than the ice-core date.

There is also disagreement between the ice-core date and the conventional archaeological date (1550–1500 BC) for Late Minoan IA/Late Cycladic I. But Betancourt[7] has proposed recently a revised archaeological date for Late Minoan IA. Starting from the cluster of calibrated radiocarbon dates from Thera "in the seventeenth century BC", he re-examined the archaeological correlations to produce a new Late Minoan chronology that many Aegean archaeologists will find hard to accept. His arguments depend on the stylistic dating and contextual dating of features of Minoan culture that may be correlated with Egypt. He wishes to date the phase to about 1700–1610 BC. (Note that he had not seen the new calibrations when he wrote his paper. Their effect is to make the sixteenth and seventeenth centuries BC dates equally likely.)

A principal difficulty with introducing a radically different chronology is its 'push-me-pull-you' effect. If the seventeenth century BC belongs to the Late Minoan IA phase, then the subsequent phases must be stretched out — there is no dispute about the date of the end of the Late Minoan period several centuries later — and a much reduced span must be given to the preceding Middle Minoan period in which the Minoan palaces were founded. Warren[8] has reviewed Betancourt's arguments and suggests that Late Minoan IA started at about 1600 BC or a little earlier. This is an attractive idea in view of the considerable amount of cultural history — notably massive building programmes in Crete and on the Aegean islands like Thera — that took place in this phase and of the rather early look (still in the Middle Bronze Age tradition) of some of the pottery in the Late Minoan IA/Late Cycladic I destruction of Akrotiri.

So, which date is preferable for the eruption (and abandonment, if contemporary) of Thera? Most archaeologists would find 1645 BC or 1628–1626 BC difficult to accept, but such dates could fit the radiocarbon span. A date in the later part of the sixteenth century BC would be archaeologically acceptable, and could fit the radiocarbon span, whereas 1500 BC lies outside the radiocarbon span and is probably no longer tenable. As for the evidence for 1645 BC and 1628–1626 BC, can we be sure that there were no other causes, volcanic or non-volcanic, that could have produced the acid fallout and/or frost-ring damage? Taking everything into account, a date of the sixteenth century BC seems the most likely. □

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4. Aitken, M. J. in *Proc. Third Archaeometry Meeting Brit. Sch. Athens* (in the press).
5. Pearson, G.W. & Stuiver, M. *Radiocarbon* **28**, 805–838 (1986).
6. LaMarche, V.C.J. & Hirschboeck, K.K. *Nature* **307**, 121–126 (1984).
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Gerald Cadogan is Archaeology Correspondent of the Financial Times *and lives at The Old Rectory, Culworth, Banbury OX17 2AT, UK.*