Santorini Eruption Radiocarbon Dated to 1627–1600 B.C.

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The Minoan eruption of Santorini (Thera) in Greece spread a huge fan of volcanic ash deposits over the Eastern Mediterranean region. Worldwide effects have been ascribed to the eruption: sulphuric acid and fine ash particles in the Greenland Ice Sheet, climatic disturbances in China, and frost damage to trees in Ireland and California. On Santorini, the eruption produced a thick layer of pumice and ash (fig. S1) (*1*) that buried flourishing Bronze Age settlements. Left behind is Akrotiri, a "Pompeii of the ancient Aegean," which is currently being excavated (*2*). Precise dating of this eruption is important, because the tephra layer acts as a universal time marker of Late Bronze Age contexts in the Eastern Mediterranean region.

On the basis of linkages between the Aegean and Egyptian cultures (*3*), some archaeologists have traditionally placed the Minoan eruption around the mid- to late-16th century B.C., whereas evidence from ice cores, tree rings, and a large number of radiocarbon dates favor a date 100 years earlier (*4*). Radiocarbon dates on short-lived organic material, like seeds, from Akrotiri on Santorini have been of limited precision because of a plateau in the radiocarbon calibration curve for part of this time trajectory. Even by applying refined statistical analysis on the most suitable series of radiocarbon dated samples grouped by archaeological evidence, it has not yet been possible to date the eruption of Santorini more precisely than ranging (2σ) from 1663 to 1599 B.C. (*5*).

We have found (*6*) a branch from an olive tree that was buried alive in tephra on Santorini, with branches of the crown partly preserved in life position (Fig. 1A and fig. S1) (*1*). The horizontal position of the seven molds of branches in the pumice 1 to 3 m above its base and remnants of olive leaves and twigs covered by the pumice further support our claim that the olive was buried alive. We obtained a series of radiocarbon dates from a defined sequence of tree rings in the branch that can be wiggle-matched to the latest radiocarbon calibration curve IntCal04 (Fig. 1B). One problem with olive trees is that they form irregular, barely visible rings. We thus used x-ray tomography to identify 72 rings in a section of the branch with preserved bark (Fig. 1C) (*1*). We divided the section into four consecutive groups of rings and obtained ^{14}C dates for each (*1*). Using the calibration program OxCal (*7*), we determined the calibrated age range of the outermost ring to 1621–1605 B.C. (1σ, 68% confidence) or 1627–1600 B.C. (2σ, 95% confidence). Even when we take into account an uncertainty of 50% in the ring count, potentially caused by growth irregularities of olive, these limits are increased by only a decade (table S2). We also excluded a significant local offset of the ^{14}C ages by volcanic CO_2, because then it would be impossible to match our ^{14}C sequence anywhere to the shape of the calibration curve (Fig. 1C).

Our wiggle-matched sequence adds to the already strong evidence of an eruption date in the late 17th century B.C. It is the first accurately (close to annually) defined sequence based on an object buried alive by the eruption. A date around 1520 B.C. or later, as assumed by some archaeologists working with Egyptian contexts, is not consistent, even within 3σ (99.7% confidence), with our result, which consequently suggests a flaw in either their linkage of the Aegean to the Egyptian chronology or in the chronology itself for the relevant time range.

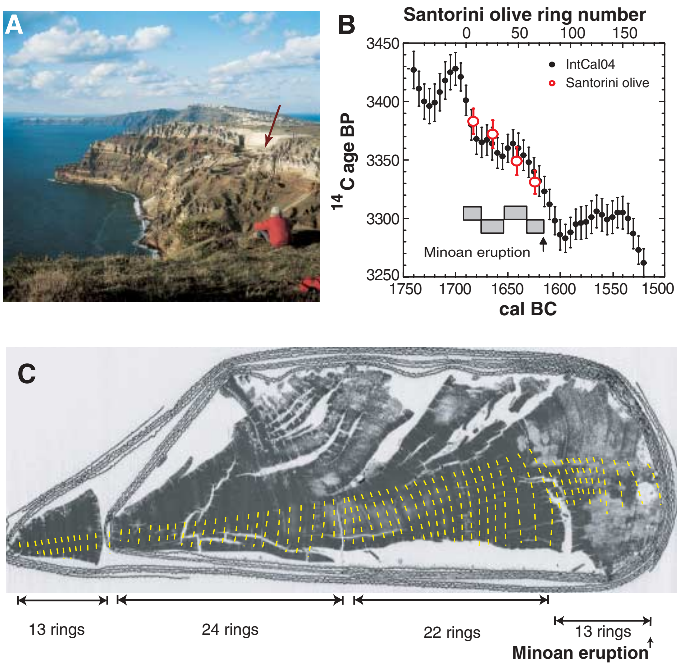

Fig. 1. (**A**) The arrow marks the site where an olive tree was found buried under the <60-m-thick pumice layer of the Minoan eruption on top of the caldera wall on Thera. (**B**) ^{14}C dates of the four segments of the olive section wiggle-matched to the calibration curve IntCal04. The relative position of the segments in the branch is indicated by the bars. BP, years before the present. Error bars indicate 1 SD. (**C**) X-ray tomography of a section of the olive branch, with yellow lines indicating identified growth rings. The four dated segments are indicated by arrows.

References and Notes

1. Materials and methods available as supporting material on *Science* Online.
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Supporting Online Material

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Materials and Methods
Table S1
References

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