Thera, now called Santorini, erupted sometime in the Bronze Age, creating a caldera now mostly filled with water.

ARCHAEOLOGY

Study reignites debate about when Thera blew its top

Radiocarbon curve suggests archaeological data were right

By **Lizzie Wade**

Hundreds of years before the Trojan War, the volcanic island of Thera in the Aegean Sea blew its top in an explosion that rocked the ancient world. Sixty times greater than the 1980 eruption of Mount St. Helens in Washington, the blast completely buried the Theran town of Akrotiri and sent 12-meter-high tsunamis hurtling toward the heart of the Minoan civilization on Crete, 110 kilometers to the south. Some authors have even speculated that the Atlantis myth may stem from a cultural memory of the cataclysm.

But when exactly did it happen? The eruption spread ash across the eastern Mediterranean, so a precise date could pin down the chronologies of ancient cultures including the Greeks, Minoans, and Egyptians. Archaeologists and radiocarbon daters have battled fiercely over the timing. By correlating Egyptian records and pottery, archaeologists put the eruption as early as 1500 B.C.E. But radiocarbon dates from Akrotiri and nearby sites, including an olive tree buried by the eruption, pointed to a date more than 100 years earlier, in the late 17th century B.C.E. (*Science*, 28 April 2006, p. 508).

A new study promises a truce. A team led by archaeologist and tree ring scientist Charlotte Pearson of The University of Arizona in Tucson measured the radiocarbon stored in individual rings from five trees. Because tree rings can also be dated by simply counting them, the team could correct the radiocarbon dates. That broadens the possible dates of the eruption to include the traditional archaeological date of the 16th century B.C.E.

"It's a very impressive data set," says Paula Reimer, a geochronologist at Queen's University Belfast and chair of the International Calibration Working Group (IntCal), which establishes the worldwide radiocarbon calibration curve. If another lab can reproduce the findings, she says, every radiocarbon date between 1700 B.C.E. and 1500 B.C.E. might need to be recalibrated.

The radiocarbon clock doesn't tick steadily. Organisms contain both carbon-14 (^{14}C) and carbon-12 (^{12}C). At death, ^{14}C starts to decay at a known rate while ^{12}C levels stay the same. By comparing the ratio of isotopes, scientists can calculate how long ago an organism was alive. But ^{14}C in the atmosphere, and therefore in all organisms, fluctuates with the amount of cosmic radiation hitting Earth. To calibrate the clock, scientists must track those fluctuations. That's where tree rings come in, because they yield both a radiocarbon reading and an absolute age.

The IntCal curve was largely built using 10-year chunks of wood. But Pearson's team was able to measure the radiocarbon more precisely, in single, annual rings of three ancient bristlecone pines in California and two oak trees in Ireland. The resulting calibration curve differs slightly but significantly from the IntCal curve, with a so-called radiocarbon plateau that allows a much broader range of eruption dates. Some fall in the late 16th century B.C.E, perhaps around 1540 B.C.E.—closer to the archaeological date.

"This slight adjustment to the shape of the calibration curve can allow all the lines of evidence to overlap," Pearson says. "It doesn't give us the definite date but it moves us a step in the right direction."

For radiocarbon experts, the result is bittersweet, vindicating archaeologists without challenging the radiocarbon measurements themselves. Christopher Ramsey of the University of Oxford in the United Kingdom helped date the Thera eruption to the 17th century B.C.E. and has fielded years of critiques of his dates; just last week, for example, a paper in *Scientific Reports* showed that olive trees grow irregularly and might give artificially old dates. But if Pearson's paper is correct, Ramsey says, "then all the measurements are fine!" It's the calibration data—the gold standard used by researchers around the world—that may be off. "That was not something I expected," he says ruefully.

Sturt Manning, an archaeologist at Cornell University who led the earlier radiocarbon work, worries the new findings will encourage traditionalists to disregard radiocarbon evidence altogether. "This paper will now be cited for the next decade to demonstrate that there's ambiguity with the radiocarbon, and therefore we should ignore it," he says. He emphasizes that the new calibration data must be confirmed independently.

Jeremy Rutter, an archaeologist emeritus at Dartmouth College, considers the work "a real step forward." But, he says, "I'm a little disappointed by where we end up," with no absolute date for the eruption.

"It's very bad luck that this really important eruption happens to occur on a radiocarbon plateau," Pearson says. "But on the other hand, this is science, isn't it?" ■

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