

ARCHAEOLOGY

New Carbon Dates Support Revised History of Ancient Mediterranean

During the Late Bronze Age, the Aegean volcanic island of Thera erupted violently, spreading pumice and ash across the eastern Mediterranean and triggering frosts as far away as what is now California. The Thera town of Akrotiri was completely buried. Tsunamis up to 12 meters high crashed onto

work. If correct, the earlier dates would have “major consequences” for the relationships between Egypt, Minoan Crete, and Mycenaean Greece, says archaeologist Jeremy Rutter of Dartmouth College: “The issue of which direction artistic and other cultural influences was traveling may change significantly.”



Under the ash. Akrotiri, buried by the eruption of Thera, is often called the “Pompeii of the Aegean.”

the shores of Crete, 110 kilometers to the south, and the cataclysm may ultimately have sped the demise of Crete’s famed Minoan civilization. For nearly 30 years, archaeologists have fought over when the eruption took place. Those who rely on dates from pottery styles and Egyptian inscriptions put the event at roughly 1500 B.C.E., whereas radiocarbon experts have consistently dated it between 100 and 150 years earlier.

Now, two new radiocarbon studies on pages 548 and 565 claim to provide strong support for the earlier dates. The studies “convincingly solve the problem of the dating of the Thera eruption,” says archaeologist Colin Renfrew of Cambridge University in the United Kingdom, who was not involved in the

But many archaeologists who have long defended the later dates are unmoved. “I am not impressed,” says Egyptologist Manfred Bietak of the University of Vienna in Austria, who prefers to rely on detailed Egyptian records for the same period. Archaeologists on both sides agree on one thing: The pottery found at Akrotiri since Greek archaeologists began excavating there during the 1960s has a distinctive style featuring spirals and floral motifs, known as Late Minoan IA (LM IA). The LM IA period also corresponds to what archaeologists consider the height of Minoan civilization. Because pottery was widely traded across the Mediterranean, sites that have pottery styles later than LM IA—such as Late Minoan IB, which features depictions of dol-

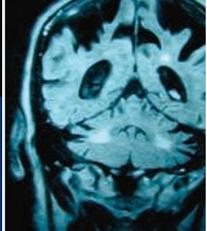
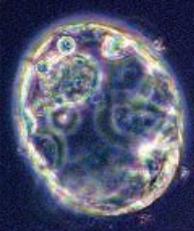
phins, octopi, and other sea creatures—must postdate the eruption. This makes it possible to construct relative chronologies for the region despite the debates over absolute dating.

One team, led by archaeologist Sturt Manning of Cornell University, dated 127 radiocarbon samples from Akrotiri and other Aegean sites thought—based on relative chronologies—to span a period from about 1700 to 1400 B.C.E. Manning and colleagues used a new radiocarbon calibration curve (described last year in the journal *Radiocarbon*) as well as sophisticated statistical models and cross-checked some samples among three different dating labs. They dated the eruption to between 1660 and 1613 B.C.E., within 95% confidence intervals.

That’s a fairly close match to the findings of a second team, led by geologist Walter Friedrich of the University of Aarhus in Denmark. In 2002, Friedrich’s graduate student Tom Pfeiffer found an olive branch, complete with remnants of leaves and twigs, that had been buried alive in pumice from the eruption. Radiocarbon dating fixed the death of the branch’s outermost ring, and thus the eruption of Thera, between 1627 and 1600 B.C.E., again at 95% confidence levels. The authors of both papers argue that these earlier dates rule out the “conventional” chronology of about 1500 B.C.E.

“That is great news about the olive tree,” says dendrochronologist Peter Kuniholm of Cornell, although he cautions that it is more difficult to assign specific years to the rings of a slender olive branch than to more commonly used trees such as conifers and oaks. Archaeologist Gerald Cadogan of the University of Reading, U.K., adds that the dates given by the two papers are “pretty consistent” and that their validity is bolstered because they are “put in context by other dates from before and after from elsewhere in the Aegean.”

Manning and colleagues say the early dates suggest that the conventional linkage between Minoan and Egyptian chronologies, which puts the apex of Minoan civilization contemporaneous with Egypt’s 16th century B.C.E. New Kingdom, is wrong. The New Kingdom, especially during the rule of Pharaoh Ahmose, was the high point of Egyptian power. Rather, the Minoans would have reached their own heights during the earlier Hyksos period, when the Nile delta was ruled by kings whose ancestors came from the Levant. Rutter says Egyptologists have tended to discount the importance of the Hyksos, whom Ahmose eventually chased out of Egypt: “The Hyksos have gotten lousy press.”



This chronological realignment would also mean that the famous gold-laden Mycenaean Shaft Graves—excavated by German entrepreneur Heinrich Schliemann in the late 1800s and known to correlate with the LM IA period as well as the beginnings of Mycenaean power in the Aegean—would also be contemporaneous with the Hyksos. Some archaeologists had speculated that the Mycenaeans owed their rise to a strategic alliance with the New Kingdom; the new radiocarbon dates would instead raise the possibility that they were allied with the Hyksos, Rutter says. At the very least, Manning says, “it would make the Hyksos world much more important and interesting.” Manning adds that the earlier chronology would create “a different context for the genesis of Western civilization.”

But many proponents of the later chronology are sticking to their guns. The radiocarbon dates create “an offshoot from the historical



Egyptian chronology of 120 to 150 years,” says Bietak. “Until the reasons for this offshoot are solved, we are chewing away at the same old cud.”

Bietak and others have argued that radiocarbon dating is not infallible and that the earlier

Buried treasure. Excavations at Akrotiri have unearthed fabulous frescoes and distinctive pottery.



date for the Thera eruption is contradicted by excavations in Egypt and on Thera itself. He and other archaeologists have found LM IA pottery in stratigraphic layers that Egyptian records date to later periods, and at Akrotiri they have unearthed a style of Cypriot pottery that apparently does not show up until the 16th century B.C.E. in Egypt.

“There are no current grounds for thinking that the Egyptian historical chronology could be out by more than a few years,” says archaeologist Peter Warren of the University of Bristol, U.K. “This chronology has been constructed by hundreds of expert Egyptologists over many decades.”

Nevertheless, Rutter says, the *Science* authors “have done what they can to overcome” the objections by advocates of a later date for Thera. And both sides agree that there is a lot at stake in the debate. Until it is resolved, Warren says, at least for the Late Bronze Age, “we would have to forget about serious study of the past and relationships between peoples.”

—MICHAEL BALTER

STEM CELLS

Court Rules in Favor of California Stem Cell Institute

A California court has ruled that a \$3 billion initiative for funding stem cell research does not violate the state's constitution. The ruling, a widely expected victory for California's research institutions, means that bond sales can proceed so that the California Institute for Regenerative Medicine (CIRM) can fund grants. But the plaintiffs plan to appeal, so CIRM may remain hamstrung for at least another year.



Triumphant. Robert Klein, chair of CIRM's board, is celebrating after a court ruled that California's stem cell initiative is constitutional.

CIRM, created by Proposition 71 and approved by California voters in November 2004, was set up to fund research on human embryonic stem cells that is not eligible for federal support. The institute has gotten off to a slow start, however, because of lawsuits filed partly by groups opposed to embryo research. Last year, the California Family Bioethics Council and two taxpayer groups argued that CIRM and its board, the Independent Citizens' Oversight Committee (ICOC), are not operating as state agencies because they are not subject to full government oversight. The suit contended, for example, that because ICOC's membership includes scientists from institutions that may apply for grants, they represent their own interests and not those of citizens.

On 21 April, Alameda County Superior Court Judge Bonnie Lewman Sabraw rejected these arguments. CIRM officials and ICOC “are operating in the same fashion as other state agencies,” the ruling says. ICOC members have filed financial disclosure forms, the committee has developed conflict-of-interest policies, and it has held public meetings, among other steps. The plaintiffs “have not shown that the Act is clearly, positively, and

unmistakably unconstitutional. The Act and the bonds issued thereunder are valid,” Sabraw concluded.

“We are extremely pleased,” said Robert Klein, chair of ICOC, in a statement. And even though the matter isn't over—appeals could take “at least a year,” says CIRM spokesperson Nicole Pagano—the institute is moving ahead, Klein notes. Earlier this month, CIRM issued its first \$12.1 million in research training grants, using money raised by selling “bond anticipation notes” (*Science*, 21 April, p. 345). Klein will announce soon another \$31 million from the same kind of bonds, Pagano says. (A separate federal lawsuit trying to block CIRM by arguing that fertilized eggs are “persons” was dismissed last year for lack of venue but has been appealed, Pagano says.)

Researchers at California universities in line to receive CIRM funds are rejoicing, too. “We're happy,” says Michael Clarke, deputy director of the 4-year-old Stanford Institute for Stem Cell Biology and Regenerative Medicine. He adds, however, that although Stanford has raised other funds to start the institute's work, “its progress is slowed until CIRM is fully functional.”

—JOCELYN KAISER

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Science **312** (5773), 508-509.
DOI: 10.1126/science.312.5773.508

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