In the aftermath of the eruption of Thera, the life of the seafaring Minoan traders seems to have gone on much as it did before.

THE THERA THEORY

This beautiful Aegean island has been charged with an ancient and terrible crime: its eruption supposedly wiped out the peace-loving Minoan civilization on Crete. But the latest evidence says "not guilty."

BY ALLAN CHEN

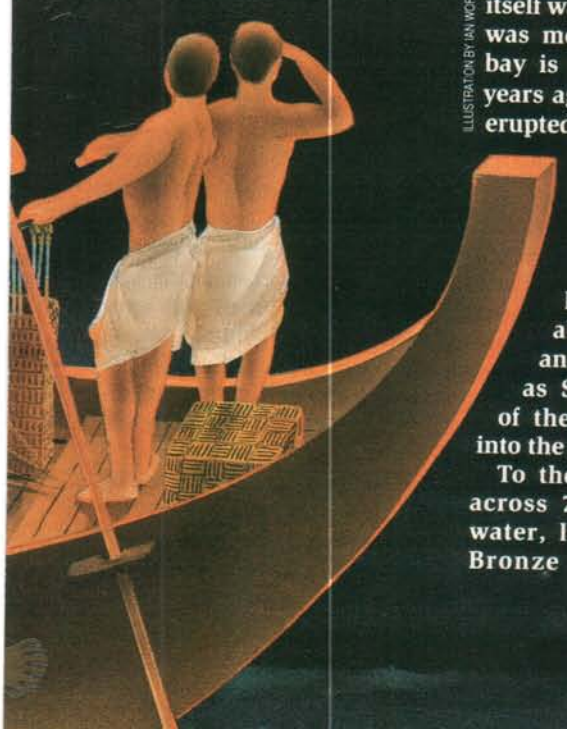


ILLUSTRATION BY IAN WORPOLE

The Greek island of Thera, also known as Santoríni, is a west-facing crescent of volcanic rock, a spectacular ridge towering above a deep, round bay. At one time the island itself was round, and there was mountain where the bay is now. About 3,500 years ago, however, Thera erupted. Molten rock that had been pooling under the island for centuries exploded in a cataclysm so violent it was probably seen in Egypt and heard as far away as Scandinavia. Most of the island collapsed into the Aegean Sea.

To the south of Thera, across 70 miles of open water, lies Crete. In the Bronze Age, Crete was inhabited by a peaceful, seafaring people known as the Minoans, after their legendary ruler, King Minos. The Minoans built dozens of towns and four major palaces, of which the greatest was at Knossos; they dominated the Aegean, colonizing other islands and trading with the Egyptians and Phoenicians. Theirs was the first true European civilization. About 3,500 years ago, however, that civilization was snuffed out at its zenith. The towns and palaces burned and were abandoned.

It is tempting to connect these two stories, of an island that exploded and a civilization that died at about the same time. Such a connection seems to satisfy some enduring hunger we have for a reality with the resonance of myth; and, in fact, the collapse of Thera into the sea may have given rise to the Atlantis myth, which first surfaced in the dialogues of Plato.

In 1939 Greek archeologist Spyridon Marinatos proposed that the relationship between the eruption of Thera and the destruction of Minoan Crete was indeed real. While excavating a Minoan port, Marinatos had found a piece of Theran pumice. From that rock and others he extracted a rich tale: of volcanic ashfalls that blanketed the Minoan fields, of giant waves that smashed Minoan ships and ports, and of earthquakes that shook Minoan buildings, toppling oil lamps and

To tourists Thera is one of the jewels of the Aegean; to archeologists it is home to the Aegean Pompeii.

igniting conflagrations that leveled the palaces. It was a tale compelling enough to seize the imaginations of archeologists, yet one that was simple enough to relate to schoolchildren.

Unfortunately, it seems to have been pure myth. Over the past decade or so evidence against Marinatos's theory has been piling up. Much of it has come from unlikely sources—the Greenland ice sheet, for instance, and trees in California and Ireland. But nearly all of it points to the same conclusion: whatever precipitated the Minoan collapse, it was probably not Thera. The volcano seems to have erupted more than a century before Minoan civilization died.

Marinatos's eruption theory was always controversial, not least because so much was at stake. The fall of Minoan Crete was a watershed in ancient European history. With the Minoans out of the way, the Mycenaeans—whose exploits at Troy were praised by Homer in the *Iliad*—filled the power vacuum in the Aegean, occupying the abandoned Minoan cities and launching a long period of domination by mainland Greece. That period culminated in the classical Greek civilization that laid the foundations of European culture. Marinatos's theory suggested an unsettlingly large element of chance in all this: had it not been for a random cataclysm, the theory implied, European history might have had a decidedly more Cretan slant.

Passions over the theory ran high from the day Marinatos proposed it. The editors of *Antiquity,* the journal in which he published his paper, felt compelled to issue an unusual disclaimer: "In our opinion, the main thesis of this article requires additional support from excavations on selected sites." But scholars such as Stanley Casson, an archeologist at Oxford, rallied to Marinatos's defense. "The facts are there," Casson wrote. "They can be found. An apple fell on the head of Newton. Mr. Marinatos tripped over some pumice stone."

Marinatos himself realized he needed to find more facts. In the mid-1960s he began looking on Thera for ancient settlements whose artifacts might help him pin down the date of the eruption. In 1967, near the village of Akrotíri on the island's southern flank, he scored.

His discovery was sensational—the "Pompeii of the Aegean," as it would later be called. Marinatos found two-story houses preserved intact in the volcanic ash. He found astonishing wall paintings whose scenes of Therans at work, play, and worship revealed a gentle, sensual culture, one that seemed altogether more familiar and more alive than that, say, of the ancient Egyptians. Yet two things were notably absent at Akrotíri. Marinatos found no skeletons, apparently because the inhabitants had had warning of the eruption and had fled; and he found no written records.

The absence of archives was not surprising. Written evidence from the Aegean Bronze Age is generally scant. To establish a chronology of Aegean history archeologists must therefore fall back on an analysis of changing pottery styles. And to calibrate their pottery clock, they must find those same styles of Aegean pots as imports in Egypt, where the date of an archeological find can be established from written records. Pottery dating, says archeologist Philip Betancourt of Temple University, "is a rather subjective art, not an exact science." Making matters worse, he adds, is that "there's very little evidence from the periods we'd like to have the most" in order to establish what wiped out the Minoans.

PHOTOGRAPH BY GEORGE BASS

Minoan Crete, the first true European civilization, was snuffed out at its zenith.

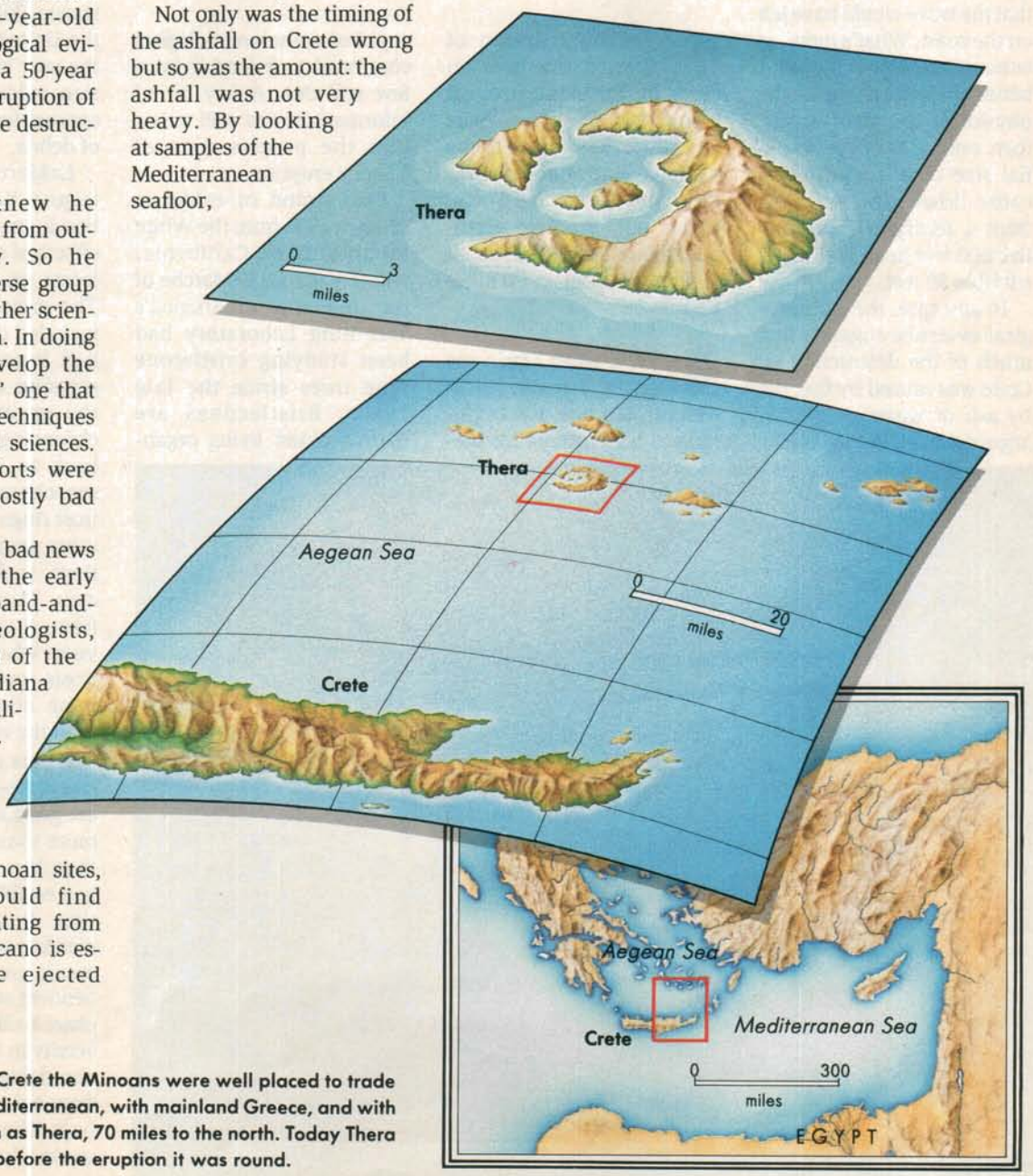
Such evidence as was available, however, did not support Marinatos's theory. Archeologists have long agreed that the widespread destruction of Minoan settlements on Crete took place around 1450 B.C. At Akrotíri Marinatos found plenty of imported Minoan pottery; Thera and Crete had close economic ties. But he found none dating from any later than 1500 B.C. Assuming the Therans weren't in the habit of importing 50-year-old pots, the archeological evidence pointed to a 50-year gap between the eruption of the volcano and the destruction on Crete.

Marinatos knew he needed help from outside archeology. So he encouraged a diverse group of geologists and other scientists to study Thera. In doing so he helped develop the "new archeology," one that draws heavily on techniques from the physical sciences. Ironically, his efforts were rewarded with mostly bad news.

Some of the first bad news was reported in the early 1970s by a husband-and-wife team of geologists, Charles Vitaliano of the University of Indiana and Dorothy Vitaliano of the U.S. Geological Survey. Marinatos had urged them to search for Theran ash at Minoan sites, hoping they would find heavy ashfalls dating from 1450 B.C. (The volcano is estimated to have ejected nearly five cubic miles of ash into the atmosphere.) After years of collecting and analyzing samples, the Vitalianos found ash, all right, but none anywhere near the date that would support Marinatos's theory. "We were very disappointed in our findings," Dorothy Vitaliano recalls, "because it is such an attractive theory."

Not only was the timing of the ashfall on Crete wrong but so was the amount: the ashfall was not very heavy. By looking at samples of the Mediterranean seafloor, oceanographers from the Lamont-Doherty Geological Observatory determined that most of the ash from the eruption actually fell to the east of Thera, not to the south. Thick ash deposits were later found on Rhodes by archeologist Christos Doumas of the University of Athens, and on Kos by other investigators, but neither island seems to have been seriously affected by the ashfall. "The current thinking," says Dorothy Vitaliano, "is that not more than half an inch fell on eastern Crete"—where most of the Minoan settlements were—"which was not enough to do any serious damage."

While the Vitalianos were examining the Cretan ash, other researchers began to re-

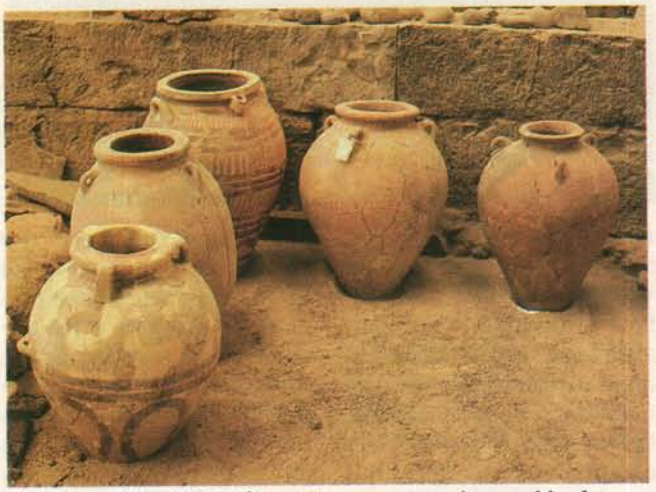


MAPS BY JOE LEMONNIER

From their home on Crete the Minoans were well placed to trade with the eastern Mediterranean, with mainland Greece, and with Aegean islands such as Thera, 70 miles to the north. Today Thera is crescent shaped; before the eruption it was round.

consider the rest of Marinatos's scenario. His claim that giant waves set off by the eruption of Thera had pounded Minoan ports on the north coast of Crete was at least plausible: eruptions of island volcanoes have been known to trigger such waves, or tsunamis. The problem was that there was no clear evidence that a Theran tsunami actually occurred; no one had found the distinctive type of sedimentary deposit that the wave would have left on the coast. What's more, as tsunami experts achieved a better understanding of the physics of the giant waves, their estimates of the potential size of a Theran wave came down dramatically, from a terrifyingly destructive 600 feet to an eminently surfable 30 feet.

In any case, the archeological evidence suggests that much of the destruction on Crete was caused by fire, not by ash or water. Marinatos argued that earthquakes triggered by the eruption of Thera started the fires on Crete by knocking over oil lamps. But as volcanologist Grant Heiken of the Los Alamos National Laboratory, who has studied Thera, points out, volcanic earthquakes are usually too small to do much damage 70 miles away.



The excavation of Akrotíri on Thera uncovered a wealth of fine pots (above) as well as frescoes that revealed the gentleness of Theran culture. The one below is called "Spring."

By 1974, when Marinatos died in a freak fall at Akrotíri, the tide was beginning to turn against his theory. But some archeologists continued to defend it (as a few still do). A key bit of information was still missing: the precise date of Thera's eruption.

One strand of evidence came in 1984 from the White Mountains of California, where Valmore LaMarche of the University of Arizona's Tree-Ring Laboratory had been studying bristlecone pine trees since the late 1960s. Bristlecones are Earth's oldest living organisms—they can survive for more than 4,500 years—and the pattern of growth preserved in their annual rings is an excellent record of past weather conditions, particularly temperature, at the high elevations where the trees are found.

As it happens, large volcanic eruptions can lower temperatures over much of the Earth by injecting sunlight-blocking gases into the atmosphere. In 1816, for instance, killing frosts struck the United States in August; the year before, the Indonesian volcano Tambora had spewed forth 25 cubic miles of debris.

LaMarche and his colleague Katherine Hirschboeck could easily spot the effects of those late-summer frosts on the bristlecones. The growth rings for 1816 included darkened cells that had been crushed by the pressure of ice forming in the growth layer. In the chronology, which extends back to 3000 B.C., the researchers noticed similar frost rings in years following other major volcanic eruptions, such as that of Krakatau. They found a striking frost ring in **1627** B.C.—a year whose late-summer frosts could be attributed to none other, they decided, than the eruption of Thera.

It was a remarkably precise date—tree-ring studies are good at that—and it was more than a century earlier than the date archeologists had established for the eruption. But LaMarche, who died last year, lived to see his result confirmed by independent studies. In 1984 Michael Baillie of Queen's University in Belfast published a chronology he had compiled from oak trees found in Irish bogs. The oaks all had an abnormally narrow growth

PHOTOGRAPHS: TOP, BY ALLAN CHEN; BOTTOM, FROM ART RESOURCE

Note: the 1627 B.C. date has been corrected from the originally published date of 1626 B.C. which was incorrect

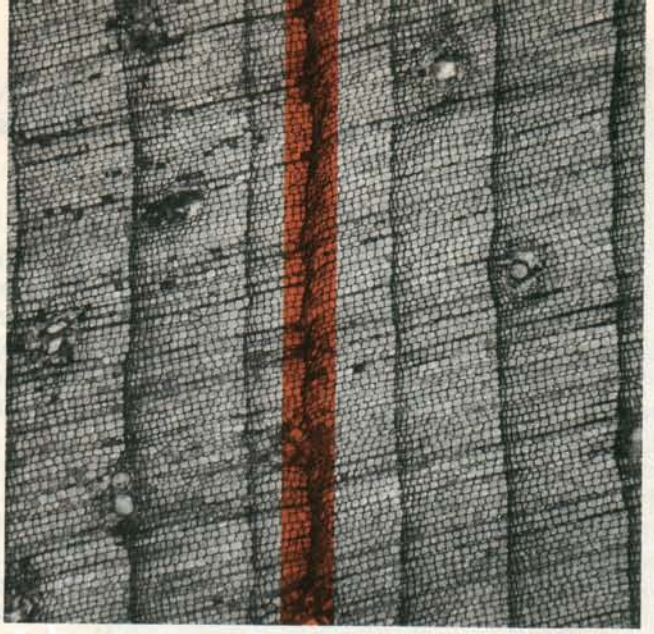
The bristlecone pines of the American Southwest are Earth's oldest living things. They can survive for more than 4,500 years.

ring sometime in the 1620s B.C., indicating that the temperature that year had been much too low to support normal growth.

What's more, the tree-ring date matches the date established by other methods. A large volcanic eruption can shoot sulfuric gases into the stratosphere, where they spread around the planet before precipitating as sulfuric acid. Claus Hammer of the University of Copenhagen realized that the acid from the eruption of Thera might be preserved in the Greenland ice sheet, buried under the layers of ice that accumulate annually (not unlike tree rings). If an ice layer contained acid, Hammer reasoned, the hydrogen ions in the acid would enable that layer to conduct electricity more readily than the surrounding ice. In 1987, after several years of drilling ice cores and searching the cores for layers that showed voltage peaks, Hammer's group published their eruption date: 1645 B.C., plus or minus 20 years.

All these results came as no surprise to Henry Michael, a researcher at the University of Pennsylvania museum. Since the early 1970s Michael had been radiocarbon-dating twigs, fava beans, and barley grains from the Akrotíri site. He had found nothing dating from later than 1625 B.C.; but his evidence, he says, "was roundly rejected by the archeologists." Yet in late 1987, when Michael reported his analysis of a new batch of samples, indicating an eruption date of 1620 B.C. (give or take 20 years), he was no longer a voice in the wilderness. Four different methods had now converged on roughly the same date for the Theran eruption.

PHOTOGRAPHS COURTESY LABORATORY OF TREE-RING RESEARCH, UNIVERSITY OF ARIZONA



The frost-damaged cells (color) in this section of a bristlecone pine record the date of Thera's eruption: 1627 B.C.

Archeologists have taken notice. Inspired in particular by Michael's work, Betancourt has reexamined some of the artifacts that had been used to cross-date Minoan pottery with Egyptian written records. He now argues that the old pottery chronology may have been wrong, and that the last Theran pots before the eruption may date from no later than 1600 B.C., rather than 1500. In other words, he argues that the archeological evidence does not contradict the new date for the eruption. "My feeling," he says, "is that the pattern of imports and exports is so ambiguous that it can easily support the earlier as well as the later dating."

Not everyone agrees. University of Bristol archeologist Peter Warren, a longtime supporter of the Marinatos theory, has become the chief opponent of Betancourt's revised Aegean chronology and of the seventeenth century B.C. eruption date. "I think that date is just not possible; it's far too early," says Warren. The radiocarbon and ice-core dates, he argues, are too imprecise to warrant so drastic a change in Aegean history. As for the frost rings, they are "proxy data. They could equally well be caused by other influences on climate."

But support for this view seems to be fading. "I still have reservations about taking every scientific dating as gospel," says Christos Doumas, who now runs the excavations at Akrotíri, "but I am more for accepting the new chronology by Betancourt because I can see the archeological and scientific dating approaching the same point."

That convergence may well become the final nail in the coffin of Marinatos's theory. Which raises a question: If the eruption of Thera did not wipe out Minoan civilization, what did? One obvious possibility is that Crete was invaded by the Mycenaeans, or perhaps even by Therans fleeing the effects of the eruption. The trouble with that, as Doumas has pointed out, is that "it is not well supported by the mythological evidence. In the Minoan tradition, nowhere is a battle described."

A second possibility is that Minoan civilization was torn apart by internal strife. But this too doesn't seem to fit the facts. "The evidence is completely in the other direction," says Warren. "At the moment of its destruction, the society appears to have been a harmonious one." In the absence of written records, the real cause of the Minoan downfall may never be known.

Almost as unsatisfying as this effect without a cause is a cause without an effect. Did the Theran cataclysm, enormous as it was, really do no more than destroy the abandoned homes of the people living on the flanks of the volcano? In searching for a broader impact, some researchers have turned to the Bible. Perhaps, they have suggested, the author of Exodus had Theran ash in mind when he described the ninth plague as "darkness upon the land of Egypt, even darkness which may be felt." In 1986 two Smithsonian Institution geologists, Daniel Jean Stanley and Harrison Sheng, reported finding a fine layer of ash in Nile River sediments; they speculated that the ash might have come from Thera. Doumas speaks cautiously of the eruption's having a "possible concordance with events mentioned in the Bible."

Such theories have long been dismissed by biblical scholars, and in any case they are virtually untestable. What we can hope to know about the events in the Aegean between the seventeenth and fifteenth centuries B.C. may never seem quite as satisfying as the mythical possibilities. What we now know is this: A grand civilization collapsed, for reasons that elude us; a grand volcano exploded, but its wider impact seems to have been slight. ❑

Former DISCOVER staff member Allan Chen now edits an in-house publication for the Intel Corporation.