Santorini volcanic ash found in Egypt

Today towns of brilliantly white houses cling to the tranquil but steep cliffs of the partially collapsed volcano called Santorini in the southern Aegean Sea of Greece. But 3,500 years ago the volcano raged with a fury at least comparable to the 1883 eruption of Krakatoa, whose blast was heard 1,500 kilometers away and whose ash cloud extended 50 km into the sky. Santorini's massive eruption may have given rise to the Atlantis legend and is thought to have destroyed the Minoan civilization on Crete, 120 km to the south.

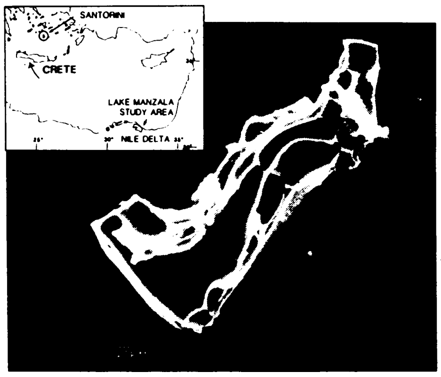
In spite of the 13 to 18 cubic km of material ejected by Santorini, until recently no traces of the ash had been found on land south of Crete. Last week, however, at the Geological Society of America meeting in Orlando, Fla., two researchers reported the southernmost find of Santorini volcanic ash grains — microscopic glass shards—along Egypt's northern coast, 800 km southeast of Santorini.

Daniel Jean Stanley and Harrison Sheng of the Smithsonian Institution's National Museum of Natural History in Washington, D.C., discovered the ash grains in four cores taken from the banks of Lake Manzala in the Nile Delta. The researchers had searched for a year, sorting through hundreds of thousands of silt grains, before they found 12 volcanic shards. Microprobe and scanning electron microscope analyses revealed that the chemical makeup of the ash grains closely coincides with that of the ashes that cover Santorini.

Stanley and Sheng dated the grains by interpolating the radiocarbon dates of core mud layers lying 1 meter above and below the ash layers. They obtained an age of about 3,500 years, which falls right in the range of eruption dates estimated for Santorini by others. "It's right on the button," says Stanley.

According to Stanley, the find confirms that Santorini produced a tremendously powerful blast and that the ash cloud covered a wide area including Egypt. The site of the new discovery extends the pattern mapped by previous finds in deep-sea cores, indicating that the Santorini ash was carried southeast by winds. Stanley suspects that the grains found in Egypt survived because they had been dropped into a quiet coastal environment; grains dropped farther offshore were probably carried away by strong ocean currents or masked by large sediment deposits from the Nile.

The new find also adds some scientific spark to a long-standing debate among archaeologists and historians over the date of the Israelites' exodus from Egypt, for which the Bible notes: "... for three days there was deep darkness over the whole land of Egypt" (Exodus 10:21). Many biblical scholars have maintained that the exodus took place around 1200 B.C., while others have suggested a date closer to 1450 B.C. Stanley believes that some of the ash that darkened Egyptian skies now provides the strongest nonarchaeological evidence in favor of the latter theory by offering a radiocarbon-based date of about 1500 B.C. —*S. Weisburd*



Smithsonian

Smithsonian SEM Lab

Twelve grains of volcanic ash thought to have come from Santorini's eruption in 1500 B.C. were discovered in northern Egypt. The scanning electron micrograph shows one of the micron-scale grains. Researchers plan to hunt through 17 newly drilled Egyptian sediment cores for additional Santorini ash.

Asteroid origin of the Everglades?

A crowd of earth scientists, eager to hear Edward J. Petuch's saga of how the Everglades formed, packed the lecture room at last week's Geological Society of America meeting in Orlando, Fla. What enticed so many people was Petuch's idea that the evolution of the United States' largest tropical wetland began when an asteroid slammed into the region 36 million years ago, at the end of the Eocene epoch.

However, at least one crater specialist in the audience remained unconvinced. "There are seeds of something very interesting in his talk, but I don't think it points to an impact," observes Gene Shoemaker of the U.S. Geological Survey in Flagstaff, Ariz.

The Everglades is a swampy and forested area surrounded by an oval-shaped system of ridges upon which most of southern Florida's cities sit. "The general consensus has been that the Everglades is a surficial [surface] feature, a little puddle or very shallow basin produced...in the Holocene [the epoch of the last 1 million years] as groundwater etched down into the limestone and sand built up around the rim," says Petuch, a paleontologist at Florida International University in Miami. But now, drawing on nine years of his own field work and the data of others, Petuch presents a much different picture.

He and Jack Meeder of the University of Miami in Coral Gables, Fla., recently discovered that a giant, oval-shaped coral reef, dating from the Pliocene epoch 6 million years ago, is buried beneath the rim surrounding the Everglades. "My curiosity was really stimulated," says Petuch. "No other carbonate platforms [limestone beds] in the world have anything comparable to this."

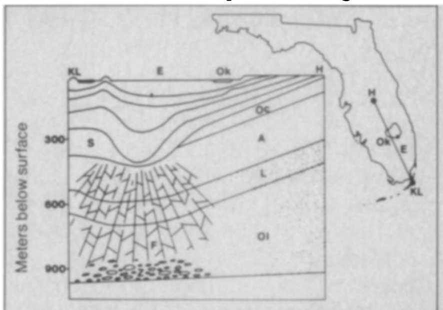
So Petuch started poring through the literature. He found that the layer of limestone formed 25 million years ago, during the Oligocene epoch, dipped under the southern tip of the Everglades; at its lowest point, other scientists had measured a magnetic field strength greater than 25 times that of the surrounding region. Then Petuch discovered that 250 to 300 meters of the next-deepest section, originally laid down about 40 million years ago, during the Eocene epoch, were missing over most of the southern part of the Everglades. Other scientists had noted that an extensive network of fractures in the rocks works its way up through the Eocene layers but then abruptly stops.

For Petuch, all of this adds up to an impact. Near the end of the Eocene, he postulates, an asteroid slammed into the limestones covered by about 180 meters of water, fracturing rocks and generating enormous tidal waves that may have swept away much of the nearby Eocene sediment. Perhaps a piece of the asteroid became lodged in the crater, or the impact induced molten rock to well up from the underlying mantle. Either of these events might explain the anomalous magnetic field readings obtained today. Petuch thinks the Everglades basin actually formed during the next epoch, the Oligocene, when the sea level dropped about 300 meters and the climate became much colder. Groundwater percolating down the limestone may have leached out the mineral gypsum, weakening the limestones and causing the collapse of a basin about one-third the size of the present Everglades.

Petuch proposes that as the world warmed at the end of the Oligocene, coral reefs began to form around the essentially circular collapsed basin. But as sea level rose, the reefs grew toward the north, where the ground was higher. Petuch thinks that by 4 million years ago, this process had caused the reef system to elongate into an oval that completely enclosed an area much larger than either the original crater or collapsed basin. Sediment and sand filled in the Everglades basin, built up the coral atoll and eventually connected the atoll to the mainland.

What really convinced Petuch of the impact idea, he says, were studies of the Eocene-Oligocene boundary layer in the Caribbean island of Barbados. Scientists had found that this layer contains high levels of iridium (an element abundant in extraterrestrial bodies but rare on earth) but none of the silicate spherical particles called tektites that are usually created when an asteroid collides with continental rocks. Petuch argues that had an asteroid bombarded the carbonate rocks under Florida, carbon dioxide and calcium oxide would have been produced. And since calcium oxide grains are water soluble, any trace of them at the Eocene-Oligocene layer would have long ago dissolved, leaving only the iridium dust.

While Shoemaker has no quarrel with Petuch's scenario from the growth of the coral reefs onward, he doesn't think there is evidence for an impact. He argues that



At right, dark ridges surround the oval-shaped Everglades. The stippled area represents the missing Eocene layer. Petuch thinks an asteroid hit near the Everglades' southern tip, creating the fracture zone and leading to the sedimentary patterns shown in the cross section above. (Letters refer to geologic formations and geographic locations.)

George Valcarce/Fla. International Univ.

the proposed asteroid would have deposited material outside the crater and would not have wiped away the Eocene layers. He also contends that chunks of asteroids are never found buried beneath craters and that the magnetic anomaly in Florida is not consistent with the way impacts are known to alter the magnetic fields of rocks.

Petuch says he welcomes other theories explaining the Florida magnetic anomaly, but he thinks the impact idea is the only plausible one now in the running. "This is the last place in the world you'd expect to see such an anomaly, because the nearest igneous rock [that would have a magnetic signal] is over 5 miles straight down through solid limestone," he observes. Moreover, he argues that the bulk of impact research to date has focused on craters in continental crust and that the record of an impact may look considerably different in carbonate rocks. The Florida impact could represent "a whole class of craters to itself, completely different from any other one known," he says.

If Petuch is proved wrong, he has, at the very least, raised some tantalizing questions about the geology of Florida—questions that he hopes will inspire more field work. And if he is right, he should expect standing-room-only crowds for some time to come. —*S. Weisburd*

Switching-on genes in development

Studies of the simplest gene system in plants and animals are drastically changing scientists' ideas of how genes work in complex organisms, Donald D. Brown of the Carnegie Institution in Baltimore reported last week at the National Institutes of Health in Bethesda, Md. Whether these genes are active or silent, he has found, depends both on the folding of DNA with proteins into its characteristic "chromatin" structure and on the stable binding of particular proteins to a site in the center of the gene. This mechanism of gene control is quite different from that of bacteria, which previously was the only such mechanism described at this level of detail. Gene regulation is a basic puzzle of modern biology, with implications for all aspects of how organisms function.

Brown and his colleagues studied two families of genes found in the African clawed toad, *Xenopus laevis*. Each gene encodes a small RNA molecule, called 5S ribosomal RNA, which is part of the cellular organelle that makes protein. The two families of genes are called the oocyte (egg cell) genes and the somatic (body) genes. The families differ in about six positions among the 120 nucleotides that make up each gene.

In the toad egg cell, or oocyte, all of the 5S ribosomal RNA genes are active. But because there are 20,000 oocyte genes and only 400 somatic genes, the oocyte form of 5S ribosomal RNA predominates. In contrast, in somatic cells of the toad, the somatic genes are 1,000 times as active as the oocyte genes.

A two-tiered system governs the activity of the oocyte gene, Brown reports. The top tier involves chromatin, the natural chromosomal structure in which the DNA is condensed with proteins called histones. Brown's team has developed a new test that measures the activity of chromatin, rather than just naked DNA. When the chromatin from somatic cells is dipped into a solution containing all the required components, the somatic genes are expressed and the oocyte genes remain repressed, as in the intact cell.

The scientists next disrupted the chromatin structure, dissociating the DNA from the histone H1. The result was a massive synthesis of the oocyte form of 5S ribosomal RNA. Brown concludes that the repressed state of this gene and others is maintained by the interaction between DNA and histone H1.

The second tier of gene control relies on three proteins that Brown calls transcription factors A, B and C. These proteins must bind to the center of the gene, forming a "transcription complex," before the enzyme called polymerase III begins making new RNA.

The surprising finding about this transcription complex is its stability. It remains in place for many rounds of RNA synthesis. Somehow the complex avoids being knocked off the DNA as the polymerase works its way along the gene. "The polymerase goes through the transcription complex as if it were butter," Brown says.

In recent experiments, Brown and his colleagues demonstrated that the presence of a transcription complex underlies the specific activity of the oocyte gene. In the region where the factors bind, the oocyte and somatic genes differ by three nucleotides out of 50. The A factor, they find, binds more strongly to the somatic than to the oocyte gene. This discrimination is most evident in situations where there is limited factor. In the oocyte there are 10,000,000 factor A molecules per 5S ribosomal RNA gene, but in the somatic cell there is only one factor A molecule for every five of these genes.

The intriguing question now is whether the transcription complex is the "memory" that maintains the activity state of the gene from one cell generation to the next. If so, it might be the basis by which—as an organism differentiates — various cell lines become committed to expressing different patterns of gene activity.

—*J.A. Miller*

Paying attention at many levels

An animal is continuously bombarded with sensory input — all the sights, sounds, smells and skin sensations delivered by the environment. Somehow the brain selects from this barrage the relatively few stimuli important for the animal's immediate behavior. This essential screening occurs at many levels within the brain. But surprisingly, scientists now report, the screening process begins before the signals reach the brain's complex processing centers, perhaps even before they reach the brain.

"The screening occurs right when information comes into the central nervous system, not as some higher function of the cortex," Mary C. Bushnell of the University of Montreal reported last week in Dallas at the meeting of the Society for Neuroscience. The new data stem from scientists' increased ability to study awake animals trained in particular tasks.

In their recent experiments, Bushnell and Ronald Dubner of the National Institute of Dental Research in Bethesda, Md., trained monkeys to press a button to begin a trial, to wait for a cue and then to release the button to get a juice reward. Each monkey learned to recognize two cues—a light signal and small increase in heat from a heating element on its face.

The scientists recorded the electrical activity of nerve cells that receive input from the face's pain receptors. These cells