**Massive tsunami that struck centuries ago could recur**

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COURTESY GERARD FRYER / UNIVERSITY OF HAWAI‘I

Hundreds of years ago a giant tsunami deposited the equivalent of nine shipping containers worth of debris into the Makauwahi sinkhole southwest of Lihue, according to a study by Hawaii researchers. The sinkhole was discovered by David Burney, former director of the National Tropical Botanical Garden on Kauai, in 1992.

Scientists studying a sinkhole above the coast of Kauai have concluded that it was inundated by a tsunami from a magnitude-9.25 earthquake in the eastern Aleutian Islands.

And a similar disaster could happen again, they warn.

The Hawaii researchers conclude a wall of water 30 feet high hit the isles between 1425 and 1665.

"You're going to have great earthquakes on planet Earth, and you're going to have great tsunamis," said Rhett Butler, a geophysicist at the University of Hawaii at Manoa and lead author of the study published online recently in Geophysical Research Letters. "People have to at least appreciate that the possibility is there."
Key to the conclusion is the debris -- nine shipping containers worth -- that the giant "paleotsunami" deposited into the Makauwahi sinkhole southwest of Lihue.

The tsunami was at least three times the size of the April 1, 1946, tsunami that killed 159 people in Hawaii. That was generated by a magnitude-8.6 quake in the Aleutians.

Gerard Fryer, a geophysicist at the Hawaii-based Pacific Tsunami Warning Center, estimated quakes the size of the one that inundated the sinkhole happen once every 1,000 years.

That translates to a 0.1 percent chance per year, the same probability for the March 2011 quake that hit Japan, Fryer said.

Still, the research has prompted officials to take another look at tsunami evacuation maps to account for the possibility of such extreme events. The new maps, due out by the end of the year, would more than double the area of evacuation in some locations, Fryer said in a statement last week.

The Makauwahi sinkhole, a limestone cave whose roof collapsed about 7,000 years ago, was discovered by study co-author David Burney, the former director of the National Tropical Botanical Garden on Kauai, in 1992.

Nearly 7 feet below the surface inside, he found coral fragments, mollusk shells and sand that could only have come from the ocean. But the coast is 328 feet away and the sinkhole has 24-foot-high walls.

Burney figured that sedimentary layer could have been deposited only by a massive tsunami.

But it was not until the 2011 Japan quake that his theory gained momentum.

In Japan, water surged inland like a fast-acting tide, reaching heights of 128 feet above normal sea level.

That quake "was bigger than almost any seismologist thought possible," said Butler. "Seeing the devastation it caused, I began to wonder, did we get it right in Hawaii? Are our evacuation zones the correct size?"

The maps are based largely upon the 1946 tsunami, which caused water to rise only 8 feet up the side of the Makauwahi sinkhole.

Butler and colleagues used computer models to figure out what it would take to deposit the debris inside Makauwahi. They considered local submarine
landsides, a meteor strike on the ocean's surface, and large quakes in Kamchatka, the Alaskan Peninsula, and the Andreanof Islands, in the western Aleutians, where a magnitude-8.3 quake in March 1957 generated small tsunamis around the isles.

None of them worked as well as a 9.2 quake in the eastern Aleutians. Inundation models showed such a quake could produce water levels on the shore that reached 26 to 30 feet high, easily topping the Makauwahi sinkhole wall.

Using radiocarbon dating, Butler and colleagues also showed that marine deposits from Sedanka Island, near Dutch Harbor off the coast of Alaska, and along the west coasts of Canada and the United States date back to the same time period as the Makauwahi deposits. Specifically, nine sites from British Columbia to Oregon have a matching range of dates.

So all could have come from the same tsunami, according to the study.

Robert Witter, a geologist at the U.S. Geological Survey in Anchorage, said the research "stitched together geological evidence, anthropological information as well as geophysical modeling to put together this story that is tantalizing for a geologist but it's frightening for people in Hawaii."

However, Witter, who was not involved in the study, said all three locations offer evidence of a great tsunami occurring between 350 and 575 years ago, but it is hard to know if it was the same tsunami or ones that occurred decades apart.

"I'm absolutely convinced it's a tsunami, and it had to be a monster tsunami," said Fryer, who was not involved in the study but who visited the sinkhole with Butler in February 2013.

"We prepared ourselves for the worst tsunami that's likely to happen in 100 years," Fryer said of the current tsunami evacuation maps, based on the 1946 waves. "What hit Japan was a 1,000-year event ... and this scenario a 1,000-year event."

The National Oceanic and Atmospheric Administration operates buoys near the Aleutians under its DART program, which stands for Deep-ocean Assessment and Reporting of Tsunamis. There are no other sensors that can characterize a potentially great tsunami from the Aleutians as it propagates toward Hawaii, the report says.

David Walsh of the Pacific Tsunami Warning Center was the third author of the study.
EVIDENCE OF A SUPER TSUNAMI
The Makauwahi sinkhole, a limestone cave complex on Kauai, holds evidence that a massive tsunami struck Hawaii about 500 years ago. Only a huge wave, scientists contend, could have overtopped the wall of the sinkhole and deposited shells, sand and other ocean debris inside. A new study concludes that material must have been washed into the hole by a tsunami from a magnitude-9.25 earthquake in the eastern Aleutian Islands. The graphic below shows the tsunami energy directed at Hawaii from such a quake, with Kauai at the center of the red circle. The age of the Kauai deposits also matches those found at nine sites from British Columbia to Oregon, meaning all could have come from the same Pacific-wide wave.

Source: Geophysical Research Letters

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