

Post-Tsunami Earthquakes Rumbled Around the Globe

By [KENNETH CHANG](#)

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The shock waves from December's giant earthquake set off devastating tsunamis. They also set off a series of temblors nearly 7,000 miles from the epicenter in the Indian Ocean.

One hour after the earthquake struck off the Indonesian island of Sumatra on Dec. 26, seismometers that keep watch over Mount Wrangell in Alaska recorded an unusual pattern: 14 earthquakes over 11 minutes.



B. Cella, National Park Service, 1987
Fourteen earthquakes over 11 minutes were recorded at Mount Wrangell in December.

The small quakes, up to magnitude 2.0, coincided with a train of shock waves from Sumatra. When the ground pulled apart slightly, Mount Wrangell shuddered.

"Pulsing, if you will, in sync with the waves from Sumatra," said Dr. Michael E. West, a seismologist at the Alaska Volcano Observatory.

Mount Wrangell is a huge 14,000-foot-high volcano - "It has little pimples on the side of it that are the size of Mount St. Helens," Dr. West said - in southern Alaska, and while it has not erupted in historic times, it regularly spews out steam, and small earthquakes are common.

The findings by Dr. West and his colleagues appear in the current

issue of the journal *Science*, part of a package of scientific papers describing the earthquake, which ruptured more than 800 miles of

the sea floor in the eastern Indian Ocean.

The earthquake started about 180 miles south of Banda Aceh, the hard-hit city on Sumatra, and the fault broke to the north-northwest. At first, the fault broke relatively slowly for an earthquake: 2,000 miles per hour. At a bend in the fault to the west of Banda Aceh, the breakage sped up to 5,000 to 6,000 m.p.h. and continued to the Nicobar Islands. The shaking lasted 10 minutes.

North of the Nicobar Islands, hundreds of miles of the fault also slipped, but the slippage occurred so slowly, an hour or longer, that it did not generate seismic waves as it tilted and lifted the Andaman Islands.



The New York Times

"That is something we have not observed before," said Dr. Thorne Lay, a professor of earth sciences at the University of California, Santa Cruz, and the lead author of one of the articles in Science. "It tells us there is frictional behavior on these faults that we don't understand."

That slow slippage also contributed to the tsunamis, Dr. Lay said, although less than if the fault had broken quickly. That is also partly why the earthquake, initially measured at magnitude 9.0, is now regarded as having been between magnitude 9.1 and 9.3.

The largest earthquake ever recorded was a magnitude 9.5 earthquake in Chile in 1960. A magnitude 9.2 earthquake occurred in Alaska in 1964. But the Sumatra earthquake "is the longest rupture we've ever seen," said Dr. Roger Bilham, a professor of geological sciences at the University of Colorado who wrote an article in Science summarizing the other papers.

Dr. Bilham calculated that the movement, pushing the Indo-Australian tectonic plate up to 50 feet beneath the Eurasian plate, reduced the size of the Indian Ocean enough to raise sea level by 0.5 millimeters globally, and the quake released the energy equal to a billion tons of TNT.

The shock waves, with wavelengths of hundreds of miles, traveled around the world, lifting and dropping the earth's rocky crust by at least half an inch. Vibrations of the entire earth, ringing like a bell, continued for days and weeks afterward.

Twenty years ago, seismologists doubted that an earthquake, even a large one, could unhinge a distant fault. Then, in 1992, an earthquake with a magnitude of 7.3 in Landers, Calif., was followed by a series of small earthquakes in Mammoth Lakes, Calif., nearly 300 miles away, and at Yellowstone National Park, 800 miles away. An earthquake with a magnitude of 7.9 in Denali, Alaska, showed that the triggering could extend farther, setting off quakes in Yellowstone, 2,000 miles distant.

Now, with Sumatra, "This tells us that earthquake triggering can happen on a global scale," Dr. West said. "We're learning the earth is a far more connected place than we once thought it was."

The triggered earthquakes observed to date have all been small and in volcanically active areas that appear to be more sensitive to rumblings in the ground. Seismologists still doubt that one earthquake can set off a major earthquake on a different fault. "There's no reason to think that they could," Dr. West said. "I think there's no precedent for it."