

# Potential for large earthquake off coast of Sumatra remains large

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The subduction zone that brought us the 2004 Sumatra-Andaman earthquake and tsunami is ripe for yet another large event, despite a sequence of quakes that occurred in the Mentawai Islands area in 2007, according to a group of earthquake researchers led by scientists from the Tectonics Observatory at the California Institute of Technology (Caltech).

"From what we saw," says geologist Jean-Philippe Avouac, director of the Tectonics Observatory and one of the paper's lead authors, "we can say with some confidence that we're probably not done with large earthquakes in Sumatra."

Their findings were published in a letter in the December 4 issue of the journal *Nature*.

The devastating magnitude 9.2 earthquake that occurred off the western coast of Sumatra on December 26, 2004—the earthquake that spawned a lethal tsunami throughout the Indian Ocean—took place in a subduction zone, an area where one tectonic plate dips under another, forming a quake-prone region.

It is that subduction zone that drew the interest of the Caltech-led team. Seismic activity has continued in the region since the 2004 event, they knew. But have the most recent earthquakes been able to relieve the previous centuries of built-up seismic stress?

Yes . . . and no. Take, for instance, an area just south of the 2004 quake, where a magnitude 8.6 earthquake hit in 2005. (That same area had also been the site of a major earthquake in 1861.) The 2005 quake, says Avouac, did a good job of "unzipping" the stuck area in that patch of the zone, effectively relieving the stresses that had built up since 1861. This means that it should be a few centuries before another large quake in that area would be likely.

The same cannot be said, however, of the area even further south along that same subduction zone, near the Mentawai Islands, a chain of about 70 islands off the western coasts of Sumatra and Indonesia. This area, too, has been hit by giant earthquakes in the past (an 8.8 in 1797 and a 9.0 in 1833). More recently, on September 12, 2007, it experienced two earthquakes just 12 hours apart: first a magnitude 8.4 quake and then a magnitude 7.9.

These earthquakes did not come as a surprise to the Caltech researchers. Caltech geologist and paper coauthor Kerry Sieh, who is now at the Nanyang Technological University in Singapore, had long been using coral growth rings to quantify the pattern of slow uplift and subsidence in the Mentawai Islands area; that pattern, he and his colleagues knew, is the result of stress build-up on the plate interface, which should eventually be released by future large earthquakes.

But was all that accumulated stress released in 2007? In the work described in the Nature letter, the researchers analyzed seismological records, remote sensing (inSAR) data, field measurements, and, most importantly, data gathered by an array of continuously recording GPS stations called SuGAR (for Sumatra Geodetic Array) to find out.

Their answer? The quakes hadn't even come close to doing their stress-reduction job. "In fact," says Ali Ozgun Konca, a Caltech scientist and the paper's first author, who did this work as a graduate student, "we saw

release of only a quarter of the moment needed to make up for the accumulated deficit over the past two centuries." (Moment is a measure of earthquake size that takes into account how much the fault slips and over how much area.)

"The 2007 quakes occurred in the right place at the right time," adds Avouac. "They were not a surprise. What was a surprise was that those earthquakes were way smaller than we expected."

"The quake north of this region, in 2005, ruptured completely," says Konca. "But the 2007 sequence of quakes was more complicated. The slippage of the plates was patchy, and it didn't release all the strain that had accumulated."

"It was what we call a partial rupture," adds Avouac. "There's still enough strain to create another major earthquake in that region. We may have to wait a long time, but there's no reason to think it's over."

Source: California Institute of Technology

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