Learning from Earthquakes

April 11, 2012, M 8+ Sumatra Earthquakes

Note: This preliminary report was submitted by EERI member Lori Dengler and is based in part on the USGS Earthquake Summary Poster at http://earthquake.usgs.gov/earthquakes/eqarchives/poster/ and the IRIS Teachable Moment at http://www.iris.edu/hq/retm/#1599. The information is preliminary and subject to change.

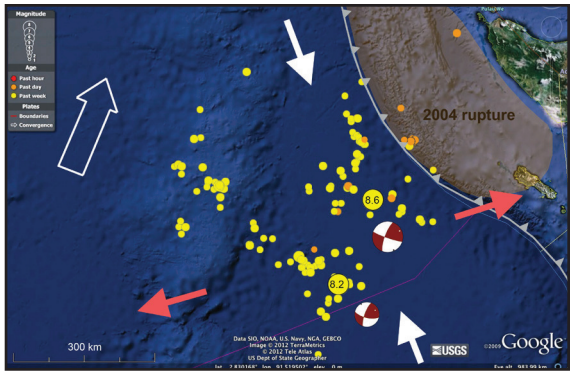
An unusual earthquake sequence began on April 11 at 8:38 UTC with a magnitude 8.6 earthquake offshore of Northern Sumatra. It was located within the Indo-Australian plate about 260 miles southwest of the Aceh coast at a depth of 23 km. A magnitude 8.2 earthquake followed at 10:43 UTC, located further offshore, about 340 miles southwest of the coast. A vigorous aftershock sequence followed, including 51 earthquakes of magnitude 5 or larger (as of 4-22). Rupture for both magnitude 8 earthquakes was nearly entirely strike slip, on either NW trending right-lateral or NE trending left-lateral faults. The preferred causative fault orientation is not clear at this time. Aftershocks following the 8.2 earthquake appear to align on the NW trending right-lateral solution. There are both NW and NE trending aftershock zones in the vicinity of the 8.6 earthquake. Both fault planes are consistent with a maximum compressive stress aligned sub-parallel to the Andaman-Sumatra subduction zone.

This sequence is particularly unusual because of the magnitude, intraplate setting, and strike-slip rupture. It is located within a poorly defined zone of deformation between the Indian and Australian segments of the Indo-Australian plate and near the southern boundary of the region that participated in the December 26, 2004, megathrust rupture.

The largest earthquakes were felt throughout Sumatra and also in Singapore, Malaysia, and in the Nicobar Islands. Damage due to ground shaking was modest. Sutopo Purwo Nugroho, head of Indonesia's national disaster management agency, reported a prison, a bridge and a school dormitory were damaged in Aceh, ten deaths (seven attributed to heart attacks) and 12 injuries primarily attributed to chaotic evacuation.

A tsunami watch was issued by NOAA's Pacific Tsunami Warning Center six minutes after the first earthquake (the highest alert level PTWC can issue for the Indian Ocean). The watch was canceled about four hours later when water level recordings showed that no large tsunami had been generated. At nine of the 18 locations in the Indian Ocean where tide gauges recorded a tsunami signal, a clear second tsunami pulse was recognized that could be attributed to the 8.2 earthquake. The tsunami events were also detected on two deep ocean tsunami sensors (DART) in the Indian Ocean. Twenty-five deep ocean instruments have been deployed in the Indian Ocean in the past five years, but only three were functioning during the April 11 events. The largest amplitude tsunami signal (1.07 meter) was recorded at Meulaboh, Indonesia. The relatively small size of the tsunami is attributed to the strike-slip focal mechanisms of the earthquakes, which produce small vertical sea floor deformations compared to dip-slip earthquakes.

The tsunami warning centers in Indonesia, India, and Thailand ordered evacuations for their coasts soon after the earthquake. There were numerous reports of problems with the evacuation, including sirens that didn't function, gridlock as people used cars to evacuate, confusion over evacuation routes, and jammed cell phone networks. It is fortunate that the April 11 earthquakes did not cause significant ground shaking or tsunami damage. This sequence of earthquakes deserves careful study in order to understand the factors that caused them and to determine whether earthquakes of similar size could occur in other settings.



Google Earth map of the April 11 M_w 8.6 and 8.2 earthquake sequence. The red and white beach balls show the focal mechanisms. Solid white arrows: the approximate direction of maximum compressive stress. Red arrows: the least compressive stress based on the P-axis orientations of the focal mechanisms. Open white arrow: the convergence direction of the Indian plate relative to a fixed Eurasian plate.

Announcement

Quake Summit 2012

Quake Summit 2012, the annual meeting of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), sponsored by the National Science Foundation, will be held July 9-12 jointly with the 2012 NSF Engineering Research and Innovation Conference, sponsored by the Division of Civil, Mechanical and Manufacturing Innovation and hosted by Northeastern University in Boston, Massachusetts. The meeting will contain both plenary and concurrent technical sessions, as well as a poster reception for student researchers. All professionals, researchers, funding agencies and other colleagues are encouraged to attend. Registration is first-come, first-served, so register soon. For more information, visit http://nees.org/quakesummit2012