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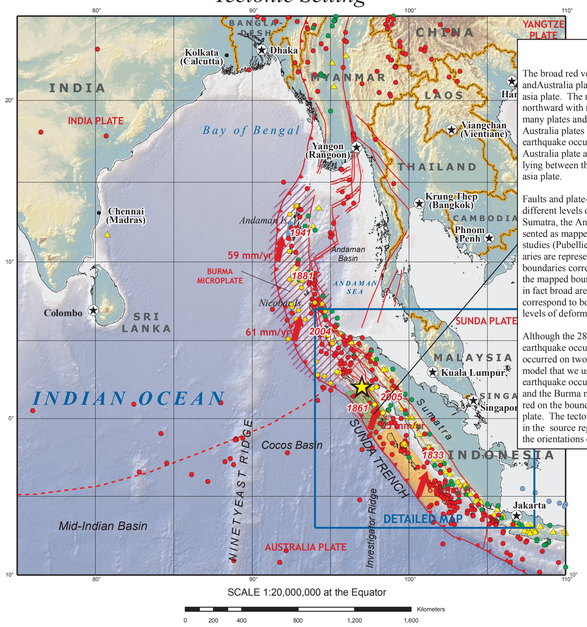
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

EARTHQUAKE SUMMARY MAP XXX

Prepared in cooperation with the Global Seismographic Network
GSN

M8.7 Northern Sumatra Earthquake of 28 March 2005

Tectonic Setting



RELATIVE PLATE MOTIONS

The broad red vectors represent the motion of the India andAustralia plates with respect to the interior of the Eurasia plate. The motion of India and Australia generally northward with respect to Eurasia produces motion of many plates and microplates that lie between the India/Australia plates and the Eurasia plate. The 28 March earthquake occurred on the boundary between the Australia plate and the Sunda plate, one of the plates lying between the India/Australia plates and the Eurasia plate.

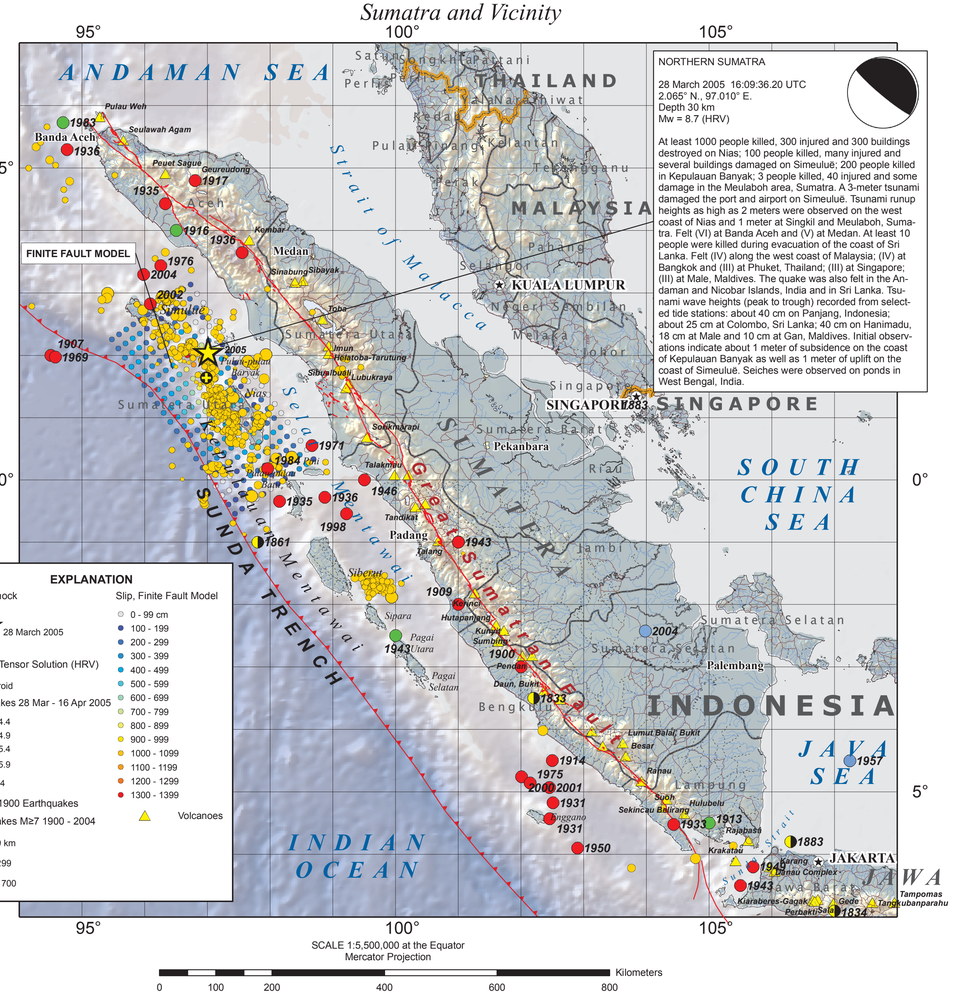
Faults and plate-boundaries in this map are represented at different levels of precision. Within the region of northern Sumatra, the Andaman Sea, and Burma, faults are represented as mapped in regional geologic and oceanographic studies (Pubellier and others, 2003). Elsewhere, plate boundaries are represented very generally. Some of the mapped boundaries correspond to narrow fault zones, but others of the mapped boundaries are line approximations to what are in fact broad areas of distributed deformation, and yet others correspond to boundaries between regions having different levels of deformation.

Although the 28 March 2005 earthquake and the 26 December earthquake occurred near to each other, the two earthquakes occurred on two different plate boundaries in the plate-tectonic model that we use to describe plate motions. The 26 December earthquake occurred on the boundary between the India plate and the Burma microplate, and the 28 March earthquake occurred on the boundary between the Australia plate and the Sunda plate. The tectonic processes at the Sunda trench are very similar in the source regions of the two earthquakes, however, as were the orientations of the earthquakes' faults.

SCALE 1:20,000,000 at the Equator

Kilometers
0 200 400 800 1,200 1,600

Sumatra and Vicinity



NORTHERN SUMATRA

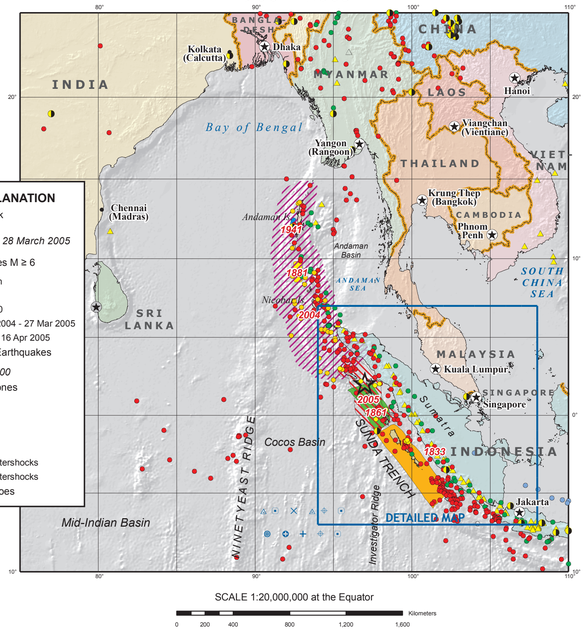
28 March 2005 16:09:36.20 UTC
2.065° N., 97.010° E.
Depth 30 km
Mw = 8.7 (HRV)

At least 1000 people killed, 300 injured and 300 buildings destroyed on Nias; 100 people killed, many injured and several buildings damaged on Simeulué; 200 people killed in Kepulauan Banyak; 3 people killed, 40 injured and some damage in the Meulaboh area, Sumatra. A 3-meter tsunami damaged the port and airport on Simeulué. Tsunami runup heights as high as 2 meters were observed on the west coast of Nias and 1 meter at Singkil and Meulaboh, Sumatra. Felt (VI) at Banda Aceh and (V) at Medan. At least 10 people were killed during evacuation of the coast of Sri Lanka. Felt (IV) along the west coast of Malaysia; (IV) at Bangkok and (III) at Phuket, Thailand; (III) at Singapore; (III) at Male, Maldives. The quake was also felt in the Andaman and Nicobar Islands, India and in Sri Lanka. Tsunami wave heights (peak to trough) recorded from selected tide stations: about 40 cm on Panjang, Indonesia; about 25 cm at Colombo, Sri Lanka; 40 cm on Hanimadu, 18 cm at Male and 10 cm at Gan, Maldives. Initial observations indicate about 1 meter of subsidence on the coast of Kepulauan Banyak as well as 1 meter of uplift on the coast of Simeulué. Seiches were observed on ponds in West Bengal, India.

SCALE 1:5,500,000 at the Equator
Mercator Projection

Kilometers
0 100 200 400 600 800

Seismicity of the Northeast Indian Ocean 1900 - 2005



SCALE 1:20,000,000 at the Equator

Kilometers
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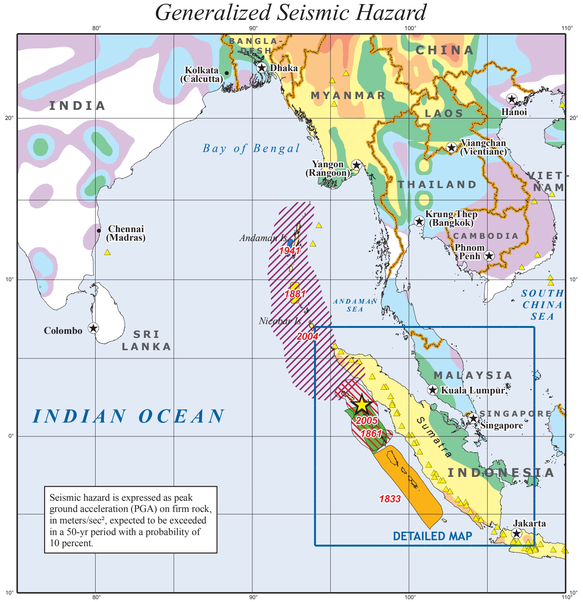
Generalized Seismic Hazard

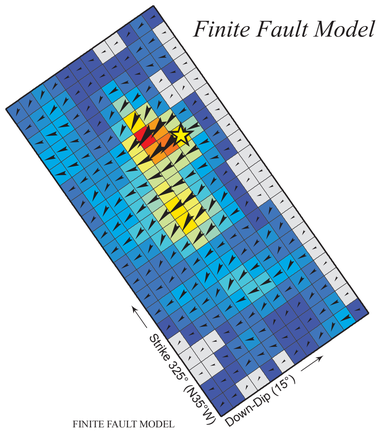


Seismic hazard is expressed as peak ground acceleration (PGA) on firm rock, in meters/sec², expected to be exceeded in a 50-yr period with a probability of 10 percent.

SCALE 1:20,000,000 at the Equator

Kilometers
0 200 400 800 1,200 1,600

Finite Fault Model



FINITE FAULT MODEL
Contributed by
C. Ji, California Institute of Technology

Distribution of the amplitude and direction of slip for subfault elements (small rectangles) of the fault rupture model are determined from the inversion of teleseismic body waveforms. Arrows indicate the amplitude and direction of slip (of the hanging wall with respect to the foot wall); the slip amount is also color-coded as shown. The view is from above, perpendicular to the fault plane.

The fact that the orientation of the finite fault plane may differ from the corresponding best double couple nodal plane depicted in the focal mechanism diagram on the main map reflects differing methods of analysis and data sets.

The strike of the fault rupture plane is 325° (N35°W) and the dip is 15°. The dimensions of the subfault elements are 20 km in the strike direction and 16 km in the dip direction.

DISCUSSION

The earthquake of 28 March 2005 occurred principally on the interface of the Australia plate and Sunda plate and was caused by the release of stresses that develop as the Australia plate subducts beneath the overriding Sunda plate. The Australia plate begins its descent into the mantle at the Sunda trench, which lies to the southwest of the earthquake's epicenter. At this latitude, the trench is the surface expression of the plate interface between the Australia plate and the Sunda plate.

In the region of the earthquake, the Australia plate moves toward the northeast at a rate of about 5 cm/year relative to the Sunda plate. This results in oblique convergence at the Sunda trench. The oblique motion is partitioned into thrust-faulting, which occurs on the plate-interface and which involves slip directed perpendicular to the trench, and strike-slip faulting, which occurs several hundred kilometers northeast of the trench and involves slip directed parallel to the trench. The 28 March earthquake occurred as the result of thrust faulting.

This earthquake was likely triggered by stress changes caused by the 26 December 2004 (M9.0) earthquake. However, it occurred on a segment of the fault 100 miles (160 kilometers) to the southeast of the rupture zone of the M9.0 Sumatra earthquake.

The most recent magnitude 8+ earthquake in the immediate region of this earthquake occurred in 1861. The 1861 earthquake generated a regionally destructive tsunami. Another earthquake of similar magnitude occurred farther south in 1833.

DISCLAIMER

Base map data, such as place names and political boundaries, are the best available but may not be current or may contain inaccuracies and therefore should not be regarded as having official significance.

DATA SOURCES

EARTHQUAKES AND SEISMIC HAZARD
USGS, National Earthquake Information Center
NOAA, National Geophysical Data Center
IASPEI, Centennial Catalog (1900 - 1999) and extensions (Engdahl and Villaseñor, 2002)
HDF (unpublished earthquake catalog) (Engdahl, 2003)
Global Seismic Hazard Assessment Program

PLATE TECTONICS AND FAULTS
PB2002 (Bird, 2003)
Pubellier and others, 2003
Historical rupture zones (Zachariasen and others, 1999; Ortiz and Bilham, 2003)

VOLCANOES
Smithsonian Institution, Global Volcano Program

BASE MAP
NIMA and ESRI, Digital Chart of the World
USGS, EROS Data Center

OTHER SOURCES
Associated Press
UN Office for Coordination of Humanitarian Affairs (OCHA)

REFERENCES

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Map prepared by U.S. Geological Survey
National Earthquake Information Center
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Map not approved for release by Director USGS