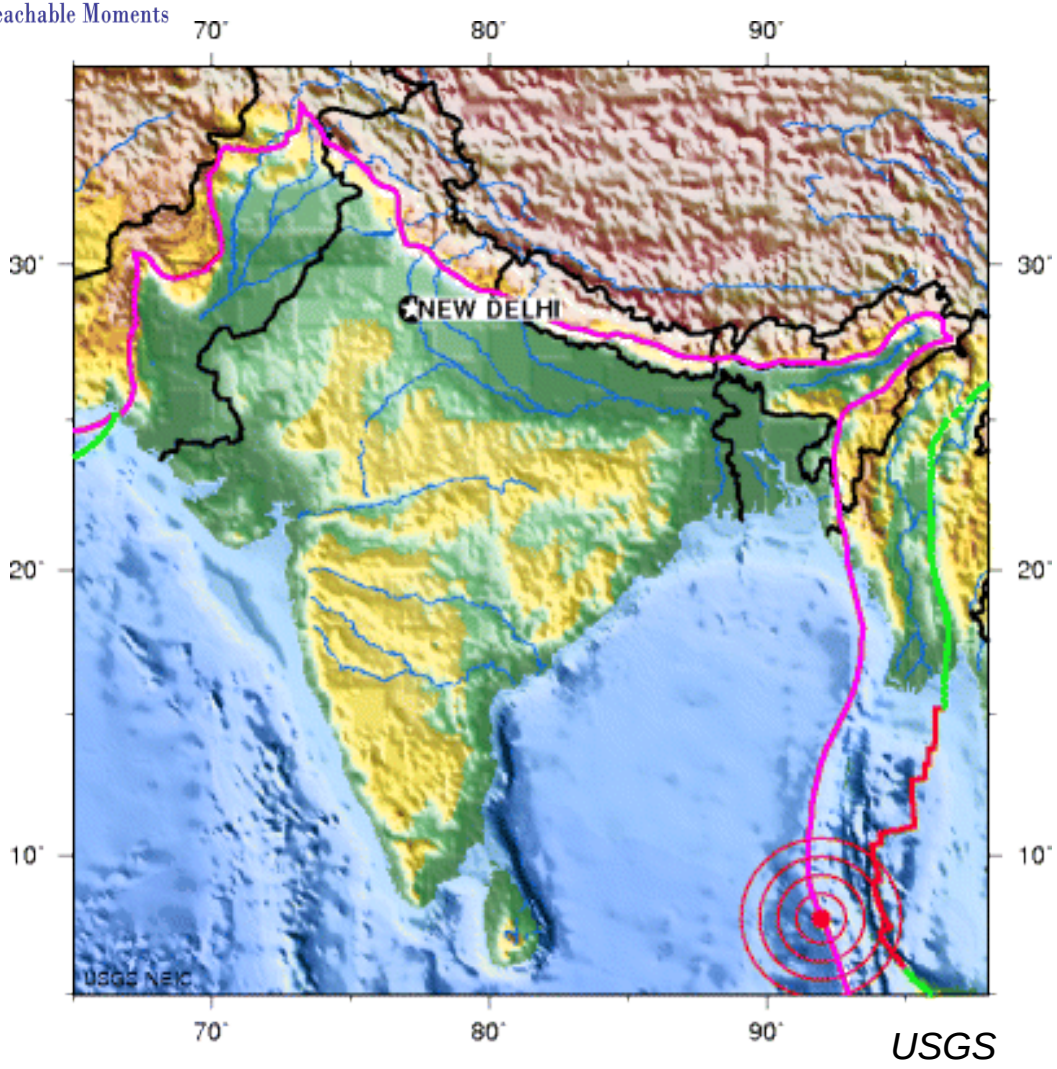
Magnitude 7.5 NICOBAR ISLANDS, INDIA REGION

Saturday, June 12, 2010 at 19:26:50 UTC

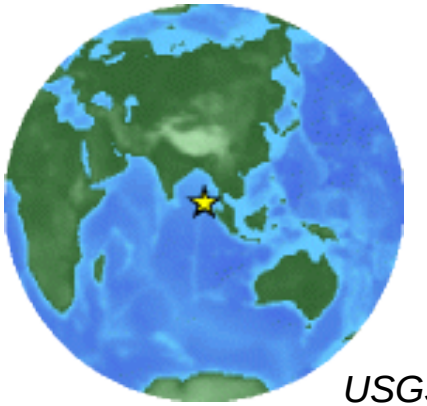


USGS

NICOBAR ISLANDS, INDIA REGION

2010 06 12 19:26:50 UTC 7.75N 91.94E Depth: 35.0 km, Magnitude: 7.5

Earthquake Location



USGS

A major earthquake occurred Saturday 155 km (95 miles) west of Mohean in the Nicobar Islands region north-northwest of northern Sumatra.

Light ground shaking was reported in Sumatra, the Andaman Islands, on Sri Lanka, and across the east coast of India.

Images courtesy of the U.S. Geological Survey

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The epicenter of the earthquake is indicated by the red star. The orange line on this map is the surface trace of the plate boundary where the Australia – Indian Plate subducts below the Sunda microplate (= southeast promontory of the Eurasian Plate) at a rate of 60 mm/yr (6 cm/yr).

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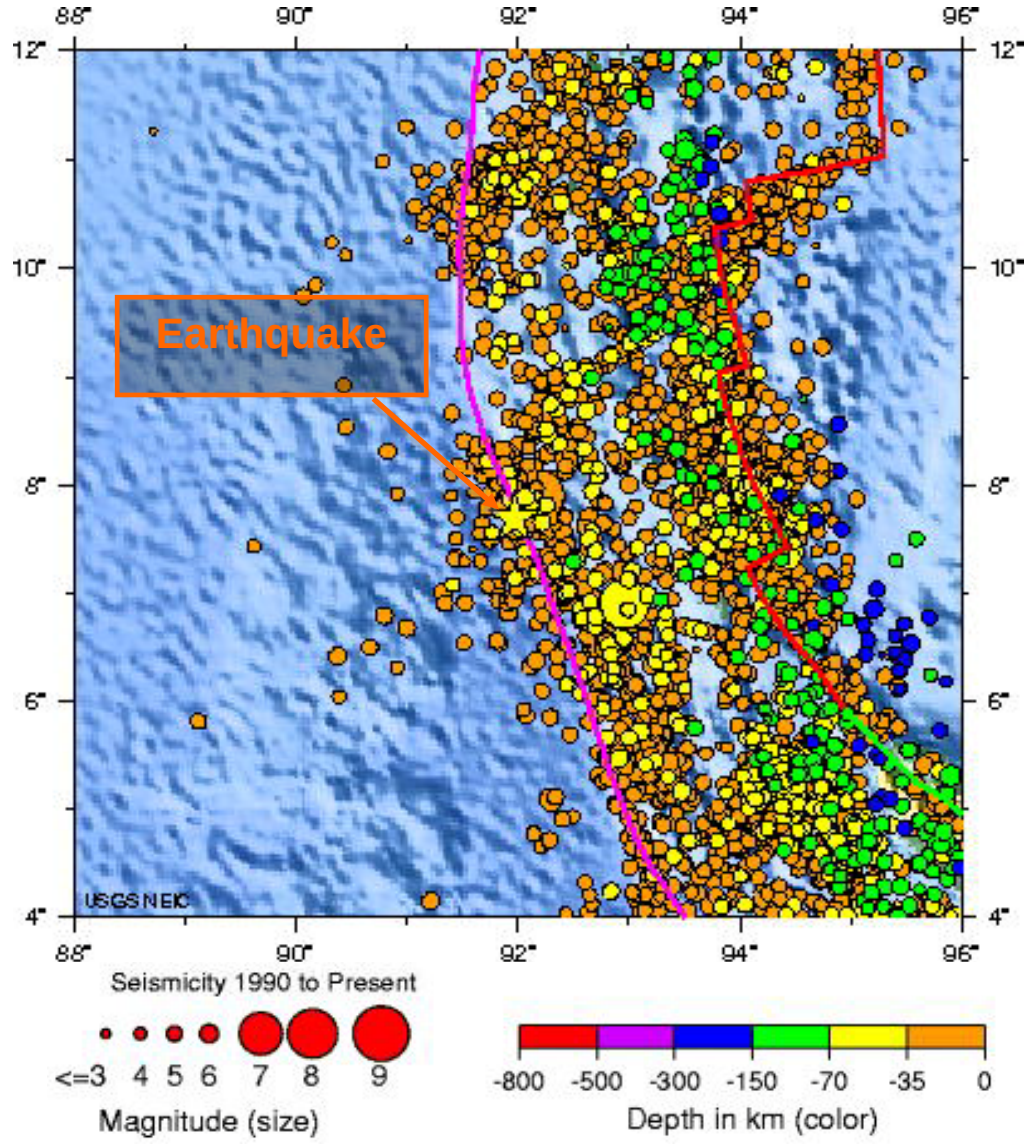

Image courtesy of the U.S. Geological Survey

This map shows historic earthquake activity near the epicenter (yellow star) from 1990 to present. This region has seen much earthquake activity over the past six years beginning with the great M 9.1 earthquake of December 26, 2004 that generated the devastating Indian Ocean tsunami. That 2004 great earthquake ruptured along the boundary between the Australia – Indian Plate and the Sunda microplate for a distance of >1000 km, including the patch of the subduction zone where the June 12, 2010 earthquake occurred.

Early this year, the plate boundary to the south of the June 12, 2010 event experienced two major earthquakes (M 7.7 on April 6 and M 7.2 event on May 9).

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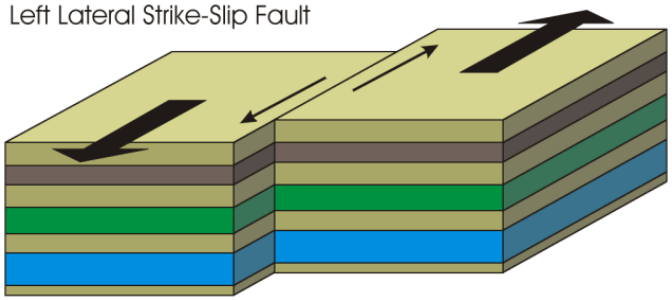
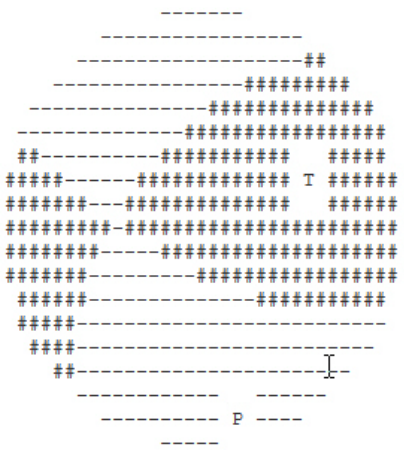
Earthquake depths increase from southwest to northeast across this plate boundary. The June 12, 2010 earthquake may have occurred on the interface between the Australia – Indian Plate and the Burma microplate or within the Australia – Indian Plate very near the plate boundary.



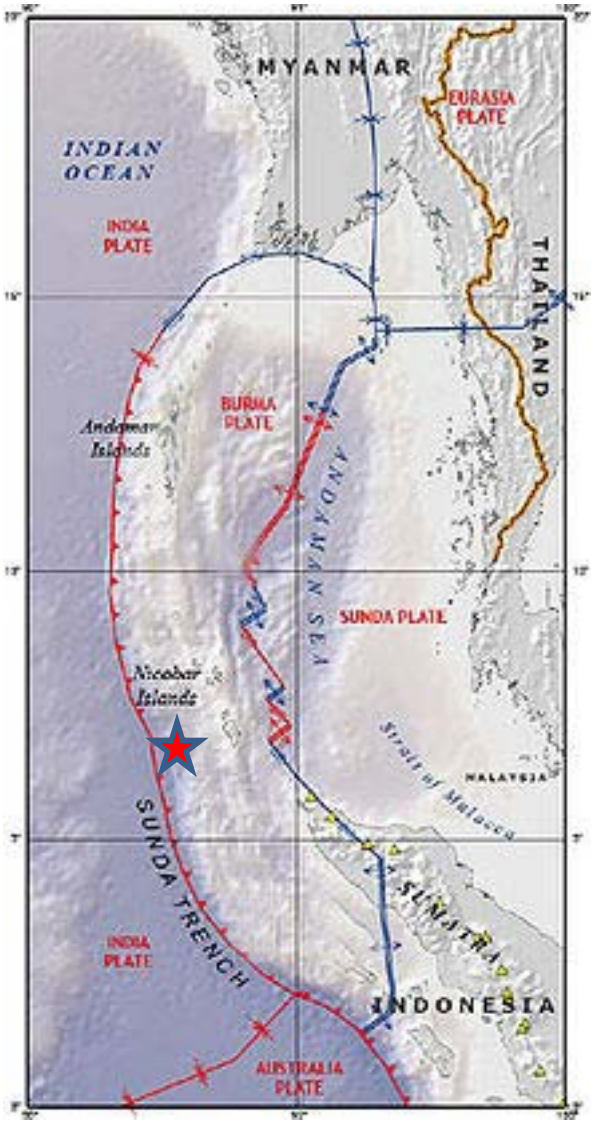
USGS

The focal mechanism implies this earthquake was strike slip.



USGS Centroid Moment Tensor Solution

The tension axis (T) reflects the minimum compressive stress direction. The pressure axis (P) reflects the maximum compressive stress direction.



USGS

Images courtesy of the U.S. Geological Survey

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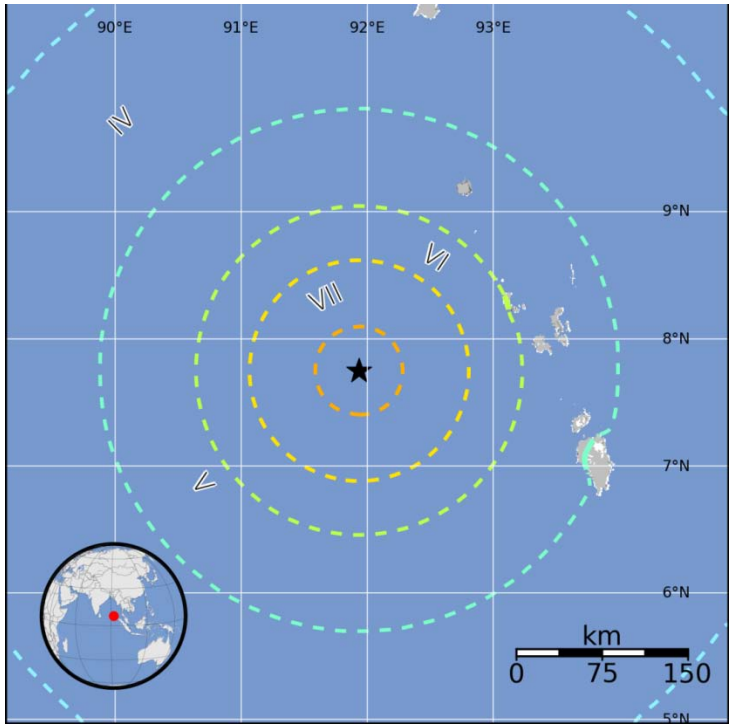


USGS

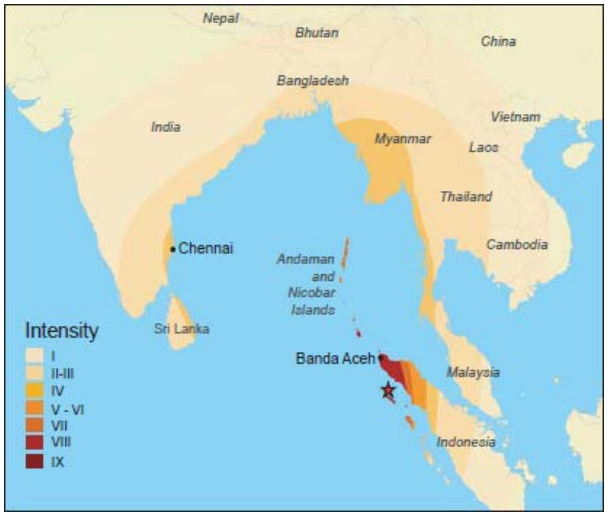
Estimated Population Exposed to Earthquake Shaking

Modified Mercalli Intensity (MMI) map of the M 7.5 earthquake, showing the limited exposure to shaking and damage from this earthquake.

Est. Modified Mercalli Intensity	Est. Population Exposure	Perceived Shaking	Potential Structure Damage	
			Resistant	Vulnerable
X	0	Extreme	V. Heavy	V. Heavy
IX	0	Violent	Heavy	V. Heavy
VIII	0	Severe	Moderate/Heavy	Heavy
VII	0	Very Strong	Moderate	Moderate/Heavy
VI	2k	Strong	Light	Moderate
V	35k	Moderate	V. Light	Light
IV	13k	Light	none	none
II-III	--*	Weak	none	none
I	--*	Not Felt	none	none

In contrast: 2004 M 9.1

USGS



Modified Mercalli Intensity (MMI) map of the M 9.1 2004 earthquake, showing violent shaking and heavy damage (MMI level IX) on the western coast of Aceh Province of Indonesia.

Images courtesy of the U.S. Geological Survey

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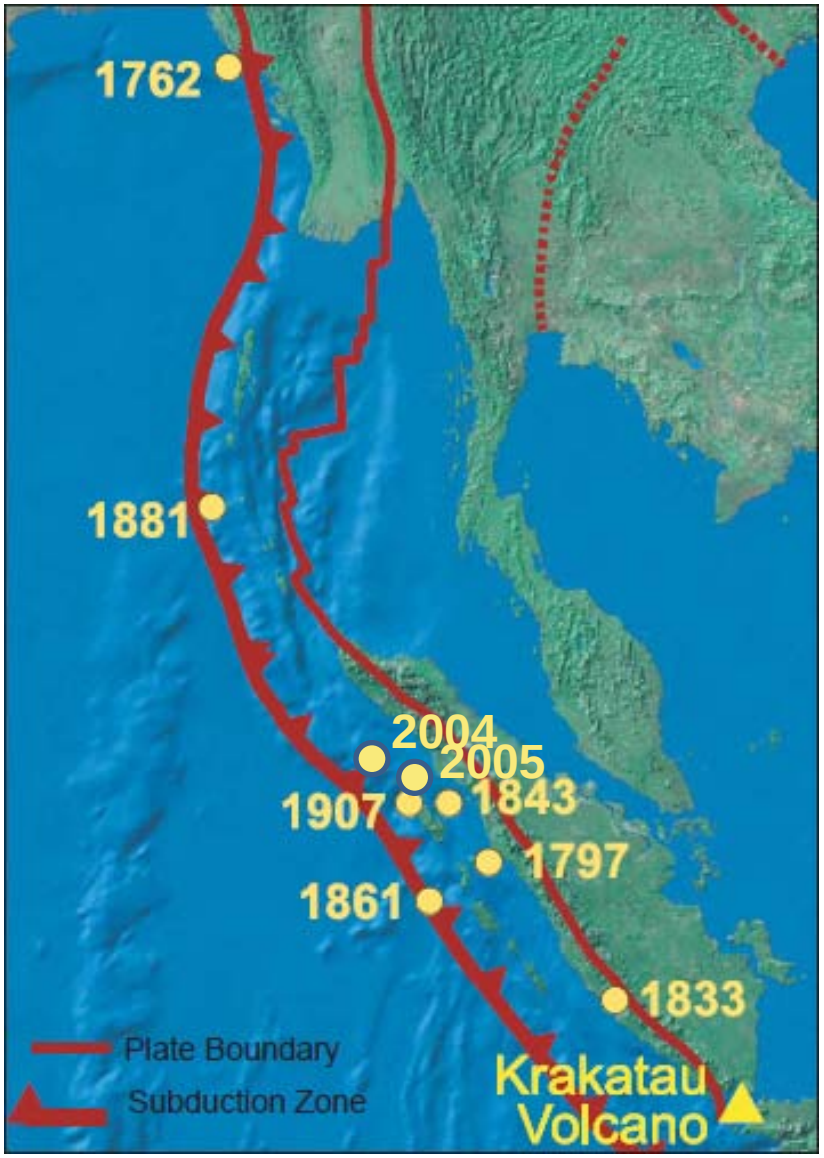
There is a long record of tsunamis affecting the coastlines of the Indian Ocean, principally along the western coast of Sumatra

According to the Pacific Tsunami Warning Center, a regional tsunami watch was initially issued for all areas of the Indian Ocean. However, when the initial magnitude estimate of 7.7 was revised downward to 7.5, the area of the tsunami watch was reduced to only India.

The tsunami watch was later cancelled.



Location of earthquakes and volcanic eruptions that have generated significant tsunamis in the Indian Ocean since 1762

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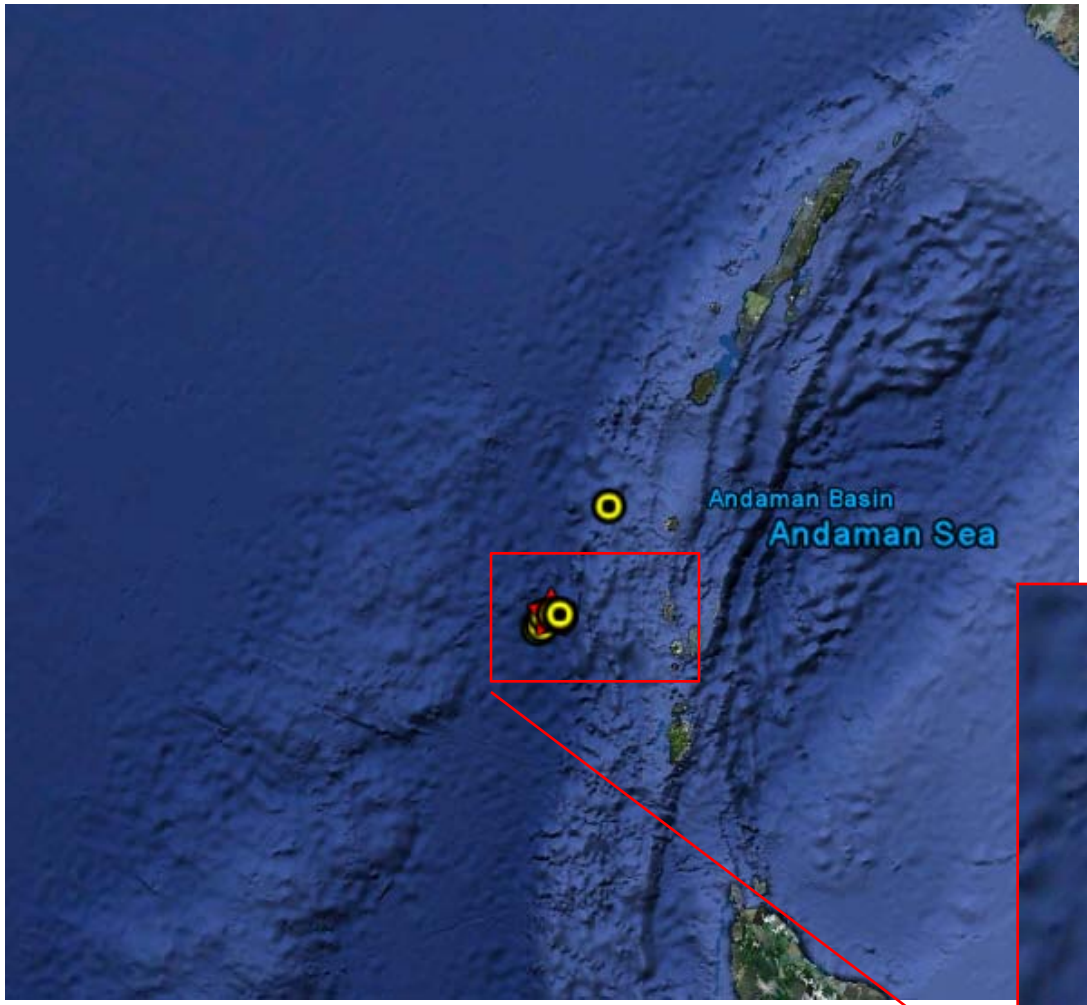
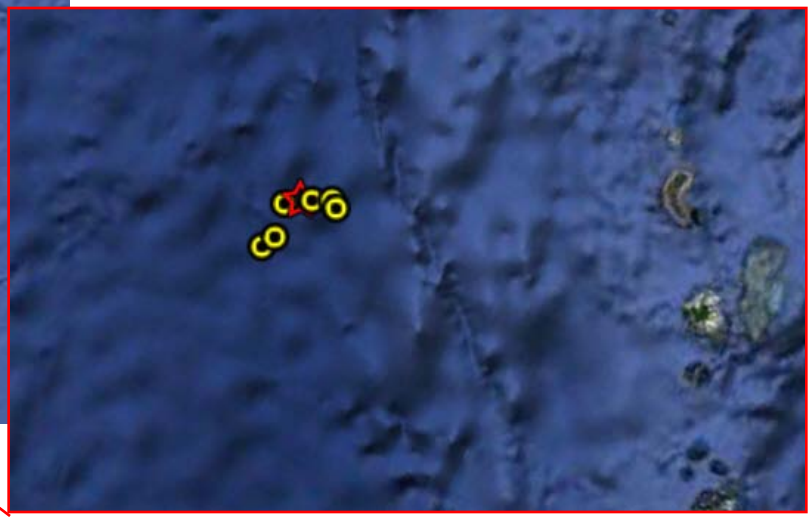
Aftershocks



Google Earth™ mapping service

Aftershocks are earthquakes that follow the largest shock of an earthquake sequence. They are smaller than the mainshock and within 1-2 rupture lengths distance from the mainshock. Aftershocks can continue over a period of weeks, months, or years. In general, the larger the mainshock, the larger and more numerous the aftershocks, and the longer they will continue.



Aftershocks in the first 12 hours following the M 7.5 earthquake

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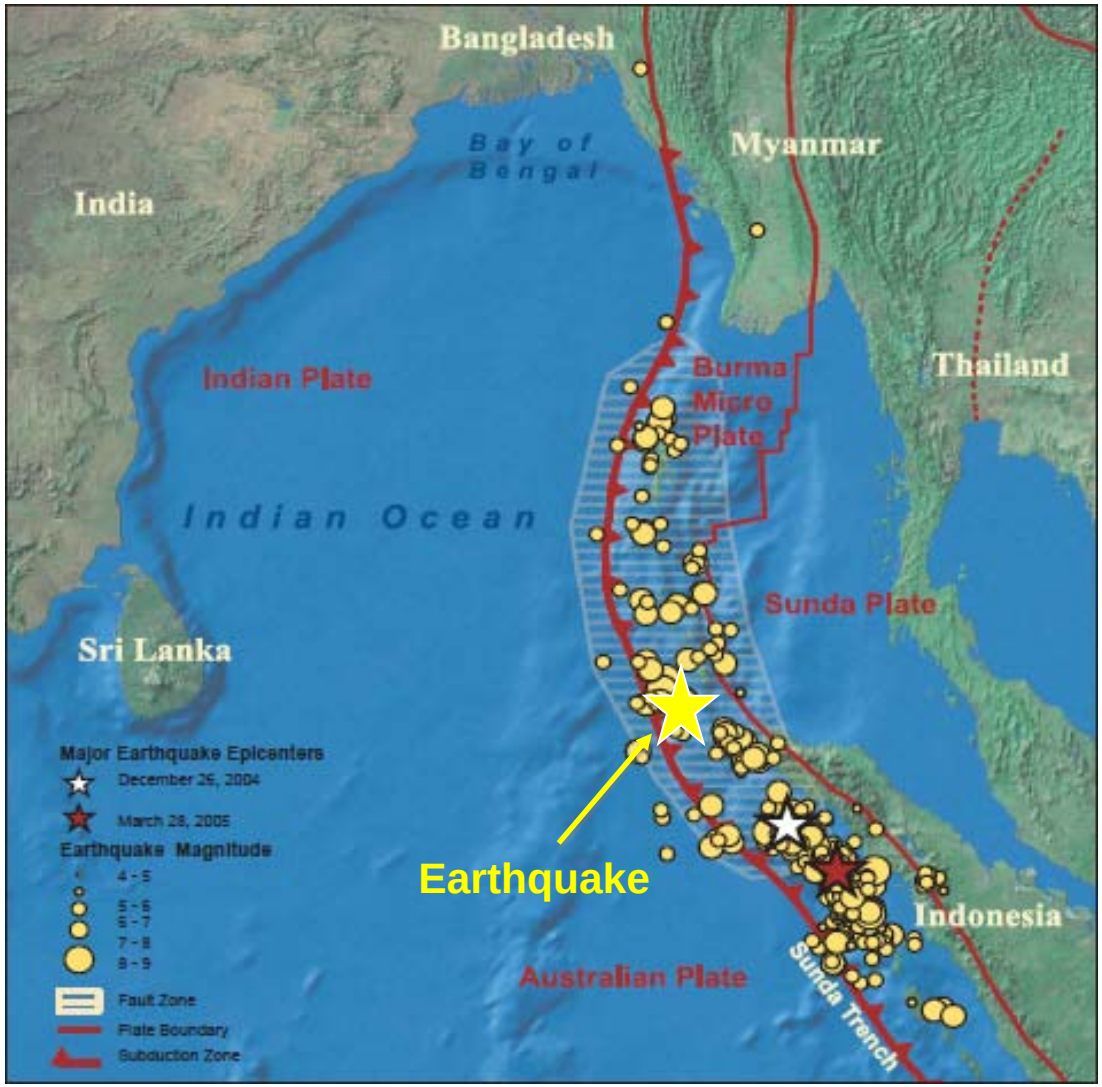
Should this M 7.5 event be considered an "aftershock" of the M 9.1 2004 EQ?

At six years after the M 9.1 event, it becomes arguable whether this M 7.5 should be considered an aftershock. In terms of time since the main shock, the June 12, 2010 earthquake is not within the major swarm of aftershock activity that one expects within hours, days, weeks, and months of the main shock.

However, great earthquakes change the stress on the plate boundary. How subsequent earthquakes within the rupture zone may be "triggered" months or even years after such a great earthquake is a matter of current seismological research.



Map showing the earthquake epicenter, aftershocks, and the extent of the main fault rupture for the M 9.1 December 26, 2004 earthquake (white) and the M 8.7 March 28, 2005 earthquake (red).

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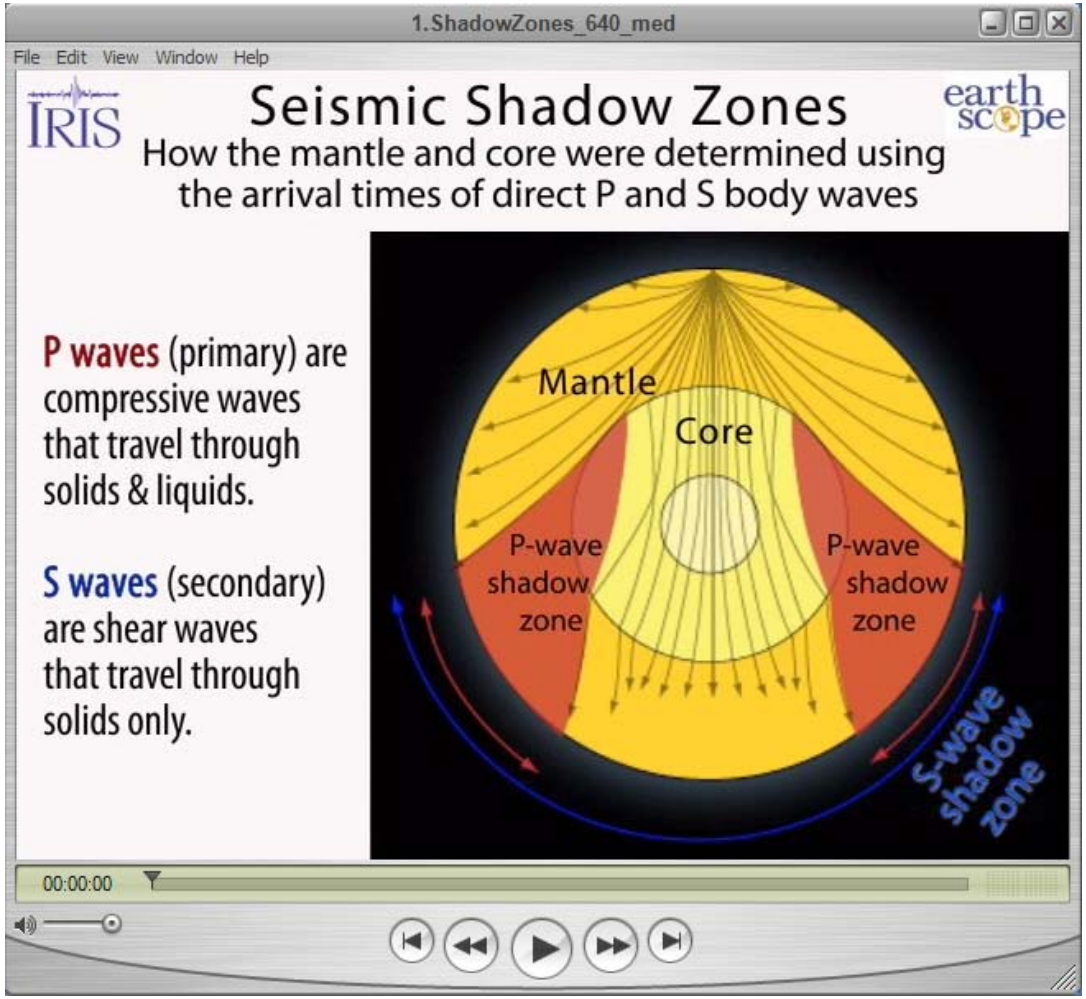

Quick Time Required

Body waves travel through Earth's mantle from the earthquake to a distant station along paths that curve upwards because the velocity of seismic waves generally increase with depth in the mantle. However, direct P and S waves cannot travel to stations more than epicentral distance $\Delta > 103°$ because of the large decrease in wave velocities across the boundary between the mantle and the liquid outer core. This is described as the P-wave shadow zone.

(Epicentral distance, Δ, is the angle formed by the intersection of the line from the earthquake to Earth's center with the line from the observing point to the Earth's center.)

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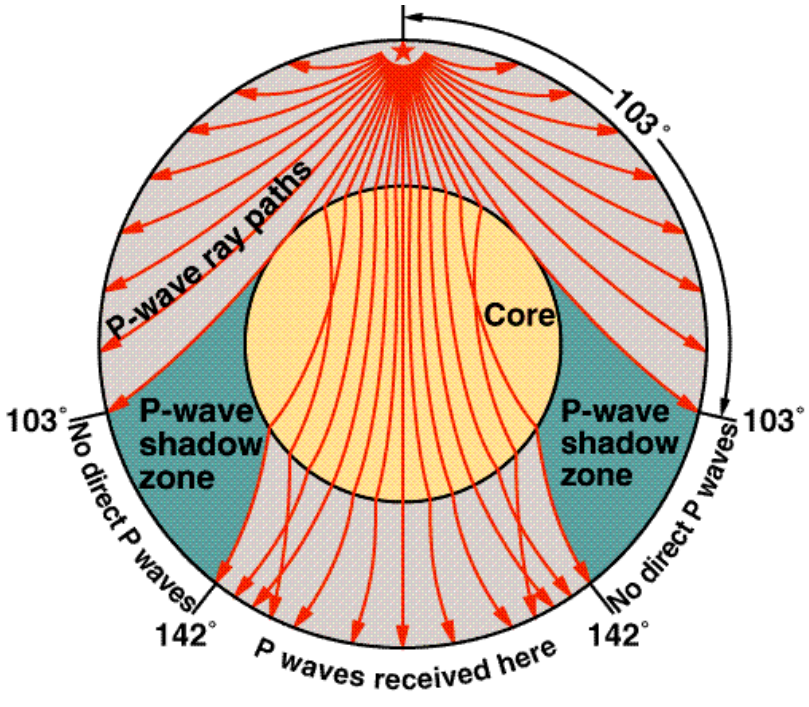
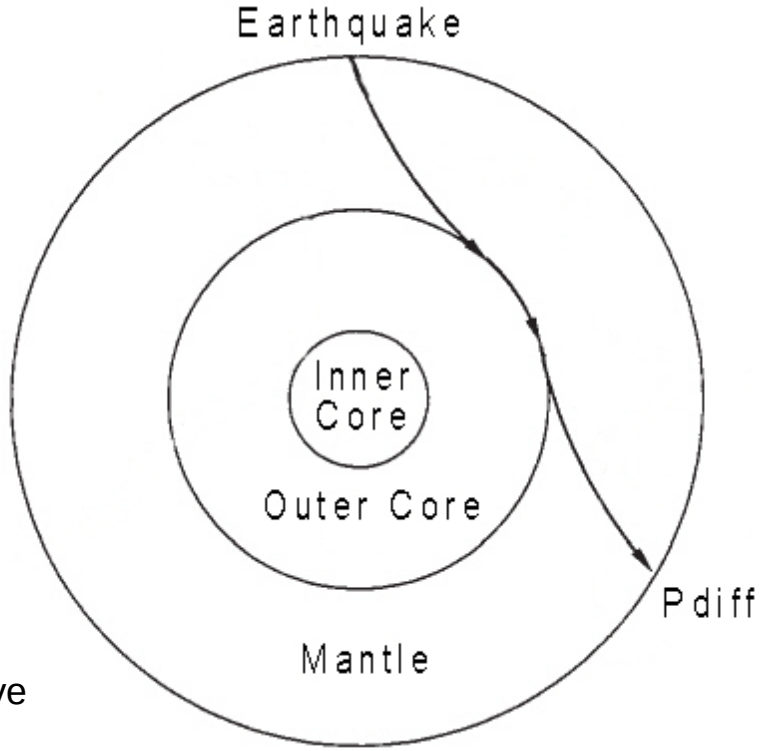


While there are no direct P wave arrivals in the P-wave shadow zone, body wave energy does arrive.

P waves can be diffracted on the core mantle boundary. The first arrival to a station in the shadow zone is the P diffracted wave (Pdiff).



Travel path of the diffracted P wave

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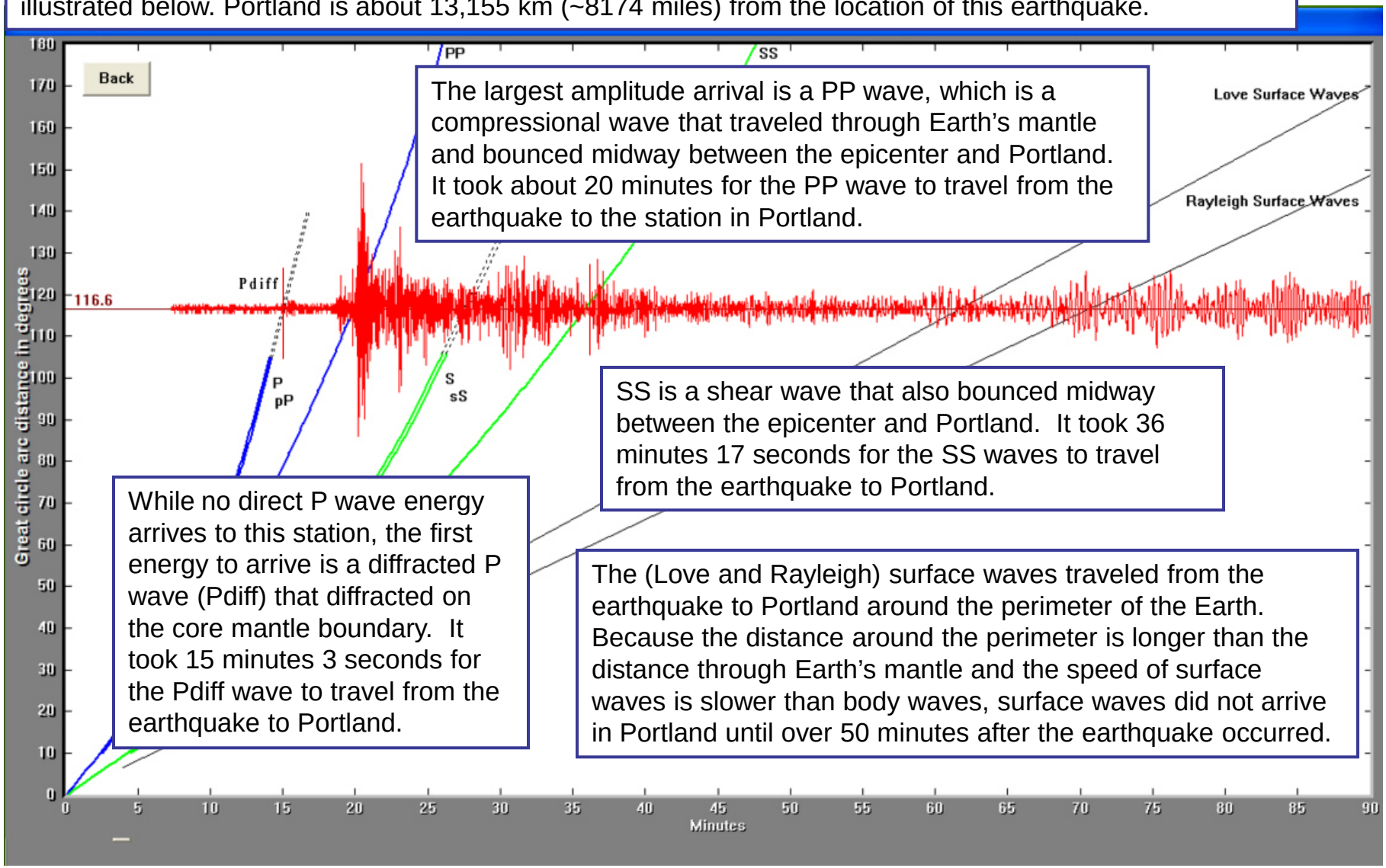
The record of the June 12, 2010 Nicobar Islands earthquake on the University of Portland seismometer is illustrated below. Portland is about 13,155 km (~8174 miles) from the location of this earthquake.



The largest amplitude arrival is a PP wave, which is a compressional wave that traveled through Earth's mantle and bounced midway between the epicenter and Portland. It took about 20 minutes for the PP wave to travel from the earthquake to the station in Portland.

SS is a shear wave that also bounced midway between the epicenter and Portland. It took 36 minutes 17 seconds for the SS waves to travel from the earthquake to Portland.

While no direct P wave energy arrives to this station, the first energy to arrive is a diffracted P wave (Pdiff) that diffracted on the core mantle boundary. It took 15 minutes 3 seconds for the Pdiff wave to travel from the earthquake to Portland.

The (Love and Rayleigh) surface waves traveled from the earthquake to Portland around the perimeter of the Earth. Because the distance around the perimeter is longer than the distance through Earth's mantle and the speed of surface waves is slower than body waves, surface waves did not arrive in Portland until over 50 minutes after the earthquake occurred.

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Quick Time Required

Animation of the generalized path of seismic waves traveling from the Nicobar Islands earthquake to a seismometer in Portland, Oregon