NEWS RELEASE
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The Science behind the Aceh Earthquake

Figure 1

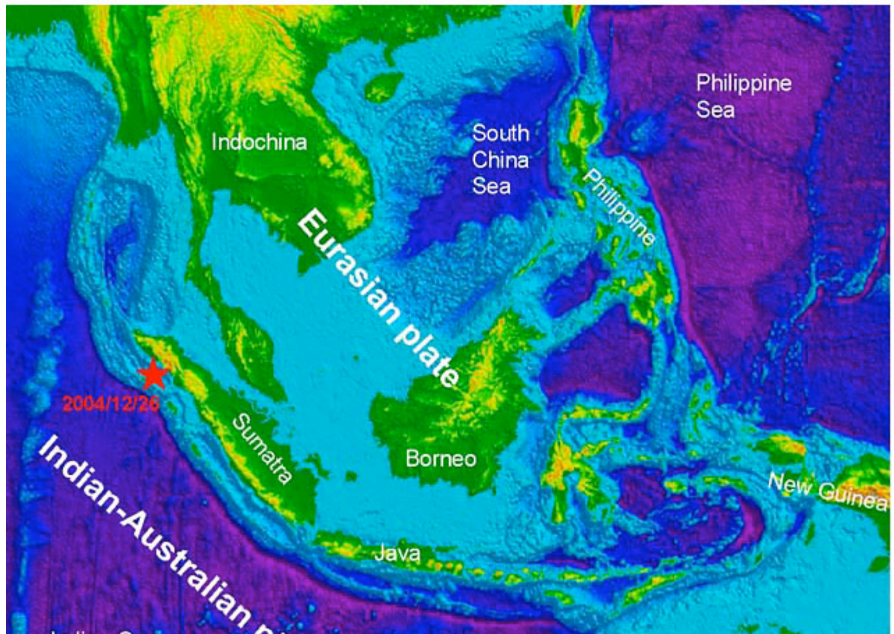
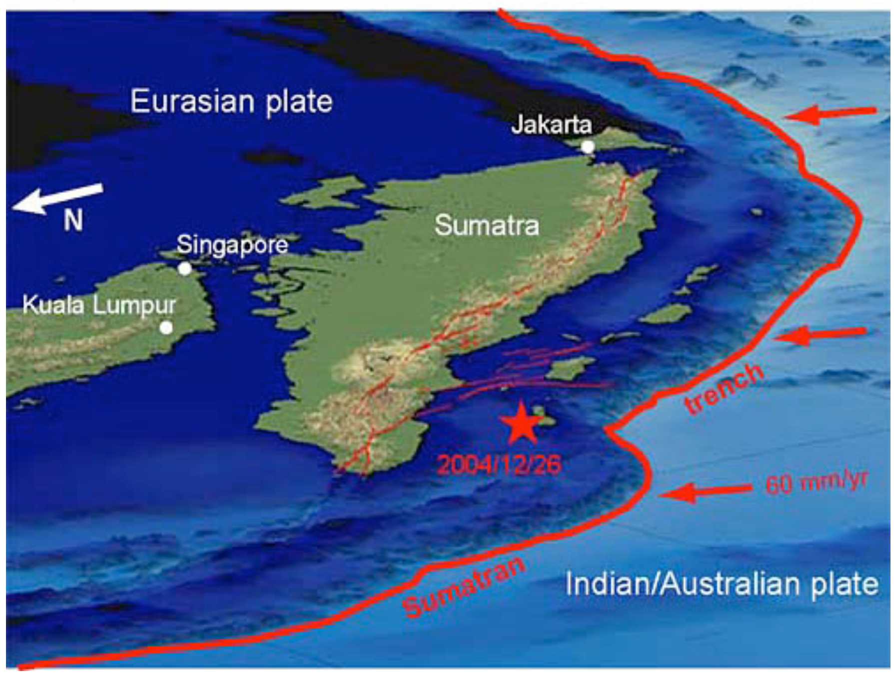


Figure 2

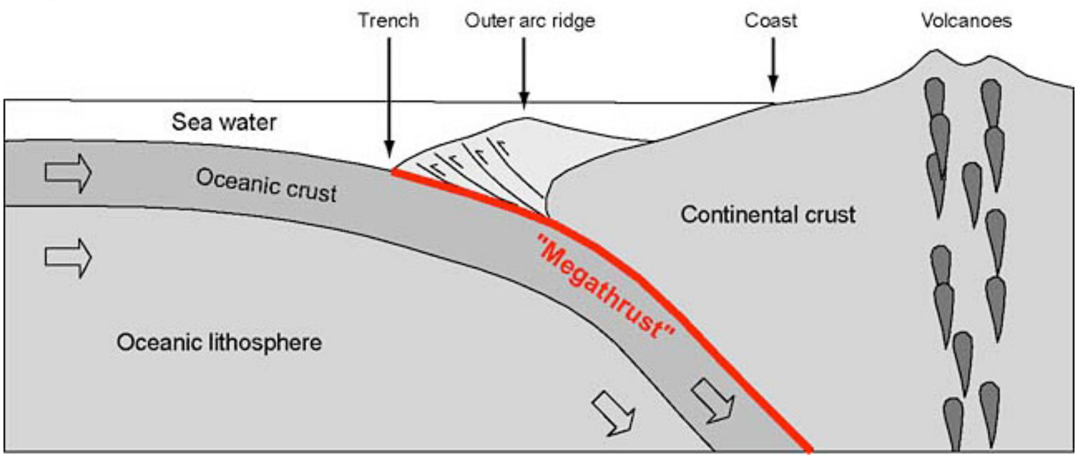


PASADENA, Calif. - Kerry Sieh, the Robert P. Sharp Professor of Geology at the California Institute of Technology and a member of Caltech's Tectonics Observatory, has conducted extensive research on both the Sumatran fault and the Sumatran subduction zone. Below, Sieh provides scientific background and context for the December 26, 2004 earthquake that struck Aceh, Indonesia.

The earthquake that struck northern Sumatra on December 26, 2004, was the world's largest earthquake since the great (magnitude 9.2) Alaskan earthquake of 1964. The great displacements of the sea floor associated with the earthquake produced exceptionally large tsunami waves that spread death and destruction throughout the Bay of Bengal, from Northern Sumatra to Thailand, Sri Lanka, and India.

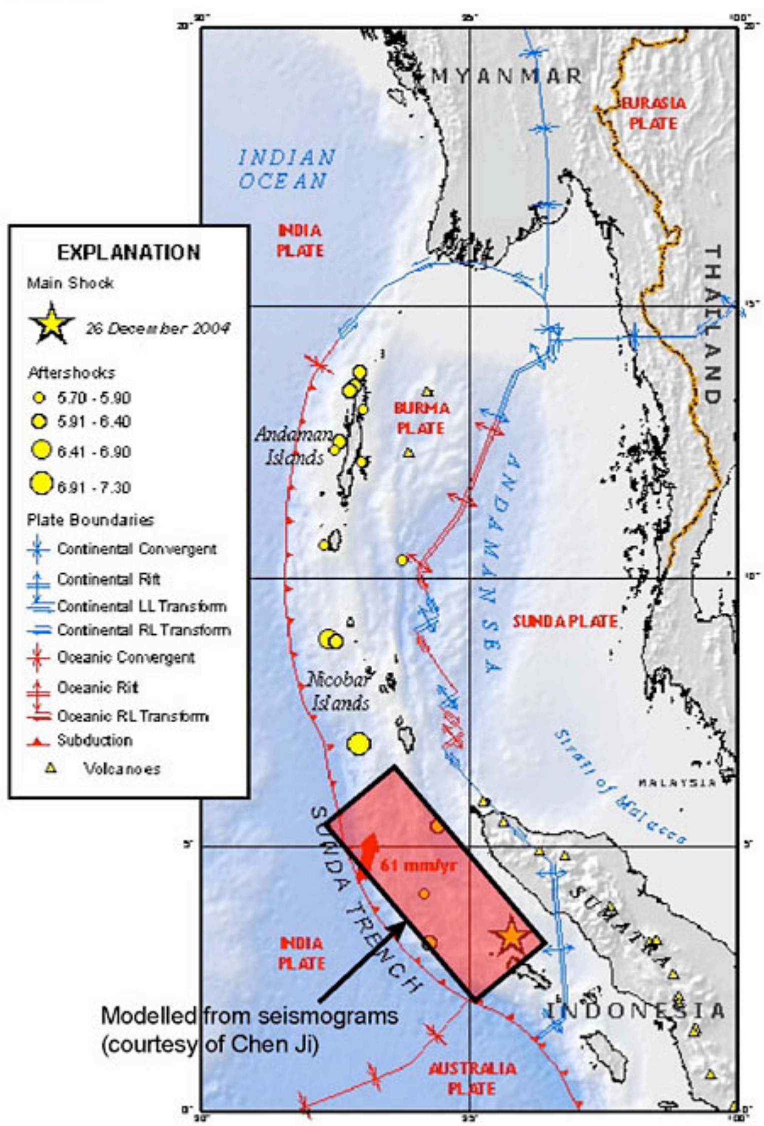
The earthquake originated along the boundary between the Indian/Australian and Eurasian tectonic plates, which arcs 5,500 kilometers (3,400 miles) from Myanmar past Sumatra and Java toward Australia **see Figure 1**. Near Sumatra, the Indian/Australian plate is moving north-northeast at about 60 millimeters (2.4 in.) per year with respect to Southeast Asia. The plates meet 5 kilometers (3 miles) beneath the sea at the Sumatran Trench, on the floor of the Indian Ocean Figure 2. The trench runs roughly parallel to the western coast of Sumatra, about 200 kilometers (125 miles) offshore. At the trench, the Indian/Australian plate is being subducted; that is, it is diving into the earth's interior and being overridden by Southeast Asia. The contact between the two plates is an earthquake fault, sometimes called a "megathrust." Figure 3 The two plates do not glide smoothly past each other along the megathrust but move in "stick-slip" fashion. This means that the megathrust remains locked for centuries, and then slips suddenly a few meters, generating a large earthquake.

Figure 3



History reveals that the subduction megathrust does not rupture all at once along the entire 5,500-kilometer plate boundary. The U.S. Geological Survey reports that the rupture began just north of Simeulue Island **Figure 4**. From the analysis of seismograms, Caltech seismologist Chen Ji has found that from this origin point, the major rupture propagated northward about 400 kilometers (249 miles) along the megathrust at about two kilometers per second. By contrast, the extent of major aftershocks suggests that the rupture extended about a thousand kilometers (620 miles) northward to the vicinity of the Andaman Islands. During the rupture, the plate on which Sumatra and the Andaman Islands sit lurched many meters westward over the Indian plate.

Figure 4



The section of the subduction megathrust that runs from Myanmar southward across the Andaman Sea, then southeastward off the west coast of Sumatra, has produced many large and destructive earthquakes in the past two centuries **Figure 5**. In 1833, rupture of a long segment offshore central Sumatra produced an earthquake of about magnitude 8.7 and attendant large tsunamis. In 1861, a section just north of the equator produced a magnitude 8.5 earthquake and large tsunamis. Other destructive historical earthquakes and tsunamis have been smaller. A segment to the north of the Nicobar Islands ruptured in 1881, generating an earthquake with an estimated magnitude of 7.9. A short segment farther to the south, under the Batu Islands, ruptured in 1935 (magnitude 7.7). A segment under the Enganno Island ruptured in 2000 (magnitude 7.8), and a magnitude 7.4 precursor to the recent earthquake occurred in late 2002, under Simeulue Island.

This recent earthquake was generated by the seismic rupture of only the northernmost portion of the Sumatran section of the megathrust. Therefore, the fact that most of the other part of the section has generated few great earthquakes in more than a hundred years is worrisome. Paleoseismic research has shown that seismic ruptures like the one in 1833, for example, recur about every two centuries. Thus, other parts within the section of this fault should be considered dangerous over the next few decades.

During rupture of a subduction megathrust, the portion of Southeast Asia that overlies the megathrust jumps westward (toward the trench) by several meters, and upward by 1-3 meters (3-10 feet). This raises the overlying ocean, so that there is briefly a "hill" of water about 1-3 meters high overlying the rupture. The flow of water downward from this hill triggers a series of broad ocean waves that are capable of traversing the entire Bay of Bengal. When the waves reach shallow water they slow down and increase greatly in height--up to 10 meters (32 feet) or so in the case of the December 26 earthquake--and thus are capable of inundating low-lying coastal areas.

Although the tsunami waves subside in a short period of time, some coastal areas east of the megathrust sink by a meter or so, leading to permanent swamping of previously dry, habitable ground. Islands above the megathrust rise 1 to 3 meters, so that shallow coral reefs emerge from the sea. Such long-term changes resulting from the December 26 earthquake will be mapped in the next few months by Indonesian geologists and their colleagues.

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Figure 5