briefing note
312
March 2016

March 2, 2016 Earthquake off Sumatra and Breakup of the Australia - India Plate

by Paul Somerville, Risk Frontiers.

On March 2, 2016, an Mw 7.8 earthquake occurred in oceanic lithosphere approximately 600 km to the southwest of the major subduction zone offshore Sumatra (Figure 1) at which the India and Australia plates subduct to the north-northeast beneath the Sunda plate. The oceanic lithosphere in which the earthquake occurred is commonly viewed as part of a broad zone of deformation (Figure 2) that separates the relatively undeformed interiors of the India and Australia plates and that accommodates the motion of the interior of the Australia plate north-northwestward with respect to the interior of the India plate at a velocity of roughly 11 mm/yr.

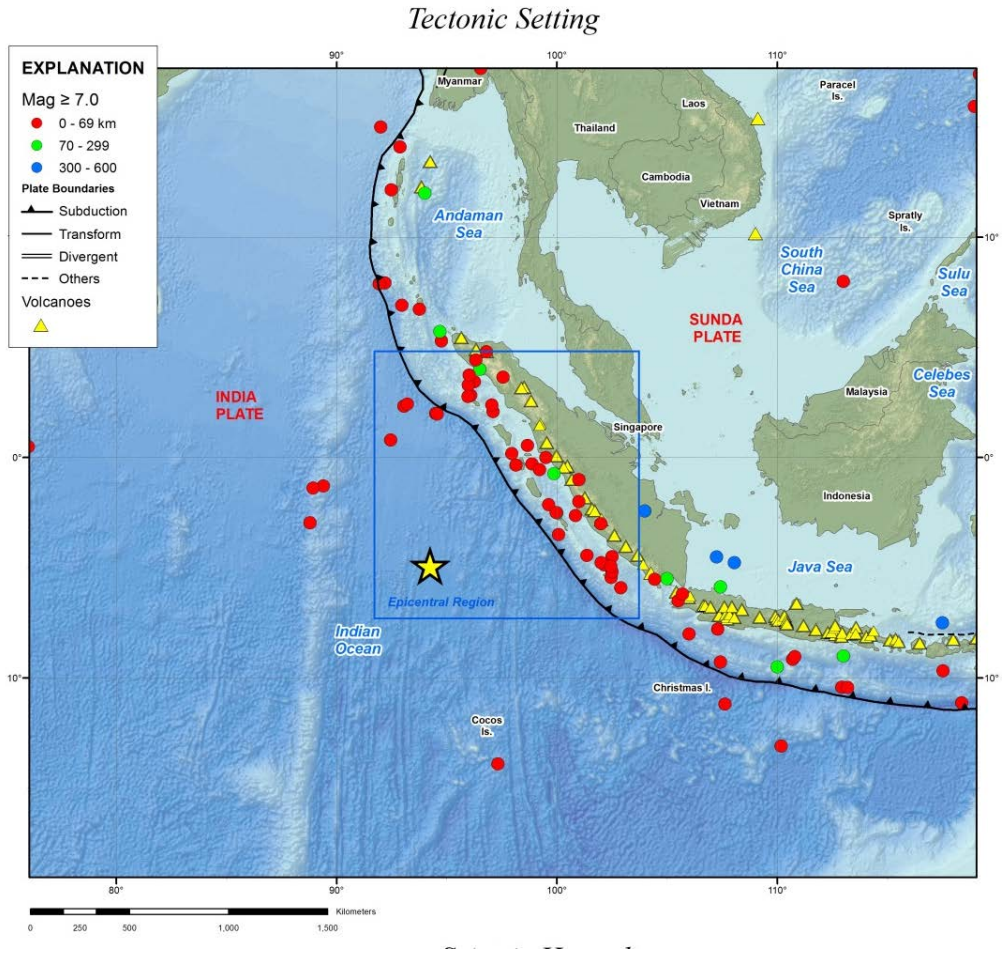

Figure 1. Location of the March 2, 2016 earthquake, shown by the yellow star. The 2004 Sumatra earthquake involved subduction of the Australia – India plate beneath Sumatra along the fault whose sea floor outcrop is shown by the black line running from top left to bottom right inside the blue box. Source: USGS.

Large strike-slip earthquakes are not unprecedented in the diffuse plate boundary region separating the India and Australia plates, southwest of the Sumatra subduction zone. In 2012, two events of M 8.6 and M 8.2 on the same day (04/11/2012), whose locations are shown in Figure 2, ruptured a series of oceanic strike-slip faults 650-850 km to the north of the March 2, 2016 event. On June 18, 2000, an M 7.9 earthquake ruptured an oceanic strike-slip structure about 1000 km southeast of the March 2, 2016 earthquake. Because of the remote locations of these oceanic earthquakes, such events rarely cause shaking-related fatalities (though the 2012 M 8.6 event caused two). Also, strike-slip earthquakes do not typically generate tsunamis because they involve predominantly horizontal fault movement.

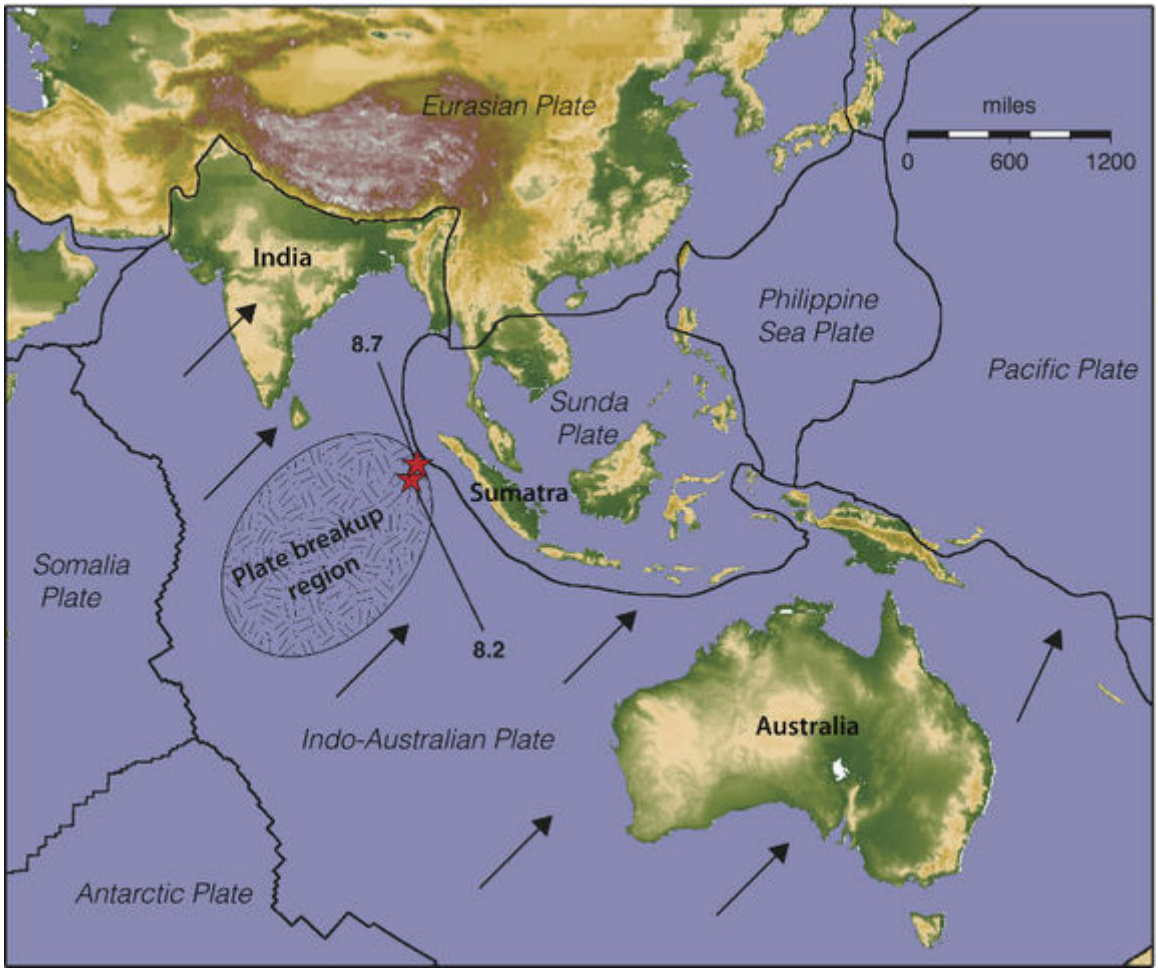

Figure 2. Boundaries and motion vectors of the Earth's plates, epicenters (red stars) of two great earthquakes that occurred on April 11, 2012, and region of breakup of the Australia - India Plate. Source: Keith Koper, University of Utah Seismograph Stations.

The Mw 9.1 2004 Sumatra earthquake involved several tens of metres of movement of the Australia – India plate beneath Sumatra in the northeasterly direction shown by the arrows in Figure 2. This movement has clearly facilitated the occurrence of these subsequent large strike-slip earthquakes, which involve northeast extension of the interior of the plate in the direction of the arrows.

All 22 of the early-warning buoys Indonesia deployed after the 2004 tsunami disaster were inoperable when the earthquake occurred, mostly due to vandalism. The March 2, 2016 Mw 7.8 earthquake did not trigger a tsunami, and there were no deaths and no major damage, but it did expose gaps in the systems put in place to prevent a disaster similar to that of the Mw 9.1 Sumatra earthquake that killed more than 200,000 people in 2014. In addition to the malfunctioning of buoys designed to warn of massive waves, authorities said there were not enough evacuation routes or shelters in Padang, a Sumatra island port city of around one million people that felt the earthquake.

Soon after the 2004 disaster, Indonesia introduced a sophisticated early warning system using buoys, sea-level gauges and seismometers that can send alerts to countries' tsunami warning centers within 10 minutes of an earthquake. The procedure is to issue a tsunami warning if an earthquake of more than 6.5 magnitude and with its hypocenter less than 20 km deep occurs at sea. That warning was issued immediately after the earthquake, but the buoys were the missing link in the chain. Authorities delayed lifting their tsunami warning because of the inoperable buoys, which cost around $2.3 million a year to maintain. Government officials explained that they do not have enough money to afford this maintenance cost.

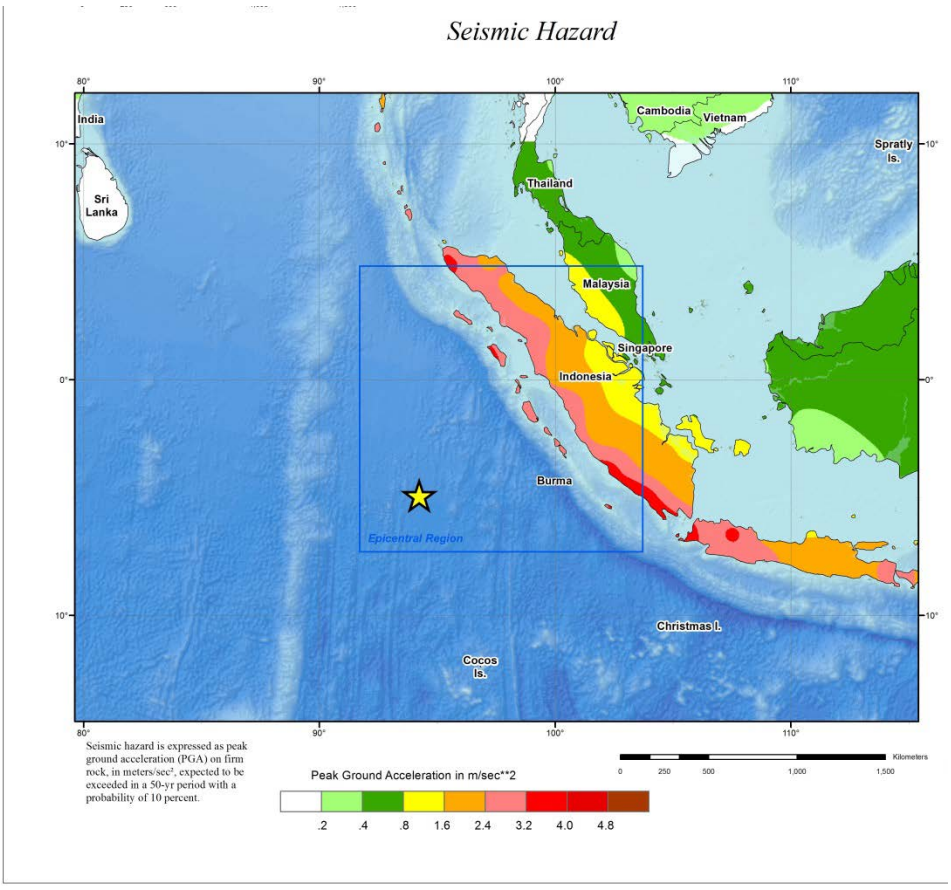

Figure 3. Seismic hazard map of Indonesia showing peak acceleration for 500 year ARP. Australia would be mostly coloured green in this map, between 4% and 8% g. Source: USGS.