

Groundtruthing Seismic Displacement: Sumatran Earthquake And Tsunami Offshore Survey (SEATOS), 2005

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At 00:58:47 on December 26, 2004, subduction of the Indian plate beneath the Burma-Sunda plate (Asian Plate) resulted in a M9.3 earthquake along a 1200 km-long rupture zone (Ishii et al., 2005). The resulting tsunami was observed around the world and devastated coastal areas surrounding the Bay of Bengal and the Indian Ocean, causing it to be one of the largest natural disasters in history with respect to loss of human life. Focal mechanisms of the earthquake, derived from seismic arrivals, show the earthquake was a reverse thrust at 30 km depth, occurring along a shallow dipping fault (8°) oriented 329° strike (Harvard CMT catalog, <http://www.seismology.harvard.edu>).

Tsunami generation requires significant seafloor displacement. Determination of the location and amount of this coseismic displacement remains problematic. To date, best estimates derive from earthquake seismic waves (Ammon et al., 2005). These results are constrained by uncertainties in the degree of translation of rupture to seafloor displacement amongst other factors. Inconsistencies in model results compared with GPS-measured displacements remain. Direct measurement of seafloor bathymetric change is not feasible as there are few and poorly constrained baseline data prior to the earthquake. Investigation of the seafloor in

regions of probable shallow movement; however, warrants justification in the search for evidence and possible quantification of seafloor displacement. To this end, the HMS Scott conducted a detailed multibeam bathymetric survey over the Sunda accretionary prism off northern Sumatra following the December 26th, 2004 earthquake (Tappin et al., 2005). Although the surficial morphology is incredibly complex, as expected from an accretionary wedge at a subduction margin, the expedition identified numerous features speculated to have resulted from this earthquake. Groundtruthing of these features with subbottom seismic reflection and Remotely Operated Vehicle (ROV) observations was the mission of SEATOS; the Sumatran Earthquake And Tsunami Offshore Survey.

SEATOS was conducted in May of 2005 from the *M/V The Performer*. High resolution seismic reflection profiles of the accretionary wedge underscore the complex geologic conditions of the region. In the forearc basin of the Sunda accretionary wedge, reflections are flat-lying and coherent over long distances. There is a strong record of periodic debris flows, perhaps representing a history of seismic events, but little evidence of faulting or near-surface displacement that may have resulted from the 2004 earthquake. Along

the forearc high, there is little concrete evidence of recent fault activity, although steep-sided thrust ridges are difficult to image with high resolution seismic reflection techniques. Sedimentary layers within inter-ridge basins show a history of folding and growth faulting related to the ongoing compressional stress regime. Along the front edge of this accretionary wedge, a number of leading toe thrust blocks are notable, bounded by normal and reverse faults at their leading and trailing sides and landward-verging folds within them. There is evidence of significant (metres) seafloor displacement at these positions.

References

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