Continuing Investigation of Structures of the Accretionary Wedge off Aceh Province, Sumatra, using 2D MCS and Multibeam Bathymetric Data

Details

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Abstract

The Indo-Australian Plate is being subducted obliquely at a rate of 4-6 cm/yr under Sumatra, which is part of

the Eurasian Plate. Following the December 2004 (Mw ~9.2) giant earthquake and March 2005 (Mw ~8.6) great earthquake offshore of Aceh Province, unprecedented seismic and bathymetric field data were collected over this region. Our study area is between 1-7°N and 92-97°E and extends over the entire forearc from northwest of Aceh to west of Simelue Island. The accretionary wedge offshore Aceh is comprised of a plateau ~200 km wide with seafloor depths ranging from 4.5 km near the Sunda Trench to <1 km on the forearc high proximal to the Aceh (forearc) Basin. In the south, the wedge width narrows to ~50 km offshore of Simelue Island, with the same seafloor depth ranges. Merged bathymetric data reveal that the accretionary wedge is comprised of lineated highs and lows with distances between presumed anticlines of 2-16 km. The high regions have widths of 2-45 km and the troughs are 1-8 km wide. The forearc high proximal to the Aceh Basin formed the widest anticlinal structure (~45 km). Dominant trends in the strike of the anticlines are ~320° in the north and ~290° in the south, which we suspect is the result of changing vectors of the subducting plate along strike. For comparison, the deformation front strikes ~310° in the south and ~330° in the north. A prominent lineated trough is observed which strikes ~0° and continues to be evident within the accretionary wedge between 93-93.5°E. This feature may be the surface expression of a subducted oceanic fracture zone being reactivated by recent seismicity. The accretionary wedge offshore of Simelue Island reveals a rugged terrain due to predominant slope failures. All MCS profiles, with track line spacings of 7-100 km, show that the surficial wedge is affected by a complex system of both landward- and seaward-dipping fault planes. Resulting anticlinal structures (lineated highs on the bathymetry) each exhibit a separation between a first -order thrust fault and its paired conjugate of 2-14 km; second and third order (i.e., smaller- scale) faults are separated by generally <1 km within the anticlines. Near the Sunda Trench, faults are identifiable down to the interpreted décollement (~7 km depth), but within the plateau they are harder to identify >2 km below the seafloor due to presumed highly compacted, lithified, dewatered sand- and silt-rich sediment. Within the observed fold and thrust belt, there are piggy-back basins bounded by active faults. Analysis of the seismic profiles and bathymetry simultaneously reveal four main structural zones: 1) landward-vergent fold and thrust dominated, 2) seaward-vergent fold and thrust dominated, 3) mixed vergence folds, and 4) erosion/landslide dominated. The landward-vergent zone is located closer to the Sunda Trench with a width of ~70 km (north) and ~50 km (south), spanning the slope from the Trench to the outer portion of the plateau. The seaward-vergent zone makes up the eastern portion of the plateau, towards the Aceh Basin, and has a width of ~60 km (north). In between these zones, the region of mixed vergence folds is 20-35 km wide. The erosion/landslide dominated area is 20-50 km wide, and is located within the landward-vergent zone. Slope failures occur presumably due to over-steepening.

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