Distribution of submarine faults off northwest Sumatra and estimation of their subsurface deformation activity

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A huge ocean-wide tsunami, with average heights of more than 20 meters along the west coast of the northern tip of Sumatra followed the 2004 Sumatra-Andaman earthquake (Mw9.2). Several working hypotheses have been proposed, but the generation mechanism for this tsunami remains unresolved. Several hypotheses suggest a possible coseismic slip on splay faults in the outer-arc-high off northwest Sumatra [e.g., Sibuet et al., 2007]. Among these splay faults, the Middle Thrust(MT) (or possibly the Lower Thrust(LT)), can best account for features of the Indian Ocean tsunamis observed at regional and ocean-wide distances [Hirata et al., 2008]. In 2009, we conducted KY09-09 bathymetry survey offshore northern Sumatra and recognized many geological structures, including candidate traces of these splay faults in the outer-arc-high. In 2010, we conducted the KH-10-5 high-resolution MCS survey with a total of 18 seismic lines to image the subsurface structure associated with LT, MT, and the Upper Thrust(UT) in the outer-arc high.

Many of subsurface deformation that can be identified on MCS profiles are distributed along these major thrusts. The uppermost sediment layers of the basins adjoining the major thrusts are deformed, either progressively tilted up to a horizontal sea floor, or sub-parallel tilted along with the sea floor. This suggests a possibility of geologically “recent” deformation associated with slip along the major fault. For an example, 14 MCS lines cross basins adjoining MT. At least six of 14 MCS profiles show clear indication of “recent” subsurface deformation along MT. However, other MCS lines did not image such a clear “recent “deformation structures near MT. This may imply lack of deformation, or lack of recent sediment along these profiles to record the deformation. Three MCS lines cross UT of Sibuet et al.[2007] or neighboring basins but we could not find any “recent” deformation signature there. 7 MCS lines cross LT. Among them, however, only one MCS profile show possible “recent” deformation along LT. It is possible that MT was most active co-seismically during a ″recent″ great earthquake. A fraction of “recent” subsurface deformation is distributed along other faults existing between these major thrusts. Therefore these other faults may be considered as a part of major thrust system in the outer-arc high off northwest Sumatra.

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