Insights on Structure and Deformation in the Input Section of the Sumatra Seismogenic Zone: Preliminary Results from International Ocean Discovery Program (IODP) Expedition 362

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The Sunda Trench where the Indo-Australian Plate subducts beneath the Sunda and Burma Plate, is an active seismogenic zone which generated the 2004 Mw 9.2 mega-earthquake and devastating tsunami offshore Northern Sumatra, characterized by a large shallow slip near the trench and an extremely thick (>4 km) incoming section at the deformation front. To investigate the nature and impact of the incoming section on seismogenic processes, the International Ocean Discovery Program (IODP) Expedition 362 drilled into the Indo-Australian Plate ~225 km distance from the trench at 2 primary sites offshore Northern Sumatra during August to October 2016. Here, we report preliminary results from shipboard structural observation on the recovered cores.

The lithostratigraphic sequence of the oceanic plate acquired from Site 1480 consists of Unit I: subsurface calcareous and silty clay (~26.4 m), Unit II: silty clay and sand of the Nicobar Fan sequence (~26.4-1250 m), Unit III: pelagic gray-green to reddish-brown tuffaceous claystone and chalk (~1250-1327 m), Unit IV: basaltic lava flows and volcaniclastic/tuffaceous sandstone (~1327-1350 m), Unit V: chalk and calcareous claystone with magmatic intrusion/extrusion with abundant mineral veins (~1350-1420 m), and Unit VI: basaltic basement cut by veins (1420 m~). Units I and II exhibit little deformation as observed from the continuously near-horizontal bedding dips (<10˚), except for several localized horizons of syn-sedimentary normal faults in Unit II and intervals of slumping and folds. The bottom of Unit II (~460 m interval) was particularly undeformed, possibly reflecting the most distal portion of the fan deposit. A distinct concentration of normal faults was observed in Unit III, characterized by primarily two sets of thin anastomosing normal faults which randomly cross-cut each other. Sand injections and lighter-colored diagenetic spots also occur in the sediments, and the normal faults generally cut through the sand injections but generally leave the diagenetic spots uncut. The flattened geometry of the diagenetic spots overprinting the normal faults and the high conjugate angle (>90˚) and curvy geometry of the faults may imply that the normal faulting occurred before significant compaction.

Concentrated deformation in the pelagic section may have occurred in an active ridge environment at that time and thermal subsidence followed by rapid sedimentation of the Nicobar Fan, but the actual mechanism is yet to be revealed.
Ongoing post-cruise research will further examine the internal structure, paleo-stress state, and material properties at these horizons of localized deformation in the input section, and ultimately investigate how they would evolve upon entering the subduction zone through comparison with current stress states and active fault systems.

Keywords: International Ocean Discovery Program, Sumatra Seismogenic Zone, Indo-Australian Plate

