The role of input materials in shallow seismogenic slip at subduction zones: Initial results from IODP Expedition 362, North Sumatra

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In 2004, a Mw 9.2 earthquake ruptured the Sunda subduction zone from North Sumatra to the Andaman Islands, a length of ~1500 km, and triggered a devastating ocean-wide tsunami. This earthquake and the 2011 Tohoku-Oki Mw 9.0 earthquake showed unexpectedly shallow megathrust slip, i.e. extending further beneath the forearc than expected. In the case of North Sumatra, this shallow slip was focused beneath a distinctive plateau of the accretionary prism. This intriguing seismogenic behavior and forearc structure are not explained by existing models or by observations at many other margins where seismogenic slip typically occurs farther landward. The oceanic plate input sequence is thick and geophysically shows strong evidence for induration and dewatering and has probably reached the temperatures required for sediment-strengthening diagenetic reactions. The input materials may be key to driving the distinctive slip behavior and long-term forearc structure. IODP Expedition 362 (conducted in 2016) drilled two boreholes within the input section of the Indian oceanic plate entering the North Sumatran subduction zone. The section reaches 4-5 km at the trench, therefore the more distal and deeper part of this section was targeted where it is only ~1.5 km thick and drilling is feasible. The Expedition successfully cored the entire sedimentary sequence to, and including, the Late Cretaceous oceanic basement. This sequence includes a significant section of Nicobar Fan sediments underlain by a series of pelagic and igneous units. At U1480 coring to 1430 mbsf was completed and to 1500 mbsf at Site U1481 (both in water depths > 4100 m). In addition, a full suite of logs were collected through the entire sedimentary sequence at Site U1481. The two boreholes, U1480 and U1481, together provide a composite cored and logged section and indicate the degree of local variability of the sequence. Initial results will be presented on the lithological composition, geochemistry and physical properties of the deeper input materials where the plate boundary décollement forms. These indicate the current state and potential for diagenesis and fluid generation. Post-expedition research will include experimental work on core samples to test how frictional and physical properties will evolve with increasing burial as the section thickens towards the subduction zone. Details of depositional history of the sequence are relevant to the plate boundary fault properties and evolution of the North Sumatran forearc. They also provide information on the significance of the Nicobar Fan as part of the Indian Ocean sedimentary record, related to Indo-Eurasian collision, Himalayan-Tibetan Plateau uplift and regional climatic conditions. Ultimately post-expedition research integrating core, log and seismic data with experimental and numerical methods will aim to predict the physical, thermal, fluid, and mechanical properties and diagenetic evolution of the sediments as stresses and temperatures increase due to burial and subduction.

Keywords: subduction, megathrust properties, input materials, ocean drilling, shallow slip

