Sumatra Seismogenic Zone: IODP Expedition 362 Overview

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The 2004 Mw 9.2 earthquake and tsunami that struck North Sumatra and the Andaman-Nicobar Islands devastated coastal communities around the Indian Ocean and was the first earthquake to be analysed by modern techniques. This earthquake and the Tohoku-Oki Mw 9.0 earthquake and tsunami in 2011 showed unexpectedly shallow megathrust slip. In the case of North Sumatra, this shallow slip was focused beneath a distinctive plateau of the accretionary prism, unusual along this subduction zone and on others. This intriguing seismogenic behavior and forearc structure are not well explained by existing models or by relationships observed at margins where seismogenic slip typically occurs farther landward. The input materials of the North Sumatran subduction zone are a distinctive, thick (up to 4–5 km) sequence of primarily Bengal-Nicobar Fan-related sediments. These are thicker and more slowly accumulated than the input section analysed through drilling at any other global subduction zone, but are not atypical, e.g., the Makran and southern Lesser Antilles have similar input sections and relatively unknown seismogenic potential. The Sumatra input sequence shows strong evidence for induration and dewatering and has probably reached the temperatures required for sediment-strengthening diagenetic reactions before accretion. The correspondence between the 2004 rupture location and the overlying prism plateau, as well as evidence for a strengthened input section, suggests that the input materials are key to driving the distinctive fault slip behaviour and the longer term forearc structure. IODP Expedition 362, August-October 2016, will help us start to understand the nature of seismogenesis in North Sumatra by sampling its input materials and assessing their progressive evolution, as they become buried and incorporated into the subduction zone. Properties of the incoming section affect the strength of the wedge interior and base, likely promoting the observed plateau development. In turn, properties of deeper input sediment control decollement position and properties, and hence hold the key to shallow coseismic slip. During Expedition 362, two primary, riserless sites will be drilled on the oceanic plate to analyse the properties of the input materials. Coring, downhole pressure and temperature measurements and wireline logging at these sites will constrain sediment deposition rates, diagenesis, thermal and physical properties, and fluid composition. Post-expedition experimental analyses and numerical models will then be used to investigate the mechanical and frictional behaviour of the input section sediments/sedimentary rocks as they thicken, accrete, and become involved in plate boundary slip system and prism development. Secondary objectives include analysis of the stress state of the incoming oceanic plate, where one of the largest recorded oceanic plate and strike-slip earthquakes occurred in 2012, and the history of Nicobar fan sedimentation as related to the history of Himalayan uplift and monsoon development.

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