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The updip seismic/aseismic transition as seen by aftershocks of the 28 March 2005 Nias and 26 December 2004 Aceh-Andaman earthquakes

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The transition between creeping (aka velocity-strengthening, unconditionally stable) to seismogenic (aka velocity-strengthening, unstable) conditions along the subduction plate interface is a function of lithology, effective normal stress and temperature. The release and transport of fluids has a particularly strong influence on the effective normal stress through controlling the pore pressure. An intermediate regime, the so-called conditionally stable regime, is often implicated for phenomena such as episodic creep events, or tsunami earthquakes. The transition between these regimes is often assumed to be fairly sharp, and with no small-scale variations along strike. We challenge this assumption using observations along the North Sumatran following the great earthquakes of 2004 and 2005.

Beginning in October 2005 we operated a temporary network of 43 ocean bottom and 8 land stations on the forearc of the Sumatran subduction zone on and around the island of Simeulue as a component of the SEACAUSE project, with recording times of 3-5 months. The marine work was carried out during Sonne cruise SO186. This area represents the segment boundary between the 2004 Aceh-Andaman and 2005 Nias earthquakes and the northern part of the Nias earthquake. Most of the aftershocks recorded in this region are concentrated into a narrow band trenchward of the locus of coseismic uplift and at the downdip end of the afterslip zone. They are thus likely to have occurred on the plate interface updip of the coseismic rupture. Even though a relatively sharp transition between the seismogenic zone and stable sliding is implied

by the narrowness of the active zone, a consideration of the total moment release compared to the total displacement indicates, that seismogenic and stable behaviour must co-exist in the same depth range. Significant along-strike differences of more than an order of magnitude exist in the seismic efficiency of afterslip (or the relative size of seismic and aseismic patches within the transition region if locally a bimodal behaviour is assumed), not unlike the observations made in strike-slip systems.