Geophysical Research Abstracts
Vol. 16, EGU2014-10542, 2014
EGU General Assembly 2014

On the relationship between forearc deformation, frictional properties and megathrust earthquakes

Nadaya Cubas and Satish Singh
Institut de Physique du Globe de Paris, Paris, France (nadaya.cubas@gmail.com)

A better understanding of the relation between the structural geology and the morphology of forearc wedges with frictional properties could provide insights on earthquake mechanics. Therefore, we study, with simple mechanical analysis allowing for inverse studies, the three subduction zones that produced the major earthquakes of the 21st century : Central Chile (Maule 2010 Mw 8.8), NE Japan (Tohoku-Oki 2011 Mw 9.0) and Sumatra (Sumatra-Andaman 2004 Mw 9.1, Nias 2005 Mw 8.7). We first apply the critical taper theory that yields the effective friction of the subduction interface, the wedge internal friction and pore fluid pressure. We then apply the limit analysis approach to constrain variations of frictional properties along the megathrust from the location and style of forearc faulting. We show that seismic ruptures most often coincide with the mechanically stable part of the wedge whereas regions undergoing aseismic slip are at critical state, consistent with evidence for active deformation. In the rupture area, we found a low effective dynamic friction, probably reflecting strong dynamic weakening. Where no frontal rupture was observed, we obtain intermediate values of long-term effective friction along the frontal aseismic zone, implying hydrostatic pore pressure. On the contrary, where the rupture reached the seafloor (Tohoku-Oki earthquake, parts of the Sumatra-Andaman 2004 earthquake), a very low long-term effective friction and a high pore pressure are observed. The difference of properties of the frontal wedge might reflect differences in permeability. A lower permeability would enhance dynamic weakening and allow for frontal propagation of ruptures. We also show that spatial variations of frictional properties between aseismic and seismogenic zones can lead to the activation of splay faults. We also show that a high pore pressure along accretionary wedges can change the vergence of frontal thrusts. As a consequence, wedge morphology and deformation can be used to improve seismic and tsunamigenic risk assessment.