Geophysical Research Abstracts, Vol. 8, 01585, 2006
SRef-ID: 1607-7962/gra/EGU06-A-01585

Stabilization of subduction wedges and the effect on subduction-thrust seismicity

C. Fuller (1), S. Willett (1), M. Brandon (2)

(1) Dept. Earth and Space Sciences, Univ. Washington, USA, (2) Dept. Geology and Geophysics, Yale Univ., USA

Accreting subduction margins are associated with broad regions of active deformation in the overriding plate, which we refer to as the subduction wedge. Subduction wedges show a distinctive structural morphology defined by at least 3 margin-parallel domains. From trench to arc, these domains are: (1) the trench slope, (2) a trench-slope break or outer-arc high, and (3) a forearc basin. In longer-lived margins with more accreted material, the margin morphology includes two additional landward domains: (4) a subaerial forearc high and (5) a more landward forearc basin. Accretion related deformation is observed in the trench slope domain and within the subaerial forearc high but less-often beneath the regions including the trench-slope break and the more seaward forearc basin. Traditionally these non-deforming regions have been described as "backstops" that support the deformation of the more seaward regions. To investigate why these non-deforming regions exist and how they influence the behavior of subduction wedges we conducted a numerical modeling study. We use a thermo-mechanical model with a thermally activated viscous and frictional rheology to represent a subduction margin with deformation driven by the traction applied by the subducting oceanic plate and by the forced accretion of a thin sedimentary layer. Other elements of our model are flexural compensation, erosion, sedimentation and contrasts in material strength within the model domain. Our modeling shows the entire margin tends towards a critical state in which the subduction wedge attains a wedge taper such that it deforms throughout. However, non-deforming segments of the subduction wedge exist where the wedge is in a stable state as defined by critical wedge theory and which develop as a natural consequence of the geometry and physical properties of the subduction zone. Sedimentation in the seaward forearc basin and erosion of subaerially exposed outer arc highs can lead to the development of more persistent and more extensive stable regions. Recent studies showing an association between the stable, non-deforming regions of subduction wedges and the maximum slip during large subduction-thrust earthquakes suggest that there is an important link between the deformation within the subduction wedge and seismicity on the subduction thrust. We propose that the lack of deformation in the stable region increases the likelihood of large seismic slip on the thrust by increasing the potential for thermal pressurization of the thrust and by allowing greater healing of the fault between rupture events.