Geophysical Research Abstracts
Vol. 13, EGU2011-9686, 2011
EGU General Assembly 2011

Shear heating and subduction initiation

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Despite their importance in geodynamics, the processes that result in subduction initiation remain incompletely understood. Shear heating has been put forward as a mechanism to create lithospheric-scale shear zones (e.g. Ogawa 1987, Regenauer-Lieb et al. 2001), thus being capable of decoupling two plates. A scaling analysis highlighted the governing parameters that control shear localization (Kaus and Podladchikov 2006), and showed that the boundary between localization and no localization is quite sharp. Recently, this scaling analysis was extended to include more realistic lithospheric rheologies and structures and it could be demonstrated that shear-heating induced lithospheric scale localization might occur for Earth-like parameters (Crameri and Kaus, 2010).
It is however unclear if all lithospheric-scale shear zones evolve into self-sustaining subduction zones. Here, we therefore extend the models used by Crameri and Kaus to greater depths and take into account an underlying asthenospheric mantle. It could be shown that whole lithosphere failure does not necessarily lead to subduction initiation. We determine the parameters governing both processes and present scaling laws that are able to predict the behaviour of our models.