Geophysical Research Abstracts
Vol. 14, EGU2012-7430, 2012
EGU General Assembly 2012

Testing the role of rheology with simple subduction models

S. Buiter (1,2) and S. Ellis (3)

(1) Geological Survey of Norway, Trondheim, Norway (susanne.buiter@ngu.no), (2) Physics of Geological Processes, University of Oslo, Norway, (3) GNS Science, Lower Hutt, New Zealand

Slab strength is among the primary controls on the evolution of subducted slabs in the mantle and has as a consequence been the subject of various, often numerical, investigations. Stiff (and/or thick) slabs have been shown to maintain their initial curvature throughout the upper mantle, leading to a sideways U-shape, whereas (thin) slabs of moderate to weak strength can unbend and subduct with a shallow to vertical dip angle. Here, slab strength is relative to the surrounding mantle and is determined by the brittle, viscous and elastic material behaviour within the slab, together with the pressure- and temperature-dependence of the rheology components. However, no universal consensus exists so far concerning the roles of elastic and brittle rheologies and for the values of the effective strengths of slabs and mantle.

We use one numerical model to show how slab rheology may impact later stages of model evolution. We use SULEC, our thermo-mechanical finite-element (ALE) code, which is tailored to modelling large deformation processes at crustal to upper-mantle scales with a true free surface. Our models start from the most simplified situation of subduction of a linear viscous slab which is freely falling into a linear viscous mantle. We progressively build up the system to more complex rheologies by including elasticity, brittle behaviour, pressure-dependence, temperature-dependence, phase changes, and rheological weakening. Our results quantify the role of rheology for simple subduction models through trench migration, slab tip depth, slab dip in the upper mantle, surface topography, root-mean-square slab velocity, and slab rate of dissipation of energy. We hope that our set of models may trigger a discussion on whether a minimum set of slab rheology requirements could be identified and if so, whether the range of material parameters for slab rheology could be further narrowed down.