Geophysical Research Abstracts, Vol. 7, 03049, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03049

Deformation of subducted slabs in the transition zone

H. Cizkova (1), A. van den Berg (2) and J. van Hunen (3)

(1) Faculty of the Mathematics and Physics, Charles University in Prague, (2) Faculty of Earth Sciences, Utrecht University, (3) Swiss Federal Institute of Technology, Zurich

We simulate subducting slabs in a 2-D Cartesian box in the numerical model with composite rheology. Rheological description incorporates diffusion creep, dislocation creep and stress limiter approximating Peierl's creep. Byerlee's law is taken into account to limit stresses in shallow parts of the model. We concentrate on the style of deformation in the upper mantle transition zone. We investigate the effect of several model parameters and we also study the influence of the initial and boundary conditions (free-slip versus kinematic boundary condition at the top of the subducting plate). The deformation of the plate in the transition zone depends on the combination of rheological parameters, trench migration rate and the age (and thus thermal profile) of the plate. The ability of the slab to penetrate the 660 km phase boundary and reach the lower mantle is strongly sensitive to small changes in the above mentioned parameters. The key controlling parameter is the stress limit, which predicts the strength of the coldest portions of the old slabs. For stress limits lower than 0.5 GPa, slabs are easily deflected by 660 km phase boundary, while for a stress limit higher than about 5 GPa slabs always penetrate into the lower mantle. If the stress limit is about 1 GPa, slab behaviour in the transition zone depends on the combination of other parameters (e.g. high trench migration rate of 4 cm/yr enhances the deflection of the slab above 660 km interface and lowers its ability to penetrate). Stress conditions of the slab interior (and thus slab deformation) are further strongly influenced by the boundary conditions prescribed at the top. In kinematic boundary condition models slabs tend to keep the curvature obtained during motion along the predefined free-slip fault and develop unnatural backwards deflection. Free-slip boundary condition models produce more realistic stress distribution within the slabs in the transition zone and lower mantle.