Geophysical Research Abstracts, Vol. 8, 08521, 2006
SRef-ID: 1607-7962/gra/EGU06-A-08521

Subduction along a subduction fault or along a subduction channel: expected signatures from 2D numerical experiments

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The plate contact zone is an important feature in the development and response of subduction processes. Both faults and subduction channels have been used to describe subduction contacts in quantitative models. The fault is a discontinuity where normal stress and velocity are continuous, and tangential velocity and shear stress are discontinuous. The subduction channel is a weak lubricating layer between the plates; here all velocity and stress quantities are continuous. This approach well describes weak plate contact, where the deformations are mainly along the interface. Large subduction earthquakes show that substantial shear stresses can accumulate in the plate boundary zone, which therefore cannot be weak in general. Thus, there is support for both types of contact zones. Here, we seek to find possible consequences of either plate boundary type.

We use a two-dimensional finite element method in a Lagrangian domain to solve the mechanical equilibrium equation with an elastic-plastic-powerlaw rheology and the heat equation, since the viscosity is temperature dependent. We adopt the rheology of Karato and Wu (1993), with dislocation creep in the shallow upper mantle (non-Newtonian rheology) and diffusion creep in the Transition Zone (Newtonian rheology). The fault is described through slippery nodes and assuming zero shear stress. The subduction channel models have a low Newtonian viscosity.

We investigate the influence of variable ratios of channel viscosity and channel width. We discuss differences and similarities of the fault and channel models, and compare the model results with stress regimes and displacements in real world overriding plates.