Geophysical Research Abstracts, Vol. 9, 03388, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03388

Subduction zone dynamics:

3-D numerical models and energy balance

E. Di Giuseppe (1), J. van Hunen (2), F. Funiciello (3), C. Faccenna (3) and D. Giardini (1)

(1) Institute of Geophysics, ETH-Zurich, Switzerland, (2) Dep. of Earth Sciences, Durham University, UK, (3) Dip. Geologia, Univ. "Roma Tre", Roma, Italy

(erika.digiuseppe@tomo.ig.erdw.ethz.ch / PHONE: +41 44 6333248)

The motion of the trench at convergent margin is equally partitioned on the earth surface between advancing and retreating modes with respect to the upper plate, and is susceptible to abrupt changes in velocity and direction, as revealed by plate reconstruction and geodetic data.

Here we explore the idea that trenches motion represents the surface manifestation of the dynamics of subduction. We performed 2- and 3-dimensional numerical models in an attempt to understand the complex trench dynamics. Numerical models allow a quantitative investigation of a wide range of parameters and the assessment of derived quantities such as the amount of energy dissipated during the whole subduction process. The adopted model setup is inspired to the analogue one used in laboratory experiments.

Simulating a multilayered lithosphere-upper mantle system, we found that slabs with different geometries and rheological properties interact differently with the 660-km discontinuity, which is modeled in this case as an impermeable barrier. The energy dissipated in the system varies during the several phases of process and also, it is partitioned differently between slab and upper mantle depending on the subduction mode. During the initial slab sinking, the energy dissipated by the lithosphere is similar for all model calculations. In the subsequent steady state phase, differences become much larger. In both advancing and retreating (rollback) modes, most of the total initial energy is dissipated by the mantle, $\sim$60% and $\sim$70%, respectively. The extra 10% in the retreating mode is caused by a more vigorous backward toroidal flow compared with forward toroidal flow in the advancing style. Furthermore, the rollback motion is the favorable configuration from an energy point of view. In the intermediate situation, plates fold and pile up on the discontinuity. In this mode, the plate dissipates $\sim$60-65% of the total energy, with an evident minor contribution of the surrounding mantle.

We conclude that the potential energy provided by the negative buoyancy of the subducting plate is mainly dissipated by the mantle viscous flow, and the remaining part to bend and deform the lithosphere.