Geophysical Research Abstracts,
Vol. 11, EGU2009-7401-1, 2009
EGU General Assembly 2009

The temporal evolution of a subducting plate in the lower mantle

C. Loiselet (1), D. Grujic (2), J. Braun (1), P. Fullsack (3), C. Thieulot (4), and P. Yamato (1)

(1) Geosciences Rennes, UMR CNRS 6118, University of Rennes1, Rennes, France (christelle.loiselet@univ-rennes1.fr), (2) Department of Earth Sciences, Dalhousie University, Halifax, NS Canada, (3) Department of Oceanography, Dalhousie University, Halifax, NS Canada, (4) Department of Earth Sciences, Bergen University, Norway

It is now widely accepted that some subducting slabs may cross the lower/upper mantle boundary to ground below the 660 km discontinuity. Indeed, geophysical data underline long and narrow traces of fast materials, associated with subducting slabs, from the upper mantle transition zone to mid-mantle depths that are visible beneath North and South America and southern Asia (Li et al, 2008). Furthermore, seismic tomography data (Van der Hilst et al., 1997; Karason and van der Hilst, 2000, 2001) show a large variety of slab geometries and of mantle flow patterns around subducting plate boundaries (e.g. the slab geometry in the lower mantle in the Tonga subduction zone). However, seismic tomography does not elucidate the temporal evolution of the slab behaviour and geometry during its descent through the upper and lower mantle.

In this work, we therefore propose to study the deformation of a thin plate (slab) falling in a viscous fluid (mantle) by means of both analogue and numerical modelling.
The combination of both analogue and numerical experiments provides important insights into the shape and attitude evolution of subducting slabs. Models bring information into the controls exerted by the rheology of the slab and the mantle and other physical parameters such as the density contrast between the slab and the surrounding mantle, on the rate at which this deformation takes place.
We show that in function of a viscosity ratios between the plate and the surrounding fluid, the plate will acquire a characteristic shape. For the isoviscous case, the plate shape tends toward a bubble with long tails: a "jellyfish" form. The time necessary for the plate to acquire this shape is a function of the viscosity and density contrast between the slab and the mantle.
To complete our approach, we have developed a semi-analytical model based on the solution of the Hadamar-Rybinski equations for the problem of a dense, yet isoviscous and thus deforming sphere. This model helps to better describe flow processes around the downgoing plate and, simultaneously, to characterize its deformation. In this way, we were able to calculate the velocities in the mantle, the forces exerted by the fluid on the plate, and the dissipated energy in the surrounding fluid. Experimental results will be correlated with geophysical data.