Water induced convection and slab dehydration in the Earth's mantle transition zone

Guillaume Richard[1], **David Bercovici**[2]

[1] *Earth Sciences Institute, J.W. Goethe University, Frankfurt am Main, Germany*
[2] *Dpt of Geology and Geophysics, Yale University, New Haven, USA*

Water enters the Earth's mantle at trenches by subduction of oceanic lithosphere. Most of this water immediately returns to the atmosphere through arc volcanism, but a part of it, retained in Dense Hydrous Magnesium Silicates (DHMSs) and Nominally Anhydrous Minerals (NAMs) like olivine, is expected as deep as the mantle transition zone (410-660 km depth). There, slabs can be deflected and linger before to sink into the lower mantle. Because it lowers the density and viscosity of the mantle minerals which may hold it at this depth (wadsleyite, ringwoodite) water is likely to affect the dynamics of the stagnant slab.
Here we investigate, the consequence of water presence on the dehydration of a stagnant slab. In particular, we focussed on the possible onset of small scale mantle convection despite the unfriendly thermal state of the studied area (mantle is cooled from below). The competition between the thermal and water effects on the density and thus on the convective stability of the top layer of the slab is questioned using numerical model including water dependent density and viscosity and temperature dependent water-solubility.
Depending on the value of the initial water content in the slab reaching the transition zone, convection occurs or not. Others important controlling parameters are the water dependence of density and viscosity. If small scale convection is taking place at the top a stagnant slab in addition to considerably enhance the speed of the process of slab dehydration (otherwise controlled by the slow diffusion of water) it provides an efficient way to heat up the slab. Our preliminary results suggest that young and wet stagnant slabs are unlikely to reach the lower mantle because they would thermally relatively quickly equilibrate with the surrounding mantle within the transition zone.

References:

Richard G.C. & Bercovici D., Water-induced convection in the Earth's mantle transition zone. Geophys. Res. Lett., in prep, 2007.