Thermochemical Convection and He Concentrations in Mantle Plumes

Henri Samuel[1] **and** **Cinzia Farnetani**[1]

[1] *Institut de Physique du Globe, 4 place Jussieu, 75252 Paris, Cedex 05, France*

Mantle convection is still a subject of controversy since geochemistry indicates the existence of at least two chemically different reservoirs isolated over billions of years, while seismic tomography shows that slabs penetrate in the lower mantle. Recent tomographic studies suggest the existence of chemically denser material at the bottom of the lower mantle. The presence of such a layer, if primitive, may reconcile geochemical and geophysical observations.

We use a 2D numerical convection model with a chemically denser layer at the bottom of the mantle and we vary the ratio of chemical to thermal density contrast ($\Delta\rho_c/\Delta\rho_{th}$). We find that for $\Delta\rho_c/\Delta\rho_{th}$ greater than 0.5, convection takes place in two units separated by an intermediate thermal boudary layer. This thermal boundary layer forms a topography which could make its seismic detection difficult. Moreover, the chemically denser layer remains stable and poorly mixed for ages comparable to the age of the Earth.

To investigate if such configuration could explain both the undegassed nature of plumes and the presence of recycled oceanic lithosphere in the source of OIB, we use a numerical model which includes: 1) active tracers to study the dynamics of a primitive and chemically denser layer at the bottom of the lower mantle, and 2) passive/active tracers to follow the subduction of oceanic crust and of the depleted oceanic lithosphere. The model has temperature dependent viscosity, depth dependent thermal expansion coefficient and includes phase transitions. Internal heating depends on local concentrations of radioactive elements producing internal heating (^{238}U, ^{235}U, ^{232}Th, ^{40}K). The model calculates the time evolution of the ^{4}He and ^{3}He concentrations in the mantle, in the denser layer and in the subducted material. We then focus on the ^{4}He and ^{3}He concentrations in ascending mantle plumes.