# Slab dehydration and fluid migration at the base of the upper mantle

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Water enters the Earth's mantle at trenches by subduction of oceanic crust. Most of this water immediately returns to the atmosphere through back 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 bottom of the upper mantle (660 km depth). Then, due to its low solubility in lower mantle minerals, water is likely to be released as an hydrated fluid, during the spinel-postspinel phase change. The dynamics of this fluid phase is investigated through a 1-D model of compaction, in which a source term has been introduced to take the fluid precipitation into account.

The competition between the advective transport by the descending slab and the buoyant rise of the fluid results in three distinct situations, depending on the properties of the solid and the fluid phases. Low matrix permeability and high fluid viscosity inhibit the compaction and favor the leakage of fluid toward the deep mantle. In this case, the entire slab water content would enter the lower mantle and would be mixed at large scale. Nevertheless, realistic values of the fluid viscosity and matrix permeability make this possibility unlikely. When effective, compaction results in an accumulation of fluid at and below the phase change. Depending on the value of the matrix viscosity, the situation evolves differently. Above $10^{20}$ Pas, accumulation of fluid extends below the phase change and the pressure difference between the fluid and the matrix increases continuously, exceeding the yield strength of rocks. As a results, cracks would initiate and evolve toward the formation of dykes. In case of very low mantle viscosity, possibly due to strong grain size reduction during phase change, compaction becomes very efficient and the fluid remains confined within the phase change horizon, without increasing pressure. On the long term, this last situation appears unstable and would also evolve toward the formation of dykes.

Thus, it is expected that water comes back to the upper mantle by the way of dykes propagating along the direction of the maximum compressive stress. Since slabs appears to be down-dip compressional below 300 km depth, we predict the formation of dykes extending from the 660 km phase change to 300 km depth. The possible existence of such dykes in slabs offers the necessary conditions for strong double couple component earthquake in the deepest part of the upper mantle.

**References:**

*Richard G.C., Monnereau M. and Rabinowicz M. Slab dehydration and fluid migration at the base of the upper mantle: implication for deep earthquake mecanisms. Geophys. J. Intl., submitted, 2005.*