# Fluids nature at peak of ultrahigh-pressure metamorphism in deep subduction zones – Evidence from diamonds

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Role of fluid circulating in deep subduction channels was/is a subject of many outstanding geochemical and numerical modelling studies. One of the intriguing processes is a fluid-rock interaction during subduction of the continental slab because the latter is characterized by contrast chemistry in comparison with the surrounding mantle and its fluids. Diamond due to its chemical inertness is the only mineral which contains “unchanged” fluids that was trapped during its crystallization at the peak of UHP metamorphism. We have demonstrated earlier with FIB-TEM studies that many diamonds from the UHPM terranes of Kazakhstan and Germany preserved intact C-O-H fluid inclusions [1]. This fluid responsible for diamond crystallization contains traces of both crustal and mantle components: Al, K, Ca, Mg, Fe, Si, Ti, V, Zn, Co, Fe F, Cl, S [1]. We have recently found more evidence to support crust-mantle origin of the fluids penetrating continental slabs in the deep subduction channels. This derives from a new finding of the polycrystalline diamonds included in zircons from Erzgebirge quartz-feldspathic gneisses containing remnants of fluid available for their compositional evaluation with EDAX spectrometry. The diamonds consist of 5-15 crystals of 0.3-5 micron size with a typical “zig-zag” grain boundaries and triangle voids filled with a C-O-H fluid with traces of Al, Co, F, V, Zn, Si, Cl, S, Ca, Mg, Fe, K in different combination. Such observations emphasize that diamonds from UHPM terranes have a similar nature of crystallization – from a fluid originated from a mixed crust-mantle geochemical reservoir. Moreover, the Kokchetav diamonds $^3He/^4He$ ratios are similar to those known for OIB setting [2]. Sumino *et al.* have suggested an interaction of the subducted continental slab with the deep mantle plume at the depth of the diamond stability filed. Therefore, the fluids penetrated continental slabs in deep subduction channels at peak of UHPM might originate from crust – mantle – deep mantle plume reservoirs.

[1] Dobrzhinetskaya *et al*. (2007) *PNAS* **104,** 9128-9132. [2] Sumino *et al*. (2011) *EPSL* (in press)

# Kinetics of the reaction perovskite + ferropericlase = ringwoodite

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The kinetics of solid-state disproportionation reactions can be strongly assymetric due to the different diffusive length scales of disproportionation versus recombination. Transport of material from the lower mantle into the transition zone requires the reaction of perovskite (pv) plus ferropericlase (fp) to produce ringwoodite (rw); this reaction is diffusive on the grain-length scale and hence might allow a significantly wide region where metastable phases exist. We present experiments to investigate the kinetics of this reaction. We have assumed that the transformation from pv to majorite (mj) is fast (being diffusive at the unit-cell length scale) and hence performed coupled reaction experiments of MgO with $(Mg,Al)(Al,Si)O_3$ mj at a pressure of 20 GPa (in the rw and mj stability fields) at temperatures of 1773 to 2123 K. The reaction is, as expected, mediated by diffusion of chemical components through the growing rw layer, with growth rate of the layer being linear with $t^2$. Rw grows with strong topotactic relations to the MgO which would, on completion of the reaction, result in single (or twinned) crystals of rw replacing the MgO grains. However, the kinetics of the reaction is further complicated by the incompatibility of aluminium in rw. As the rw layer grows, a double-diffusive instability develops with the rw-mj interface becoming fingered to maximise the surface area from which to diffuse aluminium into the garnet. The mean grain-size of regions with this texture is ~2 micrometres, which shows little coarsening due to zenner pinning. Reaction continues until all of the MgO is replaced leaving fine-grained reaction rims between these rw regions and the remaining excess $(Mg,Al)(Al,Si)O_3$ garnet. Two ways to estimate the grain size of the lower mantle might arise from this:

1. Seismological estimates of the thickness of the 670-km discontinuity are consistent with the equilibrium reaction. This means that the width of the region where the metastable mj + fp = rw reaction occurs is below seismological resolution.
2. The reaction texture might (occasionally) survive in porphyroclastic mantle xenoliths.

Both these estimates are consistent with a maximum lower-mantle grain size of about 1 cm.