



## **Mantle mineral microcavities filled with aqueous fluids: HPHT reactors producing unexpected mineral assemblages**

Marcello Campione

University of Milano Bicocca, Earth and Environmental Sciences, Milan, Italy (marcello.campione@unimib.it)

The action of slab-derived fluids on mantle rocks frequently brings about the formation of microcavities in minerals which represent microenvironments where the interaction between fluid and host mineral is preserved during the whole geological path of the rock. The entrapped fluid and the host matrix constitute a system which evolves towards an equilibrium under peculiar chemical-physical constraints. By explicating these constraints through mass conservation laws and stoichiometry relations which account for the composition of the host mineral and of the initial fluid, and for the presence of a finite fluid-solid interface, we show that cavities in minerals filled with slab-derived fluids can re-equilibrate following a crystallisation mechanism which is not predictable through simple equilibrium arguments holding for open systems (Campione et al., 2017). Moreover, the found mineral assemblages in inclusions allow us to constrain the composition of the entrapped fluid. As an application example, we model the solid-solution equilibrium in mantle garnet filled with slab-derived fluids (Malaspina et al., 2017). The modellisation is based on Gibbs free energy minimization through Perple-X software (Connolly, 2005), and calculation of solid solution equilibria using the aqueous speciation-solubility code EQ3 (Wolery, 1992) adapted to include equilibrium constants calculated with the Deep Earth Water (DEW) model (Facq et al., 2014; Sverjensky et al., 2014). Surprisingly, the garnet-fluid cavity system is demonstrated to re-equilibrate to a pyrope + spinel + chlorite assemblage at the same high P-T of its formation. The basis of the occurrence of such unexpected mineral assemblages in mineral inclusions is a dissolution-reprecipitation mechanism, triggered by a dilute, non-equilibrated slab fluid.

Campione, M., Tumiati, S., Malaspina, N., 2017. Primary spinel + chlorite inclusions in mantle garnet formed at ultrahigh-pressure. *Geochem. Perspect. Lett.* 4, 19–23. <https://doi.org/10.7185/geochemlet.1730>

Connolly, J.A.D., 2005. Computation of phase equilibria by linear programming: A tool for geodynamic modeling and its application to subduction zone decarbonation. *Earth Planet. Sci. Lett.* 236, 524–541. <https://doi.org/10.1016/j.epsl.2005.04.033>

Facq, S., Daniel, I., Montagnac, G., Cardon, H., Sverjensky, D.A., 2014. In situ Raman study and thermodynamic model of aqueous carbonate speciation in equilibrium with aragonite under subduction zone conditions. *Geochim. Cosmochim. Acta* 132, 375–390. <https://doi.org/10.1016/j.gca.2014.01.030>

Malaspina, N., Langenhorst, F., Tumiati, S., Campione, M., Frezzotti, M.L., Poli, S., 2017. The redox budget of crust-derived fluid phases at the slab-mantle interface. *Geochim. Cosmochim. Acta* 209, 70–84. <https://doi.org/10.1016/j.gca.2017.04.004>

Sverjensky, D.A., Harrison, B., Azzolini, D., 2014. Water in the deep Earth: The dielectric constant and the solubilities of quartz and corundum to 60kb and 1200°C. *Geochim. Cosmochim. Acta* 129, 125–145. <https://doi.org/10.1016/j.gca.2013.12.019>

Wolery, T.J., 1992. EQ3/6: A software package for geochemical modeling of aqueous systems: package overview and installation guide (version 7.0). Lawrence Livermore National Laboratory, Livermore, California.