Fluid migration and fluid-rock interaction in the fore-arc region of subduction zones

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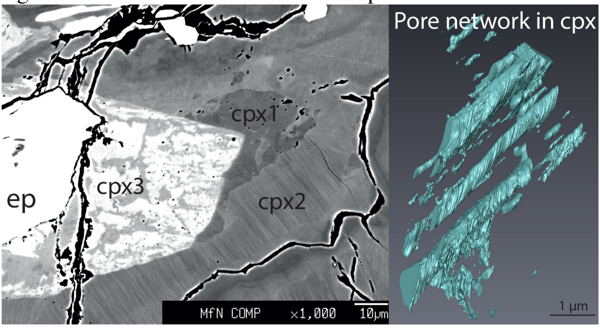
A crucial aspect for the physical and chemical properties of rocks in the fore-arc region, especially along the plate interface, is the mode and quantity of fluid migration and fluid-rock interaction. As we have excellent examples of exhumed rocks from that region, we have the opportunity to study fluid liberation and fluid migration processes in natural samples. In high pressure-low temperature samples from the Franciscan mélange a reaction induced interconnected porosity is excellently preserved. Utilising focused ion beam techniques and transmission electron microscopy this porosity can be visualized and processes during fluid-rock interaction can thus be studied *in situ* down to sub-micron scale. Interconnected fluid pathways in the metasomatic samples are generated by dehydration (see figure) and rehydration reactions as well as by hydraulic fracturing. These pathways are used as conduits for fluid migration and element transport in the percolating fluid. Creep mechanisms together with mineral precipitation leads to closure of this transient permeability. The porosity features visible in these samples are consistent with theoretical considerations of episodic and pulse like metamorphic fluid migration in a transient interconnected pore network.



Interconnected pore network in dehydration products (cpx)

A combination of thermodynamic and geochemical forward models can then be used to quantify the amount of percolating fluids through such pore networks. Boron is excellently suited as an indicator for fluid-rock interaction as it is highly fluid mobile, it is present in different rock-forming minerals in measurable quantities and undergoes temperature-controlled equilibrium isotope fractionation between solid and liquid phases. Combining *in situ* trace element measurements in natural samples with thermodynamic and geochemical models that yield quantitative information about the changing phase assemblage and compositions during metamorphism displays a powerful tool to detect and quantify fluid migration and fluid rock interaction in subduction zones.