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Exploring new frontiers in fluids processes in subduction zones

Highly oxidizing fluids generated during serpentinite breakdown in subduction zones (invited)

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In subduction zones, the dehydration of serpentinites is a major process responsible for the transfer of water from the slab to the mantle wedge. Serpentinites are also an important host of volatiles (e.g. sulfur, fluorine, chlorine) such that their dehydration also leads to the modification of the mantle wedge and arc magmas compositions by fluids enriched in these volatiles. In this context, constraining the evolution of serpentinite redox state is a key to obtain a better understanding of the nature and composition of slab-derived fluids and fluid/rock interactions in subduction zones. These processes play a fundamental role in governing metasomatic processes taking place in the mantle wedge as well as magma genesis and magma degassing processes and will also affect the stability of redox sensitive phases (e.g. carbonates, sulfides), the mantle wedge solidus and the properties of the resulting melts.

The aim of my work is to constrain the behaviour and mobility of redox sensitive elements, in particular iron, in serpentinites from their formation at the ridge to their devolatilization during prograde metamorphism in subduction zones. To address this, I have selected samples from the Western Alps (Italia and France) and Sierra Nevada (Spain) ophiolitic complexes. These remnants of the oceanic lithosphere have preserved different stages of serpentinization and deserpentinization: from oceanic serpentinization and the formation of lizardite and chrysotile assemblages, to the prograde destabilization of oceanic serpentine into antigorite, from greenschist to blueschist facies, and finally the dehydration of antigorite into olivine-orthopyroxene-chlorite assemblages at eclogite facies. I have combined iron K-edge μ-XANES and magnetic measurements, as well as the use of theoretical chemical mass transfer calculations to predict the redox state of fluids generated during serpentinite dehydration. The results demonstrate that serpentinite devolatilization produces highly oxidized fluids in subduction zones and can contribute to the oxidization of the sub-arc mantle wedge. This provides some of the first direct constraints on the redox state of serpentinites-derived fluids in subduction environment.