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Constraining the effect of fluid-rock interaction on amount and composition of subduction zone fluids using thermodynamic and trace element models

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The Sesia Lanzo Zone (SLZ, Western Alps, Italy) is a sliver of continent-derived eclogite facies rocks that was exhumed on top of a subducted oceanic slab. Fluids derived from the dehydrating oceanic crust overprinted the SLZ rocks to different extents under blueschist-facies conditions. Overprinting in weakly deformed samples resulted in pronounced compositional zonations of major and trace elements in phengite and sodic amphibole grains. Both minerals show a distinct increase in Fe2+ content associated with Mg decrease, visible in high contrast back scattered electron images, which enables tracing of the pathways of infiltrating subduction- related fluids into the rocks. In contrast, analogous mylonitic samples of the same rock types show compositionally homogeneous phases and well-equilibrated textures. A comparison of thermodynamic and trace element model results with naturally observed fluid-rock interaction features enables quantification of the amount and composition of the infiltrating fluids.

Thermodynamic forward models show that the observed compositional trends are the result of influx of a hydrous fluid phase at around 1.3 GPa during the exhumation of the SLZ on top of a subducted oceanic slab. Time integrated fluid fluxes during infiltration in the weakly- deformed samples were in the order of 10 to 50m3/m2. Compositional and textural differences between weakly deformed and mylonitic samples are the result of different fluid flux intensities within and around a large-scale blueschist-facies shear zone.

Combining thermodynamic and trace element forward models allows detailed investigation and quantification of the trace element budget and distribution during fluid influx and fluid-rock interaction. Our models show that increasing Li and Be concentrations in sodic amphibole rims are the result of a rehydration-induced internal redistribution of these elements between consumed omphacite and newly precipitated sodic amphibole overgrowth zones. In contrast, decreasing concentrations of Li, Be and B in phengite rims can only be modeled assuming a significant leaching effect by a fluid phase percolating through the rock volume. Pb and Sr concentrations are controlled by the retrograde formation of epidote in our samples. Further, our models allow quantification of the trace element composition of the infiltrating fluid, which was in the order of 250, 2 and 50 μg/g for Li, Be and B respectively.