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Evidence for oxygen isotope disequilibrium during serpentinite breakdown

Romain Lafay, Lukas Baumgartner, Benita Putlitz, and Guillaume Siron
Institute of Earth Sciences, University of Lausanne, Géopolis, 1015 Lausanne, Switzerland

Serpentinite break-down has received a lot of attention since this reaction is a major source for water in subduction zones. The fluids escaping from serpentinite are used as tracers in the arc volcanoes overlying subduction zone. Moreover, it has been proposed that dehydration could result in small tremors along the subducting slab, and that escaping fluids might produce porosity waves in the overlaying rocks.
We document that the textures resulting from serpentinite break-down in the Bergell contact aureole in the Malenco unit (North Italy). Serpentinite break-down in these high-T, medium P contact aureole results in talc-olivine fels. Spectacular Jack-straw olivine textures are present close to the serpentine out reaction, and olivine crystals size distribution within the aureole decreases with proximity to the intrusion. Our observations are in agreement with those made by Roselle et al. (1997) for olivine in a siliceous dolomite contact aureole. These olivine textures are interpreted to show progressively larger overstepping, as the intrusion is approached, with the transition of olivine growth dominated by surface or diffusion to nucleation dominated. Abundant anastomosing talc veinlets observed in the talc stability field are interpreted as localized pathway for fluid drainage, possibly representing the traces of porosity waves.
Laser fluorination extraction coupled with detailed in-situ (SIMS) oxygen isotope analysis was conducted to establish the talc-olivine fractionation. Δ18O(talc-fo) varies between 1.8 and 3.3 ‰ which correspond to very high temperatures (650 to 1100 °C). Surprisingly, no correlation between metamorphic grade and Δ18O(talc-fo) is observed. This suggest that rampant oxygen isotope disequilibrium is present throughout the contact aureole. This suggests that, at least in this environment, oxygen isotope compositions of fluids were several per mill out of equilibrium with the protolith, despite the fact that the serpentine break-down reaction produces abundant fluid. Thus, isotope – and by extrapolation trace element - compositions of fluids cannot be directly linked to the rocks they were produced from (assuming equilibrium). Indeed, dehydration fluids might not carry a lot of information on the kinetics of dehydration reaction, and the source composition. This has to be taken into account given the similarity with the textures observed in some regional metamorphic and subduction terrains.

Roselle, G.T., Baumgartner, L.P., and Chapman, J.A., 1997, Nucleation-dominated crystallization of forsterite in the Ubehebe Peak contact aureole, California: Geology, v. 25, p. 823–826.