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Short-lived brine infiltration during upper amphibolite facies metamorphism in the continental collision zone

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The importance of brine is increasingly recognized because of its role on mass transportation at the mid- to lower-crustal pressure-temperature (P-T) conditions (e.g., Newton & Manning, 2010). However, the passage and residence times of brine are not well understood.
This study deals with garnet-hornblende (Grt-Hbl) veins, discordantly cutting the gneissose structure of garnet-orthopyroxene-hornblende gneiss from the central Sør Rondane Mountains (SRM), East Antarctica. The Cl contents of hornblende and biotite, K content of hornblende, and the thickness of Na-richer rims of plagioclase decreased with distance from the Grt-Hbl vein. The P-T conditions of the vein formation were estimated to be ∼680 °C, ∼0.69 GPa (Higashino et al., under review).
In the wall rock in the vicinity of the vein, addition of Li, Cu, Rb, Ba, Pb, and U, which tend to be mobile in brines rather than in melts is observed, using Zr as an immobile element (Higashino et al., 2015). This indicates that the Grt-Hbl vein was formed by the infiltration of NaCl-KCl brine. Trace element concentrations in the wall rock minerals decrease with distance from the vein, and in most cases show concave up/down profiles. Distances where these concentrations in each mineral species become constant are dependent on elements, and not on mineral species. These profiles can be best modelled by diffusion equations, suggesting that the diffusion is the major process transferring the trace elements perpendicular to the vein. Although plagioclase does not show significant trace element zoning within each single grain, the discontinuous drop of anorthite content at rims is preserved. Thin brine films in grain boundaries presumably caused dissolution-reprecipitation (e.g., Ruiz-Agudo et al., 2014), and lattice diffusion in plagioclase would have followed this to form homogeneous trace element zonings. Therefore, the main process of brine infiltration into the wall rock is possibly grain boundary diffusion in wet conditions, and the different chemical profiles would represent differences in diffusion coefficients for each element. In addition, we estimated trace element concentrations of the brine and duration of the microstructural development, using elemental partition coefficients between fluids and minerals and diffusion equations. The duration, which was estimated to be ∼4 Myr, suggests short-lived brine infiltration in an otherwise long-lived continental collision scenario (e.g., Elburg et al., 2016).

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