Hydrologic properties evolution during magmatic fluid activity in the middle-crustal conditions estimated from metamorphic fluid-rock reaction zones, Sør Rondane Mountains, East Antarctica.

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Aqueous fluids flow could be responsible for changing hydrologic and thermodynamic properties of rocks. It is generally accepted that fluids play a key role in the earthquake's generation and crustal evolution. Fractures created by rapid fluid pressure rise providing fluids pathways and provide hydration reactions. The extent, chemistry, time of infiltration, distribution and flow mechanisms of such hydration reactions are controlled by fluid flow rate and hydrologic and chemical properties of rocks where reactions have happened. However, fluid pressure gradients and permeability within the crust remain poorly constrained due to their heterogeneity. Therefore, it is important to constrain fluid flow rate and hydrological properties to understand fluid pressure gradient and permeability. We applied new methodology connecting fluid infiltration timescales and fluid pressure gradients to estimate permeability from fluid-rock reaction zones by reactive-transport modeling of trace element profiles.

This study aims to investigate fluid-rock reaction zones with relation to pegmatite melt in amp-opx gneiss samples (~0.55 GPa, 750°C) from Brattnipene, Sør Rondane Mountains (SRM), East Antarctica, and constrained pressure gradient and permeability. Previous studies (e.g., Higashino et al., 2013; Higashino et al., 2019; Uno et al., 2017) suggested Cl-bearing fluid infiltration in the SRM from melt and aqueous fluids. Samples are partially hydrated along fractures associated with mm-scale hydration reaction zones. Pegmatite intrusions are crosscutting the schistosity.

We divide samples into several reaction zones from the fracture by modal amount of minerals, reaction textures, and trace elements (Cl and F) concentrations distributions profiles. The host rock is dominated by clinopyroxene, orthopyroxene, plagioclase, with minor amount of ilmenite, magnetite, biotite, and apatite. In the reaction zone, pargasite, tschermakite, plagioclase, with minor amount of quartz, biotite, and apatite were observed. Pegmatite consists of quartz and pyroxene with pargasite and biotite inclusions. Also, replacement textures of orthopyroxene and clinopyroxene by pargasite and biotite in the reaction zones are observed. CaO and Al_2O_3 are depleted in the host rock, whereas Na_2O, K_2O, and H_2O are enriched in the reaction zone. Cl concentration in apatite, biotite and pargasite grains were gradually decreasing with distance from the fracture, the highest concentrations were observed next to partial melt. Cl distributions profiles in pargasite were analyzed by a reactive-transport model to define transport mechanism and timescales of fluid infiltration. Duration of fluid infiltration was estimated to be 1-46 h depending on partition coefficient. Based on these result we will estimate fluid pressure gradient and permeability during magmatic fluid activity in the SRM. Estimated timescales represent process starting from fluid pressure rise, fractures propagation, and further fluid infiltration, which caused hydration reactions and reaction zone formation.

Higashino F. et al. Precambrian Research, 234 (2013) 229-246.
Higashino F. et al. Journal of Petrology, 60.2 (2019) 329–358.
Uno M. et al. Lithos 284–285 (2017) 625–641.

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