Time scales of Cl-bearing fluid infiltration and permeability estimated by reactive transport modelling for granulite/amphibolite-hosted reaction zones, Sør Rondane Mountains, East Antarctica

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Fluids in arc crusts are important for crust evolution, ore deposit formation and geothermal activities. Hydrologic properties in the crust, such as permeability to aqueous fluids, control advection, mass transport, and generation of elevated fluid pressures. However, permeability in the crust is of great uncertainty, because of its heterogeneity as well as experimental difficulties in high *P-T* conditions (Ingebritsen and Manning, 2010). Abundant evidence of Cl-bearing fluids in Sør Rondane Mountains (SRM), East Antarctica (e.g., Higashino *et al.,* 2013; Kawakami *et al.,* 2017; Uno *et al.,* 2017) make this area as one of the most suitable areas to study activities of Cl-bearing fluids. However, permeability, elemental transport mode, mechanism of fluid infiltration, as well as duration of fluid infiltration in the SRM are still unknown.

This study aims to investigate Cl-bearing fluids infiltration under crustal *P-T* conditions by examining hydrous veins in the mafic granulite and amphibolite samples from Mefjell, southern SRM, East Antarctica. Studied area is metamorphosed under granulite facies.

Mafic granulite and amphibolite are cut by numerous randomly-oriented veins. Mafic granulite and amphibolite samples are partially hydrated along veins, and associated with mm-sized hydration reactions zones. Based on the local mineral assemblage and the minerals mode, samples were divided into vein, reaction zone and host rock domains. Mafic granulite was divided as follows: vein (1 mm width; plagioclase (pl)+hornblende (hbl)+quartz (qtz), minor orthopyroxene (opx)+biotite (bt)+ilmenite (ilm)+clinopyroxene (cpx)+magnetite (mag)+apatite (ap)+potassium feldspar (kfs)+chlorite (chl)), host rock (pl+cpx+opx, minor bt+ilm+mag+kfs+ap). In amphibolite, vein, reaction zones, and host rock domains are identified as follows: vein (2 mm width; act+hbl+cum, minor ilm+ap+ep+serp), actinolite zone (2.3mm; act+hbl+cum, minor opx+ilm+ap+ep+mus), muscovite zone (2.5mm; hbl+opx, minor act+cum+ilm+ap+ep+mus+pl), host rock (hbl+opx, minor ilm+ap+ep+mus+pl).

P-T conditions were identified using pseudosections, Al-in-hornblende geobarometry and hornblende–plagioclase geothermometry, and estimated as 6±0.5 kbar, 635±50°C for the veins, and 770–820°C, 5.5-10 kbar for the host rock. For amphibolite, vein temperature was estimated by magnetite-ilmenite thermometer to be around 400±50°C.

Distribution of Cl in apatite in the reaction zones were measured by EPMA and used to estimate type of mass transport and duration of fluids infiltration. Cl-contents in apatite decrease from 0.2 mass% in vein to 0.02 mass% in host rock for mafic granulite, and from 1.54 mass% to 0.1 mass% for amphibolite. The Cl distribution profiles were analyzed by a reactive-transport model with local equilibrium. The Cl profile was fit using Peclet number ($Pe\# = vL/D$, where v is pore velocity, L is length of reaction zone, D is hydrodynamic dispersion). For mafic granulite $Pe\#$ is around 0.05, for amphibolite is around 90. Duration of fluid infiltration was estimated to be 6×10^{-3} yr for granulite, and 6×10^{-5} yr for amphibolite, which is

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short in geological time scales.

These results are combined to constrain permeability, transport mechanism and to show a comprehensive model for fluid activities in lower-middle crustal conditions in the SRM. Infiltration conditions, transport mechanism is defined by *Pe#* and duration of fluid infiltration are different for mafic granulite and amphibolite. Diffusion transport was dominant for mafic granulite. Contrary, in amphibolite, transport by advection was greater, influencing the time-scale of fluid infiltration.

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