Investigation of Mass Transport and Reactive Mechanism by Cl Bearing Fluid Infiltration during Multiple Hydration Events, Sør Rondane Mountains, East Antarctica.

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1 Introduction

Fluids in the Earth's crust are important for an ore deposition, the crust evolution and a geothermal activity in subduction zones. Aqueous fluids liberated from subducting slab are transported to overlying crust and mantle, and cause hydration reactions. Especially at lower crust, where aqueous fluids infiltrate, hydration reactions and mass transport are expected.

In continental crusts, where granulite facies metamorphism is expected Cl-bearing fluids are the major fluid species present (Kawakami et al., 2017). Cl-bearing fluids play a remarkable role in melting processes, chemical compositional and mineral assemblage changes, and influence on mass transfer (Uno et al., 2017).

Abundant evidences of Cl-bearing fluids in Sør Rondane Mountains, East Antarctica (e.g Higashino et al., 2013; Kawakami et al., 2017; Uno et al., 2017) such as present of Cl-rich minerals (e.g. apatite, biotite and hornblende) in felsic and mafic gneisses along the large-scale shear zones and tectonic boundaries make this area as one of the most suitable to study activities of Cl-bearing fluids in crusts. However, elemental transport mode and mechanism, as well as fluids infiltrating time in Sør Rondane Mountains are still unknown.

This study aims to investigate mass transport by fluid infiltration under crustal P-T conditions by examining hydrous veins in the mafic granulite and amphibolite samples from Mefjell (Eastern Sør Rondane Mountains (SRM), East Antarctica). Veins, reaction zones and host rock are investigated for mineralogical, textural and petrographic analyses.

Elements enrichment and depletion in the host rock and reaction zones, and associated mineralogical changes were observed. These chemical and mineralogical changes were interpreted as mass transfer associated with fluid infiltration, and subsequent hydration reactions with the host rock. These results are combined to constrain transport mechanism and to show a comprehensive model for fluid activities in lower-middle crustal conditions in Sør Rondane Mountains.

2 Geological settings

The Sør Rondane Mountains (22°–28°E, 71.5°–72.5°S) East Antarctica, are thought to be a part of the collision zone between East and West Gondwana.

The Sør Rondane Mountains are underlain by low- to high-grade metamorphic rocks and various syn-metamorphic intrusive rock, divided into the Northern Eastern and South Western terranes by mylonite zone named the Main Tectonic Boundary (Osanai et al., 2013), (Fig.1). The NE-terrane underlain by granulite-facies metamorphic pelitic, psammitic, and igneouse rocks and exhibits a clockwise pressure–temperature–time path, while the SW-terrane by amphibolite to greenschist-facies metamorphic rocks of intermediate to mafic composition and exhibits a counter-clockwise P–T–t path (Osanai et al., 2013).

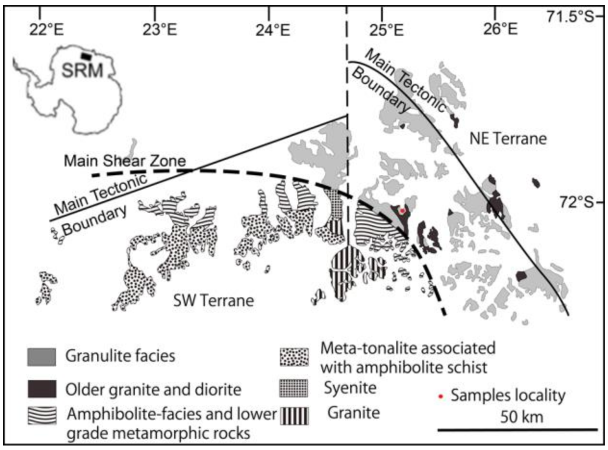

Figure 1. Geological map of Sør Rondane Mountains with subdivision into SW and NE terranes. Modified after Osanai et al. (2013).

3 Hydrous veins in Mafic Granulite and Amphibolite

In this study, we use two mafic granulite samples (sample no. 121403A1 and 121403A2) and one amphibolite sample (sample no. 121403B) from SW-terrane (S 72.049, E 25.152) of Mefjell, Sør Rondane Mountains, East Antarctica collected during the 51st Japan Antarctic Research Expedition in 2009-2010. Mafic granulite slightly foliated is cut by numerous randomly-oriented veins. For amphibolite, the schistosity is well developed.

4 Petrological characteristics

The strong hydration zone (shz) of the mafic granulite consists of dominantly plagioclase, orthopyroxene and clinopyroxene, with minor amount of ilmenite, magnetite, K - feldspar, biotite and apatite. The weak hydration zone consists (whz) of mainly plagioclase, hornblende and quartz, with minor amount of orthopyroxene, biotite, ilmenite, clinopyroxene, magnetite, apatite, potassium feldspar. In the shz mode of hydrous minerals is high. In the whz rock plagioclase and pyroxene are dominant (Fig. 2a). The amphibolite sample was divided into four domains (actinolite-cummingtonite zone, actinolite-hornblende zone, muscovite zone, and host rock) based on mineral assemblage. The act-cum, act-hbl and muscovite zones in the reaction zone, and the host rock consist of hornblende, orthopyroxene, cummingtonite, actinolite, with minor amount of muscovite, ilmenite, apatite, epidote and plagioclase. Amphiboles including hornblende, actinolite and cummingtonite exist in all domains. (Fig. 2b).

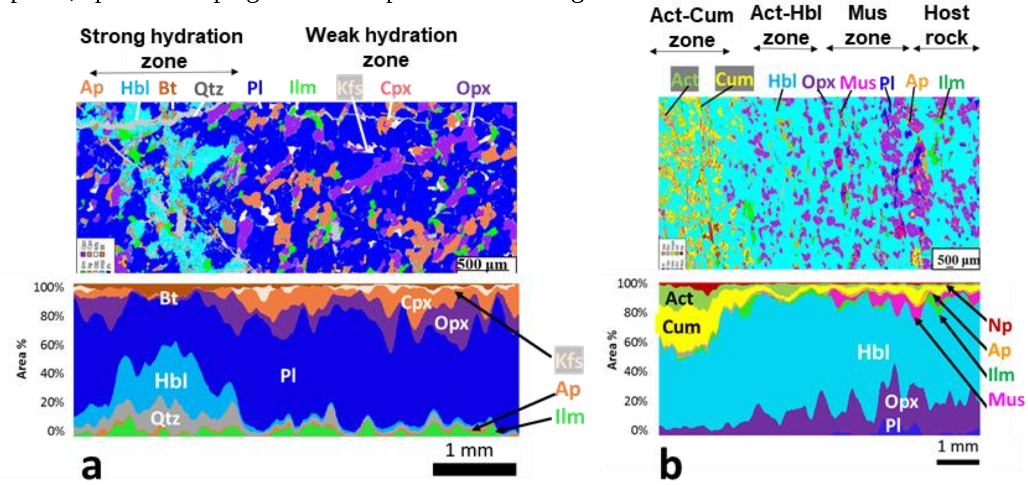

Figure 2. Mineral phase maps and mode profile variations with distance for mafic granulite (a) and amphibolite (b).

5 Mass transfer during fluid infiltration

Clear differences of chemistry among reaction zones are observed for several elements such as Na, K, Ca and H_2O. These mass transfer in granulite and amphibolite shows contrasting element behavior during fluid infiltration: Na_2O and CaO removal and K_2O addition for mafic granulite, and Na_2O addition and K_2O and CaO removal for amphibolite (Fig.3).

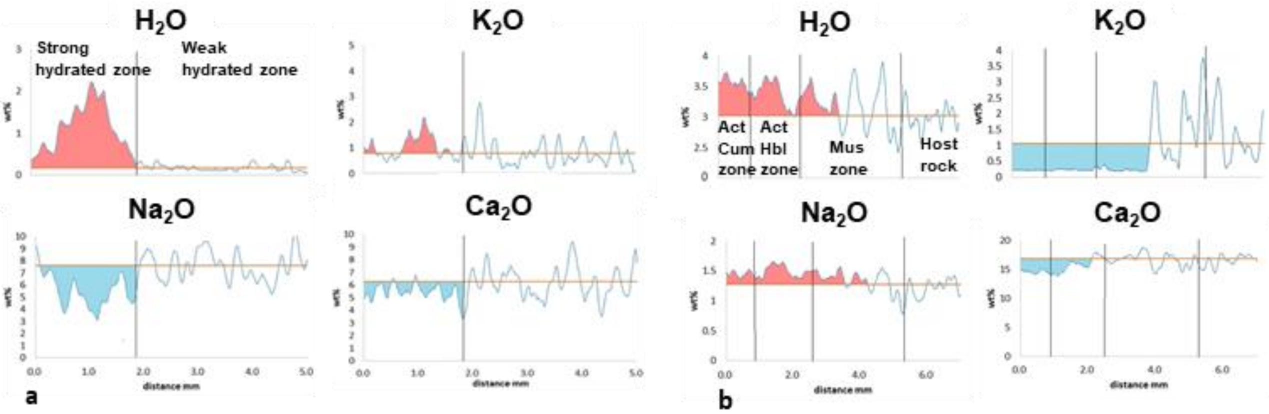

Figure 3. Element distribution with distance for mafic granulite (a) and amphibolite (b). Blue shows depletion, red shows enrichment.

6 Conclusion

We have analyzed hydration process in partially hydrated mafic granulite and amphibolite in Sor Rondane Mountains, East Antarctica and constrain P-T conditions of fluid infiltration. We discuss mass transport by fluid infiltration. We have measured Cl content in apatite which is an evidence of Cl bearing fluids infiltration and implicate Cl concentration to conclude reactive transport model. Duration of fluid infiltration was short in term of geological time scale.

References

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