角閃岩相高温部における高濃度塩水流入に伴う物質移動

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Mass transfer during highly saline brine infiltration under upper amphibolite facies metamorphism

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Highly saline brine can play an important role in large-scale mass transfer, because it is a powerful solvent and has low viscosity and low wetting angle (Watson & Brenan, 1987; Holness, 1997; Tropper et al., 2011; Williams-Jones et al., 2012). Experimental studies show that brine can dissolve silicate minerals and REE-bearing minerals under high pressure-temperature (*P-T*) conditions (Newton & Manning, 2010; Tropper et al., 2011). REE is found to be mobile during brine-rock interaction under low *P-T* condition (Williams-Jones et al., 2012). However, there is no experimental studies on REE transport during brine-rock interaction under high *P-T* condition. Previous studies on natural samples discussing mass transfer during highly saline brine activity often show a combined influence of both Cl-bearing and F-bearing fluids, and the major cation existed in the fluid is sometimes ambiguous (Harlov & Förster, 2002a, b). In the Sør Rondane Mountains (SRM), a Cl-rich fluid activity is distributed somewhat linearly for 200 km (Higashino et al., 2013; under review). *P-T* condition of the brine activity is estimated to be $\leq$ 700 ºC, $\leq$ 0.75 GPa from garnet-orthopyroxene-hornblende gneiss from Brattnipene, central SRM (Higashino et al., under review). Such an occurrence is suitable for a study of mass transfer during highly saline brine activity because *P-T* condition of the brine activity is already known, and devoid of other type of fluids..

The garnet-orthopyroxene-hornblende gneiss is discordantly cut by a ca. 1 cm-thick garnet-hornblende vein. Chlorine contents of hornblende and biotite and K content of hornblende decrease with a distance from the vein center. Thickness of Na-richer rim of plagioclase also decreases with a distance from the vein center. Isocon analysis supports Cl and Na gain at the vein during its formation. Therefore, we consider that the garnet-hornblende vein was formed by the infiltration of NaCl-KCl brine (Higashino et al., under review).

In situ LA-ICPMS REE and trace element analysis of garnet, orthopyroxene, hornblende, biotite and plagioclase was performed in order to detect the variation of REE and trace element concentration in these minerals as a function of distance from the vein center. Garnet, hornblende, and plagioclase are the main host minerals of REE among the major minerals. REE concentrations of garnet, hornblende and plagioclase increase with a distance from the vein center and become constant at ca. 1.6 cm away from the vein center. Although the Cl concentrations of hornblende and biotite decrease as a distance from the vein, the trend becomes constant at the same distance from the vein center. Furthermore, addition of REE in the vein is evidenced by isocon analysis. These observations mean that redistribution of REE would have occurred coeval with brine infiltration and recrystallization of low REE minerals. Although Williams-Jones et al. (2011) shows that LREE is carried by a brine further than HREE, such a trend is not observed.

On the other hand, transport of trace elements other than REE occurs as well and they show various trends. Among 36 trace elements analyzed, Nb concentration of hornblende and Sc concentration of garnet increase with a distance from the vein center, and Pb concentration of plagioclase decreases with a distance from the vein center. These changes are recognized at more than 2 cm away from the vein center.

It is clear from this study that NaCl-KCl brine under upper amphibolite facies condition is a powerful medium for mass transfer. A mass transfer by a brine activity might be recognized, paying attention to more mobile elements than Cl.

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