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角閃岩相高温部における塩水流入に伴うザクロ石ー角閃石脈の形成と物質移動
Garnet-hornblende vein formation and mass transfer by brine infiltration during upper amphibolite facies metamorphism

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The importance of chloride brines during metamorphism is being increasingly recognized among various metamorphic fluids. This is because chloride brines can coexist with a CO_2-rich fluid under the granulite facies condition (Heinrich, 2007), has low a_{H2O}, and acts as a powerful solvent not only for metals but also for various oxide and silicate minerals (Newton and Manning, 2010; Tropper et al., 2011). Therefore, chloride brines would play an important role in mass transfer especially when the pressure-temperature (P-T) conditions of metamorphism are around the wet solidus, because X_{H2O} in the brine can control the melting/non-melting behavior of the rock (Aranovich et al., 2013).

In the Sør Rondane Mountains (SRM), East Antarctica where Late Proterozoic to Cambrian granulites are widely exposed, Cl-rich hornblende and biotite in mafic gneisses are locally but widely distributed for ca. 200 km (Higashino et al., under review). Formation mechanisms of these Cl-rich minerals can be different if the modes of occurrence of them are different. Therefore, this study deals with the Cl-rich hornblende-bearing garnet-hornblende (Grt-Hbl) vein which discordantly cuts the gneissose structure of a mafic gneiss in the Brattnipene area, and discuss the formation mechanism and mass transfer that accompanied the vein formation.

In the Grt-Hbl vein, Cl contents of hornblende and biotite, K content of hornblende, as well as the development of a Na-richer rim of plagioclase decrease with a distance from the vein center. Whole-rock composition analyses as a function of distance from the vein show mass imbalances around the vein, suggesting that the Grt-Hbl vein was formed through an open system process. Taking into account the possibility of partial melting, distribution of Cl between melt, aqueous fluid and minerals, and microstructural evidences of minerals, the Grt-Hbl vein was shown to have formed by the Cl-rich aqueous fluid infiltration. The Cl-rich aqueous fluid was possibly NaCl brine because whole-rock analyses showed that Na was added to the vein compared to the wall rock. We estimated that the Grt-Hbl vein was formed at ca. 700 ℃ and 0.70 GPa. This means that the NaCl brine infiltrated into the wall rock at the early stage of retrograde metamorphism in this area. The whole-rock analyses and fractional mass change values calculated according to Ague (2001) also revealed that the NaCl brine infiltration caused additions of Si, Ti, Al, Fe, Mn, Mg, Ca, Na, Li, Sc, V, Cu, Zn, Ge, Sr, Y, Ba, Pb, Bi, Th and U to the wall rock. These added elements are similar to those contained in previously reported brines which were present in mineral assemblages implying subduction metamorphism and implying metal segregation in hydrothermal systems (e.g., Heinrich et al., 1992; Philippot and Selverstone, 1991). The Grt-Hbl vein formed by the NaCl brine infiltration as shown in this study is a clear example that brine could move at least a few meters, and was playing a role in mass transfer at ca. 700 ℃ and 0.70 GPa in the lower crust of the continental collision setting.

キーワード: NaCl brine, trace elements, metasomatism, continental collision, Sor Rondane Mountains, Antarctica
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