Paper Number: 3592

Geochemical behaviour of Zr around a metasomatic vein and possible brine infiltration under upper amphibolite facies conditions

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Understanding zircon behaviour provides a link between metamorphic events and geochronology data. Formation and recrystallization of zircon could occur at various stages of metamorphism as long as supply of Zr is sufficient, e.g. [1]. On the other hand, zircon is regarded as a mineral that is less susceptible to secondary alteration even in presence of fluids, e.g. [2]. As a result, Zr is often used as an 'immobile element' when relative mass addition/loss is estimated, because most of bulk rock Zr in crustal rocks is hosted in zircon, e.g. [3]. Therefore, zircon and Zr behaviour is a matter of interest in discussing mass transfer as well.

In the Sør Rondane Mountains, East Antarctica, late Proterozoic to Cambrian granulites are widely exposed. This study deals with about 1 cm-thick garnet–hornblende (Grt–Hbl) vein from the Brattnipene area which discordantly cuts the gneissose structure of the wall rock [4]. In the Grt–Hbl vein, Cl contents of hornblende and biotite, K content of hornblende, as well as the development of Na-richer rims of plagioclase decrease with distance from the vein and become constant at a few cm away from the vein centre. These compositional changes imply a possibility that the Grt–Hbl vein was formed by NaCl–KCl-bearing fluid or melt infiltration. The *P*–*T* conditions for the vein formation are estimated to be ~700°C, ~0.7 GPa, using geothermobarometry.

With distance from the vein centre, 1 cm-thick slices were prepared parallel to the Grt-Hbl vein, and the bulk rock Zr concentration of each slice was determined by ICPMS. The bulk rock Zr concentrations stay almost constant from the vein to the wall rock, beyond the distance where Cl concentration of hornblende and biotite becomes constant. Every zircon grain preserves cores, which can be recognized as bright-cathodoluminescence (CL) domain; darker-CL domains characterize mantles and rims. Grain size of zircon, and U-Pb ages and REE concentrations of zircon rims are constant with distance from the vein. The rim age is consistent with the timing of peak metamorphism in this area within error [5]. Therefore, it is concluded that zircon is not significantly dissolved or overgrown during the Grt–Hbl vein formation in this sample and that the timing of the vein formation is not recorded in zircon. This suggests that Zr is an appropriate immobile element for analysing relative mass addition/loss around the vein.

Using Zr as an immobile element, a mass balance analysis [6] was performed based on the bulk rock chemical variation with distance from the vein. This revealed that elements compatible with alkali–chloride-rich fluid were added to the wall rock rather than those compatible with melt and chloride-free fluid [e.g., 7], supporting formation of the Grt–Hbl vein by brine infiltration. This implies that brine transferred elements such as Ba, Pb and U in the middle crust at least on the scale of 10m.

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