A new scheme of diffusion-limited REE-uptake model for prograde-zoned garnets in low-temperature eclogites: Principle and application

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Garnet has received considerable attention because of its common occurrence and its major element/REE zoning in rocks metamorphosed under various pressure–temperature (*P*–*T*) conditions . Because of the limited scale of cation diffusion at low-*T*, strong compositional zoning patterns are observed in garnet metamorphosed below ~600°C. This characteristic feature enables us to understand a snapshot of the metamorphic history. One of the most promising methods for unraveling metamorphic record is REE uptake modeling in low-*T* garnet, especially the diffusion-limited REE-uptake model proposed by Skora *et al.* (2006). Their model takes into consideration *T*-induced increase of REE diffusion coefficients around a given garnet porphyroblast. This model can reasonably explain 'secondary peaks' of REEs in the mantle of zoned garnets.

In this contribution, we will introduce a new scheme of diffusion-limited REE-uptake modeling for low-*T* prograde zoned garnet. Using this new model, we tried to reproduce REE profiles in garnets from Syros and South Motagua Mélange (SMM) eclogites (Fukushima *et al.*, in this conference). The rim-to-rim trace-element zoning in the SMM garnets are characterized by both 'A'-shaped (Tb, Dy, Ho, Y, Er, Tm, Yb, Lu) and 'M'-shaped (Sm, Eu, Gd) profiles, resembling the results of Skora *et al.* (2006). Our new model is designed to predict 'D_0/α' for each garnet, which means the ratio of the pre-exponential factor of REE diffusion coefficients around a garnet porphyroblast (D_0) to its growth rate (α). Although Skora *et al.*'s (2006) model regarded these two values as distinct parameters, we found that this ratio could be regarded as a single parameter only if a given garnet radius could be approximated by a linear function of time. The incorporation of the parameter 'D_0/α' enabled us to evaluate: (1) a possible range of REE diffusion parameters in the SMM eclogite, and (2) difference of growth rates between the Syros and the SMM garnet. Applying the new model to the quantitative core-to-rim profiles, we concluded that the Syros garnet had grown ~2–3 orders of magnitude faster than the SMM garnet. In essence, the new scheme of diffusion-limited REE-uptake model would be a useful predictive tool for comparing difference of garnet growth kinetics in low-*T* eclogites.

Keywords: diffusion-limited REE-uptake model, garnet, eclogite

