Effect of water on Fe-Mg interdiffusion in garnet and some geological implications

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Garnet is an important rock-forming mineral of various magmatic, metamorphic and metasomatic rocks. Knowledge of diffusion rate in garnet allows constraints to be placed upon detailed records of geological processes, timescales and thermodynamic conditions in many natural contexts where mass transport is dominated by solid state diffusive processes [1,2]. However, the effect of water on the cation diffusion kinetics in garnet has not yet been resolved.

In this study, we investigated the effect of water on Fe-Mg interdiffusion in garnet at 3 GPa and 1373-1673 K under the anhydrous and hydrous conditions using the diffusion couple technique. Presynthesized dry or wet (306-1517 ppm wt.% water) pyrope and almandine polycrystals were used as diffusion couples. Before and after the diffusion experiments, water content was measured using the FTIR spectroscopy. Diffusion profiles in garnet were measured across the interface between pyrope and almandine by electron microprobe analysis, and simulated by the Boltzmann-Matano method.

Our results indicate that the interdiffusivity D is two orders of magnitude larger than that measured under anhydrous conditions. The enhancement in diffusivity in the presence of water results from an increase in the concentration of cation vacancies associated with the introduction of high concentrations of protons as point defects into the garnet structure.

This work was supported by the Strategic Priority Research Program (B) of the Chinese Academy of Sciences (XDB 18010401), the 1000Plan Program for Young Talents and Hundred Talent Program of CAS and NSF of China (41303048) to BZ.

Reference

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