

## Multi-mode diffusion of lithium in olivine from mafic layered intrusions

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Lithium is generally known as a fast-diffusing element in both olivine and silicate melt at magma temperature. The variations of Li concentration and Li isotopes in olivine have been widely adopted for solving short-lived magmatic processes and crust-mantle interaction. Decoding such variations in olivine, however, depends on our understanding of crystal growth and Li diffusion behaviors, both of which play a key role in elemental enrichment and isotopic fractionation [1-2]. To disentangle the process of crystal growth from post-crystallization diffusion, we conducted high resolution LA-ICP-MS elemental mapping for olivine from two mafic layered intrusions in SW China. The results show that the olivine grains commonly show complex, coupled Li-P zoning. The Li-P-rich zones generally contain Li concentration two to three times higher than that of the Li-P-poor olivine domains. Using SIMS for Li isotopic analysis, we also found that the Li-P-rich zones in each olivine grain commonly have lower  $\delta^7\text{Li}$  than that of the Li-P-poor domains, with the maximum fractionation of Li isotopes in a single grain being up to 15%. Combining the results of boundary layer numerical modeling for a 3-D spherical crystal growth [3], we suggest that rapid olivine growth can result in variable degrees of Li and P enrichment in concentration and high  $\delta^7\text{Li}$  in the Li-P-rich zone of olivine, which is inconsistent with our observations. Instead, the coupled Li-P zoning and Li isotopic variations can be well simulated by uphill diffusion of non-coupled Li along pre-existing P gradient in olivine through an exchange of  $\text{Li}^+ + \text{P}^{5+} = \text{H}^+ + \text{P}^{5+}$ , which led to the non-coupled Li became the coupled Li. The uphill diffusion of Li may be activated by dehydration of olivine due to exsolution of a fluid phase from the hydrous interstitial liquid within a crystal mush of a mafic magma chamber. Thus, caution should be taken when dealing with the Li-in-olivine geospeedometer and the large Li isotopic variations of olivine.

References:

- [1] Watson & Müller (2009), *Chem. Geol.*, 267: 111-124.
- [2] Lynn et al. (2020), *Front. Earth Sci.*, 8:135.
- [3] Shea et al. (2019), *Contrib. Mineral Petrol.*, 174: 85.