Correlation of Li chemical and isotope profiles with Fe-Mg inter-diffusion in volcanic olivines

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Various magmatic processes, such as cooling and the evolution of a magma, can develop compositional contrasts between minerals and the surrounding melt. Such disequilibrium leads to diffusion which produces chemically zoned minerals and large isotope fractionation at magmatic temperatures. Chemical and isotopic zoning are frequently coupled and isotopic zoning can be used to identify a diffusive origin of a zoning and elucidate the complex evolution of magmatic systems. The aim of this study is to utilize the fast-diffusing Li isotope system comparatively to the more established Fe-Mg exchange diffusion couple with a newly developed *in situ* fs-LA-MC-ICP-MS analytical technique for analyses of high precision Li isotope profiles in minerals with low Li concentration levels (e.g. olivine).

Olivines from two locations in the Massif Central volcanic region have been investigated. Lithium chemical and isotopic profiles have been determined and compared to Mg and Fe isotope inter-diffusion profiles in regard of profile length and crystallographic orientation. Lithium chemical profiles of all measured crystals show elevated Li concentrations at the rim (12 to 6 ppm) decreasing towards the cores (~3 to 1 ppm). Lithium isotope profiles show heavier compositions in the rims (with δ^7Li ~10 to 8 ‰) and lighter values in the cores (as low as -30.7 ‰, relative to IRMM-16). Compared to Fe-Mg inter-diffusive isotope profiles Li isotope profiles are both longer and shorter, in cases which appears to depend on the crystallographic orientation of the measured profile. The combined use of *in situ* δ^7Li with other isotope systems may further improve the capabilities to determine diffusion-driven time scales and to unravel complex volcanic processes.