Fractionation of Li and Fe Isotopes During Magmatic Differentiation

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Lithium and Fe isotopes both show significant isotope fractionation at mantle temperatures, which can exceed 10‰ for Li [1, 2] and 1‰ for Fe [3]. Li-isotope fractionation is mainly produced by diffusion [1, 2]. Iron isotope fractionation appears to occur either during metasomatic processes [3, 4] or during partial melting [4, 5], the latter resulting in a ≈ 0.1‰ Fe-isotope fractionation between the lithospheric mantle the crust. However, we have little evidence, whether this fractionation occurs either during kinetic processes or in isotopic equilibrium.

Here we studied Li and Fe isotope fractionation during fractional crystallisation, i.e. between basalts and their cpx and olivine phenocrysts. Some of the olivine separates may also contain xenocrysts. The samples are from the Canary Islands and some German volcanoes (Vogelsberg, Westerwald, Kaiserstuhl). The host basalts display isotope compositions, which are within the typical range for MORB/OIB (≈ +3 to +5‰ for δ^7Li and +0.05 to 0.25‰ for δ^{56}Fe). In contrast, the isotopic compositions of the minerals are highly variable. Significant isotope fractionation between basalt and olivine was observed for both, Li and Fe, with olivines being isotopically lighter than basalt (up to -13‰ for Li and up to -0.3‰ for Fe). One cpx displays the lightest Li-isotope composition (with Δ^7Li = - 21‰), but no Fe-isotope fractionation relative to its host basalt.

The Li isotope composition of mantle cpx is typically lighter than its coexisting olivine, which indicates diffusion of Li from olivine to cpx [1, 2]. Following this argumentation we can interpret our observation of generally lighter Li isotope ratios in the minerals as being produced by Li diffusion from the host basalt into both, cpx and olivine. Additionally, our first data for these samples reveals a positive correlation of Li- and Fe- isotope fractionation between olivine and basalts. This indicates that preferential diffusion of light Fe isotopes is coupled with diffusion of light Li into olivine. In cpx, Li- and Fe-isotopes are decoupled. This may imply that Li diffusion in cpx is significantly faster than that of Fe in cpx and both elements in olivine. The variable magnitude of coupled Li and Fe isotope variations in olivine may be related to a variable portion of xenocrysts. Alternatively, the Fe diffusion may be driven by the difference in $Fe^{3+}/\Sigma Fe$ between basalt and the mineral phases. Because of their similar $Fe^{3+}/\Sigma Fe$, isotopic exchange between cpx and basalt may not occur. In contrast, $Fe^{3+}/\Sigma Fe$ in olivine and basalt are vastly different, which may result in a diffusive light Fe-isotope enrichment in olivine. This process may be important for Fe-isotope fractionation during magmatic processes in general.

References

[1] Rudnick & Ionov (2007) *EPSL* **256,** 278-293. [2] Ionov & Seitz (2008) *EPSL* **266**, 316-331. [3] Williams et al. (2005) *EPSL* **235**, 435-452. [4] Weyer and Ionov (2007) *EPSL* **259**, 119-133. [5] Weyer et al. (2005) *EPSL* **240**, 251-264.

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Abs. No. **393**
Meeting: **DMG 2008**
submitted by: **Weyer, Stefan**
email: **stefan.weyer@em.uni-frankfurt.de**
date: **2008-06-01**
Req. presentation: **Vortrag**
Req. session: **S05**