Lithium and Magnesium Isotope Fractionation in the Earths Mantle

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In recent studies on mantle rocks variations of up to 27‰ in the $^{7}Li/^{6}Li$ ratio were found. Particularly, isotopic differences between coexisting olivine and pyroxenes (ΔLi_{ol-px}) range from close to zero up to about 24‰ (see recent compilation in Ionov and Seitz (2008) and refs therein). Such extreme fractionations were interpreted to represent disequilibrium processes such as diffusion-driven kinetic isotope fractionation (as evidenced by strong intra-mineral Li isotope zoning within single crystals; Jeffcoate et al., 2007), assuming that equilibrium Li isotope fractionation at mantle temperatures is negligibly small. The Mg isotope composition reported for mantle rocks and minerals is less variable (<1‰ in $^{26}Mg/^{24}Mg$) (e.g., Young and Galy, 2004; Wiechert and Halliday, 2007). However, systematic isotopic differences between minerals (olivine, pyroxene, spinel) from mantle xenoliths were found that suggest potential for this system to be used as an isotope geothermometer (Tonui et al., 2007).

A prerequisite for the interpretation of the isotopic signals of Li and Mg observed in natural rocks and for potential applications is knowledge of inter-mineral equilibrium isotope fractionation factors. To date, no experimental data on inter-mineral equilibrium isotopic fractionation of Li and Mg isotopes at temperatures and pressures relevant for the mantle are available. To get a better understanding of the processes influencing the distribution of Li and Mg and its isotopes in the mantle we have begun piston cylinder experiments at a pressure of 2 GPa and a temperature range between 800 and 1000°C designed to investigate equilibrium Li and Mg isotope fractionation between forsterite and enstatite as a function of temperature. To distinguish between kinetic and equilibrium isotope fractionation and to determine the timescales of isotopic equilibration between enstatite and forsterite, experiments with isotopically enriched tracers are employed. Moreover, crystallisation experiments producing coexisting forsterite and enstatite are in progress using mixtures of $Mg(OH)_2$ and SiO_2 as starting materials. The experimental products will be analysed for their Li and Mg isotope composition by MC-ICP-MS to quantitatively assess the inter-mineral isotope partitioning. The data to be obtained will be discussed in the light of recently published Li and Mg isotope data from natural mantle-derived rocks. A combined Mg and Li isotope approach has the potential to better understand magmatic processes in the Earth's mantle through the isotopic signals of a major (Mg) and a trace element (Li) with distinct chemical behaviour.

References

Ionov, D.A. and Seitz, H.M. (2008) EPSL 266(3-4), 316-331
Jeffcoate, A.B. et al. (2007) GCA 71(1), 202-218
Tonui, E. et al. (2007) GCA 71(15), A1030
Wiechert, U. and Halliday, A.N. (2007) EPSL 256(3-4), 360-371
Young, E.D. and Galy, A. (2004) Rev. Min. Geochem. 55, 197-230

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Abs. No. **464**
Meeting: **DMG 2008**
submitted by: **Schuessler, Jan A.**
email: **j.schuessler@bristol.ac.uk**
date: **2008-06-02**
Req. presentation: **Poster**
Req. session: **S04**