

## High-precision Mg isotope measurements of inner solar system materials by HR-MC-ICPMS

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Magnesium has three naturally occurring isotopes -  $^{24}\text{Mg}$ ,  $^{25}\text{Mg}$  and  $^{26}\text{Mg}$  - with relative abundances of 79%, 10% and 11%, respectively. Variations in the isotopic composition of Mg can potentially occur in solar system materials through a number of processes including (1) stellar nucleosynthesis, (2) the former presence and decay of the  $^{26}\text{Al}$  nuclide (half-life  $\sim 0.73$  Myr) and (3) mass-dependent isotopic fractionation during high temperature processes such as partial evaporation and condensation as well as from low-temperature fluid/rock interactions. Thus, studying the potential variability of  $^{26}\text{Mg}/^{24}\text{Mg}$  and  $^{25}\text{Mg}/^{24}\text{Mg}$  ratios in solar system solids can be used to infer genetic relationships between early solar system reservoirs and terrestrial planets.

We have developed novel methods for the chemical purification of Mg from silicate rocks, and high-precision analysis of Mg-isotopes by high-resolution multiple collector inductively coupled plasma source mass spectrometry (HR-MC-ICPMS) [1]. Based on the repeated analyses of international rock standards of variable matrices, we show that it is possible to routinely analyze the Mg-isotope composition of silicate materials with an external reproducibility of 2.5 and 20 ppm for the  $\mu^{26}\text{Mg}$ \* and  $\mu^{25}\text{Mg}$  values, respectively ( $\mu$  notation is the per  $10^6$  deviation from the DSM-3 reference material).

Using these techniques, we have analyzed to unprecedented precision the Mg-isotope composition of a strategically-selected suite of inner solar system materials, including calcium-aluminium-rich inclusions and amoeboid olivine aggregates from the reduced Efremovka CV chondrite as well as bulk chondrite meteorites and meteorite samples originating from differentiated asteroids. These new data provide important constraints regarding the relative and absolute Mg-isotope composition of bulk inner solar system planetary reservoirs, the distribution of  $^{26}\text{Al}$  in the solar protoplanetary disk, and the mechanism and timescale of asteroidal differentiation in the young solar system.

[1] Bizzarro, M. *et al.* (2011) *JAAS* **26**, 565-577

## Electrochemically-driven lithium isotopic fractionation

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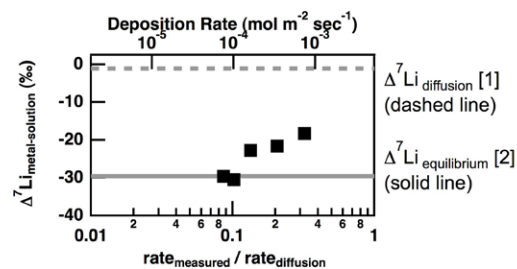
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Lithium is a mobile element, with a high diffusion coefficient, and a large difference in solution diffusivities for the two stable isotopes,  $^6\text{Li}$  and  $^7\text{Li}$  [1], making it an ideal element for studying isotopic fractionation during electro-deposition processes. Rates of mass-transport and deposition can be dialed-in using experimental electrochemical techniques to study the competing isotopic fractionation effects of reduction/precipitation and diffusion. Previous experiments measured the equilibrium fractionation between Li metal and  $\text{Li}^+$  in a propylene carbonate (PC) solvent [2], and large fractionations (up to  $-30$  per-mil in  $^7\text{Li}/^6\text{Li}$ ) were observed between electrodeposited Li and stock solutions [3]. The magnitude of fractionation was largest closest to the equilibrium reduction potential, and decreased as the thermodynamic driving force (and thus deposition rate) was increased (Fig. 1) [3]. Two hypotheses for this trend are 1) mass-transport-limited supply of Li to the reactive interface resulted in an attenuated isotopic signature, and 2) the observed changing isotopic signature is an intrinsic rate-dependent kinetic effect. These competing hypotheses will be directly tested in models and experiments of temperature-dependent isotopic fractionation during Li electrodeposition.



**Figure 1.** Lithium isotope composition of metal samples electroplated from 1M Li(PC) solutions, squares [3].

[1] Richter *et al.* (2006), *GCA* **70**, 277-289. [2] Singh *et al.* (1972), *J. Chem. Phys.* **56**, 1855-1862. [3] Black *et al.* (2009), *J. Am. Chem. Soc.* **131**, 9904-9905.