

## Mg isotope thermometry in Earth's mantle

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Advances in computational chemistry afford the capacity to predict quantitatively Mg isotope fractionations among high-temperature geological materials. High-precision MC-ICPMS measurements in turn provide the opportunity to test these predictions in well-characterized samples. We present new high-precision  $^{25}\text{Mg}/^{24}\text{Mg}$  and  $^{26}\text{Mg}/^{24}\text{Mg}$  measurements of mantle minerals and compare these ratios with predictions for temperature-dependent inter-mineral fractionations. Results show that systematic fractionations among minerals in high-temperature rocks are resolvable and are broadly consistent with theoretical predictions. Our first target was a spinel lherzolite from the San Carlos Arizona volcanic field. The crystal chemistry of the Cr-rich spinels from these mantle rocks suggests equilibration temperatures of between 800 and  $820 \pm 60^\circ\text{C}$  (Uchida *et al.* 2005).

Analyte Mg was extracted from olivine (ol), spinel (sp), and clinopyroxene (cpx) mineral separates and purified using a two-column (AG50W-X12) cation exchange technique. Isotope ratios were measured using dry plasma and sample-standard bracketing to correct for instrumental mass bias.

Our initial analyses yield olivine  $\delta^{25}\text{Mg}$  and  $\delta^{26}\text{Mg}$  values of  $-0.079 \pm 0.008$  and  $-0.151 \pm 0.011\%$  ( $1\sigma$ ), respectively, consistent with, but not identical to, previous measurements (Young and Galy 2004; Wiechert and Halliday 2007). Spinel  $\delta^{25}\text{Mg}$  and  $\delta^{26}\text{Mg}$  values are  $+0.333 \pm 0.017$  and  $+0.640 \pm 0.025\%$ , respectively, and clinopyroxene  $\delta^{25}\text{Mg}$  and  $\delta^{26}\text{Mg}$  values are  $+0.117 \pm 0.066$  and  $+0.207 \pm 0.011\%$ , respectively. The fractionations between sp, ol, and cpx have been estimated using density functional perturbation theory (Schauble *et al.*, this meeting). Comparison of the measured sp-ol fractionation ( $\Delta^{26}\text{Mg}_{\text{sp-ol}} = 0.79 \pm 0.03$ ) with these predictions yields a temperature of  $835 \pm 40^\circ\text{C}$ , in good agreement with previous estimates. The cpx-ol fractionation yields lower  $T$  of  $355 \pm 20^\circ\text{C}$ , suggesting disequilibrium or systematic errors involving the cpx predictions.

### References

- Uchida, H., B. Lavina, R.T. Downs and J. Chesley (2005). *American Mineralogist* **90**, 1900-1908.  
 Wiechert, U.H. and A.N. Halliday (2007). *Earth and Planetary Science Letters* **256**, 360-371.  
 Young, E.D. and A. Galy (2004). *Geochemistry of Non-Traditional Stable Isotopes*, MSA. **55**: 197-230.

## Determination of 33 elements in kimberlites from South Africa and China by ICP-MS

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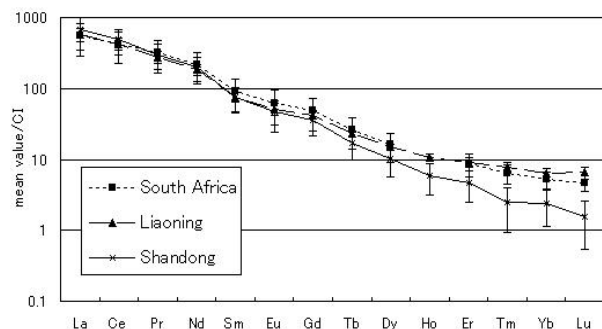
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In order to understand chemical characteristics of kimberlites from different areas we have determined 33 elements in 21 samples collected from South Africa and China (Shandong and Liaoning) by ICP-MS (inductively-coupled plasma mass spectrometry).

Homogenized samples (50mg) were decomposed with  $\text{HNO}_3$ , HF and  $\text{HClO}_4$  in a teflon bomb. After dilution with  $\text{HNO}_3$  (2%), the elements such as Na, Mg, K, Ca, Sc, Cr, Rb, Sr, Y, Nb, Mo, Cs, Ba, REE, Ta, W, Th and U were measured by ICP-MS. For I and Br, samples (200mg) were heated in a quartz tube and evaporated I and Br were collected in a trap solution. Then they were measured by ICP-MS.

Concentrations of incompatible elements such as light REEs, Th, U, Ba and Hf were highly enriched in kimberlite samples compared to other ultramafic rocks, suggesting the small degree of partial melting in the formation of kimberlite magma. The Th/U ratios in the samples, with a special reference to the Chinese samples, were much higher than that in other common igneous rocks. The I/Br ratio of samples from China showed a significantly lower value than that in South African samples.

The chondrite-normalized REE patterns of the kimberlites from South Africa (11 samples), Shandong (5 samples) and Liaoning (5 samples) are shown in Fig.1, as their average values. It was found that light REEs were strongly enriched in all samples, whereas the levels of heavy REEs were very low. A marked difference was found between the concentrations of heavy REEs in two Chinese regions, i.e. the value in Shandong was much lower than that in Liaoning. The average REE patterns obtained for South Africa and Liaoning were very similar.



**Figure 1:** The chondrite-normalized REE patterns of the kimberlites