Stable isotopic fractionation of Sr and Eu among igneous rocks

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Sub-permil isotopic variations of Mg, Si, Fe and Sr were observed among igneous rocks, and the possibillity of high temperature isotope fractionation during magmatic processes have been documented (e.g.; Charlier *et al.* , 2012; Savage *et al.* , 2011; Teng *et al.* , 2007; Teng *et al.* , 2008). We report sub-permil to permil order stable isotopic variation of Sr and Eu among igneous rocks with various origins.

28 igneous rocks covering a wide range of chemical compositions (SiO_2 = 46.7 - 78.2 wt.%) were analyzed. Samples were decomposed with a mixture of HF, HNO_3 and $HClO_4$. Granite samples were processed using Teflon bombs. Sr was separated by extraction chromatography using Sr Spec resin (Eichrom). Eu was separated by cation exchange column chromatography using AG 50W-x8 (Bio-Rad) with HCl and α-HIBA. Stable isotopic composition of Sr was analyzed by DS-TIMS technique using ^{84}Sr-^{86}Sr double spike and VG Sector 54-30 at NU. The results are expressed with relative to NBS 987 as $\delta^{88}Sr = [(^{88}Sr/^{86}Sr)_{sample}/(^{88}Sr/^{86}Sr)_{NBS\ 987} - 1] \times 10^3$. The reproducibility of δ^{88}Sr was ± 0.06. Stable isotopic composition of Eu was analyzed on the Thermo Neptune MC-ICP-MS at JAMSTEC with external normalization using Sm. Potential isobaric interference of BaO was checked and found to be neglegible. The results are expressed with relative to an *Alfa Aesar* Eu_2O_3 reagent as $\varepsilon^{153}Eu = [(^{153}Eu/^{151}Eu)_{sample} /(^{153}Eu/^{151}Eu)_{STD} - 1] \times 10^4$. The reproducibility of ε^{153}Eu was ± 0.31.

The δ^{88}Sr and ε^{153}Eu of the mafic and intermediate samples agreed each other with an average of +0.27 and +0.13, respectively. Felsic samples showed significantly large variations both on δ^{88}Sr and ε^{153}Eu ranging from +0.36 to -0.99 and from +0.20 to -5.73, respectively. Our δ^{88}Sr results for six international reference rocks agree well with the previously reported values. The observed variations of both δ^{88}Sr and ε^{153}Eu are correlated with SiO_2 abundances and also with the magnitude of negative Eu anomaly. The correlation between δ^{88}Sr and ε^{153}Eu with negative Eu anomaly indicates that the variation of δ^{88}Sr and ε^{153}Eu was caused by plagioclase fractionation during magmatic differentiation processes. This observation suggests that the melt-plagioclase isotope fractionation factor (α-1) of Sr and Eu at magmatic temperature is on the order of 10^{-4}.

Anisotropy: A cause of heat flux variation at the CMB?

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We have used atomic scale simulations to determine the thermal conductivity of $MgSiO_3$ perovskite and post-perovskite under D″ conditions and shown that the thermal conductivity of post-perovskite (~12 W/mK) is 50% larger than that of perovskite under the same conditions (~8.5 W/mK). This finding, in agreement with previous studies on analogue materials, means that the high heat flux into cold regions of D″ where post-perovskite is stable is enhanced relative to a simple single-phase case [1]. Furthermore, we have found that the thermal conductivity of post-perovskite is anisotropic, with conductivity along the *a*-axis being 40% higher than conductivity along the *c*-axis. Thus, – similarly to the lithosphere [2] – there is potential for texturing caused by deformation to modify how the mantle is heated from below. We test this idea by coupling our atomic scale results to previous models of texture in D″ [3] and find that anisotropic thermal conductivity may help to stabilise the roots of mantle plumes (Figure 1).

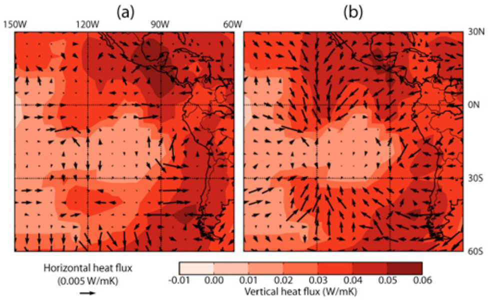

Figure 1: Modelled CMB heat flux at the base of a large plume in the East Pacific. Compared to the isotropic case (a) the horizontal heat flux in the anisotropic textured case (b) feeds heat, and thus boyancy, into the plume.

[1] Hunt *et al.* (2012) *EPSL* **319-320**, 96–105. [2] Tommasi *et al.* (2001) *Nature* **411**, 783-786. [3] Walker *et al.* (2011) *Geochemistry Geophysics Geosystems* **12**, Q10006.

DOI:10.1180/minmag.2013.077.5.23