Chondritic Sm/Nd in the Earth, Moon and Mars

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One of the most fundamental assumptions in geochemistry is that refractory lithophile elements occur in chondritic relative abundances in the bulk Earth. However, the accessible silicate Earth exhibits a ~20 ppm higher ^{142}Nd/^{144}Nd than most chondrites [1], and this may reflect a higher-than-chondritic Sm/Nd of the bulk Earth [2-4]. Caro *et al.* [2] argued that because the ^{146}Sm-^{142}Nd isochrons of the lunar and martian mantles intersect at a higher-than-chondritic ^{147}Sm/^{144}Nd *and* at the ^{142}Nd/^{144}Nd of the modern terrestrial mantle, the Earth, Moon and Mars all are characterized by a common, superchondritic bulk composition (termed 'SCHEM' [3]). Such non-chondritic compositions may result from collisional erosion of early-formed crust or may reflect assembly of the terrestrial planets from non-chondritic materials [4].

Here we re-examine the lunar and martian ^{146}Sm-^{142}Nd systematics and show that the lunar and shergottite isochrons intersect almost exactly at the chondritic ^{147}Sm/^{144}Nd, whereas SCHEM plots off both isochrons. This as well as evidence from the Hf-Nd isotope systematics of lunar samples [5] indicates chondritic Sm/Nd in the Earth, Moon and Mars. The ^{142}Nd/^{144}Nd of the lunar and shergottite isochrons at a chondritic Sm/Nd are slightly lower than albeit not clearly resolved from that of the modern terrestrial mantle, but are distinctly higher than the mean ^{142}Nd/^{144}Nd of ordinary and carbonaceous chondrites. We interpret these ^{142}Nd/^{144}Nd variations to be nucleosynthetic in origin and show them to be consistent with a heterogeneous distribution of *s*- and *p*-process Nd. Of note, the resulting nucleosynthetic anomalies in Sm and non-radiogenic Nd isotopes are small and consistent with currently available data for chondrites [*e.g.*, 6].

A nucleosynthetic origin of the ^{142}Nd difference between the Earth and chondrites provides further evidence that the *isotopic* composition of the Earth is distinctly non-chondritic [7]. However, the *chemical* composition of the Earth, at least for refractory lithophile elements, appears to be chondritic.

[1] Boyet & Carlson (2005) *Science* **309**, 576-581. [2] Caro *et al.* (2008) *Nature* **452**, 336-339. [3] Caro & Bourdon (2010) *GCA* **74**, 3333-3349. [4] Campbell & O'Neill (2012) *Nature* **483**, 553-558. [5] Sprung *et al.* (2013) *EPSL*, subm. [6] Carlson *et al.* (2007) *Science* **316**, 1175-1178. [7] Burkhardt *et al.* (2011) *EPSL* **312**, 390-400.

Investigation of boron, carbon, and oxygen isotope systematics in the aragonite-CO_2-H_2O system

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Calcium carbonate has been ubiquitous on the surface of the Earth. Therefore, marine and continental carbonates, such as forams and speleothems, play a critical role in paleoceanography and paleoclimatology as a key climate archive. Hence, a proper understanding of stable isotope systematics in carbonates with respect to their formational environment is important for the reconstruction of Earth's climate history.

Stable isotope systematics of boron, carbon, and oxygen in the aragonite-carbon dioxide-water system were simultaneously investigated using synthetic aragonite as a function of solution chemistry at 25 °C. A refined version of the constant addition method [1] was used to synthesize a polymorph of $CaCO_3$, aragonite, in aqueous solutions of various, but constant pH values and ionic strengths. The mineralogy of the carbonate was confirmed by XRD analysis and their isotopic compositions were determined by either IRMS or MC-ICPMS.

Results of our study suggest that the effect of ionic strength (~0.7 mol/kg) on the stable isotope fractionation between aragonite and water (for oxygen) as well as between aragonite and DIC (for carbon) in the aragonite-CO_2-H_2O system is negligible. In addition, boron isotope analysis of synthetic aragonite prepared from aqueous solutions of seawater-like ionic strength indicates that borate ions are preferentially incorporated into the aragonite crystal.

[1] Kim *et al.* (2007) *Geochim. Cosmochim. Acta.* **71**, 4704-4715.

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