Hafnium isotopic compositions of refractory inclusions

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Calcium-aluminum-rich inclusions (CAIs) are commonly interpreted as the earliest formed condensates in the solar nebula. The isotopic composition of these refractory inclusions consequently provides us with information about the earliest sampled reservoir of the Solar System. Relative to inner Solar System planetary bodies, normal (non-FUN) CAIs display homogeneous excesses in isotopes created by the *r*-process of nucleosynthesis in the elements Sr, Zr, Mo, Ru, Ba (i.e. A<140) [1-4] and deficits in *r*-process isotopes of Nd, Sm, Gd, Dy, Er, Yb (i.e. A>140) [4-7]. Interestingly, for A>176, the case is less clear. Variable *r*-excesses exist in fine-grained CAIs for W, but seem to be minor to absent in coarse-grained inclusions [8]. Additionally, previous studies have yielded ambiguous results regarding the consistency and magnitude of non-radiogenic Hf isotopic compositions in CAIs [9-10], and thus, the nucleosynthetic signatures in CAIs remain poorly understood for A>176.

In this study, we present non-radiogenic Hf isotope data of CAIs to further examine their observed isotopic character. After purification of Hf from the sample matrix [11], Hf isotope compositions were measured by MC-ICPMS in Münster. The external reproducibility of our method was assessed by repeated analyses of BCR-2 and BHVO-2 terrestrial basalts, yielding 4 and 7 ppm (2SD) for ^{178}Hf and ^{180}Hf, respectively. The Hf isotopic compositions of the CAIs studied here are indistinguishable from one another, yet distinct from terrestrial standards, supporting an isotopically homogeneous CAI-forming region. Using the nucleosynthetic model of [12], the average Hf isotopic composition of CAIs is consistent with a deficit in *r*-process material relative to the Earth. This *r*-deficit is of similar magnitude as previously observed for Er and Yb [7] and may reflect a tendency of decreasing *r*-process anomalies with increasing mass.

[1] Hans et al. (2013) *EPSL* **374**, 204. [2] Moynier et al. (2012) *ApJ* **785**, 45. [3] Burkhardt et al. (2011) *EPSL* **312**, 390. [4] Brennecka et al. (2013) *PNAS* **110**, 17241. [5] Brennecka et al. (2014) *45th LPSC*, #2280. [6] Shollenberger et al. (2015) *46th LPSC*, #2593. [7] Shollenberger et al. (2016) *47th LPSC*, #1964. [8] Kruijer et al. (2014) *EPSL* **403**, 317. [9] Sprung et al. (2010) *EPSL* **295**, 1. [10] Akram et al. (2013) *ApJ* **777**, 169. [11] Bast et al. (2015) *JAAS* **30**, 2323. [12] Bisterzo et al. (2011) *Mon. Not. R. Astron. Soc.* **418**, 284.