TIN ISOTOPE COMPOSITIONS OF CARBONACEOUS CHONDRITES

M. Friebel[1], M. Schönbächler[1], E. R. Toth[1] and M. A. Fehr[1]. [1]Institute of Geochemistry and Petrology, ETH Zürich, Clausiusstrasse 25, 8092 Zurich, Switzerland. E-mail: friebel@erdw.ethz.ch

Introduction: Nucleosynthetic isotope variations in bulk meteorites have been reported for various refractory elements [e.g. 1, 2]. In contrast, studies of moderately volatile elements do not reveal such nucleosynthetic variations [e.g. 3]. A recent study [4], however, suggested that the moderately volatile element Zn exhibits small, but resolvable nucleosynthetic variations. The nucleosynthetic source of these variations is currently debated [4]. The variations in bulk carbonaceous chondrites are around +0.4 for ε^{66}Zn relative to the terrestrial composition. Additionally, leaching experiments indicate that the Zn isotope anomaly of the bulk meteorite is also present in most leach steps of the meteorite [4]. Tin and Zn display very similar half-mass condensation temperatures under solar nebula conditions (704 K and 726K, respectively [5]). Moreover, Sn has 10 isotopes that are of variable nucleosynthetic origin. This entails that the nucleosynthetic variations in Zn isotopes should also be reflected in Sn isotopes and that Sn isotopes may help to determine the nucleosynthetic origin of these variations. Four Sn isotopes are produced by a single nucleosynthetic process: ^{112}Sn, ^{114}Sn (p-process); ^{116}Sn (s-process); ^{124}Sn (r-process), while ^{117}Sn-^{122}Sn are synthesized by both the s- and r-process. The nucleosynthetic origin of ^{115}Sn is under debate [6]. Previous Sn isotope studies, dating from the 1960s [7,8], could not detect nucleosynthetic isotope variations. However, developments in methodology and mass-spectrometry since then have significantly increased the precision at which the Sn isotope composition can be measured. Taking advantage of these improvements, we carry out high precision analyses of Sn isotopes for a suite of bulk carbonaceous chondrites to address the issue of nucleosynthetic heterogeneity in moderately volatile elements. High precision Cd isotope data from the same samples are reported in a companion abstract [9].

Analytical Method: We set up a novel analytical method for high precision Sn isotope analyses that allows us to separate Sn efficiently from matrix elements, even at low Sn concentrations [10]. Our method includes sample digestion using a hot plate or Parr® bombs, followed by the Sn purification in a two-stage chromatographic separation procedure. Tin isotope ratios are measured on a NU Plasma II multi collector inductively-coupled plasma mass spectrometer (MC-ICPMS) coupled to a DSN-100 introduction system at ETH Zürich. For high precision Sn isotope measurements, individual Sn analyses comprise 20 dynamic isotope measurements. The first cycle collects all ten Sn isotopes, while the second cycle monitors isobaric interferences of Cd, In and Te isotopes. The Sn isotope data are normalized to ^{122}Sn/^{118}Sn = 0.19125 and are reported in the epsilon notation as $\varepsilon^{x}\mathrm{Sn} = \{(\varepsilon^{x}\mathrm{Sn}/^{118}\mathrm{Sn})_{\mathrm{sample}} / (\varepsilon^{x}\mathrm{Sn}/^{118}\mathrm{Sn})_{\mathrm{NIST\ 3161a}} - 1\} \times 10^4$.

Results and Discussion: The external reproducibility (2 sd) for a 200 ppb Sn standard solution (NIST 3161a) measured repeatedly (n=37) on a single day was ±90 ppm for ^{112}Sn/^{118}Sn, ±160 ppm for ^{114}Sn/^{118}Sn, ±116 ppm for ^{115}Sn/^{118}Sn, ±18 ppm for ^{116}Sn/^{118}Sn, ±19 ppm for ^{117}Sn/^{118}Sn, ±15 ppm for ^{119}Sn/^{118}Sn, ±13 ppm for ^{120}Sn/^{118}Sn and ±23 ppm for ^{124}Sn/^{118}Sn. Terrestrial samples (basalts, dunite and lake sediments) yield Sn isotope compositions identical to the NIST 3161a standard solution within the analytical uncertainty. This demonstrates the robustness of our new method for different sample matrices. The Sn isotope composition of the carbonaceous chondrite Allende from the Parr® bomb digestion also overlaps with the terrestrial samples. The hot plate digestion of the same meteorite, however, yields apparent small deviations from the terrestrial Sn standard of up to 0.2 ε. This hints at the presence of a refractory carrier phase with an anomalous Sn isotopic signature, that was not dissolved during the hot plate digestion. Further analyses of bulk carbonaceous chondrites are underway to further investigate the potential presence of small Sn isotope variations and will be presented at the conference.

References: [1] Akram W. et al. 2015. *Geochimica et Cosmochimica Acta* 165:484–500. [2] Burkhardt C. et al. 2011. *Earth and Planetary Science Letters* 312: 390–400. [3] Fehr M. A. et al. 2005. *Geochimica et Cosmochimica Acta* 69: 5099–5112. [4] Savage P. S. et al. 2014. *Meteoritics & Planetary Science* 49:A356 [5] Lodders. K. 2003. *The Astrophysical Journal* 591:1220-1247. [6] Dillmann I. et al. 2008. Abstract #091. 10th Symposium on Nuclei in the Cosmos. [7] De Laeter J. R. and Jeffery P. M. 1965. *Journal of Geophysical Research* 70: 2895–2903. [8] De Laeter J. R and Jeffery P. M. 1967. *Geochimica et Cosmochimica Acta* 31: 969–85. [9] Toth E. R. et al. 2016. 79th Annual Meteoritical Society Meeting. [10] Friebel M. et al. 2015. Goldschmidt Conference Abstract #948