

Tin Isotope constraints on the Formation of the Moon

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One of the salient features of the lunar composition in comparison with the Earth is its significant depletion in moderately volatile elements. While this depletion has been known since the first return of Apollo samples, its origin remains poorly understood. Recent observations of Zn [1] and K isotopes [2] have both shown small but significant enrichment in heavy isotopes relative to the terrestrial compositions. K isotope results were interpreted as due to the effect of partial condensation while Zn isotopes were thought to reflect evaporation under kinetic conditions. In parallel, thermodynamic models of the protolunar disk have inferred that the temperature of vapor-liquid separation could have been in the range 3500-4000°C [3,4] with relatively high pressure conditions. In this study, we have measured the Sn isotope composition of the Earth and the Moon as an attempt to provide new constraints on the formation of the Moon.

We have designed a new analytical method for the analysis of tin isotopes in geochemical samples by MC-ICPMS using a double spike technique [5]. Our method shows that it is possible to determine the tin isotope composition of geological samples with a conservative uncertainty of 0.1 ‰ (2 SD) based on replicate measurements of terrestrial standard material using as little as 10 ng of Sn. This method has been used to analyze a series of terrestrial rocks (peridotites and basalts) and it was possible to derive the tin isotope composition of the Bulk Silicate Earth [6]. We have also analyzed a series of lunar samples including low-Ti and high-Ti basalts to determine the tin isotope composition of the bulk silicate Moon. These results are then interpreted in parallel with the Zn and K isotopes as an attempt to reconcile the interpretations of these isotope systems.

[1] Kato C. et al. (2015) Nature Comm., DOI: 10.1038/ncomms8617. [2] Wang K., Jacobsen S.B. (2016) Nature, 538, 487-490. [3] Canup R.M. et al. (2015) Nature Geosci. 8, 918-921. [4] Lock S.J. et al. LPSC XLVII 2881. [5] Wang et al., JAAS, in revision. [6] Wang et al., submitted; Amet et al., this meeting.