

The composition of the lunar core through zinc and copper isotopes

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The Earth and the Moon share a close genetic link, evidenced by their near identical composition in a number of refractory stable isotopic systems, such as Ni, Ti, Cr, and W and also their elemental Hf/W contents [1, 2]. Unlike the refractory lithophile elements, however, the isotopic fractionation of more volatile elements, such as Cu and Zn, show significant variability across the two bodies.

By combining experimental results with high-precision isotopic measurements of Zn and Cu isotope fractionation factors, we show that at conditions relevant to the formation of the lunar core there are resolvable isotopic fractionations between metallic, sulphide, and silicate melts. For both Zn and Cu, the carbon saturated metallic liquid is slightly enriched in heavier isotopes relative to both the silicate melts and sulphide melt. In contrast, the sulphide melt is isotopically the lightest of the three phases. In all experiments Zn isotopes display a smaller degree of fractionation than Cu isotopes.

Cu isotope fractionations are consistent with previously reported studies on iron meteorites [3] and experimentally determined Cu-isotope fractionation for metal/silicate and sulphide/silicate liquids [4]. Unlike Zn, however, Cu partitions strongly into sulfides ($100 < D^{\text{sulfide/melt}} < 200$), implying that segregation of a sulfide melt from the cooling lunar magma ocean can explain the larger offsets of the Cu isotope compositions between lunar rocks and the bulk silicate Earth, relative to other moderately volatile elements. This is not the case with the more volatile Zn, which exhibits negligible fractionation with lunar core formation and sulfide extraction. Hence, the Cu isotope composition of the Moon is explained by its sequestration to a carbon-free, sulfur-bearing core, whilst the lunar Zn isotopic inventory is best explained by volatility driven processes.

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3. Williams, H.M. & Archer, C. *GCA*, 2011. **75**(11): p. 3166-3178.
4. Savage, P.S., et al., *GPL*, 2015. **1**(1): p. 53-63.