Origin of volatile element depletion in early solar system material

E. A. PRINGLE[1], F. MOYNIER[1], P. BECK[2], R. PANIELLO[3], AND D. C. HEZEL[4]

[1]Institut de Physique du Globe de Paris (pringle@ipgp.fr)
[2]Institut d'astrophysique et de planétologie de Grenoble
[3]Washington University in St. Louis
[4]Universität zu Köln

Volatile lithophile element abundances are depleted in the different planetary materials to various degrees [1]. The origin of these depletions is still debated.

Stable isotopes of moderately volatile elements such as Zn can be used to understand the origin of volatile element depletions. Samples with significant volatile element depletions, including the Moon and terrestrial impact rocks, display heavy Zn isotope compositions (i.e. enrichment of ^{66}Zn vs. ^{64}Zn), consitent with Zn isotope fractionation during evaporation [2, 3]. However, [4] found a negative correlation between δ^{66}Zn and 1/Zn among CI, CM, CO, and CV chondrites, opposite to what would be expected if evaporation caused the Zn abundance variations among chondrite groups.

We have analyzed the Zn isotope composition of an extended range of carbonaceous chondrites: CI (4), CM (4), CO (4), CV (3), CB (2), CH (2), CK (4), and CR (1). Bulk samples define a negative correlation in plots of δ^{66}Zn vs Mg/Zn and Ca/Zn, further confirming that Zn abundance variations between carbonaceous chondrites are not due to evaporation, but rather due to nebular processes. The exceptions are CB and CH, which display Zn systematics consistent with a collisional formation mechanism that created an enrichment in heavy Zn isotopes relative to the trend defined by CI-CR.

In addition, we present Zn isotope analyses of chondrite components, including chondrules from Allende (CV3) and Mokoia (CV3), as well as an aliquot of Allende matrix. All chondrules exhibit light Zn isotope enrichments (~500 ppm on ^{66}Zn/^{64}Zn) relative to the bulk, showing that the Zn depletion observed in chondrules is not due to evaporation. Sequential leaching experiments in several un-equilibrated ordinary chondrites show sulfides are isotopically heavy compared to silicates and the bulk meteorite. We suggest sulfide removal from either chondrules or their precursors was the mechanism responsible for the light Zn isotope enrichments in chondrules.

References: [1] O'Neill, H.S.C. & Palme, H. 2008. PTRS A 366. [2] Moynier, F. et al. 2009. EPSL 277. [3] Day, J. & Moynier, F. 2014. PTRS A 372. [4] Luck, J.M., et al. 2005. GCA 69.