Extreme volatile depletion in the eucrite parent body

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The abundance of volatile elements provides fundamental constraints on the formation of planetary bodies. It has been demonstrated that the Moon is depleted in Zn and other moderately volatile elements (MVE) compared with Earth or Mars [1,2]. The isotopically heavy Zn isotope compositions (δ^{66}Zn = +1.4 ±0.5 ‰ [1]) and low Zn abundances of lunar mare basalts reflect a large-scale 'drying out' of the Moon, either during a magma ocean phase, or in a Giant Impact. If volatile depletion occurred during magma ocean phases and is scaled to the size of planetary bodies [3], a prediction would be that the parent body of Howardite Eucrite Diogenite (HED) meteorites (likely Vesta) should be even more MVE depleted than the Moon, due to its smaller size and lower gravitational potential. Unlike lunar mare basalts, however, HED meteorites have been variably affected by post-crystallization impact processes, requiring that independent petrological and geochemical constraints on 'prisitinity' are available for individual samples to assess the meaning of volatile compositions.

We present new Zn isotope data for unbrecciated and monomict eucrite meteorites that we have characterized [4]. The new data confirms and extends the previously published range [5] in Zn abundances (0.1 to 8.9 μg g^{-1}) and δ^{66}Zn for eucrites (-8.5 to + 6.3‰). Zinc isotope ratios in the eucrites fall along a mass dependent fractionation line for ^{68}Zn/^{64}Zn and ^{66}Zn/^{64}Zn corresponding to a slope of two and show a negative relationship with Zn concentration and δ^{66}Zn. Eucrite samples with the heaviest Zn isotope compositions and lowest Zn abundances exhibit petrological and geochemical evidence for greatest 'pristinity'. Based on these relationships, we estimate a significantly more MVE depleted HED parent body (δ^{66}Zn >6‰) than the Moon. These results are consistent with a volatile-depleted HED parent body that 'dried out' during magmatic differentiation and outgassing.

[1] Paniello, R.C. et al. (2012) *Nature* 490, 376-379. [2] Kato, C. et al. (2015) *Nature Comm* 6, 8617. [3] Day, J.M.D. & Moynier, F. (2014) *Phil. Trans. Royal Soc. A.,* 20130259. [4] Dhaliwal, J.K. et al. (2017) *this volume.* [5] Paniello, R.C. et al. (2012) *Geochim. Cosmochim. Acta* 86, 76-87.