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Volatile depletion and evolution of Vesta from coupled Cu-Zn isotope systematics

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The moderately volatile elements, Cu and Zn, are not strongly affected by magmatic differentiation [1, 2] and are important tracers of volatile depletion in planetary bodies, particularly low-mass, airless bodies [3]. New isotopic ratio and abundance measurements for both Cu and Zn are presented for eucrites to more fully understand volatile depletion processes that affected the parent-body of the howardite-eucrite-diogenite (HED) meteorites, the asteroid 4-Vesta. Zinc isotope ratios are reported for twenty-eight eucrite samples, which along with prior data [4] yield a range of δ^{66}Zn from -1.8 to +6.3 ‰, excluding one outlier, PCA 82502 (δ^{66}Zn = -7.8 ‰) and a Zn concentration range from 0.3 to 3.8 p.p.m. Heavy Zn isotopic ratios (positive δ^{66}Zn compositions) in eucrites form a negative trend with Zn concentration, reflecting volatile depletion processes on Vesta that are similar to the Moon [5, 6]. Within the combined sample set, eleven eucrites have light Zn isotopic compositions from δ^{66}Zn of -0.02 to -7.8 ‰, with the majority having more negative compositions than likely chondritic precursors (maximum δ^{66}Zn of ~ -0.2 ‰ [7]). These samples are interpreted to reflect condensates formed subsequent to surface volatilization and outgassing, such as during impact bombardment. Measurements of Cu compositions are also reported for nineteen of the samples, yielding a range of δ^{65}Cu from -1.6 to +0.9 ‰, and range of Cu concentrations from 0.2 to 2.8 p.p.m., with the exception of Stannern (Cu > 10 ppm). As with Zn, negative Cu isotopic ratios that are lighter than chondritic compositions (δ^{65}Cu ~ -0.5 ‰ [8]) are attributed to recondensation that occurred following impact-induced vaporization (cf. [9]). Within the wide ranges of Zn and Cu isotopic compositions measured in eucrites, most samples cluster within ~ 0 ‰ < δ^{66}Zn < +3 ‰ and ~ 0.2 ‰ < δ^{65}Cu < +0.9 ‰. This range is interpreted to reflect volatile depletion processes similar to those that affected the Moon (BSM: δ^{66}Zn +1.4 ± 0.5‰ [5, 6, 10, 11] and δ^{65}Cu = +0.92 ± 0.16‰ [9-11]). The greater heterogeneity in eucrite Zn and Cu isotopic compositions compared to lunar samples can be attributed to the smaller size of the HED parent asteroid, which may have experienced more limited homogenization of these signatures following volatile depletion and for eucrites which have experienced complex impact addition and metamorphic processes.

[1] Chen et al. (2013) EPSL, 369, 34-42. [2] Savage et al. (2015) Geochemical Perspective Letters, 1, 53-64. [3] Day and Moynier (2014) Philisophical Transactions of the Royal Society A, 372,

p.20130259. [4] Paniello et al. (2012) GCA, 86, 76-87. [5] Paniello et al. (2012) Nature, 490, 376-379. [6] Kato et al. 2015 Nature Communications, 6, 1-4. [7] Luck et al. (2005) GCA 69, 5351-5363. [8] Luck et al. (2003) GCA, 67¸143-151. [9] Day et al. (2019) GCA, 266, 131-143. [10] Moynier et al. (2006) GCA, 70, 6103-6117. [11] Herzog et al. (2009) GCA, 73, 5884-5904.