Metal-silicate equilibrium signature preserved in pristine eucrites

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Planetary differentiation into a metallic core and silicate mantle should strip highly siderophile elements (HSE: Re, Os, Ir, Ru, Pt, Rh, Pd, Au) from planetary mantles due to the high metal-silicate partition coefficients (>10^4) typical of these elements at low pressures and temperatures. However, all planetary mantle-derived materials measured to date, including terrestrial, lunar and martian rocks, angrites and aubrites, indicate mantle HSE abundances higher than expected [1]; these HSE also generally exhibit chondritic relative abundances. Hypotheses proposed to account for these data include high-pressure/temperature metal-silicate partitioning and late accretion.

Eucrite meteorites are part of the Howardite-Eucrite-Diogenite (HED) clan of meteorites, and previous studies indicate a large range of relative and absolute HSE abundances in these samples [2,3]. We report a petrological and geochemical study for a range of unbrecciated, monomict and brecciated eucrites, that evaluates the degree of post-crystallization impact contamination, thereby providing a pristinity index akin to that developed for lunar crustal samples [4]. Brecciated howardites and eucrites, and even some monomict and unbrecciated eucrites, show high absolute HSE abundances (>0.001-0.05×CI-chondrite) and chondritic relative HSE abundances. The most pristine eucrites, however, have extremely low HSE abundances (0.001 to 0.00001×CI-chondrite) and non-chondritic relative HSE abundances, with ubiquitously high Ir/Os and Pt/Os ratios. We argue that such signatures in pristine eucrites do not reflect significant contributions from late accretion. Instead, they likely preserve metal-silicate equilibrium and variable HSE partitioning during a magma ocean phase on Vesta.

[1] Day, J.M.D. et al. (2016) *Rev. Min. Geochem*. 81, 161-238. [2] Dale, C.W. et al. (2012) *Science*, 336, 72-75. [3] Day, J.M.D. et al. (2012) *Nat. Geosci.*, 5, 614-617. [4] Warren, P.H., Wasson, J.T. (1977) LPSC, XII, 2215-2235.