Highly siderophile element fractionations in Apollo 16 impact rocks: Origin by small-scale or large-scale processes?

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The record of ancient lunar impact rocks (LIR) may provide constrains on the composition of material accreted late to the Moon and the terrestrial planets [1-3]. Increasingly precise highly siderophile element (HSE) and osmium isotope data are now available for ancient lunar impact melt rocks but the origin of observed differences in composition is debated.

In the simplest case, HSE budgets of LIR are assumed to be controlled by a HSE-rich impactor and HSE-poor lunar crust. In these cases, regressions of HSE vs. Ir from different subsamples of the same rock should yield linear trends with slopes corresponding to the HSE/Ir ratio of the impactor. However in some cases, scatter beyond analytical uncertainty and curved trends are observed and interpreted as either subcentimeter-scale fractionation processes during crystallization [2] or simply incomplete mixing of HSE carrier phases from impactors of different compositions [3]. Another unanswered key question is whether slopes derived from linear correlations of HSE abundances in a LIR represent the signature of a specific ancient impactor or mixing and homogenization of multiple impactor compositions during the impact process.

Many Apollo 16 LIR display more strongly fractionated HSE patterns compared to samples from other landing sites, which tend to be closer to chondritic compositions. We will present new data on metal- and sulfide-rich separates that suggest that small-scale fractionation processes are due to solid metal-liquid metal partioning of the HSE and sulfur. Differences in abundances and ratios of the HSE between metal separates are controlled be the abundances of light elements like sulfur. Modelling of fractional crystallization indicates closed system crystallization of solid metal and sulfur-rich metal from already fractionated metal melt compositions. The latter likely were formed by impacts of large fragments of planetesimal cores.

[1] Puchtel et al. (2008) *GCA*, **72**, 3022-3042. [2] Fischer-Gödde and Becker (2012) *GCA*, **77**, 135-156. [3] Liu et al. (2015) *GCA* **155**, 122-153.