Pb isotope evolution in the Martian mantle

J.J. BELLUCCI[1*], A.A. NEMCHIN[1], M.J. WHITEHOUSE[1], J.F. SNAPE[1]

[1]Department of Geosciences, Swedish Museum of Natural History (*correspondence: jeremy.bellucci@gmail.com)

The Pb isotopic composition of maskelynite, plagioclase, K-feldspar and/or sulfide grains in mantle-derived Martian meteorites has been measured in four enriched Shergottites, two depleted Shergottites, one intermediate Shergottite, Nakhla, Chassigny, and ALH84001 using Secondary Ion Mass Spectrometry (SIMS) [1-3]. The least radiogenic Pb measured for each individual sample represents the Pb isotopic composition at the time of crystallization (initial Pb). These data can be used to construct models of Pb isotopic growth, determine Pb model ages and constrain the variability of time integrated μ- ($^{238}U/^{204}Pb$) and κ- ($^{232}Th/^{238}U$) of the Martian mantle.

Using the model of Bellucci *et al*. [2] for Martian mantle differentiation, μ- and κ-values have been estimated for the mantle source specific to each meteorite. The enriched Shergottite source region has a range in μ-values from 3.75 to 4.6, which is similar to ALH 84001 ($\mu \sim 4.3$) despite crystalization ages that are ~4 Ga apart. The depleted Shergottites have source μ-values of ~1. The intermediate Shergottite studied here has a μ-value of 3.1. The resolvable differences in μ-values argue for different source reservoirs and eruptive locations for the depleted, enriched, and intermediate Shergottites. This model, however, cannot explain the initial Pb isotopic compositions of Nakhla and Chassigny, which indicate separate differentiation events at 4 Ga and 3.6 Ga, respectively, or a single event at 3.8 Ga. When compared to initial source reservoir compositions for other radiogenic isotopic systems, these new values define excellent negative linear correlations with $\varepsilon^{143}Nd_i$, $\varepsilon^{176}Hf_i$, and $\varepsilon^{182}W_i$ and a positive linear correlation with $\gamma^{187}Os_i$. All of this evidence together suggests that differentiation of the Martian mantle affected all parent-daughter ratios of radiogenic isotopic systems at a similar time. It also supports a coherent model of differentiation in the Martian mantle and indicates that variable sulfide precipitation had the biggest effect on μ-values in the Martian mantle. Lastly, a time integrated Th/U is calculated to be 3.7, which is consistent throughout Martian history and is similar to the bulk Earth and the Moon.

[1] Bellucci *et al*., (2015a) EPSL 410, 34-41. [2] Bellucci *et al*., (2015b) JGR 120, 2225-2240. [3] Bellucci *et al*., (2016) EPSL 433, 241-248.