Towards a coherent radiogenic isotopic model for Mars

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Initial Pb in three enriched Shergottites, two depleted Shergottites, Nakhla, Chassigny, and ALH84001 have been measured in multiple maskelynite, plagioclase, K-Feldspar, and/or sulfide grains by Secondary Ion Mass Spectrometry (SIMS) following [1]. These measurements are the least radiogenic Pb measured for each individual sample and very likely represent the Pb isotopic composition at the time of crystallization. As such, these data can be used to construct time-integrated models of Pb growth, initial Pb model ages, and constrain the m- ($^{238}U/^{204}Pb$) and k- ($^{232}Th/^{238}U$) of each meteorite's source region.

ALH84001 and the Shergottites have been linked to a similar source region by Sm-Nd and Lu-Hf isotopic systematics, which formed from a chondritic reservoir at 4.513 Ga e.g., [2]. Using a similar, chondritic model for Pb growth and t of mantle differentiation, the depleted and enriched Shergottites yield initial Pb model ages of ~170 Ma and ~500 Ma, respectively. These model ages challenge any >4 Ga ages for the Shergottites calculated from Pb-Pb isochrons e.g., [3]. This model, however, cannot explain the initial Pb isotopic compositions for Nakhla and Chassigny. Initial Pb from Chassigny and Nakhla indicate seperate differentiation events at 4 Ga and 3.6 Ga, respectively.

Using these models for mantle differentiation, m- and k-values can be determined for the sources of these meteorites. The enriched Shergottites source regions with m-values from 4.1-4.6, which is similar to ALH 84001 (4.3). The depleted Shergottites have source m-values of ~1. Nakhla and Chassigny have sources m-values of 2.4 and 3.2, respectively. When compared to initial source reservoir compositions for the other radiogenic isotopic systems measured in these meteorites, these new values have negative linear correlations with $e^{143}Nd_i$, $e^{176}Hf_i$, and $e^{182}W_i$ and a postive linear correlation with $g^{187}Os_i$. All of this evidence together suggests that differentiation of the Martian mantle affected all radiogenic isotopic systems at a similar time and supports a coherent model of differentiation in the Martian mantle and timing of crystallization for Martian meteorites.

[1] Bellucci et al., (2015) *EPSL* **410**, 34-41. [2] Lapen et al., (2010) *Science* **328**, 347-351 [3] Bouvier et al., (2009) *EPSL* **280**, 285-295.