Lead isotopes in olivine-phyric shergottite Tissint: Implications for the geochemical evolution of the shergottite source mantle

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Geochemically-depleted shergottites are basaltic rocks derived from a martian mantle source reservoir. Geochemical evolution of the martian mantle has been investigated mainly based on the Rb-Sr, Sm-Nd, and Lu-Hf isotope systematics of the shergottites [1]. Although potentially informative, U-Th-Pb isotope systematics have been limited because of difficulties in interpreting the analyses of depleted meteorite samples that are more susceptible to the effects of near-surface processes and terrestrial contamination. This study conducts a 5-step sequential acid leaching experiment of the first witnessed fall of a geochemically-depleted, olivine-phyric shergottite, Tissint, to minimize the effect of low temperature distrubance.

Trace element analyses of the Tissint acid residue (mostly pyroxene) indicate that Pb isotope compositions of the residue do not contain either a martian surface or terrestrial component, but represent the Tissint magma source [2]. The residue has relatively unradiogenic initial Pb isotopic compositions (e.g., $^{206}Pb/^{204}Pb$ = 10.814) that fall within the Pb isotope space of other geochemically-depleted shergottites. An initial μ-value ($^{238}U/^{204}Pb$ = 1.5) of Tissint residue at the time of crystallization (472 Ma [3]) is similar to a time-integrated μ-value (1.7 at 472 Ma) of the Tissint source mantle calculated based on a two-stage mantle evolution model [1]. On the other hand, the other geochemically-depleted shergottites have initial μ-values of their parental magmas (e.g., 0.97 for NWA 1195 [4]) distinctly lower than those of their modeled source mantle (e.g., 3.0 for NWA 1195). These results suggest that only Tissint potentially reflects the geochemical signature of the shergottite mantle source that originated from cumulates of the martian magma ocean.

[1] Debaille, V. et al. (2008) *EPSL*, **269**, 186-199 [2] Moriwaki, R. et al. (2015) *46th LPSC*, Abs#1921. [3] Shih, C. Y. et al. (2014) *45th LPSC*, Abs#1184. [4] Bouvier, A. et al. (2009) *EPSL*, **280**, 285-295.