Titanium Isotope Compositions of Chondrites and Achondrites

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Titanium is an element of particular interest in planetary sciences as, (i) it is refractory and cannot easily be lost by impact-induced vaporization, (ii) it is lithophile meaning that core partitioning is irrelevant, and (iii) it is fluid immobile, meaning that it is immune to parent-body alteration. Thus, the range of processes susceptible of fractionating Ti isotope ratios is rather limited and involves primarily nebular and magmatic/metamorphic processes. For example, in terrestrial magmatic systems, the Ti isotope composition (expressed as δ^{49}Ti; deviation in ‰ of the ^{49}Ti/^{47}Ti ratio relative the OL-Ti standard [1]) correlates positively with SiO_2 concentration [2]. This observation was interpreted to reflect preferential incorporation of light Ti isotopes in Ti-oxides during fractional crystallization [2]. To evaluate if Ti isotopes can be used to trace nebular and magmatic processes in meteorites, we have measured the δ^{49}Ti values of several chondrites, eucrites and aubrites using the protocol of [1].

The δ^{49}Ti values of all ordinary and enstatite chondrites are indistinguishable within uncertainty, ranging from -0.027 ‰ (Bald Mountain, L4) to +0.027 ‰ (Blithfield, EL6) with an average of +0.004 (n=11). This δ^{49}Ti value is identical to that proposed for the BSE [1, 2].

Eucrites have fractionated δ^{49}Ti values that are both heavier and lighter compared to the chondritic average. δ^{49}Ti values are positively correlated with indices of magmatic fractionation such as FeO/MgO ratios, similar to trends observed in terrestrial systems.

Preliminary results for aubrites indicate strongly fractionated δ^{49}Ti values, ranging from around -0.10 ‰ to +0.25 ‰. The Ti isotope compositions correlate negatively with the MgO concentration. Core formation and magmatic differentiation on the aubrite parent body occurred under extremly low fO_2, allowing Ti to be present in the Ti^{3+} and Ti^{4+} oxidation states. Thus, the highly variable δ^{49}Ti in aubrites might be caused by crystallization of Ti^{3+}-rich pyroxene or Ti-bearing sulfides.

These results demonstrate that Ti isotope systematics are a valuable tool in deciphering magmatic and crust-mantle differentiation processes on planetary bodies.

[1] Millet, M.A. and Dauphas, N. (2014) *JAAS*, **29**(8), 1444. [2] Millet, M.A. et al. (in review) *Earth Planet. Sci. Lett.*