Nucleosynthetic Yb isotope anomalies in chondrites

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Recent studies on high precision isotope analyses for bulk aliquots of meteorites discovered the existence of planetary scale nucleosynthetic isotope variabilities for a variety of elements (e.g., Cr, Sr, Mo, Ru) [1-4]. By contrast, some elements (Hf, W, and Os) do not show such anomalies at the current level of analytical precision [5-7]. The processes responsible for generating the isotopic heterogeneity/homogeneity in the early Solar System are not fully resolved yet, however, two plausible models have been proposed to account for the isotopic characteristics recorded in meteorites. The first model considers nebular thermal processing which caused selective destruction of thermally weak-isotopically anomalous carriers, followed by subsequent physical separation of volatile phase and ultra-refractory components [8]. On the other hand, the injection of isotopically anomalous materials from a nearby core-collapse supernova (ccSN) and subsequent aerodynamic sorting of grains in different sizes can be an alternative possibility to cause planetary scale isotope heterogeneity [9].
Ytterbium is an intriguing element which would provide a strong constraint on the origin of planetary scale isotope anomalies in the Solar System. The $T_{50\%}$ for Yb (1487 K) is lower than those of the other heavy-REEs (1659 K) and is comparable to that of Sr. Therefore, the thermal processing would lead to heterogeneous Yb isotope distribution in the Solar System, whereas the injection of a nearby ccSN would not generate *r*-nuclides of Yb. Here we report preliminary results on Yb isotope compositions in one ordinary chondrite (Olivenza, LL5) and one rumuruti chondrite (NWA 753, R3.9). The Yb isotope ratios for meteorite samples are reported as μYb notations which represent the parts par 10^6 deviations from the terrestrial isotope ratios. The ordinary and rumuruti chondrites possess large negative anomalies for μ^{168}Yb (–2500 ppm on average) and μ^{170}Yb (–130 ppm on average) exceeding analytical uncertainties of the standard material, whereas the μ^{171}Yb, μ^{173}Yb, and μ^{176}Yb values are indistinguishable from the terrestrial component. The patterns of μYb for the chondrites are not consistent with that representing the deficit of *s*-process nuclides relative to the terrestrial component. Therefore, the negative anomalies in in μ^{68}Yb and μ^{170}Yb are attributed either to the deficit of *p*-process nuclides relative to the terrestrial component, or to the analytical artifact due to the overcorrection of interferences from ^{168}Er and ^{170}Er. By contrast, the absence of anomalies for μ^{171}Yb, μ^{173}Yb, and μ^{176}Yb is consistent with the marginal isotope anomalies in ordinary chondrites for Mo and Ru isotopes synthesized by the *s*- and *r*-processes, which are significantly smaller than those observed in carbonaceous chondrites and iron meteorites [3-4].
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