Ti isotope systematics of bulk chondrites and CAIs

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Along with the isotopes of other light elements such as Mg, Ca, Cr, and Ni, Ti isotopes can serve as an important tracer to unravel the origin, chemical evolution, and transportation processes of the early solar system materials. With recent technical advances in mass spectrometry using modern MC-ICP-MS, high-precision Ti isotopic composition of bulk meteorites, as well as very small fragments of CAIs can now be obtained (e.g. Williams et al. 2016, Davis et al. 2018, Render et al. 2019). Nevertheless, a detailed isotopic investigation of CAIs with distinct morphologies and/or mineralogical characteristics, as well as search for correlation between the isotopic signatures of Ti and heavy elements such as the rare earth elements (REE) are still limited. Here we report high-precision Ti isotopic data for bulk chondrites and CAIs extracted from the carbonaceous chondrite Allende.

In this study, the Ti isotopic composition of three ordinary chondrites (Holbrook, Bechar, and NWA532), one carbonaceous chondrite (Allende), and five CAIs (both spherical and non-spherical CAIs) from Allende was determined. Ti was separated using a newly developed chemical separation technique that allows sequential separation of Ti and other important elements such as Ca, Ni and REEs. The Ti isotopic composition was measured at the University of Tokyo using the method described in Hibiya et al. 2019.

All bulk chondrites and CAIs investigated here showed isotopic signatures distinct from the terrestrial standard (NIST SRM 3162a). Analyses of bulk CAIs (~10mg in size) and fragments of CAI (<6 mg) all showed uniform anomalies in $\varepsilon^{46, 48, 50}Ti$ of about +1.7, +0.5, and +9.2, respectively. This implies that these CAIs, regardless of their distinct morphological and mineralogical features, originated from an isotopically uniform reservoir. Positive Ti isotopic anomalies were also observed in bulk Allende, but were much smaller than the CAIs (+0.6, +0.2, and +3.4 for $\varepsilon^{46, 48, 50}Ti$). The ordinary chondrites, on the other hand, showed no positive anomaly in ^{50}Ti. This may imply that the transportation of CAIs to the ordinary chondrite forming region was limited during the accretion period of the ordinary chondrite parent body.

[References] [1] Williams et al. 2016, Chem. Geol., 436, 1-10; [2] Davis et al. 2018, GCA, 221, 275-295; [3] Render et al. 2019, GCA, 254, 40-53; [4] Hibiya et al. 2019, Geostand. Geoanalytical Res. 43, 133-145.

Keywords: Titanium, Isotope, Chondrite, CAI

