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Abstract

The main objective of this thesis is to investigate Te isotope anomalies in chondrites to better understand the nucleosynthetic processes in stellar environments as well as how precursor solids have evolved into the building blocks of rocky planets in the early solar system. To this end, we developed a new method for precise Te isotope analysis by N-TIMS along with an improved technique for chemical separation of Te from geochemical samples. In Te separation of rock samples, an improved chromatographic separation technique for Te was established in which a three-step column chemistry procedure utilizing AG1-X8, TRU-Spec, and CG-71C resins achieved better separation of Te from unwanted elements and organic matter compared with previous studies. In N-TIMS analysis, the optimum analytical condition for obtaining a stable and strong Te^- ion beam was established when a zone-refined Re single filament was employed with a $Ba(OH)_2$ activator by maintaining filament temperature between 810 and 860 °C during isotope measurement. The precision of our new technique was comparable to that of previous MC-ICP-MS studies.

The method was applied to acid leachates and residues from three carbonaceous chondrites (Allende, Murchison, Tagish Lake). Most of the Te isotope compositions in acid leachates/residues were indistinguishable from that of the terrestrial standard within analytical uncertainties, indicating homogeneous distribution of Te isotopes in the solar nebula. The homogeneous isotope compositions in leachates suggest that anomalous Te isotope signatures within carbonaceous chondrites (i.e., presolar phases) were erased via temperature-controlled nebular processes before the onset of parent body formation. In contrast, the Allende acid residue (step 7) displayed the depletion of $\delta^{130}Te$ when mass fractionation during TIMS was corrected using $^{124}Te/^{128}Te = 0.14853$. The anomaly can be explained most likely by the depletion of r-process component calculated in Maas et al. (2001), although the mixing of anomalous Te compositions in nanodiamond reported by Richter et al. (1998) cannot be ruled out.

To discuss the process that controls the isotope compositions of various elements that are recorded in chondrites and their components, we compiled precise isotope data for 16 elements in bulk meteorites and their acid leaching samples, and discovered that the elements can be categorized into three groups based on the signature of isotope anomalies. The difference of these groups is most likely caused by the difference of 50% condensation temperatures for these elements.