Ti-Cr-O isotope systematics and the dichotomy of planetary materials

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Mass-independent isotope variations in bulk meteorites provide vital information regarding petrogenetic links among planetary materials. It has been proposed that the Cr isotopic composition of bulk meteorites, along with Δ^{17}O values, may denote an important dichotomy among planetary materials [1,2]. This bimodality (principally between carbonaceous and non-carbonaceous materials) may also reveal processes associated with mixing, unmixing, and the accretion of solids over a wide spatial region in the early Solar System [1,2,3]. Here, we continue our investigations using mass-independent variations in bulk meteorites to further illuminate potential petrogenetic links among planetary materials. In particular, this study extends previous investigations into the Ti-Cr-O isotope systematics of achondritic meteorites (ung. achondrites, howardites, and a lunar meteorite) and chondritic meteorites (R-, ordinary, and ungr. chondrites).

The separation of Cr was completed following the procedures described in [4,5] and its isotope ratios were made using a Thermo *Triton Plus* thermal ionization mass spectrometer at the University of California at Davis (UC Davis). Titanium was separated from the matrix using a combination of cation and anion exchange chromatography following the methods of [6] and measured with a Thermo *Neptune Plus* MC-ICPMS at UC Davis. New and previously described meteorite data cluster into two distinct groups: All carboanceous chondrites cluster into a single group based on their Ti-Cr-O isotopic compositions. These carbonaceous chondrites display anti-correlated trends in ε^{50}Ti- Δ^{17}O and ε^{54}Cr- Δ^{17}O isotope space producing a negative correlation in ε^{50}Ti- ε^{54}Cr space with slope of circa two. A select few “carbonaceous chondrite-like” achondrites likely originated from carbonaceous chondrite parent bodies and also lie within this field. Conversely, all non-carbonaceous materials form a second distinct group with positive correlations in ε^{50}Ti-Δ^{17}O, ε^{54}Cr-Δ^{17}O, and ε^{50}Ti-ε^{54}Cr isotope space. These data provide critical information regarding the provenance for planetary accretion in the early Solar System.

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