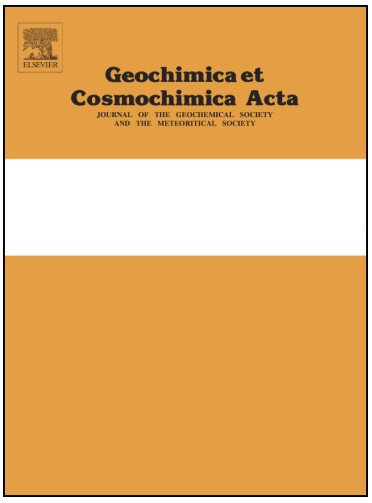

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Lack of resolvable titanium stable isotopic variations in bulk chondrites

Zhengbin Deng[a, *], Frédéric Moynier[a, b], Kirsten van Zuilen[a], Paolo A. Sossi[a], Emily A. Pringle[a], Marc Chaussidon[a]

[a] Institut de Physique du Globe de Paris, Université Paris Diderot, Université Sorbonne Paris Cité, CNRS UMR 7154, 1 rue Jussieu, 75005, Paris, France.

[b] Institut Universitaire de France, Paris, France.

* Corresponding author: deng@ipgp.fr

Abstract

Titanium and calcium are both refractory lithophile elements. Significant stable isotopic variations on Ti and Ca have been documented within calcium, aluminum-rich inclusions (CAIs) in carbonaceous chondrites. To trace the condensation history of Ti in the solar nebula, we conducted a high-precision double-spike Ti stable isotopic study on a large set of chondrites. The studied chondrites have a homogeneous bulk Ti stable isotopic composition ($\delta^{49/47}Ti_{IPGP\text{-}Ti} = -0.069 \pm 0.018‰$, 2se, n = 22, i.e., the per mil deviation of the $^{49}Ti/^{47}Ti$ ratios relative to the IPGP-Ti reference material). The homogeneity across eleven chondrite groups implies that chondrites have acquired, through the condensation sequence at equilibrium, the average stable isotopic composition of Ti in the refractory solids that condensed early in the solar nebula. In contrast, the light Ca stable isotopic compositions of bulk chondrites can be attributed to either the presence of CAIs (CV-, CM- and CO-type) or parent-body aqueous alteration (CR- and CI-type).