Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.24298

Mg- and Ti-poor hibonites from CM2 chondrites: mass-dependent and mass-independent isotope effects

XIN YANG[1,2], GARY R. HUSS[3], KAZUHIDE NAGASHIMA[3], JULIE M. KORSMEYER[1,2,4], ANDREW M. DAVIS[1,2,5] AND PHILIPP R. HECK[1,2]

[1]Department of the Geophysical Sciences & Chicago Center for Cosmochemistry, The University of Chicago

[2]Robert A. Pritzker Center for Meteoritics and Polar Studies, Negaunee Integrative Research Center, Field Museum of Natural History

[3]Hawai‘i Institute of Geophysics and Planetology, School of Ocean and Earth Science and Technology, University of Hawai‘i at Mānoa

[4]Department of Chemistry, The University of Chicago

[5]Enrico Fermi Institute, The University of Chicago

Presenting Author: xinyoung@uchicago.edu

Hibonite ($CaAl_{12-2x}Mg_xTi_xO_{19}$) is one of the earliest condensates from a hot nebular gas of solar composition and stands out from other refractory phases due to its substantial nucleosynthetic isotopic anomalies in Ca and Ti and variations in O isotopes and the extinct radionuclide ^{26}Al [1-3]. Hibonite show variations in mineral chemistry dominated by the substitution of $Ti^{3+} \leftrightarrow Al^{3+}$ and of $Ti^{4+} + Mg^{2+} \leftrightarrow 2Al^{3+}$. Most hibonite grains separated from meteorites have a few wt% Mg and Ti, causing the blue color under reducing conditions [1,3]. We extracted twenty-four hibonites from specimens of the Murchison and Aguas Zarcus CM2 chondrites from the Field Museum of Natural History [5]. Notably, nine of these grains have TiO_2 and MgO contents below our EDS detection limit of 0.1 wt%. The Mg- and Ti-poor grains are colorless due to the low abundance of Ti and all display large mass-dependent fractionation (MDF) of O isotopes [6]. Here we report the Ca and Ti isotopic composition of these twenty-four hibonites determined with the University of Hawai‘i Cameca ims-1280 following an established method [7]. The colorless hibonites exhibit a large MDF of Ca with intrinsic fractionation F_{Ca} of ~10‰ amu^{-1}, while grains with more Mg and Ti show F_{Ca} of <4‰ amu^{-1}. The Mg- and Ti-poor hibonites have smaller Ca and Ti isotopic anomalies ($|\delta^{48}Ca|$ <7‰; $\delta^{50}Ti$ unresolvable) compared to the others ($|\delta^{48}Ca|$ >50‰; $|\delta^{50}Ti|$ >40‰). We suggest that the colorless grains experienced strong evaporation in the early solar nebula which resulted in the large MDF and loss of Mg and Ti.

[1] MacPherson (2014) *Treatise on Geochemistry* 2nd Ed. 1:139–179. [2] Davis A. M. and Richter F. M. (2014) *Treatise on Geochemistry* 2nd Ed. 1:335–360. [3] Kööp et al. (2016) *GCA*, 189, 70–95. [4] Berry A. J. et al. (2017) *Chem. Geol.*, 466, 32–40. [5] Korsmeyer J. et al. *in prep.* [6] Yang et al. (2023) *MetSoc*, #6115. [7] Kööp et al. (2018) *EPSL,* 489, 179–190.