Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17871

Volatile-depletion processing of the building blocks of Earth and Mars recorded by stable potassium isotopes

YAN HU[1], FRÉDÉRIC MOYNIER[2] AND XIN YANG[3,4]

[1]Université Paris Cité, Institut de Physique du Globe de Paris
[2]Université Paris Cité, Institut de Physique du Globe de Paris, CNRS UMR 7154
[3]Department of the Geophysical Sciences, The University of Chicago
[4]Robert A. Pritzker Center for Meteoritics and Polar Studies, Negaunee Integrative Research Center, Field Museum of Natural History

Presenting Author: yanhu@ipgp.fr

Potassium (K) is the most abundant moderately volatile element that allows for isotopic analysis. Its isotopic variation in planetary bodies provides insights into their building blocks and assembly processes. The stable K isotopic signatures of Earth and Mars have been interpreted to reflect either nucleosynthetic isotope anomalies [1] or evaporation during collisional accretion [2]. Chondrites are primordial materials that have formed planetary bodies and are critical samples for this discussion. Here, we employ a collision/reaction cell-equipped multi-collector ICP-mass-spectrometer (i.e., the Nu Sapphire) to remove Ar-based interferences and enable high-precision K isotopic analyses on low-K meteorite samples. Our study revealed an unprecedented K isotopic variation (−1.08 to 4.68‰) in 34 meteorites with diverse compositions. Furthermore, we discovered considerable overlap in K isotopic composition between carbonaceous and non-carbonaceous meteorites that strongly refutes the nucleosynthetic origin of stable K isotopic variations in meteorites. Instead, we found that the isotopic compositions of K in chondrites correlate with those of other moderately volatile elements (e.g., Rb, Cu, Zn, Sn, Ga, and Te), indicating that volatility-related fractionation is a common mechanism for mass-dependent isotopic variations in the Solar System. Additionally, we observed that carbonaceous chondrites display a coinciding depletion of K and its heavier isotopes, with Earth and Mars following this trend. Therefore, we conclude that the depletion of moderately volatile elements on Earth and Mars reflects incomplete accretion by their precursors, with possibly a lesser effect for Mars than for Earth.

[1] Ku and Jacobsen (2020) *Sci. Adv.,* 6: eabd0511.
[2] Tian et al., (2021) *PNAS,* 118 (39): e2101155118.