Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18648

Knudsen Effusion Study of Equilibrium Isotope Fractionation during Evaporation in the Early Solar System

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Isotopes of moderately volatile elements (MVEs) such as K, Rb, Cu and Zn have become increasingly used as a chemical tracer to investigate the origin and evolution of the Solar System [e.g., 1]. MVEs are often significantly but not entirely depleted from the initial solar concentration, making them a strong recorder of evaporation and condensation processes. Recent studies have pointed to the interplay between pure kinetic and equilibrium isotope fractionation in samples that have undergone evaporative loss [e.g., 2-4]. There are a number of studies that have experimentally investigated isotope fractionation of MVEs during kinetic evaporation [e.g., 5, 6], however, all are free (Langmuir) evaporation studies, which have known limitations [e.g., 7].

To fill this gap we conducted a series of Knudsen cell effusion experiments on a natural basalt powder using molybdenum crucibles. All experiments were conducted at 1400 °C for durations ranging from 30 minutes to 7 hours. The crucibles were cut in half and analyzed on an electron microprobe. We observed no significant chemical interaction between the basalt and crucible. Additionally, the residual glasses were homogenous and did not show any concentration gradients. MVEs are variably depleted relative to the starting material, the extent to which depends on the duration of the run. Ongoing isotopic measurements of MVEs using MC-ICP-MS will be presented at the conference. These findings have the potential to enhance our understanding of the isotope signatures of planetary materials and the conditions under which they formed.

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