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Potassium and Chlorine Isotope Compositions of Ordinary Chondrites

ZOLTAN VACI[1], ANTHONY M GARGANO[2], PIERS KOEFOED[1] AND KUN WANG[1]

[1]Washington University in St. Louis

[2]Scripps Institution of Oceanography

Presenting Author: vaci@wustl.edu

Moderately volatile elements (MVE), elements with 50% nebular condensation temperatures (T_C) between 650 K and 1250 K, such as K, Rb, Cu, Zn, and Cl, are generally depleted in planetary materials relative to the solar photosphere and CI chondrites [1]. Potassium isotope measurements are used to trace this volatile depletion, and the progressively heavier K isotopic compositions of Earth, Mars, the Moon, and Vesta, which correlate with their size [2], suggest that depletions in MVEs occurred during the accretion and impact phases of solar system formation. K isotopic composition also varies among chondrite groups, with carbonaceous chondrites generally heavier in K than ordinary and enstatite chondrites [3,4,5]. Although the fractionation among chondrites in MVE is poorly understood, it likely requires mixing of various chondritic components, and it does not correlate with K content, petrologic type, shock level, cosmic ray exposure (CRE) age, or terrestrial alteration [4].

To better understand the MVE depletion and isotopic fractionation in chondritic material, we are measuring the K isotopic compositions of 21 ordinary chondrites whose Cl isotopic compositions were previously analyzed. Preliminary data suggest a positive correlation between K and Cl isotopic compositions in ordinary and enstatite chondrites (Fig. 1), which is consistent with a recent report that K isotopic composition is also correlated with Rb, another MVE [5]. These correlations among MVE isotopes suggest that the fractionations of K and Cl in ordinary and enstatite chondrites are coupled, volatility-controlled, and mass-dependent (as opposed to nucleosynthetic anomalies). The different T_C values of K (1006 K) and Cl (427 K) also suggest that the fractionation occurred later than the initial condensation of solids in the solar nebula [6].

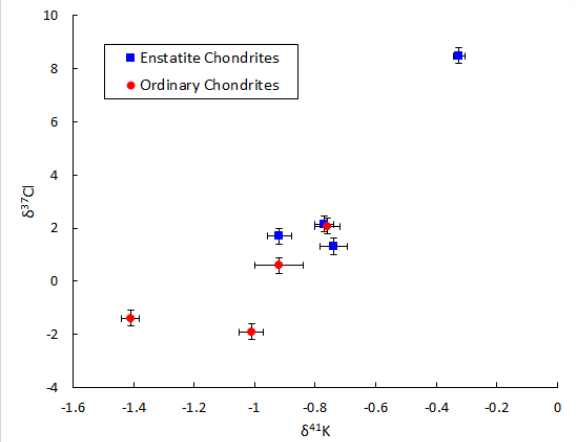

Figure 1. Potassium vs. chlorine isotopic compositions of ordinary and enstatite chondrites. K isotopes are from Zhao et al. (2019) and Bloom et al. (2020).

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[2] Tian et al. (2019), *Geochimica et Cosmochimica Acta* 266, 611-632.

[3] Zhao et al. (2019), *Meteoritics and Planetary Science* 55:6, 1404-1417.

[4] Bloom et al. (2020), *Geochimica et Cosmochimica Acta* 277, 111-131.

[5] Nie et al. (2023), *Geochimica et Cosmochimica Acta* 344, 207-209.

[6] Lodders and Fegley (2023), *Geochemistry*, https://doi.org/10.1016/j.chemer.2023.125957.