THE POTASSIUM ISOTOPE COMPOSITION OF CI CHONDRTIES AND THE ORIGIN OF ISOTOPIC VARIATIONS AMONG PRIMITIVE PLANETARY BODIES.

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Introduction: The δ41K of many chondrite groups, most notably the CI and CR chondrites, remain poorly constrained. In order to address this, we undertook a systematic study looking at the K isotope compositions of a range of chondrite falls. This is especially important for CI chondrites as the K isotopic composition of CI-chondrites could be taken as a proxy for the solar system initial value (elemental K agrees with the solar photosphere within uncertainties) [1,2]. Several different hypotheses have been suggested to explain the overall variability in K isotopic compositions observed across the different chondrite classes and groups, such as incomplete mixing of nucleosynthetic variations [3], volatility related processes in the protoplanetary disk (i.e., evaporation or condensation) [4,5], and parent body processes such as thermal or aqueous alteration [6,7]. To assess the cause of the δ41K variations, chondrite K isotope data are compared to the isotopic compositions of other mass dependent MVEs and mass independent systems.

Methods: A total of 26 bulk chondrites were analyzed, consisting of 9 CI (8 Orgueil and 1 Ivuna), 2 CM, 2 CO, 3 CV, 4 CR, 1 CK, 1 EH, 1 H, 1 LL, and 2 L chondrites. All samples other than the four CR chondrites are falls. Potassium isotope analysis was undertaken using a Neptune Plus MC-ICP-MS paired with an APEX Ω desolvation system. The standard used for all K isotope analyses, and what all data is reported relative to, is NIST SRM 3141a.

Results and Discussion: The K isotope composition of all bulk chondrites analyzed in this study is from −0.89 to −0.17‰. All CI chondrites analyzed ranged from −0.29 to −0.17‰ δ41K, with mean δ41K value of −0.21 ± 0.03‰. When the chondrite K isotope data from this study are assessed together with all previous δ41K data [2-10], ordinary chondrites show the lightest mean K isotopic compositions, enstatite chondrites the middle, and carbonaceous chondrites the heaviest. For the carbonaceous chondrites, the CK, CR, and CV chondrites show heavier δ41K compositions compared to the CO, CM, and CI chondrites. Compared with other MVE isotope systems (δ87Rb, δ66Zn, δ71Ga, δ128Te), δ41K shows correlations with δ87Rb, δ66Zn, and δ71Ga across all chondrite groups, and correlations with all four MVE isotope systems assessed here for the carbonaceous chondrites only. When chondrite δ41K compositions are compared against the mass independent isotope systems of ε54Cr, ε64Ni, ε50Ti, and Δ17O, a comparison using all chondrites shows trends with ε54Cr, ε64Ni, and ε50Ti (see Fig. 1), while comparing across carbonaceous chondrites only shows no trends. These observations suggest that the overall K isotopic variations observed across the major chondrite classes are likely caused by inherited isotopic variations form different precursor reservoirs (the cause of which is unable to be conclusively determined, however it is likely related to the NC-CC dichotomy), while for the carbonaceous chondrite groups, the variations are likely a result of volatility related processes, such as partial condensation during chondrule formation and mixing between an isotopically light chondrule component and a CI-like matrix component.

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Fig. 1. Average K isotope composition of all chondrite groups versus (A) ε54Cr [11-14], (B) ε64Ni [15-17], (C), ε50Ti [14,18,19], (D) Δ17O [20-23].