POTASSIUM ISOTOPIC COMPOSITIONS OF EVOLVED ACHONDRITES.

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Introduction: The moderately volatile isotopic compositions of planetary materials reflect processes such as incomplete nebular condensation, partial evaporation in pre-solar or nebular environments, mixing of various pre-planetary components, accretional volatile loss, magma ocean degassing, and atmospheric and impact processing. Measuring the K isotopic compositions of planetary materials can help delineate and constrain these processes, since K is both a highly lithophile and moderately volatile element. While the K isotopic compositions of chondrites show significant variation, due to both nebular and parent body processes [1], differentiated planets generally show less spread due to homogenization [2,3]. Here we present K isotopic measurements of four ungrouped evolved achondrites whose isotopic compositions potentially serve as proxies for their protoliths.

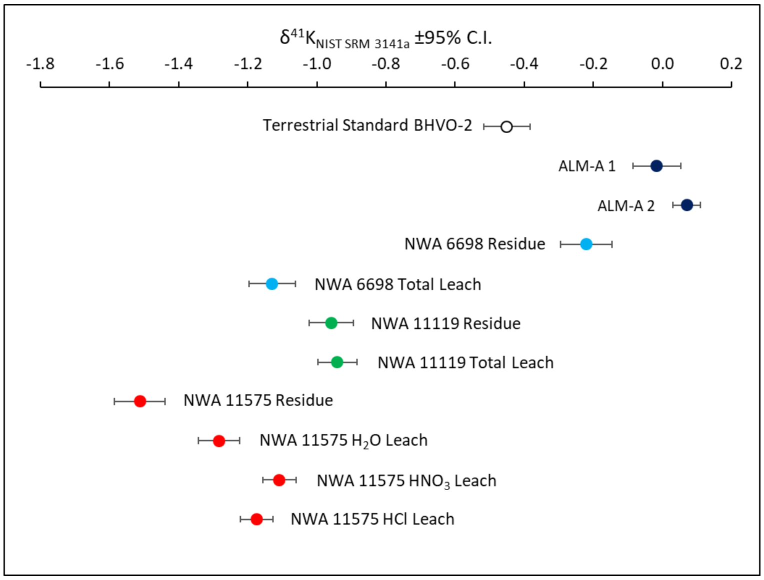

Figure 1. K isotopic compositions of evolved achondrites.

Methods: Since Northwest Africa (NWA) meteorites are hot desert finds, NWA 6698, 11119, and 11575 were immersed in H_2O, 1N HNO_3, and 1N HCl and sonicated for five minutes for each step, to leach any terrestrial weathering products. This was not done with ALM-A because it is sourced from the Almahata Sitta fall. Leachates were processed and measured using the same methods as bulk samples, outlined in [3]. K concentrations in leachates were all below 8.5 % of their bulk quantities and were highest in the water rinse step, suggesting that most of the terrestrial K that was removed consisted of salts or other water-soluble phases. The separated leachates in NWA 6698 and 11119 were recombined because there was not enough K in each step for isotopic analysis.

Results and Discussion: K isotopic results are shown in Fig. 1. NWA 6698 plots close to both ALM-A measurements, reflecting its relationship to the evolved clasts in Almahata Sitta [4]. It does not overlap with ALM-A, likely because not all of the isotopically light desert alteration was removed during leaching steps. The bulk measurement for NWA 11119 overlaps with its leachate measurement, reflecting the relative lack of weathering that this sample has experienced. All three leaching measurements for NWA 11575 are heavier than its bulk measurement and skew towards the bulk Earth value of -0.5 ‰. Importantly, NWA 6698 and 11575 represent different styles of terrestrial weathering. NWA 6698 has undergone alteration, and its alteration products are isotopically light [5]. NWA 11575 has experienced addition of terrestrial weathering products, as indicated by its elevated Ba content, and those weathering products are isotopically heavier than its bulk K isotopic composition. Some glass was invariably dissolved in all acid leaching steps, convoluting the signals of the terrestrial weathering products.

The K isotopic values of NWA 11119 and 11575 are not likely to be proxies for volatile loss during accretion, as they are probably sourced from planetesimal-sized objects [6,7], yet their K isotopic compositions are much lighter than that of Earth. Instead, their isotopic compositions might reflect those of their chondritic precursors. As NWA 6698 and ALM-A are isotopically heavier than Earth, and they are likely sourced from the ureilite parent body (UPB) [4,8], their isotopic compositions could represent higher degrees of volatile loss during UPB accretion and serve as proxies for parent body size. However, as ureilite petrology and geochemistry are extremely complicated, more measurements are needed to confirm and quantify this possibility.

References: [1] Bloom H. et al. (2020) *GCA* 277:111-131. [2] Tian Z. et al. (2019) *GCA* 266:611-632. [3] Tian Z. et al. (2021) *PNAS* 118:39 e2101155118. [4] Vaci z. et al. (2021) *LPS LII* #2378. [5] Chen H. et al. (2020) *EPSL* 539:116192. [6] Srinivasan et al. (2018) *Nat. Comm.* 9:3036. [7] Agee C. B. et al. (2018) *LPS XLIX* #2226. [8] Bischoff et al. (2014) *PNAS* 111:35 12689-12692.