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Potassium isotopic anomalies constrain the source of Moderately Volatile Elements of Ryugu

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The JAXA Hayabusa2 spacecraft returned samples from the near-Earth C_b-type asteroid (162173) Ryugu. Previous studies demonstrate that the Ryugu samples show clear chemical and mineralogical affinity to CI (Ivuna-type) carbonaceous chondrites [1]. Ryugu samples offer a valuable opportunity to investigate the origins of various elements in the bulk silicate earth (BSE), especially for volatile elements, given that the CI chondrites are conventionally considered to be the primordial unfractionated material of the Solar System. A key issue for understanding the path to form habitable planets is understanding the distribution of volatiles in the early Solar System and the processes by which the Earth accreted volatile elements.

To investigate the origin of the moderately volatile elements (MVEs) of Ryugu and evaluate its contribution to the building blocks of BSE, we reported potassium isotopic anomalies in two Ryugu samples (C0044 and A0228), along with four carbonaceous chondrites (two CI and two CM). The results reveal that the values of $\varepsilon^{40}K$ in Ryugu samples C0044 and A0228 are 2.3±0.4 and 3.0±0.4, respectively, comparable to the values from two Orgueil fragments (2.7±0.4 and 2.3±0.4, respectively). CM chondrites exhibit distinct $e^{40}K$ compared with Ryugu and CI chondrite ranging from 0.2eto 1.5e. The identical $e^{40}K$ values and K/Ca ratios of Ryugu and CI chondrite therefore constrain the CI-like reservoir of the parent body of Ryugu. Our result is consistent with previous observation that such reservoir could be originated from the outskirts of the solar disk [2]. Together with previous analyses of $e^{40}K$ in CCs and NCs [3], the inverse correlation between $e^{40}K$ and K/Ca in CCs may indicate mixing processes between the materials from CI-like reservoirand particles that do not carry significant $e^{40}K$ anomaly.

References:

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[3] Nie et al., 2023, Science, abn1783