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Probing Elusive Solar System Isotopic Reservoirs with $\mu^{30}Si$ and $\mu^{54}Fe$ Signatures of Micrometeorites

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Micrometeorites are 10–2000 micrometer-sized grains representing the largest flux of extraterrestrial material reaching Earth throughout most of its geological history [1]. As such, micrometeorites are an essential tool for constraining the chemical input of extraterrestrial material to terrestrial planets. Previous investigations into the origins of micrometeorites include oxygen isotope analyses, but these are affected by atmospheric processing, which can alter their primary signatures [2]. Combined mass-dependent and mass-independent isotope systematics of more refractory elements, although challenging to measure, can mitigate these effects to link their isotopic signatures back to Solar System materials. Additionally, these samples may include materials that fall outside the chemical bounds of larger meteorite falls. Therefore, we analyze nucleosynthetic Si and Fe isotope signatures of micrometeorites to fill gaps in our current knowledge of the isotopic variability of the Solar System and the chemical distribution of planetary building blocks.

For the first time, we present $\mu^{30}Si$ and $\mu^{54}Fe$ signatures of individual scoriaceous (relatively unmelted) micrometeorites characterized by X-ray synchrotron nanotomography and fs-LA-ICPMS analyses. We will also present isotope data of group 1, 3 and 4 micrometeorites previously classified using oxygen isotope analyses [3], as well as a suite of CY chondrites that have not been analyzed for Si isotopes before for comparison. Here, we report the preliminary $\mu^{30}Si$ data for scoriaceous micrometeorites and 6 CY chondrites.

Our Si isotope data show that the micrometeorites include material with an isotopic range spanning the entire Solar System. Approximately 33% of the samples (n=12) are isotopically similar to CI chondrites ($\mu^{30}Si$ = 32.4±2.4 ppm; [4]), including Bennu and Ryugu, whereas 17% of samples are within error of cometary signatures ($\mu^{30}Si$ = 4.7±1.8 ppm; [5]). The remaining 50% of samples peak around the averaged value for carbonaceous chondrites, excluding CI ($\mu^{30}Si$ = 17.7±3.7 ppm; [4]). Fe isotope analyses of these micrometeorites will further constrain their parent reservoirs.

[1] Love, S.G. & Brownlee, D.E. (1993) *Science* 262:550–553. [2] Lampe, S. et al. (2022) *GCA* 324:221–239. [3] Jonker, G. (2024) *MAPS* 59:1236–1257. [4] Onyett, I.J. et al. (2023) *Nature* 619:539–544. [5] van Kooten, E. (2024) *Sci. Adv.* 10(eadp1613).