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A new estimate of the solar Zn nucleosynthetic composition and evidence of ^{70}Zn heterogeneity amongst protoplanets

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The nucleosynthetic isotope composition of the moderately volatile element Zinc (Zn) of chondrites and achondrites has recently been used to constrain the source and the proportion of Earth's volatiles (e.g. [1-3]). However, these studies overlook one of the largest portions of parent bodies that are known to have existed in the early Solar System, namely ungrouped iron meteorites that sample >50 distinct parent bodies [4]. As such, the lack of a systematic study of the nucleosynthetic Zn isotopic composition of ungrouped irons may bias our knowledge of the volatile reservoirs in the early Solar System. Moreover, due to instrumental limitations, high-precision data on the neutron-rich ^{70}Zn is scarce and lacks required precision to take full advantage of this tracer.

Using the Neoma MC-ICP-MS new generation mass spectrometer, we analyze Zn isotopes of ungrouped irons and the new CI chondrite Oued Chebeika 002 (OC002), including ^{70}Zn. The mass-independent Zn isotope data are reported as ppm deviation from SRM 683 and normalized to ^{68}Zn/^{66}Zn=0.67204 using the exponential law. The external reproducibility of the μ^{64}Zn, μ^{67}Zn and μ^{70}Zn values are improved by a factor of >2-5 relative to earlier work [1, 3]. Three individual aliquots of OC002 yield μ^{64}Zn, μ^{67}Zn and μ^{70}Zn values of -54±3, -26±4, 29±4 ppm, respectively, representing the most accurate estimate of the solar Zn nucleosynthetic composition. Ungrouped iron meteorites New Baltimore and Cruz del Aire record μ^{64}Zn and μ^{67}Zn anomalies intermediate between CI chondrites and bulk silicate Earth (~0). However, although the μ^{70}Zn value of Cruz del Aire is identical to that of CI chondrites, the μ^{70}Zn value of 120±14 ppm defined by New Baltimore is significantly more anomalous. This ^{70}Zn decoupling suggests a different presolar carrier phase for neutron-rich and neutron-poor nuclides. We will investigate additional ungrouped iron meteorites to better understand the extent and origin of the ^{70}Zn heterogeneity, ultimately aiming to constrain the source of volatiles in early formed planetesimals.

[1] Savage et al. (2022). Icarus, p. 115172.

[2] Steller et al. (2022). Icarus, p. 115171.

*[3] Martins et al. (2023). Science, **379**(6630): p. 369-372.*

*[4] Goldstein et al. (2009). Geochemistry, **69**(4): p. 293-325.*