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Can nucleosynthetic isotope variations reveal the impact origin of pallasites?

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Nucleosynthetic isotope variations in bulk meteorites represent distinct regions of the early Solar System from which their parent bodies accreted [1]. Different nucleosynthetic isotope compositions for distinct phases within an extraterrestrial sample may indicate multiple nebular regions contributing to the formation a meteorite body. Pallasites are stony-iron meteorites composed of silicates set in a metal matrix. They represent either remnants of the core-mantle interface of asteroids [e.g., 2] or originate from multiple parent bodies via impacts [e.g., 3]. Because of the relatively high Fe abundance in both metal and silicates, Fe isotope data are a promising tool to investigate the potential diversity of nucleosynthetic signatures in pallasites. We aim to verify whether different components in pallasites are derived from a single or multiple bodies by obtaining high-precision Fe isotope data for both phases.

Metal and olivines from main-group (MG) and Eagle Station (ES) pallasites were digested on a hotplate following [4-5] and processed through ion-exchange chemistry to purify Fe [6]. The sample selection covers the outer and inner solar system. Iron isotope measurements were performed by MC-ICP-MS. The external reproducibility (2 SE, n = 22) is 0.03 ± 0.07 for ε^{54}Fe, and 0.05 ± 0.11 for ε^{58}Fe.

Preliminary results show resolved ε^{54}Fe excesses relative to the terrestrial value in olivine crystals from all measured MG and ES pallasites, and in metal from ES pallasites. Conversely, no ε^{54}Fe variations are resolved for MG pallasite metal. The ε^{54}Fe isotope variations in olivine and metal pairs from each sample are within uncertainties. The most prominent ε^{54}Fe excesses are observed for the ES pallasite, consistent with the Fe isotope composition of carbonaceous chondrites and irons sampling the outer solar system [6]. Moreover, no resolvable ε^{58}Fe were detected in the studied phases. Results from additional MG pallasites and their implications will be presented at the conference.

[1] Mezger et al. (2020), Space Sci. Rev. 216:27. [2] Boesenberg et al. (2012), GCA 89, 134-158. [3] Walte et al. (2020), EPSL 546, 116419. [4] Akram et al. (2015), GCA 165:484-500. [5] Hunt et al. (2017), GCA 216:82-95. [6] Liszewska et al. (2021) 84th METSOC, 6175.