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Coupled mass-dependent and mass-independent Mo isotope anomalies in iron meteorites

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Investigations into mass-independent Mo isotope anomalies in bulk meteorites have been numerous in recent years. Along with those found for other elements, including Cr, Ti, Zr and others, the Mo anomalies have been inferred to reflect the heterogeneous distribution of nucleosynthetic components [1]. In contrast, studies into mass-dependent Mo isotope compositions of bulk meteorites have been scarce [e.g., 2]. To assess this issue, we have obtained high-precision MC-ICP-MS measurements of coupled mass-dependent and mass-independent Mo isotope compositions for an extensive range of iron meteorites, comprising the largest dataset available to date and with improved precisions in comparison to previous studies [2-4].

The mass-independent isotope data reveal systematic nucleosynthetic Mo isotope anomalies in bulk iron meteorites. All meteorites analysed, apart from those in the IAB/III CD complex, display clear overall deficits in s-process components, with the size of anomalies varying between groups. The s-deficits are posited to have resulted from thermal processing of material in the solar nebula, which involved the destruction and removal of unstable phases hosting p- and r-process Mo isotopes [1]. In this model, the material closest to the Sun experienced more thermal processing and hence lost a higher proportion of p- and r-nuclides. As a consequence, the Earth, which formed closer to the Sun than the iron meteorite parent bodies, accreted from material that experienced more thermal processing than the building blocks of the iron meteorite parent bodies.

This model is further gauged by our measurements of the mass-dependent Mo isotope compositions. These analyses utilised the double-spike technique and previously published methods to subtract any mass-independent isotope effects from the data [2]. Our results afford, for the first time, coupled mass-dependent and mass-independent isotope evidence for the processes operating in the solar nebula and in particular, those that produced the distinct nucleosynthetic isotope signatures of meteorite parent bodies.

[1] Poole et al. (2017) *EPSL*, in revision. [2] Burkhardt et al. (2014) *EPSL* 391, 201-211. [3] Dauphas et al. (2002) *ApJ* 565, 640-644. [4] Burkhardt et al. (2011) *EPSL* 312, 390-400.