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Hf-W isotope systematics of chondrites

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The short-lived ^{182}Hf-^{182}W system ($t_{1/2}$ ~8.9 Myr) is widely used for constraining the timing of metal-silicate separation of planetary bodies and nebular reservoirs [*e.g.,* 1,2]. Importantly, Hf-W model age calculations for metal-silicate fractionation require knowledge of the Hf/W ratio and the associated W isotopic composition of a bulk body and its precursor materials. However, the Hf/W ratios of different nebular reservoirs and bulk parental bodies vary significantly. While carbonaceous chondrites appear to exhibit essentially uniform Hf/W ratios [3], the different ordinary chondrite parent bodies evolved with distinct Hf/W ratios, and the ordinary chondrite precursor reservoir, prior to nebular metal-silicate fractionation, exhibited a significantly lower Hf/W ratio than the value determined for carbonaceous chondrites [2]. To further explore the variability of Hf-W isotope systematics of different nebular reservoirs, and also to assess the level of Hf/W heterogeneity in individual chondrites, we determine W isotope compositions and ^{180}Hf/^{184}W ratios of bulk enstatite, ordinary, and carbonaceous chondrites.

All analyzed chondrites exhibit W isotopic compositions that agree with the values inferred for their parent bodies. However, some chondrites display Hf/W ratios that deviate from the inferred parent body compositions, likely reflecting heterogeneous distribution of metal on the sample scale. Combined Hf-W data from this and a previous study [4] suggest that enstatite chondrites evolved with a Hf/W ratio that was substantially lower than that of carbonaceous chondrites. If this low Hf/W ratio applies not only to enstatite chondrite parent bodies, but also to early differentiated planetesimals that accreted in the inner solar system, W model ages of non-carbonaceous iron meteorites and achondrites may be too old. Finally, possible Hf/W heterogeneity among Earth's building blocks, as indicated by the variable Hf/W ratios in chondrites, might result in a core formation age for Earth that significantly deviates from current estimates.

References: [1] Kruijer et al. (2014), *Science 344,* 1150-1154. [2] Hellmann et al. (2019), *GCA 258,* 290-309. [3] Kleine et al. (2004), *GCA 68,* 2935-2946. [4] Lee & Halliday (2000), *Science 288,* 1629-1631.