TUNGSTEN ISOTOPIC EVIDENCE FOR COEVAL METAL-SILICATE FRACTIONATION AND CHONDRULE FORMATION IN ORDINARY CHONDRITES. J. L. Hellmann[1], T. S. Kruijer[1] and T. Kleine[1], [1]University of Münster, Institut für Planetologie, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany (Contact: jan.hellmann@uni-muenster.de).

Introduction: Assessing the timescale for chondrule formation is key for understanding the origin of chondrules and the accretion history of chondrite parent bodies. However, the timing and duration of chondrule formation is still hotly debated, and reported ages for chondrules range from ~0 to ~3–4 million years (Ma) after formation of Ca-Al-rich inclusions (CAI) [1-3]. As chondrules probably accreted into chondrites shortly after their formation [1, 4], independent constraints on the timing of chondrule formation can be obtained by dating the accretion of chondrite parent bodies. Here we show that the timing of chondrite parent body accretion can be determined by dating the metal-silicate fractionation among ordinary chondrites.

Ordinary chondrites contain abundant metal and exhibit variable metal-to-silicate ratios, defining the three subgroups (H, L and LL), which each represent a distinct parent body. As the distinct metal abundances in the ordinary chondrites led to different bulk Hf/W ratios [5], the timing of metal-silicate fractionation among ordinary chondrites can be examined using the short-lived ^{182}Hf-^{182}W decay system. We conducted a Hf-W isochron study on metal and silicate separates of equilibrated H, L and LL chondrites of petrologic types 4 to 6, and here report data for three L chondrites (Tennasilm, L4; Saratov, L4; Kunashak, L6), four LL chondrites (NWA 7545, LL4; NWA 6935, LL5; Tuxtuac, LL5; NWA 5755, LL6), and three H chondrites (Ste. Marguerite, H4; ALH 84069, H5; Estacado, H6).

Methods: The chondrites were gently crushed to grain sizes between 40 and 250 µm. The grain size separates were then subdivided into different fractions using a hand magnet, resulting in several silicate-rich fractions and metal separates. The methods for separation of Hf and W, the measurement of Hf and W concentrations by isotope dilution, and the W isotope measurements followed our established procedures [1]. All measurements were conducted using the Neptune *Plus* MC-ICPMS at Münster, and results are reported in ε^{182}W as the parts-per-10^4 deviation from the ^{182}W/^{184}W of terrestrial bracketing standards.

Results: All metal separates have deficits in ε^{182}W, consistent with their very low Hf/W ratios. In contrast, the silicate fractions show more radiogenic and variable ε^{182}W values coupled with higher Hf/W ratios. For each sample, ε^{182}W is linearly correlated with Hf/W, defining precise isochrons. The isochron intercepts are essentially defined by the metal data points, which provide precise estimates of the initial ε^{182}W for each sample.

Discussion: Our results show that type 6 ordinary chondrites have younger Hf-W ages than type 4 samples, consistent with the slower cooling expected for chondrites of higher petrologic types. These systematic variations are consistent with a concentrically layered 'onion-shell' structure of chondrite parent bodies after they had undergone thermal metamorphism [6, 7]. In a diagram of initial ε^{182}W *vs.* time, all type 4 chondrites (including H, L and LL samples) cluster around a common initial ε^{182}W and Hf-W age corresponding to ~3-4 Ma after CAIs. In contrast, for type 6 chondrites the initial ε^{182}W vary and decrease from LL6 to L6 to H6, yet they all have similar Hf-W ages of ~9–11 Ma after CAIs. These data show that the different groups of ordinary chondrites evolved with distinct Hf/W ratios, where LL chondrites are characterized by the highest and H chondrites by the lowest Hf/W. The distinct Hf/W ratios are correlated with the variable silicate-to-metal ratios of ordinary chondrites, which also decrease in the order LL>L>H. Thus, the distinct Hf/W ratios of the ordinary chondrites were most likely established by a nebular metal-silicate fractionation just prior to accretion of ordinary chondrite parent bodies.

The Hf-W isotope evolution lines for each ordinary chondrite group intersect at ~2–3 Ma after CAIs. This observation suggests that the primitive ordinary chondrite reservoirs first evolved with a uniform Hf/W ratio up to that point in time and that the distinct bulk Hf/W of the H, L, and LL groups were only established later, at ~2–3 Ma after CAI formation. Thus, the metal-silicate fractionation among ordinary chondrites leading to their different bulk Hf/W occurred significantly later than CAI formation, but coincided with the formation of chondrules from ordinary chondrites at ~2 Ma after CAI formation. Collectively, these data indicate that chondrule formation, metal-silicate fractionation and chondrite accretion were coeval at about ~2 Ma after CAI formation.

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