TUNGSTEN ISOTOPE DICHOTOMY AMONG IRON METEORITE PARENT BODIES: IMPLICATIONS FOR THE TIMESCALES OF ACCRETION AND CORE FORMATION.

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Introduction: The ^{182}Hf-^{182}W chronology of iron meteorites shows that their parent bodies accreted and segregated their cores within a few Ma after the start solar system history [*e.g.,* 1]. Moreover, recent work, employing high-precision W isotope measurements coupled with Pt isotope *in situ* neutron dosimetry, revealed that small ^{182}W variations exist amongst the major iron meteorite groups [2]. These variations in pre-exposure (*i.e.*, unaffected by neutron capture) ^{182}W/^{184}W values very likely reflect that the iron meteorite parent bodies segregated their cores at different times, but the specific origin of these ^{182}W variations remains incompletely understood. They could reflect that either the parent bodies (i) melted at variable temperatures (ii) accreted at different times, or (iii) had variable bulk Hf/W ratios. To assess which of these options is correct, we here report combined Pt-W isotope data for several additional iron meteorite groups (IC, IIC, IIF, IIIE, and IIIF) with the ultimate aim to better understand the accretion and core formation history of their parent bodies.

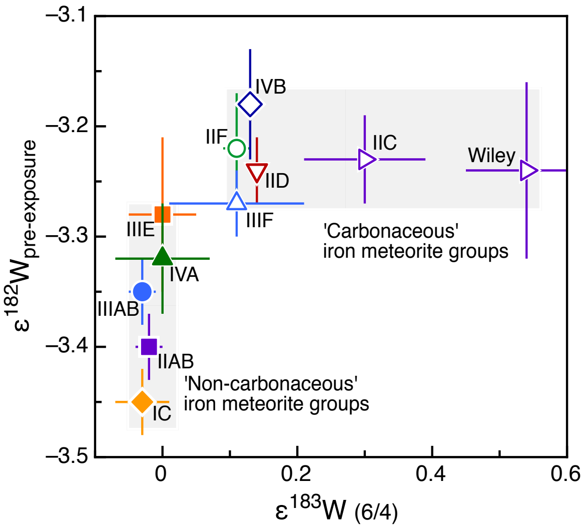

Fig. 1: Pre-exposure ε^{182}W vs. ε^{183}W for different iron meteorite groups from this study and [2].

Analytical Methods: After dissolution of the iron meteorite samples (~0.5 g) in HNO_3–HCl, Pt and W were separated by anion exchange chromatography following previously established procedures [2]. The Pt and W isotope compositions of the iron meteorites were determined using a Neptune *Plus* MC-ICPMS at the University of Münster [2], and ^{182}W/^{184}W and ^{183}W/^{184}W (internally normalised to ^{186}W/^{184}W) are reported as ε-unit (*i.e.*, parts-per-10^4) deviations relative to terrestrial standards with an external reproducibility of ~0.05-0.10 ε (95% conf.)

Results: The investigated iron meteorites exhibit strong but variable ε^{182}W deficits that are coupled with their Pt isotope signatures, reflecting isotope variations induced by secondary neutron capture. After correction for these effects [2], the iron meteorite groups exhibit small, but resolved variations in pre-exposure ε^{182}W, from ~–3.45 to ~–3.15. Moreover, several iron meteorite groups (IIC, IID IIF, IIIF) exhibit uniform and resolved ε^{183}W excesses of ~+0.1, indicative of nucleosynthetic W isototope heterogeneity, whereas other groups lack such excesses (IC, IIIE).

Discussion: A key observation from our data is that iron meteorite groups with nucleosynthetic ε^{183}W excesses also have higher pre-exposure ε^{182}W than groups lacking such anomalies (Fig. 1). Of note, this W isotope dichtomy appears to be mirrored by N isotope variations among iron meteorites [3]. Moreover, a similar dichotomy has previously been observed for nucleosynthetic Mo isotope signatures [4], the latter being consistent with a general dichotomy between ‘carbonaceous’ and ‘non-carbonaceous’ meteorites [5]. Generally this dichotomy implies that iron meteorite parent bodies accreted in two genetically distinct nebular reservoirs that were separated in space and/or in time. We propose that the elevated pre-exposure ε^{182}W of ‘carbonaceous’ iron meteorite groups implies that their parent bodies accreted either (i) at a later time, or (ii) in a nebular reservoir with higher Hf/W, than ‘non-carbonaceous’ iron meteorite parent bodies. In addition to this dichotomy, the individual ‘non-carbonaceous’ iron meteorite groups show resolved variations in pre-exposure ε^{182}W that appear to scale with the inferred degree of volatile element depletion [2]. This most likely reflects that in parent bodies with relatively high volatile element (notably S) concentrations (*e.g.*, the IC and IIAB cores), large volumes of melt can form rapidly, allowing for early and efficient core segregation. In contrast, core segregation in parent bodies with lower volatile contents (*e.g.*, the IVA and IIIE cores) was more protracted because of the limited amount of melt formed at an early stage.

Conclusion: Our results show that variations in pre-exposure ε^{182}W among iron meteorite groups, and hence their variable Hf-W ages, are simultaneously controlled by different parameters including the accretion of their parent bodies in two distinct nebular reservoirs, as well as the degree of volatile element depletion, which controls the melt fraction, and hence, the efficiency of core segregation at each instance during the evolution of a parent body.

References [1] Kleine T. et al. 2009. *GCA* 73:5150-5188. [2] Kruijer T.S. et al. 2014. *Science* 344:1150-1154. [3] Prombo, C.A. and Clayton, R.N 1993. *GCA* 57:3749-3761. [4] Budde G. et al. 2016. Submitted. [5] Warren P.H. (2011) *EPSL* 311:93-100.