Combining W and Pt Isotopes with Thermal Modelling to Determine the Evolution of the IAB Parent Asteroid

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The IAB iron meteorites consist of multiple sub-groups that may originate from one parent body and that include brecciated textures and silicate inclusions [1,2,3]. Competing theories suggest that either the parent body evolved through multiple impact events [e.g., 1,2], or alternatively underwent incomplete differentiation followed by impact disruption [e.g., 3]. The ^{182}Hf-^{182}W decay system can be used to constrain the timing of core formation, but may be disturbed by the effects of neutron capture reactions [4,5]. Platinum isotopes provide a dosimeter to correct for this [5,6,7]. Here we investigate the W and Pt isotope compositions of samples from four IAB sub-groups to assess the timing of differentiation. Furthermore, we compare the results to thermal models of parent body evolution.

After correcting for neutron capture effects using Pt isotopes, a single pre-exposure ε^{182}W of -2.90 ± 0.06 is defined for all four sub-groups. This corresponds to metal-silicate separation at 5.95 ± 0.75 Myr after CAI and suggests that the IAB parent asteroid underwent a single differentiation event at this time. Furthermore, W nucleosynthetic anomalies are absent in all samples, consistent with a single parent body origin. Using thermal models of interior evolution consistent with this age, it is suggested that the IAB parent body underwent metal-silicate separation as a result of internal heating by short-lived radionuclides. This demands the parent body accreted at around 1.5 Myr with a radius of greater than 60 km. A later impact event occurring more than ~10 Myr after CAI led to a catastrophic break-up and subsequent reassembly of the parent body [3,8].

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