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Chronology of the oldest CC planetesimals inferred from Cr isotopes in group IVB irons

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Magmatic iron meteorites are thought to sample the metal cores of differentiated planetesimals that formed after segregation and crystallization of metallic melts. Based on ^{182}Hf-^{182}W chronometry it has been shown that core formation in iron meteorite parent bodies occurred within the first ~3 Ma of the solar system [1]. The group IVB irons are the most strongly volatile element-depleted irons and have the youngest Hf-W ages among the magmatic irons. Variations in metallographic cooling rates among the IVB irons indicate that the IVB core cooled without an insulating mantle, which probably was removed during collisional disruption of the parent body [2]. This event may have led to partial resetting of the chronometers used to date formation and crystallization of the core. To better understand the chronology of the IVB parent body, and to search for isotopic signatures that may record post-core formation re-mixing of metal and silicates, we applied the ^{53}Mn-^{53}Cr system to chromites from four IVB irons. We focus on chromites because these are devoid of cosmic ray-induced modifications of Cr isotopes [3]. All four samples have indistinguishable nucleosynthetic ^{54}Cr signatures, similar to those of CV chondrites, and consistent with the genetic association of the IVBs to the carbonaceous chondrite (CC)-type reservoir. The IVBs of this study have distinct radiogenic ^{53}Cr signatures that correspond to an apparent Mn-Cr model age difference of ~3 Ma. This, however, is unlikely to reflect real differences in the time of metal segregation, given that all four samples have identical Hf-W metal segregation ages [1]. Instead, the ^{53}Cr differences more likely reflect addition of mantle-derived radiogenic ^{53}Cr to some parts of the core through partial metal-silicate re-equilibration during impact disruption of the parent body. This is consistent with evidence from metallographic cooling rates for outward crystallization of the IVB core [2] and our observation that the more radiogenic ^{53}Cr signatures occur for later-crystallized IVB samples.

Ref: [1] Kruijer et al. (2014) *Science*, 344, 1150-1154. [2] Yang et al. (2010) *Geochim. Cosmochim. Acta*, 74, 4493-4506. [3] Anand et al. (2021) *Geochem. Persp. Let.*, 20, 6-10.