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A Refined Chronology and Systematics of Nodular Graphite in IAB Iron Meteorites: Insights from New Re-Os Ages

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Canyon Diablo, a primitive achondrite IAB main group iron meteorite, is host to large (> cm), silicate-graphite-troilite nodules making these meteorites distinguishable from most non-IAB irons [1-3]. While magmatic core formation is the dominant mechanism of planetary differentiation in achondrite iron meteorite parent bodies, other mechanisms have been proposed to explain the formation of IAB irons, namely impact melt events. Justification for this origin is derived from the presence of graphite-troilite nodules and silicates that are suspended in an Fe-Ni matrix. In this model, as the impact-generated melt rapidly cools, the carbon rich Fe-Ni metal crystallizes, and carbon precipitates as nodular graphite becoming trapped within the metal [4-5].

However, Canyon Diablo graphite preserves primordial noble gas signatures in addition to an excess of ^{129}Xe, telling a contradictory low temperature origin story, whereby graphite formed in a nebular environment during the earliest stages Solar System formation [6]. These two competing hypotheses are mechanistically and temporally contradictory in that the primordial origin story implies a graphite formation age that is near synchronous with the formation of the first condensates, whereas the impact event origin story would record a younger age.

Here we aim to resolve timing, and by extension mechanism, by applying the rhenium-osmium (^{187}Re-^{187}Os) decay system to graphite preserved within the Canyon Diablo iron meteorite. This innovative approach reveals that the graphite, indeed, likely formed during an impact event that occurred ca. 20 Myr after Solar System formation. This new dataset refines our chronological knowledge of IAB parent body evolution and demonstrates that Re-Os dating can be extended to other graphite-nodule-bearing meteorites.

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