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Reassessment of the age of the solar system and the chronology of chondrule formation

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Chondrules, submillimetre igneous silicate spherules, are the most abundant high-temperature objects formed during the evolution of the circumsolar disk. The chronology of their formation remains however highly controversial. Absolute Pb−Pb ages and ^{26}Al−^{26}Mg ages relative to calcium−aluminium-rich inclusions (CAIs) provide inconsistent chronologies, with Pb−Pb ages showing early and protracted chondrule formation up to 4 Ma after CAIs [1] whereas ^{26}Al−^{26}Mg ages suggest that chondrule production was delayed by at least 1.5 Ma [2–3]. We have developed a new method to precisely determine *in situ* ^{26}Al−^{26}Mg ages of spinel-bearing chondrules, with spinel being far less sensitive to secondary asteroidal processes compared to the other phases commonly used for ^{26}Al−^{26}Mg dating [2–3]. Our data demonstrate that ^{26}Al−^{26}Mg chondrule formation actually starts 1 Ma earlier than previously thought, i.e., as early as 0.75 ± 0.26 Ma, and extends over the entire lifetime of the disk [4]. Such a shift in chondrule ages relative to CAIs is however not sufficient to reconcile the Pb−Pb and ^{26}Al−^{26}Mg chronologies of chondrule and achondrite formation, as no chondrule yet formed simultaneously with CAIs. Thus, either chondrules' Pb−Pb ages and volcanic achondrites' ^{26}Al−^{26}Mg ages are incorrect or the age of CAIs should be revaluated at 4,568.7 Ma to ensure consistency between chronometers. Given that the canonical age of CAIs was determined using only 4 specimens [5] and older ages up to 4,568.2 Ma have also been measured [6], modelling based on our new spinel-derived ^{26}Al−^{26}Mg ages favours the adoption of 4,568.7 Ma as the new absolute canonical age of CAIs. This enables reconciling both the Pb−Pb, ^{26}Al−^{26}Mg and ^{182}Hf−^{182}W ages of chondrules and achondrites, highlights a 0.7–1 Ma gap between the formation of refractory inclusions and chondrules, and supports the homogeneous distribution of ^{26}Al in the circumsolar disk.

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