Early incipient melting on chondritic parent bodies

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Understanding the initial stages of planetary formation and differentiation, in particular the extent and timing of metal-silicate segregation, is crucial to constraining the early evolution of planetary embryos. In this context, metal-rich CR chondrites have been studied, as well as the Tafassasset meteorite. Tafassasset is of special interest as it has been proposed to be related to CR chondrites by some authors, although others argue in favor of a metal-rich brachinite. Besides, this meteorite is not altered contrary to CRs.

Tafassasset silicates show mass-independent W isotope anomalies, while the metal phase does not [1]. These nucleosynthetic anomalies are interpreted as reflecting the presence of SiC presolar grains in the matrix of the meteorite, carrying *s-process* ^{184}W. Similarly, CR chondrites also carry W nucleosynthetic anomalies. After correction of these anomalies, a correlation is observed in Tafassasset between the ^{182}W/^{184}W isotope compositions and the Hf/W ratios of the different fractions. An age of ca. 2.9 Ma after CAIs is inferred from the ^{182}Hf-^{182}W chronometer for the last equilibration of metal and silicates, slightly older than other estimates based on the ^{53}Mn-^{53}Cr, ^{26}Al-^{26}Mg, and Pb/Pb chronometers, but consistent with the difference in closure temperatures of the different isotopic systems [1]. The ^{60}Fe-^{60}Ni age is underconstrained; an upper limit of a few 10^{-7} can be estimated for the ^{60}Fe/^{60}Ni ratio. According to ^{182}Hf-^{182}W systematics, CR chondrites formed a few million years later than Tafassasset.

Numerical modeling of the thermal evolution of Tafassasset indicates accretion of a parent-body less than ~50 km in diameter, ≤ 1 Ma after the formation of CAIs, at a time when short-lived radio-nuclides induced metal-silicate separation and partial melting of the silicates with extraction of a basaltic component [1]. According to these new data, Tafassasset may represent an inner part of a CR-like parent body, with a differentiation history similar to, but less severe than, that of brachinites.

[1] Breton T. et al. (2015) Tafassasset: evidence of early incipient differentiation on a metal-rich chondritic parent body. *EPSL*, accepted.