Old Sm-Nd ages for cumulate eucrites and redetermination of the Solar System initial $^{146}\text{Sm}/^{144}\text{Sm}$ ratio

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Early solar system evolution from planetesimal formation to initial differentiation is studied using short-lived radioisotope systems to provide high temporal resolution. However, extinct radionuclides must be used in combination with long-lived chronometers in order to convert the relative time intervals provided by the extinct radioisotopes into absolute ages. Sm-Nd systematics include two decay schemes: the extinct $^{146}\text{Sm}-^{142}\text{Nd}$ ($T_{1/2}=103$ Ma) and the long-lived $^{147}\text{Sm}-^{143}\text{Nd}$ chronometers ($T_{1/2}=106$ Ga). Because absolute ages can be obtained from the latter, no additional anchor point is required for Sm-Nd studies. In the case of a protracted cooling history, coupled Sm-Nd systematics present the advantage that both chronometers have the same isotopic closure temperature.

In order to better understand the chronology of the HED parent body differentiation and, in particular, its crustal evolution, we focused on three cumulate eucrites. Isotopic measurements were performed using the DTM Finnigan Triton. Coupled Sm-Nd measurements on whole-rocks and mineral separates of two cumulate eucrites (Binda and Moore County) give concordant results and suggest that the last Sm-Nd isotopic closure occurred at ~4547 Ga. Moama has known a more complex history and probably multi-stage evolution as illustrated by its initial radiogenic Nd isotope composition and younger Sm-Nd isotopic closure age.

Considering these new results and eucrite data from the literature, we find an initial solar system $^{146}\text{Sm}/^{144}\text{Sm}$ ratio of 0.00865±0.00038. This value is more precise but fully consistent with the previous estimate of 0.008±0.001 defined from angrite and eucrite studies. This work suggests that $^{146}\text{Sm}$ was homogeneously distributed in the inner solar system, with the exception of the formation region for carbonaceous chondrites which preserved nucleogenic anomalies [1, 2].