Magnesium isotope constraints on the mechanisms and timing of global silicate differentiation of Vesta

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We have undertaken a systematic major and trace element study of 22 eucrites, along with high-precision measurements of magnesium (Mg) isotopes by MC-ICP-MS. These data and those for diogenites bring the number of high-precision Mg isotopic analyses of Vesta to ca. 50 and provide an opportunity to evaluate the significance of the Mg isotope data in constraining the mechanisms and timing of global silicate differentiation of this differentiated protoplanet.

All eucrites with super-chondritic Al/Mg ratios exhibit variable excesses in ^{26}Mg* (μ^{26}Mg* up to +40 ppm) related to the decay of now extinct ^{26}Al. In contrast to diogenites, μ^{26}Mg* values for the eucrites do not exhibit a good correlation with their bulk rock Al/Mg ratios and mineral major and trace element chemistry. These anomalies can be used to calculate ^{26}Al–^{26}Mg model ages of 1–5 Myr after CAIs, *assuming* single stage Al/Mg fractionation of the Vestan mantle took place during partial melting and formation of basaltic eucrites. However, a number of lines of evidence strongly suggest these model ages do not date either the partial melting event that produced eucrites or their crystallization, but instead the ^{26}Mg* excesses were inherited from an evolving magma ocean or bodies on Vesta whilst ^{26}Al was extant. Firstly, the ^{26}Al–^{26}Mg model age of Juvinas is older than an internal ^{53}Mn–^{53}Cr isochron age for this eucrite. Secondly, the lack of correlation between eucrite chemistry and μ^{26}Mg* is consistent with continuing magmatic evolution of eucrite magma bodies after ^{26}Al became extinct. In contrast, most diogenites crystallized early whilst ^{26}Al was extant.

Finally, we will explore the significance of a small but significant stable Mg isotopic difference between eucrite and diogenite meteorites that has implications for the genetic relationship between these two group of meteorites.