Mn-Cr chronology of Vesta and other Vestoids

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The vast majority of eucrite and diogenite meteorites (defined here as *normal*) are thought to have originated from a single parent body, Vesta, based on shared geochemical and spectral characteristics [1]. A subset of eucrites, termed *anomalous* eucrites, may originate from distinct parent bodies (non-Vesta) based on differences in their isotopic composition ($\Delta^{17}O$ and $\varepsilon^{54}Cr$) compared to *normal* eucrites [2-5]. The ^{53}Mn-^{53}Cr isotope system has been used in the past to investigate the silicate differentiation of the eucrite parent body (EPB) using *normal* eucrites [6,7]. Using whole-rock eucrite and diogenite ^{53}Mn-^{53}Cr measurements, previous estimates have placed the EPB silicate differentiation event at 4564.77 ± 0.59 Ma [6,7]. Here, we attempt to further constrain the timing of the silicate differentiation event on the EPB by investigating the ^{53}Mn-^{53}Cr systematics of nine whole-rock *normal* eucrite and diogenite samples. We also investigate the ^{53}Mn-^{53}Cr systematics of nine *anomalous* eucrites for which $\varepsilon^{54}Cr$ has been measured previously [4,5].

The whole-rock ^{53}Mn-^{53}Cr isochron of the nine *normal* eucrites and diogenites yields a $^{53}Mn/^{55}Mn$ of $(4.88 \pm 0.36)\times10^{-6}$ at the time of last isotopic closure. This translates to an absolute age of 4565.56 ± 0.47 Ma relative to the D'Orbigny angrite [8-10], indicating a global scale magma ocean differentiation and crustal formation was complete by this time on Vesta. The timing of silicate differentiation obtained here is consistent within error with that of [6,7]. Among the nine *anomalous* eucrites analyzed, six do not fall along the isochron line defined by the *normal* eucrites and diogenites, plotting both above and below the whole-rock EPB isochron. The plotting off of the isochron by these *anomalous* eucrites indicates that their source reservoir likely did not experience silicate differentiation contemporaneously with that of the *normal* eucrites and the EPB. This provides additional evidence for multiple parent bodies for the *anomalous* eucrites as indicated by $\Delta^{17}O$ [2,3] and $\varepsilon^{54}Cr$ [4,5].

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