Origin of Cr isotopic variations in physically separated components of the unequilibrated chondrites Allende and Murchison

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Bulk carbonaceous chondrites exhibit clear excesses in $\varepsilon^{53}Cr$ and $\varepsilon^{54}Cr$ compared to terrestrial rock standards. These excesses are linearly correlated, also with Mn/Cr. Study of Cr isotopic variations in chondrite components may be useful to understand the origin of these variations, the processing history of nebular dust and the role of parent body processes. In this study, we report Cr isotopic data on separated components of the carbonaceous chondrites Allende (CV3) and Murchison (CM2).

Mn/Cr ratios of components of Allende (Mn/Cr = 0.366-1.901) and Murchison (Mn/Cr = 0.580-1.221) show significant variations compared to the bulk rocks (Allende: 0.47 ± 0.06; Murchison: 0.62 ± 0.03, literature data and this study). Except for chondrules, CAIs and non-magnetic fractions, matrix and magnetic components of Allende show limited variation in their Mn/Cr ratio (0.53 ± 0.04) and there is no systematic correlation between $\varepsilon^{53}Cr$, $\varepsilon^{54}Cr$ and Mn/Cr. In contrast to Allende, components of Murchison have much more variable Mn/Cr compared to their Allende counterparts. In Allende components $\varepsilon^{53}Cr$ and $\varepsilon^{54}Cr$ vary from -0.23 ± 0.07 to 0.37 ± 0.05 and from -0.43 ± 0.08 to 3.7 ± 0.1 (relative to NIST 3112a Cr standard), respectively. The CAI fraction shows highest $\varepsilon^{54}Cr$ (3.7 ± 0.1). In components of Murchison $\varepsilon^{53}Cr$ and $\varepsilon^{54}Cr$ vary from -0.06 ± 0.08 to 0.5 ± 0.1 and from 0.7 ± 0.2 to 1.7 ± 0.1, respectively. Chondrules in both meteorites show the lowest Mn/Cr and $\varepsilon^{54}Cr$ values, consistent with the loss of a $\varepsilon^{54}Cr$ rich carrier phases during thermal processing in the course of chondrule formation.

In contrast, to the linear variations of bulk carbonaceous chondrites, components of both meteorites show non-systematic variations in $\varepsilon^{53}Cr$, $\varepsilon^{54}Cr$ and Mn/Cr indicating local isotopic and chemical heterogeneity and different carrier phases of ^{53}Cr and ^{54}Cr in the components. The small-scale variations of $\varepsilon^{53}Cr$ and $\varepsilon^{54}Cr$ with Mn/Cr indicate either heterogeneity of initial ^{53}Cr or later changes in Mn/Cr or $^{53}Mn/^{55}Mn$ in different components due to secondary processes on meteorite parent bodies. We will discuss which of these processes may be excluded on the basis of systematic variations of major and minor elements in the components.