

Nucleosynthetic variances between bulk CM1 and CM2 chondrites

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The CM chondrite group is the most abundant carbonaceous chondrite group available for study, with its wide range of alteration degrees providing valuable insight into parent body processes involving fluid alteration during ice melting [1,2]. Isotopic differences between the mildly altered CM2 and highly hydrated CM1 chondrites have been observed, particularly in $\Delta^{17}\text{O}$ signatures, where bulk CM1 chondrites exhibit lighter $\Delta^{17}\text{O}$ values compared to CM2 chondrites [2,3]. This study combines nucleosynthetic $\mu^{54}\text{Fe}$, $\mu^{54}\text{Cr}$, and $\mu^{50}\text{Ti}$ isotopic signatures from 10 individual CM bulk chondrites, previously analyzed using XRD techniques [3], to investigate potential nucleosynthetic differences between CM2 and CM1 chondrites. Understanding these differences could help address the longstanding question of whether CM chondrites originated from a single or multiple parent bodies [2].

We find no resolvable variations in $\mu^{54}\text{Fe}$ isotopic signatures between the CM1 and CM2 chondrite groups (WM = 20.8 ± 7.0 ppm, 2SD). However, while six of the 10 chondrites match literature values (22.3 ± 5.4 , 2SD) [4], four chondrites, regardless of alteration degree, display significantly lower $\mu^{54}\text{Fe}$ values (WM = 11.3 ± 2.4 ppm, 2SD), resembling those of CO chondrites. This discrepancy may be attributed to terrestrial weathering. For $\mu^{54}\text{Cr}$ isotopes, we observe no resolvable differences between individual CM chondrites (WM = 93.6 ± 14.5 ppm, 2SD), which agree with literature values (92 ± 26 ppm, 2SD) [5]. Notably, CM1 chondrites have a tighter distribution (96.9 ± 3.0 ppm) compared to CM2 chondrites (91.8 ± 15.6 ppm), potentially reflecting isotope homogenization during alteration. Since the average $\mu^{54}\text{Fe}$ and $\mu^{54}\text{Cr}$ values for each CM chondrite group are consistent with published bulk values, it is unlikely that CM1 and CM2 chondrites originated from separate parent bodies with distinct formation and alteration processes.

Additionally, we will present nucleosynthetic $\mu^{50}\text{Ti}$ isotopic signatures for all 10 CM chondrites. We expect minimal variation in $\mu^{50}\text{Ti}$ due to the resistance of aqueous Ti dissolution, suggesting that $\mu^{50}\text{Ti}$ signatures would not reflect heterogeneous parent body alteration.

[1] Lee, M.R. (2025) *Space Science Rev.* 221: 11. [2] Suttle, M.D. (2021) *GCA* 299:219-256. [3] King, A.J. et al. (2017) *MAPS* 52: 1197-1215. [4] Schiller, M. et al. (2020). *Sci. Adv.* 6: eaay7604. [5] Zhu, K. et al. (2021) *GCA* 301: 158-186.