The evolution of planetesimal reservoirs revealed by Fe-Ni isotope anomalies in differentiated meteorites

Fridolin Spitzer, Timo Hopp, Christoph Burkhardt, Nicolas Dauphas, and Thorsten Kleine

*Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany, spitzer@mps.mpg.de

Isotope anomalies in meteorites reveal a fundamental dichotomy between non-carbonaceous (NC) and carbonaceous (CC) materials [1], observed in both early- and late-formed planetesimals. Whether these generations formed from the same or distinct materials remains unclear. We analyzed Fe and Ni isotopes in meteorites from ~22 differentiated parent bodies. The new data show that early- and late-formed planetesimals from the CC reservoir share similar Fe and Ni isotope compositions, indicating they accreted from the same dust mixture, likely within long-lived or compositionally similar disk structures. Among CC bodies, many ungrouped irons match CR chondrites, suggesting this reservoir formed early and stayed isolated throughout the disk's lifetime. In contrast, CI chondrites have no isotopic match among differentiated meteorites, implying they formed only late, by a distinct mechanism [2] or reservoir [3].

[1] Kleine et al. (2020) Space Sci. Rev. 216, 55. [2] Spitzer et al. (2024) Sci. Adv. eadp2426. [3] Hopp et al. (2022) Sci. Adv. eadd8141.