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Dynamic evolution of the inner Solar System inferred from Ti and Cr isotope anomalies in meteorites

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Bulk meteorites display a fundamental isotopic dichotomy, distinguishing between 'non-carbonaceous' (NC) and 'carbonaceous' (CC) meteorites. This dichotomy reflects the presence of two isotopically distinct reservoirs in the early solar accretion disk, possibly separated by the early formation of Jupiter's core. However, the efficiency with which the NC and CC reservoirs were spatially separated over time remains controversial [1,2]. Prior studies inferred that Ti and Cr isotope anomalies among NC meteorites are correlated and point towards the compositional field of CC meteorites, thereby intersecting the composition of CI chondrites [3]. This would be consistent with the proposal that the correlated anomalies among NC bodies reflect the continuous addition of CI-like dust into the inner Solar System [2].

To better constrain the efficiency of the NC-CC separation and its implications for the dynamical evolution of the inner Solar System, we obtained Ti isotopic data for 37 NC meteorites from previously un-investigated groups. For 20 of these samples, we additionally obtained Cr isotopic data. Contrary to prior observations [3], the refined NC trend in ε^{50}Ti vs. ε^{54}Cr space intersects the CC field no longer at its endmember position (i.e., that of CI chondrites), but instead at its central position. Furthermore, a comparison of the Ti and Cr isotopic compositions of the NC meteorites with inferred accretion ages of their parent bodies reveals no temporal trend, but rather suggests that the NC trend records the existence of small-scale spatial heterogeneities in the early inner disk reservoir that were preserved by the rapid accretion of NC parent bodies. These spatial heterogeneities may reflect the continuous change in the isotopic composition of infalling cloud material from CAI-like to NC-like [1]. Combined, these observations are difficult to reconcile with the idea of continuous addition of CI-like dust into the inner Solar System. Instead, the new data are in line with an effective spatial separation of the NC and CC reservoirs, consistent with the expected effects of the Jupiter barrier.

References: [1] Spitzer et al. (2020), *ApJL* 898, L2. [2] Schiller et al. (2018), *Nature* 555, 507–510. [3] Trinquier et al. (2009), *Science* 324, 374–376.