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Complex mixing of nebular materials inferred from combined O-Ti-Cr isotope variations in individual chondrules

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We obtained coupled ε^{54}Cr, Δ^{17}O, and ε^{50}Ti data for individual chondrules from enstatite (EC), ordinary (OC), and carbonaceous (CV, CR) chondrites. Whereas EC and OC chondrules display homogeneous ε^{54}Cr, Δ^{17}O, and ε^{50}Ti, CV chondrules have heterogeneous signatures. The ε^{50}Ti and ε^{54}Cr anomalies of CV chondrules are not correlated, and some plot in-between and outside the discrete noncarbonaceous (NC) and carbonaceous (CC) fields defined by bulk meteorites. By contrast, in the Δ^{17}O–ε^{54}Cr plot, all chondrules plot in one of the two fields. Combined, our data indicate that the isotopic variability among chondrules does not reflect disk-wide transport of chondrules, but reflects local small-scale heterogeneities in the chondrule precursors. This is in line with recent proposals explaining the distinct signatures of the NC and CC reservoirs by mixing of primordial disk reservoirs, and extends this concept to the individual chondrule level.

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