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Origin of Strontium-84 homogeneity in the inner Solar System

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Nucleosynthetic isotope anomalies in meteorites have been identified for a number of elements and show that the solar system can be subdivided into the non-carbonaceous (NC) and carbonaceous (CC) reservoirs. These anomalies may either reflect secondary processing of presolar carriers in a well-mixed disk [1], or primordial mixing of isotopically distinct materials during time-varied infall from the Sun's parental molecular cloud [2,3]. Using improved thermal ionization mass spectrometry, we obtained high-precision ^{84}Sr data for a comprehensive set of NC and CC meteorites, and also including martian meteorites, and samples from the Earth and Moon. The new data reduce the ^{84}Sr variability among NC meteorites, Mars, and the Earth and Moon from >50ppm observed in previous studies [1,4] to less than ±4ppm, indicating that the NC reservoir is largely homogeneous for ^{84}Sr. This homogeneity contrasts with the well-resolved and correlated isotope anomalies observed among NC meteorites for other elements, including Fe-group elements (e.g. Cr, Ti) and heavier elements (e.g. Zr, Mo, Ru) [3]. The absence of ^{84}Sr variations in the NC reservoir likely reflects correlated and counteractive variations in *p*-, *s*-, and *r*-process Sr, which translate into apparent ^{84}Sr excesses and depletions of similar magnitude. As such, the ^{84}Sr homogeneity of the NC reservoir is difficult to reconcile with models in which the nucleosynthetic isotope variability reflects processing of distinct presolar carriers in an initially well-mixed disk. Such processing is expected to result in enrichments or depletions of specific presolar carriers such as SiC grains [3], but not in correlated abundance variations of distinct carriers that result in positive and negative anomalies that cancel out. By contrast, primordial mixing of isotopically distinct dust reservoirs readily accounts for the ^{84}Sr homogeneity in the NC reservoir, as demonstrated by the magnitude of ^{84}Sr depletions and excesses calculated by comparison to anomalies in other elements.

[1] Paton, C., et al. (2013), Astrophys. J. Lett. 763, 2. [2] Nanne J.A.M. et al. 2019, Earth Planet. Sci. Lett. 511, 44-54. [3] Burkhardt, C., et al. (2019), Geochim. Cosmochim. Acta 261, 145–170. [4] Moynier, F., et al. (2012), Astrophys. J. 758:45.