The great carbonaceous vs. non-carbonaceous chondrite isotope schism: A heretical view

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Introduction: An isotopic dichotomy between carbonaceous (CC) and non-carbonaceous (NC) chondrites in terms of ^{16}O , ^{54}Cr , ^{50}Ti , ^{62}Ni , ^{84}Sr and ^{92}Mo [1, 2, 3] has led to the suggestion that the CCs formed in the outer Solar System (beyond Jupiter) and the NCs formed in the inner Solar System. But this popular idea has glaring problems [4, 5]. Chondrites are heterogeneous aggregates of diverse materials with differing isotopic signatures. CCs differ from NCs in their abundance of Ca-Al-rich inclusions (CAIs; except CI), noble metal grains, and Cr-oxide nanograins. Most of the isotopically-dichotomous elements are refractory, suggesting high-temperature processes and carriers. Sr and Ti are refractory lithophiles, and CAIs are known carriers of ^{84}Sr and ^{50}Ti . Ni is a moderately refractory siderophile, and ^{62}Ni may be in Fe-Ni metal (at least in CV3s). More-volatile ^{54}Cr is carried in oxide nanograins [6]. Ultra-refractory Mo is carried in noble metal nuggets. ^{16}O enrichment is a hallmark of CAIs [7] and the Sun [8]. ^{54}Cr correlates [1] with ^{16}O (negative $\Delta^{17}\text{O}$) due to the abundance of both CAIs and Cr-oxide grains in CCs. On such a plot, Earth, Mars, Moon, and ordinary chondrites plot in heliocentric order with Earth plotting *closest* to the CCs. This is not expected if CCs formed in the outer solar system. In fact, we argue that CCs and their components formed in the *inner* solar system, opposite to the idea of [1]; the NCs and their components did also, but exterior to CCs. The dichotomy arises from their differing components and processing histories.

References: [1] Warren P. H. (2011) *EPSL* **311**, 93; [2] Charlier B. et al. (2019) *GCA* **265**, 413; [3] Burkhardt C. et al. (2011) *EPSL* **312**, 390; [4] Huss G. *Met. Soc. Ann. Mtg.*, #6200; [5] MacPherson G. J. (2019) *LPSC 50th*, #3005; [6] Qin L. et al. (2011) *GCA* **75**, 629. [7] Clayton R. N. et al. (1973) *Science* **182**, 485; [8] McKeegan K. D. et al. (2011) *Science* **332**, 1528.