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L-Amino Acid Enantiomeric Excesses in Meteorites: Formation Mechanisms and Implications for the Origin of Homochirality

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Introduction: The delivery of organic compounds by carbonaceous meteorites to the early Earth and other planetary bodies could have been an important source of prebiotic compounds required for the emergence of life. However, one major unsolved question is how the homochirality observed in life (*i.e.*, L-amino acids and D-sugars) originated from presumably racemic mixtures in a prebiotic world. Slight to significant L-enantiomeric excess for several indigenous α -dialkyl amino acids were first reported in the Murchison and Murray CM2-type carbonaceous meteorites [1]. Since then L-enantiomeric excesses of up to 21% for the terrestrially rare, non-protein amino acid isovaline have been reported across a wide range of carbonaceous meteorite groups [2], and appear to correlate with the degree of parent body aqueous alteration as inferred from their mineralogy (Fig. 1). Much larger L-excesses of ~45 to 99% have been reported in the Tagish Lake meteorite for the protein amino acids threonine, serine, aspartic and glutamic acids, whereas another common protein amino acid alanine was racemic, suggesting minimal terrestrial contamination of the meteorite [3]. Asymmetric photolytic decomposition of amino acids or their precursors by polarized radiation in the presolar nebula has been proposed as a source of the L-excesses in meteorites, however such large L-excesses would require photodestruction of >99% of the starting materials [4]. We will present the most recent data and discuss plausible amplification mechanisms that could explain the large enantiomeric enrichments observed in meteorites.

References: [1] Cronin, JR and Pizzarello, S (1997) *Science*, 275, 951-955. [2] Elsila JE, Aponte JC, Blackmond DG, *et al.* (2016) *ACS Central Science* 2:370-379. [3] Glavin DP, Elsila JE, Burton AS, *et al.* (2012) *Meteorit. Planet Sci.* 47:1347-1364. [4] Flores JJ, Bonner WA, Massey GA (1977) *J. Am. Chem. Soc.* 99:3622-3655.

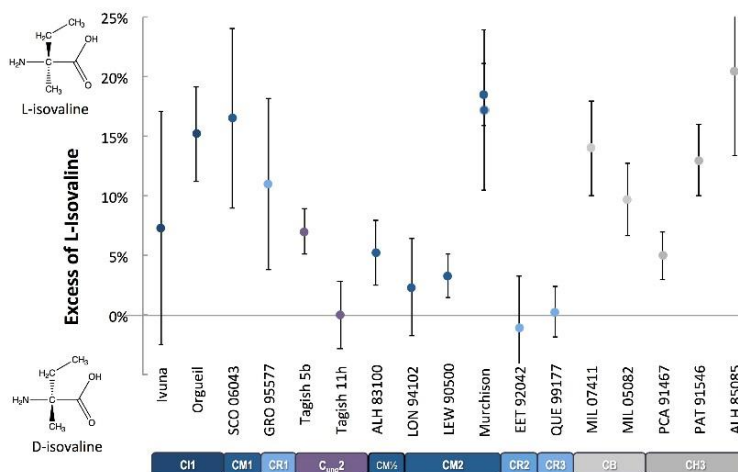


Figure 1 – L-enantiomeric excesses of the non-protein amino acid isovaline found in carbonaceous meteorites range from ~0 to 21%. D-isovaline excesses have not been found in any meteorite to date.