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ISOTOPIC CONSTRAINTS ON THE ORIGIN OF METEORITIC ORGANIC MATTER

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Salient features of the isotopic distribution of H, C and N in the organic material found in carbonaceous meteorites are the following: Most organic fractions are strongly enriched in D with respect to the D/H ratio characteristic of H₂ in the protosolar system; substantial variations in ¹³C/¹²C ratio are found among different molecular species, with oxidised species tending to be ¹³C-enriched relative to reduced species; some homologous series reveal systematic decrease in ¹³C/¹²C with increasing C number; considerable variation in ¹⁵N/¹⁴N ratio is observed within organic matter, though no systematic pattern to its distribution has yet emerged; no interelement correlations have been observed between isotope enrichments for the different biogenic elements. The isotopic complexity echoes the molecular diversity observed in meteoritic organic matter and suggests that the organic matter was formed by multiple processes and/or from multiple sources. However, existence of a few systematic patterns points towards survival of isotopic signatures characteristic of one or more specific processes. The widespread D enrichment implies either survival of many species of interstellar molecule or synthesis from a reservoir containing a significant interstellar component.

Several of the questions raised above can be addressed by more detailed determination of the distribution of the H, C and N isotopes among different well-characterised molecular fractions. Thus, the present study is aimed at discovering whether the different amino acids have comparable D enrichments, which would imply local synthesis from a D-enriched reservoir, or very variable D enrichments, which would imply survival of some interstellar amino acids. The same approach is also being applied to polycyclic aromatic hydrocarbons. Because the analytical technique employed (secondary ion mass spectrometry) can acquire data for all three isotopic systems from each molecular fraction, any presently obscured interelement isotopic correlation should also be revealed, which will aid in identifying pertinent synthetic processes.