Genealogy of Deuterium in Insoluble Organic Matter in Chondrites

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The D/H ratio of chondritic insoluble organic matter (IOM) exhibits variations between and within chondrites and shows heterogeneities down to the molecular scale [1,2,3]. The D/H can be used as a tracer of the IOM synthesis and evolution. However, it remains encrypted by the superimposition of various processes occurring during the complex history of chondrites. The investigation of the origins of these heterogeneities may reveal how the IOM and its precursors were formed.

With the exception of the Abee chondrite [4], IOM exhibits significant D-enrichment that cannot be produced by isotope exchange at equilibrium with molecular H_2 in the protosolar disk. The large D/H of IOM may result from cold chemistry (T<100K) in the interstellar medium, the parent molecular cloud or the protosolar disk [1,3]. Irradiation in the protosolar disk at 300 K could also induce significant isotopic fractionation [5] and may be responsible for the observed intramolecular heterogeneities [6]. However, it remains ineffective to produce the extreme D-enrichments observed in ordinary chondrites (OC) [1] and in micron-sized “hot spots” observed in some carbonaceous chondrites (CC) [3]. Additional processes are thus required.

Interestingly, while IOM in OC appears to bear a thermally stable D-rich component [7], the D-rich hot spots in CC, which may be related to organic radicals, are destroyed with increasing thermal treatment [3]. This could point to different organic precursors having distinct birthplace. The observed variations between the different classes of chondrites [1] may then arise from heterogeneous associations of different organic precursors formed in the insterstellar medium, the molecular cloud or the protosolar disk, which subsequently evolved on the parent body.

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