Coupled H-isotopic signature and structural evolution of experimentally irradiated insoluble organic matter.

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Organic matter found in carbonaceous chondrites is highly enriched in deuterium, relative to H_2 in the protosolar nebula (PSN) [1]. In the scenario where the insoluble organic matter (IOM) is a PSN product [2], ion-molecule or gas-grain reactions could lead to a D-enrichment of organics [3]. The ionizing irradiations in the protosolar nebula potentially enhanced such mechanisms [4]. Recent experimental irradiations of natural and synthetic analogues of IOM under high energy (300 keV) have shown that electron irradiation could act as a driving mechanism for D-enrichment [5,6].

In this context, we conducted irradiation experiments on a large range of well characterized analogues. All the samples consist in thin polymer films, from 1 to 10 μm thick. The ionizing excitation was obtained by electron irradiation with a scanning electron microscope (SEM) at moderate energy (30 keV), and at room temperature. With increasing energy deposition, a gradual and significant D-enrichment is observed, from 320±85‰ up to 590±85‰. This enrichment is closely related to the structural evolution of the analogue and to its initial structure.

From our data, a quantitative kinetic model is derived. This model accounts for both structural and isotopic evolutions of the IOM. Moreover, our results show that such isotopic signature can be produced over a timescale compatible with the lifespan of the protoplanetary disk.

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