Deuteration of insoluble organic matter and silicates by ionizing irradiation in the solar nebula

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Organic matter found in carbonaceous chondrites is highly enriched in deuterium, relative to H_2 in the protosolar nebula [1]. It is also enriched compared to the bulk "chondritic water" mainly adsorbed on or dissolved in silicate and oxide grains [2]. Here we test experimentally the possibility that these signatures result from the ionizing irradiation of solid precursors in the protosolar nebula.

Recent experimental irradiations of natural and synthetic analogues of IOM under high energy (200 keV) have shown that electron irradiation could act as a driving mechanism for D-enrichment [3,5]. In this context, we conducted irradiation experiments on a large range of well-characterized analogues. All the samples consist in thin polymer and hydrous silicate films. The ionizing excitation was obtained by electron irradiation with a scanning electron microscope (SEM) at moderate energy (30 keV), and at room temperature. For organic analogues and 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 initial structure of the analogue and to its evolution. Turning to silicates, a deuteration of the irradiated targets is also observed. However, for a given deposited energy, the fractionation is much lower than for organics. Furthermore, it does not follow the same dependence regarding the deposited energy.

From our data, a quantitative model is derived. This model accounts for both structural and isotopic evolutions of the IOM and silicates. Moreover, our results show that the isotopic signatures can be produced over a timescale compatible with the lifespan of the protoplanetary disk and may explain the contrasted D/H signature of chondritic organics and silicates.

[1] Robert F. and Epstein S. (1982) *GCA,* **46**, 81–95. [2] Alexander et al., (2010) *GCA,* **74,** 4417-4437. [3] De Gregorio B. *et al* (2010) *GCA,* **74**, 4454–4470. [4] Le Guillou C. *et al* (2013) *Icarus,* **226**, 101–110. [5] Laurent et al., (2014), GCA, **142**, 522–534.