

**SPATIAL RELATIONS BETWEEN D/H AND N ISOTOPIC ANOMALIES IN ORGUEIL AND MURCHISON INSOLUBLE ORGANIC MATTER: A NANOSIMS STUDY.**

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**Introduction:** Most of the organic carbon in Carbonaceous Chondrites (CC) is in the form of Insoluble Organic Matter (IOM). Isotopically, the IOM in CC appears to be highly un-equilibrated: discrete H and N isotopic anomalies - the so-called *hotspots* - with  $\delta$  values up to +19400‰ and +1770‰, respectively, are embedded in the bulk IOM, which has average compositions that are lower by a maximum one order of magnitude [1]. This isotopic heterogeneity is often interpreted as a result of interstellar-like processes occurring in the Solar Nebula or inherited from its parent molecular cloud [1]. Previous studies have observed that the D and  $^{15}\text{N}$  *hotspots* can be either spatially correlated (*i.e.* at the same location in the IOM) or uncorrelated [1,2]. Here we present new Hydrogen and Nitrogen isotopic measurements with the NanoSIMS in order to shed light on these spatial correlations.

**Methods:** IOM from Murchison and Orgueil, extracted by acid attack from the bulk meteorite [3], was pressed in pure gold foil. Two terrestrial kerogen standards (Type I and III) were analyzed in parallel. A 16 keV  $\text{Cs}^+$  primary ion beam of 10pA rastered across a  $20 \times 20 \mu\text{m}^2$  surface with an ion spot of 200 nm and a counting time of 1 ms/pixel. Three magnetic fields were used to measure successively: (i) H<sup>-</sup> and D<sup>-</sup>, (ii)  $^{12}\text{C}^{14}\text{N}^-$  and  $^{12}\text{C}^{15}\text{N}^-$  and (iii)  $^{13}\text{C}^-$  and  $^{13}\text{CH}^-$ . To improve the counting statistic, especially for Hydrogen isotopes, a typical measurement of IOM is composed of 100 such cycles. Under these conditions, the total acquisition time for the 100 cycles is about 7 hours. Each of these 100 cycles is systematically bracketed by 2 standard measurements to monitor the possible instrumental shifts.

**Results:** In Orgueil and Murchison IOM, about 57% and 80% of the *hotspots* in D and  $^{15}\text{N}$  are spatially correlated, respectively. Hydrogen and Nitrogen isotopic composition of Orgueil *hotspots* range from +2300‰ to +4000‰ and from +135‰ to +412‰ respectively. For Murchison, H and N *hotspots* range from +2400‰ to +4500‰ and from -157‰ to +480‰, respectively. No correlation is observed between the magnitude of the hotspot anomalies, *i.e.*  $\delta\text{D}$  and  $\delta^{15}\text{N}$ , in Orgueil and in Murchison. Based on H/C and N/C elemental ratios, the *hotspots* are, at a first approximation, indistinguishable from the bulk IOM chemical composition within the 25% relative error.

Recent studies performed on IOM isolated from Orgueil show hydrogen isotopic variations at a molecular scale. [3,4]. For instance, the Orgueil D-rich *hotspots* are a mixing between D-rich radicals ( $\delta\text{D} = +95,000\text{‰}$ ) and the bulk IOM ( $\delta\text{D} = +1360\text{‰}$ ) [4,5]. As for the D-rich radicals, it can be hypothesized that the spatially correlated D-rich and  $^{15}\text{N}$ -rich *hotspots* are caused by  $^{15}\text{N}$ -rich radical carriers. Such an assumption could be validated by EPR spectroscopy.

As a corollary of this hypothesis, the occurrence of spatially uncorrelated *hotspots* suggests that some D-rich radicals do not have any Nitrogen in their chemical formula, therefore yielding a  $\delta^{15}\text{N}$  equal to that of the bulk IOM.

**References :** [1] Busemann H. et al. (2006) Science, 312, 727-730. [2] Nakamura-Messenger K. et al. (2006) Science, 314, 1439-1442. [3] Remusat L. et al. (2006), EPSL, 243, 15-25. [4] Gourier D. et al. (2008) GCA, 72, 1914-1923. [5] Halbout J. et al. (1990) GCA, 54, 1453-1462.