NanoSIMS imaging of insoluble organic matter in ordinary chondrites: Comparison with carbonaceous chondrites

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The insoluble organic matter (IOM) is known to be enriched in deuterium in carbonaceous chondrites (CC) and ordinary chondrites (OC) [1]. Moreover, the isotopic composition of the IOM in CI and CM chondrites is heterogeneous at the molecular scale [2] and the micron scale [3]. In Orgueil IOM, the occurrence of D-rich hot spots is related to the heterogeneous distribution of organic radicals caracterised by a D/H ratio of 1.5% [4]. The D-isotopic enrichment is related to ion-molecule like reactions - taking place in the outer areas of the protosolar nebula or the interestellar space - that have affected the IOM before accretion on the parent body. The isotopic variations of IOMs in various types of chondrites are complex and have been related to parent body processes [1], if we assume a comon precursor to the IOM in all the parent bodies. However, this hypothesis seems inconsistent with in situ imaging of organic matter in the matrices of carbonaceous chondrites, which reveals that it exists at least two kinds of organic matter [5].

We have performed NanoSIMS imaging of stable isotopes of C, N and H in the IOM of Murchison (CM), Semarkona (LL3) and Bishunpur (L3.1). Despites higher bulk D and ^{15}N contents, we do not observe any spatially resolved ^{15}N or D isotopic anomaly in the IOM of the two OC studied, in contrast to Murchison IOM. In addition, some ^{13}C anomalies are observed and are likely related to the occurrence of presolar silicon carbide. The lack of D-rich hot spots might be related to a lack in organic radicals. This could be the result of heating on the parent body (even if it is moderate for the two studied OC, less than 250ºC) or the lack of organic particles rich in radicals during the accretion of the parent bodies. As heating of Murchison IOM induces not only a destruction of D-rich hot spots but also a decrease of the bulk D/H, the later hypothesis appears more likely, ruling out the common precursor hypothesis.

[1] Alexander *et al*. (2007) *GCA* **71**, 4380-4403. [2] Remusat *et al*. (2006) *EPSL* **243**, 15-25. [3] Busemann *et al*. (2006) *Science* **312,** 727-730. [4] Remusat *et al*. (2008) *XXXIXth LPSC* Abst. #1399. [5] Remusat, Guan & Eiler *XXXXth LPSC* Abst. #1399.

Olivine-rich troctolites from the Internal Liguride ophiolites (Northern Apennine, Italy)

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The Internal Liguride ophiolites represent an intra-oceanic domain of the Middle to Late Jurassic Ligure-Piemontese basin. The gabbroic plutons of these ophiolites consist mostly of coarse-grained gabbros to olivine-gabbros and contain, at different stratigraphic levels, sill-like lenses of olivine-rich troctolites.

The olivine-rich troctolites are mainly composed of rounded to polygonal olivine (70-90 vol%, Fo88-85), anhedral plagioclase, minor poikilitic clinopyroxene (Mg# 90-86) and accessory spinel (Cr# 54-46). Accessory Cr- and Ti-rich amphibole is locally present, as rim around spinel and as inclusion within spinel. Other silicate inclusions in spinel are Cr- and Ti-rich (Na-)phlogopite, and Al-poor orthopyroxene. The compositions of silicate inclusions in spinel document the involvement of melts rich in H_2O, alkalies and SiO_2.

Locally, the olivine-rich troctolites are associated with centimetre-scale layers that vary modally from troctolite to anorthosite and chromitite, and contain gabbroic dykelets with fuzzy contacts. In addition, one of the studied olivine-rich troctolite lenses shows a metre-scale layer displaying a “harrisite” pegmatoid texture, in which huge skeletal olivines (up to 30 cm) are intergrown with plagioclase [1].

The olivine-rich troctolites from the Internal Liguride ophiolites bear textural and compositional similarities to the olivine-rich troctolites from modern oceanic core complexes in slow and ultraslow spreading ridges. We show that the olivine-rich troctolites of the present study are not cumulates that developed under closed system conditions. Their formation most likely requires a complex interplay of petrogenetic processes.

[1] Bezzi & Piccardo (1971) *Mem Soc Geol It* **10**, 53-63.