

IN SITU OBSERVATION OF C AND N ANOMALOUS ORGANIC GRAINS IN THE MATRIX OF MET00426 (CR3.0)

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Introduction: Ion microprobe studies of organic grains in the matrices of primitive chondrites have revealed the presence of micron-sized hotspots with anomalous δD , $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ ratios [1, 2]. These extreme isotopic anomalies could be inherited from low temperature ion-molecule reactions that may have occurred in either the interstellar medium [1] or in the solar nebula [2]. These grains occur in the matrices with isotopically normal organic grains.

To better understand the differences between isotopically normal and anomalous carbonaceous grains, we have conducted a coordinated NanoSIMS-FIB-TEM study of both types of grains in the matrix of the pristine CR chondrite MET 00426 (CR3.0). We have examined the compositional, structural and morphological characteristics of the organic grains and their textural relationships with other components. MET00426 is one of the least altered carbonaceous chondrites currently known and exhibits minimal evidence of aqueous alteration and thermal metamorphism [3]. It thus represents a unique opportunity to study organic grains *in situ* in a pristine chondrite matrix.

Results and discussion: Two N-anomalous ($\delta^{15}\text{N} = 956 \pm 70\%$; $1242 \pm 52\%$), one C-anomalous ($\delta^{13}\text{C} = 140 \pm 15\%$) and two normal grains ($\delta^{13}\text{C} = 20\%$) characterized by NanoSIMS [2] were extracted. TEM reveals no detectable differences between normal and isotopically anomalous grains. The grain sizes range between 300 and 500 nm and they all have rounded morphologies. Only the C-anomalous grain has a nanoglobule morphology, with a hole in the center. HRTEM images show nanometer long fringes, similar for all particles, indicating the presence of small aromatic units. Remarkably, every grain is embedded within the Fe-rich amorphous silicate matrix material and shows no spatial relationships with sulfides or phyllosilicates, in contrast with some other grains in the depth of the section which are associated with oxysulfides. Nevertheless, other phases could have been present in the third dimension prior to FIB preparation and have been lost during ion milling.

The striking similarity in terms of size and morphology as well as textural environments would argue for a common formation mechanism, despite their heterogeneous isotopic compositions. These observations seem to rule out the parent body origin [4], incompatible with the absence of aqueous alteration around the grains and formation of such isotopically heterogeneous grains at this localized scale. It would rather suggest accretion of different populations of grains which inherited their isotopic compositions from precursor organic compounds that formed either in the interstellar media or in the solar nebula. These isotopically heterogeneous grains were subsequently mixed extremely thoroughly prior to accretion in asteroidal parent bodies.

References: [1] Remusat et al. 2010. *Ap J.* 713: 1048-1058. [2] Floss C. and Stadermann F. 2009. *Ap. J.* 697:1242–1255. [3] Abreu N. M. and Brearley A. J. 2010. *GCA* 74:1146-1171. [4] Cody G. 2009. 40th Lunar & Planetary Science Conference. #2325.