

## Investigation of organic matter in the matrix of Allende meteorite using FIB and compact STXM

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Allende meteorite (Allende), which classed as carbonaceous meteorite (CV3), fell in Pueblito de Allende, Chihuahua State, Mexico, on February 8, 1969. Allende is composed of chondrule, Calcium-aluminium-rich inclusions (CAIs), Amoeboid olivine aggregates (AOAs), Fe/Ni metal, and matrix. Organic matters (OM) is contained in matrix phase, however, distribution of OM in the Allende at the micrometer-scale has not investigated yet.

In this study, we analyzed a focused ion beam (FIB) milled thin section (approximately 150 nm) of Allende transected a region of fine-grained matrix employing carbon X-ray absorption near-edge structure (C-XANES) spectroscopy using compact scanning transmission X-ray microscope (cSTXM), which is installed to BL-13A at Photon Factory, high energy acceleration research organization. The cSTXM analysis revealed that the thin section of matrix of Allende contains c-rich grains, the C-XANES spectra were obtained from eight of these grains of which are similar to Allende's insoluble organic matter (IOM) reported by Cody et al. (2008). Some of eight c-rich grains has exciton peak of the diamond (288.6-288.9 eV). Existence of this peak indicates the possibility that nano-diamonds were contained in these grains. In addition, one of the c-rich grains has possibility of contain of C-N bond (nitrile or heterocyclic imine). As to diffuse OM, distributing like vein, whose C-XANES were carboxylic rich OM compared to grains. Diffuse OM was investigated in CM and CI chondrites by C-XANES, whose compositions were mainly labile and low molecules OM and which was carboxylic rich OM was reported by Le Guillou et al. (2014). However, C-XANES of diffuse OM, was investigated in this study, was different from already reported. This difference caused from the difference of empirical temperature between CV, CI, and CM.

From these results, OM was existed in matrix phase as small grain and diffuse OM. And cSTXM measurement was revealed that speciation of OM. Grains have IOM-like feature, and possibility of containing nano-diamonds and C-N compounds. Diffuse OM is carboxylic-rich OM. As to the future work, existence of nano-diamonds and C-N compounds should be confirmed by TEM observation and N-XANES, respectively. In addition, metamorphosis of OM between OM and inorganic minerals when thermal denaturation should be investigate using cSTXM and Raman microscope.

Keywords: Allende meteorite, Scanning Transmission X-ray Microscope, Organic matter, Focused ion beam, Carbon XANES, Characterization