Investigation of the organic matter in ALH 77307 by STXM

*Hiroki Suga¹, Motoo Ito², Yoko Kebukawa³, Matthew A Marcus⁴, Takuji Ohigashi⁵, Yoshio Takahashi¹

1. Graduate School of Science, The University of Tokyo, 2. Kochi Institute for Core Sample Research JAMSTEC, 3. Faculty of Engineering, Yokohama National University, 4. Advanced Light Source, Lawrence Berkeley National Laboratory, 5. UVSOR Synchrotron Facility, Institute for Molecular Science

Organic matter (OM) is one of the most important building blocks of the solar system, it contributes to the planetary evolution and relates to the origin of life. The primitive OM is preserved in the carbonaceous chondrites (CCs), comets, and interplanetary dust particles. However, it is difficult to understand that what is the primitive OM (*e.g.*, information of it such as chemical composition and occurrence). Therefore, various candidates and formation process of OM has being discussed still. Here, we focused on the one of the most pristine CCs, ALH 77307 (petrological type 3.03: less altered). Primitive OM in its matrix and chondrule rim phases were explored using X-ray microscopic analysis. The aim of this study is to find primitive OM in the most primitive CCs.

First, matrix and chondrule rim phases were identified by SEM-EDS elemental imaging. Then, the ultra-thin section of matrix and chondrule rim were prepared using FIB system in the Kochi Institute for Core Sample Research JAMSTEC. After that, prepared ultra-thin sections were analyzed by STXM installed BL4U in IMS UVSOR and beamline 5.3.2.2 in ALS LBNL to investigate OM distributions and their functional groups composition of C, N, and O.

As a result, we found two types of OM in both matrix and chondrule rim. These OM showed the same functional groups composition (aromatic C: C=C, ketonic C: C=O, carboxylic C: C=O[-HO], and graphitic layer structure: C-C) and different functional groups ratio. OMs in the chondrule rim were surrounded the aqueous alteration related secondary minerals such as iron hydroxides and carbonates. Although it was suggested that OM in the chondrule rim have the functional groups composition which related to aqueous alteration (*e.g.*, hydroxyl and aliphatic compounds), these functional groups related peaks could not be identified. Therefore, it was suggested that OM preserved original (before the accretion of the matrix and chondrule rim) information and secondary minerals origin were also before the accretion. From these characteristics, two types of OM in matrix and chondrule rim phase may have different origins such as nanoglobules and primitive insoluble OM (or insoluble OM-like nanoglobules reported in De Gregorio et al., 2013).

In this study, we succeeded in the *in-situ* observation (occurrence-preserved OM analysis with FIB system) to clarified that the original occurrence and functional groups of tow primitive OMs in ALH77307. As for the future plan, H-, C-, N-, and O-isotopic characteristics of these two OMs and carbonates are going to be analyzed by NanoSIMS in Koch Institute for Core Sample Research JAMSTEC. After that, OMs and secondary minerals morphology will be investigated by TEM in the University of Tokyo.

Keywords: ALH77307, STXM, Primitive organic matter