TEM observations of amorphous silicates and the adjacent alteration products in MIL 090657 matrix

M. SUGIMOTO[1], A. TSUCHIYAMA[1], J. MATSUNO[1], A. TAKAYAMA[1], A. MIYAKE[1], K. NAKAMURA-MESSENGER[2], A. S. BURTON[2], AND S. MESSENGER[2]

[1] Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto University, Kyoto, JAPAN

[2] Astrominerals Research and Exploration Science Division, NASA Johnson Space Center, Houston, TX, USA

Miller Range (MIL) 090657 meteorite (CR2.7) is one of the least altered primitive carbonaceous chondrites[1]. Its matrix has abundant amorphous silicates like GEMS (glass with embedded metal and sulfide), which are characteristically contained in cometary dust [2,3] as with the Paris meteorite matrix[4]. Previous studies have suggested six lithologies in the matrix based on SEM, TEM and X-ray CT obseravations [2,3,5]; Lithology-1 (L1) dominated by submicron anhydrous silicates, L2 by GEMS-like amorphous silicates, and L3-6 by probably phyllosilicates with different Fe contents. L2 was devided into sublithologies of L2-B (Fe-rich) and L2-D (Fe-poor) [5]. Organic materials are abundant in L1 and L2 [2,3] based on TEM observation. However, the TEM observations were made only on ultramicrotorm thin sections of L1 and L2, which did not ensure matching with lithologies on potted butt samples observed by SEM and X-CT. In this study, a TEM section was extracted from L2-B in a potted butt by FIB and observed with (S)TEM/EDS.

GEMS-like objects were observed in L2-B of the present sample. In addition, amorphous silicate domains without metal and sulfide nanoparticles were observed. Weak rings in the SAED indicates that they suffered slight aqueous alteration as reported in Paris meteorite matrix [4]. Some regions are occupied with serpentine and smectite. Pores are also present and most of them are occupied with organic materials. These featurtes are somewhat different from L2 in the ultramicrotorm thin sections, where amorphous slicicates are mostly GEMS-like and organic material network is filled in abundant pores. Thus, both pristine and slightly altered regions are present in L2. In the present sample, the regions with different degrees of aqueous alteration are distributed in typically a few hundred nm with distinct boundaries. This might correspond to the onset stage of aqueous alteration.

Reference: [1] Davidson et al. 2015, 46th LPSC, 1603. [2] Cao et al. 2016, 47th LPSC, 2427. [3] Sugimoto et al. 2016, Goldschmidt Workshop on Experimental Cosmochemistry, 15. [4] Leroux et al. 2015, GCA, 170: 247-265. [5] Sugimoto et al. 2017, JpGU, PPS10-P09.