

PPS25-14

会場:213

時間:5月2日 12:30-12:45

C-XANES analyses of carbonaceous solid inclusions from Monahans halite C-XANES analyses of carbonaceous solid inclusions from Monahans halite

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Monahans meteorite (H5) contains fluid inclusion-bearing halite (NaCl) crystals [1]. Microthermometry and Raman spectroscopy showed that the fluid in the inclusions is an aqueous brine and they were trapped near 25°C [1]. Their continued presence in the halite grains requires that their incorporation into the H chondrite asteroid was post metamorphism [2]. Abundant solid inclusions are also present in the halites. The solid inclusions include abundant and widely variable organics [2]. Analyses by Raman microprobe, SEM/EDX, synchrotron X-ray diffraction and TEM reveal that these grains include macromolecular carbon similar in structure to CV3 chondrite matrix carbon, aliphatic carbon compounds, olivine (Fo₉₉₋₅₉), high- and low-Ca pyroxene, feldspars, magnetite, sulfides, lepidocrocite, carbonates, diamond, apatite and possibly the zeolite phillipsite [3]. Here we report organic analyses of these carbonaceous residues in Monahans halite using C-, N-, and O- X-ray absorption near edge structure (XANES).

Approximately 100 nm-thick sections were extracted with a focused ion beam (FIB) at JSC from solid inclusions from Monahans halite. The sections were analyzed using the scanning transmission X-ray microscope (STXM) on beamline 5.3.2.2 at the Advanced Light Source, Lawrence Berkeley National Laboratory for XANES spectroscopy. C-XANES spectra of the solid inclusions show micrometer-scale heterogeneity, indicating that the macromolecular carbon in the inclusions have complex chemical variations. C-XANES features include 284.7 eV assigned to aromatic C=C, 288.4-288.8 eV assigned to carboxyl, and 290.6 eV assigned to carbonate. The carbonyl features obtained by C-XANES might have been caused by the FIB used in sample preparation. No specific N-XANES features are observed. Various degrees of 1s-σ*exciton shown in the C-XANES spectra indicate that the solid inclusions contain macromolecular carbon which experienced various degree of thermal processing. The natures of the macromolecular carbon in the solid inclusions observed by C-XANES are consistent with the previous studies showing that the solid inclusions have not originated from Monahans parent body [1-3].

References: [1] Zolensky et al. 1999. Science 285: 1377-1379. [2] Fries et al. 2011. 74th MetSoc #5390. [3] Zolensky et al. 2013. 76th MetSoc #5200.

Keywords: C-XANES, Halite, Carbon, Chondrite, Organic matter