CONSTRaining Thermal Processing of Carbon-rich Aggregates in Xenolithic Clasts from Sharps (H3.4) Meteorite.

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Introduction: Primitive xenolithic clasts are often found in many regolith-bearing meteorites, e.g. [1]. The Sharps (H3.4) ordinary chondrite contains unusual carbonaceous clasts up to ~1 cm across. They have been reported earlier as intergrowth of graphite and magnetite [2], then corrected as poorly graphitized carbon (PGC) with Fe,Ni metal and described as “carbon-rich aggregates” [3]. Carbonaceous matter can be used as a thermometer due to its sensitivity to the thermal processes. Here we report analyses of the carbon-rich aggregates using FTIR, Raman, C-XANES and TEM, in order to constrain their thermal process and possible origins.

Sample and Analytical Methods: A chip of Sharps (USNM640) containing dark mm-sized clasts was provided for analysis by the National Museum of Natural History; Smithsonian Institution. For FTIR analysis, a small amount of the clast were crushed between two baked (500°C, 3 h) glass slides, then pressed onto a KBr plate. For C-XANES (conducted using beamline 5.3.2.2 at the Advanced Light Source) and subsequent TEM analysis, a ~100 nm-thick section was prepared from the clast using a focused ion beam (FIB), and an ultra-microtome with sulfur embedding. The Raman analyses were conducted on the sulfur mounted surface after the ultra-microtoming. We also prepared acid residues of the clast using HCl/HF method.

Results and Discussion: The FTIR spectra of the acid residue from the Sharps clast show almost no features, suggesting that less hydrogen and oxygen contents than acid residues from typical type 3.4 ordinary chondrites. The peak metamorphic temperature obtained by Raman spectroscopy ranges between ~320 to ~340 °C. TEM observation of C-rich aggregates in the clast shows the low degree of graphite ordering with spacings of carbon d_{002} layer lattice fringes vary from 0.36 to 0.39 nm, indicating that this material have not been heated above 300°C. These estimations are consistent with the earlier estimation, 330 ± 50 °C [3]. Meanwhile, the C-XANES spectra of C-rich aggregates have high exciton intensities and suggesting that the graphene structures have been developed at around 700°C to 800°C, using the method proposed by [4], although surrounding matrix areas show < 300-500 °C.

So far at least, it seems that the C-rich aggregates have formed high temperature condition, and mixed with lower temperature matrix and then incorporated into the Sharps parent body probably after thermal metamorphism. We will also discuss the meanings of temperature variations obtained from three different methods.