

**AROMATIC MACROMOLECULAR VARIATIONS OF INSOLUBLE ORGANIC MATTER FROM METAMORPHOSED CM2 OBSERVED IN SOFT X-RAY ABSORPTION ENERGY SHIFTS**

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**Introduction:** Metamorphosed CM2 chondrites experienced unique and diverse secondary processes. The complex histories of the individual meteorites are reflected in the elemental and isotopic variations of their insoluble organic matter (IOM) [1, 2]. On the other hand, solid state <sup>13</sup>C NMR spectra of the IOM have shown no clear differences between them in the relative abundance or chemical shift of the dominant aromatic peak [3, 4]. Also, the weak exciton intensity (291.1 eV) in the Carbon X-ray Absorption Near Edge Spectroscopy (C-XANES) spectra of their IOM are not as useful as those of type 3 chondrite IOM for evaluating the thermal histories [4, 5]. To try to better characterize changes in IOM structure associated with the secondary processes, this study has taken a close look at the lower photon energy range in C-XANES spectra of IOM from the metamorphosed CM2.

**Experimental:** The meteorite samples used in this study include: 5 kinds of metamorphosed CM2s (LEW85311, Yamato [Y-] 793321, Y-86720, PCA91008, and WIS91600), an unheated CM2 (Murchison), CI (Orgueil), and Tagish Lake. The IOM were prepared by demineralization of the bulk meteorites using a CsF-HF solution. The IOM was embedded into sulfur, microtomed to ~100 nm thickness, and was analyzed by XANES combined with Scanning Transmission X-ray Microscopy (STXM).

**Result and discussion:** Small but discernable energy shifts in the 285–287 eV range of the normalized C-XANES spectra are seen for the IOM from the 5 metamorphosed CM2s, while similar C-XANES spectral patterns without energy shifts are seen for the unheated CM, CI, and Tagish Lake IOM. The energy (eV) of the peak for C1s →  $\pi^*_{C=C}$  transition assigned to aromatic carbon is 285.1 for Murchison, 285.2 for LEW85311, 285.3 for Y-793321 and WIS91600, 285.6 for Y-86720 and PCA91008, respectively. Energy calibration using CO<sub>2</sub> absorption features and constant energy for the C1s (C=O) →  $\pi^*_{C=O}$  transition for all meteoritic IOM demonstrate that the energy shifts are not due to instrumental drift during the analyses. Similar behavior is reported for the specific chemical structure of a variety of aromatic polymers [6]. The energy shifts are not clearly correlated with the H/C ratio of IOM, but could be related to inductive effects of various side groups and/or hetero atoms (N, O) substitution in aromatic rings. In fact, the peaks for C1s →  $\pi^*_{C=C}$  for most of the metamorphosed CM2s are broader than those for the unheated CM and CI, which appears to indicate greater complexity in their aromatic structures as a result of the range of secondary processes they experienced.

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