

Probing the Composition of Sediment Organic Matter using Scanning Transmission X-ray Microscopy

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Current knowledge regarding the complex nature of sediment organic matter (OM) has been obtained using bulk sediment extractions followed by a variety of characterization techniques and molecular biomarkers. These extraction procedures create artifacts, selectively removing specific organic macromolecules, potentially masking many of the fine details required to properly understand the OM preservation mechanisms occurring within sediments. Here, nano-scale Scanning Transmission X-ray Microscopy (STXM) was used to characterize OM moieties found in marine and lacustrine sediments from a variety of depositional settings. These analyses allow better understanding the mechanisms responsible for the selective preservation of the small fraction of OM which survives degradation in the water column and deposition at the sediment water interface.

Near Edge X-ray Absorption Fine Structure (NEXAFS) spectra were collected at the C and N K-edge and the Fe L_{3,2} edge for intact sediment particles. Our goal was not only to characterize the nature of the OM but also to compare the functionalities co-localized to the sediment mineral matrix, specifically with iron oxides. In all studied samples the presence of iron co-localized OM was widespread with similar functionalities being seen across samples from similar depositional settings. Specifically the presence of carboxylic, aliphatic and aromatic functionalities were primarily matrix associated while peptidic moieties were present as both matrix associated and unassociated. Although positive identification of individual peaks using C-1s spectra can be difficult, the use of a dual element approach (N in this case) it is possible to narrow down the identity of the preserved OM functionalities, giving us more information regarding the preservative bonding mechanisms occurring between OM and sediment particles.