Nanoscale Geochemistry of Phosphorus Within Marine Sediments

J. A. BRANDES[1], E. D. INGALL[2], D. PATERSON3 AND M. DE JONGE4

[1] Skidaway Institute of Oceanography, Savannah, USA
[2] Georgia Tech, Atlanta, USA ingall@eas.gatech.edu
[3] Australian Synchrotron,
[4.] Advanced Photon Source, Argonne National Laboratory, USA

Phosphorus plays a critical role in regulating terrestrial primary productivity, and exists in a wide variety of organic, inorganic and mineral forms in the environment. The interplay of P with shifting redox conditions has been a subject of many studies, yet the controlling mechanisms remain elusive. We investigated the effect of oxygen on sedimentary phosphorus (P) composition in Effingham Inlet, a fjord located on the west coast of Vancouver Island. Scanning tandem fluorescence and transmission X-ray microscopy, together with Phosphorus Near Edge X ray Fluorescence Spectroscopy (P-NEXFS), were used to examine P composition in these samples on sub-micron scales. The results revealed a heterogeneous P distribution characterized by several micron-diameter P-rich regions associated with polyphosphates as well as regions associated with different mineral phases. Such P-rich regions comprised roughly 50% of the total P within the sediments. Mineral phosphates exhibited a considerable range of P-NEXF spectra. Intriguingly, no enriched region appeared to be associated with iron phosphates, and there was no evidence for a physical association between polyphosphate and mineral P regions. Polyphosphate regions were common in surface oxic sediments, but were rare in surface anoxic sediments and absent in deeper (~20 cm) sediments in both locations.

The results support recently published papers suggesting that the redox-sensitive formation and remineralization of polyphosphates plays a central role in regulating the formation of phosphorites (apatite) in marine sediments. The role of iron in P cycling in these sediments is unclear, but may be primarily in low P concentration regions rather than as $FePO_4$ minerals.