Changes in phosphorus biogeochemistry along an estuarine salinity gradient: The iron conveyer belt

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Limnol. Oceanogr., 53(1), 2008, 172-184 | DOI: 10.4319/lo.2008.53.1.0172

ABSTRACT: We used sequential extractions to quantify different forms of particulate phosphorus (PP) in sediments along the salinity gradient of the Patuxent River estuary. About 50-90% of the PP was phosphate bound to iron oxides (Fe-P), and 8-30% was organic P (org-P). Loosely sorbed phosphate (sorb-P), detrital apatite, and authigenic plus biogenic apatite each made up <10% of the PP. Suspended sediments from the watershed and deposited sediments in tidal freshwater had the highest concentrations of Fe-P, ranging about 30-55 μmol g^{-1} sediment. As pore-water salinity increased to 7 along the estuarine gradient, Fe-P declined to 15-25 μmol g^{-1}, org-P increased from 4 to 10 μmol g^{-1}, sorb-P increased from 0.5 to 2.5 μmol g^{-1}, and total sediment PP declined from 60 to 40 μmol g^{-1}. Concentrations of pore-water solutes also changed with salinity. As salinity increased, dissolved Fe and ammonium decreased, while dissolved phosphate increased. Near the freshwater end of the gradient, the molar ratio of pore-water ammonium : phosphate was generally >16 (the Redfield ratio) and ranged up to >700, while at the saline end of the gradient the ratio was generally <16 and ranged down to <1.5. Our observations are consistent with the hypothesis that phosphate is released from terrigenous sediments when they are deposited in saline portions of the estuary where sulfide may enhance dissolution of Fe-P and form Fe sulfide precipitates. Such phosphate release may contribute to the generally observed switch from phosphorus limitation in freshwater to nitrogen limitation in coastal marine water.

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