Marine Phosphorus Biogeochemistry:

Ecological Insights from Analytical Chemistry

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Phosphorus (P) is essential to the functioning of all biological systems. In the marine environment, diverse communities of planktonic microorganisms (i.e., phytoplankton, bacteria, Archaea) not only require P for cellular structure and metabolic regulation but also rapidly mediate the flux of carbon, nutrients, and energy through reduction-oxidation pathways and trophic interactions. These critical relationships between P and marine plankton have far-reaching consequences that fundamentally impact marine ecosystem health and biogeochemical cycling. However, the available supply of P has been notoriously difficult to define and assess. The overall objective of my dissertation research was to examine the biogeochemistry of phosphorus with an emphasis on its availability to marine plankton. This work was conducted at two environment scales, community-scale and molecular-scale, using a variety of analytical chemistry techniques. The first component (community-scale) of this research sought to examine the seasonal and tidal variability of water column carbon (C), nitrogen (N), and P stoichiometry within a tidally-dominated estuary. Results will be presented that demonstrate significant seasonal variability of C:N:P stoichiometry, which also complemented seasonal patterns of tidal material exchange within the estuary. Furthermore, stoichiometric variability led to the development of a community nutrient status model that specifically considered bioavailable fractions of dissolved organic N and P. The second component (molecular-scale) of this research was to assess the molecular composition of dissolved organic P (DOP) and compare its potential variability with environmental conditions. In this work, I will present an updated estimate on the molecular compound classes of DOP using a technique that coupled electrodialysis-reverse-osmosis with solution ^{31}P-NMR analysis, specifically developed for this work. Our results reveal a more holistic, complex, and variable view of marine DOP composition across and within P-bond classes.