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Phosphorus cycling in the Sargasso Sea: Investigation using the oxygen isotopic composition of phosphate, enzyme-labeled fluorescence, and turnover times

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ABSTRACT

Dissolved inorganic phosphorus (DIP) concentrations in surface water of vast areas of the ocean are extremely low (<10 nM) and phosphorus (P) availability could limit primary productivity in these regions. We explore the use of oxygen isotopic signature of dissolved phosphate (d18OPO4) to investigate biogeochemical cycling of P in the Sargasso Sea, Atlantic Ocean. Additional techniques for studying P dynamics including 33P-based DIP turnover time estimates and percent of cells expressing alkaline phosphatase (AP) activity as measured by enzyme-labeling fluorescence are also used. In surface waters, d18OPO4 values were lower than equilibrium by 3–6%, indicative of dissolved organic phosphorous (DOP) remineralization by extracellular enzymes. An isotope mass balance model using a variety of possible combinations of enzymatic pathways and substrates indicates that DOP remineralization in the euphotic zone can account for a large proportion on P utilized by phytoplankton (as much as 82%). Relatively short DIP turnover times (4–8 h) and high expression of AP (38–77% of the cells labeled) are consistent with extensive DOP utilization and low DIP availability in the euphotoc zone. In deep water where DOP utilization rates are lower, d18OPO4 values approach isotopic equilibrium and DIP turnover times are longer. Our data suggests that in the euphotic zone of the Sargasso Sea, DOP may be appreciably remineralized and utilized by phytoplankton and bacteria to supplement cellular requirements. A substantial fraction of photosynthesis in this region is supported by DOP uptake.