Iron-sulfur-phosphorus cycling in the sediments of a shallow coastal bay: Implications for sediment nutrient release and benthic macroalgal blooms

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ABSTRACT: We conducted a study to determine the seasonal relationship between iron, sulfur, and phosphorus in the upper sediments and pore waters of a shallow intercoastal bay. From April 1999 to September 2000, sediment cores were collected from Rehoboth Bay, Delaware. Analyses of the sediments in the upper 4 cm revealed that redox conditions controlled Fe-S-P concentrations in the sediments, pore waters, and overlying water. Monthly sampling showed a marked decrease in the reactive solid phase P pool (ascorbate leachable fraction, ASC-P) and sharp increases in soluble P (measured as PO_4^{3-}) in pore waters and overlying waters, as the conditions became more reducing throughout the summer months. These changes were paralleled by decreases in the amorphous Fe(III) (ascorbate leachable fraction, ASC-Fe) and total Fe(III) oxyhydroxide pools [dithionite extracted fraction, $Fe(III)_2$] and increases in solid FeS/FeS_2. The release of soluble P from sulfidic sediments to oxygenated overlying waters only occurred during periods of solid FeS/FeS_2 production, which indicates that Fe(III) oxides act as a barrier to diffusive P flux. During these anoxic conditions, the regenerative P appears to induce secondary benthic algal blooms and promotes eutrophication in these inland bays through late summer. By the late fall and into early spring, sulfide production diminished and oxic conditions were reestablished as indicated by increases in solid amorphous and crystalline Fe(III) oxides and decreases in FeS/FeS_2 concentrations. During this period, increasing ASC-Fe concentrations correlated with increases in ASC-P concentrations and decreases in pore-water PO_4^{3-}. The seasonal correlations between Fe-S-P indicate that Fe redox chemistry controls sediment P flux to the overlying water column.

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