Effect of bottom water oxygen on phosphorus composition and diagenesis in marine sediments

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Sedimentary organic phosphorus (P) composition was investigated in Effingham Inlet, a fjord located on the west coast of Vancouver Island in Barkley Sound. Solid state ^{31}P nuclear magnetic resonance (NMR) spectroscopy was applied to demineralized sediment samples from sites overlain by oxic and anoxic bottom waters. The two sites were similar in terms of key diagenetic parameters including mass accumulation rate, integrated sulfate reduction rate and bulk sediment organic carbon content. In contrast, P benthic fluxes calculated from sediment pore water profiles were markedly different at the two sites with fluxes of 0.034 and 0.16 mol/m^2/y at the oxic and anoxic sites respectively. ^{31}P NMR results show that P-esters and phosphonates are the major organic P species present at the surface and at depth in sediments at both sites. Polyphosphates were only found in the surface sediment of the site overlain by oxic waters.

Varying stability of polyphosphates in microorganisms under different redox conditions may in part explain their distribution as well as differences in P flux between the two sites. The redox sensitive stability of polyphosphates is related to the ability of some microorganisms to store and accumulate P as intracellular polyphosphate granules under aerobic conditions when excess dissolved P is available. If these microorganisms are then exposed to anaerobic conditions, the stored P is utilized and released in dissolved form to the surrounding waters. The presence of abundant phosphate coupled with the availability of oxygen in the water column oxic/anoxic transition zone in Effingham Inlet, provides an ideal environment for polyphosphate accumulation by microorganisms. Presence of polyphosphates in the oxic site sediments suggests that polyphosphate containing microorganisms are transported and sedimented from the redox transition zone. Complete utilization of sedimented polyphosphates and the ensuing release of dissolved P at the anoxic site may both explain their absence in the sediments and partially account for the enhanced benthic P flux at this site.

Elemental cycling in coastal tropical sediments, Saint Lucia, Lesser Antilles: Results from multiple pore water sampling techniques (dialysis, centrifugation, DET, and DGT)

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The rate and vertical distribution of early diagenetic reactions in tropical nearshore sediments often differ from those in temperate or polar climates due to higher sedimentation rates, more constant seasonal temperatures, higher concentrations of secondary weathering products, and higher phytoplankton production rates. These redox reactions involving Fe, Mn, S, and C are important to understand because these reactions largely control the precipitation and dissolution of many mineral phases, including $CaCO_3$, FeS_2, and possibly some clay phases, as well as influence the mobility of micronutrients or trace metals such as Pb, Zn, Cu, Mo, Ag, Ni, Cr, and As. In this study, we examine the distribution and fluxes of major, minor, and trace elements in modern coastal sediments off the Carribbean island of Saint Lucia using four different pore water solute sampling techniques: dialysis equilibrium (peepers), centrifugation, DET (diffusive equilibrium in thin films), and DGT (diffusive gradients in thin films).

Solutes were determined by ICP, IC, and ICP-MS analyses and DGT concentrations were calculated for trace metals and H_2S from chelex and AgI gels, respectively.

The results show that DET and DGT probes are capable of providing high spatial resolution pore water solute profiles, which can be used to quantify early diagenetic reactions such as iron and manganese reduction, sulfide production, carbonate dissolution, and trace element cycling. Due to the modern areal extent and volume of tropical coastal sediments in the geologic record, these results will help us quantify modern and ancient oceanic elemental budgets.