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TRACE METALS AND INTERSTITIAL WATER CHEMISTRY
OF BACK RIVER, MARYLAND

Owen P. Bricker, John F. Ferguson, Robert J. Huggett

The objective of understanding the effects of a waste discharge on a receiving water requires knowledge of, among many things, the mass emission rate for components of the waste, concentrations in the water column, and for many components knowledge of concentrations in the sediments, the reactions that take place there, and the mechanism of transport to and from the sediment and the water column. It is believed that for many trace metals, which are greatly concentrated in the sediments compared to the water column, chronic effects on biota may be caused through toxicity to or accumulation by benthic organisms and to other organisms through the food chain. Consequently, a study of the areal and vertical concentrations of trace metals and other substances in the sediments and their contained pore waters was carried out in the summer of 1973 in Back River, which is a sub estuary of the Chesapeake Bay. Back River receives about 45 mgd of the chlorinated trickling filter effluent from Baltimore's Back River Sewage Treatment Plant and has an average freshwater inflow of the same magnitude.

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A survey of the trace metal (Zn, Cu, Pb, and Cd) concentrations in the upper 1 cm. layer of the sediments found high concentrations throughout the estuary with maximum concentrations located either at or just downstream from the outfall (Figure 1). In the absence of other significant sources, the wastewater discharge appears to be the source for the metals, whose concentrations are about a factor of five greater than in other sub estuaries of the Chesapeake not receiving significant waste discharges.

More detailed analyses of eight cores taken along the axis of the estuary show that the concentrations of trace metals (Zn, Cu, Pb, Cd, Ni, Cr, and Co in both HNO_3 and HCl extracts) and organic matter (as carbon and nitrogen)

decline markedly at depths between 40 and 60 cm. The type of sediment changes abruptly at this depth from a green, organic poor compact clay to an organic rich, black mud. This change in sedimentation may represent the beginning of operation of the sewage treatment plant about 60 years ago.

Interstitial waters were squeezed from layers of the sediment cores and analyzed for Fe, P, NH_3 , alkalinity, Cl^- , sulfide, Pt electrode potential, and pH and will be analyzed for several trace elements. The concentrations of the dissolved ions are often very high and indicate that significant transport may occur due to diffusion from the pore waters to the water column. Calculations for diffusion of phosphate and ammonia based on average gradients for the upper 10 cm of the sediments indicate that the sediments return soluble components to the water column at a reasonably high rate. This transport is an important buffer in maintaining concentrations in the water column.

Using the interstitial water concentrations, we have calculated individual ion activities and activity products for various iron solids. The calculations and x-ray diffraction analysis indicate FeCO_3 (siderite) and $\text{Fe}_3(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$ (vivianite) control the solubility of Fe and PO_4 in the sediments. The high degree of supersaturation in many cores may indicate a significant effect of organic complexing with ions in the pore water environment. Possible supersaturation of other solids including MgNH_4PO_4 and $\text{Ca}_5(\text{PO}_4)_3\text{OH}$ will be assessed. The interstitial water concentrations of the trace metals are not yet available. However, we expect that these results can be interpreted to indicate mineral phases which may control soluble metal concentrations and, hence, the potential for accumulation by benthic organisms or for transport back to the water column.

At the same time as the cores were taken, benthic organisms were sampled using a clamshell dredge with the intention of measuring trace metal accumulation. The biomass collected averaged less than 100 mg/sq. meter and was too little to analyze. The numbers of pollution tolerant organisms are exceedingly low

for such an enriched environment and indicate some form of toxicity, possibly from metals.

The study is an investigation of some aspects of the effects of a waste discharge on a small estuary. We especially wish to show that analysis of the pore waters has potential advantages in being a sensitive indicator of chemical reactions that occur in the sediments--reactions which cannot be detected by conventional analysis of the bulk material--and that these results indicate the importance of transport of soluble material from the sediments to the water column.

CONCENTRATION, mg/kg, ZN, PB, Cd($\times 10^2$)

FIGURE 1. TRACE METALS IN SURFACE SEDIMENTS IN BACK RIVER