Phosphorous regeneration and burial in coastal marine sediments (the Gulf of Trieste, N Adriatic)

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Abstract: The data from the incubation experiment indicates that the degradation of sedimentary organic matter is the principal mechanism of P regeneration in the central part of the Gulf of Trieste, N Adriatic and is much more extensive during anoxic condition. The release of phosphate adsorbed on the iron oxide surface is of minor importance. The results of the tentative mass balance show that approximately 50% of P is retained in the sediments presumably in the form of fluoroapatite.

Key words: phosphorous, pore water, incubation experiment, sediment

INTRODUCTION

The status of phosphorous (P) as an essential nutrient for all biological organisms has attracted the focus of scientists for decades. The low concentration of biologically available P in many aquatic systems can result in P-limitation of biological productivity which seems to be also the case in the N Adriatic (POJED & KVEDER, 1977; DEGOBBIS, 1990). The links between biological uptake of P during photosynthesis in surface water, remineralization and recycling of P both in the water column and in underlying sediments, burial of P with sediments make the integrated study of this element a truly interdisciplinary endeavour.

The objective of the present study was to learn more about the distribution of P in coastal marine sediments and how the P cycle near the sediment-water interface influences the flux of phosphate to overlying water. The study was carried out at a sampling Station F (45° 32' 43'' N, 13° 33' 13'' E) at the depth of 20 m in the central part of the Gulf of Trieste, N Adriatic using a combination of pore water and solid phase analysis, as well as incubation experiment performed during oxic and anoxic conditions.

RESULTS AND DISCUSSION

The location, coring methodology, benthic flux experiment and all analysis are presented elsewhere (OGRINC ET AL., 2003; OGRINC & FAGANELI, 2003). The benthic fluxes are estimated from the slope (determined by linear regression) of the concentration of the solutes *vs*. time and are presented in Figure 1.

Short scientific paper

Pore water data suggest that in June 1995 and January 1996 iron cycling was playing some role in the phosphate distribution in these sediments. However, the iron redox boundary is too deep that would promote the phosphate transport across the sediment-water interface. The linear observation between pore water concentrations of PO_4^{3-} and NH_4^+ indicate that PO_4^{3-} is released in relation with NH_4^+ by »fresh« organic matter degradation close to Redfield ratio except in January 1996. The NH_4^+/PO_4^{3-} ratio was high suggesting a sedimentary sink of phosphate in this period.

Our data from incubated flux chamber experiments indicate that benthic regeneration of phosphate is about six times more extensive in anoxic conditions. The parallel formation of dissolved inorganic carbon, ammonium, dissolved Fe and phosphate indicate that phosphate regeneration is mostly the consequence of degradation of sedimentary organic matter. The simultaneous release of phosphate and dissolved iron and manganese in anoxic phase of benthic flux experiments further suggests the important association of phosphate to iron oxides in sediments of the Gulf of Trieste. It should be note however, that the role of Fe may simply be transient since it was estimated that only < 1 % of the yearly total benthic P flux is associated with the reduction of Fe. The predominant end product is more likely to be authigenic apatite or some other phases that will ultimately remain within the sediment.

Measurements of sediment-water exchange and sediment burial have been combined to construct the benthic mass balance of P at station F. It was found that the mean recycling efficiency of P was 50 %, similar to those reported by HAMMOND ET AL. (1999) in the northern Adriatic off Emilia Romagna (Italy). The significant retention of P in sediments is the cause of P deficiency of benthic microalgae in the Gulf of Trieste while phytoplankton P-limitation mostly originates from seawater column N/P imbalances caused by fresh-water inputs.

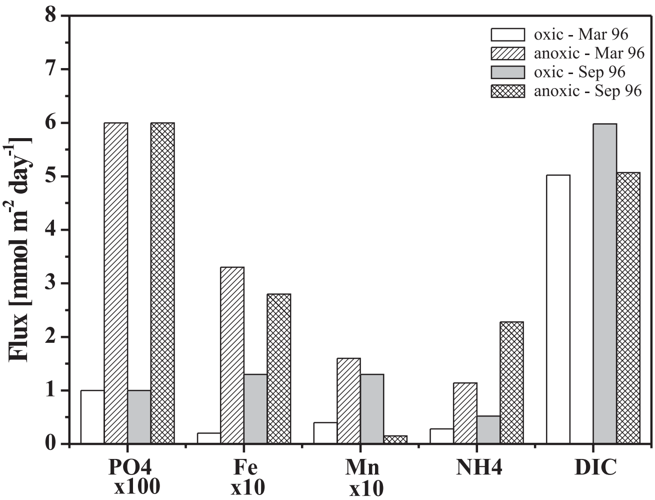

Figure 1. Average fluxes in the incubation experiment performed in March and September, 1996. Note that Fe and Mn fluxes have been multiplied by 10, and phosphorous fluxes have been multiplied by 100.

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