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PHOSPHORUS RECYCLING IN BRACKISH AND MARINE ENVIRONMENTS
– SEDIMENT INVESTIGATIONS IN SITU IN THE BALTIC SEA AND THE BY FJORD

Lena Viktorsson
Institutionen för geovetenskaper
Naturvetenskapliga fakulteten

Akademisk avhandling för filosofie doktorsexamen i Oceanografi, som med tillstånd från Naturvetenskapliga fakulteten kommer att offentligt försvaras torsdag den 20de, december, 2012 kl. 10.00 i Stora Hörsalen, Institutionen för geovetenskaper, Guldhedsgatan 5C, Göteborg.

ISBN: 978-91-628-8604-2

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Abstract

The phosphorus load to the oceans from land started to increase since around 1950 when man started to mine phosphorus-mineral from phosphorus-rich soils and bedrock. The increased use of phosphorus fertilizers in agriculture together with the growth of coastal cities increased the load of phosphorus to the coastal ocean where plankton production flourished. In the Baltic Sea the increase in plankton production resulted in an increased frequency of harmful cyanobacterial blooms and in expanding areas of anoxic bottoms due to the restricted water exchange with the North Sea. Introduction of sewage treatment plants in major cities in the 1960's and further improvements of these in the 70's and 80's decreased the phosphorus and later nitrogen loads to the waters. Despite the decreased loads to the Baltic Sea the water quality did not improve. Recently, this led researchers to focus more on internal feedback mechanisms instead of external sources to understand the eutrophication of the Baltic Sea.

From a combination of in situ measurements of the phosphorus flux from sediment to water and a budget model for the Baltic Sea, the importance of the sediments as a source of phosphorus have been investigated. In situ measurements were performed in two basins of the Baltic Sea (the Eastern Gotland Basin and the Gulf of Finland) and in a small fjord on the Swedish west coast (the By Fjord). These measurements showed that the flux of dissolved inorganic phosphorus (DIP) was higher at anoxic bottoms than at oxic in all three areas. Furthermore the flux at anoxic bottoms was enriched in phosphorus compared to carbon (and nitrogen). At oxic bottoms, on the other hand, the flux was lower and at times also showed an uptake of DIP from the water to the sediment. The fluxes at oxic bottoms in the Baltic Sea did not show any correlation with the degradation rate of organic carbon while the fluxes from anoxic bottoms in the Baltic Sea and at all bottoms in the By Fjord showed a positive correlation with the degradation rate of organic carbon. This indicated that at the oxic bottoms in By Fjord the DIP flux was primarily controlled by the degradation rate. On the contrary, the fluxes at oxic bottoms in the Baltic Sea were controlled by secondary mechanisms like adsorption to iron-oxides or storage of poly-phosphates in bacteria.

The flux measurements indicate that phosphorus is preferentially remineralised under anoxic conditions and the budget model shows that anoxic sediment act as a source of phosphorus in the Baltic Sea. This calls for further investigations of phosphorus remineralisation under anoxic conditions and highlights the importance of the anoxic bottoms for the on-going eutrophication of the Baltic Sea.

Keywords: phosphorus, sediment, anoxia, benthic flux, Baltic Sea, By Fjord