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Influence of resuspension on sediment-water solute exchange and particle transport in marine environments

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AKADEMISK AVHANDLING

för avläggande av filosofie doktorsexamen i marin kemi, som med tillstånd från Naturvetenskapliga fakulteten kommer att offentligt försvaras fredagen den 16:e december 2011, klockan 10.15 i sal KA, Institutionen för kemi, Kemigården 4, Göteborg. Avhandlingen kommer att försvaras på engelska.

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Abstract

Marine sediments contain a large pool of nutrients, which if released would contribute to increased eutrophication, in spite of decreased nutrient loads from land and atmosphere. Resuspension is a process, which might influence the release of nutrients from the sediment to the overlying water. The influence of resuspension on benthic fluxes of oxygen, dissolved inorganic carbon (DIC), nutrients, dissolved iron (dFe) and dissolved manganese (dMn) was therefore investigated in three different marine environments. The measurements were performed using a benthic lander with the advantage of operating *in situ*.

The method of measuring the effects of resuspension was developed in the archipelago of Gothenburg (Paper I). This method was then further improved and used during field studies in the Gulf of Finland (GoF; Paper II) and in a Scottish sea loch (Paper III). During the latter study also the effects of massive (simulating dredging or trawling) and repeated resuspension events on the benthic fluxes were studied. Natural resuspension significantly increased the oxygen consumption in the GoF and at a station with organic rich sediment in Scotland. There were no significant effects of natural resuspension on nutrient, DIC and dMn fluxes, but the fluxes and concentrations of dFe increased at stations with low bottom water oxygen concentrations (GoF). Massive resuspension increased the oxygen consumption enormously and instantly changed the bottom water concentrations of phosphate (which decreased), DIC, silicate and ammonium (which increased).

Results confirmed that the general magnitude of phosphate fluxes was dependent on the oxygen regime (GoF; Paper IV). However, results also showed a strong correlation between phosphate and DIC fluxes during anoxic conditions implying that phosphate fluxes are controlled by input and degradation of organic matter under anoxia. The internal load was calculated to be about 66 000 ton P yr^{-1} in the GoF. If all oxic bottoms below 40 m would turn anoxic the internal load was computed to increase with about 35 000 ton P yr^{-1}.

Results from a fully coupled high-resolution biogeochemical-physical ocean model, including an empirical wave model, showed that a large fraction of the sedimentary organic carbon has at least once been resuspended, and the largest contribution of resuspended organic matter to the total transport of particulate organic matter occurred at shallow transport and erosion bottoms (long-term average, 1979-2007) in the Baltic Sea (Paper V). The fraction of resuspended organic matter in the deepest areas of the Baltic Sea was low (< 10%) even though there was a large horizontal transport of suspended organic matter and a high sedimentary content of it. A map of different bottom types, accumulation, transport and erosion bottoms, was also created.

Keywords: Resuspension, benthic fluxes, oxygen, dissolved inorganic carbon, nutrients, dissolved iron and manganese, in situ chambers, benthic lander, organic matter transport, ecological modeling, Gothenburg Archipelago, Gulf of Finland, Baltic Sea, Loch Creran, Scotland.

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