Mercury fluxes on the sediment water interface and bioavailability of mercury in Southern Baltic Sea sediments

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Abstract: Fluxes of mercury on the boundary between sediments and water, and mercury bioavailability in surface sediments are an important elements of mercury cycle. Mercury speciation, sediment properties and hydrodynamic calculations were used to estimate magnitude of this processes in the study area.

Key words: mercury, speciation, return flux, bioavaliability

Introduction

Mercury, emitted on land, through atmospheric outfall and river outflow reaches the sea, which has led to accumulation of this metal in marine bottom sediments (Boening, 2000).

As discovered in 90's, mercury contained in bottom sediments could be re-emitted to water column (Gobeil & Cossa, 1993; Covelli et al., 1999).

Main mechanisms of remobilization are diffusion from porewaters and sediment resuspension. (Jackson,1998; Covelli et al., 1999).

Another mechanism of mercury remobilization is it's uptake by living organisms. Inorganic forms of mercury (II) may be accumulated by organisms. According to Jackson (1998), dissolved and fulvic acid-bound mercury are assimilated very good. Mercury bound to humic acids is assimilated harder. However, bioavaliability of mercury is mainly associated with its methylated form (Boening, 2000).

Behavior of mercury in sediments, its ability to remobilization and bioavailability depend on mercury physico-chemical form – speciation (Jackson et al., 1998; Wallschlager et al., 1998).

Speciation and concentration of mercury in sediments, suspended matter and water were used in assessing bioavailability and potential remobilization of mercury from sediments to water. Results of such assessment were then used for estimating the effects of increased input of mercury to ecosystem.

Short scientific paper

RESULTS AND DISCUSSION

Samples collected for this work have been collected in several areas of southern Baltic. Surface sediments, fluffy layer of suspended matter and water samples were collected from an area of a Puck Bay, Gdańsk Basin, Bornholm Basin and Arkona Basin (Fig. 1). Apart from total mercury concentration, dissolved mercury and mercury bound to fulvic and humic acids were separated, according to Wallschlager et al. (1998).

Calculated diffusion fluxs are significantly smaller than those from highly polluted areas (Gulf of Trieste, Gulf of Bellingham) (COVELLI ET AL., 1999; BOTHNER ET AL., 1980), but are higher then those found at Laurentian through (GOBEIL and COSSA, 1993), despite the region being highly polluted by mercurials. It might be the effect of different sediment composition, and therefore different mercury speciation. High values of fluxes calculated for Arkona Deep and western slope of Gdańsk Deep (3 and 4.8 ng/year/cm^2 respectively) are caused in the first case by high mercury concentration, in second one by high mobility. High diffusion flux calculated for sediments close to Vistula mouth (5.1 ng/year/cm^2) seem to be caused by fact, that those sediments are not the final destination of mercury, but rather a transport area.

In Gdańsk Basin area, higher return fluxes due to resuspension were recorded for autumn and winter, which is caused by higher currents speeds in this time period.

Sediments collected from the western slope of Gdańsk Deep are characterized with highest sum of resuspension fluxes (3.33 ng Hg/cm^2/year), which can be associated to high frequency of resuspension in this area. Central part of Gdańsk Deep has similar resuspension fluxes to Bornholm Deep.

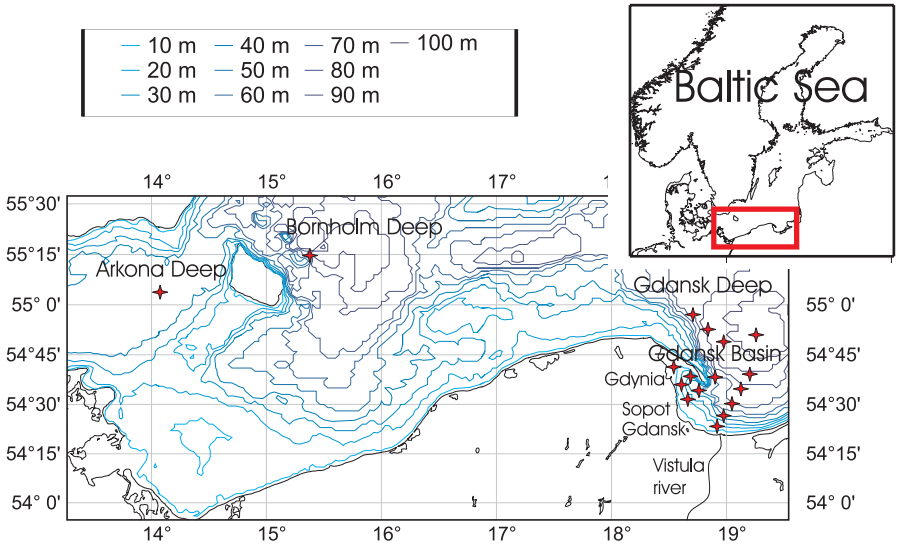

Figure 1. Location of sampling stations

Fluxes due to uptake of mercury by living organisms were not quantified, but qualitative approach have been used to assess mercury bioavailability of mercury in study area. Highest concentration of well assimilated mercury forms was recorded nearby Mechelinki sewage treatment plant and close to shipyard-harbor complex in Gdynia, and sediments of western slope of Gdańsk Deep. Except the latter, mercury in offshore areas is characterized by lower bioavailability then in nearshore areas.

Basing on reactive mercury species concentration and organic matter content in the sediments, methylation potential index (Pm) has been developed. Calculated values of Pm are highest in sediments from western slope of Gdańsk Deep.

Calculated sediment properties were used to assess changes in mercury return flux and bioavailability in case of increased input (110 % and 150 %).

Both bioavailability and return fluxes increase due to increased input. For some sediments changes are proportional to input changes, but for some sediments (from the area of Gdańsk Deep) increase is up to 17 % higher then corresponding increase of input.

Conclusions

Mercury speciation proved to be a useful tool in assessing its return flux from sediments and bioavailability. Remobilization of labile fractions form uppermost layers of sediment occurs with different intensity in all researched sediments. Return flux of mercury from sediments of study area, was significant, and reached in certain sediments even 50 % of input. It also appears, that both remobilization of mercury and it's return flux will increase in case of increased input.

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