Equilibrium sampling of PCBs and DDT metabolites in sediments from the River Elbe

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Introduction: Since the early 1990s, sediments from the German part of the River Elbe have regularly been monitored for total concentrations of contaminants by the German Federal Institute of Hydrology. In contrast, freely dissolved concentrations (C_{free}) of hydrophobic contaminants in these sediments are largely unknown though they are considered the effective concentrations. They are more indicative of potential exposure of aquatic organisms than total concentrations. Recently, the applicability of equilibrium sampling using polydimethylsiloxane (PDMS) coated glass jars has been shown in marine sediments with background contamination of polychlorinated biphenyls (PCBs) [1].
The aims of the present study were to 1.) test the applicability of equilibrium sampling using coated glass jars to sediments from the River Elbe, 2.) assess freely dissolved sediment porewater concentrations of PCBs (PCB 28, 52, 101, 118, 138, 153, 180) as well as Dichlordiphenyltrichlorethane (DDT) and its metabolites and 3.) determine site-specific sediment/water distribution ratios (K_D).

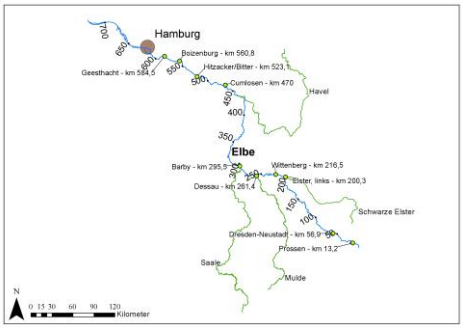

Fig. 1: Sampling sites for sediments along the River Elbe. Tributaries are depicted in green.

Methods: Sediments were sampled at ten different locations within the German part of the River Elbe from the Czech border to Geesthacht (Fig. 1). In the laboratory, sediments were incubated in PDMS-coated glass jars for two weeks. For validation of equilibrium sampling, sediment sub-samples were incubated in coated glass jars with differing PDMS thicknesses of 2, 4 and 8 µm. After incubation, glass jars were cleaned, extracted with heptane and extracts were analysed by gaschromatography with MS/MS detection. Freely dissolved porewater concentrations were calculated by dividing analyte concentrations in PDMS with analyte-specific polymer to water partition coefficients.

Results: Analyte amounts in PDMS were proportional to the amount of PDMS for all investigated contaminants and sampling sites. Freely dissolved concentrations were in the pg / L range for PCBs and up to the lower ng / L range for DDT metabolites. Patterns of PCB accumulation in passive samplers reflect total sediment contamination quantified by conventional sediment extraction and analysis. In contrast, freely dissolved concentrations of p,p'-DDD and o,p'-DDD were highest in comparison with other DDT metabolites while p,p'-DDT could only by detected in single passive sampling extracts.

Discussion: The present study demonstrates the applicability of PDMS coated glass jars for the measurement of freely dissolved concentrations of hydrophobic contaminants in sediments. Equilibrium passive sampling with PDMS coated glass jars could easily be integrated in routine sediment monitoring. Freely dissolved concentrations of PCBs and DDT metabolite clearly reflect the contamination of the river Elbe. PCB contamination is comparable to conventional chemical sediment analysis while accumulation of DDT metabolites in equilibrium passive samplers reflects accumulation in biota.

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References: [1] Jahnke et al. (2012) ES&T 46 18 : 10114–10122