PCB fluxes from the sediment to the water column following resuspension – A column experiment

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Introduction: Since the French implementation of the EC regulation n 1881/2006 setting maximum contaminants values in food, ban of fresh water and sea water fish consumption has significantly increased (Meunier, 2008). This ban was systematically due to significant levels of PCB-DL and PCDD/F in fish tissue. New campaigns of characterization confirmed that many French rivers and lakes sediments are contaminated by PCBi at levels ranging from 50 to 150 µg/kg. Currently, French regulators are asking for adequate solutions to manage the billions of cubic meters of contaminated sediments and to improve the understanding of the behavior of PCB in the aquatic ecosystem. Many works have been performed on PCBs since the first detection of these molecules in the environment in the sixties. However, as stated Lohmann et al. in a review carried out in 2007 « it is not clear to what degree the storage of PCBs in coastal sediments is a permanent sink ». Research work is still needed to describe and predict sediment behavior accurately. For the Rhône river, the lack of data regarding sediment and contaminant exchanges is an evidence particularly when sediment is mobilized due to dredging or flooding.

Material and Methods: Stainless steel columns of 2 m high and of a section of 0.2 m, have been specially designed to study PCB behavior during sediment resuspension, settling and compression (Figure 1). They enable the monitoring of the water column, of the interstitial water of the sediment and of gas produced in the course of the experiment. Dissolved PCB concentration is determined using the SBSE technique (Stirring Bar Sorptive Extraction). S and Fe speciation are also characterized among various parameters including pH, TOC and ion concentrations. The sediment used for this experiment is a silty material containing about 1 mg/kg of PCBi.

Results and discussion: First results (after 2 weeks of settling) show that interstitial water of the settled sediment has a lower pH than the water column. Gaz analysis shows that CO_2 is also produced. These changes can be explained by the oxidation process of particles while they remain in suspension (mineralization of organic matter, O_2 reduction, sulfide oxidation…).

Fig. 1: stainless steel columns use to simulate and monitor sediment/water exchanges during resuspension and settling.

The sediment should then get more reduced due to the progressive bacterial consumption of electron acceptors.
Finally, laboratory data will be modeled to estimate the fluxes of PCB from the sediment to the water column associated with flooding and/or dredging operations.

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References:

Lohmann R. et al., Env. Pollut. (2007), 150-165.
Meunier P., Rapport d'information n°998 de l'Assemblée Nationale (2008), 135 p.