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Recent spatial and seasonal variations of mercury in suspended particulate matter of the legacy contaminated river Elbe (Germany)

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The Elbe is historically one of the most contaminated rivers in central Europe [1]. Together with its tributaries, it drains a heavily industrialized and densely populated area including e.g., Praha, Dresden, Berlin, and Hamburg. For many decades, the river Elbe has been strongly affected by contaminants from diverse sources (e.g., industry, mining). Mercury (Hg) is one of the priority pollutants and, despite decreasing inputs and Hg contents in river water and suspended particulate matter (SPM) over the last decades, Hg concentrations remain elevated and the environmental quality standard of the EU Water Framework Directive for Hg in biota is still clearly exceeded in all parts of the river. Riverine Hg transport is dominated by strong binding to SPM. However, the biogeochemical controls and seasonal variations of Hg binding to riverine SPM and its speciation are still poorly understood.

Here, we present recent investigations on Hg concentrations and binding forms in SPM collected at multiple sites along the river Elbe throughout different seasons. SPM was collected monthly from sedimentation boxes and different preservation methods were tested (e.g., on-site freezing with liquid N₂ in the framework of sampling for the German environmental specimen bank [2]). Total Hg contents were measured by a direct Hg analyzer. Pyrolytic thermodesorption (PTD) was used to determine Hg binding forms in SPM by continuous heating up to 650°C in a N₂ gas flow and comparison to Hg release curves of reference compounds [3]. Moreover, public data from federal monitoring programs [4] was used to evaluate long term trends in comparison to our new results.

Total Hg concentrations in SPM generally ranged from about 300 to 1700 µg kg⁻¹. While these concentrations are much lower than historical values >50 mg kg⁻¹ [1, 4], they are still elevated compared with estimated natural background values <200 µg kg⁻¹. Higher concentrations were generally observed after the confluence of the tributaries Mulde and Saale, but also further downstream in the Hamburg region. Seasonal variations were apparent at most sampling sites with fluctuations up to a factor of 2-3. Several sites exhibited higher Hg concentrations in winter, which could be potentially explained by dilution with more organic matter in SPM during summer, but an additional control by hydrological fluctuations is likely. The PTD results revealed a dominance of “matrix-bound” Hg(II), likely associated with organic matter and/or oxide minerals,

while elemental Hg(0) and sulfidic Hg were not detected in riverine SPM. Future work will include methyl-Hg analysis as well as the characterization of microbial communities in SPM and sediments to further elucidate the complex biogeochemical Hg cycling in such dynamic riverine environments.

[1] Wilken R.D., Wallschläger, D. (1996) The Elbe river: a special example for a European river contaminated heavily with mercury. In *Global and Regional Mercury Cycles: Sources, Fluxes and Mass Balances* (pp. 317-328). Springer, Dordrecht.

[2] German Environmental Specimen Bank (<https://www.umweltprobenbank.de/en>)

[3] Biester H., Scholz C. (1996) Determination of mercury binding forms in contaminated soils: Mercury pyrolysis versus sequential extractions. *Environ. Sci. Technol.* 31, 233-239.

[4] <https://www.elbe-datenportal.de>; <https://www.ikse-mkol.org>; <https://undine.bafg.de>