

# In-situ Trace Metals Distribution in Lake Sediment Pore Waters: High Spatial Resolution Depth Profiling and 2D-Mapping

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The chemistry of important species with regards to water quality like redox-sensitive metals in lake pore water sediments is dependent on physical, chemical and biological processes that control their distribution and fate. In particular, the sediment-water interface is chemically and microbially the most active site in natural waters. Settling particles accumulate to relatively high concentrations at the sediment surface and, compared to their time in the water column, have a long residence time in which to react. The microbially mediated oxidation of natural organic carbon and the subsequent reduction of electron acceptors such as O<sub>2</sub>, NO<sub>3</sub><sup>-</sup>, Mn(IV), Fe(III) and SO<sub>4</sub><sup>2-</sup> results in sharp gradients of pH, redox potential and ionic composition across the interface and as a result, trace metals may be liberated. Understanding geochemical processes occurring in the sediments such as trace metal remobilization requires a better knowledge of their spatial distribution at the sub-mm scale. For instance precise and simultaneous measurements of concentration profiles at high spatial resolution are needed for calculation of metal fluxes to and from sediments, as these fluxes could have been underestimated due to sharp concentration gradients and poor spatial resolution. Moreover the distribution of trace metals in pore waters could appear more heterogeneous than previously thought, when investigated at the micro-scale. Diffusive gradients in thin-films (DGT) have proved to determine concentration-depth profiles of metals in surface sediment with fine scale features (Zhang et al., 1995 a). When a DGT probe is inserted in the sediment, metal ions bind to a chelating resin after diffusion through a layer of polyacrylamide hydrogel

(Zhang et al., 1995 b). This device allows minimum disturbance of the sampled medium and induces a flux from the pore water that can be related to the elemental concentration in the sampled medium. *In-situ* techniques for trace metals analysis like Laser ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) can then be used for the direct micro and spatial analysis of the DGT devices, providing multi-elementary depth-integrated or 2D- pictures. The aim of this study was to exploit the DGT methodology to determine in-situ vertical profiles and horizontal maps of trace metals at ultra-high resolution (100 µm) together with Fe and Mn in pristine lake sediments pore waters. First the performances of the method was evaluated together with analytical artifacts in homogeneous medium like synthetic media and recreated natural systems (mesocosms) at different spatial resolutions. DGT devices were then deployed in sediments cores taken from a seasonal anoxic lake. Multi-elementary profiles for trace metals, Fe and Mn were then established together with 2D-mapping. These were then used to investigate the distribution and inter-correlation of trace metals at different space scales and their association to the major geochemical phases. Mechanistic information about the distribution remobilization processes of metals at the water-sediment interface could be also provided.

Zhang H, Davison W, Miller S & Tych W, *Geochim. Cosmochim. Acta.*, **59**, 4181-4192, (1995a).

Zhang H & Davison W, *Anal. Chem.*, **67**, 3391-3400, (1995b).