Mobility and sulfidization of heavy metals in sediments of a shallow eutrophic lake, Lake Taihu, China

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ABSTRACT

The technique of DGT (diffusive gradients in thin films) using three diffusive gel thicknesses was applied to estimate the mobility and bioavailability of heavy metals in sediments and porewater of Lake Taihu, China. The DGT results showed significantly positive correlations between Co, Pb, Cd and Mn, and Ni and Fe concentrations in porewater. Cu and Zn showed a significantly negative correlation with Mn, due to Cu combination with carbonates and Zn derived from agricultural pollution, respectively. The rank order of average concentrations of Co, Ni and Cd at each station was DGT1.92 > DGT0.78 > DGT0.39, suggesting stronger resupply from sediments to porewater when using thicker diffusive gels. Comparing centrifugation and DGT measurements, Co, Ni and Cd are highly labile; Mn and Fe are moderately labile; and Cu, Zn and Pb are slightly labile. The variations of AVS concentrations in sediment cores indicate that metal sulfides in deeper layers are easily diffused into surface sediments. © 2015 The Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences. Published by Elsevier B.V.

Introduction

Heavy metals accumulate in sediments mainly from natural diagenesis, and as a function of anthropogenic activities, including mineral resource extraction, industrial manufacturing, and other non-point sources (Kishe and Machiwa, 2003; Torres et al., 2013; Zan et al., 2011). Metals from different sources often accumulate with fine-grained sediments, and can then diffuse into porewater, mostly as free ions, and can form metal complexes, and metal precipitates (e.g., metal sulfides) (Lehto et al., 2006; Prica et al., 2008). The distributions of these species, as well as the processes controlling them are critical to understanding the impacts and fates of heavy metals in the environment. Generally, in net depositional areas, heavy metal concentrations in surface sediments reflect contemporary sediment quality. Free metals (e.g., Cu, Zn, Cd, Hg, Pb) in sediments may harm aquatic ecosystems, because of their toxicity, environmental persistence, mobility and availability (Sakan et al., 2009). Depending on the reduction conditions in deeper sediment layers, metal sulfides can be common, are relatively stable and insoluble, and are not toxic (until/unless the sulfide is depleted). Additionally, metals co-precipitated with clay minerals and Fe/Mn-oxides are also stable under anaerobic conditions (Yu et al., 2001). When oxygen concentrations and redox potential (Eh) values increase in surface sediments, metal sulfides and metals co-precipitated with Fe/Mn-oxides may be released into porewater and overlying water (Gao et al., 2009), increasing metal bioavailability for benthos in sediments and aquatic life in overlying waters. Thus, it is important to