Chemical bioavailability of metals in tropical estuarine sediments

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Introduction.

The present study covers the distribution and bioavailability patterns of major and trace elements (Al, Fe, Ti, Mg, Ca, P, S, Na, K, Mn, Cr, Ni, Cd, V, Zn, Cu, Pb, Sb, Bi, Sn, Ag, Li, Co, As, Zr and Mo) in the surface sediments of the Cai River estuary and the Nha Trang Bay of the South China Sea, under multiple stresses. The specific goal of the study is a comparative analysis of ecologically significant chemical forms of metals.

Materials and Methods.

The surface sediment samples were collected in summer periods 2010-2013. The bulk metal concentrations were determined on the X-7 ICP-MS (Thermo Scientific, USA). In order to assess chemical form of metals in sediments, the samples were objected to single chemical reagent (single step) extraction procedures. The strong acid-soluble metals were extracted by 2M nitric acid, the weak acid-soluble (labile) metals were extracted by 25% acetic acid, non-silicate metals were extracted by sodium dithionite at pH 6.5-7 (Mehra-Jackson extraction), metals bound to amorphous Fe/Mn oxides were extracted by ammonium oxalate–oxalic acid buffered solution at pH 3.2 (Tamm extraction) and organically-bound metals were extracted by 0,1 sodium pyrophosphate.

Results and Conclusions.

Mineralogy, grain-size and depositional conditions generally determine the abundance and distribution of elements in the sediments that were studied. However, the natural (such as turbidities) and human-generated (such as harbor activities) pressures are shown to influence the fractionation and speciation of potential contaminants and therefore change its bioavailability.

The combined method of single chemical reagent extractions revealed labile to relatively stable associations of metals in surface sediments along the salinity gradient. The sediments are primarily enriched with bioavailable metal forms in the riverine part of the estuary. The most bioavailable parts of trace metals that were studied are associated with easily soluble amorphous Fe and Mn oxyhydroxides.

The threshold bulk level of trace elements in sediments is shown to be not bioavailable if derived from resistant mineral phases (Ag); the natural level of contaminants in sediments may be harmful if the element occurs in potentially bioavailable forms (Pb).