Global impact of solute-particle interaction on the estuarine production of heavy metals

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Current understanding of removal and production of reactive metals in estuaries remain poorly constrained due to their complex cycling processes. We carried out comprehensive investigation of the water and suspended particulate matter (SPM) of the Ganga (Hooghly) River estuary. Our collective data on the dissolved, suspended particulate and exchangeable phases establish that the solute-particle interactions (coupled adsorption and desorption) contribute to large-scale production of dissolved Co, Ni and Cu in the estuary. The estuarine production of these metals results in significant enhancement of their dissolved fluxes from the Hooghly River by ~250% to ~1800%.

An important observation of our study is that the dissolved fluxes of heavy metals from the Hooghly River, normalized to its water flux, are the highest among the major river estuaries of the world. Furthermore, ($Flux_{Metal}/Flux_{water}$) are tightly correlated with ($Flux_{SPM}/Flux_{water}$) for a number of major river estuaries of the world where production of these metals have been reported. Comparison of Al-normalized metal concentrations in the SPM of these major rivers suggests that large metal fluxes from the Ganga and the Hooghly Rivers are unlikely to be a result of the SPM composition. The tight coupling between the metal and SPM fluxes rather point to the dominant control of the degree of solute-particle interaction on the production of metals in estuaries around the world.

We use the global correlation of the metal and the SPM fluxes to estimate the metal contributions from the South Asia Rivers that have the highest SPM load among the World Rivers. Such estimates show that the South Asian Rivers that supply only ~9% of the global river waters discharge, contribute a far more significant proportion to the global supply of the dissolved metals from the rivers (40±2% Ni and 15±1% Cu).