Investigating copper and zinc adsorption to natural sediment using experimental and modelling methods

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As a by-product of industrial processes, such as mining, heavy metals are generated in toxic concentrations, and can be environmentally hazardous if not cared for properly. A potential inexpensive and abundant remediation option is the adsorption of aqueous heavy metals by natural sediments, which reduces the bioavailability and transport of heavy metals. The purpose of this study was to (i) investigate the ability of natural sediment to adsorb aqueous copper and zinc; (ii) elucidate the influence of various soil components on adsorption; and (iii) determine the effects of cations and organic matter that leached from the sediment on adsorption. Batch adsorption experiments in the pH range of 3 to 8 were conducted using natural sediment, and surface complexation models were used to simulate copper and zinc adsorption under the experimental conditions. Experimental results showed that substantial quantities of copper and zinc could be adsorbed by the sediment and high concentrations of multivalent cations and organic matter could be leached from the sediment to water. Surface complexation models sufficiently simulated the experimentally observed copper and zinc adsorption and indicated that at pH <6.5, soil organic matter was the dominant adsorbing phase for both copper and zinc, whereas metal oxides were the major adsorbent at pH >6.5. It was also found via surface complexation model calculations that clays were insignificant in adsorbing copper, but important for zinc adsorption at pH <5. Furthermore, surface complexation model results indicated that the leached cations markedly decreased Cu adsorption at pH <6 and Zn adsorption at pH 3−8. Dissolved organic matter (DOM) was found to decrease Cu adsorption at pH >6 due to formation of Cu-DOM aqueous complexes, but increase Zn adsorption at pH 4−7 due to formation of aqueous complexes between DOM and major cations, which reduced competition from these cations against Zn for binding sites on the sediment. The results of this study demonstrate the capacity of natural sediment to adsorb copper and zinc and could be useful in developing remediation strategies.

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