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Lability of trace metals in submerged soils: a column study

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The reduction of Fe (III) and Mn (IV) and the decomposition of organic matter exert a great influence on the biogeochemical cycles of many trace metals and nutrients in the environment. In the particular case of intermittently submerged soils, metals associated with Fe and Mn oxides become readily available due to the reductive dissolution of Fe and Mn oxides. The effects of oxido-reductive conditions on the release of Cu and Zn from heavy metal contaminated soils and the changes in their chemical speciation were studied. Column experiments were performed, using Rhizon soil moisture samplers inserted at different heights to monitor the mobility and transport of metals in the submerged soil samples. Cu was released in solution immediately, in the first red-ox cycle, either due to the solubilization of Fe and Mn oxides, or to the oxidation of organic matter with which Cu is commonly complexed, or both. During the following reductive half-cycles, the amount of Cu extracted from the soil solution decreased. However, the concentration of Cu in the solution leached from the column, which was percolated in aerobic conditions, increased. Since in the successive red-ox cycles the Eh decreases faster and to lower values, it is possible that Cu might have been removed from pore water by sulfide precipitation during the anaerobic half-cycle and released during the aerobic half-cycle, due to the oxidation of sulfides to sulfates. The release of Zn was similar to the dissolution of Fe and Mn oxyhydroxydes, and the amount extracted by Rhizon and by leaching increased during the four red-ox cycles. The chemical fractionation of the soils was also studied and the results showed that the alternate oxidative-reductive conditions cause, in general, an increase in the lability of trace metals. While Zn speciation suffers little change, Cu showed a much higher exchangeable fraction in the submerged soils, as compared to the initial, not submerged ones. The results of this study indicate that intermittent submergence of contaminated soils not only causes the release of trace metals previously bound to Fe and Mn oxides and to organic matter, but also leads to an increase in their lability, rending them more readily available to be released into the environment.