

Chromium transformation in the presence of both clay minerals and organic ligands under fluctuating redox conditions

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Iron-bearing clay minerals, common and widespread silicate minerals in soils and sediments, play critical roles in the migration and transformation of chromium. Reduction and immobilization of highly toxic Cr(VI) to less toxic Cr(III) by structural Fe(II) in iron-bearing clays have been reported extensively to date. However, it is still unclear about the effects of organic ligands, commonly co-existing with clays in the environment, on chromium transformation mediated by clay minerals, especially under fluctuating redox conditions. Herein, we report the synergistic effects of reduced nontronite and organic ligands on Cr(VI) reduction under anoxic condition and the transformation of resulting soluble Cr(III)-bearing products, i.e., organically complexed Cr(III), under oxic condition. The presence of organic ligands belonging to α -hydroxyl or carbonyl carboxylates, such as tartrate, malate, lactate, pyruvate and mandelate, significantly promoted the rate and extent of Cr(VI) reduction by reduced nontronite under anoxic condition, likely because of the formation of Cr(V)-ligand complexes and resulting electron transfer from ligands to Cr(V). Soluble Cr(III)-organic complexes were the dominant products of Cr(VI) reduction in the presence of tartrate and malate. The Cr(III)-organic complexes could be partially immobilized by hydroxyl radicals produced during oxygenation of structural Fe(II) in nontronite under oxic conditions. These results highlight the importance of organic ligands in chromium transformation mediated by iron-bearing clay minerals under dynamic redox conditions and has significant implications for chromium remediation in contaminated environments.