Reduction cycle of Cr(VI) by Fe(II) with humic acid and its application to environmental remediation

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Highly Cr(VI) contaminated fields are still being found around Edogawa and Koto areas in Tokyo. Slag from a chromate manufacturing plant had been disposed underground at those locations until 1972. The Cr(VI) contaminants have often been found in groundwater and soil although the government made attempts to deal with the Cr(VI) pollution by applying $FeSO_4$ treatment. We investigated Cr(VI) pollution in these areas and found that ongoing pollution are caused by elution from the slag due to both heavy rain and snowfall.

Both Fe(II) and humic acid exist naturally in soil, and strongly contribute to reduce Cr(VI) in the environment. We made a fundamental research on how Fe(II) and humic acid contribute to reduce Cr(VI) to Cr(III), and applied the results to remediation of the pollution. In this study, the quick-XAFS(QXAFS) was used for consecutive high time resolved observations of the reduction reaction. The results showed that Fe(II) directly contributes to Cr(VI) reduction, meaning that Fe(II) is simultaneously oxidized to Fe(III) by Cr(VI). It is noteworthy that the Cr(VI) reduction reaction remained even when the initial Fe(II) had run out. We consequently focused on the role of humic acid in this process. The chemical state changes of Fe during the Cr(VI) reduction were examined using ^{57}Fe Mössbauer spectroscopy. The results of Mössbauer measurements revealed that Fe(III) produced through Cr(VI) reduction was reduced back to Fe(II) by humic acid, which had the same state as the initial Fe(II). It indicated that humic acid reproduces usable Fe(II) component from the spent Fe(III) during the Cr(VI) reduction reaction. Humic acid therefore act as a promoter and continue the Cr(VI) reduction cycle. We can conclude that this reduction cycle works in the natural environment as well as the simple system at our laboratory experiment; Fe(II) significantly contributes to the remediation by reduction of a Cr(VI)-contaminated soil, that reaction becomes more efficient by adding humic acid.