

Natural attenuation of Cr(VI) contaminated groundwater at two industrial sites in the eastern U.S.A.: A Cr isotope study

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Hexavalent chromium [Cr(VI)], found in various compartments of the environment, has generated much interest due to its extreme toxicity and mobility. We studied natural attenuation of Cr(VI)-contaminated groundwater at one site in Connecticut (site A), and one site in New Jersey (site B), U.S.A. Shallow groundwater was contaminated by electroplating solutions at site A, and by water-soluble chromite ore-processing residues at site B. Site A had lower Cr(VI) concentrations of less than 1 mg L⁻¹ in comparison to site B (200 mg L⁻¹). Site A also had lower mean $\delta^{53}\text{Cr}$ values (1.4 per mil) than site B (2.9 per mil). Chromium isotope composition of the pollution sources (plating bath, ore) was known ($\delta^{53}\text{Cr}$ of 0.0 to 0.2 per mil). The positive Cr isotope shift from the pollution source Cr(VI) to groundwater Cr(VI) at both sites indicated that spontaneous Cr(VI) reduction to insoluble Cr(III) is under way. This process is removing toxicity from the groundwater. $\delta^{53}\text{Cr}$ values of groundwater were strongly positively correlated with the concentration of dissolved organic carbon (DOC), but not with divalent Fe and Mn, indicating that DOC may be the main Cr-reducing agent. A Rayleigh model indicated that 30 and 57 % of the original contaminant may have been removed from the groundwater by natural attenuation at site A and B, respectively. Interestingly, $\delta^{53}\text{Cr}$ values of the residual Cr(VI) in the groundwater at site A decreased significantly over the past 15 years, during which the water is being extracted for chemical treatment. At present, older, less fractionated Cr(VI) may be extracted at site A.