

Chromium (VI) adsorption onto quartz, selected oxides and clay minerals

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In this study, we combine quantitative thermodynamically-based mechanistic surface complexation models (SCMs) with a spectroscopic approach to distinguish the type of hexavalent chromium (Cr(VI)) surface sorption complexes onto soil components. The redox transformation of chromium during adsorption/desorption/precipitation is also studied.

First, the adsorption of Cr(VI) was measured as a function of pH (3-10), ionic strength (0.001-0.1 M KNO₃), sorbate concentration (10⁻⁴, 10⁻⁵ and 10⁻⁶ M Cr(VI)) and sorbate/sorbent ratio (50-500) on quartz, selected Fe- and Mn-oxides, kaolinite and illite. Diffuse layer surface complexation model (DLM) stability constants were derived for each important Cr-surface complex using FITEQL 4.0. Surface complexation models provided by Visual MINTEQ 3.1 were used for further modeling.

Subsequently, individual components were mixed to generate different multicomponent systems in order to simulate the behavior of Cr in natural soils. The influence of the major soil components on Cr adsorption was determined using the component additivity approach.

The potential change of the oxidation state during the Cr(VI) adsorption was monitored by the surface characterization of soil components using X-ray photoelectron spectroscopy (XPS) and X-ray absorption spectroscopy (XAS). The fractions of Cr(III)/Cr(VI) were determined using XANES by linear combination fits with the standards. Additionally, in order to confirm and support the modeling results, Fourier transform infrared spectroscopy (FTIR) was used to constrain the selection of suitable surface complexes including surface reactions.

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