

Mechanistic modeling of arsenic retention on natural red earth in simulated environmental systems

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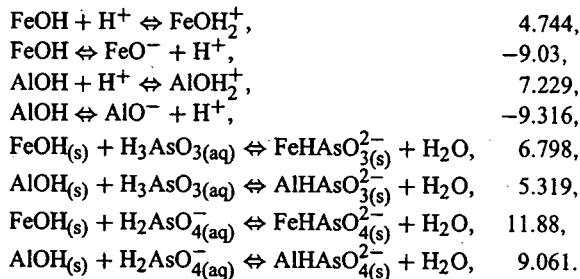
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Abstract

Arsenic retention on natural red earth (hereafter NRE) was examined as a function of pH, ionic strength, and initial arsenic loading using both macroscopic and spectroscopic methods. Proton binding sites on NRE were characterized by potentiometric titrations yielding an average pH_{zpc} around 8.5. Both As(III)- and As(V)-NRE surface configurations were postulated by vibration spectroscopy. Spectroscopically, it is shown that arsenite forms monodentate complexes whereas arsenate forms bidentate complexes with NRE. When $4 < \text{pH} < 8$ and [total arsenic as As(III) or As(V)] = 0.385 $\mu\text{mol/L}$ both arsenite and arsenate exhibit near 100% adsorption for a 10-fold variation of ionic strength that is ascribed to inner-sphere complexation of surface bonding. Arsenite exhibits an apparent bond-switching mechanism from inner-sphere to outer-sphere at excess As(III) loading (total arsenic as As(III) or As(V)] = 38.5 $\mu\text{mol/L}$. Competitive effect of arsenate for arsenite adsorption sites was observed when [initial As] = 0.385 $\mu\text{mol/L}$. In dual adsorbate systems the $\Gamma_{\text{As(III)}}$ was reduced over 20%, showing a competition of arsenite for arsenate binding sites (or vice versa). All experimental data were quantified with a 2pK generalized diffused layer model considering two site types for both protons and anions binding using reaction stoichiometries, as follows:



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Keywords: Surface complexation; Generalized diffuse layer; Arsenite; Arsenate; Competitive adsorption; Natural red earth