
Modeling of Organic and Inorganic Cation Sorption by Illite

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Abstract: Sorption of several organic and inorganic cations on illite (Clay Minerals Society Source Clay Imt-2) was determined experimentally and results compared to model calculations. The cations studied were crystal violet (CV⁺), benzyltrimethylammonium (BTMA⁺), benzyltriethylammonium (BTEA⁺), Ca²⁺, Mg²⁺, K⁺, Na⁺, Cs⁺, and Li⁺. The adsorption-model calculations involved a solution of the electrostatic Gouy-Chapman equations. The model considered specific adsorption and sorption/exclusion in the double-layer region in a closed system. Model calculations considered the simultaneous presence of four to six cations in the system. The adsorption of CV included formation of neutral and charged complexes. The adsorption attained 0.37 mol kg⁻¹ or 150% of the cation exchange capacity (CEC) of illite in aqueous suspension. The adsorption of BTMA and BTEA did not exceed the CEC and was reduced with an increase in ionic strength. The sorption of CV below the CEC was rather insensitive to the ionic strength because of the large binding coefficients and was only slightly reduced in NaCl, CsCl, or Na₂SO₄ solutions. When added in amounts exceeding the CEC in high ionic strength, 0.667 M NaNO₃, NaCl, or CsCl solutions, the adsorbed quantities of CV increased to three times the CEC. At high sulphate concentrations (0.333 M Na₂SO₄), the adsorption was below the CEC. Model calculations yielded satisfactory simulations for the adsorption, particularly for cations added in amounts approaching or exceeding the CEC. The binding coefficients for formation of neutral complexes followed the sequence: CV > Ca > BTMA > BTEA > Cs > Mg > K > Na > Li. Model calculations also suggested that sites were present which bound exchangeable cations, particularly K⁺, Na⁺, and Mg²⁺, very tightly.

Key Words: Benzylalkylammonium • Cation Adsorption Model • Crystal Violet • Illite • Ionic Strength • Source Clay Imt-2 • Montmorillonite

Clays and Clay Minerals; June 1999 v. 47; no. 3; p. 366-374; DOI: [10.1346/CCMN.1999.0470313](https://doi.org/10.1346/CCMN.1999.0470313)

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