Exchange Reactions in the Ca-Mg-Na-Montmorillonite System

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Abstract: The exchange reactions of Na, Ca and Mg on montmorillonite are revisited employing recently developed analytical and theoretical approaches. The fractional adsorption of the cations has been determined by displacing them from the adsorbed state in one step, using a low concentration of an organic cation of large binding affinity. The analysis of displaced and solution cations employed inductively coupled plasma emission spectrometry. An adsorption model was employed in the analysis of the data. The procedure consists of solving the electrostatic Gouy-Chapman equations and calculating adsorbed amounts of the cations as the sum of the cations residing in the double layer region, and the cations chemically bound to the surface, in a closed system. The model also accounts explicitly for cation complexation in solution. Thus the calculations also considered the adsorption of $CaCl^+$ and $MgCl^+$, which eliminated the apparent increase of the cation exchange capacity (CEC) with divalent cation concentration. The model could explain and yield predictions for our measured adsorbed amounts as well as previously published data, in the binary and ternary systems of Ca/Mg/Na, provided that the fraction of surface sites occupied by calcium did not exceed 0.4. For a larger coverage of surface sites by calcium, a fit of the experimental data required an order of magnitude increase in the binding coefficients of the divalent cations in the binary system Ca/Na and in the ternary system Ca/Mg/Na.