Extended Version of Gouy-Chapman Electrostatic Theory as Applied to the Exchange Behavior of Clay in Natural Waters

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Abstract: A model based on Gouy-Chapman theory, describing the ion exchange behavior of clays in mixed electrolyte solutions is presented. Computed ionic distributions, taking into account variations in relative permittivity, ion activity, and closeness of approach of ions to clay surfaces, are compared with experimental data for smectite and kaolinite in contact with river and saline waters. To obtain reasonable agreement between theoretical prediction and observation the most important extension of Gouy-Chapman theory involves the introduction of a closeness of approach term. Furthermore, the aggregated nature of smectites plays an important part in controlling its exchange properties, whereas a fixed-charge model provides a poor description for the ion exchange properties of kaolinite.

Key Words: Electrolyte • Gouy-Chapman theory • Ion exchange • Kaolinite • Smectite • Water