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Low frequency complex impedance measurements of Na-montmorillonite suspensions

Philippe Leroy¹, Guillaume Mériquet², Eggon Zimmermann³, JohanAlexander Huisman³

¹D3E division, French Geological Survey, BRGM, Orléans, France

²Phenix Laboratory, Pierre et Marie Curie University, UMR 8234, Paris, France

³Forschungszentrum, Jülich, Germany.

E-mail: p.leroy@brgm.fr

The accurate knowledge of the textural and electrochemical properties of clay suspensions is of great importance for many applications in soil and environmental chemistry involving the use of clay-rich porous media. These applications concern, for example, the understanding of the reactive transport properties of bentonites and argillites for the long-term prediction of the diffusivity of ionic species around radioactive waste repositories¹. Na-montmorillonite suspensions are characterized by an anisotropic surface charge distribution: a permanent high surface charge of their basal planes and a pH and salinity dependent surface charge of their edge planes. Current complex impedance measurements of charged suspensions are limited at low frequencies (typically <1 kHz) by the electrochemical polarization of the current and potential electrodes and by the phase accuracy of the impedancemeter. A new four electrodes sample holder (separate current injection and potential electrodes, Fig. 1a) and a very high accuracy impedancemeter² are proposed to improve the low-frequency complex impedance measurements of charged Na-montmorillonite suspensions. Low-frequency (0.1 Hz to 45 kHz) complex impedance measurements, at various clay volume fractions (0.1, 0.2, 0.4, 0.6, and 2%), pH (5, 7, 9) and salinities (NaCl, from 10^{-4} to 5×10^{-2} mol L⁻¹), were done to elucidate the textural and electrochemical properties of Na-montmorillonite suspensions. Our results show that the electrochemical polarization of the electrical double layer around the Na-montmorillonite particles can also be observed at low frequency and high salinity (Fig. 2a). Nevertheless, our measurements are also disturbed by the electromagnetic coupling due to the short triaxial cables, which connect the electrodes to the impedancemeter.

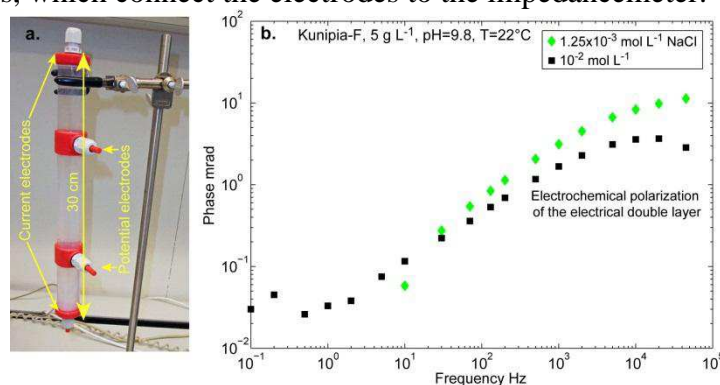


Fig. 1. a. The four electrodes sample holder for the complex impedance measurements and b. the recorded phase of Na-montmorillonite suspensions

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