Size of Mica Domains and Distribution of the Adsorbed Na-Ca Ions

I. Lebron[1], D. L. Suarez[1], C. Amrhein[2] and J. E. Strong[2]

[1] U.S. Salinity Laboratory, USDA, ARS, 4500 Glenwood Drive, Riverside, California 92501
[2] University of California-Riverside, Department of Soil and Environmental Sciences, Riverside, California 92521

Abstract: Mica domains have received less attention in the literature than smectite quasi-crystals. This study was conducted to determine whether mica crystals form domains in suspension, the conditions in which those domains exist, and the distribution of adsorbed Na and Ca ions in the domains. Particle size distributions and electrophoretic mobilities (EM) of Silver Hill illite in suspension densities of 0.5 g liter^{-1} were determined by photon correlation spectroscopy (PCS). Solutions at salt concentration from 2 to 10 mmol$_c$ liter^{-1}, sodium adsorption ratio (SAR) from 0 to ∞ (mmol liter^{-1})$^{0.5}$, and pH values 5, 7, and 9 were used to prepare the clay suspensions. The particle size of Silver Hill illite suspensions showed a bimodal distribution. Through PCS measurements at low angles, the second peak of the bimodal distribution of the illite was found to be associated with the rotational movement of the b-dimension of the particles. Illite domains broke down in the range of SAR 10 to 15 (mmol liter^{-1})$^{0.5}$ equivalent to exchangeable sodium percentages (ESP) of 13 to 18. Illite thus demonstrates a similar stability to smectites that require ESP $\approx$ 15 to disaggregate quasi-crystals. The EM of the illite particles increased drastically when the SAR increased from 2 to 10 (mmol liter^{-1})$^{0.5}$. This increase in EM could not be explained exclusively by the change in the particle size. Cation demixing is required to explain the increase of the zeta potential at the shear plane. The EM of the Silver Hill illite was doubled when the pH increased from 5 to 9 at SAR > 15, but no pH effect was found when SAR < 15. The effect of pH on the EM at SAR values > 15 can be understood if we consider that at SAR > 15 most of the particles are single platelets. The relative importance of variable charge on single platelets or crystals is apparently greater than on domains because the pH affected the mobility of the individual crystals but not the mobility of the domains. The combination of particle size distribution and EM data gives additional information about the zero point of charge of the variable charge, also called point of zero net proton charge (PZNPC) of the clay. For Silver Hill illite, we estimate a PZNPC value between 5 and 7.

Key Words: Electrophoretic mobility • Mica domains • Photon correlation spectroscopy

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