Effect of calcium on kaolinite surface properties

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Interaction of cations with clay particles governs the organisation of particles at short and long scale. During the lime stabilisation of soil for engineering applications, the combination of calcium ions and pH modify the particle interactions and finally the mechanical properties of the soil. Soil stabilisation with lime is commonly used in earthworks since it allows using most of the natural soil located within the project area. However, certain soils rich in kaolinite or mica show a delay in the development of the pozzolanic reaction and so, in the modification of the soil resistance. In this study, we focused on the short term effect of the lime addition of different kaolinites by probing the interface modification from gas adsorption and atomic force microscopy.

The study of Ar adsorption at the kaolinite surfaces showed first that both lateral and basal faces of the particles of kaolinite are concerned by the calcium uptake. The decrease of gas adsorbed and the associated decrease in basal surface area argued in favor of a aggregation of the particles and the adsorption of CaOH⁺ at high pH. So the calcium adsoprtion led to a coating of the kaolinite surface preventing the dissolution of the kaolinite and delayed the pozzolanic reaction.

Surface force measurement technique (AFM) was used to examine the surface charge properties of the two faces of kaolinite. The surface charge on both faces showed dependence on the concentration of $Ca(OH)_2$ with similar trend to that of zeta potential. However, the silica face of kaolinite was probed to be much more negative and relatively less dependent on the concentration of $Ca(OH)_2$ than alumina face of kaolinite, revealing different charging mechanism on the two faces of kaolinite. The charge on alumina face appears to be highly pH dependent than silica face.

The dependence of electrical double-layer interaction force and surface potential on the concentration of NaOH and $Ca(OH)_2$ followed the same trend as the rheological behavior [1].

[1] Chemeda et al., (2015) App Clay Sci 107, 1-13.