Monitoring the structural changes during stabilization of expansive nanoclay

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Expansive Nanoclays are nanoparticles of layered mineral silicates known as montmorillonite. Montmorillonite nanoclay consists of ~ 1 nm thick aluminosilicate staked in multilayer. It is negatively charged due to the isomorphous substitution in the octahedral layer and to a lesser extent to the tetrahedral substitution. Inorganic ions, relatively small (sodium), hold these stacks together and giving a natural hydrophilic character to the structure. It is widely distributed in western and southern US, generated from the reaction of volcanic ashes with sea water during the Cretaceous period (85 – 125 million years ago), when these areas were under the sea. The process and time of alteration of the ash to clay may vary but certainly the change began with contact with water and facilitated by the availability of marine chemistry. Probably the most important single factor in the formation of the clay was the availability of sufficient magnesium in the marine sediment environment.

One important consequence of the charged nature of montmorillonite nanoclay is that it is generally highly hydrophilic species. Water migrates to the interlayers to hydrate inorganic cations, causing expansion. Exposure to excess water may results in expansion beyond that needed to give an interlayer separation, which results from diffuse double layer forces between the hydrated montmorillonite unit layers. However, complete dispersion of lamellae is prevented by the formation of tactoids, which are stable regions where the lamellae are orientated essentially parallel to one another. Montmorillonite can expand 10 times of its original volume because of this hydrophilic behavior. This expansive nature of soils containing montmorillonite causes severe problems to the building industry.

Environmental Soil stabilization, LLC, introduced a new cation exchanger that undergo an electrochemical cationic exchange to reduce the negative charge and converts expansive montmorillonite nanoclay to none expansive/low expansive structure. The objective of this paper is to present the results of studying the structural changes in pure montmorillonite nanoclay as a result of treatment with an acidic soil stabilizer using Magic Angle NMR spectroscopy, and the effect produced on strength and pore structure. The stabilizer is designed to alter the structure of montmorillonite nanoclay in such a way to reduce the negative charge and stabilize the structure.