Effect of Heating on Swelling and Dispersion of Different Cationic Forms of a Smectite

M. Chorom[1] and P. Rengasamy[2]

[1] Department of Soil Science, Waite Agricultural Research Institute, The University of Adelaide, Glen Osmond, Australia
[2] Co-operative Research Centre for Soil and Land Management, P.M. Bag No. 1, Glen Osmond, SA 5064, Australia

Abstract: The effect of heat treatments on the swelling, dispersion, particle charge and particle aggregation of Li-, Na-, K-, Mg-, Ca- and Al-Wyoming bentonite was investigated. Before thermal treatment, unheated (25 °C) Li-, Na- and K-clays showed increased d_{001} spacing on glycerol solvation and dispersed spontaneously in water. Mg-, Ca- and Al-clays did not disperse spontaneously in water, but the d_{001} spacing increased upon glycerol solvation. After heating at 300 °C or above, none of these clays dispersed spontaneously. However, swelling varied with the type of cation and the temperature of heating.

The results generally suggested that swelling and dispersion of homoionic Wyoming bentonite after heating at various temperatures depended upon the nature of bonding between clay particles and the cations. Enhanced swelling and dispersion of clays indicated the more ionic character of the cationic bonding than cases where heating resulted only in swelling, with polar covalent bonding of cations to clay surfaces allowing limited hydration. It is also suggested that, when both swelling and dispersion as a result of thermal treatment are absent, a covalent bond is formed between cation and clay surface.

Thermal treatment apparently affects the bonding in different ways. It appears that the smaller cations (ionic radius <0.7 Å) Li, Mg and Al migrate to octahedral vacant sites and form covalent bonds after heating at 400 °C; this drastically reduces the negative charge. This process for Li-clays occurred even at 200 °C. The larger cations (ionic radius > 0.9 Å) Na, K and Ca apparently did not migrate into the lattice sites after heating to 400 °C; a high proportion of them were exchangeable. The data for exchangeable cation, particle charge and clay particle size were consistent with the postulated effect of the nature of cationic bonding upon swelling and dispersion properties.

Key Words: Cationic Clay Bonding • Dispersion • Particle Charge • Swelling • Thermal Treatment • X-ray Diffraction

Clays and Clay Minerals; December 1996 v. 44; no. 6; p. 783-790; DOI: 10.1346/CCMN.1996.0440609

Clay Minerals Society (www.clays.org)