Migration of Cations in Copper(II)-Exchanged Montmorillonite and Laponite upon Heating

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Abstract: Two clay minerals, a dioctahedral, Na-montmorillonite from Wyoming and a trioctahedral, synthetic Na-laponite, were exchanged by cupric (Cu(II)) ions and subsequently heated at 100 ° C intervals up to 500 ° C. The resulting materials were analyzed by chemical analysis, X-ray diffraction (XRD), cation exchange capacity (CEC) measurements, combined thermogravimetric and differential thermal analysis (TGA-DTA), infrared (IR) spectroscopy, electron paramagnetic resonance (EPR) and X-ray photoelectron spectroscopy (XPS). Montmorillonite exhibits a well-known Hoffmann-Klemen effect in that, when heated, cupric (Cu) ions migrate into the lacunae of the octahedral sheet, where they compensate the negative charge deficit of the clay layer. In the case of laponite, CEC measurements and spectroscopic measurements reveal that Cu ions migrate into the octahedral sheet where they replace Li and Mg ions. After heating at 200 ° C approximately half the interlayer Cu ions are exchanged. The exchange appears to be 1 Cu for 1 Li, resulting in a slight decrease of the negative charge of the layer. After heating at 300 ° C, the remaining Cu ions are exchanged by either 1 Mg or 2 Li, which does not result in any further charge reduction. At 400 ° C some of the extracted Mg remigrates into the structure and exchanges some Li (1 Mg for 2 Li). The final product at 400 or 500 ° C is then a Li-laponite with Cu(II) in the octahedral sheet.

Key Words: CEC Measurements • Cu-Laponite • Cu-Montmorillonite • EPR • Hofmann-Klemen Effect • IR • XPS

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