
Pedogenic Formation of High-Charge Beidellite in a Vertisol of Sardinia (Italy)

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Abstract: The fine clay (<0.1 μm) fraction of a clayey soil (Vertisol) from Sardinia (Italy) was studied by means of X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy, cation exchange capacity (CEC) and surface area measurements. Smectites were the dominant clay minerals both in the parent material and the soil horizons. The magnitude and location of the smectites' layer-charges were analyzed using the Hofmann & Klemen effect (suppression of the octahedral charge following lithium-saturation and heating). The amount of montmorillonite layers was evaluated by measuring the reduction of total surface area and CEC after suppression of octahedral charges and subsequent collapse of montmorillonite interlayers. Reduction of total surface area and CEC after fixation of K and irreversible collapse of interlayers were used to quantify high-charge layers before and after the suppression of octahedral charges. This allowed us to evaluate the amount of tetrahedral high-charge layers. The smectites in the parent material were montmorillonitic-beidellitic mixed layers and exhibited a small proportion of high-charge layers; in particular, layers with a high tetrahedral charge were a very minor component. In the upper soil horizons, the amount of montmorillonitic layers decreased whereas the amount of smectite layers with a high tetrahedral charge increased. FTIR spectroscopy indicated more Fe for Al substitution in the smectites of the soil horizons than in the smectites of the parent material. The results suggested that octahedral charged smectite layers (montmorillonitic) were altered, whereas high-charge beidellitic layers were formed in this soil environment characterized by rather high pH (>8.0).

Key Words: Beidellite • High-charge Smectite Layers • Illite-Smectite Mixed Layers • Italy • Smectite • Soil • Vertisol

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