Pedogenic Smectites in Podzols from Central Finland: An Analytical Electron Microscopy Study

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Abstract: Transmission electron microscopy (TEM) including high-resolution transmission electron microscopy (HRTEM) and analytical electron microscopy (AEM) were used to study the fine clay fraction (<0.1 μm) from the eluvial E horizon of podzols located in central Finland that had developed from till materials. Soils of increasing age (6500 – 9850 y BP) were selected to represent a chronosequence of soil development. Expandable phyllosilicates (vermiculite, smectites) are formed in the eluvial E horizon of podzols in a short time (6500 y). TEM observations show that dissolution and physical-breakdown processes affect the clay particles. As the age of the soils increases, fragmentation and exfoliation of large precursor minerals lead to thinner clay particles of two to three layers thick. The chemical compositions of individual particles obtained by AEM indicate that expandable phyllosilicates from the E horizon of podzols are heterogeneous, involving a mixture of vermiculite, Mg-bearing smectites, and aluminous beidellite. Results suggest that heterogeneity is related to the nature of their precursors. Vermiculite and Mg-bearing smectites are derived from biotite and chlorite weathering whereas phengitic micas alter to aluminous beidellite. Because the transformation of biotite and chlorite is more rapid than phengitic micas, biotite and chlorite contributes predominantly to smectites in the younger soils, as long as ferromagnesian phyllosilicates are present in the E horizons. If not, a larger proportion of smectites is derived from phengitic micas in the older soils. Direct measurement of *d*(001) values on lattice fringe images from alkylammonium-saturated samples shows that interlayer charge varies from high-charge expandable minerals (0.6 – 0.75 per half unit cell) in the younger soils to 0.5 – 0.6 per half unit cell in the oldest soils. Thus, the proportion of the components in the clay assemblage, as well as their chemistry and interlayer charge, change over time with soil evolution.

Key Words: Analytical Electron Microscopy • Finland • High-Resolution Transmission Electron Microscopy • Podzols • Smectites

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