

Clay minerals in Luvisols formed from acid glacial till of the Drawsko Lake District (North Poland)

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Abstract

Preliminary investigations of Luvisols formed from acid glacial till of the Drawsko Lake District and soils developed from them concentrated on the assays of composition of clay minerals of the clay fraction and fine clay fraction of glacial till. Effects of pedogenic processes on the rate and direction of their transformation was also studied. Mineralogical composition of the clay fraction was assessed by X-ray diffraction. The soils under study revealed a very diversified mineralogical composition of clay fraction of a profile and inter-profile nature. The profile distribution of swelling minerals suggested a significant influence of the fallowing process. One of the indices for inter-profile differentiation was the occurrence of vermiculite minerals in some of the profiles.

Key words

Clay minerals, glacial till, Luvisols, mixed layers minerals.

Introduction

Glacial till of the Drawsko Lake District was deposited over the youngest stage of the Vistulian (Weichselian) glaciation. It's the most characteristic feature is acidic reaction, which increased in the soil horizons. In consequence it intensified the transformation of clay minerals (Righi and Elsass 1996, Righi *et al.* 1997). That is why the objective of the investigations pursued within the framework of the project no. N 305 053134 granted by the Polish Ministry of Science and Higher Education is an assessment of the composition of clay minerals of the clay and fine clay fractions of glacial till and soils formed from it. Another aspect of the study is an evaluation of the pedogenic processes on the rate and direction of their transformations.

Methods

The Drawsko Lake District is a mesoregion of 1861 km² surface belonging to the Central European Lowland, the South Baltic Lake District sub-province, and the West Pomeranian Lake District macroregion. It is an area with a very diversified relief where the main elements are glacial and fluvioglacial forms formed during the Pomeranian stage of the Vistula (Weichselian) glaciations. The evidence of that phenomenon is the occurrence of ground moraine, outwash plain, stagnation deposits, kames, kameic terraces, and dead-ice moraines. However, the main formation covering the Lake District is glacial till. That is why the basic objective of this monograph are soils formed from glacial till of the Pomeranian stage localized on the western area of the Drawskie Lake (Klysz 2001). The objective of the research are Luvisols formed from the Pomeranian stage glacial till localized in the south part of the Drawskie Lake District between Zlocieniec and Czaplinek (Figure 2). In general you find sandy loam and loam, rather acidic (pH in 1 M KCl between 3.76–7.42). More data on the soils under study have been published in: Soils of the Drawskie Lake District formed from glacial till (Dlugosz *et al.* 2009)

The clay fraction samples (< 2 µm) for mineralogical investigations were separated by the Beckman centrifuge after dispersion with Na-ionite (Amberlite 120). Prior separation of the samples were prepared according to Jackson that was used to get rid of peptising components (CaCO₃, organic matter and free iron oxide). Mineralogical composition of the clay fraction was assessed by X-ray diffraction using the HZG – 4 instrument with a Cu K α lamp and nickel filter. As for this analysis, samples of specific fractions were saturated with Mg²⁺ ions (Mg), then solvated with ethylene glycol (Mg+EG), and K⁺ ions. Next, the samples were heated at 300°C and 550°C. These were oriented preparations obtained from a water suspension by sedimentation.

Results

Diffraction analysis of the mineralogical composition of the clay fraction of the soils under study revealed a significant differentiation in profiles and among the investigated profiles. Illite (reflexes at 1.0, 0.500, and 0.334 nm) was the only mineral identified in all the samples, however, its percentage in fraction from various horizons was different. Its clear domination was observed in the case of the clay fraction of the surface horizons, where mixed-layer minerals of the illite/smectite type and chlorites were found in high concentrations, too (reflexes at 1.4, 0.72, 0.483, 0.356 nm) (Figure 1).

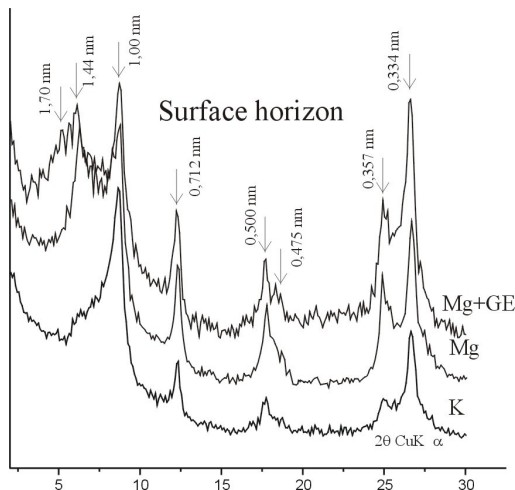


Figure 1. Diffraction of clay fraction from surface horizon

These minerals occurred also in the eluvial horizons, what probably indicated that they are present in the coarse clay fraction. Smectite minerals dominated in the illuvial horizons. It was probably caused by the illuvial process enriching them in the fine clay fraction (Figure 2). Similar results were reported by Allen and Fanning (1983) and Długosz (2002). A confirmation of such relationship between the amount of fine clay fraction and the percentage of swelling minerals could come from the transition EB horizons, where the clay fraction shows a higher content of these minerals. They are mainly mixed-layer minerals of the illite/smectite type.

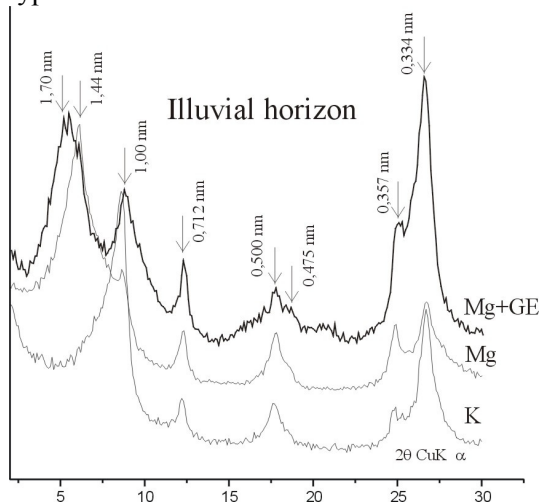


Figure 2. Diffraction of clay fraction from illuvial horizon

Clay fraction of the glacial till showed the highest diversity. The profile studies revealed both the fraction of the illite-smectite-chlorite composition and the illite-vermiculite one (Figure 3). Vermiculite in these soil profile replaced probably chlorite minerals. These results indicated a different set of minerals as compared with that described for the glacial till of that area (Długosz 2002).

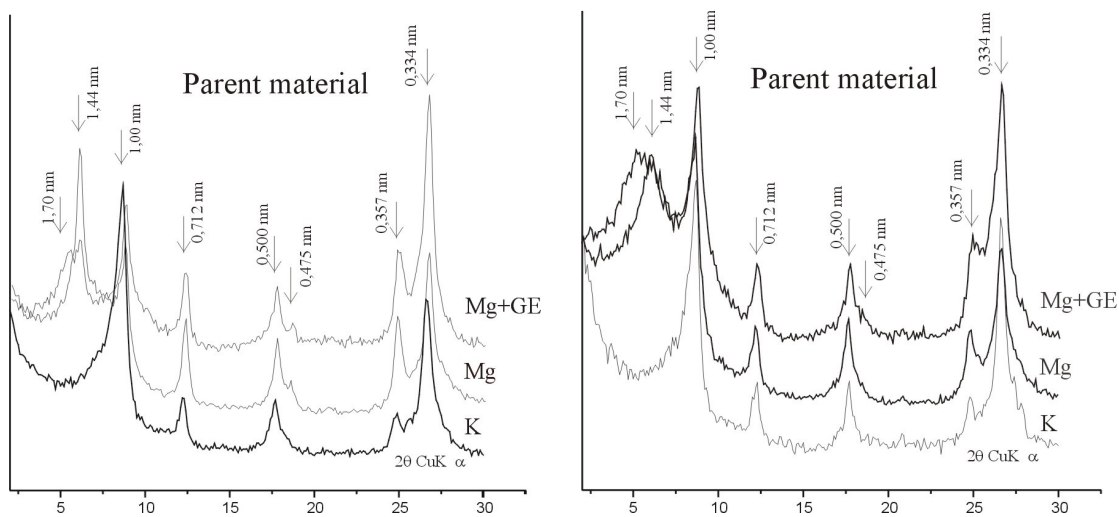


Figure 3. Diffractograms of clay fraction from parent material (glacial till)

Conclusion

The soils under study were characterized by significantly different mineralogical composition of the clay fraction. It was both of the profile and inter-profile nature. The distribution of the swelling minerals indicated a considerable effect of the fallowing process on their distribution. The occurrence of vermiculite minerals in some profiles suggested a inter-profile diversification. The investigations need further profound studies to learn more about the area and processes occurring there.

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