SOME NOTES ON CLAY MINERALS IN PODZOL PROFILES IN FENNOSCANDIA

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Abstract

Montmorillonite is found to be a predominant clay mineral in the $<2\mu$ fraction of the A_2 horizon of podzol profiles in Fennoscandia, even when these are only 300 years old. In fractions between 2μ and 20μ vermiculite and hydrobiotite predominate, but are rarely detected in the fraction coarser than 20μ. Vermiculite and hydrobiotite are also found in the finer fractions of the B horizon, but are only rarely detected in the C horizon where their presence is apparently due to contamination with inter-glacial or older products of weathering. The presence of kaolinite in some profiles is explicable in the same way.

Introduction

In the study of pedogenic processes it is of interest to investigate the secondary minerals, especially the clay minerals, formed by the weathering of primary minerals during profile development. This note is concerned with clay mineral formation associated with the development of podzol profiles in the central parts of Norway and Sweden, along the shores of the Bay of Bothnia and North Finland.

Materials and Methods

Samples from the A_2, B and C horizons of podzol profiles developed on freely drained sandy materials (<5 per cent. clay) were selected. The parent materials date from the last glacial age or are postglacial.

The samples were dispersed with Calgon (Kilmer and Alexander, 1949) or with 0·1 N EDTA at pH 4 and a mechanical analysis carried out by the hydrometer method (Gandahl, 1952). The samples were fractionated by sedimentation into $<2\mu$, 2–6μ, 6–20μ and 20–60μ fractions, care being taken to avoid admixture of finer material with the coarser fractions. The fractions were flocculated with calcium chloride, washed with water, and dried. Some of the samples, especially those from the B horizons and from young profiles, were deferrated by the sodium dithionite-hydrochloric acid method of Mitchell and Mackenzie (1954). The samples were examined by usual X-ray diffraction methods as applied to clay minerals (Brindley,

1951) using a North American Philips X-ray Spectrometer with CuKα radiation. Air dry samples, samples treated with glycerol (for identification of montmorillonite and interstratified montmorillonite), samples ignited at 600°C for ½ hour (for identification of montmorillonite, vermuculite, kaolinite and interstratified aggregates), and samples treated with 0·1 N hydrochloric acid for ½ hour at 100°C (for identification of chlorite and interstratified aggregates) were examined in oriented aggregates.

Results

Montmorillonite was found to be a predominant clay mineral in the $<2\mu$ fraction of the A_2 horizon in practically all profiles, but could not be found in similar fractions from the B and C horizons. Montmorillonite did not occur in samples from the A_2 horizons coarser than 20μ. Vermiculite and hydromica, presumably hydrobiotite, were found as predominant clay minerals in the $2–6\mu$ and $6–20\mu$ fractions of A_2 horizons, but were only rarely detected in the $20–60\mu$ fraction. This agrees with the findings of Rove (1926) who, by optical methods determined the limit of biotite weathering in clays from Eastern Norway to be 10μ. Curves *A*, *B*, *C* and *F* in Fig. 1 show X-ray diffraction patterns for a series of fractions from an A_2 sample.

Vermiculite and hydrobiotite were also found in the finer fractions of the B horizons, but these minerals were only rarely detected in the C horizons. However, profiles from Telemark (Norway) and the shore of the Bay of Bothnia contained vermiculite and hydrobiotite in the C horizons. This is apparently due to admixture of hydrobiotite and vermiculite with the parent material, since flakes of these minerals could be isolated from the 0·2–0·6 mm fraction in addition to unweathered biotite. Curves *D*, *E* and *F* in Fig. 1 show X-ray diffraction patterns for clay fractions from different horizons of a profile.

In profiles from Sørnesset, Sollia (Norway), kaolinite was found in both the A_2 horizon and the subsoil, even in the $20–60\mu$ fraction; this is interpreted as contamination of the parent material with kaolinite from the products of interglacial or older weathering.

It is concluded that montmorillonite forms in the clay fraction of the A_2 horizon during podzolization under the conditions prevailing in Fennoscandia during the postglacial period. Vermiculite and hydrobiotite are formed in the A_2 and B horizons from biotite flakes up to 20μ in size; biotite flakes larger than 20μ still give the char-

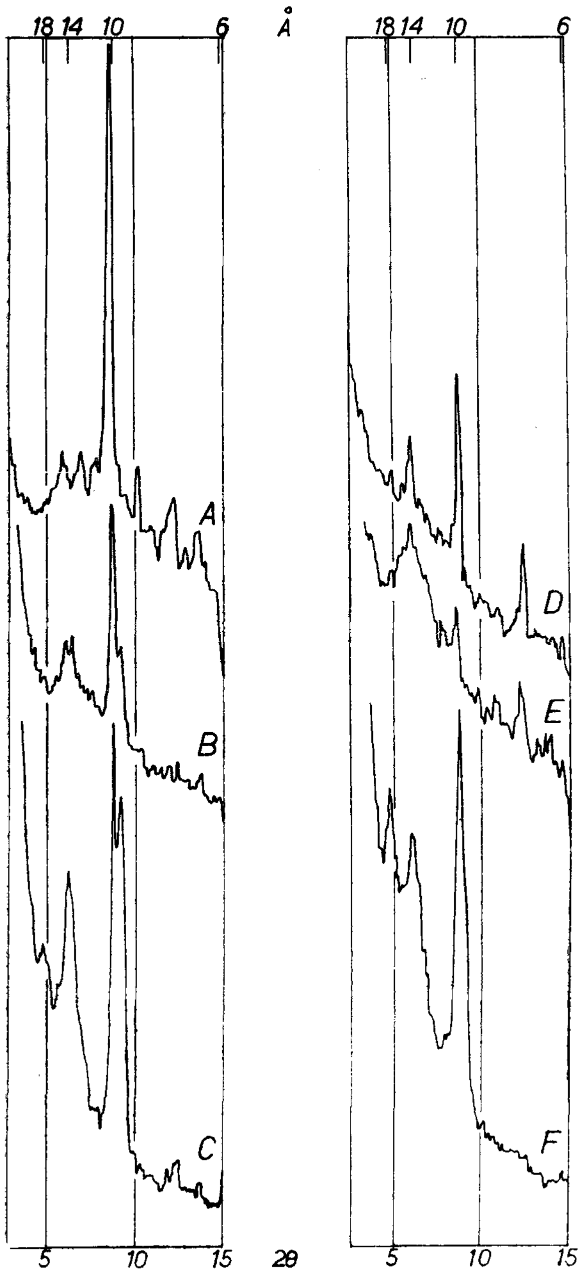

FIG. 1—X-ray diffraction patterns for glycerol-treated oriented aggregates of samples from a podzol profile from Øksna, Norway. *A*—A_2 horizon, 20-60μ; *B*—A_2 horizon, 6-20μ; *C*—A_2 horizon, 2-6μ; *D*—C horizon, $<2\mu$; *E*—B horizon, $<2\mu$; *F*—A_2 horizon, $<2\mu$.

acteristic biotite X-ray reflections. Although chlorite is often a predominant mineral in the finest fractions of C horizons, only traces are usually found in the corresponding fractions of A_2 horizons. In some A_2 horizons interstratified chlorite-vermiculite minerals have been formed as a result of the weathering of chlorite. These results are consistent with those obtained by Brown and Jackson (1958) for soils from northern Wisconsin, and Droste and Tharin (1958) for soils from Illinois.

Since it is important to assess the time required for formation of montmorillonite in the A_2 horizon, samples were collected at different levels along the shore of the Bay of Bothnia down to 3 m above sea level. The rate of uplift is known to be about 1 m/100 years, and 3 m therefore corresponds to about 300 years of leaching. Thorough descriptions of such young podzol profiles have been given by Tamm (1920). Even in the youngest of these podzol profiles the clay fraction of the A_2 horizons showed strong evidence of the presence of montmorillonite, while this mineral could not be found in the C horizons. Other clay minerals such as vermiculite and hydrobiotite were also more abundant in the A_2 than in the C horizons.

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