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Makro- and micromorphological evidence of processes taking place during Albeluvisol development in S Norway

Daniela Sauer (1), Isabelle Schülli-Maurer (2), Ragnhild Sperstad (3), and Rolf Sørensen (4)

(1) Institute of Geography, Dresden University of Technology, Helmholtzstr. 10, D-01069 Dresden, Germany, (2) Institute of Soil Science and Land Evaluation, Hohenheim University, Emil-Wolff-Str. 27, D-70599 Stuttgart, Germany, (3) The Norwegian Forest and Landscape Institute, 1431 Ås, Norway, (4) Department of Plant and Environmental Sciences, Norwegian University of Life Sciences, 1432 Ås, Norway

We studied two soil chronosequences in S Norway to identify processes involved in Albeluvisol formation. For this purpose, field observation of vertical and horizontal sections of soil profiles, soil chemical and mineralogical analyses were carried out, and in particular, micromorphological analysis was applied. The study area is located at the western and eastern side of the Oslofjord, S Norway, in the counties Vestfold and Østfold. This region is characterized by continuous glacio-isostatic uplift over the entire Holocene. Hence, the age of the land surface continuously increases from the coast towards higher elevations.

Twelve soil profiles in loamy marine sediments were studied. Based on macro- and micromorphological observations and analytical data progressive soil formation is characterized as follows:

As soon as the land surface is raised above sea level, five major processes are initiated:
1) development of deep desiccation cracks, forming a polygonal pattern;
2) compaction, taking place as soon as the coarse pores have been drained;
3) pyrite oxidation and release of sulfuric acid;
4) carbonate dissolution by acids from pyrite and iron oxidation resulting in rapid decarbonatization of the originally calcareous sediments;
5) precipitation of iron hypocoatings and coatings in the capillary fringe

Soon after these very early processes have taken place, limited water permeability of the fine-textured sediments leads to horizon differentiation into Ah, Eg and Btg horizons within less than 2.1 ka. Eg horizons become lighter in colour with time. Also illuvial clay is already observed in the 2.1 ka-old soil. Soil pH in the upper part of the E horizon of this soil is already too low for significant clay mobilization. Clay illuviation is still active in all soils studied, but the upper boundary of the zone where pH favours clay mobilization is at 20-50 cm depth. Progressive clay illuviation over time is recorded in increasing thickness of clay coatings and proportion of voids having clay coatings.
Clay mobilization and iron co-eluviation in the upper Eg horizon ceases within less than 2.1 ka, whereas weathering and formation of clay minerals and iron oxides continue, leading to formation of a BE horizon in the upper part of the Eg horizon.
Albeluvic tongues start to form after 4.6-6.2 ka, developing preferably along desiccation cracks. Albeluvic material is washed into the cracks, and also enhanced leaching of bases and clay eluviation take place in the cracks. As both processes proceed, the albeluvic tongues get longer and wider.
Clayey intercalations occur in the older soils (Stagnic Albeluvisols), and the following concept is suggested to explain their genesis: When after snow melt or a rainy period infiltrating water arrives at the lower end of an albeluvic tongue, the tongue fills up with water. Perched water accumulates also on top of the dense Btg horizon. Water, carrying suspended clay, penetrates under the pressure of the overlying water column from the tongue into the Btg horizon, where additional clay is mobilized. The clay settles when the velocity of the water decreases, forming clayey intercalations in the dense matrix of the Btg horizon.