Geophysical Research Abstracts,
Vol. 11, EGU2009-6790, 2009
EGU General Assembly 2009

Expected and unexpected features in soil chronosequences in SE-Norway: Podzolization in Albeluvisols and Lessivage in Podzols

D. Sauer (1), I. Schülli-Maurer (1), R. Sperstad (2), R. Sørensen (3), and K. Stahr (1)

(1) Hohenheim University, Institute of Soil Science, Stuttgart, Germany (d-sauer@uni-hohenheim.de), (2) Norwegian Institute of Forest and landscape, 1431 Ås, Norway, (3) Norwegian University of Life Sciences, 1432 Ås, Norway

Introduction

The Oslofjord region in SE-Norway has been subject to steady glacio-isostatic uplift during the whole Holocene. The final retreat of the ice at the termination of the last glacial took place in this area between 13,900 (retreat from Hvaler ice-marginal ridge) and 11,500 years BP (retreat from Ski ice-marginal ridge). Since then, the area has been characterized by continuous glacio-isostatic uplift. The upper limit of the former sea level varies between 155 m a.s.l. at Larvik, Vestfold, and 190 m a.s.l. at Halden, Østfold. This region provides particularly suitable conditions for studying soil development with time, because land surface age continuously increases from the coast inland. Several sea level curves, based on radiocarbon datings, enable estimation of land surface age for all locations.

Study areas

Soil chronosequences have been studied in the counties Vestfold and Østfold situated at the western and eastern side of the Oslofjord, between 59° and 59°40' North and 10° to 11°30' East. The climate in the study area is moist and comparatively mild, with mean annual temperatures ranging between 4.8 and 6.4 °C and a mean annual precipitation of 909 – 1150 mm in Vestfold and 770 – 880 mm in Østfold. The vegetation consists predominantly of mixed forest. Soil formation in loamy marine sediments leads to Albeluvisols; soil development in beach sand to Podzols.

The soil chronosequences

Twelve pedons were studied in loamy marine sediments under forest, six each in Vestfold and Østfold respectively. Land surface ages at the sites range from 1650 to 11 050 years. In addition, three samples of fresh sediments were taken from the shore line. The fresh sediments were characterized by varying amounts of carbonates in the form of shell fragments. Rapid drop in pH during drying of the samples indicated the presence of sulfides. Clay illuviation in the loamy sediments started in less than 1,650 years. E horizons became lighter with age, but their lower boundary stayed around 40 cm for more than 10,000 years. Albeluvic tongues developed between 4,600 and 6,200 years. Initially, they formed along intersections of cracks. As preferential flow and leaching along the cracks continued, the tongues increased in length and width, progressively consuming the prisms between the cracks in the upper Bt horizon. The two oldest soils of each sequence (VF7.3 and VF9 in Vestfold, and ØF8 and ØF11 in Østfold) were typical Albeluvisols with clay coatings in the Bt horizons and well expressed albeluvic tonguing. Iron-manganese nodules in the E horizons and gray ped surfaces and mottled ped interior in the Bt horizons indicated temporary water stagnation in these soils.

Six pedons in sandy beach deposits with ages ranging from 2,300 to 9,650 years were studied in Vestfold. The youngest soil showed no evidence of podzolization, while slight lightening of the A horizon of the second soil (3,800 years) indicated initial leaching of organic matter. In the 4,300 years old soil also iron and humus accumulation in the B horizon were perceptible, but only the 6,600 years and older soils exhibited spodic horizons and were thus classified as Podzols.

Expected and unexpected features

During Albeluvisol development, the upper part of the E horizon turned brown, as soon as it became too acid for further clay mobilization, while weathering and brunification continued. Further acidification led to initial

podzolization, provided enough time and presence of vegetation producing hard-to-decompose litter. The oldest soil of each Albeluvisol sequence, i. e. the 9,000 year-old soil in Vestfold and the 11,050 year-old soil in Østfold, showed initial podzolization in the A horizon and upper part of the former E horizon. However, the 6,550 year-old soil in Østfold also exhibited already initial podzolization. All three soils showing podzolization were under coniferous forest, in contrast to the other soils of the sequence that were under mixed forest. The fact that a 6,550 year-old soil under coniferous exhibited already initial podzolization, whereas in contrast, a 9,750 year-old soil under mixed forest was not yet podzolized, indicates that acidification and beginning podzolization is not primarily a result of time but of vegetation. Initial podzolization in the upper parts of Albeluvisols has been reported in various studies; more unexpected than this phenomenon was, vice versa, the occurrence of well-expressed clay coatings below the Bs horizons in several soils of the beach sand sequence. These clay coatings had not been recognized during field work, but were clearly visible under the microscope. The youngest soil, a 2,300 year-old Endostagnic Umbrisol with the horizon sequence Ah1-Ah2-Bw-BC-Cg1, exhibited well-developed clay coatings in the BC horizon (46-56 cm depth). The 7,650 year-old Endostagnic Podzol (AE-Bsh-Bs1-Bs2-BCg) had thin clay coatings in the Bs2 horizon (40-65 cm depth). Apparently, the beach sands were sufficiently buffered during the first millennia of soil formation so that acidification proceeded slowly enough to allow for clay translocation prior to podzolization.