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Micromorphological changes over time observed in the Vestfold Podzol chronosequence, SE Norway

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The Oslofjord region in SE-Norway has undergone steady glacio-isostatic uplift all over the Holocene. Hence, in the coastal areas land surface age continuously increases with elevation, providing ideal conditions for studying soil development with time. A chronosequence of soils on beach sand and sandy terraces of the Lågen River, showing progressive podzolisation with soil age, was studied in the Vestfold region, on the western side of the Oslofjord. In total, 31 pedons with soil ages ranging from 85 years (0.25 m a. s. l.) to ca. 10,150 years (62 m a. s. l.) were described and analysed. Soil ages were estimated by relating elevations of the sites to a Holocene relative sea level curve based on twelve AMS 14C-dates of gyttja from the isolation contact (marine/fresh water boundary) and six marine macrofossil 14C-dates (Sørensen et al., 2012).
The climate in the study area is comparatively mild, with mean annual temperatures ranging from 5.3 °C (Ramnes) to 6.3 °C (Sandefjord, Larvik) and mean annual precipitation of 909 mm (Sandefjord) to 1150 mm (Stokke). The predominating vegetation is mixed forest. The parent material of the soils consists of 70-95% sand in most profiles, composed mainly of quartz and feldspars.
Under these conditions, initial podzolisation becomes visible after 800-1200 years, and the development of a major Podzol requires about 6000 years. Bh and Bs horizons occur first in the 1220 year-old soil. Their combined thickness shows a logarithmic increase over time. Micromorphological changes of the Bh and Bs horizons with soil age include accumulation of increasing amounts of dark fine material in the Bh horizons and cloudy, iron-rich, reddish fine material in the Bs horizons over time. These accumulations turn the original coarse monic c/f-related distribution into chitonic and enaulic c/f-related distribution in the Bh and Bs horizons. The reddish colour of the granules of fine material in the Bs horizons becomes more intense with soil age.
In addition, micromorphological analysis shows that clay translocation took place prior to strong acidification and podzolisation in many profiles. In some rare cases, clay coatings are observed even on top of spodic material, suggesting that - at least to minor extent - translocation of coarse clay may take place even contemporarily to podzolisation. This apparent contradiction can be explained by different depths of mobilisation of metal-organic complexes and clay. Apparently, even when the upper, strongly acid part of the soils is already subject to podzolisation, acidification and Al saturation at some depth are still not as advanced as further up in the profile and still allow for clay mobilisation. In addition, cappings of coarse clay and fine silt on top of larger grains suggest that water flushing through the coarse voids of the sandy material, e.g., after snow-melt, may sweep down also clay particles in a not completely dispersed state. In this way, clay translocation might take place also outside the pH range that is usually considered suitable for clay migration.

Reference

Sørensen, R., Høeg, H.I., Henningsmoen, K.E., Skog, G., Labowsky, S.F., Stabell, B., 2012. Utviklingen av det senglasiale og tidlig preboreale landskapet og vegetasjonen omkring steinalderboplassene ved Pauler, Larvik kommune, Vestfold. In: Jaksland, L. (Ed.), E18 Brunlaneprospektet. Varia 79. Kulturhistorisk Museum, University of Oslo.