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Pedogenic Fe and Al fractions in a Norwegian Podzol chronosequence comprising 31 pedons with soil ages from 85 to 10150 years

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A soil chronosequence on beach sand and sandy river terraces on the western side of the Oslofjord enables quantitative assessment of progressive pedogenesis over time. This paper focuses in particular on the formation and translocation of pedogenic Fe and Al fractions.

In studies reported so far, soils were investigated on discrete sandy beach ridges or dunes. In this study, continuously progressing age of the land surface in the area, due to glacio-isostatic uplift, allowed us to increase profile density in age ranges of special interest. In this way, e.g. the time-spans needed for podzolization could be determined more exactly than before. 31 pedons with soil ages ranging from 85 to 10150 years were described and analysed.

Under the conditions of the study area in Vestfold (MAT: ca. 6 °C; MAP: ca. 975 mm (Sandefjord); texture: 70-95% sand in most profiles) initial podzolization becomes visible after 800-1200 years, and the development of a major Podzol requires 6000 years. Bh and Bs horizons occur first in the 1220 year-old soil. Their combined thickness is very variable but nevertheless shows a general trend of logarithmic increase over time (R^2 = 0.48). High sand contents increase the rate at which the combined horizon thickness of Bh+Bs horizons increases, low sand contents and high amounts of rock fragments tend to decrease it.
Amounts of pedogenic Fe and Al (Fed and Ald [kg m-2]) in each profile were calculated by summing up the amounts of all horizons down to the lower boundary of the B or BC horizon, or to the upper boundary of a hydromorphic horizon, whichever occurred at shallower depth. Increasing amounts of both, pedogenic Fe and Al, over time can be best described by power functions (R^2 = 0.90 for Fed and 0.93 for Ald).
Amounts of Fep and Alp in ΣBh,Bs,BCh,BCs horizons increase linearly, showing greater variability than Fed and Ald (R^2 = 0.62 for Fep and 0.51 for Alp). Amounts of Fep and Alp in the topsoils are 10-605 g m-2 and 5-608 g m-2, respectively, showing no trend over time.
Amounts of Feo and Alo in the ΣBh,Bs,BCh,BCs horizons also exhibit linear increases, with a variability similar to that of Fep and Alp (R^2 = 0.58 and 0.47). Amounts of Feo and Alo in the topsoils are 21-861 g m-2 and 3-524 g m-2, respectively, showing no trend over time.

It is concluded that the progressive formation of pedogenic Fe and Al (Fed, Ald) in a soil profile is closely related to soil age (as indicated by the high R2), whereas the rates of accumulation of organic complexes of Fe and Al (Fep, Alp) and poorly crystalline Fe and Al oxides in subsoils (Feo, Alo) in the course of proceeding podzolization processes are also influenced by other factors than soil age (as reflected in the lower R2), such as slight variations in texture and mineralogy of the parent material, somewhat variable relief position and differences in vegetation.

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