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Soil structure formation through the action of plants

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During soil formation, the interaction of different biota (plants, soil fauna, microbes) with weathered mineral material shape characteristic structures of pores and solid depending on the parental material and the site specific climatic conditions.

We here explore soil structure formation on a chronosequence of recultivation site in the Rheinisch lignite mining area, Germany. In this area loess material from a depth of 4-10 m is used for reclamation in a standardized procedure since 24 years. Thus, it is an ideal site for studying soil structure formation as a function of time.

Changes in soil pore system are characterised by parameters such as tortuosity, connectivity and pore size distribution. To derive these pore space properties, undisturbed soil columns with a diameter of 10 cm were taken from two different depths (0-20 cm and 40-60 cm) with sites ranging in age from 0 to 24 years. X-ray CT is used for scanning the original columns as well as undisturbed subsamples of 3 and 1 cm diameter. This hierarchical sampling scheme was developed to overcome the trade-off between sample size and resolution – starting with an effective resolution of 57 μm for 10 cm cores via 19 μm for 3 cm columns to 6 μm for the smallest samples size of 1 cm. Subsamples therefore reveal information on micropores and small roots. In detail, image analysis is used to derive porosity, pore size distribution, connectivity and biopore density.
The data are complemented by destructive sampling and determination of root length with WinRHIZO. Furthermore HYPROP measurements of water retention curves and unsaturated hydraulic conductivities are conducted to obtain effective properties of the pore system.

First results show an increase of macro pores and connectivity over time. Especially in 40 – 60 cm (under the ploughed layer) a marked increase of biopore density during the first 12 years could be observed while differences between 12 and 24 year old soil samples are low. However, in the topsoil (0-20 cm) the effect of soil management (ploughing) is stronger than the effect of time, leading to a decrease of connectivity over time in the first 20 cm compared to soil samples from 40 – 60 cm depth. In summary we were able to quantify for the very first time how roots alter the pore structure on a recultivation site and how fast a dynamic equilibrium of biopores can develop in soils.

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