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Roots change the pore structure only if they have to – development of biopores and compaction around roots.

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During soil formation, the interaction of different biota (plants, soil fauna, microbes) with weathered mineral material shapes unique structures depending on the parental material and the site specific climatic conditions. While many of these interactions are known, the relative importance of the different biota is difficult to quantify.
Here we explore soil structure formation within a chronosequence in the Rhenish lignite mining area in Germany. Loess material from a depth of 4-10 m has been used for reclamation in a standardized procedure for 24 years.
Soil columns with a diameter of 10 cm were taken in two different depths (0 - 20 cm and 40 - 60 cm) at different sites ranging in age from 0 to 24 years. X-ray CT was used for scanning the original columns as well as undisturbed subsamples of 3 and 0.7 cm diameter. This hierarchical sampling scheme was developed to overcome the trade-off between sample size and resolution.
For the very first time also information on the development of biopores could be measured by separating them from other structural pores based on shape. The data were complemented by destructive sampling and determination of root length with WinRHIZO.
An increase in biopore density throughout year zero to year 12, in particular in 40 - 60 cm soil depth could be observed. This increase had low effect on the overall pore size distribution despite high biopore length densities. The biopore length densities of approximately 16 cm / cm3 obtained in year 12 was similar to the one measured in year 24, suggesting that equilibrium was reached. Only about 10% of these biopores were filled with roots.
In the second part of this study, the CT derived information (visible porosity, gray value) was used to calculate the density around biopores. Whether biopores were surrounded by soil with higher or lower porosity compared to the bulk soil was dependent on plot age and depth. In plots with low macroporosity a significant compaction around biopores was observed. Thus, a greenhouse experiment with maize, growing for 20 days in three different bulk densities (1.3, 1.45 and 1.6 g cm-3), corresponding to different macroporosity, was conducted. Again, 3 cm subsamples were taken and analyzed as described above. The results show a clear interaction between macroporosity and root induced compaction.

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