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Micro- and macro-scale structures of root and earthworm induced biopore networks

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Roots and earthworms are main contributors to structure formation on various scales and are considered to play an important role for nutrient and water cycling. At the macro-scale the interaction between soil life and soil matrix controls fluxes of water, organic matter and gases between the atmosphere and pedosphere while forming characteristic pore networks within the rhizo- and drilosphere to exploit the soil volume for nutrients and water at the micro-scale. The modification of their physical environment and its control on soil functions can be considered as an example for self-organisation which recently has gained increasing recognition in soil ecology. Understanding the spatially heterogeneous nature of the physical habitat of soil life by quantifying the dynamics of micro- and macroscale structures could help to relate physical, geochemical and biological soil functions and reveal the complexity of interacting mechanisms.
This paper highlights results gathered within a research unit on nutrient acquisition from the subsoil. Here we focus on X-ray microtomography (XRCT) studies ranging from large soil columns (70 cm length and 20 cm diameter) to individual biopores and its surrounding rhizosphere. Samples were collected from sites with different crop rotations characterized by different root architectures. We present approaches for quantitative image analysis combined with micro-scale physical measurements of oxygen distribution as a step towards finding quantitative relationships between pore structure and transport functions. Implications of various biopore architectures for the accessibility of nutrient resources in soils and the potential of parameters derived from image analysis to be included in novel spatially explicit modelling approaches that could foster our understanding of the interacting physical and biological mechanisms will be discussed.