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Discovering Soil Pore Spaces by Synchrotron-Radiation-based Microtomography

S. Peth (1), F. Beckmann (2), R. Horn (1), and A. Smucker (3)

(1) Institute for Plant Nutrition and Soil Science, Soil Science, Kiel, Germany (s.peth@soils.uni-kiel.de), (2) GKSS-Research Centre Geesthacht GmbH, Germany, (3) Dept. Crop and Soil Sciences, Michigan State University, USA

Soils are complex environments governing numerous interacting processes which control ecosystem functions. For instance storage and transport of water, gas and nutrients, retardation and transformation of contaminants, and habitat functions for soil biota are strongly dependent on the internal structures and accessibility of interfaces within pore networks. The undisturbed exploration of microscale pore regions is therefore of great value for interpreting many soil environmental processes.

Non-invasive 3D imaging utilizing synchrotron-radiation offers an excellent technique to study and quantify morphological properties of pore network geometries at a spatial resolution of a few micrometers. Such non-invasive 3D microscopy will significantly enhance our understanding of microscale soil functions and processes. This paper presents examples for visualizing and measuring pore structure characteristics within small soil aggregates at a voxel resolution of < 5 micrometer. Various soil aggregates have been scanned at the SR-μCT facility operated by the GKSS Research Center at HASYLAB / DESY (Hamburger Synchrotron Strahlungslabor / Deutsches Elektronen Synchrotron) in Hamburg/Germany. Processing and analyses of image reconstructions using transformation and quantification algorithms are demonstrated. The potential application of morphological and topological properties derived from synchrotron-radiation-based microtomography in future soil research will be discussed.