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Imaging of pore networks and related interfaces in soil systems by using high resolution X-ray micro-CT

Gerhard Zacher (1), Thilo Eickhorst (2), Hannes Schmidt (3), and Matthias Halisch (4)

(1) GE Sensing & Inspection Technologies GmbH, Wunstorf, Germany (gerhard.zacher@ge.com), (2) University of Bremen, Soil Microbial Ecology, Bremen, Germany, (3) University of Vienna, Department of Microbiology and Ecosystem Science, Division of Microbial Ecology, Vienna, Austria, (4) Leibniz Institute for Applied Geophysics, Hannover, Germany

Today's high-resolution X-ray CT with its powerful tubes and great detail detectability lends itself naturally to geological and pedological applications. Those include the non-destructive interior examination and textural analysis of rock and soil samples and their permeability and porosity – to name only a few. Especially spatial distribution and geometry of pores, mineral phases and fractures are important for the evaluation of hydrologic and aeration properties in soils as well as for root development in the soil matrix. The possibility to visualize a whole soil aggregate or root tissue in a non-destructive way is undoubtedly the most valuable feature of this type of analysis and is a new area for routine application of high resolution X-ray micro-CT.

The paper outlines recent developments in hard- and software requirements for high resolution CT. It highlights several pedological applications which were performed with the phoenix nanotom m, the first 180 kV nanofocus CT system tailored specifically for extremely high-resolution scans of variable sized samples with voxel-resolutions down to < 300 nm. In addition very good contrast resolution can be obtained as well which is necessary to distinguish biogenic material in soil aggregates amongst others.

We will address visualization and quantification of porous networks in 3D in different environmental samples ranging from clastic sedimentary rock to soil cores and individual soil aggregates. As several processes and habitat functions are related to various pore sizes imaging of the intact soil matrix will be presented on different scales of interest – from the mm-scale representing the connectivity of macro-pores down to the micro-scale representing the space of microbial habitats. Therefore, soils were impregnated with resin and scanned via X-ray CT. Scans at higher resolution were obtained from sub-volumes cut from the entire resin impregnated block and from crop roots surrounded by rhizosphere soil. Within the scanned structures we will highlight interfaces i.e. pore-solid interface and soil-root interface. The latter will be linked to examples of fluorescent microscopy and scanning electron microscopy obtained from 2D sections revealing additional biological and chemical information in the respective microenvironment. Based on the combination of all 3D and 2D imaging data habitat features of soils can be characterized and combined with studies analyzing microbial rhizosphere colonization.