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3D imaging of soil pore network: two different approaches

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Pore geometry imaging and its quantitative description is a key factor for advances in the knowledge of physical, chemical and biological soil processes. For many years photos from flattened surfaces of undisturbed soil samples impregnated with fluorescent resin and from soil thin sections under microscope have been the only way available for exploring pore architecture at different scales.
Earlier 3D representations of the internal structure of the soil based on not destructive methods have been obtained using medical tomographic systems (NMR and X-ray CT). However, images provided using such equipments, show strong limitations in terms of spatial resolution. In the last decade very good results have then been obtained using imaging from very expensive systems based on synchrotron radiation.
More recently, X-ray Micro-Tomography has resulted the most widely applied being the technique showing the best compromise between costs, resolution and size of the images.
Conversely, the conceptually simpler but destructive method of "serial sectioning" has been progressively neglected for technical problems in sample preparation and time consumption needed to obtain an adequate number of serial sections for correct 3D reconstruction of soil pore geometry.
In this work a comparison between the two methods above has been carried out in order to define advantages, shortcomings and to point out their different potential.
A cylindrical undisturbed soil sample 6.5cm in diameter and 6.5cm height of an Ap horizon of an alluvial soil showing vertic characteristics, has been reconstructed using both a desktop X-ray micro-tomograph Skyscan 1172 and the new automatic serial sectioning system SSAT (Sequential Section Automatic Tomography) set up at CNR ISAFOM in Ercolano (Italy) with the aim to overcome most of the typical limitations of such a technique.
Image best resolution of 7.5 μm per voxel resulted using X-ray Micro CT while 20 μm was the best value using the serial sectioning system but on less noisy images.
SSAT system showed more flexibility in terms of sample size although both techniques allowed investigation on REVs (Representative Elementary Volumes) for most of macroscopic properties describing soil processes. Morover, undoubted advantages of not destructivity and ease sample preparation for the Skysan 1172 are balanced by lower overall costs for the SSAT and its potential of producing 3D representation of soil features different from the simple solid/porous phases.
Both approaches allow to use exactly the same image analysis procedures on the reconstructed 3D images although require some specific pre-processing treatments.