PROJECT FACTSHEET

www.list.lu/en/research/project/soil3d/?no_cache=1&cHash=c11f849912cb29456f17afeba3d078d1

Soil3D

Development of a single 3D model for the analysis of soil microstructures at high resolution

Inspiration

The 3-dimensional structure of soil microaggregates has a vast impact on macroscopic properties of soil. The association of mineral constituents, organic matter together with biota i.e. plant or microbial residues represents a unique system in nature balancing the air, water and nutrient interaction and hence influencing the shape of plants and microbial systems. Particularly microaggregates smaller than 250 µm are of research interest as it turned out that they play a significant role for soil organic matter sequestration.
While soil microaggregates are highly complex structures consisting of various particle sizes and chemical elements, nowadays they are still considered as heterogeneous associations of random 3-dimensional composition. The lack of knowledge about principles of soil structure formation is mainly due to an insufficient resolution of the analysing techniques.

Innovation

In the last years, a high resolution and sensitivity device was developed at the Luxembourg Institute of Science and Technology (LIST) to perform in-situ correlative microscopy i.e. combining the topographic information from a helium ion microscope (HIM) and chemical mapping from a secondary ion mass spectrometer (SIMS), therefore it is called HIM-SIMS. Within the SOIL3D project, the HIM-SIMS instrument will allow to reconstruct soil particles by performing photogrammetry, hence by taking high resolution electron images with HIM of different perspectives and creating a 3D model using an appropriate software. On top of the 3D model the SIMS image will be overlaid. Additionally, 3D models of soil particles will be obtained by using atomic force microscopy (AFM) such that both approaches will be compared and discussed.
Soil samples enriched with carbon (^{13}C) and nitrogen (^{15}N) isotopes will be provided by the Technical University of Munich (TUM). Typical elements constituting the mineral phase like aluminium ^{27}Al, silicon ^{28}Si and iron ^{56}Fe will be imaged with SIMS. The isotopic labelling will allow to trace fresh organic matter and therefore to see where exactly it is deposited in the 3D microstructural entities e.g. in voids, on rough surfaces or pure mineral phases.

Impact

By combining the microscopic and spectroscopic analyses, it will be possible to visualize the 3D architecture as well as the elemental distribution of soil microstructures in a single model. These models will in general help to study biogeochemical processes and their ecological functioning.

Partners

Technische Universität München (DE)

Financial Support

German Research Foundation (DFG) , Fonds National de la Recherche

Contact

5, avenue des Hauts-Fourneaux
L-4362 Esch-sur-Alzette
phone: +352 275 888 - 1 | LIST.lu

Dr Jean-Nicolas AUDINOT (jean-nicolas.audinot@list.lu)

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY | LIST