EGU2020-4126
https://doi.org/10.5194/egusphere-egu2020-4126
EGU General Assembly 2020

Interplay between water adsorption and viscosity determines the spatial configuration of EPS during soil drying

Andrea Carminati, Pascal Benard, Judith Schepers, Margherita Crosta, and Mohsen Zarebanadkouki
University of Bayreuth, Chair of Soil Physics, Bayreuth, Germany (andrea.carminati@uni-bayreuth.de)

Bacteria alter the physical properties of soil hotspots by secreting extracellular polymeric substances EPS. Despite the biogeochemical importance of these alterations is well accepted, the physical mechanisms by which EPS shapes the properties of the soil solution and its interactions with the soil matrix are not well understood.

Here we show that upon drying in porous media EPS forms one-dimensional filaments and two-dimensional interconnected structures spanning across multiple pores. Unlike water, primarily shaped by surface tension, EPS remains connected upon drying thanks to its high extensional viscosity. The integrity of one-dimensional structures is explained by the interplay of viscosity and surface tension forces (characterized by the Ohnesorge number), while the formation of two-dimensional structures requires consideration of the interaction of EPS with the solid surfaces and external drivers, such as the drying rate. During drying, the viscosity of EPS increases and, at a critical point, when the friction between polymers and solid surfaces overcomes the water adsorption of the polymers, the concentration of the polymer solution at the liquid-gas interface increases asymptotically and the polymers can no longer follow the retreating gas-water interface. At this critical point the polymers do not move any longer and are deposited as two-dimensional surfaces, such as hollow cylinders or interconnected surfaces. EPS viscosity, specific soil surface and drying rates are the key parameters determining the transition from one- to two-dimensional structures.

The high viscosity of EPS maintains the connectivity of the liquid phase during drying in soil hotspots, such as bacterial colonies, the rhizosphere and biological soil crusts.