Microfluidics study of the heterogeneity impact on microbial transport through porous media

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In the shallow subsurface soil, rocks, fluids and organisms are in close contact due to the confined nature of the host medium. The proximity of these compounds and the confined nature of the host medium control the overall reactivity of the underground that is often catalysed and triggered by microorganisms that drive a plethora of geo-chemical reactions relevant for natural (e.g. element cycles) and human (e.g. remediation) systems. Models based on rates derived from soil samples typically fail by orders of magnitude when based upon macroscopic observations: this is because such measures are averages over the volume sampled, but they do not represent the pore scale environment experienced by micro-organisms involved in such reactions. This happens because the spatial distribution and transport of microorganisms in soil is known to be heterogeneous and spatially variable. In my master's thesis I am investigating the relationship between the host medium heterogeneous structure, bacteria transport and their filtration (removal from liquid phase to deposit on the solid medium structure) using microfluidics and time-lapse video-microscopy. For the microbial system, I plan to work with non-pathogen bacteria isolated (single strain cultures) and grown following well established procedures, in liquid cultures. These cultures will be inoculated in a previously saturated microfluidics characterised by the presence of vertical pillars whose size and location represents the solid structure of a soil: different pillars organisations will be designed to investigate the impact of the medium geometry on the macroscopic microbial transport and filtration. The diagnostic quantity I will use to quantify and characterise transport will be the suspension breakthrough curves (time series of the outlet suspension concentration), while for filtration I will measure the bacteria deposition profile (the concentration of attached bacteria at different distances from the inlet).