Microbial Activity in Sediments: Effects on Soil Behavior

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Abstract:

Microorganisms have played a critical role in geological processes and in the formation of soils throughout the geological times. It is hypothesized that biological activity can also affect soil properties in short engineering time-scales. Bioactivity in sediments is determined by the classical limiting factors (i.e., thermal, nutrients, water, C for biomass) as well as by pore-size geometrical limits and mechanical interactions between bacterial cells and soil particles. These constraints restrict the range of grain size and burial depth where biomediated geochemical processes can be expected in sediments, affect the interpretation of geological processes and the development of engineering solutions such as bioremediation. When biological, geometrical and mechanical limiting factors are satisfied, bioactivity can be designed to alter the mechanical properties of a soil mass, including lowering the bulk stiffness of the pore fluid through controlled gas bio-generation, increasing the shear stiffness of the soil skeleton by bio-mediated cementation, and reducing hydraulic conduction through biofilm formation and clogging. Each of these processes can be analyzed to capture the bio-chemo-hydro-mechanical coupling effects, leading to the identification of governing equations that can be used for process design. Design must recognize the implications of spatial variability and reversibility.