The L.A. Colding Lecture Series

in Environmental Science and Technology

Dani Or, Professor, ETH Zurich, CH

Life on Partially-Hydrated Rough Surfaces

Room 011, Building 113

Thursday, October 30th 2008, 15:00

Abstract:

The high degree of microbial diversity found in soils is attributed to the complex and heterogeneous pore surfaces and spaces with dynamic aqueous and chemical microenvironments. Evidence suggests that fragmentation of aquatic habitats in partially-saturated soils limit diffusion pathways and form physically isolated niches capable of supporting diverse species within small soil volumes. The opacity of soils makes it difficult to directly observe and control microbiological activity in detail; we thus use partially-hydrated rough surfaces as simplified and experimentally observable analogs that permit quantitative description of diffusion-facilitated microbial interactions while retaining salient features of real porous media. Theoretical studies focused on the role of rough surface hydration status and simple nutrient supply at boundaries on growth and coexistence of two competing microbial species inhabiting the domain. For mathematical simplicity, surface roughness is represented as a network of v-shaped channels, or by patches with prescribed roughness and water retention properties. Simulations show that fragmentation of diffusion capacity with changes in hydration conditions impart local survival and coexistence of less competitive microbial species due to nutrient flux interception and creation of depletion zones that inhibit invasion by stronger competitors. Results also illustrate effects of pore space geometry and spatial distribution of roughness elements on aqueous phase connectivity and on effective diffusion and microbial motility, consequently, control of microbial growth under different water potentials (hydration). The effective aqueous diffusion coefficient of the surface was a key parameter controlling microbial growth rates and was estimated by mean saturation of bonds in time or space. Pioneering studies conducted at DTU provided preliminary experimental confirmation for some of the theoretical predictions, in particular, regarding the role of diffusion heterogeneity on coexistence and hydration status limitation to growth rate and expansion rates. These theoretical and experimental studies not only provide new insights regarding mechanisms that promote and sustain diversity in soils, but may also be instrumental in improved management of bioremediation and nutrient cycling in soils.

Ludvig August Colding was Copenhagen´s city engineer in the period 1857-1886 and designed the city´s water supply system. He chose to base the supply entirely on groundwater. The system´s general layout and many of its details date back to Colding´s era. From 1869-1886, Colding was a professor at the Technical University of Denmark. At the age of 26, he discovered the law of conservation of energy, simultaneously with, but independently of Joule.

DTU Environment
Department of Environmental Engineering

Technical University of Denmark
Miljoevej, Building 113
DK - 2800 Kgs. Lyngby
Phone: (+45) 45 25 16 00
www.er.dtu.dk/English/Education/Events/tlcls.aspx