Highly-resolved Imaging in aggregated soils: Which are the interfaces formed by interaction of water flow, oxygen transport and biodegradation?

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Objectives
- Dissolved oxygen primary electron acceptor and the concentration underlies consumption reactions
- Prerequisite to quantify the distribution of dissolved oxygen is to know the water content distribution
- Non-invasively map dissolved oxygen in structured porous media, with high spatial and temporal resolution
- Determine water content, again via fluorescence imaging methods
- Model the results with MIN3P to simulate and verify our results

Hypothesis
- existing 2D dissolved oxygen imaging method can be applied and modified to quantitatively observe dissolved oxygen in partly water filled pore space

Methodological Approach
- Step I: Fluorescent image F is corrected for nonuniform lightning using one image of a black flat cardboard LV on front of the flow cell (same for the reflection image R)
- Step II – Effect of spatial variability of soil surface on the fluorescence signal can be corrected using corrected images from step I and R_
- Step III – Background correction to avoid the introduction of noise

First Achievements

Oxygen mapping in saturated conditions:
- Glass beads 0.75 – 1 mm, homogeneous

Water content mapping with fluorescence imaging:

Oxygen mapping in unsaturated conditions:
- lots of problems with cross sensitivities like sorption (1), small intensity change between O₂ rich (2) and O₂ depleted (3) but...

... latest images show increasing intensities with decreasing O₂ content

Water content mapping with Neutron Radiography:
- Preliminary experiment to verify if transparent containers are applicable to neutron radiography (NR)


Conclusion
- We can visualize O₂ gradients under saturated conditions
- We can visualize water content
- We cannot visualize O₂ gradients under unsaturated conditions because we observe cross sensitivities of fluorescence due to sorption
- to reduce cross sensitivities and increase spatial resolution we incorporate an oxygen probe in a polymer matrix attached to one side of the slab

Contribution to SPP Goals
- We resolve O₂ gradients in space and time and help to clarify the architecture of BGIs
- We link our results observed at aggregate scale to a mechanistic reactive transport code

References