Contribution ID: **310** Type: **Oral Presentation**

Microfluidic and numerical investigation of anisotropic permeability alteration during biomineralization in porous media

Wednesday, 24 May 2023 10:00 (15 minutes)

Biomineralization, e.g. enzymatically (or microbially) induced calcium carbonate precipitation (EICP) is a promising geo-engineering method with the potential, for example, to seal leakage pathways in the subsurface or to stabilize soils. It is associated with an alteration of porosity and, consequently, permeability. A major source of uncertainty in modelling EICP is in the quantitative description of permeability alteration due to precipitation, based on commonly applied porosity-permeability relations [1]. To improve these relations for REV-scale models, we investigate the effect of EICP on hydraulic properties in microfluidic experiments by measuring the pressure drop to calculate the permeability and by observing the pore-space alterations with optical microscopy. The experimental setup and procedure are described in [2]. The results of the presented study show that preferential flow paths can form under continuous flow conditions and ongoing precipitation [3]. Our aim is to analyze this effect of strong local inhomogeneity for REV-scale permeability. We expect to quantify this as anisotropy also in pore-scale numerical investigations based on the images obtained from optical microscopy.

Participation

In-Person

References

[1] Hommel, J., Coltman, E., Class, H. (2018). Porosity-Permeability Relations for Evolving Pore Space: A Review with a Focus on (Bio-)geochemically Altered Porous Media. Transport in Porous Media, 124 (2), 589-629.
[2] Weinhardt, F., Class, H., Dastjerdi, S. V., Karadimitriou, N., Lee, D., & Steeb, H. (2021). Experimental Methods and Imaging for Enzymatically Induced Calcite Precipitation in a microfluidic cell. Water Resources Research, 57, e2020WR029361.
[3] Weinhardt, F., Deng, J., Hommel, J., Vahid Dastjerdi, S., Gerlach, R., Steeb, H., & Class, H. (2022). Spatiotemporal Distribution of Precipitates and Mineral Phase Transition During Biomineralization Affect Porosity–Permeability Relationships. Transport in Porous Media, 143(2), 527–549.

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Session Classification: MS05

Track Classification: (MS05) Biochemical processes and biofilms in porous media