Contribution ID: **289** Type: **Oral Presentation**

The microscale dynamics of water films during evaporative precipitation of minerals in porous media

Wednesday, 21 May 2025 14:05 (15 minutes)

Wetting and drying cycles are often found in natural and engineered porous medium exposed to water. Examples include soils, underground porous rocks or building materials. When a porous medium dries, minerals contained in the water can supersaturate and consequently precipitate. The location and mechanism of precipitation of these minerals is dependent on the drying dynamics, which are controlled by the atmospheric conditions (e.g. humidity/temperature) as well as the structure and chemistry of the porous medium (and the evolution of structure and chemistry during the process). In hydrophilic media, connected water films are often retained on the pore surfaces during evaporation. These films can contribute to the drying rate by allowing water to flow through them towards the evaporation front. This leads to supersaturation at the outer surface of the porous medium, resulting in nucleation and growth of precipitates at the outer surface, a process known as efflorescence. The precipitates that form are often porous themselves and can contain water films which supply supersaturated water that can sustain their growth [1]. Efflorescence often occurs in building materials exposed to wetting and drying cycles of rainwater, but a similar phenomenon also can occur in porous reservoirs when they are used for injection of a dry gas such as CO2 or hydrogen.

The effects of structural properties of the porous medium, such as the pore surface roughness, on how the drying process and efflorescence formation take place are still a large open question. In this study, we focus on the dynamics of the water film on the outer surface of the porous medium, by imaging the mineral nucleation and growth from water films and investigating how the surface structure plays a role in the initial phases of precipitation. We developed a technique for measuring dynamics of water films and surface structure evolution using in-situ atomic force microscopy (AFM) on the grains of a porous limestone [2], which we saturated with NaCl solution. This allows us to track the water film and precipitate formation on the surface during the entire drying period. The measurements show that the film decreases in size in a non-uniform way largely dependent on the initial surface structure. Precipitates predominantly form inside cavities in the surface topology, indicating a significant effect of surface structure. The insights from this study are valuable as input for drying models taking into account film dynamics and surface structure.

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References

[1] Sghaier, N., & Prat, M. (2009). Effect of efflorescence formation on drying kinetics of porous media. Transport in Porous Media, 80(3), 441–454. https://doi.org/10.1007/S11242-009-9373-6/METRICS [2] Wensink, G., Schröer, L., Dell, H.-P., Cnudde, V., & Rücker, M. (2023). Spontaneous Imbibition and Evaporation in Rocks at the Nanometer Scale. Energy & Fuels, 37(23), 18713–18721. https://doi.org/10.1021/ACS.ENERGYFUELS.3C02456

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Session Classification: MS06-A

Track Classification: (MS06-A) Physics of multiphase flow in diverse porous media