Contribution ID: **377**

Type: **Oral Presentation**

How the Probabilistic Nature of the Nucleation Process Affects and Controls the Distribution of Mineral Precipitates in Porous Media

Wednesday, 1 June 2022 16:30 (15 minutes)

Nucleation and growth of secondary mineral phases is of great importance in a variety of processes in different fields. Mineral precipitation alters the morphology and hydrodynamics of the porous media by blocking the pore and throats and changing the tortuosity and permeability of flow paths. Even reaction rates are affected by the reshaping of available reactive surfaces. Any mineral precipitation process begins with the nucleation, which is a probabilistic phenomenon. It is often overlooked in studying the reactive transport phenomena. Nucleation controls the location and timing of crystal formation in a porous structure. The spatial distribution of stable secondary nuclei is crucial to precisely predict the hydrodynamics of the porous medium after mineral precipitation. Thus, a deeper understanding of the mineral nucleation and growth process is essential and it is necessary to develop a new probabilistic nucleation approach that could produce more reliable results. Accordingly, we have developed a new probabilistic nucleation model and incorporated it into a pore-scale Lattice Boltzmann reactive transport model to investigate the effect of various factors such as saturation ratio, flow rate, temperature, interfacial free energy, nucleation rate, and growth rates on the distribution of precipitated secondary minerals. In our model, the probabilistic induction time statistically spreads around the measured or reported induction time, either obtained from experiments or approximated by the exponential nucleation rate equation suggested by the classical nucleation theory (CNT). We provide a detailed explanation on how to implement the developed probabilistic nucleation approach into pore-scale reactive transport models. We also gave a thorough description of each parameter of the probabilistic nucleation model and how to measure or calculate them for different fluid and rock systems. Additionally, we used a new approach to measure the disorder of the spatial mineral distributions. The developed models provide new insights into the spatiotemporal evolution of porous media during mineral precipitation. Furthermore, the outcomes provide the basis for implementing mineral nucleation and growth for reactive transport modeling across time-scales and length-scales.

Acceptance of the Terms & Conditions

Click here to agree

MDPI Energies Student Poster Award

No, do not submit my presenation for the student posters award.

Country

Norway

References

Fazeli, H. et al. (2020) 'Pore-Scale Modeling of Nucleation and Growth in Porous Media', ACS Earth and Space Chemistry. American Chemical Society, 4(2), pp. 249–260. doi: 10.1021/acsearthspacechem.9b00290.

Hellevang, H., Wolff-Boenisch, D. and Nooraiepour, M. (2019) 'Kinetic control on the distribution of secondary precipitates during CO2-basalt interactions', E3S Web Conf., 98. Available at: https://doi.org/10.1051/e3sconf/20199804006.

Masoudi, M. et al. (2021) 'Pore scale modeling and evaluation of clogging behavior of salt crystal aggregates in CO2-rich phase during carbon storage', International Journal of Greenhouse Gas Control, 111, p. 103475. doi: https://doi.org/10.1016/j.ijggc.2021.103475.

Nooraiepour, M., Masoudi, M. and Hellevang, H. (2021) 'Probabilistic nucleation governs time, amount, and location of mineral precipitation and geometry evolution in the porous medium', Scientific Reports, 11(1), p. 16397. doi: 10.1038/s41598-021-95237-7.

Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

In person

Primary authors: Dr MASOUDI, Mohammad (University of Oslo); Dr NOORAIEPOUR, Mohammad (University of Oslo); Prof. HELLEVANG, Helge (University of Oslo)

Presenter: Dr MASOUDI, Mohammad (University of Oslo)

Session Classification: MS09

Track Classification: (MS09) Pore-scale modelling