Supplement of Saf. Nucl. Waste Disposal, 1, 181–182, 2021
https://doi.org/10.5194/sand-1-181-2021-supplement

SaND
Safety of Nuclear Waste Disposal
Open Access

Supplement of

Deciphering porosity clogging at barrier interfaces in deep geological repositories for radioactive waste

Mara I. Lönartz et al.

Correspondence to: Mara I. Lönartz (m.loenartz@fz-juelich.de)

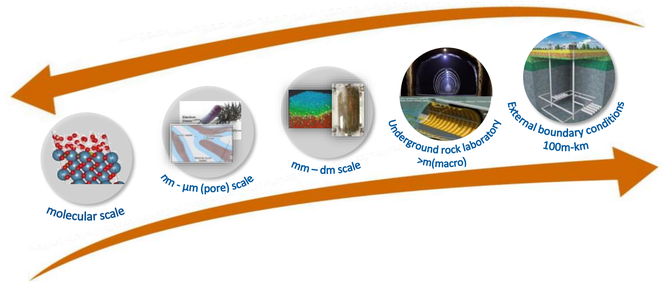
Deciphering porosity clogging at barrier interfaces in deep geological repositories for radioactive waste

Mara I. Lönartz[1], Jenna Poonoosamy[1], Naila Ait-Mouheb[1], Yuankai Yang[1], Guido Deissmann[1], Dirk Bosbach[1]

[1]*Institute of Energy and Climate Research: Nuclear Waste Management and Reactor Safety (IEK-6), Forschungszentrum Jülich GmbH, 52425 Jülich, Germany*

email: m.loenartz@fz-juelich.de

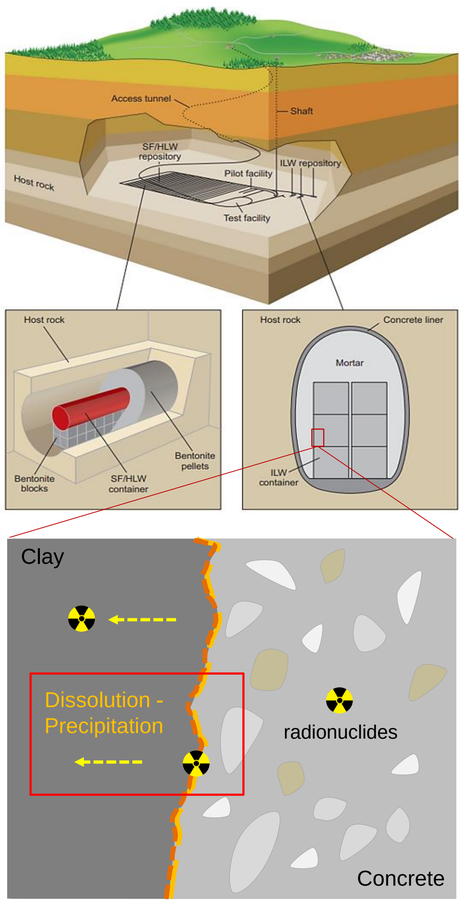
JÜLICH Forschungszentrum

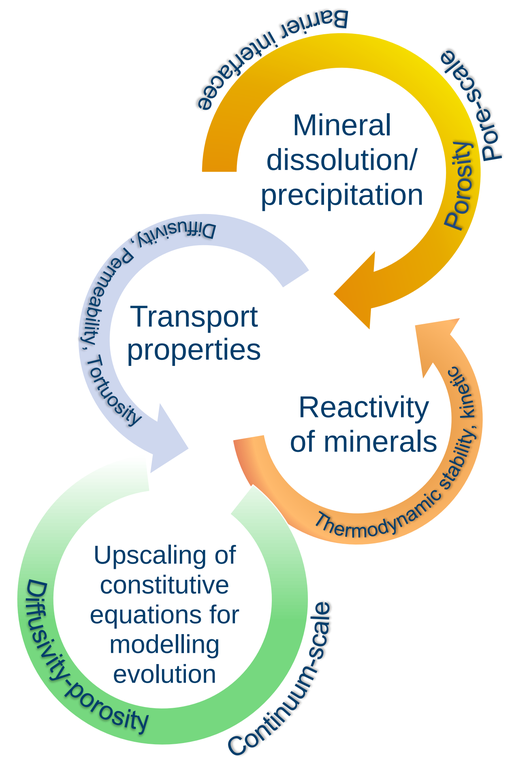


MOTIVATION

Understanding geochemical processes at the pore-scale to develop upscaling approaches for implementation in continuum-scale reactive transport models

- A reliable safety assessment of a deep geological repository over time scales of several hundred thousand years requires a profound and comprehensive understanding of the complex coupled physical (thermal, hydraulic, mechanical), chemical and biogeochemical (THM/CB) processes that govern the long-term evolution of the repository system

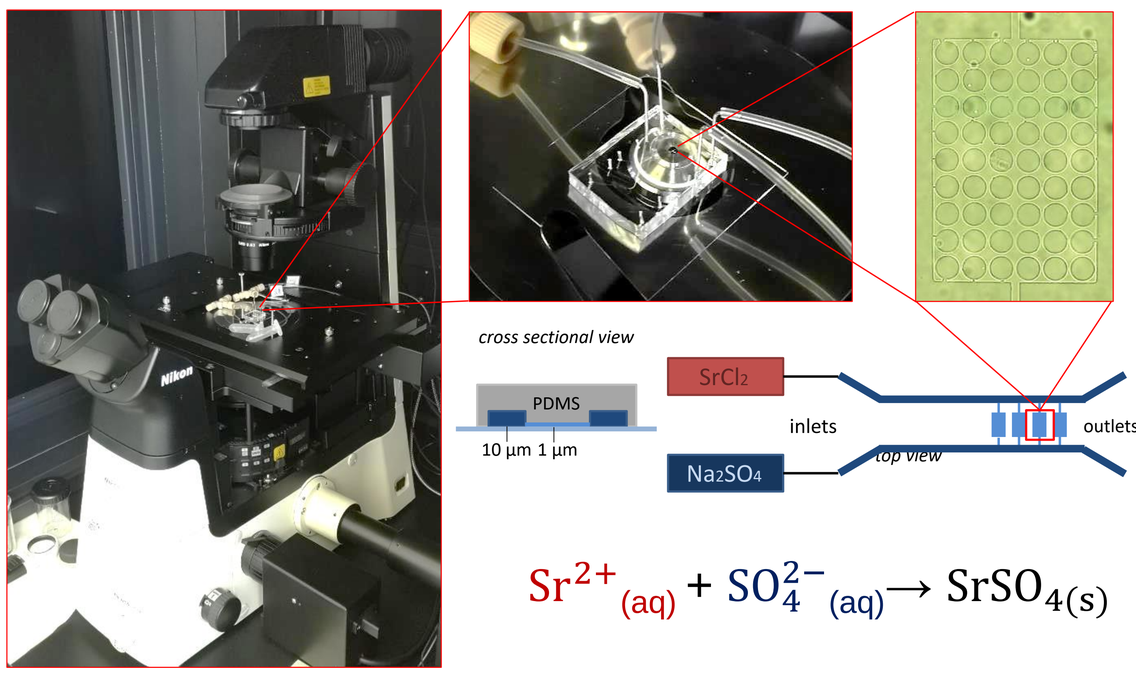




How does a significant reduction in porosity (porosity clogging) affect the diffusivity of porous media?

EXPERIMENTAL APPROACH

"Lab on a chip" approach for the *in situ* quantification of changes in pore space and diffusivity

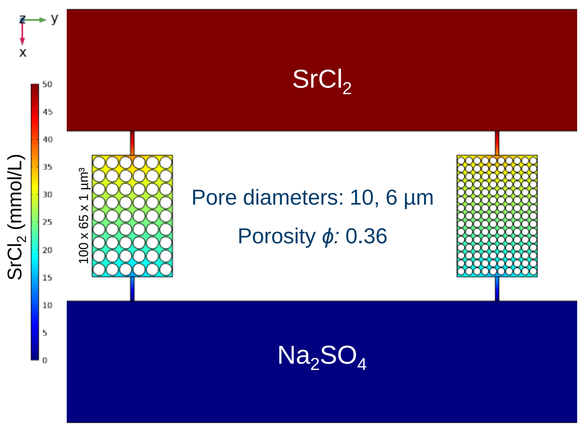


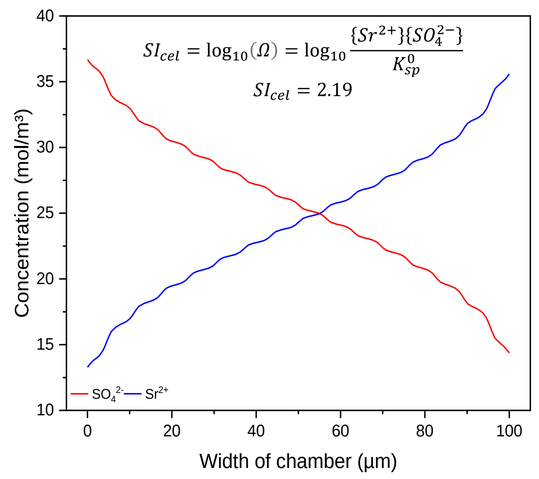
$$Sr^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow SrSO_{4(s)}$$

Microfluidic chamber to precipitate celestine ($SrSO_4$) from the mixing of $SrCl_2$ and Na_2SO_4 solutions

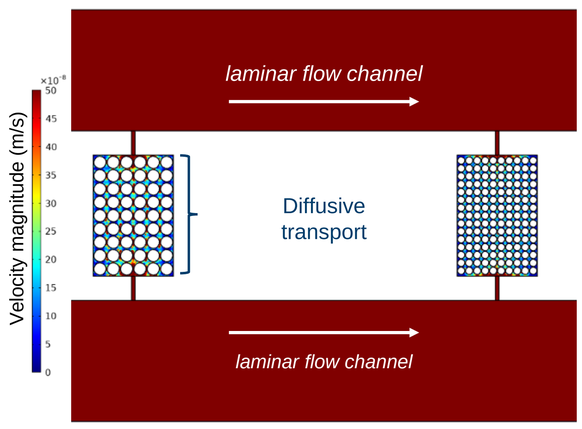
- 2D and 3D Raman imaging for the time- and space-resolved visualization of the evolving porosity
- Raman tracer studies with D_2O and ^{18}O-labelled solutions to study the change in diffusivity and re-precipitation processes

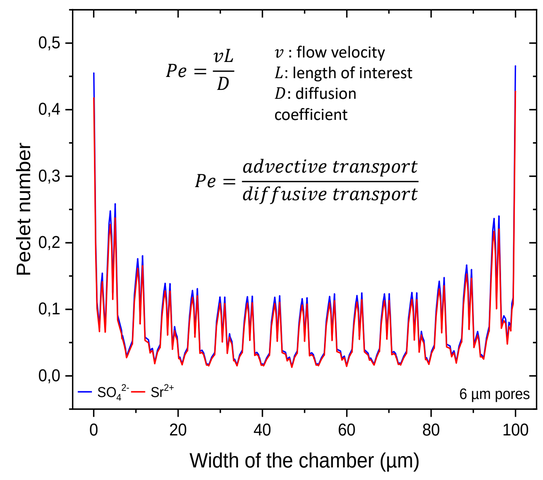
MULTIPHYSICS MODELLING APPROACH





- Maximum of theoretical saturation index (SI) of 2.19 in the centre of the microfluidic chamber

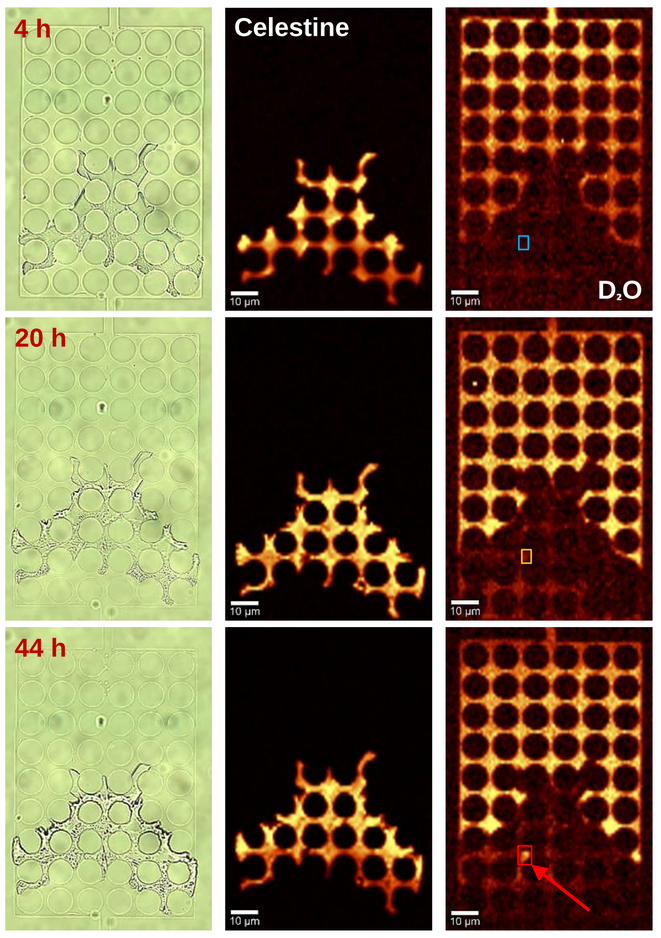




- Diffusive transport inside the microfluidic chambers

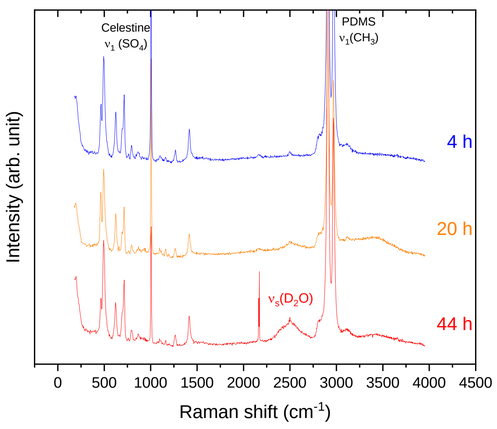
FIRST MICROFLUIDIC EXPERIMENTS

I. Start of crystal nucleation T = 0.33 h
II. Clogging & injection of D_2O T = 1.83 h



III. Decreased crystal growth rate after clogging

IV. Re-dissolution and precipitation observed



- Diffusion of D_2O through the crystals
- Is the crystal developing nano porosity?

OUTLOOK

- Complementary pore scale modelling to derive key relationships that describe changes in transport properties of porous media (e.g., clay rocks, cementitious materials, etc.) due to mineral precipitation induced porosity clogging

ACKNOWLEDGEMENTS

The research leading to these results has received funding from the German Federal Ministry of Education and Research (BMBF, grant agreement 02NUK053A) and from the Initiative and Networking Fund of the Helmholtz Association (HGF grant SO-093) within the iCross project.

Bundesministerium für Bildung und Forschung