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PORE-SCALE MODELLING IN SUPPORT OF SAFETY ASSESSMENT STUDIES FOR NUCLEAR WASTE REPOSITORIES IN FRACTURED ROCK

Wednesday, 2 June 2021 10:00 (1 hour)

Safety assessment (SA) studies for spent nuclear fuel repositories in fractured rock entail the need to account for very large spatial and temporal scales. This is typically done by using continuum-based or Discrete Fracture Network (DFN)-based numerical simulations, which in turn rely on upscaled groundwater flow and transport parameters. However, model parameterisation is sometimes based on gross simplifications and there are still open questions such as: (i) what is the role of fracture filling minerals for flow channelling? (ii) what is the influence of mineral precipitation/dissolution processes on the evolution of flow channelling and on radionuclide transport including retention? and (iii) what is the impact of the altered rim zone bordering flowing fractures on radionuclide uptake by matrix diffusion? Here, we show how pore-scale simulations are used to address such questions and thus provide the basis for a more consistent derivation of effective parameters for use in large-scale SA simulations. The pore-scale models are based on a realistic yet synthetic single fracture that was generated using fractal theory1 and later imported followed by meshing using the open software OpenFOAM (http://www.openfoam.org). Calcite filling patches, which are typically found in field observations on drill-cores2, were subsequently generated using Sequential Indicator Simulations (SIS) carried out using the geostatistical software SGeMS3. Groundwater flow through the partly-filled fracture was computed using a Darcy-Brinkman-Stokes formulation4 and the ingress through the inlet of a slightly acidic unsaturated solution was simulated. The results show that the dissolution of calcite patches leads to a gradual increase of the fracture flow wetted surface area (i.e. the area of the fracture in contact with the flowing water) as well as a gradual increase of groundwater flow rates. In terms of retention capacity, due to diffusion in the matrix, the system shows a progressive decrease of the F-factor5 (i.e. the ratio between the flow wetted surface area and the groundwater flow rate), which is consistent with an alternative interpretation based on the integration of the transport resistance6 along transport pathways traced at different simulation times. We will also show the results of an on-going project, where a limited part of the fracture has been extracted and the bordering rock matrix included explicitly. The aim of this model is to study the effect of thin alteration rims on matrix diffusion processes.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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