Saf. Nucl. Waste Disposal, 2, 163–163, 2023
https://doi.org/10.5194/sand-2-163-2023

SaND
Safety of Nuclear Waste Disposal
Open Access

Semi-analytical approach to modelling matrix diffusion in fractured media

Andreas Poller[1], **Georg Resele**[1], **Christian Missal**[2], **Nils Dahlhaus**[3], **and Marie Voss**[1]

[1]CSD Engineers AG, Schachenallee 29A, 5000 Aarau, Switzerland
[2]Dr. Spang Ingenieurgesellschaft für Bauwesen, Geologie und Umwelttechnik mbH, Rosi-Wolfstein-Strasse 6, 58453 Witten, Germany
[3]Itasca Consultants GmbH, Leithestrasse 111A, 45886 Gelsenkirchen, Germany

Correspondence: Andreas Poller (a.poller@csd.ch)

Received: 7 April 2023 – Revised: 14 June 2023 – Accepted: 14 June 2023 – Published: 6 September 2023

Abstract. The German Site Selection Act (StandAG, 2017) mentions crystalline rock as one of the candidate host rocks for the deep geological disposal of high-level radioactive waste (HAW). Crystalline rock is generally interspersed with fractures and other permeable structures, thus allowing for substantial water flow even at depths of a few hundred metres, where a deep geological repository for HAW may be situated. Radionuclides that become mobile in case of disposal canister failure could then migrate along fractures, thus potentially causing a relevant release of radionuclides from the barrier system. Diffusion of radionuclides into the rock matrix adjacent to the fractures, called matrix diffusion, has the potential to markedly attenuate such release of radionuclides. Therefore, an adequate conceptualisation and mathematical formulation of matrix diffusion is key for the assessment of radionuclide release from a deep geological repository in crystalline rock.

Analytical solutions for contaminant transport along planar features with matrix diffusion exist for some special cases. Generally, however, numerical models are required to adequately address more realistic situations. In the early phase of the site-selection process, when site-specific data are still sparse and the goal is more to explore under which circumstances a repository in crystalline rock could provide effective confinement of radioactive substances, a modelling approach with intermediate complexity may be best suited.

In this talk, we present a semi-analytical approach to modelling the transport of a single radionuclide along a fracture with diffusion into the adjacent rock matrix. The approach has been implemented in an Excel spreadsheet by using Visual Basic for Applications. Comparison of the results of the semi-analytical approach with those of a numerical model featuring the code AMBER has allowed us to determine the scope of application of the semi-analytical approach.

Financial support. The work has been funded by the Federal Office for the Safety of Nuclear Waste Management (BASE).

References

StandAG: Gesetz zur Fortentwicklung des Gesetzes zur Suche und Auswahl eines Standortes für ein Endlager für Wärme entwickelnde radioaktive Abfälle und anderer Gesetze, 5 May 2017, Bundesgesetzblatt Jahrgang 2017, Teil I, No. 26, 1074–1102, 2017.