

## **Reactive transport in evolving porous media – Challenges and opportunities**

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Many problems of relevance in the fields of the earth and environmental sciences are affected by evolving porous media properties, including reactivity, porosity, permeability, tortuosity and effective diffusion coefficients, as well as moisture retention capacity.

These problems include for example the weathering of mine waste rock and tailings. In this case, reactivity often declines over time due to mineral alteration, changes in reactive surface area and surface passivation. In extreme cases, the formation of hardpans may substantially inhibit the progress of weathering in the long term. Similarly, surface passivation can affect the effectiveness of carbon sequestration in ultra-mafic mine waste by limiting the release of Mg into solution. Surface passivation has also been shown to play an important role in engineered systems for water treatment such as permeable reactive barriers and limestone drains, reducing their long-term effectiveness to remove contaminants.

Evolving porous media properties are not restricted to evolving reactivity, mineral-dissolution precipitation reactions can also lead to significant changes in porosity and subsequently permeability, leading to either permeability increase or reduction. A reduction of permeability can lead to well-fouling, associated with the precipitation of amorphous Fe- and Mn-oxide mineral phases, or can jeopardize well development in the oil and gas industry including hydraulic fracturing operations, for example due to the precipitation of barite. On the other hand, porosity and permeability enhancement can lead to karstification in limestone aquifers. In the case of interfaces in constructed waste disposal facilities, including cement-clay and cement-bentonite contacts, it is also important to understand the evolution of tortuosity and effective diffusion coefficients to enable meaningful assessments of long-term evolution and waste containment. Additional complexity arises in evolving porous media in the vadose zone due to feedbacks affecting the medium's moisture retention characteristics.

This presentation will provide an overview on available formulations for evolving porous media based on selected case studies and will discuss existing challenges and possible future research directions.