

## **Multi-scale modelling for the assessment of water quality and land subsidence due to salt layers dissolution**

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Long term evolution of salt mine depends on mechanical behavior of the material but also on specific conditions like the intrusion of water into working areas. Such phenomenon has been observed in the Nancy Basin (East of France) where brine percolates through access shafts accompanied by significant subsidence at the surface level, bringing about growing societal concerns.

In order to understand the mechanisms and kinetics of dissolution of salt inducing the phenomenon of subsidence, a numerical model is implemented. The circulation of water between the salt layer and the impervious layer induces the creation of dissolution channels. In active dissolution zones, the channel network constantly evolves: new channels appear with new dissolution zones while others collapse because of their too important dimensions.

The model simulates the phenomenon of dissolution at the channel scale first, then at the basin scale. Dissolution channels modeling has been realized using COMSOL Multiphysics<sup>®</sup> with Darcy's Law and Solute Transport interfaces.

At the channel scale, realistic parameters used as input data gave rise to output results consistent with the expected range of values for numerical assessment of the transient period and mass fluxes.

At the basin scale, initial porosity and hydraulic conductivity fields, related to each other by a cubic law, are assumed to follow a Weibull distribution. From this initial state, the transient model calculates the evolution of porosity with time, taking into account Darcy's velocity as it was formulated by Yao et al. (2014). Progress in dissolution and transport gives rise to the creation of dissolution channels.

Channels mechanical behavior is investigated through extending 2D model into 3D one. The calculations show that open channels collapse when they reach a width of approximately one meter. The results of these investigations are consistent with the in situ measurements, notably with the estimation of the subsidence rate.

The coupled hydro-mechanical model developed in the frame of this study allows simulation of creation and collapse of dissolution channels. It is a relevant tool for describing the environmental consequences of salt mine closure on groundwater quality and land stability. It can be easily transposed to karstic environment.