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Rock-mechanical investigations regarding the proof of long-term safety of abandoned salt production cavities using hazardous waste as backfill material

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Abstract

The numerical simulation of the long-term load-bearing behaviour of abandoned sealed caverns in rock salt is very complex, especially if the cavities are back-filled with hazardous waste. This waste will for example be pre-processed to a suspension and filled into the brine-filled cavity displacing the brine. Therefore, within the cavity at any time during emplacement a fluid-pressure is active to support salt rock mass. After emplacement, the waste suspension will solidify in-situ more or less due to sedimentation, consolidation and compaction processes as well as maybe due to chemical processes and will also support salt rock mass independent of consistency.
With respect to safety analysis it is necessary on the one hand to have an adequate approach for physical modelling of the mechanical processes occurring in the surrounding salt rock mass, but on the other hand it is also necessary to have an adequate approach for physical modelling of the mechanic-hydraulically coupled processes occurring within the backfill material in the sealed cavern as well as in the surrounding salt rock mass due to not excludable infiltration of pore fluids from the disposed waste subjected to rock mass pressure. For these purposes, at Chair in Waste Disposal and Geomechanics of Clausthal University of Technology the constitutive model Lux/Wolters has been developed.
The constitutive model Lux/Wolters is based on intensive laboratory investigations and consists of two sub-models, a thermomechanical sub-model and a hydromechanical sub-model. The thermomechanical sub-model is able to model the creep behaviour of salt induced by deviatoric stresses as well as mechanically induced damage and damage reduction processes. The hydromechanical sub-model is able to model permeability changes resulting from mechanically induced damage or damage reduction processes as well as resulting from hydraulically induced damage or damage reduction processes, which is known as pressure-driven fluid infiltration process. The constitutive model Lux/Wolters is implemented into a TH2M-coupled simulation tool named FTK-simulator.
For verification and validation of the physical modelling and of the numerical simulation tools, different field tests have been successfully back-analysed in the past.

Key words: rock salt, gas storage, salt caverns, cavern abandonment, rock mechanics