Geophysical Research Abstracts
Vol. 13, EGU2011-11892, 2011
EGU General Assembly 2011

Simulation of high-contrast densitiy-driven transport at field scale

Eric Zechner (1), Ali Zidane (1), Anis Younes (2), and Huggenberger Peter (1)

(1) University of Basel, Department of Environmental Sciences, Basel, Switzerland (eric.zechner@unibas.ch), (2) Mechanical Institute of Fluids and Solids, Louis Pasteur University, CNRS, UMR 7507, France

Recent 2D density-coupled solute transport simulations have revealed the importance of geological dip for predicting subsurface dissolution of halite. In the presented experiments, relevance of additional field parameters such as depth of extraction wells, time-variable permeability, aquifer width, and normal fault width were evaluated. The study site in the Tabular Jura is an approximately 1000m long, and 200m deep 2D field scale model, which represents a setup of two aquifers connected by subvertical normal fault zones. The resulting high contrasts in groundwater density were simulated with a numerical model based on Mixed Finite Elements for the fluid flow problem and a combination of Discontinuous Galerkin Finite Element and Multi-Point Flux Approximation methods for the transport. Steady-state concentration distribution in the upper aquifer is reached in most simulations after a few years, and increased salinities are affecting most parts of the aquifer.

Different scenarios were run to study the effect of the well depth on the dissolution process. Well depth in the about 50 m thick upper aquifer varied between 20 m to 50 meters. Results show that the depth of the well has no significant effect on the process (difference is in the order of 1%).

The effect of variable permeability, which is due to fracture opening in the evaporitic rock formation, is simulated with a discrete fracture approach, which includes small fractures and bedding partings of a karstic, or fissured aquifer directly into a porous flow model. The fracture aperture, or void opening, is time-dependent and a function of salt dissolution. The results demonstrate that the permeability has a large impact on the dissolved salt mass: the total simulated mass with time-variable permeability is more than 25% larger compared to the dissolved mass with constant permeability.

The effect of the normal fault zone thickness of higher permeability is studied by simulating fault zone thicknesses between 10 cm and 40 m. The corresponding simulated dissolution rates sharply increase with fault widening before they apparently start to level out at 40 m.

Finally, the range of the unknown lower aquifer thickness above the rock salt is varied from 10 cm to 10 m. Simulated density-driven flow velocities are directly related to the imposed aquifer thickness: if the lower aquifer thickness decreases, then the flow velocity will increase, which leads to more dissolved salt, and vice-versa.