1D REACTIVE TRANSPORT MODEL FOR THE OPALINUS CLAY AT MONT TERRI UNDERGROUND LABORATORY

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Pore waters from the Opalinus clay at Mont Terri show a compositional trend as a function of the distance to the formation limits, being the more saline waters those found in the centre of the formation and becoming more diluted as they are closer to the formation limits. The ratios of conservative components, such as Br/Cl, are equivalent to that of seawater. Considering that the Opalinus clay has a very low permeability, it could be assumed that seawater was trapped during sedimentation or at the first stages of diagenesis. According to this assumption, it is clear that the present-day porewater composition is the result of outward diffusion of the original porewater components, inward diffusion of groundwaters from the surrounding formations (Jurensis marls and lower Dogger limestones) and water-rock reactions.

We developed a geochemical model that considers groundwater diffusive transport in the Opalinus Clay, considered to be initially saturated with seawater. This process together with the relevant mineral equilibria and the appropriate cation exchange processes determine the main processes governing pore water evolution. Groundwater circulation and associated diffusion in the Opalinus Clay started after sedimentation of the marine sequence during the Triassic-Cretaceous period. This implies that any model concerning the hydrogeochemical evolution of the Opalinus Clay pore water should start after this period.

The comparison between analytical data and modelling results, based on conservative components, indicate that the best agreement is when considering a total evolution time of the system ranging between 4 and 5 million years. For longer time periods the calculated salinity is lower than that of the analytical data.

The agreement between the measured data and the modelling results is also satisfactory for major cations as calcium, sodium, potassium, and magnesium. In the case of sodium and potassium, the diffusive transport and the cation exchange control their concentration. Magnesium and calcium concentrations are in addition controlled by the equilibrium with calcite and dolomite respectively.

Strontium is also an important component in the Opalinus Clay system. Its behaviour is controlled by equilibrium with the cation exchanger and celestite. The model results also fit reasonably the analytical data.

The problem arises when comparing the results for the carbonate evolution and pH with the measurements. In both cases there is a systematic disagreement between modelling results and analytical data. This systematic difference could be the result of CO_2 loss during the long time period of water seeping into the packer zone in boreholes or in the case of the squeezing experiments at atmospheric conditions. This would allow CO_2 to escape resulting in a decrease of the total carbonate concentration relative to its in situ value. This has an

immediate effect on pH, which increases proportionally to the amount of CO_2 loss. In order to test this loss of CO_2, we simulated the effect of adding CO_2 to the samples. In this simulation we added CO_2 up to a pressure of log pCO_2 of -1.5 bars, which is the mean value obtained during the model calculation, and equilibrate the resulting waters with calcite. The results from this simulation are in agreement with the reactive transport modelling results.

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