MODELLING THE HG-A IN SITU EXPERIMENT GAS MIGRATION THROUGH EDZ

D. Arnedo, E.E. Alonso, S. Olivella*

Geotechnical Engineering and Geosciences, Universitat Politècnica de Catalunya, Barcelona, Spain (Diego.Arnedo@upc.edu, Eduardo.Alonso@upc.edu, Sebastia.Olivella@upc.edu).

With the objective of understanding the gas flow processes through argillaceous rocks in schemes of radiaoactive waste disposal, the HG-A in situ experiment was planned. The modelling of the experiment will permit to improve the design and the action to be taken, to better understand of the responses, to confirm hypothesis of mechanisms and processes and to learn in order to design future experiments. The experiment and modelling activities are included in the project FORGE (FP7).

The in situ test HG-A is to be performed by NAGRA at the Mont Terri underground research laboratory. Figure 1 shows a three-dimensional layout of the test. A micro-tunnel of 1m diameter was excavated in Opalinus Clay departing from a niche in the 2004 gallery. The drilling was performed parallel to the bedding planes, which have a dipping angle of 50º to SE. The aim of the test is to monitor the creation and evolution of the excavation damage zone around the micro-tunnel, to asses the variations in the hydromechanical behaviour of Opalinus Clay, with especial focus on its flow properties, and to observe its impact in the gas migration properties during gas injection phase. The experiment main stages are: tunnel excavation; tunnel backfill and emplacement of instrumentation; packer inflation and backfill saturation; gas injection tests; and a second campaign of hydraulic tests.

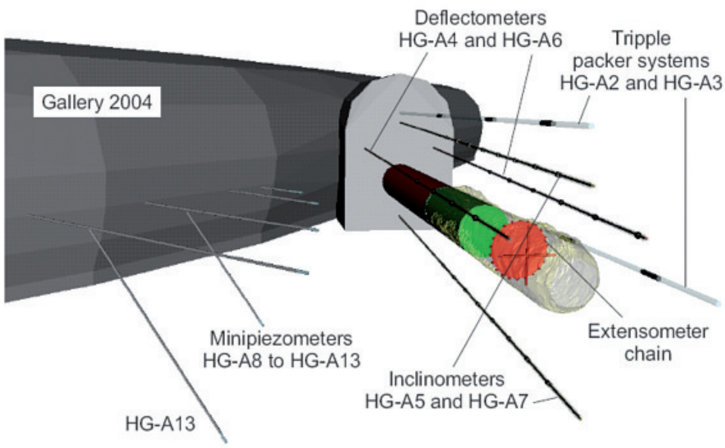

Figure 1: 3D Layout of the HG-A experiment at Mont Terri showing the excavated micro-tunnel with the megapacker installed (in green) and the backfilled test interval (transparent). The instrumentation around the tunnel (boreholes) and inside the backfilled section (in red) are included.

A cross section model of the test is being developed. The modelled section corresponds to the gas injection interval (backfilled section) and is perpendicular to the tunnel axis and the bedding. The constitutive model considers the hydro-mechanical anisotropy of argillaceous rocks. A composite mechanical law for argillaceous rocks (Gens & Vaunat, 2003) allows taking into account the elastoplastic response of the clay matrix and the damage behaviour for the bonding material of Opalinus Clay. The elastic law is a cross anisotropic linear elastic model that includes the bedding orientation. Increases in permeability can be obtained by increase of rock damage and deformation due to excavation and also due to wetting-drying cycles during open tunnel phase. An embedded fracture permeability model can be adopted for the hydraulic problem (Olivella & Alonso, 2008) in order to include the process of bedding opening due to unloading or fluid injection. In this model, permeability and retention curve depend on strains through a fracture aperture. Both hydraulic and mechanical parts are coherently linked trough the bedding orientation.

The following test stages are foreseen to be included in different modelling stages: the formation of the EDZ due to the tunnel excavation and its evolution due to the ventilation process taking place during the open tunnel period prior to the backfilling and installation of the so-called mega-packer. The simulation results will be compared to the experimental data once the model is reliable. The backfilling and saturation/ water injection stages will be also included in the simulation. Finally a scoping calculation of the gas injection test will be carried out considering different gas injection techniques. First the replacement of the backfill pore-water by gas is considered prior to the gas injection stage. In the second case the possibility of gas injection directly into the saturated backfill is simulated.

References:

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