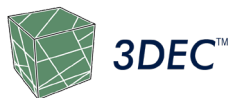


## PROJECT DESCRIPTION

Svensk Kärnbränslehantering AB  
(SKB) / CNRS

Sweden



As part of the EU Horizon 2020 ENIGMA ITN project, ICSAS, the CNRS, and SKB proposed a PhD project entitled “Flow and transport in fracture networks: reducing uncertainty of DFN models by conditioning to geology and geophysical data”, to develop and test a methodology for rock characterization that would help in the decision-making process for an adequate location of the nuclear waste canister burying. The main objectives are to assess the contribution of the Ground Penetrating Radar (GPR) method for:

- 3-D fracture mapping and flow path imaging in a very low-permeability deep environment
- Reducing Discrete Fracture Network (DFN) models uncertainty for flow and transport predictions (scale of  $\approx 1 - 10$  m)

## ITASCA'S ROLE



GPR data were acquired in a tunnel at the SKB Äspö Hard Rock Laboratory in Sweden, at 410 m depth:

- Static surface-based GPR to map individual fractures in subsurface up to 10 m depth
- Time-lapse surface-based GPR and tracer tests to map the connected network between two boreholes

A DFN model of the tunnel area was also developed, conditioned by tunnel and borehole trace data, and the acquired GPR data.

## PROJECT RESULTS

In very low permeable crystalline rock, GPR is able to:

- Detect  $\approx 80\%$  of open and sub-horizontal fractures with sub-mm apertures (correlation between GPR and borehole data)
- Image the fracture connectivity by detecting fracture aperture variation induced by high-pressure injection (combination with a hydromechanical study)

Finally, conditioning of stochastic DFN with deterministic GPR information leads to an improvement of the predictive capability of model (up to 40% more realizations) at least in terms of connectivity.

## REFERENCES

- Molron, J., Linde, N., Baron, L., Selroos, J. O., Darcel, C., & Davy, P. (2020). Which fractures are imaged with Ground Penetrating Radar? Results from an experiment in the Äspö Hardrock Laboratory, Sweden. Engineering Geology, 273, doi: <https://doi.org/10.1016/j.enggeo.2020.105674>
- Time-lapse GPR experiment and tracer test on video at [https://www.youtube.com/watch?v=-8PUB1K2F2w&feature=emb\\_title](https://www.youtube.com/watch?v=-8PUB1K2F2w&feature=emb_title)

