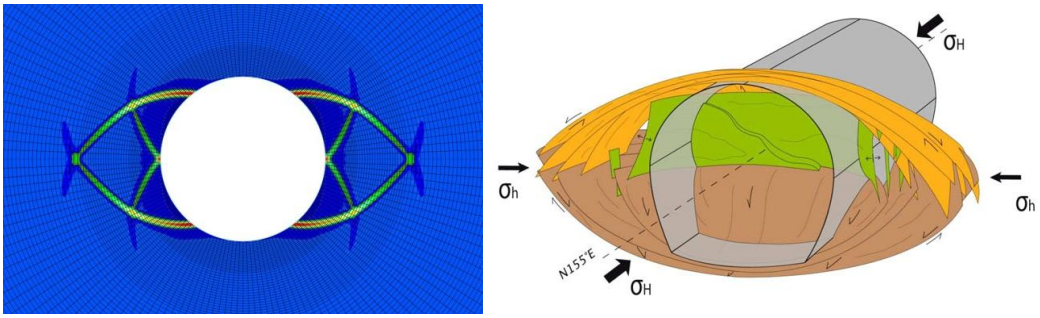
Using numerical modelling for the design of Nuclear Waste Geological disposal (F. Collin)

The long-term management of high-level nuclear wastes is envisaged by deep geological repository. Due to the safety function of the host formation, the behaviour of the Excavation Damaged Zone (EDZ) that develops around underground galleries during their drilling is of paramount importance. The EDZ is dominated by fracturing process which engenders irreversible modifications of the hydro-mechanical properties of the porous rock. In this zone, a significant hydraulic permeability increase of several orders of magnitude is observed. It may alter the safety function of the host formation by creating preferential flow paths for the migration of radionuclides towards the biosphere. Consequently, the understanding and the prediction of the EDZ hydro-mechanical behaviour are crucial issues for the long-term management of nuclear wastes. Among the different low-permeability media that are envisaged for the deep repository, the lecture will focus on the Callovo-Oxfordian claystone, which the reference host rock in France.

The fracturing behaviour, the water transfers, and the coupled processes that occur around the underground galleries are most particularly addressed, especially in the EDZ. The fractures induced by the excavation process are reproduced with strain localisation in shear bands. An appropriate model allowing to properly reproduce the strain localisation in geomaterials with a finite element method is used. It is an enhanced model for microstructure media called the coupled local second gradient model and which involves a regularisation method. Its application is extended to unsaturated anisotropic rocks with compressible solid grains. The numerical modelling of the fractured zone with shear banding provides information about its shape, extent, fracturing structure, and behaviour that are in good agreement with in situ measurements. In particular, the shape of the EDZ in the Callovo-Oxfordian claystone is governed by its anisotropy and the gallery convergence strongly depends on the appearance of the shear bands.



Numerical prediction and in situ observation of fracturing around horizontal drift

In a second part, the numerical model will be used to help designing the support structure during the different phases of the repository. We investigated both the short-term and the long-term interactions between the support structure and the host rock in the context of deep underground nuclear waste storage.