

Construction phase

- Increase of the pore water pressure (and decrease of the effective stress) => Localised damage (fractures) due to excavation
- Increase of permeability.

Exploitation phase

- Increase of the suction due to ventilation.
 - Indurated clay => desaturation with decrease of permeability
 - Plastic clay (Boom clay)=> no desaturation.
 - Experiments on the water retention properties performed by EPFL allowed to understand this effect.
- Chemical alterations of the clay due to the presence of oxygen .

Early closure phase

- Permeability and resaturation is restored after 1 year of excavation (more or less).
- Changes the constitutive parameters of clays (thermoplasticity)
- Thermal expansion of the grains and water (anisotropy!)=> increase of the pore water pressure => decrease of effective stress =>fractures (and localised increase of permeability).
 - Experiments on the water retention properties at different temperatures performed by EPFL allowed to understand this effect.
 - Laboratory experiments have shown that the intrinsic characteristics of the clay were restored after the thermal phase (what about the experiments on cement ?).
 - THM triaxial tests
 - ATLAS in-situ tests (coupling)

Long-term post-closure phase

- Resaturation 100%
- Anoxic conditions (no oxygen).
- Lost of containment after the thermal phase.
- Fractures (are sealed) but may cause preferential paths for gas.
- Migration of the corrosion products to the host-rock => can modify the chemical composition of the host rock.

Message to safety assessors

- Estimation of the DZ based on the most detrimental process to the long-term safety (conservative estimation).
- Estimation of the uncertainties of the phenomenological processes in particular
 - limit of thermoplasticity.
 - Extend of the fractures due to the thermal expansion.