Overview of geomechanical test results from Opalinus Clay core samples

Silvio Giger[1)], Paul Marschall[1)], Lyesse Laloui[2)], Alessio Ferrari[2)], Valentina Favero[2)]

1) Nagra, Nationale Genossenschaft für die Lagerung für die Lagerung radioaktiver Abfälle, Wettingen, 2) EPFL, Lausanne

In 2011 Opalinus Clay core samples were recovered in the geothermal well Schlattingen-1 from a depth of between 830 to 950m below ground. Extensive geomechanical testing was conducted on these core samples over the past two years, including constrained and unconstrained uniaxial, undrained triaxial and constrained and unconstrained swelling tests. Substantial efforts were also made to characterize unsaturated samples and investigate the effect of suction on the geomechanical behaviour.

This contribution provides an overview of the Schlattingen-1 core test results, highlighting many of the typical characteristics in the mechanical behaviour of the Opalinus Clay. These characteristics include a distinct strain softening and localized deformation, anisotropic rock strength and stiffness, but also aspects more pertinent to normally consolidated clays such as a moderate swelling pressure and swelling heave, and complex non-saturated behaviour.

The results of Schlattingen-1 core tests are then compared with those from cores of the Benken borehole, where Opalinus Clay was sampled at a more shallow depth interval of 540 to 650m. It is shown that the quantitative results for the two sites are similar, despite the difference in present depth. In contrast, significant differences exist between the integrated test results of Benken and Schlattingen-1 cores and results from the Mont Terri underground laboratory in western Switzerland with present overburden of typically less than 300m.

To account for the observed depth dependency in strength and stiffness, two different geomechanical data sets are recommended for addressing the technical feasibility of underground structures at potential high level waste repository sites in Northern Switzerland. The geomechanical data set derived from Mont Terri is considered more representative for Opalinus Clay at relatively "shallow" present burial depth (<500m), whereas the combined data sets from Benken and Schlattingen-1 are considered more representative of the Opalinus Clay at "intermediate" to "deep" present overburden (500-900m).