

Challenges associated with laboratory testing on Opalinus Clay, test interpretation, and definition of rock mechanical properties

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Claystones are among the most difficult rock types to characterize in a laboratory setting. These difficulties are primarily related to the strong hydro-mechanical coupling, the extremely low and anisotropic permeability, the anisotropy in strength and stiffness, the brittle (dilatant) failure behaviour, and the sensitivity of mechanical properties to moisture changes. Characterizing the Opalinus Clay suffers the same difficulties.

Our contribution is primarily related to rock mechanical test results on Opalinus Clay specimens obtained at the Mont Terri research laboratory. Based on a comprehensive series of laboratory test results obtained in the past six years, together with published data, we provide general insight into the hydro-mechanical behaviour and key rock mechanical properties of Opalinus Clay relevant for the construction of a repository drift. Using a comparative study of laboratory tests results we illustrate and discuss aspects altering the representativeness of rock mechanical laboratory data for short- to medium term hydro-mechanical processes in the near-field of a repository drift. We also focus on the state-dependency of strength, stiffness and mechanical anisotropy, and we quantitatively illustrate its significance.

A further aspect of our contribution is associated with previous testing procedures where relatively fast loading rates were utilized. As a consequence of these fast loading rates compared to the characteristic diffusion time (extremely low permeability), the obtained test results are essentially undrained. Since pore pressure changes were not measured during these undrained tests, the effective rock strength properties remain unknown, and the derived strength properties should not be used for effective stress calculations.

We also provide results from conceptual numerical models which illustrate how rock mechanical properties used in standard constitutive models affect our ability to reproduce results from full-scale experiments in terms of pore pressure response or failure localization. These difficulties will be qualitatively addressed based on often used constitutive models and related constitutive properties derived from to date laboratory test results.