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Cyclic deformations in the Opalinus clay: a laboratory experiment

Emanuel Huber (1), Peter Huggenberger (1), Andreas Möri (2), and Edi Meier (3)

(1) Applied and Environmental Geology, University of Basel, Switzerland (emanuel.huber@unibas.ch, peter.huggenberger@unibas.ch), (2) Swiss Geological Survey, Swisstopo, Switzerland (andreas.moeri@swisstopo.ch), (3) Edi Meier + Partner AG, Technoparkstr. 2, 8406 Winterthur, Switzerland (info@emp-winterthur.ch)

The influence of tunnel climate on deformation cycles of joint openings and closings is often observed immediately after excavation. At the EZ-B niche in the Mt. Terri rock laboratory (Switzerland), a cyclic deformation of the shaly Opalinus clay has been monitored for several years. The deformation cycles of the joints parallel to the clay bedding planes correlate with seasonal variations in relative humidity of the air in the niche. In winter, when the relative humidity is the lowest (down to 65%), the joints open as the clay volume decreases, whereas they tend to close in the summer when the relative humidity reaches up to 100%. Furthermore, in situ measurements have shown the trend of an increasingly smaller aperture of joints with time.

A laboratory experiment was carried out to reproduce the observed cyclic deformation in a climate chamber using a core sample of Opalinus clay. The main goal of the experiment was to investigate the influence of the relative humidity on the deformation of the Opalinus clay while excluding the in situ effects (e.g. confining stress). The core sample of Opalinus clay was put into a closed ended PVC tube and the space between the sample and the tube was filled with resin. Then, the sample (size: 28 cm $\times$ 14 cm $\times$ 6.5 cm) was cut in half lengthways and the open end was cut, so that the half-core sample could move in one direction.

The mounted sample was exposed to wetting and drying cycles in a climate chamber. Air temperature, air humidity and sample weight were continuously recorded. Photographs taken at regular time intervals by a webcam allowed the formation/deformation of cracks on the surface of the sample to be monitored. A crackmeter consisting of a double-plate capacitor attached to the core sample was developed to measure the dynamics of the crack opening and closing.

Preliminary results show that:
- Deformation movements during different climate cycles can be visualized with the webcam
- The crackmeter signal gives a relatively precise response for relative humidity below 80%
- The sample weight variations are clearly related to the climatic conditions (temperature and relative humidity) and associated with deformation of the sample (widening and narrowing of the cracks)
- The control of the relative humidity in the climate chamber turned out to be difficult in a laboratory without climate conditioning, especially during summer time