



Mini-Seismic Methods applied for small-scale barrier integrity investigations

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Properties of Excavation Damaged Zones / Excavation disturbed Zones (EDZ/EdZ) are relevant for the safety assessment of final repositories for radioactive waste. Under this aspect BGR developed a series of ultrasonic and seismic methods for comprehensive in-situ investigations which we call Mini-Seismic Methods (MSM, Schuster et al. 2017). They span a very broad band of emitter center frequencies, starting from 100 kHz (ultrasonic borehole probe) until 1 kHz (bolt firing tools). This results in seismic wavelength, for example in clay stones, between 2.7 cm (P-waves) and 1.4 cm (S-waves) until 270 cm (P) and 140 cm (S). As seismic receivers different 1- and 3-component piezoelectric transducers are applied. Transient recorders with up to 160 channels are used as recording systems.

With several experiments in potential host rock formations for radioactive waste disposal we run through the whole cycle of the characterization of an EDZ/EdZ evolution. Starting from an initial characterization of an undisturbed rock mass (e. g. fracture detection, determination of basic dynamic elastic rock parameters, seismic anisotropy), followed by the characterization of the excavation related disturbances (EDZ creation). We applied targeted repetition measurements in order to assess the time dependent changes of rock properties (e. g. influence of ventilation). After the emplacement of a simple and a heated dummy canister in repository drifts, backfilling the sections with pure bentonite or sand/bentonite mixtures and closing the sections the evolution of the surrounding rock as well as the evolution of the backfill material was monitored over several years.

Two emplacement experiments were accompanied with MSM in the Opalinus Clay at the Mont Terri rock laboratory (Switzerland).

The Engineered Barrier emplacement experiment (EB) lasted for 13 years (2002 – 2015). With a 24 piezoelectric transducer array the first 1.7 years and after a temporal interruption of 8.5 years the last 2 years were monitored on a daily basis. The dismantling of the backfill material was included in the long-term monitoring.

The second emplacement experiment where seismic methods are applied is the 1:2 scale heater experiment (HE-E) which started in 2011 and is still running. With 15 piezoelectric transducers the creation and sealing of the EDZ with seismic parameters could be monitored.

MSM are quick employable, robust and cheap tools which allow a reliable access to relevant basic geomechanical rock properties.

Reference: SCHUSTER, K., AMANN, F., YONG, S., BOSSART, P., CONNOLLY, P., 2017. High-resolution mini-seismic methods applied in the Mont Terri rock laboratory (Switzerland). *Swiss J. Geosci.* 110, 213-231, doi:10.1007/s00015-016-0241-4, open access: <https://link.springer.com/article/10.1007/s00015-016-0241-4>.