Geophysical Research Abstracts, Vol. 9, 06666, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06666

Measurement of the effect of reconfinement on rock properties around a slot

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Excavation of underground openings induces the formation of an Excavation Damaged Zone (EDZ) in which the mechanical and hydraulic properties of the rock are changed. The knowledge of EDZ extension and properties is needed for assessing the safety of a radioactive waste disposal. Indeed, such an EDZ may constitute a potential pathway to the biosphere. ANDRA is conducting dedicated experiments at the Meuse/Haute-Marne Underground Research Laboratory, excavated in a clay-rich Callovo-Oxfordian formation.

Among these, a specific experiment called KEY is focused on the efficiency of thin radial slots filled with swelling material in the framework of drift sealing concept. A 2 m deep, 33 cm thin radial slot has been excavated at the bottom of an experimental drift, to interrupt the fractured zone below the drift. To check the effect of a confining pressure in the slot on the mechanical behaviour of the host rock around the slot, two kinds of loading were used :

- hydromechanical jacks were used to apply a cyclic pressure on the slot walls, to give a first indication on the effect of reconfinement on mechanical properties of the rock around the slot ;
- the jacks were then taken away and the slot filled with bentonite bricks ; a system was installed to hydrate the bentonite.

During the loading, the evolution of ultrasonic waves velocity around the slot was recorded in order to show the effect of reconfinement on the mechanical behaviour of the host rock. The experimental device was composed of four probes equipped with

ultrasonic sensors. Three probe were installed in vertical boreholes at distances of 10 to 25 cm from the slot sides. The fourth probe was incorporated in the slot. This device allowed the measurement of ultrasonic waves velocities on the side and below the slot. Geotechnical measurements were also carried out to record deformations around the slot (inclinometers, extensometers), as well as the pressure applied on the slot walls.

During the loading phase with the hydromechanical jacks, cyclic increase of the pressure was applied by step of 1 MPa. A first loading to 2 MPa was carried out, then the jacks were unloaded down to 1 MPa, and then loaded again to about 3 MPa before final unloading. A very good correlation could be measured between the evolution of the pressure applied in the slot and the evolution of ultrasonic velocities on the side of the slot. Velocities increased proportionally to the increase in pressure, and decrease during the unloading phases. For some ray paths, the increase in velocity reached more than 150 m/s (for an initial velocity of about 3200 m/s).

The effect of bentonite swelling is recorded for one year and is still running. The pressure increases progressively, and velocity variations are measured with an acquisition frequency of one measure per day. The evolution of ultrasonic velocity is consistent with what was measured during the loading with the hydromechanical jacks. Increase in velocity up to 300 m/s for an applied pressure of about 2,5 MPa are recorded on the side of the slot. No velocity variations are measured below the slot, the closest ray paths being about 50 cm below the slot.

These results show that the application of a confining pressure in a radial slot, excavated to interrupt the fractured zone around a drift, improves the properties of the host rock on the sides of the slot.