EZG08 PROJECT: ACOUSTIC EXPERIMENTS TO MONITOR THE EDZDURING THE GALLERY EXCAVATION PROCESS IN THE MONT TERRIUNDERGROUND RESEARCH LABORATORY (SWITZERLAND)

Y. Le Gonidec[1], A. Schubnel[2], J. Wassermann[3], D. Gibert[4], Y. Guéguen[2], J. Sarout[5], B. Kergosien[1], C. Nussbaum[6]

1. Géosciences Rennes, Campus de Beaulieu, Université de Rennes 1, 35042 Rennes, France (ylegonid@univ-rennes1.fr)
2. Laboratoire de Géologie, Ecole Normale Supérieure, 24 rue Lhomond, 75005 Paris, France (aschubnel@geologie.ens.fr)
3. Institut de Radioprotection et de Sûreté Nucléaire, Centre de Saclay, 91192 Gif-sur-Yvette, France (jerome.wassermann@irsn.fr)
4. Insitut de Physique du Globe de Paris, 4, place Jussieu, 75252 Paris, France (gibert@ipgp.jussieu.fr)
5. CSIRO Petroleum Resources, 26 Dick Perry Avenue, WA 6151 Perth, Australia (joel.sarout@csiro.au)
6. Federal Office for topography, Swisstopo, Fabrique de Chaux, 2882 St. Ursanne, Switzerland (christophe.nussbaum@net2000.ch)

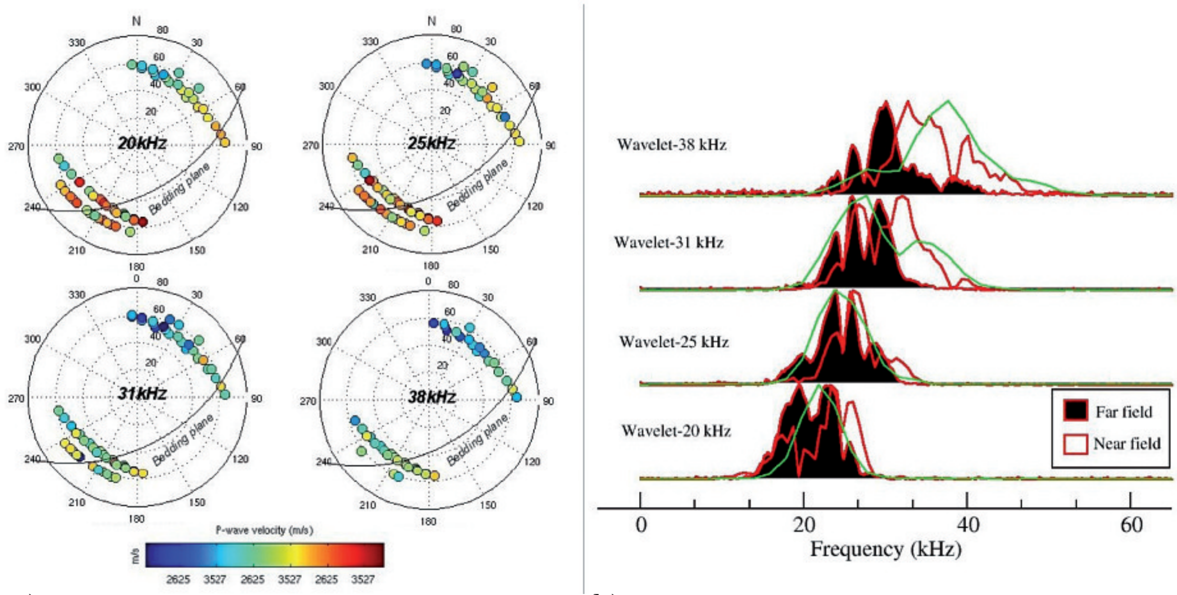
In the Underground Research Laboratory (URL) at Mont Terri, a new gallery G08 was planned to be excavated in 2008 following an original process: the excavation process allowed to monitor the Excavation Damaged Zone (EDZ) from geophysical measurements designed and installed at the end of face of the EZ-G04 gallery during the excavation from the other side, i.e. the end face of the EZ-G08 gallery. The objectives of the project concern spatio-temporal changes of the EDZ: among the methodological developements adapted for the EZG08 project to provide complementary information, acoustic experiments have been prepared in horizontal boreholes to perform the continuous acoustic monitoring of the Excavation Damaged Zone (EDZ).

The acoustic measurements, performed on acoustic arrays of several receivers, have been recorded during one month, following two main steps:

- Active acoustic surveys: a source is introduced in a central borehole (BEZG5) allowing tomography experiments in the far field and in the near field, i.e. close to and far from BEZG5, respectively.
- Acoustic emissions: during the excavation process, numerous acoustic emissions can be detected and associated to microseismic events due to rapid crack propagation, generated by the rock relaxation, or simply associated to the excavation process.

From the tomography measurements, the acoustic wave velocity field can be estimated, with P and S-wave velocities roughly equal to 2500 m/s-3500 m/s, and 1500 m/s, respectively. The acoustic setup does not show variations of P-wave velocity during the campaign, but spatial variations which could be associated to anistropic elastic properties of the rock with the maximum P-wave velocities close to the bedding plane (Figure 1a). An original method based on a multifrequency approach puts in evidence a frequency dependence of the velocity, with a stricking phenomena since the wave velocity decreases with increasing frequency. This effect is under study and can be related to elastic wave propagation in a fluid-filled borehole (Cheng and Toksöz, 1981) or to the presence of heterogeneities inside the rock volume. The presence of heterogeneities is also put in evidence by the frequency spectra of four different source wavelets, from 20 kHz to 38 kHz: the signals are recomposed with strong resonances showing filtering effects inside the medium which increase with the distance from the source (Figure 1b).

More than 20000 acoustic events were recorded during the two weeks period of the excavation pause. To be localised, an event has to be detected by at least five receivers and the velocity model used for the location can be derived from the tomography measurements. Almost 1400 acoustic emissions could be located, ranged from magnitude Mw~ -2 to Mw~ -0.5, From the recorded data base of the events, critical dates were identified during the excavation process, and especially at the excavation pause. Moreover, it was possible to discriminate the event source which can be localized. A cluster within the rock mass probably indicates that a pre-existing fault was reactivated by the excavation (Figure 2).



a) b)

Figure 1: (a) Stereograms of the P-wave velocities, suggesting an anisotropic properties of the rock mass, derived from far field tomography at different wavelet frequencies; (b) Signal recomposition showing frequency resonances increasing with the distance to the source.

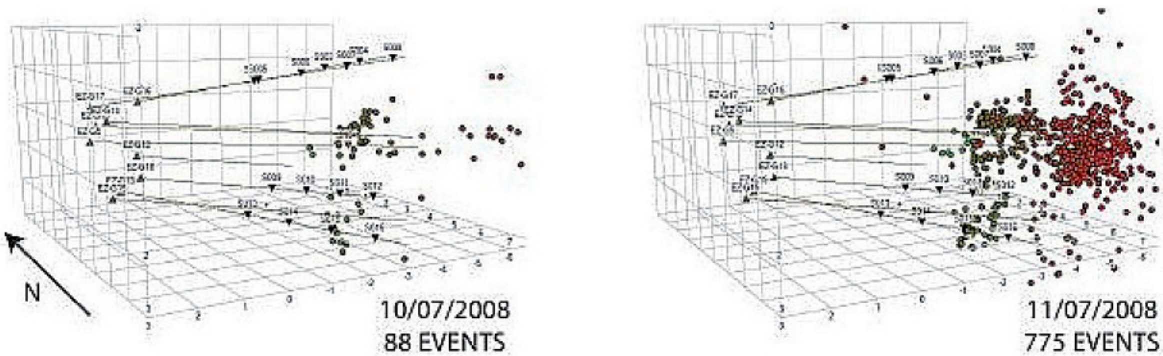


Figure 2: Acoustic emissions located inside the rock mass at two different dates: in green, the emissions probably indicate a fault reactivated by the excavation process.

Reference:

Cheng, C. H., Toksöz, M. N., 1981. Elastic wave propagation in a flui-filled borehole and synthetic acoustic logs. *Geophysics*, 46(7), 1042-1053.