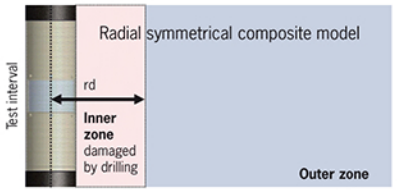
Characterisation of the Hydrodynamic Properties within the EDZ around Drifts at the -490 m Level in the Bure URL: A Methodology for the Consistent Interpretation of Hydraulic Tests

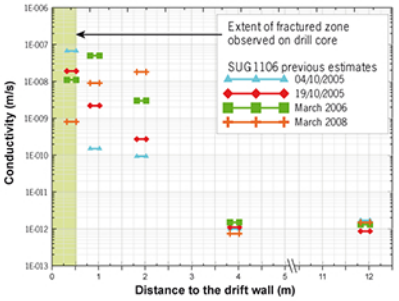
AF-Colenco Ltd

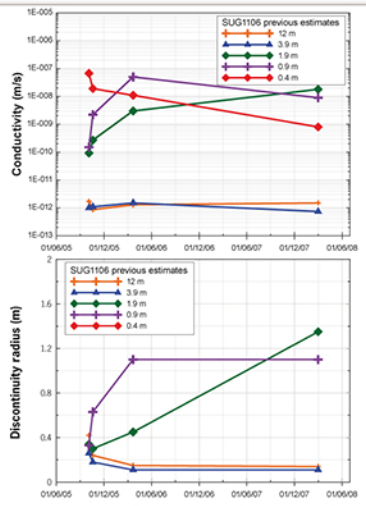
S. Baechler[1], J.-M. Lavanchy[1], G. Armand[2], M. Cruchaudet[2]

The starting point are certain conclusions from the EDZ hydrotest campaigns conducted 2005 – 2008:

- It was difficult to simulate the measurements with a coherent set of parameters
- There were inexplicable variations with time of the discontinuity radius (rd) and the hydraulic conductivity (K)
- There were inconsistencies between the results from the hydrotests and
  - the distribution of fractures observed in drill cores
  - the apparent stabilisation of the formation observed by deformation measurements
  - the rd estimate from a diffusion experiment



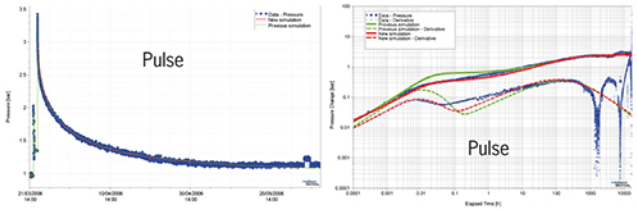


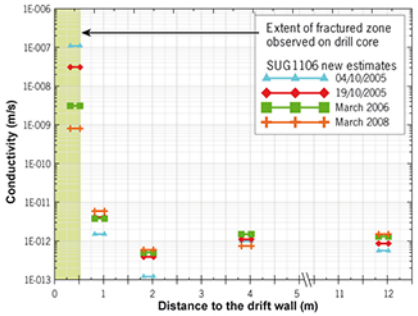


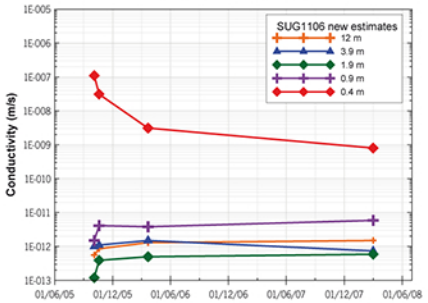
With an enhanced conceptual model and new assumptions

- Allow the specific storage S_s to vary by considering unsaturated conditions, i.e. the compressibility of the fluid phase may increase, where the maximum S_s in the EDZ would correspond to the porosity
- Based on an estimate from a diffusion experiment in Bure URL, constrain rd to ≤ 0.1 m

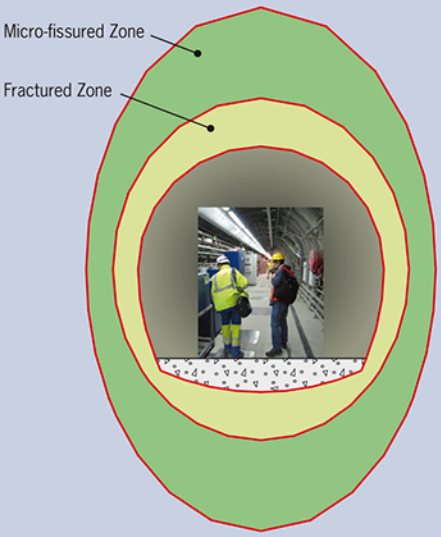
Parameter	Previous model	Revised model
$K_{inner\ zone}$ $K_{outer\ zone}$	Fitted	Fitted
rd	Fitted	≤ 0.1 m
$S_{inner\ zone}$ $S_{outer\ zone}$	Fixed value from literature (10^{-6} 1/m)	Fitted
Formation pressure	Fitted	Fitted







Conceptual Model of the EDZ

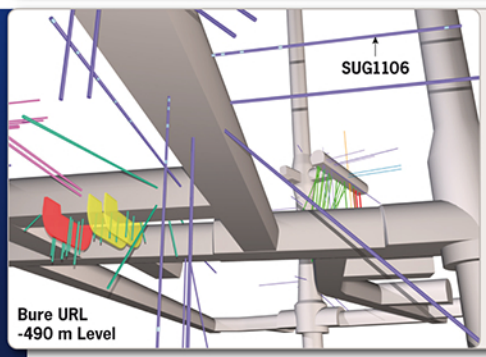


… we found:

- The fit between simulations and hydraulic measurements is excellent
- S_s is a very sensitive fitting parameter
- The results are coherent with drill core observations
- The evolution of permeability with time now is much more consistent with deformation measurements
- Data from new hydrotest campaigns could be analysed successfully with the revised conceptual model and assumptions
- In borehole SUG1106, a drastic decrease in K with time at ~ 0.5 m from the drift wall has been confirmed
- The permeability estimates for the outer zone in previous models appear to be consistent with the revised formation permeability values

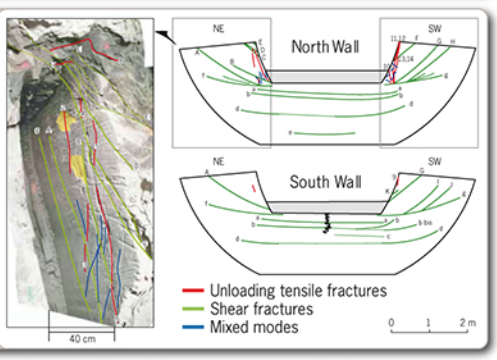
For the interpretation of hydrotests we recommend:

- To apply an integrated approach for reducing the uncertainties, e.g. through cross validation and by honoring major constraints from diffusion experiments, drill core observations, deformation measurements etc.
- In particular, to measure saturation profiles which may significantly help to constrain S_s estimates
- To use sequences with, preferentially, constant head tests and pulse tests in the EDZ for the retro control of fitted parameters
- To repeat test campaigns periodically and compare the results
- To design interference tests to improve S_s estimation



Background

The excavation of a drift causes the redistribution of stresses in the formation and induces the development of a fracture network that could result in preferential flow paths parallel to the drift. The excavation damaged zone (EDZ) fosters an environment of partially saturated conditions and of complex flow geometry. Its characterisation is a key issue for the long-term safety of geological repositories for radioactive wastes.



[1] AF-Colenco Ltd, Groundwater Protection and Waste Disposal, Täfernstr. 26, CH-5404 Baden, Switzerland, E-mail: serge.baechler@afconsult.com
[2] ANDRA, 55290 Bure, France

Reference: Armand, G., Nussbaum, C., Cruchaudet, M. and Rebours, H. (2009) Characterisation of the Excavation Damaged Zone (EDZ) in the Meuse Haute-Marne underground research laboratory (France). In Proceedings of the International Conference on Rock Joints and Jointed Rock Masses, January 4-9, 2009, Tucson, USA

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