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Permeability Model of Extensional Faults in Metamorphic Rocks; Verification by Pre-Grouting in sub-sea Tunnels

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Fault models predict a zoned permeability in fault zones. In general, a low permeability fault core is surrounded by a more permeable damage zones towards pristine, lower permeable host rocks (Caine et al. 1996; Evens et al. 1997). We present two case studies of faults in metamorphic and magmatic/crystalline rocks with neglectable primary porosity, in which tunnels-scale injection of cement document consistent permeability contrasts within faults.

Permeability zoning relates to the distribution of more or less impermeable fault rocks in the core, and networks of open fracture sets of the damage zone. The permeability patterns support a division of the fault into sub-zones characterised by distinct fracture populations and fracture characteristics (Braathen & Gabrielsen 2000; Braathen et al. 1998; Evens et al. 1997; Caine et al. 1996). An orderly description of fault rocks is reached through the classifications presented in Braathen et al. (2004). In light of the resolution of our injection dataset, we merge these fault sub-zones into three parts, namely (i) extended core, (ii) inner damage zone, and (iii) outer damage zone. The established permeability characteristics come from large extensional faults truncated by sub-sea tunnels. In these tunnels, injection of cement into the faults (pre-grouting) gives semi-quantitative data for permeability and porosity. These data are compared with tunnel and drill core data, which document that the extended fault core consistently in all faults shows a drop in injection volumes compared to the damage zone. The core has injection characteristics close to the host rock outside the fault, while the peak of cement injection lies in the inner damage zone.

The study indicates that there is good correlation between fracture frequency and cement injection in tunnels. The fracture frequency and injection volume increase towards the core of the fault and the fault core is commonly nearly impermeable if it contains fault gouge or clay. This demonstrates that fracture frequency obtained during site investigations could found the basis for calculating required cement masses, which can be used to predict the cement mass and thereby improve the budgeting of a tunnel project.

References

Braathen, A., Osmundsen, P.T. & Gabrielsen, R.H. 2004: Dynamic development of fault rocks in a crustal-scale detachment: An example from western Norway, 23, TC 4010, pp: 1-21, DOI: 10.1029/2003TC001558

Braathen, A. & Gabrielsen, R.H. 2000: Bruddsoner i fjell - oppbygning og definisjoner, *Gråsteinen nr: 7* (in norwegian)

Braathen, A., Gabrielsen, R.H., Henriksen, H., Lothe, A., Midtbø, E., Midtgård, A.K., Berg, S., Lyslo, K. & Skurtveit, E. 1998: Lineament architecture and distribution in metamorphic and sedimentary rocks, with application to Norway, *Norges geologiske undersøkelse* NGU Report 98.043, 78

Caine, J.S., Evans, J.P. & Forster, C.B. 1996: Fault zone architecture and permeability structure, 24, 11, pp: 1025-1028

Evens, J.P., Forster, C.B. & Goddard, J.V. 1997: Permeability of fault-related rocks, and implications for hydraulic structure of fault zones, 19, pp: 1393-1404