

A field assessment of the ability of Ground Penetrating Radar to detect fractures in very low permeable crystalline rock



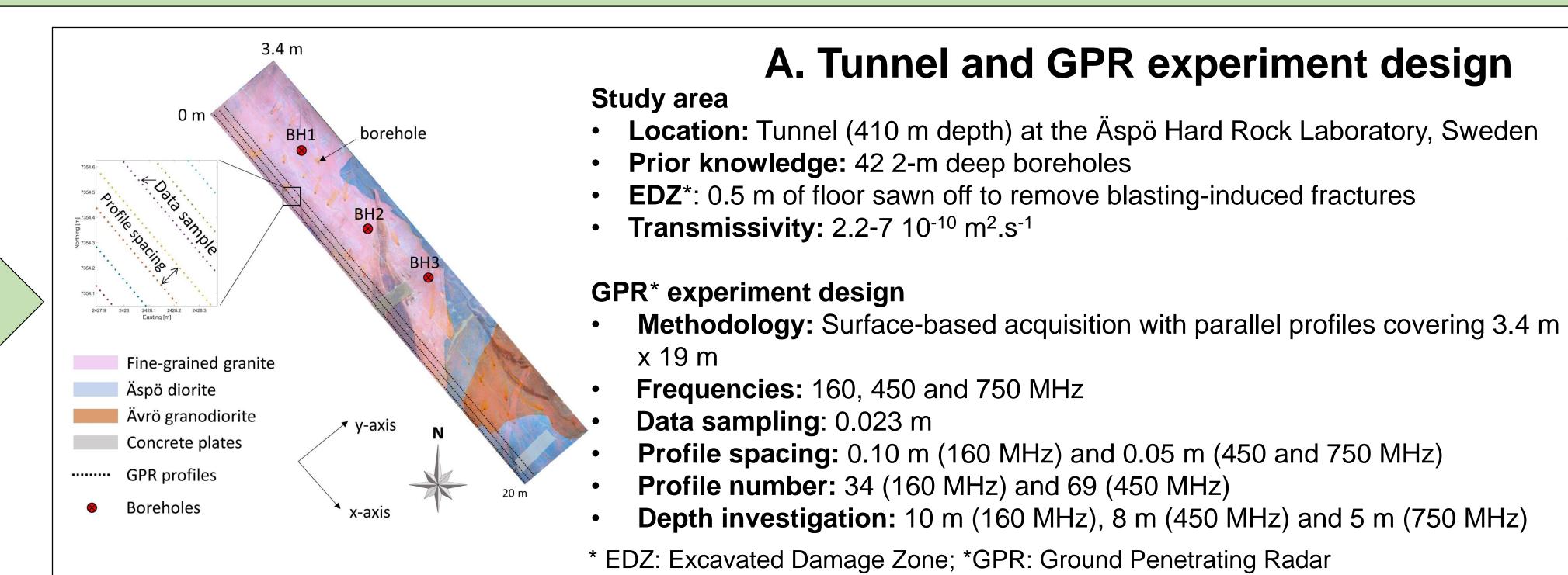
B. GPR fracture model and borehole siting



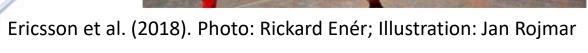


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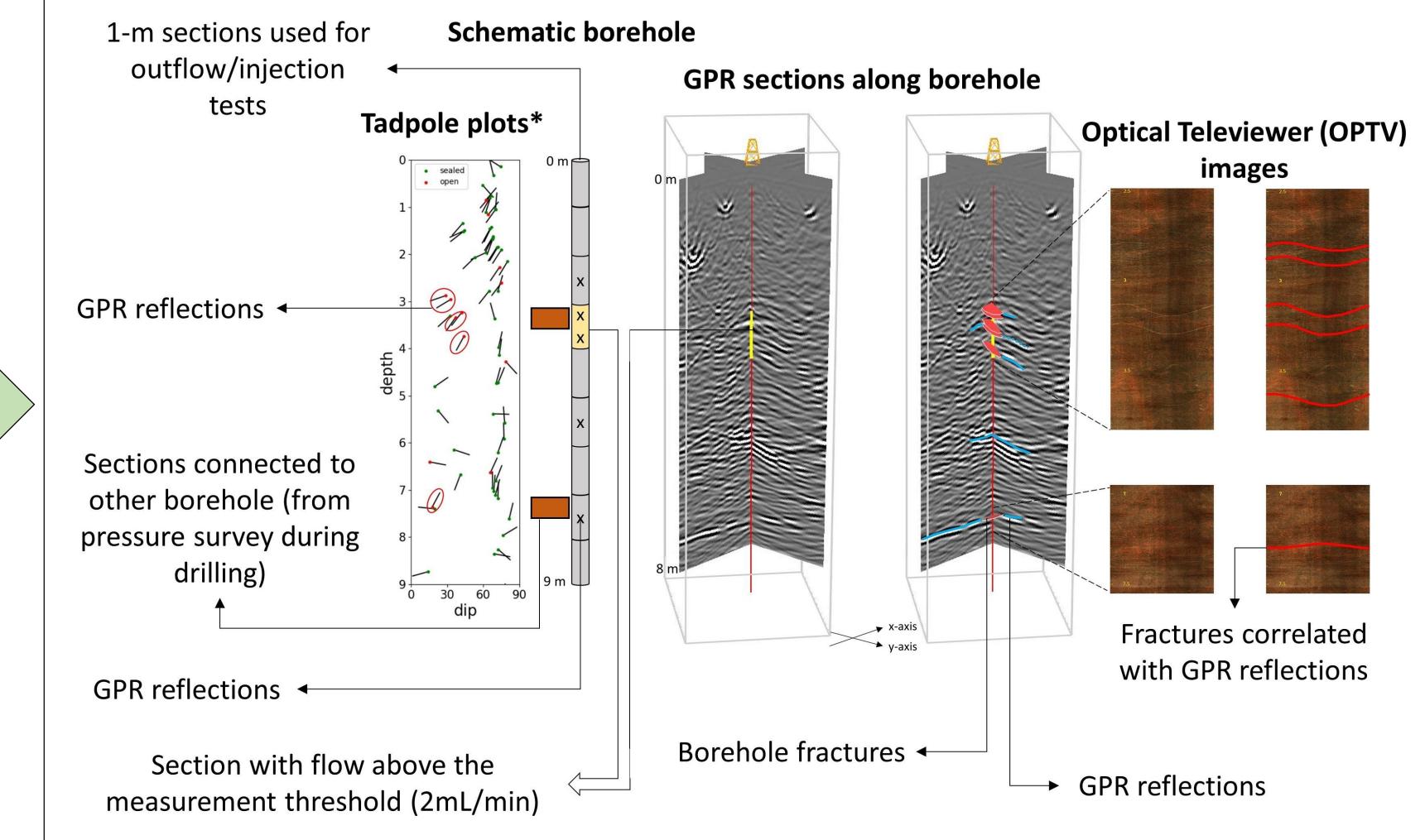
Manual choice of reflections: 17 subhorizontal + 3 sub-vertical fracture planes

Three 9.5 m deep boreholes drilled after choice of reflections (BH1, BH2, BH3)

9 "GPR fractures" crossing the boreholes

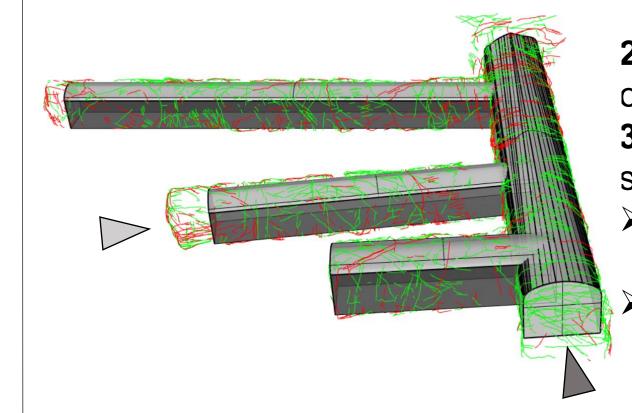
A. Comparison with borehole data

Nature of the GPR reflections



> Fracture detection ability of the GPR in terms of fracture orientations and sizes

B.1 3D statistical model

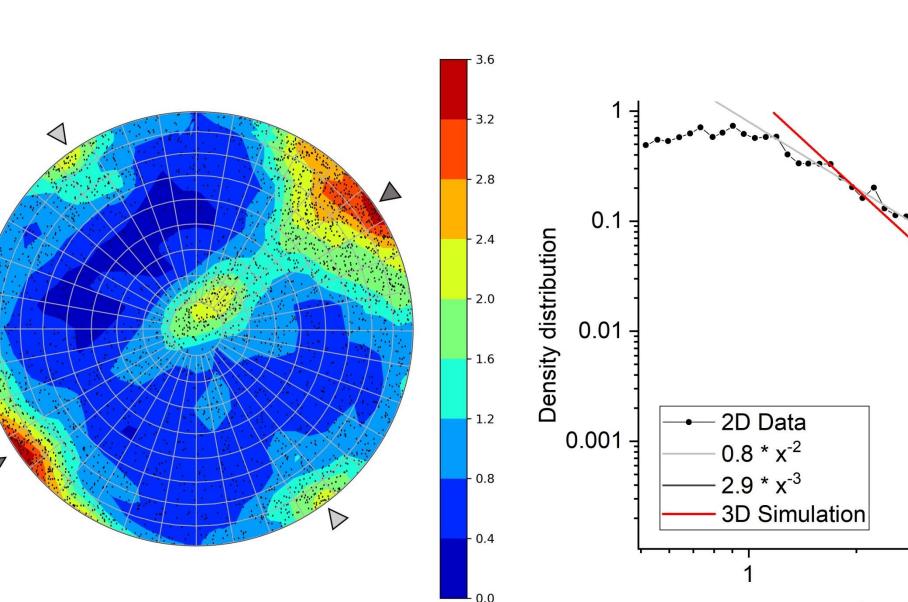


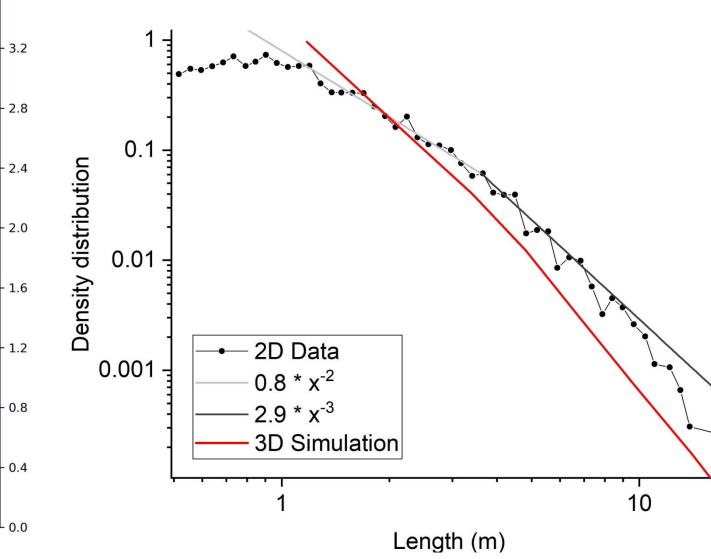
2D data: 3513 fracture traces with orientation

B. Comparison with statistical model

3D model: derived from 2D traces by stereological rules:

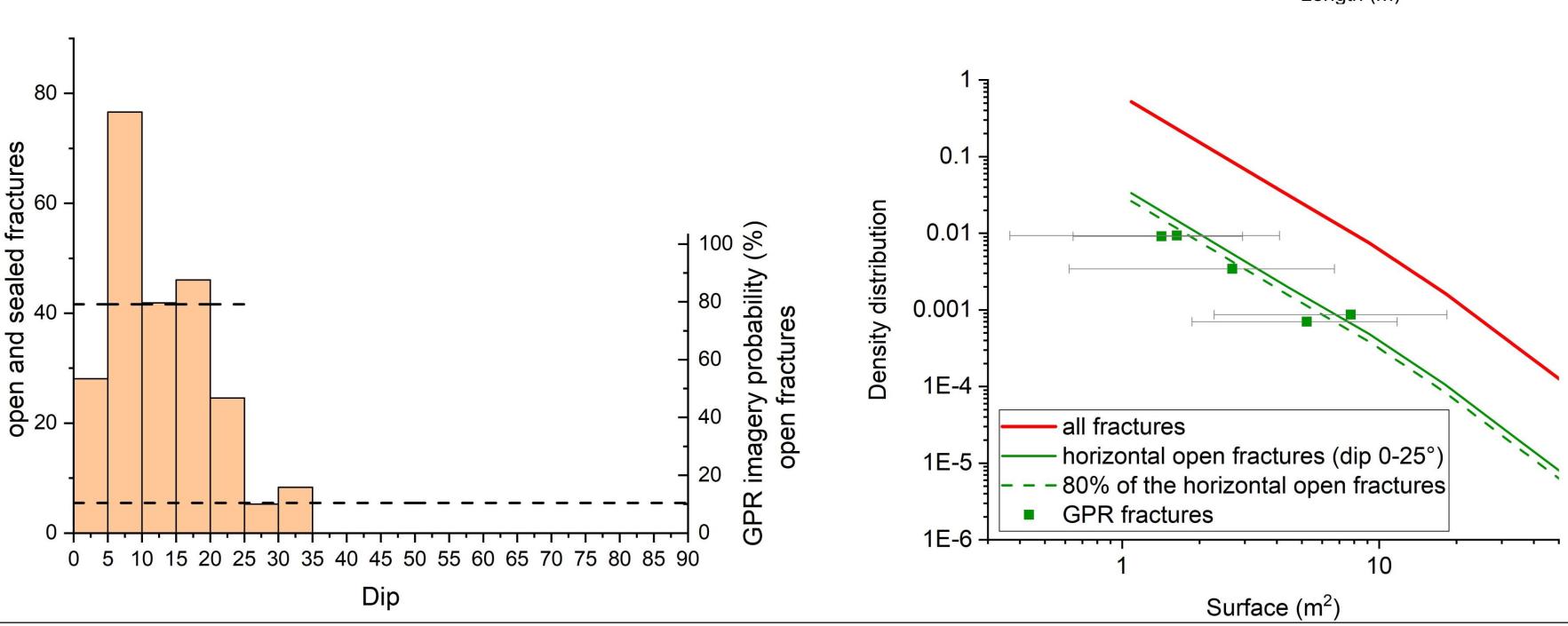
- Fracture size density distribution (Piggott, 1997)
- Fracture orientation distribution (Mauldon and Mauldon, 1997)





B.2 GPR detection ability

- Estimation of the GPR detection capacity (%): GPR fracture density/3D statistical density
- Estimation of GPR fracture density distribution and comparison with statistical model
- Fracture area between 1-10 m²
- Fracture dip between 0-25°



Tadpole plots show fracture localizations (circle) as a function of depth (y-axis) and dip (x-axis). The segments represent the dip direction with the North at the top.

Sensing capacity of surface-based GPR to image fractures with sub-mm apertures **GPR reflection nature:**

- Open fractures
- 5/9 are situated in transmissive zones (above the measurement threshold)

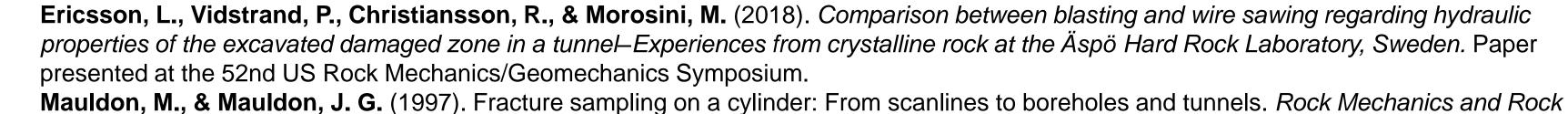
GPR detectability in terms of fracture sizes and orientations (Molron et al., submitted):

- 5.5 % of detection: open + sealed fractures, dip 0-90°, surface area 1-10 m² • 42 % of detection: open + sealed fractures, dip 0-25°, surface area 1-10 m²
- 80% of detection: open fractures, dip 0-25°, surface area 1-10 m²

Next experiment:

Time-lapse GPR imaging during tracer tests

Biblio



Engineering, 30(3), 129-144. Molron, J., Linde, N., Baron, L., Selroos, J-O., Darcel, C. and Davy, P. (submitted). Which fractures are imaged with Ground Penetrating

Radar? Results from an experiment in the Äspö Hardrock Laboratory, Sweden. Engineering Geology. Piggott, A. R. (1997). Fractal relations for the diameter and trace length of disc-shaped fractures. Journal of Geophysical Research, 102(18),

121-125. doi: https://doi.org/10.1029/97JB01202

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