ECOLE LEMANIQUE DES SCIENCES DE LA TERRE
DES UNIVERSITES DE GENEVE ET DE LAUSANNE

Master ès Sciences in Earth sciences

Fracture intersections and their link to ground-penetrating radar diffraction patterns

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Context

The ground-penetrating radar (GPR) method is the geophysical method of choice for in-situ mapping of fracture geometry and properties at depths down to some ten meters. Yet, few systematic studies have considered the responses obtained at fracture intersections (e.g., between a sub-horizontal and sub-vertical fracture). This interference is simply not accounted for in most modeling and imaging algorithms. We have developed a semi-analytical method that simulates the GPR response of fractures with complex aperture distributions (Shakas and Linde, 2015 ; 2017). The coupling between fracture elements have been included in the code, but it has yet not been investigated in this detail. In this project, the student will work on high-quality 3-D GPR datasets acquired at a Hard Rock Laboratory in Sweden in the context of nuclear waste storage. These data sets contain significant diffraction events and the origin of these events are unclear. Grasmueck et al. (2015) has suggested that they might be caused by fracture intersections. The aim of this MSc project is to investigate what type of fracture geometries that could give rise to the observed diffractions. Fracture intersections often provide preferential pathways for radionuclide transport, which suggests that the ability to map these intersections is of very high relevance in the context of nuclear waste management. This project is suitable for a student with a keen interest in physics, geophysics and numerical modeling.

Objectives and Methods

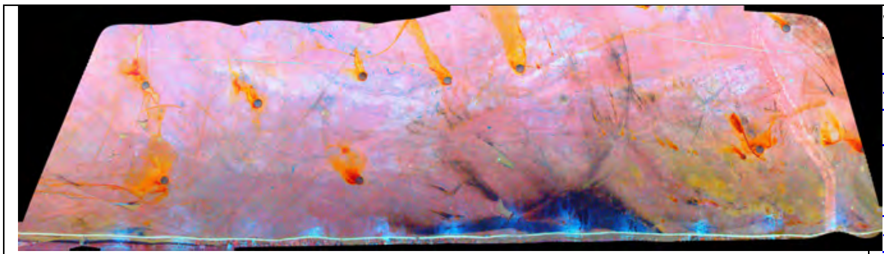
Adapt an existing semi-analytical code (Shakas and Linde, 2015; 2017) to enable accurate simulation of crossing fractures with arbitrary geometry. Characterize the observed diffractive events in existing 3-D GPR data. Infer the type of fracture connections that could be responsible for the observed GPR responses. Investigate the ability to probabilistically infer the fracture-intersection geometry.

Literature

Grasmueck, M., T. J. Moser, M. A. Pelissier, J. Pajchel, and K. Pomar 2015), Diffraction signatures of fracture intersections. Interpretation, 3, SF55-SF68.

Shakas, A., and Linde, N., 2015, Effective modeling of ground penetrating radar in fractured media using analytic solutions for propagation, thin-bed interaction and dipolar scattering. *Journal of Applied Geophysics, 116, 206-214.*

Shakas, A. and N. Linde, 2017. Apparent apertures from ground penetrating radar data and their relation to heterogeneous aperture fields. *Geophysical Journal International, 209*(3), 1418-1430.



WEB sites

http://www.skb.com/research-and-technology/laboratories/the-aspo-hard-rock-laboratory/

https://enigma-itn.eu/esr-n4-flow-transport-fracture-networks-reducing-uncertainty-dfn-models-conditioning-geology-geophysical-data/

Choice of orientation :

1) Sedimentary, Environmental and Reservoir Geology **/** 2) Geochemistry, Alpine tectonics, Ore Deposits **/ 3**) Geological Risks