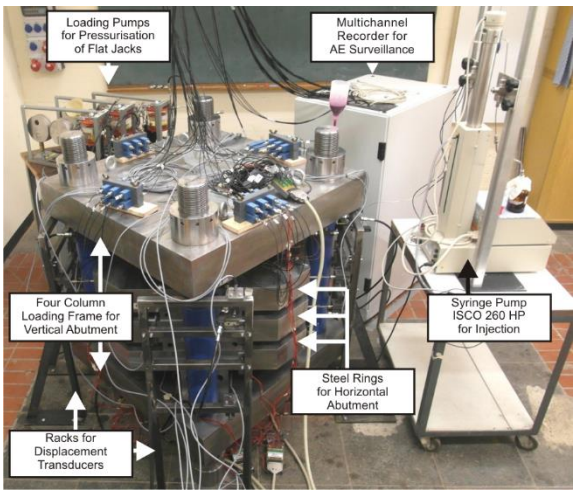
Geotechnik im Bauwesen
Geotechnical Engineering
Univ.-Prof. Dr.-Ing. Martin Ziegler

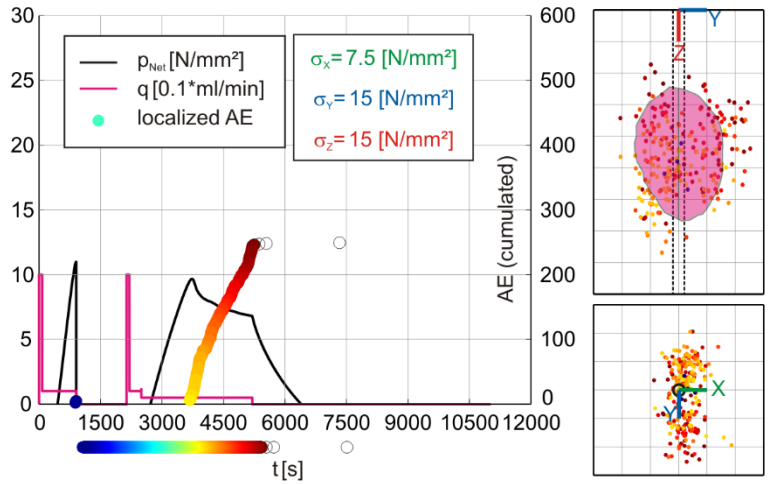
Laboratory Experiments on Hydraulically Driven Fractures in Dense Plutonic Rocks

Motivation

Three institutes of RWTH Aachen University investigate the propagation of hydraulically driven fractures in dense plutonic rocks in a joint research project funded by the Federal Ministry for Economic Affairs and Energy. The current project is the first step in the „Development of a design tool for Hot Dry Rock (HDR) fracture systems“. The principle of HDR systems is to stimulate fractures in great depth (3-5 km), to use them as heat exchangers for a fluid that is pumped through and thereby heating up. The stimulation is mostly carried out by pressurizing sealed borehole sections until a fracture opens and propagates with continued injection. Especially for this project, a new testing device to run hydraulic fracturing experiments in plutonic rocks has been developed by the Chair of Geotechnical Engineering. The test results are used to verifiy a numerical simulation of the fracture propagation that is based on the extended finite element method (XFEM).



New test device



left: Injectionrate, -pressure and cumulated AE
right: Fracture area and AE projected into plane Y-Z and X-Y

Laboratory Experiments

The tests start by setting up an initial stress state onto the specimen (300 mm x 300 mm x 450 mm). Stresses up to 15 N/mm² in horizontal direction and stresses up to 30 N/mm² in vertical direction can be applied. This maximum stress equals an overburden of about 1000 m. The fractures are initiated and propagated by injecting fluid with constant flow rate into a sealed borehole section with a high pressure syringe pump. Reaching the break down pressure, a fracture grows from the boreholes´ wall into the specimen. Initiation and propagation of the hydraulically driven fractures are monitored by recording acoustic emissions (AE), measuring the pressure of injection, the flat jack pressure/volume and the deformation of the specimen itself.

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