Hydraulic Stimulation and Geophysical Fracture Monitoring in the GeneSys-Project

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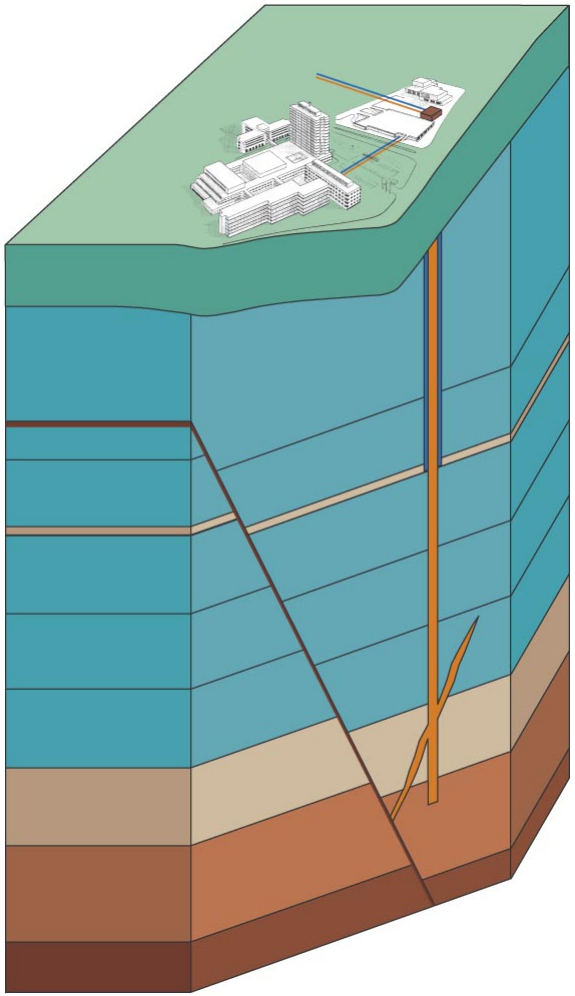
Objective



- supply geothermal heat for direct use
- use one-well concepts

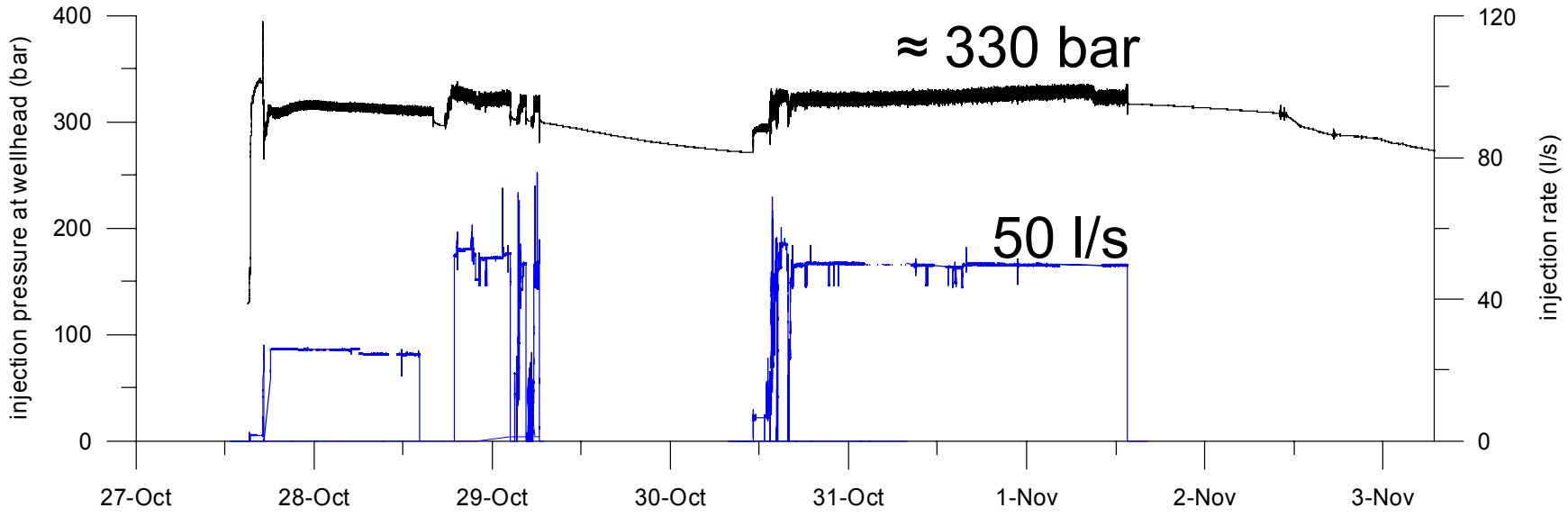
thermal power:	2 MW
flowrate:	25 m^3/h
temperature:	130 °C
costs:	7.5 Mio €

GeneSys

- sedimentary rocks
- low porosity & permeability
- create artificial geothermal systems (EGS)
- transfer waterfrac technology to sediments
- Is there a self propping mechanism for sediments?
- fracture propagation in layered sediments?
- ….

Stimulation operations

- Injection of 20.000 m³ fresh water
- Creation of a large fracture with high conductivity



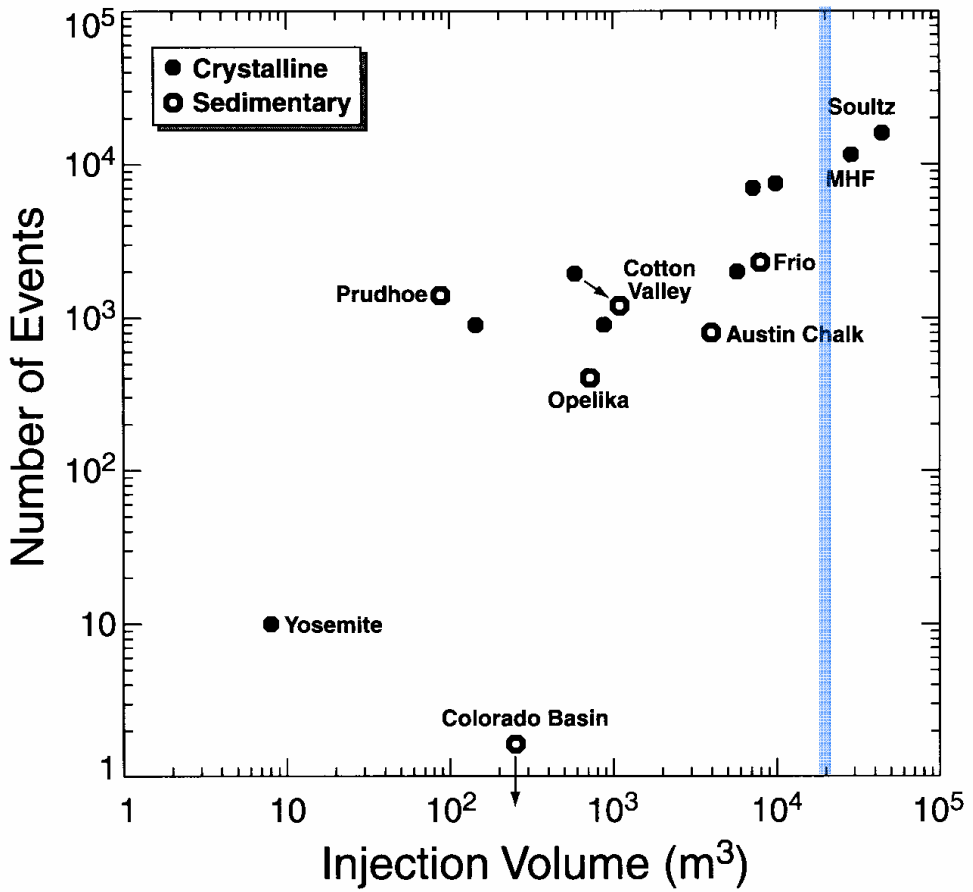
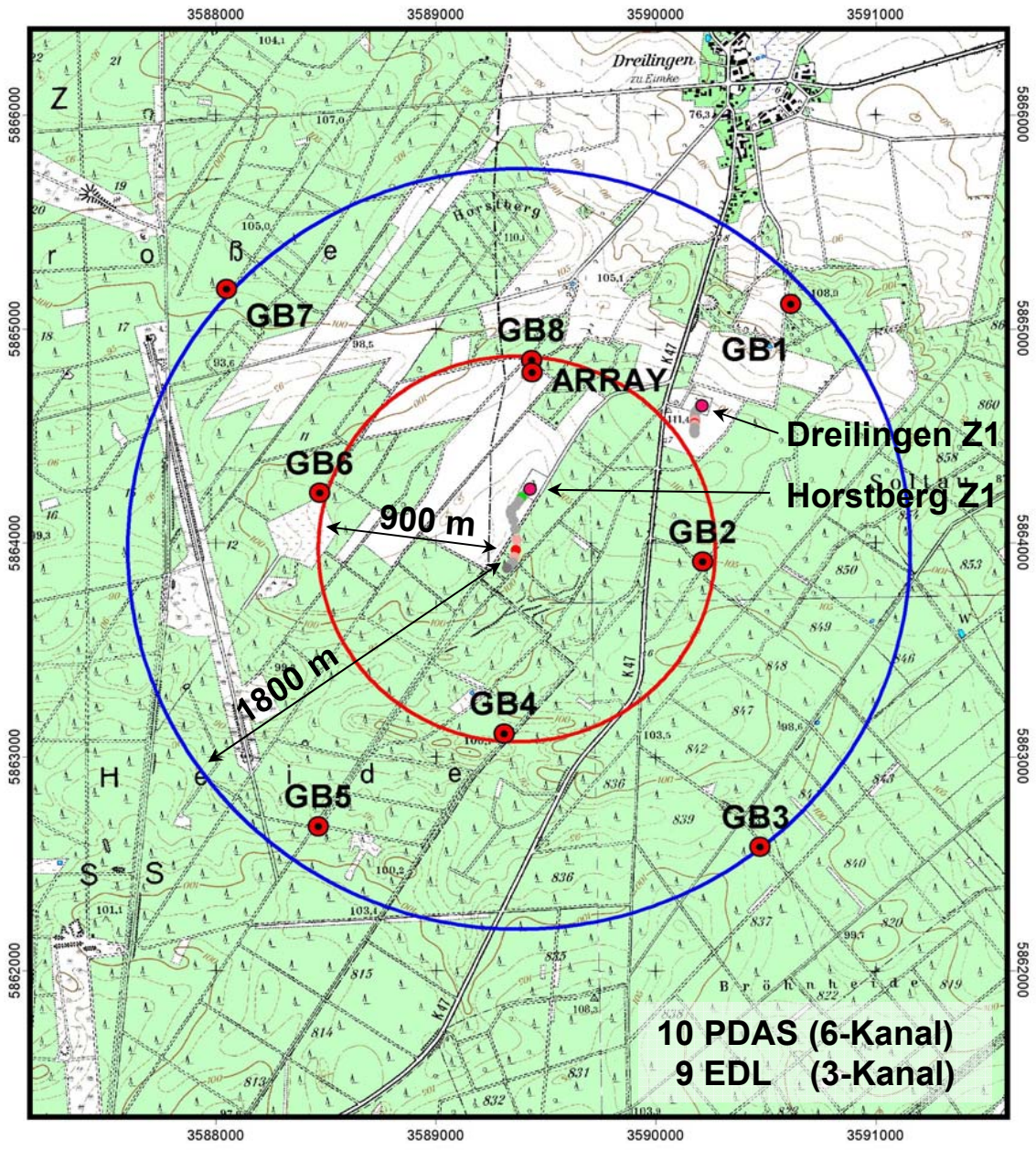


Figure 1

Number of recorded events versus injection volume from a sampling of crystalline and sedimentary reservoir experiments. Crystalline rock experiments are represented by filled circles and include many Fenton Hill injections. Sedimentary experiments are represented by open circles. The Colorado basin experiment produced no observable events, as indicated by an arrow. Results from a Cotton Valley injection coincide with a Fenton Hill experiment, also indicated by an arrow.

Phillips et al. 2002



3 - component 4,5 Hz geophone

GGA INSTITUT

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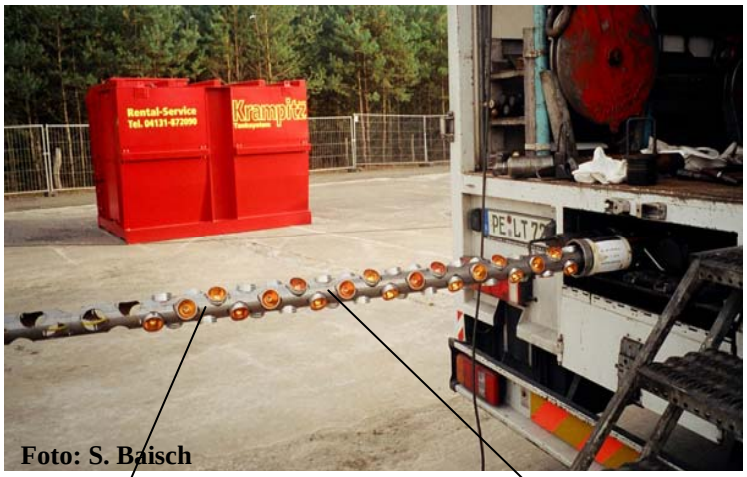


Foto: S. Baisch

charges (each 30 g)

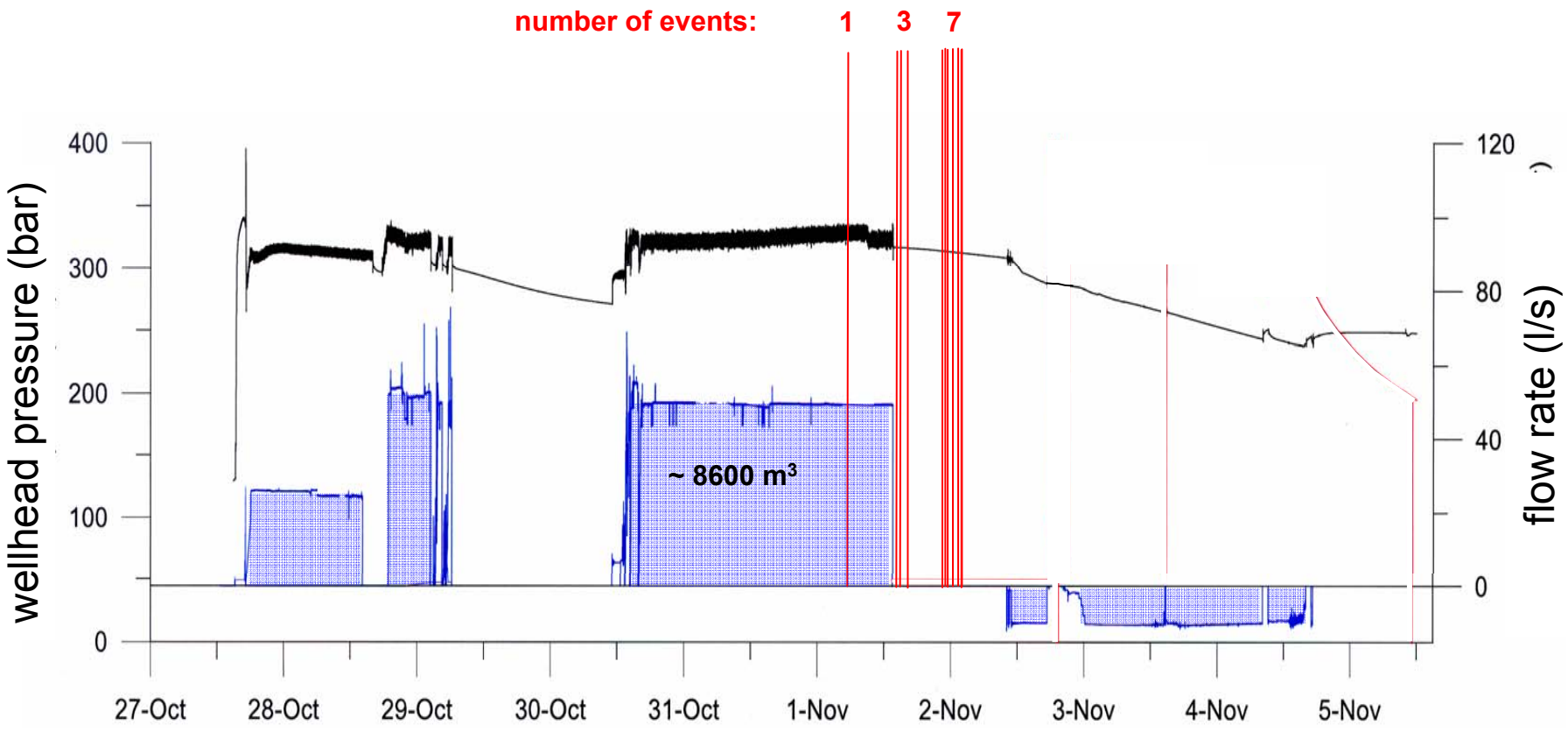
use seismic signals from perforator guns to:

- calibrate velocity model

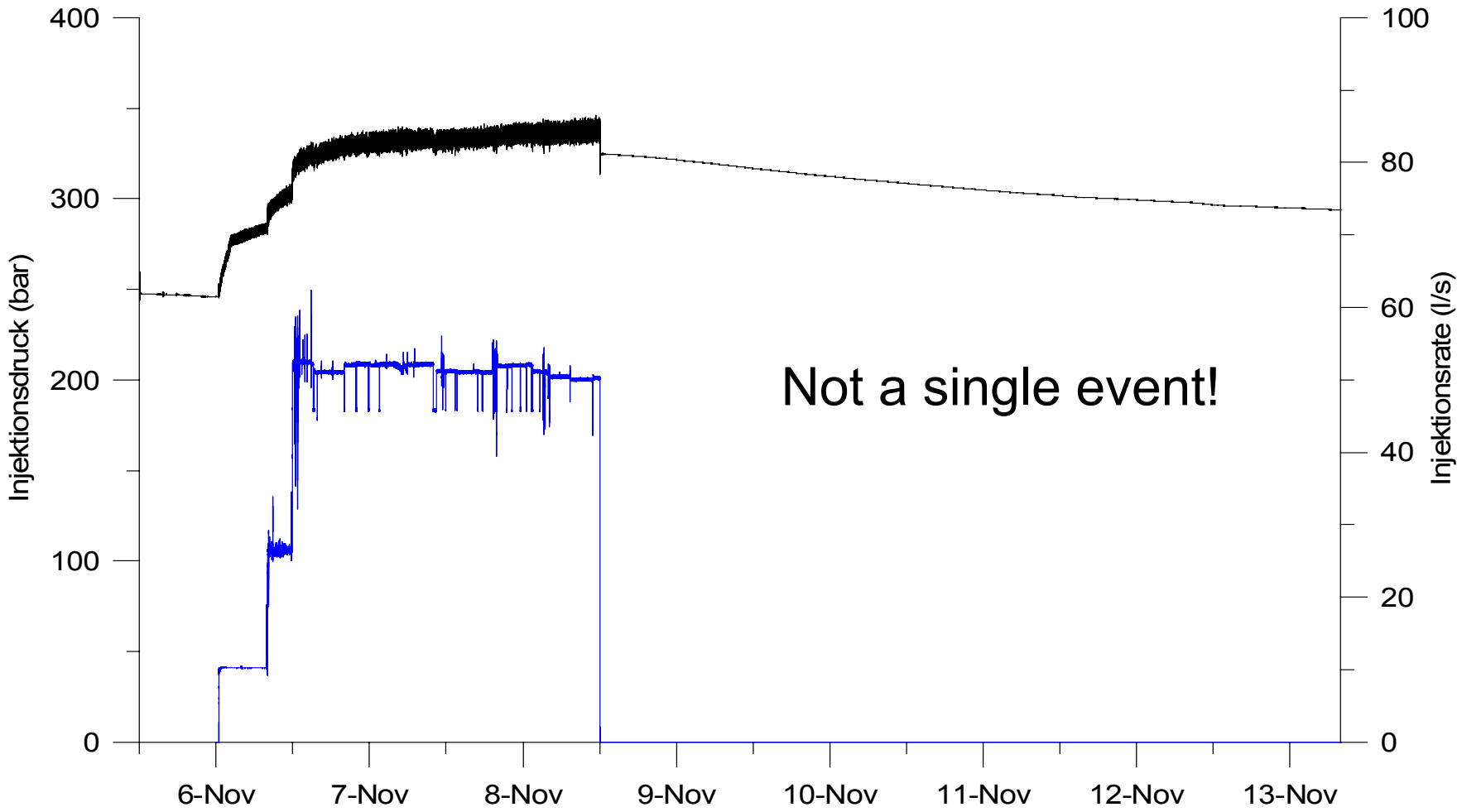
- estimate detection level (seismic efficiency only vaguely known)

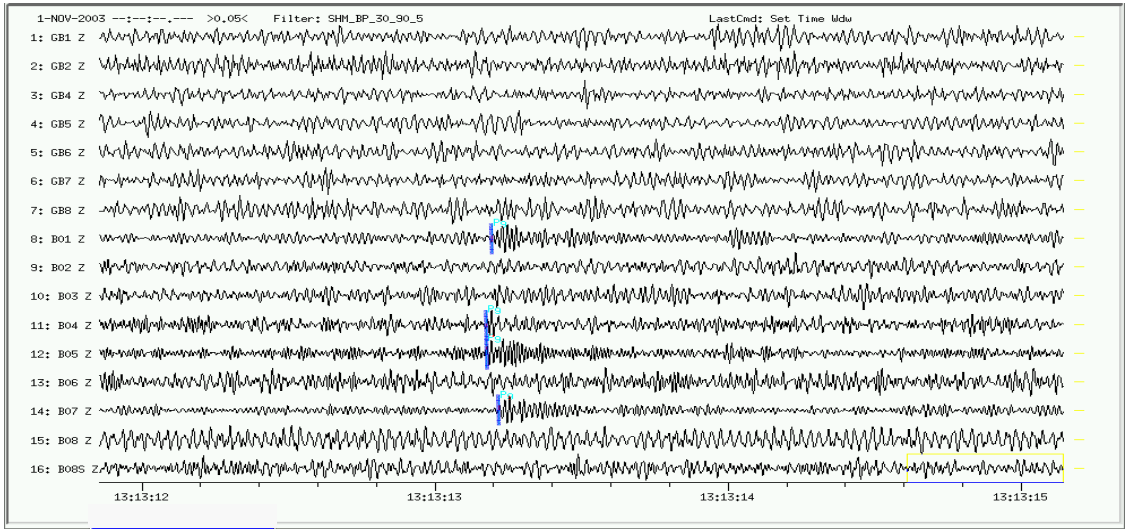
- **M ~ 0. to -0.5** (comparable to Soultz)

Induced seismicity – temporal occurence

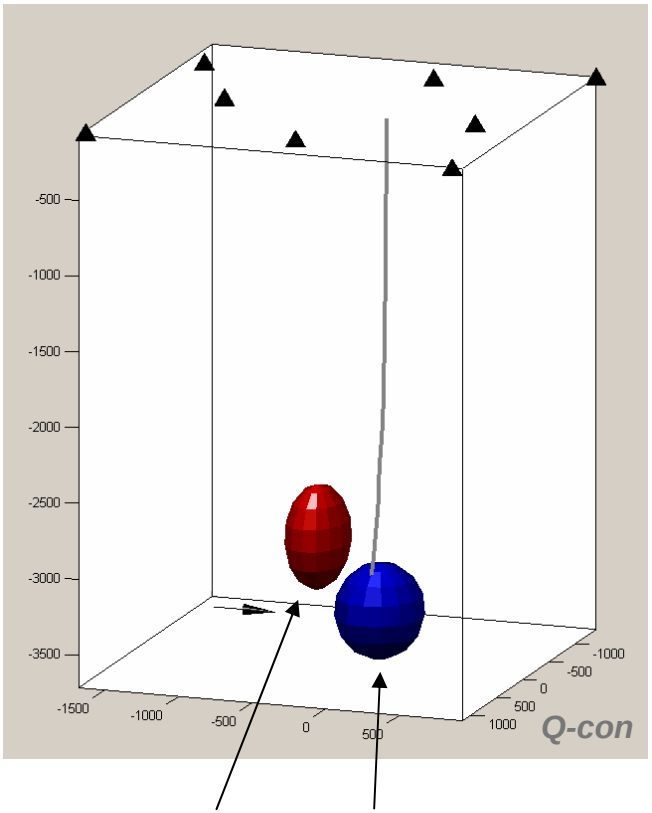


Second Stimulation

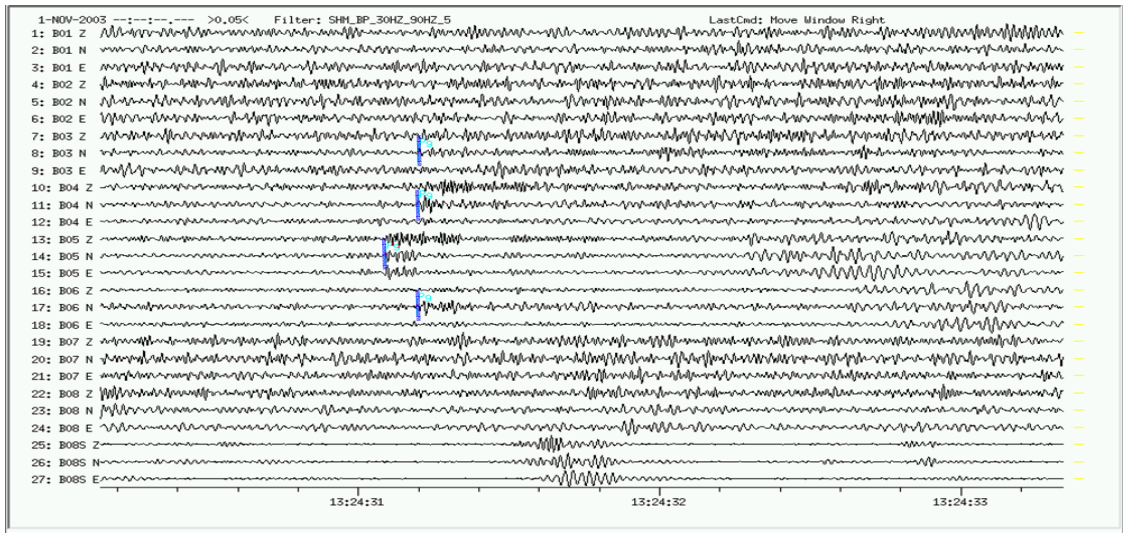




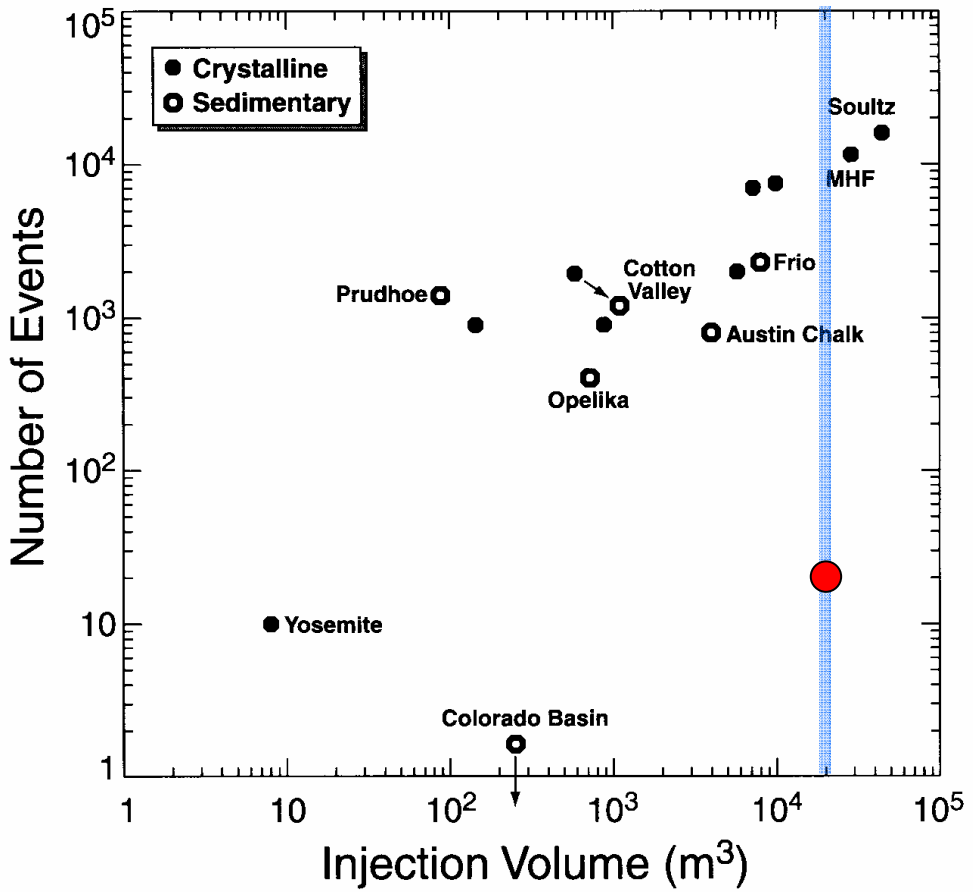
Seismic Event 1.11., 13:13:11. all stations, z-component



Event 13:13:11 / 13:24:29



Seismic Event 1.11., 13:24:29. EDL - stations, all components, bandpass 30 – 90 Hz.



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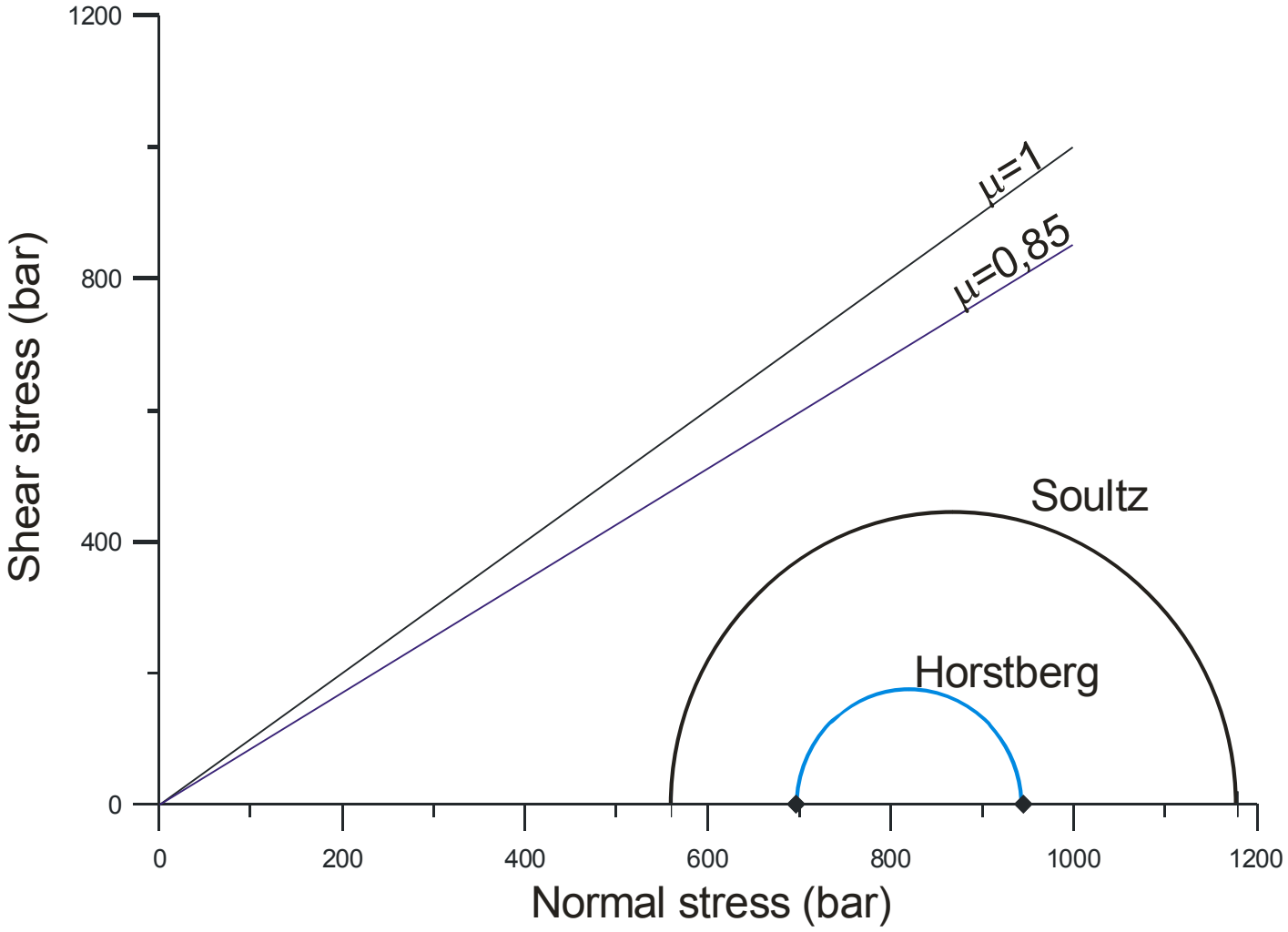
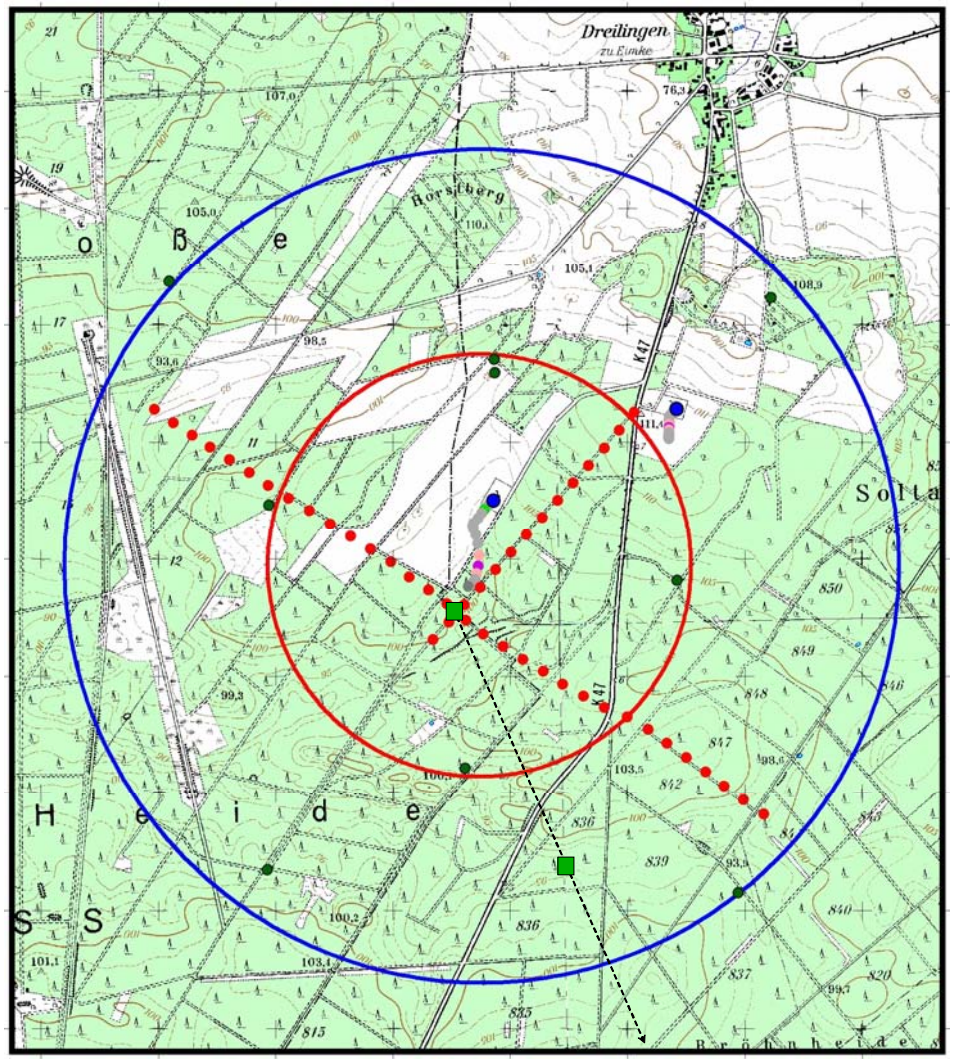
Phillips et al. 2002

Mohr Circle


1200
800
400
0
Shear stress (bar)
μ=1
μ=0,85
Soultz
Horstberg
0
200
400
600
800
1000
1200
Normal stress (bar)

Self-potential & tiltmeter

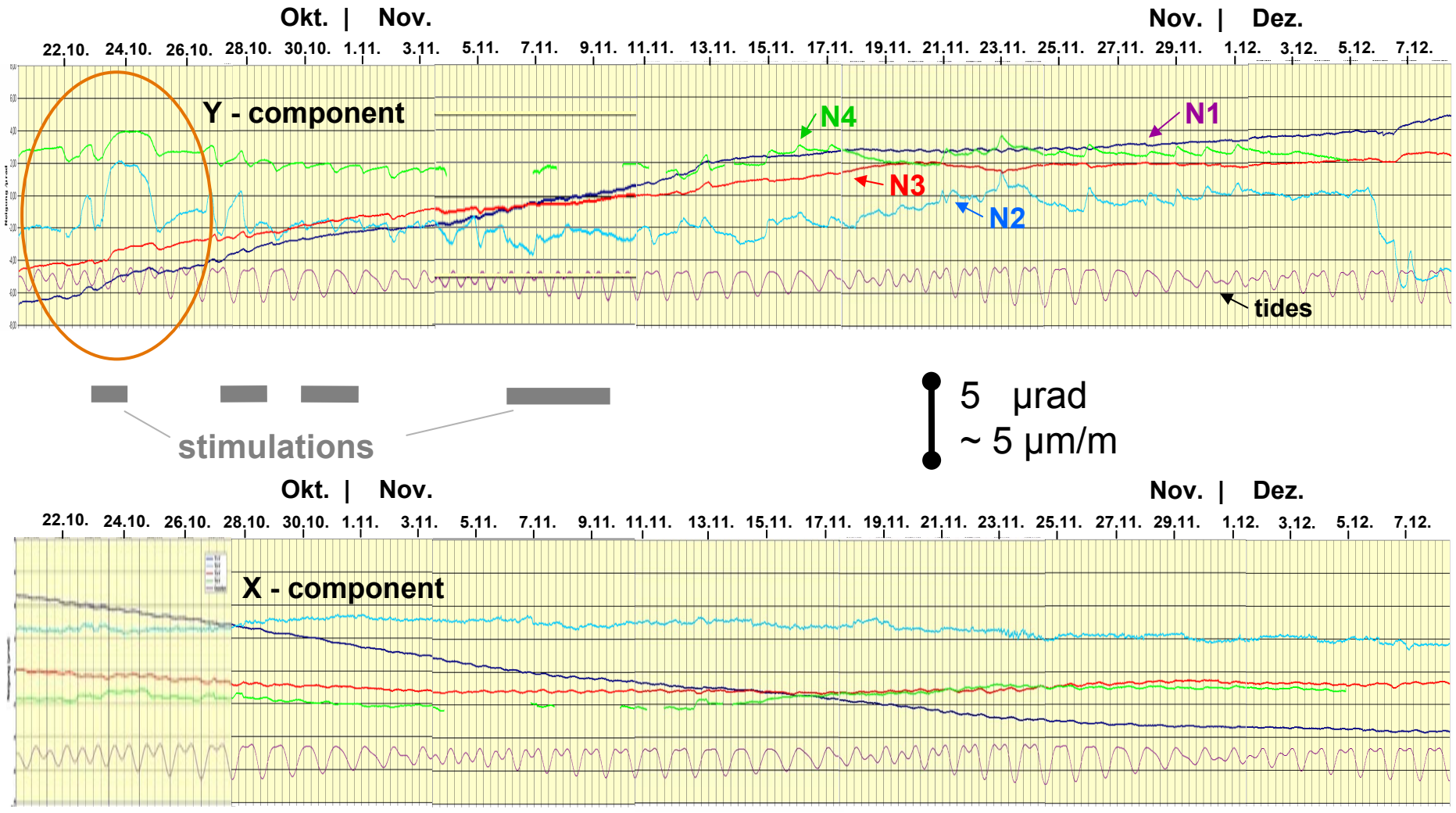


geophones tilmeter

self-potential

…no clear correlation to hydraulic activities…

Tiltmeter

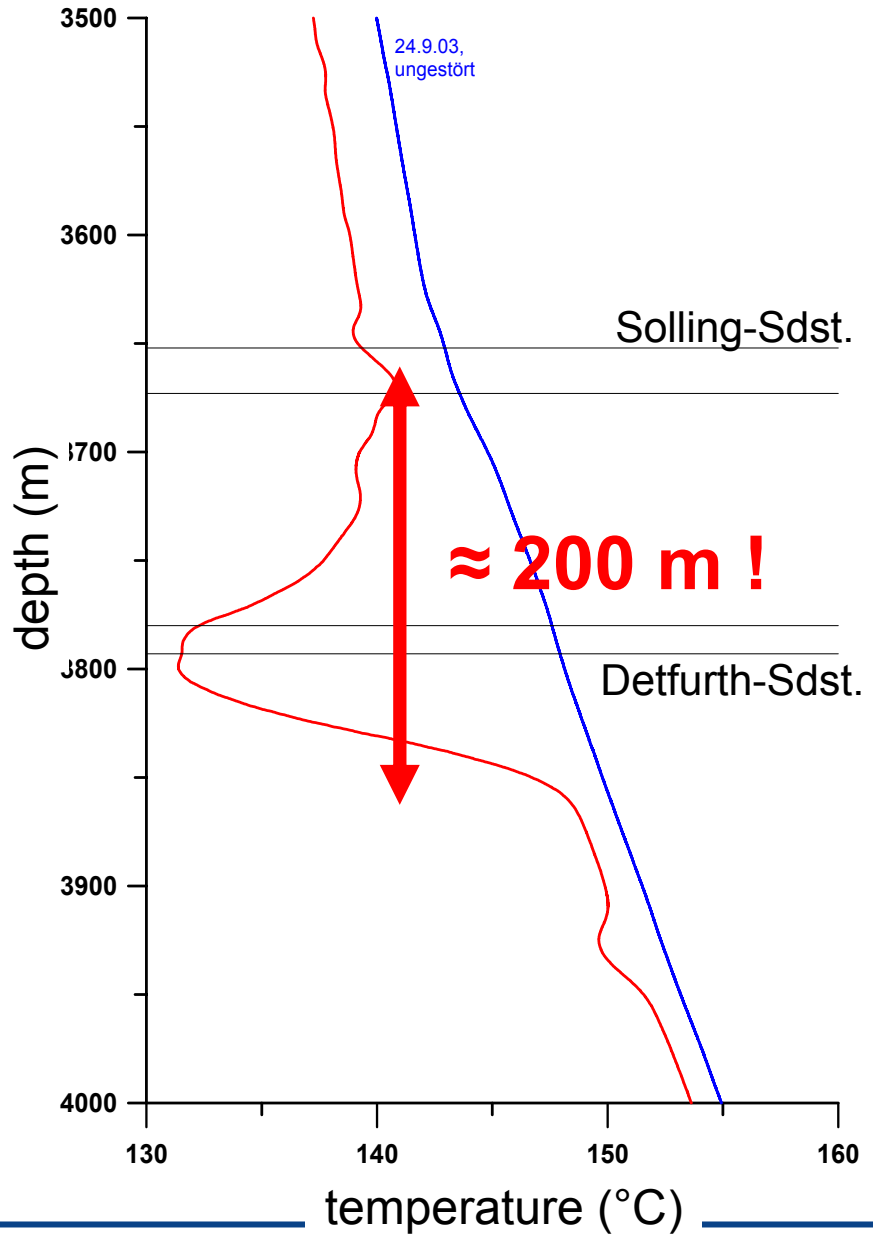

Okt. | Nov.
Nov. | Dez.
22.10. 24.10. 26.10. 28.10. 30.10. 1.11. 3.11. 5.11. 7.11. 9.11. 11.11. 13.11. 15.11. 17.11. 19.11. 21.11. 23.11. 25.11. 27.11. 29.11. 1.12. 3.12. 5.12. 7.12.
Y - component
N4
N1
N3
N2
tides
stimulations
5 µrad
~ 5 µm/m
Okt. | Nov.
Nov. | Dez.
22.10. 24.10. 26.10. 28.10. 30.10. 1.11. 3.11. 5.11. 7.11. 9.11. 11.11. 13.11. 15.11. 17.11. 19.11. 21.11. 23.11. 25.11. 27.11. 29.11. 1.12. 3.12. 5.12. 7.12.
X - component

outlook

- demonstration project Hannover
- 3.800 m deep well
- massive waterfrac-tests
- installation of a micro-seismic network in preparation

Conclusions/Summary

- propagtion of a large tensile fracture by injection of 20.000 m³ of fresh water
- only very few events detected
- Soultz-like events did not occur
- low stress difference between S_h and S_v: presumably no shearing, tensile fracture
- potentially numerous smaller events not detected
- deeper observation wells desirable, but too costly
- more experience from Hannover site 2007/2008

Estimate of fracture height

- fracture clearly propagates through clay stones
- vertical fracture extension approx. 200 m