New Approaches for Enhanced Geothermal Systems Research in Europe

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New Approaches for Enhanced Geothermal Systems Research

- Introduction – conceptual background – stress & fractures
- Re-use of an abandoned former gas exploration well
- Drilling a well oriented new well in the deep sedimentary reservoir
- Application of several treatments to enhance water productivity
- Lessons learnt

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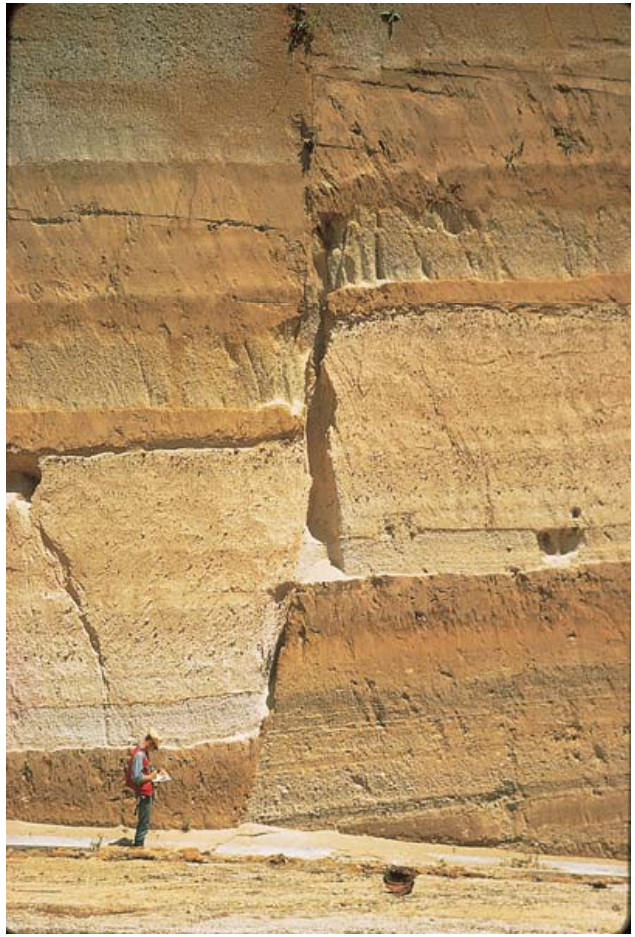

fracture systems

- observations
- geological/tectonic history
- mechanics – paleo and recent
- generated fracture systems

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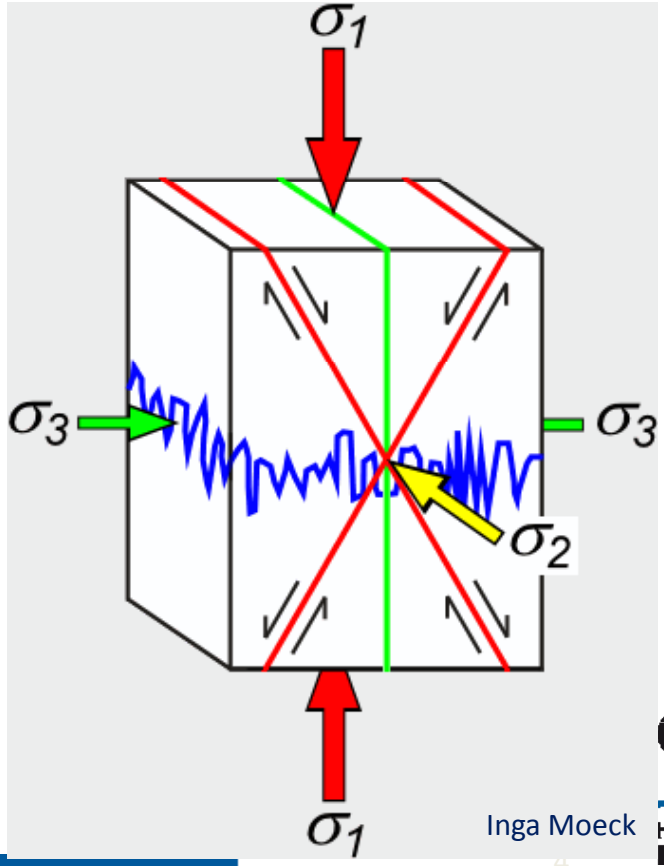
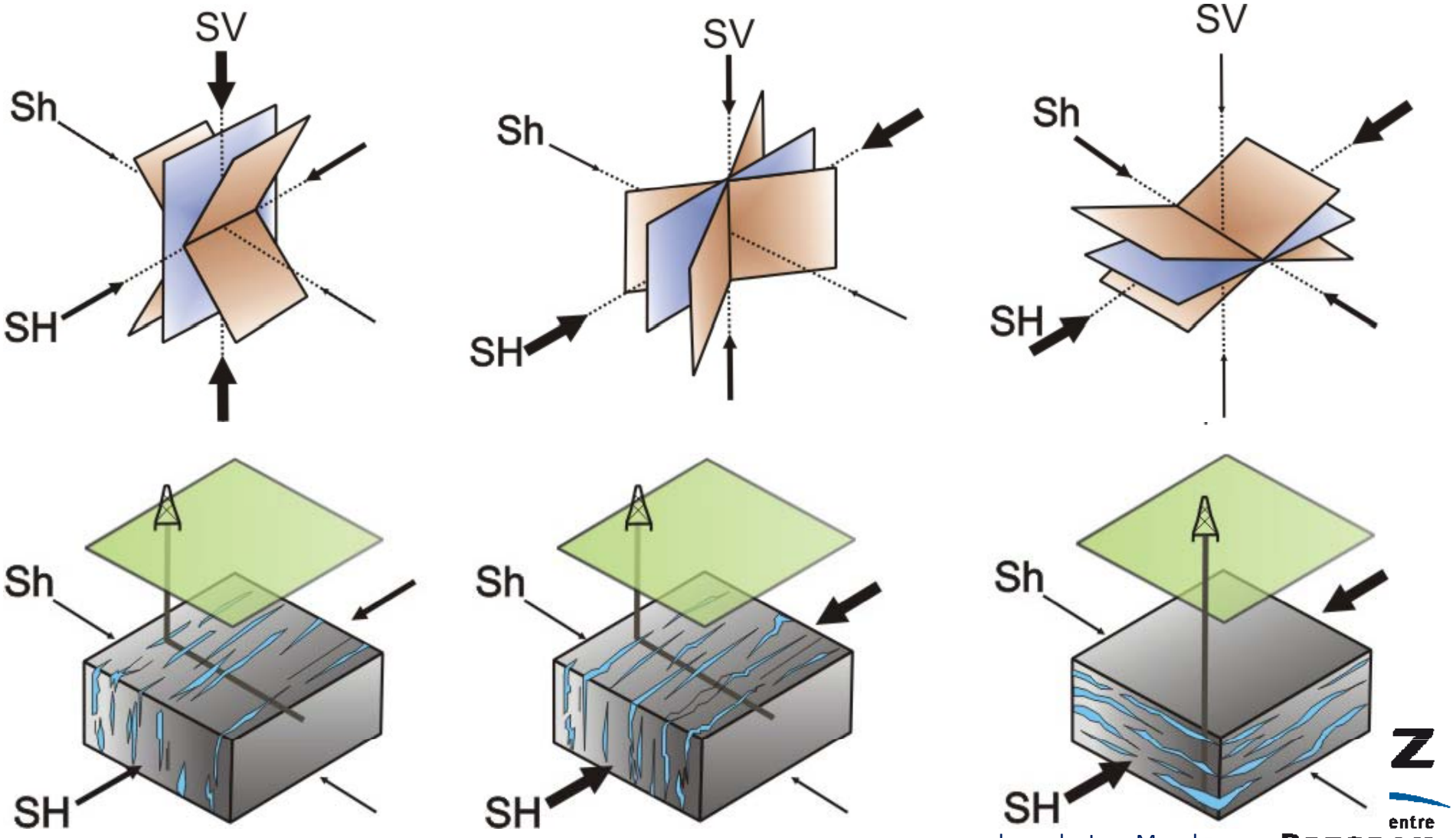
fracture systems as a result of forces

- stress tensor
- material: strength tensile, shearing
- characteric angle +/- 30° σ_1 / σ_3



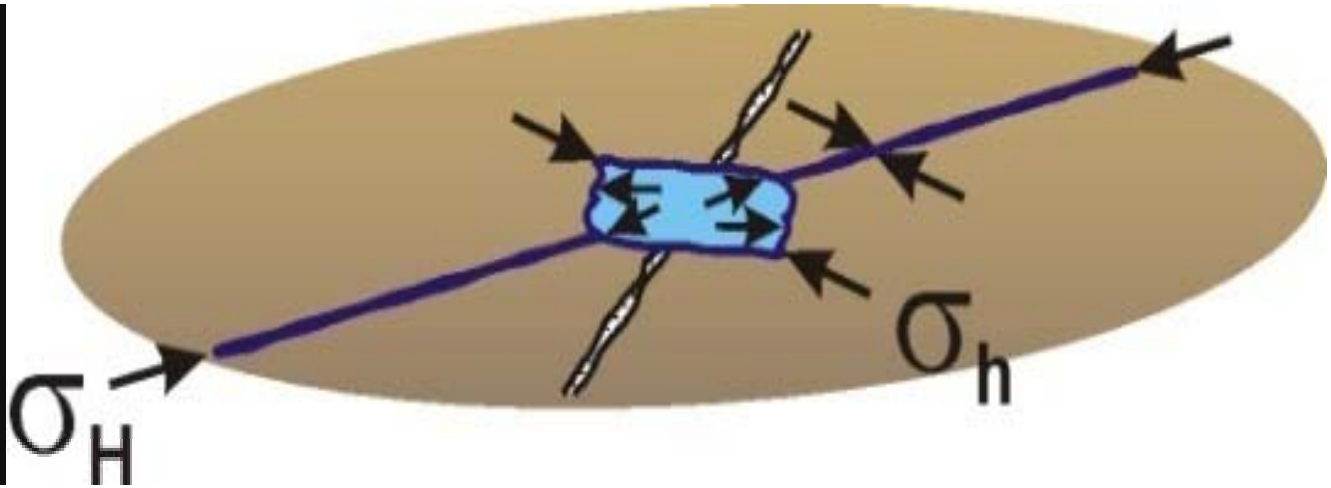
stress regimes and their impact to frac orientation

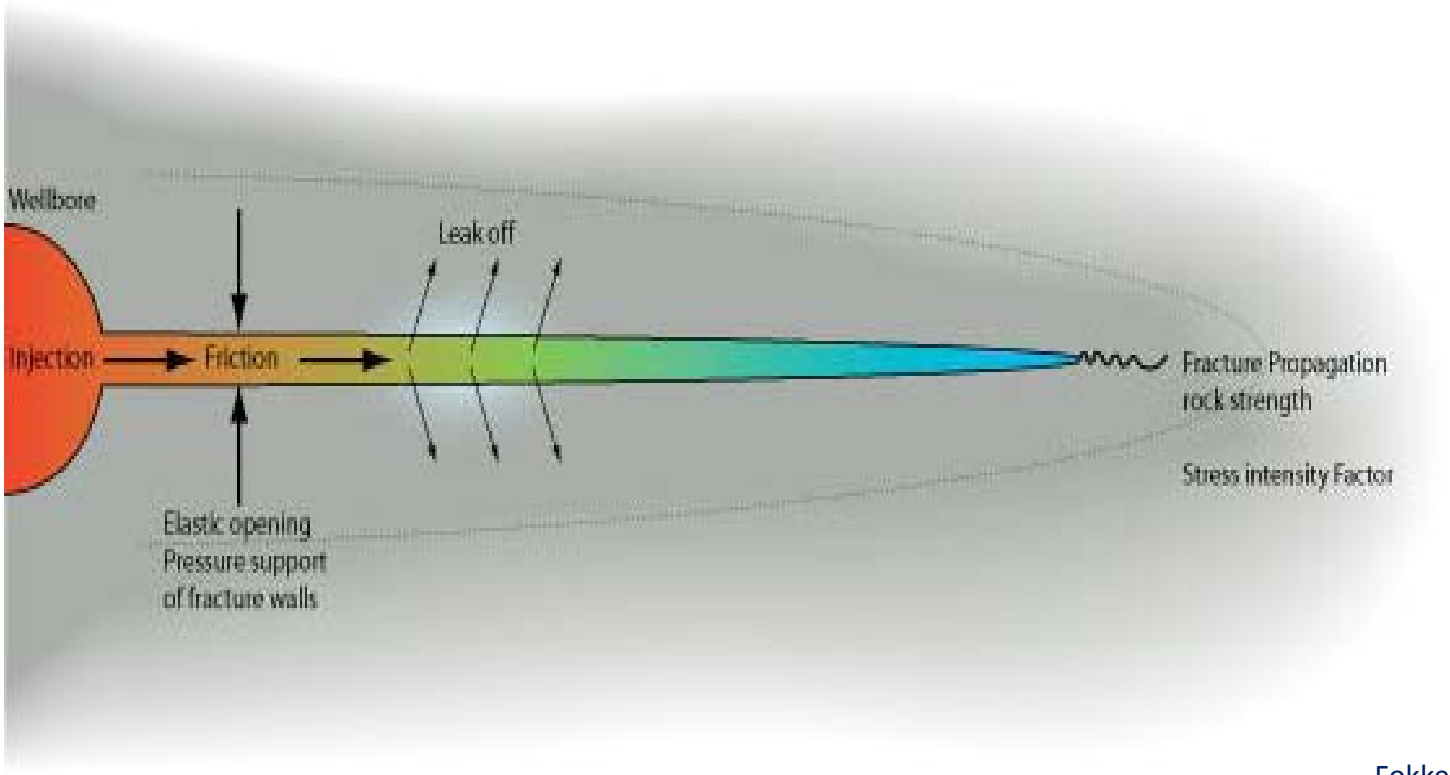
Normal Faulting | **Strike Slip** | **Reverse**



redrawn by Inga Moeck

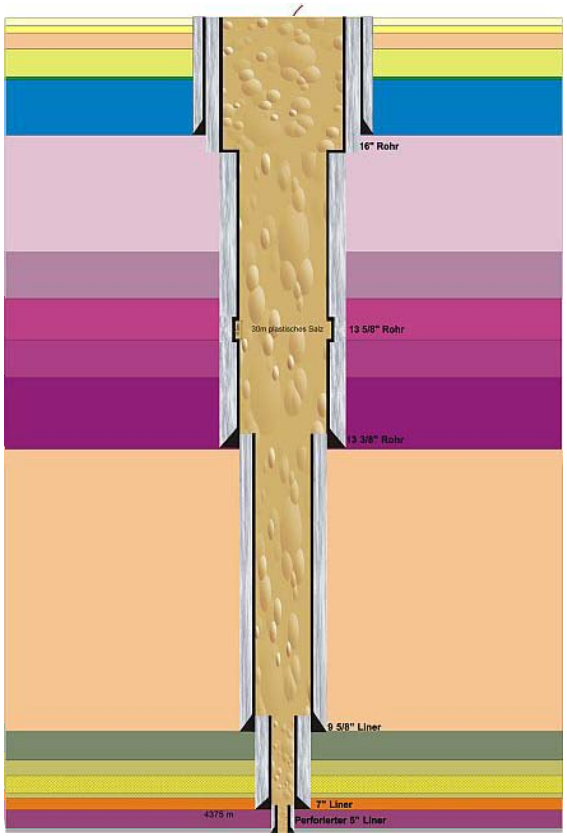
hydraulic stimulation (Enhanced Geothermal Systems)

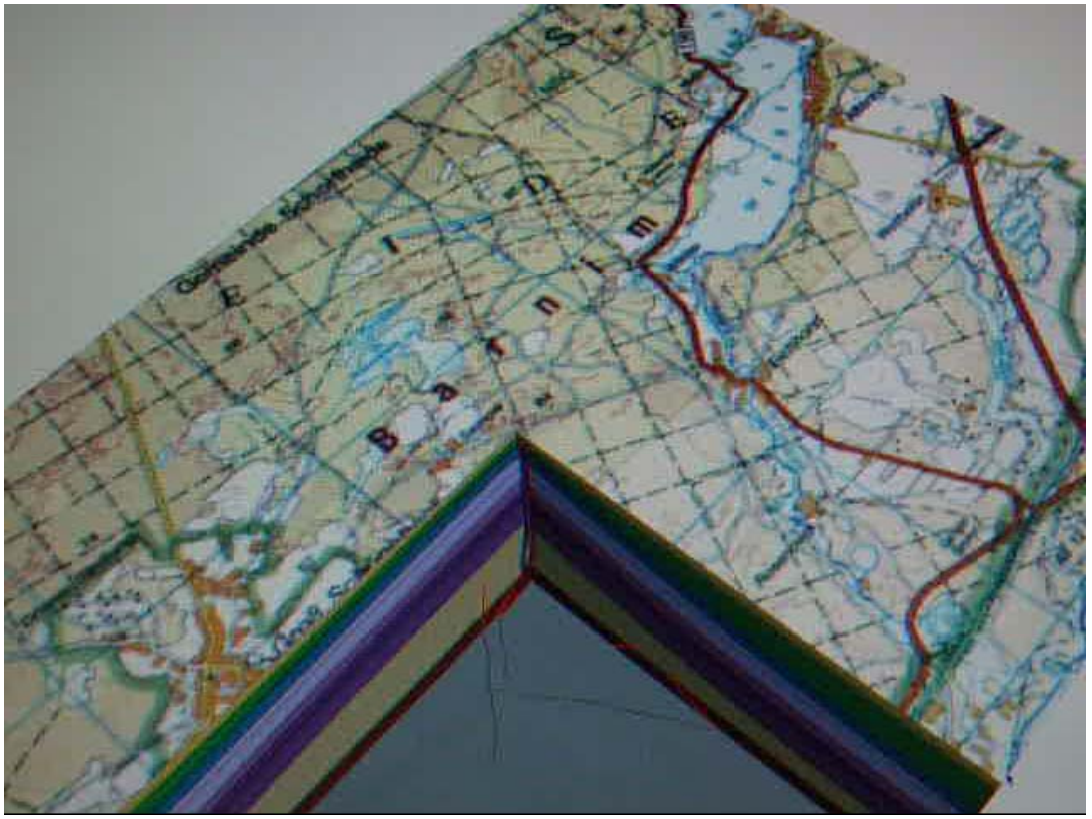




Fokker 2007

In situ Geothermielabor Groß Schönebeck





- In situ geothermal lab with 2 research wells in sediments (4.3 km depth and 150 °C)
- 2nd drillhole with new concept (large diameter, deviated well, and no formation damage)
- reservoir rocks of both wells successful treated with „hydraulic-fracturing“

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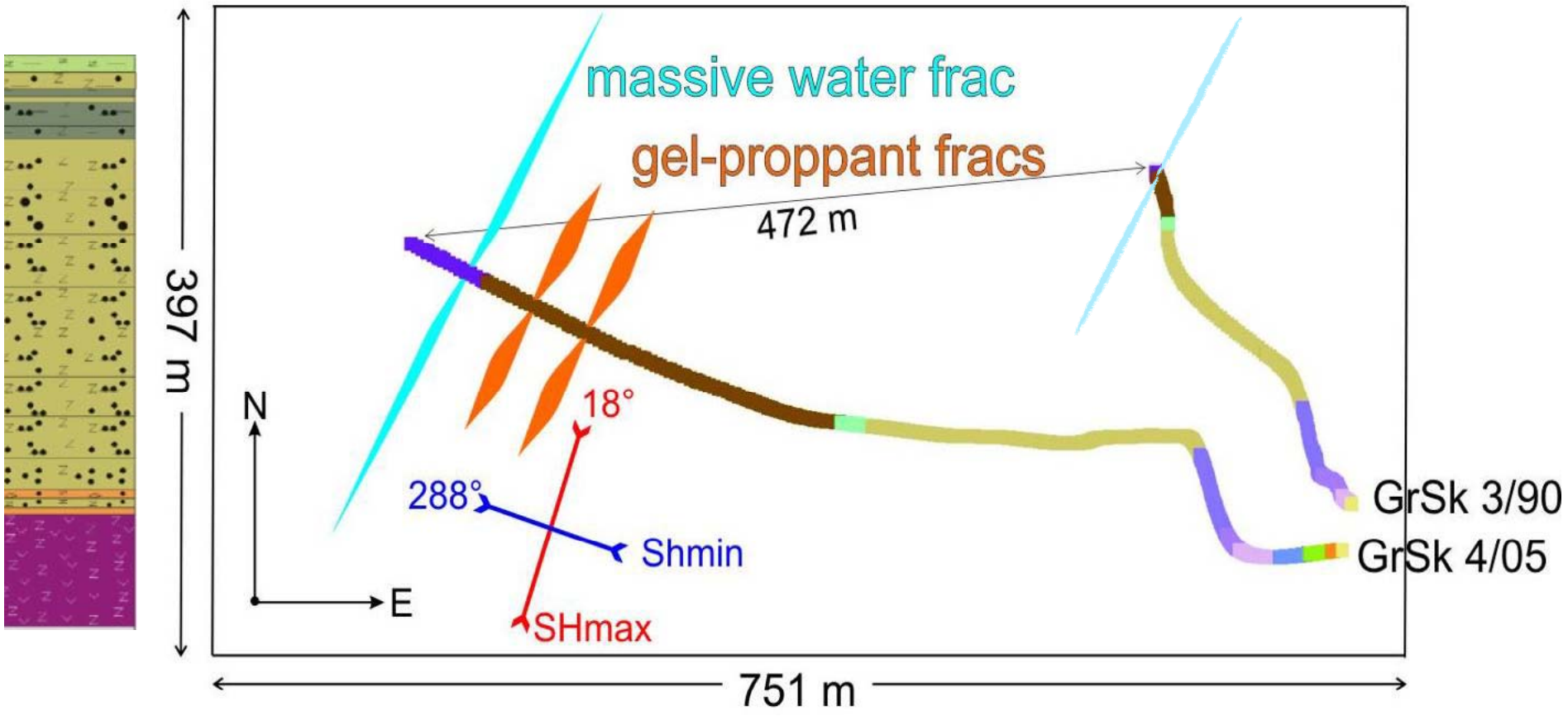
reservoir engineering



frac equipment

well head

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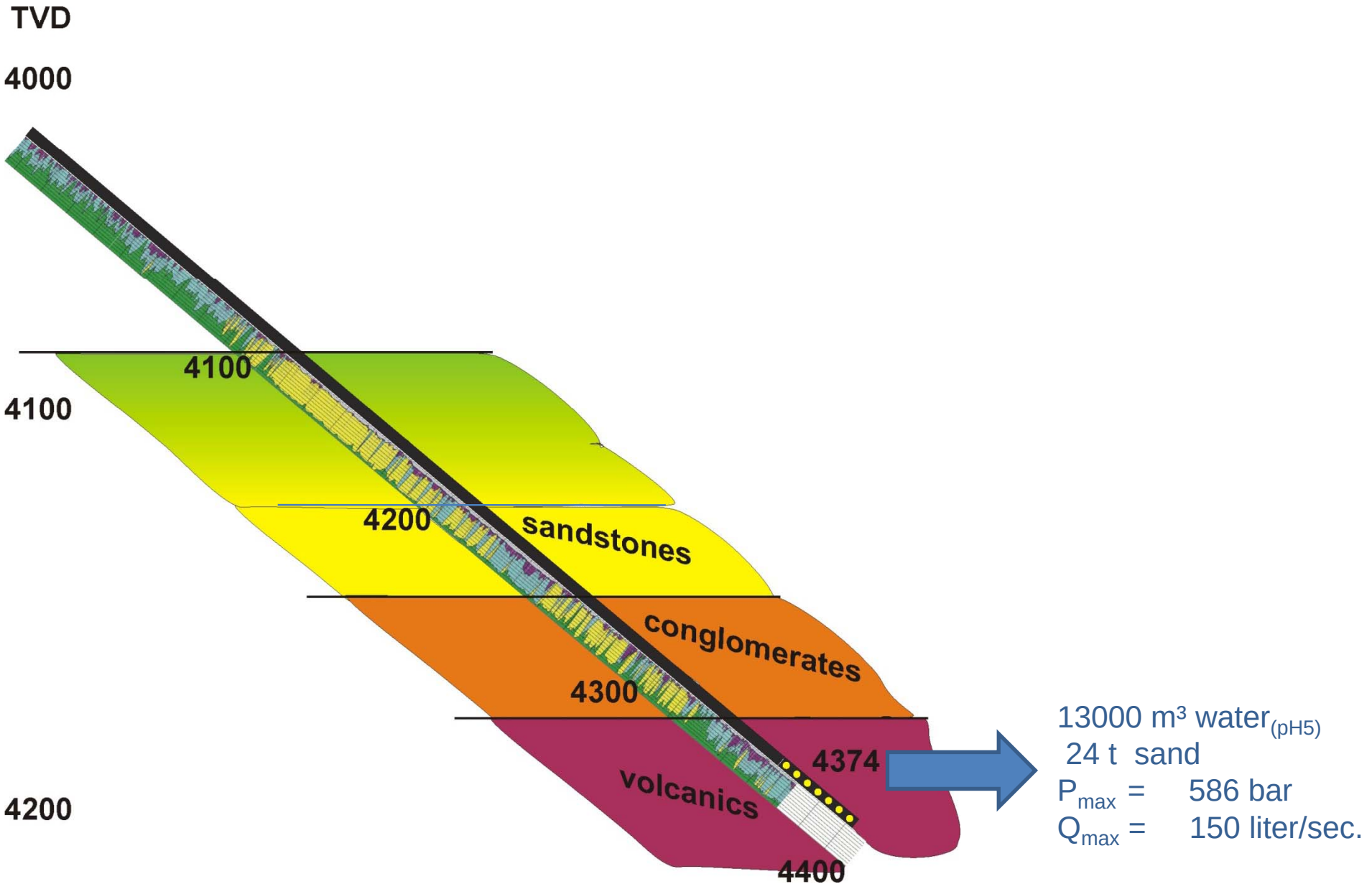
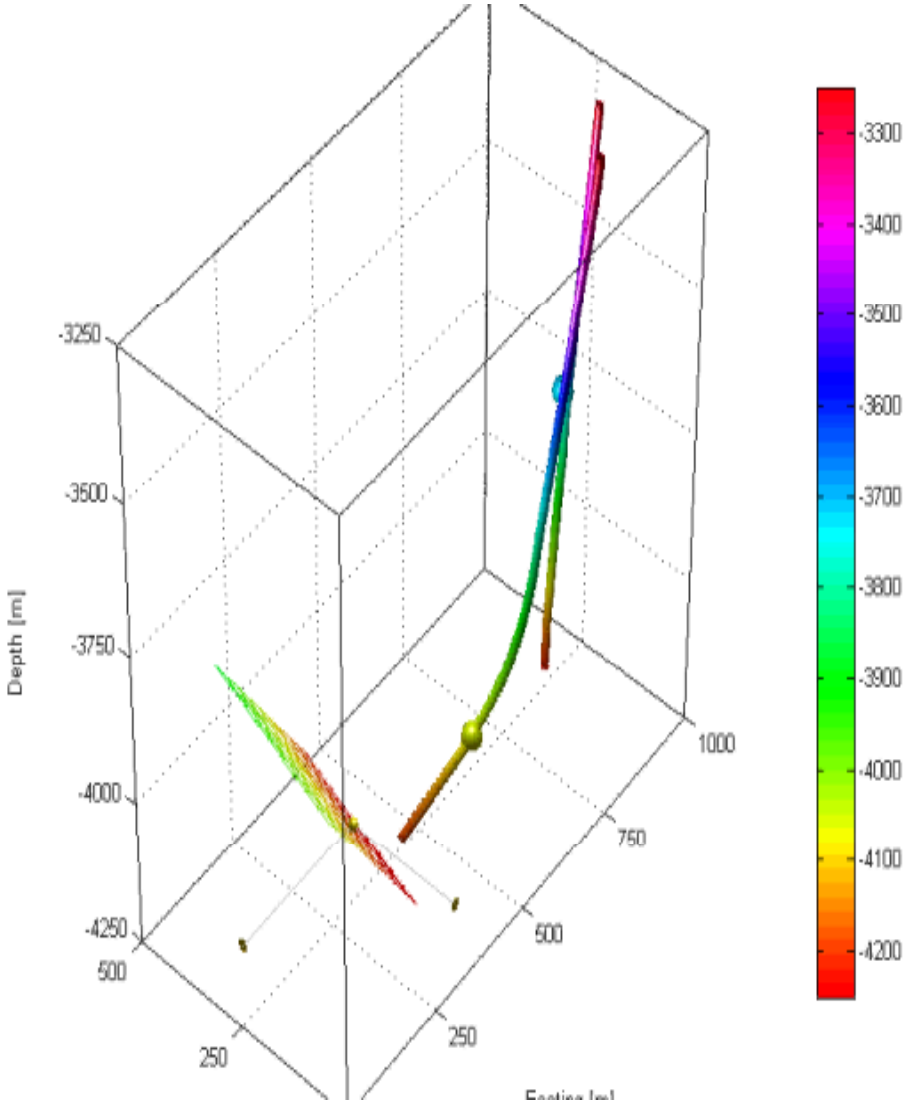


Zimmermann et al. In prep.

end of waterfrac treatment

relocation of induced seismic events



-2 < M < -1

refined stimulation treatments to enhance hydraulic productivity while reducing the risk of seismic hazard. EU-project GEISER

Kwiatek et al. 2009
submitted

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TVD

4000

4100

4100

4200

sandstones

conglomerates

4300

4374

volcanics

4400

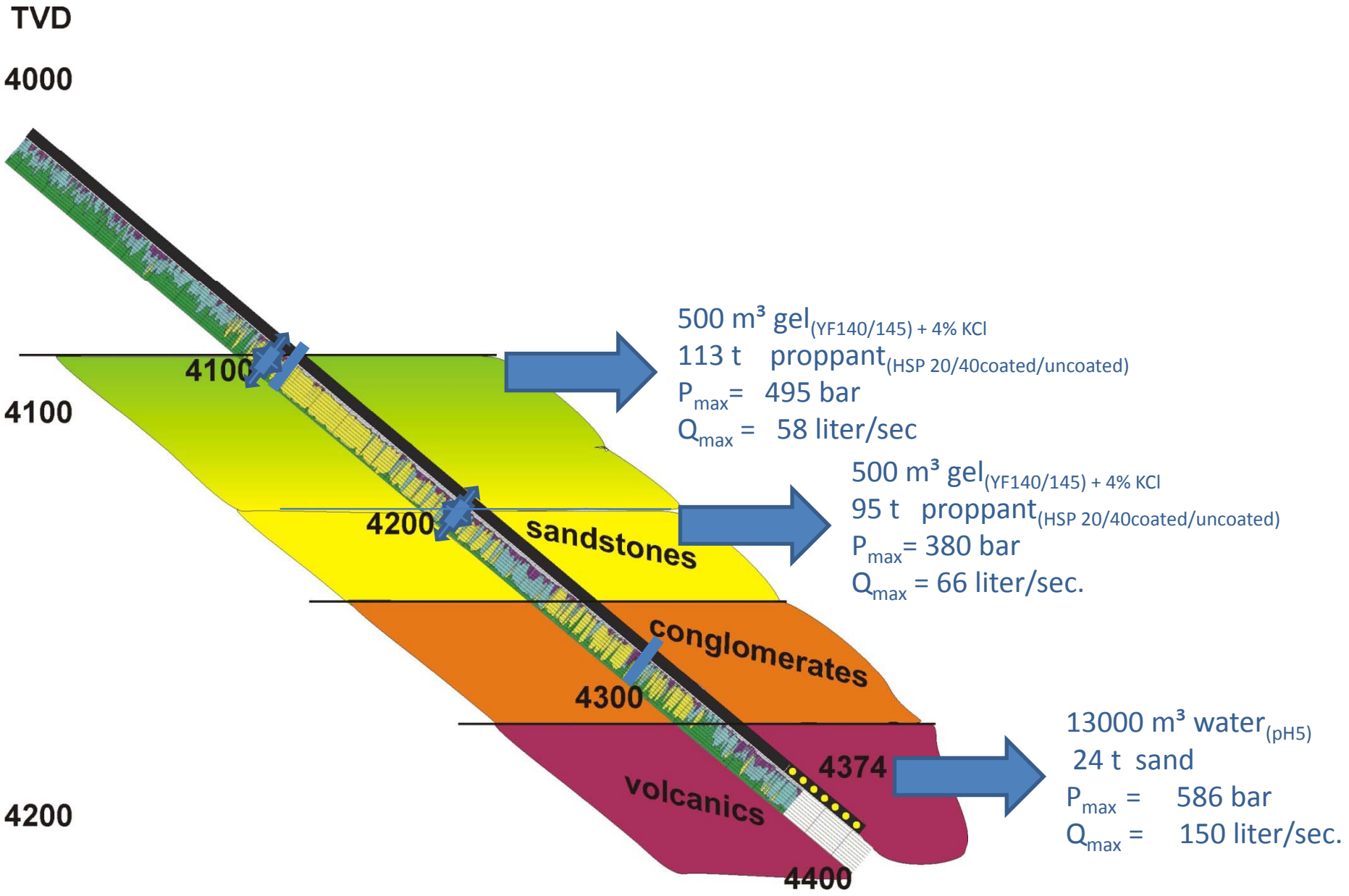
500 m^3 $gel_{(YF140/145) + 4\% KCl}$

95 t $proppant_{(CarboHSP\ 20/40coated/uncoated)}$

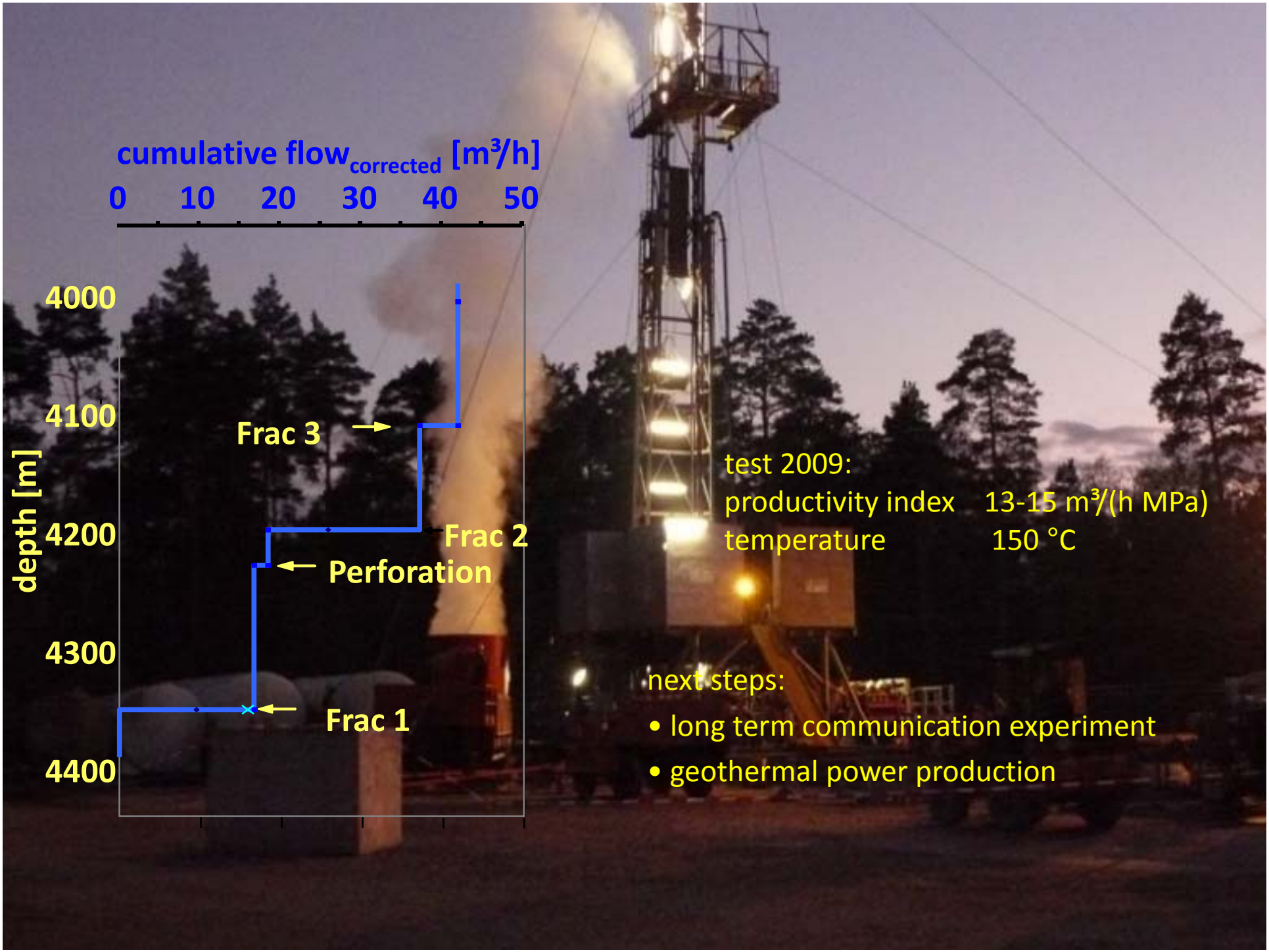
P_{max} = 380 bar

Q_{max} = 66 liter/sec.

Zimmermann et al. In prep.



Zimmermann et al. In prep.


cumulative flow corrected [m³/h]
0
10
20
30
40
50
depth [m]
4000
4100
4200
4300
4400
Frac 3
Frac 2
Perforation
Frac 1
test 2009:
productivity index 13-15 m³/(h MPa)
temperature 150 °C
next steps:
• long term communication experiment
• geothermal power production

lessons learnt

- engineering a deep sedimentary reservoir feasible with sufficient (short-term) tested productivity
- practise for drilling a deep sedimentary geothermal well (large diameter, deviation ,& minimised formation damage)
- multisection hydro fracturing (waterfrac, gel-proppant frac)-technology developed
- doublet now available to test and qualify system components
- long-term circulation incl. monitoring beneath downhole pump

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Thank you for your attention

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