Research demand for geothermal development in Europe

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Outline:

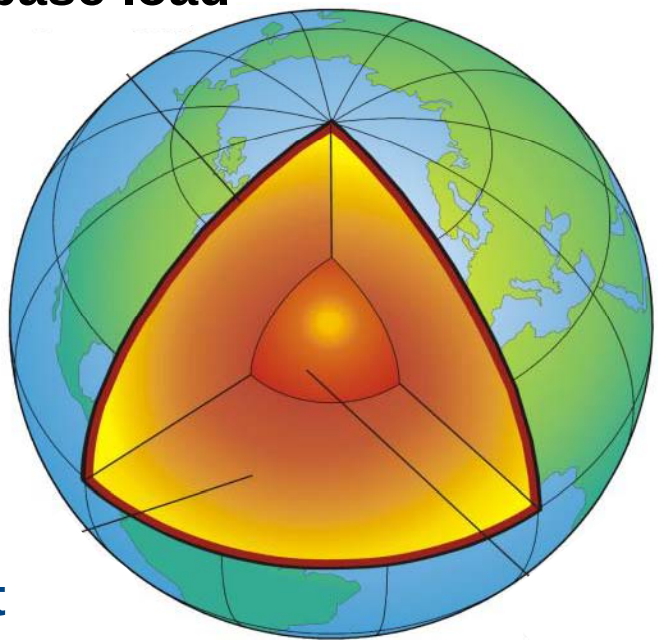
- Introduction
- Exploration strategies
- Soft stimulation treatments
- Mitigation of seismic hazards
- Corrosion and scaling
- Monitoring and modelling
- Storage of heat and chill
- Conclusions

Status and Potential

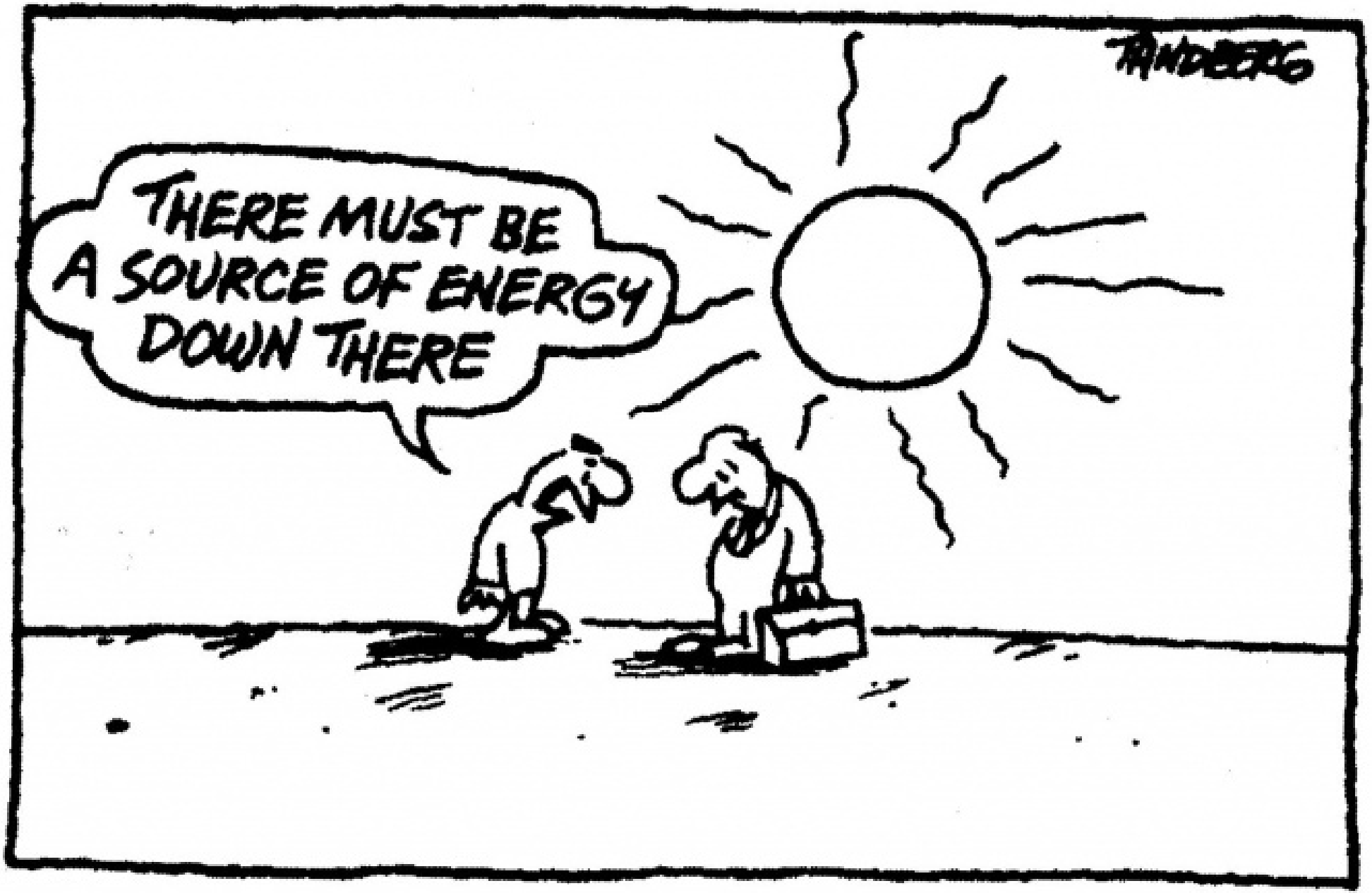
- Energy mix today: ~ 50 % heat, ~ 25 % electricity, ~ 25 % mobility

  from renewables:
  - ~ 11 % heat
  - ~ 25 % electricity

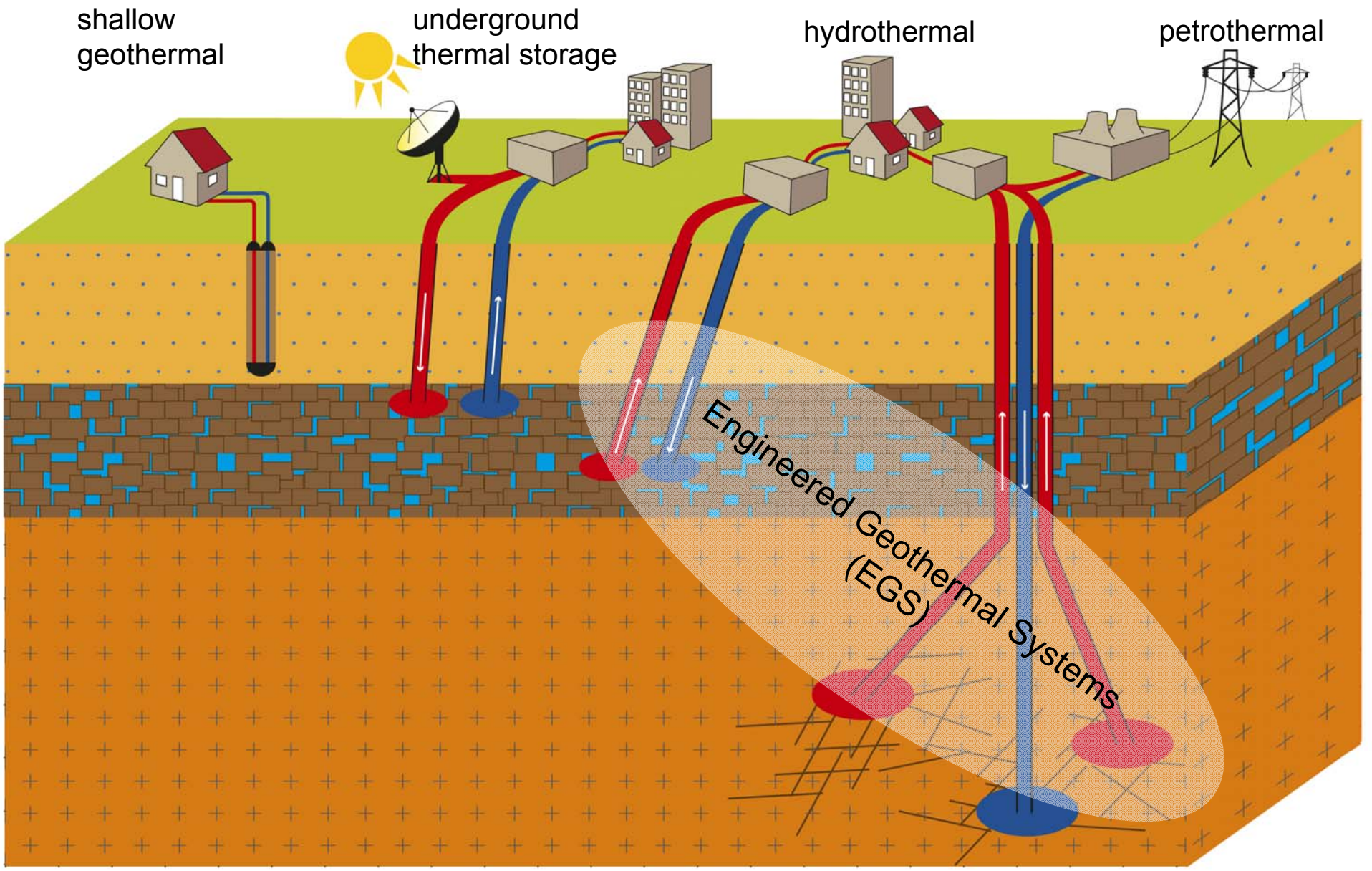
- Future energy requirements:
  - **renewable heat, & dispatchable and decentral base load**
- Contribution of geothermal energy
  - **domestic resource** (up to **5 % of electricity** and **10 % of heat** demand in Germany)
  - potentially **fulltime available**
  - **advanced technology**



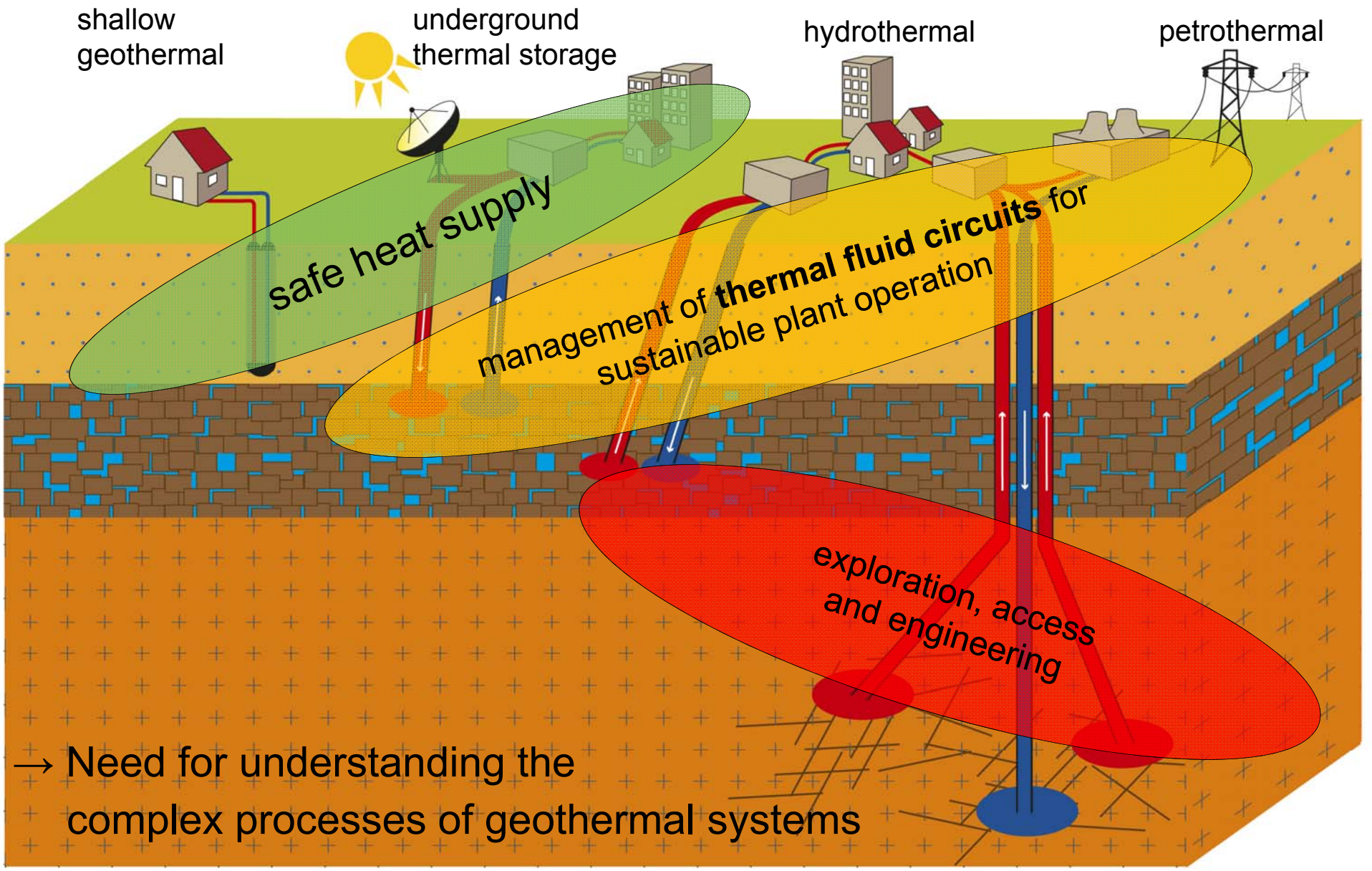
→ **stabilisation of the market for electricity and heat**


THERE MUST BE A SOURCE OF ENERGY DOWN THERE

Geothermal Energy Systems



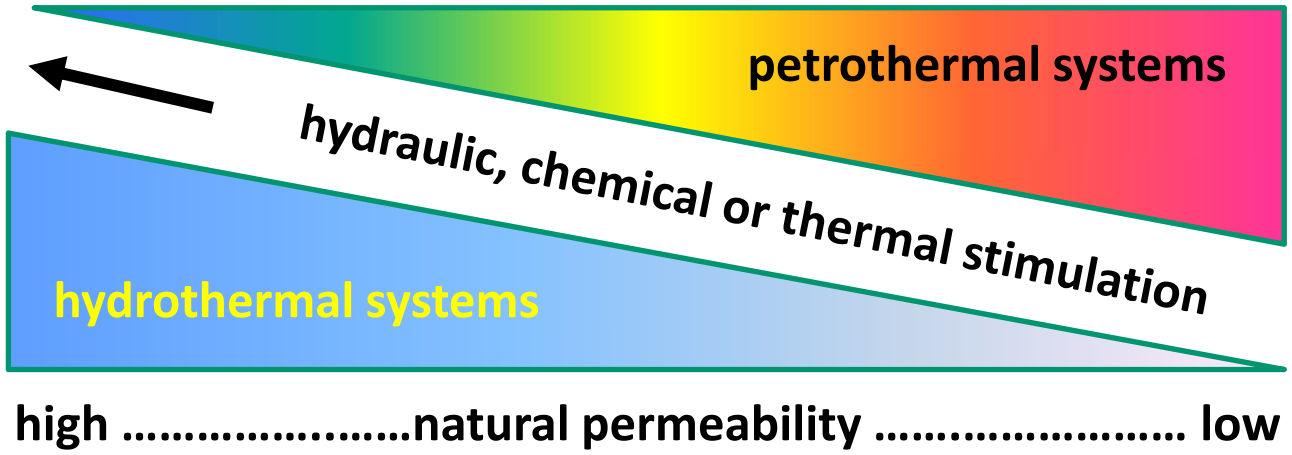
Key Scientific Challenges

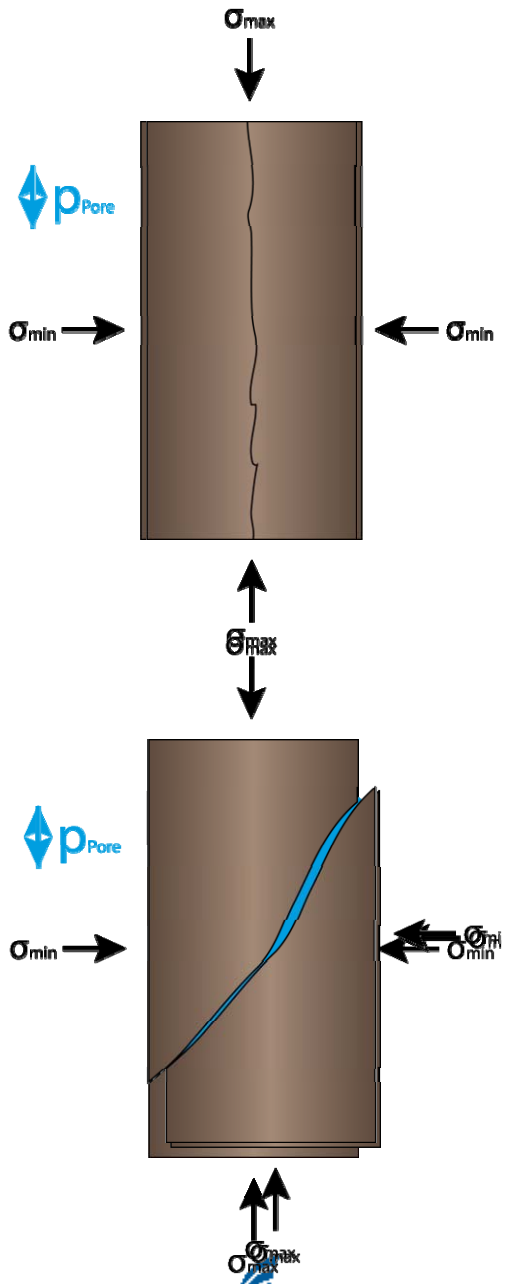


Public acceptability: environmental issues and communication

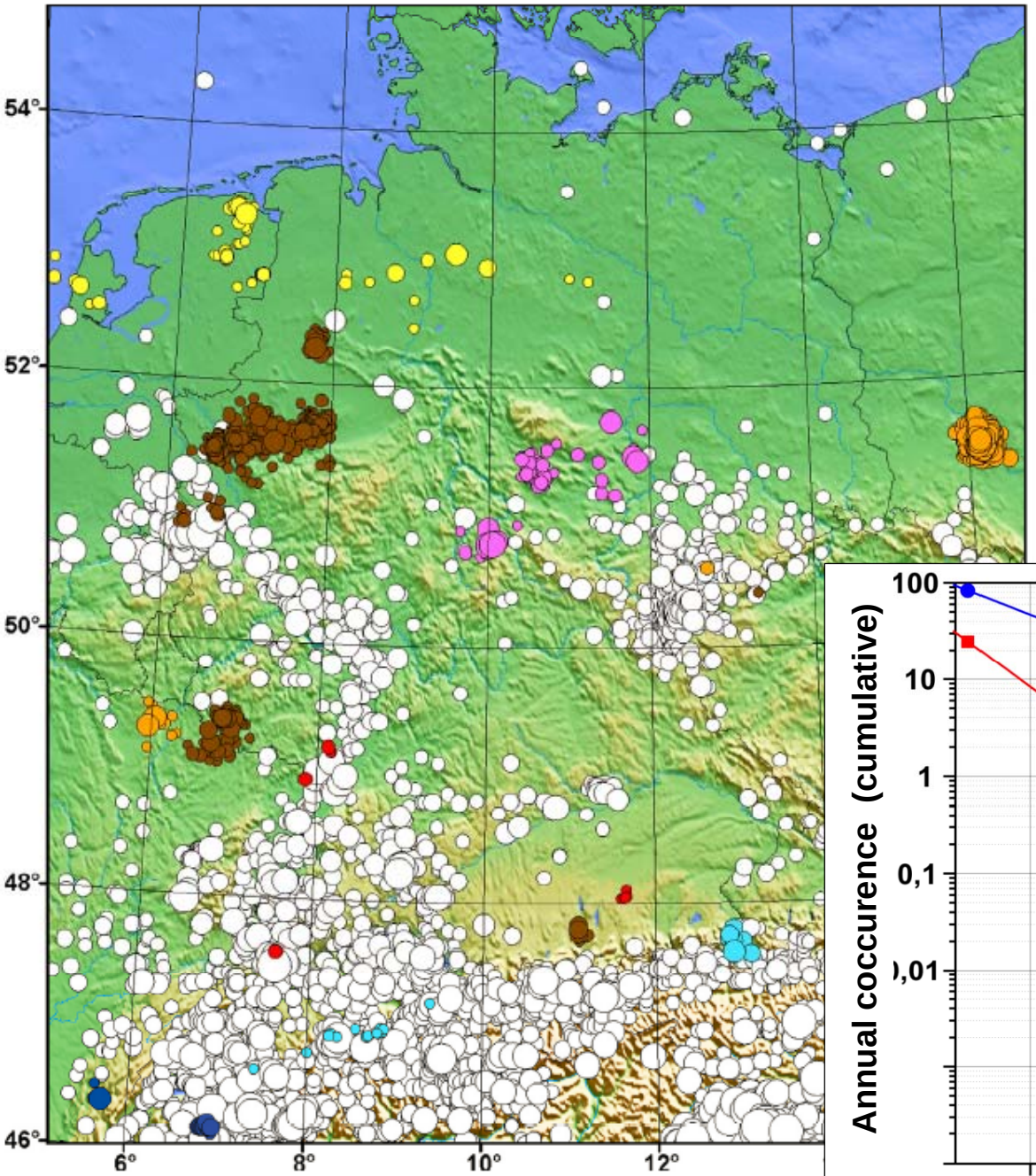
Enhanced geothermal systems (EGS)

- The EGS concept includes artificial improvement of the hydraulic performance of a reservoir with the goal to use it for an economical provision of heat or electric energy
- Enhanced vs Engineered





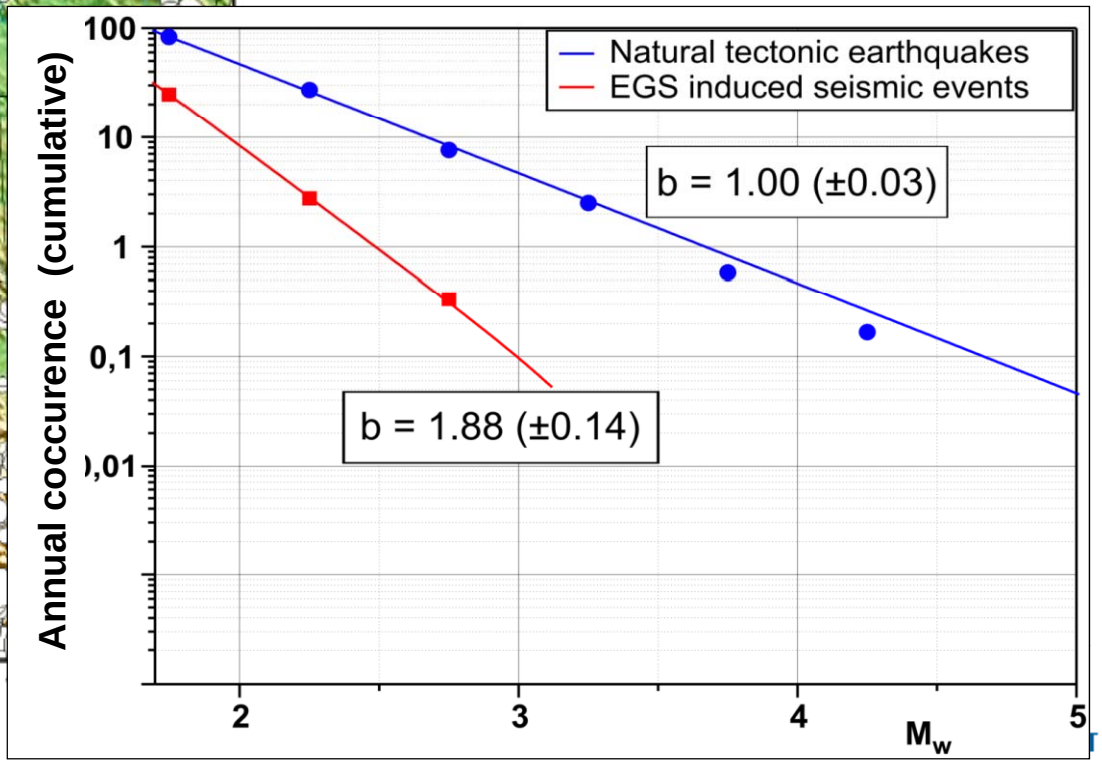
Induced vs. Natural Seismicity



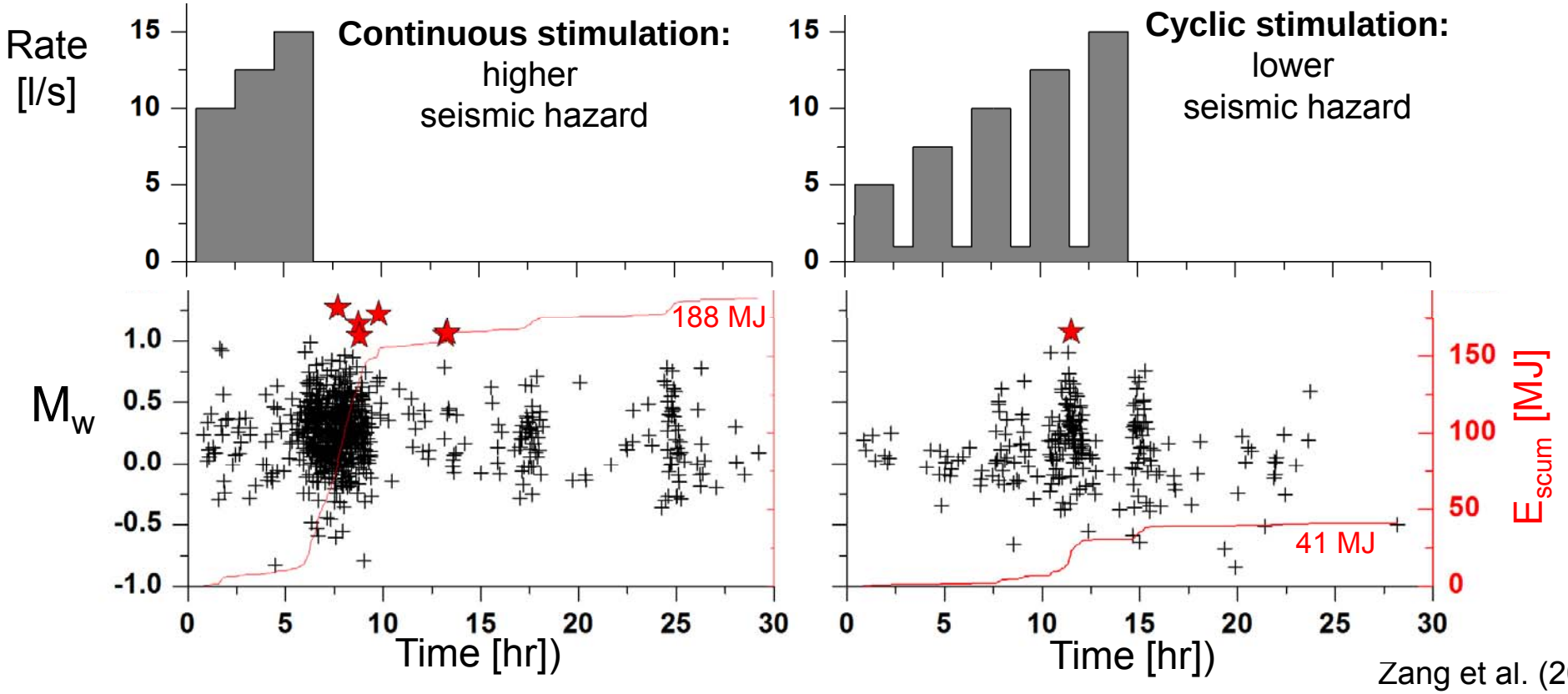
Grünthal (2013)

Induced or triggered in connection with

- Geothermal projects
- Hydrocarbon exploitation
- Coal mining
- Salt and potash mining
- Ore mining
- Artificial water reservoirs
- Heavy rainfall in karst geology



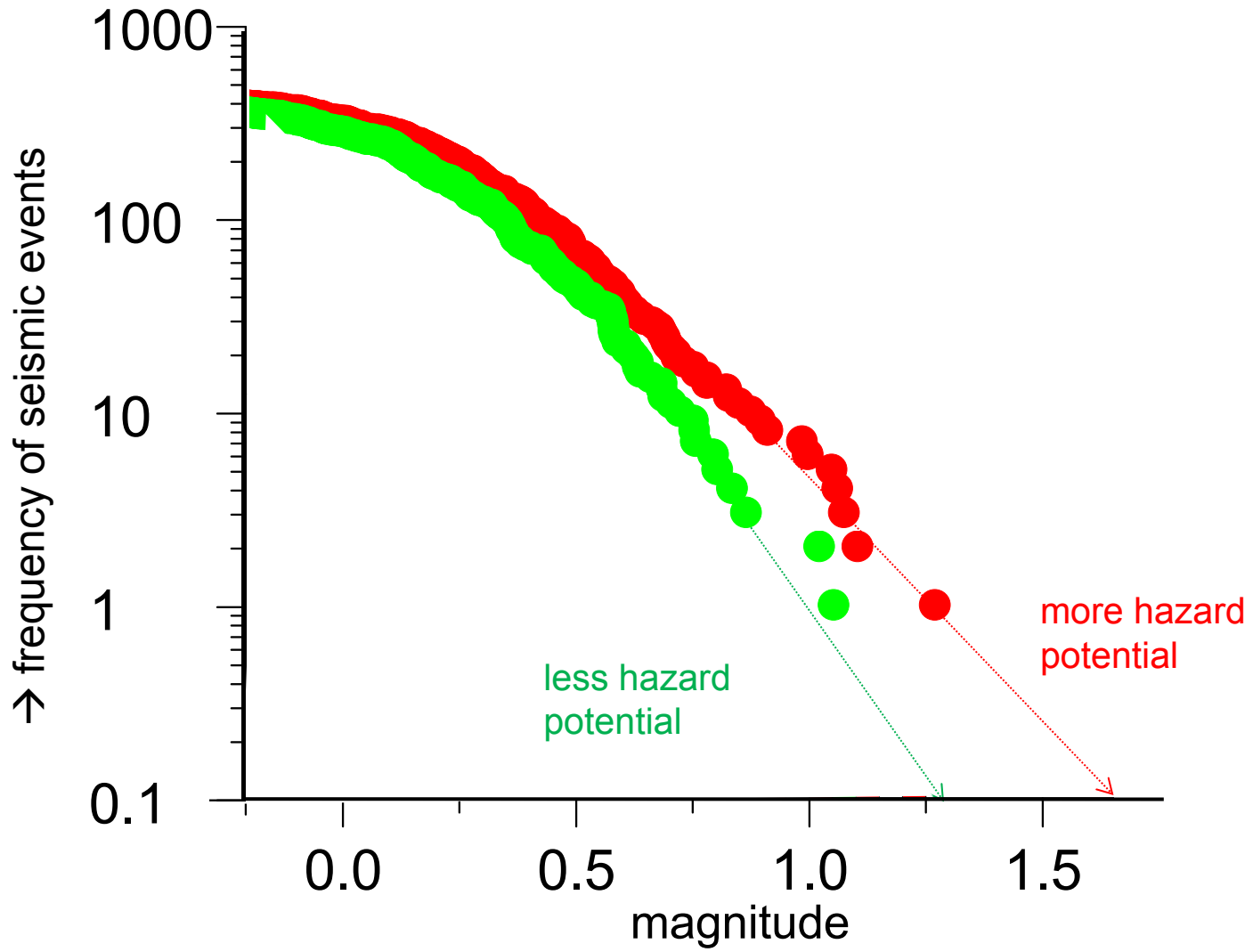
Induced Seismicity – Mitigation Strategy



Zang et al. (2013)
Yoon et al. (2014)

Modelled stimulation scenarios to enhance hydraulic productivity while reducing number and magnitude of induced events

Refined stimulation treatments to enhance hydraulic productivity while reducing the seismic hazard

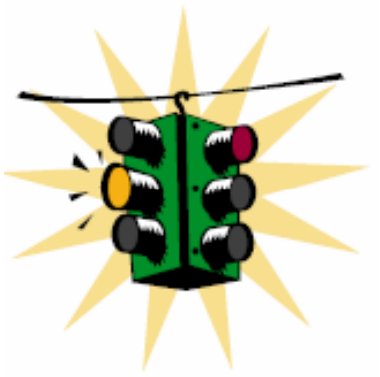


Zang et al., GJI 2013
Yoon et al., IJRMMS 2014

Seismic Activity Assessments based on Soultz-sous-Forêts data

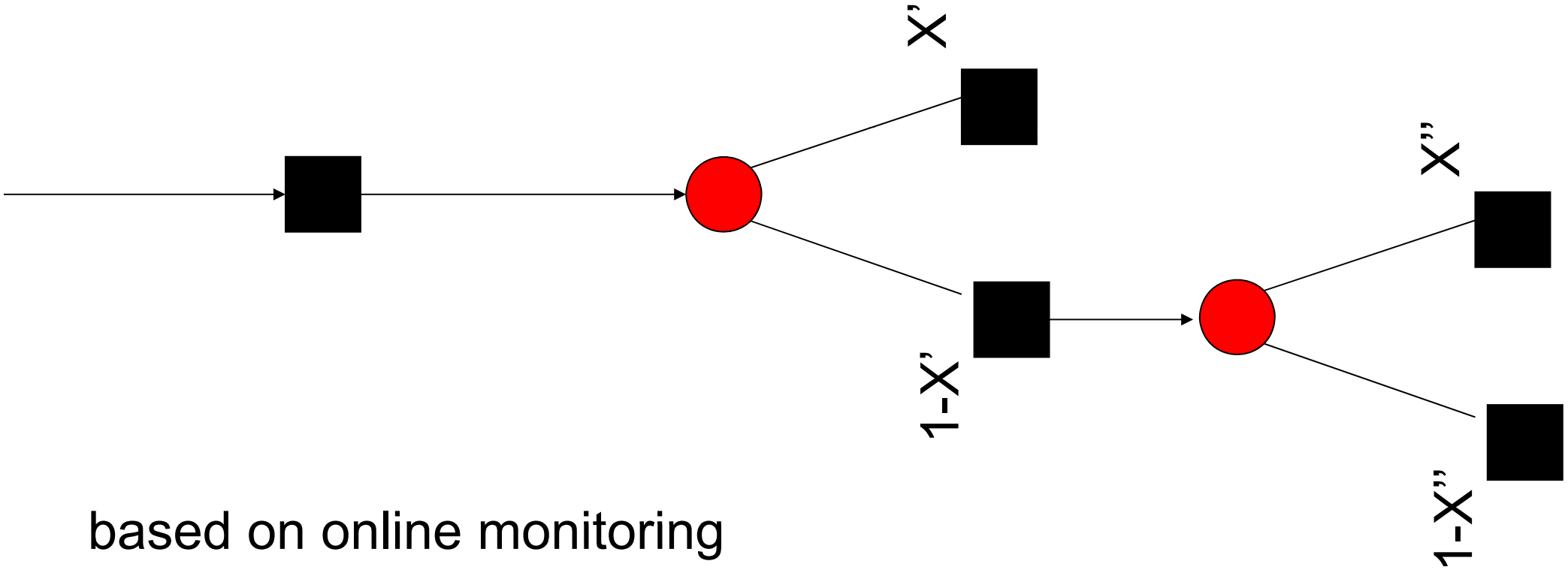
Decision process (traffic light concept)

keep (future) IS below given threshold



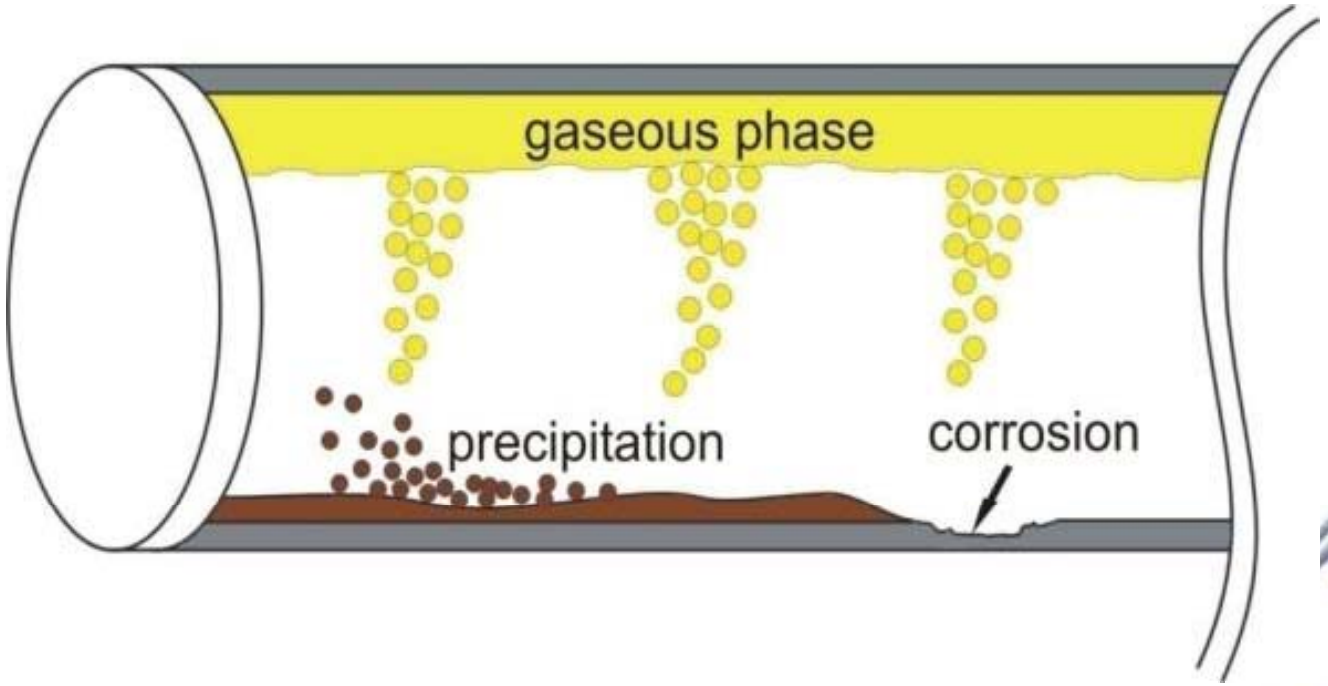
Decision process (advanced traffic light concept)

liability!!



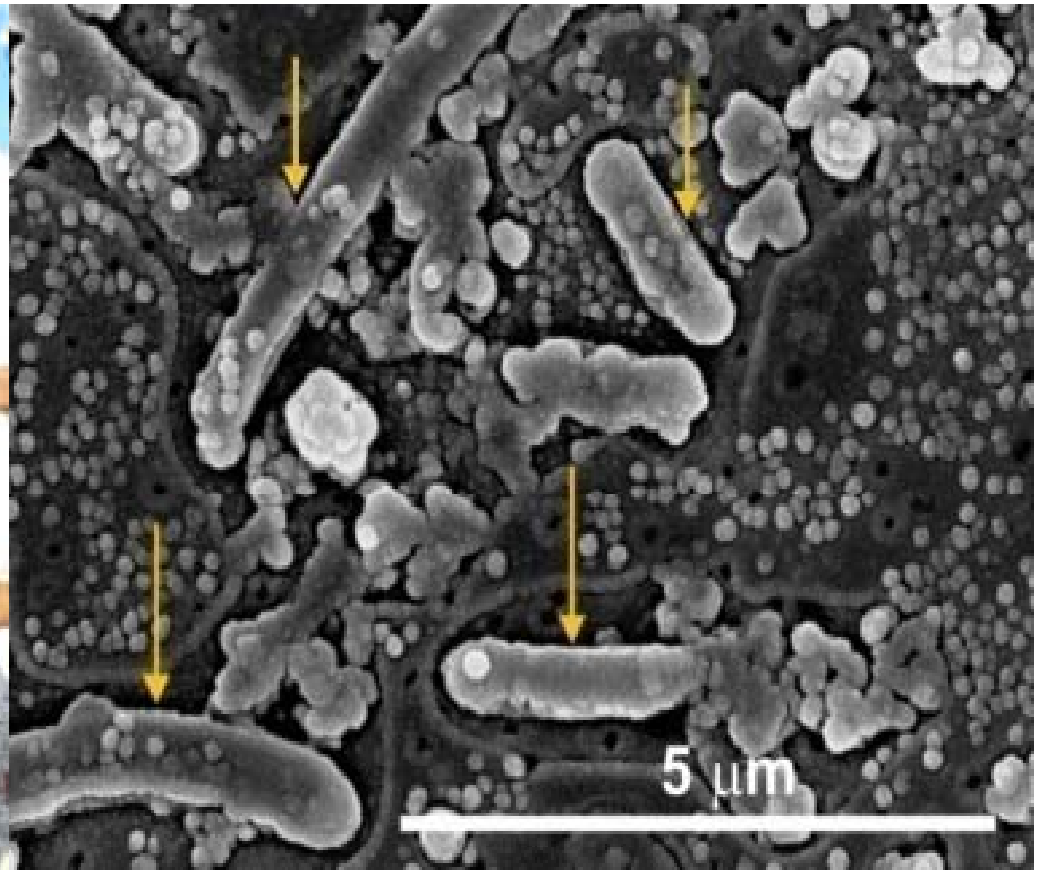
based on online monitoring
and adjusted forecasting

Quantification of corrosion and scaling processes in geothermal systems during operation.



possible biogeochemical alterations and strategies helping to prevent

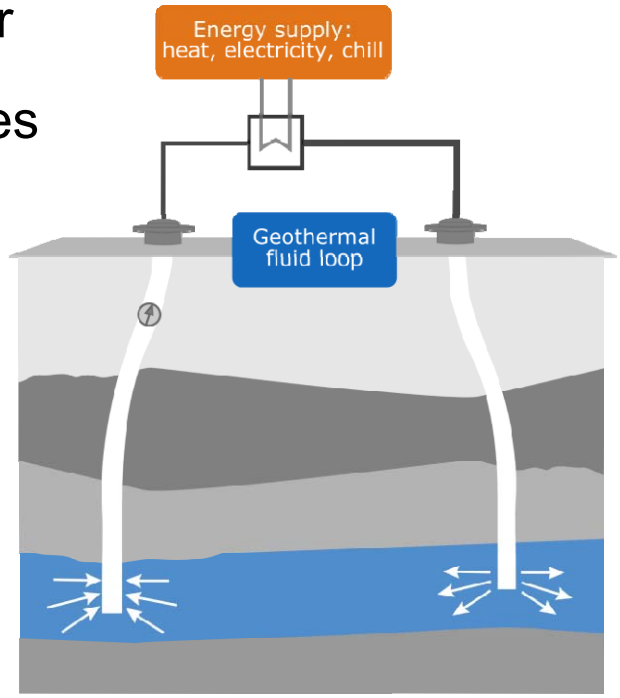
corrosion and precipitation driven by microbes



Würdemann et al 2015, in prep.

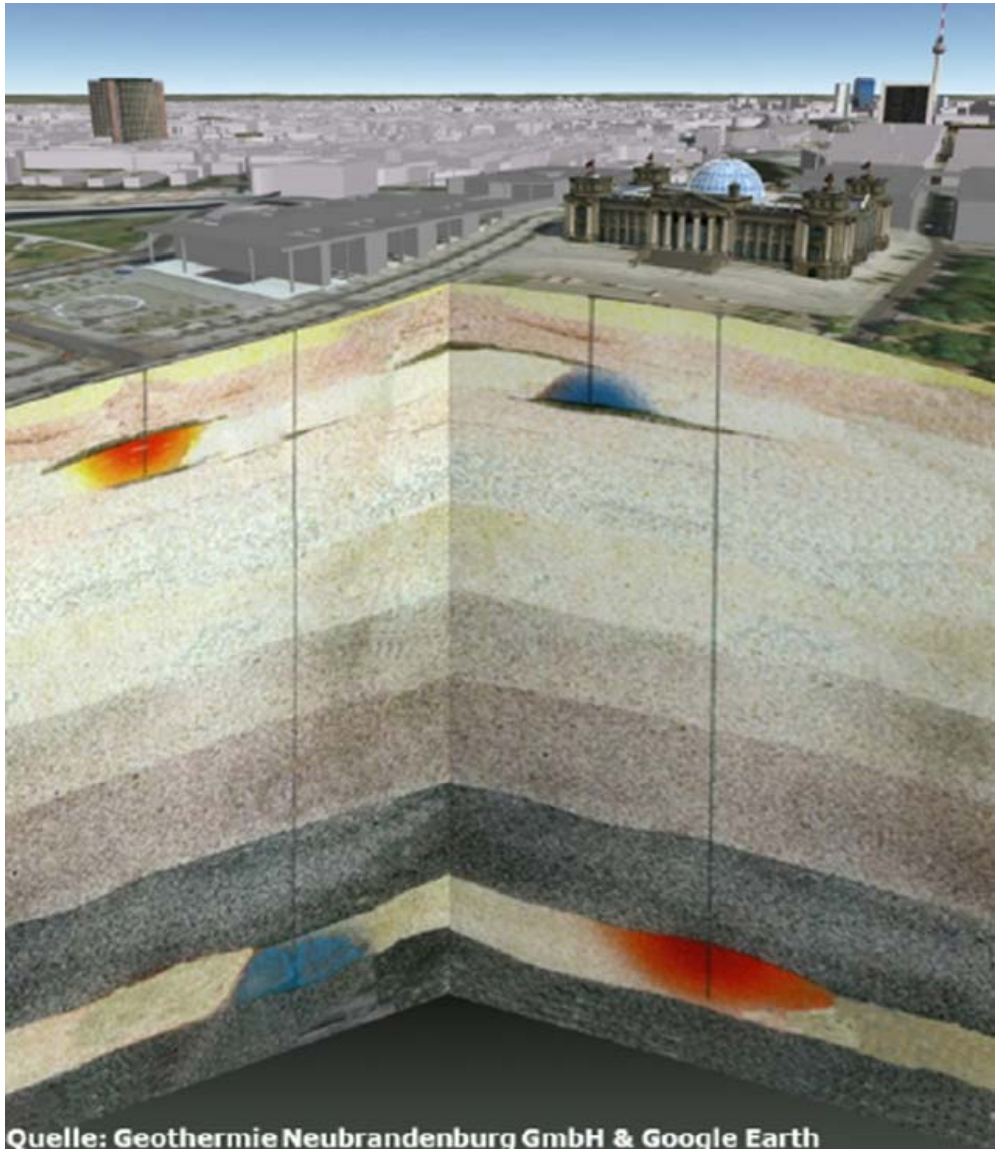
Monitoring: Integrated Approach

- Reservoir to Surface / Field and Lab
- During Reservoir Engineering and Operation
- Reservoir and Fluid Behavior
- Solid, Liquid, and Gas Phases
- Environmental Issues



- Hybrid Downhole Logging System
- Fluid Monitoring System
- Labs for Fluid-Chemistry and Fluid/Rock-Physics

ATES: Aquifer – Heat and Chill Storage Berliner Reichstag

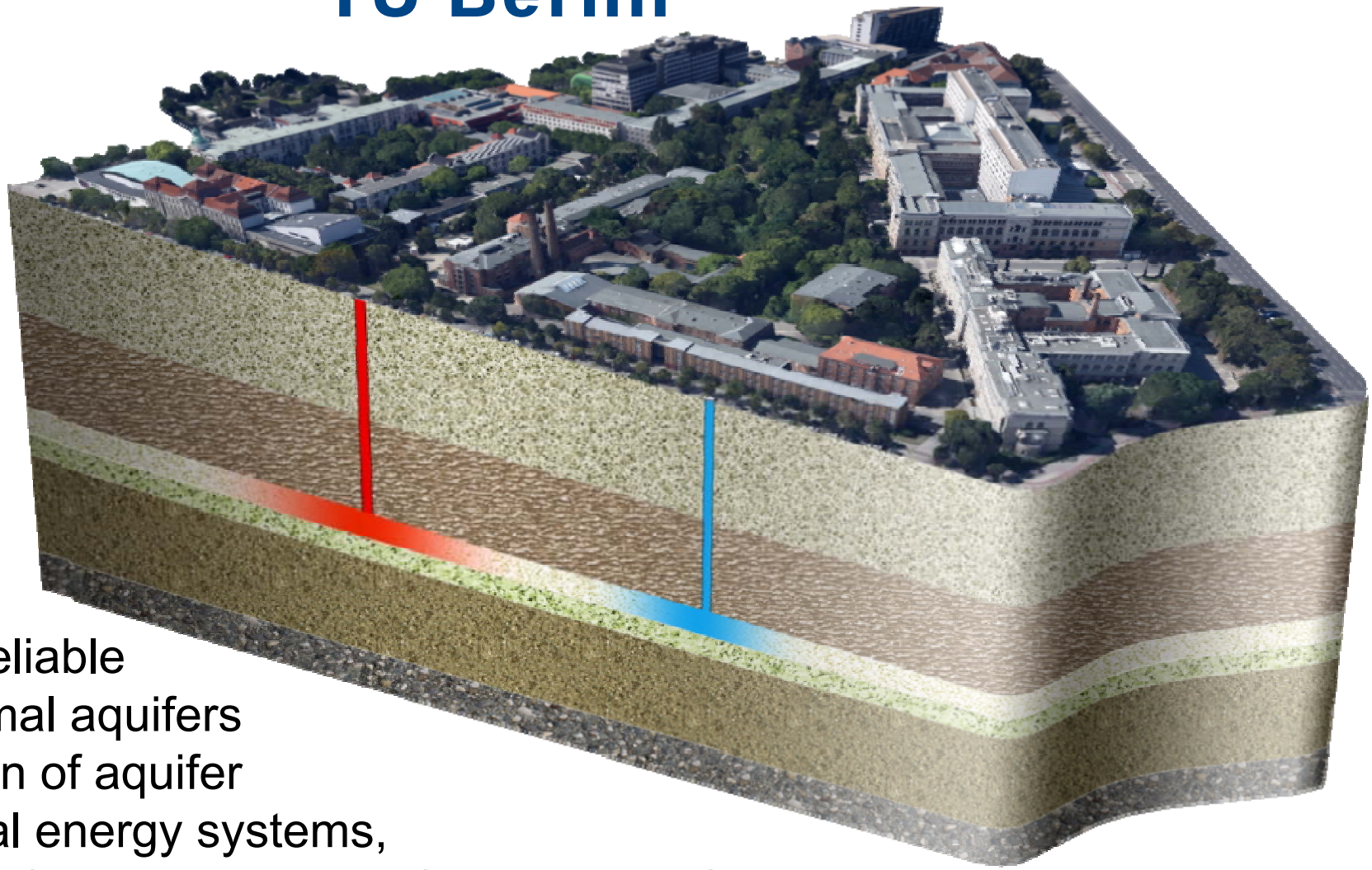


Heat:
- 285 to 315 m depth
- temperature: ~ 20°C
- temperature storage-fluid: ~ 70°C
- capacity: ~ 2650 MWh
- heat recovery: 70%

Chill:
- 30 to 60 m depth
- temperature: ~ 12°C
- temperature storage-fluid: ~ 5°C
- capacity: ~ 6000 MWh

Operation since 2002

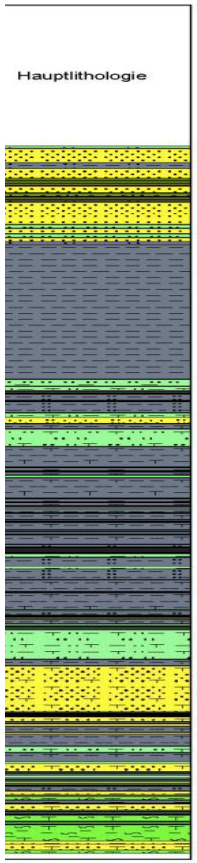
ATES: Aquifer – Heat Storage
TU Berlin



Objectives:

- efficient and reliable usage of thermal aquifers
- safe integration of aquifer storage in local energy systems,
- Development of plant technology for heat transformation
- Optimize heat supply for city quarters

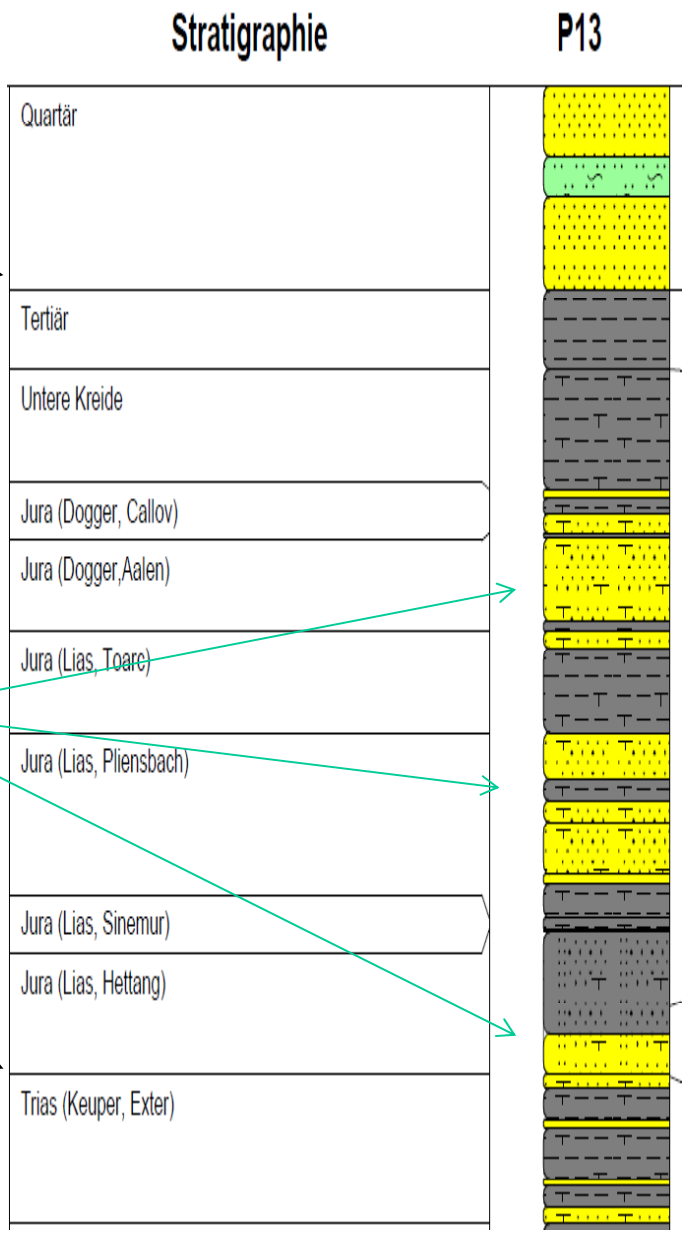
Ketzin



Norden 2012

Potsdam 13

Bohrbericht Potsdam 13

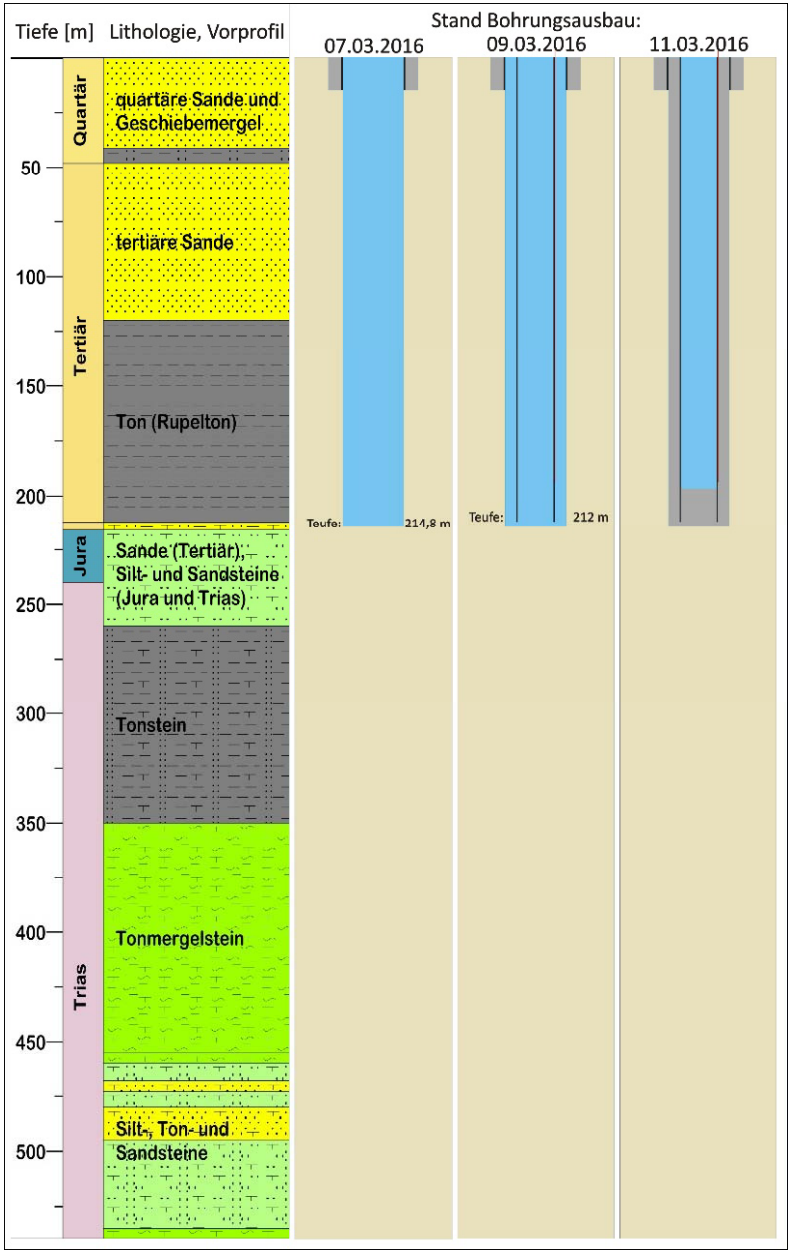


tap water horizons

Rupelton

saline aquifers (20 – 40 °C)

Altlas zur Geologie von Brandenburg 2010


Tiefe [m]
Lithologie, Vorprofil
Stand Bohrungsausbau:
07.03.2016
09.03.2016
11.03.2016
Quartär
Tertiär
Jura
Trias
quartäre Sande und Geschiebemergel
tertiäre Sande
Ton (Rupelton)
Sande (Tertiär), Silt- und Sandsteine (Jura und Trias)
Tonstein
Tonmergelstein
Silt-, Ton- und Sandsteine
50
100
150
200
250
300
350
400
450
500
Teufe: 214,8 m
Teufe: 212 m


MiSWACO

New Projects on Geothermal Energy started (EU Horizon2020)

DESTRESS: Demonstration of soft stimulation treatments of geothermal reservoirs
coordinated by GFZ ; start: 1 March 2016, 48 months, 16 partners

Focus: Development of site specific concepts to enhance the productivity of low permeable geothermal reservoirs to actively make reservoir conditions profitable.

SURE: Novel Productivity Enhancement Concept for a Sustainable Utilization of a Geothermal Resource
coordinated by GFZ ; start: 1 March 2016, 42 months, 10 partners

Focus: Investigation and testing of the Radial Water Jet Drilling technology for increasing the performance of geothermal wells with low productivity across different spatial and temporal scales.

GEOWELL: Innovative materials and designs for long-life high-temperature geothermal wells
coordinated by Iceland GeoSurvey (ÍSOR); start: 1 February 2016, 36 months, 8 partners

Focus: Development of reliable and cost effective technologies for design, completion and monitoring of high-temperature geothermal wells to accelerate the development of geothermal resources.

Conclusions

- Research demand along the whole geothermal development chain
- Reduced finding risk by improved exploration concepts
- Improved performance by methods of the EGS-concept
- Mitigation of induced seismicity by cyclic stimulation and/or advanced traffic light
- Understanding of corrosion and scaling → interaction material with in situ fluids low
- Monitoring systems required for performance control and environmental protection
- Geothermal system analyses → numerical model validation by experiments
- Storage of heat and chill: 70 – 90 % recovery of energy