

# **Modeling of Short-Term Stimulation and Long-Term Operation of EGS Reservoirs**

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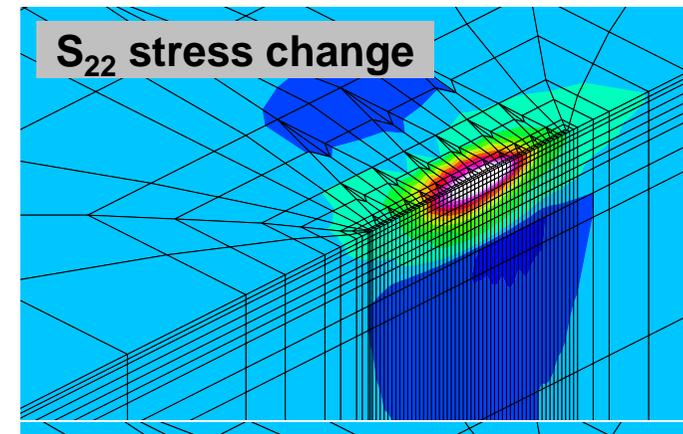
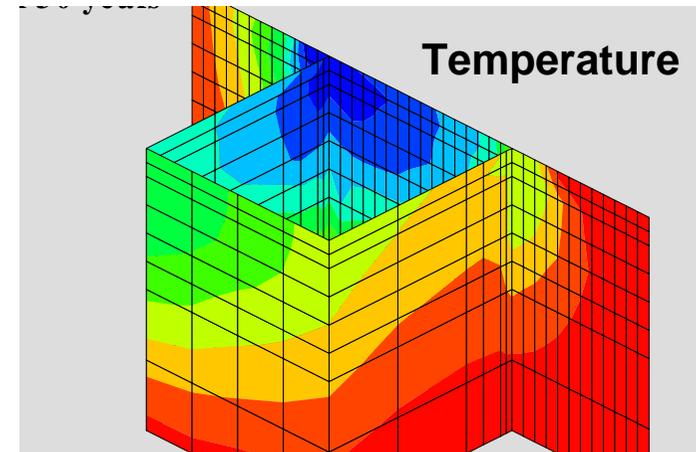
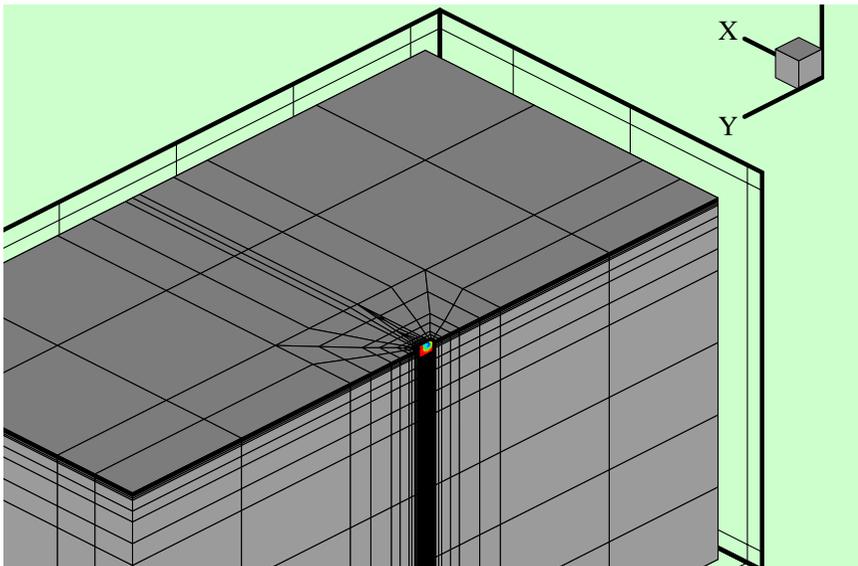
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- **Investigation of the dynamic response of an "Enhanced Geothermal Systems" to forced injection of cold fluid**
  - **Individual processes (pressure, temperature and stress) result in specific time-constants.**
  - **Extending the evaluation can usually only be carried out by numerical modeling**
    - **Deterministic reservoir models**
    - **Stochastic reservoir models**
  - **H-T-M evaluations calculated with the simulators FRACTure and HEX-S (identical FE kernel)**

# Experience on deterministic H-T-M simulations

## 3D Reservoir

- 4 fracture zones
- Poro-Elasticity & Thermo-Elasticity (Kohl, 1995)
- Normal aperture compliance
- No shearing

-> not suited for hydraulic stimulation



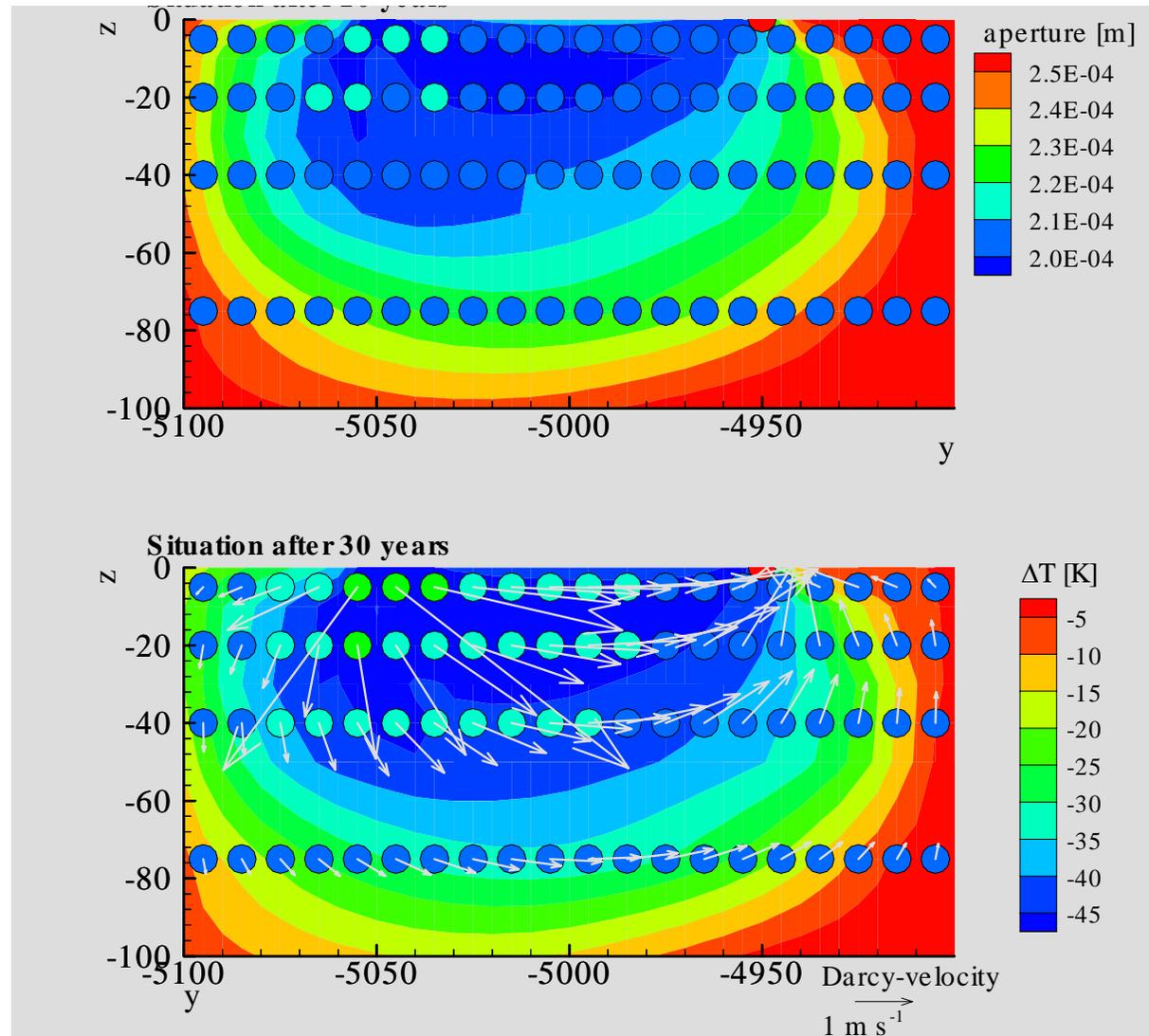
# 3D- Deterministic Fracture Geometry

## Dynamic Long Term Behaviour

Synthetic example  
aperture:  $a_0=200\mu\text{m}$

$t=10\text{yrs}$

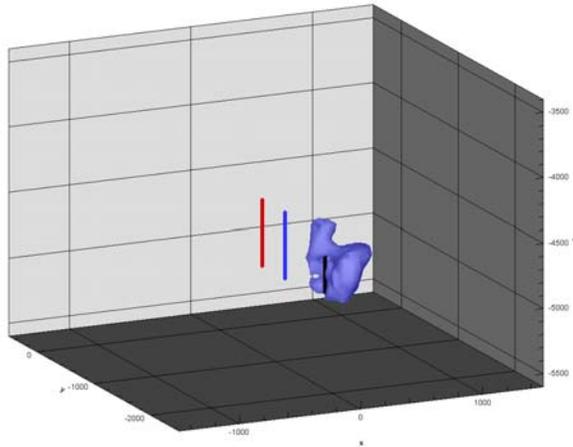
$t=30\text{yrs}$



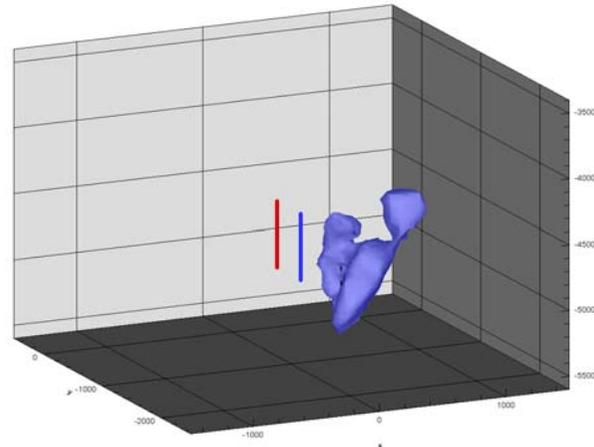
# Example: Simulation GPK4

## Development of aperture ( $\cong$ permeab.)

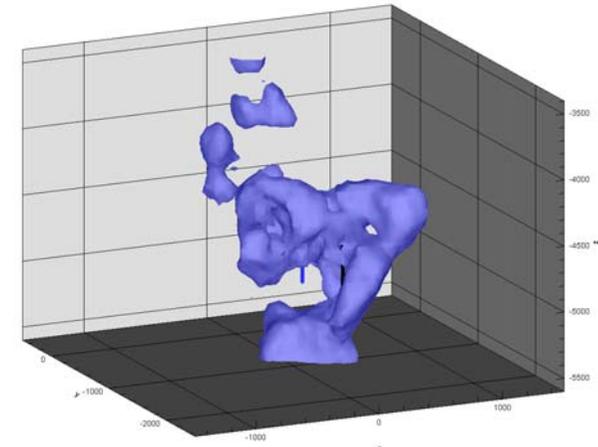
2.7 h



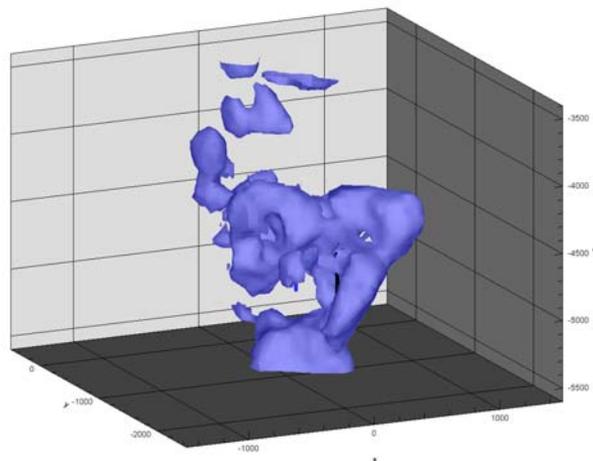
5 h



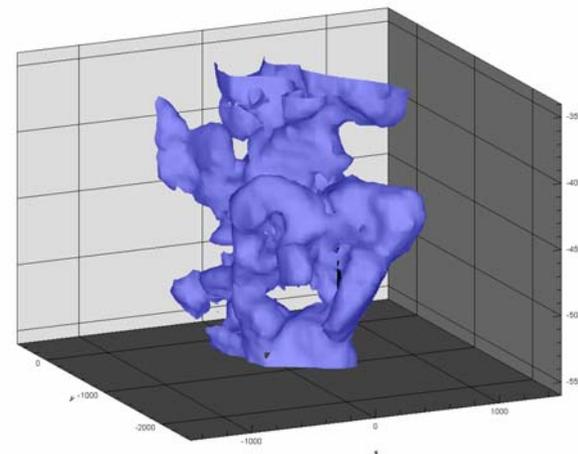
20 h



36 h



53 h



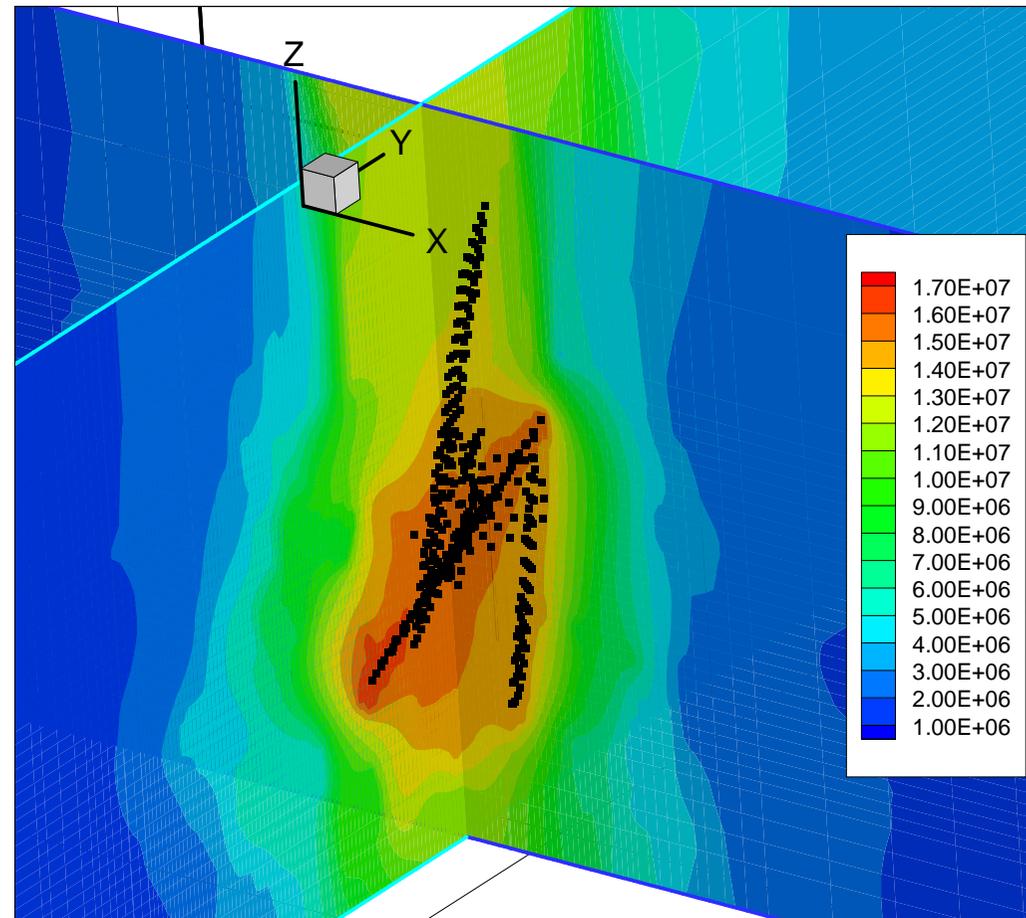
Iso-Surface = 0.0001 m

# Reservoir Pressure Distribution

## Simulated shearing events & pressure distribution GPK3

Flow aligned along seismic structures

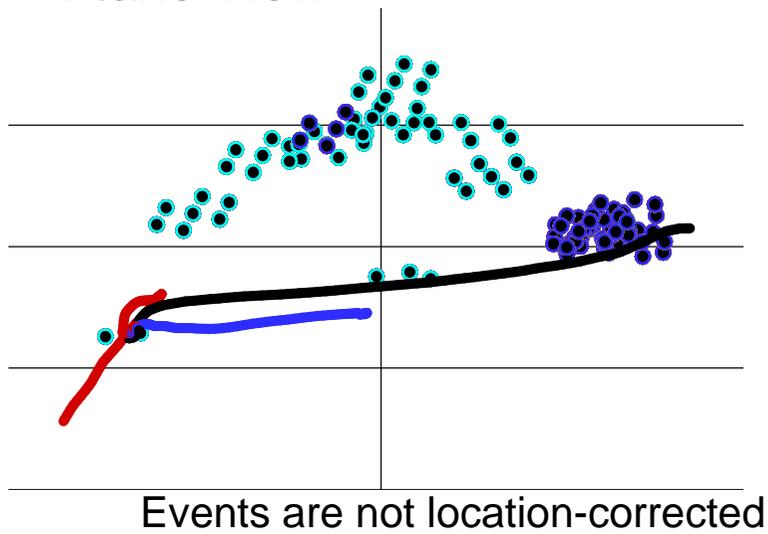
Seismicity connected to zones of high pressure



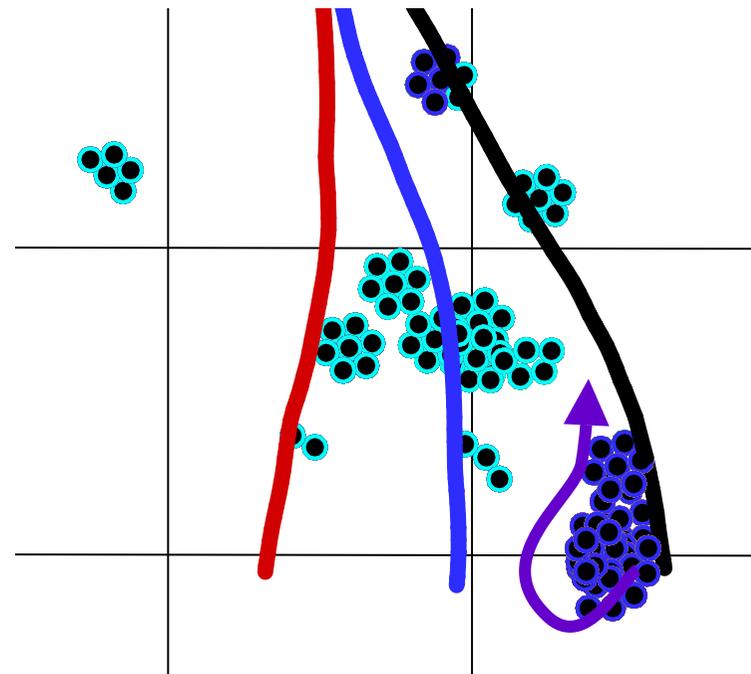
# Forecast GPK4 stimulation: HEX-S Hydraulic Model

Predicted evolution of shearing events at GPK4 after 1 day stimulation

Plane View



View from West



Path of development