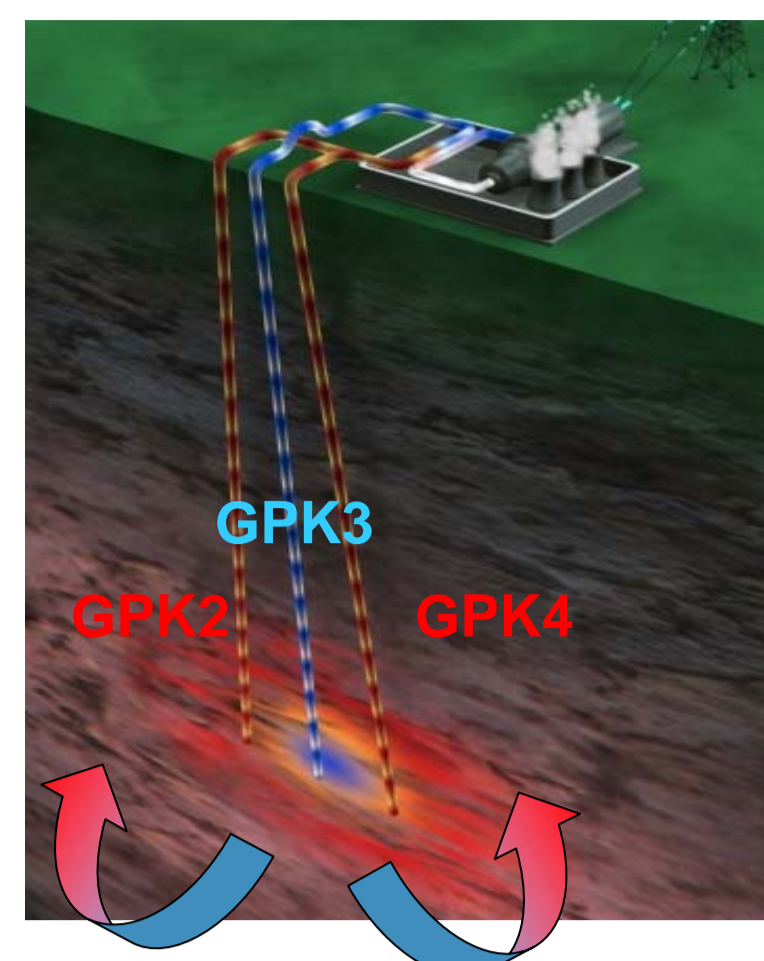


The Soultz project: reservoir development by hydraulic stimulation

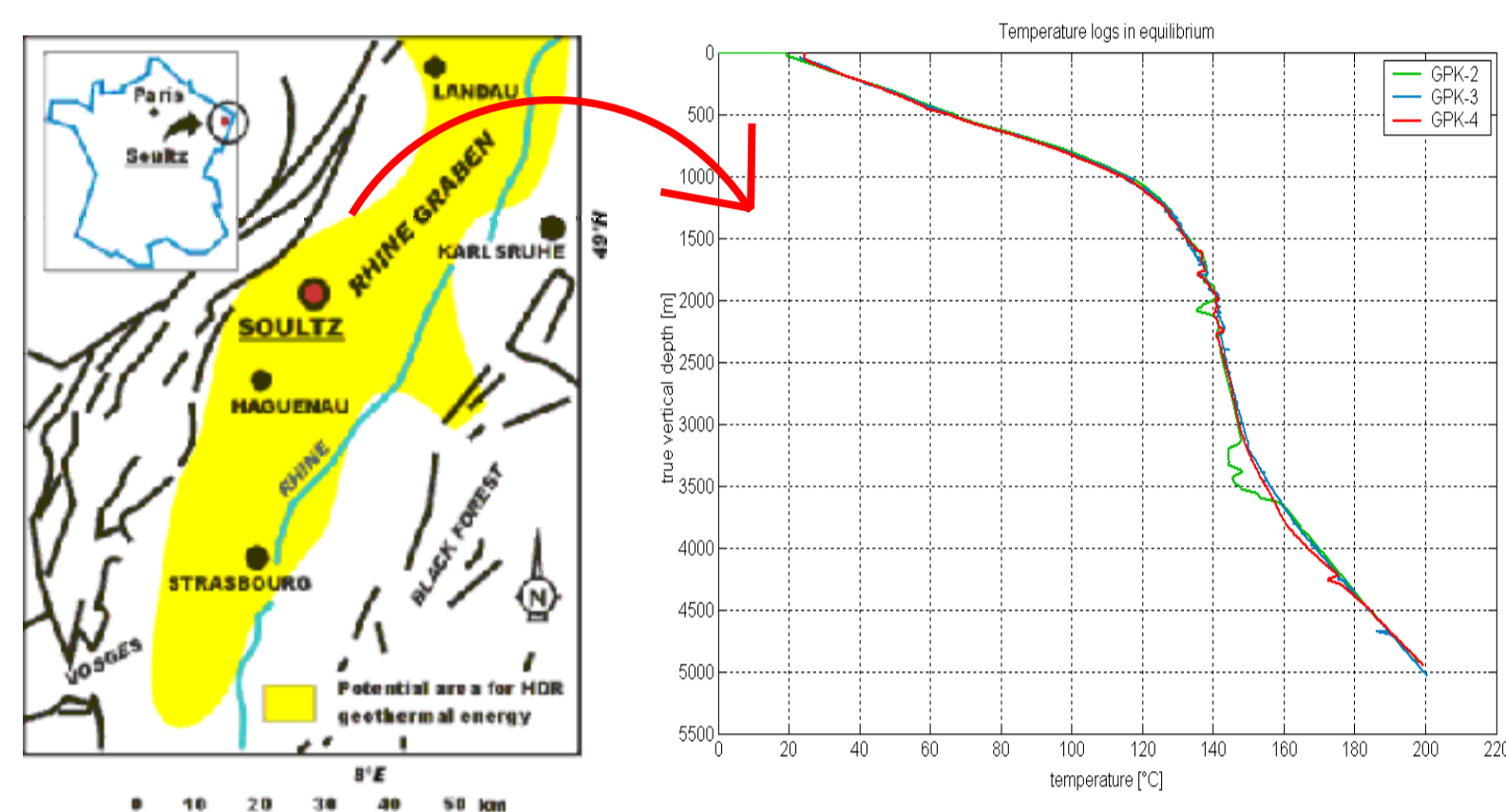
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Introduction

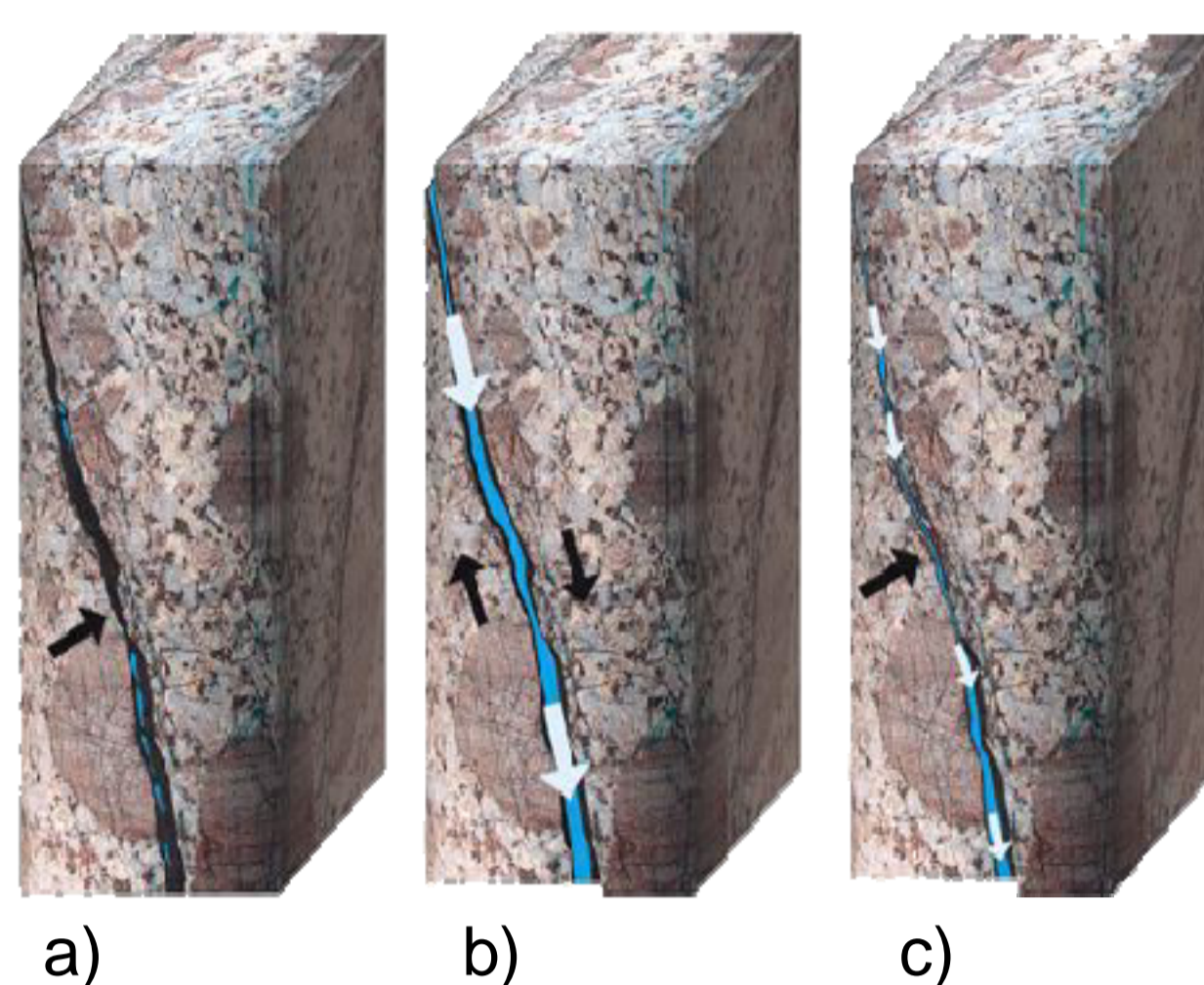
The European EGS project in Soultz-sous-Forêts (France) aims at recovering geothermal heat from crystalline formations. The EGS concept bases on the creation and opening of fractures by massive water injections to connect two or more boreholes by a fracture network. The idea is to circulate water in a closed loop and to convert its energy into electricity at surface. In Soultz, a shallow and a deep artificial geothermal reservoir have been created in the last 15 years. The future circulation and power production will use the 5000 m deep artificial reservoir with two production (GPK2 and GPK4) and one injection well (GPK3).

Why EGS in Soultz?



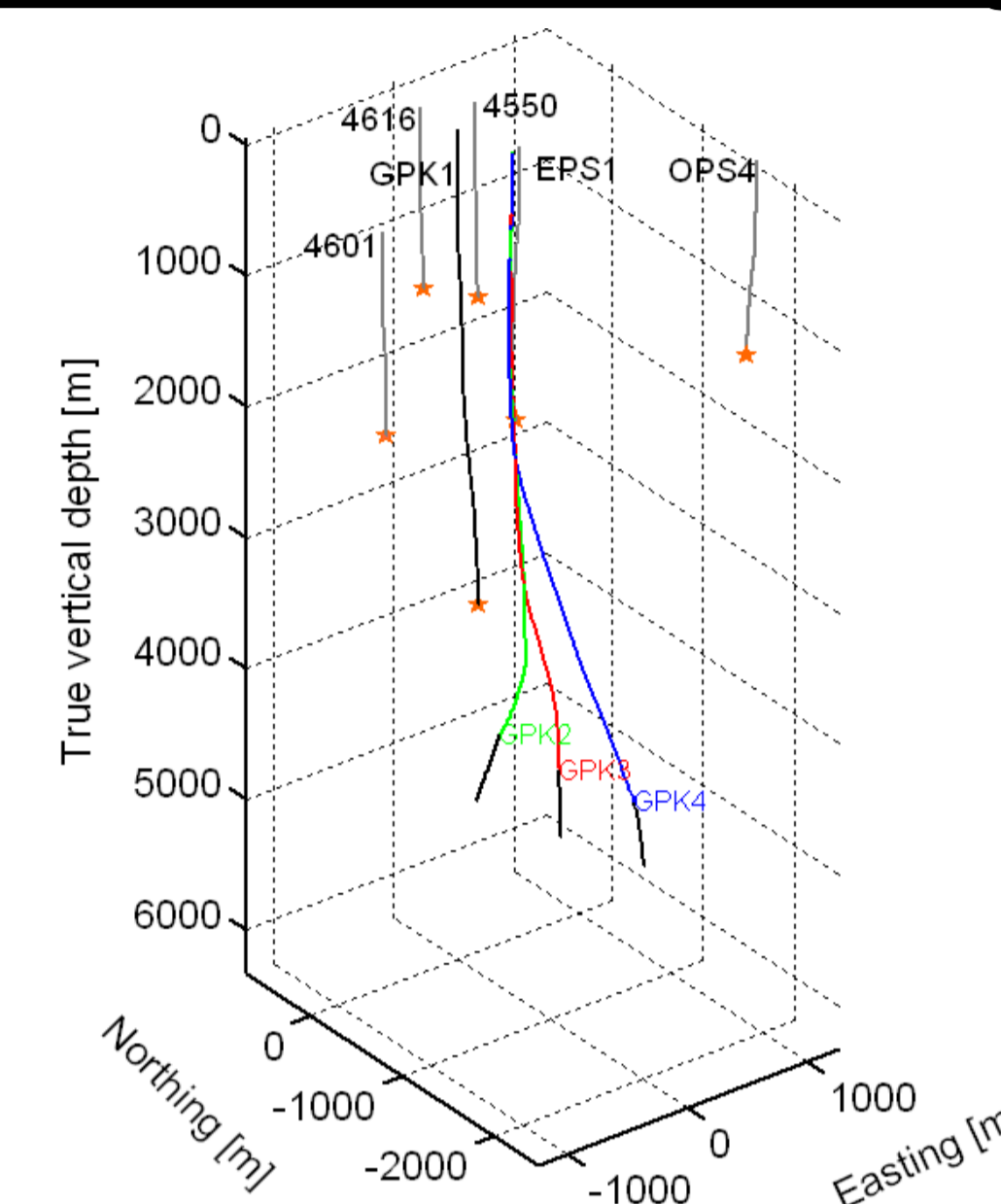
Soultz has favorable conditions for EGS research: the Soultz granite shows comparable low stresses and a natural network of hydrothermalized fractures. A local temperature anomaly yields 200 °C at 5000 m in all three wells.

Hydraulic Stimulation



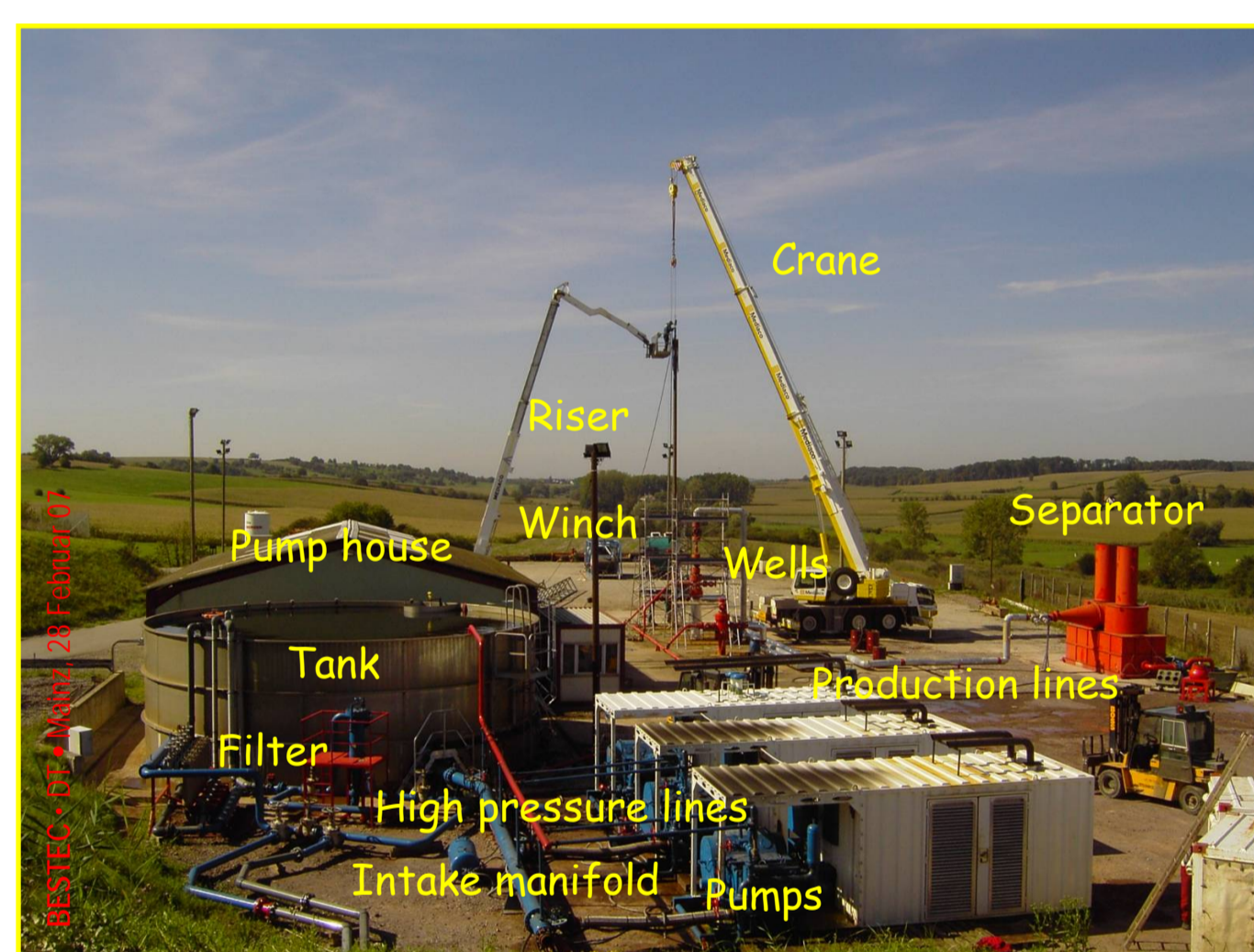
Hydraulic fracturing in Soultz means massive water injections (a+b). Shearing on preexisting or artificial fracture surfaces (b) emits microseismic energy. Stimulated fractures stay permeable due to the roughness of the shifted surfaces (c).

Microseismic monitoring



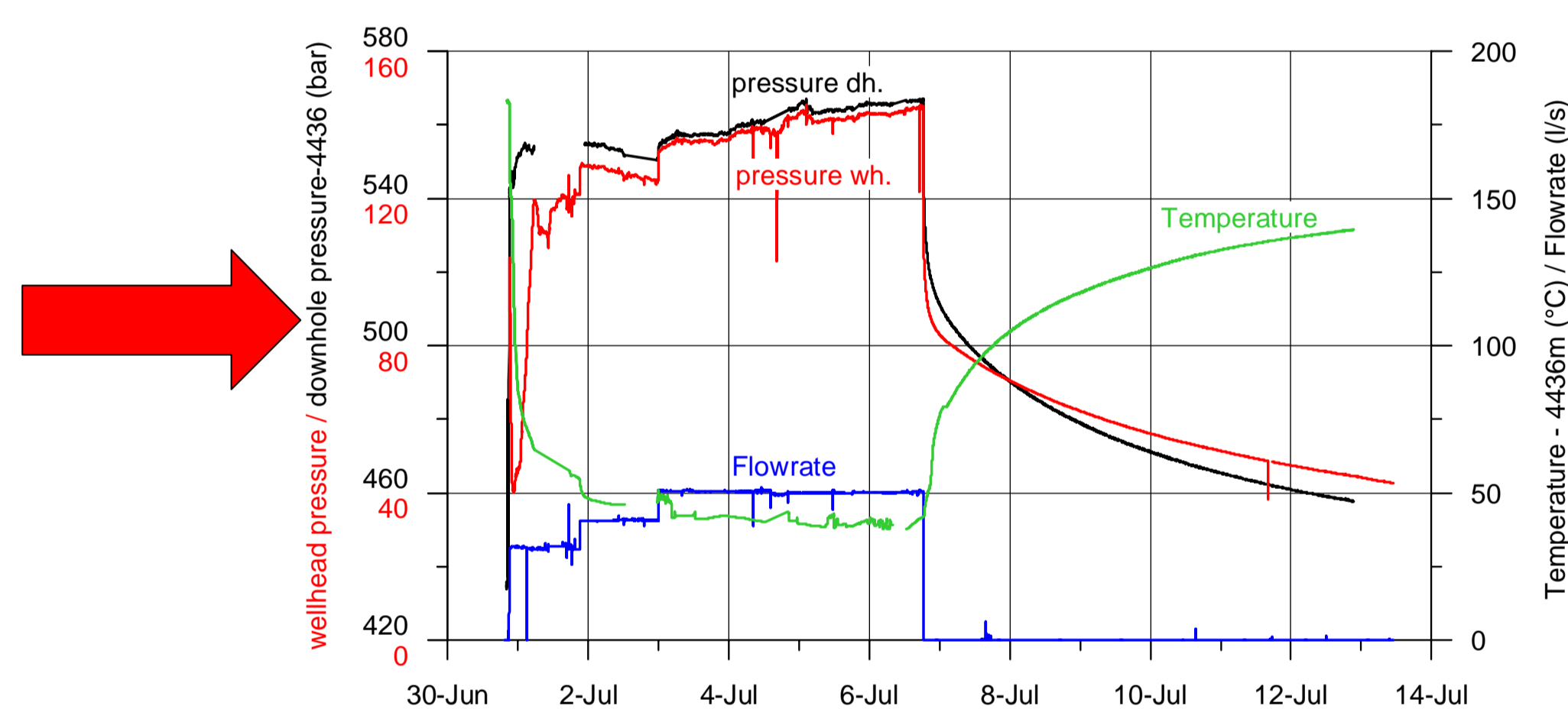
A high resolution downhole network of accelerometers and geophones (orange stars) records the microseismic events. This allows to monitor the development of the reservoir and to target the wells and to investigate stimulation processes.

Stimulation operation



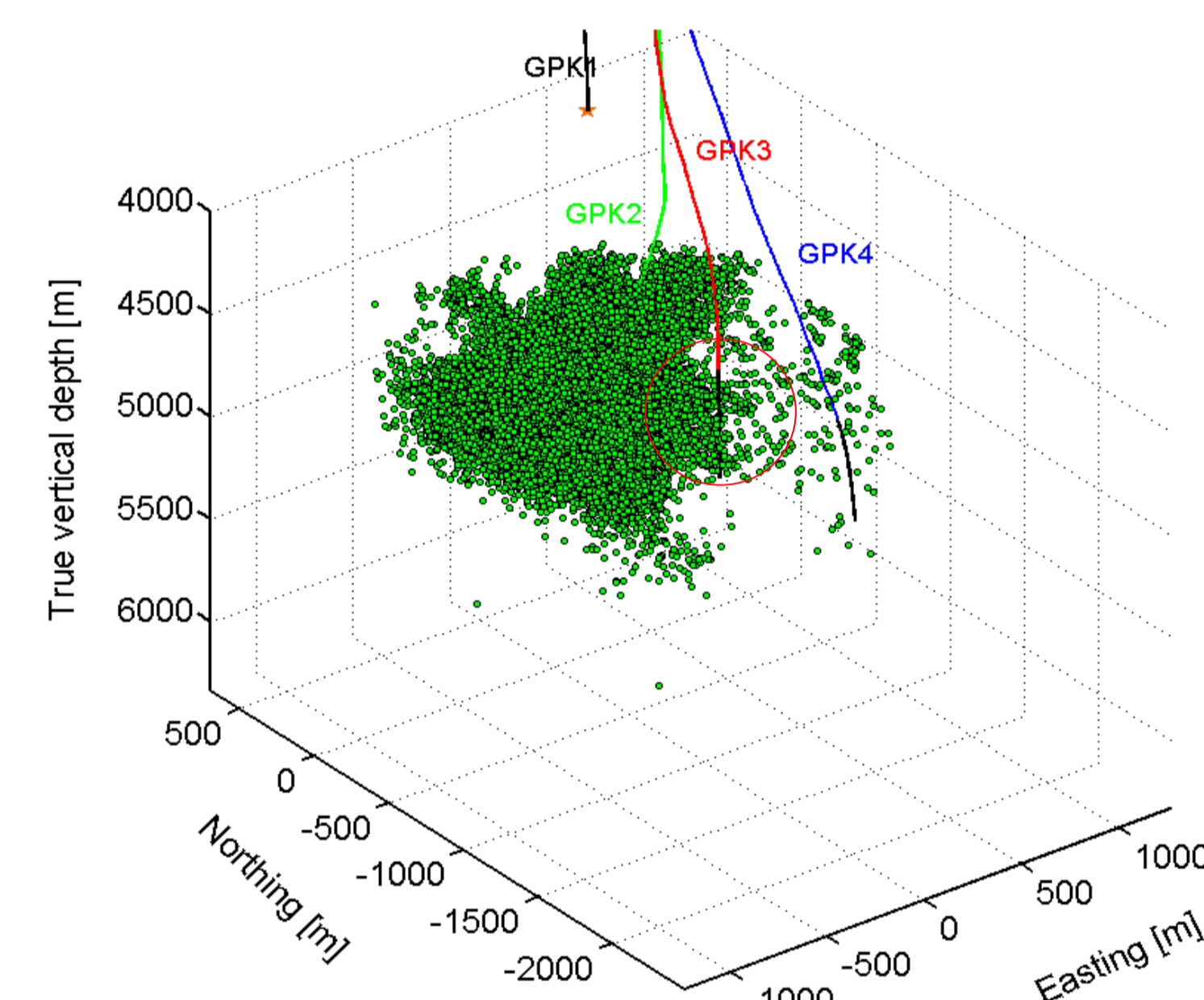
A stimulation operation requires hardware: high pressure pumps, tanks for water supply, cranes and a riser to deploy downhole tools. The separator serves to produce the fluid if necessary.

Pressure recording (GPK2)



With ~23.000 m³ fresh water at maximum rate of 50 l/s, an effective stimulation was performed. The injectivity was increased by a factor of twenty to ~ 0.4 l/s/bar at GPK2.

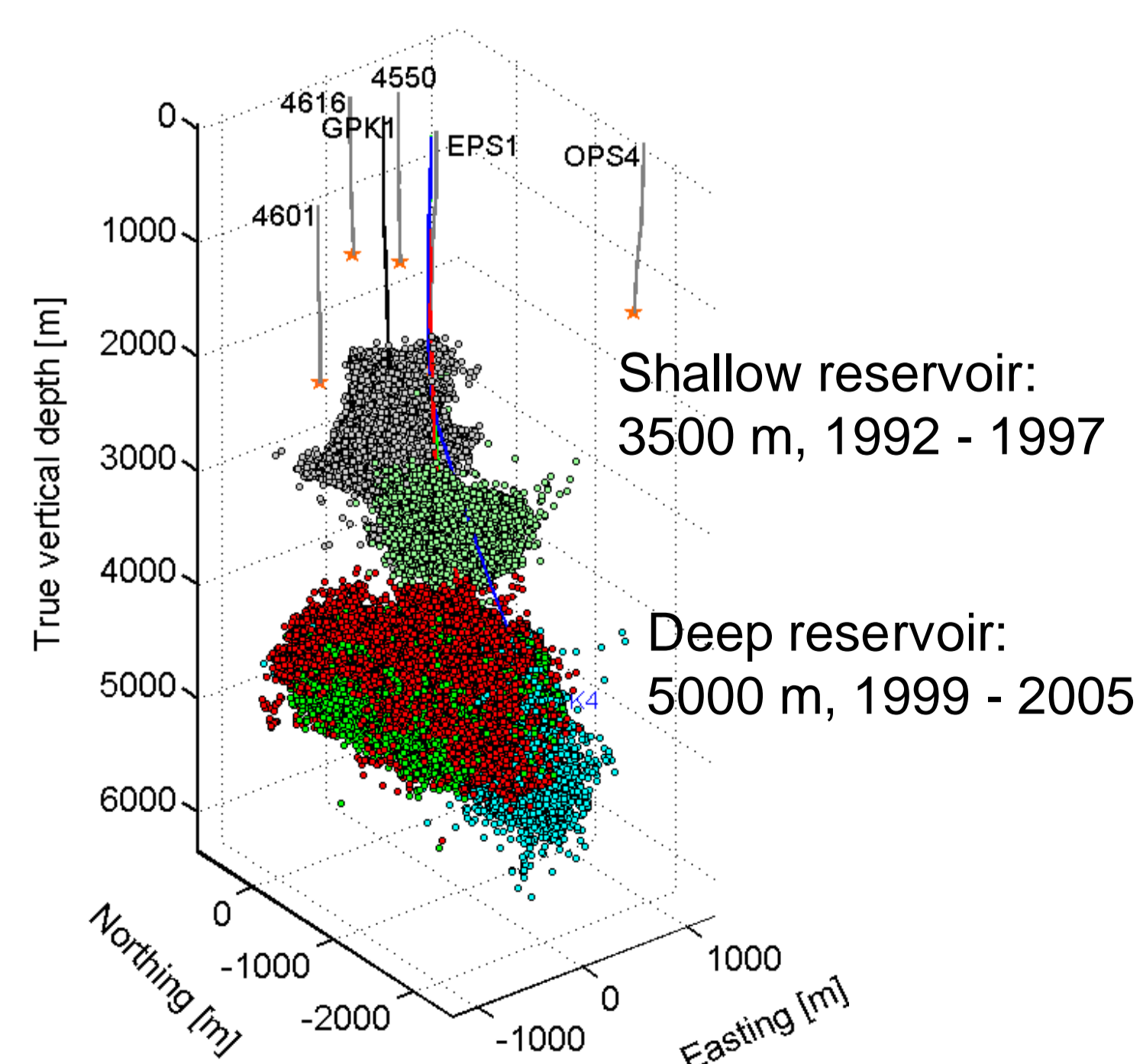
Seismic events (GPK2)



About 31500 microseismic events were recorded of which 14000 events were located. The target zone for GPK3 (red circle) was designed after evaluating the seismic events.

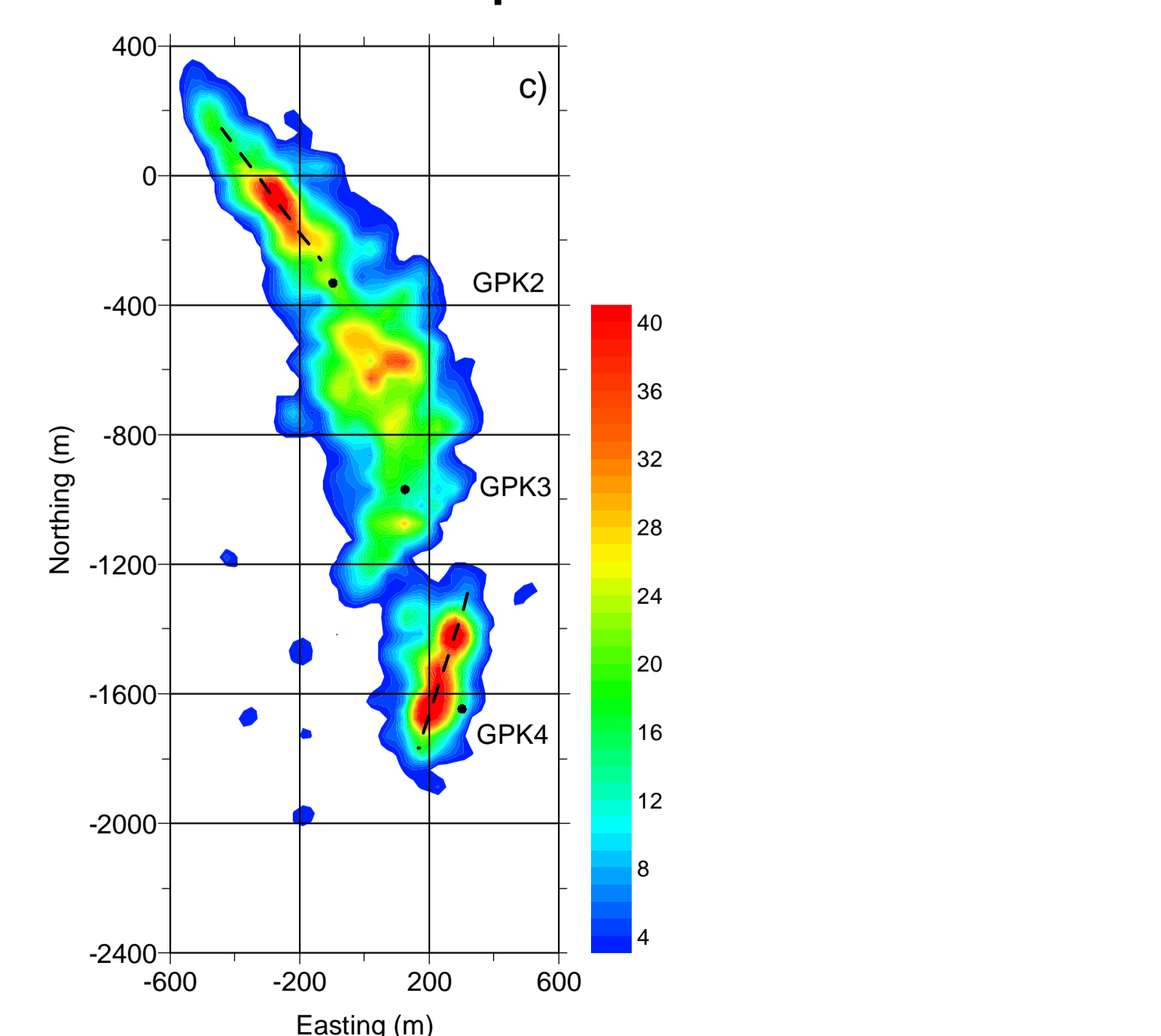
Reservoir development

Location of all microseismic events from 1992 - 2005



The stimulation operations in the shallow and deep reservoir (left) show the project history in Soultz. The reservoir in 5000 m (left in side view, right in top view) extends about 2.5 km in N-S-direction and 1.5 km in E-W and in height. The seismic events are aligned NW/SE according to the local stress field. Production temperature from this reservoir is around 175 °C for an envisaged flow rate of 30 – 35 l/s. In 2008, the worldwide first geothermal artificial reservoir will deliver the heat for a 1.5 MW electricity production.

Deep reservoir: seismic density distribution at 4900-5000m depth



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