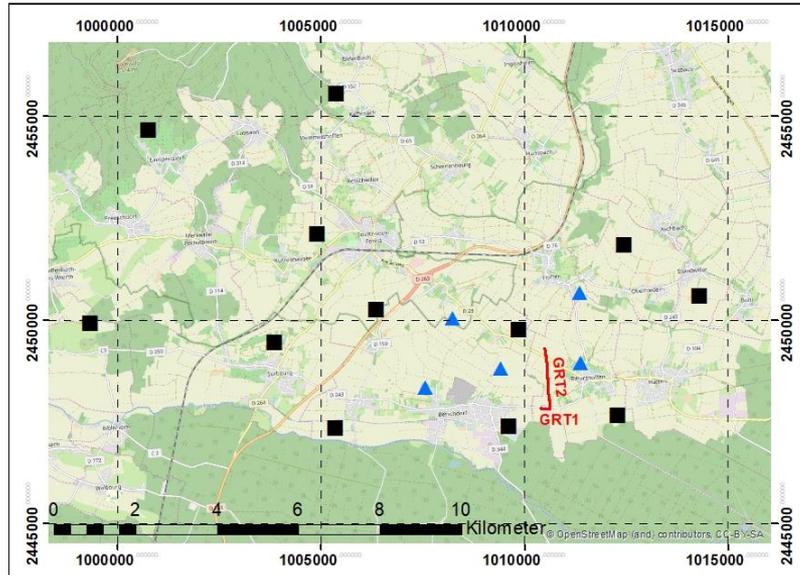


Fault network development during repeated fluid injection at the Rittershoffen deep geothermal site, France

Rike Köpke^{1,2}, Olivier Lengliné², Emmanuel Gaucher¹, Jean Schmittbuhl², Thomas Kohl¹

1:Karlsruhe Institute of Technology, 2:University of Strasbourg

Rittershoffen Geothermal Site



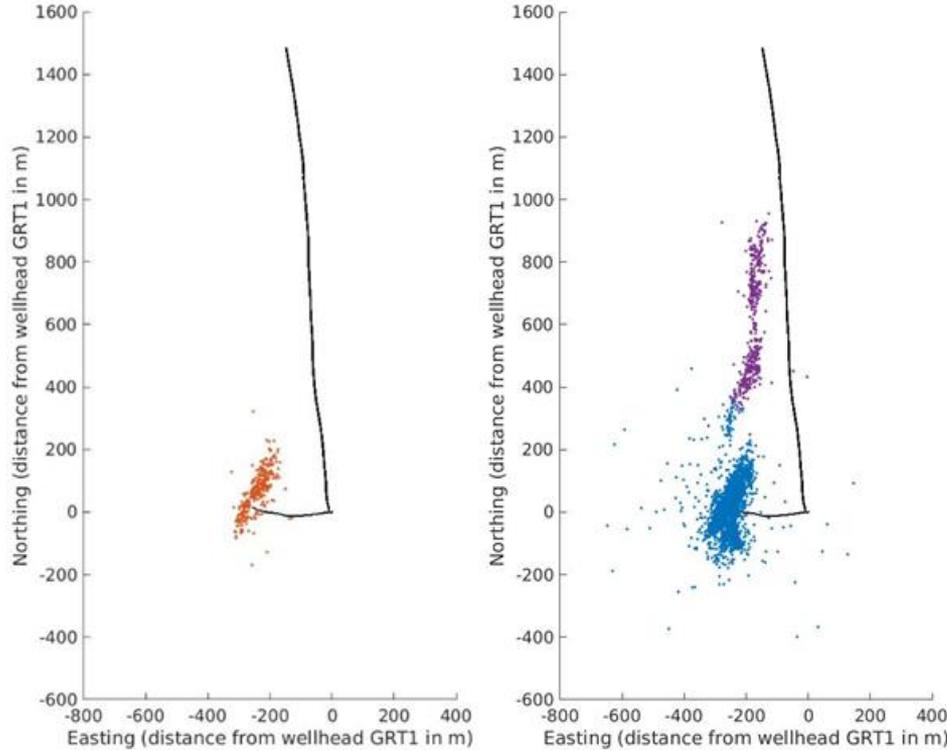
Rittershoffen site:

- Situated in the Upper Rhine Valley
- Well doublet GRT1/GRT2, drilled to around 2.5 km depth
- Targeted reservoir: just below the transition from sedimentary cover to granitic basement, intersected by a major fault zone
- GRT1 underwent thermal, chemical and hydraulic stimulation

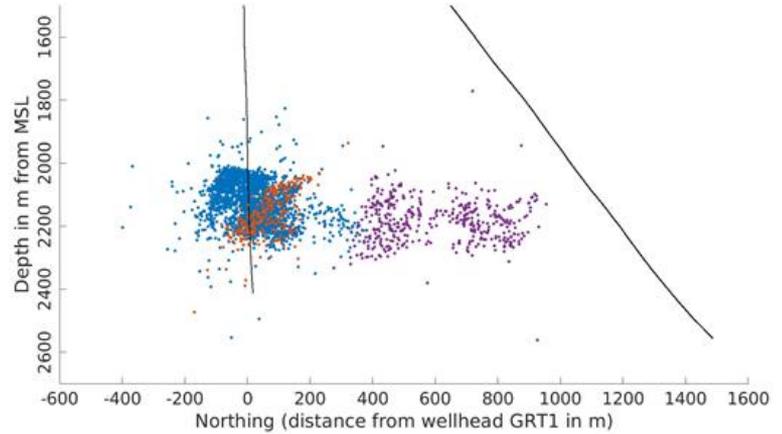
Seismic networks:

- Permanent network: 12 stations (black squares), operational during all stimulations
- Temporal network: 5 additional stations (blue triangles) operational during chemical and hydraulic stimulation

Spatial distribution of seismicity – Relative locations

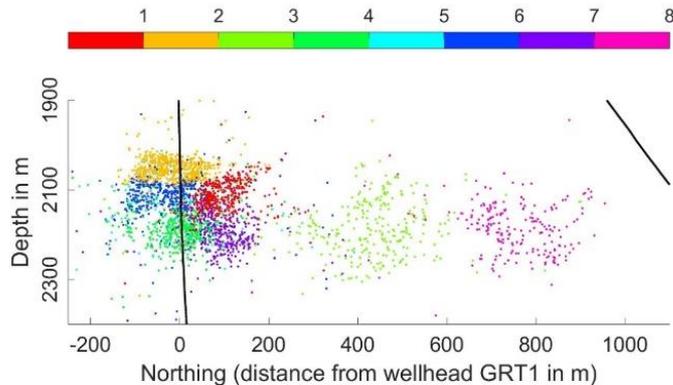
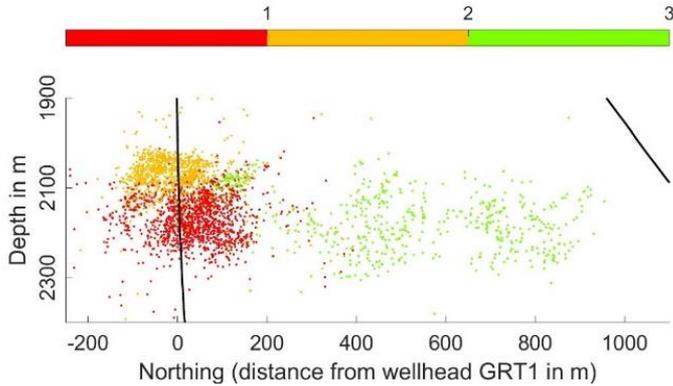


■ Orange: thermal stimulation, blue: main interval hydraulic stimulation, purple: delayed interval hydraulic stimulation



- Same fault active during therm. and injection interval of hyd. stim. (oriented NNE-SSW, vertical to near vertical dip)
- Seismic cloud of hyd. stim. extends farther SW-upward
- Delayed seismicity on a second structure farther north in same depth range (varying strike N-S to NNE-SSW, steep dip to W)
- Some events of the injection interval of hyd. stim. are also located on this second structure

Clustering analysis



Method:

- K-means clustering: partitioning of n observations into k clusters by minimizing the sum of distances between each cluster member and cluster mean
- Events with similar correlation patterns are grouped together in a cluster

Results (shown for $k = 3$ and $k = 8$):

- Clusters of events based on waveform similarity are largely also spatially grouped together
- The same clusters active during therm. stim. are still active during injection interval of hyd. stim.
- The events from the injection interval of the hyd. stim. that are co-located with the delayed seism. belong partly to a cluster 3 active during the delayed interval, partly to clusters active during the whole injection interval of hyd. stim.