Seismic surveys at an artificially created field-test cavern within a salt pillar

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Contribution for:

- long-term integrity and safety of technical caverns during their operation and abandonment
- early detection and controllability of salt solutions in mines

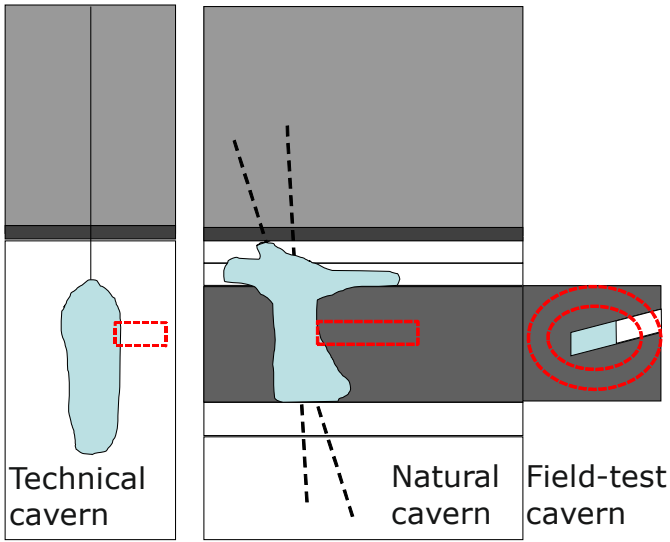
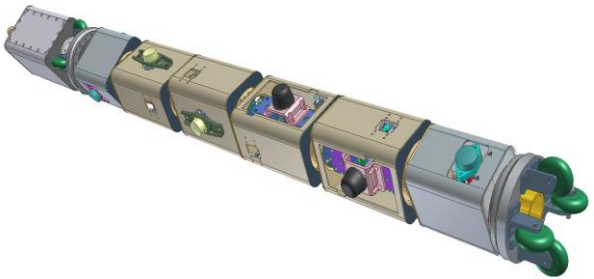


Figure based on Höntzsch and Zeibig (2014), GeoFrankfurt 2014

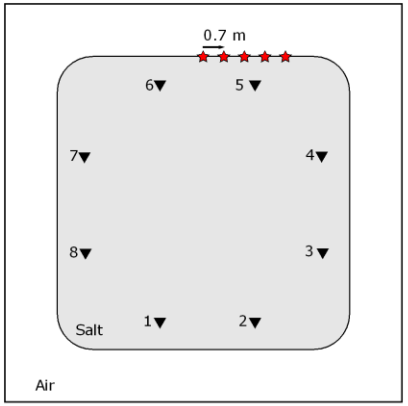
Aims of the seismic surveys:

- imaging the changes of the salt rocks in the vicinity of the cavern
- assessing the potential enlargement of the field-test cavern due to water-infill



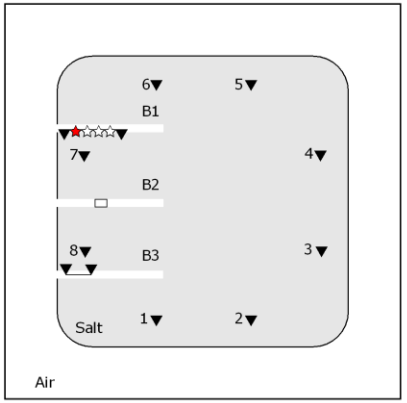
Left: Seismic vibration source systems around the pillar wall and right: within the observation wells.

Set-up of the seismic surveys



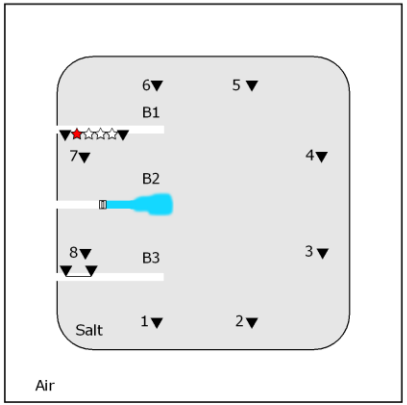
1. Baseline survey

Eight three-component piezo-electrical sensor rods (triangles) and a seismic vibration source (0.1 -12 kHz) around the surface (104 source points-stars) of the salt pillar were used, without an installed field-test cavern.



2. Cross-hole survey

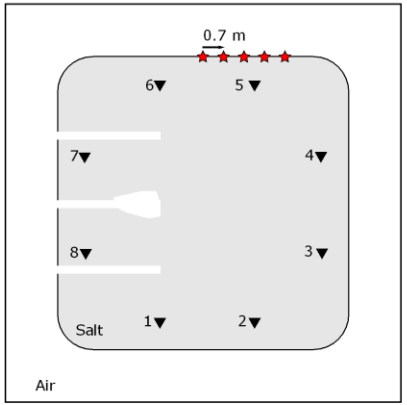
After drilling and installing the field-test cavern (B2), seismic cross-hole measurements between observation wells (B1,B3) were performed after producing a partial vacuum in the test cavern.



3. Cross-hole survey after infill of gas and

4. Infill of water

Measurements were carried out after a longer exposure time. (several days)



5. Repetition of the baseline survey

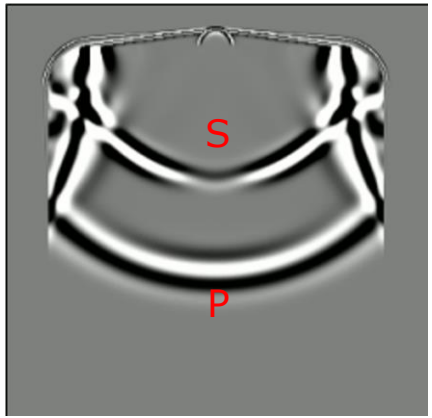
Measurements were performed after the experiments adressing gas-water-rock interactions were finalized.

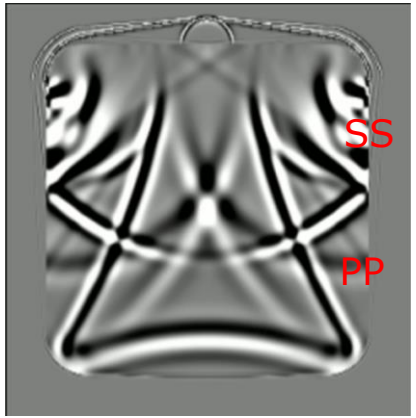
★ Shot points

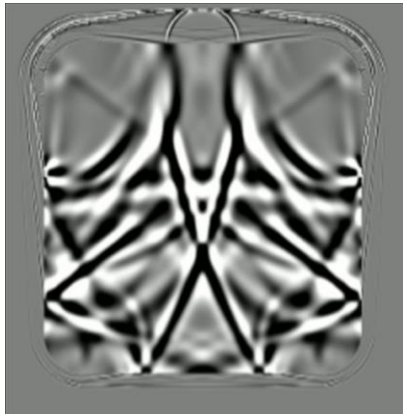
▼ Receiver points

2D-FD-Modeling of seismic waves within the salt pillar

The figures show the propagation of the direct P- and S-waves within the salt pillar during the baseline survey. After hitting the pillar walls, the direct waves are reflected backward.

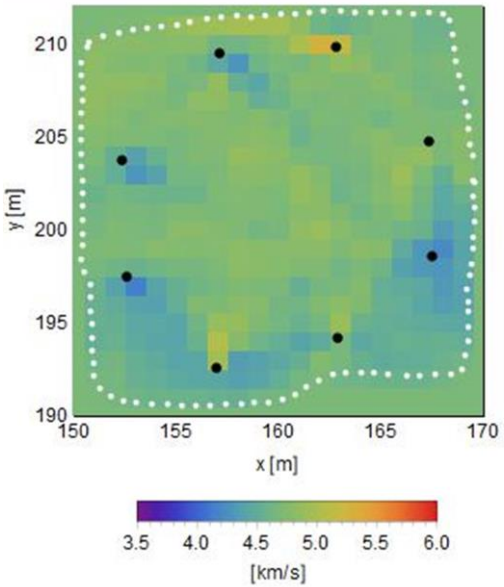






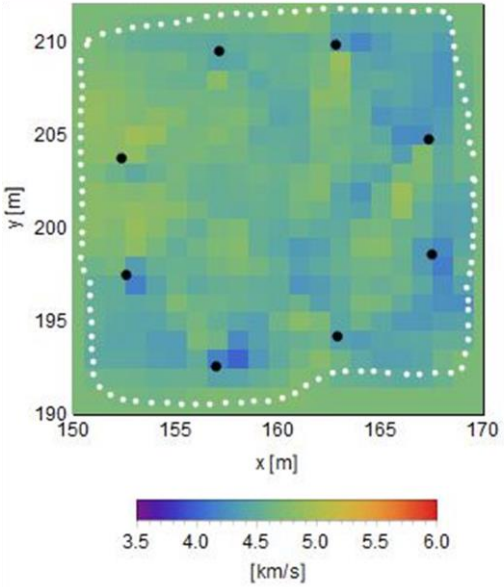
First results of the salt pillar survey
(Travel-time tomography of direct p-waves)

Baseline survey



The image shows the result of the first surface seismic survey without test cavern and observation wells. Green areas show zones of velocities determined in the range of 4600 m/s, which indicates intact salt rocks. Blue areas show zones of low velocities, which indicate more loosened rock.

Repetition of baseline survey



The image shows the result of the last surface seismic survey after performing all gas-water-rock interactions within the cavern. Zones of low velocities are increased in the salt pillar, which indicates more loosened rock areas. The cavern contour could not image with p-wave surface tomography.