ProSalz – Investigations of the transition zone between cavity and undisturbed salt rocks

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Background

Salt rocks serve as host rock for technical caverns due to their high impermeability. In order to ensure the long-term integrity and safety of caverns during their operation and abandonment a detailed process understanding of the multiphase system salt-gas-water in the transition zone between cavity and undisturbed salt rocks is required.

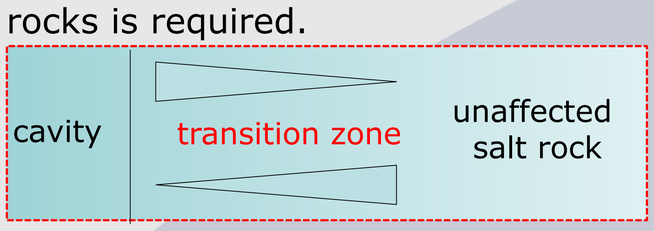


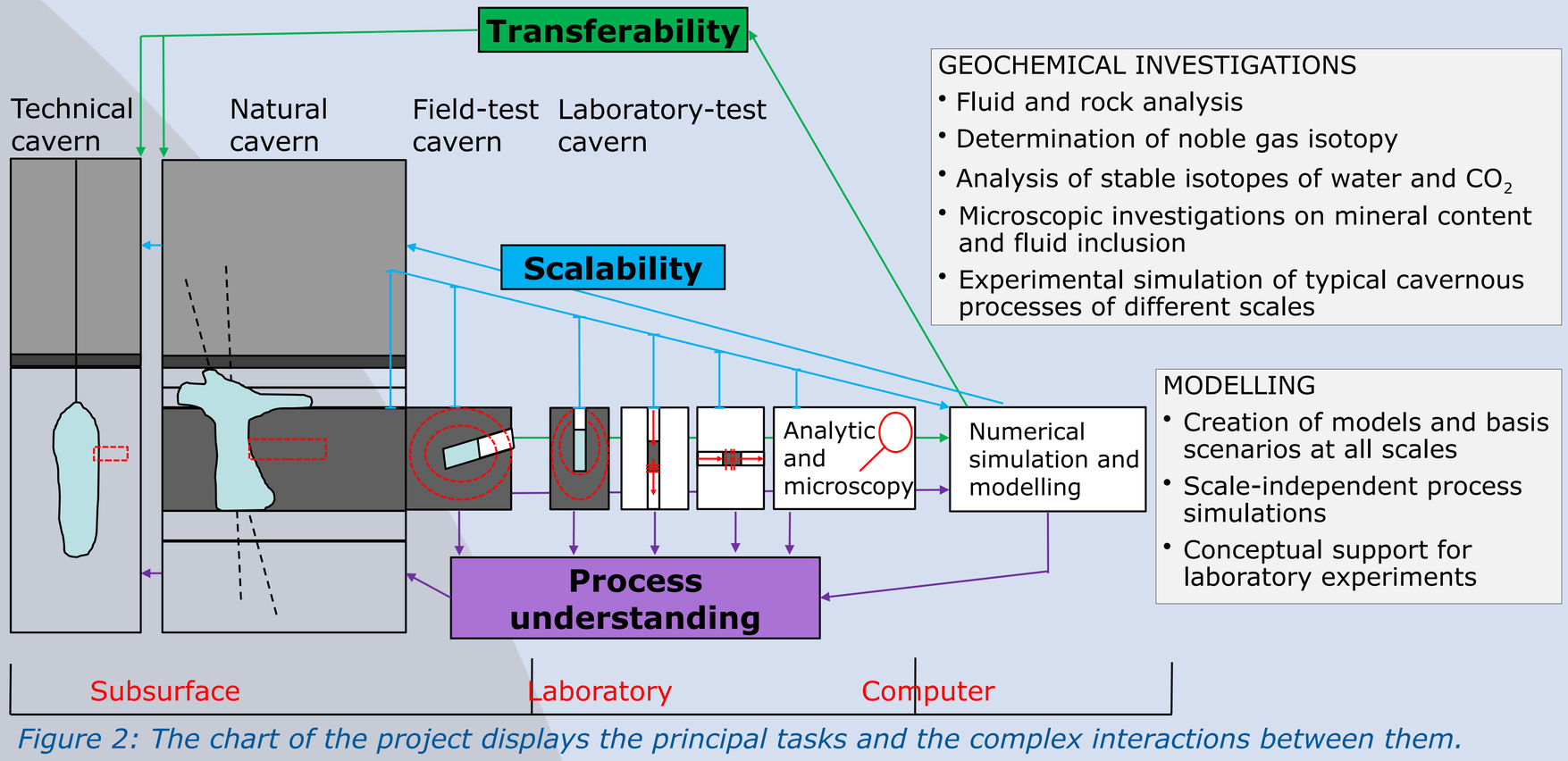
Figure 1: Chart of the area to be investigated, the transition zone between cavity and undisturbed rock.

INVESTIGATION AT THE TRANSECT
- Drill core and fluid sampling in defined distances
- Seismic monitoring
- Long-term monitoring of the fluid release

FIELD-TEST CAVERN IN A SALT PILLAR
- Experimental simulation of typical cavernous processes and monitoring
- Process monitoring with seismic sensor array
- Geochemical monitoring in sample drillings

Methods

Within the Geo:N project ProSalz the process understanding, scalability and transferability of reactive multiphase transport is addressed by numerical modelling as well as geochemical and geophysical measurements. Due to the inaccessibility of cavern walls, comparable structures in an underground salt mine will serve as analogue which makes *in-situ* studies possible.



GEOCHEMICAL INVESTIGATIONS
- Fluid and rock analysis
- Determination of noble gas isotopy
- Analysis of stable isotopes of water and CO_2
- Microscopic investigations on mineral content and fluid inclusion
- Experimental simulation of typical cavernous processes of different scales

MODELLING
- Creation of models and basis scenarios at all scales
- Scale-independent process simulations
- Conceptual support for laboratory experiments

Figure 2: The chart of the project displays the principal tasks and the complex interactions between them.

Seismic surveying

The main tasks of the first seismic survey is to image the structure of the salt rocks close to a geogenic cavern by travel time tomography, in particular P-wave tomography and P/S-wave tomography in 2D and 3D, and pre-stack migration methods. The first evaluation of the seismic data showed an average P-wave velocity of 4.60 km/s and an average S-wave velocity of 2.63 km/s in salt rocks.

Transect survey

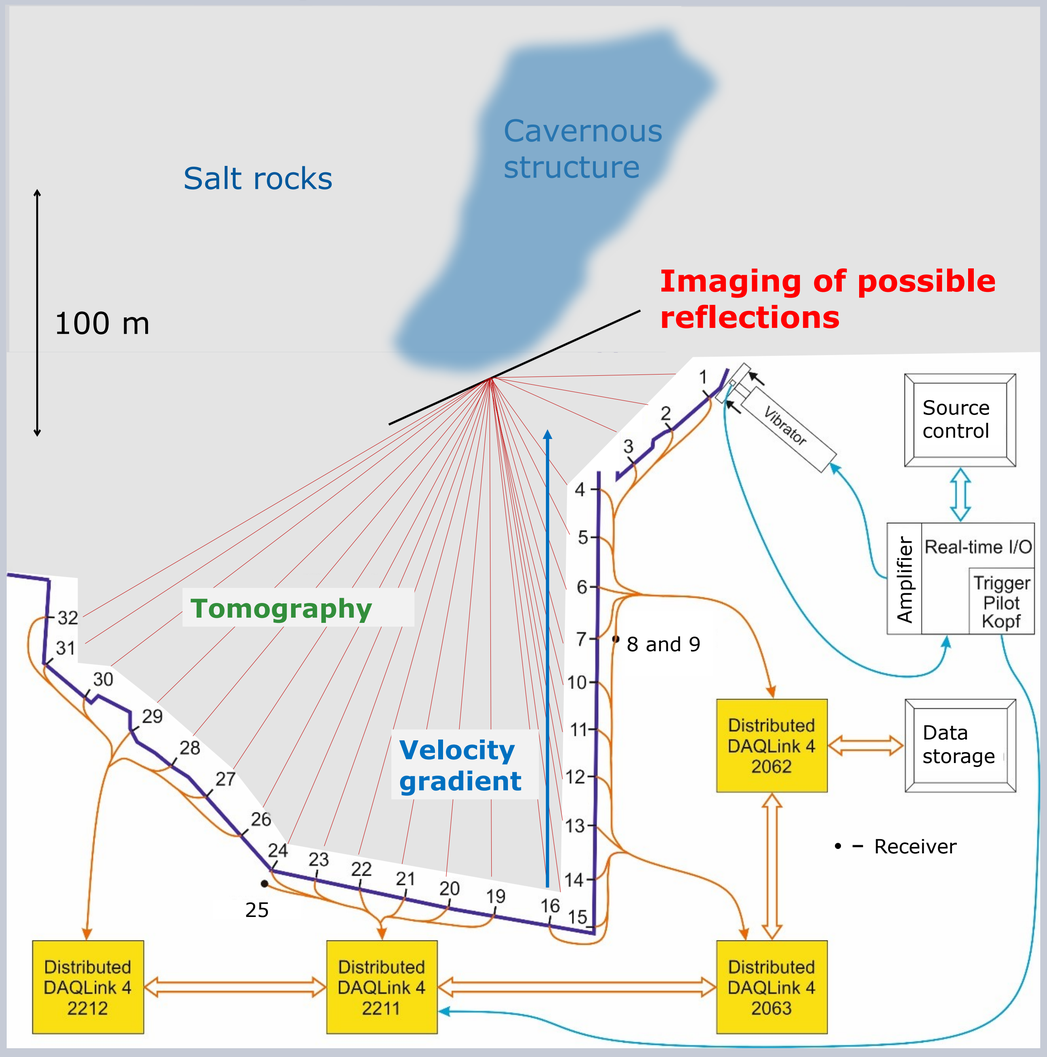


Figure 3: Seismic field set-up to investigate the transition zone between cavernous structure and undisturbed salt rocks.

- Determination of possible velocity gradients as indicator for the convergence to a cavernous structure
- Comparison of unaffected salt rocks and cavernous structures
- Characterization of fracture zones as natural pathways for fluids

Salt pillar survey

In a second survey, a seismic sensor array is installed around a salt pillar to monitor effects around an artificially created field-test cavern influenced by fluid entries. A further task is to detect the potential migration front of fluids within the salt pillar.

- Baseline survey

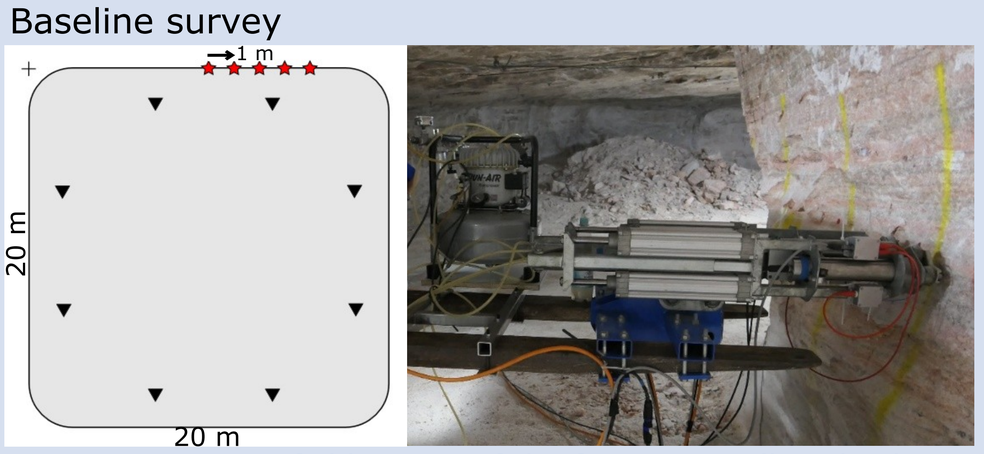


Figure 4: Seismic field set-up of the first survey (baseline) using 8 three-component sensor rods (triangles) and a seismic vibrator source sending sweeps in a frequency range of 100 to 11000 Hz into the salt rocks.

- Second survey

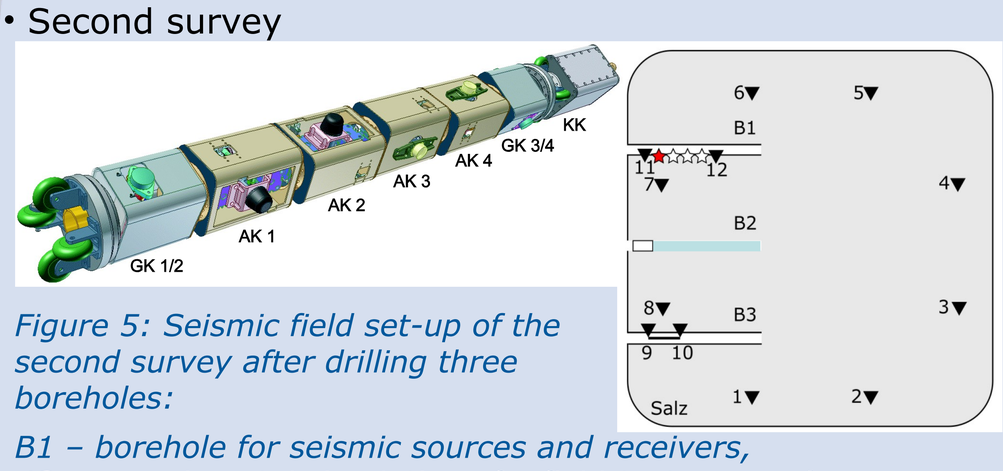


Figure 5: Seismic field set-up of the second survey after drilling three boreholes:
B1 – borehole for seismic sources and receivers,
B2 – experimental simulation of a field-test cavern (vacuum),
B3 – borehole for a receiver tool.

- Further steps:
  Seismic measurements after filling field test cavern with CO_2 and water

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