

APPLICATION OF ULTRASONIC TECHNIQUES FOR QUALITY ASSURANCE OF SALT CONCRETE ENGINEERED BARRIERS: SHAPE, CRACKS AND DELAMINATION

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Challenge: Safe storage of nuclear waste

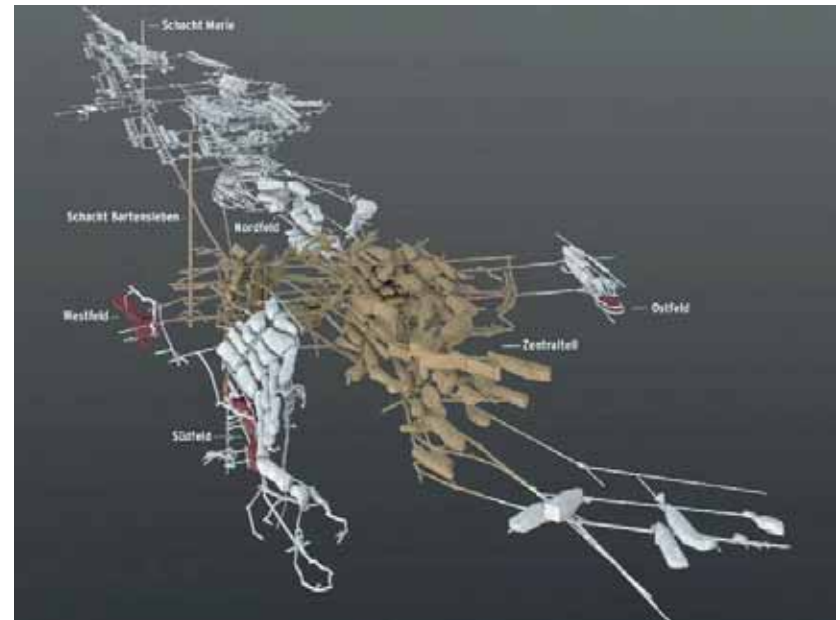


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Repository ("Endlager") Morsleben ERAM Central Germany

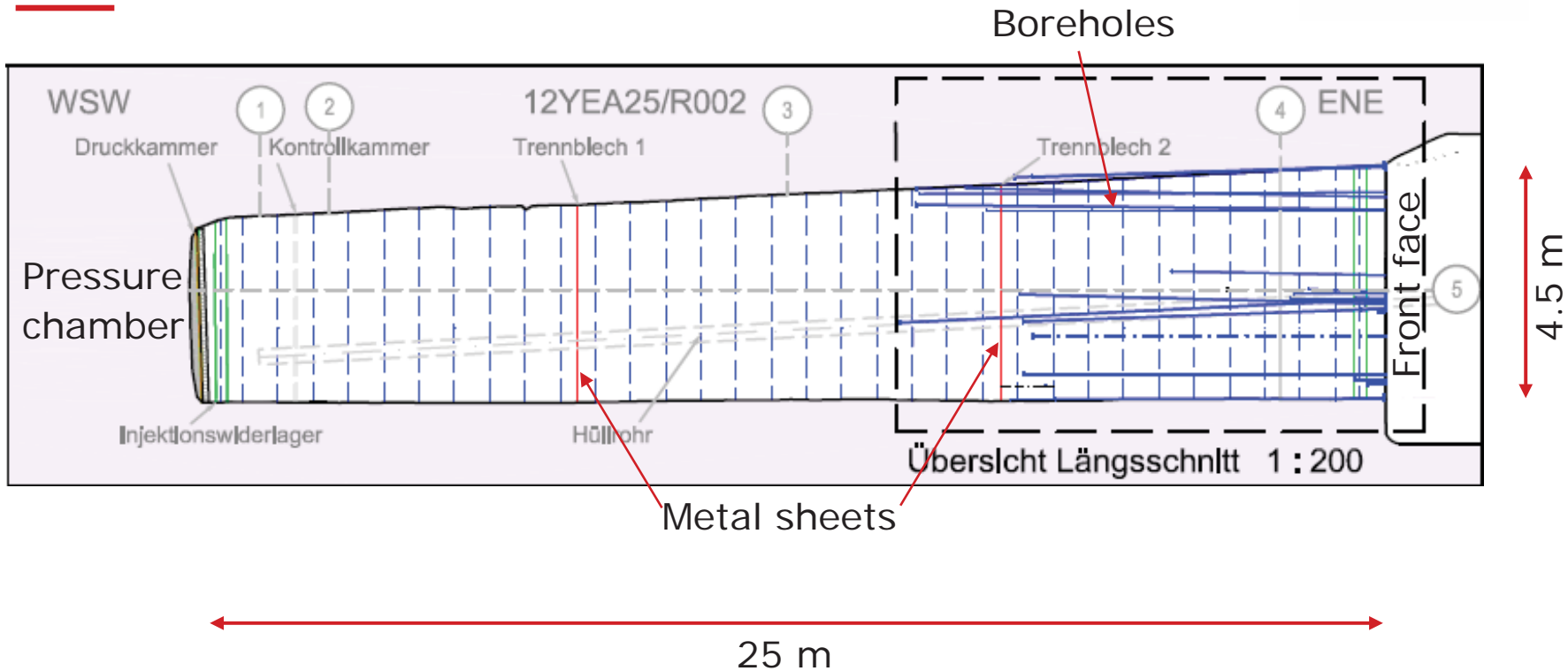


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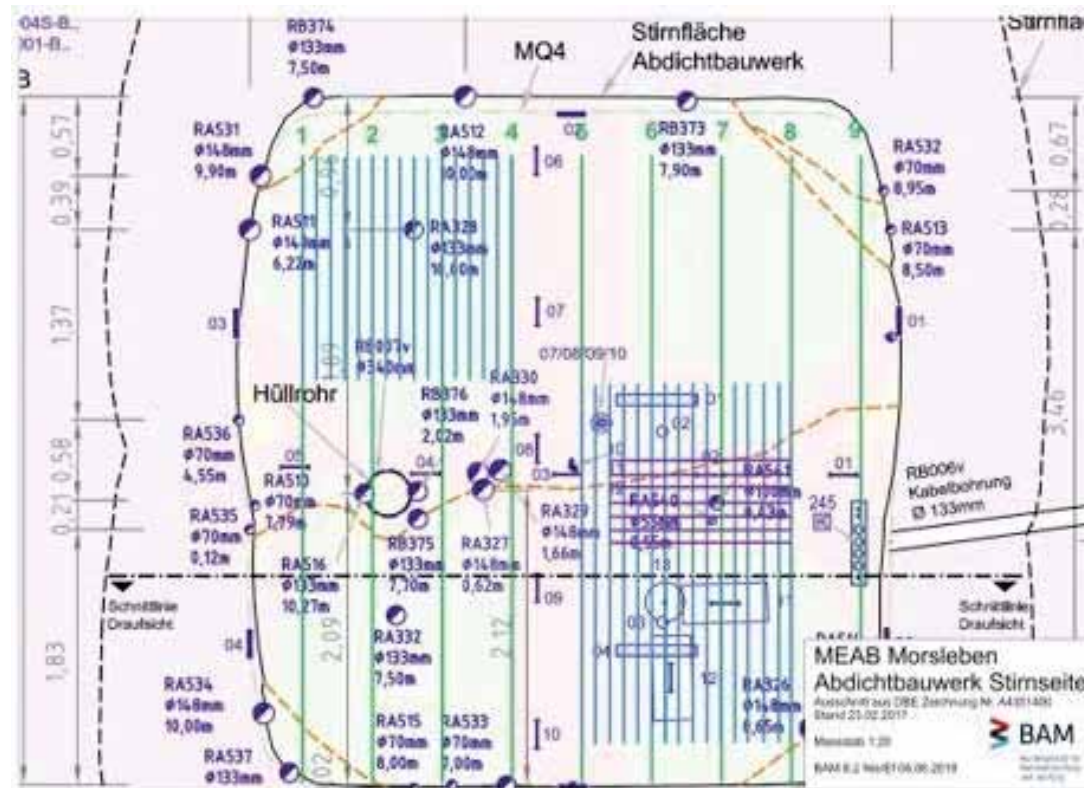


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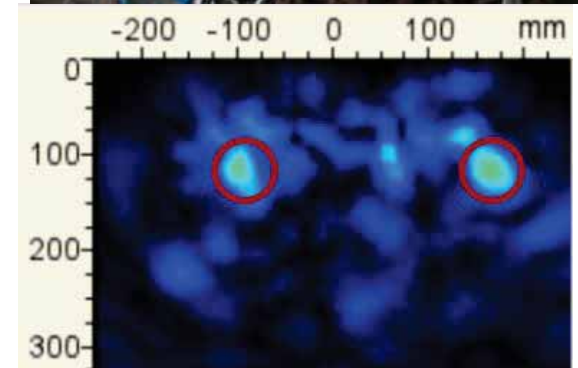
Engineered barrier (trial)



Engineered barrier (trial)



Ultrasonic-Echo Commercial instruments for concrete inspections

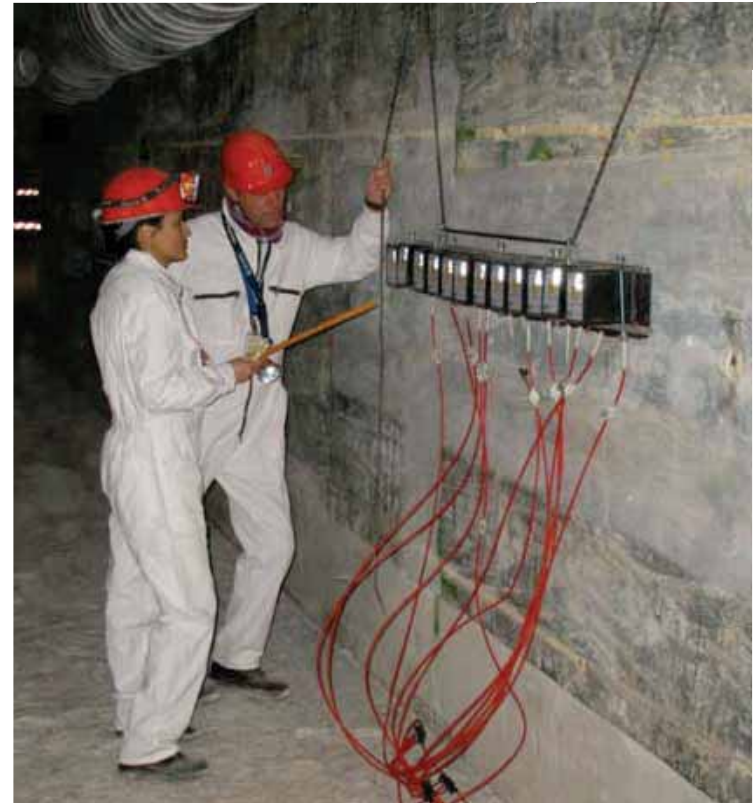


Ultrasonic Echo

LAUS Large Aperture Ultrasonic System

LAUS US-Module:

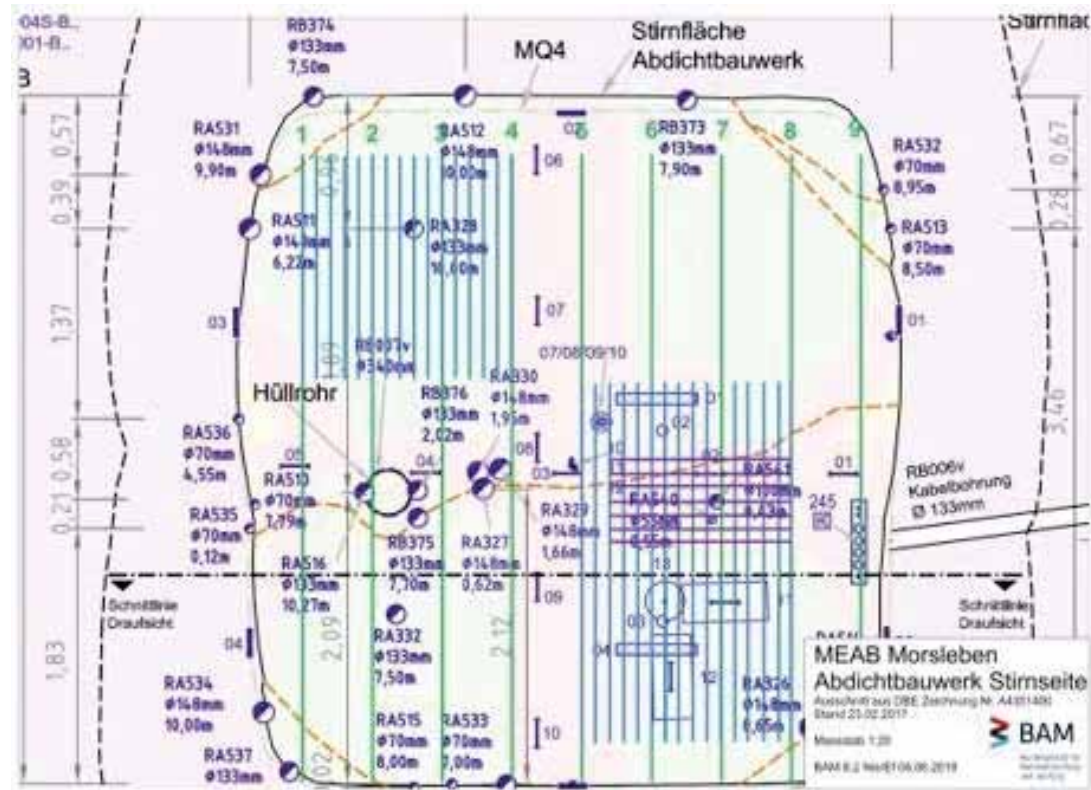
- 32 coupled shear wave probes each
- Frequency: 25 – 75 kHz



LAUS measurements on front face of the trial engineered barrier



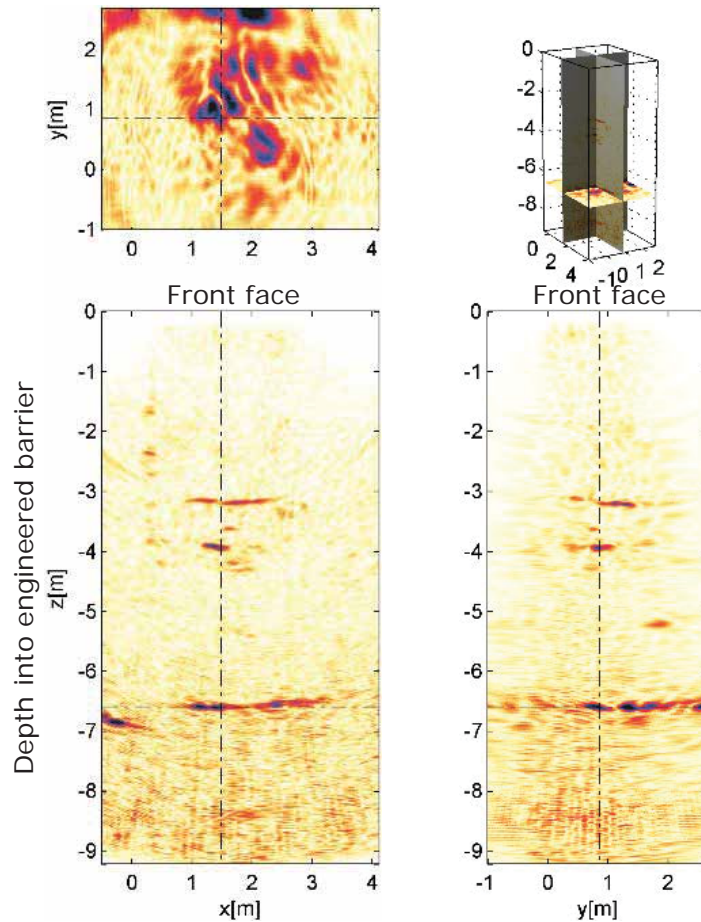
Engineered barrier (trial)



Ultrasonic-Echo - LAUS

First results

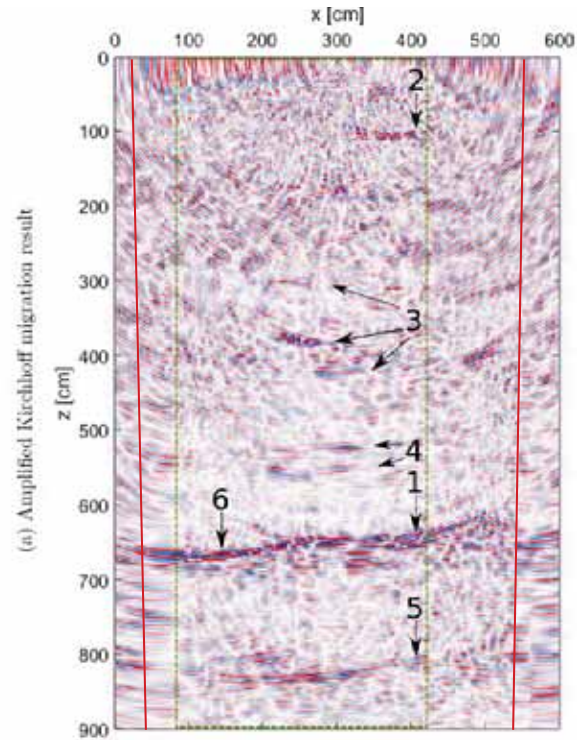
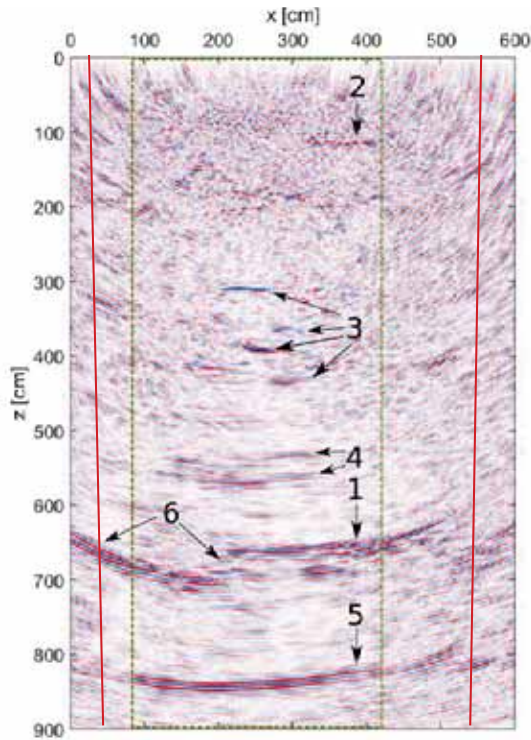
- Depth of penetration > 6m
- SAFT-Reconstruction
- Reflections from cracks and objects
- "Blind" near surface
- Metal sheet at 8,5 m ?
- Boundary salt concrete /rock salt?



Ultrasound-Echo Imaging with Reverse Time Migration (RTM)



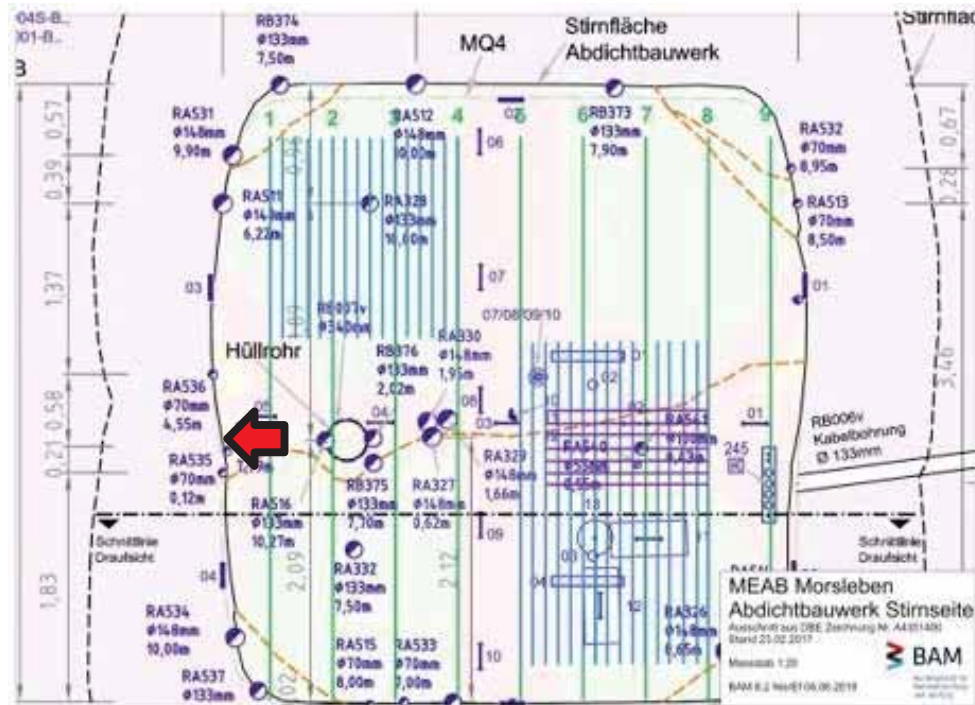
Kirchhoff
(SAFT)



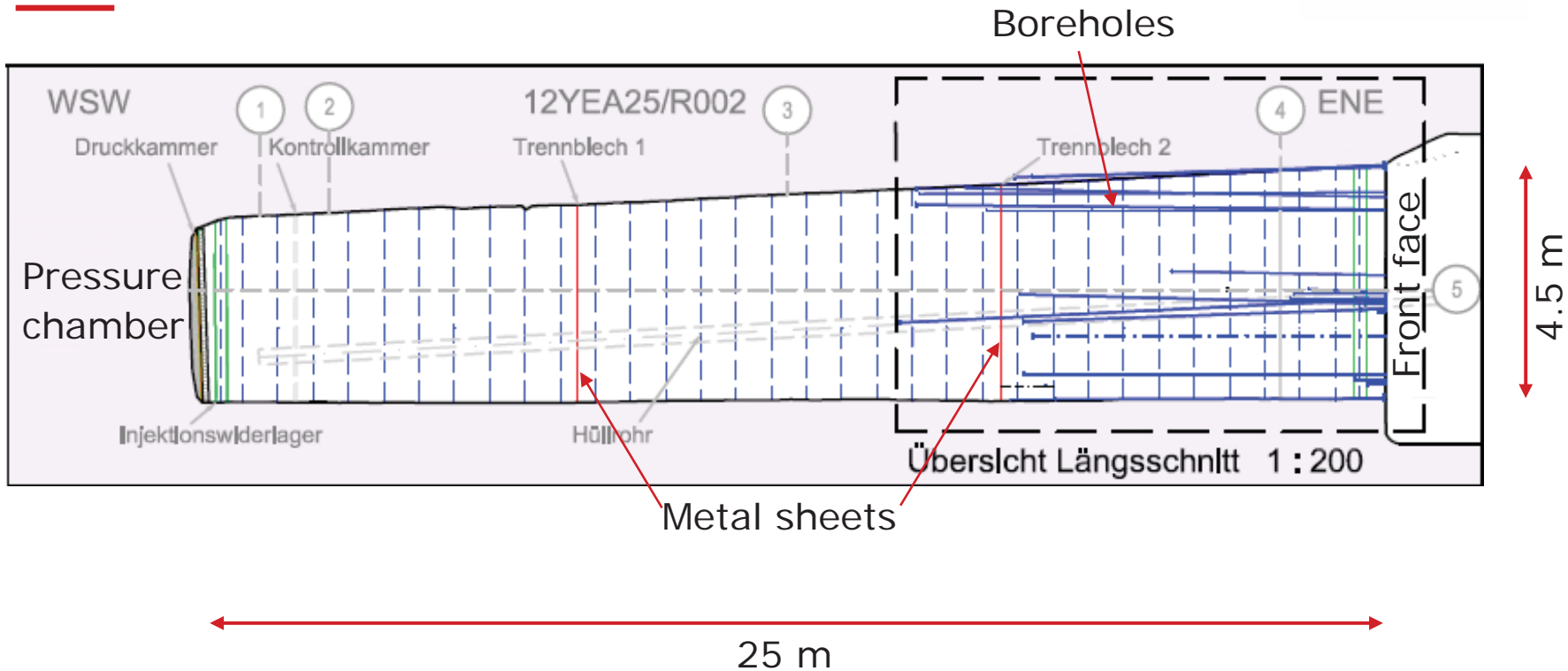
RTM

(Büttner, 2019)

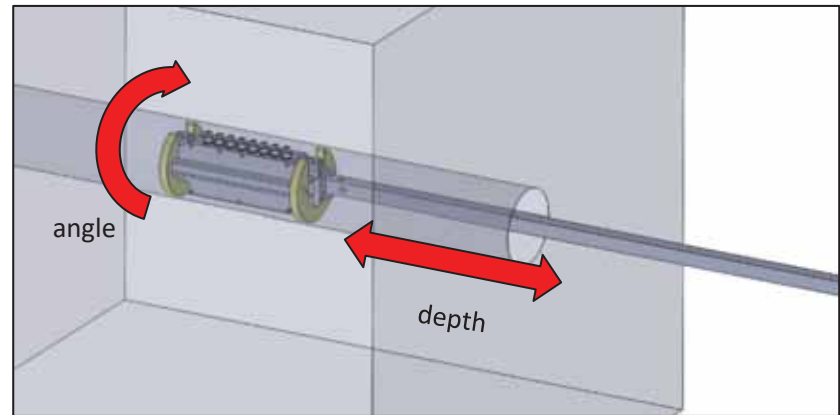
Engineered barrier (trial)



Engineered barrier (trial)



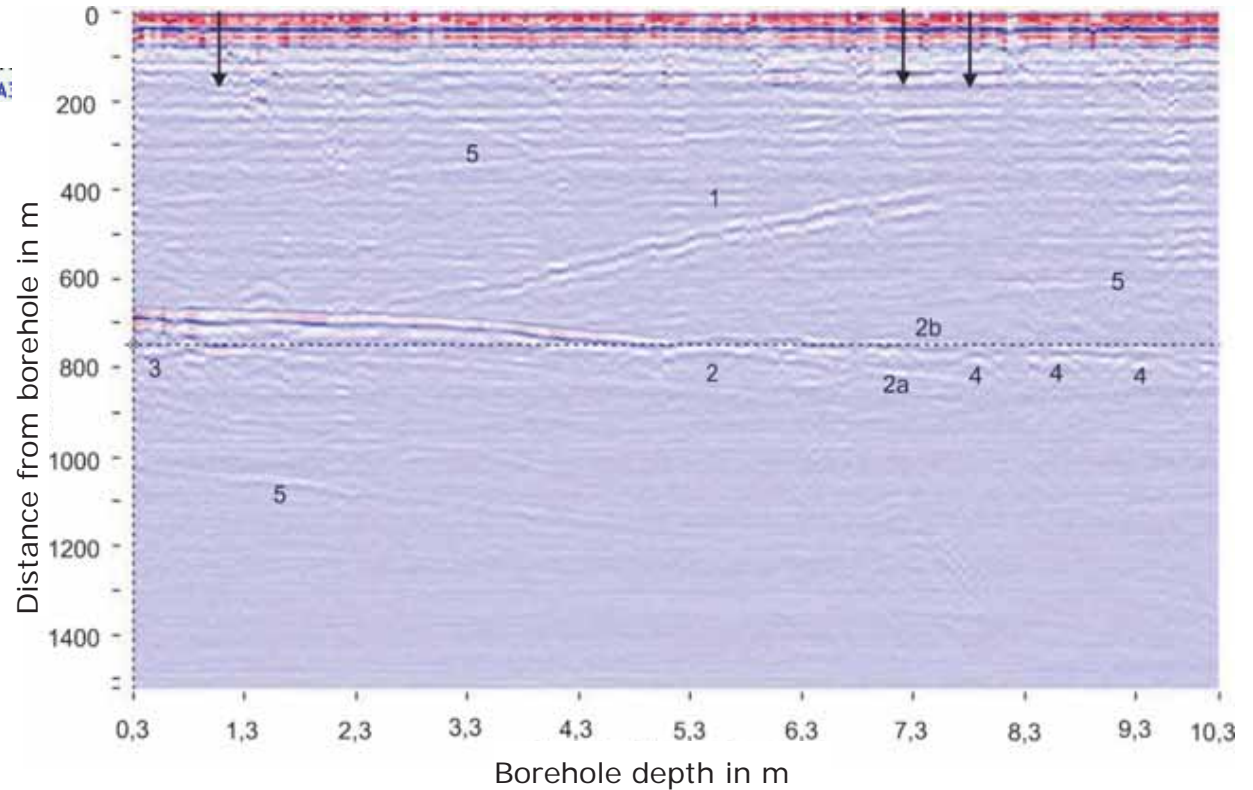
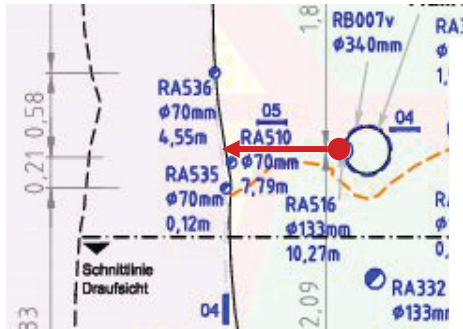
Ultrasonic-Echo Borehole probe



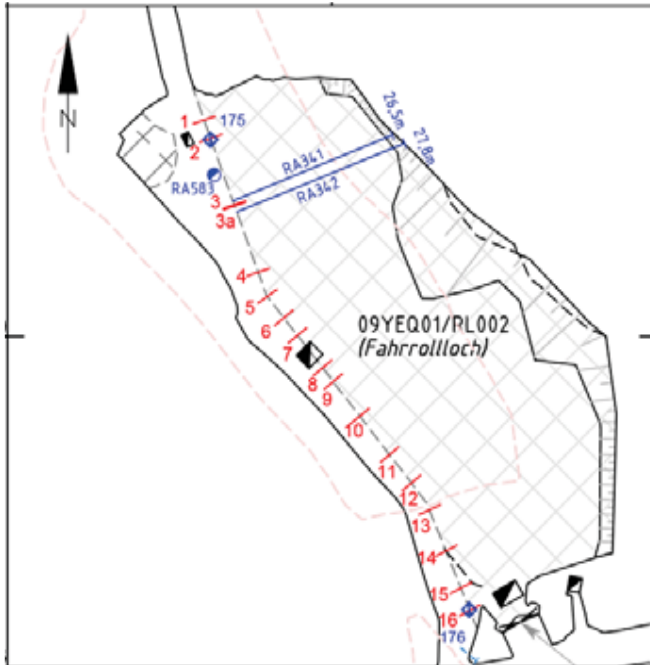
Ultrasonic-Echo Borehole probe



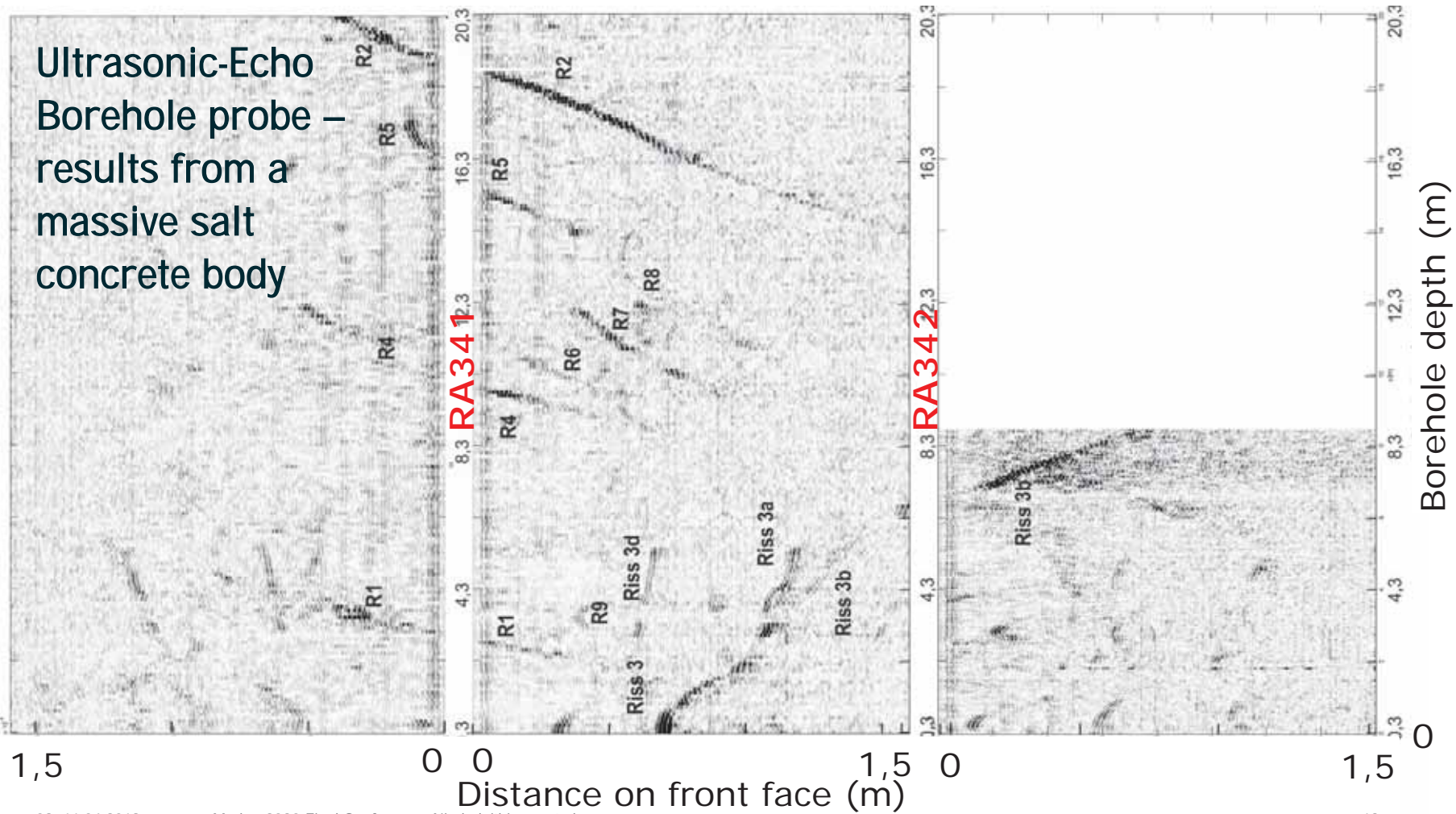
Ultrasonic-Echo Borehole probe – first results from the trial site



Ultrasonic-Echo Borehole probe – results from a massive salt concrete body



Ultrasonic-Echo
Borehole probe –
results from a
massive salt
concrete body



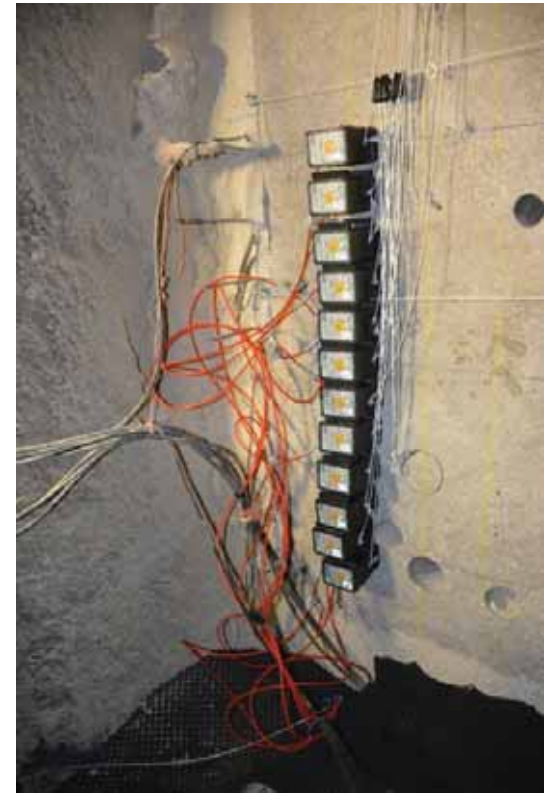
Summary

Investigations from front face

- Methods from NDT-CE transferable
- Crack +/- parallel to surface visible
- Objects detected
- Depth of penetration with LAUS > 8 m
- RTM gives new insight, but still limitations in image quality

Investigations using the borehole probe

- It works!
- Cracks and boundaries perpendicular to surface visible
- Limitations in image quality and depth of penetration



Outlook

Thematic project SealWasteSafe

- Under negotiation, start expected mid 2019
- Cross departmental
- 3.5 years, 17 py
- Basis for applied research and testing

- Concrete technology
- Monitoring
- Ultrasonic QA

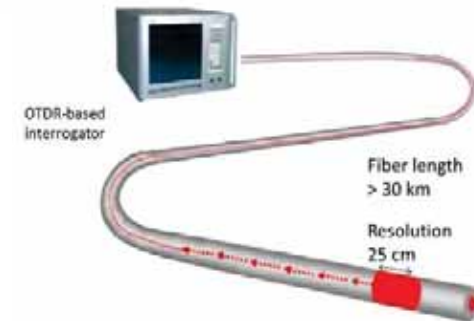
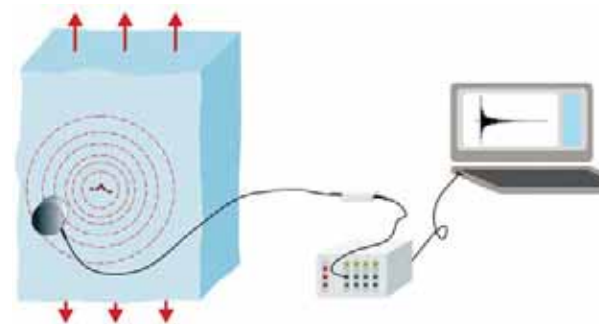
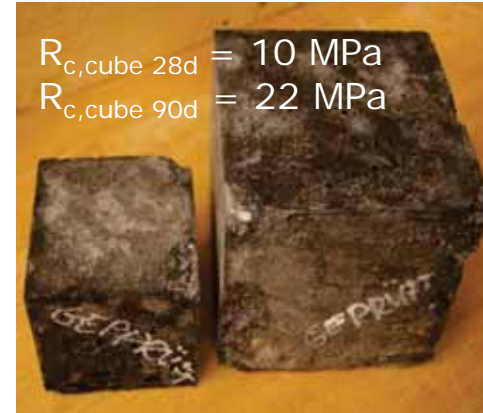


Figure 2.10 Distributed fiber optic sensor.