

What's new at Ketzin?

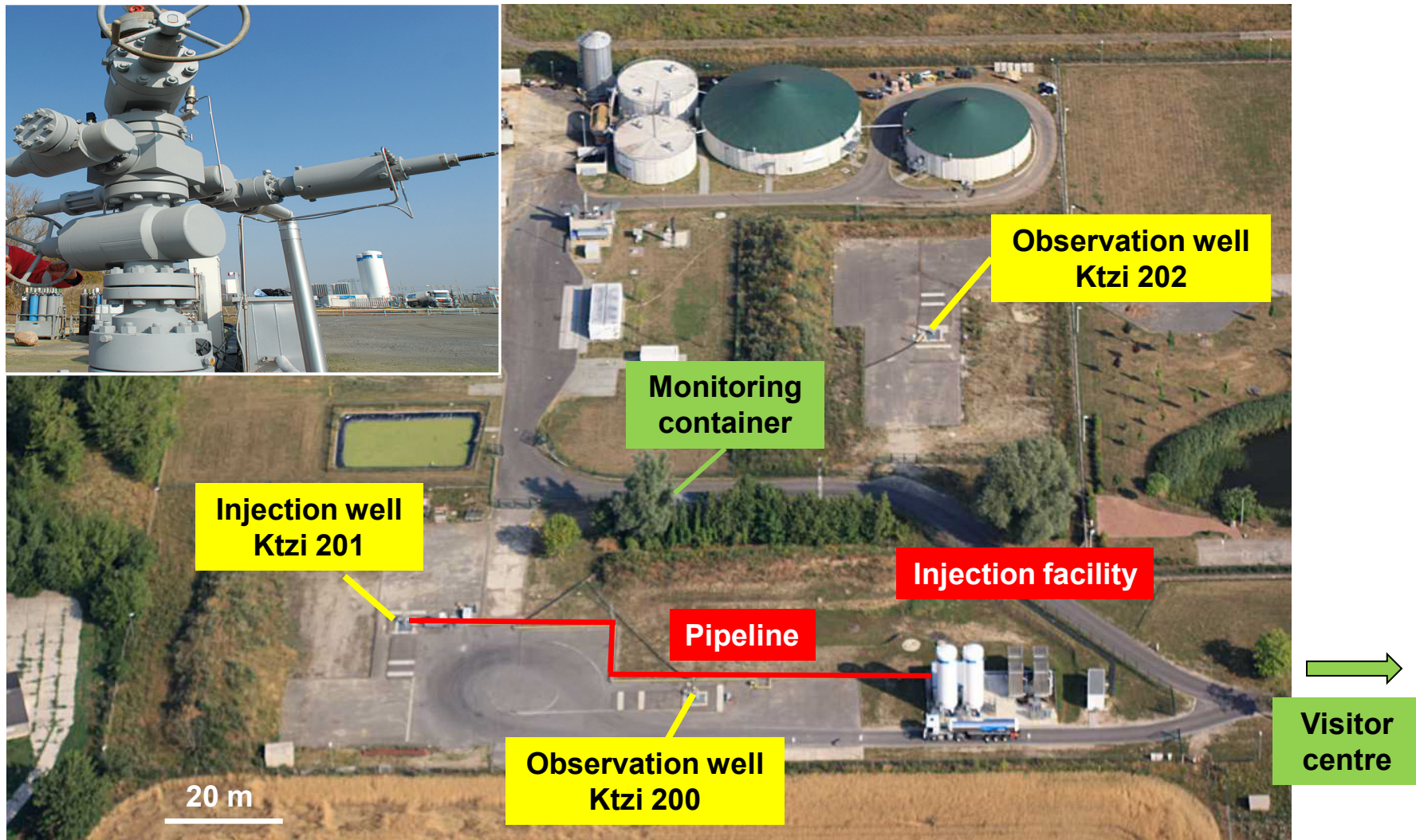
Progress report on Europe's longest-operating on-shore CO₂ storage site

Sonja Martens, Thomas Kempka, Axel Liebscher, Stefan Lüth, Fabian Möller, Michael Kühn and the Ketzin Group

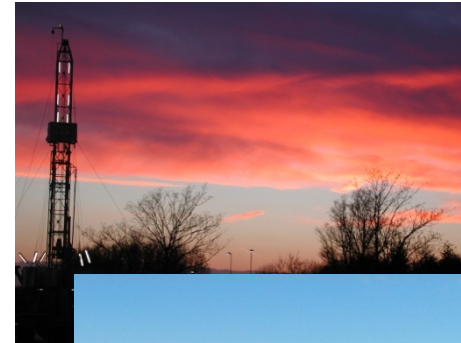
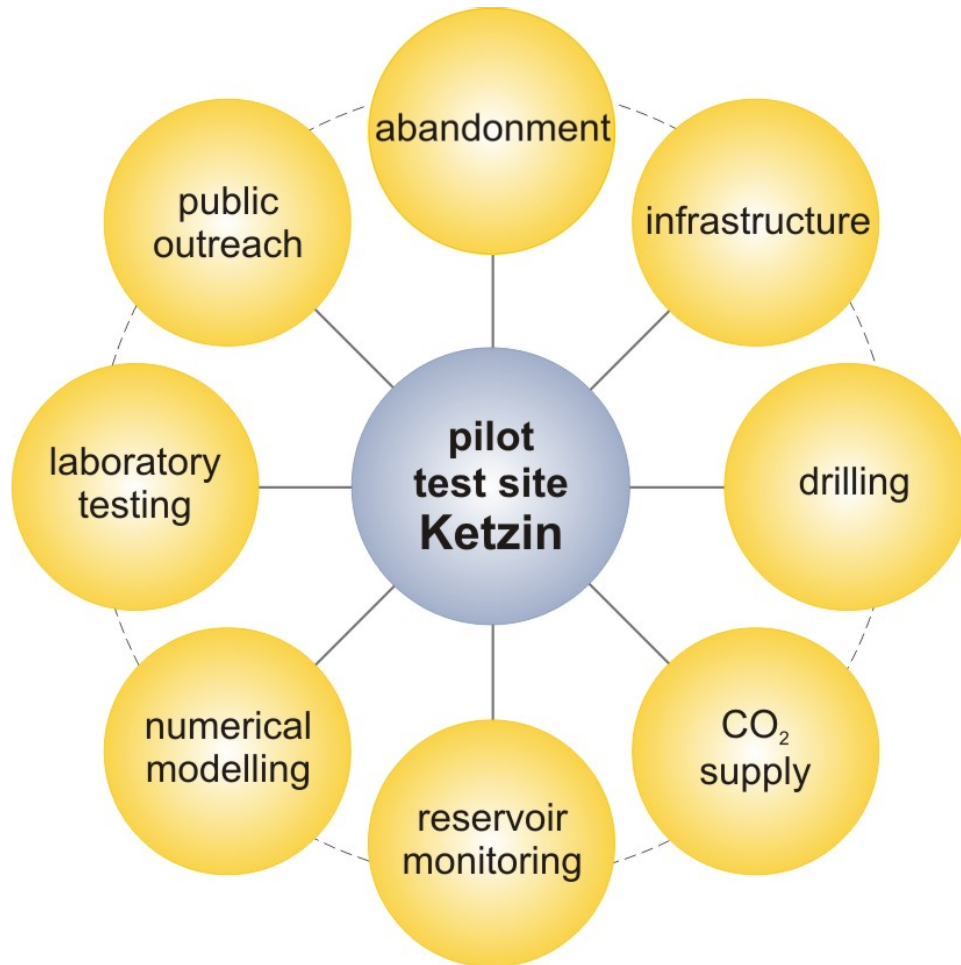
GFZ German Research Centre for Geosciences



Aerial view of the Ketzin site west of Berlin



Ketzin covers all aspects of a CO₂ storage site with a focus on monitoring



Project partners since 2004



Universität Stuttgart



Friedrich-Schiller-Universität Jena

UNIVERSITÄT LEIPZIG

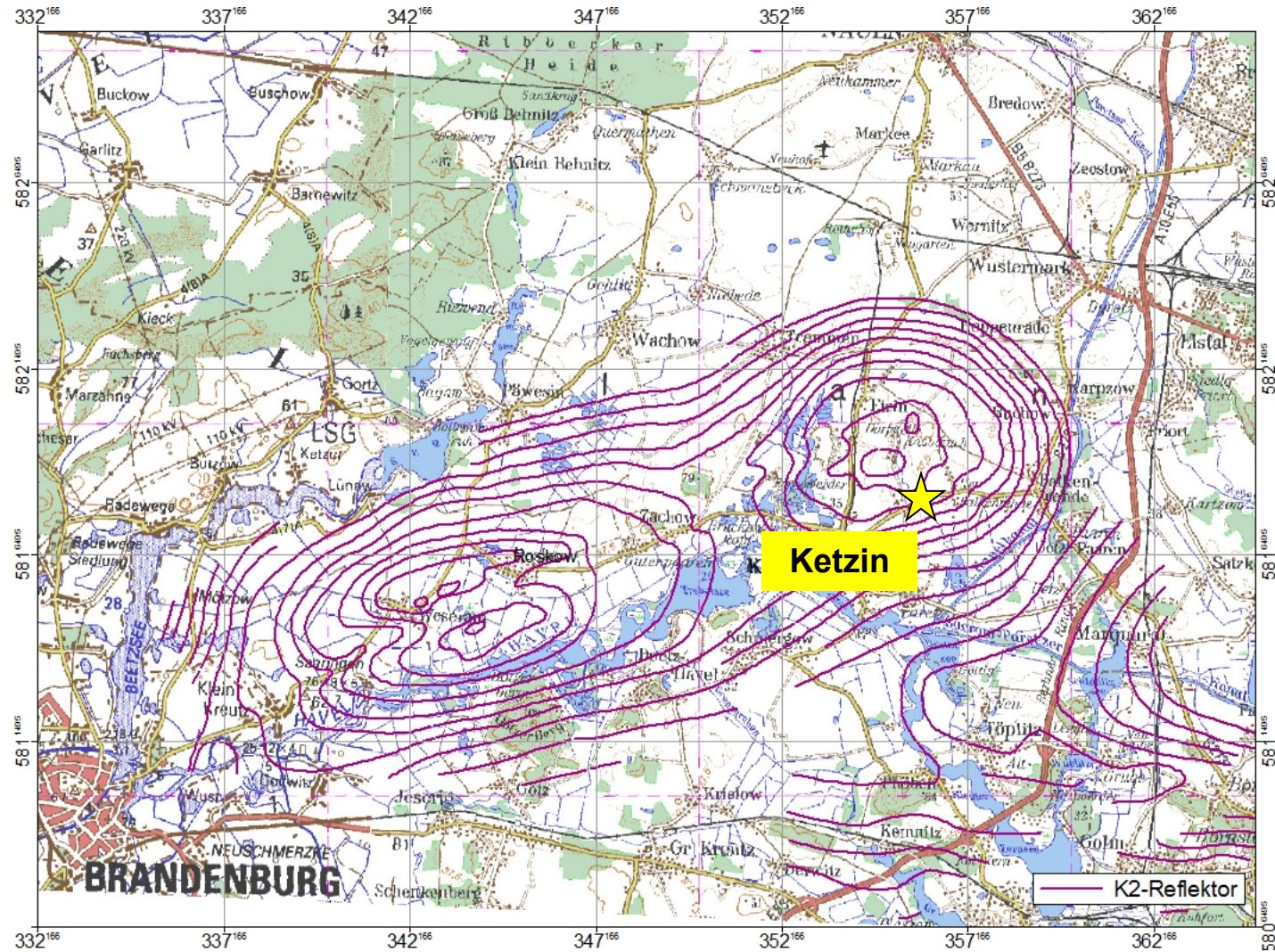
Schlumberger



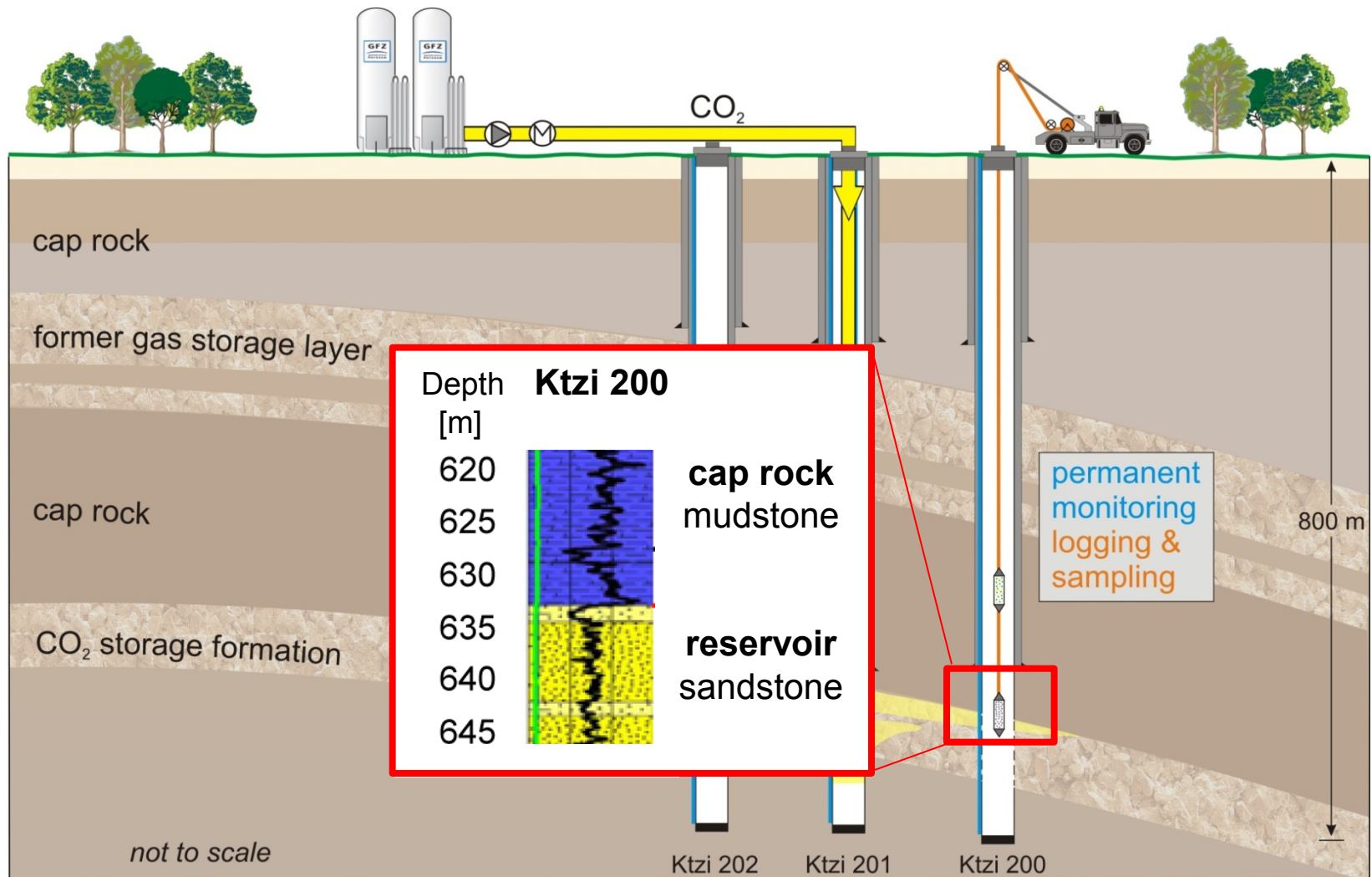
SIEMENS



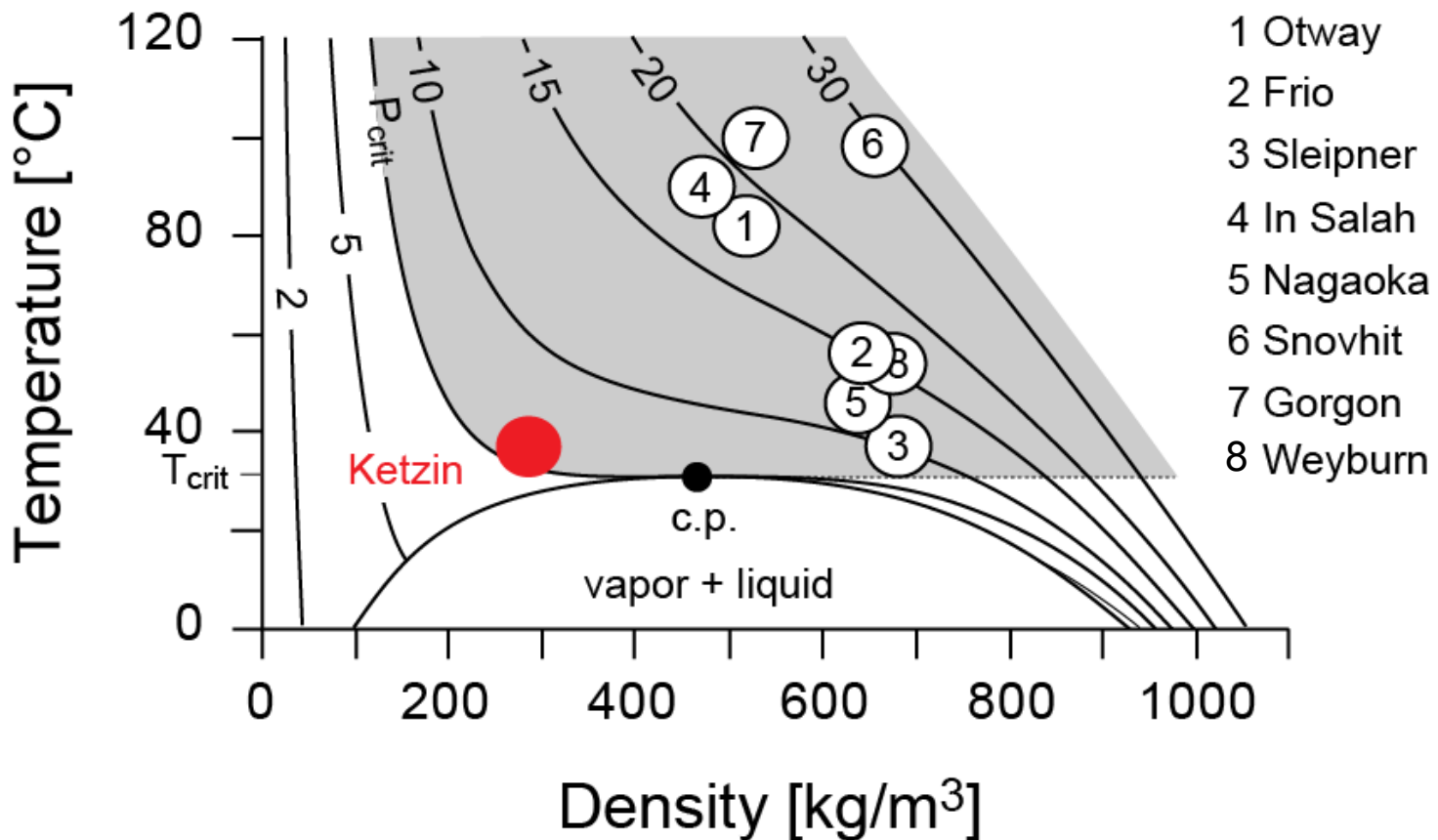
Ketzin at the SE flank of a double anticline



Schematic cross-section of the Ketzin anticline



The Ketzin site with comparably low pressure and density

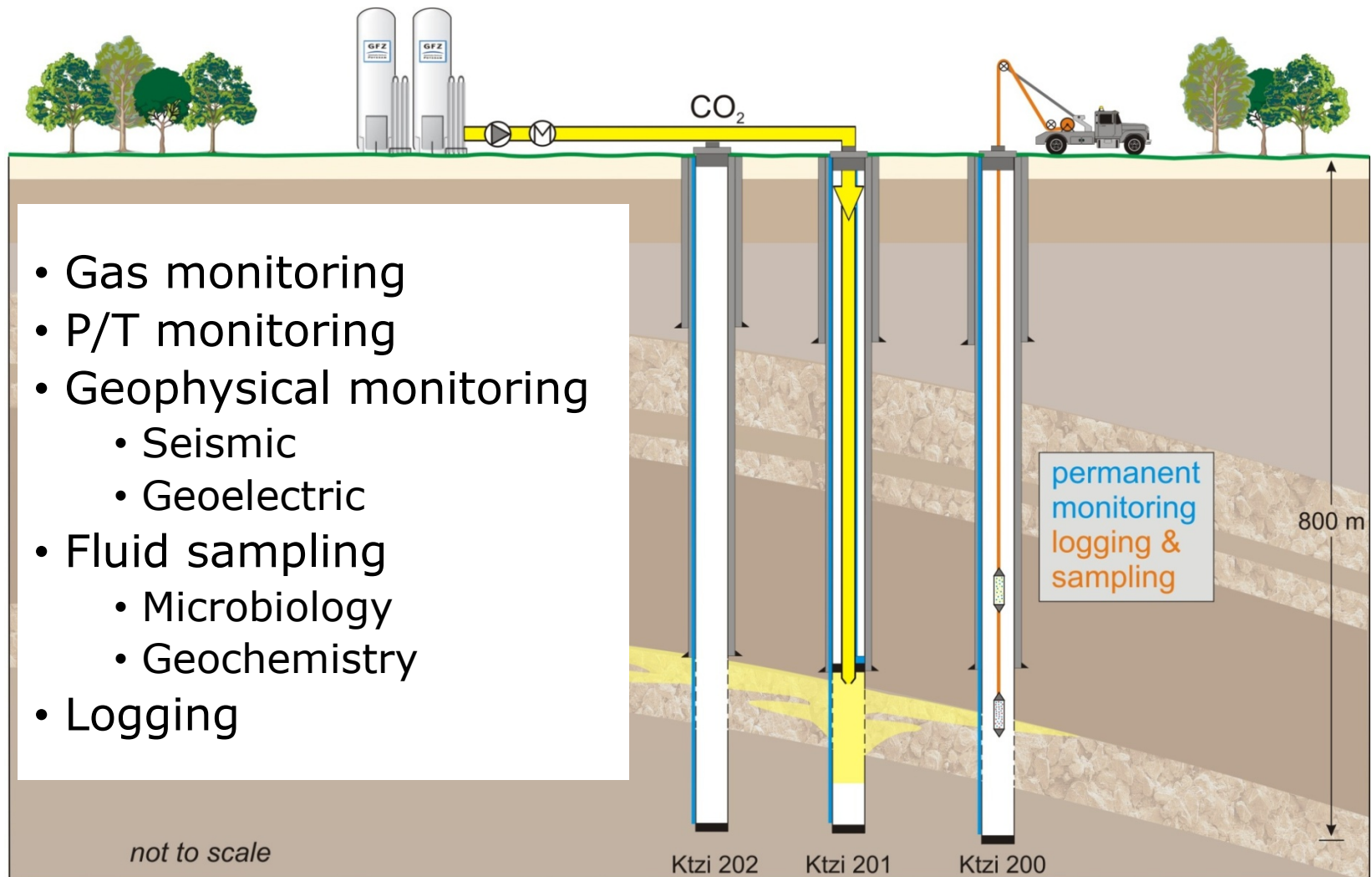


The CO₂ injection runs safely and reliably

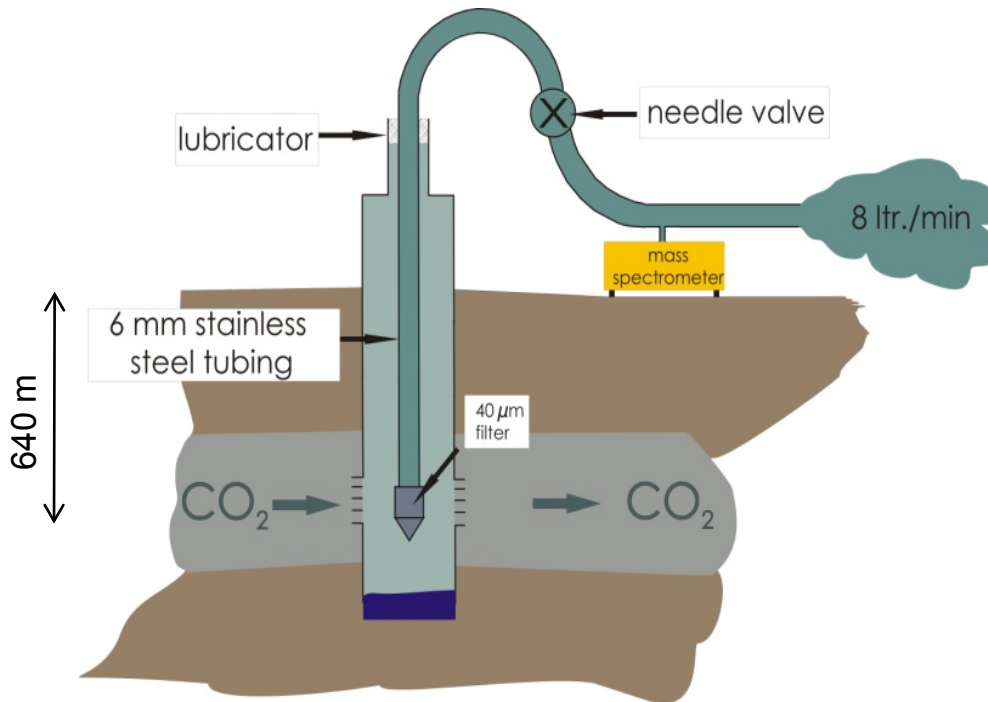
- Start of CO₂ injection: 30.06.2008
- CO₂ quality: > 99.7%
 - Primary source: food-grade CO₂ (Linde)
 - Secondary source: Schwarze Pumpe pilot plant (Vattenfall)
- Injection rates: 24 to 77 t/day
- 12.06.2011: 50,027 t CO₂ injected



An interdisciplinary monitoring concept is applied

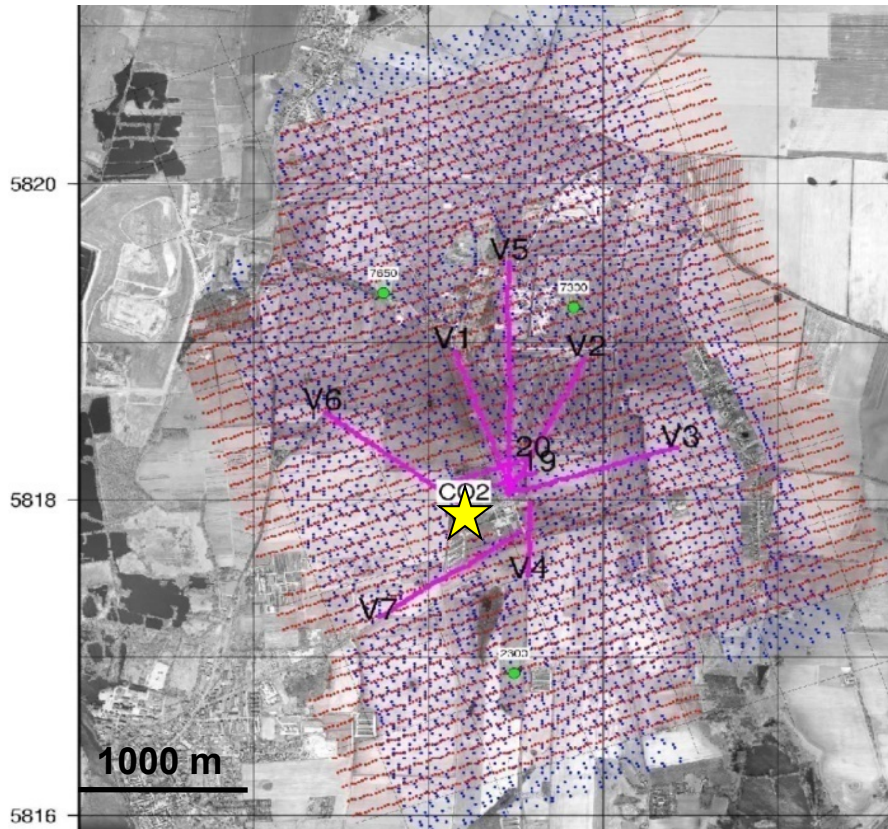


In-situ gas monitoring in well Ktzi 200



- Installation in March 2010
- Krypton and SF₆ tracer tests conducted in Spring 2010 and 2011

Geophysical methods with different spatial resolution are applied



3D Baseline 2005: 41 Templates $\sim 14 \text{ km}^2$
3D Repeat 2009: 20 Templates $\sim 7 \text{ km}^2$

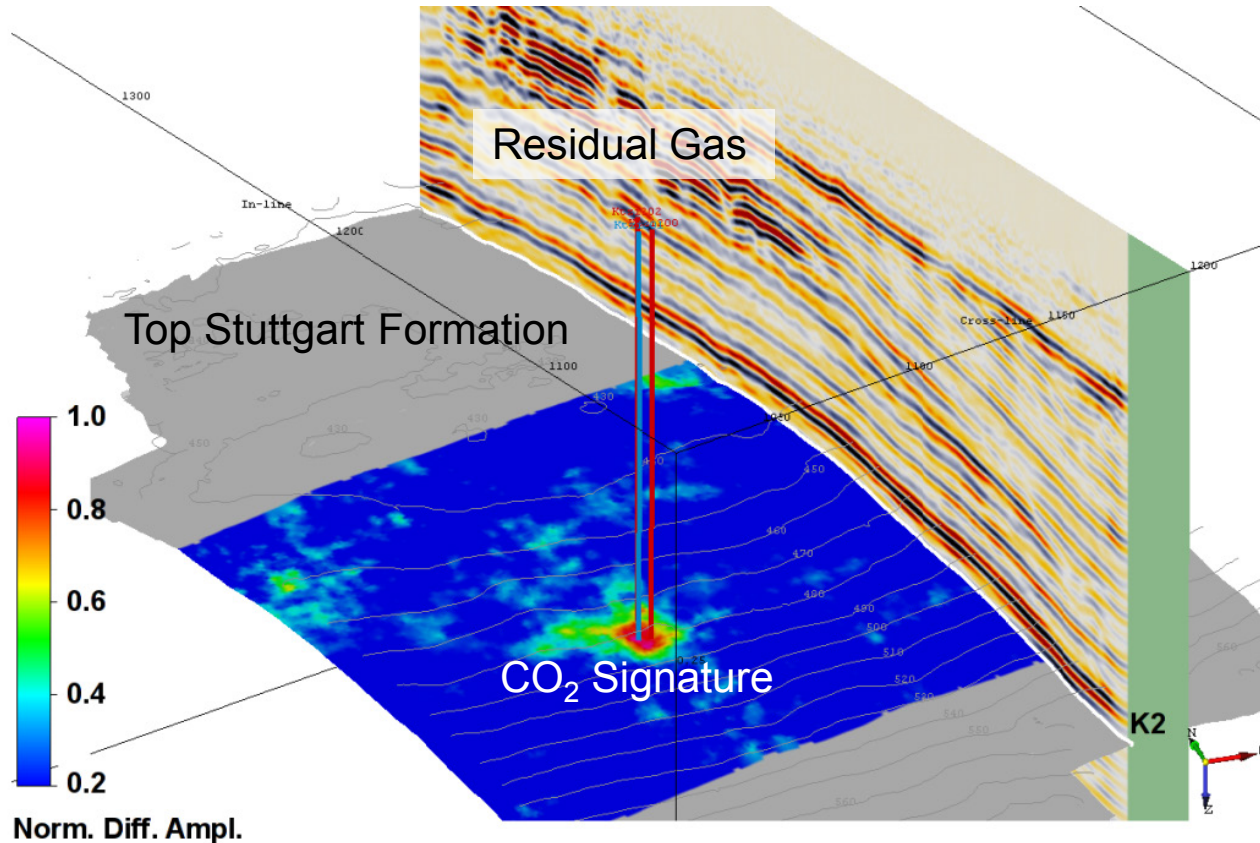
Active seismic monitoring

- (i) surface - surface: 3D, 2D star
- (ii) surface - downhole: VSP/MSP
- (iii) cross-hole measurements



3D seismics: Time-lapse amplitude analysis visualizes the CO₂ signature

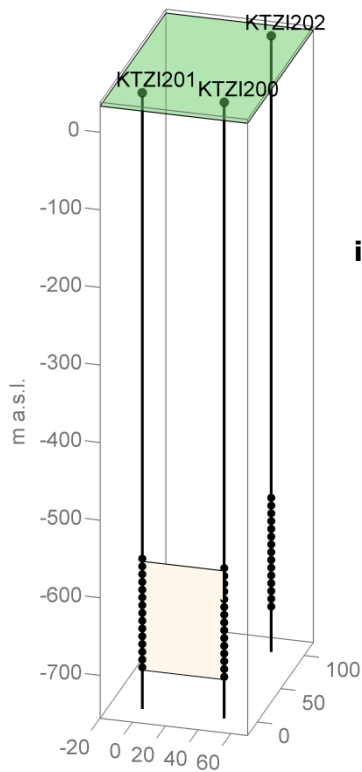
Normalized amplitude variation (3D Baseline 2005 vs. 3D Repeat 2009)



3D-Repeat 10/2009 ~22 kt CO₂ injected

Geoelectrical cross-hole measurements show resistivity increase at reservoir level

The Vertical Electrical Resistivity Array-system

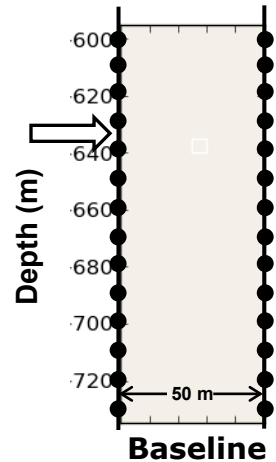


Installation of the VERA system

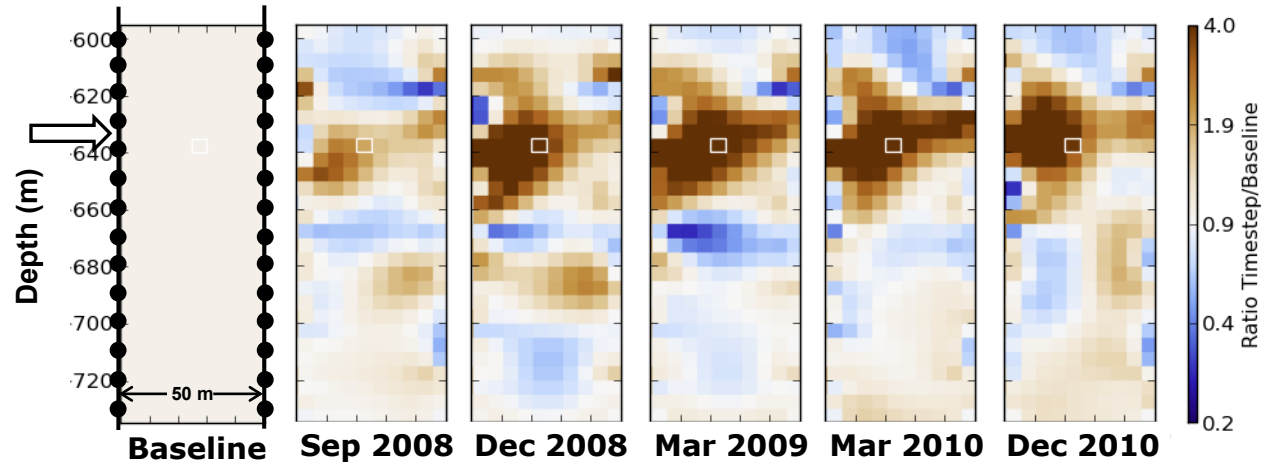


injection well
Ktzi 201

observation well
Ktzi 200

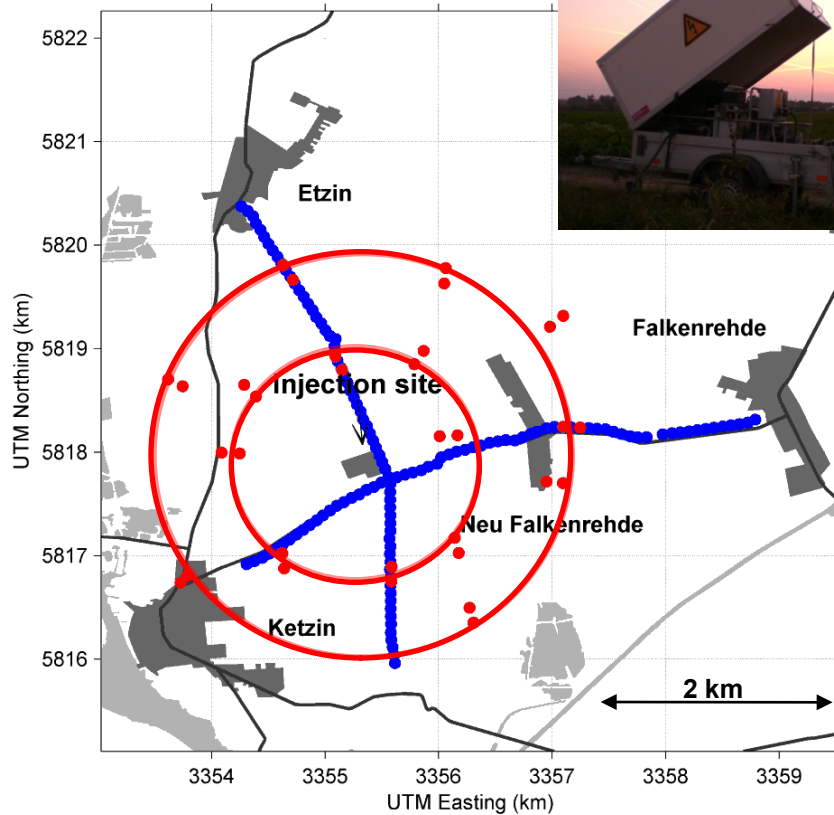


2D time-lapse results

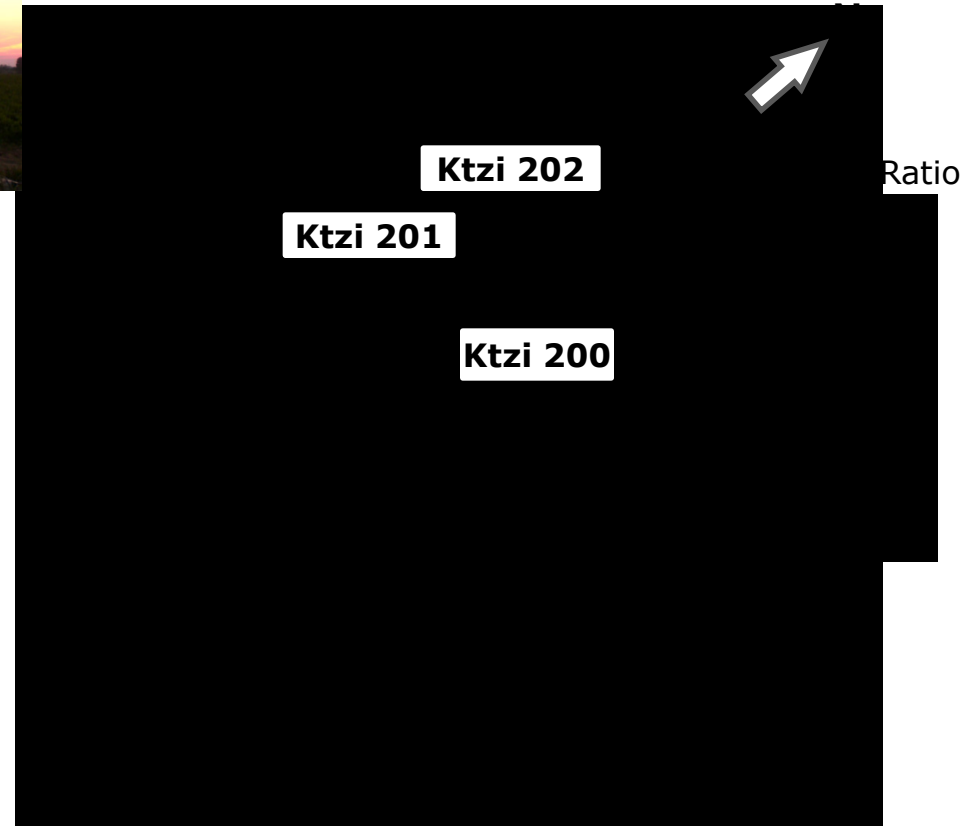


Geoelectrical surface-downhole surveys enlarge the investigation area

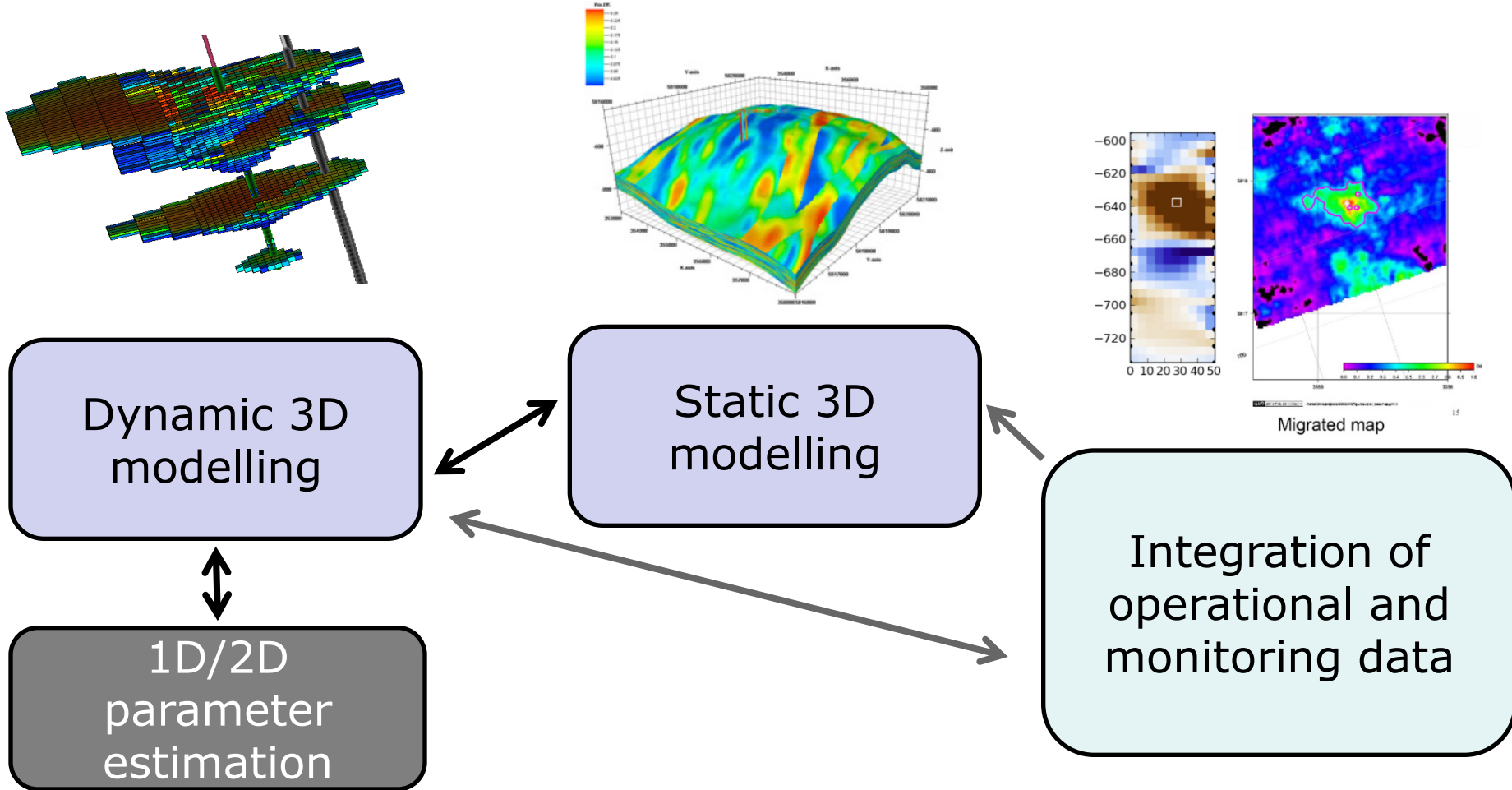
Investigation Area



Inversion Results (Repeats vs. Baseline 2)



Status of modelling activities – Integrated *History Matching* process



Dynamic model matches pressure and arrival times of CO₂ at observation wells

well Ktzi 201

well Ktzi 202

100 m

TIMESTEP: (1) 24/Jun/2008 (02:24:59)

Ktzi_202

Ktzi_201_200

well Ktzi 200

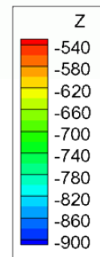
Gas saturation

0.00000 0.14044 0.28088 0.42131 0.56175

Simulated arrival times

Ktzi 200: 23 days (measured 21 d)

Ktzi 202: 257 days (measured 270 d)



5 km x 5 km

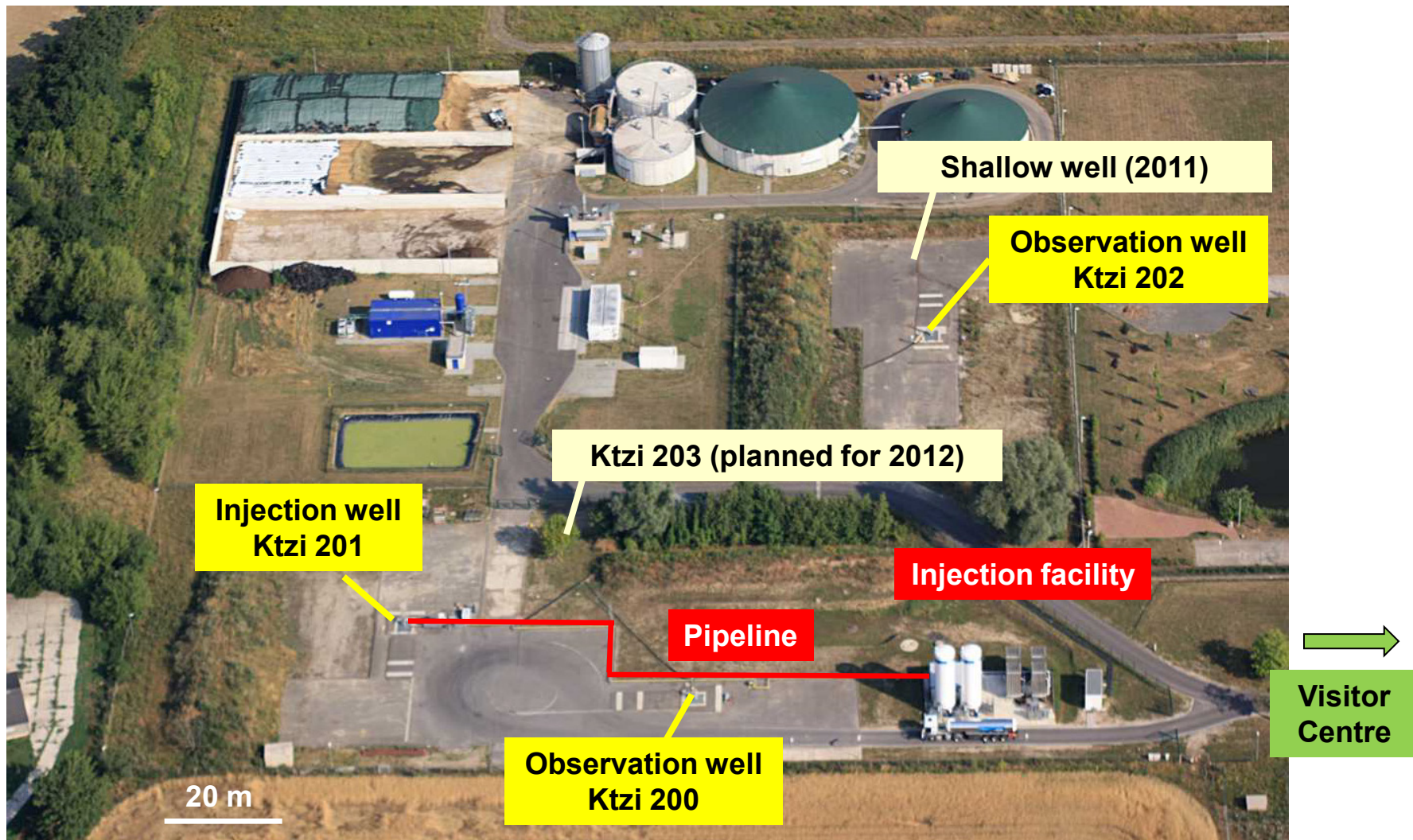
Persistent Scatterer Interferometry

- **Displacement monitoring** based on TerraSAR-X Stripmap image data (3m resolution)
- Installation of **4 corner reflectors** (CRs) as artificial scatterers due to rural character of the site
- **TerraSAR-X** scenes with CRs since April 17, 2011
- **Data processing** in progress

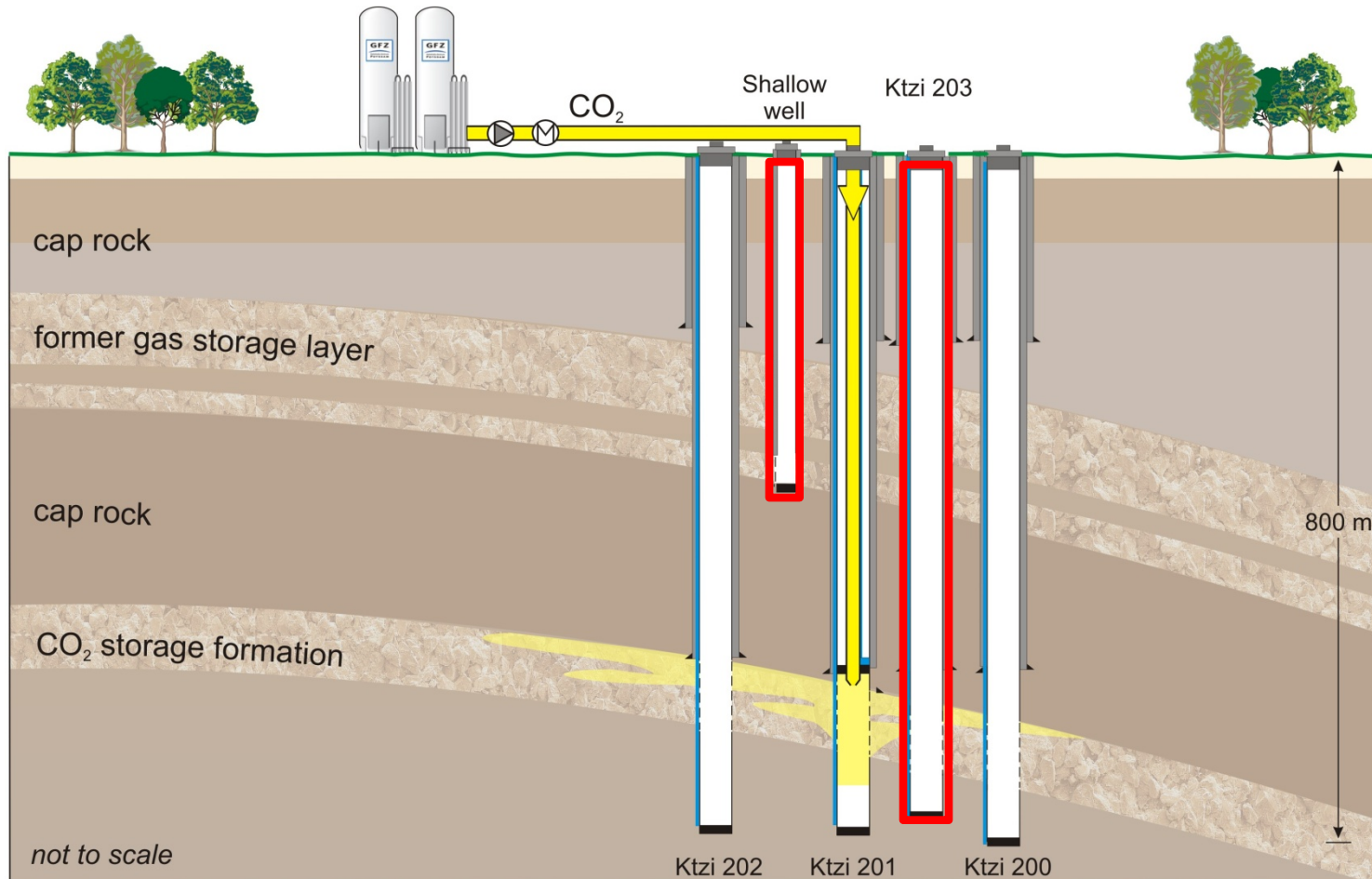


Photo: C. Lubitz

Drilling at the Ketzin site

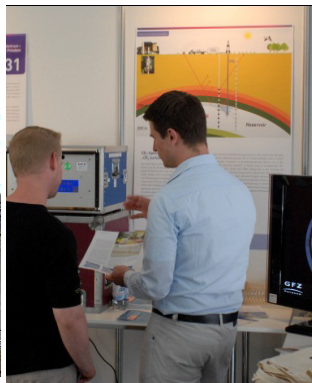


Drilling at the Ketzin site



Public outreach

- Set-up of new **Ketzin website** (www.co2ketzin.de)
- Extension of **visitor centre** and visiting times
- **Annual Open House** at Ketzin site brings researchers and local community together
- **Networking** with other storage sites welcome



Conclusion

- **Ketzin** project demonstrates successful CO₂ storage in a saline aquifer on a **research scale**.
- **Injection** operation since June 2008 is **safe and reliable** (today ~ 50 kt CO₂ injected).
- **Geophysics** detects the CO₂ signature on **various scales**.
- Dynamic **model matches** the field observations.

