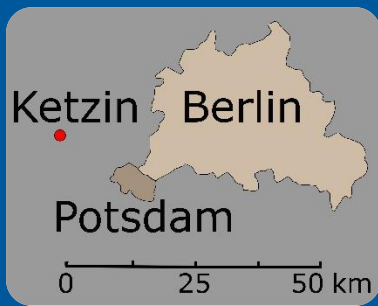


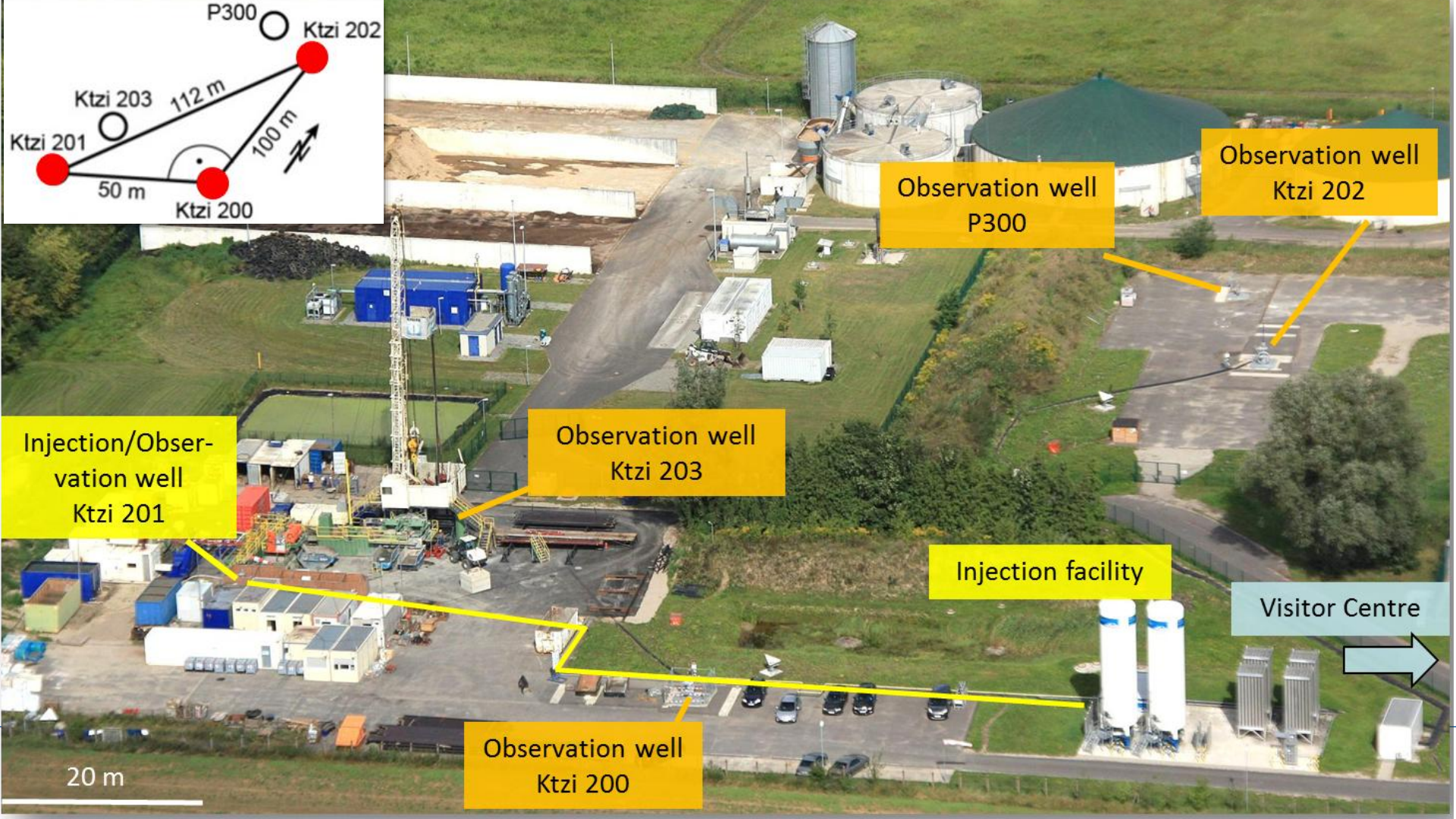
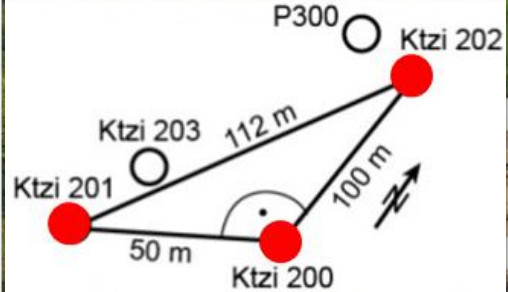
Multi-disciplinary monitoring of the Ketzin CO₂ pilot site as successful concept for storage integrity assessment

Michael Kühn, Cornelia Schmidt-Hattenberger & Ketzin Team
GFZ Helmholtz Centre for Geosciences



Aerial view of the Ketzin CO₂ pilot site





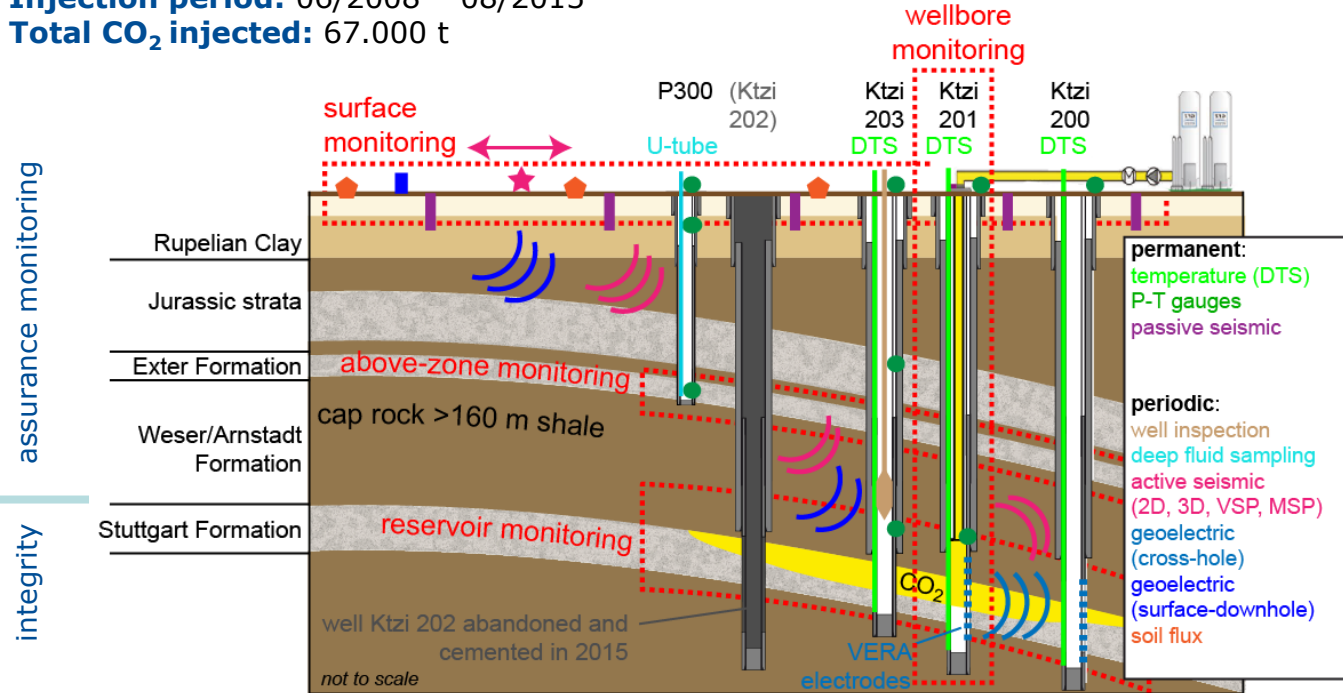
Multi-disciplinary monitoring concept of Ketzin

Reservoir: Saline aquifer, sandstones of the Upper Triassic Stuttgart Fm., Porosity ~26% ; Permeability ~100 mD

CO₂ reservoir depth: 625 m – 650 m

Injection period: 06/2008 – 08/2013

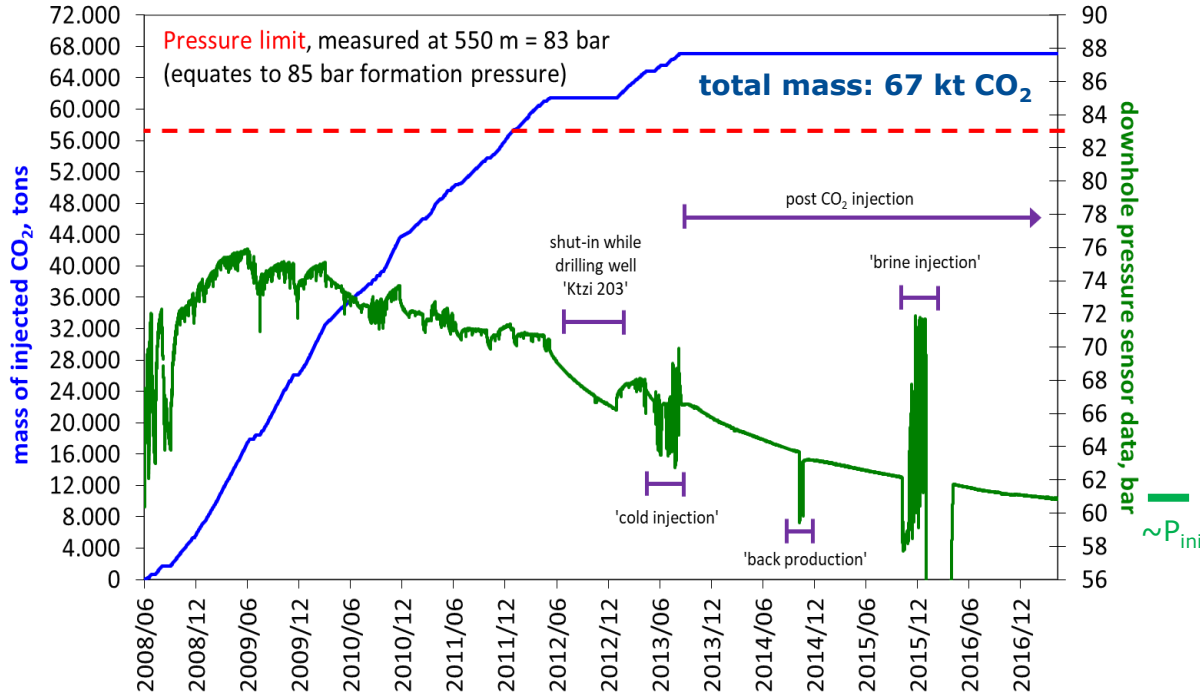
Total CO₂ injected: 67.000 t



Monitoring tasks in the geological CO₂ storage:

- Detection of break-through
- Observation of plume migration
- Safety monitoring to guarantee tightness of the storage complex

Injection history and pressure management

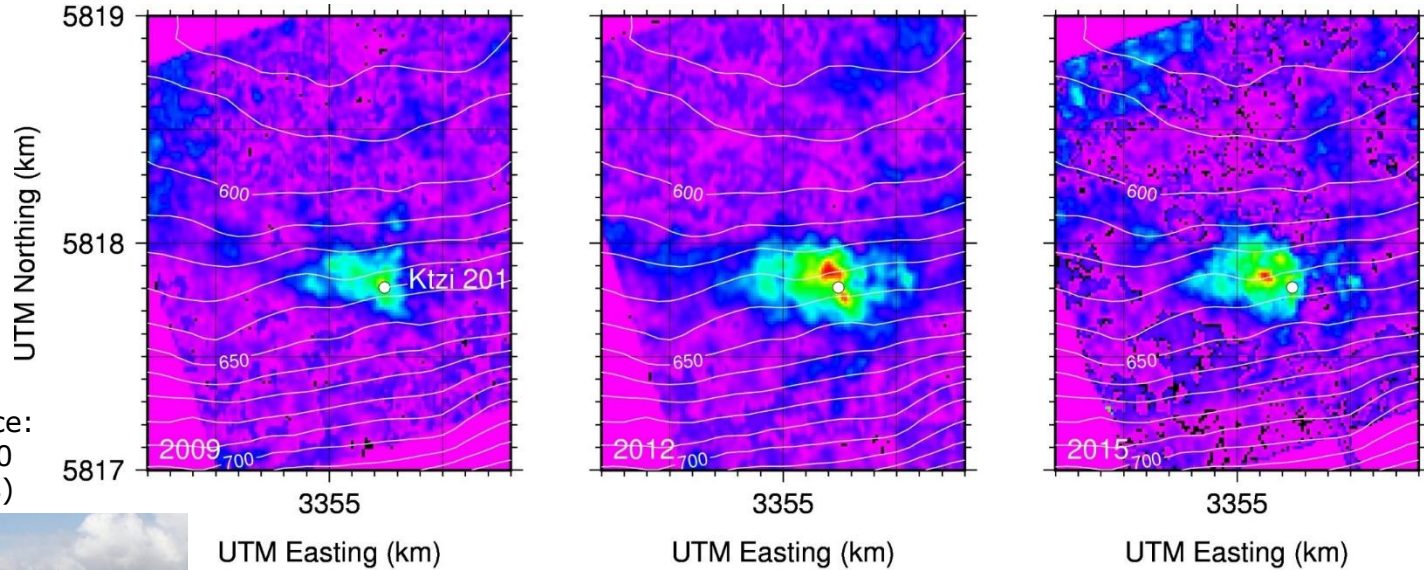


- Smooth injection process, maximum p-increase ~ 16 bar
- No safety issues, $p \ll$ pressure limit
- Continuous p-decline after stop of injection (= towards long-term stability)

The Ketzin safety case: ---

Limit of injection **bottom-hole pressure (BHP)** should be less than the lowest value of **capillary entry pressure (CEP)** and **fault propagation pressure (FPP)** and a suitable safety margin (typically 10% below the lower of these pressures)

Time-lapse amplitudes in the storage layer showing stabilisation of the CO₂ plume



Seismic source:
VIBSIST-1000
(Vibrometrics)

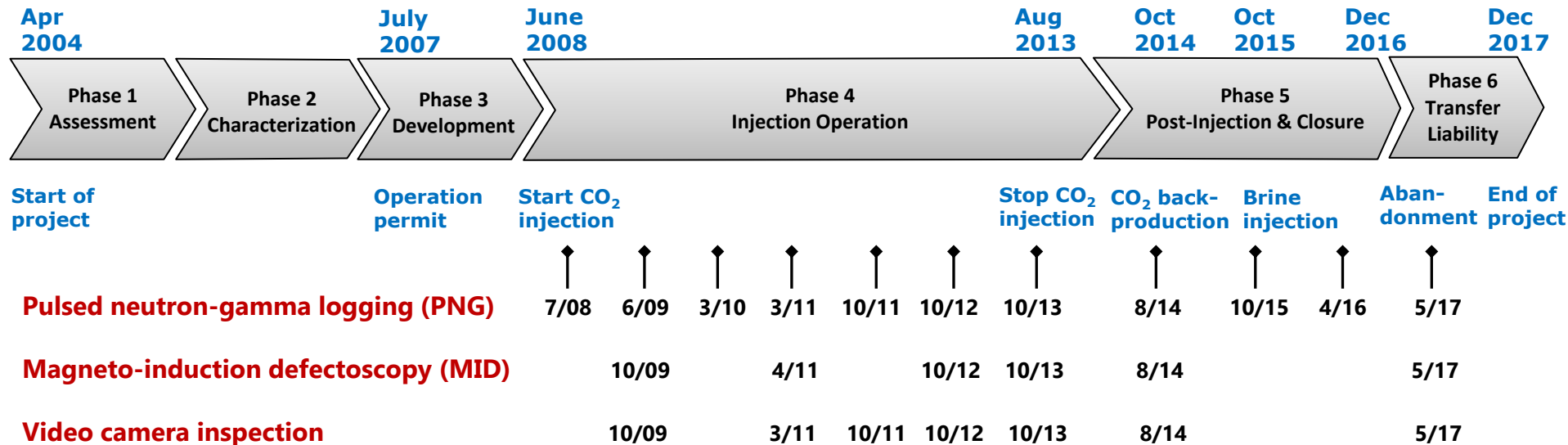
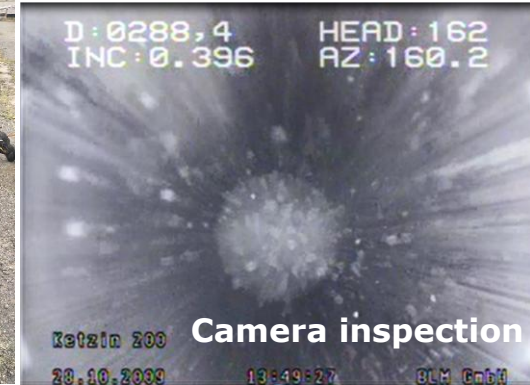


2009 (~23.000 t)

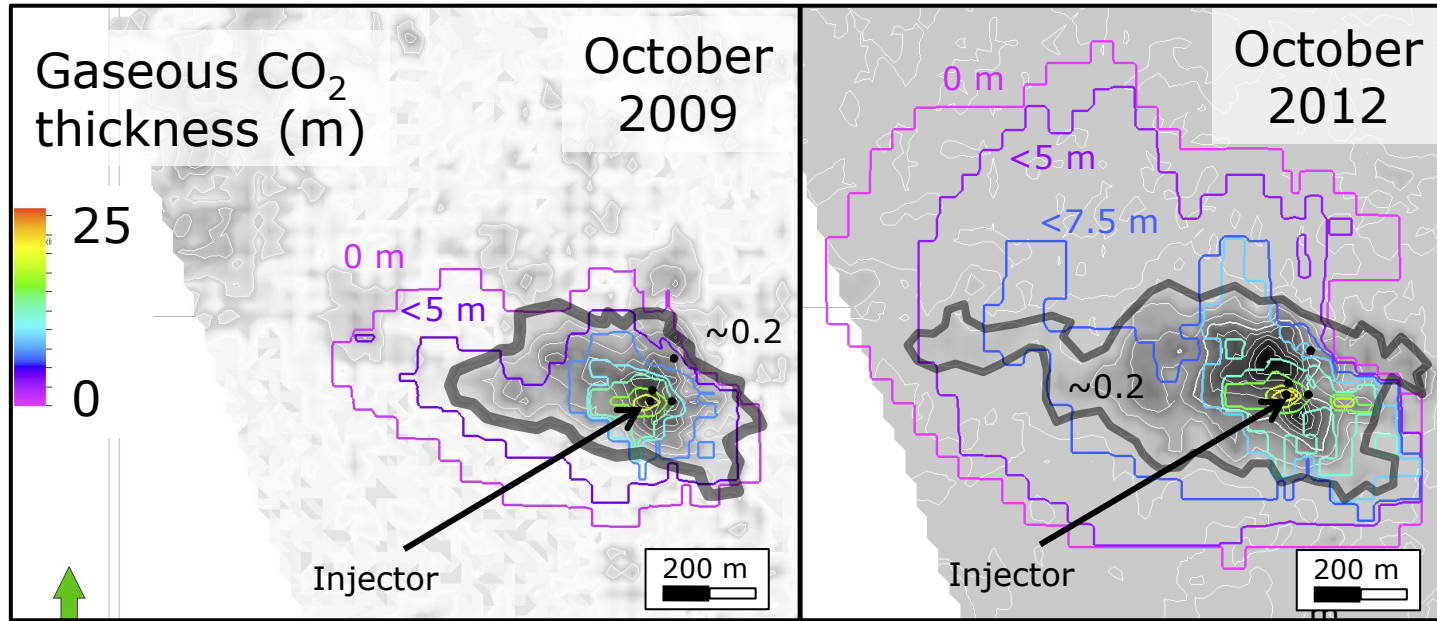
2012 (~61.000 t)

2015 (~67.000 t)
~ 2 years post-injection

Combination of methods contributing to well integrity surveillance



Conformity study based on comparison of simulated and observed CO₂ footprint



Difference in reflection amplitude from **time-lapse 3D seismic**
(darker colors indicate higher values)

Ketzin pilot site at the end of its life-cycle

- Demonstration of safe and reliable **on-shore** CO₂ storage
- Gaining quantitative and holistic understanding of the underground processes
- Fulfilment of all legal and regulatory requirements
- Local/regional acceptance throughout the operational lifetime of the storage facility
- Collaboration of 15+ international scientific and 13 industry partners
(2004-2017: ~50 Mio. € third-party funding with ~80/20 public/industry)
- >360 GFZ-involved publications, 7 popular scientific videos and 3 patents
(see under: <https://www.co2ketzin.de/en/media-publications/publications>)
- **Ongoing: knowledge transfer to national/international standardisation DIN/ISO**

