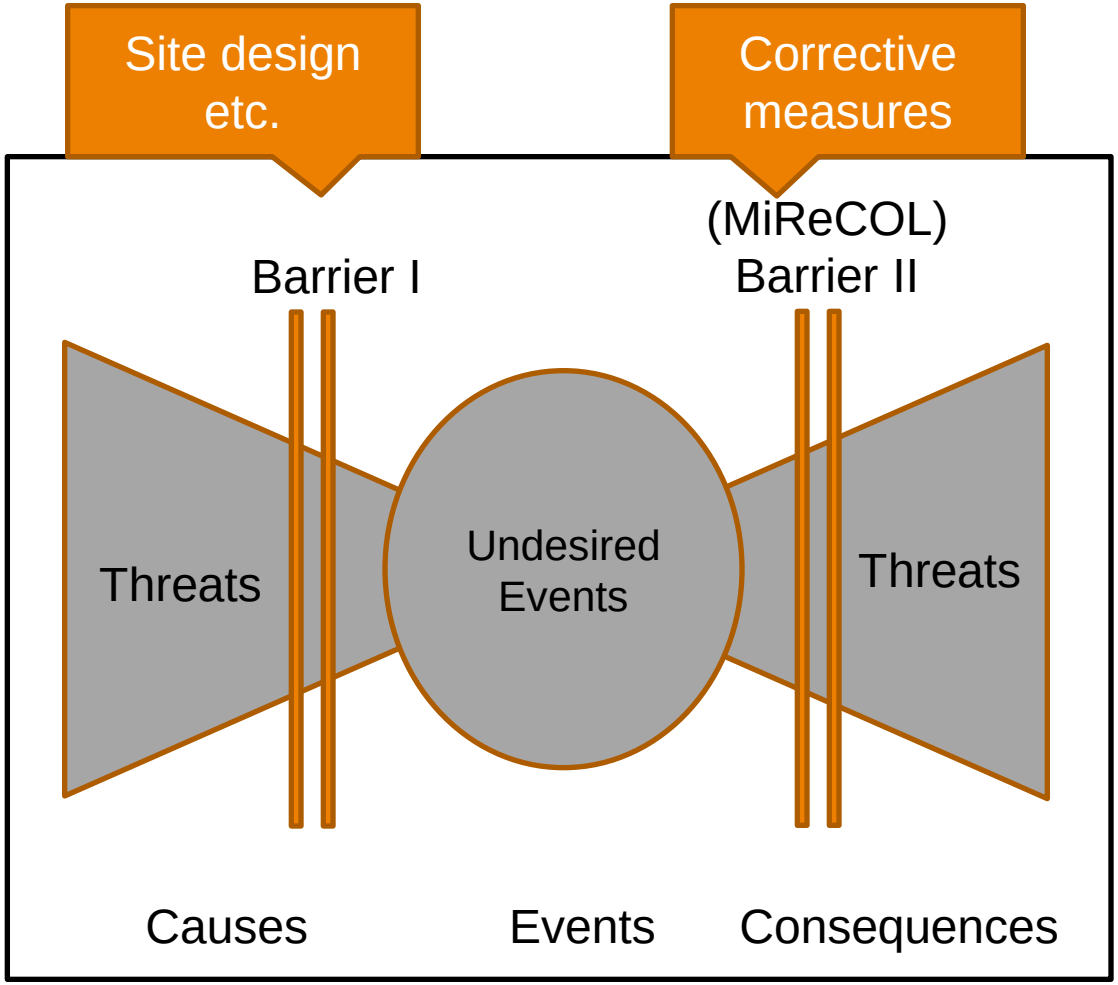
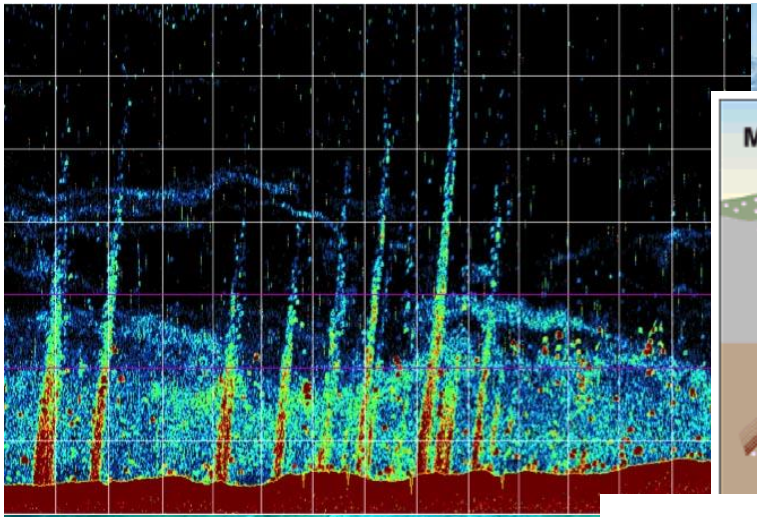
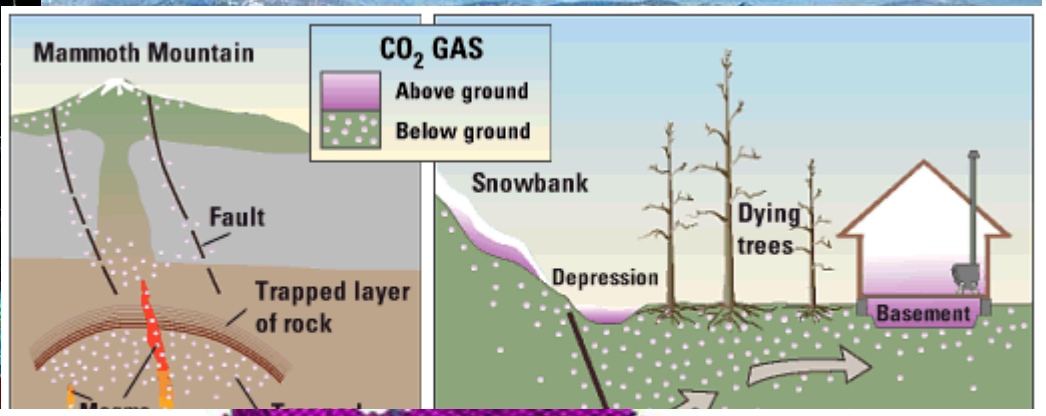
MIRECOL: MITIGATION AND REMEDIATION FOR CO2 STORAGE

Filip Neele

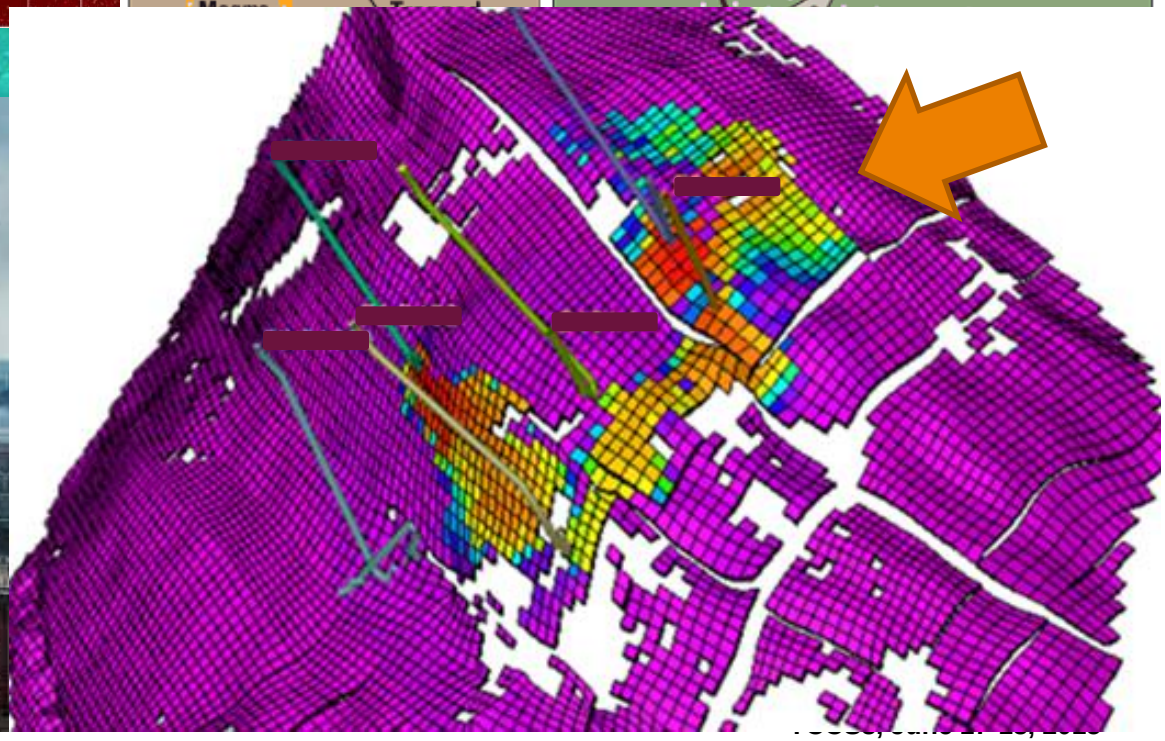
TNO innovation for life


Site design etc.
Corrective measures
(MiReCOL)
Barrier I
Barrier II
Threats
Undesired Events
Threats
Causes
Events
Consequences



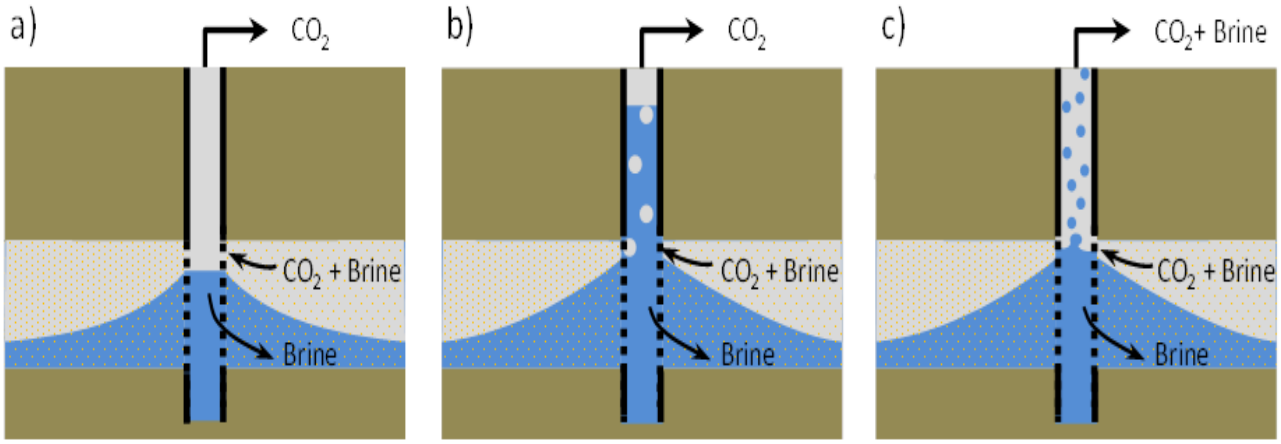

Mammoth Mountain
CO_2 GAS
Above ground
Below ground
Fault
Trapped layer of rock
Snowbank
Dying trees
Depression
Basement


BLOW-OUT!
HET GEVAAR VAN CO_2-OPSLAG IN DE ACHTERTUIN



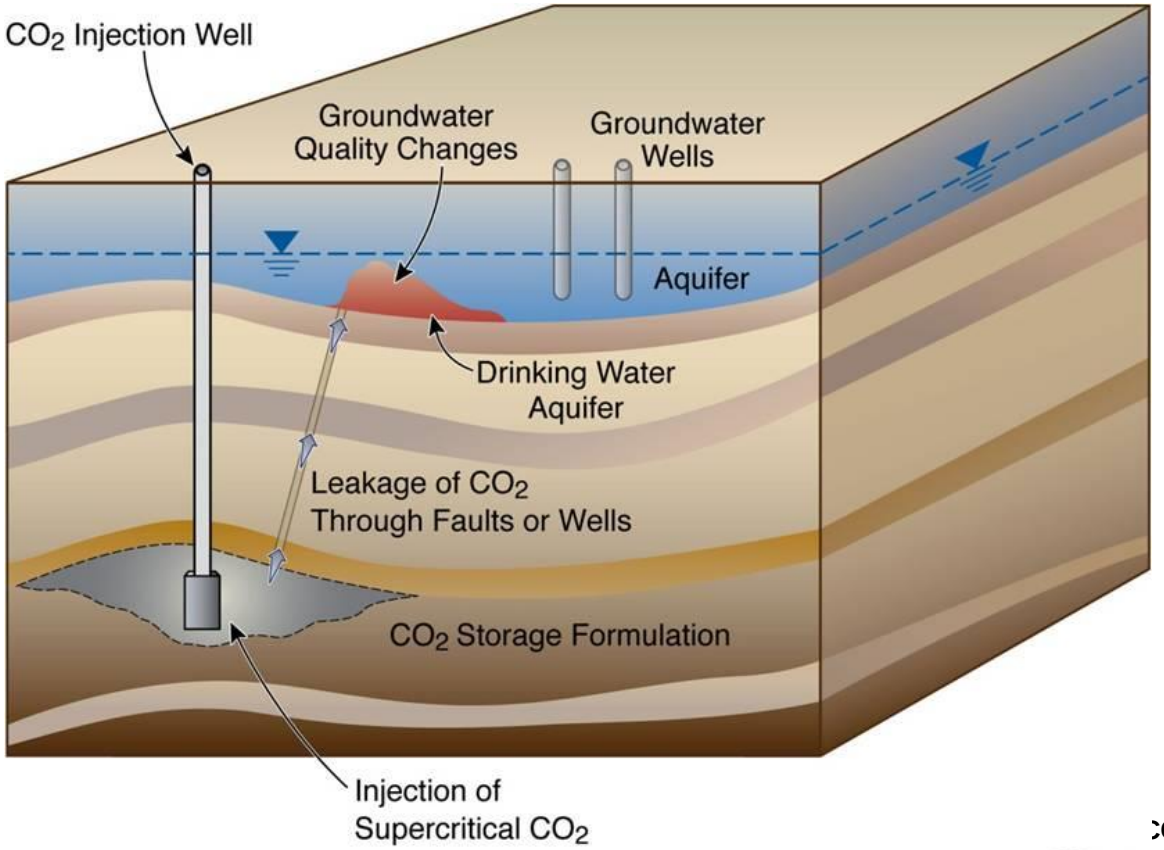
CURRENTLY AVAILABLE TECHNIQUES

- Existing techniques
  - Pressure management
  - Back production of CO_2
  - Well remediation techniques



MIRECOL OBJECTIVE

- To develop a toolbox of techniques available to mitigate / remediate undesired migration or leakage of CO_2
  - Support the definition of corrective measures plans
  - Help building confidence in deep subsurface storage of CO_2



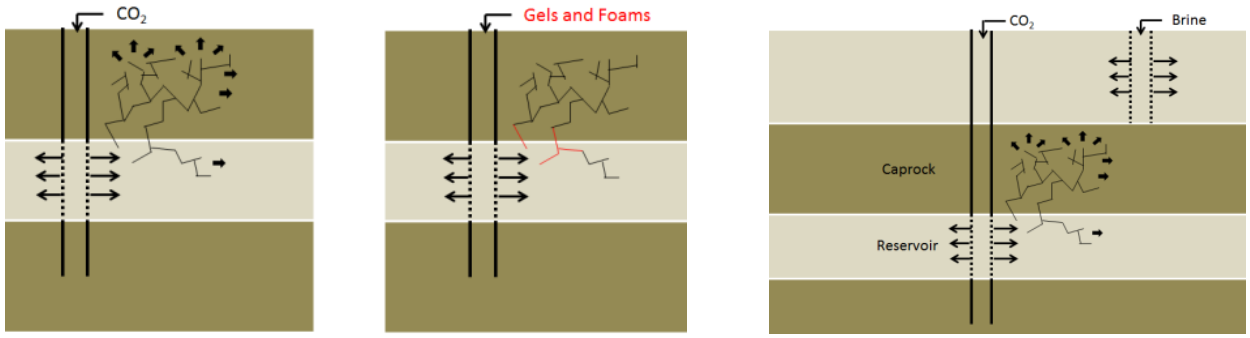
Berkeley Lab Earth Sciences Division

PROJECT APPROACH

- Central concept is **risk level**
- Merit of mitigation or remediation technique is obtained by establishing overall risk level *before* and *after* deployment of the technique
  - ***Unmitigated risk*** (i.e., threat or leak has occurred, but no action is taken)
  - ***Mitigated risk*** (i.e., residual risk of threat or leak after deployment of mitigation or remediation technique, plus the impact of the deployment of the technique on the risk level of the storage site)
- A mitigating or remediating action should be taken only when the mitigated risk is lower than the unmitigated risk

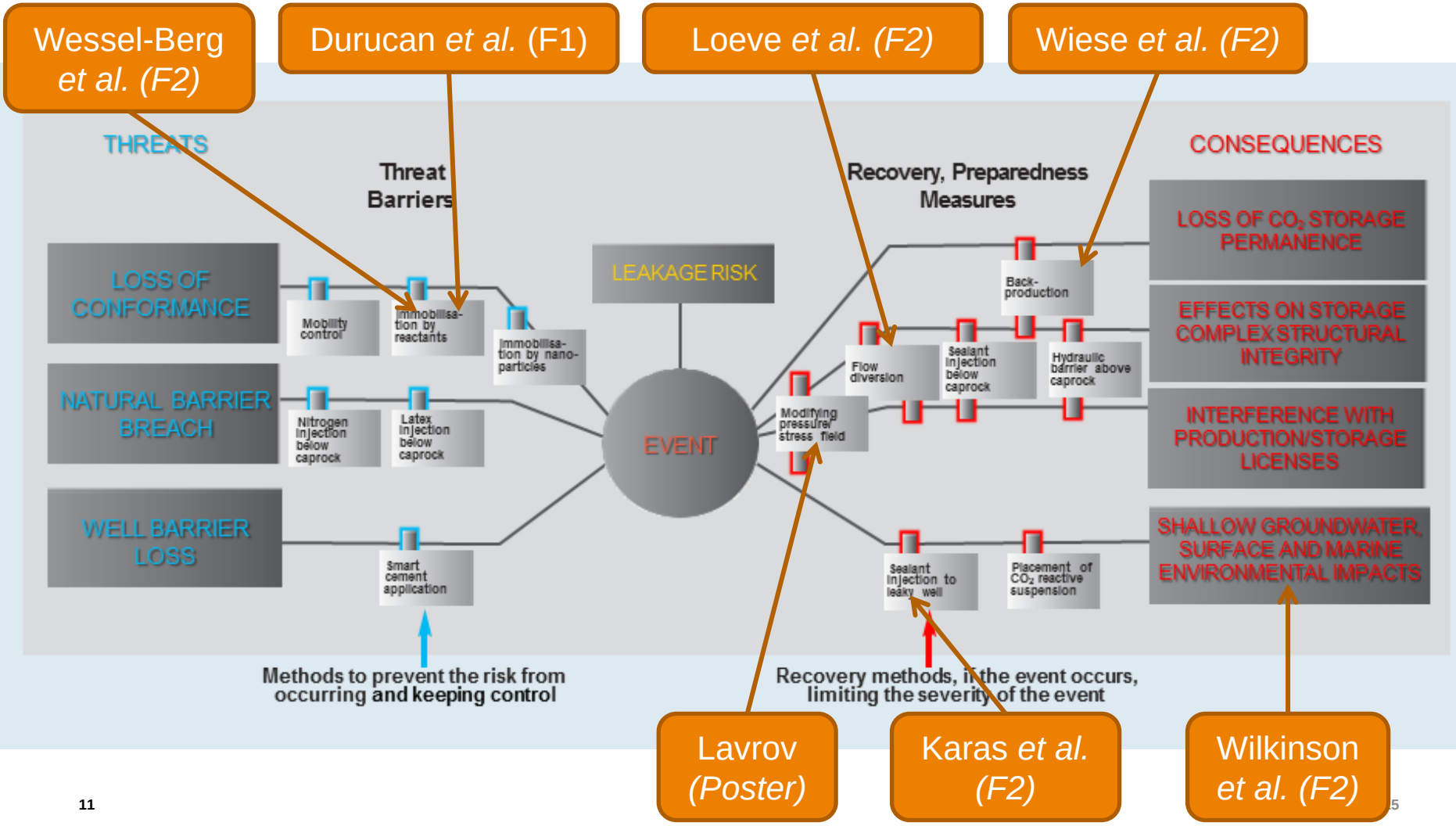
PROJECT APPROACH

- **Site specificity vs general guidelines**
  - The details of threats to safe and secure storage, and of leakage events are strongly **site specific**, and so are the options to mitigate or remediate
  - The project will study mitigation and remediation techniques on a range of real or realistic storage complexes, to derive a range of *site-specific results*, from which more general conclusions will be drawn

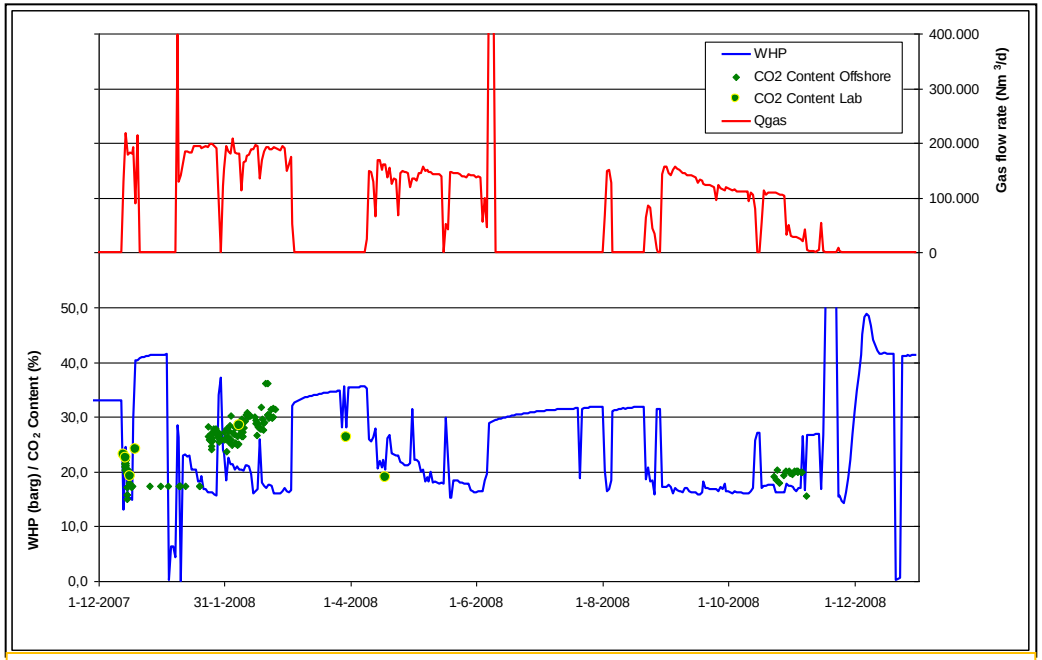


MITIGATION / REMEDIATION TECHNIQUES CONSIDERED

- Reservoir
  - Pressure control, flow diversion
  - Back production
  - CO_2 immobilisation (gels, foams)
  - Nitrogen injection
  - Nanoparticles
- Faults
  - 'Managing' faults
    - Immobilising flow: gels, foams
    - Creating fracture networks
- Wells
  - Injection of sealants
  - Injection of reactive suspension
  - Smart cement
- Field tests
  - Back production
    - Ketzin – 2014
    - K-12b – 2014
  - Becej: injection of reactive materials


Wessel-Berg et al. (F2)
Durucan et al. (F1)
Loeve et al. (F2)
Wiese et al. (F2)
THREATS
Threat Barriers
Recovery, Preparedness Measures
CONSEQUENCES
LOSS OF CONFORMANCE
NATURAL BARRIER BREACH
WELL BARRIER LOSS
Mobility control
Immobilisation by reactants
Immobilisation by nano-particles
Nitrogen injection below caprock
Latex injection below caprock
Smart cement application
LEAKAGE RISK
EVENT
Modifying pressure/ stress field
Flow diversion
Back-production
Sealant injection below caprock
Hydraulic barrier above caprock
Sealant injection to leaky well
Placement of CO_2 reactive suspension
LOSS OF CO_2 STORAGE PERMANENCE
EFFECTS ON STORAGE COMPLEX STRUCTURAL INTEGRITY
INTERFERENCE WITH PRODUCTION/STORAGE LICENSES
SHALLOW GROUNDWATER, SURFACE AND MARINE ENVIRONMENTAL IMPACTS
Methods to prevent the risk from occurring and keeping control
Recovery methods, if the event occurs, limiting the severity of the event
Lavrov (Poster)
Karas et al. (F2)
Wilkinson et al. (F2)

EXAMPLE: BACK PRODUCTION

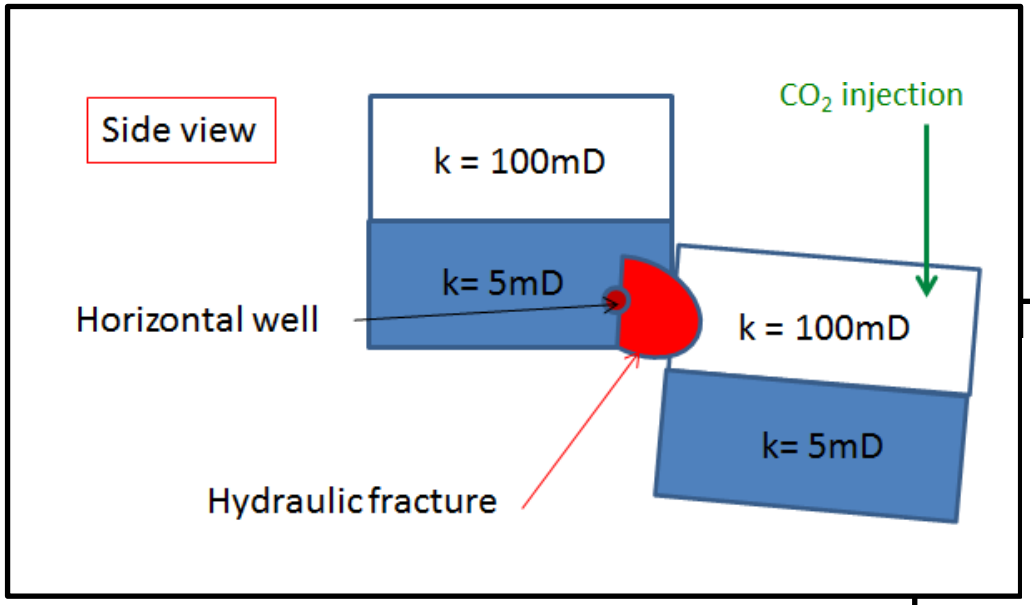


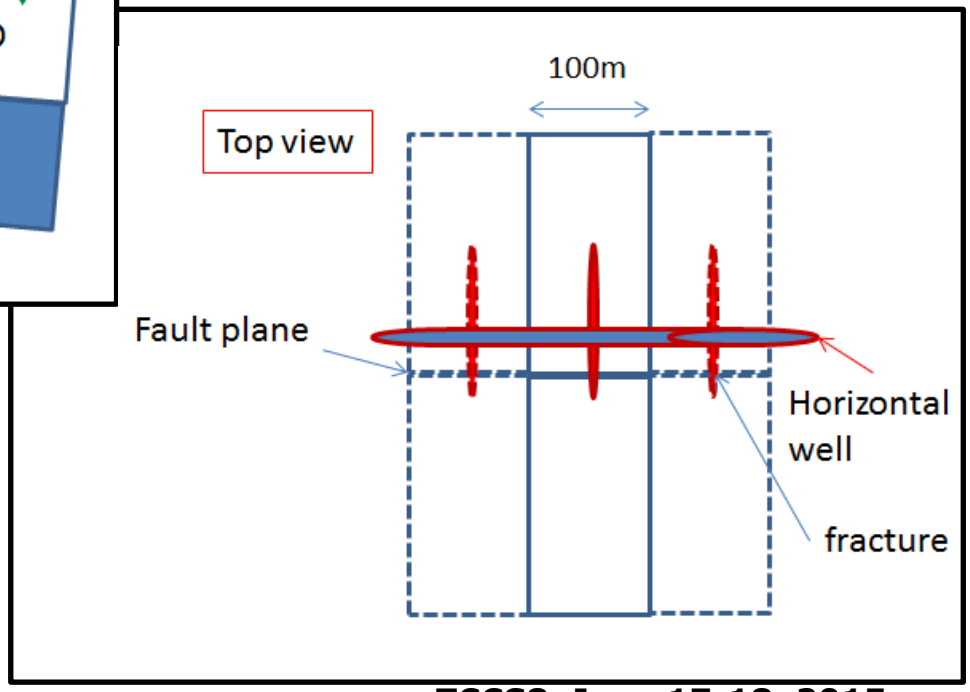
Gas back production data at K12-B.
Data used to assess feasibility of back-producing injected CO_2 as corrective measure

Installations at Ketzin (Germany)
For back-production test.
Data to be used to asses feasibility
Of back producing stored CO_2.

Picture courtesy T. Kollersberger, GFZ

EXAMPLE: FLOW DIVERSION





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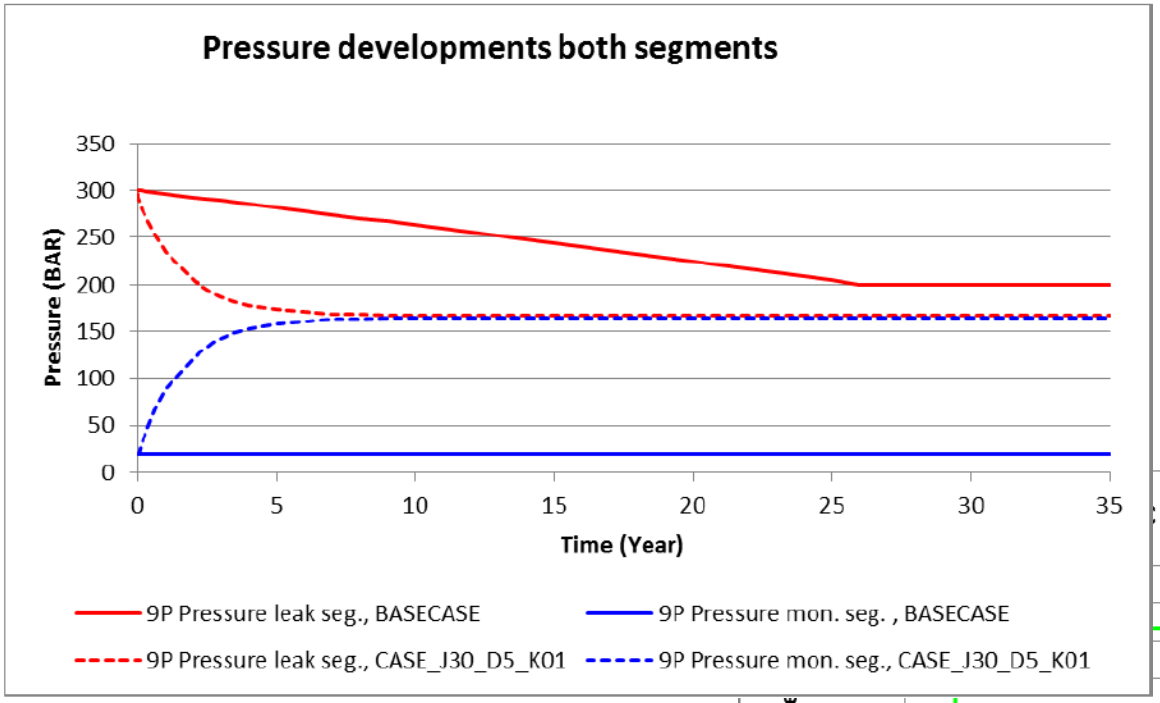

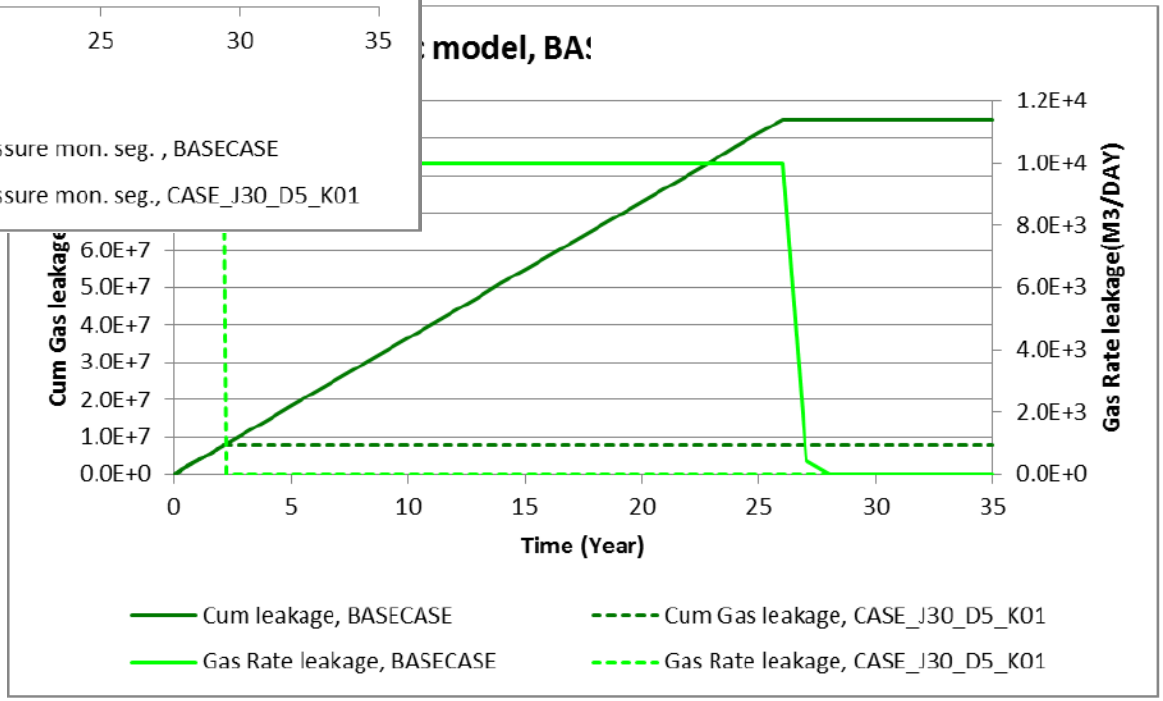

RESULT OF THE PROJECT

- "**Handbook**" of remediation and mitigation options that can be applied in different parts of storage complex, against various leakage scenarios.
  - *Handbook to inform operators, regulators, public*
  - *Results in handbook based on modelling for specific sites, to illustrate value of remediation & mitigation options*

- The Handbook will also be implemented in a **web-based tool** that allows easy access to the project's results
  - This tool will also support operators in setting up a corrective measures program

MIRECOL – RESULTS, HANDBOOK *STAKEHOLDER INPUT REQUIRED*

- Project started March 2015, now in second year
- Technical results available at and of year 2 (March 2016)

- Year 3 of project:
  - Formulate guidelines for mitigation / remediation measures
  - Write / implement Handbook

- MiReCOL & CCS projects, stakeholders
  - Interaction needed to optimise Handbook
  - 'Event' around March 2016
    - Presentation of results
    - Proposal for Handbook
    - **Discussion with stakeholders**

Please contact us!
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MiReCOL Mitigation and Remediation of CO_2 Leakage

MITIGATION AND REMEDIATION OF CO_2 LEAKAGE

Project granted under

EU FP7 Energy – Theme 5.2

Mitigation and remediation of leakage from geological storage

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www.mirecol-co2.eu