MiReCOL: mitigation and remediation for CO_2 storage

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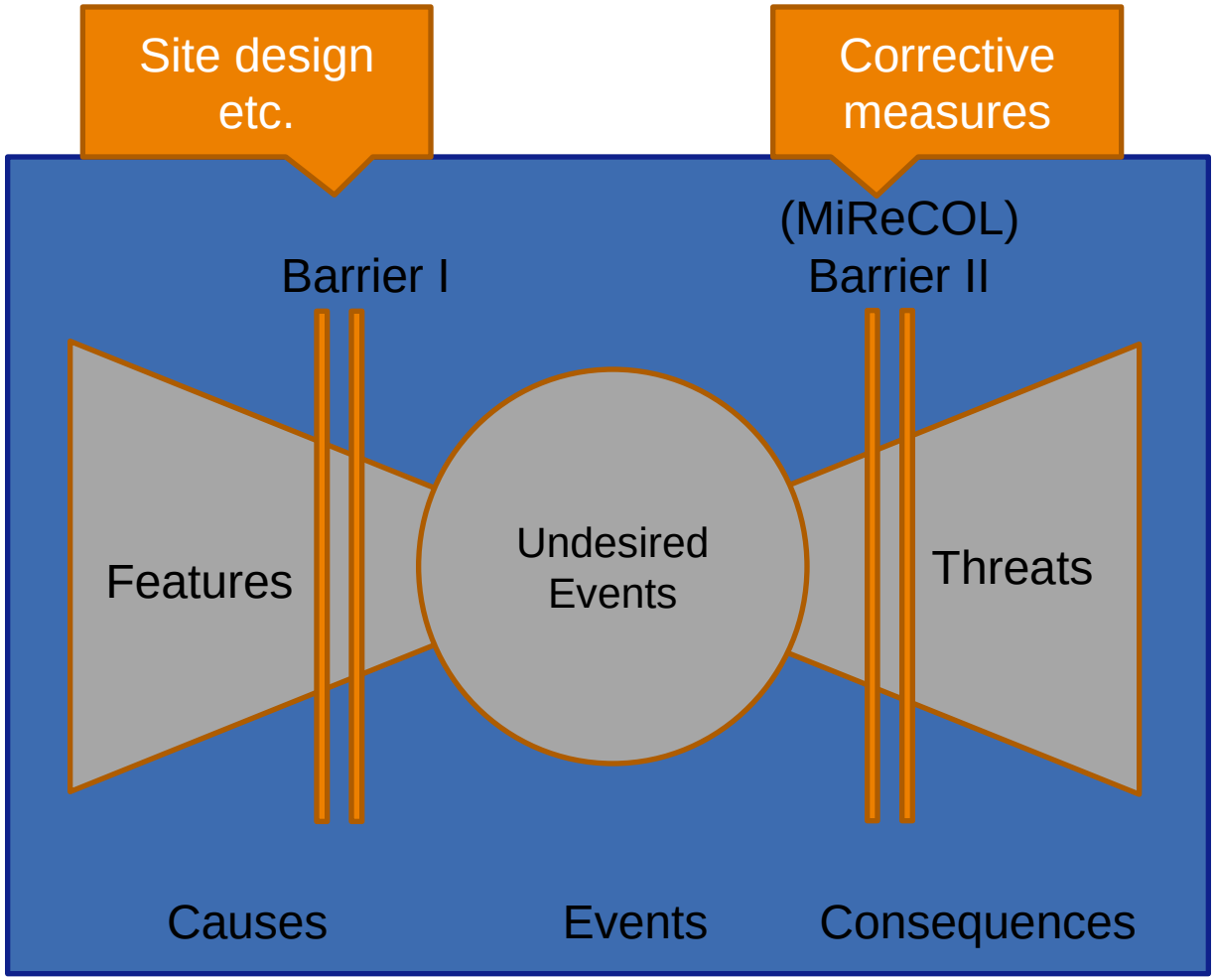
TNO – The Netherlands

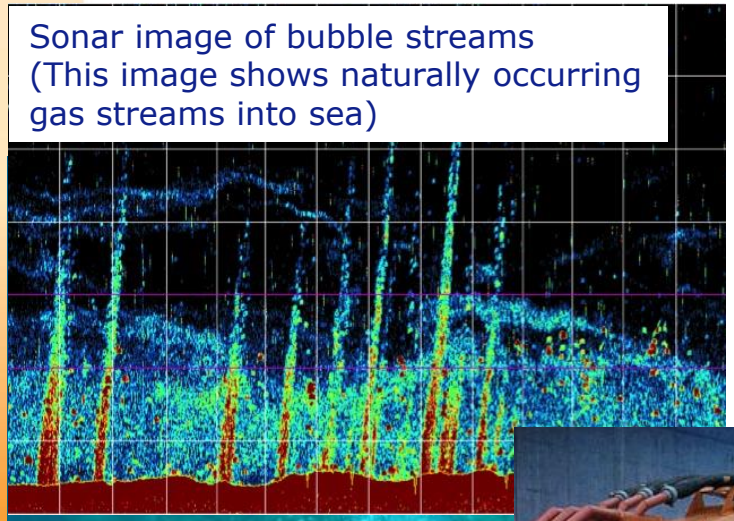
MiReCOL Mitigation and Remediation of CO_2 Leakage

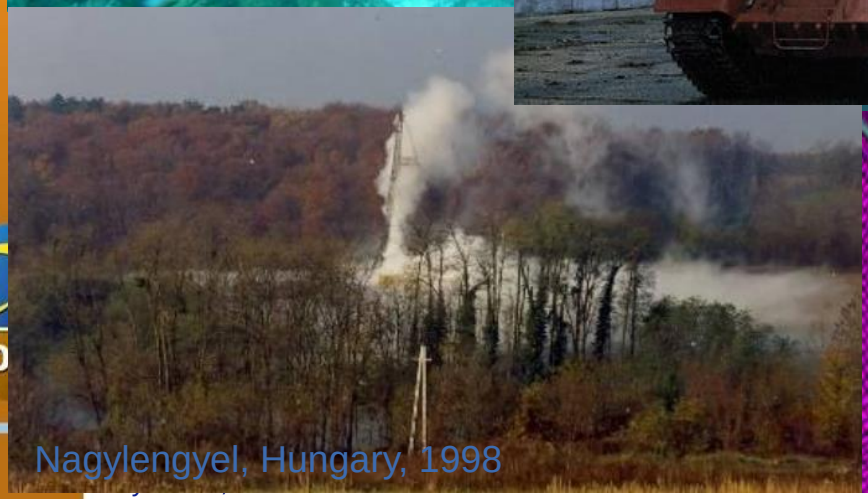

Site design etc.
Corrective measures
(MiReCOL)
Barrier I
Barrier II
Features
Undesired Events
Threats
Causes
Events
Consequences

MiReCOL Mitigation and Remediation of CO_2 Leakage

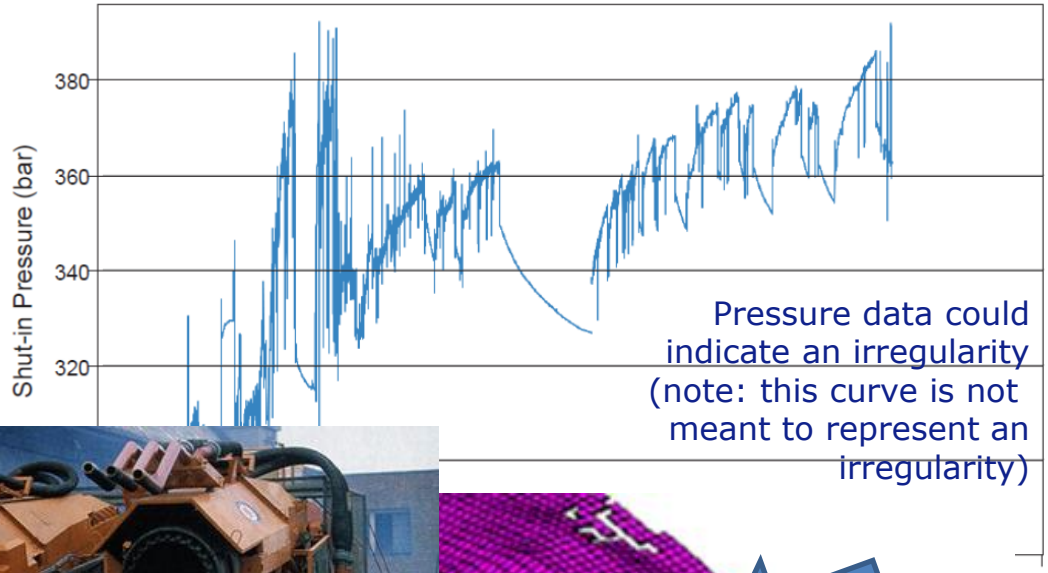
Significant irregularities?

Sonar image of bubble streams
(This image shows naturally occurring gas streams into sea)

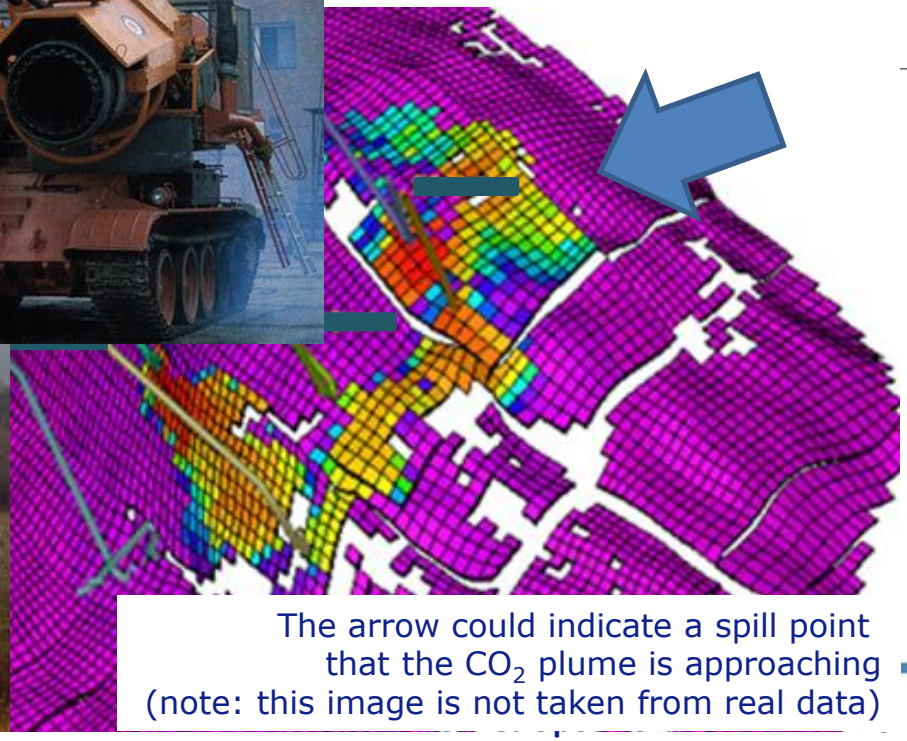




Nagylengyel, Hungary, 1998



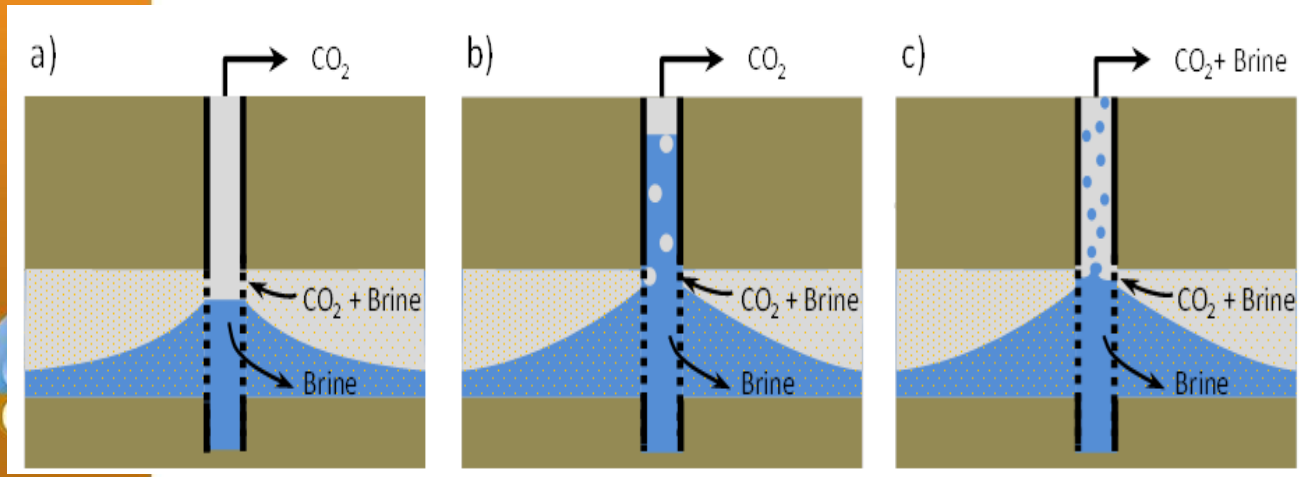
Pressure data could indicate an irregularity (note: this curve is not meant to represent an irregularity)



The arrow could indicate a spill point that the CO_2 plume is approaching (note: this image is not taken from real data)

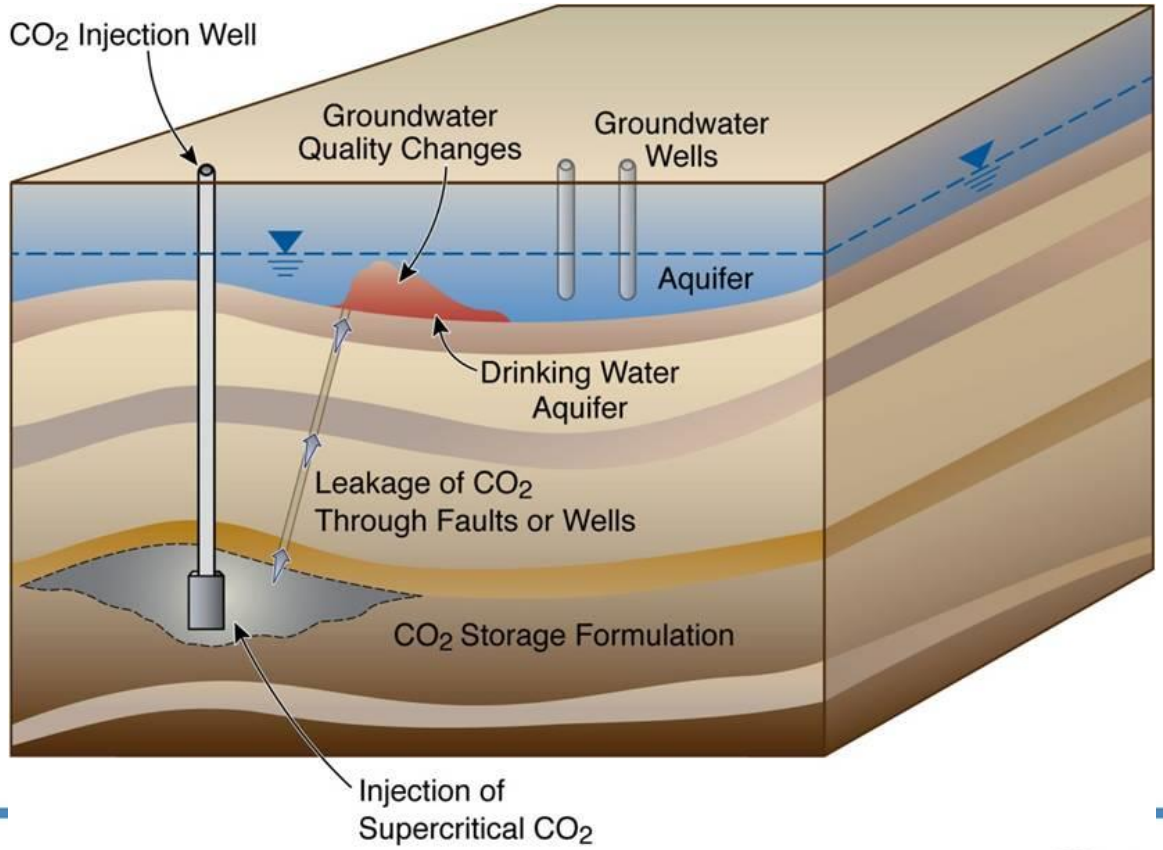
Currently available techniques

- Existing techniques
  - Pressure management = suspend injection
  - Back production of CO_2
  - Well remediation techniques



MiReCOL objective

- To develop a toolbox of techniques 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

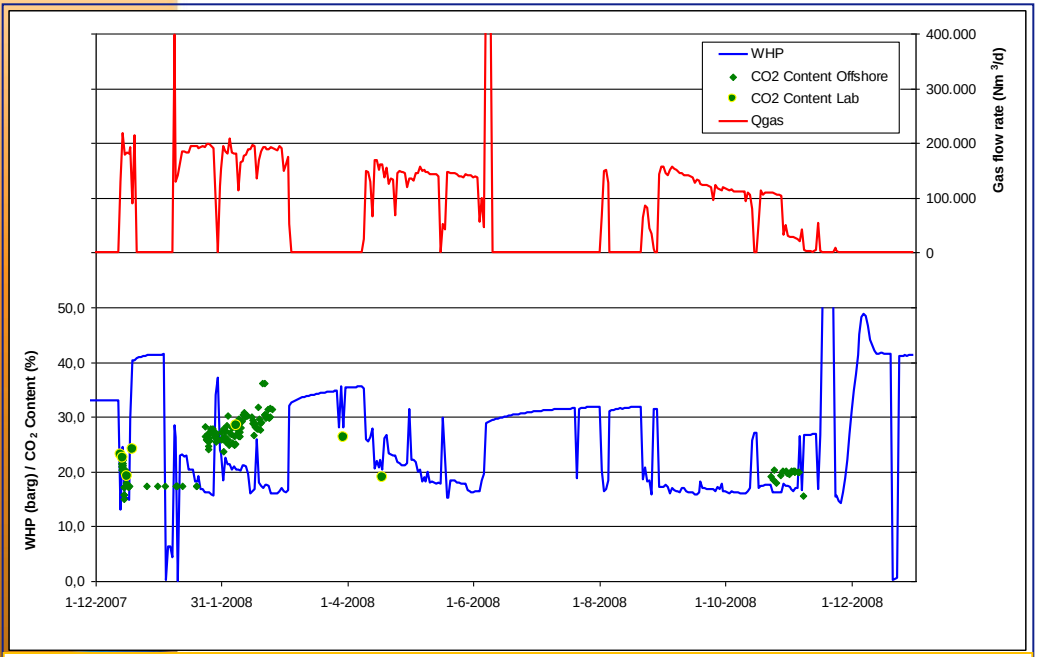


Berkeley Lab Earth Sciences Division

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
  - Bečej: injection of reactive materials

Example: back production

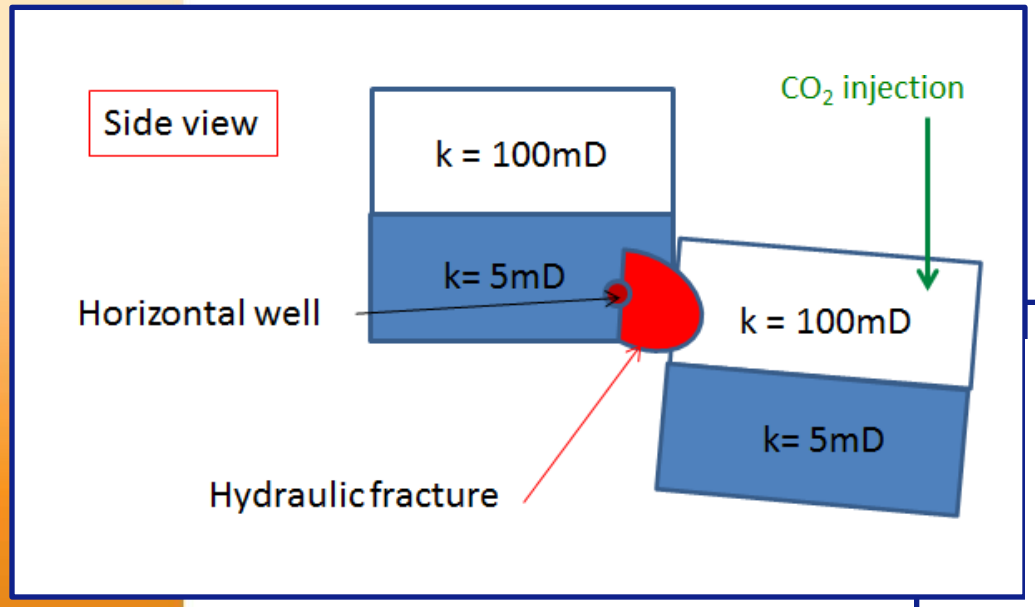


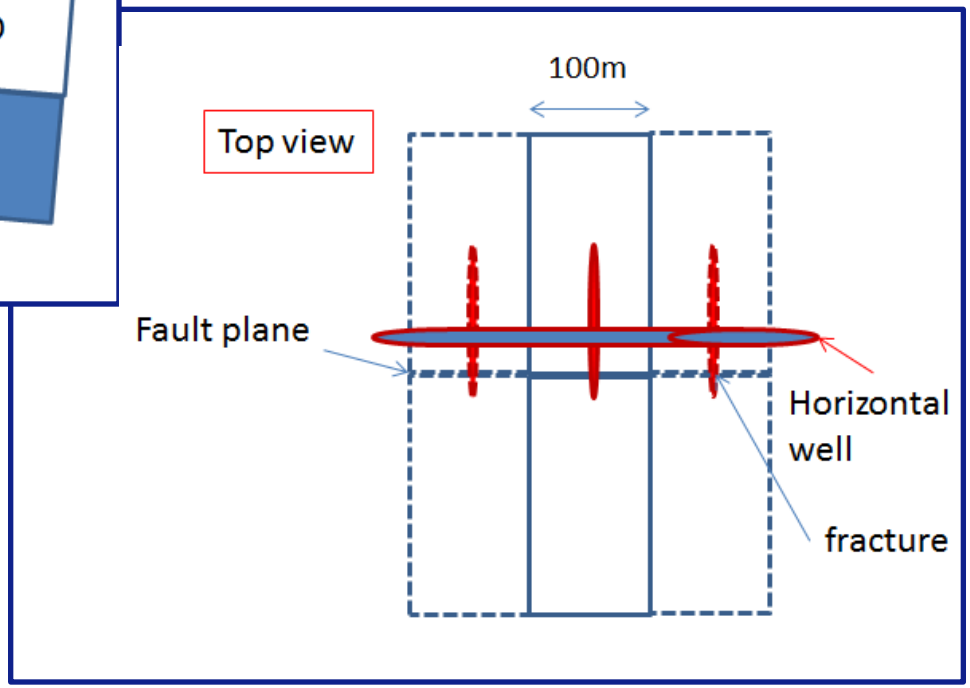
Gas back production data at K12-B.
Data used to assess feasibility of back-producing injected CO_2 as corrective measure

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

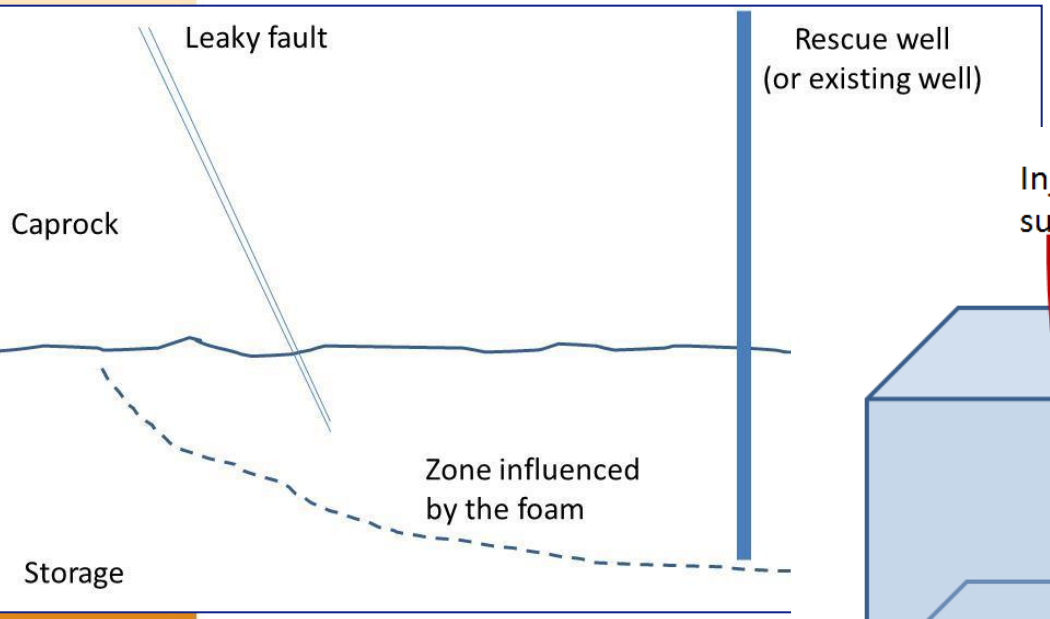
Picture courtesy T. Kollersberger, GFZ

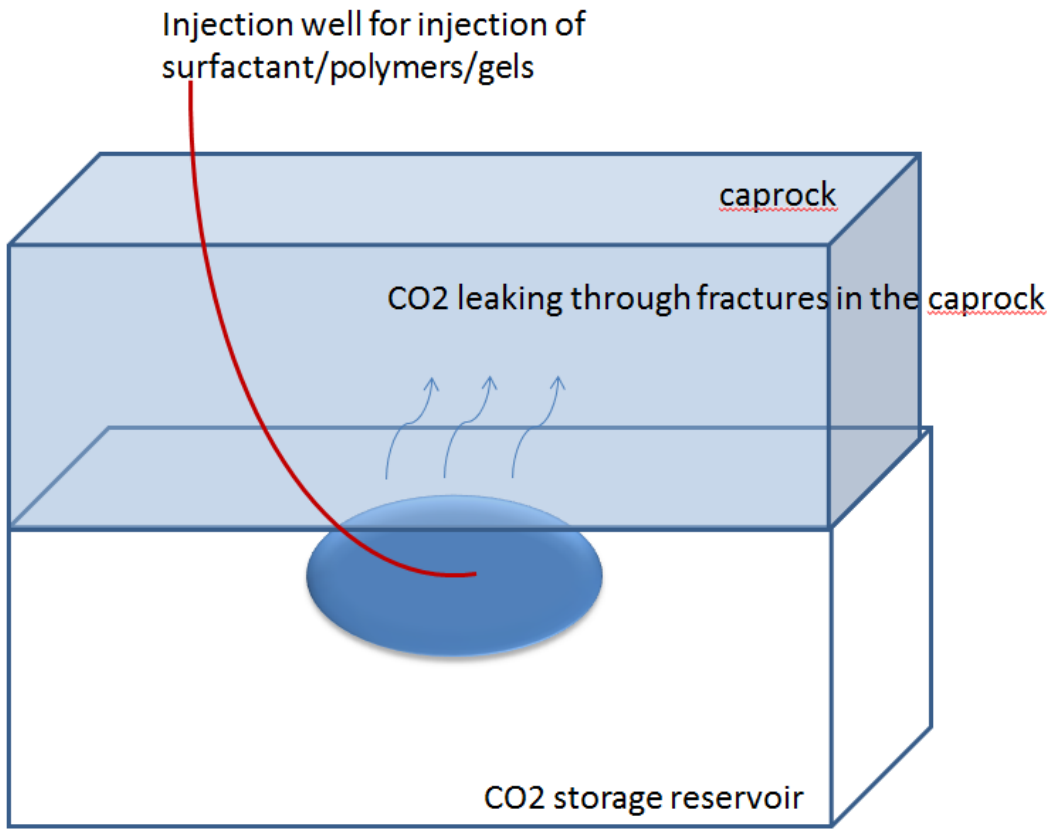
Example: flow diversion





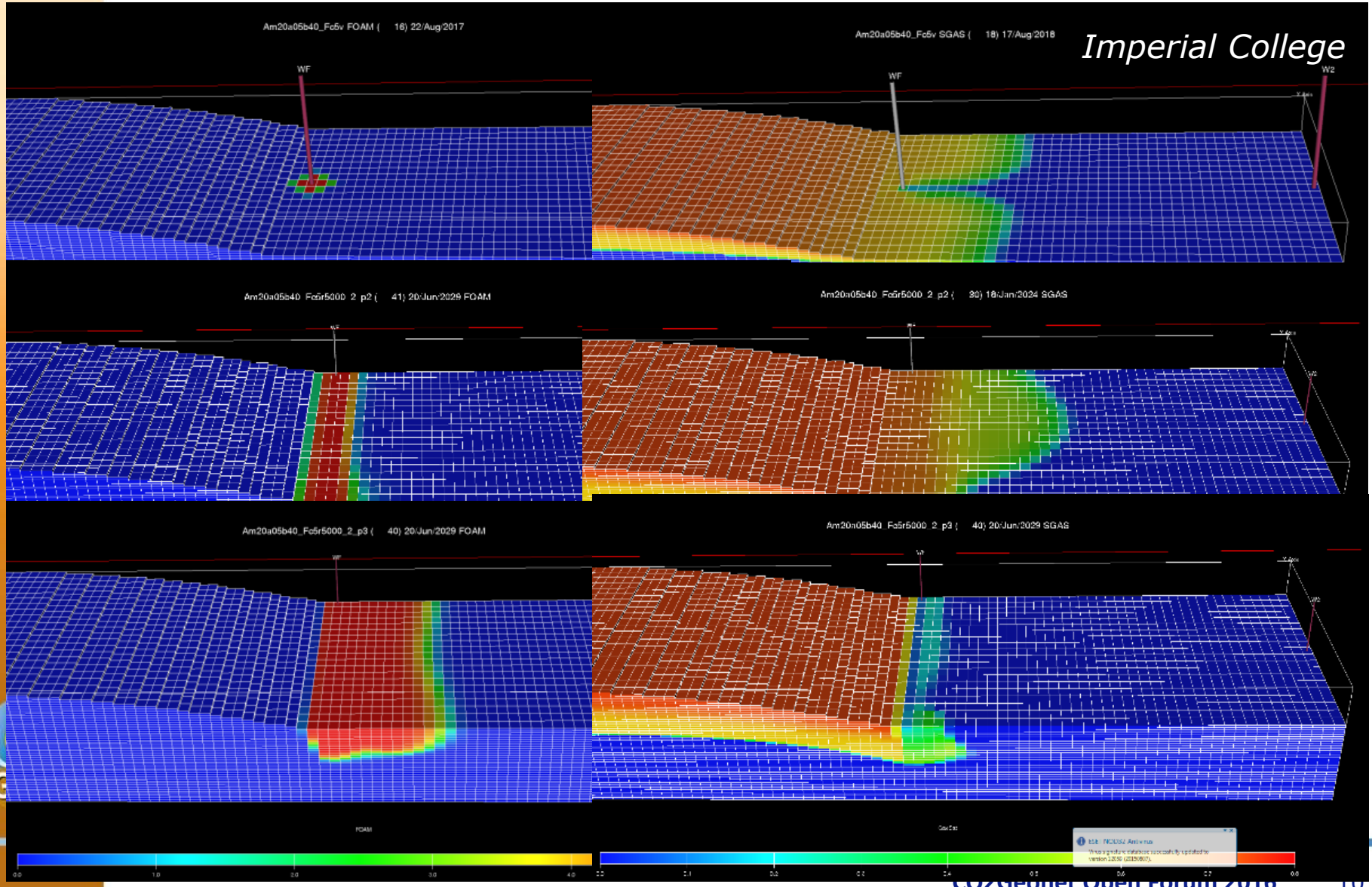
Example: foam injection





MiReCOL Mitigation and Remediation of CO_2 Leakage

Surfactant injection into fault



Project approach

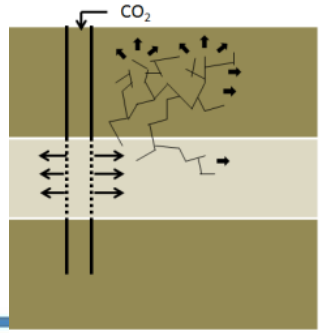
- Central concept is **risk level**
- Merit of mitigation or remediation technique is obtained by establishing overall risk level *before* and *after* deployment of the technique
  - ***Unmitigated risk*** (i.e., threat or leak has occurred, but no action is taken)
  - ***Mitigated risk*** (i.e., residual 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

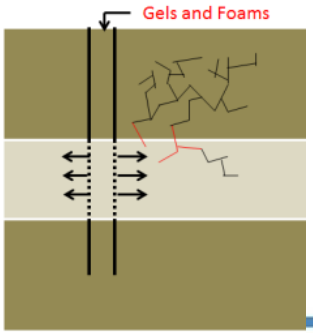
Project approach

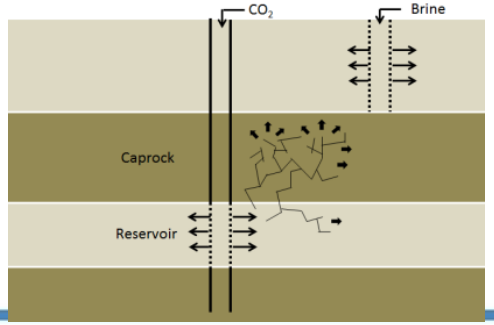
Site specificity vs general guidelines

- In reality, 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

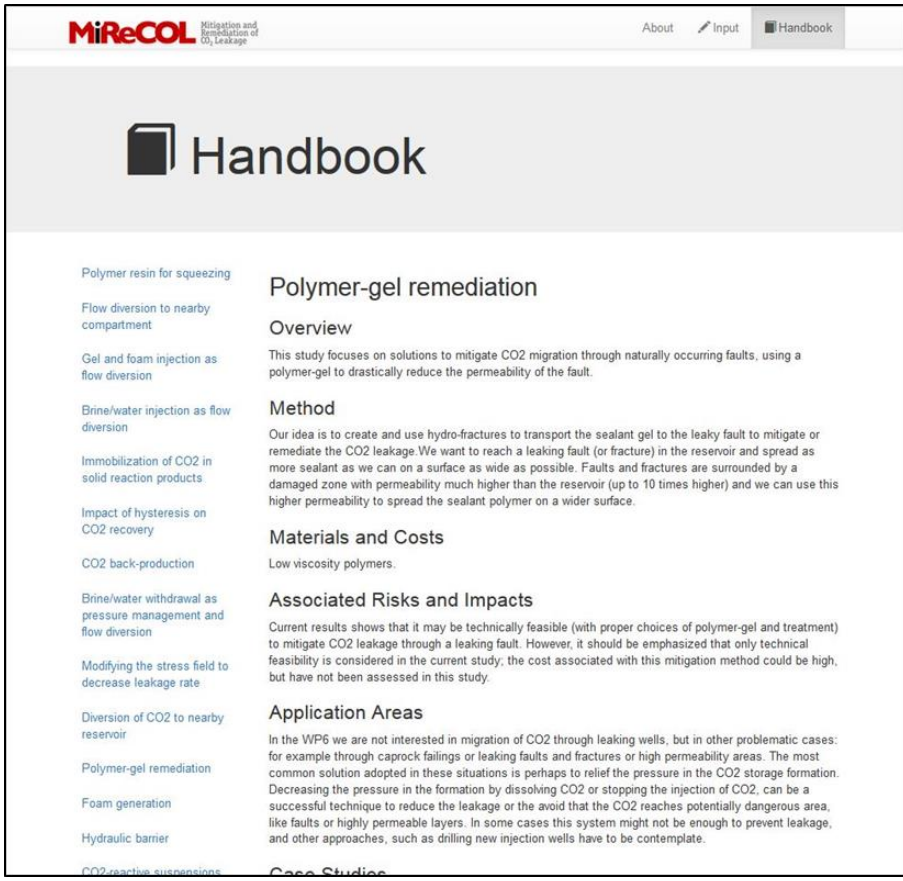






Results of the project: Corrective measures handbook

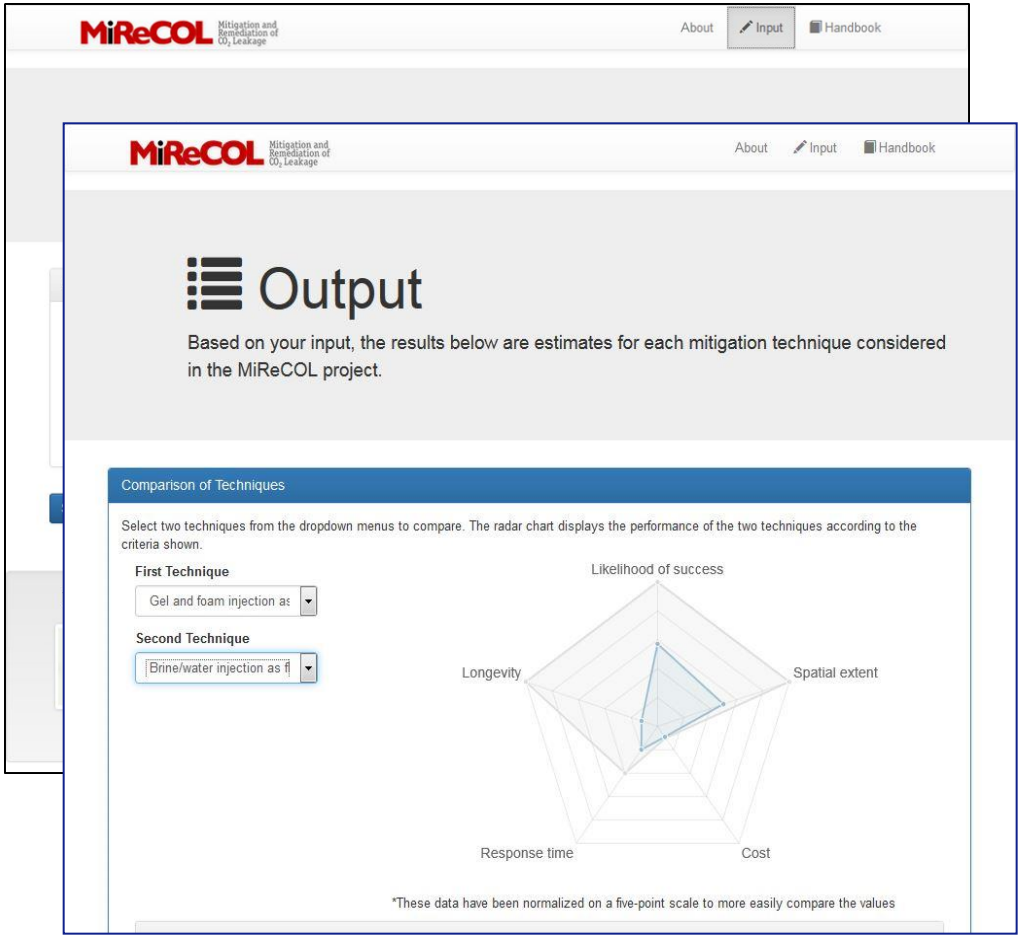
- "**Handbook**" of remediation and mitigation options that can be applied in the deep subsurface.
  - *Handbook to inform operators, regulators, public*
  - *Results in handbook based on MiReCOL modelling on a variety of scenarios, to illustrate value of remediation & mitigation options*



Example of web-based Handbook

Results of the project: Corrective measures Tool

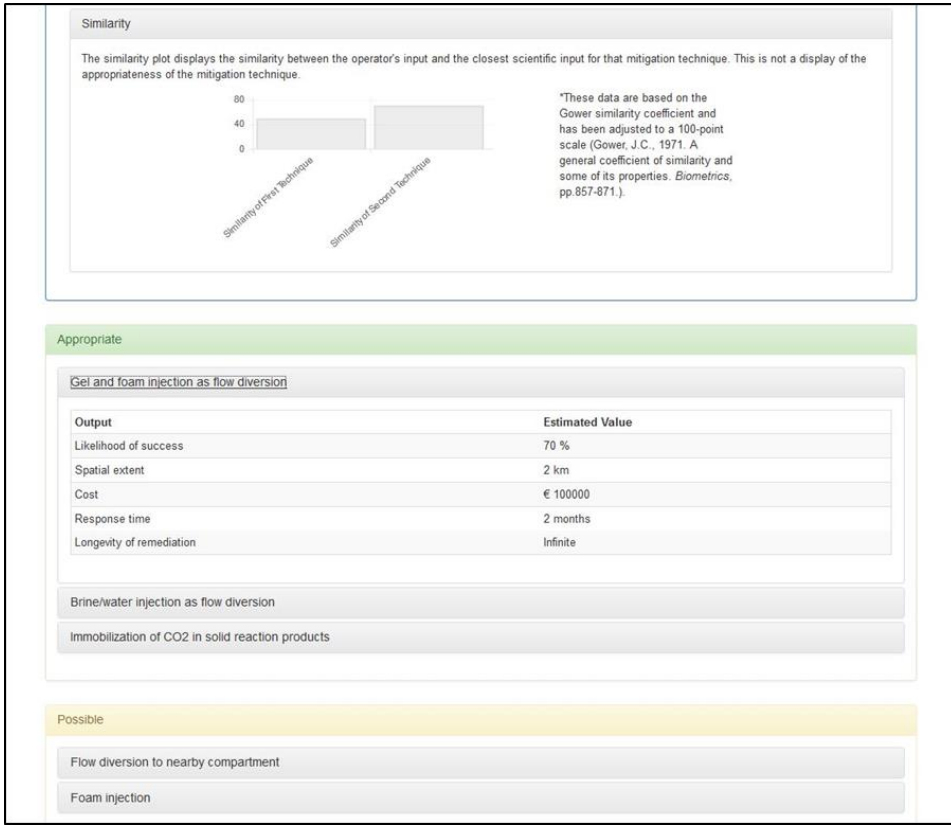
- Web-based tool: suggests suitability of remediation and mitigation options for a specific site and a specific leakage scenario
  - *Tool informs operators, regulators*
  - *Provides first-order assessment of options available to operator to remediate or mitigate undesired migration in or leakage from storage complex*



Example of input & output from web-based MiReCOL corrective measures tool

Results of the project

- Project started March 2015, now starting final year
  - Formulate guidelines for mitigation / remediation measures
  - Construct tool, write Handbook
- **Gassnova – CO2Geonet workshop, Wednesday**
  - Two technical papers
  - Detailed presentation of Tool – discussion!



Example of output from web-based MiReCOL corrective measures tool

MItigation and Remediation of CO_2 Leakage

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