IEAGHG CO$_2$ Storage

Research Highlights and Future Plans

- Supports R&D projects in capture & storage
- Organize Network meetings
  - Modelling
  - Monitoring
  - Risk Management
  - Environment
- GHGT biannual conference
- Summer school
- Webinar – offshore monitoring Oct 2015
Storage Technical Study Programme

- Technical Programme delivery over 2 years
  - 9 reports/reviews published
  - 4 studies at reporting stage
  - 3 studies planned and approved
  - 3 Combined Research Network meetings
  - 2 Network meetings planned for 2015

- General conclusions from Monitoring & Modelling Networks

- Future Research
<table>
<thead>
<tr>
<th>Title</th>
<th>Contractor / IEAGHG</th>
<th>Report number</th>
<th>Publication date</th>
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<tbody>
<tr>
<td>Monitoring Network and Modelling Network – Combined Meeting</td>
<td>✓</td>
<td>2015-01</td>
<td>02/03/2015</td>
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<td>Summary of the Modelling and Risk Management Network Meeting</td>
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<td>2013-14</td>
<td>20/11/2013</td>
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<td>Review of CO₂ Storage in Low Permeability Strata</td>
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<td>Monitoring Network and Environmental Research Network – Combined Meeting</td>
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<td>2013-15</td>
<td>02/12/2013</td>
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<td>Induced Seismicity and its Implications for CO2 Storage Risk</td>
<td>CO2CRC</td>
<td>2013-09</td>
<td>25/06/2013</td>
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<td>Interaction of CO2 Storage with Subsurface Resources</td>
<td>CO2CRC</td>
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<td>17/04/2013</td>
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<td>The Process of Developing a CO2 Test Injection Experience</td>
<td>CO2CRC</td>
<td>2013-13</td>
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<td>Criteria of Fault Geomechanical Stability during Pressure Build-up</td>
<td>NGI</td>
<td>June 2015</td>
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<td>Operational Flexibility of CO₂ Transport and Storage</td>
<td>EERC</td>
<td>August 2015</td>
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<td>Cost Components for CO₂-EOR</td>
<td>TNO</td>
<td>September 2015</td>
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# Studies planned

<table>
<thead>
<tr>
<th>Study</th>
<th>Provisional Publication date</th>
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<tr>
<td>Case studies of CO$_2$ storage in depleted oil and gas fields</td>
<td>December 2015</td>
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<tr>
<td>Fault Permeability</td>
<td>November 2015</td>
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<tr>
<td>Application and advances in Monitoring at different CO$_2$ storage sites</td>
<td>March 2016</td>
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Research Networks 2015 meetings

- **Monitoring Network.** LBNL, California. 10-12 June, 2015
  - Monitoring for large-scale industrial projects
  - Review of regulations – a comparison of permit requirements for monitoring
  - Induced seismicity
  - Shallow monitoring: how much do we need and how can we do it?
  - CO₂ distributions, saturations or pressure - What does geophysics actually ‘see’ in storage reservoirs?
  - Leakage failure scenarios
  - Pressure monitoring and its application to reservoir management / leakage detection
  - Monitoring tool development: technology R&D for shallow deep monitoring
  - Post closure monitoring: What should be required for closure?

- **Risk Management Network and Environmental Research Network.**
  National Oceanography Centre, UK. 30 Sep – 2 Oct 15

General Conclusions from last Network Meeting - Monitoring

- Tracers - most useful when used in combination and have shown good results for residual saturation (containment) - Australia
- Complexity at shallow depth at CO$_2$ Fieldlab - Norway
- New data on marine shallow subsurface and water column from QICS – UK, CO$_2$ retained in sediment pore fluid.
- P-cable providing high resolution data on shallow overburden - USA
General Conclusions from last Network Meeting - Monitoring

- Pressure monitoring could be an early indicator of leakage - pressure gauge data is providing new insights
- Seismic monitoring applied offshore and onshore – example of cheaper offshore per unit area
- At what point does CO₂ EOR switch from oil recovery to CO₂ storage and how is CO₂ storage efficiency (recycle rate) measured?
- Microseismic - benefits: data from current projects is identifying and reducing uncertainty e.g fracture patterns and verification of geomechanical models.
- Monitoring to modelling iteration is essential and proving effective
General Conclusions from last Network Meeting - Modelling

• Are the current numerical models limited in their ability to capture some fundamental physics? Sleipner example suggest pressure artefacts could have an influence.
• Site-specific models show good match with observed data but how do you assess their broader applicability?
• How do you link reduced order models with monitoring data?
• How many modelling realizations are needed to capture site-specific heterogeneities/uncertainties
General Conclusions from last Network Meeting - Modelling

• More similarities than differences amongst countries in regulatory requirements
  - modelling essentially required in all
  - in most, attempts to be prescriptive about what information is needed from models and not what models to use
  - still much uncertainty/variability about long-term issues (e.g., liability transfer)
• Glaciation should be accounted for in some environments
General Conclusions from last Network Meeting - Faults

- Fault permeability still remains an uncertainty
- Database of fault properties in literature, and pulled together by operators
- Other industries (rad. waste, dam construction)
- Slip event often not large enough to impact entire fault permeability
- Some experiments show fault slip in clay rich shale lowers fault permeability (range of applicability?)
Future research - Monitoring

- Surface monitoring for leak detection – large area with high sensitivity
- Will introduced tracers make it to the surface?
- Monitoring fracture zones and migration mechanism/process
- Secondary accumulations at shallower depths
- Defining baselines for CO$_2$ EOR projects
- Need (shallow) monitoring techniques which are continuous, real time, accurate, and cost effective – problems with accuracy of available sensors – benchmarking of available sensors
- Monitoring for commercial-scale deployment: what will be the right balance between cost and sensitivity to meet regulatory requirements
Future Research

- \( \text{CO}_2 \) storage in depleted oil & gas reservoirs
- Fault permeability
- Leakage into the overburden from reservoirs / wellbores
- Storage efficiency – estimating capacity (reservoir facies, open / closed systems / salinity)
- Brine disposal – pressure management
Thank You - Any questions?