DiSECCS

http://www.bgs.ac.uk/diseccs/home.html

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DiSECCS

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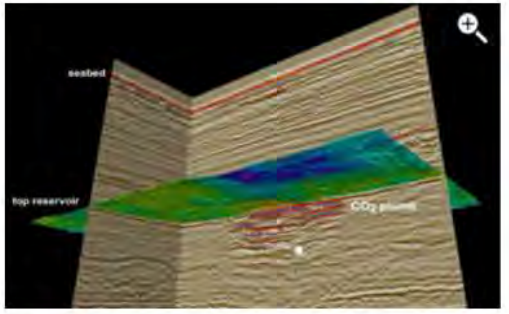
Diagnostic Seismic Toolbox for Efficient Control of CO_2 Storage: DiSECCS

Carbon capture and storage (CCS) has been identified by the UK Department of Energy and Climate Change (DECC) and the Committee on Climate Change as key to achieving the UK's carbon dioxide (CO_2) emissions targets, but two major related issues confront its large-scale rollout: storage integrity and storage capacity. A number of recent papers have highlighted the potential consequences of progressive pressure build-up in storage reservoirs as large amounts of CO_2 are injected and highlight important issues concerning pressure increase and geomechanical integrity that have to be faced.



3D seismic image of the injected CO_2 plume at the Sleipner storage site in 2006

DiSECCS will develop monitoring tools and methodologies to identify and characterise injection-induced pressure build-up in storage reservoirs, to predict the onset of mechanical instability, and to improve in situ quantification and understanding of processes. Seismic techniques provide the key to verifying site performance at the wide spatial scales required (tens of square kilometres and upwards) and our industrial partners, BP and Statoil, have provided unique access to monitoring datasets from the three global large-scale CO_2 storage operations: Sleipner, In Salah and Snøhvit.

Experience shows that underground storage of CO_2 is associated with significant levels of public concern. A better understanding of these concerns and how they might be manifest is a key element of establishing monitoring protocols to instil wider public confidence in CO_2 storage. DiSECCS will draw on analogue activities, in conjunction with a discursive process involving the general public to gain insights into how people engage with similar geological processes and how controversies surrounding particular projects develop and evolve.

Funding

- EPSRC Engineering and Physical Sciences Research Council

Partners

- University of Edinburgh
- University of Manchester — Tyndall Centre
- University of Leeds
- National Oceanography Centre

Linked with

- UKCCSRC

Andy Chadwick (BGS)

UKCCS RC Biannual meeting, Cranfield 21& 22 April 2015

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

UKCCS RESEARCH CENTRE

DiSECCS team

British Geological Survey (Andy Chadwick, Gareth Williams, Jim White, Dave Noy)
University of Edinburgh (Mark Chapman, Giorgos Papageorgio)
University of Leeds (Doug Angus, Lisa Roach)
National Oceanographic Centre Southampton (Angus Best, Ismail Falcon Suarez)
University of Manchester – Tyndall Centre (Claire Gough, Sarah Mander, Rebecca Cunningham)

BP Alternative Energy (Tony Espie)
Statoil (Anne-Kari Furre)

DECC – EDU (Jonathan Thomas)

Why DiSECCS? …… Storage capacity and pressure

2010: Ehlig-Economides & Economides - Pressure increase renders CCS unfeasible at any price .....

2012: Zoback & Gorelick - CCS will trigger earthquakes and leaks ..... except in large offshore aquifers

- **Not all reservoirs are suitable for large-scale storage; pressure-sensitive reservoirs need to be identified and linked to suitable monitoring strategies.**
- **Reservoir pressures need to be monitored and controlled to maintain reservoir mechanical stability**
- **Pressure limitation requirements will place a cap on ultimate storage capacity.**
- **Optimisation of storage in very high quality reservoirs is key to maximising storage capacity**

DiSECCS Objectives

Technical objectives

Develop monitoring tools and protocols to measure and control pressure increase, predict geomechanical stability and induced seismicity in storage reservoirs

Identify the spectrum of reservoir types that, with appropriate monitoring, are suitable for large-scale storage without unwanted geomechanical effects

Improve detailed understanding of storage processes to help optimise storage in suitable reservoirs and maximise their storage capacity

Policy impacts

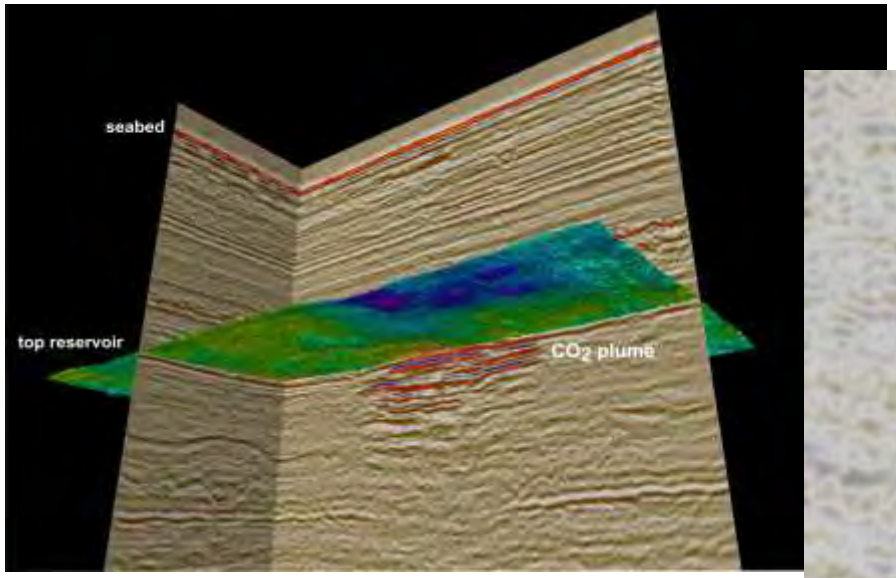
Effective and secure utilisation of a range of storage reservoir types typical of the UK offshore

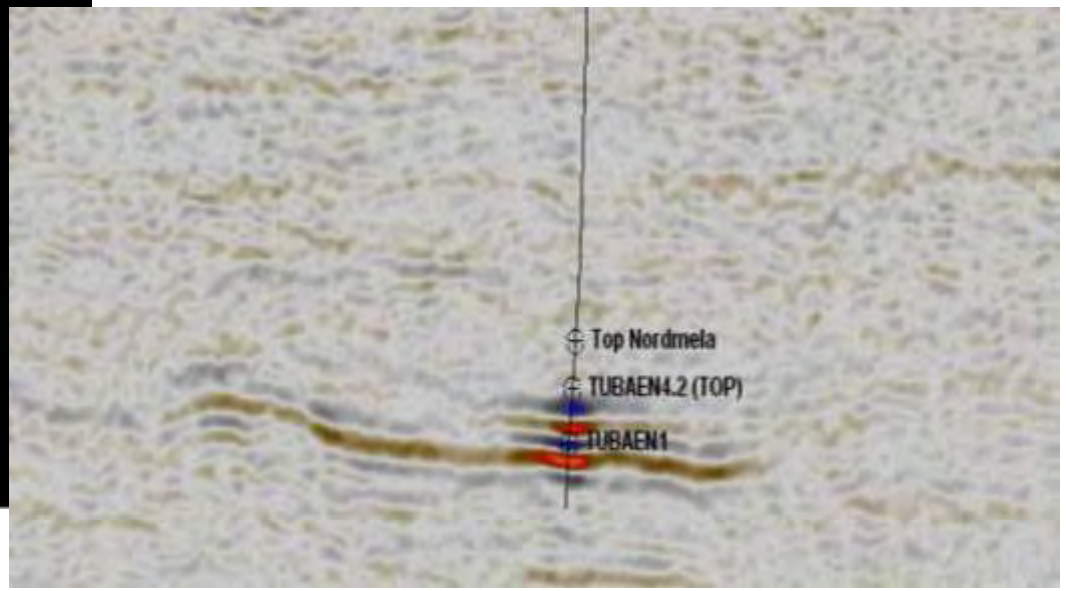
Optimisation of the UK storage resource for different loading requirements

More robust estimates of UK storage capacity

Generic relevance with impacts worldwide …….. public acceptance

DiSECCS Datasets

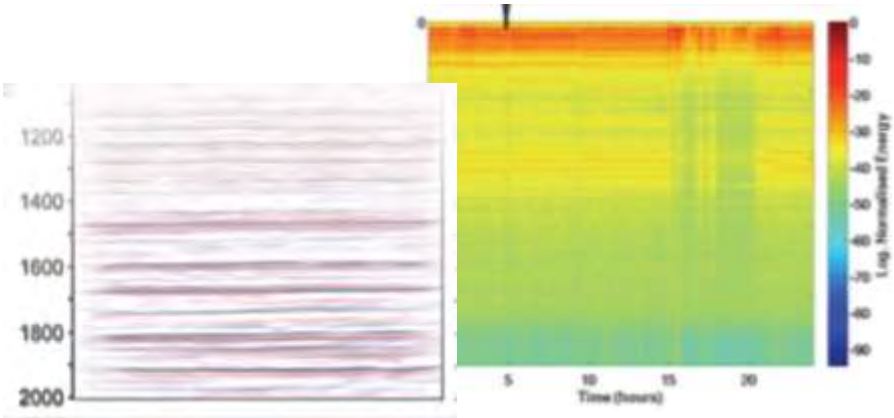




Sleipner, Snøhvit

Multiple time-lapse surveys

- **3D seismics (pre-stack and migrated)**
- **2D seismics multi-azimuth**



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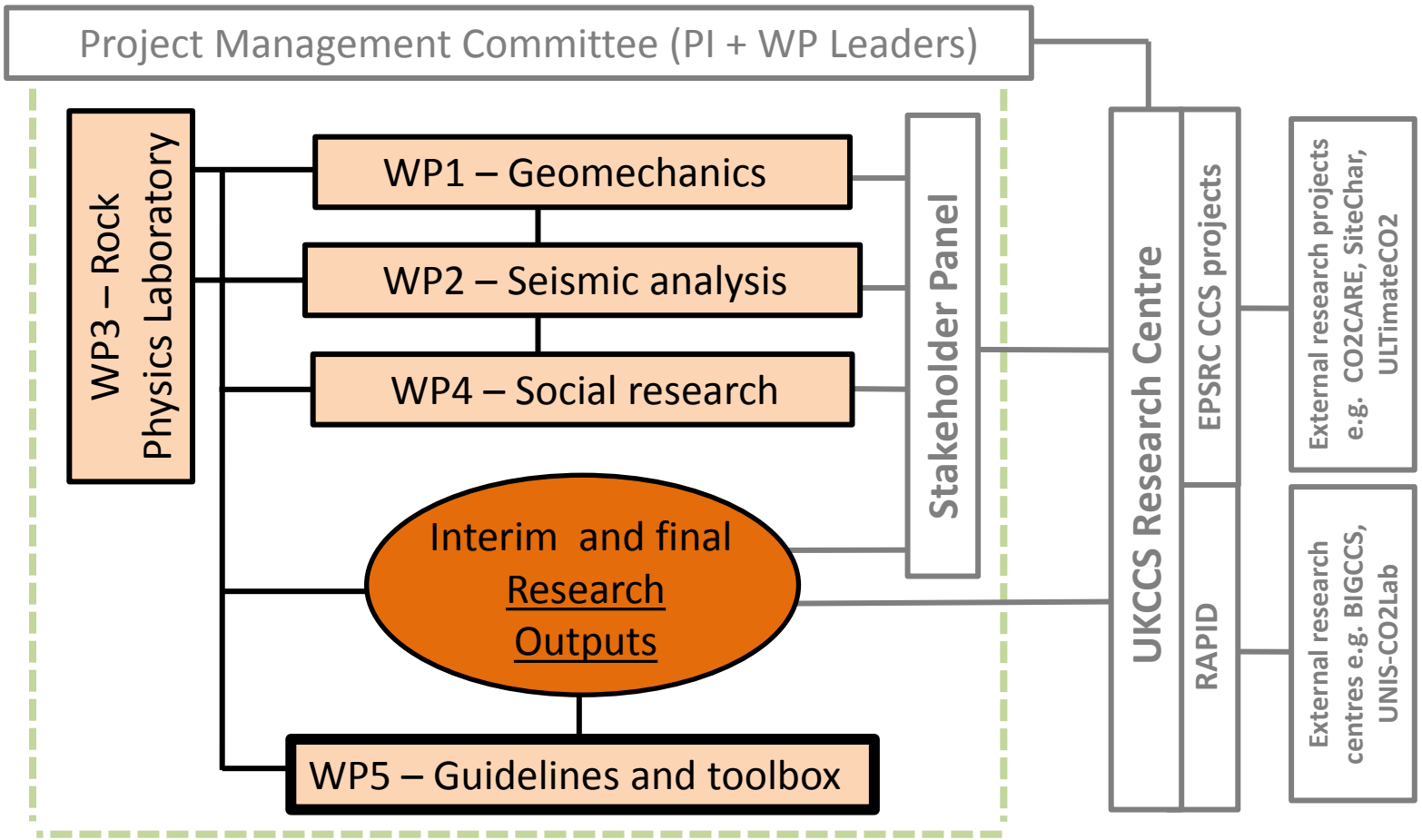
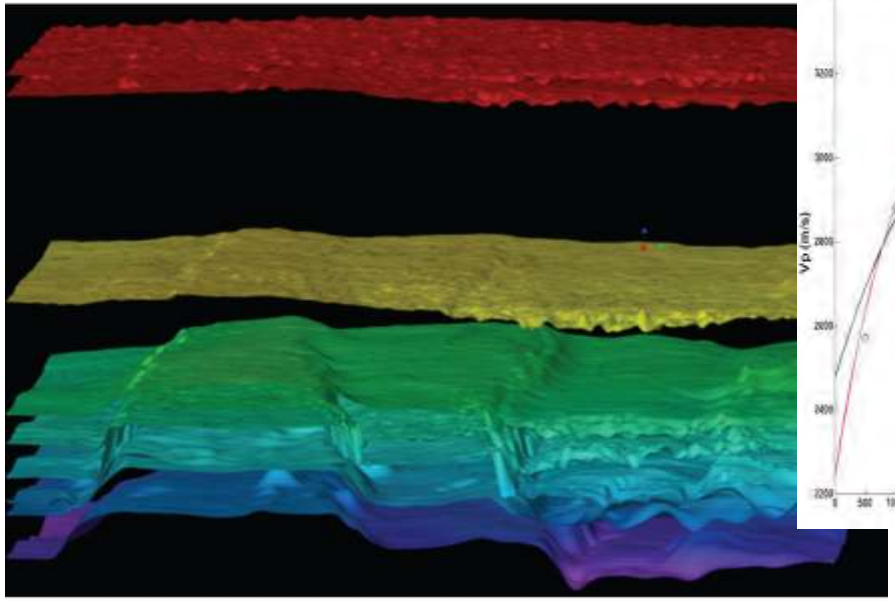
Active and passive seismics

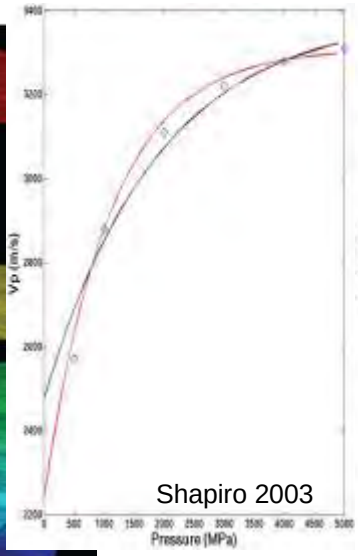
- **Multi-azimuth 3D**
- **Permanent receiver arrays**

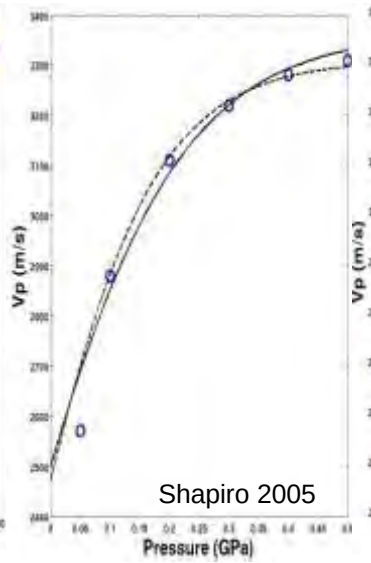
DiSECCS project structure

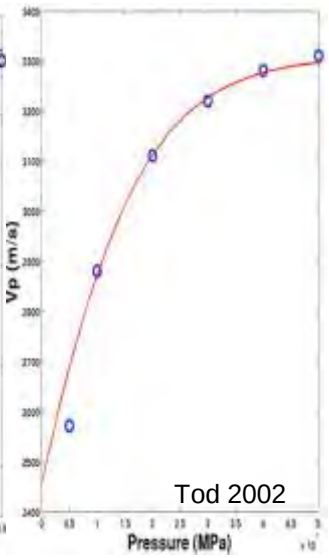


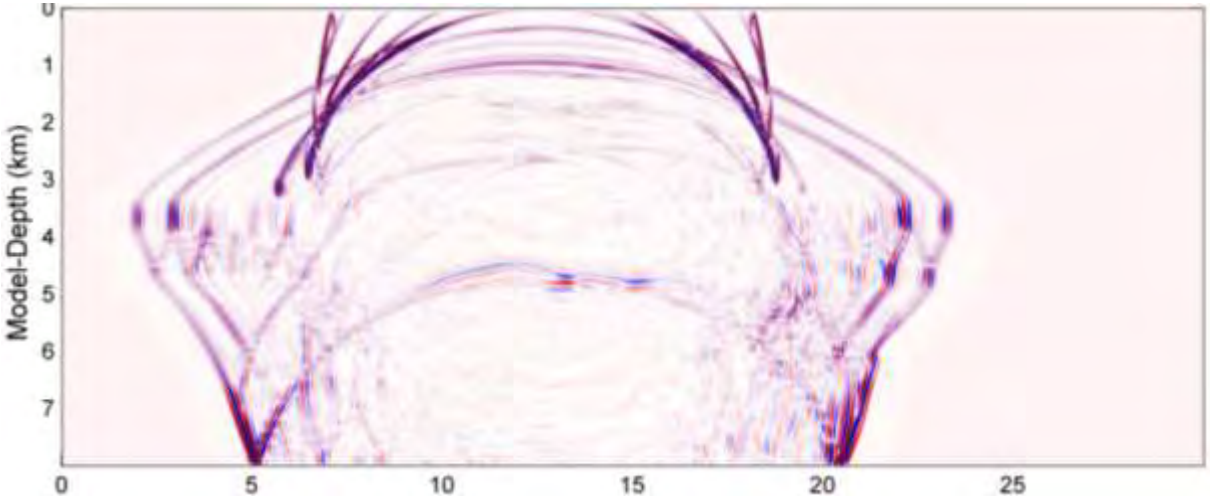
WP1 Geomechanics / seismic response











Velocity models

Acoustic/Elastic

Isotropic/anisotropic/viscoelastic

Seismic simulation tools

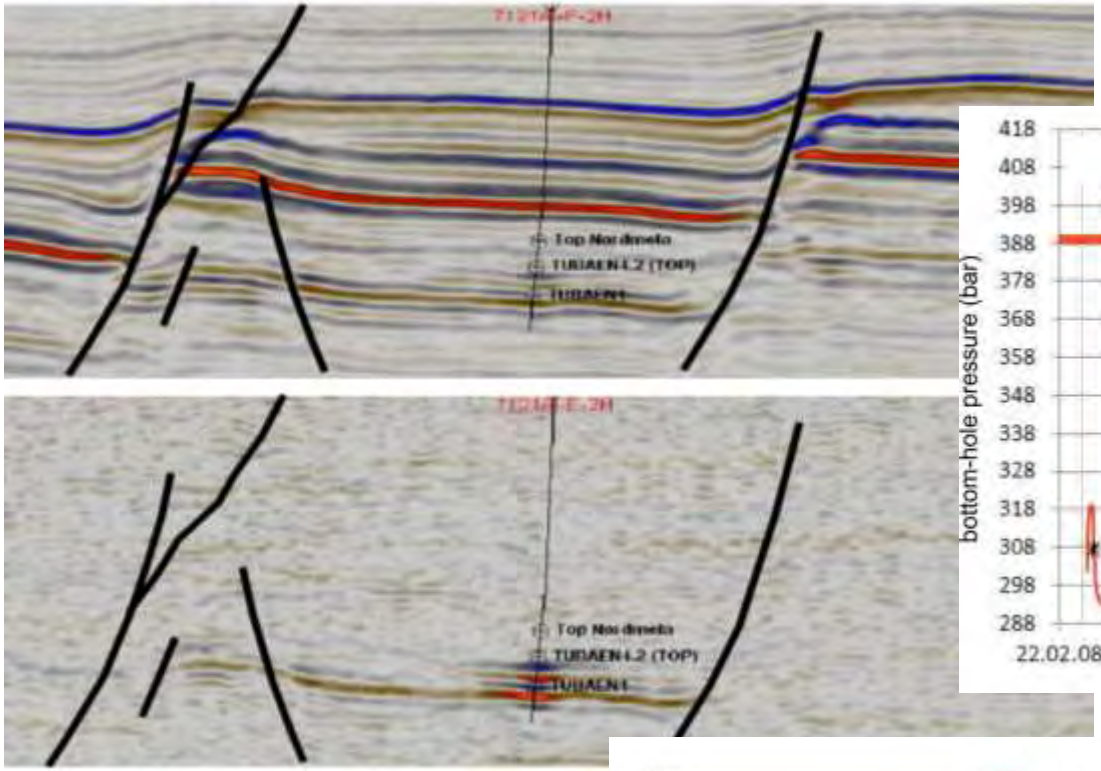
Ray tracing/Eikonal solver

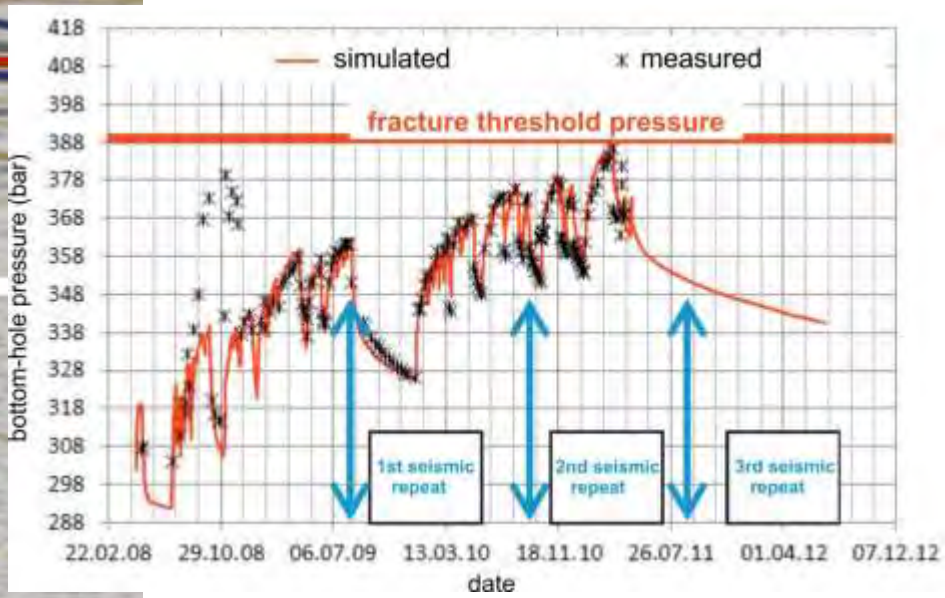
1D reflectivity

FD (acoustic/elastic/viscoelastic)

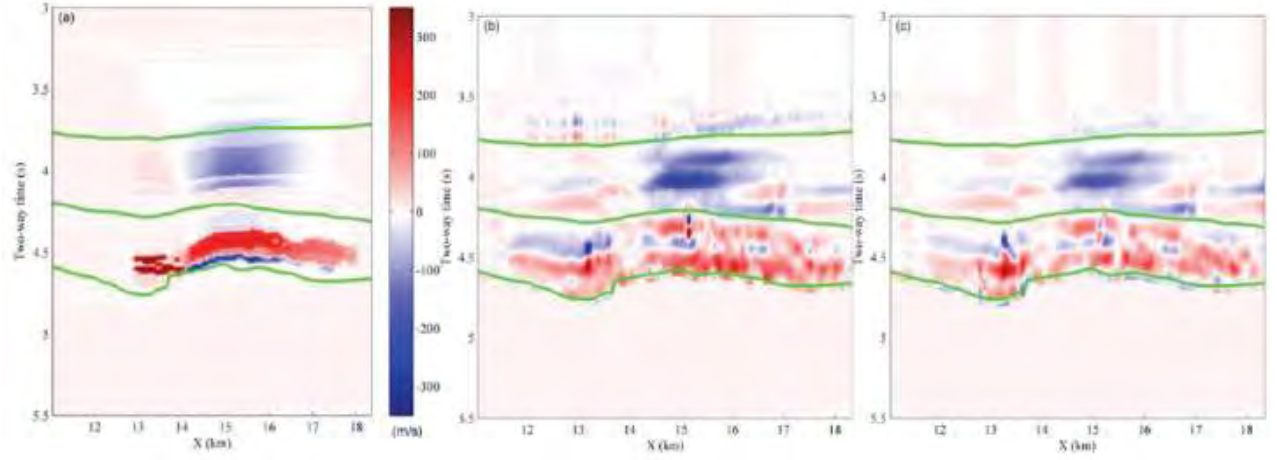
Model building / testing

WP1 Geomechanics / seismic response



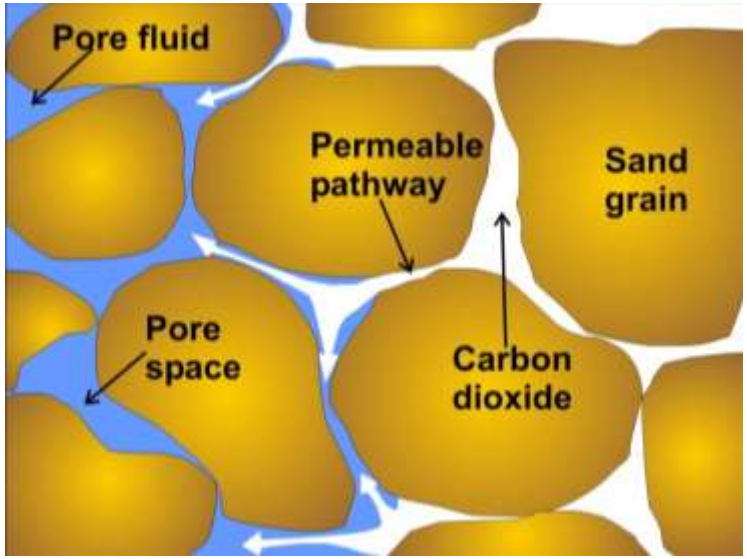


Real case-study at Snøhvit comparing predicted responses with observed monitoring data

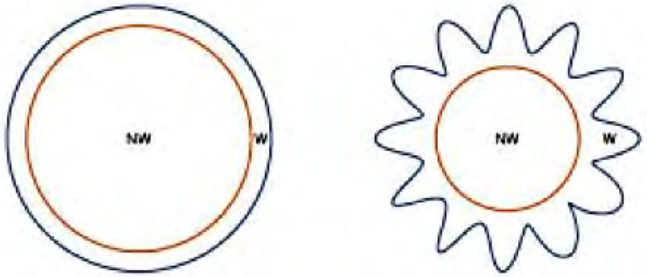


observed synthetic - full synthetic - near

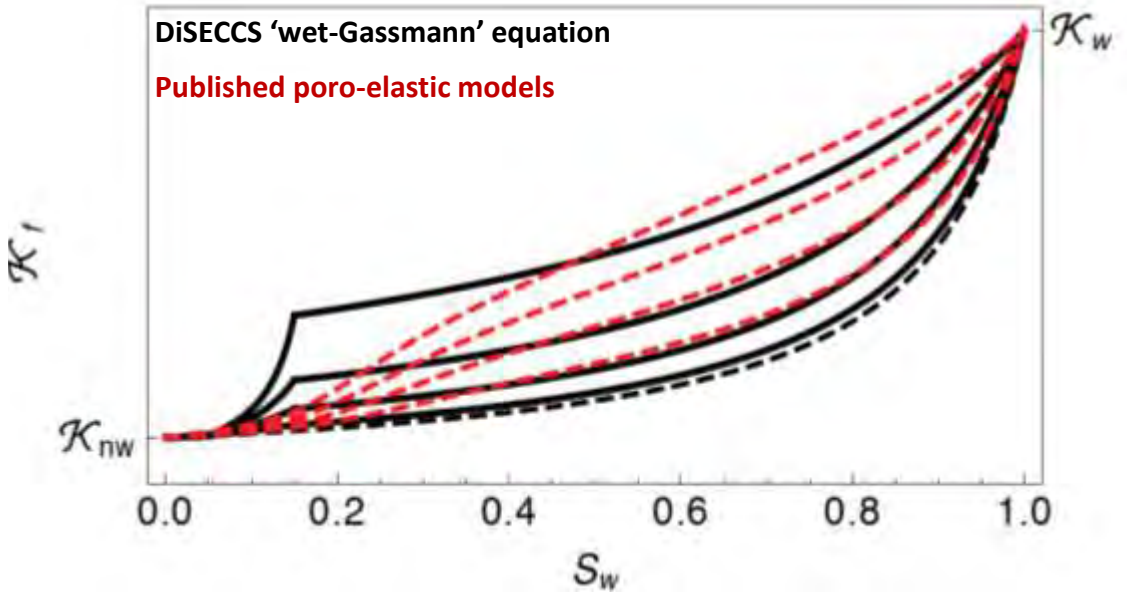
WP2 Seismic analysis – rock physics



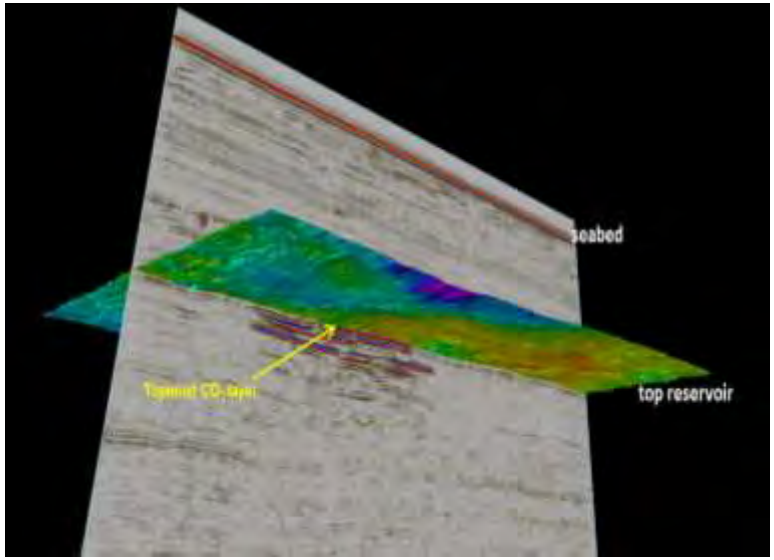
Effect of capillary processes (wetting) on seismic response during fluid substitution

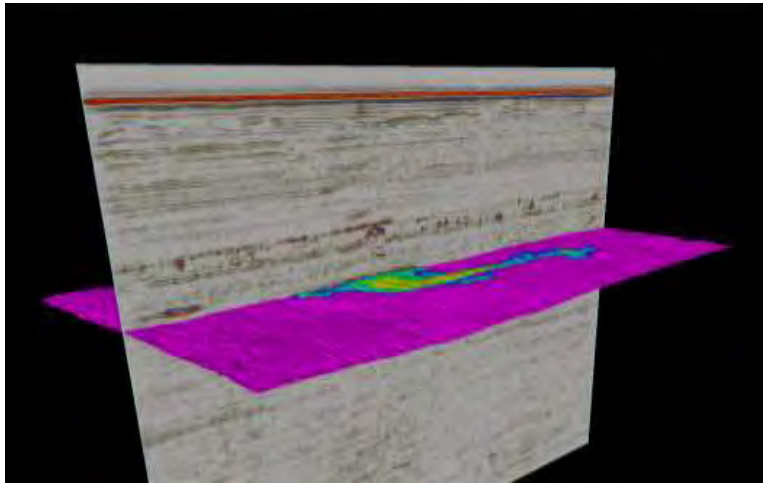


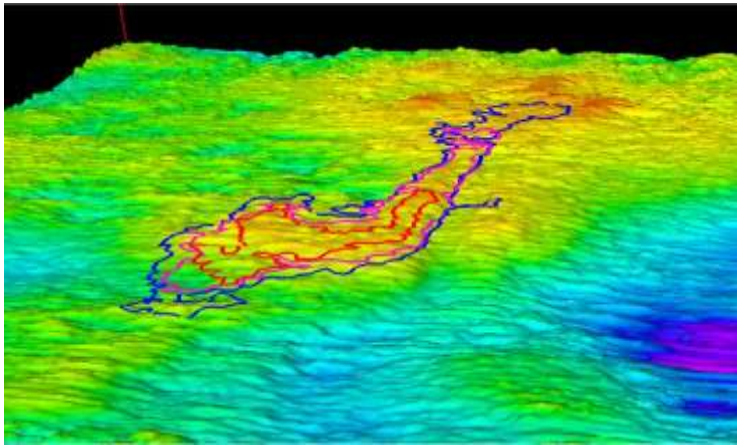
spherical pores – thin wetting film (W)
ragged pores – thicker wetting film (W)

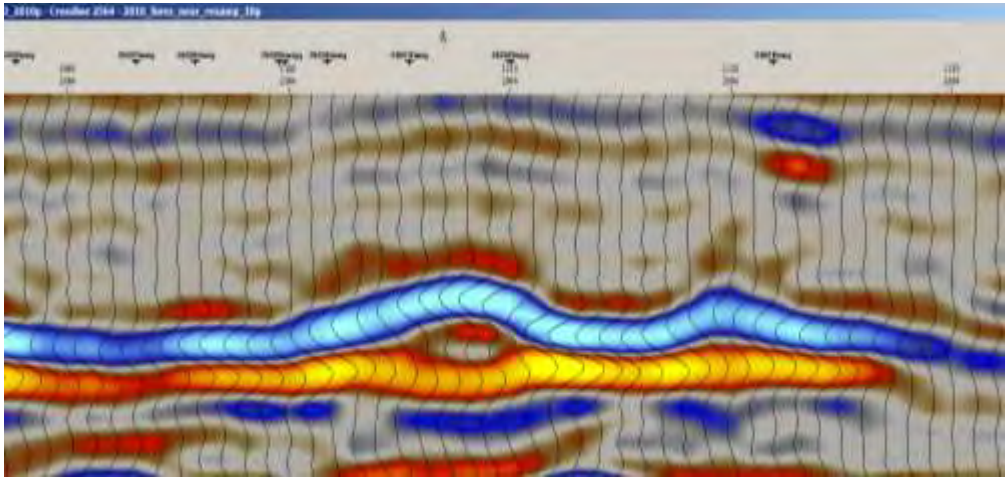


WP2 Seismic analysis – forensic interpretation





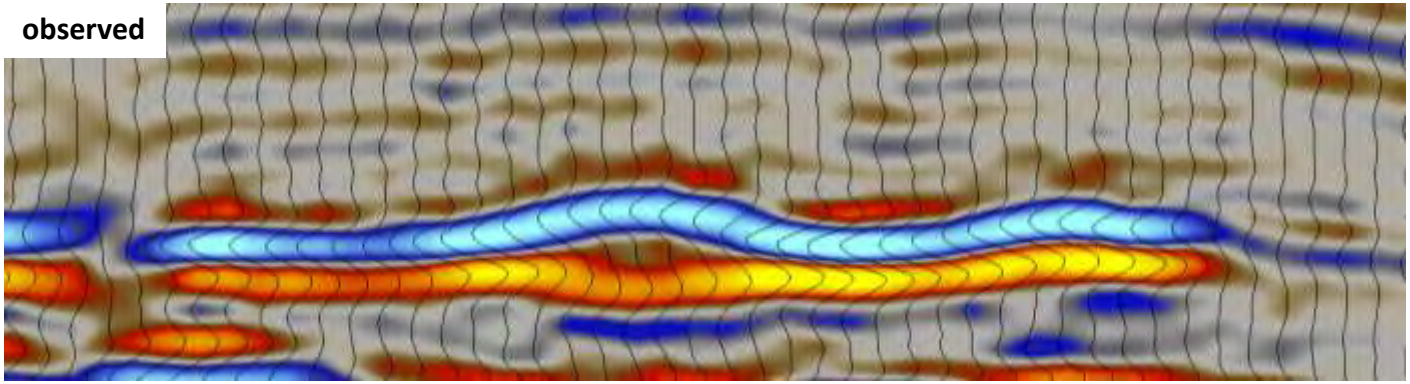




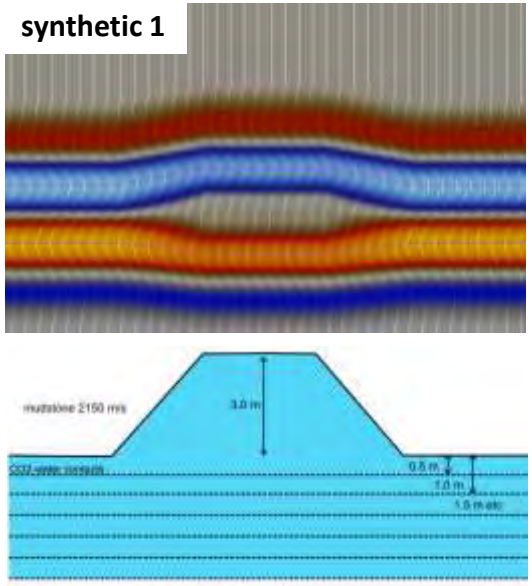
Latest time-lapse 3D seismics from Sleipner (improved resolution)

WP2 Seismic analysis – forensic interpretation

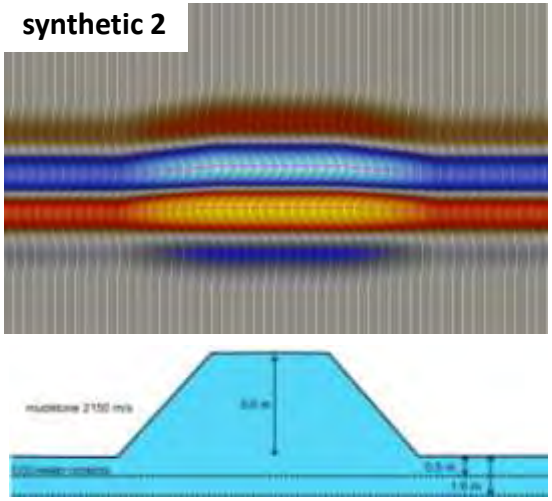
observed

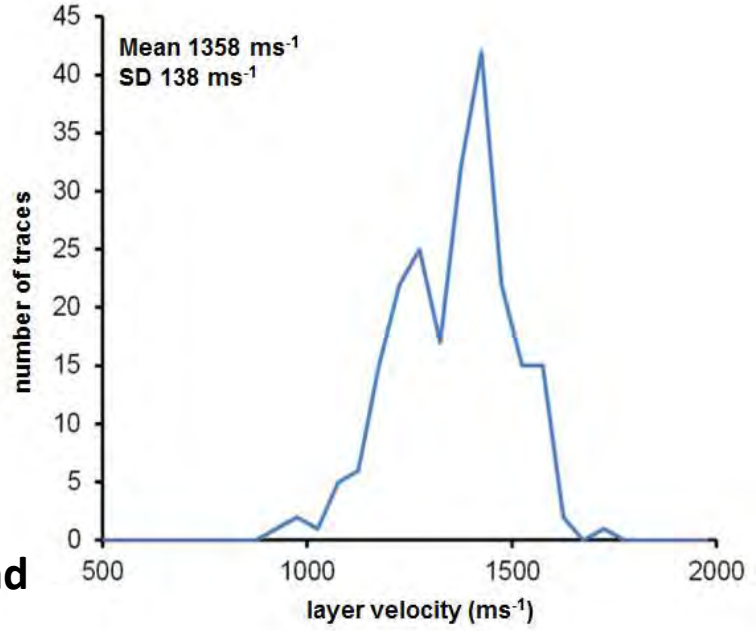


synthetic 1



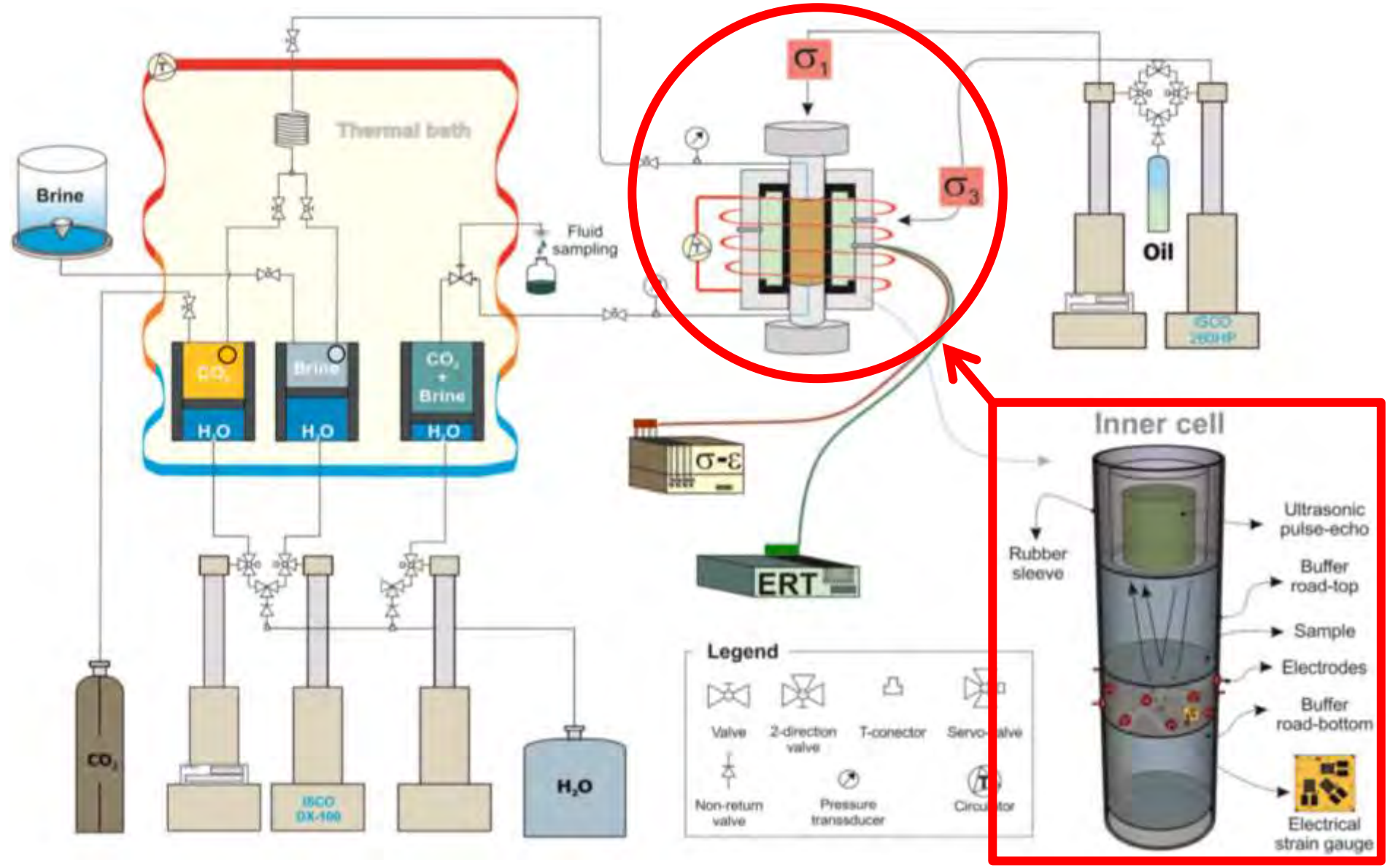
synthetic 2





Detailed layer properties from coupled data analysis and synthetic model matrix

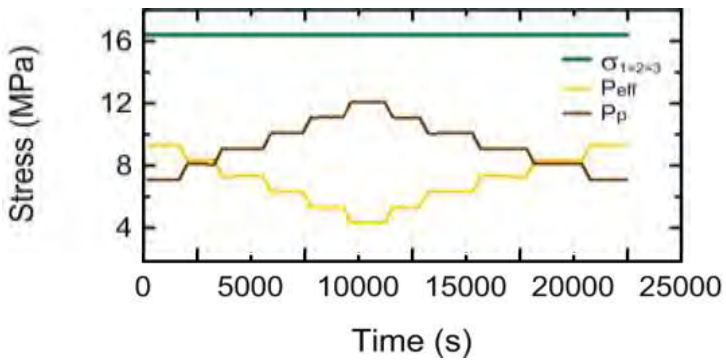
WP3 Experimental Rock Physics

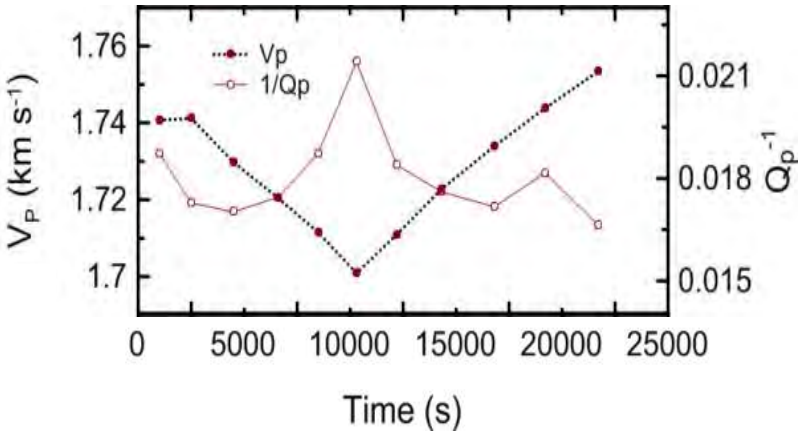


Vary applied (axial, radial) stresses, fluid pressure, CO_2 – water ratio, temperature
Ultrasonic, resistivity, strain measurements

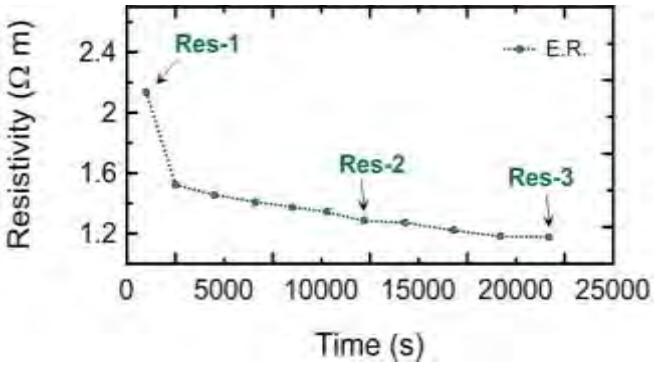
WP3 Experimental Rock Physics

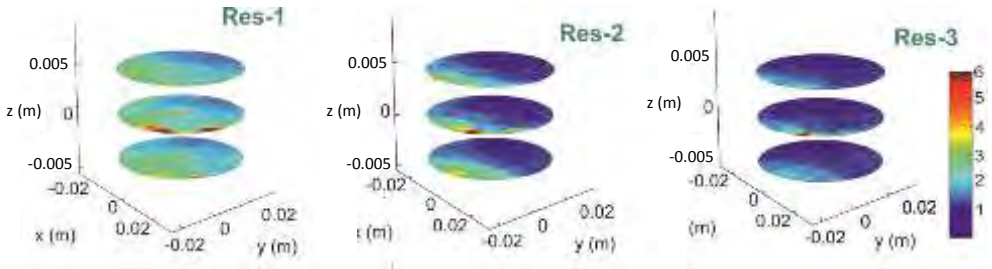
Vary pore pressure (effective stress)





Vary pore fluid





Current experiments on Utsira Sand samples (unconsolidated)
Next experiments on synthetic rocks with fractures of known geometry

WP4 Social research

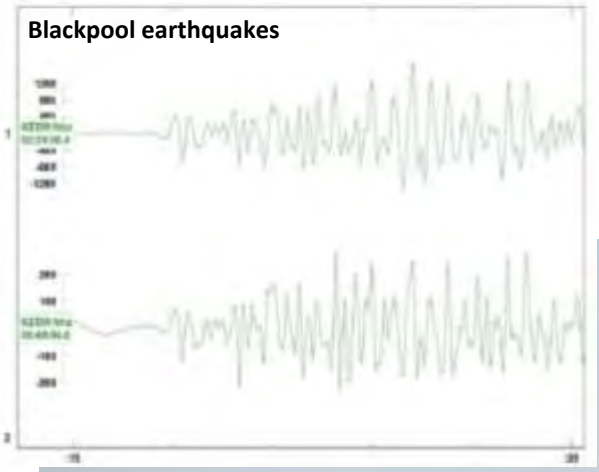
Analysing Analogues

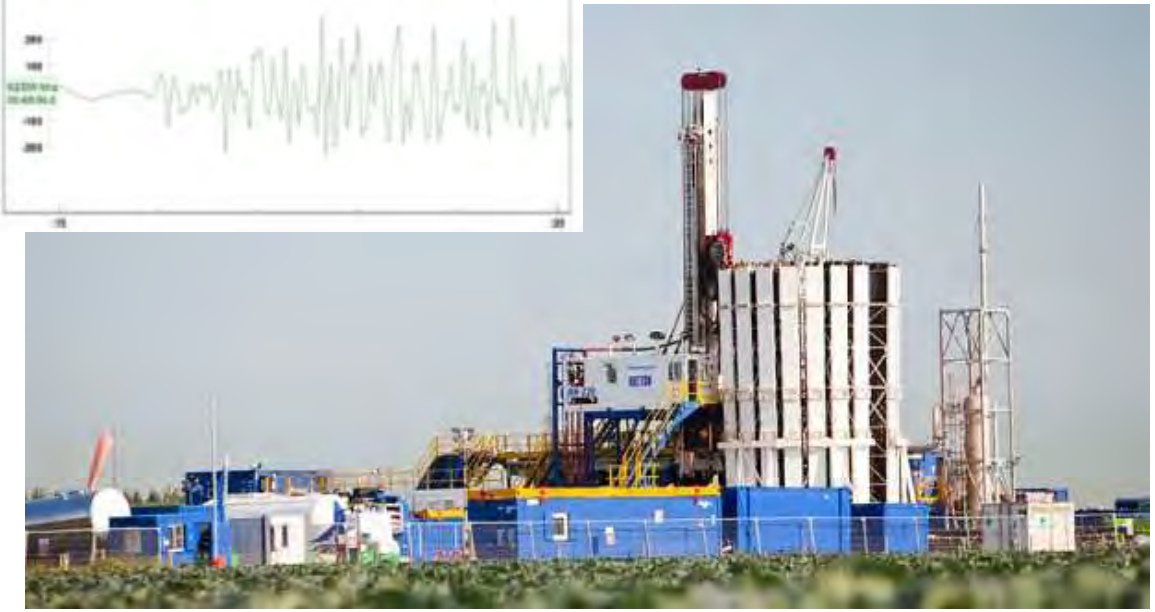
- How do lay publics engage with the use of sub surface? e.g. use of fracking in context of shale gas

- Method: Cross sectional case studies; Qualitative content analysis of media (social and print)

- Case Sites:
- Blackpool (Shale Gas)
- Lancashire (Shale Gas)
- Kingsnorth (CCS)
- Peterhead (CCS)

- Questions:
- *What are the prominent themes?*
- *Where are the voices coming from (geographically and politically)?*
- *Are there concerns about the technology? (e.g., induced seismicity / property prices / noise)*





WP4 Social research

Mapping Knowledge

- What is the social structure of knowledge sharing around sub surface activities around CCS and shale gas respectively?
- Method: Social Network Analysis (SNA) based on semi-structured interviews
- Case sites:
- Blackpool and Drax / Teesside
- Questions:
- *What has been their experience of shale gas and/or CCS?*
- *What is their knowledge of the technology?*
- *Where is the information acquired?*
- *Who do they share information with?*

Mapping Knowledge

- How do perceptions of CO_2 storage differ from the case study analogues and how might site monitoring affect the response
- Method: Focus Groups and semi-structured interviews
- Case sites:
- Blackpool and Drax / Teesside
- Questions:
- *What has been their experience of shale gas and/or CCS?*
- *Are there concerns about this technology in this region?*
- *Do varying levels of information and knowledge of monitoring techniques affect the perception of CCS?*

Will appropriate storage monitoring help allay public opposition?

Outputs

One paper in press incorporates DiSECCS work:

C. Jenkins, A. Chadwick & S. Hovorka. (in press). The state-of-the-art in monitoring and verification - ten years on. International Journal of Greenhouse Gas Control - IPCC Special Report Anniversary Volume.

Five conference abstracts have been prepared:

R.A. Chadwick, G.A. Williams & J.C. White. Forensic analysis of a carbon-dioxide layer at Sleipner from time-lapse 3D seismics. Accepted for oral presentation at TCCS-8 in Trondheim, 16 – 18 June 2015.

G. Papageorgiou & M. Chapman. Multi-fluid substitution, capillarity and inclusion models. Accepted for oral presentation at 3rd International Workshop on Rock Physics, Perth, 13-17 April 2015.

C. Birnie, A. Stork, L. Roach, D. Angus & S. Rost. Spatial and temporal properties of noise from the Aquistore CCS pilot permanent surface array. Third Sustainable Earth Science Conference & Exhibition: Use of the Deep Sub-surface to serve the Energy Transition, Celle, Germany, 13-15 October 2015.

L.A. Roach, D.A. Angus & D.J. White. Determining the limitations to deep reservoir caprock fracture characterisation using AVOA analysis. Third Sustainable Earth Science Conference & Exhibition: Use of the Deep Sub-surface to serve the Energy Transition, Celle, Germany, 13-15 October 2015.

I. Falcon-Suarez, L.J. North & A.I. Best. Geophysical and Hydro-Mechanical Coupled Monitoring for Efficient Control of CO_2 Storage. 3rd International Workshop on Rock Physics, Perth, 13-17 April 2015.

Thank you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Research Council


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