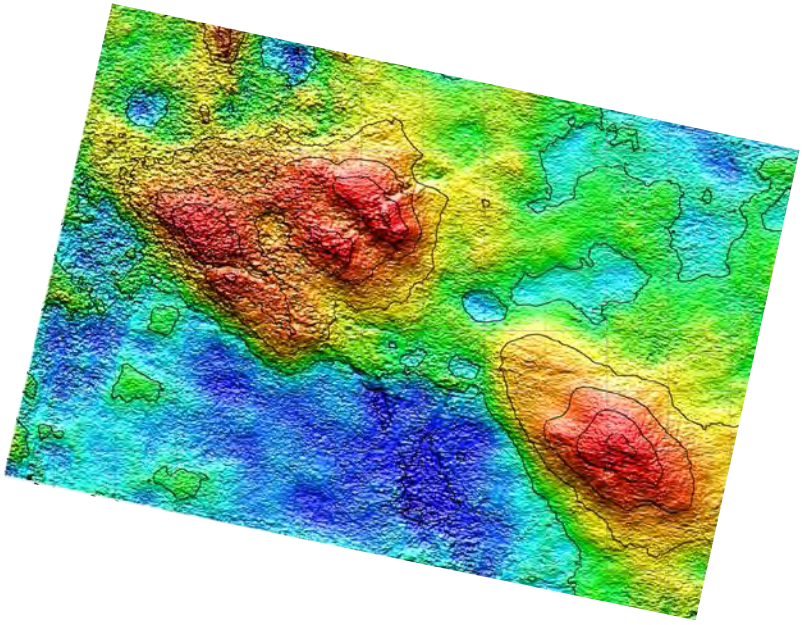
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

DiSECCS: Diagnostic Seismic Toolbox for Efficient Control of CO_2 Storage



UKCCS RC Biannual meeting, Nottingham 4-5 September 2013

Andy Chadwick (BGS)

EPSRC
Pioneering research and skills

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DiSECCS team

British Geological Survey - Andy Chadwick (PI), Dave Noy, Gareth Williams, Jim White
University of Edinburgh - Mark Chapman, PDRA
University of Leeds - Doug Angus
National Oceanographic Centre - Angus Best, Jeremy Sothcott, PDRA
University of Manchester Tyndall Centre - Gough, Sarah Mander, Laura O'Keefe

BP Alternative Energy (Tony Espie)
Statoil (Olav Hansen)

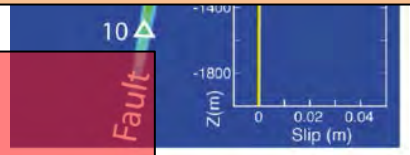
DECC – EDU (Jonathan Thomas)

The pressure issue

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

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



[from Cappa & Rutqvist 2012]

HIGH-LEVEL IMPACTS

- **National storage inventories / policy**
- **Public acceptance**

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DiSECCS Objectives (1)

Technical objectives

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

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

To further 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

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DiSECCS Methodology

Hydromechanical and hi-res numerical simulations of real and synthetic storage reservoirs

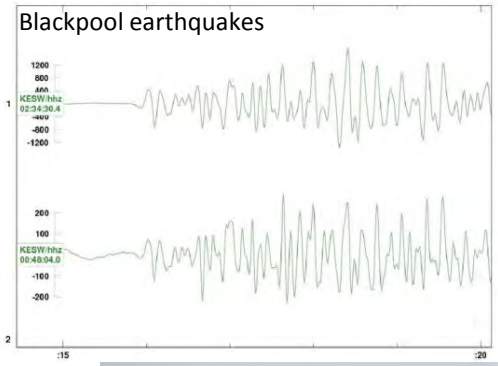
- pressure increase
- geomechanical response
- CO2 layer geometry and spreading
- ……. for a spectrum of reservoir types

Time-lapse seismic tool development

- fluid saturation changes – timeshifts, spectral methods, attenuation, AVA
- fluid pressure changes – timeshifts, spectral methods, AVA
- incipient seismicity – azimuthal anisotropy

Passive seismic monitoring method development

- measure and characterise induced seismicity
- image potential leakage pathways



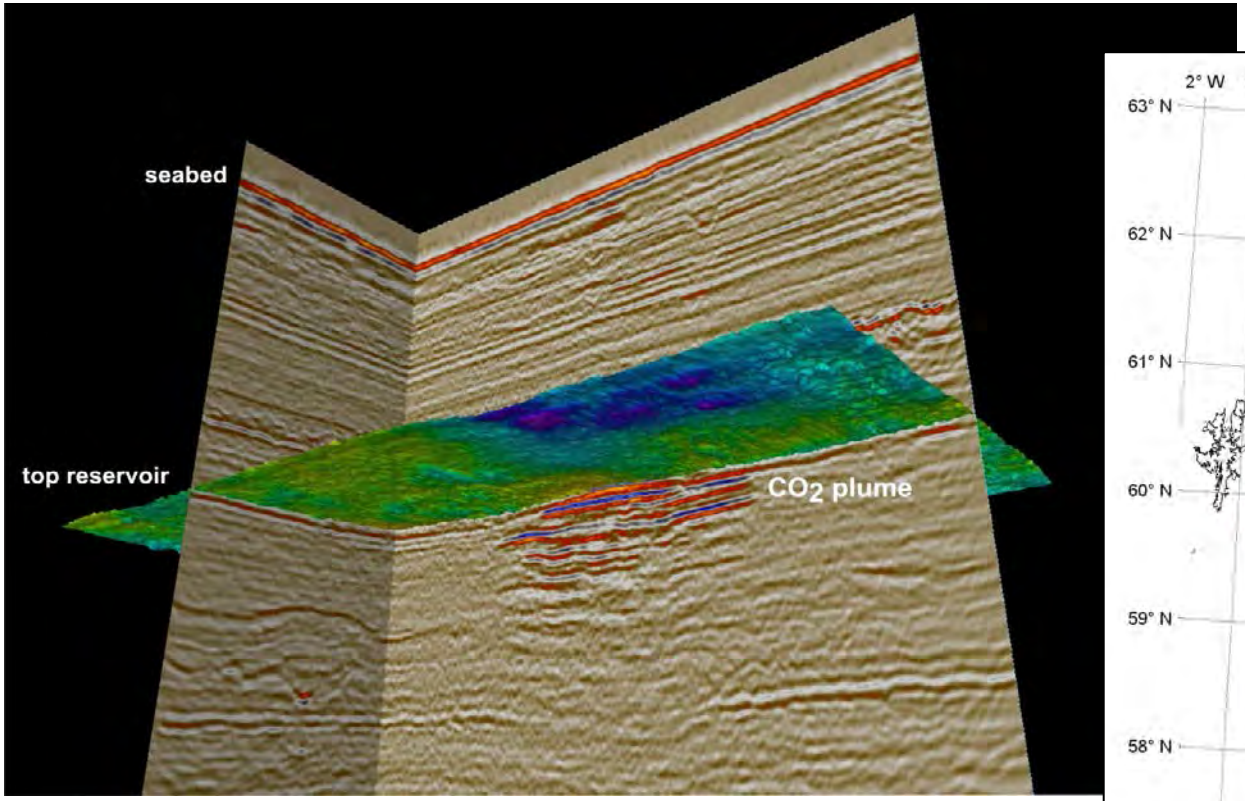
Experimental rock physics

- variable differential stress
- synthetic cracked rocks
- unconsolidated lithologies

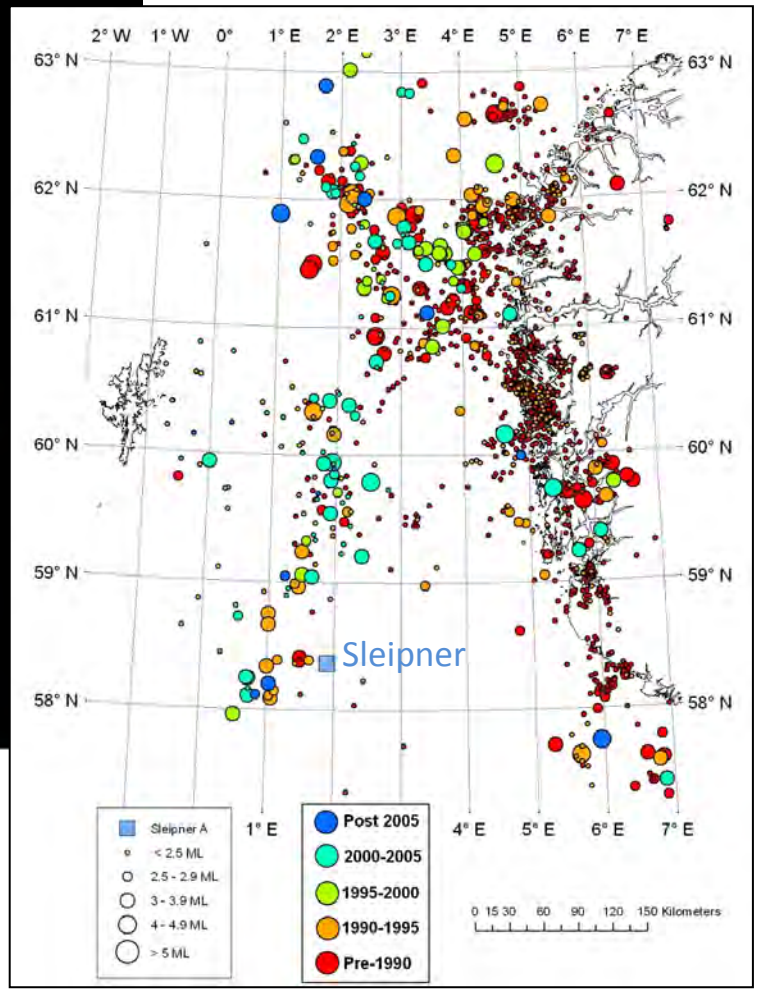
Social responses to subsurface injection

- induced seismicity (shale gas analogue)
- site monitoring approaches

DiSECCS Datasets (1): Sleipner



[Data courtesy of Statoil]



[BGS dataset]

Multiple time-lapse surveys
- 3D seismics
- 2D seismics multi-azimuth

Minimal pressure increase (~0.1 MPa)
No measured seismicity

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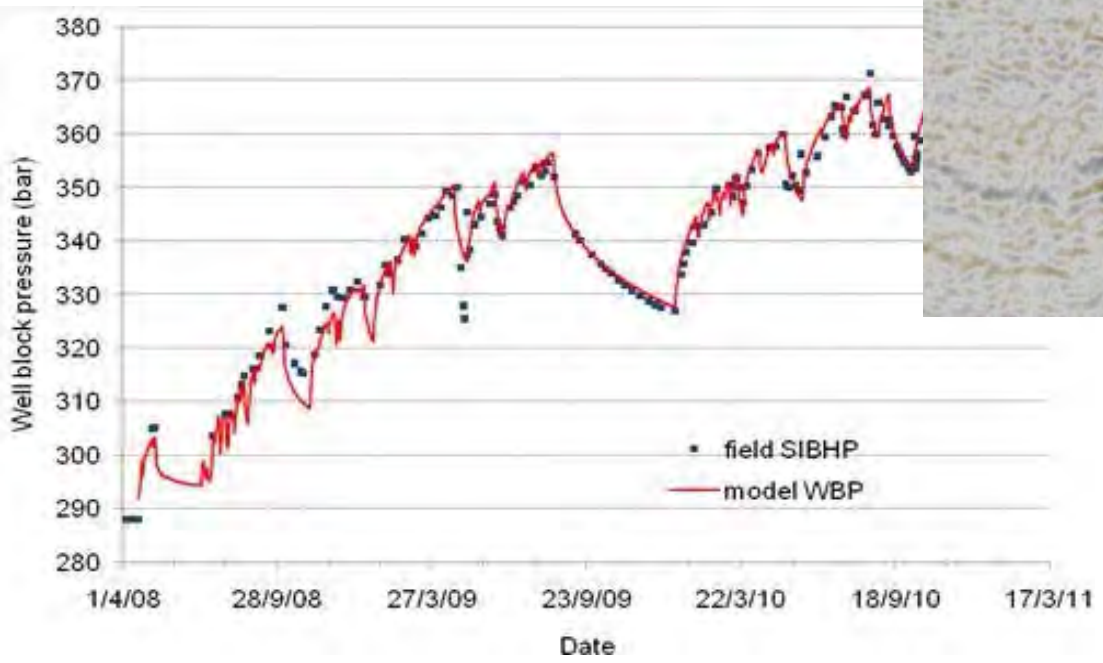
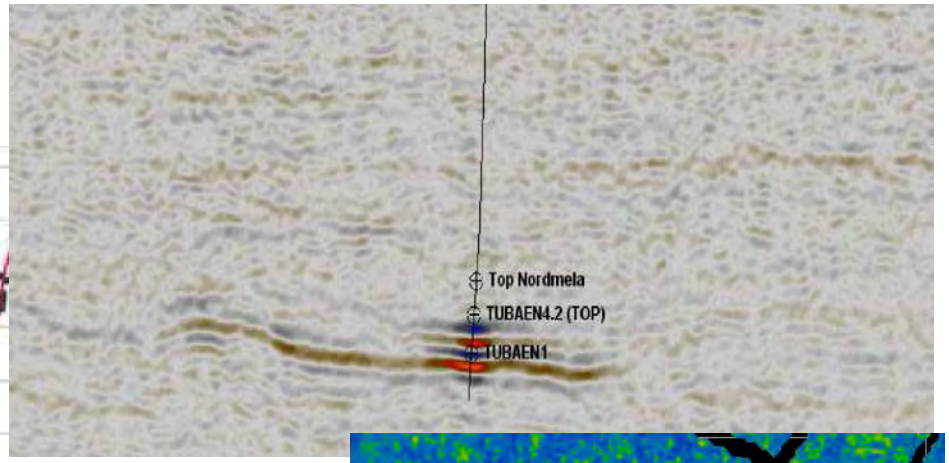
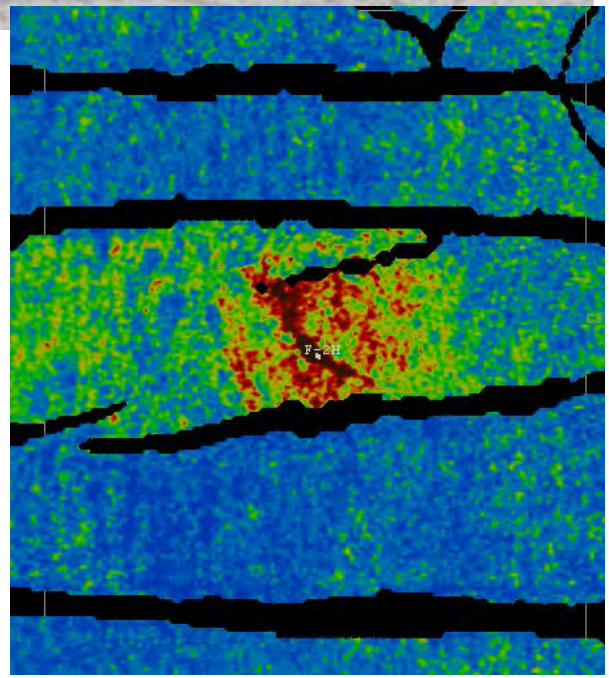
DiSECCS Datasets (2): Snøhvit







[Data courtesy of Statoil]

Multiple time-lapse surveys
- 3D seismics
- Downhole pressure

Pressure increase (~ 7 Mpa)
Complex aquifer
Injection plan modified

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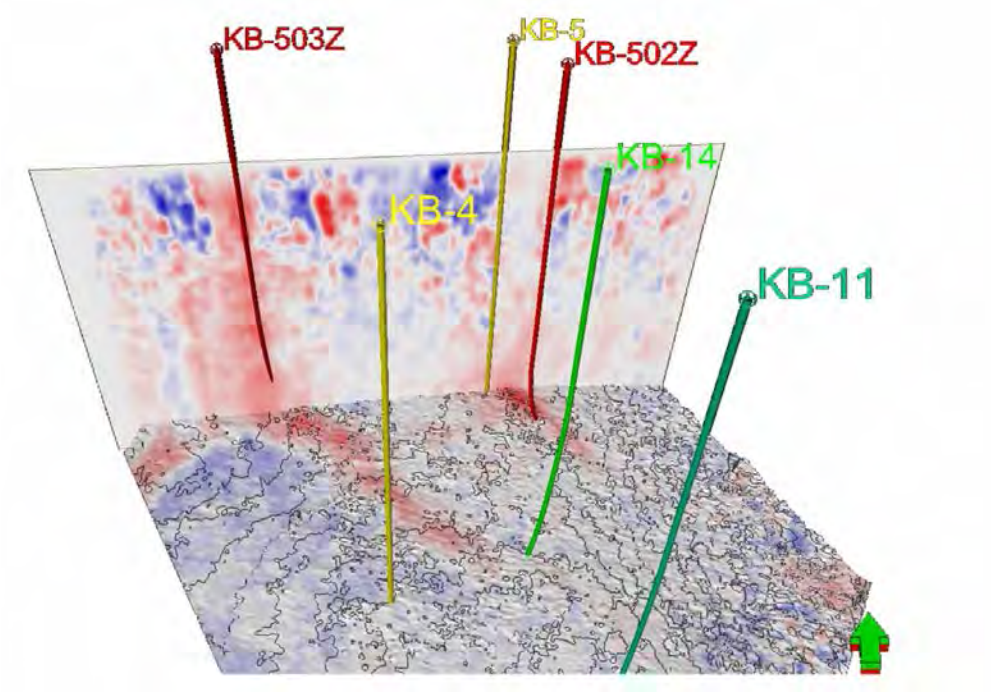
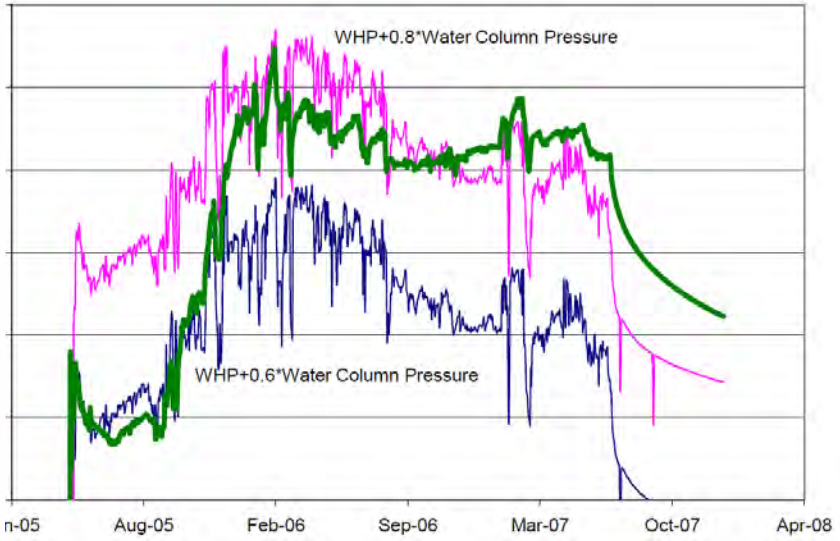
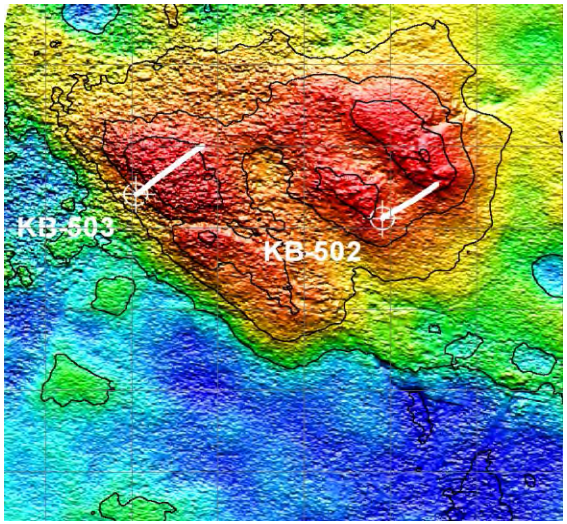
DiSECCS Datasets (3): In Salah







[Data courtesy of BP and Statoil]

Time-lapse onshore seismics (inc. multi-azimuth)
Pressure
Passive seismics
Surface displacements

Pressure increase (~8 MPa)
Complex aquifer
Surface displacements (mm) and induced fracturing

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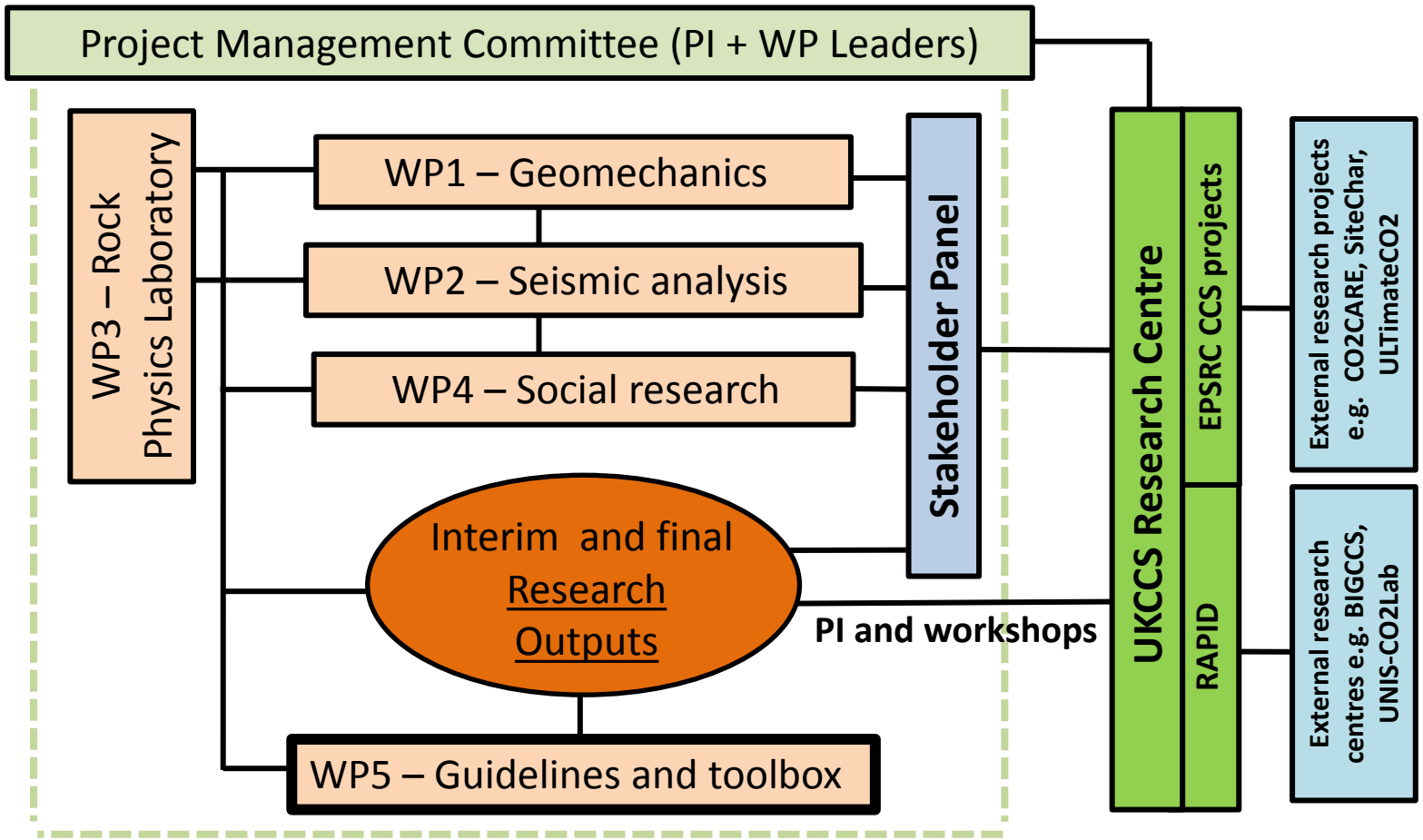
DiSECCS project structure



Thank you ☺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