Characterisation of European CO_2 storage

Licence application for a multi-store site, UK northern North Sea

Maxine Akhurst
British Geological Survey (NERC)

Outline of the presentation

- **Overview of the SiteChar UK offshore site**
- **Research to inform the dry-run licence application**
  - **Site characterisation**
  - **Risk assessment and reduction**
  - **Indicators of storage site performance**
- **Dry-run licence application submission to the competent authorities**
- **Summary**

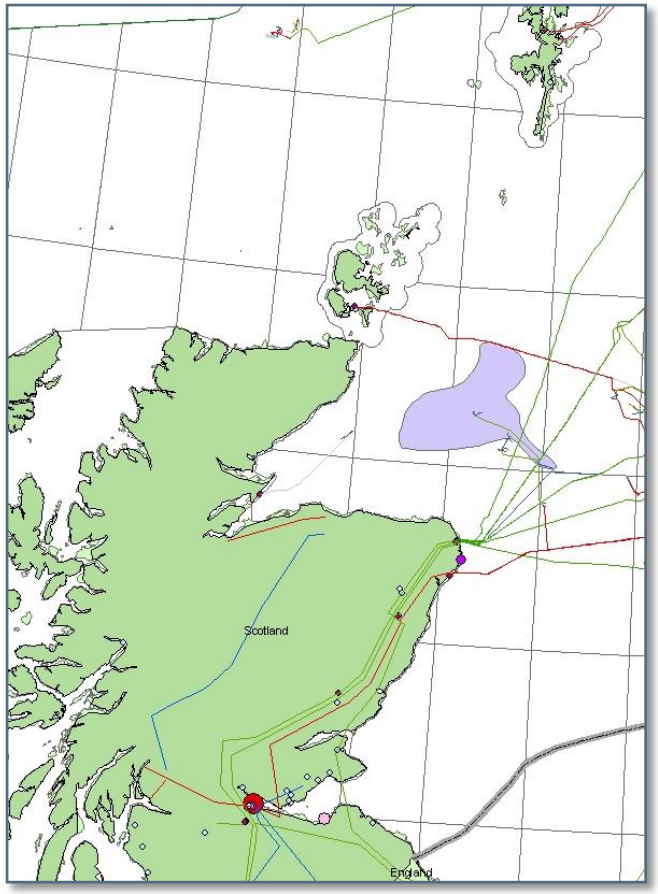
Overview of UK multi-store site

- **Objective of investigations of the UK offshore site**
  - **To provide sufficient information on a multi-store site in the UK North Sea for a 'dry-run' storage permit application to Scottish Government**

- **Why a multi-store site?**
  - **Hydrocarbon fields are planned as stores for demonstrator projects**
  - **Sandstones containing salt-water (saline aquifers) are anticipated for commercial-scale storage**
  - **The SiteChar multi-store site investigates the Captain Sandstone and a hydrocarbon field hosted within it in the Outer Moray Firth**

Overview of UK multi-store site

UK northern North Sea multi-store site

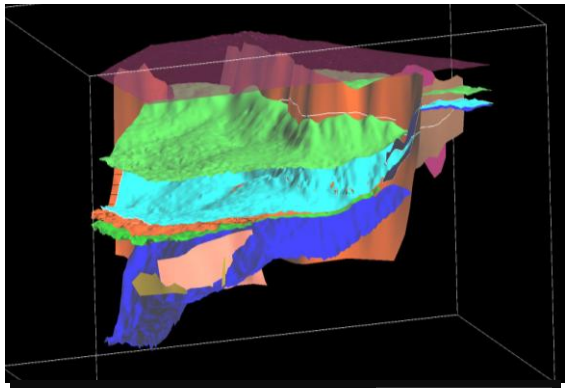


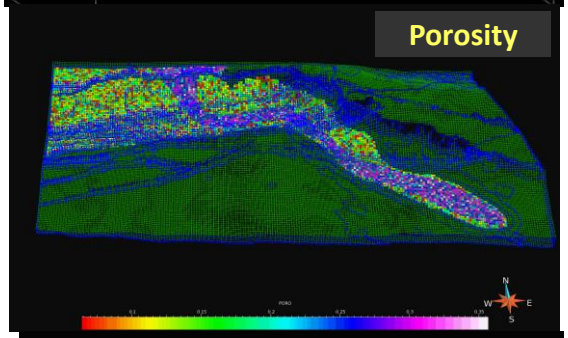
- **Selection of one of the hydrocarbon fields hosted within the Captain Sandstone in the Outer Moray Firth**
- **Based on geological and non-geological criteria**
  - **Depth of storage site rocks**
  - **Storage capacity of site**
  - **High-quality data**
  - **Availability of data**
  - **Close proximity of the Captain Sandstone to onshore CO_2 sources and offshore pipelines**

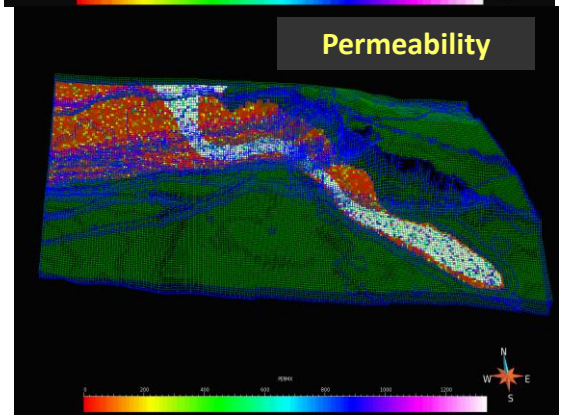
Overview of UK multi-store site

- **SiteChar is a research project**
- **The Outer Moray Firth storage project, though a feasible realistic target for future storage, is a concept:**
  - **Freedom to explore more challenging aspects of site characterisation and storage permit application than actual demonstration projects in the near-future**
  - **Reduces the risks associated with developing 'dry-run' storage permit applications and allows us to 'learn by doing'**
  - **Resources are constrained to the research budget and so this limits the depth of the characterisation and associated storage permit application**

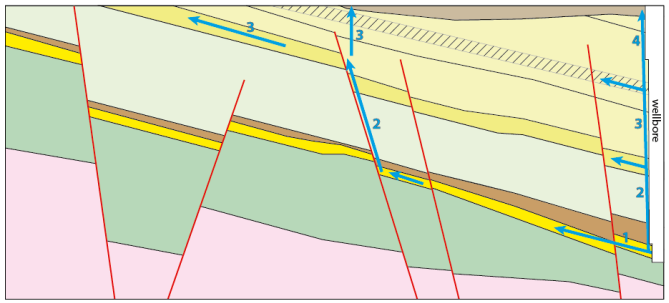
Research to inform the dry-run licence application – site characterisation (1)



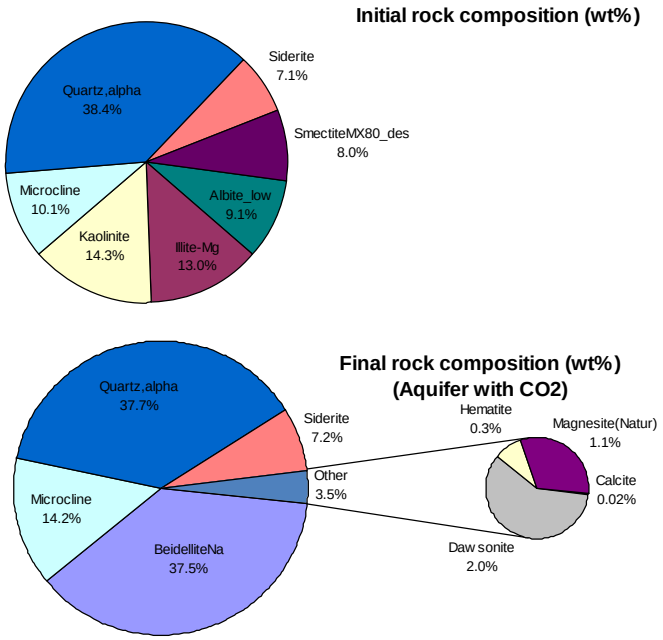




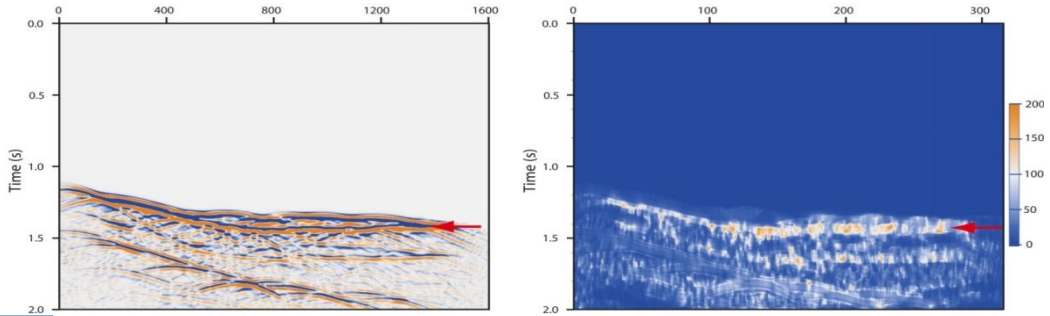
- **Construct a 3D computer model of the storage site**
- **Simulate injection of CO_2 into the storage site rocks using reservoir software**
- **Predict hypothetical pathways of leakage by substantially over-filling the storage site**
- **Model the effect of existing oil & gas wells on the flow pathway of injected CO_2**



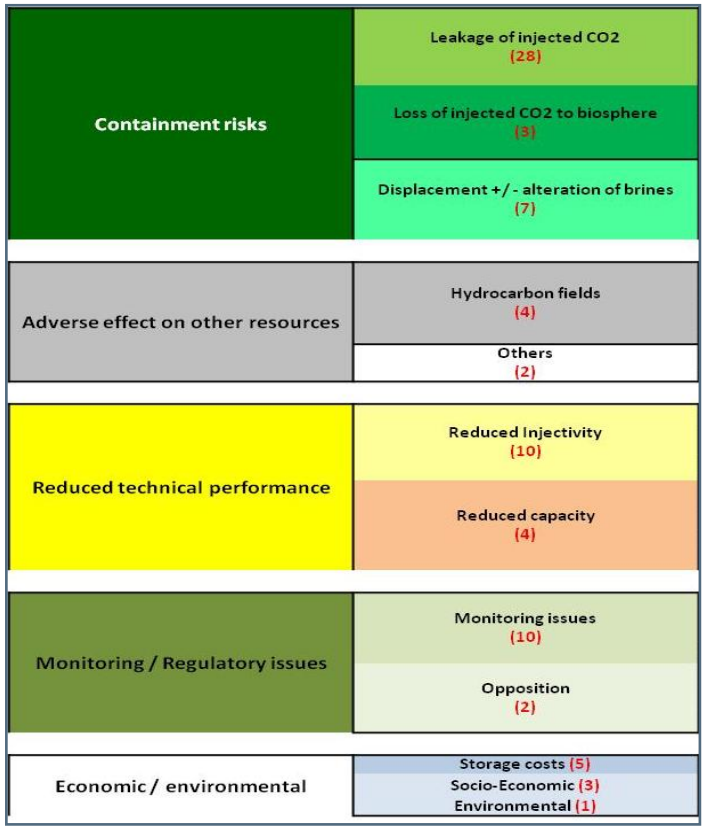
Research to inform the dry-run licence application – site characterisation (2)



- **Appraise the effects of chemical reactions between the host rocks and injected CO_2**
- **Assess the effect of increased pressure due to CO_2 injection on the mechanical stability of the rocks**
- **Review the site area for features in the shallow subsurface**
- **Calculate the effectiveness of monitoring the site using standard seismic survey techniques**



Research to inform the dry-run licence application – risk reduction (1)



- **Guided by an assessment of risks for the storage site**
  - **Risk assessment workshop of SiteChar researchers**
  - **List of individual risks (risk register) grouped into categories:**
    - **Containment risk**
    - **Adverse effects on other resources**
    - **Reduced technical performance of CO_2 store**
    - **Monitoring and regulation issues**
    - **Economic and environmental**
  - **Individual risks are assigned to SiteChar researchers**
  - **Investigation of risk reduction and mitigation activities**

Research to inform the dry-run licence application – risk reduction (2)

Containment risks	Migration / leakage of injected CO_2
	Loss of injected CO_2 to biosphere
	Displacement or alteration of brines
Adverse effect on other resources	Hydrocarbon fields
	Others
Reduced technical performance	Reduced Injectivity
	Reduced capacity
Monitoring / Regulatory	Monitoring issues
	Regulatory issues
Economic / Environmental	Socio-economic
	Storage costs
	Environmental

- ~ 80 risks have been defined
- This will reduce with mitigation measures
- Key findings to date:
  - Mainly uncertainties due to data gaps at this stage
  - However, as this is a theoretical project, many of the risks may have high remaining uncertainty at the end of SiteChar

Storage Permit Application content	Interim Mar 2012	Final Feb 2013
1. Name and address of proposed operator	✓	
2. Appraisal term	✓	
3. Project description		
i. Injection parameters and project concept	✓	
ii. Storage development plan incl.		✓
Injection & Operating plan		✓
Storage Performance Forecast		✓
4. Site description		
i. Boundaries	✓	
ii. Site geology, hydrogeology…	✓	
iii. Past development history	✓	
iv. Storage capacity estimate	Draft	✓
5. Measures to prevent significant irregularities		
i. Risk register	✓	✓
ii. Plan of risk mitigation	Draft	✓
iii. Dialogue with stakeholders	Draft	✓
6. Monitoring plan		✓
7. Corrective measures plan		
i. Key Performance Indicators	✓	
ii. Corrective measures plan (provisional)		✓
8. Post-closure plan		
i. Key Performance Indicators	✓	
ii. Post-closure plan (provisional)		✓
9. Environmental Impact Assessment		
i. Description of relevant features	✓	✓

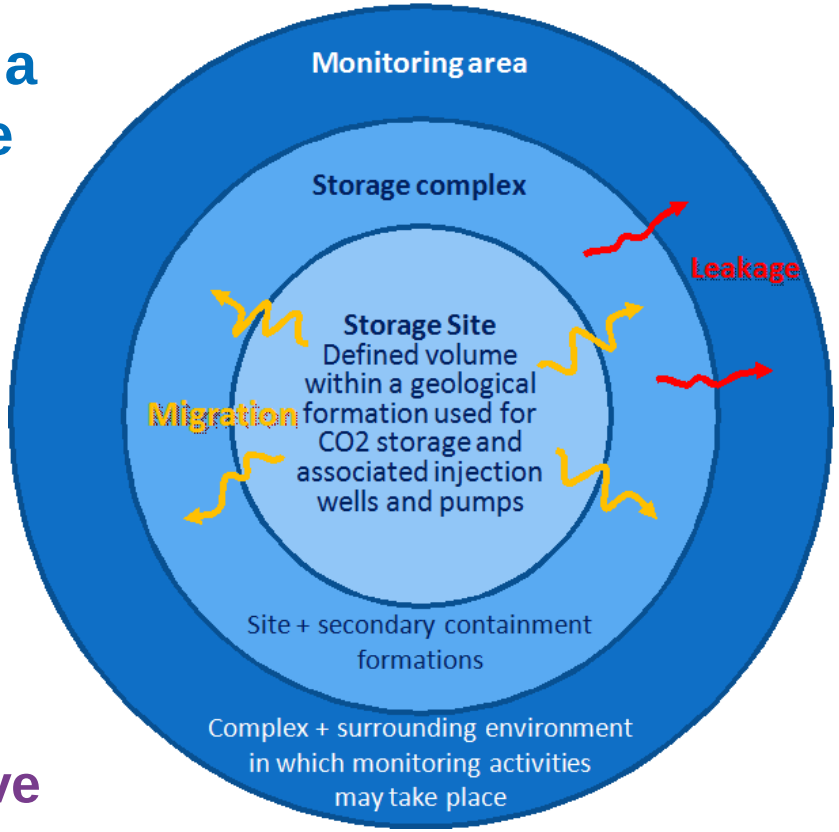
Site Character-isation

Risk Assessment

Performance Indicators

Research to inform the dry-run licence application – Store performance indicators

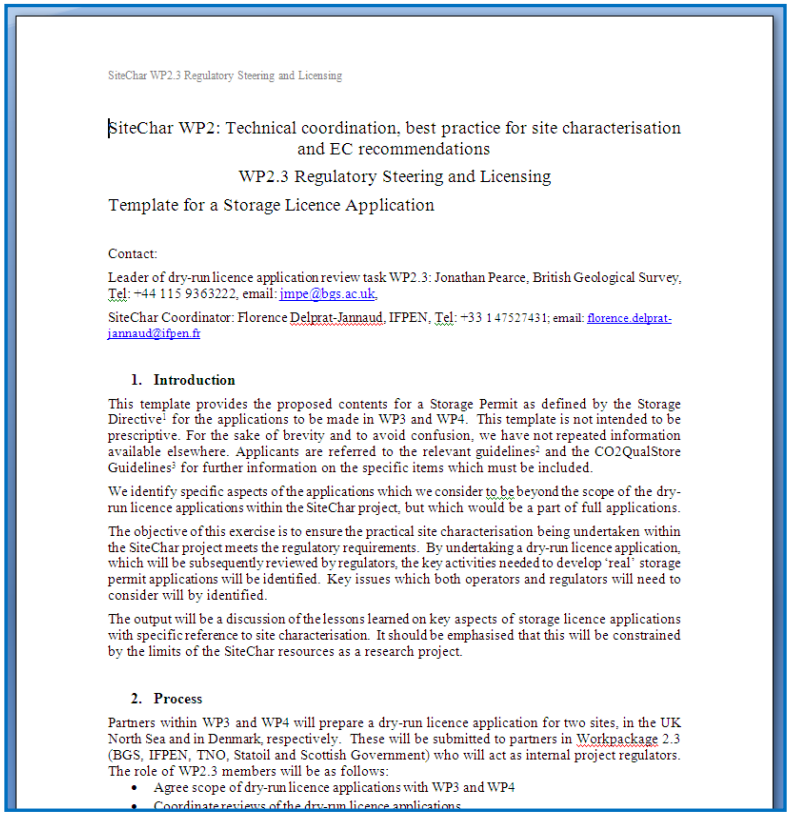
- **Define limits to site behaviour which, if exceeded, indicate that a significant irregularity or leakage has occurred.**
  - **Identified through Risk Assessment**
  - **Inform the Monitoring Plan**
  - **Trigger Corrective Measures if exceeded**
  - **Indicators will be in the Corrective Measures and Post-Closure parts of the licence application**



From 'Implementation of Directive 2009/31/EC on the Geological Storage of Carbon Dioxide' Guidance Document 2)

Dry-run licence application submission to the competent authorities

- **SiteChar storage permit licence application template**
- **Meets the requirements defined by the EC Directive on the Geological Storage of Carbon Dioxide**



SiteChar WP2.3 Regulatory Steering and Licensing

SiteChar WP2: Technical coordination, best practice for site characterisation and EC recommendations

WP2.3 Regulatory Steering and Licensing

Template for a Storage Licence Application

Contact:

Leader of dry-run licence application review task WP2.3: Jonathan Pearce, British Geological Survey, Tel: +44 115 9363222, email: jmpe@bgs.ac.uk,

SiteChar Coordinator: Florence Delprat-Jannaud, IFPEN, Tel: +33 1 47527431; email: florence.delprat-jannaud@ifpen.fr

1. Introduction

This template provides the proposed contents for a Storage Permit as defined by the Storage Directive[1] for the applications to be made in WP3 and WP4. This template is not intended to be prescriptive. For the sake of brevity and to avoid confusion, we have not repeated information available elsewhere. Applicants are referred to the relevant guidelines[2] and the CO2QualStore Guidelines[3] for further information on the specific items which must be included.

We identify specific aspects of the applications which we consider to be beyond the scope of the dry-run licence applications within the SiteChar project, but which would be a part of full applications.

The objective of this exercise is to ensure the practical site characterisation being undertaken within the SiteChar project meets the regulatory requirements. By undertaking a dry-run licence application, which will be subsequently reviewed by regulators, the key activities needed to develop 'real' storage permit applications will be identified. Key issues which both operators and regulators will need to consider will by identified.

The output will be a discussion of the lessons learned on key aspects of storage licence applications with specific reference to site characterisation. It should be emphasised that this will be constrained by the limits of the SiteChar resources as a research project.

2. Process

Partners within WP3 and WP4 will prepare a dry-run licence application for two sites, in the UK North Sea and in Denmark, respectively. These will be submitted to partners in Workpackage 2.3 (BGS, IFPEN, TNO, Statoil and Scottish Government) who will act as internal project regulators. The role of WP2.3 members will be as follows:

- Agree scope of dry-run licence applications with WP3 and WP4
- Coordinate reviews of the dry-run licence applications

- **The storage licence application template has been applied to the offshore UK site**
- **SiteChar researchers will contribute results from their site characterisation research to inform the licence application**
- **The Competent Authority (regulatory group) has been approached by the Scottish Government:**
  - **Introduced to SiteChar research January 2012**
  - **Presented the interim licence application April 2012**
  - **Agreed to review the final SiteChar 'dry-run' licence application**
- **Preparation of the final SiteChar licence application for the UK site is in progress**

WP8 Research to inform the dry-run licence application

Storage Permit Application content	Mar 2012	Feb 2013
5. Measures to prevent significant irregularities		
i. Risk register	✓	✓
ii. Plan of risk mitigation	Draft	✓
iii. Dialogue with stakeholders	Draft	✓

- **Advancing public awareness at the UK northern North Sea site in SiteChar**
  - **Activities for advancing public awareness for the UK site are taking place within SiteChar**
  - **Emerging findings will be incorporated into the dry-run storage permit licence application**

Research to inform the dry-run licence application- Summary

Characterisation of the UK North Sea multi-store site

- Defines and tests a licence application for the UK site that conforms with the requirements of the CCS Directive
- Informs the SiteChar workflow for characterisation of offshore sites
- Considers credible scenarios for storage of CO_2 by demonstrator and commercial-scale projects
- Investigates the relationship between depleted hydrocarbon fields and the host sandstones used for CO_2 storage