UNIVERSITY OF LIVERPOOL

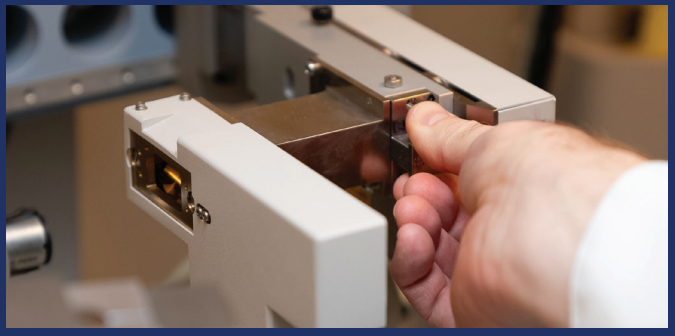
Department of Earth, Ocean and Ecological Sciences

GEOLOGICAL CARBON STORAGE

Research Theme

Geological carbon capture is a method of permanently mitigating greenhouse gas emissions. Carbon dioxide can be injected deep underground into porous and permeable rock formations, typically either sandstones or carbonate saline aquifers, or depleted gas reservoirs.

The success of the technique requires a variety of key factors to be addressed. The rocks used must have sufficient capacity that many megatonnes of carbon dioxide can be trapped along with being sufficiently permeable to allow safe and efficient carbon dioxide injection through as few wells as possible, without causing damage to the carbon dioxide storage site. Keeping costs to a minimum is a key challenge, and so reusing infrastructure is important wherever possible, as well as having long-term expansion capabilities to extend the storage lifetime. There must also be minimal chance of gas leakage through either natural faults or man-made routes such as poorly plugged and abandoned wells.



Research Team

At the University of Liverpool, we have worked with many of the key players in the carbon capture and storage world on numerous focused geological carbon storage and other subsurface projects, specifically In Salah in Algeria, Acorn and East Mey offshore NW Scotland, and on sites in the East Irish Sea and Southern North Sea Basins."

We offer wide collective experience of most of the key rock types relevant to geological carbon storage projects such as Permian, Triassic, Cretaceous and Palaeocene reservoir and top-seal lithologies in the UK and NW Europe, and a range of Palaeozoic and Mesozoic rocks in North Africa and the Arabian Peninsula. This experience has been gained over many years of applied research projects, typically working with companies, as well as via fieldwork and field teaching.

We can provide tailored training courses covering the full extent of geoscience issues linked to geological carbon storage, such as a broad-ranging but detailed overview of the whole geological carbon storage domain, and focused courses on the geochemistry and geomechanics of carbon storage. We can also offer short orientation courses to non-technical staff.

- **Dr Emma Michie** is Lecturer in Geology and her research focusses on faults, particularly related to the integrity of potential CO2 storage sites, and is developing a predicative algorithm for carbonate fault seals.
- **Professor Richard Worden** is a senior academic in Geology; his research focuses on geological reservoir and top-seal quality assessment and prediction, and petrophysical, geomechanical and geochemical processes that result from carbon capture. He has worked and published on applied geological carbon storage projects for more than 23 years.

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Facilities and Expertise

Our research and facilities can be applied to key challenges for any carbon geological storage project.

Rock characterisation

The University of Liverpool has extensive experience in seismic imaging, well log analysis, core description, conventional core analysis and use of modern analogues to better understand ancient and deeply buried equivalents.

Advanced reservoir, caprock and fault characterisation can be undertaken using specialist petrography, high-resolution micro-CT imaging, X-ray diffraction, electron microscopy, simultaneous thermal analysis, gas adsorption-pore characterisation and mercury intrusion porosimetry.

Geomechanics and structural analysis

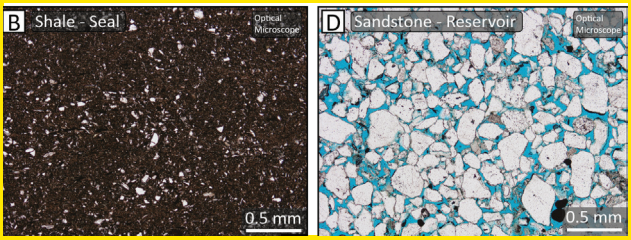
The University of Liverpool has a unique Rock Deformation Lab with bespoke rigs designed to assess static and dynamic rock attributes including strength, porosity, permeability, acoustic properties, reactivity of rocks to flowing carbon dioxide and flow properties at subsurface conditions.

Geochemistry

Both experimental approaches and software are used to assess the reactivity of the reservoir and caprock to carbon dioxide, predicting the potential for reaction, dissolution and weakening of rocks, wellbore cement and pipes and potential for precipitation of minerals that can block pores and damage permeability and carbon dioxide injectivity.

Monitoring

Application and interpretation of microseismic techniques to assess the response of reservoir top-seal systems to increasing fluid pressure during carbon dioxide injection. We are also moving into the new field of data interpretation from distributed downhole sensors.



Case Study:

Researching the feasibility of a carbon capture and storage facility in the North Sea

In partnership with:
The ACT Acorn Project

Challenge

Geological carbon storage reduces carbon emissions and will play a key role in working towards a net zero economy. Identifying suitable storage sites for capturing and storing carbon emissions long-term is challenging, requiring in-depth analysis of geological formations.

Solution

The ACT Acorn project combined geology experts from multiple universities, including the University of Liverpool, to assess the feasibility of establishing a CCS facility in the Moray Firth Basin in the North Sea. University of Liverpool researchers provided expertise in geology and rock deformation to research the sandstone reservoirs and mudstone caprocks at two potential storage sites (Lower Cretaceous and Palaeocene sandstones and caprocks), assessing their suitable for injection and long-term storage. The team analysed multiple core samples, testing their porosity, permeability, mineral content and strength under pressure using the specialist equipment in the Rock Deformation and Diagenesis Laboratories.

Impact

Using the specialist high-pressure deformation apparatus at the University of Liverpool, the team found that both potential storage sites would be suitable for injection and storage of carbon dioxide. The ACT Acorn project also confirmed that the UK's existing North Sea oil and gas transport infrastructure, allied to the high quality of both the Lower Cretaceous and Palaeocene storage sites, offered significant value. The project has now progressed forward for industrial application.

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