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Reservoir characterisation and modelling of CO_2 storage underground

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Department: Department of Earth Science and Engineering
Funding and Deadline: Deadline for applications is January 2, 2026. Funding through the Doctoral Training Centre in Green Industrial Futures, Departmental Scholarships or the President's scholarship depending on eligibility

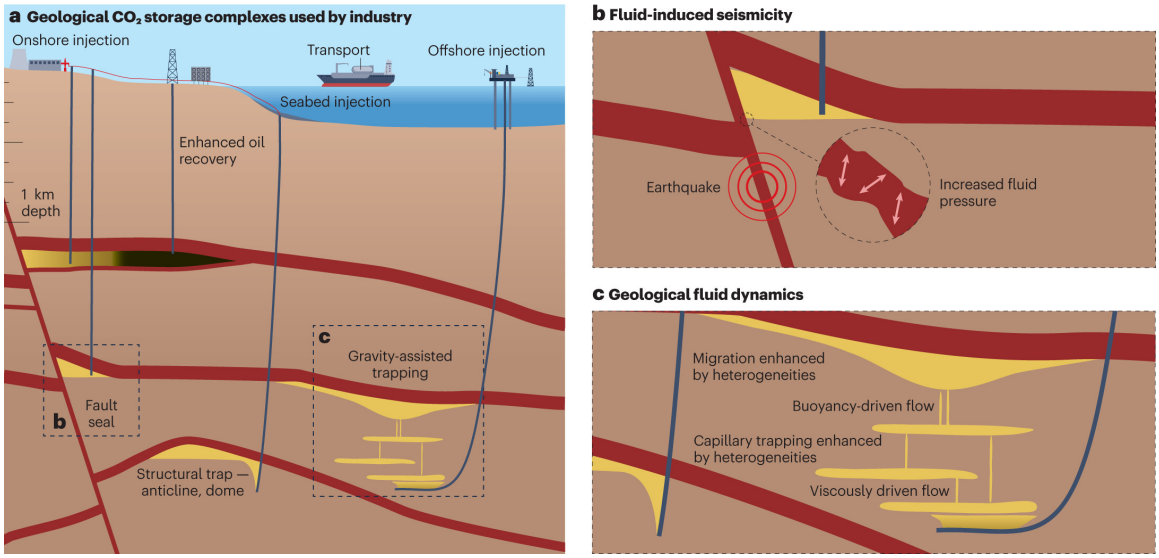

Figure 1. Geological settings and subsurface flow processes during CO_2 storage underground (Krevor et al., 2023)

The goal of this project is to overcome the outstanding issues preventing the accurate modelling of injected CO_2 migration and trapping at industrial scale storage projects. Currently modelling of CO_2 storage sites is challenging, with CO_2 observed to move in directions and at speeds that are not predicted through conventional simulation workflows. Advances made in the Subsurface CO_2 Storage Research group have identified that the source of these discrepancies are due to small scale heterogeneities in the reservoir systems (Jackson et al., 2020). In this project, the student will advance methods for characterising the reservoir and/or simulating CO_2 storage in a way that accounts for the impacts of realistic rock structures.

The objectives of this project to this end are to (1) Identify sites of particular interest to implement geologically realistic reservoir architecture, (2) apply upscaling approach to various geological structures and identify structure types of key interest for implementation of the core-to-field upscaling approach, (3) identify reduced descriptions of rocks, architectures, and reservoir units which identify the type and magnitude of impacts of small scale heterogeneities and (4) apply the core-to-field modelling approach for hydrogen storage applications.

Depending on the skill set and interest of the student, this project could focus either primarily on the reservoir characterisation aspects of the workflow – this comprises laboratory analyses of reservoir rock samples combined with the use of advanced

numerical interpretation schemes known as digital rock techniques (Figure 2) to capture the subtle heterogeneities in the rock fabric (Reynolds et al., 2018).

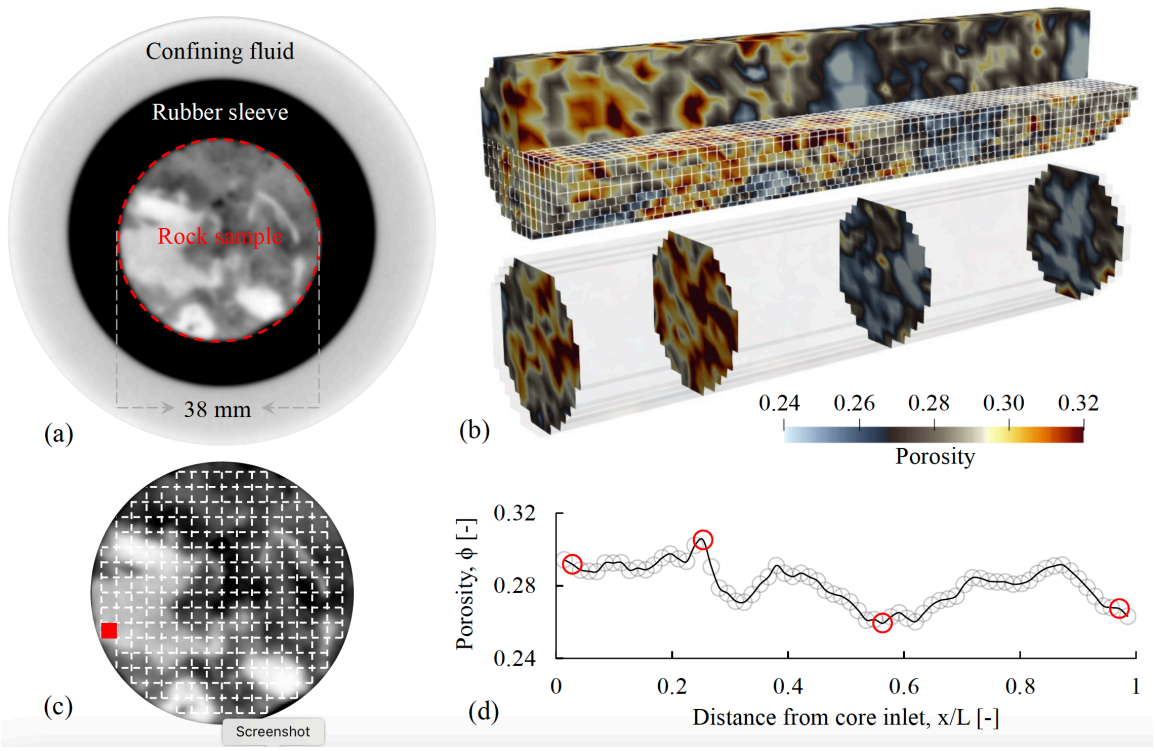

Figure 2. X-ray images of rock cores (a and c) are analysed using in-house software to extract properties, like porosity, describing the heterogeneity of the rock core (b and d). These are then used to build numerical simulations of CO_2 flowing underground. From An et al., 2023.

Alternatively, the student could focus on the development and application of the numerical modelling techniques used to simulation CO_2 flow in the subsurface (reservoir simulation with upscaling), Figure 3. There are also opportunities for students to combine both skill sets – laboratory and numerical modelling – as per their interests.

Research Environment: The researcher will be based within the Subsurface CO_2 Research Group https://www.imperial.ac.uk/subsurface-co2/ We are a diverse group of individuals with background in geology, geochemistry, reservoir engineering, environmental engineering, applied mathematics, and numerical modelling. Researchers from the group have gone on to highly successful careers in academia, industry (CO_2 storage and otherwise), consulting, law, finance, and government. The researcher will be supported to participate in international conferences and encouraged to participate in internships and secondments as per their professional interests.

References:

An, S., Wenck, N., Manoorkar, S., Berg, S., Taberner, C., Pini, R., & Krevor, S. (2023). Inverse modeling of core flood experiments for predictive models of sandstone and carbonate rocks. *Water Resources Research*, *59*(12), e2023WR035526

Reynolds, C. A., Blunt, M. J., & Krevor, S. (2018). Multiphase Flow Characteristics of Heterogeneous Rocks From CO 2 Storage Reservoirs in the United Kingdom. Water Resources Research, 54(2), 729-745.

Jackson, S. J., & Krevor, S. (2020). Small-Scale Capillary Heterogeneity Linked to Rapid Plume Migration During CO_2 Storage. Geophysical Research Letters, 47(18), e2020GL088616.

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