Imperial College London

Pore-to-core linkages and upscaling for CO_2 Storage

Funding: Departmental Scholarship, President's Scholarship, and the INFUSE Programme
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Description

Digital rock analysis has raised enormous research interest in recent years as a replacement for traditional laboratory techniques characterising flow properties - relative permeability, residual trapping – key to modeling the movement of fluids, e.g. for CO_2 sequestration and hydrocarbon production, deep in the subsurface. This kind of analysis typically simulates fluid flow through detailed 3D X-ray imagery of rocks obtained with state of the art X-ray microscopes (Figure 1, [1]). However, thus far flow properties estimated in this way have been an unsatisfactory alternative to traditional laboratory techniques, resulting in considerable uncertainties in modeling subsurface fluid flow. It is now understood that characterising heterogeneous features of the rock structure at multiple scales is key to bridging this divide between pore scale imagery and centimeter scale laboratory rock core experiments. In this project we will make use of recent significant developments in accurate characterization of the key properties of interest at multiple scales – fluid dynamics, mineralogy, and wetting state at the pore scale [1-3], capillary and permeability heterogeneity at the rock core scale (25 – 100cm) [3-7]. We will combine these techniques with Darcy scale numerical models, using the data to inform a next generation of digital rock models. This will be applied towards highly topical problems in subsurface fluid flow including the prediction of CO_2 plume migration during injection underground [8].

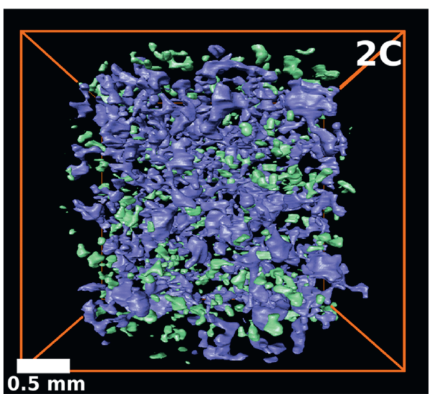

Figure 1. Pore scale imagery of fluid dynamics inside a rock [1]

Project aims

The aims of this work are to deepen our understanding of the mechanisms of multiphase flow in the pore spaces of rocks. This project aims to use the most advanced experimental and modeling tools available in characterizing flow phenomena, potentially opening the door to the development of fully predictive models of multiphase hydrogeologic processes.

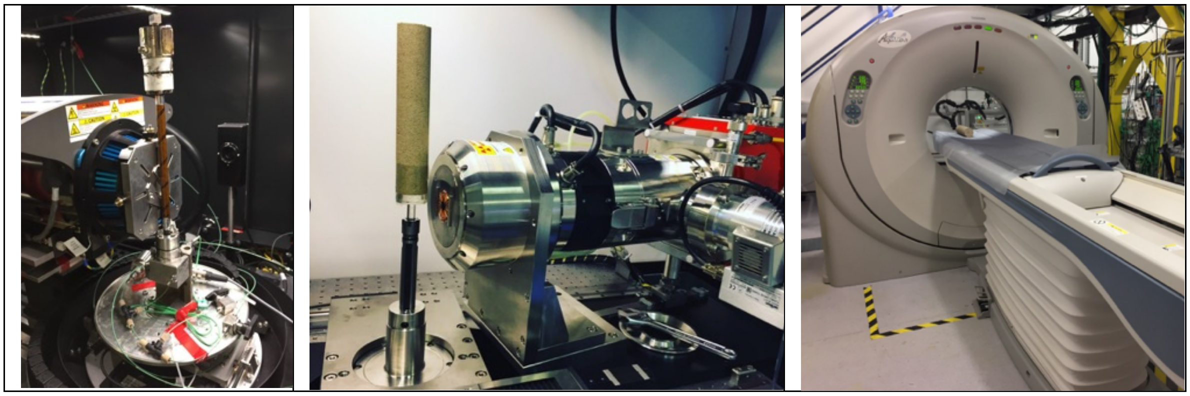

Figure 2. The multi scale X-ray imaging and experimental core flooding facility at Imperial College London with micro X-ray CT (left, centre) and medical X-ray CT (right)

Student profile and Imperial Research Environment

The project could combine both components of laboratory research, image processing, and the use of in-house numerical models to analyse and simulate flow properties, and reservoir simulation. The students may have primarily background in experimental or computational work, but should be willing to adopt an approach where various tools will be combined. The digital rock experimental and analytical facilities within the research group (Figure 2) are world leading, with in house capabilities for 3D X-ray imaging of fluid displacement at scales ranging from the micrometer size of individual pores up to meters where continuum models of multiphase flow are typically applied.

The researcher will be based within the Subsurface CO_2 Research Group

Please do not hesitate to contact me for further information and informal enquiries: s.krevor@imperial.ac.uk

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