OR/18/013 Summary

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Quinn, M, Hannis, S, Williams, J, Kirby, G, and McCormac, M. 2018. Multiscale Whole Systems Modelling and Analysis Project — A description of the selection, building and characterisation of a set of 3D generic CO2 storage models. *British Geological Survey Open Report*, OR/18/013.

This report details the selection and building of three 3D geological models by the British Geological Survey (BGS) as part of the NERC funded 'Multiscale Whole Systems Modelling and Analysis for CO_2 capture, transport and storage (CCTS)' project (Grant Reference: NE/H013946/1). The 3-year project (2010–2013) was led by Imperial College, London (Lead Grant reference: NE/H01392X/1) with Cranfield University (later Hull), Sussex University and the British Geological Survey (BGS) as partners. The overall aim of this project was to measure the performance of different components of the CCTS chain, at micro to macro scales depending on the process, to identify possible 'best' capture, transport and storage options in different CCTS scenarios; and where possible, explore efficiencies in the integration of these very different technologies.

The BGS effort focused on developing methods in the building of a set of CO_2 storage reservoir models and then exploring how best to represent their diverse characteristics ahead of flow modelling. In partnership with Imperial College, the research aim was to investigate and quantify the evolution of the CO_2 plume during the lifetime of an operation and post-closure of a subsurface store. Investigations focused on modelling CO_2 injectivity to evaluate the storage capacity and performance of a number of reservoir types typical of North Sea geology.

The stores chosen for this study were those considered most likely to be utilised in the near term. This report lists reservoirs located offshore on the United Kingdom Continental Shelf (UKCS), east of the UK mainland, that could potentially store CO_2. It identifies four geological reservoirs, the Palaeogene Forties and associated Cromarty sandstone members (Central North Sea), the Lower Cretaceous Captain Sandstone (Moray Firth), the Lower Triassic Bunter Sandstone Formation (Southern North Sea) and the Permian Leman Sandstone Formation (Southern North Sea). Regional and detailed models of the Captain Sandstone already exist (Quinn et al., 2010[1] and 2012[2]) and this reservoir is not considered further here. This report describes the methodology for building the other three 3D models, including discussion on their attribution. The 3D geological models are:

1. The Ravenspurn Gas Field located in the northern part of the Southern North Sea Basin. The reservoir comprises faulted fluvial and aeolian sandstones of the Leman Sandstone Formation, part of the Late Permian Rotliegend Group, sealed by lacustrine mudstone of the Silverpit Formation and a thick Upper Permian (Zechstein Group) evaporite succession. In this report, the model is referred to as the '**Rotliegend model**';
2. The predominantly saline aquifer of the Lower Triassic Bunter Sandstone Formation, also located in the Southern North Sea Basin. The reservoir comprises folded fluvial sandstone sealed by overlying mudstone and halite beds. In this report, the model is referred to as the '**Bunter model**';
3. A Palaeogene submarine fan reservoir, incorporating the Forties and Cromarty sandstone members of the Sele Formation, Moray Group in the UK Central North Sea. The model is built around the Forties and Nelson oil fields, where the shale prone succession of the Sele and Lista formations form the top and base seals respectively to the model. In this report, the model is referred to as the '**Cenozoic model**'.

The aim was to make each model generic and able to reflect the range of properties of the chosen reservoir expected in different parts of a sedimentary basin. By varying attributes such as porosity, permeability, thickness and depth, the reservoir could represent the different parts of a basin where storage might occur. This study introduces the concept of 'Area Types', areas which have a common set of reservoir attributes into which the 3D model can be placed.

The report describes the original purpose for the models in the wider Whole Systems project, their scope and limitations and references their use in CCS investigations so far. The report details how each model was constructed, the data used and guidance on their attribution.

This is the first time that detailed 3D models of potential CO_2 storage reservoirs have been constructed with the functional capability to represent the storage reservoir in different parts of the basin. They have direct relevance to the study of CO_2 plume migration in the sub-surface and have the potential to contribute to future research in this area.

This work has developed the methodology and confirmed the approach to building complex 3D models from publically available information to further understand and measure CO_2 injection and storage performance. These models or those built using similar methods and data sources to those described in this report may have applicability in other fields of research where detailed earth models are required as a framework for flow modelling investigations. The papers published utilizing these models in flow modelling scenarios demonstrate their use as tools in progressing the understanding of the processes controlling CO_2 storage.

The report provides a detailed overview of the variation in reservoir characteristics in the Cenozoic Forties Sandstone, the Permian Rotliegend Lower Leman Sandstone and the Triassic Bunter Sandstone.

References

1. ↑ QUINN, M F, CALLAGHAN, E, and HITCHEN, K. 2010. Scottish CCTS Development Study: The mapping and characterisation of the Captain saline aquifer, Moray Firth. *British Geological Survey Commissioned Report* CR/10/114.
2. ↑ QUINN, M F, AKHURST, M C, FRYKMAN, P, HANNIS, S, HOLVIKOSKI, J, KEARSEY, T, LECOMTE, J-C, and MCCORMAC, M. 2012. Geological report of the Integrated Blake Oil Field and Captain Sandstone aquifer, UK multi-store site, SiteChar. European Commission DG Research. Seventh Framework Programme, Theme 5 – Energy. Collaborative Project – GA No. 256705. Deliverable No D3.1.

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