NERC Centre for Doctoral Training in Oil & Gas (2018 start)

Project Title: Geological Uncertainty of CO_2-EOR in North Sea Tertiary Oil Fields: the Nelson Reservoir Case Study

Host institution: University of Manchester

Supervisor 1: Masoud Babaei

Supervisor 2: Mads Huuse, Jonathan Redfern

Additional Supervisor (s): Caroline Gill (Lead Geologist, Operated Assets at Shell UK)

Project description:
Unlocking additional oil resources from the North Sea, whilst locking in greenhouse gases, is of vital importance for the UK's energy security. The most readily available future oil production from the UKCS is that which can be unlocked from existing fields by EOR using miscible CO_2 injection. Considering the lack of a framework for pure CCS projects, the only currently viable mechanism for geological carbon disposal is through CO_2 EOR, providing a dual incentive to designing optimal workflows and models for CO_2 EOR of existing depleted oil fields.

Two reservoirs that have been considered for potential CO_2 storage through EOR in the UK Sector of the Central North Sea are the Forties and Nelson oilfields, which feature high-quality Palaeocene channel sandstone reservoirs. A detailed reservoir model has been constructed by which accounts for the lithological facies distribution of the Forties Sandstone Member dominated by channelized turbidites. Considering the initial-oil-in-place of 800 MMBO (125 $x10^6$ m^3) and a recovery factor of ~0.58 by 2016, the reservoir still contains significant quantities of oil left in-place. Modelling work indicates that the Nelson Field is not a "single tank" but more complex, producing from nine discrete drainage volumes. Of these nine cells, four have been identified to contain significant remaining "mobile" oil. As identified by previous researchers, the distribution of shale within the channel sands and defining the character and location of the channel margins are some of the main sources of uncertainty. These uncertainties can be addressed through subsurface characterization using an extensive set of well data tied with advanced seismic data including 4D.

The aim of the research is to quantify and constrain the geological uncertainties in the reservoir architecture and properties that will influence our understanding of the lithological facies distribution and compartmentalization. The PhD will assess the viability of secure sequestration of CO_2, and quantify the effect of geological uncertainty on the economic case to generate additional revenue from the hydrocarbons generated. The research will assess the sensitivity for infill drilling wells to evaluate the potential of incremental oil recovery due to CO_2 injection and possible related carbon sequestration benefits. CO_2 injection into the reservoir will be considered by miscible oil-gas displacement modelling. The dissolution of CO_2 in aqueous phase, surrounding aquifer influx, communication with the neighbouring hydrocarbon fields, and risk of leakage through the existing wells in the Nelson platform will be accounted for.

CDT Research theme(s):
Extending the life of mature basins
Research context:
The North Sea can become a commercially proven and guaranteed, secure site for storage of CO_2 received from across the European Union. The project investigates in detail the CO_2-EOR option for the Nelson Oilfield.
Research costs:
Costs include regular meetings with Shell collaborators and conference travel expenses. These are covered within the RTSG provided by the CDT.
Career routes:
The student will have an opportunity to work in an interdisciplinary group of supervisors, will acquire skills in 3D seismic and well data integration, facies analysis and modelling using the analogue filed outcrops, and geological model construction for channelized turbidites.