## NERC Centre for Doctoral Training in Oil & Gas (2017 start)

**Project Title: Spatio-temporal evolution of petrophysical properties of carbonate rocks during water flooding - multiscale modelling and experiments**
**Host institution: University of Manchester**

**Supervisor 1: Vahid J. Niasar**

**Supervisor 2: Cathy Hollis**

**Additional supervisors: Sebastian Geiger (Heriot-Watt University)**

**Project description:**
Oil recovery factor in carbonate reservoirs is often low, due to multiscale heterogeneity spanning from micrometer to kilometre scale, complex wettability and trapping of non-wetting phases. Highly reactive carbonate rocks aggravate this problem as geochemical reactions (in e.g. lowsal water flooding, $CO_2$-assisted oil recovery) will modify the pore morphology and petrophysical properties. The complex combinations of multiphase flow, reactive chemistry and multiscale heterogeneities make the "predictive modelling of carbonate rocks" a grand challenge. Traditional laboratory measurements of petrophysical parameters are inhibited by cost, sample size and uncertainty as to the wettability and reactivity of the rock. Exciting developments in pore-scale modelling and imaging provide the potential to build a better understanding of fluid flow in complex pore systems at multiple scales. By developing advance multi-scale modelling techniques coupled with multiscale experiments, we aim to achieve the objectives of this project. A spectrum of modelling techniques developed by the project supervision team integrated with the world-class expertise and laboratory facilities at University of Manchester enables us to conduct multi-scale analysis of carbonate rock, both statically and during flooding. The potential to visualize and simulate the evolution of porosity within a carbonate rock during flooding is an exciting opportunity as it will inform our understanding of a) the diagenetic spatio-temporal evolution of the pore system, b) evolution of the petrophysical properties such as relative permeabilities and capillary pressure, and c) real-time modification of the pore network during waterflooding and EOR.

**CDT Research theme(s)**: This project is related to the theme (b) extending the life of mature basin. Novel modelling and experimental techniques to increase the predictive capability of petrophysical properties of carbonate rocks will be developed.

**Research context:**
This project builds on active research on different aspects of carbonate reservoir led by the project supervision team. The main supervisor is supervising three PhD students and one PDRA who are currently developing different enabling capacities (micromodel lab, micromodels, and computational pore-scale models) directly linked to this project.

**Research costs**: Research costs for the project are relatively low. Major laboratory infrastructure exists at both institutions. However there are analytical costs associated with the use of MicroCT imaging facilities at University of Manchester, which are estimated at about £10k.

**Career routes**: The project will benefit from the close collaboration of the project supervisors at University of Manchester and Heriot-Watt University. Both UoM and HWU have extensive experience and world class reputation in carbonate reservoir characterisation and petrophysics. working on producing carbonate fields worldwide. The candidate will be able to exploit the full capability of different teams involved in this project. It is also envisaged that the PhD student to spend 1-2 internships at different leading institutes in UK and Germany at different stages of the project. That would provide the student an unrivalled opportunity to develop their knowledge for a future career in the oil industry or academia.