NERC Centre for Doctoral Training in Oil & Gas (2016 start)

Project Title: **Evaluating the geological case for carbon dioxide gas storage capacity in depleted fields and saline aquifers**

Host institution: Heriot-Watt University

Supervisor 1: Professor John Underhill

Supervisor 2: Dr Rachel Jamieson

Project description: Recognition of the deleterious impact that greenhouse gas emissions have for global climate has led scientists to seek ways and means to sequester CO2. As a consequence, there has been a significant research effort to identify geological storage sites in depleted oil and gas fields and saline aquifer fairways in which they sit. To date, the focus has largely been on quantifying the opportunity and many have assumed that the geology of depleted fields and saline aquifers is a given. However, since CO2 is a smaller and more nimble molecule than any long-chained hydrocarbon, the physical integrity of seals that retain oil and gas remains uncertain. Furthermore, dissolution of carbon dioxide to form carbonic acid may have deleterious effects on seal integrity, especially if the latter contains smectite, with which it reacts.

Whilst the injection and safe storage of CO2 is in its infancy, the natural occurrence of CO2 in some subsurface traps has long been recognised. Despite the discovery of CO2 in traps often being viewed as exploration 'failure', the full understanding of such sites effectively provides a 'proof-of-concept' that CO2 can be stored safely over geological time scales (Underhill et al., 2009: Yielding et al., 2011). Furthermore, if the circumstances that govern the presence of CO2 at a site are understood and replicated elsewhere, more confidence would then exist in the storage potential possessed by analogous traps. If the understandable and legitimate concerns of people living above onshore CO2 sites are to be allayed, it seems wise to document and fully understand the geological controls on entrapment at locations where CO2 occurs naturally before attempting to inject at new sites devoid of any proven CO2 content. The main aim of the PhD will be to investigate, describe and understand the geological factors that maintain seal integrity and CO2 entrapment at sites where the gas has already been found over geological timescales. The student will apply forensic geoscience through well-calibrated seismic interpretation and core-based sampling to evaluate which fields and aquifers might prove to be the best and safest repositories to use. It is anticipated that the results will help determine whether the life of the mature petroleum provinces like the North Sea can be extended in this way.

References: Underhill, J.R., Lykakis, N. & Shafique, S. 2009. Turning exploration risk into a carbon storage opportunity in the UK Southern North Sea. Petroleum Geoscience, 15, 291-304
Yielding, G., Lykakis, N. & Underhill, J.R. 2011. The role of stratigraphic juxtaposition for seal integrity in proven CO2 fault-bound traps of the Southern North Sea. Petroleum Geoscience, 17, 193-203

CDT Research theme(s): Extending the Life of Mature Basins

Research context: The project/studentship complements existing PhD students and their projects in the Centre for Exploration Geoscience at HWU.

Research costs: All the key budget costs for hardware, software, data purchase, field and lab costs are covered as part of the support from HWU. The seismic data is being provided by a licence with Common Data Access, the portal by which data is released into the public domain after 5 years.

Career routes: The project will be ideal for a candidate seeking future employment in the oil and gas sector as an exploration geologists or geophysicist be it with an oil company or in the service sector. The project also lends itself to a career in academia, the BGS or government departments such as DECC, BIS or the Scottish Government Oil & Gas Directorate.