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

Project Title: Structural and passive seismic data fusion for the detection of fluid migration pathways in the overburden

Host institution: University of Strathclyde

Supervisor 1: Dr Stella Pytharouli

Supervisor 2: Prof Rebecca Lunn

Additional Supervisor (s): Prof Zoe Shipton

Project description: Passive microseismic monitoring data resulting from hydrocarbon extraction or gas storage operations can be used to better understand the stimulation of small-scale geological structures present in the rocks above the reservoir or target horizons. Analysis and interpretation of passive seismic data is commonly based on seismological theory, however this does not take into account available data on the structural geology within the overburden. This project aims to develop a different approach: analysis will be based on data fusion of structural geological and microseismic data sets, to illuminate the spatial and temporal evolution of structures in the rocks above a reservoir, and hence to assess its potential for providing future containment. The project will deliver new analysis tools to aid in the assessment of depleted reservoir storage potential. Data fusion refers to the integration of two or more independent data sets in order to accurately describe a single process. It is a mathematical approach that has been applied to various areas in engineering (especially in mining), aerospace systems etc. but is not a commonly used approach for oil and gas despite it being a powerful tool. The PhD student will use readily available data owned and/or accessible by the University of Strathclyde on microseismicity, structural geology, well pressure and CO_2 flow collected at a CO_2 storage site (Aquistore, Canada). These data will be used to develop a methodology for the identification of potential leakage structures that could accommodate gas migration. The main objectives are 1) optimisation of the detection of potential induced microseismic events from long, continuous microseismic recordings. A new detection algorithm is now being developed within the framework of LASMO project, funded by Radioactive Waste Management Ltd. This project will further extend this algorithm with existing mathematical approaches to better suit the nature of the projects within the oil and gas sector. 2) accurate location of microseismic events based on clustering and cross-correlation techniques (this approach has been successfully applied within project NE/E004210/1, funded by NERC), 3) identification of potential leakage pathways based on data fusion. A background in geophysics or engineering will enable the student to develop the methodology and interpret the results.

CDT Research theme(s): Environmental Impact and Regulation. The reduction of the uncertainties involved in the interpretation of microseismic data can positively influence the public attitude towards the use of shale gas/unconventional hydrocarbons as well as increase regulatory confidence, e.g. for safety case development. The project will provide information to policy-makers for the assessment of future storage potential in depleted reservoirs; the results will help develop regulatory control measures, whilst at the same time minimising the cost of taking an unnecessarily precautionary approach.

Research context: The suggested PhD project fits well with existing studentships on the use of induced microseismicity in the development of a tool for the imaging of fractures and the characterisation of flow systems in crystalline rocks.

Research costs: £20,000 for the total duration of the PhD. High performance workstation: £8,000, consumables (incl. software licences): £4,000. Travel costs to training courses: £2,000. Int'l Conferences: £6,000. The Department of Civil and Environmental Engineering will guarantee the RTSG budget over 4 years. **Career routes**: Experience in the interpretation of structural geological information and the analysis of microseismic monitoring data, based on signal processing and data fusion techniques should provide a highly desirable background for jobs related to exploration, production and environmental control for oil and gas.