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

Project Title: New insight into the internal structure of turbidites from physical modelling of relevant erosion and deposition processes during their formation

Host institution: University of Dundee

Supervisor 1: Dr Alan Cuthbertson (Civil Engineering, School of Science and Engineering)

Supervisor 2: Dr Sue Dawson (Geography, School of Social Science)

Additional Supervisor (s): Dr Karl Stephen & Prof. Dorrik Stow (Institute of Petroleum Engineering, Heriot Watt University)

Project description: Deepwater sedimentary deposits from large-scale turbidity currents contain distinctive vertical grading patterns and internal structural features generated by erosion-deposition processes between granular and cohesive sediments. These turbidites have considerable economic and strategic importance as exploitable oil/gas reserves and potential reservoirs for CO_2 storage. Exploration within these deepwater fields requires new process-based reservoir models that rely less on stochastic techniques used currently to determine the internal structure and flow continuity in layered sedimentary deposits and, hence, enhance future predictive capabilities for hydrocarbon recovery/CO_2 storage in order to maximise economic benefits and minimise risks.

The proposed project will improve physical understanding of how turbidites are formed through a combination of experimental modelling and field data analysis. This will inform more realistic, and better calibrated, representations of erosion-deposition sequences from turbidity currents to support the key project deliverable: *development of advanced, process-based geological models to reduce prediction uncertainty in hydrocarbon recovery from turbidites*. This will also promote improved geohazard assessment for pipelines and other oil/gas installations, with continued warming of the Arctic increasing the potential for destabilization of sediment accumulations on continental slopes.

The experimental programme will focus on scaled laboratory studies to elucidate the fundamental behaviour of laterally-confined, channelised turbidity currents over erodible, multi-layered sediment beds to determine parametric controls on layer erosion, deposition and bed restructuring processes that lead to spatial heterogeneity (e.g. discontinuities) in evolving turbidite deposits. Field studies will focus on analysis of (i) nested & meandering channelled turbidite outcrops in Oligo-Miocene Numidian Flysch (Sicily), and (ii) fully-available datasets and/or existing geo-models for the North & East Brae or Nelson turbidite systems, to elucidate analogous structural and compositional features.

Parameterisations from the experiments, supplemented by field data analyses, will inform new process-based representations of layer discontinuities in turbidite deposits for enhanced reservoir models. As well as validating these improved geo-models, the range of experimental outcomes will inform uncertainties to be considered in real reservoirs, thereby improving forecasting confidence.

CDT Research theme(s): The project aligns closely with themes ***b. extending the life of mature basins*** by informing enhanced oil/gas recovery or CO_2 storage in maturing basins; and ***c. exploitation in challenging environments*** by reducing uncertainty associated with hydrocarbon recovery from deepwater turbidites and in assessing the risks from submarine geohazards that may pose threats to seabed installations. The project also overlaps with theme ***d. environmental impact and regulation*** through clear benefits in using depleted turbidite fields for long-term CO_2 storage.

Research context: The PhD candidate will have access to advanced, instrumented flume facilities in the recently-refurbished Environmental Fluid Mechanics Laboratory at Dundee, where several other relevant projects have been undertaken on gravity-driven flow behaviour. Geological modelling and simulation will be carried out in IPE, which is a centre of expertise in this area with several similar projects under way using industry-standard, state-of-the-art software with associated expertise.

Research costs: Key items for laboratory tests (e.g. small instrumentation, consumables) will be purchased (~£10k). Access to the HPC cluster and a multi-core workstation (~£6k) at IPE Heriot Watt will be required, while funds are requested to support travel and subsistence costs (~£1k). Access to outcrop data sets will also be provided through IPE. **Career routes**: Possible routes include: as a geologist/modeller in the oil/gas, CO2 storage, or environmental/geo-hazard risk assessment industries; or further research at university/institute level.

Submissions must conform to this single-sided A4 format. The Awards Committee reserves the right not to consider submissions that do not adhere to this condition.