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

Project Title: **Constraining the role of faults as seal-bypass systems.**

Host institution: University of Strathclyde
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Additional Supervisor (s): Liz Petrie (Western State University), Jim Evans (Utah State University), Davie Richie (Anadarko)

Project description: Cross-fault flow properties of fault zones have long been studied to constrain their ability to hold a hydrocarbon column. However, flow *within* fault zones can lead them to act as sub-vertical conduits. Faults can act as seal bypass systems, permitting linkage of compartments in conventional hydrocarbon systems. Faults can also provide conduits for gas flow out of unconventional reservoirs, reducing the economic gas in place; or provide pathways for water into unconventional wells, increasing water production and the consequent environmental impacts. There is, therefore, an urgent need to develop new workflows and tools for quantifying the risk of within-fault flow for a given subsurface fault.

The risk of flow within fault zones is affected by the internal structural architecture of the fault, the petrophysical properties of the fault rocks and the interplay of mechanical and chemical processes within the fault zone (fault zone diagenesis). The latter is the least-studied aspect of within-fault flow.

The Little Grand Wash and Iron Wash faults, Utah, provide surface analogues for faults in unconventional and conventional reservoirs respectively. The sites represent excellent natural labs for characterising the processes that constrain within-fault flow: the research team have collected unparalleled data at both sites from surface exposures and wells (both scientific and industry) and have extensive datasets of fault zone structure subsurface samples of fault rocks. Subsurface samples allow exploration of the appropriate ways to correct for the effect of weathering on surface analogues. The PhD student will collect new field data, at these and other faults within Utah, to investigate the effect of geochemical reactions on both the mechanical response of the fault rocks and the hydraulic properties of the fault rocks. They will constrain the fault zone diagenesis using petrological tests, SEM techniques and whole-rock chemical and isotopic analyses; use state of the art flow modelling developed at Strathclyde to investigate the range of likely within-fault flow scenarios; collect new mechanical data in Strathclyde geo-mechanics labs; and develop a predictive workflow/tool for within-fault flow. Finally, they will validate this tool against industry datasets both in the literature and provided by NERC CDT partners.

CDT Research theme(s):
Extending the life of Mature Basins and Effective production of unconventional hydrocarbons

Research context: The student will join a vibrant research group of about 10 PhD students and 5 post-docs studying all aspects of faulting and flow. They will have access to the £6M labs at Strathclyde as well as the £1M OGIC funded X-Ray CT scanner, which will enable mapping of fault diagenetic products and their effect on fault rock petrophysics.

Research costs: The project will require field work (£8k) and analytical costs (£7k). Two international conferences (£3k). Travel and subsistence to attend the CDT Training Academy (£2k). Total £20k.
Career routes: This student will gain skills for a future academic career, or a role as a research or operational geologists within industry.

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.