



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

**Project Title: Reducing uncertainty in the subsurface interpretation of fold-thrust structures – machine learning from outcrop**

**Host institution: University of Aberdeen**

**Supervisor 1: RWH Butler**

**Supervisor 2: CE Bond, J Howell**

**Project description:**

Complex structures are difficult to image seismically - making their subsurface interpretation uncertain, especially in fold-thrust systems. Consequently idealized models together with “type examples” from outcrop are commonly used when building subsurface interpretations. But this approach, commonplace through industry and academia, has led to significant interpretation bias, over-optimistic forecasts on structural risks and numerous drilling failures in thrust belts. This project will help to reduce these risks by capturing and quantifying structural geometry along well-exposed transects of outcropping fold-thrust systems to collect fully-representative suites of structures. Digital mapping will employ UAV and ground-based photogrammetry to obtain accurate structural geometries for analysis. The impact of interpretation bias in building structural knowledge will then be investigated using machine-learning approaches. In these, coherence between natural fold-thrust structures and idealized models will be automated, with machine-based “supervised learning” used to investigate the impact of bias arising from reliance on narrow samples of idealized or model-conforming structures. Biases in the selection of reference examples will be investigated by comparing those chosen from expert elicitation (and published type examples) with those machine-selected and examining convergence with the natural range of structural geometry. Mismatches between different models and reality will be quantified to identify which parts of the structural interpretation (back-limbs, forelimbs, fold crests, different levels in axial surfaces etc.) carry the greatest risks. The results will be compared with interpretations from a range of seismically-imaged subsurface examples. Fieldwork will use transects on coastal sections in Pembrokeshire and Devon, together with long cliff-sections in the French-Swiss SubAlpine chains.

Although this is a fully independent study, the student will join a growing group of researchers in Aberdeen, both in using digital technologies to quantify outcrop geometry, and in quantifying interpretation bias and developing strategies for its mitigation. The project explicitly addresses the role of artificial intelligence in structural interpretation – with the aim of increasing our ability to forecast complex subsurface structure before drilling.

**CDT Research theme(s):**

Fold-thrust systems host major oil and gas reserves and represent frontier exploration settings fold-thrust complexes and improve risk assessment for sub-surface exploration - **Exploration in Challenging Environments**. The project maps directly onto an ambition of the NPIF programme of using AI to enhance understanding – in this case to mitigate interpretation bias.

**Research and training context:** The student will be trained in structural geology, especially in complex structures in fold-thrust belts, together with digital outcrop capture, uncertainty analysis and computational methods. They will gain excellent training in 3D structural interpretation, model building, hypothesis testing and visualization during the completion of the PhD. Although fully independent, they will sit alongside researchers involved in the SAFARI and F-TRG teams in Aberdeen – working on digital outcrop and AI –enhanced interpretation and on thrust systems respectively. The project ties into Bond’s RSE-funded research on interpretation uncertainty.

**Research costs:** will be met by the RSTG – with UoA funding extra costs.

**Career routes:** The student will emerge well-placed to follow a career in subsurface interpretation – in the Oil and Gas and other commercial sectors, or within the research base. The project will include the use of industry data and software.