CASP Research Award for Geological Fieldwork- 2017 Award Winner

Applicant: Mr. James King, University of Oxford.
Project title: The Propagation, Growth, and Termination of Polygonal Fault Systems - Analogue fault outcrop examples from the Taranaki Basin & Kaikoura Peninsula, New Zealand
Award: £3,000.

Scientific question and rationale: Polygonal faults are normal layer bound faults that form exclusively in fine-grained sediments, and are of great importance to petroleum geoscience and CCS as their influence on sub-surface fluid flow and cap-rock integrity is poorly understood. How do polygonal faults propagate, grow, and terminate? I aim to use several 3D seismic datasets to constrain this alongside detailed fieldwork of normal fault outcrops in the fine-grained sediments of the Taranaki Basin & Kaikoura Peninsula, New Zealand which host the best known polygonal fault field analogues.

Specific Objectives and Deliverables:
The purpose of the project is to progress the understanding of polygonal fault systems and to constrain nucleation, propagation, and termination mechanisms. Despite over two decades of research polygonal fault systems are still relatively poorly understood. The project aims to characterise polygonal fault systems from several different locations with varying physical properties to constrain the mechanisms outlined above. The implications and applications of polygonal fault research are of great importance to petroleum geoscience, carbon capture storage and nuclear waste storage site planning, and also to the understanding of blind and syn-sedimentary fault propagation in fine-grained sediments. Polygonal fault systems are found in fine-grained sediments all over the world and are the most abundant fault type on Earth (they have even been found on Mars!), yet are the least understood. Initially the project will utilise 3D seismic data focusing on the polygonal fault systems in the Turonian to Middle Miocene carbonates of the Exmouth Plateau, Northwest Australian shelf. Following on from the Exmouth Plateau, the project will broaden its focus and will compare and contrast several polygonal fault systems in 3D seismic data from the Norwegian Sea, Faroe-Shetland, and New Zealand. The project also aims to contextualise observations from 3D seismic data with detailed field outcrop study in the Taranaki Basin and Kaikoura Peninsula New Zealand.

Proposed Work Plan:
Fieldwork is essential to complement polygonal fault observations from 3D seismic data. Analogous faults in fine-grained siltstones and mudrocks of the Taranaki basin (NZ), and fine-grained limestones and mudstones of the tectonically active Kaikoura Peninsula (NZ), will be used to glean insights into features below the resolution of 3D seismic. I will use high resolution photography and 'structure-from-motion' to create detailed 3D models of the outcrops which can be used to accurately measure fault displacements and enable me to 'revisit' the field area from my desk back in the UK. The variation of displacement as a function of fault height will give insights into the fault growth history. Coupling this with analysis of structure unresolvable in seismic data will contextualise polygonal fault observations and aid the understanding of mechanisms that remain ambiguous in seismic data. I aim to collect detailed observations and measurements of the fault architecture and gouge, and look for evidence of fluid flow along faults (mineralisation in the fault zone). I will also collect samples and parameterise deformational textures in the fault zone and host rock, as well as undertaking detailed SEM work to understand microstructural variations across and along the fault zone. My project aims to encompass fault characteristics at all scales.

Work Plan:
- Spend 8 days at Taranaki Faults, followed by 6 days at the Kaikoura Peninsula Faults
- First 2-3 days spent geologically mapping area with particular attention to mapping fault orientations, dips, and crosscutting relationships
- Following 4-5 days spent taking detailed measurements of fault displacements, dips, characterising fault architecture and gouge, and physical properties.
- Throughout fieldwork take photos for 'structure-in-motion' and collect samples for further analysis.
- Repeat for second field area

Proposed Expenditure including details of any other sources of funding:
Return Flight: £650
Per Diem (Accommodation, Food): £120 * 14 = £1680
Car Rental: £45 * 15 = £675
Car Fuel: £100
Ferry Transfer Between North & South Island: £110
Thin Sections: £10 * 10 = £100
TOTAL: £3315

(Shortfall of £315 will be covered by my PhD RTSG)