NERC DOCTORAL TRAINING

UK Oil and Gas Collaborative Doctoral Training Centre (2017 start)

Project Title: **Controls on Mesozoic-Recent sediment routing in the Falkland Basins: implications for reservoir distribution in a frontier exploration setting**
Host institution: Institute of Petroleum Engineering, Heriot-Watt University
Supervisor 1: Uisdean Nicholson (HWU)
Supervisor 2: Dorrik Stow (HWU)
Additional supervisors: David Macdonald (Aberdeen); Dave McCarthy (BGS); John Underhill (HWU)

Project description:

The Late Jurassic to Early Cretaceous rifting and subsequent separation of South America from Africa was accommodated along the southern margin of both continents by the ~1200 km long Agulhas-Falklands Transform-Fracture Zone (Figures 1 and 2). The Falklands Plateau and its various sub-basins were dominated by the tectonic evolution of the transform margin for most of the Mesozoic, until the onset of continental collision along the southern margin of the plateau at the start of the Cenozoic (Bry et al., 2004).

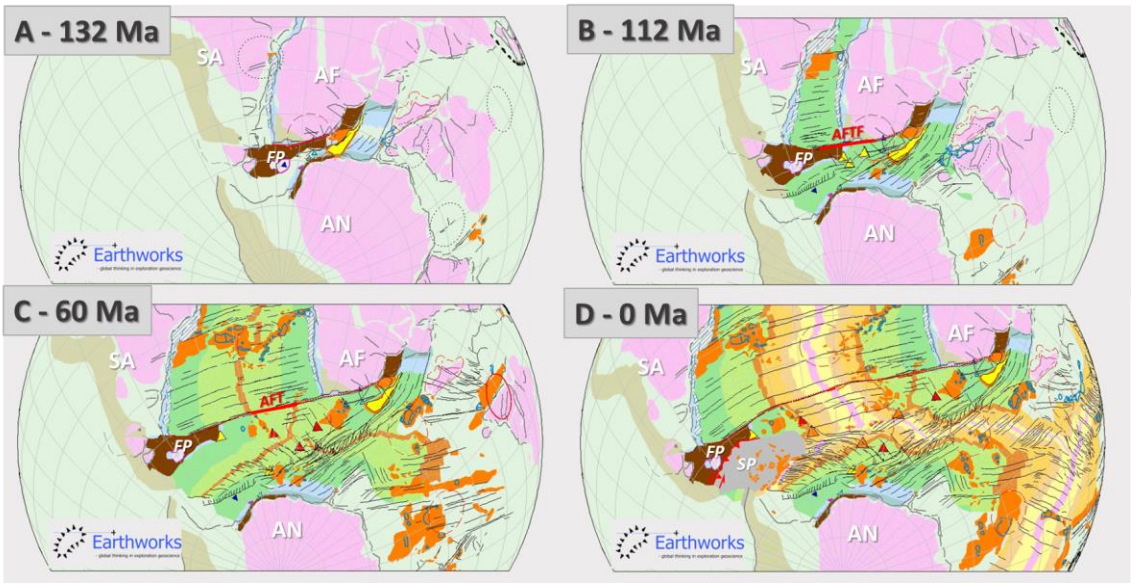

Figure 1. *Tectonic evolution of the Falklands Plateau (FP), modified from Reeves, 2016.* ***(A):*** *During the Jurassic to Early Cretaceous, the Falklands Plateau was located in Gondwana, between the South American (SA), African (AF) and Antarctic (AN) plates.* ***(B):*** *Following continental break-up, extension in the South Atlantic was accommodated along the Agulhas-Falklands Transform Fault (ATFT). This transform phase continued until the passage of the South Atlantic Mid Ocean Ridge late in the Cretaceous* ***(C),*** *forming the Falklands Fracture Zone.* ***(D)*** *During the Cenozoic, the Falklands Plateau has been dominated by the effect of oblique continental collision along its southern margin.*

These evolving tectonic boundary conditions led to significant changes in the structural evolution of the sedimentary basins surrounding the Falkland Islands, including the rate of subsidence and the orientation and style of faulting and magmatic intrusions, which vary significantly across the region (Richardson and Underhill, 2002; Stone et al., 2008). This in turn had a first-order control on the generation (by erosion during thermally induced and tectonically driven uplift) and distribution of sediments, including the sands which now form the main reservoirs for hydrocarbons in the region. This project aims to understand the distribution and nature of reservoir sands, particularly in the Cretaceous-Early Tertiary deep-water sequences; the presence and quality of such sands is a key risk for hydrocarbon

exploration in these basins. This will be done by taking a 'source-to-sink' approach: by palinspastically reconstructing the various source regions; systematically evaluating existing petrographic and heavy mineral data and supplementing with new datasets where necessary; constraining the timing of rock uplift and deformation using geochronology and thermochronology; and seismic mapping of shelf-deepwater sedimentary systems using an extensive 2D and 3D seismic dataset covering the North Falklands Basin and Falklands Plateau Basin (Figures 2 and 3), together with a suite of exploration and development wells which will be provided by the BGS. The combined datasets will lead to the construction of a suite of detailed palaeogeographic maps, which can be used to aide hydrocarbon exploration in this challenging offshore environment, as well as providing an important scientific contribution to models of landscape and basin evolution along this transform margin.

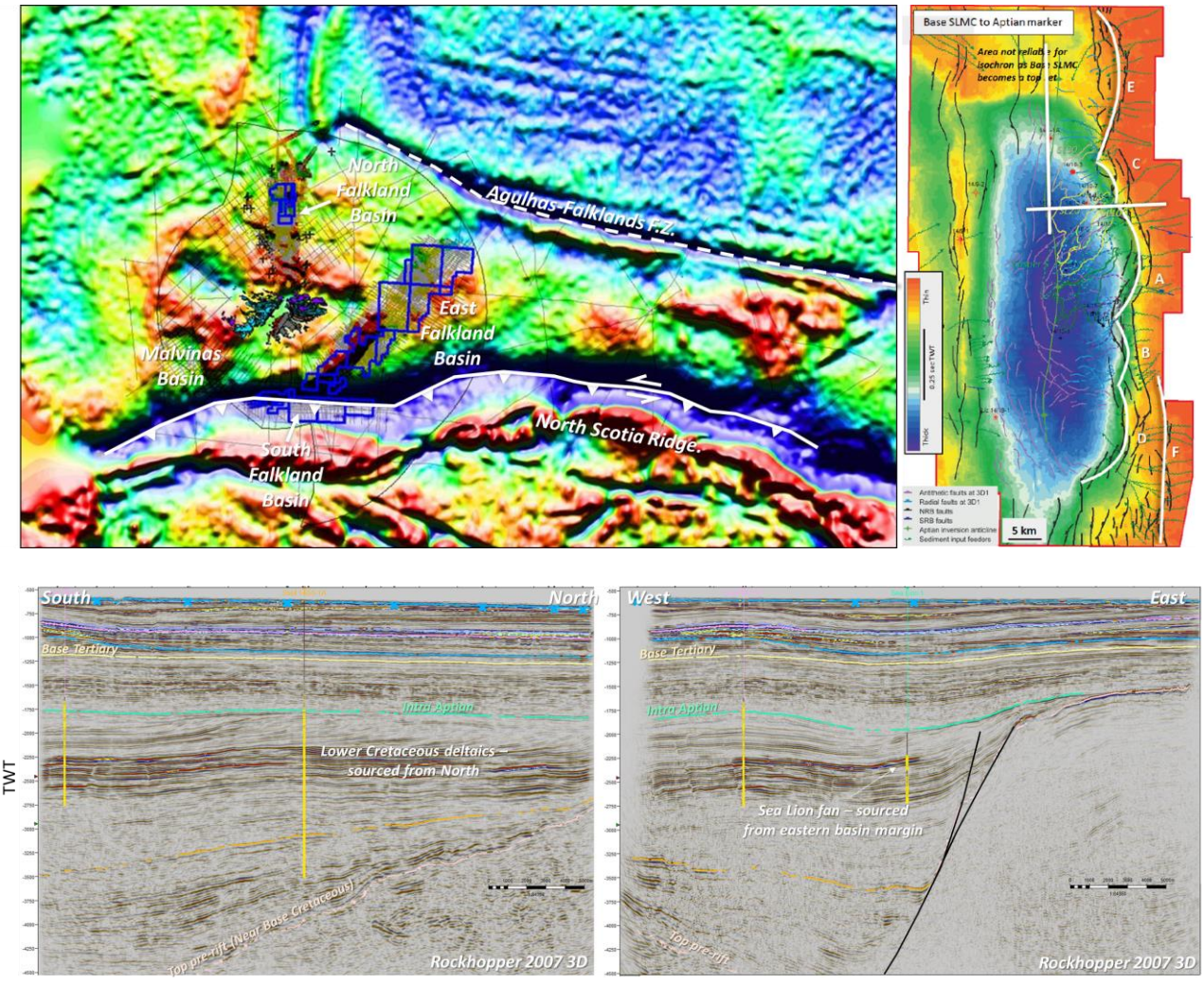

Figure 3. ***Top Left****: Seismic database provided by BGS superimposed on Free Air Gravity map showing the main structural elements of the greater Falklands Plateau and its sub-basins. Current hydrocarbon exploration and development licenses are outlined in blue.* ***Top right*** *shows a Lower Cretaceous isopach map in the North Falklands Basin and location of seismic sections (Lohr and Underhill, 2015).* ***Bottom****: TWT seismic sections across the northern North Falklands Basin, showing a range of sediment routing systems supplying sands to the Early Cretaceous lacustrine basin, with turbidites fed by a large southerly-prograding delta system interfingering with point-sourced fan systems derived from the basin margin, including the Sea Lion fan complex.*

The project may also include seismic interpretation and fieldwork in the Cretaceous basins of the conjugate margin in South Africa. The student will also be encouraged to apply to sail in an IODP drilling expedition in the region, if existing pre-proposals are approved.

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The project will be well suited to a geologist or geologically-minded geophysics graduate at either MSc or BSc level with interests in seismic interpretation, geophysics, petrophysics, gravity and magnetic data, sedimentology and structural geology.

Bry, M., White, N., Singh, S., England, R., and Trowell, C., 2004, Anatomy and formation of oblique continental collision: South Falkland basin: Tectonics, v. 23, no. 4.

Lohr, T., and Underhill, J. R., 2015, Role of rift transection and punctuated subsidence in the development of the North Falkland Basin: Petroleum Geoscience, v. 21, no. 2-3, p. 85-110.

Richardson, N. J., and Underhill, J. R., 2002, Controls on the structural architecture and sedimentary character of syn-rift sequences, North Falkland Basin, South Atlantic: Marine and Petroleum Geology, v. 19, no. 4, p. 417-443.

Stone, P., Richards, P., Kimbell, G., Esser, R., and Reeves, D., 2008, Cretaceous dykes discovered in the Falkland Islands: implications for regional tectonics in the South Atlantic: Journal of the Geological Society, v. 165, no. 1, p. 1-4.

Research Theme: Exploration in Challenging Environments

Research context: The project is independent from but builds upon previous and on-going work in oil and gas exploration in the Institute of Petroleum Engineering, where the student will be able to deploy state-of-the-art seismic software. The student will maintain close links to the British Geological Survey, who manage the seismic data and are co-located with Heriot-Watt University and will also benefit from the extensive experience of SW Gondwana geology at Aberdeen through the link with David Macdonald.

Research costs: All the key budget costs for hardware, software, data storage, field and lab costs are covered by the NERC RTSG or as part of the support from HWU.

Career routes: The project will provide an excellent basis for a future career as an explorationist or research specialist within an Oil and Gas company or to follow a career in sedimentary geology or basin evolution within academia.