



NERC Centre for Doctoral Training in Oil & Gas (2017 start)

Project Title: Full Waveform Inversion of the Atlantic Seafloor from 0-80 My
Host institution: University of Southampton
Supervisor 1: Assoc. Professor Catherine Rychert
Supervisor 2: Dr. Nicholas Harmon

Project description: Simple thermal models can explain the formation of the oceanic lithosphere to first order, yet there are substantial differences that may require compositional effects or more complicated patterns of mantle flow to explain the ocean basins. In this PhD the student will use a newly acquired geophysical data set to probe the oceanic lithosphere and asthenosphere to examine the structure of the tectonic plate near the Mid Atlantic ridge to 80 Ma seafloor of the coast of West Africa, which is a major global oil and gas producing regions.

This project will combine the strengths of two seismic techniques (surface waves and receiver functions) to image crust and mantle discontinuities and also seismic wave speeds, including seismic anisotropy, beneath the Atlantic Ocean. These constraints will be used to interpret earth properties, thermal structure, locating melt and/or compositional changes. Seismic interferometry will be used to constrain shallow crustal velocities, and examine crustal production and sedimentation over an 80 My timespan. Developing an understanding of the evolution of oceanic lithosphere and thermal structure on the seafloor provides key constraints required to predict hydrocarbon maturation and formation. The research will provide a generic platform from which to characterise the rheological properties of the oceanic lithosphere.

The PhD will bring together methodologies implemented in imaging oil reservoirs with those used to image crust and mantle discontinuity structure in academia producing a significant step in imaging resolution and accuracy. The PhD will develop full waveform inversions assuming the elastic 3-dimensional wave field using the SPECFEM code. These inversion techniques are the state of the art in imaging in both industry and academia. The development of waveform inversion using the full vector wavefield was highlighted as a future challenge at the recent joint SEG-AGU workshop on full waveform techniques (Vancouver, July 2014). In particular the PhD will advance our ability beyond the scalar wavefield technique typically applied in the exploration industry and also the typical 1-D waveform modelling (with vector wavefield) applied in academia. U. Southampton is the ideal place for this PhD since the supercomputing facilities are some of the best in the world and our group has several postdocs and PhDs already running SPECFEM models in 2 and 3D.

The development of a fully elastic full waveform inversion technique will place the student on the cutting edge of the seismic exploration community. The student will develop skills and learn techniques from both active and passive source seismology, as a member of one of the largest and most active geophysics groups in the UK. In addition the student will learn seismic waveform-modelling techniques useful for a wide range of systems as well as gaining experience in seismic imaging in deep water. This training will prepare the student for a career path in academia and industry.

CDT Research theme(s): Exploitation in challenging environments: The development of joint inversion techniques with full elastic waveform inversion allows the full information of the multi component seismic wave field to be exploited in deep water.

Research context: This work will build upon ongoing work by the Southampton group in surface wave imaging, receiver function analysis, oceanic lithosphere evolution and inversion. The group is responsible for the first high resolution shear velocity model for the East Pacific Rise to 10 Ma and for mapping lithospheric structure across the Pacific ocean using SS precursors.

Research costs: The student will be actively engaged in fieldwork in the region including upcoming ocean bottom seismic deployments. RTSG funds and active NERC grants will be sufficient to cover the costs of the student.

PhD Proposal: UK Oil and Gas Collaborative Doctoral Training Centre (2014 start)

Career routes: Possible career routes for graduates include exploration and production monitoring particularly using full waveform inversion techniques. The student will receive a strong background in applied research and will therefore be qualified for specialist research in the oil and gas sector. In addition, the PhD will provide a solid background in pure research and opens the possibility of pure academic research.