



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

Project Title: Calibrating Geothermometers: integrating field, laboratory and well data for appraising thermal maturation of organic matter.

Host institution: University of Aberdeen

Supervisor 1: Dr D. K Muirhead

Supervisor 2: Dr A. T. Brasier

Project description:

Thermal alteration of organic matter is crucial to our understanding of working petroleum systems in challenging and frontier basins. For R&D in the petroleum sector, it is important to integrate data and methodologies from several sources to provide an holistic view of potential reserves, with the need to develop and calibrate new laboratory and field assessment approaches. Work will focus on metamorphic aureoles around intrusions that are excellent natural laboratories for studying thermal alteration of organic matter synchronous with carbonate and clay mineral growth and alteration in sedimentary rocks. This project focusses on both field and lab-based techniques to provide an updated framework for understanding the relationships between unconventional hydrocarbons, their thermal evolution and potential reserves. Metamorphic index minerals, fluid inclusion analyses of silicate/carbonate minerals ($\delta^{18}\text{O}$ for temperatures) and Raman spectroscopic analyses of carbonaceous materials will be combined to produce geothermometric data. These data will be calibrated against magmatic geothermometers to constrain minimum temperatures of thermal alteration, alongside potential for constraining minimum and maximum cooling rates of emplaced material. Samples will be collected from localities on the West coast of Scotland, intrusions adjacent to organic rich shales (Raman spectroscopy of solid carbon, low grade metamorphic index minerals), sandstones and carbonates (silicates/carbonates/cements, fluid inclusions). This study will allow for a more complete appraisal of the extent of thermal alteration of sedimentary organic matter with implications for understanding the co-precipitation of organic and inorganic minerals, downhole logging correlation, basin wide thermal gradients in rifted margin settings and the efficacy of mineralogical geothermometers. Work will build upon research by Muirhead focused on the thermal alteration of organic materials and compliment research by Brasier on carbonate mineralisation and sediment diagenesis.

CDT Research theme(s):

This project bridges the following **CDT Research Themes: Extending the Life of Mature Basins** – through improved understanding of thermal alteration of organic matter *and* **Exploitation in Challenging Environments** – with focus on sub-basalt host rock alteration whilst improving our understanding of the thermal input of intrusions to petroleum systems.

Research and training context:

Understanding relationships between organic and inorganic minerals has implications for any sub-surface fluid flow (e.g. aquifers, barriers to fluid flow, carbon capture and storage). The student will receive training in Raman spectroscopy, fluid inclusion microthermometry, scanning electron microscopy. These will give the student a significant advantage when seeking employment or further academic roles, with the potential to generate important publications in these novel approaches. The student will join a large cohort of HC focused PhD students.

Research costs: Field work (£8k), laboratory costs (£6k). UoA will fund extra costs.

Career routes: The student will be well placed for a career in research, exploration & production geoscience, and specialist geochemical consultancy. The project will include the use of industry data and software.