PhD topic – for the UK Oil and Gas Training Academy

Calibrating geothermometers: integrating field, laboratory and well data for appraising thermal maturation of organic matter.
Supervisors: David Muirhead, Alex Brasier (University of Aberdeen).

Thermal alteration of organic matter is crucial to our understanding of working petroleum systems in challenging and frontier basins. This student will work on metamorphic aureoles around intrusions that are excellent natural laboratories for studying the thermal alteration of organic matter synchronous with carbonate and clay mineral growth and alteration in sedimentary rocks (Fig. 1).

This project focusses on both field and lab-based techniques that have the capability 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 ($^{18}$O of carbonates and fluid inclusions for rock and water palaeo-temperatures) and Raman spectroscopic analyses of carbonaceous materials will be combined to produce geothermometric data surrounding intrusions. These data will be calibrated against magmatic geothermometers (e.g. Al-in-olivine geothermometry) to constrain minimum temperatures of thermal alteration, alongside potential for constraining cooling rates of emplaced material.

Samples will be collected from localities on the West coast of Scotland (Fig. 2) for an integrated suite of chemical and petrographic analyses of intrusions adjacent to organic rich shales (Fig. 3) (Raman spectroscopy of solid carbon, biomarker analyses, low grade metamorphic index minerals, siliciclastic and carbonate sedimentary rocks (examining silicates, carbonates, and their cements and fluid inclusions). Work will be focused on the impact of large igneous complexes on basin scale rock- and organic-matter altering thermal input.

**Fig. 1.** SEM EDS map of calcite mobilisation and precipitation adjacent to intrusion

**Fig. 2.** The Cuillin, Isle of Skye. One of many field areas for this study focussing on thermal alteration surrounding large igneous centres.

This study will allow for a more complete appraisal of the extent of thermal alteration of sedimentary organic matter coupled to precipitation of organic and inorganic minerals and compounds, and correlated to data that could be obtained from downhole logging, basin wide thermal gradients in rifted margin settings and mineralogical geothermometers.
Fig. 3. Location of oil window adjacent to intrusion as noted by \( n \)-alkanes (modified after Muirhead et al., 2017)

The student 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.

The student will receive training in Raman spectroscopy, fluid inclusion microthermometry, scanning electron microscopy, organic geochemistry. These skills will help the student generate high calibre publications and also give the student a significant advantage for a future career in either academia or industry. The student will join a successful cohort of geochemistry and geofluids focused PhD students, including researchers studying contact metamorphism, intrusion related maturation of hydrocarbons, fold-thrust belt thermal alteration of sedimentary organic matter, and global stratigraphy and environmental change. The student will be well placed for a career in research, exploration & production geoscience, and specialist geochemical consultancy.

Further Reading:


Applications to: https://www.abdn.ac.uk/study/postgraduate-research/
By noon on Friday 13\textsuperscript{th} April 2018.

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This project is part of the UK Training Academy in Oil and Gas – a continuity programme of the NERC Centre for Doctoral Training in Oil and Gas. Studentships are funded for 4 years and recipients benefit from a bespoke training programme, delivered nationally, that prepares individuals for careers in the energy industry and supporting systems (including academic research).