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

Project Title: How depositional properties dictate the early diagenetic pathways and reservoir quality? –integrating outcrop examples, modern analogues to pore-scale observations

Host institution: Newcastle University

Supervisor 1: Dr. Sanem Acikalin (Newcastle Uni)

Supervisor 2: Prof. Richard Worden (Liverpool Uni), Dr. Cees van der Land (Newcastle Uni)

Project description: Porosity and permeability (pore-scale attributes) of a host rock are the two important parameters controlling the quality hydrocarbon reservoirs. These parameters determine the economic value and the development plans for an oil and gas fields. Although there are vast amount of individual studies on pore-scale reservoir quality controls of particular fields/formations, there are only few overarching approaches towards the predictability of reservoir quality.

Pore-scale reservoir quality controls are typically divided in two categories: (i) depositional and (ii) diagenetic. In most cases, however, these two factors act together to determine the final pore-scale attributes of a reservoir. Particularly in clastic reservoirs, early diagenesis is strongly linked to *depositional properties,* which includes: 1) texture (grain-size, sorting and detrital clay content), 2) detrital composition (i.e. detrital clay types), 3) fabric (sedimentary structures) and 4) original pore water composition. These factors determine the fluid flow pathways and available elements in the relatively closed system. Although the sedimentology and diagenesis of clastic reservoirs are widely studied, they are often examined in isolation by different research groups.

This study fills the gap between large-scale sedimentological studies and pore-scale observations to form a complete picture of the early developments within a sandstone reservoir. Here we focus on the lateral and vertical variations in the depositional properties of paralic systems. Paralic settings have been selected here, as they are often linked to porosity-preserving early-diagenetic chlorite formation. The study will focus on two examples; 1) several well-exposed and intensely-studied Cretaceous deltaic successions in Utah (USA), and 2) Holocene cores from Ravenglass Estuary (UK). Studying the modern and ancient systems together will additionally allow to investigate the effects of compaction on depositional properties. Main tasks will include:

- Field work to build the sedimentological background for the study, including core and outcrop logging, correlation, process interpretation and sampling.
- Sandstone petrography, XRD and SEM studies to define textural properties, grain composition, detrital clay types and diagenetic phases.
- In the Ravenglass Estuary we will sample pore water to characterise the original pore-water chemistry in various facies associations throughout the estuary.

CDT Research theme(s): Extending the life of Mature Basins, as the understanding of the links between the depositional properties and early diagenetic pathways will increase the predictability of the pore-scale reservoir quality in mature basins.

Research context: Acikalin has a background in sedimentology and pore-scale reservoir quality analysis. During her time in an oil&gas consultancy company she has experienced the challenges of upscaling the pore-scale observations to a basin-scale. Worden has extensive expertise on diagenesis and pore-scale reservoir quality issues. This study will be in close collaboration with his world-leading group at the University of Liverpool.

Research costs: Newcastle University has relevant facilities for this study. Ravenglass cores are currently available in Liverpool University. Sample preparation, field trips and visits to Liverpool University, are the main costs of this study and are estimate at £15k.

Career routes: The student will be equipped with an in depth knowledge on the sedimentology of paralic systems and sandstone diagenesis. The unique combination of skill sets (field, petrography, geochemistry) will provide opportunities in academia, oil&gas industry as well as the environmental sector.