NERC DOCTORAL TRAINING

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

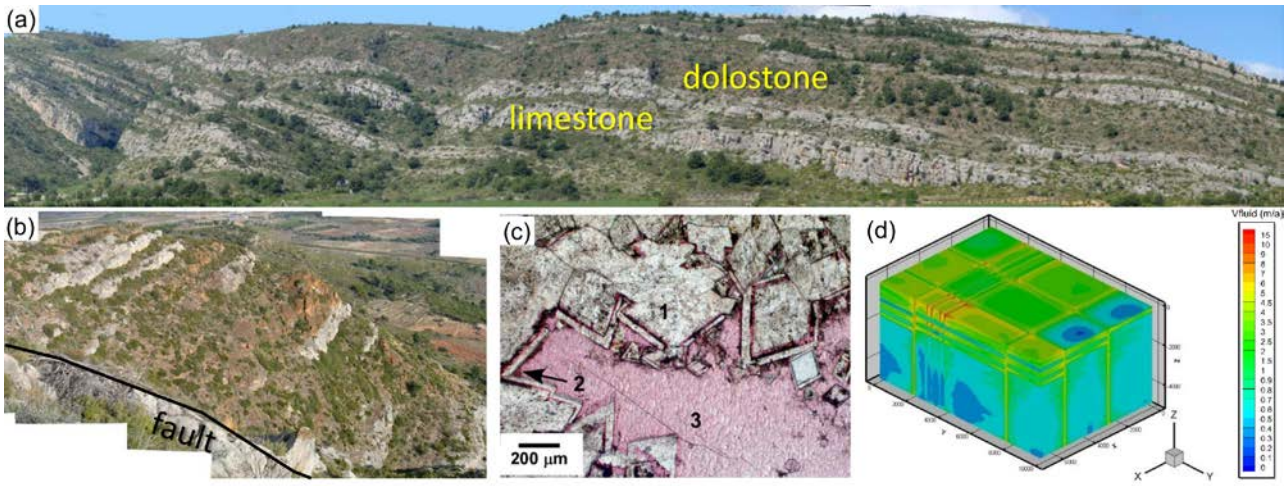
Project: **Determining the main controls on fault-associated dolomitisation and their influence on reservoir quality distribution** (4-year long PhD project)

Host institution: University of Aberdeen

Supervisors: Dr. Enrique Gomez-Rivas (University of Aberdeen; e.gomez-rivas@abdn.ac.uk), Dr. Joyce Neilson (University of Aberdeen) and Dr. Juan D. Martín-Martín (University of Barcelona)

Project description:
Carbonate reservoirs contain more than 60% of the World's oil and 40% of its gas reserves. Predicting their performance is very difficult, since post depositional diagenetic alterations can significantly enhance or degrade their reservoir potential. Structurally-controlled hydrothermal dolomite (HTD) typically forms when warm fluids are transported along faults and react with host limestones. The resulting geobodies have a variety of geometries, ranging from massive irregular patches close to faults to stratabound forms that extend several km away from them. Prediction of such geometries, their connectivity and associated reservoir quality is critical to reservoir management but is challenging from limited subsurface data, especially because the main factors determining the transition between these end-members are not fully constrained.

This PhD project will study world-class Jurassic and Cretaceous outcrop reservoir analogues in the Iberian Chain (Spain) to identify the main depositional, structural and geochemical controls on the geometry of fault-associated dolostones, and will provide predictive models for their subsurface characterisation. A combination of fieldwork, laboratory and modelling techniques will allow us to unravel and compare such controls in a variety of alteration geometries, from massive patches to stratabound. The project has a strong fieldwork component.



(a) Field view (~3 km long) of stratabound dolomitisation in the Maestrat Basin (Spain). (b) Field view of patchy dolomitisation close to a fault in the same area. (c) Photomicrograph of replacive dolomite (1), dolomite cement rim overgrowth (2) and meteoric calcite cement (3) filling the remaining intercrystalline porosity. (d) Screenshot of a large-scale 3D numerical simulation of fluid and heat flow, showing preferential circulation of dolomitising fluids along specific beds.

The main tasks are:

1) Field mapping of dolomitised geobodies within the stratigraphic and structural framework.

2) Logging to identify and correlate stratigraphic sequences and their relation with dolomitisation.

3) Identification of the complete paragenetic sequence with petrography (using optical, electronic and cathodoluminescence microscopy) and geochemistry (stable and radiogenic isotopes, elemental analysis, microthermometry). This will allow unravelling the sources of the dolomitising fluids, the conditions under which reactions took place and the resulting reservoir quality.

4) Field analysis of fracture and stylolite networks in selected units to understand their former role in constraining or channelizing the paleofluids responsible for dolomitisation.

5) Systematic analysis of dolomitisation fronts from the outcrop to the pore scale, to characterise their width and their relation with sediment components and pre-replacement alterations.

Originality of the science: A multidisciplinary and multiscale approach will help fill the knowledge gap of the controls on diagenetic replacement geometries, using outcrop analogues where dolomitised geobodies of the same age and type present a variety of patterns.

Research theme: Extending the life of mature basins and exploration in challenging environments. A systematic understanding of the main controls on diagenetic alteration geometries is key for forecasting the behaviour of carbonate reservoirs, both to improve recovery from existing fields and to explore for further resources in basins with complex diagenetic histories.

Research context: The student will join a group of researchers working in integrated characterisation of carbonate reservoirs and outcrop analogues. This includes projects in structural diagenesis, sedimentology, static and dynamic reservoir modelling and virtual outcrop geology.

Career routes: The student will become an expert in carbonate reservoir characterisation and will be trained in fieldwork (geological mapping, sequence stratigraphy, fracture analysis), petrography, geochemistry and reservoir modelling. This unusual combination of skills will grant the student outstanding job opportunities in academia or for a career in the oil & gas industry.

Applications: The closing date for applications is 31st January 2017. Instructions on how to apply can be found by clicking here. Please contact Enrique Gomez-Rivas (e.gomez-rivas@abdn.ac.uk) for further information or if you would like to apply.

References:

- Gomez-Rivas, E., Corbella, M., Martín-Martín, J.D., Stafford, S.L., Teixell, A., Bons, P.D., Griera, A. and Cardellach, E. 2014. Reactivity of dolomitizing fluids and Mg source evaluation of fault-controlled dolomitization at the Benicàssim outcrop analogue (Maestrat Basin, E Spain). *Marine and Petroleum Geology*, 55, 26-42. [link]
- Martín-Martín, J.D., Gomez-Rivas, E., Bover-Arnal, T., Travé, A., Salas, R., Moreno-Bedmar, J.A., Tomás, S., Corbella, M., Teixell, A., Vergés, J. and Stafford, S.L. 2013. The Upper Aptian to Lower Albian syn-rift carbonate succession of the southern Maestrat Basin (Spain): Facies architecture and fault-controlled stratabound dolostones. *Cretaceous Research*, 41, 217-236. [link]
- Martín-Martín, J.D., Travé, A., Gomez-Rivas, E., Salas, R., Sizun, J.-P., Vergés, J., Corbella, M., Stafford, S.L. and Alfonso, P. 2015. Fault-controlled and stratabound dolostones in the Late Aptian-earliest Albian Benassal Formation (Maestrat Basin, E Spain): petrology and geochemistry constrains. *Marine and Petroleum Geology*, 65, 83-102. [link]
- Corbella, M., Gomez-Rivas, E., Martín-Martín, J.D., Stafford, S.L., Teixell, A., Griera, A., Travé, A., Cardellach, E. and Salas, R. 2014. Insights to controls on dolomitization by means of reactive transport models applied to the Benicàssim case study (Maestrat basin, E Spain). *Petroleum Geoscience*, 20, 41-54. [link]
- Xiao, Y., Jones, G.D., Whitaker, F.F., Al-Helal, A.B., Stafford, S.L., Gomez-Rivas, E. and Guidry, S. 2013. Fundamental approaches to dolomitisation and carbonate diagenesis in different hydrogeological systems and the impact on reservoir quality distribution. *6th International Petroleum Technology Conference*, 16579-MS. doi: 10.2523/16579-MS. [link]