

The Distribution and Origin of the Silica in the Non-Marine Carbonates of the Purbeck Formation, Dorset and Comparison to Silica Occurrences in Analogues in Brazil and Angola

Heriot-Watt University, Institute of Petroleum Engineering
In partnership with **Federal University of Rio de Janeiro**

Supervisory Team

- **Patrick Corbett, HWU** [https://pureapps2.hw.ac.uk/portal/en/persons/patrick-william-michael-corbett\(a1213bb9-10e6-4741-949c-92c18e8b511a\).html](https://pureapps2.hw.ac.uk/portal/en/persons/patrick-william-michael-corbett(a1213bb9-10e6-4741-949c-92c18e8b511a).html)
- **Jim Buckman, HWU**
- **Leonardo Borghi, UFRJ, Brazil**

Key Words

Non-Marine Carbonates, Silica diagenesis, Reservoir Characterisation.

Overview

Significant amounts of silica occurs within in the Upper Jurassic/Lower Cretaceous Lulworth and Durlston Formations, component parts of the Purbeck Limestone Group in Dorset. Exposures from Portland Bill in the west to Purbeck in the east demonstrate its presence as silicified wood, silicified ostracods, bedded cherts, nodular cherts associated with thrombolites and in the replacement of coquina limestones. These various occurrences range across all stratigraphic levels throughout the formation. This project will systematically document the occurrence and form of the silica throughout the sections through combination of close field observations and thin section analysis of samples to try to establish a model for silica distribution in non-marine carbonates. Various autochthonous and allochthonous sources are considered (direct precipitation, remobilisation on silica from underlying marine Portland beds, intercalated sands, and possibly related to active faulting/hydrothermal sources). Critical to understand the influences of the various mechanisms will be careful petrographic/SEM analysis, constrained by isotope data, coupled with understanding of the stratigraphic context. Basin analysis will feature in the project as part of the regional constraint, influence of

syn-depositional faulting, and the structural position through time of the Purbeck Formation in the Wessex Basin Petroleum system will be part of the regional contextualisation. The results will have consequences for other silica-rich carbonate reservoirs (e.g. pre-salt in Brazil and Angola) and highlight any potential for a non-marine (stratigraphic) carbonate play in the UK where the Purbeck Formation retains its porosity.



Chert (lower part) in Purbeck Formation associated with thrombolytic stromatolite (upper part), Isle of Purbeck, Dorset

The project contributes to 2 out of the 4 CDT research themes:

- b) extending life of mature fields is achieved through optimisation of development decision for brown fractured reservoirs fields;
- c) exploitation of challenging environments is addressed as the project aims to tackle the problem of lower recovery from carbonates reservoirs.

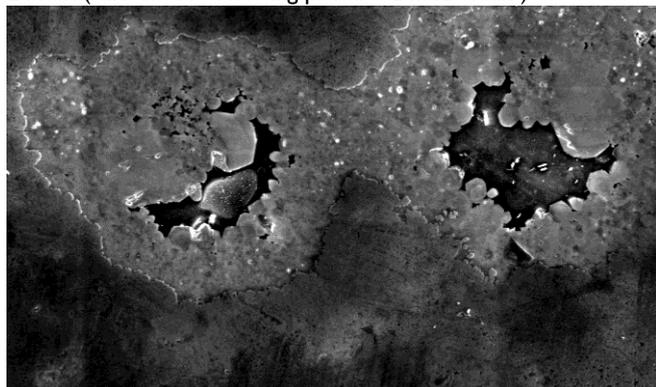
The project aims Non-marine carbonates form a relatively new and important major petroleum reservoir (examples in pre-Salt in Angola and Brazil) and the origin of the silica is not always clear. Its reservoir distribution can impact oil-in-place, recovery and drilling operations. This study will focus on the impact of silica on non-marine carbonate reservoir properties in a regional context to develop improved model(s).

This will be achieved by work in the following areas:

- (i) Detailed stratigraphic mapping
- (ii) Sampling and petrography
- (iii) Isotope Geochemistry
- (iv) Diagenetic model for calcite replacement, bed scale replacement and nodule growth
- (v) Burial and Thermal History
- (vi) Regional geology and Structural analysis
- (vii) Reservoir and Exploration application



Chert bed replacing lime mud in the Purbeck Fm, Isle of Purbeck, Dorset (surface view showing preserved mud-crack?)



Silica infilling pores in thrombolitic limestone (Purbeck Formation, Dorset) (Al-Rawahi, 2016).

Methodology

Heriot-Watt has close links with researchers in Brazil (Patrick is a Visiting Professor in UFRJ in Rio de Janeiro) and has been working on aspects of non-marine carbonate reservoir description for 5 years. It is expected that a few comparative samples from Brazil will be made available for this PhD programme. Patrick also has close connections with the quarrying and local geology community in Dorset and will tie into their local knowledge as silica also impacts the quality of the building stone. Additional members of the supervisory/ support team are: John Underhill (HWU), Sila Pla-Pueyo (Spain), Dan Bosence (Royal Holloway), Keith Westhead (BGS), Rob Ellam (SUERC), several of whom have worked the section extensively, worked with the diagenetic techniques and others providing isotope and analogue expertise.



Chert in the laminated carbonates of the Crato Fm, Araripe Basin, N.E., Brazil.

Timeline

The project will capitalise on some the outcomes of the recent research in UK and Brazil in microbial carbonates and the role/occurrence of silica.

Year 1: Literature, working on existing samples, fieldwork (UK), Purbeck Fm., microstratigraphy, petrography, SEM, lacustrine depo./struct. model.

Year 2: Fieldwork and sample collection (Brazil), isotope geology, conference attendance

Year 3: Regional analysis, basin modelling, thermal evolution, conference attendance, Reservoir characterisation.

Year 4: Data integration, thesis completion, papers for international journals

Training & Skills

As part of a CDT cohort, you will be committed to attending 20 weeks bespoke, residential training of broad relevance to the oil and gas industry: 10 weeks in Year 1 and 5 weeks each in Years 2 and 3. Instructors will be both from expert academics from across the

CDT and also experienced oil and gas industry professionals.

In addition you will receive training in:

- Non-Marine Carbonates
- Microbialites
- Carbonate Petrography and Diagenesis
- SEM and EDX techniques
- Isotope Geochemistry
- Geostatistical and Geological Modelling
- Basin Modelling
- Carbonate Reservoir Exploration

Further Information

Contact: Patrick Corbett p.w.m.corbett@hw.ac.uk in the first instance.

References & Further Reading

1. Darragi, F. and Tardy, Y., 1987. Authigenic trioctahedral smectites controlling pH, alkalinity, silica and magnesium concentrations in alkaline lakes. *Chem. Geol.*, 63: 59-72.
2. Westhead, R.K., and Mather, A.E., 1996, An updated lithostratigraphy for the Purbeck Limestone Group in the Dorset type-area, *Proc. Geol. Assoc.*, 107, 117-128.
3. Maliva, R.G., J. A. D. Dickson N. Schiavon, & A. E. Fallick., 1999, Self-organization origin of wood-grained chert, Portland Limestone Formation (Upper Jurassic), southern England, *Geol. Mag.*, 136 (4), pp. 413–421
4. Underhill, J.R., 2002, Evidence for structural controls on the deposition of the late Jurassic-Early Cretaceous Purbeck Limestone Group, Dorset, S. England, *Spec. Pap. in Palaeo.*, 68, 21-40
5. Bosence, D., 2012, Mesozoic, syn-rift, non-marine, microbialites from the Wessex Basin, UK, AAPG Hedberg Conf, June, Houston, Tx
6. Corbett, P.W.M., Yuji Hagashi, F., Alves, M, S., Jiang, J., Wang, H., Machada, A., Demyanov, V., Borghi, L., and Srivistava, N., 2015, Microbial Carbonates - A Sampling and Measurement Challenge for Petrophysics, Geol Soc Conference, June 18th, London, *Geol. Soc. Spec. Publ.* 418, doi:10.1144/SP418.9
7. Corbett, P.W.M., 2015, 'Reservoir Characterisation Challenges in Pre-Salt Brazilian Carbonates': Search and Discovery Article #51083 (2015) [online], available: http://www.searchanddiscovery.com/documents/2015/51083corbett/ndx_corbett.pdf [accessed 15 October 2015].
8. Buckman, J., Corbett, P.W.M., Mitchell, L., 2016, Charge Contrast Imaging (CCI) of the fabric of a Complex Coquina Limestone, *J. Sed. Res.*, v86(6), 734-748
9. Al-Rawahi, F., 2016, Petrographic and Reservoir Description of a Microbial Carbonate in Purbeck Limestone Group, Unpublished MSc Thesis, HWU