Basin-Scale Characterization and Modeling of Syn-Rift Non-Marine Microbial Carbonates of the Lower Purbeck Limestone Group (Late Jurassic to Early Cretaceous), Dorset, Southern England (United Kingdom)

Arnaud Gallois[1], Estanislao Kozlowski[1], Dan Bosence[1], Peter Burgess[2]

[1]Earth Sciences, Royal Holloway University of London, Egham, Surrey, United Kingdom.
[2]School of Enviornmental Science, University of Liverpool, Liverpool, Lancashire, United Kingdom.

ABSTRACT

Non-marine carbonates constitute a significant fraction of petroleum reservoirs worldwide, particularly since the recent discovery of the Lower Cretaceous pre-salt plays in the South Atlantic. In these non-marine carbonate systems, sedimentary facies and basin architecture are controlled by a range of environmental parameters (i.e. climate, hydrology and tectonic setting) but published facies models are few and only based on 2-D data that limits their predictive value. This study develops new sedimentary and stratigraphic forward models (SFM) for non-marine microbialites in a semi-arid climate setting in an extensional basin based on the Purbeck Limestone Group (Late Jurassic – Early Cretaceous) exposed in Dorset (southern England, U.K.). These are considered as a partial analogue for some aspects of the South Atlantic pre-salt carbonate reservoirs. Outcrop studies coupled with petrographic studies reveal that microbialite mounds are characterised by three morphologies associated with an on-lapping peloidal ostracod-rich inter-mound facies. Complex and irregular big microbialite mounds are commonly constructed from smaller tabular shaped mounds in the shallow margins of brackish water lakes and occur within three shallowing upward sequences capped by paleosols. Comparisons with modern day microbial systems indicate that microbial mounds preferentially develop on the lake margins and that morphologies are mainly controlled by the water depth (from tabular in the shallowest part to the microbial mats in the deepest part of the margins). Seismic and well data indicate that accumulation of strata and facies distribution of the Purbeck limestones occurred in half-grabens controlled by east-west extensional faults and an intervening relay ramp. Carbo-CAT is a new SFM developed to assess this tectono-sedimentary model and to improve the predictability by testing a variety of scenarios of fault activity and carbonate production. These SFM specify that mound distribution is controlled by the inherited palaeotopography on tops of the Portland Group and the three paleosols and the syn-depositional setting of the faults. The major results of this project are to predict the controls on the distribution of microbial mounds and to constrain the facies models and palaeogeographies of the lower Purbeck Limestone Group within the Wessex Basin; and to emphasise the importance of inter-related fieldwork and numerical modelling studies to produce more robust depositional models.