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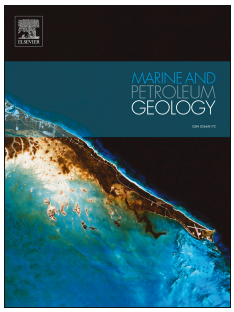

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Quantitative Controls on the Regional Geometries and Heterogeneities of the Rayda to Shu'aiba Formations (Northern Oman) using Forward Stratigraphic Modelling

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Abstract

The complex geometry of carbonate systems is influenced by a multitude of physical as well as biological processes. The Lower Cretaceous carbonates of Northern Oman are characterised by a variability of regional-scale geometries with expected vertical and lateral facies variations. The main environmental and tectonic controls acting on the depositional processes of the Lower Cretaceous ramps and platforms through space and geological time (in 4 dimensions) are only partially understood. In this study, we use a 4D DionisosFlow Forward Stratigraphic Modelling (FSM) approach to explore the role of: (i) eustasy; (ii) subsidence; (iii) initial paleobathymetry, and (iv) wave energy, to generate carbonate stacking patterns and heterogeneities. Carbonate production was maintained constant through deposition. Multi-disciplinary and multi-scale datasets were used (i.e. seismic, well and field data) to constrain the FSM input parameters and sensitivity analysis was carried out to validate or refute some depositional model hypotheses. Results show that basement topography and eustasy have the greatest influence on the progradational geometries and the lateral continuity of clinoform architectures during the Tithonian to Valanginian second-order super-sequence. In the Valanginian to Aptian super-sequence, subsidence was the primary control for the observed aggradational stacking pattern. Lateral and vertical stacking of carbonate lithologies, textures as well as facies are thus apprehended through this FSM approach, leading to a better assessment of petroleum systems elements as reservoir, seal and trap.

1. Introduction

During Jurassic and Early Cretaceous times, an extensive carbonate platform covered the eastern part of the Arabian Plate representing a period of broad marine transgression (Murris, 1980). Several regional-scale investigations were conducted to assess the stacking patterns and lateral geometries of the Lower Cretaceous carbonates, combining both outcrop and subsurface data (Masse et al., 1977; Pratt and Smewing, 1993; van Buchem et al. 1996 and; Hillgartner et al., 2003). The Lower Cretaceous reservoirs have been producing in many fields along Northern Oman and extend towards the northern part of the Ghaba Salt Basin (Figure 1) (Pratt and Smewing, 1993 and van Buchem et al., 1996). Examples of such fields include the Yibal, Al Huwaisah, Lekhwair and Safah fields (van Buchem et al., 2002), where the main producing reservoir units are the shallow marine, peri-reefal Shu'aiba Formation and the Kharaib Formation (Litsey et al., 1986).

The interior part of these carbonate ramp systems is usually imaged as widespread shallow water sectors, where carbonates mainly aggrade. Due to their negligible topography, deposition is generally assumed to