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Improving Carbonate Heterogeneity Prediction along the Arabian Plate using Innovative Forward Stratigraphic Modelling and Response Surface Approaches

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ABSTRACT

This paper discusses the results of an innovative methodology using Dionisos 4D forward stratigraphic modelling of Middle Eastern carbonate reservoirs on a field scale. Traditional stochastic techniques do not sufficiently capture carbonate reservoir heterogeneities. The methodology applied to three Lower Cretaceous UAE reservoirs
uses a deterministic approach that aims to define carbonate heterogeneity and provides a structure to develop a more accurate and usable static and dynamic model. Dionisos uses a predefined sequence stratigraphic scheme as a framework. A reference case model is manually calibrated to environmental parameters, followed by automated multi- realisations that generate several other plausible calibrated models. A sensitivity analysis provides an indication of the influencing environmental parameters controlling facies and texture distribution. Visual and quantitative calibration phase of the reference case model is conducted for every third order sequence by comparing observed sequence thickness and textures at wells with the simulated stratigraphic models.
The calibrated forward stratigraphic models resulted in the generation of 14 carbonate textures using a 200x200 m grid size and a 50 kyrs time step. Carbonate lithology production varies between 0 and 350 m/Ma, wave direction is SW (200-260°); wave action depth 7-18 m while wave energies vary between 0 and 140 kW/m. Sediment diffusion coefficients by wave transport range from 0.1 (mud) to 0.0008 km^2/kyr (bioconstructions) while gravity driven transports from 0.1 to 0.001 km^2/kyr. The lower part of Reservoir A is characterised by low angle TST sequences dominated by algal boundstones floatstones. Deposition continued with the development of a low relief margin with aggradational to progradational architectures comprising rudist shoals. This defined a topographic split into platform, slope and basin. The successive clinoform top sets (Seq4a,b) are rich in rudist boundstones-floatstones with lower slope dominated by packstones- wackestones.

Reservoir B and C are isopach with strong lateral. The overall architecture of the sedimentary systems consists of low relief interconnected algal boundstone floatstone mounds separated by gentle depressions dominated by fine grained sedimentation. The numerical simulation of these systems was driven by a carbonate production law as a function of the substratum energy and bathymetry under dynamic subsidence/uplift conditions.