Stratigraphic Trap Assessment Using Forward Stratigraphic and Diagenetic Modeling - Application to the Natih Formation, Oman

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ABSTRACT

Estimate the distribution of geological heterogeneities is a major challenge for subsurface exploration and reservoir characterization. Carbonate deposits usually host very good reservoirs but also more subtle stratigraphic traps. They can form in various depositional environments, stratigraphic and structural settings, and can be affected by many different diagenetic processes. As a result, they present very heterogeneous petrophysical and petroacoustic characteristics and are difficult to image and interpret even using up-to-date seismic data. Assessment of such subtle traps require to develop novel integrative approaches to better understand the regional-to-local sedimentological and diagenetic processes, which have shaped source rocks, reservoirs and seals.

The challenge of our study was to develop and run a fast and accurate workflow combining wireline log interpretation, detailed sedimentological, diagenetic and geomechanical studies, with deterministic stratigraphic forward and synthetic seismic modelling of a carbonate reservoir. A review of lithofacies classification (facies type and facies group) and EOD definition (Environments Of Deposition), allowed us to define stratigraphic parameters such as accommodation space, carbonate production rates, sediment transport parameters, dissolution-cementation rates, … A series of numerical simulations were performed using the DionisosFlow stratigraphic model to simulate sedimentological and diagenetic processes through geological time. The simulation results were used to estimate geomechanical and petroacoustic properties. Convolution of this rock property model with a synthetic wavelet made it possible to compared simulation results to seismic data. Finally, sensitivity analysis was performed to evaluate the impact of stratigraphic and diagenetic processes on the seismic signal.

We illustrate this workflow by simulating an intrashelf basin derived from the geological framework of the Upper Cretaceous Natih formation of Oman, part of the Wasia Group (Cenomanian and early Turonian). It was formed by a carbonate-dominated ramp bordering an intrashelf basin, with abundant rudists in the mid-ramp environment and organic-rich basinal facies. Outcrop data from the Adam foothills of Northern Oman and wireline logs were used to build a stratigraphic and diagenetic model at an appraisal scale (average thickness of about 200 m, simulated area about 40,000 km²). We show in particular that this forward stratigraphic, diagenetic and seismic modeling workflow made it possible to better understand the impact of sedimentary and diagenetic processes on large-scale carbonate reservoir properties and finally to reduce uncertainties on the appraisal-scale reservoir characterization.