Understanding the Controls on Clastic Sedimentation Using Forward Stratigraphic Modeling and Seismic Sequence Stratigraphy

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ABSTRACT

There are have been significant oil and gas discoveries in reservoirs associated with deltaic and deepwater sedimentation. However, despite the advances in data quality the industry has often struggled to quantitatively assess traditional qualitative geological assumptions, such as reservoir connectivity or facies variation; often resulting in a disconnect between the predicted sediment characteristics and the physical processes which influenced them initially. Thus, many approaches have often depended heavily on geostatistical methods. Our objective is to demonstrate the integration of numerical forward stratigraphic modeling to aid traditional methods of predicting facies distribution in a deltaic setting using data from the Dutch Sector, southern North Sea. A robust geological model was created using the well and seismic data; interpreted in term of system tracks and sequence boundaries, which lead to the understanding of the depositional environment, paleo-topography, turbiditic events, and paleo-bathymetry. Combined with the regional geology, this information is integrated in a forward stratigraphic modeling simulator based on the well-established physical principles of sediment erosion, transport and deposition. The simulation results: stratigraphic sequences and lithologies were compared to the available data to calibrate the parameters and fine-tune the model. The final model which best honours the data is used to predict reservoir properties and geometries at both a basin and finer stratigraphic scale. The stratigraphic forward modeling results are consistent with the observed seismic and well data, including sequence boundaries and lithologies. We demonstrate that numerical simulation allows one to better characterize facies variations at a high resolution and matches qualitative predictions from previous studies. The resulting model can be used to generate quantitative predictions for reservoir connectivity, porosity, and broader play definitions. This study demonstrates that forward stratigraphical modeling can be used in both frontier exploration with limited data and mature projects, allowing researchers to quantitatively assess their geological hypotheses; with insights into the dynamic interaction between sediment source, transport, deposition and diagenesis coupled to sea level variation and tectonics. Therefore, traditional qualitative methods can be enhanced using the quantitative results, thus increasing their predictive capabilities.