An Integrated Approach Using Seismic, Well Logs and Cores for Predicting the Depositional Architecture in Jurassic Reservoirs, South Mangyshlak Basin, Western Kazakhstan

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Abstract

This case study describes the model design of the Lower to Middle Jurassic producing reservoirs (fluvial and tidal, to locally marine depositional systems) in the South Mangyshlak Basin, Western Kazakhstan. The common procedure for building a depositional facies model during the exploration and development stages includes a 1D core and log analysis that is later expanded into a 3D conceptual model. Seismic data is often only introduced at later stages, as a soft constrain. A brown field being re-developed provides an excellent opportunity for integrating seismic data upfront as a hard constrain, as extensive well log coverage and good quality seismic data are generally available. Such an approach presents both increased opportunities and challenges from the early stages of well analysis and correlations, to the 3D geocellular modelling of the depositional facies. The initial stage comprised of detailed core and log interpretation to derive a consistent set of electrofacies. In parallel, the seismic data was pre-conditioned to better support the understanding of a sequence stratigraphic framework, aid with the well correlations, and guide the stratigraphic interpretation, where necessary. This approach allowed the prediction of the fundamental stratigraphic regional boundaries, which could then be consistently tracked in three dimensions. Using this approach, it was possible to establish the lateral and vertical relationship of individual depositional elements and capture their overall distribution within each stratigraphic cycle. The 3D modelling posed a challenge to the quantitative use of seismic data, as the depositional facies include characteristics that cannot be fully accounted by the seismic amplitude alone. For example, an AVO based inversion scheme may distinguish between hydrocarbon- and water-bearing sands, and shale, while a fluvial channel may comprise all, if not more, of the aforementioned lithofacies. A workflow combining a deterministic and a probabilistic approach was developed to tackle this challenge. A wide range of seismic attributes was incorporated within a probabilistic neural network particularly tailored to honor the main reservoir facies defined during the core and log analysis stage. Additionally, a sub-set of the seismic attributes made it possible to define the boundaries of reservoir geobodies, which were then combined with the probabilistic facies attribute from neural network. This workflow enhanced the resolution for channel facies probability and generated the ideal trend for the facies simulation algorithm. The resulting facies model not only improved our understanding of the reservoir, but also helped in identifying additional in-fill drilling locations, and explaining the dynamic history and current production behavior.

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