Major Controlling Factors for the Zhujiang Formation Deposition in the Panyu A Oilfield, Pearl River Mouth Basin as Revealed from Stratigraphic Forward Modelling

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9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

Knowledge of the depositional process and sedimentation is essential for determining reservoir properties, especially when diagenesis only exerts a weak effect on the reservoirs. The sandstone of the Zhujiang Formation in the Panyu A Oilfield comprises a sequence of over 1200 m thick paralic - shallow marine interbedded shales and deltaic sands deposited in an inner continental shelf. The formation is presently at a burial depth of 1500-2700 m and shows weak diagenesis with good primary porosity. By considering the key depositional processes and geological parameters, we constructed a three-dimensional depositional model using Sedsim, a stratigraphic forward modeling program, to model the depositional system of the study area and quantitatively investigate the influence of various parameters including initial topography, the frequency and magnitude of eustatic sea level, and sediment supply on the deposition. The modelling work was aimed to improve our insight of the depositional dynamic process and the controlling factors for sandstone development within the target interval (23.8Ma-16.5Ma). After numerous adjustment, the final model matches the known thickness and sandstone proportion quite well in the validation wells. The model shows that lithologies change regularly vertically and extends steadily laterally at meter- and kilometer- scales, respectively, forming multiple reservoir-caprock couplets vertically. It is concluded that the extremely gentle paleo-topography (inner shelf) is responsible for the sheet-like, planar and lateral extensive sandbody distribution. Eustatic sea level changes

play an important role in controlling the development and evolution of sandbodies, but sea level changes at different frequencies have different effects on the sedimentation. Due to the interaction of sediment supply and the 2nd-order relative sea level change, the sandstone proportion and individual layer thickness changes regularly, that is, the sandstone proportion and individual sandstone layer thickness decreased during the early stage between 23.5 Ma and 18.5 Ma, whereas the opposite trend occurred during the second stage (18.5 Ma-16.5 Ma). The 3rd-order relative sea-level fluctuations control the development of different 3rd sequences and the types and characteristics of sequence architectures, which further control the reservoir sandbody development patterns within the 3rd order sequences. High-frequency sea level changes control the fine-scale (e.g. individual reservoir units) sedimentary microfacies and lithologies distribution and variations, and the stable and laterally extensive shales were developed during sea level rises, when a slight rising of the sea level would push the shoreline back over a large distance, effectively shutting off the coarse sediments supply to the inner shelf, due to the extremely gentle paleo-topography in the study area.