Adding Reserves by Evaluating Turbidite Channel Reservoirs of Shahejie Formation of Paleogene in Beidagang Structural Belt, Bohaiwan Basin, China

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ABSTRACT

In the Bohaiwan Basin, many of the fields found in shallow formations (burial depth <3000m) have reached maturity. Reserve additions in these mature fields have mainly resulted from switching exploration target to deeper formations (>3000m). Among the reservoirs of deep formations in the Bohaiwan Basin, the turbidite channel reservoirs are widely distributed and have great potential in the hydrocarbon exploration and production. For example, the turbidite channel reservoirs in Shahejie Formation of Paleogene in Beidagang structural belt of the Bohaiwan Basin have an original oil-in-place greater than 750 million barrels at depths between 3700 and 4200meters.However, exploitation of these turbidite channel reservoirs was limited by: 1) the difficulties in reservoir characterization of the turbidite channel sands due to rapid facies variation, 2)and the fuzziness of bypassed pay identification from the conventional log in these reservoirs because of the regional variations in formation water salinity and complex pore network.

In this study, characterization of the turbidite channel reservoirs was based on high resolution 3D seismic data, and was calibrated by cores and logs. Additionally, the bypassed pay zones of these reservoirs in the study area were identified and evaluated by the resistivity and NMR logs, combining with the analysis of core and well testing.

We aimed to provide classification of rock types and description of sand body geometry in the subsurface to facilitate a better understanding for characterization of turbidite channel reservoirs of Shahejie Formation in Beidagang Structural Belt. Firstly, we developed the sequence stratigraphic framework by detailed stratigraphic analysis of integrated data sets including 3D seismic data, well logs, and core. Secondly, we identified different rock types based on the compositional characteristics and flow properties. The data used in this study were mainly from XRD data and relative permeability from displacement experiments. Finally, based on the analysis of seismic attributes and core-calibrated logs, depositional model was developed that can help characterize the distribution and geometry of turbidite channel sands. And we also analyzed the interconnectivity of reservoirs, which could help to map the horizontal and vertical barriers.

We preferred the core-calibrated resistivity and NMR logs to interpret the bypassed pay in the study area, especially focused on the cases of low contrast resistivity reservoir in which there was little resistivity contrast between water bearing formation and oil bearing formation. The core experiment and the well testing data demonstrated that some of the intervals below the high resistivity pay were productive. Combined with the logging parameters, the lower boundary of reservoirs were established while the non-reservoirs were excluded. Considering the impact of the formation water salinity, the pore network, and the contents of clay minerals, we integrated the resistivity with NMR logs to determine

the characteristics of logging response of the bypassed pay, and quantified the oil saturation to provide additional information on the producibility of the reservoir.

Reserve additions and performance improvements of the turbidite channel reservoirs in the study area mainly depended on two aspects of the work above, including reservoir characterization and bypassed pay evaluation. We expect the production of these reservoirs in the study area to increase over 10% in next few years by drilling the infill wells and employing the bypassed pay.