Integration Study of Petrophysics and Pre-Stack Seismic Inversion in Reservoir Characterization for the Zubair Formation in Central Iraq

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Abstract

The Lower Cretaceous Zubair formation in central Iraq is an important oil-bearing formation. The formation, consisted of sandstone and shale, is deposited in fluvial to shallow marine environment. Drilled wells show sand distribution varies quickly both in vertical and horizontal direction. Hydrocarbon occurrence is controlled by sand distribution. Therefore, reservoir characterization for sand distribution is essential for efficient oil exploration. Petrophysics analysis and pre-stack seismic inversion were conducted to characterize the sand distribution. First, based on the S-wave logging data in well E1, we employed the Xu-White model to estimate the shear wave velocities for other wells. Then, cross-plot of P-impedance and Vp/Vs ratio was conducted to determine the Vp/Vs to discriminate sand and shale. Finally, simultaneous inversion was conducted. Preconditioning processing including noise filtering and residual NMO was conducted on the prestack seismic gathers. A low-frequency impedance model was generated with the logging data. P-impedance, S-impedance, and Vp/Vs volumes were obtained from prestack simultaneous inversion. Slices of average Vp/Vs and sand thickness for sublayers were generated to indicate horizontal sand distribution. Petrophysics analysis shows the sand and shale of the Zubair formation have low P-wave impedance contrast. But the Vp/Vs for sands is obviously lower than that of shale. Therefore, we are able to discriminate sand and shale with the Vp/Vs volume from seismic inversion. The Vp/Vs of 1.7 was set as the high cut for sands. Profiles of Vp/Vs show vertical sand distribution which coincides with the log

interpretation conclusions. Slices of average Vp/Vs and sand thickness were used to indicate sand distribution horizontally. Favorable spots were found in the middle area of the project region. The result shows the logging interpretation conclusion coincides with the sand distribution from seismic inversion. Petrophysics analysis shows P-wave impedance is not enough to discriminate sand and shale of the Zubair formation in this region, while Vp/Vs is effective for sand discrimination. Therefore, post-stack seismic inversion is not enough for characterize sands and prestack seismic inversion is an essential tool for reservoir characterization. Sand distribution derived from Vp/Vs coincides well with the log interpretation conclusion, which provides guidance for well deployment in the future.