Thin-layer Reservoir Prediction Method of Rifted Basin Based on Low-Resolution Seismic Data

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ABSTRACT

Limited by the unfavorable ground surface conditions, inside Fula sub-basin, Muglad basin developed along with Central African Rift Zone, only low-resolution 3D and 2D seismic data could be acquired. Using traditional reservoir prediction methods will encounter great difficulties on identifying thin layers, generating accurate well-seismic tie and identifying clear or reliable sedimentary phenomenon for hidden hydrocarbon reservoir, i.e. the dominant frequency of target reservoir is about 20hz, and the thickness of that is from 3 to 5 meters and the sedimentary facies changes from delta sheet sand to alluvial sandstone or mount bar in delta plain. In order to resolve the problems mentioned above, the research team tried to find out effective technical methods from the several aspects as seismic inversion work, detailed sequence stratigraphy study and seismic sedimentology analysis.

For the seismic inversion work, new method named by waveform BP-ANN inversion based on spectrum subdivision and analysis was used. With this new idea, firstly, the spectrum subdivision using wavelet transform, was carried out on the pure wave seismic data and then generated separate data with effective high, middle and low level of frequency, among which, higher frequency reflects thin layers and low frequency reflects regional trend of lithology changes. Then, sensitive analysis on effective sandstone reservoir was done, and several sensitive attributes of well logging parameters were selected to attend the inversion. After that, a specified BP-ANN was trained to get a stable prediction network between well logging's sensitive parameters and seismic data's waveform, which was then used to carry out hydrocarbon sandstone classification on seismic data in the target formations. With this method, well logging sample's interval can greatly improve the resolution of inversion result. Thin layers of sandstone with thickness less than 10m meter, mostly were delta sheet sand, could be identified accurately.

Also detailed sequence stratigraphy study was carried out in the forth-level sequence cycles, which is controlled by the local flood surface, sudden water transgression and sand accumulation. Regarding well core sample analysis and frequency analysis on sequence cycles, well correlation and seismic sequence cycles were used to identify sequence cycle boundaries in both depth and seismic domains and built regional sequence frameworks. Based on the sequence cycle analysis and seismic sedimentology theory, time slices were generated on the seismic inversion result data with reasonable time interval. Finally, we got reasonable micro-facies maps for each sequence cycles using the dominate micro-facies for each cycles, as well as sand thickness distribution and porosity distribution maps.

After reviewing the previous study done in the recent year in the research area, it revealed that the hydrocarbon reservoir, in most cases, was sealed by faults horizontally. 3D interpretation, time slice and structure filter process were then done to improve the accuracy of faults identification. Combination with above three achievements, we identified several favorite targets for drilling and got great success.

After years of practices, the method used in this research has been proved a very reasonable way for successful exploration activities in mature rifted sedimentary basins with low-resolution seismic covering.