3D Seismic Attribute Expressions of Deep Offshore Niger Delta

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Abstract

Structural and stratigraphic interpretation of 3D seismic data for reservoir characterization in an area affected by dense faulting is typically difficult and strongly model driven because of problems with imaging. In the Freeman Field, located about 120 km offshore southwestern Niger Delta at about 1300 m water depth, 3D seismic attribute-based analogs, and structural and stratigraphic based geometric models are combined to help enhance and constrain the interpretation. The objectives being to show how 3D seismic attribute analysis enhances seismic interpretation, develop structural style and stratigraphic architecture models and identify trap mechanisms in the study area; with the main purpose of producing structural and stratigraphic framework analogs to aid exploration and production companies, as well as researchers in better understanding the structural style, stratigraphic framework and trap mechanism of the Miocene to Pliocene Agbada Formation reservoirs in the deep Offshore Niger Delta Basin. A multidisciplinary approach which involved analyses of calculated variance-based coherence cube, spectral decomposition box probe and root-mean-square amplitude attributes, sequence stratigraphy based well correlation, and structural modeling; were undertaken to achieve these objectives.

Studies reveal a massive northwest-southeast trending shale-cored detachment fold anticline, with associated normal faults; interpreted to have been folded and faulted by localized compression resulting from a combination of differential loading on the deep-seated ductile-undercompacted-marine Akata Shale, and gravitational collapse of the Niger Delta continental slope due to influx of sediments. Crestal extension resulting from this localized compression, is believed to have given rise to the synthetic, antithetic and newly observed crossing conjugate normal faults in the study area. This structure is unique to the existing types of principal oil field structures in the Niger Delta, and could have implications for permeability anisotropy. The Agbada Formation reservoirs of the Freeman Field occur as part of a channelized fan system; mostly deposited as turbidites in an unconfined distributary environment; except one that occurs as channel sand within a submarine canyon that came across and eroded previously deposited distributary fan complex, at the time. Hence, prospective area for hydrocarbon exploration is suggested southwest of the Freeman Field.