Tectono-stratigraphic evolution of the deep offshore Eastern Niger Delta: implications for hydrocarbon prospectivity.

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ABSTRACT

The structural style and evolution of the deep offshore Niger delta is characterized using a high-quality 3D seismic dataset covering an area of 10,457km^2, controlled by 8 wells. Progradation of the Niger delta offers potential for deposition of coarse clastic sediments into deeper parts of the basin, creating a favourable setting for good quality reservoirs in the upper part of the sequence. The key to unlocking prospectivity is understanding the evolution of trapping systems associated with a range of structural styles, and evidence for charge from thermally mature source rocks or biogenic gas.

The Cretaceous pre Akata interval contains extensional faults that trend NW-SE and N-S. These faults terminate in the lowermost Akata. The Akata interval is relatively undeformed, forming a thick interval of dominantly low-amplitude seismic facies. The overlying Cenozoic post-Akata section displays complex thrusting and folding, with evidence of gravity driven compression and wrenching. In this interval four structural provinces can be defined, varying in structural style: (1) the undeformed abyssal plain (2) a detachment fold belt, with thrust faults trending NW-SE; (3) a wrench related zone, trending N-S, and (4) a highly deformed E-W trending zone that was previously interpreted to comprise mud diapirs, but new seismic imaging indicates it is a heavily faulted interval, comprising steep reverse faults, and heavily deformed stratigraphy.

An area to the northwest shows a convergence of thrust fronts, with dips verging both to the SW and NE forming opposing contractional folds. This juxtaposition is interpreted to be linked with a deep-seated structure.

The interval below the top Akata contains a strong, positive acoustic impedance, continuous seismic reflection, occurring at a depth range of 7.6 – 9.8km, underlain by coherent moderate to high amplitude seismic reflections. This is interpreted to record a possible pre-Akata sedimentary sequence. A horizon can also be picked within the Akata interval, at a depth of 4.5 – 7.3km, in some locations, separating the Akata Fm into a lower and upper unit. This horizon is similar to the surface that was previously identified in the western Niger delta.

We recognize a four-stage structural evolution for the offshore Eastern Niger Delta; 1. North-South trending extension in Maastrichtian, associated with Atlantic rifting 2. Deposition of the Akata and early post Akata sediments in a passive margin on the stable distal slope/basin, 3. Niger delta progradation during the Miocene initiated gravity sliding, with décollement in the Akata mudstones. This developed compression at the toe of the delta system, and formation of Northwest – Southeast trending thrust faults and East – West reverse faults. 4. North - South trending wrench faulting with a similar trend to the Pre Akata faulting. This trend could be related to a reactivation of the older normal faults.

The results improve understanding of the structural framework and evolution of the deep eastern Niger delta basin, with multiple trapping configurations identified, potentially sourced from the Akata and pre Akata shales.