Pore Pressure Prediction for Deep Drilling in the Central Swamp Depobelt of the Niger Delta: Lessons for Deep Offshore Drilling

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Overpressures in the subsurface pose major problems for safety and cost-effective well design. Exploration for hydrocarbon in deepwater and deeper plays is gradually becoming the focus of most E&P companies. One of the major challenges of deeper exploration for oil and gas is pore pressure. Drilling information (e.g mud weight and kicks) around the Grangbene Field suggest overpressure regimes. Hence pore pressure prediction study was necessary to understand the pore pressure regime of the field.

To optimize drilling decisions and well planning in Grangbene Field, eleven well data, ten interpreted horizons, prestack volume and post stack seismic data were provided for the purpose of pore pressure prediction. The prestack gather was used to generate a high fidelity velocity field on a 100m by 100m grid. The interpreted horizons were used to build a low frequency model (LFM). The post stack data with LFM input was inverted to generate a high resolution velocity cube which is transformed to pore pressure using the integrated Pore Pressure system (iPPs) methodology. For this, a suitable rock model was derived from well data using a rock physics approach and calibrated with measured drilling data. This method considers the primary overpressure mechanisms such as disequilibrium compaction and thermal diagenesis of clay minerals.

The results show that the normal compaction trend has been disrupted in some areas by mud volcanoes from underneath. Two pore pressure models were built to represent the entire study area. In general three pressure zones were identified; (1) From the surface down to about 2000 ms TWT where the sediments display pore pressure close to hydrostatic pressure. (2) In the Eastern section from 2000 ms TWT down to about 3300 ms TWT, there are inter bedded layers with pore pressure equal and slightly above the hydrostatic pressures. This trend varies slightly at the Western section with this zone going from about 2000 ms TWT to 2500 ms. (3) At the Western section from below 2500 ms TWT where the majority of the sequence is over-pressured. While in the East, this general overpressure doesn't take place until about 3300 ms TWT. The pore pressure derived from the vertically spatially filtered high-resolution velocity ranges from about 8.7 ppg (1.042 Kg/litre) at 14.9 m, which corresponds to hydrostatic pressure from the surface through the Benin formation and part of the Agbada Formation, up to about 16.4 ppg (1.965 Kg/litre) at depth of 4122.1 m