Gravity Signatures of the Deep-Water Reservoirs of Offshore Nigeria, West Africa

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Offshore Niger Delta, Nigeria, displays a variety of structures, tectonic styles and sedimentary records and hydrocarbon plays. These plays are found both to the east and west of the deep offshore. It is better developed in the east than in the west. Its deepwater realm has been the site of the most significant oil and gas discoveries in the last two decades. The deep offshore Niger delta starts from a water depth of 200 m and it is divided into four structural belts. Most of the deepwater reservoirs are constrained structurally by massive shale diapirs.

In order to obtain information on the structural styles of the deep-water offshore of Nigeria, and its relationship to hydrocarbon accumulation and migration;one hundred satellite-gravity data were processed by applying latitude, free-air, elevation and bouguer corrections.The resulting Bouguer gravity anomaly were modelled using quasi-3D gravity models constrained by apriori information derived from the 3D seismic surveys and formation densities from well data.Forward modelling approach was adopted in calculating the gravity anomalies over a model of assumed mass distribution. The models that represent the geology of the basin were obtained when satisfactory approximation between the calculated and observed gravity fields for the basin was achieved.Furthermore spectral analyses method was applied to the Bouguer anomaly. The anomaly depth was obtained by computing least-squares fit to the lowest frequency segment for the azimuthally averaged log power spectrum. The processed satellite-gravity data showed a central negative anomaly having an average of -35 mgal amplitude characterizing the survey area. The results obtained from the gravity modelling provided valuable insight into the stratigraphy, geology and geometry of the shale diapirs, found in the basin. The gravity anomalies observed are possibly caused by lateral density contrasts within the basin. It also provides information on the migration and the possible density-velocity model that could be used in re-processing the existing seismic data. Also a better understanding of the regional structure was gained. Spectral analyses indicate that basement is at a depth of about 3 km in the basin. A good correlation between the quasi-3D modelling and spectral analysis suggest that gravity data is useful in resolving and estimating the regional structure and the tectonic setting of the offshore basin.