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Continental Margins of the South Atlantic - Deepwater Reservoirs within the Meridional Salt Basins and in the Equatorial Basins without Salt

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SUMMARY

This presentation aims to compare the seismic response of deepwater reservoirs in the main producing provinces of the South Atlantic salt basins, namely the Campos, Santos, Espirito Santo and Sergipe-Alagoas basins offshore Brazil and their mirror image counterparts in West Africa, particularly the Kwanza, Lower Congo and Gabon salt basins.These well known and prolific basins are briefly compared with the transform margin provinces in the Equatorial Atlantic Margin, where recent deepwater exploration resulted in the discovery of Upper Cretaceous oil-bearing reservoirs.

Introduction

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In the salt-bearing basins post-salt and pre-salt fields are predominantly located in the shelf, slope and rise. Exploration of these basins accelerated in the last decade, extending the drilling activity close to the continental-oceanic crust (cob) boundary. Hydrocarbon bearing reservoirs occur both in the post-salt and in the pre-salt sequences, resulting in a combination of structural and stratigraphic traps in all of these basins. Most of the presently producing fields are in the post-salt Tertiary reservoirs. However, exploration of the Late Aptian pre-salt reservoirs have clinched remarkable success in east Brazil, and recently in West Africa.

Reservoirs of post-salt sequences in all of these basins are situated in basin floor fans, prograding wedges and slope fan systems tracts. Recently acquired 2D regional and 3D seismic data show them to consist either of high amplitude high continuity or hummocky lower continuity reflectors. The seismic examples from fields in Brazil and West Africa indicate that the oil accumulations are mainly controlled by the massive autochthonous salt. Hydrocarbon migration into post-salt turbidite reservoir fields is from a syn-rift source rock via large basement-involved faults. Migration to post-salt reservoirs occurs when these faults breach the salt layer and create windows where post-salt sediments are welded to the pre-salt sequence. By contrast, seal entrapment in structuring the pre-salt carbonate reservoirs is provided by pinch-out of the syn-rift sequence towards regional highs covered by massive salt itself.

Basins with negligible amounts of salt occur along the Equatorial Margins of Eastern South America and Northwest Africa. These are predominantly offset margins in which the entire shear rift system followed closely the morphology of older continental structural trends, mainly of high grade metamorphic rocks. The Equatorial Atlantic Fracture Zones are amongst the largest in the world's ocean-floor. Offset between ridge crests are of the order of 2,000 km, about the same distance of the West Africa coast re-entrance into the Gulf of Guinea. Similar distance is also seen along the trace of volcanic extrusions of the North Brazilian Ridge, suggesting that the main motion of these sheared margins occurred in the continent prior to the final separation between Brazil and Africa. This is also supported by the regional geophysical appraisal of the Northern Brazil and Guyana's upper continental margins, which are compared with the margins offshore Ivory Coast and Liberia. Magnetic maps from Liberia and Amazon display trends with similar wavelengths, and these are oriented normal to the respective coast lines, therefore representing magnetic sources that have remained intact during the Pan-African, Eburnean and Liberian thermo-tectonic events. We suggest that these anomalies represent Precambrian basement fabrics offset by the rifting of South America and Africa. Large rivers such as the Niger and the Amazon accounts for the great Tertiary sediment accumulation off Nigeria and the Amazon continental margins.

Interpretation of modern seismic data sets have led to remarkable oil and gas discoveries in the deepwater realm of the Atlantic Equatorial Margin, offshore Nigeria and Ghana in Western Africa and off the Guyanas and Ceará basins offshore northern South America. We briefly review the petroleum geology of all of these basins and present modern seismic imaging from recently acquired deepwater datasets. These were integrated with ancillary geophysical profiles of magnetic and gravity datasets for the purpose of understanding the nature of the deeper continental crust and mapping of pods with hydrocarbon source rocks, which may yield new hydrocarbon prospects in the post-breakup sedimentary sequence of frontier regions such as the Amazon Cone.