The Structural Framework of the Gabonese Deep Water Margin and Its Conjugate – Impact of Crustal Makeup on Asymmetric Rifting, Sediment Deposition and Petroleum Systems

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ABSTRACT

Recent exploration wells drilled along the Gabon deep water margin by Shell and others have revealed a significant pre-salt gas play with large undrilled structures. We present a new crustal-scale structural interpretation for this margin, providing a conceptual framework to better understand this play. We combine potential field, stratigraphic, well, and seismic data with our current conceptual understanding of hyper-extended margins. We integrate observations from the conjugate margin (Brazilian Sergipe to Jequitinhonha Basins), to understand commonalities and differences along the margin, and their impact on pre-salt prospectivity. The regional framework comprises five structural domains (from North to South): (i) the Rio Muni Transfer margin, (ii) a domain with significant SDR's (mostly in Brazil) and rotational opening, (iii) a hyper-extended domain with horizontal pre-salt stratigraphy and complex faulting, (iv) a hyper-extended domain with deepening basement and wedges of pre-salt sediments due to off-set stacking. Our data indicates potential exhumed lower crust in this segment. Finally, (v) a domain of hyper-extended crust with exhumed mantle, and again significant pre-salt sediment wedges. The mapped boundaries between these segments correspond to oceanic transfer zones suggesting a correlation of crustal mark-up (i.e. cratonic crust under domain iii vs. Pan-African Mobile Belt crust under domain iv & v), and the early rift development. Early in the rift the Gabonese Interior Graben, and Brazilian Reconcavo-Tucano-Jaitoba Basins are 'aborted', with strains being transferred newly formed faults in the present-day Rio Muni transform margin. The impact of these structural variations on the pre-salt hydrocarbon system is broad. The variation in pre-salt stratigraphy and stacking geometries leads to variations in source rock age, distribution and depth. Differences in the underlying basement and rift kinematics affect heat flow and uplift/subsidence history, and the complex interplay of different fault generations, rift abortion and accommodation zones introduces a degree of stratigraphic variability along the margin. For example, changes in depositional environment over structurally controlled, intra-basin highs are observed. We conclude that detailed regional and 'deep crustal' understanding combined with detailed stratigraphic analysis of pre-salt sediments is key for sweet-spotting the remaining potential of the Gabonese Deep Water pre-salt plays.