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Stratigraphic evolution of a Cretaceous deep-water gravity-driven system on a strike-slip setting in the Ceara Basin, Brazilian Equatorial Margin

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Introduction

Over the past two decades, the Brazilian Equatorial Margin (BEM) has emerged as a significant frontier for deep-water hydrocarbon exploration, driven by major Oil and Gas discoveries in turbidite systems such as Jubilee in Ghana and several others in the Guyana-Suriname basins. Among these promising regions is the Ceará Basin, located in the eastern BEM, within a tectonically complex zone marked by the transition from divergent to transform margins.

Unlike classical passive margin settings, the Ceará Basin has been shaped by transform tectonics, which implies the distribution of submarine canyons and the geometry of gravity-driven deposits into deep water.

This study aims to investigate the canyons' morphology and the stratigraphic evolution of Cretaceous gravity-driven deposits such as turbidites, debrites, and mass transport complexes (MTCs) using 3D and 2D seismic, well data, and the seismic geomorphology technique.

Method

A 3D Pre-Stack Depth Migrated (PSDM) seismic dataset covering ~2,000 km² (normal polarity), 112 seismic lines, totaling 6,577 linear kilometers, and wireline logs from 29 exploration wells (GR, SP, DT, ILD, RHOB, NPHI) were utilized.

Key stratigraphic surfaces were interpreted to map the interval of the Cretaceous and generate horizon slices along it. RMS amplitude attributes highlighted sandstone-prone zones, and seismic geomorphology techniques were applied to interpret depositional features. Faults were mapped using coherence attributes to understand structural frameworks of the basement and rift/post-rift strata.

Results and Conclusions

This study identified a major north-south Albian–Cenomanian canyon, confined by a structural high likely linked to an antithetic fault. Initially linear and straight, the canyon evolved into a meandering, confined system. The Aptian Top marks the transition from Post-Rift to Drift phases, with successive regressive events from the Albian to Cenomanian eroding earlier records and stacking gravity-driven deposits within the canyon. Well data indicates a vertical stacking pattern, with basal Albian mudstones transitioning to thick Cenomanian sandstones (~150 m). From the Turonian onward, reduced sandstone sediment supply led to canyon infill with mud-rich strata, suggesting deposition in a non-confined setting. RMS amplitude and geomorphological analyses show sediment input shifting from NE–SW on the platform to N–S in deep water, controlled by reactivated rift faults. Unlike classical passive margins, the BEM’s transcurrent setting influences gravity-driven deposits.

These findings underscore the role of structural highs and reactivation of transcurrent faults in guiding sediment pathways, with implications for locating turbidite deposits farther basinward than previously drilled wells.