Frontier Prospectivity of the Deepwater Pará–Maranhão Basin

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ABSTRACT

The deepwater Pará-Maranhão Basin remains one of the least explored regions along Brazil's Equatorial Margin, yet early interpretations of high-resolution 2D seismic data suggested substantial hydrocarbon potential. Shallow-water discoveries, including the PAS-9/11 oil field and the sub-commercial MAS-5 well. These exploration wells confirmed two functioning petroleum systems and the presence of Cenomanian–Turonian source intervals consistent with those found in adjacent equatorial basins. Recent deepwater discoveries in the Ceará and Potiguar Basins, demonstrate the effectiveness of these petroleum systems and highlight the potential for analogous stratigraphic and structural plays in Pará-Maranhão. This study focuses on crustal architecture, volcanic features, and drift-phase sedimentation to better characterize the basin's frontier potential.

Covering approximately 100,000 km² in water depths from 100 to more than 4,000 m, the basin has seen only one deepwater exploration well. The singular deepwater well, Harpia (PAS-027) well was drilled in 2011 with a TD of 5,690 m in 2,060 m of water (Fig 1). This wildcat encountered oil shows in allochthonous Miocene carbonate debris within the PAMA fold-and-thrust belt (F&T B) (Fig. 1), confirming an active hydrocarbon generation but leaving the broader deepwater region untested.

Our analysis incorporates ~19,400 km² of newly acquired PAMA 3D seismic data and derived seismic attributes. Imaging of key Cretaceous units benefits from the application of advanced DM-FWI velocity model building workflows. This approach improves the final velocity model which leads to a better understanding of the crustal detail.
The area overlies Equatorial Atlantic oceanic crust and is intersected by the Saint Paul Oceanic Fracture Zone, producing variations in crustal thickness, flexural geometries and igneous intrusions/structures. Shipborne magnetic data and seismic evidence indicates multiple magmatic phases from the Albian through the Miocene, with volcanic highs exerting long-term control on sediment fairways. Post-rift sedimentary sequences reach up to 8 km in thickness and include channels, lobes, mass-transport complexes and extensive turbidite systems (Fig 1). Seismic attributes highlight well-defined Cretaceous and Oligocene channel–lobe systems and suggest reservoir continuity beyond the mapped 3D footprint. Some volcanic highs appear to host potential carbonate build-ups. Amplitude anomalies and AVO responses within the data further support the presence of hydrocarbon-charged intervals.

Modern 3D seismic imaging now provides a clearer understanding of stratigraphic, volcanic and structural relationships in this underexplored basin. These new insights significantly enhance the assessment of deepwater prospectivity, confirming the Pará-Maranhão Basin as a compelling frontier exploration domain.

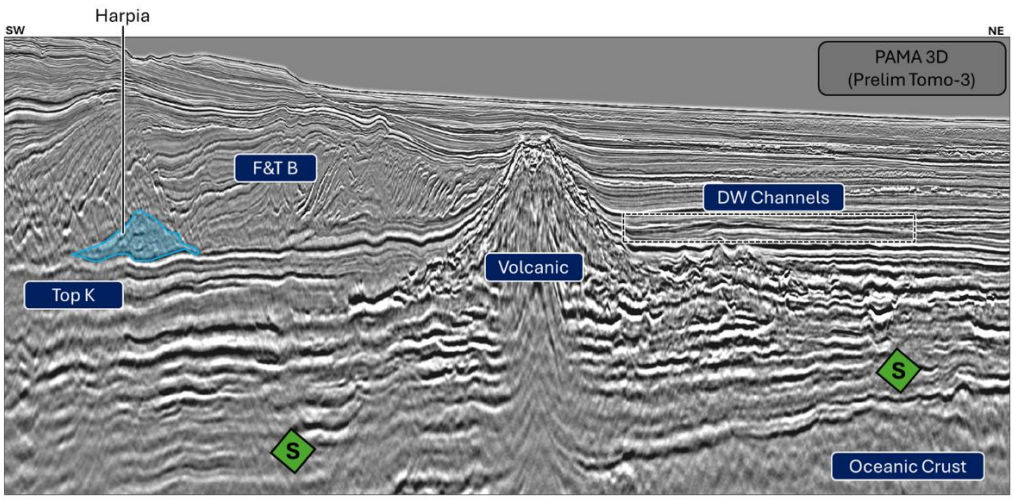

Figure 1: Preliminary PAMA 3D arbitrary line with key features labeled.