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Equatorial Atlantic Conjugate Margins: Comparing Early Stratigraphic Architectures and Depositional Histories

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Summary

The integrated analysis of seismic profiles, well data and plate reconstructions reveal a wide range of rift and drift phase elements on the conjugate margins between the St Paul and Guinea Fracture Zones. Rifted basement architectures and post-rift sedimentary units are separated by basement highs and former transform margin segments. This analysis focuses on the comparing the early margin geometries and initial passive margin sequences (~112-65 Ma) between the, once adjoined margins of northern South America and northwest Africa.

Introduction

The opening of the Equatorial Atlantic developed between transfer zones in the form of pull-apart basins (Antobreh et al., 2009). Aptian extension continued until the onset of oceanic crust production and the marine connection of the Central and South Atlantic Oceans was established. The integrated analysis of seismic profiles, well data and plate reconstructions reveal a wide range of rift and drift phase elements on the conjugate margins between the St Paul and Guinea Fracture Zones. Rifted basement architectures and post-rift sedimentary units are separated by basement highs and former transform margin segments. This analysis focuses on the comparing the early margin geometries and initial passive margin sequences (~112-65 Ma) between the, once adjoined margins of northern South America and northwest Africa. In this study we utilized approximately 385,000 km 2D and 411,000 km^2 of 3D seismic data (Fig 1). Limited well and field data was available for analysis. The GPlates plate reconstruction software (version 2.5.0) was used for accurate plate reconstructions in the region.

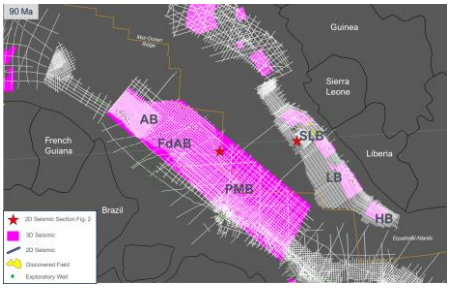

Figure 1: *90 Ma GPlates reconstruction map showing the available seismic data library, exploratory wells, fields. Amapá Basin (AB), Foz do Amazonas Basin (FdAB), Para Maranhão Basin (PMB), Sierra Leone Basin (SLB), Liberia Basin (LB), Harper Basin (HB).*

It is widely accepted that the Aptian crustal break-up between northwest Africa and northern South America evolved as a series of right-lateral pull-apart basins between the West African Craton and the Amazonian Craton (Antobreh et al., 2009; Mullin et al, 2018). Margin segment types alternate between divergent and transform along the ~1,000 km conjugate sections of continental shelf. These isolated basins formed amongst cratons and pre-existing terranes within the basement fabric, such as the Rokelide Foldbelt of Sierra Leone and the Araguaia Orogenic Belt in Brazil. Seismic data from divergent margin segments between transfer zones reveal the magnitude of crustal thinning within half-graben systems was impacted by these basement architectural elements. Where a narrow zone (20 km) of rifting is present in the Para Maranhão Basin. Conversely a wide rift zone (~80 km) is present in Sierra Leone/Liberia Basins (Fig 1), where thick sections of the Rokelide Foldbelt extend offshore as structured pre-rift section. In the Amapá Basin (Fig 1), the conjugate margin for the Rokelide example is also noted for its contrasting degree of crustal extension. This asymmetry was likely the result rupture between the boundary of the Amazonian Craton and the West African foldbelt. Crustal thinning in the varied basement domains produced a range of early passive margin geometries. A comparison of early marine sedimentary fill between conjugate seismic profiles, thicknesses and seismic character is quite similar but varies along strike (Fig 2a). Figure 2 illustrates the Late Albian-Turonian packages overlying oceanic crust are quite thick, reaching ~1,600 m. These units are interpreted to as deepwater channels, basin floor fans and turbidites (Fig 2a). Analysis of seismic attributes on 3D seismic volumes (Fig 2 B & C) permits enhanced understanding of the deepwater clastic systems on the conjugate margins.

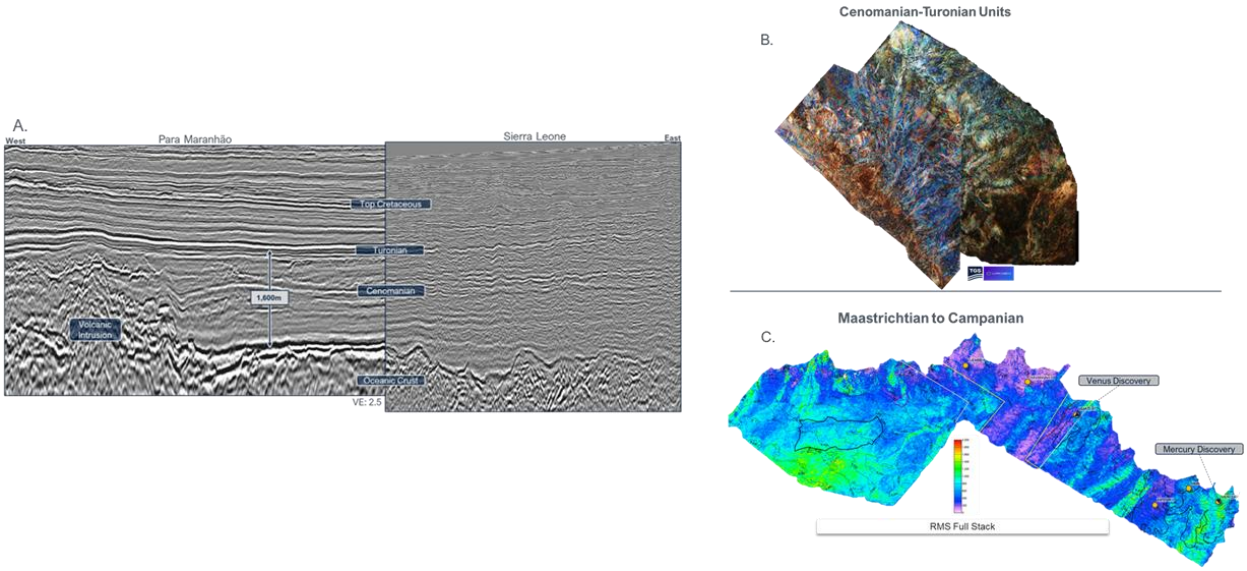

Figure 2: *A) Conjugate seismic profiles from the PMB and the SLB highlighting the similarity of early marine sedimentary seismic facies across the basin. B) AB 3D Spectral Decomposition attribute highlighting Mid-Cretaceous fans and channels; C) SLB RMS attribute with Late Cretaceous Fans and channels.*

Conclusions

By using a robust interpreted 2D and 3D seismic data library, we show conjugate evidence of early passive margin, deep-water reservoir potential charged by Early Cretaceous source rocks. Evidence of high total organic content shale units have been identified from the rift, transitional and early drift phase in the region (De Souza et al., 2021). As the exploration transition from the shelf to deep-water takes place, the region will transition from "frontier" region to a prolific oil and gas producer.

References

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