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Seismic Stratigraphic Interpretation and 3D Modeling of Turbiditic Geobodies in the Mundaú Sub-basin, Ceará Basin, Brazilian Equatorial Margin

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Introduction

The Ceará Basin, located on the Brazilian Equatorial Margin, presents increasing exploratory potential for hydrocarbon accumulations in turbiditic channel and lobe systems. This potential has been continuously reinforced by discoveries in the Guyana–Suriname Basin and by its evolutionary and geological relationship with basins of the African conjugate margin. However, gaps remain in the detailed characterization of the geometry of turbiditic deposits and the distribution of associated facies, especially in distal sectors of the basin. Therefore, the main objective of this study is to perform the seismic stratigraphic characterization and three-dimensional modeling of turbiditic systems related to sand-filled channels and lobes, covering the interval from the Middle Albian to the Upper Oligocene.

Materials and Methods

The study was conducted using depth-migrated 3D seismic data provided by TGS, along with well information from the Amontada well, made available by the ANP. Data analysis was performed using PaleoScan™ 2025.0.0 software, following a methodological workflow consisting of: (i) seismic stratigraphic and chronostratigraphic interpretation of key surfaces; (ii) application of seismic attributes such as RMS Amplitude, Sweetness, and Spectral Decomposition; (iii) use of waveform classification to group seismic traces into similarity-based classes, aiming at the inference of seismic facies; and (iv) three-dimensional modeling of geobodies by integrating previous results to reconstruct depositional geometries and delineate areas with higher exploratory potential.

Results and Conclusions

The study area was compartmentalized into two main zones: East and West. In the eastern zone, from the Middle to Upper Albian, depositional features are dominated by debris flow-related facies, marking the onset of a post-rift transgressive sequence with gravitational infill in unconfined channels. From the Cenomanian to the Upper Campanian, a turbiditic lobe system was established, characterized by high-frequency parallel reflectors and localized amplitude contrasts; the identified lobe shows a SE–NW orientation. From the Upper Campanian to the Upper Maastrichtian, a transition occurs to contourite deposits, marked by subparallel reflectors with moderate to low frequencies and discrete but continuous amplitudes. Between the Upper Paleocene and Upper Eocene, mass-transport deposits (MTDs) reappear, forming large geomorphological valleys. Notably, from the Lower to Upper Oligocene, the record includes small-scale meandering channels predominantly composed of debris flow deposits. In the western zone, amalgamated channels are observed from the Santonian to the Upper Campanian, evolving into meandering systems in response to base-level variations. Subsequently, the stratigraphic configuration becomes similar to that observed in the eastern sector. In both zones, channelized structures exhibit a predominant SW–NE orientation, indicating consistency in sediment supply direction throughout the studied interval. Igneous intrusions associated with the Macau magmatism were also identified, having a direct influence on depositional architecture. The integration of seismic attributes with waveform classification allowed for clearer identification of turbiditic sandstone facies, enabling more precise geobody modeling and reinforcing the high exploratory potential of the Ceará Basin.