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Characterization of Submarine Geohazards in the Mundaú Sub-basin (Ceará Basin) for Offshore Engineering Applications

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Introduction

The Mundaú Sub-basin, located within the Ceará Basin along the Brazilian Equatorial Margin (BEM), represents an area of significant geological, economic, and strategic importance for Brazil. In recent years, the region has gained prominence in scientific studies and exploratory projects due to its geological characteristics, which show notable similarities to other successful offshore margins, such as those in West Africa and the area encompassing French Guiana, Suriname, and Guyana. These regions have already demonstrated high potential for oil and natural gas exploration, further reinforcing expectations regarding the Ceará Basin's capacity to host substantial hydrocarbon accumulations. Given this promising outlook, conducting in-depth studies of the seafloor morphology in the Mundaú Sub-basin becomes essential to assess the presence of geohazards. A detailed understanding of the geological features and dynamics of the submarine relief is a crucial step toward ensuring the technical feasibility and safety of implementing offshore pipelines.

Method and/or Theory

For the development of this study, a detailed morphological mapping of the seafloor in the Mundaú Sub-basin was carried out, with the objective of understanding submarine features that may affect the safe installation of offshore pipelines. Seismic data provided by the National Agency of Petroleum, Natural Gas and Biofuels (ANP) were used and were essential for building a three-dimensional model of the region. These data were processed and interpreted using Petrel 2023 software, a widely used tool in the oil and gas industry for geological modeling and seismic interpretation. The software enabled the creation of a high-resolution 3D seismic model, allowing for the precise identification of relevant morphological structures that are crucial for defining suitable areas for the installation of production systems. The methodology also included the application of seismic attributes such as amplitude, envelope, variance, and GLCM, which significantly contributed to a more refined analysis of heterogeneities in the ocean floor.

Results and Conclusions

The morphological interpretation of the Mundaú Sub-basin, based on the analyzed seismic data, revealed the presence of various features that may compromise the safety and feasibility of pipeline projects in the marine environment, introducing potential geohazards. Among these structures are deep canyons, gullies, micro-depressions, escarpments, steps, landslides, submarine channels, and sediment waves, which are heterogeneously distributed across the study area. These formations suggest a past marked by intense sedimentary activity and indicate potential risks to the stability of pipelines and platform foundations if not properly considered in engineering projects. The seismic attributes used (amplitude, envelope, variance, and GLCM) proved to be highly effective in identifying variations in the seafloor substrate, enabling more detailed mapping of both surface and subsurface structures. The integration of these attributes with the three-dimensional model developed in Petrel 2023 resulted in an accurate representation of the submarine relief, contributing to a better understanding of local geodynamics and providing essential technical support for the safe implementation of future offshore infrastructure along the Equatorial Margin.