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Upper Cretaceous Submarine Channels of Ceará Basin, Brazilian Equatorial Margin: New insights on the reservoir characterization

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Introduction

Submarine channel systems have attracted growing interest in recent years due to their significance in petroleum exploration and their favorable reservoir characteristics. Among these, the basins of the Brazilian Equatorial Margin have drawn particular attention following substantial hydrocarbon discoveries in neighboring regions. In the deepwater sector of the Ceará Basin, submarine channels are emerging as promising new exploration frontiers, driven by recent discoveries in analogous basins and the presence of sand-rich deposits within Upper Cretaceous strata. Despite these developments, key aspects such as depositional elements, sedimentary architecture, and stratigraphic frameworks remain inadequately understood. This study, therefore, seeks to identify and characterize Upper Cretaceous channel systems within the Ceará Basin, with the aim of elucidating their geological controls, sedimentary evolution, and reservoir potential.

Method and/or Theory

In this study, we utilized data from four exploratory wells drilled in deepwater settings, incorporating both lithostratigraphic and biostratigraphic information, along with a depth-migrated seismic volume covering approximately 8,000 km². Through well-to-seismic integration, key stratigraphic reflectors (Upper Albian, Cenomanian, Turonian, and Lower Maastrichtian) were mapped across the study area. These intervals were selected due to their significance in the drift sequence and the geological evolution of the basin. To enhance interpretation and highlight sedimentary features characteristic of deepwater environments, various seismic attributes were calculated, including the Sobel Filter, GLCM Entropy, RMS Amplitude, and Spectral Decomposition. For integrated analysis, unsupervised machine learning techniques were applied to the derived attributes, enabling facies classification based on similarities in attribute values.

Results and Conclusions

Across the Ceará Basin, multiple channels were identified on the four main mapped horizons, with the Cenomanian and Lower Maastrichtian showing the most abundant and well-expressed channel systems. The Upper Albian channels exhibit a relatively straight pattern, appearing confined and intensely eroded features interpreted as products of a transgressive systems tract. Similarly, the Cenomanian channels, also associated with a transgressive systems tract, display a more sinuous geometry, remain strongly confined, and show localized erosion. In the Turonian, channel expression is more subdued, with smaller and less defined features; however, several sand-prone facies were identified, suggesting continued deposition during a transgressive systems tract. The Lower Maastrichtian, in contrast, features well-developed, straight, and highly confined channels, interpreted to have formed during a lowstand systems tract. Among all intervals, the Upper Albian and Cenomanian horizons yielded the most favorable reservoir quality, based on facies classifications derived from machine learning. These intervals contain numerous sand bodies, including lateral accretion packages and apparent coarse lag deposits concentrated in channel centers.