

## Introduction

Recent world-class discoveries along the conjugate West African and Guyana margins have renewed interest in the South American Equatorial Margin. As a result, Petrobras and industry partners have prioritized this region within their exploration portfolios. The offshore Brazilian Equatorial Margin (EQM) comprises the Foz do Amazonas, Pará-Maranhão, Barreirinhas, Ceará, and Potiguar sedimentary basins and remains one of the last underexplored offshore regions of the country. Given the vast extent of the EQM, a comprehensive review of its prospectivity is beyond the scope of a single paper. Therefore, this abstract focuses specifically on the prospectivity of one of them - the Ceará Basin.

Despite limited drilling, notable offshore wells within the sector include Pecém, Amontada, and Canoa Quebrada, confirming the presence of effective source, reservoir, and trap elements. Additional legacy wells encountered good-quality reservoirs and hydrocarbon shows but were not commercial at the time. This paper presents an integrated seismic screening approach aimed at identifying and de-risking stratigraphic and structural leads beyond the drilled areas, providing encouragement for continued exploration and future discoveries in this frontier basin.

## Method

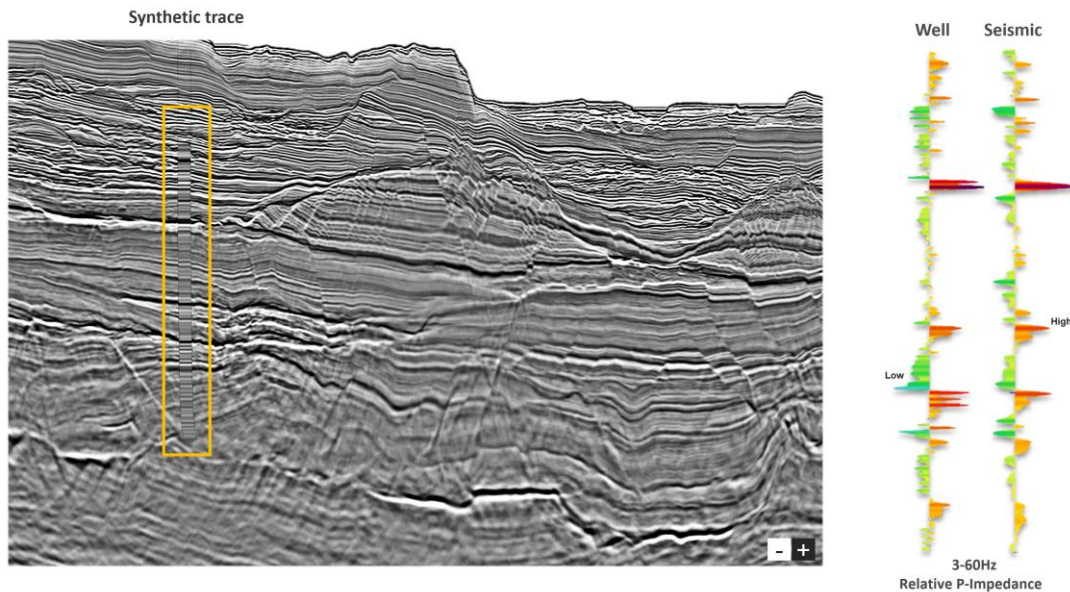
The Ceará Basin developed as part of the Brazilian Equatorial Margin during the Early Cretaceous opening of the Equatorial Atlantic. Basin formation was strongly influenced by oblique plate separation and transform tectonics associated with the South America - Africa breakup, resulting in a tectonic style distinct from the passive margins of southeastern Brazil. Transtensional deformation along fracture-zone led to the segmentation of the basin into sub-basins bounded by basement highs and fault blocks.

Initial rift and syn-rift deposition was followed by post-rift thermal subsidence, allowing the accumulation of thick marine sedimentary sequences. The stratigraphy comprises Lower to Upper Cretaceous successions overlain by Cenozoic sediments, with deposition controlled by variable subsidence, relative sea-level changes, and sediment supply. This tectono-sedimentary evolution created favorable conditions for the development of source rocks, clastic reservoirs, and a variety of structural and stratigraphic trapping configurations observed in the offshore Ceará Basin today.

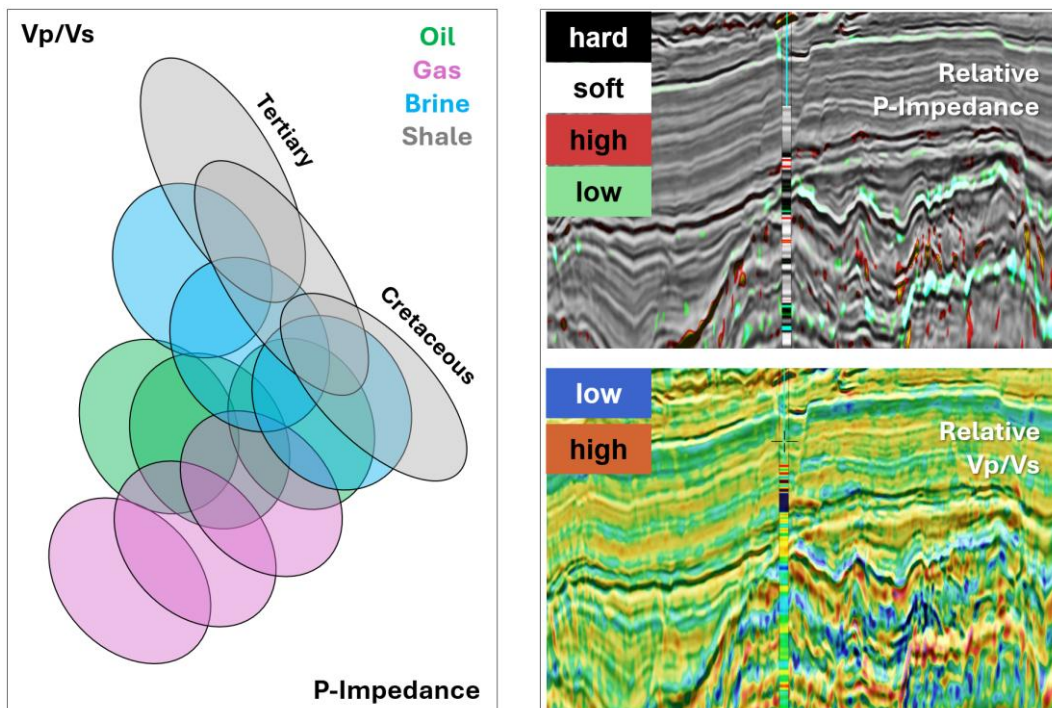
The resulting structural segmentation, lateral stratigraphic variability, and limited well control present significant challenges for prospect identification and risk reduction in the offshore Ceará Basin. Accurate imaging of complex trap geometries and stratigraphic terminations therefore requires high-quality seismic data capable of resolving subtle depositional and structural features.

Modern techniques and tools for acquiring and processing broadband seismic data enable improved risk mitigation during exploration as well as near-field studies. To evaluate the Ceará Basin's prospectivity beyond the limited well control, we implemented an integrated Well to Rock Physics to Seismic workflow leveraging the existing wells and modern dual-sensor broadband 3D seismic data. This type of acquisition provides enhanced low-frequency content, which is critical for improving seismic Amplitude Versus Offset (AVO) fidelity and achieving reliable elastic property predictions. The presence of low-frequency energy in the seismic data

ensures a robust match between derived elastic properties and measured log responses, reducing uncertainty in lithology and fluid interpretation away from the existing exploration wells.



**Figure 1** Blind well comparison of the Relative Acoustic Impedance computed from both the Canoa Quebrada well and Seismic (the grayscale section and well display). In color are the wiggle comparisons of the two, showing a high degree of match between them. The well log has been upsampled to seismic frequencies.



**Figure 2** The cross-plot on the left shows various reservoir scenarios (Oil, Gas, and Brine) at variable depths from Tertiary trough Cretaceous. On the right top and bottom images are Relative Acoustic Impedance and Relative  $V_p/V_s$  ratio accordingly.

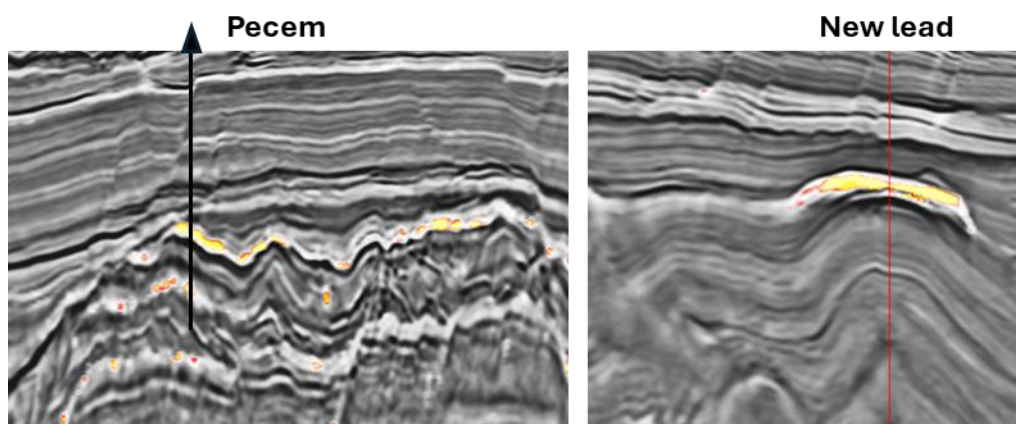
Currently, approximately 7,300 km<sup>2</sup> of multi-sensor broadband 3D seismic data are available in the offshore Ceará Basin. This dataset primarily targets Cretaceous (Paracuru Formation) to Lower Tertiary (Ubarana Formation) reservoir intervals and images depositional systems ranging from upper- to lower-slope settings. The seismic data resolve channel complexes potentially sourced from organic-rich Cretaceous source rocks. Key well control within the survey area includes Pecém (oil and gas, 2012), Amontada (minor gas show, 2012), Canoa Quebrada (gas show, 2012), Well 112 (gas show, 1993), and Well 111 (thick sandstone, 1996).

These wells provided critical calibration points for deriving depth-dependent reservoir and seal properties. End-member lithologies were interpreted from well log data, and their elastic properties including P- and S-impedance, density, P- and S-wave velocities, and Vp/Vs ratio were extracted along with associated uncertainties. The elastic properties were subsequently modeled under varying porosity and fluid saturation scenarios and analyzed as functions of depth and cross-plot relationships. This approach allowed for a better understanding of expected reservoir responses in the area, with P-impedance and Vp/Vs ratio identified as the most diagnostic parameters for lithology and fluid discrimination.

An AVO-based pre-stack seismic inversion was applied to estimate Relative P-impedance and Relative Vp/Vs volumes across the survey. In an exploration context, this approach provides an efficient means of screening large areas for amplitude anomalies and potential leads without the need for a low-frequency background model. The broadband character of the dataset, with well-preserved low frequencies and extended high-frequency bandwidth, results in a strong match between inverted elastic properties and well control. This consistency increases confidence in the interpretation of amplitude responses away from existing wells and supports the extension of prospectivity assessments into frontier areas of the Ceará Basin with limited well control.

### Examples

The interpreted seismic volumes reveal multiple leads characterized by up-dip amplitude enhancement within clastic packages. These features exhibit geometry and seismic responses comparable to proven discoveries in the Basin. The leads span Late Cretaceous to Tertiary intervals and exhibit favorable stratigraphic and structural trapping configurations.



**Figure 3** A Multi-attribute combination of the derived properties that helps to highlight the anomaly of the existing discovery – Pecem and a similar anomaly in a favorable structural setting away from the area.

Given the limited scope of this abstract, it is not possible to present all prospective features identified across the full 7,300 km<sup>2</sup> 3D seismic dataset. However, the number and consistency of identified leads indicate a high degree of prospectivity within the Ceará Basin. Considering the renewed interest in the Equatorial Margin, where Ceará Basin plays a very important role more studies are for 2026 in this area. These include the application of machine learning techniques to support automated detection of faults, horizons, and channelized depositional systems in a data-driven manner.

## **Conclusions**

The Brazilian Equatorial Margin hosts a proven yet underexplored petroleum system with substantial remaining exploration potential. Integrated interpretation of modern broadband seismic data enables more reliable identification and de-risking of prospective stratigraphic and structural traps.

The results of this study highlight several attractive leads that merit further maturation and support continued exploration efforts in the offshore Ceará Basin. Most identified leads exhibit a significant stratigraphic trapping component, emphasizing the importance of high-quality 3D seismic data combined with a sound understanding of local rock physics for effective de-risking of future drilling campaigns.

## **Acknowledgements**

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## **References**

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