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Unlocking Deepwater Prospectivity in the Southern Pelotas Basin Offshore Brazil

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Abstract Summary

Despite industry exploration focus and success on Cretaceous clastic slope and basin floor plays on the Atlantic passive margin for the last 20 years, the southernmost Atlantic margin remained unexplored, that is, until Shell and Total Energies respectively announced in 2022 the giant Graff and Venus discoveries in the Orange Basin offshore Namibia. All the wrong myths regarding a working world class petroleum system in the Orange Basin were finally busted in 2022. On the one hand, there was a model that did not support the presence, quality and oil maturity of source rocks in the Orange Basin. On the other hand, seismic evidence was pointing to the presence of a world class source rock generating hydrocarbons migrating into large traps with amplitude anomalies indicating significant reservoirs.

On the conjugate side of the Atlantic margin, in southernmost Brazil, lies the unexplored Pelotas Basin, one of the world's great Cretaceous and Tertiary Deltas. Despite success in the conjugate Orange Basin, there remain questions on source presence and hydrocarbon phase as well as reservoir presence and trapping mechanisms in traps with a dominant stratigraphic component.

The good news is that the underlying negative ideas surrounding exploration play factors that have led to the lack of exploration activity in Pelotas have finally been superseded. Recent 3D seismic data is revealing that source presence, hydrocarbon phase, reservoir presence, trap configuration and size are all extremely positively arranged in Brazil's Pelotas Basin.

Introduction

Frontier basin exploration requires a detailed petroleum systems evaluation to de-risk firstly and foremost the most critical elements, source rock presence and maturity but also to address the other three key elements, reservoir, trap and seal. As modern seismic data acquisition technology and processing algorithms result in improved imaging, invaluable observations which result in new and reliable data-based interpretations, are obtained. With access to over 20,000 km^2 of modern 3D seismic datasets offshore the Orange and Pelotas Basins in the South Atlantic, a detailed petroleum systems evaluation to de-risk source rock presence and maturity and to address the other three key elements, reservoir, trap and seal has been carried out.

Method and/or Theory

For the Atlantic deep to ultra-deep-water environment the first challenge is identifying a potential source rock with the right burial conditions and thermal regime to be mature to produce hydrocarbons. For the purpose of de-risking the key petroleum system elements, a full and consistent petroleum system evaluation was carried out using all available data. This included a review of existing plate tectonic reconstructions, definition of a stratigraphic framework, identification of potential source rock intervals from the tectono-stratigraphic framework as well as from seismic character to enable source rock maturity modelling, finally supported by identification of seismic and non-seismic hydrocarbon indications. This was accompanied by trap, reservoir and seal de-risking from the tectono-stratigraphic framework and evaluation of the first ever available 3D seismic dataset in the Pelotas Basin.

Results

Excellent quality fast-track data available soon after the last shot point of the first ever 3D seismic dataset available in the southern Pelotas Basin, acquired in 2024, confirmed the extension of the

Aptian source rock seismic character (Davison et al., 2018). A series of high amplitude, low frequency events associated with a decrease in acoustic impedance and AVO Type IV anomalies indicate at least three pulses of source rock deposition. Additionally, an extensive BSR (Bottom Simulating Reflector) towards the western portion of the 3D has enabled the generation of a BSR-derived thermal maturity model (Vohat et al., 2003) which places the source rock in the oil window. On the seabed, a series of pock marks aligned in a NW-SE trend, are clearly associated with the thickest source rock section which reaches up to 400m in the central part of the survey area.

The Pelotas delta has been previously considered to be a muddy delta, a model based on the results of a single well (BP-1), drilled in shallow water on the present-day shelf. Conversely, seismic data indicates several prospective intervals from Aptian/Albian up to an inferred Turonian age, all with AVO Type II and AVO Type III response, associated with significant potential hydrocarbon accumulations.

Comparing 3D seismic indications across the margin, in the Orange Basin the main prospectivity is limited to the Cretaceous section below the thick Middle to Upper Cretaceous Mass Transport Deposits (MTDs). In contrast, Pelotas MTDs are not observed until the Tertiary, resulting in a much thicker prospective section (Figure 1).

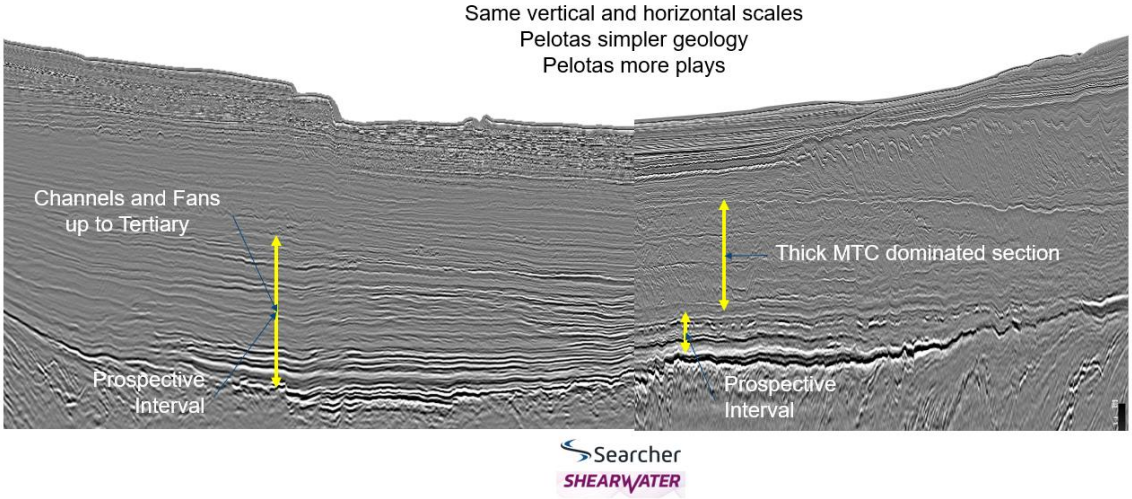

Figure 1: Pelotas Basin PostSTM fast track 3D seismic in depth (left) and conjugate Orange Basin PreSTM fast track 3D seismic in depth, comparing prospective sections across the margin.

Conclusions

With exploration moving into deeper water and more high-quality seismic data available in this setting, we are observing southern Atlantic petroleum systems in dateail for the first time and our understanding of prospectivity is advancing at a fast pace. 3D seismic is an essential tool allowing these systems to be identified and evaluated. With undrilled huge fan complexes with AVO Type III response which can be mapped on both sides of the margin, overlying a proven world class Aptian source rock, the exploration success story has just begun for the Pelotas Basin.

References

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