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Assessing the Pre-Neogene Play of the Tobago Trough

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Summary

Summary is not available

Introduction

The Tobago Trough is a fore-arc basin associated with the Lesser Antilles Arc, which separates the Caribbean Sea from the Atlantic Ocean. Located north of the island of Tobago, the Tobago Trough has a complex structural history. Although a frontier basin, existing discoveries adjacent to the Tobago Trough have targeted shallow biogenic/thermogenic gas and condensate accumulations, only scratching the surface of the hydrocarbon reserves potential in this area.

Extrapolating the trend of these Tertiary discoveries along the flanks and into the Tobago Trough and comparing AVO responses has aided in determining the potential of deeper, untested plays in the pre-Neogene.

The study (Figure 1) was conducted on 2,448km of broadband dualsensor PGS GeoStreamer MC2D depth data comprising sub-surface interpretation and amplitude analysis. Aditionally, a petroleum systems assessment was undertaken which reinforced the concept of a deeper, pre-Neogene hydrocarbon play that includes the Upper Cretaceous source rock. This source interval is proven in adjacent basins; Columbus, East Venezuela and Guyana-Suriname. Besides gas, oil reservoirs are a credible target in the Tobago Trough based on encouraging evidence for a thermogenic source rock (Schneider et al., 2012).

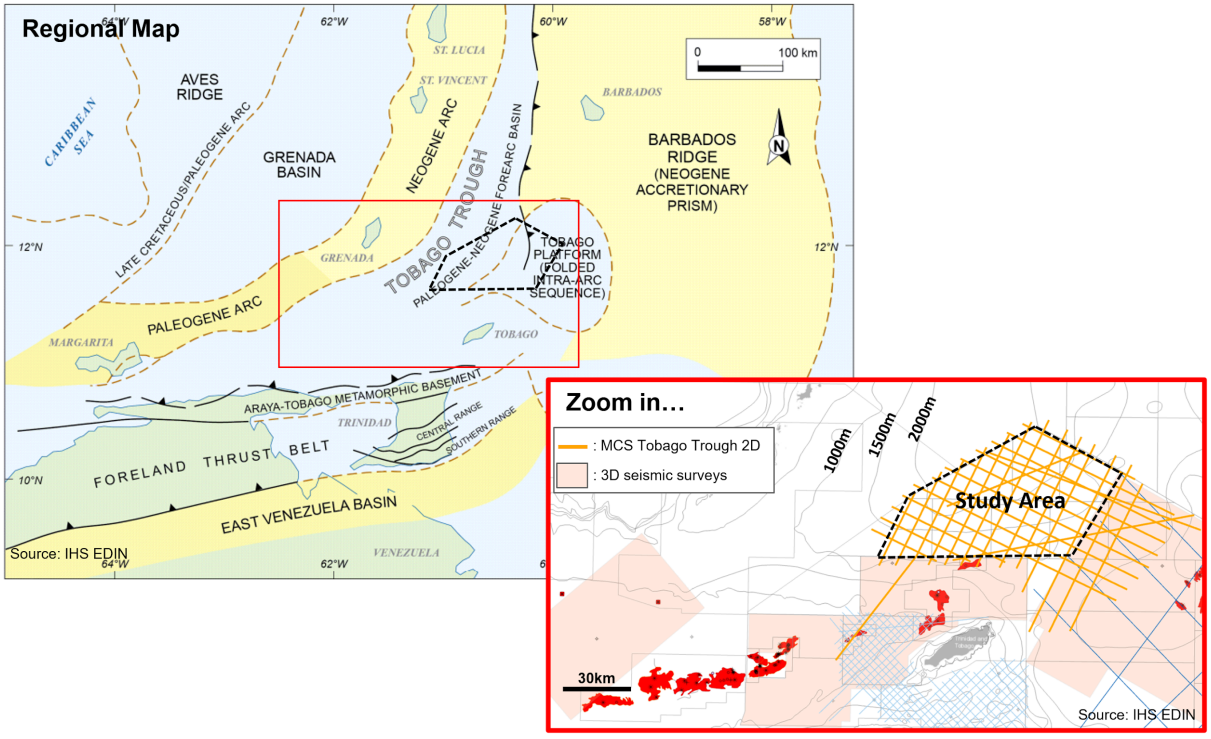

Figure 1 *Project study area, defined by data coverage.*

Structural Setting & Evolution

The Tobago Trough forms a marine fore-arc basin at the southern end of the Caribbean – Atlantic accretional plate boundary, where the gradual transition into the North Coast Coche Fault Zone results in transpressional – transtensional tectonic events, resulting in a series of flower structures and localized depocenters.

Following the separation of North and South America and subsequent convergence of the Caribbean and Atlantic plates, a series of island arcs were formed, most notably the Lesser Antilles in the Neogene. Later compression and inversion in the Mid-Miocene generated a regional unconformity – clearly visible on seismic data.

The Lesser Antilles marks the northern limit of the Tobago Trough that reveals similar oblique slip tectonics that created the Patao KK High, a northeast – southwest oriented structural high which constrains the basin to the south. The Patao KK High has confirmed a working petroleum system in place due to exploration efforts resulting in several hydrocarbon discoveries following structural trap trends.

Stratigraphy & Petroleum Systems

The stratigraphic record within the Tobago Trough is thought to include sediments as old as Mid-Cretaceous, perhaps older. At its greatest, sediment thickness reaches 10km (Speed et al., 1989). A range of source and reservoir rocks are believed to extend into the undrilled Tobago Trough, which can be broadly divided into two main petroleum system groups:

- The Neogene Play consists of Pliocene, Miocene, Eocene and Oligocene sources, charging the Upper Miocene and Pliocene Orinoco delta turbidite fan system. Presence of a thermogenic source is evident from hydrocarbons recovered from nearby fields along the Patao KK High, which produce a mixture of thermogenic / biogenic gas and condensate from shallow Pliocene reservoirs (e.g., Rio Caribe & Hibiscus Fields).

- The Cretaceous Play comprises reservoirs in the Paleogene, Eocene and Cretaceous sequences (Escalona et al., 2008; Persad, 2015) with structural-stratigraphic combination traps along the northern flank of the Patao KK High. Albian to Turonian source rock deposits are prolific over the region, known locally as the Naparima – Gautier Formation. Oil production appears as a realistic scenario for the Tobago Trough, when considering the oil-prone analogue of the Woodbourne Field in Barbados, which has produced 12mmbbl oil from Eocene sandstones. Biomarker, carbon isotope and sulfur data indicate that the oils originate from a marine, Cretaceous source rock interval, correlating with the oils recovered in Trinidad and Venezuela. Aditionally, the Mahogany, Immortelle and Amherstia oil fields that were discovered beneath gas and condensate accumulations in the offshore Columbus Basin, were also sourced by the Upper Cretaceous Naparima Hill Formation (Persad, 2015).

AVO Analysis

Areas of interest for the AVO analysis were identified during the interpretation of the seismic data where favorable clastic and carbonate facies were delineated as potential exploration targets, which combine petroleum system elements proven in neighboring basins. The AVO signatures were validated using existing nearby dry wells and gas discoveries (Orchid, Iris and Sancoche) to improve accuracy of the results and de-risk the leads.

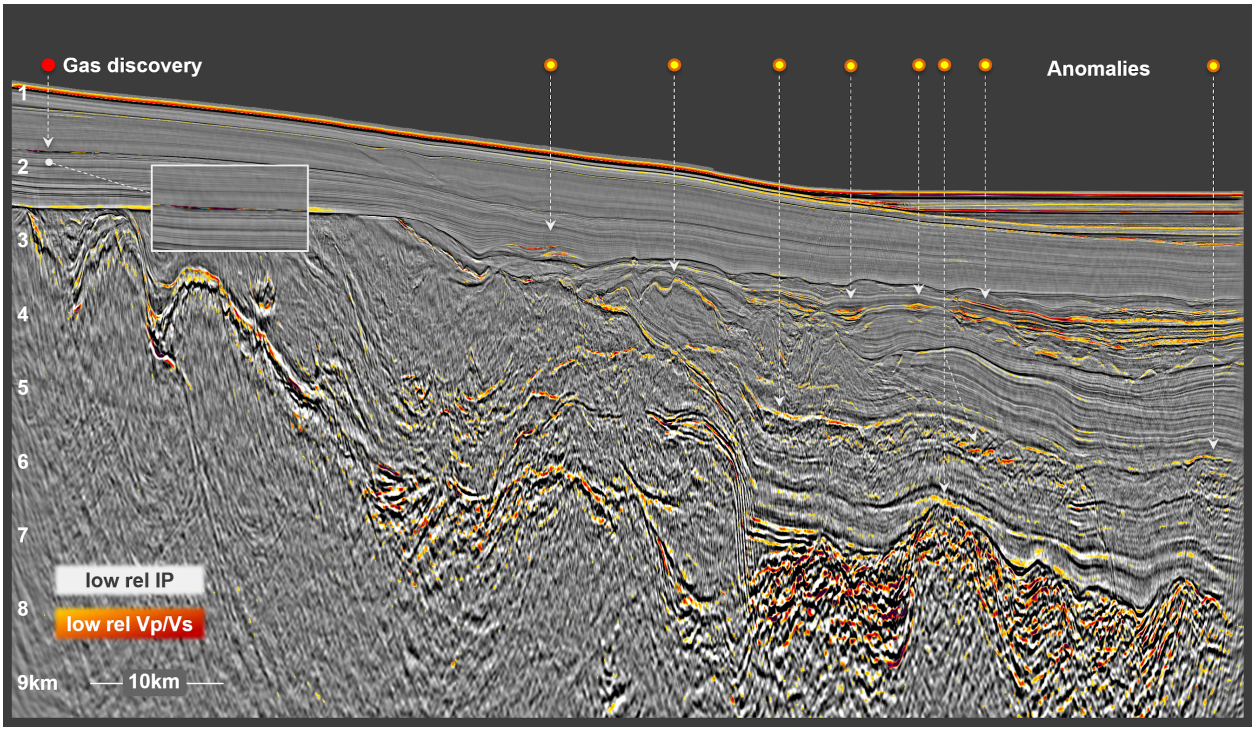

Figure 2 *A 2D line example showing a known gas discovery in a tight sand reservoir (top left). The section is an overlay of the Relative Ip (Acoustic Impedance) and Vp/Vs attributes. Anomalies below the Mid Miocene unconformity demonstrate a different character.*

An example line is shown in Figure 2, where the grayscale background represents the Relative Acoustic Impedance (rel. Ip) and the colored overlay is the Relative Vp/Vs attribute (rel. Vp/Vs). Low Vp/Vs anomalies (red and orange colors) are observed at various levels. A known gas discovery has been confirmed by the attribute (top left). Deeper sub-unconformity targets are shown with pin-arrows however, they exhibit a slightly different character to the shallow gas discovery, implying fluid hydrocarbons might be present in those intervals.

Conclusions

Sharing numerous petroleum system elements with neighboring basins that have experienced recent exploration success, puts the Tobago Trough in a favorable position.

Despite the lack of well data, several leads and features have been identified within the Tobago Trough, estimated to range from Late Cretaceous – Pliocene, displaying similar responses to the nearby gas discoveries. Additionally, some AVO results below the Mid Miocene unconformity show a different signature than the typical local gas response, further supporting the model for potential oil-prone thermogenic source rocks.

These identified leads and features are characteristic of hydrocarbon accumulations within clastic units, visibly constrained to stratigraphic sequences and often brightening up-dip. The untested stratigraphic-structural combination traps in the pre-Neogene provide a host of exciting leads to pursue in the upcoming license round.

A new 3D seismic survey over the study area would be beneficial for the next stage of exploration. This would enable more refined prospect interpretation, volumetric calculations and better understanding of trap morphology.

References

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