

## Appraising Hydrocarbon Potential with Regional Prestack Seismic Data – An Offshore Eastern Canada case study.

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### Summary

Orphan Basin is a promising deepwater exploration area in offshore Eastern Canada. In addition to the producing basins of East Canada, there are highly prospective, under-explored basins with potential for exciting new discoveries and world-class oil production. Frontier acreage is adjacent to recent discoveries in Bay du Nord, Mizzen, Harpoon, and existing fields such as Hibernia, White Rose, Terra Nova and Hebron. Access to new acreage, transparent fiscal terms and a predictable land-sale policy make East Canada an attractive region for oil and gas exploration.

Understanding the elastic properties of reservoirs is key in frontier exploration but can be very challenging, due to the lack of well information, limited regional geological understanding, and the quality and reliability of seismic data available.

This case study illustrates how these challenges can be addressed through an integrated solution from broadband seismic acquisition to elastic properties, applied recently to the underexplored deepwater Orphan Basin, offshore Eastern Canada.

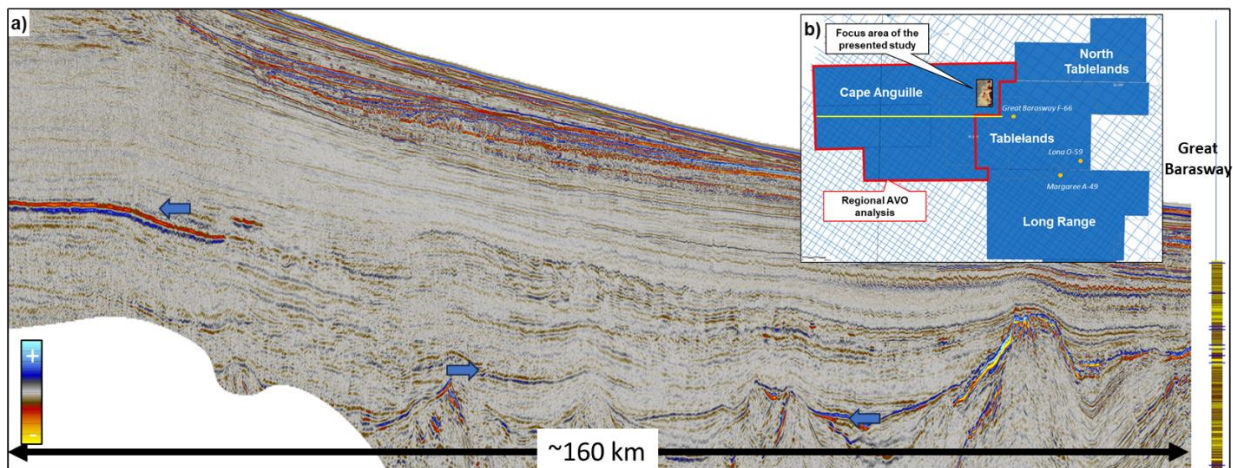
### Introduction

PGS with joint venture partner TGS has been acquiring 2D and 3D multi-client data in Newfoundland and Labrador since 2011. The library offshore Eastern Canada is extensive and the seismic-based geological products for Newfoundland and Labrador are comprehensive. The Orphan basin, north of the prolific Jeanne d'Arc Basin, is a large basin of more than 150 000 sq. km located in water depth ranging from 200m to 4 000m, in which a petroleum system has been established (Enaschescu, M et al., 2005) and presents excellent exploration potential.

Exploration targets include Late Jurassic to Early Cretaceous fluvial to shallow marine sandstone reservoirs sourced by prolific oil-prone Late Jurassic marine shales. The mainly extensional/passive margin includes large structural traps and thick regional seals.

### Analysis and workflow

Three wells are present in the region of the study (Figure 1): Great Barasway F-66 (drilled in 2006), Lona O-55 (drilled in 2010) and Margaree A-49 (drilled in 2013). These wells penetrated the Tithonian to Kimmeridgian interval and encountered the main reservoir (Upper Jurassic) and source rock in the area and would be the primary ground truth measurements for the rock physics understanding. Potential reservoirs from Lower Cretaceous to Lower Tertiary are stratigraphically positioned above the Kimmeridgian source rock superhighway. The existing fields and discoveries are often located in rotated fault blocks in the Jurassic section and adjacent to tilted half grabens. The acquired 3D multisensor streamer data is reliable for structural and stratigraphic interpretation, prestack seismic attributes and rock property analysis.

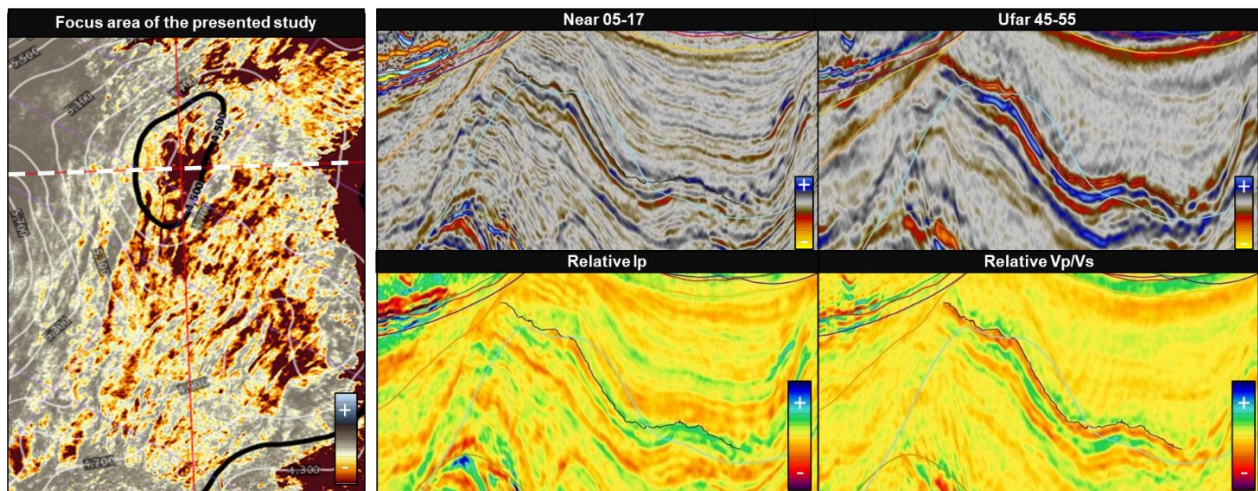


**Figure 1** a) seismic line (Ultrafar 45-55 deg angle stack) transecting over the Cape Anguille dataset indicating some potential interval of interest in the Tertiary (left hand side) and in Cretaceous and Jurassic interval (middle right section) b) Basemap showing 3D multi-client multisensor streamer datasets coverage with newest Cape Anguille outline highlighted in red. On the right hand side of the image, the Great Barasway with Gamma Ray log is giving an indication of where the reservoir units.

The continuous high-resolution seismic datasets cover Long Range, Tablelands, North Tablelands and Cape Anguille (Figure 1) surveys and provide a seamless high-quality dataset over 22 469 sq. km for exploration. In the present paper, we will focus mainly on the Cape Anguille dataset representing around 10 000 sq. km (red polygon in the Figure 1b). An integrated team of imaging and quantitative interpretation specialists performed an iterative AVO QC plan during the processing sequence to ensure that the final prestack data was fit for purpose and AVO/AVA compliant for further Quantitative Interpretation (QI) analysis of mainly Class II anomalies (Figure 2). The Cape Anguille area was processed following a broadband prestack depth migration sequence based on the upgoing wavefield (a direct product of the multisensor streamer acquisition).

During the post-migration processing sequence, a particular focus was preservation and enhancement low frequency content, gather flatness, multiple attenuation, angle stack decomposition (with up to 55 degree incidence angle of useable data), frequency harmonization between the angle stacks, and noise reduction.

To facilitate a more rapid assessment of the regional prospectivity potential of the entire area, an AVA screening workflow was implemented consisting of the estimation of the elastic properties (relative acoustic impedance, shear impedance and  $V_p/V_s$ ) from the derivation of the intercept-gradient. The Shuey 3 term equation was used as higher reliable angle of incidence were available. Five angle stacks were used for the intercept-gradient estimation with the farthest angle range being from 45 to 55 degree. The regional workflow allows the identification and mapping of the relative  $V_p/V_s$  response at the Upper Jurassic level (Figure 2) followed by a more localized area inversion (around 1 000 sq. km on the Eastern side of the Cape Anguille survey). The latter was performed using 3 terms Amplitude Versus Angle (AVA) seismic inversion of the wells as a guide, but mainly using the broadband seismic data only (Figure 2). The Margaree and Lona wells were used for a rock physics understanding and for the amplitude calibration of the elastic properties' response.



**Figure 2** AVO Class II anomaly shown in reflectivity data and relative elastic attributes over a small portion of the Eastern part of Cape Anguille focusing on a Jurassic fault bounded lead.

This recent work on prestack seismic attributes has demonstrated fan geometries in the younger section of the Orphan basin and the northern portion of the Flemish Pass basin as well as some opportunities in the late Cretaceous and Jurassic. This has allowed to further derisk a Jurassic lead identified previously based on the regional product.

## Conclusions

3D regional multisensor broadband seismic datasets acquired in the Orphan Basin combined with rock physics understanding and prestack data inversion demonstrates the reliability of the data for AVA screening and prospectivity evaluation purposes. The data allowed the refinement of the inversion for a detailed local appraisal of hydrocarbon potential.

The datasets and products discussed in this study form a robust platform for a more thorough review and provide improved geological understanding to assess the risk of an under-explored basin offshore eastern Canada.

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## References

Enachescu, M. et. al., 2005, Evolution and petroleum potential of Orphan Basin, offshore Newfoundland, and its relation to the movement and rotation of the Flemish Cap based on plate kinematics of the North Atlantic. In: Petroleum Systems of Divergent Continental Margin Basins: 25th Annual, Vol. 25, 75 –131, Society of Economic Paleontologies and Mineralogists.