PGS, in partnership with TGS, have been acquiring modern 3D GeoStreamer data offshore Canada since 2015. The South Bank 3D survey was acquired in 2020 over an area of 2,635 km$^2$ using multi-sensor towed streamer technology with 16 streamers (8 km in length) in the Province of Newfoundland and Labrador.

The survey is located across the eastern slope of Grand Banks in the Salar Basin and enables further investigation of the petroleum system elements which legacy 2D data had already indicated were present and suggested there is a significant exploration potential in the area. A promising new play concept was identified in the Upper Cretaceous to Paleogene slope settings.

The new 3D data was acquired over an extensive clastic fan system and proved that sand reservoirs are present at large scale throughout the Upper Cretaceous to Paleogene sequence. Using a simultaneous inversion of velocity and reflectivity (PGS Ultima) on AVO-compliant GeoStreamer data provides a high-resolution velocity model, with relative impedance and relative density estimates to aid litho-facies classification. In combination, these attributes helped identify the petroleum system elements and support exploration across the area.

![3D display showing a geo-body extraction from the upper marine fan (lobe 3) and its corresponding PGS Ultima relative density response.](image)
De-risking potential prospectivity in frontier areas of Canada’s petroleum basins

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Inversion (FWI) followed by Least-squares Reverse Time Migration (LS-RTM) has been employed to invert for subsurface velocity and reflectivity models. Initially, PGS introduced a new seismic inversion scheme that combines both inversion into a single process, PGS Ultima. A key aspect of the novel approach is the extraction of the low- and high-wavenumber components of the earth model, enabling the simultaneous update of the velocity and reflectivity with minimum crosstalk. The approach is equivalent to performing FWI and LS-RTM simultaneously, where both velocity and reflectivity are continuously updated at each iteration.

INVERSION FOR PRESTACK REFLECTIVITY

The simultaneous inversion workflow has recently been extended to the pre-stack single gather domain, which is crucial for improving our understanding of subsurface elastic properties. A key aspect of the approach is the extraction of angle information using elements obtained from the solution of the reflectivity-based wave equation.

APPLICATION IN A FRONTIER EXPLORATION AREA

PGS’ South Bank 3D seismic survey is located in the Belize Basin, which is a Early Cretaceous, isolated rift basin with passive margins rift from late Cretaceous period and onward. Many fine events have been identified along the margins using existing seismic data. They are interpreted as Oligocene in age, and the main prospectivity is believed to lie in these fans originating from the shelf and shelf-edge deltas. Class 1 and 2 anomalies are observed in the nearshore interval, along with Class IV responses in the deeper sections analogous to a modeled source rock in the region.

Figure 1 shows the PGS Ultima velocity model and stacked reflectivity from single gather output from the simultaneous inversion. The resolution and density of these seismic events are improved from the PGS Ultima result. Note the improved signal-to-noise ratio in the PGS Ultima result. The response of the pre-stack gather is illustrated in Figure 2. The following two figures (Figure 1 and 2) represent extraction of relative Vp/Vs ratios over a key prospect, which has three vertically stacked reservoir units. The difference between the images is that the section on the top was produced in a conventional flow using the Vp/Vs ratio on the pre-stack gather, which has three vertically stacked reservoir units. The difference between the images is that the section on the top was produced in a conventional flow using the Vp/Vs ratio on the pre-stack gather, which has three vertically stacked reservoir units.

The simultaneous inversion processes, i.e., velocity, single-parameter reflectivity, and the derived relative impedance and density, improve individual layer evaluation and provide better property constraints for QI analysis and anomaly interpretation.

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