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Atlantic Margin Source Rock Characterization – Implications for Future Exploration in Uruguay and Nova Scotia

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Summary

In frontier basins source rock presence, quality and maturity are the main elements to de-risk before undertaking any exploration activity. A full-scale integrated source rock de-risking exercise is therefore required. This type of study has been undertaken along the Atlantic margin from offshore Uruguay (Rodriguez et al., 2022) to offshore Nova Scotia, obtaining positive results which can guide future exploration in these basins.

Methodology and Workflow

The source rock is de-risked using all available information including plate tectonic reconstruction and analysis of the tectonostratigraphic evolution to identify suitable environments for source rock deposition. Conjugate Margin evidence can be key, together with well information, geochemical seabed sampling and coring results as well as sea surface naturally occurring oil seeps. Seismic evidence includes identification of regional high amplitude soft kick events associated with AVO Type IV anomalies, considered to be a positive source rock character similar to that identified offshore Namibia (Davison et al., 2018) which indicated the presence and maturity of a world class source rock. Other seismic evidence includes DHIs (Direct Hydrocarbon Indicators), fluid escape and seabed features as well as BSRs (Bottom Simulating Reflectors) found at the base of methane hydrate zones. Based on gas hydrate stability conditions, water bottom temperature and thermal conductivity, the thickness of the methane hydrate stability zone can be used to estimate shallow geothermal gradients and associated surface heat flow (Minshull, 2011, Vohat et al., 2003 and Rodriguez et al., 2021).

Slope to Deep Water Setting Offshore Nova Scotia

In the deeper water of the Scotian Slope lies the Tangier 3D dataset (Figure 1), a state of the art wide azimuth 3D processed through the most advanced algorithms available at the time and providing an unprecedented image in a complex salt basin setting. The Aspy well drilled in 2019 proved the petroleum system, though source rock quality and reservoir presence remain as key risks. Source rock characterization indicates the presence of a good quality, thick and mature, probably of mid-Jurassic age, source rock in the western sector. At the same time, BSR-derived geothermal gradients together with results from seabed core, Site 41, indicate an anomalously high geothermal gradient to the east, associated with salt diapirs which get close to the sea surface, indicating that younger source rocks could be generating hydrocarbons in the vicinity of these salt bodies.

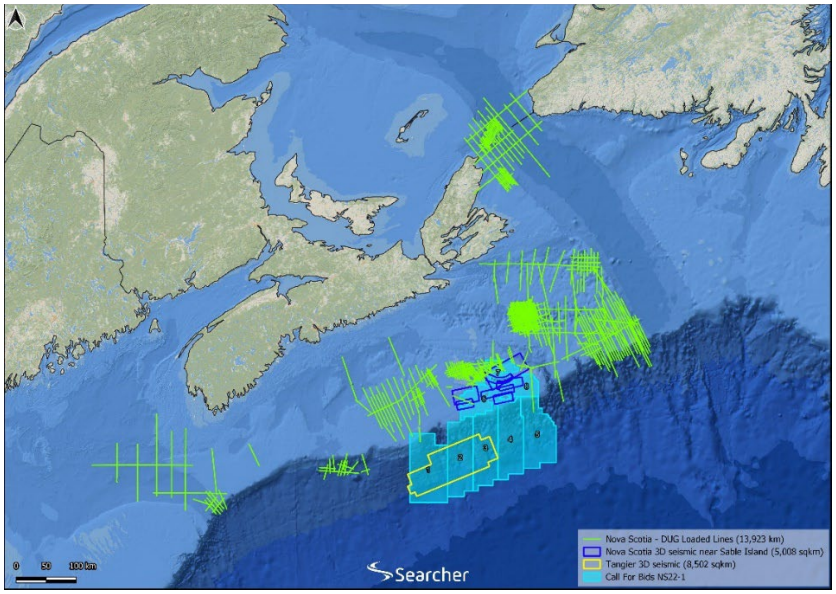

Figure 1. Map showing the location of the 3D datasets available near Sable Island as well as the Tangier 3D dataset. Available 2D seismic lines in green.

At the same, quality controlled, geologically led, automatic interpretation of hundreds of horizons together with RMS amplitude, spectral decomposition and AVO related horizon attributes were used to identify possible reservoir fairways into the basin, indicating not only the presence of major sediment fairways but also of significant potential hydrocarbon accumulations (Figure 2).

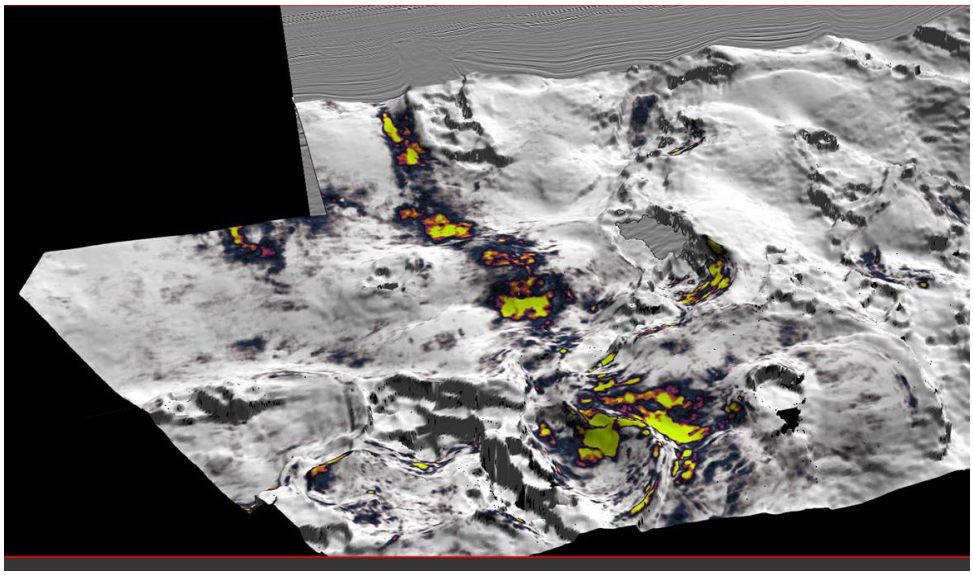

Figure 2. Large Cretaceous Channel overlying interpreted mid-Jurassic source rock, with AVO Type III anomalies in yellow. Image provided by Lyme Bay Consulting

Pelotas Basin Offshore Uruguay

Recent discoveries in Namibia have proven not only the presence and maturity of an Aptian source, but also its ability to generate sufficient hydrocarbons to charge very significant prospects. This has opened-up both slope and basin floor plays in the Orange River Basin and its conjugate margin. Source rock characterization in the Pelotas Basin indicates that the recently proven Aptian source rock offshore Namibia is also present on this side of the margin and is modelled to be thick, good quality and mature for hydrocarbon generation. This together with events associated with extensive reservoir presence point to huge, yet unexplored potential in the Pelotas Basin.

Conclusions

For offshore Nova Scotia, adjacent to the Aspy well location, significant potential has been identified. Source rock characterization has de-risked the presence, quality and maturity of an AVO Type IV Jurassic source rock. Overlying this source rock, a strong and extensive AVO type III anomaly associated with a channel and fan deposit has been identified. This is very similar to the Venus play offshore Namibia where an AVO Type IV source rock is overlain by a Type III fan system with an estimated potential resource of up to 13 BBOE. There are a lot of other plays identified which make the deep water a very attractive opportunity.

For offshore Uruguay, of all the key exploration play elements, the one factor that can be usefully conjugated across the Atlantic is the understanding of the formation and characteristics of the source rock. New imaging and analysis workflows are revolutionizing the understanding of distribution and maturity of source rocks, pointing to huge future potential in these South Atlantic Basins.

Source rock characterization is an essential step in de-risking frontier basins. Where it has been applied source rock characterization is pointing to substantial potential in the deeper water and can be expected to guide future exploration. Identifying source rock sweet spots will lead to more successful exploration campaigns, which is an essential step to address the current global demand for energy security.

References

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