Petroleum system of offshore Labrador, Canada Call for Bids 2025

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ABSTRACT

An offshore 2D seismic database, complemented by two modern 3D seismic datasets, provides a unique perspective of prospectivity in the 2025 Labrador Call for Bids. The datasets allow for reliable mapping and visualization of seismic cross sections which expose crustal architecture and depositional systems associated with the development of a proven, yet untested petroleum system on the slope and deep water. Heat flow measurements and coring samples have identified potential source rocks ranging from the Early Cretaceous to the Paleocene (Enachescu et al., 2007), with evidence of potential reservoirs in Upper Cretaceous and Cenozoic clastic systems. Amplitude versus offset (AVO) leads are identified through extensive seismic interpretation providing insight to hydrocarbon exploration inside the Call for Bids territory.

At the time of writing, the public announcement for the projected 2025 Call for Bids is roughly 20,000 km^2, directly overlying Labrador's Hawke sub-basin, however past Call for Bids have not been constrained to the published polygon. For example, the 2024 Orphan Basin Call for Bids Polygon was ~22,000 km^2 but the released area was ~102,000 km^2 hence requiring a regional approach to the evaluation of the available opportunities.

Utilizing the 2D and 3D seismic stacks and velocity models, complemented with angle-stacks and attribute volumes, fault-bounded amplitude anomalies, toe-thrusted four-way closures, and stratigraphic pinch-outs are clearly observed and characterized by their seismic facies. Interpretation of the data through the latest Call for Bids territory differentiates Labrador as a younger series of sub-basins, with fewer rift-related structures in the Mesozoic section and more intense amplitude anomalies in the Cenozoic compared to the discouraged Orphan Basin, where sub-economic wells have recently plagued the territory.

Locally, only 35 wells have been drilled in the last 50 years, none beyond the present-day shelf edge, representing an underexplored region of the north Atlantic margin. As a result of sparse well data, offshore Canada can be complemented by wells from its conjugate West Greenland Basin where comparisons show seismic character resemblances from potential source rocks in the Upper Cretaceous Markland Formation of Labrador, and the Itilli Formation of Western Greenland (Bojesen-Koefoed et al., 2004).

The basin framework of angular horst and graben geometries provide accommodation space for up to 3 km of these syn-rift source rocks on the shelf and deep-water. The overlying Cretaceous, clastic, Bjarni formation, documented with an average porosity of 15% (Carey et al., 2019), displays onlapping geometries against volcanic basement and are overlain by a south to north expanding Tertiary section including the Mokami formation with up-dip extension and down-dip toe-thrusts where far angle-stacks display ~75% increase in amplitude response compared to near angle-stacks. Cretaceous units thicken in localized troughs and thin or bypass paleo-structural highs, setting up more widespread depocenters for Paleocene marine or lacustrine source rock to be deposited, subside into the oil window (Christiansen et al., 2020), and charge sandy deposits of the Paleocene Cartwright-Gudrid Member and Eocene Kenamu-Leif Member, evidenced by increase of amplitude with offset in 3D seismic.

The untested, deep-water Pliocene to Eocene amplitude play shows potential and should be explored. During the post-drift stage of basin development, subsidence and basinward tilting led to up-dip extension and downdip compression along the Bylot unconformity shale detachment. The Gudrid Member, within the Cartwright Formation, a ~280 m thick sandstone, expands to 800 m thick in deep water with additional potential in the Paleogene Mokami and Kenamu Formations where 400 to 800 m thick packages of fault bounded amplitude anomalies are observed in water depths from 700 m to 2,800 m (Figure 1).

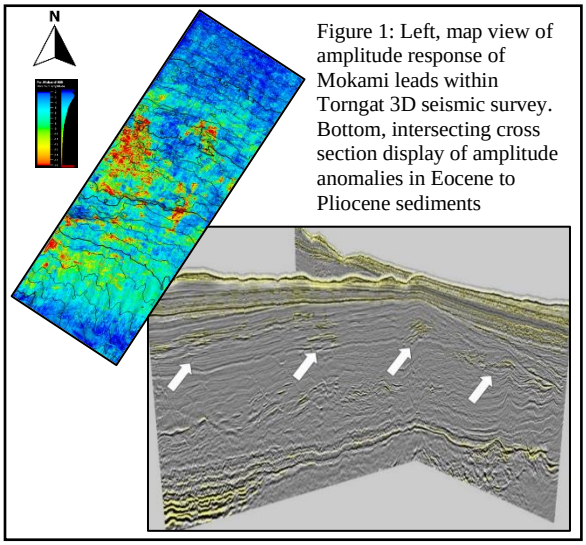

Figure 1: Left, map view of amplitude response of Mokami leads within Torngat 3D seismic survey. Bottom, intersecting cross section display of amplitude anomalies in Eocene to Pliocene sediments