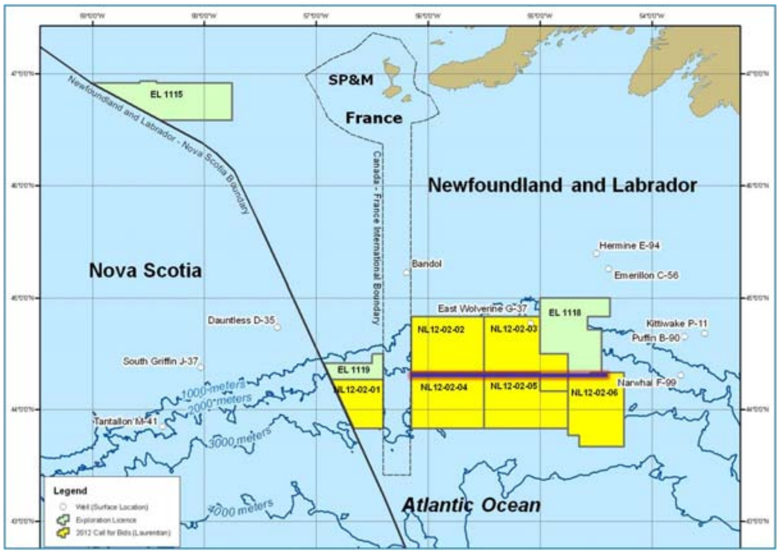
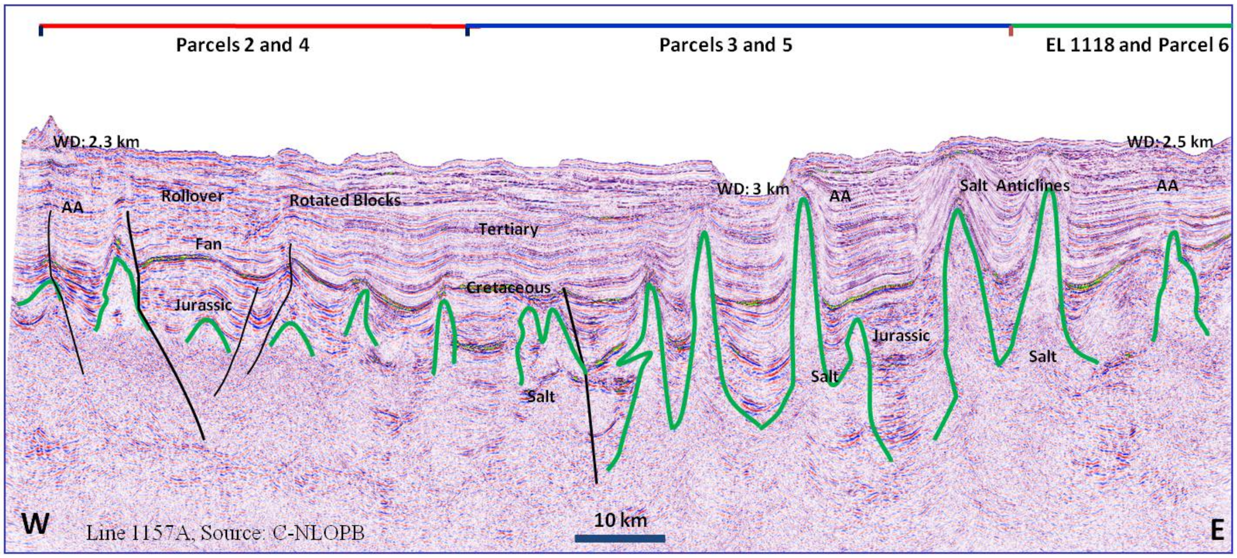
Call for Bids NL12-01, Parcels 1 to 6, Petroleum Exploration Opportunities in the Laurentian Basin,

Government of Newfoundland and Labrador
Department of Natural Resources





By Dr. Michael Enachescu, P Geoph., P Geo.

July 2012

Foreword

This report has been prepared on behalf of the Government of Newfoundland and Labrador Department of Natural Resources (NL-DNR) to provide information on land parcels offered in the Canada-Newfoundland and Labrador Offshore Petroleum Board's (C-NLOPB) 2012 Call for Bids NL12-01. This year the Board has issued two separate Calls for Bids, including:

1. **Call for Bids NL12-01** (Laurentian Basin) consisting of six parcels, and
2. **Call for Bids NL12-02** (Flemish Pass Basin) consisting of one parcel.

These seven parcels on offer comprise a total of 1,798,637 hectares (4,444,529 acres).

Call for Bids NL12-01. This report focuses on Call for Bids NL12-01 that includes six parcels with a total area of 1,589,738 hectares (3,928,328 acres), located in intermediate to deep water of the Laurentian Basin, south of the island of Newfoundland. These parcels are located within an underexplored Mesozoic exploration area with proven reservoir and source rocks. This 60,000 km^2 (23,166 square miles) Mesozoic-Tertiary basin is on trend with the gas producing Sable Subbasin (approximately 275 mmcfd) and the oil producing Grand Banks of Newfoundland (approximately 267,000 bopd from the Hibernia, Terra Nova, White Rose and North Amethyst oil fields). The basin has only two exploration wells with results of the East Wolverine G-37 released in April 2012. As detailed in this report, significant oil and gas potential exists in the six parcels offered for bids. Interested parties will have until **4:00 p.m. NL Standard Time** on **November 1, 2012** to submit sealed bids for Call for Bids NL12-01 (Laurentian Basin).

Call for Bids NL12-02. Call for Bids NL12-02 consists of one parcel comprising 208,899 hectares (516,201 acres), located in intermediate water of the Flemish Pass Basin, northeast of the island of Newfoundland. The Flemish Pass Basin is a proven petroleum basin that contains the recent Mizzen significant oil discovery which contains recoverable reserves in the range of 100-200 mmbbls. The bid for this parcel situated within the southern part of the Flemish Pass Basin will also close at **4:00 p.m. NL Standard Time** on **November 1, 2012**.

This report should be referenced as ***Enachescu, M.E., 2012. Call for Bids NL12-01, Parcels 1 to 6, Petroleum Exploration Opportunities in the Laurentian Basin, Government of Newfoundland Department of Natural Resources.***

I acknowledge the contribution of earlier researchers in the area: J. Wade, A. Grant, B. MacLean, D. MacAlpine and many other scientists at GSC Atlantic who contributed to the Grand Banks Basin Atlas (1989). I also acknowledge the professionals of ConocoPhillips and BHP who mapped and drilled the first deepwater well in the Laurentian Basin. Thanks are due to D. Brown of CNSOPB, the NSPFA researchers and OETRA, C. Jauer of GSC Atlantic and P. Fagan of A. J. Fagan Consulting. This work could not have been completed without valuable information provided by the C-NLOPB and Government of Newfoundland and Labrador Department of Natural Resources. I am grateful to W. Foote, D. Middleton, L. Hicks, L. Cook and D. Spurrell for edits and suggestions, B. Kendell, M. Stoyles and J. Owens for help with illustrations.

For information on how to submit a bid in this offshore Newfoundland and Labrador Call for Bids please go to http://www.cnlopb.nl.ca/ and see the **March 9, 2012, News Release**.

Acronyms used in this report:

NL = Newfoundland and Labrador (the legal name of the Province)
NS = Nova Scotia
NSPFA = Nova Scotia Play Fairway Analysis
C-NLOPB = Canada-Newfoundland and Labrador Offshore Petroleum Board
NL-DNR = Government of Newfoundland and Labrador-Department of Natural Resources
GSC = Geological Survey of Canada
OETRA = Offshore Energy Technical Research Association
NL12-01and 02 = identifiers for the two 2012 Call for Bids
PL = Production Licence
EL = Exploration Licence
EP = Exploration Permit (onshore only)
SDL = Significant Discovery Licence
DPA = Development Plan Application
TD = Total Depth
bopd = barrels of oil per day
mmcfd = million cubic feet per day
tcf = trillion cubic feet
bcf = billion cubic feet
mmbbls = million barrels

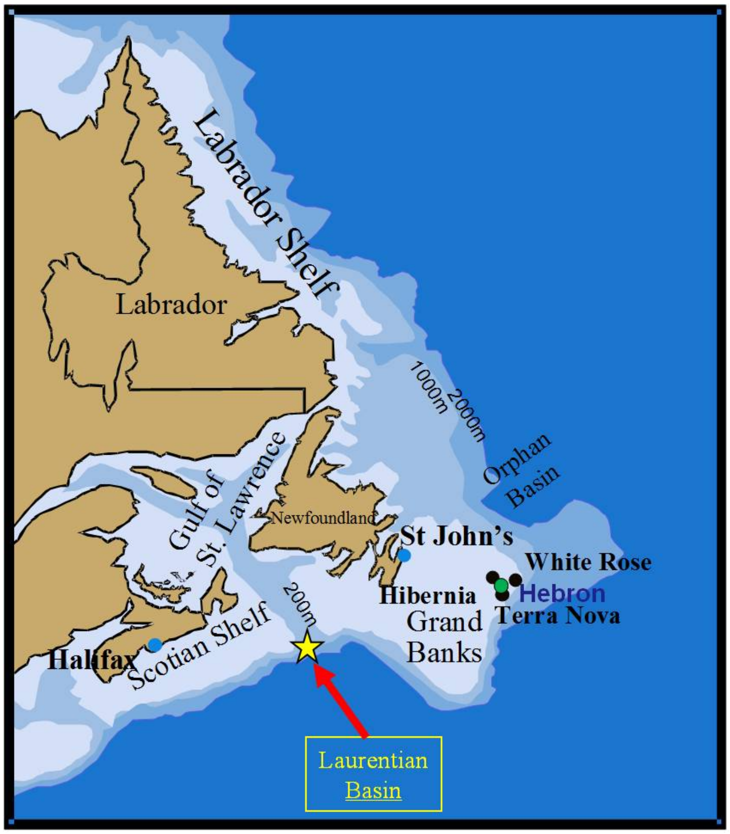


Figure 1. Location of Newfoundland and Labrador's major offshore oil fields and of the Laurentian Basin, south of the island of Newfoundland (yellow star).

Report Content

Foreword

1. **Introduction** 5
2. **Exploration and Development Background** 7
   - **2.1. NL Petroleum Production** 7
   - **2.2. Emergence of Nalcor Energy** 7
   - **2.3. Recent Exploration and Research Activity Offshore Nova Scotia** 7
   - **2.4. Recent Exploration Activity in Laurentian Basin** 8
   - **2.5. Geological Overview of Mesozoic Atlantic Basins** 9
3. **Overview of Regional Geology of the Laurentian Basin** 11
   - **3.1. Lithostratigraphic and Tectonics Charts** 12
   - **3.2. Tectono-Structural sectors** 13
4. **Overview of Petroleum Geology of the Laurentian Basin** 16
   - **4.1. Source Rock** 16
   - **4.2. Reservoir Rock** 18
   - **4.3. Seals** 18
   - **4.4. Hydrocarbon Traps** 18
   - **4.5. Maturation and Migration** 19
   - **4.6. Hydrocarbon Plays and Risks** 19
   - **4.7. Significant Wells** 20
   - **4.8. Seismic Data Quality and Availability** 22
5. **Petroleum Potential of Call for Bids NL12-01 Parcels 1 to 6** 23
   - **5.1. Seismic Data Owners and Coverage** 24
   - **5.2 Seismic Interpretation** 25
   - **5.3. Petroleum Potential Parcel 1** 27
   - **5.4. Petroleum Potential Parcel 2** 28
   - **5.5. Petroleum Potential Parcel 3** 30
   - **5.6. Petroleum Potential Parcel 4** 34
   - **5.7. Petroleum Potential Parcel 5** 35
   - **5.8. Petroleum Potential Parcel 6** 37

6. **Prospects and Leads** 39

7. **Discussion** 40

8. **Conclusions** 41

9. **Further Reading** 42

1. **Introduction**

This report focuses on Parcels 1 to 6 of the C-NLOPB Call for Bids NL12-01, which are located off the south coast of the Province of Newfoundland and Labrador, Canada. All six parcels are situated on the slope and rise of the Atlantic Ocean in an area administered jointly by the NL provincial and Canadian federal governments, through the C-NLOPB. The landsale parcels are within the Laurentian Basin in water depths ranging from 480 to 3590 m, where structural, stratigraphic and composite traps are seen on seismic data. The basin has only two exploration wells: Bandol #1 on the shelf and East Wolverine G-37 in deepwater. Results of the recent East Wolverine G-37 well were released in April 2012. Presently, there are two active Exploration Licences issued in 2009 (ELs 1118 and 1119 operated by ConocoPhillips) in the Laurentian Basin.

Figure 2. Location of Call for Bids NL12-01 parcels.

In 2004 Exploration Permits that were frozen for 30 years due to international and provincial jurisdictional moratoria were transformed into 8 ELs. Exploration on these licenses was finalized with the drilling of the East Wolverine G-37 deepwater well that was declared dry and abandoned in 2010. The basin is a high-risk/high-reward exploration area and is unique in that it is practically unexplored, is close to huge petroleum markets and is located in an iceberg-free zone where year round drilling can be performed. With only one exploration well drilled during 2001 in its shelfal part on French territory and one on the Canadian continental slope, the basin provides a great opportunity for petroleum exploration.

This report provides general background information on petroleum exploration and production on the East Coast of Newfoundland and Labrador and specific geoscience information and hydrocarbon prospectivity of the Laurentian Basin area. It also discusses the specific geology and petroleum potential of the six parcels grouped in the Call for Bids NL12-01 located within the Mesozoic part of the Laurentian Basin.

Basin vs. Subbasin Nomenclature. The C-NLOPB announced on 9 March 2012 the Call for Bids NL 12-01 **(Area "C" - Laurentian Subbasin**) consisting of six parcels.

The boundaries of the Mesozoic Laurentian basin are loosely defined. The deeper bathymetrical feature of the Laurentian Fan and both flanks are part of the Nova Scotia-Newfoundland offshore Mesozoic to Tertiary sedimentary area that is part of the larger Atlantic margin chain of rift basins, subbasins and sedimented ridges. For a long time the area was considered to be depositionaly continuous and to have similar geodynamic evolution as the Scotian Shelf and Slope. There are many similarities in the seismic reflection characteristics of the Scotian Basin and Laurentian Mesozoic area. The Geological Survey of Canada has traditionally considered it a subbasin of the larger Scotian Basin. Also, as there are no clear cross-basin geological boundaries (e.g. basin bounding faults, basement ridges) delimiting a separate disconnected Laurentian basinal area, many Atlantic Margin researchers have considered it a subbasin of the Scotian Basin.

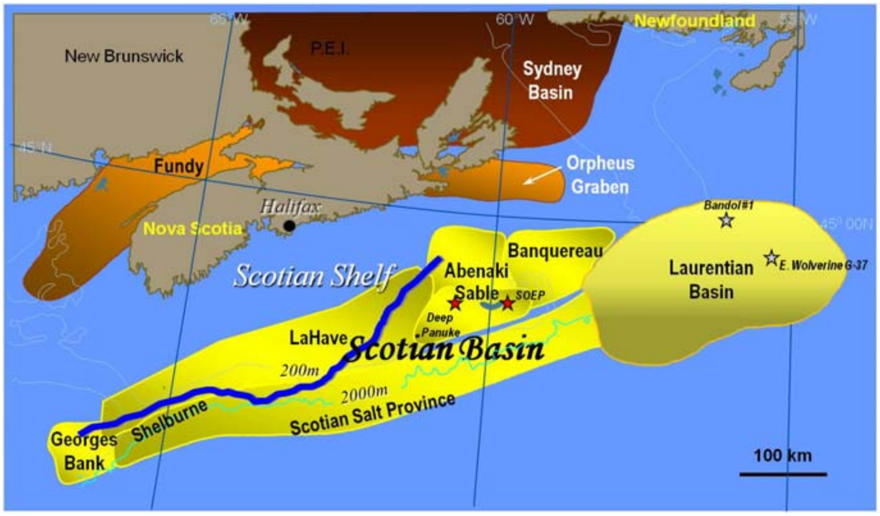


Figure 3. Location of Laurentian Basin in continuity with Scotian shelf and slope basins and subbasins (modified after Hogg and Enachescu, 2005).

However many other authors' studies (e.g. Enachescu and Lines, 2001; Louden, 2002; Enachescu et al., 2005; Fagan and Enachescu 2007 and 2008, Hogg and Enachescu, 2007; Enachescu and Fagan, 2009; Fagan, 2010 (MSc thesis); Fagan and Enachescu, 2011) show the Laurentian area as:

a) a very large Mesozoic-Tertiary sedimentary area of 60,000 square km,
b) being bounded to the North by the Cobequid- Chedabucto (CC) Fault Zone,
c) forming an unusually deep depocenter filled with mostly Jurassic and E. Cretaceous sediments, and
d) an environment where transtensional movements along the CC Fault and its imbricates, as well as on the Newfoundland Transform Fault Zone (NTFZ), have created compressional features.

These clearly distinct features and its large size justify the use of the "Basin" term rather than "Subbasin" for the Laurentian sedimentary area. Consequently the term "**Laurentian Basin**" will be used on all maps and discussions in this report.

More information on the geology of the Newfoundland and Labrador (NL) offshore petroleum potential, including evaluations of earlier Call for Bids of Laurentian parcels can be accessed at: http://www.nr.gov.nl.ca/nr/energy/petroleum/index.html and http://www.nr.gov.nl.ca/nr/energy/petroleum/offshore/offshore.html.

Selected references on the geological setting and petroleum potential of the Newfoundland and Labrador offshore and Laurentian Basin are also provided at the end of this report.

2. Exploration and Development Background

The Canadian provinces of Newfoundland and Labrador (NL) and Nova Scotia (NS) are the only Atlantic jurisdictions north of Florida allowing petroleum exploration on the offshore side of the North American continent. Approximately 800,000 sq km of Mesozoic and Paleozoic areas with oil and gas potential are distributed around the province of Newfoundland and Labrador. Continental margin research and offshore oil and gas exploration have been carried out on the Atlantic region of the province of NL for more than 45 years. Numerous NL-DNR publications discuss the geological setting, exploration history and petroleum exploration of the East Coast of NL (http://www.nr.gov.nl.ca/nr/publications/energy/index.html).

2.1. NL Petroleum Production. In 2011, NL production represented 10% of Canada's total oil production, 32.5% of Canada's light oil and more than 85% of Atlantic Canada petroleum output (http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/sttstc/crdlndptrlmprdct/stmtdprdctn-eng.html). NL's petroleum production comes from the Hibernia, Terra Nova, White Rose, and North Amethyst fields including their satellites, located in the Jeanne d'Arc Basin. In each of the past 5 years, these fields have produced in the range of 250,000 to 350,000 barrels per day of light crude (30 to 35° API) from high quality Mesozoic sandstone reservoirs. With this output, NL is Canada's 3rd largest oil producer and 7th largest oil producer among all American states and Canadian provinces (after TX, AL, CA, ND, AB and SK). In 2011 NL produced 97.3 MMbbls amounting to a daily average of 266,494 bopd.

Over 1.3 billion barrels have been produced to date from the NL offshore area. On the Grand Banks, approximately 1.77 billion barrels of proven remaining recoverable reserves/resources exist. More than 6 tcf of natural gas is discovered on the Grand Banks, but there is no gas production on a commercial basis yet. Jeanne d'Arc Basin developments are the only East Coast North America producing oilfields. The next offshore project Hebron, estimated to contain 707 MMbbls reserves/resources, will be developed starting in 2012 with first oil expected in 2017. Its peak production is estimated to be between 150,000 and 170,000 bopd.

2.2. Emergence of Nalcor Energy. Nalcor Energy - Oil and Gas Inc. (Nalcor) was formed in 2007 by the Government of NL as a subsidiary of Provincial Crown Corporation, Nalcor Energy (http://www.nalcorenergy.com/oil-and-Gas.asp). Nalcor has interest in several offshore fields: West White Rose, North Amethyst and South White Rose Extension (5%), Hebron (4.9%) and Hibernia South (10%) (http://www.nalcorenergy.com/oil-and-Gas.asp). Presently Nalcor has no involvement in the Laurentian Basin exploration; however the company is leading regional research on geochemistry of water bottom cores and oil slicks in the area.

2.3. Recent Exploration and Research Activity Offshore Nova Scotia. Several recent offshore Nova Scotia events have influence on the future activity in the Laurentian Basin. The publication of the Nova Scotia Play Fairway Analysis (NSPFA) Report and Atlas and the research performed by CNSOPB and NS University based geoscientists, have helped understand why the deep wells drilled during 1999-2004 were unsuccessful and where there is a high chance for mature source rocks and quality reservoirs. NSPFA, made available during the summer of 2011, brings new geological arguments for the existence of an Early Jurassic oil prone source rock and distribution of Mesozoic reservoirs on Nova Scotia's slope and deepwater. As mentioned previously the

Laurentian Basin is on geological trend and has similar exploration opportunities as the NS deepwater parcels recently licensed by Shell (spring 2012).

2.4 Recent Exploration Activity in Laurentian Basin. Modern exploration of the basin started after the lifting of several moratoria including arbitration of international boundaries with France in 1992, and settlement of provincial boundaries between NL and NS in 2002. After these important events, the Federal Permits that were issued earlier were converted into modern Exploration Licences in May 2004. The ConocoPhillips (CP) (89%)/Murphy (11%) partnership secured ELs 1081 to 1087 comprising 2.25 million hectares and Imperial Oil obtained EL 1088 consisting of 194,800 ha. BHP farmed into ELs 1081 to 1087 in 2004. Murphy withdrew from the area in 2008, with CP and BHP assuming their interest in all the ELs. A consolidation of CP operated ELs followed in 2008, after a drilling promissory note and acreage relinquishment was completed. EL 1088 was relinquished by Imperial in 2009.

In the fall of 2009, two parcels were offered at the Call for Bids NL09-02. Parcel 1 was acquired by CP (55%) and BHP (45%) becoming EL 1118 and Parcel 2 was acquired by CP (64%) and BHP (36%) becoming EL 1119. A comprehensive presentation on Laurentian Basin petroleum potential titled “Call for Bids NL09-2, Parcels 1 and 2 - Petroleum Exploration Opportunities in Laurentian Basin” (Enachescu and Fagan, 2009) is available from http://www.nr.gov.nl.ca/nr/invest/final_laurentian_basin_presentation.pdf.

After the abandonment of East Wolverine G-37 well in 2010, ELs 1081R, 1082R, 1086R and 1087R were relinquished by CP/BHP. The C-NLOPB Call for Bids NL12-01 discussed in this report includes some parts of the earlier ELs and large portions of the deepwater Laurentian Basin that were never explored or drilled before (Figures 1, 2 and 4).

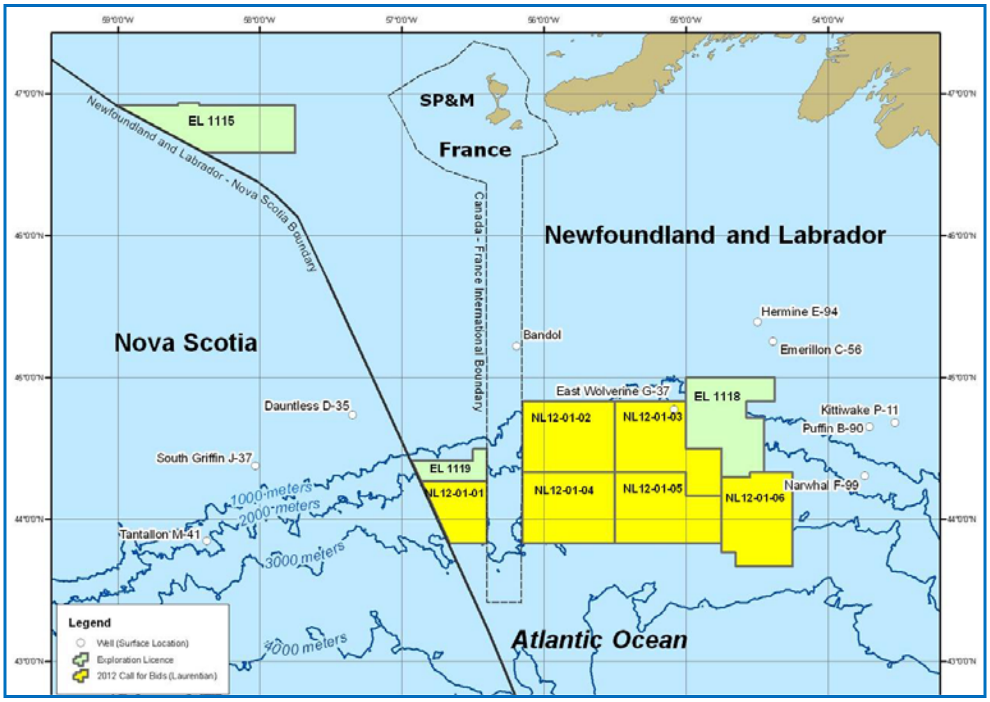


Figure 4. Laurentian Basin 2012 Land Holdings and Call for Bids parcels.

2.5. Geological Overview of Mesozoic Atlantic Basins. The rifting of Pangea during the Late Triassic-Early Jurassic created a chain of intra-cratonic basins generally oriented NE-SW and extending from the Gulf of Mexico to the Barents Sea (Tethys rift stage). In Canada, the Tethys rift basin chain starts with the George's Bank Basin in the south, stretches through the Scotian shelf and slope basins and subbasins, continues with the Laurentian Basin, unto the shallow water Grand Banks basins and then extends to the Flemish Pass and Orphan deepwater basins, and some suggest branches into the Labrador Sea.

Nova Scotia's main basins and the Laurentian Basin were located in a plate margin setting. These basins separated early from their African margin conjugate basins and have been opened to the incipient North Atlantic since the Mid-Jurassic. In addition, the Laurentian Basin is located close to and on an important ocean/continent transform margin initiated in the Middle Jurassic and active into the Middle Cretaceous. As unconfined basins, the deeper parts of the Nova Scotia Slope and Laurentian deepwater basin contain numerous salt tectonics features including detached salt canopies and shale detachment anticlines.

Unlike the Scotian Slope basins, the Grand Banks and Orphan Basin are confined basins situated on continental crust. Only the East and Northeast Newfoundland basins are located on a divergent margin. Repeated intra-continental Mesozoic rift stages took place in the NL basins. The final rift stage became oceanic in the Middle Jurassic in Nova Scotia and in the Aptian-Albian east and northeast of the Grand Banks. Volcanism is reduced in the Laurentian Basin-Grand Banks area. A thick sedimentary prism of 10-12 km exists in most of the Atlantic basins including the Laurentian Basin. Basins are thinner in the South Grand Banks due to inversion and erosion.

The Late Triassic-Early Jurassic salt is generally thick and pervasive throughout the Nova Scotia and Grand Banks basins. Deformation of sedimentary infill was mainly due to extension and salt tectonics; inversion is late and only a secondary mechanism for trap formation. Faulted anticlines that are sometimes salt cored and rotated blocks are the most successful trap types in the Mesozoic basins.

While Nova Scotia's Sable Subbasin has a petroleum system anchored on a predominately terrestrial source rock (Verrill Canyon Fm.), NSPFA has indicated that an older Early Jurassic marginal marine source rock should exist and be abundant in the Shelburne and George's Bank slope and deepwater areas. Based on similarity with other rifted areas, a lacustrine source rock with potential for generating both oil and gas should also fill the initial Late Triassic rifts. In several of the NL east coast basins, an oil prone petroleum system anchored by a predominantly marine source rock (Egret Member of the Rankin Formation of Kimmeridgian age) has produced large oil and gas accumulations. Other Late Jurassic source rock intervals were also logged. Coarse clastics deposition is widespread especially within deltaic episodes during the Late Jurassic-Middle Cretaceous. Some of the best North American oil and gas reservoirs have been drilled in the Late Jurassic-Middle Cretaceous intervals in NS and NL offshore basins.

Up to now, gas fields were found in the Sable Subbasin and the Carbonate margin trend (NS), oil accumulations in the Jeanne d'Arc Basin, Central Ridge and Flemish Pass basins (NL) and gas accumulations in Hopedale (NL) and Saglek (Nunavut Territory) basins. The Laurentian Basin, located between the Nova Scotia Margin and Grand Banks of Newfoundland, has similarities with both areas and is classified as a basin with high petroleum potential. The basin's potential is yet unproven mainly due to the scarcity of drilling activity to date.

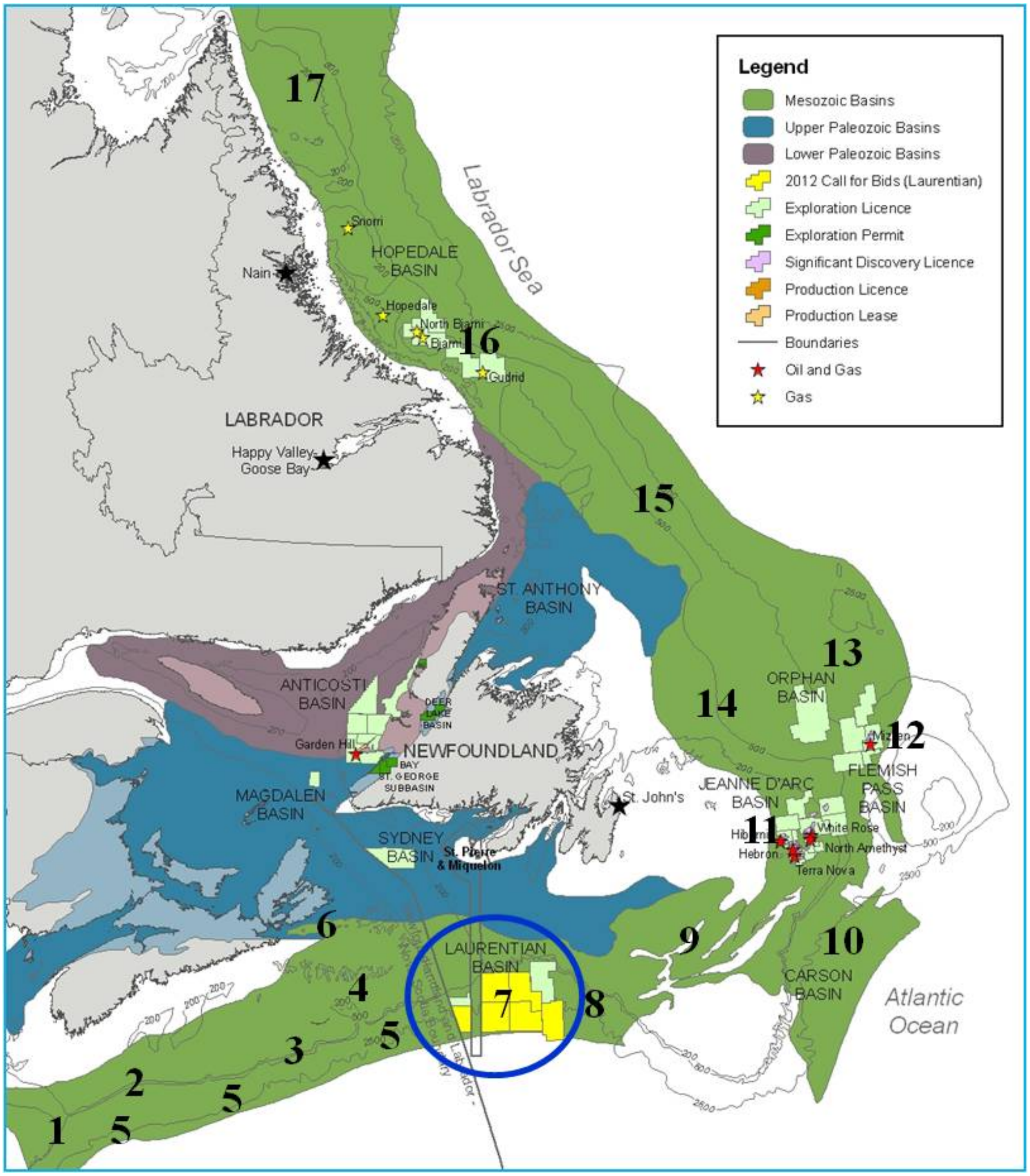


Figure 5. Atlantic Canada offshore basin map. Mesozoic basins are depicted in green, Paleozoic basins are shown in dark blue and dark purple. From south to north the basins and subbasins are: 1 = Georges Bank, 2 = Shelburne, 3 = Sable, 4 = Abenaki, 5 = Scotian Slope, 6 = Orpheus Graben, 7 = Laurentian, 8 = South Whale, 9 = South Grand Banks, 10 = Carson, Bonnition, Salar, 11 = Jeanne d'Arc, 12 = Flemish Pass, 13 = East Orphan Basin, 14 = West Orphan Basin, 15 = Hawke, 16 = Hopedale and 17 = Saglek. Encircled yellow blocks in Laurentian Basin are the 2012 Call for Bids Parcels 1 to 6.

The Grand Banks basins' tectonic-structural framework, geodynamic evolution, stratigraphy and petroleum potential were discussed in detail in several web publications available at: http://www.nr.gov.nl.ca/nr/invest/energy.html. The recent Nova Scotia offshore structural setting and petroleum geology atlas is available from http://www.novascotiaoffshore.com/analysis#atlas.

3. Overview of Regional Geology of the Laurentian Basin

The Laurentian Basin is not set apart from the surrounding offshore Nova Scotia and Newfoundland Mesozoic basins by any obvious geographical or geological or bathymetric features (Figures 5 and 6).

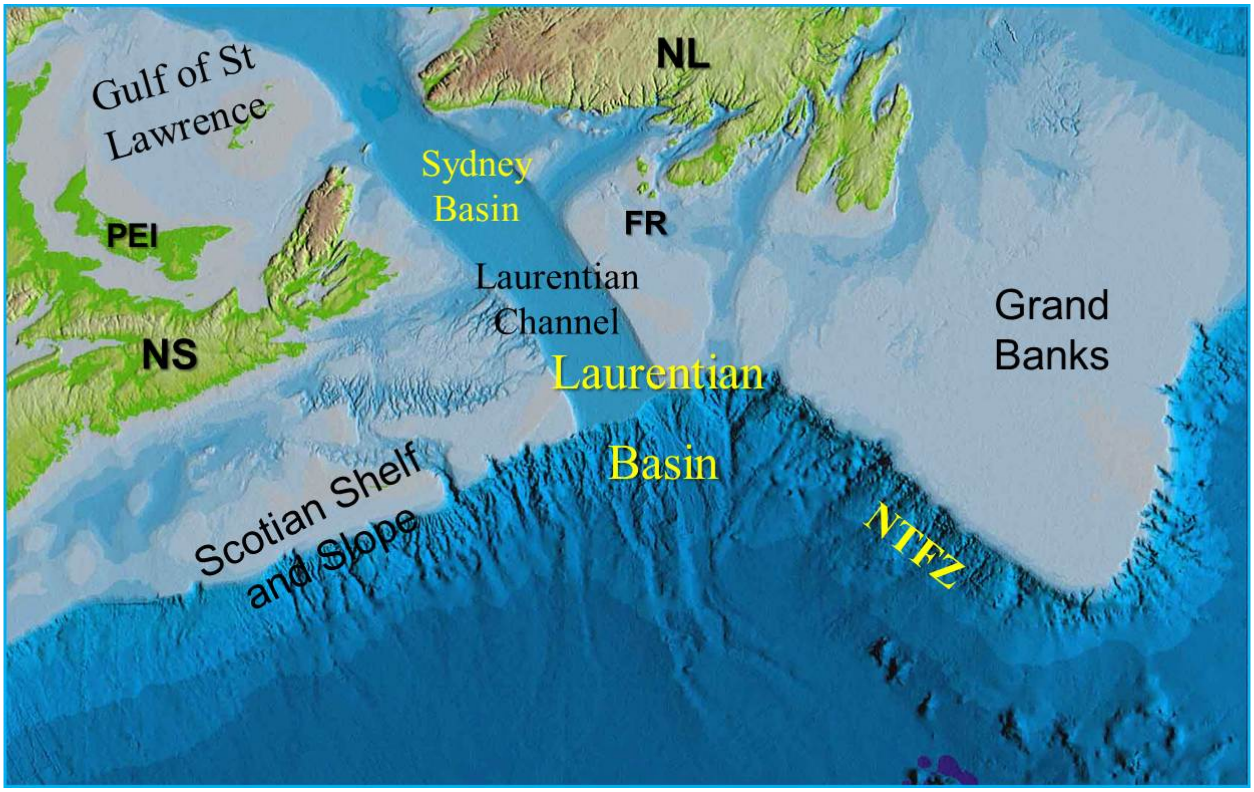


Figure 6. Bathymetric and physiographic features in the vicinity of Laurentian Basin. The basin occupies the Newfoundland and Nova Scotia shelf, the Laurentian Channel (approximately 1000 m water depth) and the Atlantic continental slope and rise. The basin is a hybrid Mesozoic basin developed between the Scotian Shelf and Slope and Grand Banks and along the Newfoundland Transform Fault Zone (NTFZ). NL = Newfoundland, FR = France, NS = Nova Scotia; PEI = Prince Edward Island.

A major basin-bounding fault/hinge zone marks the boundary between the predominantly Paleozoic Sydney Basin and the Mesozoic rifted Laurentian Basin. The Cobequid-Chedabucto (CC) fault system runs east-west along the northern boundary of the basin and a branch of it continues along the Newfoundland Transform Fault Zone (NTFZ). During the Late Triassic - Middle Jurassic the Laurentian Basin had a common evolution and similar depositional regime with the Scotian Basin. In the Middle Jurassic to Early Cretaceous, the Laurentian Basin was situated on a transform margin being extended, trans-tensed and subsided at the junction between the Nova Scotia margin transitional/oceanic crust and Grand Banks continental crust. During the Late Cretaceous - Tertiary the basin continued to subside, tilt and receive massive influx of sediment via the Paleo-St. Lawrence River.

3.1. Lithostratigraphic and Tectonics Charts. Several Scotian Basin lithostratigraphic and tectonics charts applicable to the Laurentian Basin are in use, all based on the lithostratigraphy eveloped by Wade et al. (1989), published repeatedly by GSC and largely embraced by the industry exploring offshore Nova Scotia. This chart was modified by MacLean and Wade (1992), when they published their paper on the Laurentian Basin. Several modifications of MacLean and Wade's chart were used by Young (2005) and Fagan (2010) in their MSc thesis when trying to tie the lithostratigraphy to elements of structural style and petroleum geology of the area (e.g. Figure 7).

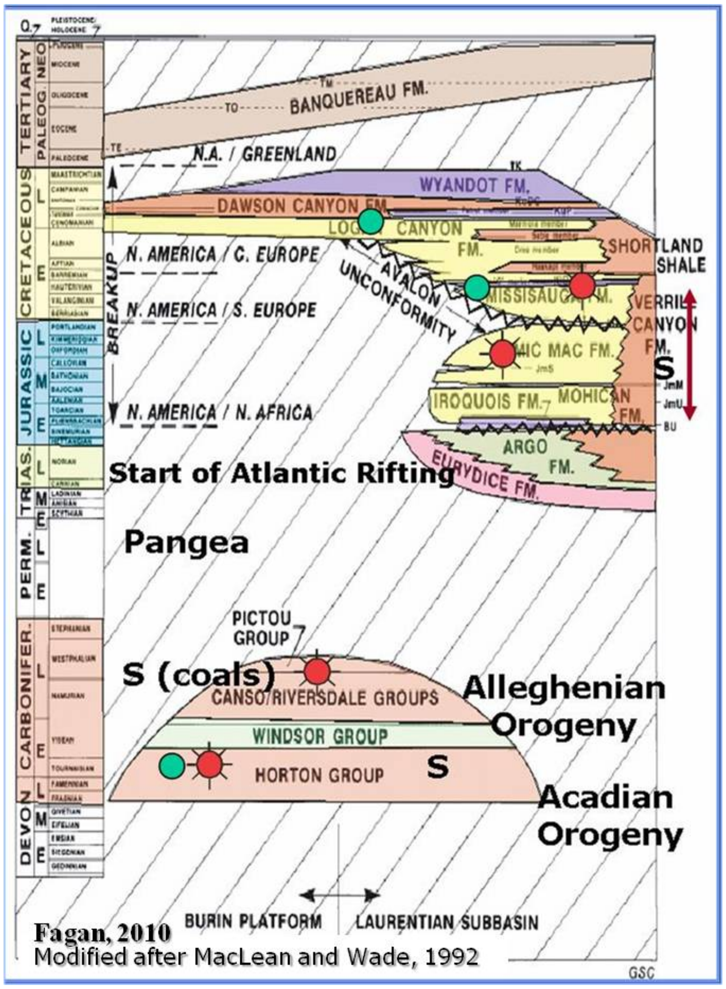


Figure 7. Evolution of the Laurentian Basin; Lithostratigraphic, Tectonics and Petroleum Geology Chart. S = source rocks (after Fagan, 2010; modified from MacLean and Wade, 1992).

The newest chart compilation on the area was published by the OETR Association in 2011 when offshore sequence and seismic stratigraphic studies were performed on the entire Nova Scotia shelf and slope area including the western part of the Laurentian Basin (Figures 4, 5 and 6). The chart is based on detailed biostratigraphy work performed on a set of key wells tied to a large regional grid of modern seismic data (Figure 8) and is available from the Nova Scotia Play Fairway Analysis Atlas (https://s3.amazonaws.com/novascotiaoffshore/atlas/final-atlas/CHAPTER_3_Complete.pdf).

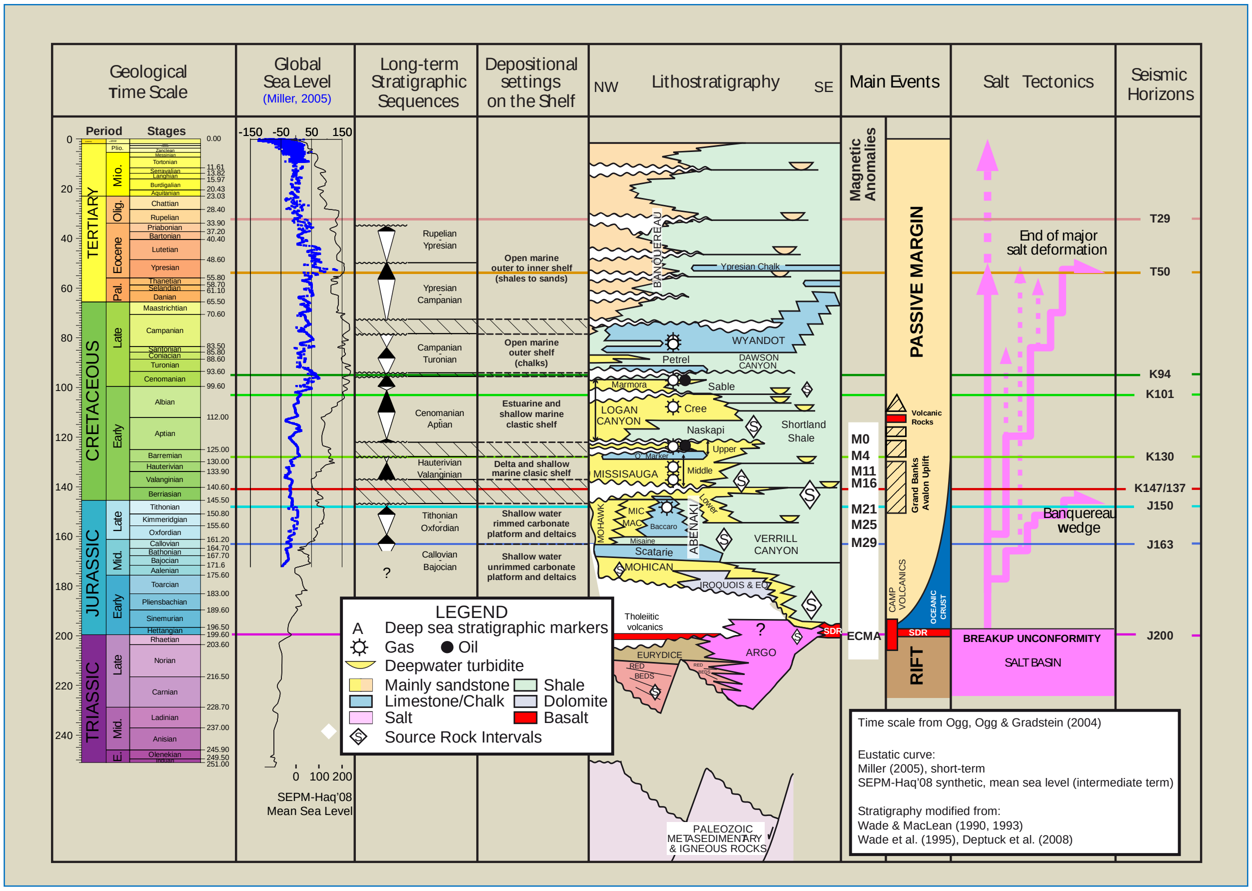


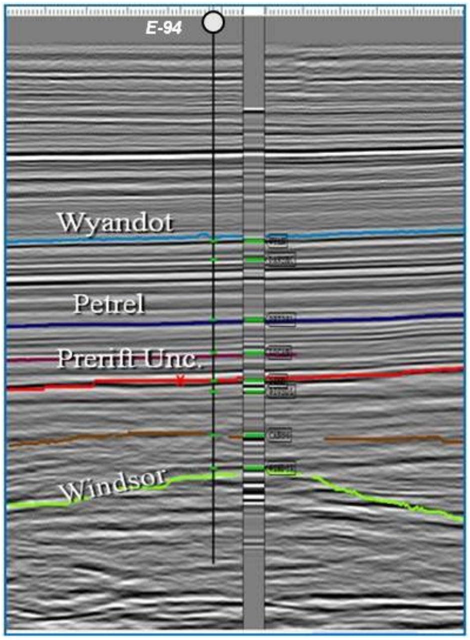
Figure 8. The newest offshore Nova Scotia Lithostratigrapic and Tectonics Evolution Chart available from OETRA (2011). The chart is applicable in the Mesozoic part of the Laurentian Basin.

3.2. Tectono-Stratigraphic Sectors. The Laurentian Basin can be divided into two sectors:

1. **Paleozoic Basin.** This sector is located north of a roughly east-west trending hinge line traced by a series of down-to-the-basin faults that coincide with the CC fault system (MacLean and Wade, 1992; Fagan and Enachescu, 2008, Fagan, 2010). North of the hinge zone there is a thin Mesozoic cover over a well-imaged Carboniferous sequence. The Mesozoic is in turn overlain by a Cenozoic wedge that thickens basinward from a zero edge. In this sector there are mainly large Paleozoic prospects and leads, some cored by Windsor salt.

2. **Mesozoic Basin.** This sector is located south of the CC fault system. The Mesozoic section south of the hinge zone is thick, deep and complexly structured. The Mesozoic basin was formed by extensional tectonics during the rifting of the Nova Scotian margin and during transtension along the NTZ. The Mesozoic and Tertiary structures in this area have been subsequently deformed by localized strike slip movement, inversion, oblique extension and salt tectonism. A Carboniferous sequence may also be present under the deformed Mesozoic basin. In this sector, where the Call for Bids parcels are located, there are large Jurassic and Cretaceous prospects and leads.

Figure 9. Seismic line over the Hermine E-94 exploration well showing Paleozoic anticline and undeformed Mesozoic postrift sequences. Line location is given in Figure 10 (after Fagan, 2010; line courtesy of GSC Atlantic).



In the northern part of the basin, the Mesozoic - Cenozoic cover is thin and large Paleozoic compressional, extensional and transtensional structures can be mapped under the Prerift Unconformity. The Jurassic sedimentary sequences are missing while Early Cretaceous beds are thin (Figure 9). Carboniferous Windsor salt features are present under the prerift Unconformity and a Paleozoic gas play similar to the East Point gas discovery and Old Harry structures in Gulf of St. Lawrence are possible.

The northern basin margin was influenced by strike-slip movements along the CC Fault and its many imbricates; a southeast trending, en echelon ridge and fault system is shown by seismic and potential field data (Fagan and Enachescu, 2007; Fagan, 2010 and Figure 10). Further south, a large ridge (or perhaps a series of coalescing smaller ridges) trends roughly east-west near the modern shelf edge. Under the slope, the prerift section drops off to greater depths, stepping across many normal faults. Large and complexly faulted Jurassic to mid-Cretaceous structural, combination and stratigraphic features are observed. A large number of structures are Argo salt cored. The mostly clastic Jurassic succession is anomalously thick in this basin when compared to other Atlantic margin basins. The Laurentian slope area is well connected to both the Scotian Slope and the deeper part of the South Whale Basin.

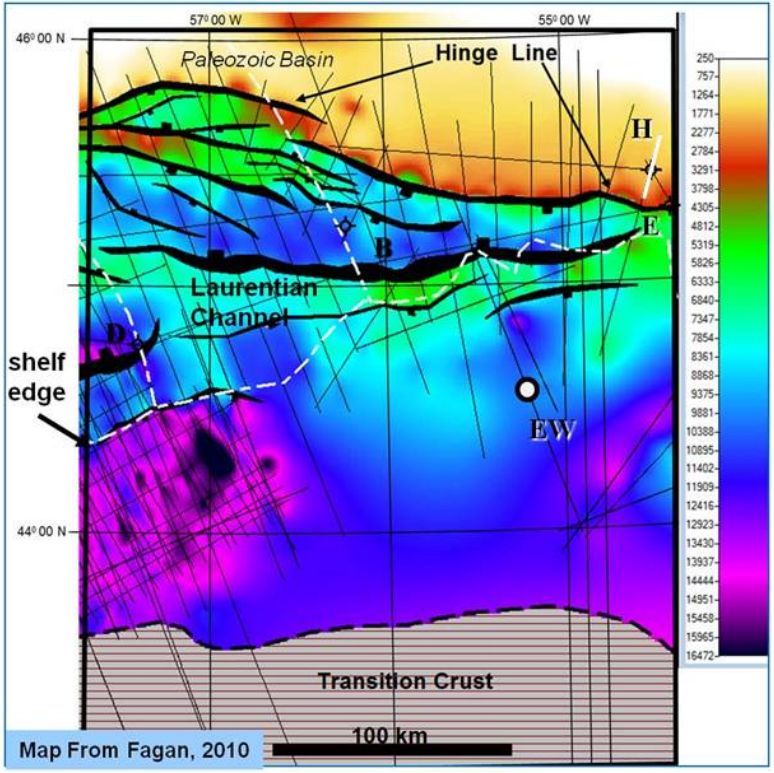


Figure 10. Depth Structure map of Prerift Unconformity, Laurentian Basin (after Fagan, 2010). Colour legend in meters. Major faults are shown in black. The shelf edge and Laurentian Channel are dashed white lines. Exploration wells are: B = Bandol #1; H = Hermine E-94; E = Emerillion C-56 and D = Dauntless D-35. EW = East Wolverine G-37 well which was drilled after this map was constructed. The white line segment over Hermine-E-94 well indicates position of seismic section in Figure 9.

Located on a dense 2D seismic grid, the Bandol #1 well was drilled in 2001 in a shelf location in French territory (Figures 4 and 10). While it was said to have found “hundreds of meters” of reservoir, the well remained confidential until the summer of 2011. However, no publicly released well logs were available for this report. This is the only well in the shelfal part of the basin. On the slope and rise, the Cretaceous succession is thin and this is evident especially on anticlinal features. The Late Cretaceous and particularly the Tertiary successions show the presence of canyons, down-slope faulting, fans and mass transport deposits.

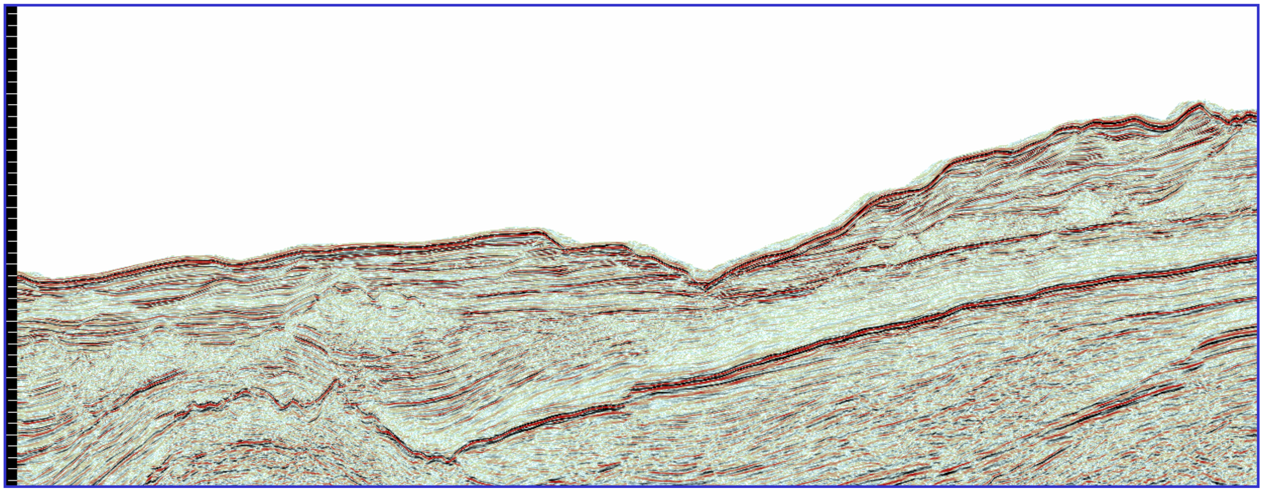


Figure 11. Representative seismic line on the Laurentian Basin slope. showing Tertiary and Late Cretaceous canyons, fans mass transport deposits and major unconformities. The deeper section shows the presence of faulted blocks and a large salt induced anticline (seismic line courtesy of GSC Atlantic, adapted from Enachescu, 2009).

4. Overview of Petroleum Geology of the Laurentian Basin. The Laurentian Basin can be considered a part of the larger Scotian Basin, a proven oil and gas basin. In spite of being adjacent to petroleum discoveries on both the Scotian Shelf and Grand Banks areas, the basin remains unexplored due to a lengthy exploration moratorium that was lifted in 2004.

The basin's infill contains a structured synrift rock succession (evaporites, coarse and fine clastics and thin carbonates) ranging in age from Late Triassic to early Middle Jurassic (Extensional Stage sedimentary sequence). The early sedimentary fill contains the Argo Salt that later became mobile and created intrusions and salt induced structures in the overlying sediments. In places the Paleozoic Windsor Salt also created deformation in the basement and synrift beds. A Late Jurassic to Albian sedimentary succession developed during the basin's Transtensional Stage and is also structured and affected by halotectonics. A multitude of hydrocarbon traps were formed in the basin during lengthy periods of extension, transtension and prolonged halotectonics. The Late Cretaceous-Tertiary successions contain a relatively thick, almost parallel bedding cover of mainly fine clastics and thin chalk and carbonates that were deformed by gravity sliding, intruded by salt and canyonized. This constitutes the post-transtension (early drift stage) or the early Thermal Subsidence Stage sedimentary sequence.

Well documented oil and gas prone source rocks are present in the Late Jurassic. The potential for other source rocks is recognized within the Paleozoic basement, Early Jurassic, Early and Late Cretaceous and Early Tertiary sequences. Reservoirs are present in all stages but good quality sandstone and carbonate reservoirs are localized. The best sandstone reservoirs were encountered on the shelf in the Sable Subbasin; thick reservoir sands were intersected by Bandol #1 and East Wolverine G-37 wells in the Laurentian Basin and several other wells near the basin. Several sedimentary slope and basin floor fans were interpreted in seismic data.

An early petroleum assessment by GSC estimated that the basin could contain recoverable resources of 8-9 Tcf of gas and 600 to 700 MMbbls of oil, but this study included only parts of the shelfal and inner slope area and did not extend to deepwater plays. The following subsections describe the petroleum system that might exist in the Laurentian Basin and is based on new information from the recently published NSPFA and on older research and industry evaluation of the area.

4.1. Source rocks. The main result of the NSPFA study is the identification of five source rocks that may contribute to offshore NS (including the Laurentian Basin) petroleum resource endowment (see also Figures 7 and 8 in present report and also https://s3.amazonaws.com/novascotiaoffshore/atlas/final-atlas/CHAPTER_4_Complete.pdf):

1. *Lower Cretaceous* - *Aptian* (deltaic); centered on the Intra-Aptian MFS (Naskapi),
2. *Lower Cretaceous* - *Valanginian* (deltaic), base age 137 Ma,
3. *Upper Jurassic* - *Tithonian* (transition from carbonate to deltaic environment), centered on the Tithonian MFS; the Tithonian source rock - upper part of Verrill Canyon Fm - is of major importance as it is well defined, organic-rich and mature,
4. *Middle Jurassic* - *Callovian* centered on the Callovian MFS - represented by middle part of Verrill Canyon Fm "Misaine Shale", and

5. *Early Jurassic source complex - Liassic*. Deposited in an earliest post-rift, hypersaline to carbonate marine environment (during Sinemurian-Pliensbachian-Toarcian). The source existence is suggested by the presence of gammacerane in piston cores and seeps collected from the Scotian Slope. The gammacerane are biomarkers representing successor molecules of cilliate bacteria that lived in hypersaline marine waters. This source rock has not been penetrated, but its presence is inferred from the Moroccan and Portuguese conjugate margins as well as from piston core samples offshore NS and several wells on the Grand Banks. Its presence is also suggested by the then- synrift and early postrift mid North Atlantic basin configuration (e.g. Sibuet et al., 2011 and Figure 12) (adapted from https://s3.amazonaws.com/novascotiaoffshore/atlas/final-atlas/CHAPTER_4_Complete.pdf).

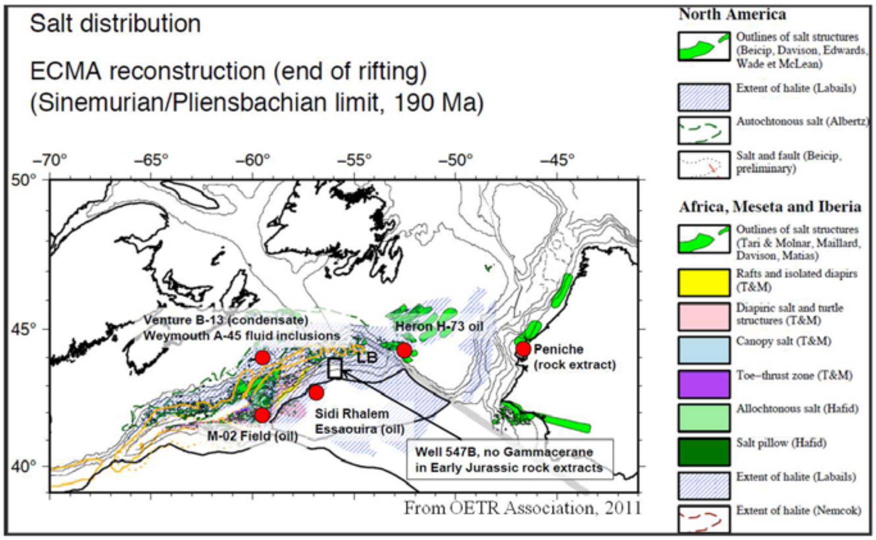


Figure 12. Rift reconstruction of mid-Atlantic in Early Jurassic (after Sibuet et al. 2011). Red dots show distribution of Gammacerane in oils, condensates, rock extracts and hydrocarbon fluid inclusions from mid-North Atlantic basins; LB = Laurentian Basin (From OETR Association, 2011).

The Late Jurassic Aged Verrill Canyon Source Rock (Figures 7 and 8) is represented mostly by shales with 2 to 4 wt% total organic carbon. This may be the time equivalent to the prolific Kimmeridgian source rock in the Jeanne d'Arc and Flemish Pass basins. This source rock generated most of the gas, condensate and oil found in the Scotian Basin. The predominant organic matter in the Verrill Canyon Formation is terrestrially formed Humic kerogen (Type III) and is gas prone. However, there are oil fields and significant oil shows offshore Nova Scotia which indicates that there may be pockets of more marine Liptinic (Type II) organic matter.

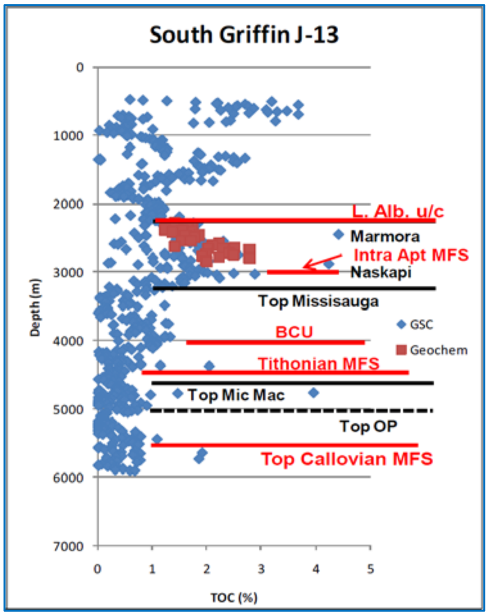


Figure 13. Depth versus TOC diagram for South Griffin J-13 well showing several good source rock intervals (From OETR Association, 2011). South Griffin J-13 is located about 100 km west of the Laurentian Basin.

Several wells (e.g. South Venture O-59, Louisburg J-47, South Griffin J-39) indicate the presence of oil prone, Type II source rock with TOC of 3% average at a moderate level of maturity (R_0 = 0.7%). South Griffin J-39, drilled 100 km west of the Laurentian Basin shows several good quality source rocks, some with potential for generating oil.

In summary, there are abundant type III and type II source rock intervals identified in the Scotian shelf and slope basins, including the Laurentian Basin.

4.2. Reservoir rocks. Stacked sandstone intervals within the Jurassic Mic Mac and Cretaceous Lower and Upper Mississauga and Logan Canyon formations are proven quality reservoirs. Most of these reservoirs are alluvial or deltaic on the shelf and inner slope. The targets in the deepwater are the equivalent of these sandstones deposited as turbidites, slope and basin floor fans, minibasins, channels, etc., situated either between salt swells or deformed by later salt movements. Good reservoirs are found in the Scotian Basin at the carbonate platform margin where reefal development and dolomitization due to solution circulation along deep faults took place; this reservoir type is less probable in the deepwater Laurentian Basin. The Early Tertiary sequence present in the deep water has a real and effectively untested potential for large oil and gas pools.

Reservoir rocks in the Scotian Basin are predominantly high porosity - high permeability sandstones of Late Jurassic to Early Cretaceous age. Similar reservoirs and additionally turbidite sands should be present in the Laurentian Basin which is a major coarse clastics depocenter.

4.3. Seals. Seal should not be a problem within the Laurentian Basin as the extensional, transtensional and thermal subsidence stages contain several successions of very fine clastics, tight sandstones and carbonates (Figures 7 and 8). Petroleum accumulations on the Nova Scotia margin were sealed by Misaine Mbr, Naskapi Mbr and inter-formational seals. The Dawson Canyon mudstone and clays form an excellent regional seal. Also, the Argo Salt is a perfect seal when it forms hanging walls and canopies above the younger clastics. Excellent regional seals are also provided by the “O” Marker, Petrel and Wyandot carbonate intervals. Therefore, numerous good seal intervals were found in Scotian Basin wells.

4.4. Hydrocarbon Traps. A variety of traps have been found to be successful on both the Scotian and Newfoundland and Labrador margin. Usually they are created during the rift stage or subsequent intrusion and movement of salt bodies. The largest petroleum accumulations were found in structural and combination traps, but many purely stratigraphic traps remain to be drilled.

The interpretation of seismic data from the Laurentian Basin shelf and Call for Bids area allows for the identification of:

- Large structural fault-bounded closures,
- Salt induced anticlines,
- Salt wall stratigraphic traps and subsalt,
- Turtle shell anticlines and minibasins,
- Structural-Stratigraphic salt related rollovers and mini-basin traps,

- Cretaceous fans, and
- Tertiary lowstand submarine fans & channel complexes.

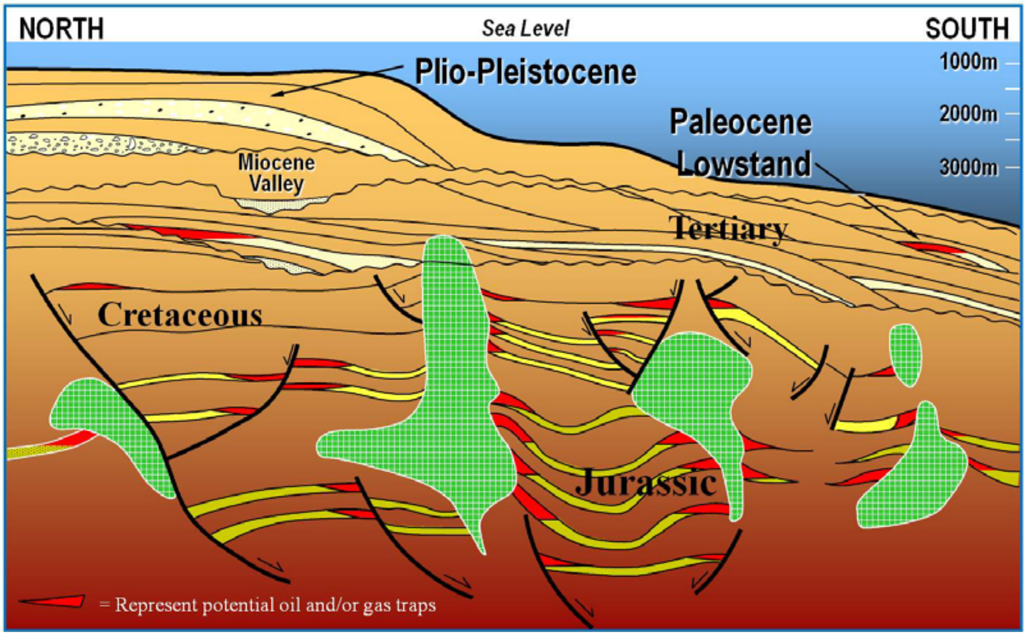


Figure 14. Conceptual traps on the slope and deepwater of the Laurentian Basin (adapted from Hogg et al., 1999). Main traps are related to Jurassic and Cretaceous sandstones trapped by listric faults and salt anticlines.

The most sought after drilling targets are structural or combination traps, with plays in the Mic Mac and Missisauga formations. Rollover anticlines and listric fault blocks have been successfully drilled on the shelf and may also work in the deepwater. Large salt induced anticlines and submarine fans of Late Jurassic and Early Cretaceous age are important targets in deepwater.

4.5 Maturation and Migration. The Verrill Canyon shale maturation started in the Mid-Early Cretaceous and continued into the Tertiary. Petroleum expulsion started at approximately 3000 m and ends at 6000 m. The top of the oil generation zone lies 4 km below the shallow regions of the continental shelf and is much deeper on the slope and upper rise. Expulsed hydrocarbons have migrated mainly vertically, predominantly along the numerous extensional faults and also using sand carrier beds. The oils found on the shelf appear to be generated from a more mature, probably deeper source located on the slope. Lateral migration occurred locally along basin flanks and on the slope. Other source rocks, including Paleozoic shales and coals may also be mature and generate hydrocarbons. Recent studies indicate a much larger variation of composition, quality and degree of maturity of the Late Jurassic - Early Cretaceous Verrill Canyon Shales: (http://www.gov.ns.ca/energy/resources/RA/offshore/Executive-Summary-Report-2006-08-26.pdf).

4.6. Hydrocarbon Plays and Risks. Conventional plays recognized in the Scotian Basin and implicitly in the Laurentian Basin (e.g. MacLean and Wade, 1992; Kidston et al., 2002; Hogg et al., 1999; Hogg, 2002; Enachescu and Hogg, 2005; Enachescu and Fagan, 2009; Fagan, 2010) are:

1) Late Jurassic Mic Mac Sandstone,
2) Early Cretaceous Lower and Upper Missisauga Sandstone, and
3) Late Early Cretaceous Logan Canyon Sandstone.

These reservoir sandstones are trapped in roll-over anticlines, listric fault bounded blocks, multi-fault closures, salt cored anticlines or ridges, drape over salt pillow or basement highs. Late Jurassic to Cretaceous and Early Tertiary lowstand sandstones are important reservoirs on the slope and upper rise and such is the case for the Call for Bids NL12-01 area. Overpressure has been encountered in both the Scotian and Jeanne d'Arc basins, usually associated with isolated sand bodies. Overpressure can play a significant role in the Laurentian Basin, especially for Jurassic reservoirs deeper than 4000 m. Reservoir quality, lack of source rock and sealing across faults are the main risks in the basin.

4.7. Significant Wells. Five wells were drilled offshore NL within or on the margins of the Laurentian Basin: Hermine E-84, Emerillon C-56, Lewis Hill G-85 (shallow water wells), Narwhal F-99 and East Wolverine G-37 (deepwater wells). Two significant wells, Dauntless D-35 (shallow water well) and Tantallon M-41 (deep water well), were drilled offshore NS in the vicinity of the basin. One well, Bandol #1 was drilled on the shelf in the central Laurentian Basin, in French territory. Little was reported on this well except that it found thick reservoirs in Late Jurassic - Early Cretaceous formations. The Tantallon, Narwhal and East Wolverine wells were drilled in water deeper than 1500 m.

Of the wells in the area, the first (Hermine) was drilled in 1971, with the latest (E. Wolverine) drilled in 2010. None of the wells reported significant amounts of oil and gas. Small shows in the form of gas sands were present in Tantallon M-41 and confirmed with LMR analysis (Goodway et al., 2008). The deep wells encountered Verrill Canyon source rocks that were only marginally mature; geochemical data on Bandol #1 was not available.

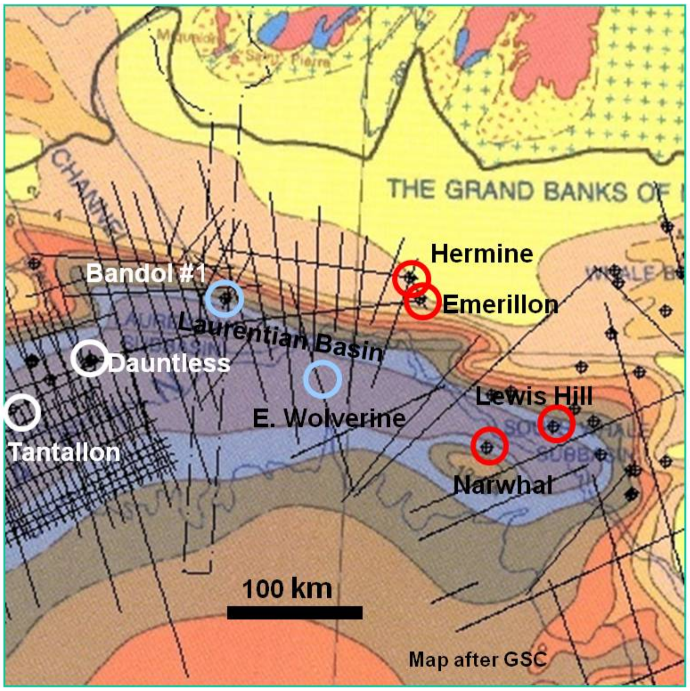


Figure 15. Location of significant wells in and around the Laurentian Basin on prerift basement depth map. White circles show wells in the Scotian Basin; blue circles show wells in the Laurentian Basin; red circles show wells in the South Whale Basin. Only the East Wolverine G-37 was drilled in the deepwater basin, at the northeastern edge of the Call for Bids NL12-01 area, within Parcel 3 (Structural map from GSC).

The East Wolverine G-37 is the first well located in the deepwater Laurentian Basin (water depth 1890 m) and the 350th well drilled offshore NL. The final well results were released to the public by the C-NLOPB at the end of April 2012. This deep well (total depth 6857 m) provides a significant amount of new data that needs to be incorporated into the geological models for the

Laurentian Basin. Most importantly, the well gives information on the presence of Late Jurassic source and reservoir rocks that can help minimize the risk on future exploration wells. The results of the East Wolverine well show the presence of Mid Jurassic shale intervals, some with high organic content. No Early Jurassic rocks were drilled. The well encountered a thick Early Cretaceous sequence (900 m) and more than 1600 m of Middle Jurassic rocks in a large salt cored anticline. The Late Jurassic (Tithonian and Kimmeridgian) rocks were eroded on the drilled anticlinal feature. Several good reservoir and source rocks were intersected in the well, but the well was abandoned without testing.

In summary, all the well results point toward moving exploration in deeper basinal areas where source rocks may be mature and lowstand sandstone reservoirs should be present. Targeting amplitude and LMR anomalies may indicate sand fairways and/or presence of hydrocarbons.

Well	Dril-led	WD m	Status	Location	TD m	Prerift unc	TD in	Reservoir	Source rock
Hermine E-84	1971	87	Aband	Grand Banks shelf	3267	1636 m	Carboniferous Windsor Salt	No	Not penetrated
Emerillon C-56	1974	120	Aband	Grand Banks shelf	3277	3118 m	Carboniferous Windsor Salt	Eider 1786 m Mic Mac 2088 m	Not penetrated
Dauntless D-35	1971	119.5	Aband	Nova Scotia shelf	4741	No	Mic Mac Fms	Yes	Interpreted
Bandol #1 French Territory	2001	119	Aband	On shelf in Laurentian B	4046		*Not Available!*		
Lewis Hill G-85	2003	100	Aband	In S. Whale Basin	3218	2779 m	Missisauga	Yes	Not penetrated
Narwhal F-99	1987	1577	Aband	Grand Banks South Slope	4585	4491 m	Basalt	No	Yes
Tantallon M-41	1986	1516	Aband	Nova Scotia slope	5602	No	L Missisauga-Verrill Canyon	L Missisauga Gas sands	Yes
East Wolverine G-37	2009/10	1890	Aband	Slope of Laurentian Basin	6857	Too deep	Verrill Canyon	Yes	Yes

Table I. Statistic characteristics of significant exploration wells for the Laurentian Basin. Only two wells, Bandol #1 and East Wolverine G-37, were drilled in the basin.

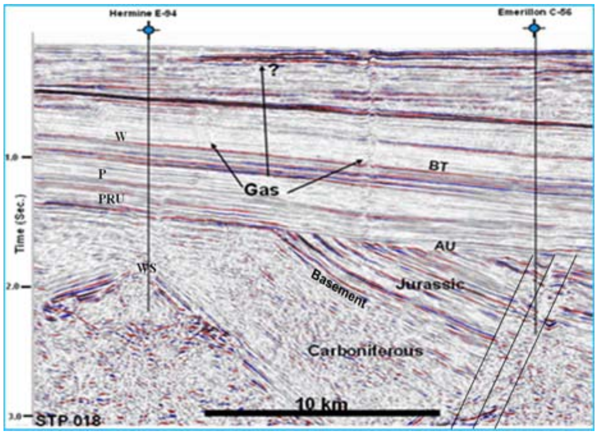


Figure 16. Interpreted seismic line showing several regional markers in the shallow part of the Laurentian Basin and the Hermine and Emerillon wells used to correlate seismic markers. BT = Base Tertiary, W = Wyndot, P = Petrel; WS = Windsor Salt, AU = Avalon Unconformity, PRU = Prerift Unconformity (seismic line courtesy of the GSC).

4.8. Seismic Data Quality and Availability. Good quality multi-client 2D grids and two exclusive 3D seismic surveys allow for mapping of several unconformities, formation tops, carbonate intervals, salt and sandstone markers such as: Wyandot (Base Tertiary), Petrel, Avalon Unconformity, “O” Marker, Missisauga, Top Jurassic, Middle Jurassic, Lower Jurassic, Argo Salt and Basement (when not too deep). Some of the markers are widespread and have good quality; some are poor in places and have to be simulated between tie points.

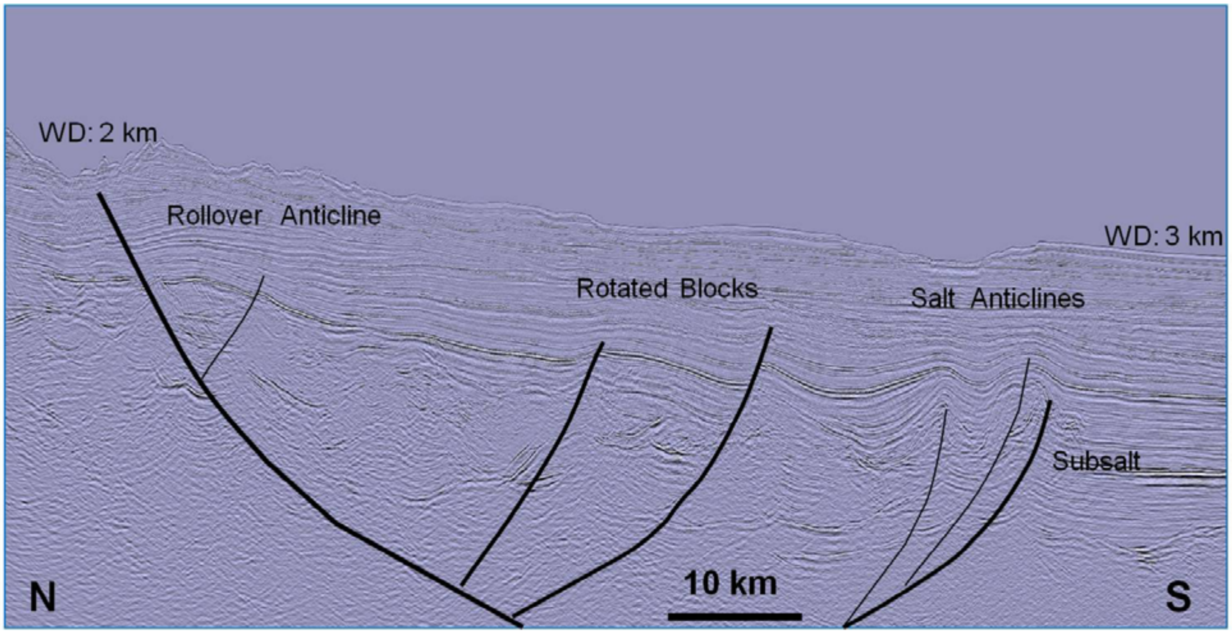


Figure 17. Examples of Seismic Data Quality and Hydrocarbon Traps in the Laurentian Basin.

Good to excellent seismic coverage exists for Parcels 2 to 6 while Parcel 1 has poor coverage. Seismic data quality is excellent in the Late Jurassic to Tertiary sequences but deteriorates in the Late Triassic - Late Jurassic interval. The main and secondary faults are easily traceable. Salt diapir walls/welds are well imaged in places, but poorly visible in other places.

Seismic data can be purchased from seismic contractors and vendors (“spec companies”), brokers or oil company owners as SEG-Y files. Selected older data can obtained in hardcopy format from the C-NLOPB, in St John’s, NL.

5. **Petroleum Potential of Call for Bids NL12-01 Parcels 1 to 6**

C-NLOPB Call for Bids NL12-01 parcels 1 to 6 are located off the south coast of the Province of Newfoundland and Labrador, Canada in an area designated Area "C" - Laurentian Subbasin, administered by the C-NLOPB on behalf of the Province of NL and the Federal Government (http://www.cnlopb.nl.ca/pdfs/cfb1201.pdf).

Offshore Newfoundland and Labrador exploration areas are licensed by the C-NLOPB to the party submitting the highest bid in the form of work commitments. The parcels are all situated in water depths ranging from 480 to 3750 metres. The deeper water parcels or portions of parcels are offered for exploration for the first time in a NL Call for Bids. Presently, there are two active Exploration Licences (ELs) in the NL sector of the Laurentian Basin (ELs 1118 and 1119, operated by ConocoPhillips) located in the Mesozoic part of the Laurentian Basin, east of the Newfoundland and Labrador/Nova Scotia maritime border. Parcels 1 to 6 are also located in the Mesozoic part of the Laurentian Basin, east of the provincial maritime border. Parcel 1 is located south of EL 1119, abutting the maritime boundaries of NS and France. Parcels 2 to 6 are located east of the French border and extend all the way to the deepwater South Whale Basin (SWB). All six parcels contain large Mesozoic petroleum prospects and leads predominantly covered by 2D seismic data

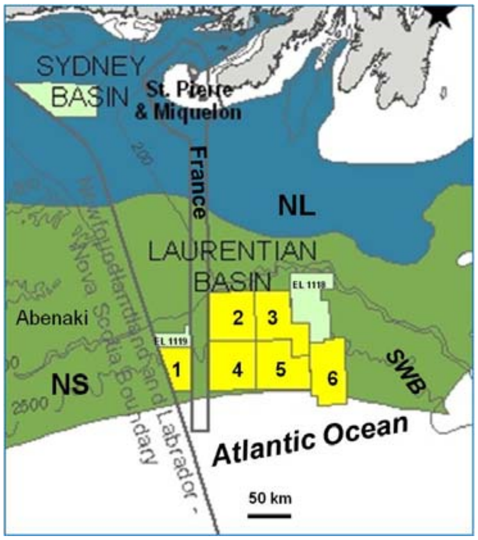


Figure 18. Location of the NL12 -01 parcels 1 to 6 within the Mesozoic Laurentian Basin.

Call for Bids	**Area**	**Area**	**Area**	**GOM tract**
CFB NL12-01	Hectares	Sq Km	Acres	multiples
Parcel #1	143,588	1,436	354,814	61.6
Parcel #2	286,598	2,866	708,199	123
Parcel #3	294,260	2,943	727,132	126.2
Parcel #4	289,016	2,890	714,174	124
Parcel #5	296,530	2,965	732,742	127.2
Parcel #6	279,746	2,797	691,267	120
TOTAL	**1,589,738**	**15,897**	**3,928,328**	**682**

Table II. Call for Bids NL12-01 Parcels 1 to 6 statistics. GOM = Gulf of Mexico.

5.1. Seismic Data Owners and Coverage. Older 2D digital data in the basin is owned mainly by ExxonMobil, through Mobil and partners that were involved in the early basin exploration stage (1970-1980s). Various other surveys were recorded in the 1970s and early 1980s by companies such as Elf (Canterra, now Husky), Chevron, Amoco (now BP), Shell, Husky/BowValley, Petro-Canada (now Suncor), Northcorp, Texaco (now Chevron), etc. These surveys were used to locate and drill the bordering wells in the Abenaki and South Whale basins. GSC recorded a regional survey in the mid 1980s that was reprocessed in 2006. More modern seismic grids were recorded in the late 1990s by Mobil and Murphy and were used to locate the Bandol #1 well. More recent 2D and 3D surveys (2000s) were conducted by ConocoPhillips and partners and were used to locate the East Wolverine G-37 well.

Multi-client seismic 2D data, recorded usually with a long streamer, are also available in digital format from seismic contractors (e.g. GSI and TGS). Long seismic lines (shelf to continental rise) connecting adjacent basins were recorded during early 2000s by GXT (now ION). This program (NovaSPAN) was depth migrated.

2D Seismic Data. The Call for Bids parcels 2 to 6 are well covered by a relatively dense 2D seismic grid; Parcel 1 has poor public domain seismic coverage. The public domain grid has a 5 to 6 km spacing in the dip direction and 3 to 5 km spacing in the strike direction. Several seismic grids in digital format (SEGY) are available from oil companies, GSC and seismic contractors. Majority of 2D lines are post-stack time migrated; most recent data has pre-stack time migration applied. Marine data was acquired with a 3 to 4.5 km streamer length during early 1980s and with a 6 to 8 km streamer length during late 1990s-early 2000s when regional surveys were acquired by GSI, TGS and GX Technology. ConocoPhillips et al. collected 3800 km of 2D lines in 2004. The main regional 2D grid is oriented N-S (dip lines) intersecting E-W tie lines (strike direction). A second NW-SE/NE-SW 2D intersecting grid also exists in the eastern parcels.

3D Seismic Data. Two large 3D surveys were acquired for ConocoPhillips et al. during 2005. This WesternGeco state of the art "Q-Technology" proprietary 3D seismic data covered a total area of 1850 km^2. The easternmost Laurentian 3D survey covers 1195 km^2. The westernmost Laurentian 3D survey covers 655 km^2 (Enachescu and Fagan, 2009). The 3D seismic has high quality time processing and also rigorous depth processing. These 3D surveys were used for the selection of the first deepwater Laurentian Basin exploration well: East Wolverine G-37. They cover only a small portion of the Call for Bids parcels.

5.2. Seismic Interpretation. Regional seismic data shown in this presentation was tied with synthetic seismograms to exploration wells from the Abenaki and South Whale basins and jump tied to the seismic markers present in the Call for Bids area. Additionally, the E. Wolverine G-37 preliminary results were also used to assist with this interpretation. Seismic lines in the parcels show the basin as a strongly deformed sedimentary wedge dipping and thickening toward the south-southwest. The older synrift sedimentary sequence (Late Triassic to early Early Jurassic) infills the extended basement consisting of horsts, grabens and rotated blocks. A thick layer of Carnian-Sinemurian salt (Argo Salt) was intensely deformed by halotectonics and halokinesis and has produced numerous diapirs, salt induced anticlines, withdrawal mini-basins and detached salt bodies. Toe thrust anticlines, some of which are salt cored, are also present in the southern parcels. The wedge of postrift/transform stage sediments (Jurassic to mid-Cretaceous) partially rests on the deformed salt layer and is also deformed in places. The Late Cretaceous to Quaternary successions are also deformed and faulted in places. This succession includes regional unconformities, with some showing paleo-canyons.

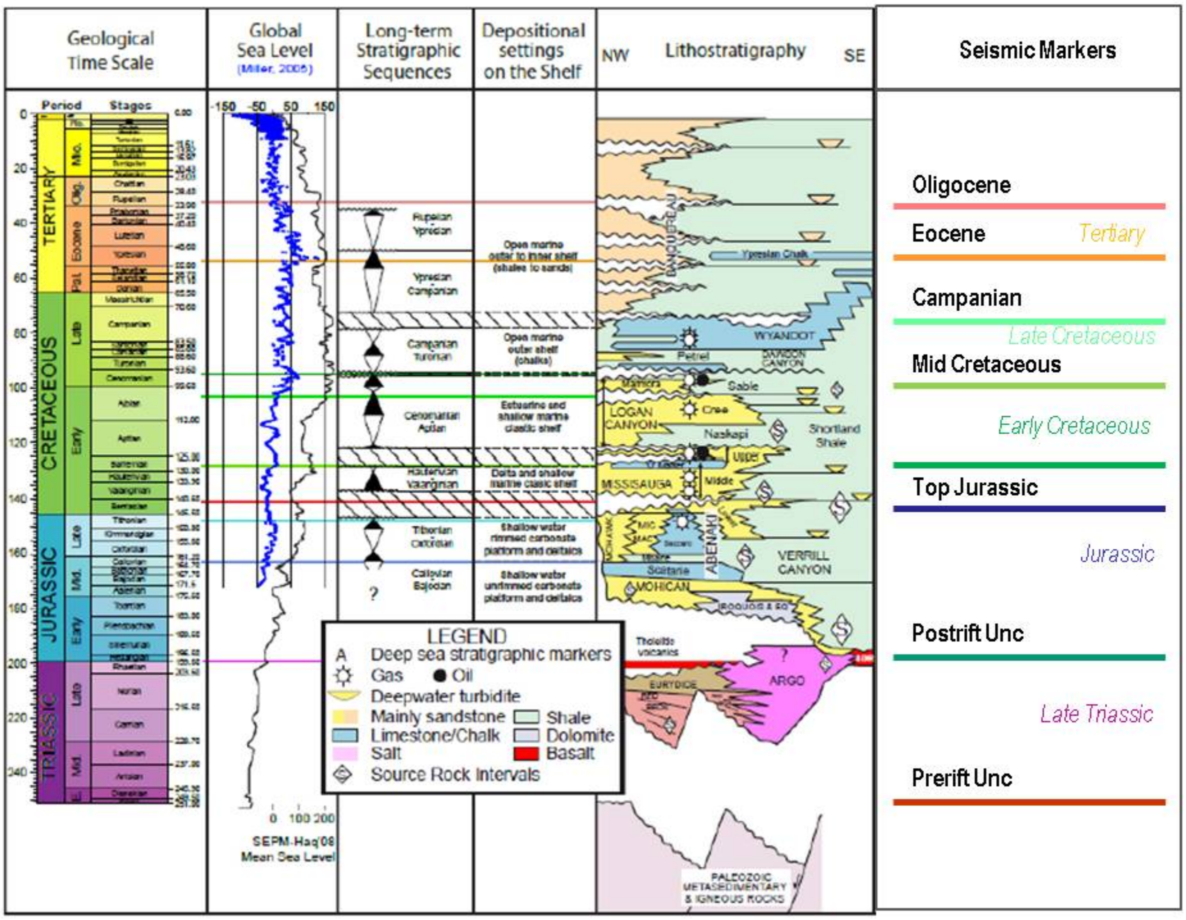


Figure 19. Lithostratigraphic, tectonics and main seismic markers chart (modified from OETRA, 2011).

On the following illustrative seismic sections only a few stratigraphic sequences, salt structures and major faults are displayed. A full synrift sequence including Argo Salt and a well developed postrift sequence that might contain lowstand reservoir sandstone of mid-Jurassic to late Early Cretaceous exist within the parcels. At the time of writing this report no digital well logs were available from Bandol #1 well. East Wolverine logs show several intervals with high quality reservoir sandstones. The Bandol logs are necessary to fully evaluate reservoir potential in the parcels and tie the reflectors interpreted on the representative seismic sections. Potential reservoirs in the basin consist of synrift and postrift sandstones including the deepwater equivalents to proven Mic Mac, Missisauga and Logan Canyon reservoir sandstones. These are prolific producing reservoirs in the gas fields of Nova Scotia, and their age equivalents produce oil in the Grand Banks oil fields. Based on results from the G-37 well, the deep-water equivalents of mid-Jurassic to mid-Cretaceous sandstones should be present in the deep water parcels 1 to 6.

Using the available public seismic grid, several hydrocarbon plays can be interpreted within the Mid Jurassic to Eocene basin fill in the NL12-01 parcels 1 to 6. Structural highs (Salt Anticline, Horst, Roll-over Anticline, Rotated Block, Drape Anticline, Toe Thrust Anticline), containing any of the mid-Jurassic to mid-Cretaceous reservoir sandstones, form the main hydrocarbon plays in the basin. In all six parcels there are locations where 3.5 to 6.5 km deep wells can test the synrift and postrift sandstone plays.

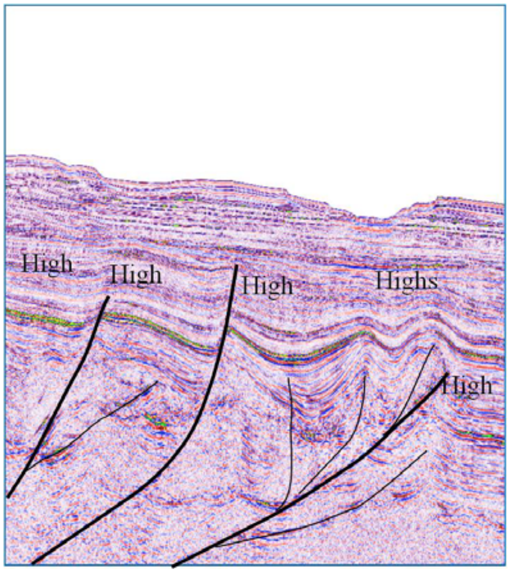


Figure 20. Representative seismic section for parcels 1 to 6 showing structural highs in the Laurentian Basin.

Several regional lines are interpreted in this presentation to illustrate the structural-stratigraphic style of the Laurentian Basin, identify drilling leads and comment on the petroleum potential of the six CFB NL12-01 parcels.

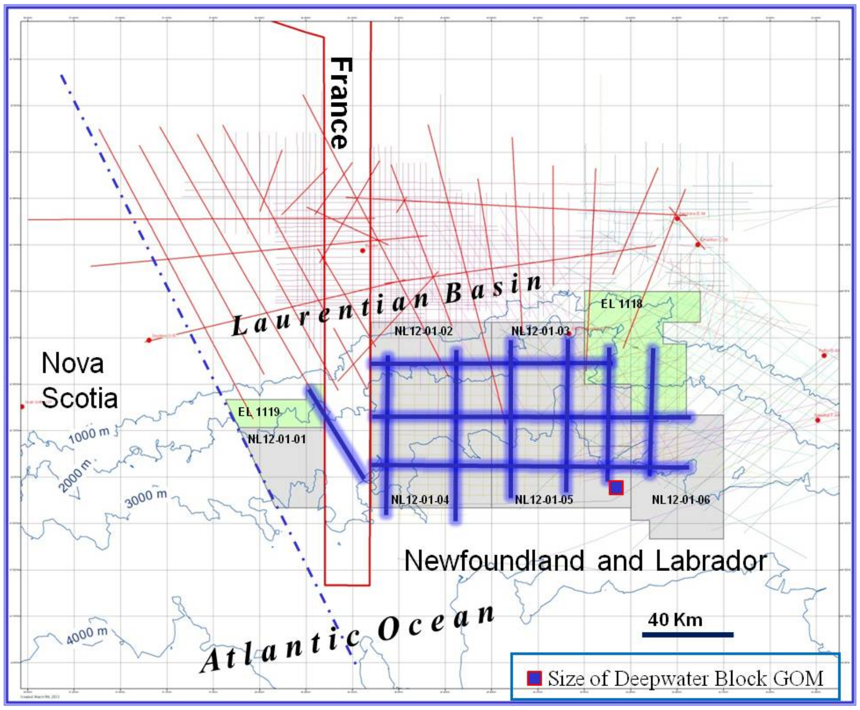


Figure 21. Location of the NL12-01 CFB, parcels 1 to 6 and of the representative seismic lines used in this report shown in thick blue. The thin red lines show the GSC Atlantic grid (in public domain) and the thin light blue lines show the public domain regional grid that can be used to tie seismic markers to significant wells. The blue square indicates the size of a typical deep water section in Gulf of Mexico.

5.3. Petroleum Potential of Call for Bids NL12-01 Parcel 1. Parcel 1, in the southwestern part of the basin, contains 143,588 hectares (354,814 acres), which is 61.6 times larger than a GOM OCS tract. The parcel is located south of EL 1119, on the lower slope, in 1720 - 3330 m of water. The public domain seismic coverage is very poor in this parcel. Seismic vendors such as GSI, TGS and ION may have lines in the parcel or vicinity. No well has been drilled in the parcel. Bandol #1 and Dauntless D-35 are the closest wells for reflector correlation.

Regional line STP-05 (NNE-SSW) used to illustrate the potential of Parcel 1 starts on Crown land, crosses into EL1119 and stretches in the eastern vicinity of Parcel 1. The dip line starts in the upper slope (500 m WD) and continues on the lower slope (2500 m WD). The line was reprocessed in 2006 and is of excellent quality allowing good structural and stratigraphic interpretations.

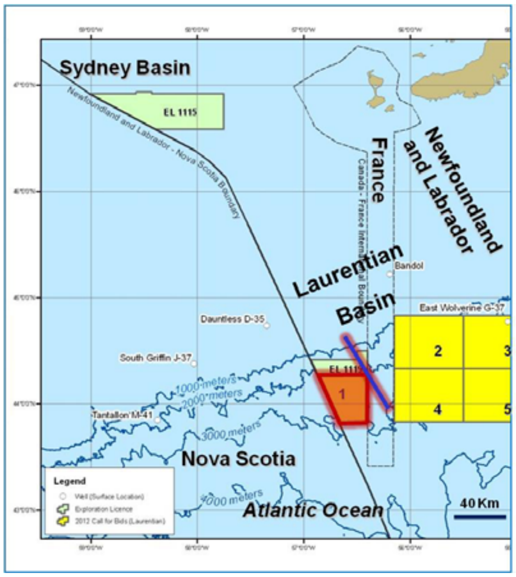


Figure 22. Location of the NL12-01 Parcel 1 and of representative seismic line STP-05.

The line shows the deformation style in the western part of the Laurentian Basin where major down-to-basin listric faults, large rollovers, rotated blocks and salt cored anticlines are present and contain successions aged from Late Triassic to Tertiary. The line starts on the southern flank of a salt cored anticline and then crosses over a minibasin filled with Jurassic and Cretaceous beds. A large faulted anticline has a SE flank cut by secondary faults. An asymmetrical salt cored diapir affecting Jurassic to Tertiary strata is imaged in the deeper part of the slope. A large Late Cretaceous fan is visible on the southern flank of the anticline. Several bright amplitude reflectors are contained in this fan. The leads on this line are 5 to 10 km wide and, if closed in the east-west direction, can contain large amounts of hydrocarbons. These interpreted leads should continue into Parcel 1.

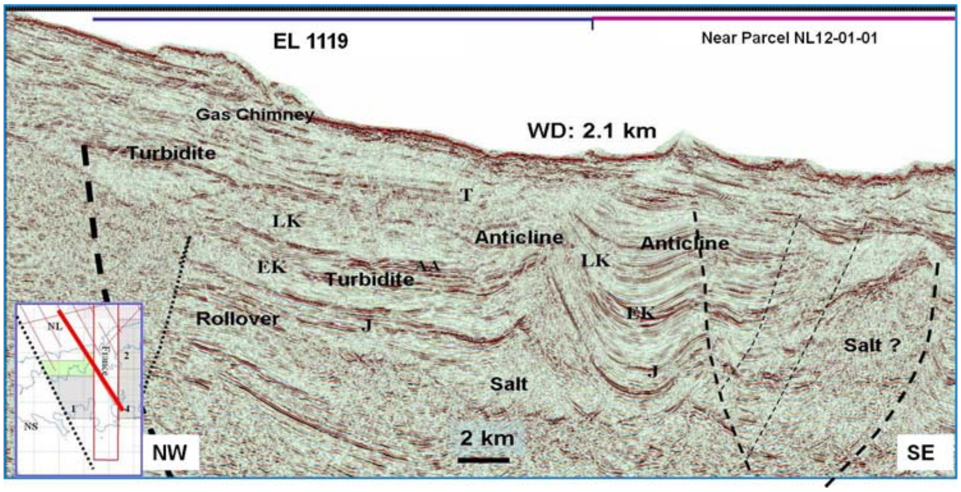


Figure 23. Interpreted dip seismic line STP-05 showing structural, tectonics and stratigraphic characteristics and possible drilling leads in vicinity of Parcel 1.

5.4. Petroleum Potential of Call for Bids NL12-01 Parcel 2. Parcel 2 covers 286,598 hectares (708,119 acres) in the eastern part of the Laurentian Basin. The Parcel shares borders with French territorial waters to the west, Parcel 3 to the east, Parcel 4 to the south, and an unlicenced area to the north. Parcel 2 is well covered by a North-South/East-West dense grid (~ 6 by 4 km) of deep penetration seismic data which is in the public domain. In the northern part of the parcel there are several lines oriented NW-SE and one NE-SW line tying the parcel's coverage to a dense grid existing on the shelf and upper slope. A data gap exists on the mid slope in the northwestern corner of the parcel. No drilling has occurred in the parcel. The Bandol and East Wolverine wells are less than 50 km away. The East Wolverine G-37 Final Well Report was released at the end of April and can be used to better tie the seismic markers.

Four modern, deep penetration, time migrated seismic lines are used to illustrate the petroleum potential of this parcel:

a) Dip lines 1202 and 1242, and
b) Strike lines 1197A and 1157A.

Figure 24. Location of representative seismic lines for Parcel 2.

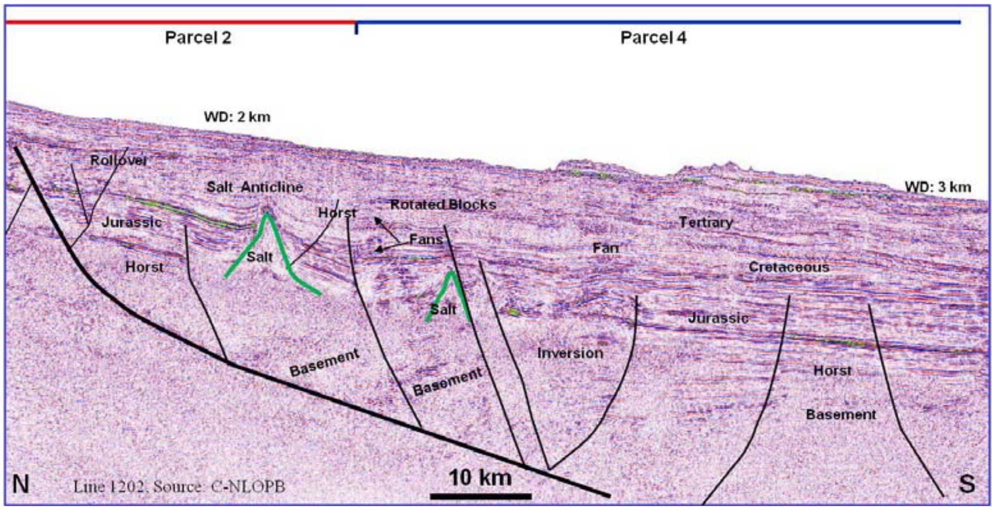


Figure 25. Interpreted dip seismic line 1202 showing structural, tectonics and stratigraphic characteristics and possible drilling leads in NL12-01 parcels 2 and 4 (location in Figure 24). The sedimentary formations thicken toward the south. Salt anticlines, fault blocks and fans are interpreted. A major crustal fault and its synthetic and antithetic faults segment the economic basement.

Dip line 1202 oriented N-S is located in the western part of Parcel 2 exiting to the south in Parcel 4 (Figure 24). The line is positioned over the continental slope of the Laurentian Basin and has good overall quality (Figure 25). The synrift and postrift sequences thicken toward the south in the downthrown side of a major crustal detachment fault. A faulted rollover with thick Jurassic beds is a possible trap. A deeper horst is also interpreted. Toward the southern part of the parcel, a salt anticline affects Late Jurassic and Cretaceous beds that are trapped against and above the salt diapir. Superimposed sedimentary fans are interpreted in the Cretaceous sequence.

Considerable thicknesses of synrift and postrift successions including sandstone reservoirs and Jurassic shales may exist in the southern large half-graben seen on this line.

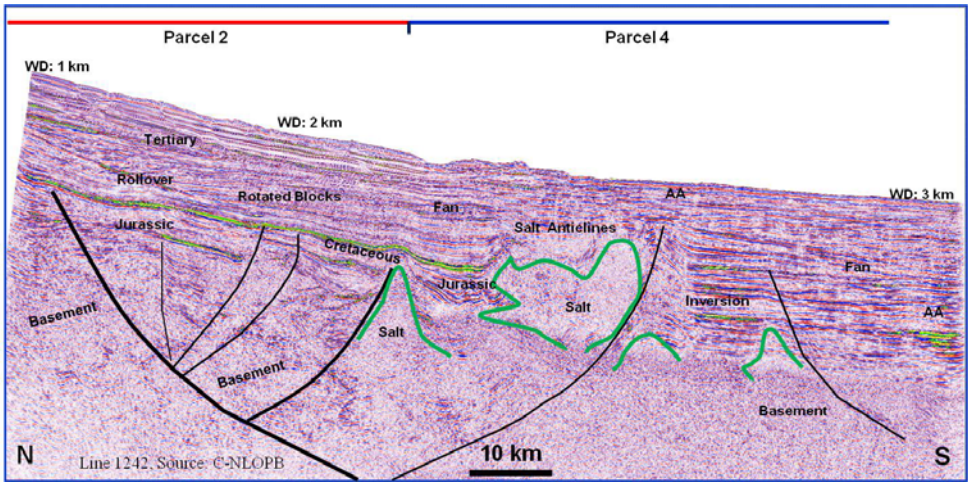


Figure 26. Interpreted dip seismic line 1242 showing structural, tectonics and stratigraphic characteristics and possible drilling leads in NL12-01 parcels 2 and 4 (location in Figure 24). Salt anticlines, fault blocks and fans are interpreted. A major crustal fault and its synthetic and antithetic faults fragment the economic basement.

Dip line 1242, also oriented N-S, is located in the eastern part of Parcel 2 exiting to the south in Parcel 4. The line is positioned over the continental slope of the Laurentian Basin (Figure 24). The line has good to excellent quality (Figure 26). The synrift and postrift sequences thicken toward the south in the downthrown side of a major crustal detachment fault. Several tilted block leads can be interpreted. Toward the southern part of the line, a salt anticline affects Late Jurassic and Cretaceous beds that are trapped against and above the salt diapir. At the southernmost part of the parcel, a sedimentary fan can be interpreted in the Tertiary sequence. The synrift and postrift formations should include sandstone reservoirs and possible high TOC shale that may have generated hydrocarbons in the parcel.

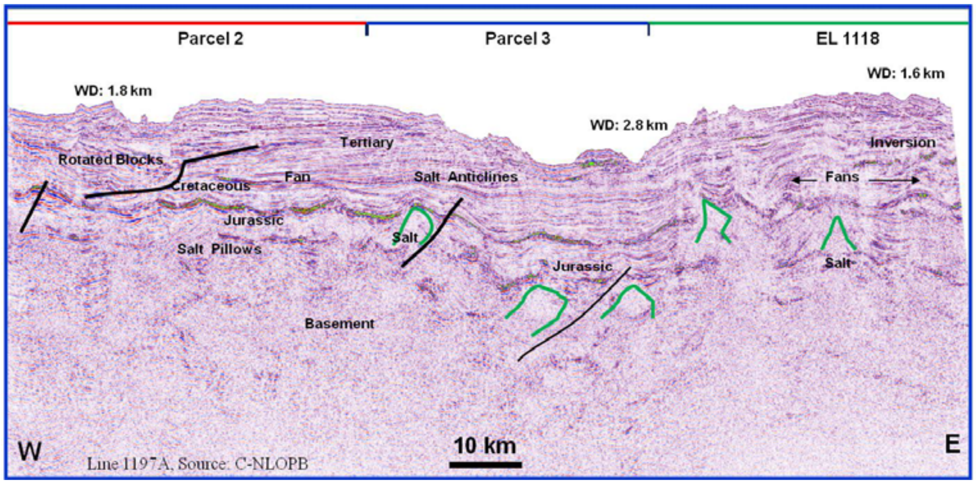
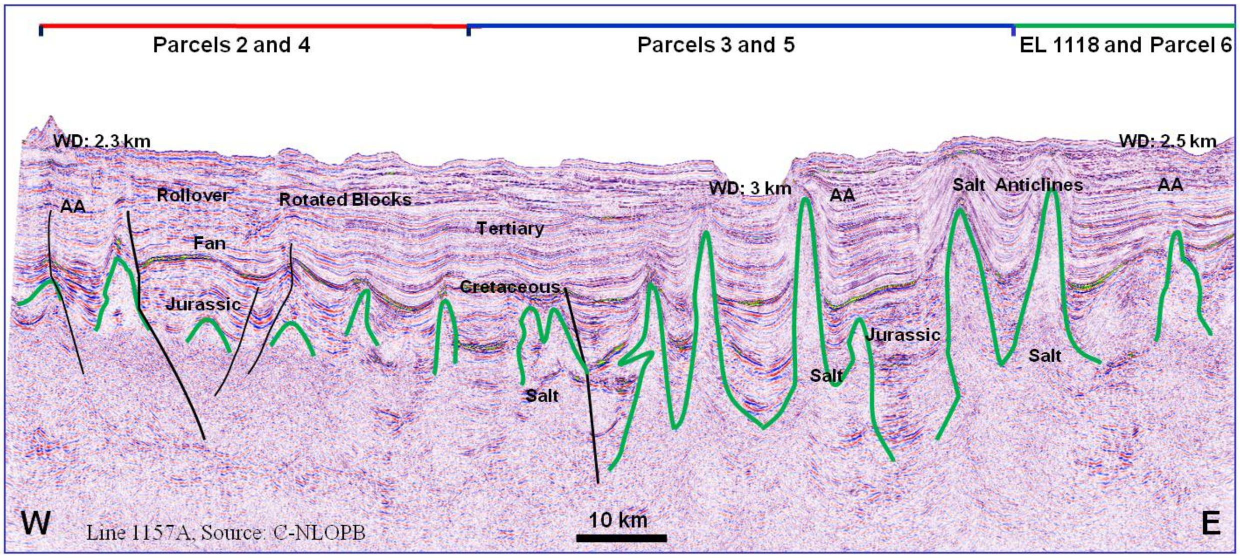


Figure 27. Interpreted strike seismic line 1197A showing structural, tectonics and stratigraphic characteristics and possible drilling leads in NL12-01 parcels 2 and 4 (location in Figure 24). Salt anticlines, fault blocks and fans are interpreted. A major crustal fault and its secondary faults fragment the economic basement.

Strike line 1197A oriented W-E is located in the central part of Parcel 2 exiting to the east in Parcel 3. The line runs parallel to the slope of the Laurentian Basin (Figure 24). Data quality is poor under several Cretaceous and Jurassic unconformities and especially under the deformed salt layer (Figure 27). In this part of the parcel, the Jurassic and Cretaceous beds are deformed by salt and affected by numerous faults which are difficult to interpret in strike view; several rotated blocks and salt pillow structures are interpreted in the parcel. A large detachment fault affects the Cretaceous and Tertiary beds and triggers rotated blocks in its downthrown side. The water bottom, Tertiary and Late Cretaceous sequences have canyons and mass transport deposits that create velocity anomalies and lower the quality of data in the older successions. The basement is poorly imaged under the deformed salt and several erosional unconformities.



Line 1157A, Source: C-NLOPB

Figure 28. Interpreted strike seismic line 1157A showing structural, tectonics and stratigraphic characteristics and possible drilling leads in NL12-01 parcels 2 and 4 (location in Figure 24). Numerous salt features are visible. The basement is obscure under the salt complex structures.

Strike line 1157A oriented E-W is located in the southern part of Parcel 2, running parallel to the lower slope of the Laurentian Basin (Figure 24). Data quality for this line is good to excellent (Figure 28). The synrift and postrift sequences (especially the Jurassic) are thicker in the southern part of the parcel. Several canyons are visible at the water bottom and several mass transport deposits can be interpreted in the Tertiary sequence. The Jurassic and Cretaceous beds are deformed by salt and affected by numerous faults which are difficult to interpret in strike view. A large rollover, rotated blocks and salt anticlines are excellent structural leads in the parcel. The amplitude anomalies visible in younger successions are related to some of the structures. The basement remains poorly imaged under the deformed salt and several erosional unconformities.

5.5. Petroleum Potential of Call for Bids NL12-01 Parcel 3. Parcel 3 covers 294,260 hectares (727,132 acres) in the eastern part of the Laurentian Basin. Parcel 3 shares borders with Parcel 2 to the west, EL 1118 to the east and parcels 5 and 6 to the south. This parcel, located on the slope in 1100-3250 m of water, is 126.2 times larger than a GOM OCS tract. It is well covered by a North-South/East-West dense grid (~ 6 by 4 km) of modern public domain, deep penetration seismic data. A subsidiary sparser grid, oblique to the rectangular grid and oriented both NW-SE and NE-SW, also covers the parcel. The East Wolverine G-37 well is located in the NE corner of the parcel. This well's results were recently released (April 2012) and can be tied to the grid using several seismic lines. The seismic horizons in the representative lines were interpreted using ties from the wells in the South Whale Basin and preliminary information from the East Wolverine G-37 well.

Five modern, deep penetration, time migrated seismic lines are used to illustrate the petroleum potential of this parcel:

a) Dip lines 1274, 1306 and 1330, and
b) Strike lines 1197A and 1157A.

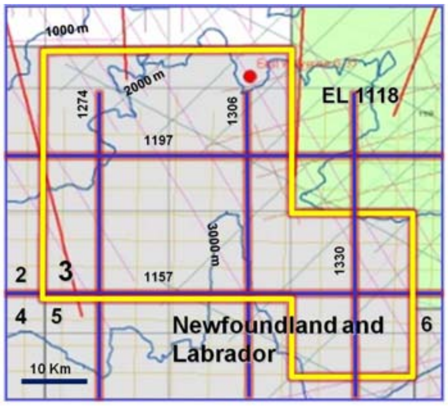


Figure 29. Location of representative seismic lines for Parcel 3.

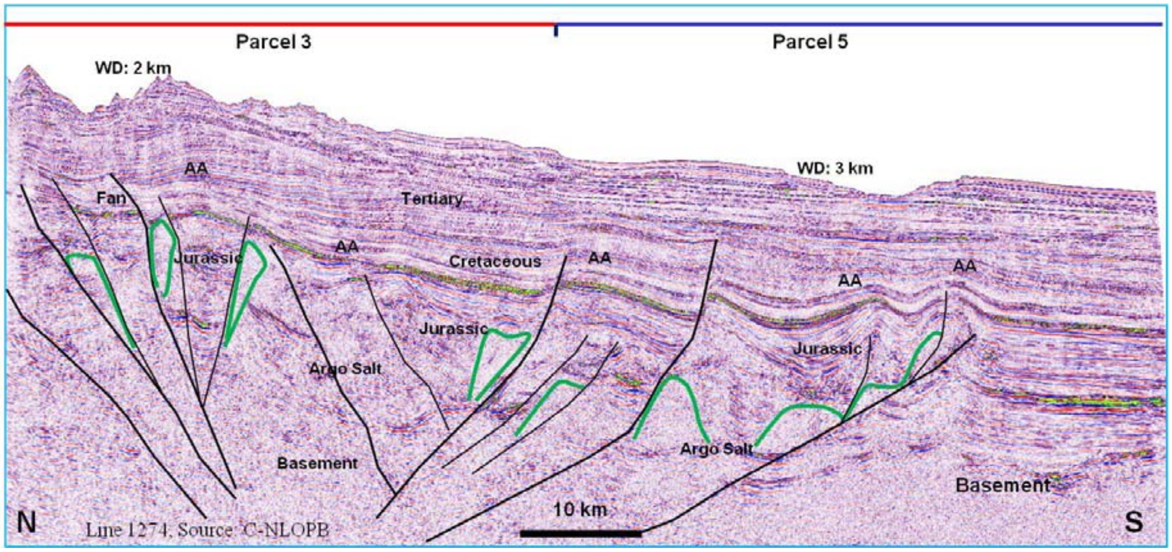


Figure 30. Interpreted dip seismic line 1274 showing structural, tectonics and stratigraphic characteristics and possible drilling leads in NL12-01 parcels 3 and 5 (location in Figure 29). The sedimentary formations thicken toward the south. Salt anticlines, fault blocks and fans are interpreted. Faults penetrate the basement, synrift and postrift sequences. The prerift unconformity is obscured by salt and faulting complexity.

Dip line 1274 oriented N-S is located in the western part of Parcel 3 and runs perpendicular to the lower slope of the Laurentian Basin (Figure 29). Data quality is good to excellent. The synrift and postrift sequences thicken to the south (Figure 30). Two canyons are visible at the water bottom and several mass transport deposits can be interpreted in the Tertiary sequence. The Jurassic and Early Cretaceous beds are deformed by salt and affected by several deep-penetrating extensional faults. A large rollover, several rotated blocks and salt induced anticlines are possible traps. Two strong amplitude anomalies (AA) in the Cretaceous and Tertiary successions are related to structural highs. The basement remains poorly imaged under the deformed salt and structural complications in the basement produced by Paleozoic salt cannot be ruled out.

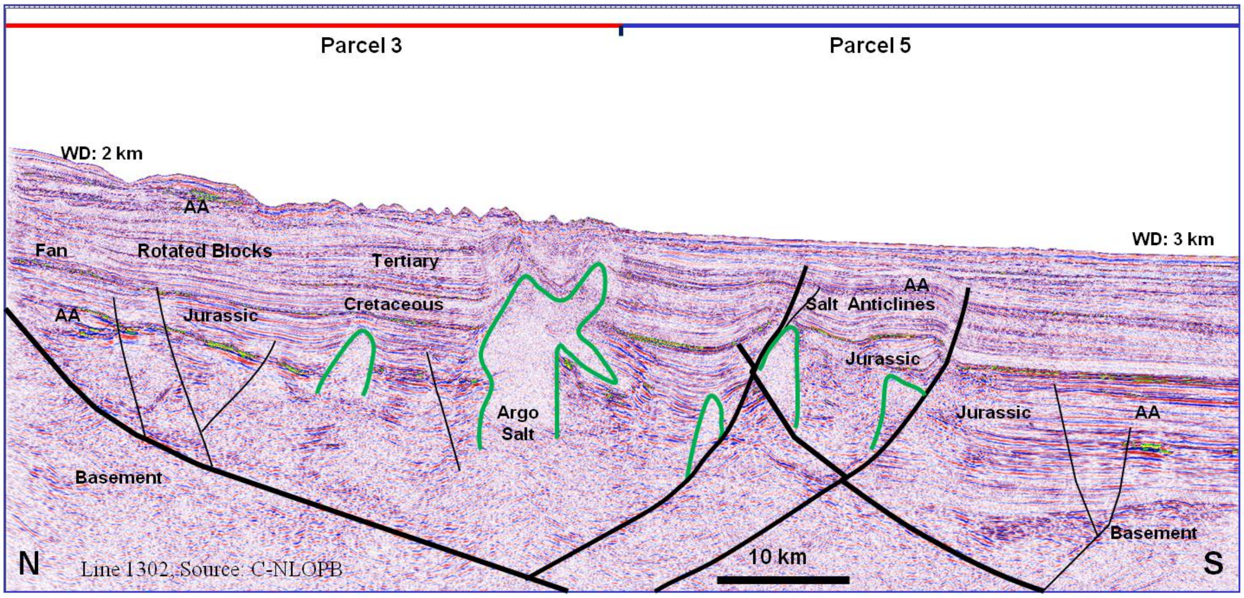


Figure 31. Interpreted dip seismic line 1306 showing structural, tectonics and stratigraphic characteristics and possible drilling leads in NL12-01 parcels 3 and 5 (location in Figure 29). The sedimentary formations thicken toward the border between parcels. Salt anticlines, fault blocks and fans are interpreted in both parcels. Deep penetrating faults are shown and several other faults are possible.

Dip line 1306 oriented N-S is located in the central part of Parcel 3 and runs perpendicular to the lower slope of the Laurentian Basin (Figure 29). Data quality for this line is generally good (Figure 31) but interference due to salt bodies causes patches of poor quality data. The section starts just 3 km south of the abandoned East Wolverine G-37 well. The well did not encounter the main objective but intersected several sandstone reservoirs, source rocks and petroleum shows in mid Jurassic and Early Cretaceous rocks. The synrift and postrift sequences thicken toward the south. A large rollover is visible in the northern part of the parcel. Several rotated blocks and salt induced anticlines are possible traps. A massive, three-dimensional salt body is present in the southern part of the parcel deforming strata as young as late Tertiary. The basement is poorly imaged under the deformed salt and structural complications in the basement produced by Paleozoic salt may produce further deterioration of data quality.

Dip line 1330 trends N-S and is located in the eastern part of Parcel 3 (Figure 29). The line runs oblique to the lower slope of the Laurentian Basin and stretches into EL 1118 and Parcel 6. Data quality for this line varies from good to fair, however data deteriorates in areas with salt bodies and under the salt (Figure 32). The synrift sequences thicken toward the south and are segmented by several major, deep penetrating faults. Some of these faults may be strike slip faults related to the Newfoundland Transform Fault Zone.

The water bottom is less canyonized than in other parcels. A large rollover, cut by several faults is interpreted in Parcel 3. The Argo salt induced structures have also produced local highs. The basement is poorly imaged under the deformed salt. Paleozoic salt may also produce structural complications in the pre-rift basement and possible synrift beds.

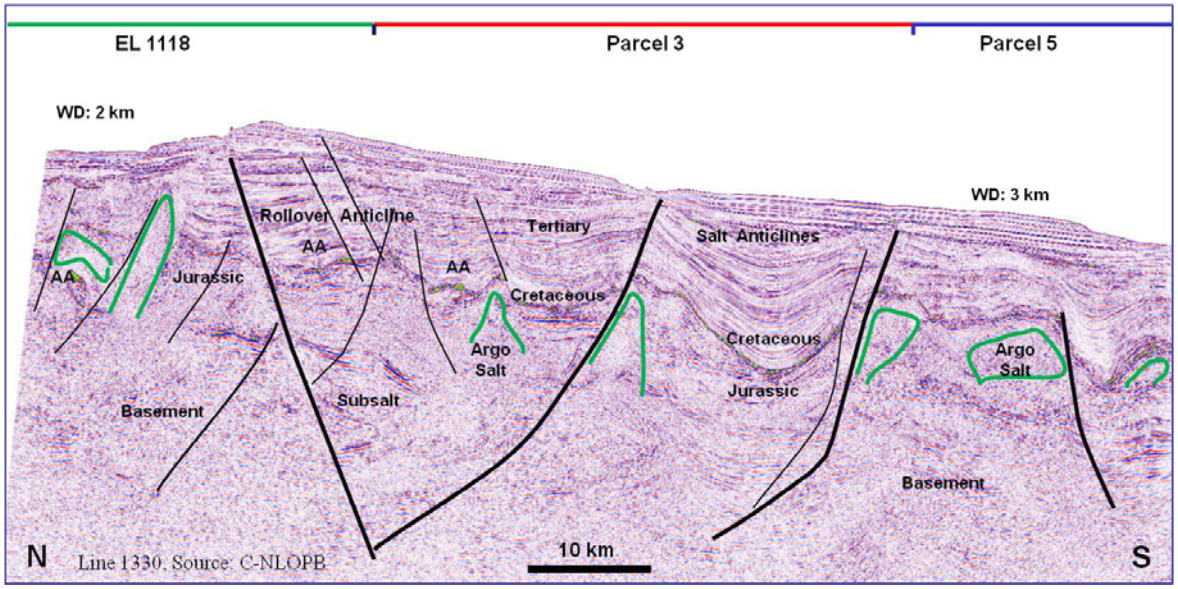


Figure 32. Interpreted dip seismic line 1330 showing structural, tectonics and stratigraphic characteristics and possible drilling leads in NL12-01 parcels 3 and 5 (location in Figure 29). The sedimentary formations thicken toward the border between parcels. Salt anticlines, fault blocks and fans are interpreted in both parcels and in EL 1118. Deep penetrating faults are shown, several other faults are possible.

Two strike lines located in this parcel were shown in previous illustrations (Figures 27 and 28) for NL12-01 Parcel 2.

Strike line 1197A (oriented W-E) is located in the central part of Parcel 3. The line runs parallel to the slope of the Laurentian Basin (Figure 29). Data quality is poor under the Cretaceous and Jurassic unconformities and especially under the deformed salt layer (Figure 27). In Parcel 3, the Jurassic and Cretaceous beds are deformed by Argo salt and affected by faults which are difficult to interpret in strike view. Several salt anticlines and salt pillow structures are interpreted in Parcel 3. More complex salt features are indicated by the seismic data and need 3D seismic data to be properly imaged. The basin is deepest in this parcel with a thick Jurassic and Late Triassic sequence present. The Late Tertiary strata are strongly canyonized and the modern-day Laurentian Channel canyon passes through the parcel. The basement is poorly imaged under the deformed salt and several erosional unconformities.

In the southern part of Parcel 3, strike line 1157A (oriented W-E) runs parallel to the lower slope of the Laurentian Basin (Figure 29). The data quality for this line is good to excellent (Figure 28). The synrift and postrift sequences and especially the Jurassic sequence, are thicker in this parcel. Several canyons including a large one are visible at the water bottom and several mass transport deposits can be interpreted in the Tertiary sequence. In this parcel, the Jurassic and Cretaceous successions are well deformed by salt with mild salt diapirs present on the western side and salt diapirs rising through the entire basin. Infill in the eastern side of the parcel creates numerous trapping possibilities, especially for Late Jurassic and Early Cretaceous beds. The amplitude anomalies in Cretaceous and Tertiary successions are related to some of the interpreted structures. The basement is too deep to be properly imaged, especially where it underlies salt bodies.

5.6. Petroleum Potential of Call for Bids NL12-01 Parcel 4. Parcel 4 covers 289,016 ha (714,174 acres) in the central part of the Laurentian Basin. The parcel borders on French territorial waters to the west, Parcel 2 to the north, parcels 3 and 5 to the east and unlicensed deep water area to the south. This parcel is located on the lower slope, in 2110-3650 m of water and is 124 times larger than a GOM OCS tract. Parcel 4 is evenly covered by a regular North-South/East-West dense grid (~ 6 by 4 km) of modern, public domain, deep penetration seismic data. Additional data in digital format is available from seismic brokers. No exploration well has been drilled in this parcel. The seismic horizons are interpreted using:

a) Dip lines 1202 and 1242, and
b) Strike lines 1157A and 1125A.

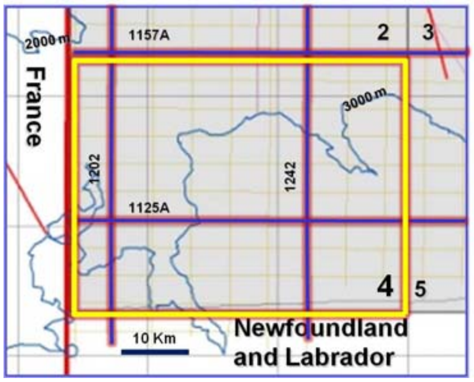


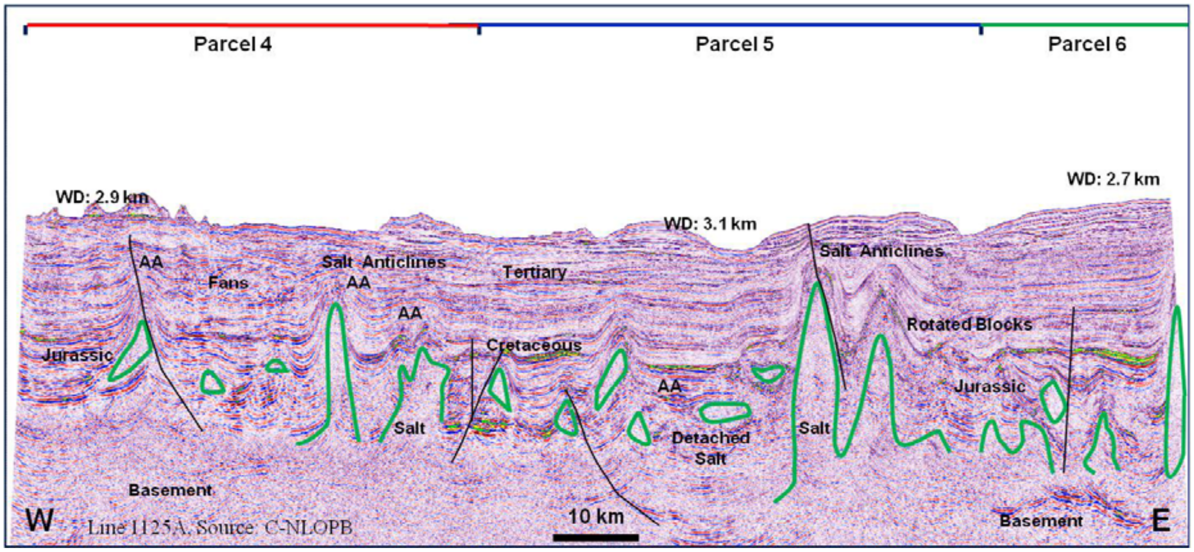
Figure 33. Location of representative seismic lines for Parcel 4.

Three of the aforementioned lines have been previously shown (Figures 25 to 27). The following discussion refers to the interpretation of these lines in Parcel 4.

Dip line 1202 (N-S) is located in the western part of Parcel 4 (Figure 33). The line is positioned over the continental slope of the Laurentian Basin and has good overall quality (Figure 25). The synrift and postrift sequences are thick in the downthrown flank of a major crustal detachment fault that starts in Parcel 2. A rotated block in the downthrown side of a major listric fault is interpreted toward the northern part of the parcel. The tilted block comprises Jurassic and Early Cretaceous beds. A salt anticline is also present in the rotated block. An inverted rollover is present in the northern part of the parcel and a sedimentary fan is imaged above the rollover. A well expressed basement horst with synrift and syn-transtension stages cover occupies the southern part of the parcel. All the identified leads are large. Considerable thickness of synrift and postrift successions including sandstone reservoirs and Jurassic shales should exist in the parcel.

In Parcel 4, the dip line 1242 (N-S) is located in the eastern part of the parcel, over the continental slope of the Laurentian Basin (Figure 33). The line has good to excellent quality, except in the area of a large salt feature (Figure 26). The synrift and postrift sequences are thick in the downthrown section of a major crustal detachment fault located in Parcel 2. A large salt body, bounded to the south by a down-to-shelf fault, intrudes the Jurassic to Cretaceous sequences. Several culminations of this body create local anticlines in Tertiary beds. In the middle of the parcel there is a large basement horst complicated on its northern flank by inversion and the presence of two small salt bodies intruding the Jurassic sequence. Several amplitude anomalies (AA) are present in the upper successions. Sandstone reservoirs and possible high TOC mature source rocks may be present in the parcel.

Strike line 1157 A (E-W) is located in the northern part of Parcel 4 running parallel to the lower slope of the Laurentian Basin (Figure 33). Data quality for this line is good to excellent (Figure 28). The synrift and postrift sequences (especially the Jurassic) are thicker in this part of the parcel. Several canyons are visible at the water bottom and several mass transport deposits can be interpreted in the Tertiary sequence. In this part of the parcel, the Jurassic and Cretaceous beds are deformed by salt and affected by faults which are difficult to interpret in strike view. A large rollover, rotated blocks and several salt anticlines are excellent structural leads in the parcel and vicinity. Amplitude anomalies in the Cretaceous and Tertiary successions are related to several of the structures. The basement remains poorly imaged under the deformed salt and several erosional unconformities.



Line 1125A, Source: C-NLOPB

Figure 34. Interpreted strike seismic section 1125A crossing parcels 4, 5 and 6. Numerous salt anticlines and fault blocks are interpreted in all parcels. Some of the salt bodies are detached in Jurassic-Early Cretaceous beds. The Prerift Unconformity is not well imaged under the salt basin.

Strike line 1125A trending W-E is located in the central part of Parcel 4. The line runs parallel to the lower slope of the Laurentian Basin (Figure 33). Data quality for this line is generally good (Figure 34), however, data quality deteriorates around salt bodies, under perched salt and salt welds. The synrift and postrift sequences (especially the Jurassic) are thick in this parcel. Several canyons are visible at the water bottom and several mass transport deposits can be interpreted in the Tertiary sequence. In Parcel 4, the Jurassic, Cretaceous and Lower Tertiary beds are deformed by salt and affected by numerous faults which are difficult to interpret in strike view. A tall salt piercement and several perched salt bodies create anticlines that are excellent structural leads. Several stratigraphic leads are present in Tertiary beds. Amplitude anomalies in Cretaceous and Tertiary successions are related to some of the salt anticlines.

5.7. Petroleum Potential of Call for Bids NL12-01 Parcel 5. Parcel 5 covers 289,016 ha (714,174 acres) in the eastern part of the Laurentian Basin. The parcel borders on Parcel 4 to the west, parcels 2 and 3 to the north, Parcel 6 to the east and unlicensed deep water areas to the south. This parcel is located on the lower slope, in 2650-3750 m of water and is 127.2 times larger than a GOM OCS tract. No exploration well has been drilled in this parcel, but East Wolverine G-37 is located 50 km to the north. Seismic lines are interpreted using ties from wells located in the South Whale Basin and indications from the newly released G-37 well. Except for the SE corner, Parcel 5 is evenly covered by a regular North-South/East-West dense grid of modern, public domain, 2D deep penetration seismic data. Additional seismic data in SEGY digital format is available from several seismic brokers. Five sections of modern, deep penetration, time migrated seismic lines are used to illustrate the petroleum potential of this parcel:

a) Dip lines 1274, 1306 and 1330, and
b) Strike lines 1157A and 1125A.

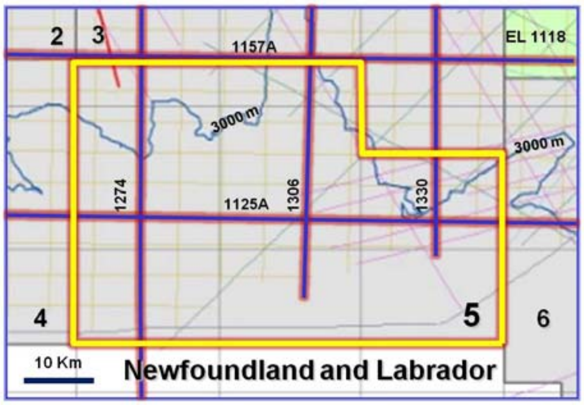


Figure 35. Location of representative seismic lines for Parcel 5.

All five of the listed lines have been previously discussed and are shown in Figures 28, 30, 31, 32 and 34. The following section contains the interpretation of these representative lines as applicable to Parcel 5.

Dip line 1274 (N-S) is located in the western part of Parcel 5 running perpendicular to the lower slope of the Laurentian Basin (Figure 35). Data quality for this line is good to excellent. The synrift and postrift sequences thicken to the south (Figure 30). Two canyons are visible at the water bottom and several mass transport deposits can be interpreted in the Tertiary sequence. In parcel 5, the Jurassic and Early Cretaceous beds are deformed by salt and cut by several deep-penetrating extensional faults. Toe thrust anticlines occupy the center of the parcel. A large rollover, several rotated blocks and salt induced anticlines are possible traps. Several strong amplitude anomalies (AA) in Cretaceous and Tertiary successions are related to structural highs. The basement remains poorly imaged under the deformed salt and structural complications in the basement produced by Paleozoic salt cannot be ruled out.

Dip line 1306 (N-S) is located in the central part of Parcel 5 running perpendicular to the lower slope of the Laurentian Basin (Figure 35). Data quality for this line is generally good. Interference due to salt bodies causes patches of poor quality data (Figure 31). The synrift sequences thicken toward the border between parcels 3 and 5. The water bottom is smooth. A massive, complex salt body deforms the entire basin infill in the northern part of the parcel. In the central part of the parcel, two shelf faults show inversion and create two large anticlines further complicated by salt intrusions which represent excellent structural leads. To the south there is a horst with a strong amplitude anomaly. The basement remains poorly imaged under the deformed salt and structural complications in the basement produced by Paleozoic salt may also affect data quality.

Dip line 1330 trending N-S is located in the eastern part of Parcel 5. It runs oblique to the lower slope of the Laurentian Basin and also stretches into EL 1118 and Parcel 6 (Figure 35). Data quality for this line varies from good to fair, however, data deteriorates in areas with salt bodies and under the salt (Figure 32). The synrift sequences thicken toward the south and are segmented by several major, deep penetrating faults. Some of these faults may be transtensional and related to the Newfoundland Transform Fault Zone. The water bottom is generally smooth. A large horst complicated by irregular salt bodies is interpreted in Parcel 5; beds as young as Late Tertiary are deformed. Argo salt induced structures have produced local highs. The basement is poorly imaged under the deformed salt. Paleozoic salt may also produce structural complications in the pre-rift basement and possible synrift beds.

Strike line 1157A (E-W) is located in the northern part of Parcel 5 running parallel to the lower slope of the Laurentian Basin (Figure 35). Data quality for this line is good to excellent (Figure 28). The synrift and postrift sequences (especially the Jurassic) are thicker in this part of the parcel. Several canyons are visible at the water bottom and several mass transport deposits can be interpreted in the Tertiary sequence. In this part of the parcel, the Jurassic and Cretaceous beds are strongly deformed. The faults while present, are difficult to interpret in strike view. A large anticline, several rotated blocks and tall salt anticlines are excellent structural leads in the parcel and its vicinity. Amplitude anomalies in the Cretaceous and Tertiary successions are related to several of the structures. The basement remains poorly imaged under the deformed salt and several erosional unconformities.

Strike line 1125A (E-W) is located in the central part of Parcel 5 running parallel to the lower slope of the Laurentian Basin (Figure 35). Data quality is generally good. However, data quality suffers around salt diapirs, under perched salt and below salt welds (Figure 34). The synrift and postrift sequences (especially the Jurassic) are thick in this parcel. Several canyons are visible at the water bottom and several mass transport deposits can be interpreted in the Tertiary sequence. In Parcel 5, the Jurassic, Cretaceous and Lower Tertiary beds are deformed by salt and affected by faults which are difficult to interpret in strike view. Two tall salt piercements and several perched salt bodies create anticlines that are excellent structural leads in the parcel. Several stratigraphic leads are present in the Tertiary sedimentary sequences. The amplitude anomalies visible in Cretaceous and Tertiary successions are related to certain anticlines.

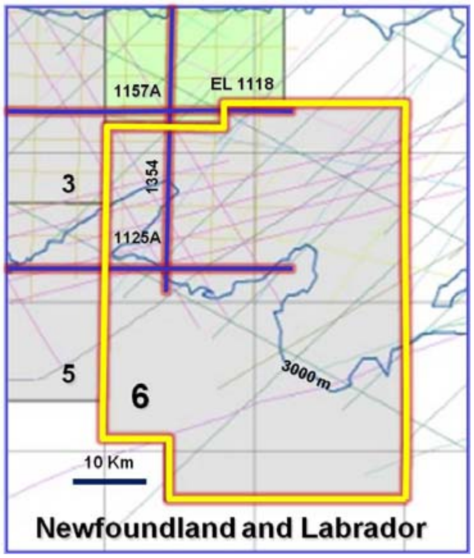
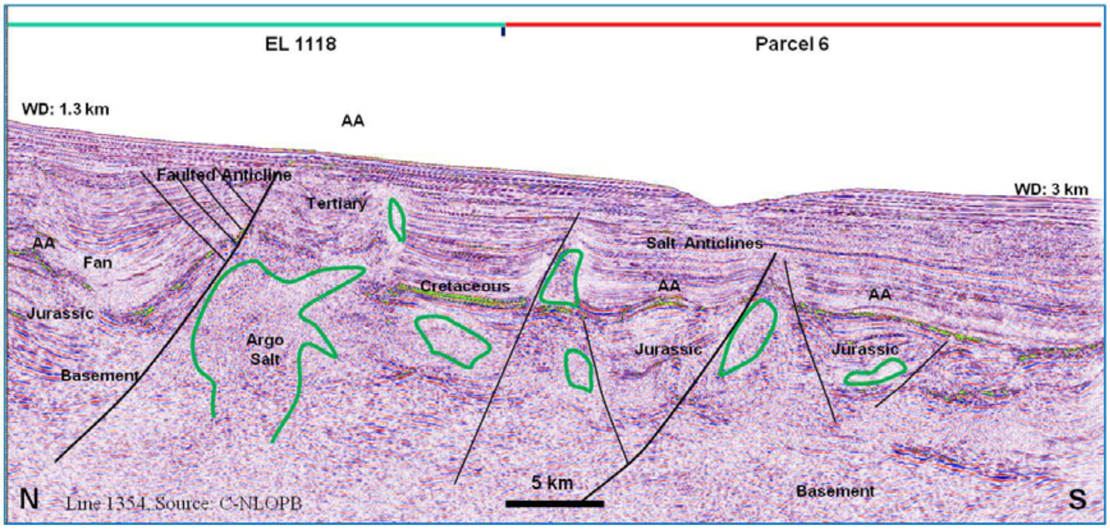


Figure 36. Location of three representative seismic lines for Parcel 6.

5.8. Petroleum Potential of Call for Bids NL12-01 Parcel 6. Parcel 6 covers 279,746 ha (691,267 acres) in the eastern part of the Laurentian Basin. The parcel borders on parcels 3 and 5 to the west, EL 1118 to the north and unlicensed areas to the west and south. This parcel is located on the lower slope, in 2250-3590 m of water and is 120 times larger than a GOM OCS tract. Parcel 6 is well covered by a dense grid oriented NW-SE/NE-SW (~ 6 by 4 km) of public domain modern and older seismic data in the northern and central parts of the parcel. Coverage is poor in the south. Additional digital data is available from seismic brokers or oil companies. No exploration well has been drilled in this parcel. The closest wells are in the South Whale Basin.

The seismic horizons are interpreted using ties from the wells located in South Whale Basin and indications from the East Wolverine G-37 exploration well situated approximately 70 km to the NW. Portions of three modern, deep penetration time migrated seismic lines are used to illustrate the petroleum potential of this parcel:

a) Dip line 1354, and
b) Strike lines 1157A and 1125A.



Line 1354. Source: C-NLOPB

Figure 37. Interpreted dip seismic section 1354 crossing parcel 6 and EL 1118. Several salt anticlines and fault blocks are interpreted in Parcel 6 that can form good traps. Some of the salt bodies are detached in Jurassic-Early Cretaceous beds. The position of basement is unclear under the salt intrusions.

Dip seismic line 1354 (N-S) is located in the northwestern part of Parcel 6 running oblique to the lower slope of the Laurentian Basin and extending northward into EL 1118 (Figure 36). Data quality for this line is generally good but data deteriorates in areas with salt bodies, salt welds and under the salt (Figure 37). The synrift and syn-transtension sequences (Late Triassic-Early Cretaceous) are thick in Parcel 6. The water bottom is smooth except for the presence of a canyon. Several large leads such as salt induced anticlines and horsts are interpreted in the parcel. Perched Argo salt features have also produced anticlines. In the southern part of the line, several structures can not be properly resolved with 2D data migration. The basement is poorly imaged under the deformed salt. Several faults are interpreted, other faults are not well imaged.

Both strike lines that extend into Parcel 6 have been previously shown and discussed. Strike line 1157A (E-W) located in the northern part of the parcel runs parallel to the lower slope of the basin (Figure 36). Data quality is good to excellent (Figure 28). The synrift and postrift sequences (especially the Jurassic) are thick in this part of the parcel. The water bottom is slightly canyonized. In the northern part of the parcel, the Jurassic and Cretaceous beds are deformed by at least two large and tall salt diapirs. A large turtle shell anticline is interpreted between two salt intrusions. The salt structures and their flanks are significant structural leads. Amplitude anomalies in the Cretaceous and Tertiary successions are related to the salt anticlines. The basement is poorly imaged under the deformed salt and several erosional unconformities.

Strike line 1125A is located in the west-central part of Parcel 6 running approximately parallel to the lower slope of the Laurentian Basin (Figure 36). Data quality for this line is generally good (Figure 34). Data quality deteriorates within salt anticlines, under perched salt and salt welds. The synrift and postrift sequences (especially the Jurassic) are thick. In Parcel 6, the Jurassic, Cretaceous and Lower Tertiary beds are deformed by salt and also affected by faults which are difficult to interpret in strike view. A tall salt piercement and several perched salt bodies create anticlines that are excellent structural leads. A sub-unconformity trap is visible in the eastern part of the parcel. The lead contains Late Jurassic and Early Cretaceous strata.

6. Prospects and Leads

The seismic lines detailed in this report are part of a regular regional grid that should allow adequate definition of leads located in the parcels. This observation is valid for Parcels 2, 3, 4, 5 and partially for Parcel 6. Parcel 1 has poor public domain coverage but, based on adjacent seismic lines, the parcel should have a thick postrift sequence and abundant salt structures.

With the limited 2D grid available, only several large leads were identified and discussed in each of the parcels. Additional seismic coverage obtained from seismic vendors or oil companies will help to confirm the prospects and leads indicated in Section 5. Several leads have significant lateral and vertical dimensions. Based on well results and regional considerations, a multi-pay play is possible for these leads. Seismic mapping was beyond the scope of this report. Using the 2D seismic grid (Figure 21) one can estimate that leads will be as large as 30-150 km^2.

The Laurentian Basin's main hydrocarbon play is structural. It involves porous mid-Jurassic to Early Cretaceous sandstones trapped by listric fault triggered roll-over anticlines, salt induced diapirs, perched salt highs, turtle shell anticlines and large rotated blocks. As shown by the representative seismic lines, the basin is rich in extensional and salt related traps. Late Cretaceous and Tertiary sequences are less affected by normal faults but are deformed by salt diapirism and gravity sliding. Source rocks are found at expulsion depths of 3000-6000 m beneath the mud line in salt evacuation mini-basins and deep basement grabens. Seals should not be a problem in the Laurentian Basin. Seismic amplitude variations and large gas chimneys are seen in the late Early Cretaceous, Late Cretaceous and Early Tertiary sequences. The main geological risks on these parcels are the quality of the reservoir and access to sufficient oil prone source rock. These risks should be mitigated by the large size of the structural traps identified in these parcels.

MacLean and Wade (1992) carried out a probabilistic analysis of the Laurentian Basin petroleum potential based on a variety of play concepts. They concluded that, at an average expectation, the basin contained 8-9 tcf of recoverable gas and 600-700 million barrels of oil. However, their analysis did not consider the deepwater plays nor the possibility of the existence of an Early Jurassic oil prone source rock.

The recent Final Report for the East Wolverine G-37 shows that this well, located on the upper to middle slope, has encountered significant intervals of good quality sandstone reservoirs in Cretaceous and Jurassic formations. The reservoir intervals are interpreted on the well logs and cuttings. These reservoir intervals can be easily extrapolated to the Call for Bids parcels using the seismic grid, increasing the value of the suggested prospects and leads.

7. Discussion

Exploration in the Laurentian Basin region is at a very early frontier stage. Only one well has been drilled in the shelfal part of the basin. Bandol #1 was reported to have encountered hundreds of meters of good reservoir, but was drilled and abandoned and the logs were not available to the author. The East Wolverine G-37 well (released April 2012) drilled on the slope has encountered reservoir and source rock intervals (some with fair shows) in Mid-Jurassic and Early Cretaceous rocks. When fully analyzed, this well can provide further insight into the petroleum geology of the basin.

On the continental slope, the main source rock for the area, the Verrill Canyon Shale, should be in mature range within the basin's basement lows and inter-salt depressions.

CFB NL12-01 parcels are much larger when compared with a Gulf of Mexico standard tract (more than 100 times larger, except for Parcel 1). Good 1990s-early 2000s quality, dense 2D seismic coverage is publicly available in the parcels to image and map hydrocarbon traps. Additional high quality digital data is available from seismic contractors. Numerous petroleum prospects and leads were identified with this modern seismic data and are waiting to be delineated and drilled.

The parcels are in a region with large extensional and salt induced traps, known reservoirs, mature source rocks and proven migration paths. Parcels contain multiple reservoir targets within synrift/syndrift sandstone reservoirs at 3500-6500 m depth that can be drilled year round and tested using semi-submersible rigs.

Risks are recognized in regard to reservoir quality, source rock quality, overpressure and fault sealing. Two adjacent ELs located to the north of parcels 1 and 6 are active in the basin (operated by ConocoPhillips with partner BHP). The cost of an offshore well in these parcels would likely be in the range of CAD $80-100 million depending on the depth to the target.

The offshore Laurentian Basin in SW Newfoundland is close to industrial regions of Central Canada, Eastern United States and Western Europe. Canada is a country with a stable political and financial system and has a long tradition in oil and gas exploration.

Newfoundland and Labrador has a marine petroleum exploration tradition of more than 45 years. The province has 15 years offshore oil production expertise that includes both a Gravity Based Structure and Floating Production Storage and Offloading Systems (GBS and FPSOs). The royalty regime is well established and places offshore NL in the middle to-upper tier of world's favorable areas for petroleum exploration and production. The Province obtains 27.5% of the nominal GDP from the oil and gas industry and is actively encouraging exploration of offshore areas especially in its less explored basins. There is a robust regulatory regime in the offshore area including HS&E. The Provincial Government encourages offshore exploration, however safety of workers and protection of environment are paramount.

8. Conclusions

Six large parcels, within the practically unexplored Laurentian Basin, are available for licensing in the C-NLOPB’s Call for Bids NL12-01 which closes on November 1, 2012, 4 p.m. NL time. These intermediate to deepwater parcels contain Mesozoic synrift and postrift (syn-transtension and syndrift), predominantly clastic successions, including proven source and reservoir rocks located within a classic Atlantic salt province. Similar reservoirs have tested high amounts of natural gas, condensate and oil in the Sable Basin, which is located approximately 300 km southwest of Laurentian Basin. Excellent oil flows are being obtained from the Jeanne d’Arc Basin oil fields located approximately 550 km to the northeast. Only two wells were drilled in this 60,000 km^2 basin, Bandol#1 on the shelf and East Wolverine G-37 on the slope. These wells have intercepted good quality reservoir sandstones**.**

Source rocks should be mature in the basin’s low areas: basement half grabens and salt withdrawal synclines. The NL12-01 parcels constitute large exploration blocks situated in a deep water Mesozoic basin and in a geologic setting similar to other prolific Atlantic margin basins. Large fault bounded rollovers, salt cored anticlines, turtle shell anticlines, toe thrust anticlines and rotated block trap-types with mid-Jurassic and Early Cretaceous reservoirs that were successful in the adjacent basins are viable leads in all parcels. Additional potential may exist in Late Cretaceous and Early Tertiary stratigraphic traps (slope and deep basin fans).

Some of the leads have clearly expressed DHIs (amplitude anomalies, gas chimneys, etc) on 2D seismic sections. Recognized risks in regard to reservoir quality and fault seal are mitigated by the presence of relatively large undrilled features and the presence of clear structurally conformable amplitude anomalies. Geological risk can be reduced by using 3D seismic data, depth migration, pre-stack and post-stack seismic analysis, CSEM methods and sea-surface slick analysis. Risks are mitigated by the large size of the interpreted leads that can contain several tcf of natural gas or more than 1 billion barrels of oil.

The basin is ice free year-round. The leads in the parcels are located in deep water and require modern, harsh environment drilling units.

The suggested leads are located in a practically unexplored basin, close to vast northeastern American and Canadian markets. The parcels on offer will give a new entrant in the area an excellent opportunity of participating in a high risk-high reward petroleum play off Canada’s East Coast. For an existing operator, the parcels provide a great option to increase its prospective portfolio of leads and prospects offshore NL.

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Additional sources of information:

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