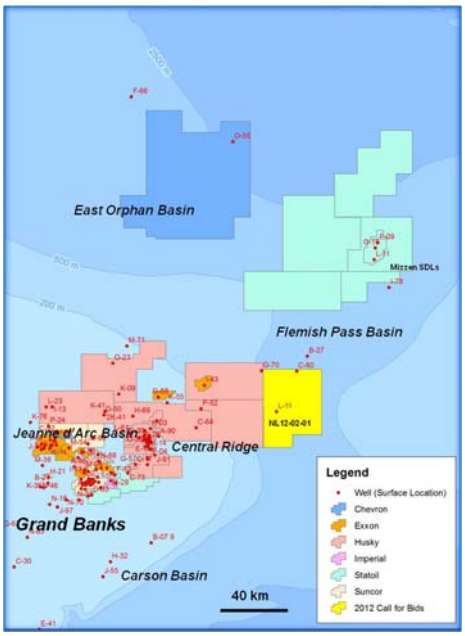
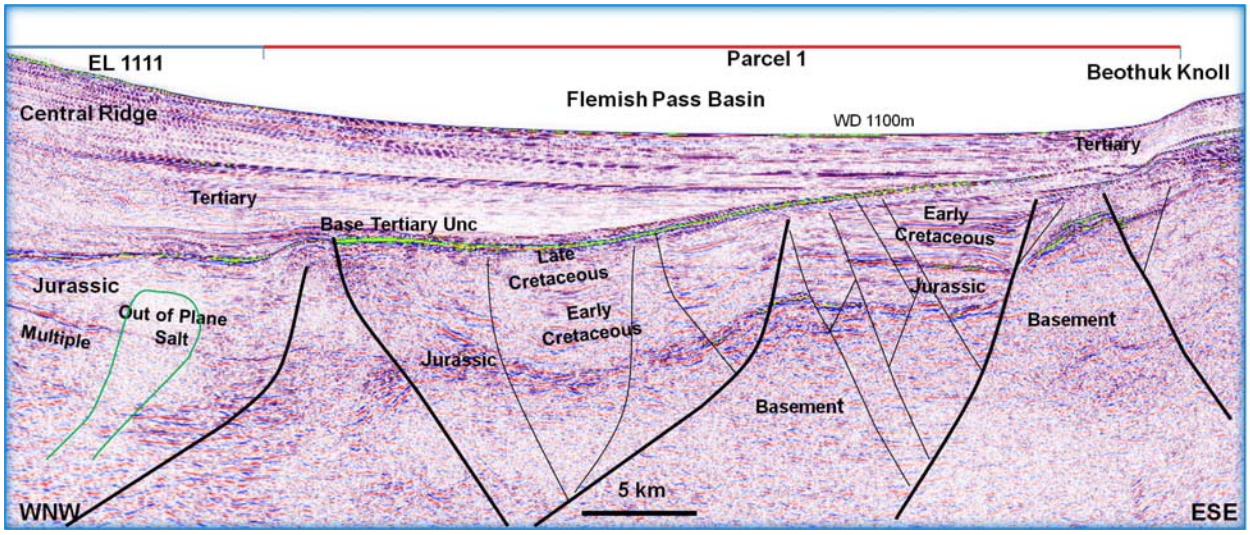
Call for Bids NL12-02, Parcel 1,
Petroleum Exploration Opportunities in the Flemish Pass Basin,

Government of Newfoundland and Labrador
Department of Natural Resources





By Dr. Michael Enachescu, P Geoph., P Geo.
September 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 a land parcel offered in the Canada-Newfoundland and Labrador Offshore Petroleum Board's (C-NLOPB) 2012 Call for Bids NL12-02. 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 offered parcels comprise a total of 1,798,637 hectares (4,444,529 acres).

Call for Bids NL12-01. Call for Bids NL12-01 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. Interested parties will also have until **4:00 p.m. NL Standard Time** on **November 1, 2012** to submit sealed bids for Call for Bids NL12-01, Parcels 1 to 6, Laurentian Basin.

Call for Bids NL12-02. This report focuses on Call for Bids NL12-02 consisting of one parcel totalling 208,899 hectares (516,201 acres), located in intermediate water depths 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 O-16 significant oil discovery which is estimated by the C-NLOPB to contain 102 mmbbls. This 14,000 km^2 (5405.4 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). As detailed in this report, significant oil and gas potential exists in Parcel 1. The bid for this parcel situated within the south-central part of Flemish Pass Basin will 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 NL12-02, Parcel 1, Petroleum Exploration Opportunities in the Flemish Pass Basin, Government of Newfoundland and Labrador Department of Natural Resources.***

I acknowledge the earlier researchers in the area: J. Wade, A. Grant, C. Keen, S. Srivastava, M. Keen., D. MacAlpine, G. Williams and many other scientists at GSC Atlantic who contributed to the Grand Banks Basin Atlas (1989). I also acknowledge the professionals of Petro-Canada, EnCana and Norsk Hydro who mapped and drilled the first significant oil show and of Statoil and Husky who recorded the first significant oil discovery in the basin - Mizzen O-16. This work could not have been completed without valuable information provided by C-NLOPB and Government of Newfoundland and Labrador, Department of Natural Resources. I am grateful to W. Foote, D. Middleton, L. Hicks, L. Cook, D. Spurrell, M. Stoyles and A. Butland for edits and suggestions; B. Kendell, J. Owens and G. Roberts are thanked 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 **April 5, 2012, News Release**.

Acronyms used in this report:

NL = Newfoundland and Labrador (the legal name of the Province)
NS = Nova Scotia
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
NL12-01 and 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
TOC = Total Organic Carbon
DHI = Direct Hydrocarbon Indicator
bopd = barrels of oil per day
bcd = barrels of condensate per day
mmcfd = million cubic feet per day
tcf = trillion cubic feet
bcf = billion cubic feet
mmbbls = million barrels

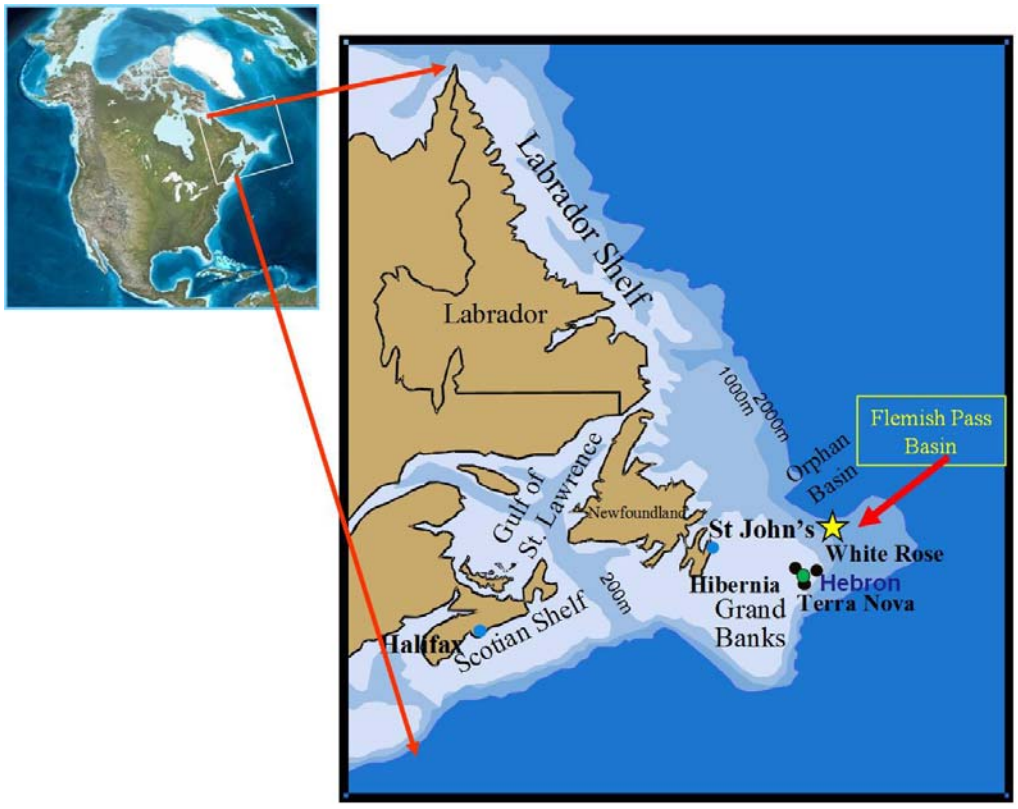


Figure 1. Location of Newfoundland and Labrador's major offshore oil fields and of the Flemish Pass Basin, northeast of the Grand Banks of Newfoundland (yellow star).

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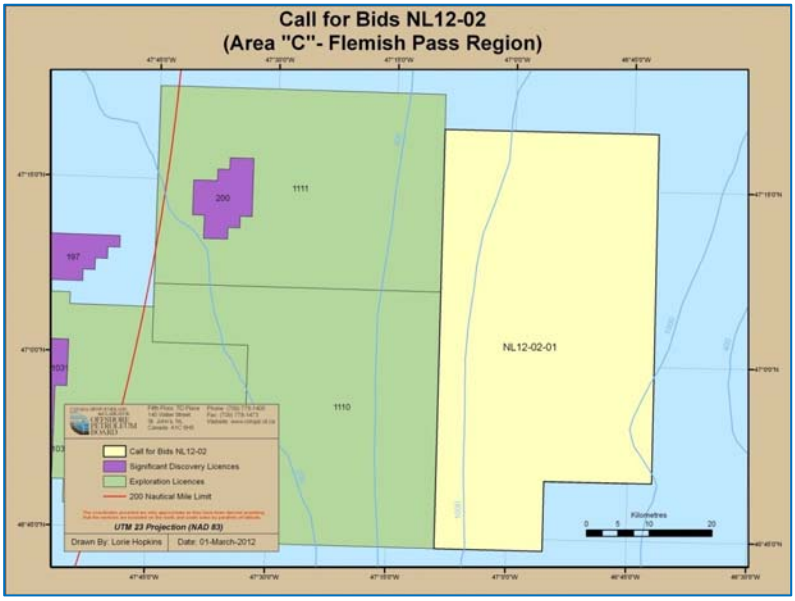
1. Introduction

This report focuses on the C-NLOPB Call for Bids NL12-02 – Parcel 1 (Area "C" - Flemish Pass), which is located off the east coast of the Province of Newfoundland and Labrador (NL), Canada. This parcel is situated in the south-central part of a bathymetric feature known as the Flemish Pass, developed northeast of the Grand Banks of Newfoundland. The area is administered jointly by the NL provincial and Canada federal governments (Figure 2).



The Call for Bids parcel is located mostly within the Flemish Pass Basin, in an area also known as the Gabriel Subbasin, where structural, stratigraphic and composite traps are seen on seismic data. The Flemish Pass Basin is a lightly explored basin that has only seven exploration wells and one delineation well. The most recent exploration well in the basin, Mizzen O-16, was a significant oil discovery. The final report of this recent well was released in 2011, but many findings in this well remain to be evaluated.

Figure 2. Location of Call for Bids NL12-02 Parcel 1 (courtesy of C-NLOPB).

Presently, there are five active Exploration Licences issued in Flemish Pass Basin (ELs 1112, 1123, 1124, 1125 and 1126 operated by Statoil), one large amalgamated EL in the neighboring East Orphan Basin (EL 1074R operated by Chevron) and 3 ELs on the Central Ridge (1190R, 1110 and 1111 all operated by Husky) (Figure 3). Two Significant Discovery Licences 1047 and 1048 were awarded in the basin and several SDLs exist on the Central Ridge.

The basin is a high-risk, high-reward exploration area and is a) mainly unexplored, b) located in intermediate deep water (400-1500 m) and c) contains very large, undrilled faulted anticlines. Only two exploration wells and one delineation well were drilled during the past decade in the basin. The recent exploration well Mizzen O-16 found oil in Late Jurassic (Tithonian) sandstones and a Significant Discovery Licence was awarded to the Statoil/Husky partnership in 2010/11. The 2012 Call for Bids provides a great opportunity for petroleum exploration in this now proven petroleum basin. The parcel on offer (Figures 2 and 3) is 90 times larger than a Gulf of Mexico lease tract.

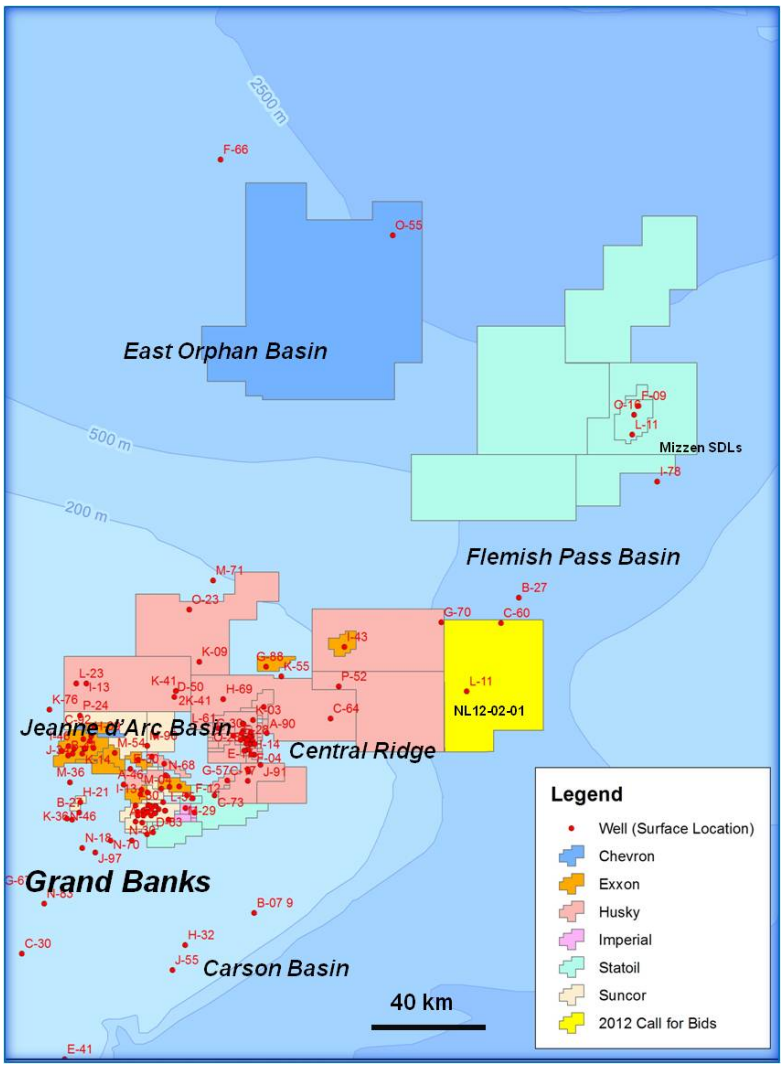


Figure 3. Location of Flemish Pass Basin relative to the Grand Banks shelf basins and subbasins.

More information on the geology of Newfoundland and Labrador and on the offshore petroleum potential, including evaluations of earlier Call for Bids Flemish Pass Basin 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.

Additional petroleum related reports and presentations from the Department of Natural Resources are available at: http://www.nr.gov.nl.ca/nr/invest/energy.html#offshore.

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

2. Exploration and Development Background

The Canadian province of Newfoundland and Labrador is one of the few Atlantic jurisdictions north of Florida allowing petroleum exploration on the Eastern Seaboard of the North American continent. Approximately 800,000 sq kms (309,000 sq miles) of Mesozoic and Paleozoic areas with oil and gas potential are distributed around the province. Continental margin research and offshore oil and gas exploration have been carried out on the Atlantic region of the province for more than 45 years. Production of light oil in the Jeanne d'Arc Basin is now in its 15th year. Numerous NL-DNR publications discuss the geological setting, exploration history, major field developments and petroleum production of NL's East Coast Atlantic Basins (http://www.nr.gov.nl.ca/nr/invest/energy.html#offshore).

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 and 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 35º API) from high quality Mesozoic sandstone reservoirs. With this output, NL is Canada's 3rd largest oil producer and the 7th largest oil producer among all American states and Canadian provinces (after TX, AK, 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 bbls 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 discovered natural gas exists on the Grand Banks, but there is no commercial gas production yet. Jeanne d'Arc Basin developments are the only East Coast North America producing oilfields. Hebron, the next offshore project, 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 the 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%). Presently Nalcor has no exploration involvement in the Flemish Pass Basin; however the company is leading regional research on geochemistry of water bottom cores and oil slicks in the area. A regional 2D grid of "ghost free" seismic reflection data is also planned to be recorded in the Flemish Pass/Orphan Knoll area as a multi-client program with Nalcor participation. Moreover, if the Mizzen oil field is developed in the future, Nalcor may participate with up to a 10% interest stake.

2.3. NL Offshore Exploration and Production Activity. Oil and gas exploration in NL's offshore started in the early 1960s. Several exploration and production specifics are outlined below.

Drilling. A total of 378 exploration delineation and development wells were drilled offshore NL. The first well, Tors Cove D-52, was spud in 1966 within the South Whale Basin. The total number of exploration wells amounts to 149 and the wells are unevenly distributed; however, the Jeanne d'Arc Basin/Central Ridge area has the majority. Currently there are 6 exploration wells in the Saglek Basin (in NL waters), 21 in the Hopedale Basin (from which only 16 are significant wells), 7 in the West Orphan Basin, 2 in the East Orphan Basin, 7 in the Flemish Pass Basin, 4 in the Carson Basin, over 30 in the South Grand Banks basins, 2 wells in Laurentian Basin, and 6 in the Paleozoic Maritimes / Anticosti basins. A total of 51 delineation and 178 development wells were also drilled with the great majority located in the Hibernia, Terra Nova, White Rose and North Amethyst fields. The latest well on record is the North Amethyst G-25 7 development well drilled in the summer of 2012 on the eastern flank of Jeanne d'Arc Basin. Several other production wells are planned and it is expected that 3 to 4 exploration wells will be drilled in the next two years.

Seismic data. Over a half million km of 2D seismic lines and approximately 1.5 million CMP km of 3D data has been collected in the NL offshore area. The various vintage 2D seismic grids are uniformly distributed on the continental shelf and slope. There is less seismic coverage in the deep water and certain basins require more modern and higher resolution surveys. The Jeanne d'Arc and Flemish Pass basins are currently well covered by 3D seismic data. More 3D data is being collected this year in the Flemish Pass Basin. The 3D coverage is limited in the Laurentian, Carson and Orphan basins while other basins (e.g. Labrador basins, Sydney and Maritime basins and most of Anticosti Basin) have no 3D coverage.

Potential Field Data. Regional, basin-wide and detailed gravity and magnetic data has been collected offshore NL by the GSC, NL Government and oil companies active in the area. Most of these surveys are now in the public domain. Of great value are potential field profiles recorded simultaneously with high resolution 2D reflection lines (e.g. TGS/PGS/Nalcor multi-client survey). Satellite Gravity data is also available from the National Oceanic and Atmospheric Administration (NOAA).

Petroleum Discoveries. Besides the four producing oil fields, there are 14 oil discoveries and 7 gas discoveries offshore NL, distributed as follows: one light oil discovery in the Paleozoic basins of West Newfoundland (Garden Hill), 11 in the Jeanne d'Arc Basin (among which Hebron is approved for development), 3 on the Central Ridge (South Tempest, Trave and North Dana), 1 oil discovery in the Flemish Pass Basin (Mizzen) and 5 gas discoveries in the Hopedale Basin (Snorri, Hopedale, North Bjarni, Bjarni and Gudrid).

Production Licences. Currently there are 10 Production Licences awarded to Hibernia (PLs 1001, 1005), Terra Nova (PLs 1002, 1003 and 1004), White Rose (PLs 1006, 1007, 1009 and 1010) and North Amethyst (PL 1008) oil fields. These fields produced 258,507 bopd during the first 4 months of 2012. The next major offshore project is the Hebron oil field. With an estimated recoverable reserve of more than 707 mmbbls, it is slated for development starting this year.

Exploration Licences. As of July 2012 there are 33 active ELs offshore NL distributed in 5 basins: 7 in the West NL Paleozoic basins, 1 in the Sydney Basin, 4 in the Hopedale Basin, 1 large consolidated EL in East Orphan Basin, 5 in the Flemish Pass Basin, 13 in the Jeanne d'Arc

/ Central Ridge area and 2 in the Laurentian Basin. More than half of these ELs have to be drilled in the next few years to meet licensing requirements.

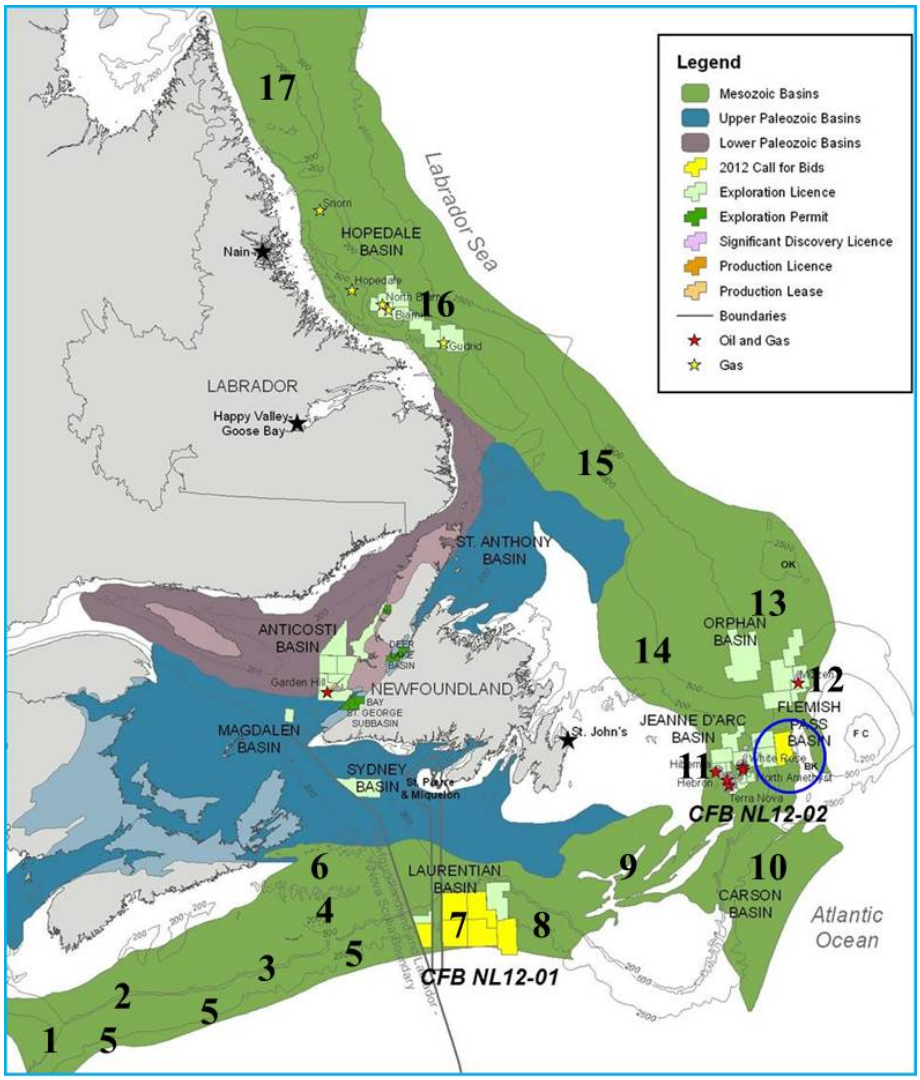


Figure 4. Atlantic Canada offshore basin map. Mesozoic basins are depicted in green, Paleozoic basins are shown in dark blue and dark purple. From south to north the basins and subbasins are: 1 = Georges Bank, 2 = Shelburne, 3 = Sable, 4 = Abenaki, 5 = Scotian Slope, 6 = Orpheus Graben, 7 = Laurentian,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

2.4. Newfoundland and Labrador Offshore Research Projects. Several large research and exploration projects are jointly administered by Nalcor and the NL-DNR through programs such as the Petroleum Exploration Enhancement Program (PEEP) and the Offshore Geoscience Data Program (OGDP). More Details of these and other research programs are given at: http://www.nr.gov.nl.ca/nr/invest/enachescu_NL1102Flemish.pdf.

A regional oil seep mapping and interpretation study funded by OGDP includes the Flemish Pass Basin. Initiated in 2010 by Nalcor / NL-DNR in collaboration with PIP/PAD of Ireland and awarded to GeoArctic of Calgary, the Plate Tectonic Kinematic Model for North Atlantic regions will be completed by the fall of 2012. A large-scale, multi-client 2D seismic program focused initially on the Labrador offshore, and now extended to the Orphan / Flemish Pass area, was partially funded by Nalcor through OGDP. The program started in 2011 and continues this year. It is operated by a partnership of experienced global contractors (TGS in collaboration with PGS).

2.5. History of Exploration in the Flemish Pass Basin. The basin was recognized by the GSC and Industry as a deeper water area containing Mesozoic and Tertiary fill. The subsurface configuration of the Flemish Pass Basin and origin and constituency of the two high crustal blocks, the Flemish Cap and Orphan Knoll, have been studied by GSC scientists involved in research of the North Atlantic evolution and continental margin formation (Figure 5).

One of the first targets of the Deep Sea Drilling Program (DSDP) was the Orphan Knoll. A hole was drilled in 1970 during DSDP Leg 12, Site 111 and cores recovered indicated the presence of Cretaceous and Jurassic sediments on the knoll (Laughton et al. 1972, Ruffman and van Hinte, 1973). Shallow cores and drag samples from the Flemish Cap, a shallow continental block, have recovered granodiorites, granites, dacites and Precambrian age sediments of Avalon terrain origin (King et al, 1986).

A region of deeper water (500 to 1500 m deep) compared to the Jeanne d'Arc Basin, the Flemish Pass has only 7 exploration wells drilled to date resulting in a well density of one well/2000 km^2 (Figure 5). Oil exploration in the deeper waters of the Flemish Pass followed exploration of the Grand Banks basins. Seismic exploration and drilling took place during four cycles:

1. Early 1970 to late 1970s,
2. Early to middle 1980s,
3. Late 1990s to 2007, and
4. 2008 to present.

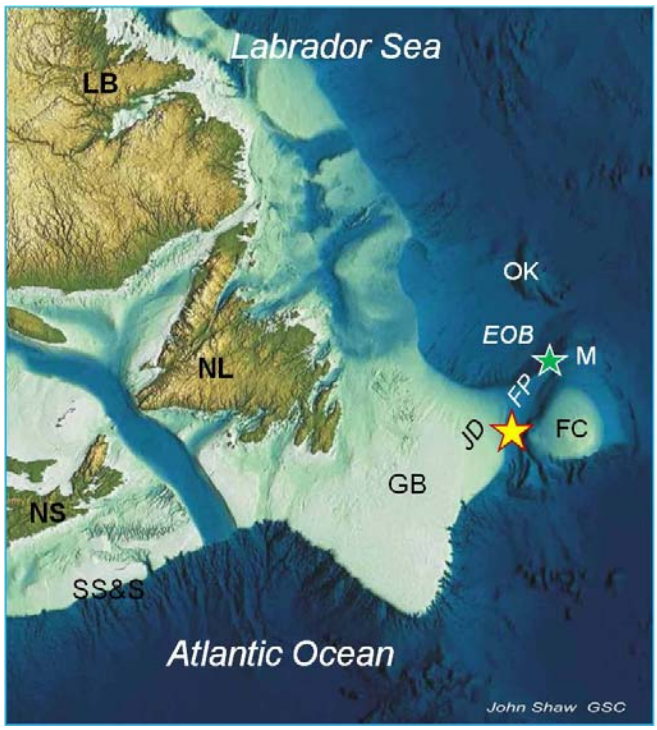


Figure 5. Location of Flemish Pass Basin (FP), Mizzen SDLs (green star) and Call for Bids Parcel 1 (Yellow star) on the Newfoundland and Labrador continental margin (modified from GSC). Annotations are: NL = Newfoundland and Labrador, NS = Nova Scotia, SS&S = Scotian Shelf and Slope basins, GB = Grand Banks, JD = Jeanne d'Arc Basin, EOB = East Orphan Basin, FC = Flemish Cap, OK = Orphan Knoll.

Cycle 1. From 1970 to late 1970s, several 2D seismic grids were collected over the area revealing large structural closures under the widespread Base Tertiary Unconformity. At this time large exploration blocks were licensed by Esso. The first well in the basin, Gabriel C-60,

drilled in 1979, encountered excellent reservoir in a Hibernia equivalent interval and good shows (Gabriel Sandstones) but was abandoned without intersecting mature source rocks (well 1 in Figure 6).

Cycle 2. In the early to middle 1980s, additional seismic coverage and delineation of large prospects resulted in the drilling of three wells. Operated by Esso, the Baccalieu I-78 drilled in 1986 and located in the northern part of the basin, encountered good reservoirs in Early Cretaceous (Baccalieu sandstone) and in Late Jurassic as well as good Kimmeridgian source rocks (well 2 in Figure 6). The following well, Lancaster G-70 was drilled by Petro Canada on a structure located in the southern part of the basin (unofficially called Gabriel Subbasin) (well 3 in Figure 6). While also abandoned, the well encountered both Late Jurassic sandstones and Kimmeridgian source rocks. Kyle L-11 operated by Esso and drilled in 1986, is the southernmost well in the basin (well 4 in Figure 6). The well encountered Early Cretaceous sandstones (Avalon and Hibernia equivalents) but terminated in basement without intersecting a Jurassic sequence.

Cycle 3. After a long exploration pause with no ELs in the area (1987-1997) the basin has seen a renewal of activity related to large discoveries in intermediate and deep waters of the Atlantic margins. During the late 1990s and early 2000s, several large ELs were licensed in the basin to Petro Canada and partners NorskHydro and EnCana. New multi-client and exclusive seismic grids were recorded and the first 3D surveys were collected. The Petro Canada et al. Mizzen L-11 was drilled in 2003 on a large faulted anticline and intersected excellent reservoirs in Early Cretaceous and Late Jurassic (well 5 in Figure 6). The well indicated 5 m light oil pay on logs dated as early Cretaceous (Baccalieu Sandstone) but was not tested. However, the well recorded the first confirmation of reservoired oil in this basin and indicated the presence of Late Jurassic reservoir with excellent qualities. The Tuckamore B-27 well was drilled in the same year by the same group of companies (well 6 in Figure 6). The well was located on an anticline in the Gabriel Subbasin. After drilling through a thick but wet Gabriel sandstone interval, the well was abandoned before reaching the Late Jurassic successions.

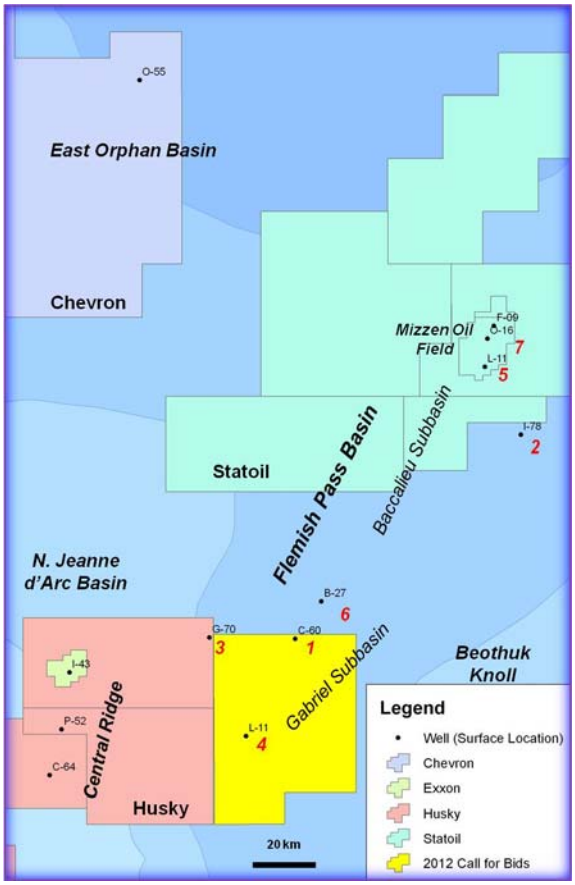


Figure 6. Location of Call for Bids NL12-02 Parcel 1 and Flemish Pass Basin historical drilling. Red numbers describe order of exploration drilling in the basin.

Cycle 4. The present exploration cycle started in 2008. At the time Statoil inherited all NorskHydro's Canadian assets (including Mizzen and Bay du Nord ELs) and then took over Petro Canada's and Encana's interests in the Mizzen Exploration Licence. Since then, Statoil has

become the lead explorer in the basin and together with Husky drilled the Mizzen O-16 discovery well in 2009 (well 7 in Figure 6). The well tested heavier oil (21-22º API) from Late Jurassic sandstones at a rate of 600 m^3/day (3774 bopd). The Mizzen discovery was awarded SDL status in 2010. Two major Calls for Bids in the basin in 2010 and 2011 concluded with 4 large licences being awarded to Statoil and partners (Husky, Repsol and Chevron). In 2011, the delineation well Mizzen F-09 was drilled on the northern flank of the Mizzen structures but the Tithonian reservoir was found below the oil water contact. In the summer of 2012 Statoil announced that the Mizzen field contains between 100 and 200 mmbbls recoverable oil.

More details about the history of petroleum exploration in the Flemish Pass Basin and environs are found at: http://www.nr.gov.nl.ca/nr/invest/cfb_nl99_1.pdf
http://www.nr.gov.nl.ca/nr/invest/cfb_nl03_01.pdf
http://www.nr.gov.nl.ca/nr/invest/enachescuNL100203.pdf
http://www.nr.gov.nl.ca/nr/invest/enachescu_NL1102Flemish.pdf,

2.6. Geological Overview of NL Mesozoic Atlantic Basins. The rifting of Pangea during Late Triassic-Early Jurassic has created a network of intra-cratonic basins generally oriented NE-SW and extending from the Gulf of Mexico to the Barents Sea (Tethys rift stage). In Newfoundland and Labrador, the Tethys rift basin chain starts with the Laurentian Basin in the south, stretches through the shallow water Grand Banks basins including the prolific Jeanne d'Arc Basin and then extends to the Flemish Pass and Orphan deepwater basins, and probably branches into the Labrador Sea.

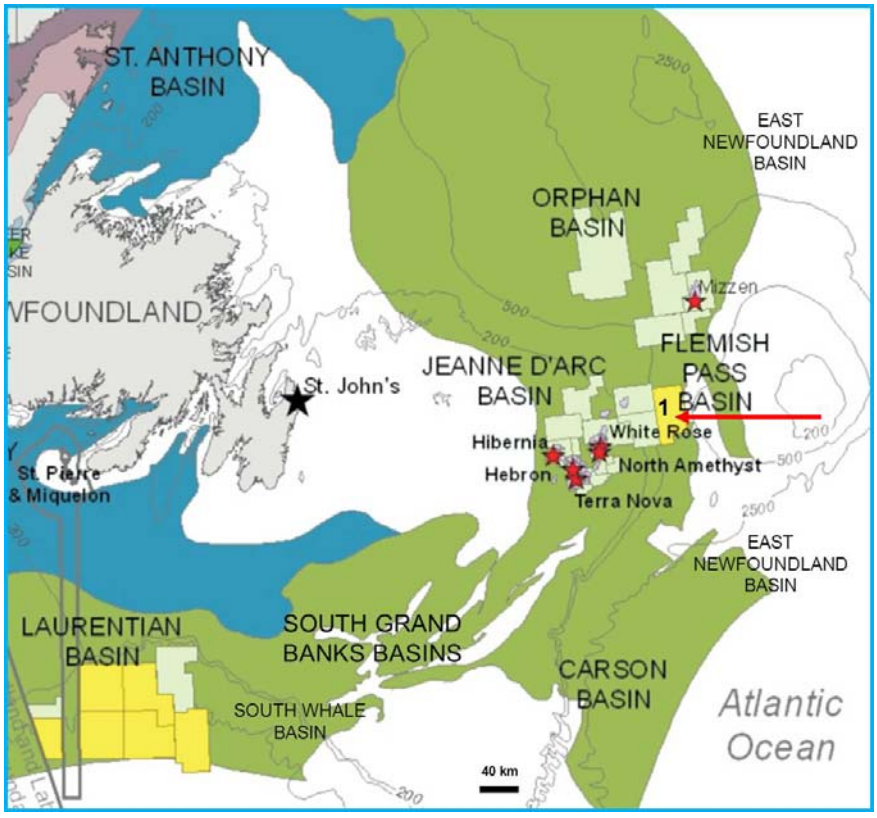


Figure 7. Mesozoic basins located on the Grand Banks of Newfoundland and surroundings (shown in green). South Grand Banks Basins (Whale and Horseshoe), Jeanne d'Arc Basin, Flemish Pass Basin and most of Orphan Basin are confined basins. Laurentian Basin, Carson Basin and Eastern part of Orphan Basin are unconfined basins. Laurentian and South Whale basins are situated on a transform margin. The largest oil fields are identified by a red star. In yellow are, Call for Bids Parcels 1 to 6 in Laurentian Basin and Parcel 1 in Flemish Pass Basin. In blue are Paleozoic basins while in white are platforms, basement highs, ridges and Atlantic areas with oceanic crust.

NL's offshore basins have had a complex geodynamic evolution including:

- Repeated extension and transtension in the Mesozoic,
- Block rotation, changes in the direction of rifting, salt tectonism, subsidence, uplift, erosion, volcanism, mantle exhumation and localized inversion (due to various causes but not plate convergence related) have created numerous hydrocarbon traps,
- Several rifting stages with changes of direction followed by postrift sedimentation, and
- Oblique slip, which is a norm rather than an exception.

Major rift bounding faults dissect the continental margin and were reactivated several times forming:

- Confined basins such as Horseshoe, Whale, Jeanne d'Arc, Flemish Pass and most of Orphan, and
- Unconfined basins such as Laurentian, South Whale, Carson, East Newfoundland and Labrador (Figure 7).

The confined basins are situated on thinned continental crust whereas the unconfined basins are situated on thinner continental crust and on transitional crust and face cross-Atlantic conjugate basins. The Laurentian Basin and deepwater South Whale Basin have a unique position on the NL margin as they occupy continental, transitional and oceanic crust, and are situated on a continent-ocean transform margin. The Flemish Pass Basin lies entirely on stretched continental crust.

The geologic subdivisions of the Grand Banks record the development of the:

- Lower Paleozoic American continental margins,
- Late Triassic intra-continental rifts incised on Grenville, Avalon and Meguma basement,
- Late Triassic - Early Jurassic massive salt and other evaporite deposition,
- Repeated phases of intra-continental extension (Late Jurassic - Early Cretaceous) and intervening subsidence which included source and reservoir rock deposition,
- Formation of transitional crust,
- The late Early - Cretaceous break-up (oceanic rifting) from Iberia and from West Ireland,
- Increased thermal subsidence in Late Cretaceous,
- Inversion at the end of Cretaceous - beginning of Tertiary, and
- Post - Paleocene widespread subsidence and basin tilting.

The Late Triassic - Early Jurassic salt is generally thick and pervasive throughout the 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, (sometimes salt cored) and rotated blocks are the most successful trap types in the Mesozoic basins. Argo Salt is less pervasive in the Flemish Pass Basin where salt structures can be identified only in the southern part and on its western flank.

Until now, large oil accumulations were discovered in the Jeanne d'Arc Basin, Central Ridge and Flemish Pass Basin and gas accumulations in Jeanne d'Arc Basin, Central Ridge, Hopedale and

Saglek (Nunavut Territory) basins. Most of the hydrocarbons are reservoired in synrift sandstones that have excellent porosity and permeability. The Flemish Pass Basin is the only NL deepwater basin that contains an oil discovery. Other deep water basins such as the Laurentian Basin, southwestern South Whale Basin (located between the Nova Scotia Margin and Grand Banks of Newfoundland), Carson Basin (located east of Grand Banks), East Orphan Basin and deep water Labrador basins have high hydrocarbon potential but no discoveries yet.

The Grand Banks and Labrador 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. An updated account on the offshore Newfoundland and Labrador's Exploration and Production, regional geology and petroleum geology of the Mesozoic basins is also contained in the 2012 presentation and report on "Petroleum Exploration Opportunities in the Laurentian Basin, Offshore Newfoundland and Labrador Call for Bids NL12-01 available from: http://www.nr.gov.nl.ca/nr/invest/energy.html and http://www.nr.gov.nl.ca/nr/invest/cfb1201laurentianbasinenachescu.pdf.

3. Overview of the Regional Geology of the Flemish Pass Basin

West of the Flemish Cap-Beothuk Knoll lineament lies a typical Mesozoic rift basin partially separated to the west from the Jeanne d'Arc Basin by the Central Ridge. Modern seismic data also indicates that the Flemish Pass Basin is in structural continuity to the north with the East Orphan Basin (Smee et al., 2003; Enachescu et al., 2005). Most of the basin lies in the bathymetric low known as the Flemish Pass that is located between the Grand Banks and the Flemish Cap (Figure 8).

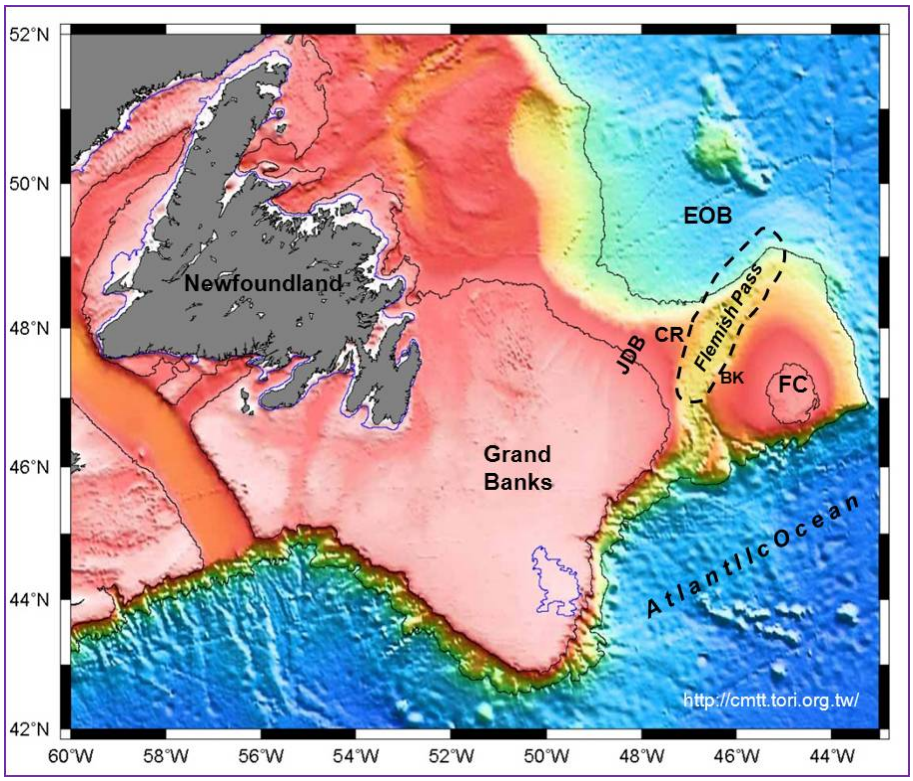


Figure 8. Bathymetric and physiographic features in the vicinity of the Flemish Pass Basin. The basin mostly occupies the bathymetric low known as the Flemish Pass (approximately 500 to 1500 m water depth) located between the Central Ridge (CR) and Beothuk Knoll (BK) and Flemish Cap (FC) and plunges toward the deep waters of the East Orphan Basin.

The Flemish Pass contains a Mesozoic-Tertiary basin that was intersected by a discovery well (Mizzen O-16) and another well with a noteworthy oil show (Mizzen L-11). Several other wells in the basin have intersected good reservoir and/or source rocks (e.g. Gabriel C-60 and Baccalieu I-78).

3.1. Adjacent Basins and Highs. The adjacent Central Ridge is a faulted intrabasinal high separating the Jeanne d'Arc and Flemish Pass basins. The ridge has two subunits, the South and the North Central Ridge, separated by a transfer zone (Enachescu, 1987). Drilled in only a few locations, the ridge contains both oil and gas discoveries (oil at South Tempest G-88; gas at North Dana I-43 and Trave E-87). Additionally, several wells (e.g. North Dana I-43, South Tempest G-88 and Panther P-52) have intersected thick source rock intervals. Toward the east, the basin is surrounded by a large shallow high, devoid of sediments, known as the Flemish Cap.

Just west of the Central Ridge, is the Jeanne d'Arc Basin, the only North American East Coast basin containing giant producing oil fields. The fields produce light crude (30 to 35ºAPI) from Late Jurassic-Early Cretaceous sandstones. There are four fields and satellites being produced, one oil field in development (Hebron) and several other oil and gas accumulations covered by SDLs. There are currently 13 ELs in the Jeanne D'Arc Basin and vicinity that must be drilled in the next 4 years to meet licensing requirements. Moreover, numerous deeper structural and stratigraphic features located in the central and northern part of the basin and on its eastern flank remain to be drilled (Smee, 2003; Enachescu et al., 2005).

Toward the north, the Flemish Pass Basin is in contact with the stratigraphically deeper East Orphan Basin which is an underexplored Mesozoic basin (Enachescu et al., 2005). The East Orphan Basin (EOB) is a highly attenuated Mesozoic-Tertiary sedimentary succession situated north and northeast of the Grand Banks of Newfoundland and the Flemish Pass in water depths ranging between 1500 and 3500 m. This large Mesozoic sedimentary area has been the focus of deep water exploration for the past 10 years. Large 2D and 3D seismic programs and CSEM surveys have been conducted. Two deep wells were drilled, but were unsuccessful (Great Barasway F-66 and Lona O-55). A large consolidated EL (1074R) validated by the drilling of these wells and now in its second exploration phase, contains large undrilled structures. According to several geodynamic models, the Late Jurassic source rocks should be present in some of the elongated troughs seismically mapped in the basin. Two of the active exploration blocks in the Flemish Pass Basin located close to the Mizzen SDL extend into the southern East Orphan Basin. The abandoned Great Barasway F-66 and Lona O-55 wells intersected a thick Late Jurassic clastic succession including reservoir and some intervals with good TOC content.

3.2. Geodynamic Evolution. Offshore NL basins were formed by intra-continental followed by oceanic rifting. Four continental rifting phases occurred in the North Atlantic region (Enachescu, 2011):

1. Tethys rift phase during Late Triassic to Early Jurassic,
2. North Atlantic Rift phase during Late Jurassic to Berriasian,
3. Labrador Sea Rift phase during Berriasian to Albian, and
4. Greenland/Europe rift phase during Late Cretaceous-Eocene.

The Flemish Pass Basin was affected by these four stages of rifting, two stages of transtension (due to change of direction of extension) and one stage of inversion (Late Cretaceous - Early Tertiary; non-plate related). A thinned continental crust underlies the basin that is bounded by shallow basement highs to the west, east and south that are underlined by normally thick crust. No transitional or oceanic crust was emplaced within the basin.

As a result of successive rifting, transtension, inversion and thermal subsidence, a thick Late Triassic to Late Cretaceous sedimentary fill (more than 10 km in places) was deposited in the basin and numerous extensional and compression modified extensional structures (CMES) were formed (Enachescu and Hogg, 2004). Triassic salt is not as abundant in this basin. Salt pillows and detached salt may play a role in the petroleum trap evolution in the Gabriel Subbasin and the western flank of the basin where it is in contact with the Central Ridge. The structures are dissected by several generations of fault systems (Enachescu, 1987 and 1988; Enachescu and Hogg, 2004 and 2006; Enachescu, 2010 and 2011). Major subsidence during Late Cretaceous and especially Tertiary provides an undeformed, relatively thick (1 to 2.5 km) cover of fine grained sediments, protecting the deeper synrift structures.

3.3. Lithostratigraphic and Tectonic Charts. Enachescu (1987, 1988 and 1992) has described the Flemish Pass Basin as the ocean-ward member of a double failed rift system that includes the westerly Jeanne d'Arc Basin and the Central Ridge. The double rift system is compartmentalized by major basement detachment faults, but the two basins and the ridge share a common evolution and comparable stratigraphy (Enachescu, 2006, 2010, 2011; Enachescu et al., 2010). There was continuity of deposition during the Late Triassic and Jurassic between the two basins, as the Central Ridge was still depressed and part of the same regional rift basin. There was communication of the Jurassic sea with the East Orphan and the conjugate Irish margin basins. Being closer to the North Atlantic triple junction and rotation of Flemish Cap (Enachescu et al., 2005; Sibuet et al., 2007), the basin has suffered several changes in the direction of the extension vector resulting in transtension and late inversion of rotated blocks.

The Flemish Pass Basin has seen little regional stratigraphic research. The Jeanne d'Arc Basin tectono-stratigraphic and tectonic charts published by Tankard and Welsink (1987 and 1989), Enachescu (1987, 1988 and 1992), Tankard et al. (1989), Grant and McAlpine (1990), McAlpine (1990), Hiscott et al. (1990), Driscoll and Hogg (1995), Sinclair (1993), Foster and Robinson (1993), DeSilva (2000), Sinclair et al. (1995b), Edwards et al. (2003), Deptuk et al. (2003) and the one posted on the web by C-NLOPB (http://www.cnlopb.nl.ca/maps/xdb_lith.pdf) are used to describe the geodynamic evolution and depositional history of the Flemish Pass Basin (Figure 9).

The tectono-structural evolution of the Flemish Pass Basin is similar to other Grand Banks basins and includes several synrift stages, each followed by thermal subsidence and accumulation of predominantly clastic sediments (shales, claystone, marlstone and sandstone). The carbonates drilled in Flemish Pass Basin are minor. A Petrel limestone equivalent was encountered in several wells. When drilled, the Rankin Formation contained some carbonate intervals. The largely carbonate successions of the Lower Jurassic (Whale and Iroquois formations) remain below drilling depth in most of the basin.

Argo salt was not drilled in Flemish Pass subbasins but there are indications of salt presence in the southern basin and on its southwestern flank. In the Flemish Pass Basin stratified salt may be the model for evaporite deposition rather than the typical thick, diapiric salt of the Grand Banks basins. Thicker salt may exist on the southwestern flank of the basin.

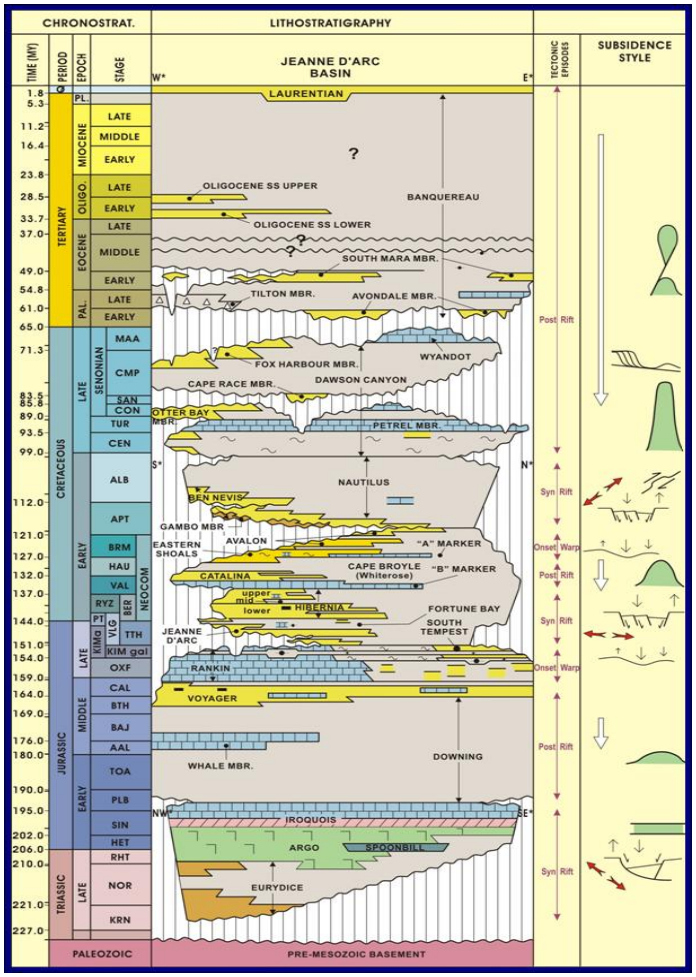


Figure 9. Jeanne d'Arc Basin Lithostratigraphy, Tectonics, Subsidence and Petroleum Geology Chart. This chart is often used for the Flemish Bass Basin (modified from C-NLOPB and Sinclair, 1993).

The above Jeanne d'Arc Basin Lithostratigraphy, Tectonics, Subsidence and Petroleum Geology Chart is often used for the Flemish Bass Basin. However, local differences between the two related basins exist as to the sand distribution and provenance and quality and distribution of source rocks (McCracken et al., 2000; Hogg, 2002; Hogg and Enachescu, 2004 and 2007; Lowe, 2010; McDonough, et al., 2010; Lowe et al., 2011; Haynes et al., 2012). Local stratigraphic terms such as the Gabriel sandstone (equivalent to Eastern Shoals and Catalina sandstones) and the Baccalieu sandstone (equivalent to Hibernia sandstone) are informally used by the industry (Foster and Robinson, 1993; Hogg and Enachescu, 2001, 2007; Figure 8). On most of the structural highs drilled in the basin, the Late Cretaceous succession is either very thin or was eroded at the Base Tertiary Unconformity, due to significant uplift and inversion of earlier structures.

The Baccalieu sandstone that was found to have good reservoir properties in several wells consists of several stacked sandstone layers. The sandstone is described as being the Hibernia equivalent and Berriasian in age, but in other reports and communications is shown as straddling the boundary between Tithonian and Berriasian (e.g. Lowe et al., 2011).

Several Tithonian sandstone reservoirs were encountered in the three Mizzen wells. These sandstones are time equivalent to Jeanne d'Arc sandstone but have different provenance area, petrographic composition and reservoir properties (Lowe, 2010; Lowe et al., 2011; McDonough et al., 2010 and 2011; Haynes et al., 2012). Lowe (2010), Lowe et al. (2011) and McDonough et al. (2010 and 2011) suggesting that Late Jurassic and Early Cretaceous sandstones encountered in the North Flemish Pass Basin wells are sourced from the Central Mobile Belt, Avalon Zone (both Appalachian terrains), Iberia peninsula and locally from the Flemish Cap granodiorites.

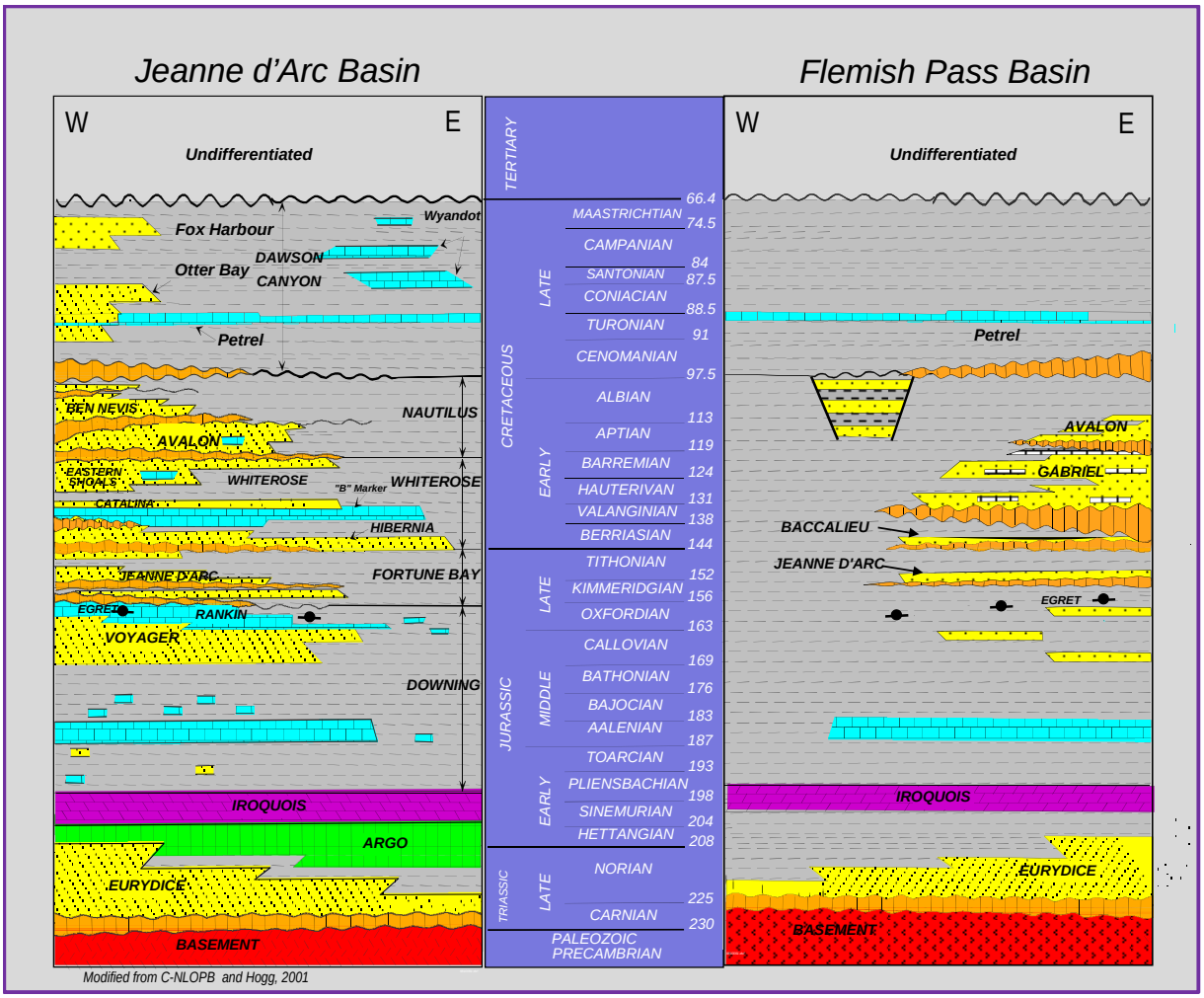


Figure 10. Comparative Stratigraphy Jeanne d'Arc and Flemish Pass basins (modified from C-NLOPB and Hogg, 2001).

The most recent stratigraphic communications in the basin (Haynes et al., 2012), have introduced the informal terms of Ti-0, Ti-1, Ti-2 and Ti-3 for four Tithonian sandstones intervals (equivalent to Jeanne d'Arc sandstone) encountered in the Mizzen wells.

3.4. Tectono-Structural sectors. Based on structural, tectonic and stratigraphic differences, the Flemish Pass Basin can be divided into two sectors separated by a transfer fault and associated accommodation zone (Foster and Robinson, 1993; DeSilva, 1999 and 2000; McCracken et al., 2000 and 2001; Thompson, pers. com. and Figure 9).

1. **Gabriel Subbasin.** This sector, trending approximately N-S is located in the southern part of the basin. Four exploration wells were drilled in this part of the basin. The first well, Gabriel C-60, encountered a thick Late Valanginian/Hauterivian to mid-Barremian sandstone interval (1600 m gross) that received the informal name of Gabriel sandstone. The Kyle L-11 well that was drilled on a southern basement high intersected more than 150 m of Hibernia equivalent sandstone but did not encounter any Jurassic rocks and terminated in Avalon metasediments. Lancaster G-70 was drilled on the western flank of the subbasin close to the Central Ridge. This well, drilled from Tertiary shales directly into Late Jurassic Rankin Formation, intersected a reservoir described as lower Tempest sandstone and Kimmeridgian source rocks. The most recently drilled well, Tuckamore B-27, intersected over 350 m of Gabriel Sandstone reservoir and reached TD short of the Jurassic beds seen on seismic data. None of the wells encountered significant hydrocarbons.

   In this part of the basin, the Late Cretaceous sedimentary sequence is either too thin or absent due to erosion. However, the Early Cretaceous sequence is thick and contains excellent reservoirs. Seismic correlations to the above-mentioned wells point toward the existence of good Early Cretaceous and Late Jurassic reservoirs, as well as thick Late Jurassic source rocks, in the central part of the subbasin. This is where the Call for Bids Parcel 1 is located. Moreover, large Jurassic and Early Cretaceous structural prospects remain undrilled in this subbasin.

2. **Baccalieu Subbasin.** This subbasin, trending NNE-SSW is located in the northern part of the Flemish Pass Basin. This part of the basin was affected by significant extension and subsidence from Hauterivian to Barremian. There is no evidence of Gabriel sandstone being deposited during this time interval but a predominantly shaly-silty sequence is present. The Baccalieu Subbasin was drilled by two older wells, the Esso et al. Baccalieu I-78 well in 1985 and the Petro-Canada et al. Mizzen L-11 well in 2003. Both wells were located on basement cored faulted anticlines. The Baccalieu I-78 well intersected a predominantly shaly Early Cretaceous sequence interrupted only by approximately 40 m of Avalon equivalent sandstone and about 80 m of Early Berriasian sandstone. Standing just above the Top Jurassic (Tithonian) Unconformity, this Berriasian interval is informally known as the Baccalieu sandstone.

   The Mizzen L-11 well was located in the Baccalieu Subbasin based on a large 3D seismic program. The well has encountered 5 m of oil on logs, within what was reported to be the Baccalieu sandstone and is now re-evaluated to be a late Tithonian sandstone (Haynes et

al., 2012). This show was successfully delineated by the Mizzen O-16 well in 2009, which encountered 42 m of Ti-3 reservoir. A follow up, Mizzen F-09 failed to extend the accumulation to the northward fault block in which it was drilled (Figure 11). This well is the northernmost drilling location in the subbasin and proved the presence of Late Jurassic source rock and stacked reservoir rocks at the border between the Flemish Pass and East Orphan basins.

Large anticlines, rotated fault blocks and parts of the Mizzen structure, remain undrilled in this subbasin and adjacent East Orphan Basin. Two intersecting fault systems oriented NNE-SSW (major system) and NNW-SSE can be interpreted on seismic data.

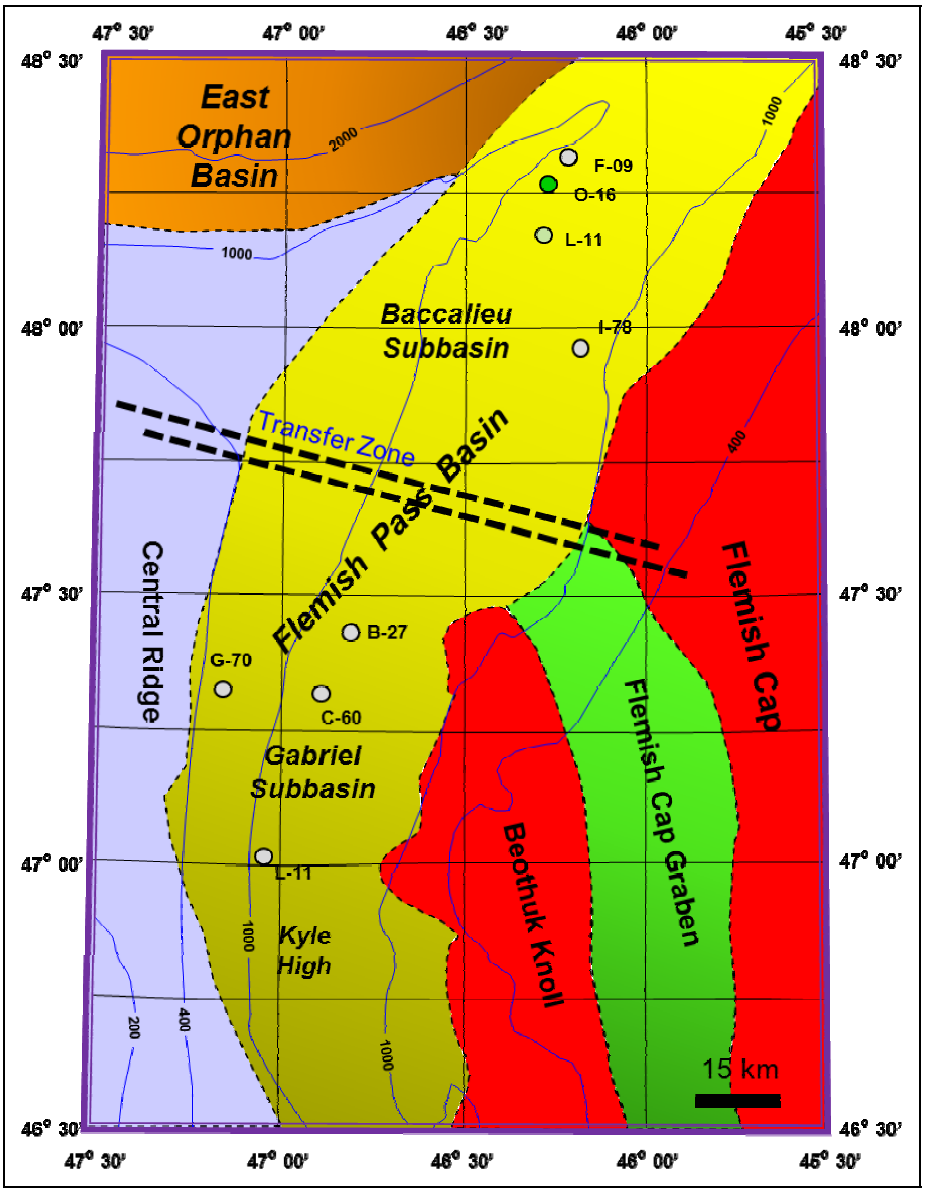


Figure 11. Tectono-structural subunits of the Flemish Pass Basin and surroundings (modified from Enachescu, 1987 and 2006). The location and direction of the Transfer Zone is tentative.

4. Overview of Petroleum Geology of the Flemish Pass Basin.

The Flemish Pass Basin has become the second offshore Newfoundland Mesozoic basin to record a significant oil discovery. Mizzen O-16, drilled in 2009 by Statoil, tested at a rate 3774 bopd from a late Jurassic sandstone interval. This oil accumulation is estimated to contain up to 200 mmbbls of recoverable oil. Several other large drilling structures were identified in the area.

As of summer 2012, only seven exploration wells were drilled in the basin. Two sizeable ELs adjacent to Mizzen SDLs were awarded at the 2010 Call for Bids (ELs 1123 and 1124). Two other large ELs were awarded at the 2011 Call for Bids (ELs 1125 and 1126).

4.1. Land Situation 2012. There are five current ELs in the basin and four others in the vicinity (Table I). The Mizzen O-16 oil discovery is covered by two SDLs (Table II).

Table I. Active Exploration Licences and their particulars in the Flemish Pass Basin and environs (as of summer 2012).

No	EL	Basin	Area (Ha)	Area (a)	Bid Amount ($MM)	Awarded	Operator	Partners
1	1112	Flemish Pass	55,957	138,273	18.7	2009	Statoil	Husky
2	1123	Flemish Pass/ East Orphan	201,951	499,032	75	2011	Statoil	Repsol
3	1124	Flemish Pass	125,421	309,922	20	2011	Statoil	Husky
	1125	Flemish Pass/ East Orphan	247,016	610,390	202.2	2012	Statoil	Chevron/Repsol
5	1126	Flemish Pass /Central Ridge	186,780	461,543	145.6	2012	Statoil	Chevron/Repsol
6	1110	North Central Ridge	138,200	341,500	18.6	2009	Husky	Suncor/Repsol
7	1111	North Central Ridge	134,227	331,682	1.2	2009	Husky	Repsol
8	1090R	North Central Ridge	136,395	337,039	second period	2010	Husky	
9	1074R	East Orphan	604,000	1,492,516	second period	2008	Chevron	Repsol/Statoil

Table II. Significant Discovery Licences and their particulars in the Flemish Pass Basin and environs (as of summer 2012).

No	SDL	Basin	Area (Ha)	Area (a)	Name	Awarded	Operator	Partners
1	1047	Flemish Pass	22,006	54,378	Mizzen	2010	Statoil	Husky
2	1048	Flemish Pass	3,773	9,323	Mizzen	2011	Statoil	Husky
3	200	N. Central Ridge	8,765	21,659	N. Dana	1987	ExxonMobil	et al.
4	197	N. Central Ridge	7,722	19,081	S. Tempest	1987	ExxonMobil	et al.
5	1031	N. Central Ridge	7,045	17,409	Trave	1990	Husky	et al.

It is noteworthy that in the past two years Statoil has accumulated the largest acreage in the Flemish Pass Basin (817,125 ha) and has become the exploration leader in the area. Statoil operates the 5 active ELs in the basin and has Chevron, Repsol and Husky as partners (Table I). They are also the operator (55% interest) of the Mizzen SDLs where Husky (35% interest) is their partner in the recent oil discovery (Table II). This is the largest single SDL area ever awarded in the Canadian Atlantic offshore. Through a recent agreement with Chevron and previous interest owners, Statoil has also become a partner (with Repsol) in the large EL 1074R situated in the East Orphan Basin just northwest of their operated Flemish Pass ELs (replacing Exxon/Imperial and Shell that have dropped out). A well is planned in EL 1074R for later this year.

Significant for the 2012 Call for Bids NL12-02 is the presence of three large ELs operated by Husky on the Central Ridge to the west of Parcel 1. In the past, three SDLs were awarded on the Central Ridge for three oil and gas discoveries (Tables I and II). As well, excellent source and reservoir rocks were encountered by several exploration wells located on the Central Ridge.

4.2. Exploration Results. Large oil discoveries recorded in the past have made offshore NL's Mesozoic basins an attractive exploration target for multinationals (ExxonMobil, Chevron, Statoil, Repsol, etc.) and Canadian energy companies (Suncor, Husky, etc.) (Tables I and II; Figures 2 and 3).

Table III. Exploration and delineation wells in the Flemish Pass Basin and environs (as of summer 2012).

Well	Location	Drilled	Water	Status	TD m
Exploration		**year**	**Depth m**		
Gabriel C-60	Flemish Pass B	1979	1109	Abandoned	5171
Baccalieu I-78	Flemish Pass B	1985	1093	Abandoned	5135
Kyle L-11	Flemish Pass B	1986	1119	Abandoned	4050
Lancaster G-70	Flemish Pass B	1986	726	Abandoned	5701
Tuckamore B-27	Flemish Pass B	2003	1134	Abandoned	2903
Mizzen L-11	Flemish Pass B	2003	1153	Aband. oil show	3823
Mizzen O-16	Flemish Pass B	2009	1095	Aband.oil discov.	3756
Delineation					
Mizzen F-09	Flemish Pass B	2011	1067	Abandoned	3762
Other significant wells					
South Tempest G-88	N. Central Ridge	1981	158	Aband.oil well	4775
Trave E-87	N. Central Ridge	1983	138	Aband. gas well	3986
North Dana I-43	N. Central Ridge	1984	221	Aband. gas well	5304
Panther P-52	N. Central Ridge	1985	191	Aband.	4203

Seven exploration and one delineation well have been drilled in the Flemish Pass Basin (Figure 11). The only NL offshore deepwater oil discovery was made in 2009 in the northern Flemish Pass Basin (Baccalieu Subbasin; Figure 11 and Tables II and III). The primary objectives for the Mizzen O-16 and F-09 wells were the Early Cretaceous sandstone and the Tithonian sandstones

(informally listed by the operator as Ti-0 to Ti-4 intervals). These reservoirs were first encountered in the Mizzen L-11 well and confirmed by the O-16 and F-09 wells.

The Mizzen O-16 well has tested 3774 bopd of 21-22° API oil from a 25 m section of porous (15 to 32%, average 23%) and permeable (90 to 900 mD estimated; in places as high as 14 Darcies) sandstone (Ti-3) (Haynes et al, 2012) encountered from 3201 to 3245 m. While thick bedded and showing excellent reservoirs, the older Tithonian sandstones distributed between 3350 and 3681 m, were found to be wet. Three of the Tithonian sandstones were first drilled in the Mizzen L-11 well and showed excellent porosity of over 20%. The well was not tested, but 5 m of oil bearing sandstone was interpreted on logs. A delineation well, Mizzen F-09, was drilled in 2011 approximately 5 km northeast of O-16. The well intersected four water bearing good quality Tithonian reservoirs and then terminated in Tithonian shale. The producible Ti-3 reservoir encountered water and residual oil.

An older oil discovery at South Tempest G-88 on the Central Ridge produced 1250 bopd of 42° API oil from the interval informally named "Tempest" sandstones. These sandstones are Kimmeridgian and are intercalated with source rock intervals which may exist above, between or below the sandstone layers. Tempest sandstone reservoirs were encountered in several other wells located on the Central Ridge and vicinity.

Two gas and condensate discoveries are located on the Central Ridge, west of Parcel 1. The Trave E-45 well tested 17.9 MMcfd and 521 bcd from Hibernia sandstone and the North Dana I-43 flowed 12.8 MMcfd and 292 bcd from Lower Tempest sandstones.

All the other Flemish Pass wells have failed to find significant petroleum accumulations. On the positive side the wells have logged quality reservoirs (Gabriel or Baccalieu sandstones) and excellent, thick source rock intervals in Late Jurassic (Tithonian, Kimmeridgian or older).

4.3 Source rocks. Geochemical research on the organic shale intervals from wells in the basin and Central Ridge area have concluded that the depositional area of the Egret Member of the Rankin Formation extends from the Jeanne d'Arc Basin across the Ridge and into the Flemish Pass. The lithology of the Egret member in the Jeanne d'Arc Basin is interbedded shales and carbonates with the shales becoming more dominant toward the northeast of the basin. In the Jeanne d'Arc Basin, the Egret Member ranges in thickness from 55 to more than 200 m, with an average TOC content of 4.5%. It contains Type II marine-derived organic matter. The Egret beds in the Flemish Pass Basin average 130 m thick, have a TOC range between 1.9 and 13% (2.3% average) and Hydrocarbon Index range of 197-586 (328 average) (McCracken et al., 2000).

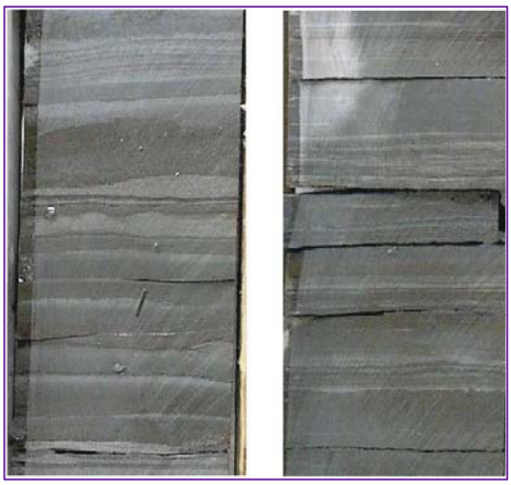


Figure 12. Core Nr 4 photo of Egret Member source rock from Baccalieu I-78 well (courtesy of J. McCracken, from McCracken et al., 2000).

A geochemical study performed on samples of the Mizzen L-11 oil collected at 3350 m depth, was reported by Fowler et al. (2007). The results of this study indicate that the oil was not biodegraded, had a complex origin and was sourced from a mixture of mature Egret Member and a more immature oil source, probably a Tithonian interval. The oil was from the presupposed early Cretaceous Baccalieu sandstone that was recently confirmed as Tithonian (Haynes et al., 2012). McCracken et al. (2000 and 2001) have mapped the extent of an Egret source rock of Type II-III into the Flemish Pass Basin. The Egret structural map shows that, depending on the position in the basin, there is a large range of variation in maturity for the source rock interval. The Mizzen oil is considered to be partially sourced from an immature to marginally mature source rock, within the Tithonian sequence. The marine shales that separate the Tithonian reservoirs in the Mizzen oil field have 8 - 12% TOC (Haynes et al., 2012).

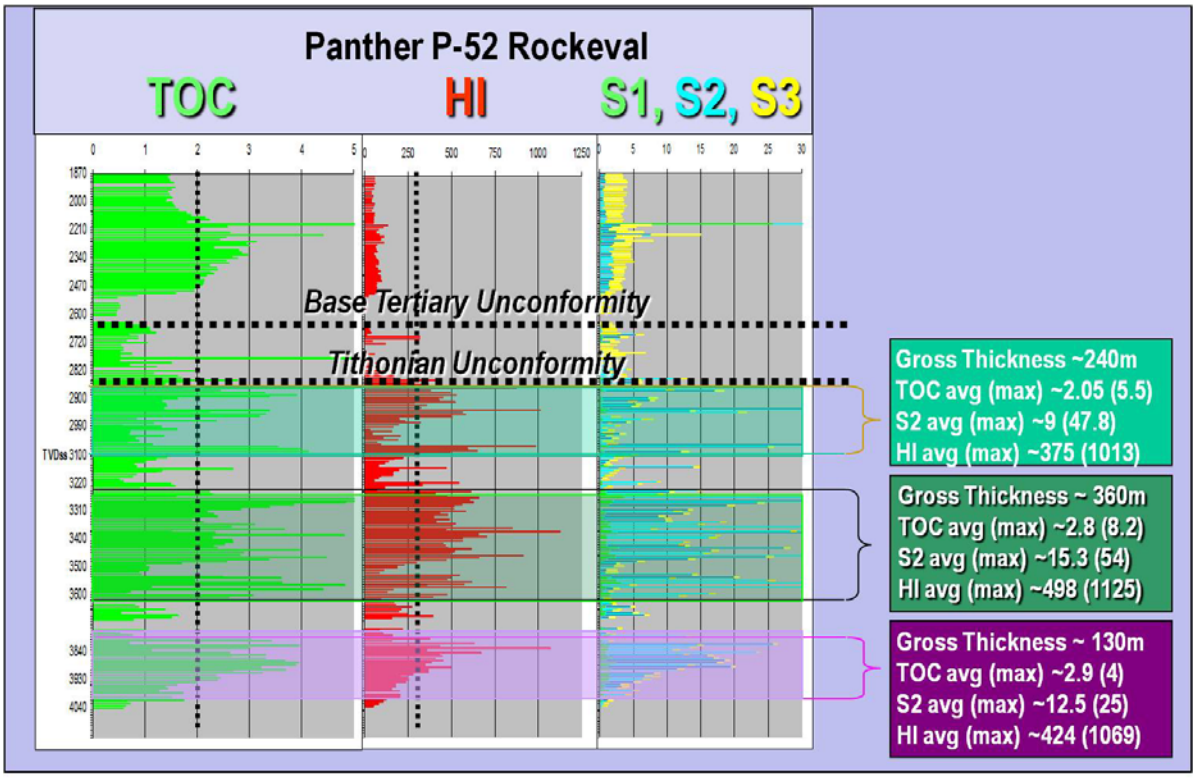


Figure 13. Rockeval parameters for the Late Jurassic interval in the Panther P-52 well (from Enachescu and Hogg, 2007).

The closest well to Parcel 1 that logged Egret source rock is Lancaster G-70 which intersected an upper Kimmeridgian source interval between 3207 and 3761 m and a Lower Kimmeridgian source interval divided by a Lower Tempest sandstone interval between 4736 and 4856 m.

Several intervals of older Late Jurassic shales (Callovian and Oxfordian) have good petroleum source properties as indicated in the lower part of the Panther P-52 well, located approximately 50 km west of Parcel NL12-02-01. Another possible source rock is the Albian shale (Nautilus Fm) that showed rich, marine organic content when drilled by the IODP leg 210, at a location situated just east of the Flemish Cap. This interval may be mature in the deeper troughs of the North Flemish Pass Basin/South East Orphan Basin.

Table IV. Petroleum geology results of wells in the Flemish Pass Basin and environs. Information contained in this table was extracted from C-NLOPB web published documents, other publications (e.g., McCracken et al., 2000; Fowler et al., 2007; McDonough et al., 2010; Lowe et al., 2011; Haynes et al., 2012, etc.) and presentations and well reports in the public domain (e.g. C-NLOPB, 2012; http://www.cnlopb.nl.ca/well_alpha.shtml).

Well Exploration	Location	Avalon ss from-to m	Gabriel ss from-to m	Baccalieu ss from-to m	Late Jurassic ss from-to m	Test	Producer	Source Rocks
Gabriel C-60	Flemish Pass B	No	2940-4553	No	No	Yes	No	No
Baccalieu I-78	Flemish Pass B	2030-2220	No	3195-3275	4 intervals 3274 to 4088	No	No	Yes, Egret, Tithonian?
Kyle L-11	Flemish Pass B	2368-2627	No	"Hibernia equiv"	No	No	No	No
Lancaster G-70	Flemish Pass B	No	No	No	Lower Tempest 3764 to 3789	No	No	Yes, Egret
Tuckamore B-27	Flemish Pass B	No	2511-2875	Not penetrated	Not penetrated	No	No	No
Mizzen L-11	Flemish Pass B	No	No	Poor intervals	3 intervals from 3340 to 3775	No	5 m on logs	Yes, Egret, Tithonian?
Mizzen O-16	Flemish Pass B	No	No	Poor beds	4 intervals from 3201 to 3664	Yes	1 interval	Yes, Tithonian?
Delineation								
Mizzen F-09	Flemish Pass B	No	No	No	4 intervals from 3335 to 3672	No	No	Yes
Other signif. Wells								
South Tempest G-88	N. Central Ridge	No	No	No	Tempest ss 7 intervals 3468 to 4117	Yes	3 intervals	Yes, Egret
Trave E-87	N. Central Ridge	No	No	Hibernia 2139-2520	No	Yes	2 intervals	Yes, Egret
North Dana I-43	N. Central Ridge	No	No	No	Lower Tempest ss 4437 to 4548	Yes	1 interval	Yes, Egret
Panther P-52	N. Central Ridge	No	No	No	2 Tempest intervals from 3580 to 3775	No	No	Yes, Egret

4.4 Reservoir rocks. Reservoir rocks in the Flemish Pass Basin are high porosity - high permeability sandstones of Late Jurassic to Early Cretaceous age. No noteworthy Late Cretaceous or Early Tertiary sandstone intervals were encountered yet in the basin (Table IV).

The only positive test in the basin was obtained from a Tithonian sandstone in the Mizzen O-16, that flowed 600 m^3/day (3800 bobd) from the interval 3213-3224 m. This reservoir was interpreted as a fine to medium grain sublitharenite of fluvial and marginal marine origin by Haynes et al. (2012). There are several other distinct coarse clastic cycles in the Mizzen wells. The Ti-3 sandstone was also encountered in the Mizzen L-11 where based on logs it had oil pay and in the F-09 well where it had water and traces of oil.

The Gabriel Sandstone was intersected in both the Gabriel C-60 and Tuckamore B-27 wells straddling the center axis of the Gabriel Subbasin. In the C-60 well the Gabriel Sandstone occurs in a Hibernia Formation equivalent section. Stacked sandstone had porosities between 10 and 20% and numerous oil shows. A core from the Gabriel Sandstone taken between 4436.5 and 4451.9 m has been reported as bleeding oil along a sand/shale interface. On the western margin of the basin the Lancaster G-70 well intersected several beds of porous Tempest sandstone. This sandstone has flowed hydrocarbons on adjacent wells located on the Central Ridge.

4.5. Seals. Seal should not be a problem within the Flemish Pass Basin as the extensional and thermal subsidence stages contain several successions of very fine clastics (Figures 9 and 10). The main seal of the Mizzen field are marine shales of Berriasian-Valaninian age. The field's many normal faults are vertically sealed by the White Rose, Nautilus and Dawson Canyon shales.

4.6. Hydrocarbon Traps. A variety of traps have been found to be successful in the Jeanne d'Arc Basin, Central Ridge and Flemish Pass Basin. The traps were usually created during the rift stage or subsequent intrusion and movement of salt bodies. In the Flemish Pass Basin, salt movements are suggested by seismic data in the southwestern part of the basin only. However, inversion due to transtension has also created structural traps. In the Jeanne d'Arc Basin, the largest petroleum accumulations were found in structural and combination traps.

The interpretation of seismic data from the Flemish Pass Basin including the Call for Bids area allows for the identification of:

- Large fault-bounded anticlinal closures,
- Rollovers and salt induced anticlines in the Gabriel Subbasin, and
- Transtensional multi-sided faulted anticlines in the Baccalieu Subbasin.

4.7. Petroleum System(s). To date, the only proven petroleum system on the Flemish Pass Basin/Central Ridge/North Jeanne d'Arc Basin area is anchored by the Egret Member of the Rankin Formation (Late Jurassic) feeding hydrocarbons into:

- Late Jurassic reservoirs such as the Voyager, Tempest, Jeanne d'Arc and time equivalent Baccalieu and Tithonian sandstones, and
- Early Cretaceous reservoirs such as Hibernia, Catalina, Avalon and Ben Nevis and time equivalents such as the Gabriel sandstone.

Late Cretaceous and Early Tertiary sandstones are of low importance, but turbidites of these ages may be encountered in the northern Flemish Pass Basin/Southern East Orphan Basin area.
Based on limited results from the Flemish Pass Basin showing some mixing of sources, the Kimmeridgian Egret Member and possible Tithonian shales have produced the oil accumulation in the Mizzen structure (Fowler et al., 2007; Haynes et al., 2012). Older Kimmeridgian and Callovian-Oxfordian source rocks are mature in parts of the basin and may have also generated hydrocarbons. More studies on the geochemistry of the Late Jurassic shales in this part of the basin are needed to confirm the distribution of the Egret shales and the importance as a source rock of the Tithonian shales (Fortune Bay equivalent?).

4.8 Maturation and Migration. The Egret Member shale maturation started in mid-Early Cretaceous and continued into Tertiary. Petroleum expulsion in the Flemish Pass Basin starts at approximately 3800 m and ends at 6500 m. The top of the oil generation zone lies 4 km below the shallow regions and is much deeper on the slope. Expulsed hydrocarbons have migrated mainly vertically, predominantly along the numerous extensional faults but also using sand carrier beds.

The low API oil found in the Mizzen reservoir appears to be generated from an immature source rock. More mature source rock should be located away from the Mizzen structural high.

4.9. Hydrocarbon Plays and Risks. Conventional plays recognized in the Flemish Pass Basin (e.g. Foster and Robinson, 1993; DeSilva, 2000; Enachescu, 2010 and 2011; Hogg and Enachescu, 2004 and 2007; Lowe et al., 2011; McDonough et al., 2010) are:

- Late Jurassic (Tithonian) Sandstone in the Baccalieu Subbasin,
- Berriasian Baccalieu Sandstone in the Baccalieu Subbasin,
- Valanginian to Barremian Gabriel Sandstone in the Gabriel Subbasin, and
- Late Jurassic Tempest (Oxfordian to Kimmeridgian) sandstone on the western margin of the basin.

These reservoir sandstones are trapped in roll-over anticlines, listric fault bounded blocks, multi-fault closures, basement cored anticlines or ridges, or drape over basement highs. Late Cretaceous and Early Tertiary lowstand sandstones may be important stratigraphic reservoirs on the slope and upper rise of the northern Flemish Pass Basin.

Main hydrocarbon risks are fault seal, quality of source rock, source rock maturation and destruction of traps by intense erosion at the Avalon and/or Base Tertiary unconformities. These risks can be mitigated by 3D seismic, depth migrated data mapping and avoidance of drilling too shallow or breached structures.

Overpressure has been encountered in the Jeanne d'Arc Basin, and is usually associated with isolated sand bodies. Overpressure can play a significant role in the NL offshore basins, especially for Jurassic reservoirs deeper than 4000 m.

4.10. Resource Potential. In a joint study the C-NLOPB and GSC (2004) have estimated that the Flemish Pass Basin's undiscovered petroleum resources are in the range of 1.7 billion barrels at a 50 percent probability, and with expected field sizes ranging from 44 to 528 million barrels.

This study is available from: http://www.cnlopb.nl.ca/news/nr20040520eng.shtml. However, this estimation did not take into account the possibility of multiple source rocks and was not extended to the northern part of the basin, in water depth exceeding 1100 m, and in the bordering area with East Orphan Basin.

5. Petroleum Potential of Call for Bids NL12-02 Parcel 1

The area offshore NL is administered by the Canada-Newfoundland and Labrador Offshore Petroleum Board on behalf of the Province of NL and the Federal Government. Offshore Newfoundland and Labrador exploration areas are normally licensed by the C-NLOPB to the party submitting the highest bid in the form of work commitments, which is the case for Parcel 1.

Parcel 1 is located in the southern part of the basin, abutting the Husky operated ELs 1110 and 1111 situated mostly on the Central Ridge. The parcel covers 2,089 km^2 (516,201 acres) and is 89.6 times greater than a standard Gulf of Mexico exploration tract. It contains large Mesozoic petroleum prospects and leads covered by a dense 2D seismic grid (http://www.cnlopb.nl.ca/pdfs/cfb1202.pdf).

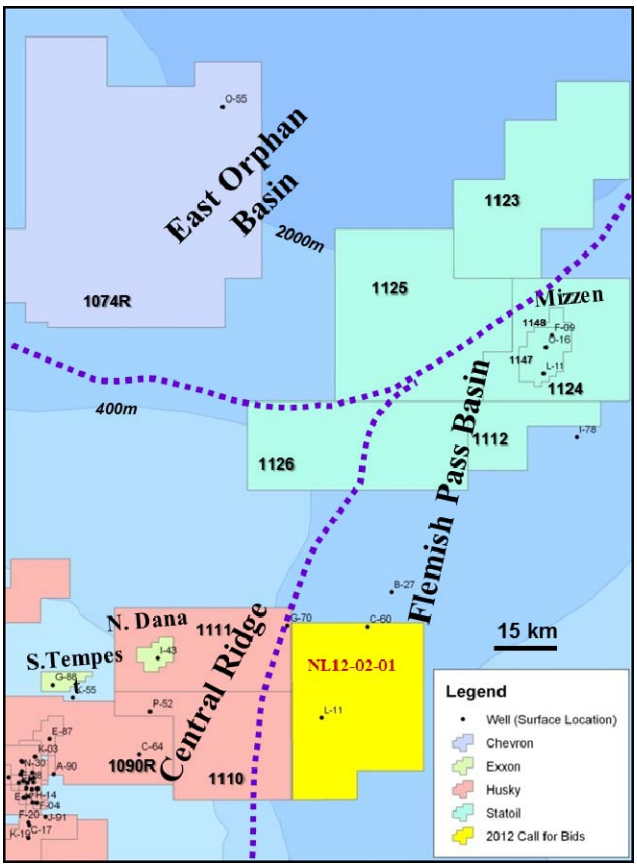


Figure 14. Location of the NL12-02-01 parcel within the Mesozoic Flemish Pass Basin. The dashed blue line represent a tentative border between the Flemish Pass Basin, East Orphan Basin and Grand Banks structural units.

Table V. Call for Bids NL12-02 Parcel 1 area statistics.

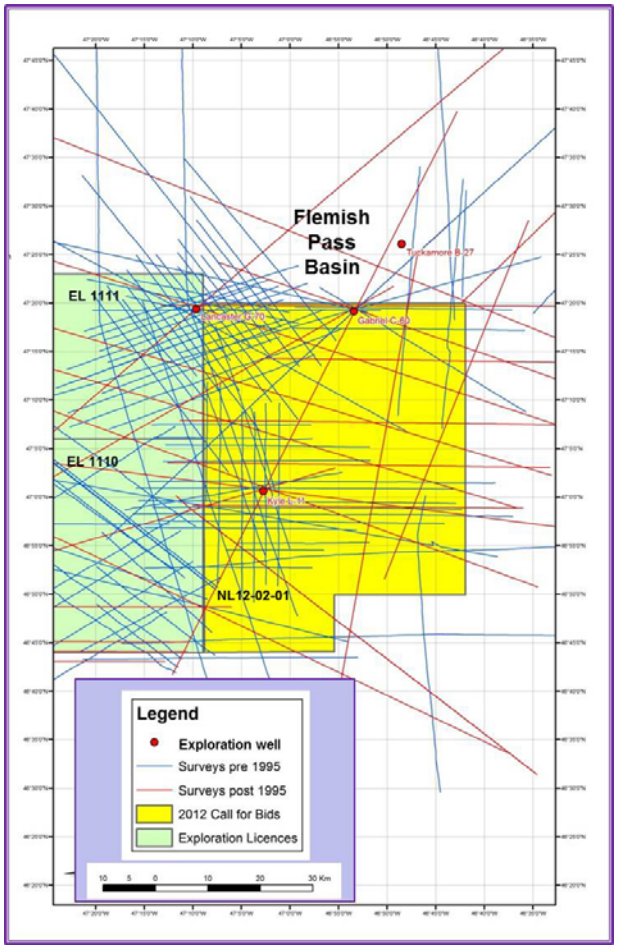
Call for Bids	Area	Area	Area	GOM tract
CFB NL12-02	hectares	sq kms	acres	multiples
Parcel 1	**208,899**	**2,089**	**516,201**	**89.6**

5.1. Seismic Data Coverage, Quality and Availability. The available seismic data covering Parcel 1 can be divided in two sets: pre-1995 and post-1995, based on the lengths of the streamer used and of modern migration algorithms (Figure 15). Additional data that is not shown in Figure

15 may be available from oil companies that were active in the area in the past decade (e.g. Statoil, Husky, Repsol and EnCana) or from seismic contractors.

Good quality, pre and post 1995 publicly released and multi-client 2D grids cover the parcel and adjacent areas. The post-1995 lines have been recorded by leading marine seismic contractors using long streamers (6 to 8 km). This both allows for good imaging of the deeper parts of the basin and adequate elimination of multiples. Released data was acquired by companies such as PetroCanada (now Suncor) and PanCanadian (now EnCana). During the late 1990s - early 2000s multi-client data was recorded repeatedly by companies such as GSI, Jebco, TGS, etc.

Older seismic lines, accumulated during the late 1970s - mid 1980s and recorded with shorter streamers (2.5 to 4 km) are also available in the block, but their quality is inferior. Older company 2D digital data in the basin is owned mainly by Exxon, which inherited data from Esso, Mobil and partners that were involved in the earlier basin exploration stage (1970-1980s). Various other surveys were recorded by companies such as Husky, Bow Valley, Canterra (now Husky), Petro-Canada (now Suncor), PAREX, etc. Numerous regional multi-client programs were recorded in the basin in the 1980s by GSI and HGS. These surveys were used to locate and drill the early wells in the Gabriel, Baccalieu and Central Ridge area. Some of these grids have been reprocessed in the past decade and are available for licensing.



Good to excellent seismic coverage exists for Parcel 1. The publicly released grid is uneven in places and much denser on the western flank of the basin where the exploration wells were drilled. However, regular seismic grids such as the ones acquired by GSI and PAREX can help establish regional trends of reservoir and source rock and map in detail the leads and prospects in the parcel

Figure 15. Public domain seismic coverage available in the call for Bids NL12-02 Parcel 1 located within the Mesozoic Flemish Pass Basin. Blue tracks are lines collected pre-1995 while red lines were collected post-1995. More data that is not released should be available from oil companies and seismic contractors.

Seismic data quality is excellent in the Late Jurassic to Tertiary sequences but deteriorates in the Late Triassic - Mid Jurassic interval. The main and secondary faults are easily traceable. The prerift Basement reflector has poor quality. Salt diapir walls/welds in the Central Ridge-West Gabriel Subbasin area are poorly imaged.

The parcel's 2D grid allows for mapping of several unconformities, formation tops, carbonate intervals and sandstone markers such as the Mid-Miocene Unconformity, Base Tertiary Unconformity, Wyandot (when present), Cenomanian Unconformity, Avalon Unconformity, Baccalieu sandstone, Top Jurassic (Tithonian Unconformity), Tempest sandstone, Middle Jurassic, Lower Jurassic, Argo Salt (when present) and Basement (when imaged). Some of the markers are widespread and have good quality. Others are poor in places and have to be phantommed between tie points.

The most continuous, high reflectivity markers are the Mid-Miocene, Base Tertiary, Avalon and Tithonian unconformities. Several intra-Gabriel Sandstone markers can also be mapped.

Seismic data on Parcel 1 can be purchased from seismic contractors and vendors ("spec companies"), brokers or owners of the SEG-Y files. Selected older data can be obtained in hardcopy format from the C-NLOPB, in St John's, NL. The map in Figure 15 contains only the released data available in analogue format from C-NLOPB. The public domain grid has a 2 to 3 km spacing on the western side of the parcel and 4 to 9 km spacing on the eastern part of the parcel. Several seismic grids in digital format (SEG-Y) are available from oil companies, GSC and seismic contractors. The majority of 2D lines are post-stack time migrated and the most recent data have pre-stack time migration applied.

5.2. Seismic Interpretation. The seismic lines (Figure 16, 18 and 19) shown in this presentation to illustrate the petroleum potential of Parcel 1 were tied with synthetic seismograms to the exploration wells from the Gabriel Subbasin and jump tied to the seismic markers present in the adjacent Central Ridge area. The lines show the structural style and several possible undrilled traps in the parcel. Only the major faults and major seismic sequences are marked on these lines.

Four main seismic sequences are visible on these seismic lines:

1. The Prerift Basement, which is well imaged only on the eastern side of the basin near the Flemish Cap and Beothuk Knoll,
2. The lower synrift beds, generally poorly imaged in the center of the basin and better rendered on its flanks,
3. The synrift Jurassic-Early Cretaceous succession, which contains the petroleum reservoir target beds and possible drilling prospects. This section is well structured, faulted and relatively well imaged, and
4. The postrift sedimentary fill that shows thin or missing Late Cretaceous on top of structures and a relatively undeformed Tertiary succession that onlaps the Base Tertiary Unconformity.

Seismic lines in the parcel and surrounding area show the basin as a strongly deformed and faulted sedimentary trough dipping toward the center of the basin and toward the north. The synrift sedimentary sequence (Late Triassic to Early Cretaceous) infills the space created by the extended basement. Basement rifting has created horsts, grabens and rotated blocks within the Gabriel Subbasin, trending approximately north-south. Several major faults detached in the basement or at the prerift unconformity level, have produced rollover anticlines within the synrift successions that were further faulted during subsequent rifting phases.

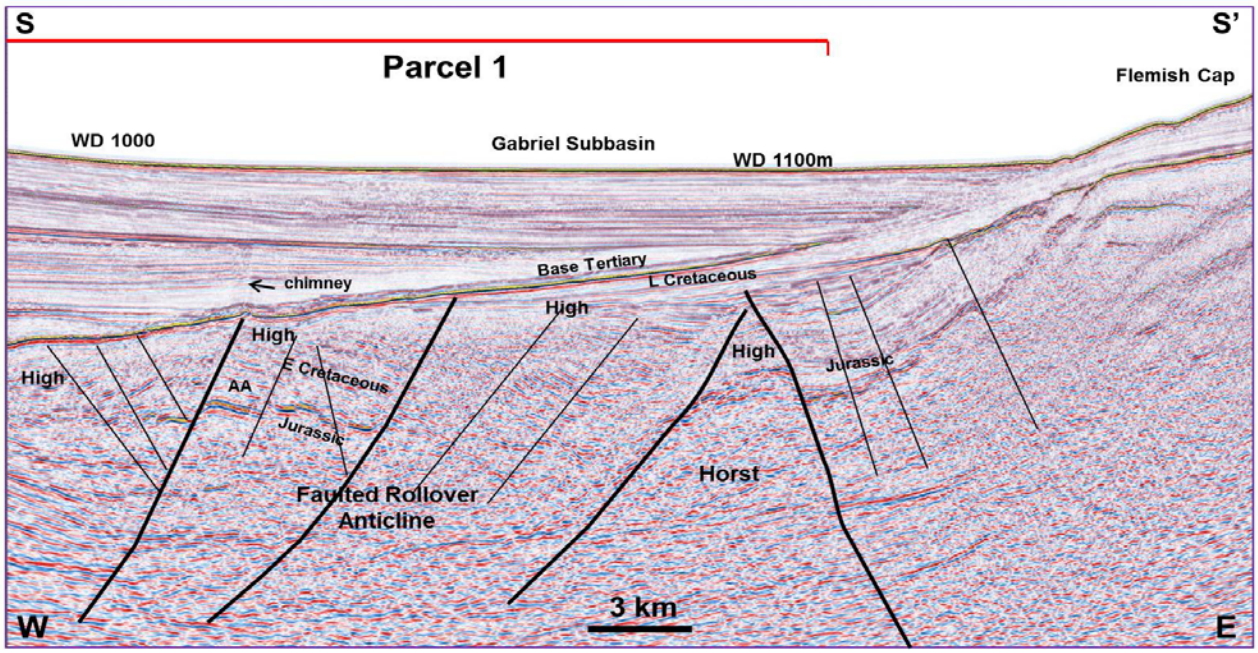


Figure 16. Representative dip seismic line S-S' for CFB NL12-02 Parcel 1 (courtesy of C-NLOPB). This line is an example of seismic data quality in the parcel. The line also shows the tectono-structural style in the parcel and indicates several possible hydrocarbon traps. Location of the line is given in Figure 17.

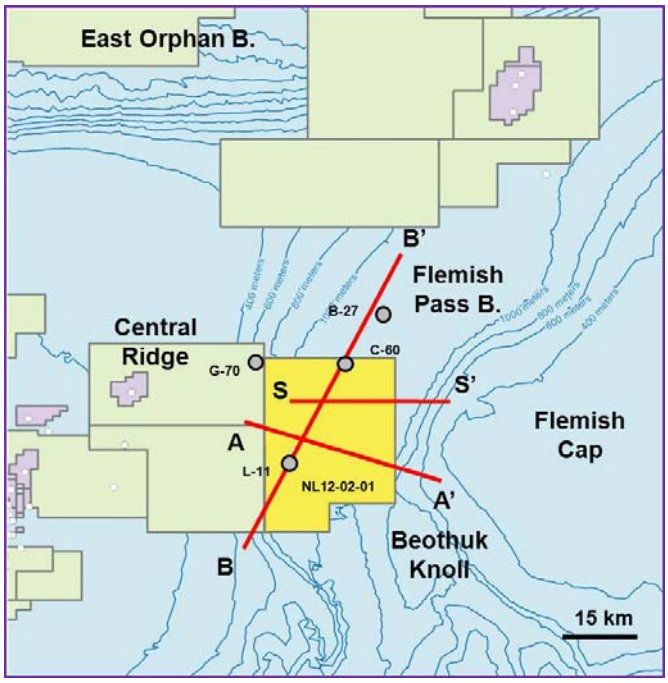
The dip seismic line S-S' stretches from the eastern side of Parcel 1, crosses the basin depocenter, exits the parcel's eastern boundary and terminates on the flank of Flemish Cap (line location is given in Figure 17). This seismic section shows the intense deformation of the synrift successions under the combined Avalon/Base Tertiary unconformities. The Gabriel C-60 well that intersected a thick sandstone reservoir interval is located about 12 km north of the line. The Lancaster G-70 well that intersected both Kimmeridgian source and reservoir rocks is located about 15 km north of the western end of the line.

In the eastern side of the seismic section the prerift basement is shallow and covered by a thin succession of Late Cretaceous and Tertiary sediments. A faulted half graben that contains Jurassic and Early Cretaceous beds truncated by the Avalon Unconformity adjoins the Cap. The eastern end of the section includes several rotated blocks in the downthrown side of a basement involved fault dipping toward the Flemish Cap. These rotated blocks and subunconformity trapping of synrift beds are good exploration leads in this part of the basin. A basement horst with synrift sedimentary cover is formed by this fault and another major fault dipping toward the basin. The horst represents a viable structural lead in the parcel.

The most prominent feature in the section is a large rollover, fragmented by secondary faults. The rollover occupies the center of the parcel. Individual rotated blocks are imaged under the Base Tertiary unconformity. Some of the blocks contain high amplitude seismic reflectors and a gas chimney is visible in the central part of this large anticlinal feature.

5.3. Petroleum Potential of Call for Bids NL12-02 Parcel 1. This large parcel, located in intermediate deep water (700 to 1100 m) in the Gabriel Subbasin of the Flemish Pass Basin represents an excellent opportunity to explore a now-proven hydrocarbon basin (Figure 17). The Gabriel C-60 and Kyle L-11 wells have been drilled in this parcel while two other wells, Lancaster G-70 and Tuckamore B-27, were drilled in the vicinity. These wells and their results were discussed in detail in Chapter 4. The wells have encountered quality synrift reservoir and/or the Kimmeridgian Egret source rock.

Using the available public seismic grid (Figure 15), several hydrocarbon plays can be interpreted within the Mid Jurassic to Early Cretaceous basin fill in NL12-02 Parcel 1. A structural high such as Basement Horst, Roll-over Anticline, Rotated Block and Drape Anticline, containing any of the Middle Jurassic to late Early Cretaceous reservoir sandstones forms the main hydrocarbon play in the basin. Salt induced anticlines are unlikely to be found in the central part of the basin but are possible in the western sector of the parcel.



In this parcel there are locations where a 3.5 to 5.5 km deep well can test the synrift sandstone plays (Avalon, Gabriel, Tempest sandstones). A secondary play is represented by Late Cretaceous and Early Tertiary lowstand coarse clastics that may exist as basin floor or basin margin fans.

Figure 17. Location map of representative seismic lines S-S', A-A' and B-B' used to illustrate this report. The lines are displayed in Figures 16, 18 and 19 and commented in figure captions and text.

Three regional seismic lines are interpreted in this report to illustrate the structural-stratigraphic style of the Flemish Pass Basin, identify drilling leads and comment on the petroleum potential of the parcel. Their location in the parcel is given in Figure 17.

Line A-A'. The regional dip line A-A' (NW-SE) used to illustrate the potential of Parcel 1 starts in Husky's operated ELs 1111 and 1110, crosses the parcel in its central part and stretches toward the small Cretaceous filled Flemish Cap Graben incised between the Beothuk Knoll and Flemish Cap (Figures 11, 17 and 18). The dip line starts in 700 m water depth in the west where the parcel adjoins the Central Ridge and spreads over the central part of the basin residing in water depth of around 1100 m. The line was recorded and processed in 2006 and has good quality allowing for adequate structural and stratigraphic interpretations.

The line shows the deformation style in the dip direction of the Flemish Pass Basin where major extensional faults involving the basement trigger large rollovers, rotated blocks and form typical horst anticlines. The structural highs identified as leads in Figure 18 contain sedimentary

successions aged from Late Triassic to late Early Cretaceous. These are the successions containing the source and reservoir rocks drilled in the adjacent wells. Several sectors of the seismic line, some associated with structural highs, show the presence of amplitude anomalies (AA) and other direct hydrocarbon indicators. Late Cretaceous beds are present only in the central syncline. In other areas these beds are eroded by the converged Avalon and Base Tertiary unconformities.

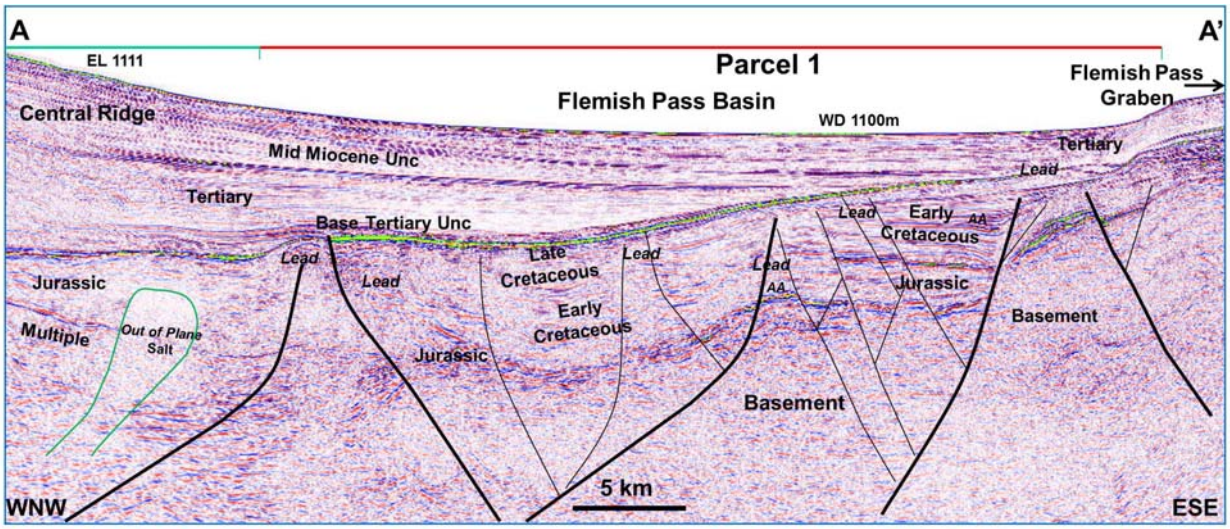


Figure 18. Interpreted dip seismic line A-A' showing structural, tectonic and stratigraphic characteristics and possible drilling leads in Parcel 1(courtesy of C-NLOPB).

Line B-B'. This regional strike line starts on the Central Ridge south of EL 1110 and tracks NNE over the central part of the Flemish Pass Basin, containing the thickest sedimentary fill. The line crosses over the basement cored anticlines drilled by the L-11 and C-60 wells.

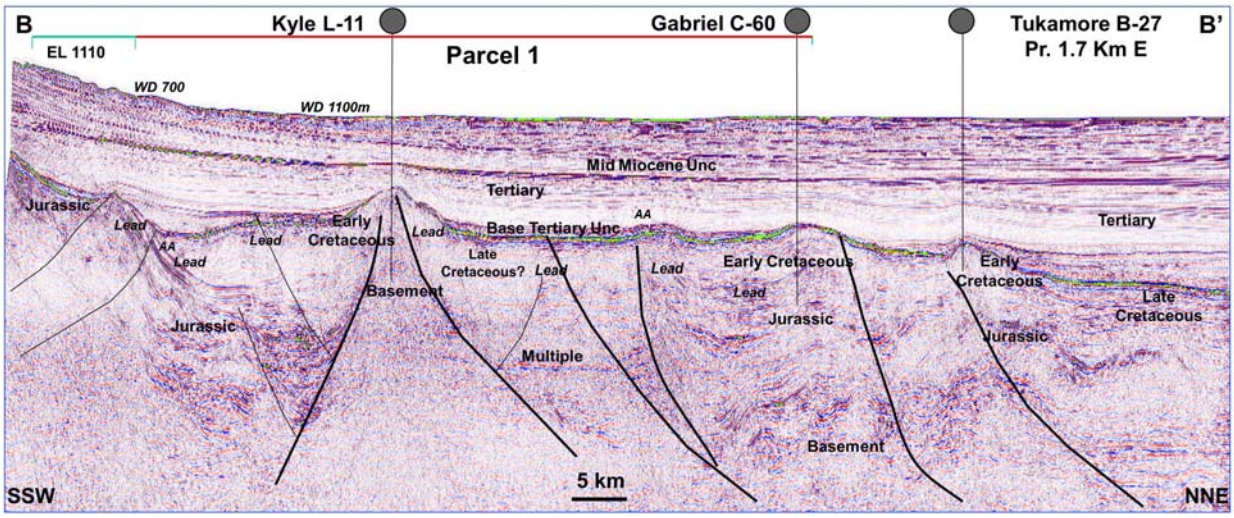


Figure 19. Interpreted dip seismic line B-B' showing structural, tectonic and stratigraphic characteristics and possible drilling leads in Parcel 1(courtesy of C-NLOPB). The line intersects the basement cored anticlines drilled by the L-11 and C-60 exploration wells that had good reservoir rock intervals.

Two wells were drilled in the parcel. The Kyle L-11 well found Hibernia equivalent intervals, while the Gabriel C-60 well intersected a thick (over 1200 m) column of Early Cretaceous sandstones. The Tuckamore B-27 well located north of the parcel also encountered several hundred meters of Early Cretaceous (Gabriel) sandstones.

On this strike line, there are several large rotated blocks with Jurassic beds that form good exploration leads in the southern part of the parcel. Structural leads exist on both sides of a fault segmenting the minibasin south of the Kyle horst. Both downthrown blocks of this horst are good leads that contain Early Cretaceous successions and possibly a thin Late Cretaceous cover. North of the Kyle horst, there is a minibasin that contains another horst with synrift sedimentary cover. A large rollover segmented by a listric normal fault creates a large, complex anticline in the synrift sequence that has an expression on the Base Tertiary Unconformity. In the minibasin in front of the Gabriel anticline, there is a deeper seated high that contains Jurassic to Early Cretaceous beds. All these leads need to be verified with crossing seismic lines. It is noteworthy that several bright amplitude reflectors are observed along the line B-B'.

All the highs shown by the three representative lines (Figures 15 to 19) have produced drape or small inversion anticlines and structural noses in the Tertiary sedimentary layers. Unlike the Jeanne D'Arc Basin, no quality reservoirs of this age have been drilled yet in the basin.

6. Prospects and Leads

The seismic lines A-A', B-B' and S-S' (vintage 1998) introduced in this report are part of a regional grid that should allow seismic mapping of the leads located in the parcel. More multiclient seismic grids that are not in the public domain or more recent proprietary company surveys are also available to map the structural leads existing in the parcel and confirm them as prospects.

The two wells drilled in Parcel 1 have tested two large anticlines in their apex position. Several down flank leads separated from the well locations by normal faults were shown as leads in the discussed seismic sections (Figures 16, 18 and 19).

Seismic mapping was beyond the scope of this report. With the limited 2D grid available, only several large and mid-size leads were identified and discussed. Some of the leads were captured only by a single seismic line. Additional seismic coverage available from seismic brokers will help to confirm the leads as valid petroleum traps. Several of the marked exploration leads have significant lateral and vertical dimensions. Using the 2D seismic grid in Figure 15, one can estimate that leads will be as large as 40 to more than 100 km^2.

The main hydrocarbon play in the basin is structural and it involves porous mid-Jurassic to Early Cretaceous sandstones trapped by normal faults triggering horsts, roll-over anticlines, and large rotated blocks. As shown by the representative seismic lines A-A', B-B' and S-S', the basin in general and the parcel in particular, is rich in extensional traps slightly modified by transtension and inversion.

Source rocks in the parcel are found at expulsion depths of 3800-6000 m beneath the mud line in mini-basins and deep basement grabens located toward the center of the parcel and its northern part. The widespread reservoir sandstone should be sealed in the parcel by the numerous shale formations straddling the Mid Jurassic to Late Cretaceous stratigraphy. High amplitude seismic patches (AA) and large gas chimneys are seen in the Early Cretaceous and Late Jurassic sequences helping to confirm the presence of an active petroleum system in the parcel (Figures 16, 18 and 19).

The main geological risks on this parcel are fault sealing and the quality and maturation of source rock. These risks should be moderated by the large size of the structural traps identified in the parcel. Firming the structural closures using 3D seismic and modelling the source expulsion in the basin will also help mitigate the risks.

The C-NLOPB with assistance from the GSC (2004) carried out a probabilistic analysis of the Flemish Pass Basin petroleum potential based on a variety of play concepts and concluded that the basin contains undiscovered oil resources to be in the range of 1.7 billion barrels. However, the study did not have the benefit of new seismic coverage, and did not consider the deep water plays existing in the northern part of the basin or the possibility of other than Kimmeridgian, Type II source rocks.

7. Discussion

Exploration in the Flemish Pass Basin region is still in the early frontier stage. Only seven exploration wells have been drilled in the basin. The seventh well, Mizzen O-16, drilled in 2009, discovered a large field that may contain up to 200 million barrels of recoverable oil. In 2010 this discovery was awarded two SDLs.

The dry holes in the basin have encountered thick reservoirs in Early Cretaceous (Gabriel and Baccalieu sandstones) and good quality Type II and II-III source rock (Egret Member, as well as younger and older shale intervals with high TOC).

CFB NL12-02 Parcel 1, located in the Gabriel Subbasin, is 89.6 times larger than a Gulf of Mexico standard tract. Good quality, late 1990s, dense 2D seismic coverage is publicly available in the parcel to image and map hydrocarbon traps. Several large petroleum leads were identified with this publicly released seismic data (Figures 15 to 19) and can be further delineated and drilled. Additional high quality digital data is available from seismic contractors to firm up these leads.

The parcel is in a region with large extensional structures, known reservoirs, mature source rocks and proven migration paths. It contains multiple reservoir targets within the synrift sequence located at 3000-5500 m depth that can be drilled year round and tested using semi-submersible rigs or drillships.

Risks are recognized in regard to reservoir quality, source rock quality, overpressure and fault sealing. Eight adjacent ELs are located in the basin (operated by Statoil), in the adjacent East Orphan Basin (operated by Chevron) and on the Central Ridge (operated by Husky) (Figures 3

and 14 and Table I). The cost of an offshore well in this parcel would likely be in the range of $60-$100 million (CDN) depending on the depth to the target.

The Newfoundland and Labrador offshore is close to industrial regions of Central Canada, Eastern United States and Western Europe. Canada is a country with one of world's most stable political and financial systems and has a long tradition in oil and gas exploration and production.

The Canadian province of Newfoundland and Labrador has a marine petroleum exploration tradition of more than 45 years. The province has 15 years of offshore oil production expertise that includes both Gravity Base Structure (GBS) and Floating Production Storage and Offloading Systems (FPSO) infrastructure. One of North America's largest oil field developments is taking place in the neighboring Jeanne d'Arc Basin, where the Hebron field is being presently developed by Exxon and partners. This field comprises a mixture of reservoirs containing both light (31° API) and heavier (20° API) oils.

The royalty regime is well established in the province and places offshore NL in the middle to upper tier of the world's favorable areas for petroleum exploration and production. In 2011, the Province obtains 27.5% of its nominal GDP from the oil and gas industry and is actively encouraging exploration of offshore areas especially in its less explored offshore basins such as the Flemish Pass Basin. There is a robust regulatory regime in the offshore area particularly with respect to Health, Safety & Environment. While the provincial government encourages offshore exploration, safety of workers and protection of the environment are paramount.

8. Conclusions

One large parcel, within the under explored southern Flemish Pass Basin is available for licensing in the C-NLOPB's Call for Bids NL12-02 which closes on November 1, 2012, 4 p.m. NL time. This parcel contains Mesozoic synrift and postrift, predominantly clastic successions, including proven source (Kimmeridgian Egret Member) and reservoir rocks (Late Jurassic and Early Cretaceous porous sandstones) located within a classic Atlantic margin extensional basin at intermediate water depths.

Similar reservoirs have produced excellent oil flows in the Jeanne d'Arc Basin oil fields located approximately 100 km to the west, on the Central Ridge located 50 km to the west and in the Mizzen field located approximately 80 km northeast in the same basin. Only seven exploration wells have been drilled in this 14,000 km^2 basin (one well/2000 km^2), in water depth between 700 m to 1150 m. These wells have intercepted good quality reservoir sandstones and some had oils shows (e.g. Mizzen L-11).

The Kimmeridgian source rocks, drilled in neighbouring wells, should be mature in the low areas of the basin, which are situated in the central and northern part of the parcel. The parcel is a large exploration block situated in intermediate to deep water in a proven Mesozoic petroleum basin. Large fault bounded rollovers, rotated blocks, horsts and inverted anticlines with mid-Jurassic to Early Cretaceous reservoirs that were successful in the adjacent basins are viable leads. Additional potential may exist in Late Cretaceous and Early Tertiary stratigraphic traps (slope and basin floor fans).

Some of the leads have clearly expressed DHIs (Amplitude anomalies, gas chimneys, etc) on 2D seismic sections. Recognized risks in regard to source quality and maturity and fault seal are mitigated by the presence of large undrilled features and of the DHIs. 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.

The interpreted leads can contain several tcf of natural gas or 250 to 500 mmbbls of oil. The leads in the parcel are located in 1100 m water depth and require modern, harsh environment drilling units.

The identified leads in Parcel 1 are located in an underexplored basin, close to vast northeastern American and Canadian energy markets. The parcel will give a new entrant operator an excellent opportunity to participate in a high-risk, high-reward petroleum play off Canada's East Coast. For an existing operator the parcel provides a great opportunity to increase its prospective portfolio of leads and prospects offshore NL.

9. Further Reading

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GSC Basins website:

http://www.nrcan.gc.ca/earth-sciences/products-services/geoscience-data-repository/11860

Nova Scotia Department of Energy website: http://www.gov.ns.ca/energy/