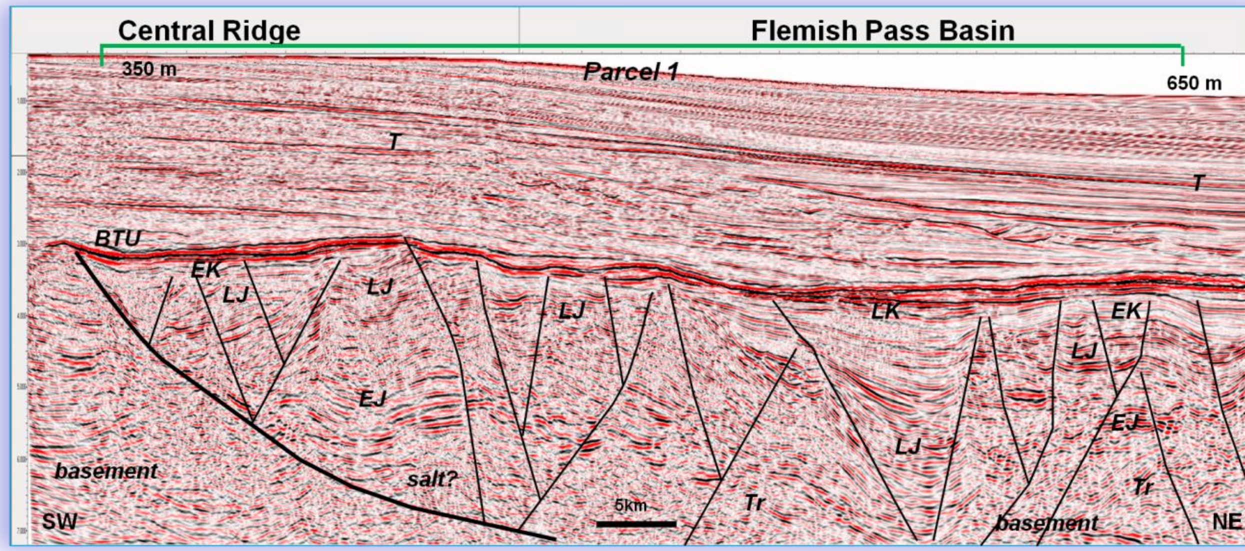
Petroleum Exploration Opportunities in the Flemish Pass Basin, Newfoundland and Labrador Offshore Area: Call for Bids NL13-01, Area “C” – Flemish Basin, Parcel 1

Government of Newfoundland Department of Natural Resources



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May 2014

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) 2013 Call for Bids NL13-01.

This year the C-NLOPB has issued three separate Calls for Bids, including:

1. **Call for Bids NL13-01** (Flemish Pass Basin) consisting of one parcel,
2. **Call for Bids NL13-02** (Carson Basin) consisting of four parcels, and
3. **Call for Bids NL13-03** (Western Newfoundland) consisting of four parcels.

These nine parcels on offer comprise a total of some 24,090 km^2 (5,952,818 acres) distributed in four regions of the NL Offshore area situated in the Flemish Pass, Carson, Anticosti and Magdalen basins http://www.cnlopb.nl.ca/news/nr20130516.shtml.

Call for Bids NL13-01. This report focuses on Call for Bids NL13-01 Area "C"- Flemish Pass (http://www.cnlopb.nl.ca/pdfs/nl1301.pdf). This Call for Bids consists of one parcel comprising 2,661 km^2 (657,644 acres) located in intermediate water depths of the Flemish Pass Basin, northeast of the island of Newfoundland. This 14,000 km^2 (5,405 mi^2) Mesozoic-Tertiary basin is situated just northeast of the oil-producing Jeanne d'Arc Basin (229,000 bopd in 2013 from the Hibernia, Terra Nova, White Rose and North Amethyst oilfields). The basin is the focus of major exploration by several multinational and Canadian companies. In the past four years, the Flemish Pass became a proven petroleum basin that contains 1) the Mizzen significant oil discovery with recoverable reserves estimates in the range of 100-200 mmbbls), 2) the recently announced major light oil (34° API) discovery at Bay du Nord C-78/C-78Z (August 2013), estimated by Statoil to be an accumulation as large as 300 to 600 mmbbls, and 3) the yet to be evaluated light oil discovery at the Harpoon O-85 (reported also by Statoil in June 2013) (http://www.statoil.com/en/NewsAndMedia/News/2013/Pages/26Sep_exploration.aspx). This parcel is one of the last areas in the Flemish Pass Basin that is not licensed. A comprehensive report of the Flemish Pass geology, geophysics and its exploration that included the petroleum potential of a parcel (now EL 1134) located just south of the Call for Bids NL13-01 was posted http://www.nr.gov.nl.ca/nr/invest/call_bids_petro_exploration_enachescu%20.pdf (Enachescu, 2012).

At the time of web-publishing this report, no precise date has been assigned for the closing of the Call for Bids NL13-01. In May 2013, the C-NLOPB issued a request for proposals for the preparation of the Strategic Environmental Assessment for the Eastern Newfoundland Offshore Area. The closing date for Call for Bids NL13-01 will be a minimum of 120 days after the completion of the *Eastern Newfoundland Strategic Environmental Assessment (2013)*. The closing date will be announced in a subsequent Notice to Bidders http://www.cnlopb.nl.ca/news/nr20140520.shtml. Interested parties have until the Closing Date and time to submit sealed bids for Call for Bids NL13-01 (Flemish Pass).

Call for Bids NL13-02. Call for Bids NL13-02 Area "C" - Carson Basin includes four large parcels in the northern Carson Basin with a total area of 11,384 km^2 (2,813,034 acres) (http://www.cnlopb.nl.ca/pdfs/nl1302.pdf). The parcels lay in shallow (190 m) to deep water (3000 m) of the basin, east of the Grand Banks of Newfoundland and south of the Flemish Cap bathymetric features. These parcels are located within an underexplored Mesozoic sedimentary basin that should include an active petroleum system. This 50,000 km^2 (19,305 square miles) Mesozoic-Tertiary basin is situated south of the oil producing Jeanne d'Arc Basin and south of the Flemish Pass Basin where the Mizzen (2009), Harpoon (2013) and Bay du Nord (2013) major discoveries were made. The Carson Basin is under-explored with only four older exploration wells drilled (two in 1973, one in 1974 and one in 1986). All four wells were drilled on the shelfal portion of the basin. A comprehensive report on the Carson Basin and petroleum potential of Call for Bids parcels 1 through 4 is available at http://www.nr.gov.nl.ca/nr/invest/PetExOpCarsonNL1302.pdf. As detailed in this report, significant oil and gas potential exists in the four parcels offered for bids. A PowerPoint presentation on the subject containing 82 slides was posted during November 2013 at http://www.nr.gov.nl.ca/nr/invest/NL1302CarsonBasinEnachescu.pdf

The C-NLOPB has decided that the closing date for Call for Bids NL13-02 will be a minimum of 120 days after the completion of the *Eastern Newfoundland Strategic Environmental Assessment (2013)*. The closing date will be announced in a subsequent Notice to Bidders http://www.cnlopb.nl.ca/news/nr20140520.shtml. Interested parties have until the Closing Date and time to submit sealed bids for Call for Bids NL13-02 (Carson Basin).

Call for Bids NL13-03. Call for Bids NL13-03 Area "B" - Western Newfoundland and Labrador Offshore Region, consists of four parcels comprising 10,045 km^2 (2,482,129,201 acres) located in the shallow waters of the Gulf of St. Lawrence, west of the island of Newfoundland. Three of the parcels are situated in the Anticosti Basin and one is located in the Magdalen Basin. The parcels are situated north and west of the Port au Port Peninsula, where a significant discovery (Port au Port #1) was recorded in 1995 and is today part of the Garden Hill South oil field. A PowerPoint presentation on the subject containing 26 slides was posted during September 2013 at http://www.nr.gov.nl.ca/nr/invest/WestNL1303.pdf

Interested parties have until 4:00 p.m. NL Standard Time on November 12, 2014, to submit sealed bids for Call for Bids NL13-03 (Western Newfoundland and Labrador).

Call for Bids NL13-01 Report. This report should be referenced as ***Enachescu, M.E., 2014. Petroleum Exploration Opportunities in the Flemish Pass Basin, Newfoundland and Labrador Offshore Area; Call for Bids NL13-01, Area "C" – Flemish Pass Basin, Parcel 1. Government of Newfoundland Department of Natural Resources*.**

I acknowledge the contribution of earlier researchers in the area: J. Wade, A. Grant, S. Srivastava, C. Keen, D. McAlpine and many other scientists at GSC Atlantic who contributed to the Grand Banks Basin Atlas (1989) that included the shallow to intermediate waters parts of the Flemish Pass Basin. I also acknowledge the professionals of Esso, PAREX, Petro-Canada, Encana and Norsk Hydro who seismically mapped and drilled the first six wells in the Flemish Pass Basin that have provided information and ties to several discoveries, prospects and leads. I particularly acknowledge the efforts of John Hogg, Jock McCracken, and their colleagues who believed in the potential of the basin and were involved in the acquisition of the first 3D surveys and the drilling of the first recognized oil reservoir at the Mizzen L-11, later abandoned untested. They also have produced some essential conference presentations on the Flemish Pass Basin and engaged in interesting discussions on the basin's potential. I also acknowledge managers of Statoil that took a second look at the area and the professional geoscientists at Statoil and Husky who drilled the first major discoveries and provided recent accounts of the Flemish Pass Basin finds. Thanks are also due to the GSC researchers who produced several more recent geological reviews and published the 2004 resource evaluation on the basin. I am indebted to J-C. Sibuet, B. Tucholke, S. Srivastava and other researchers who in the past three decades have published several important papers on the geology of the Newfoundland margin and championed the IODP drilling in the deep water south of the Flemish Cap. TGS in collaboration with PGS is warmly acknowledged for providing two portions of new seismic lines from their regional grid acquired during 2012/13 - the "first time" that marine seismic lines collected by this partnership are used to illustrate a C-NLOPB Call for Bids.

This report 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 and D. Spurrell for edits and suggestions and B. Kendell, K. Waterman 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 **May 17, 2013, News Release** (http://www.cnlopb.nl.ca/news/nr20130516.shtml).

Acronyms used in this report:

NL = Newfoundland and Labrador (the legal name of the Province)
NS = Nova Scotia
IODP = Integrated Ocean Drilling Program
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
NL13-01, 02 and 03 = identifiers for the three 2013 C-NLOPB Call for Bids
PL = Production Licence
EL = Exploration Licence
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
bcd = barrels of condensate per day
bbls = barrels
mmbbls = million barrels
Bbbls = Billion barrels

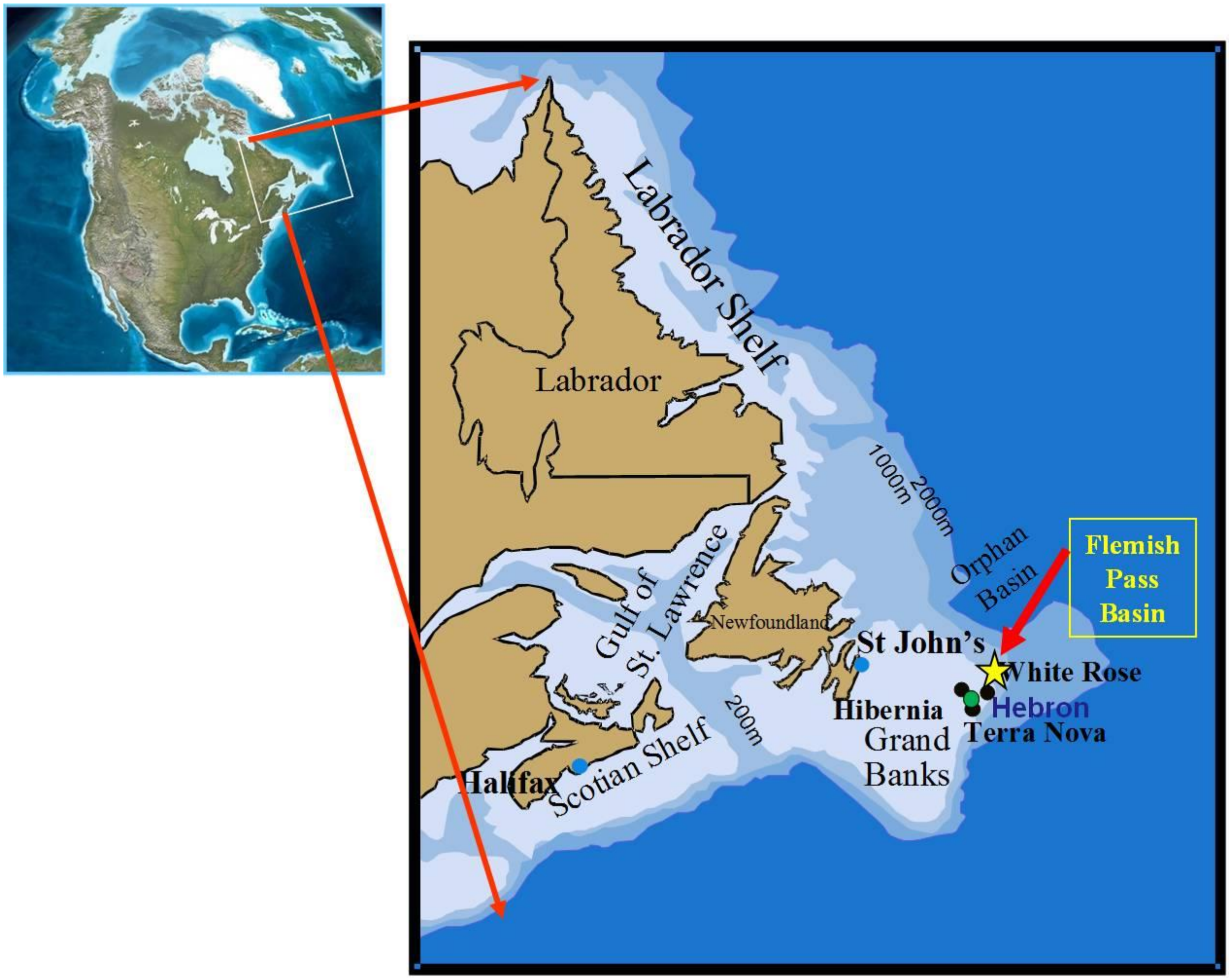


Figure 1. Location of Newfoundland and Labrador's major offshore oil fields (black dots) and of the Flemish Pass Basin. Geographically, the basin is located in the bathymetrical saddle between the Grand Banks of Newfoundland and the Flemish Cap. The Hebron oil field marked with a green dot is in development. The approximate location of the Call for Bids parcel is marked with a yellow star.

Report Content

1. **Introduction**

This report focuses on Parcel 1 of the C-NLOPB Call for Bids NL13-01 Area "C" – Flemish Pass Basin (http://www.cnlopb.nl.ca/cfb1301.shtml). This basin is located off the east coast of the Province of Newfoundland and Labrador, Canada (Figures 1 and 2). The parcel is situated on the shelf and intermediate water of the bathymetric feature known as the Flemish Pass, a water bottom depression between the Grand Banks of Newfoundland and Flemish Cap within the Atlantic Ocean. The area is jointly administered by the provincial (NL) and federal (Canada) governments, through the C-NLOPB (Figures 1 and 2). The parcel is in water depths ranging from 390 m to 1,200 m. A series of large structural, stratigraphic and combination traps were identified on seismic data collected in the basin, including Parcel 1.

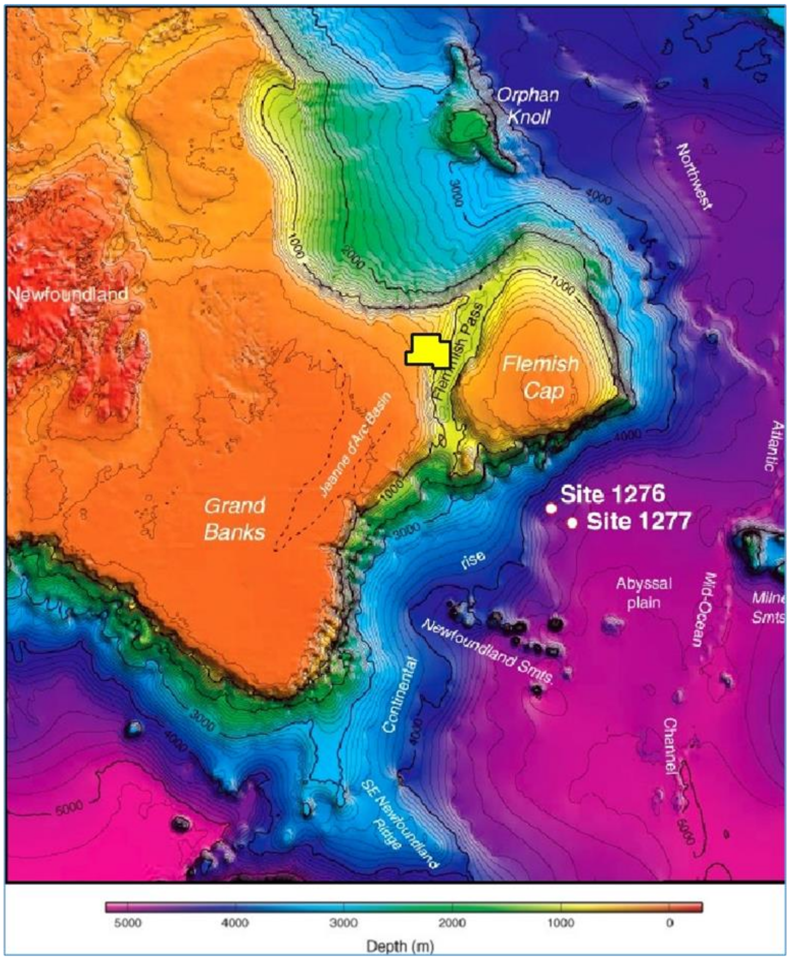


Figure 2. East Newfoundland offshore bathymetric map showing location of the Flemish Pass bathymetric low and the position of the Parcel NL13-01-01 (Parcel 1).

During three earlier exploration cycles (early to late seventies, early to mid-eighties and late nineties to mid 2000s), six exploration wells were drilled with only one indication of the presence of hydrocarbon. While all six wells were unsuccessful, they intersected good reservoirs. One well, Baccalieu I-78, logged and cored excellent Kimmeridgian source rock. In 2003 Petro-Canada and partners Encana and Norsk Hydro drilled the Mizzen L-11 well that had 5 m of oil pay on logs in Late Jurassic sandstone, and proved that oil was generated in the basin and migrated to quality reservoirs.

The modern licensing of blocks in intermediate water depths of the Flemish Pass Basin took place in late 1990s-early 2000s, when several grids of 2D lines were collected by seismic contractors and Mobil Canada and two large 3D surveys were operated by Chevron Canada and Petro Canada (http://www.cnlopb.nl.ca/pdfs/nl1301modern.pdf). At the time, Petro-Canada was leading the exploration effort in the basin. However, after drilling the Mizzen L-11 (a teaser) and Tuckamore B-27 (an unsuccessful Early Cretaceous test), the operator Petro-Canada and partners decided against further drilling their mapped prospects. Two of the partners in this exploration round, Petro-Canada and Encana, decided to drop out of the validated acreage and let Norsk Hydro retain a 100% interest in the EL containing the Mizzen structure located just northeast of the Tuckamore B-27 well. After its successful merger with Norsk Hydro, Statoil took the lead with the Flemish Pass ELs and together with a new partner, Husky Oil Operations Limited (Husky), reprocessed the existing 3D survey over the area and drilled a discovery well at Mizzen O-16 that tested oil at a rate of 600 m^3/day (3,774 bopd). This discovery allowed the partners to obtain a large Significant Discovery Licence (SDL) over the structure (Figure 3).

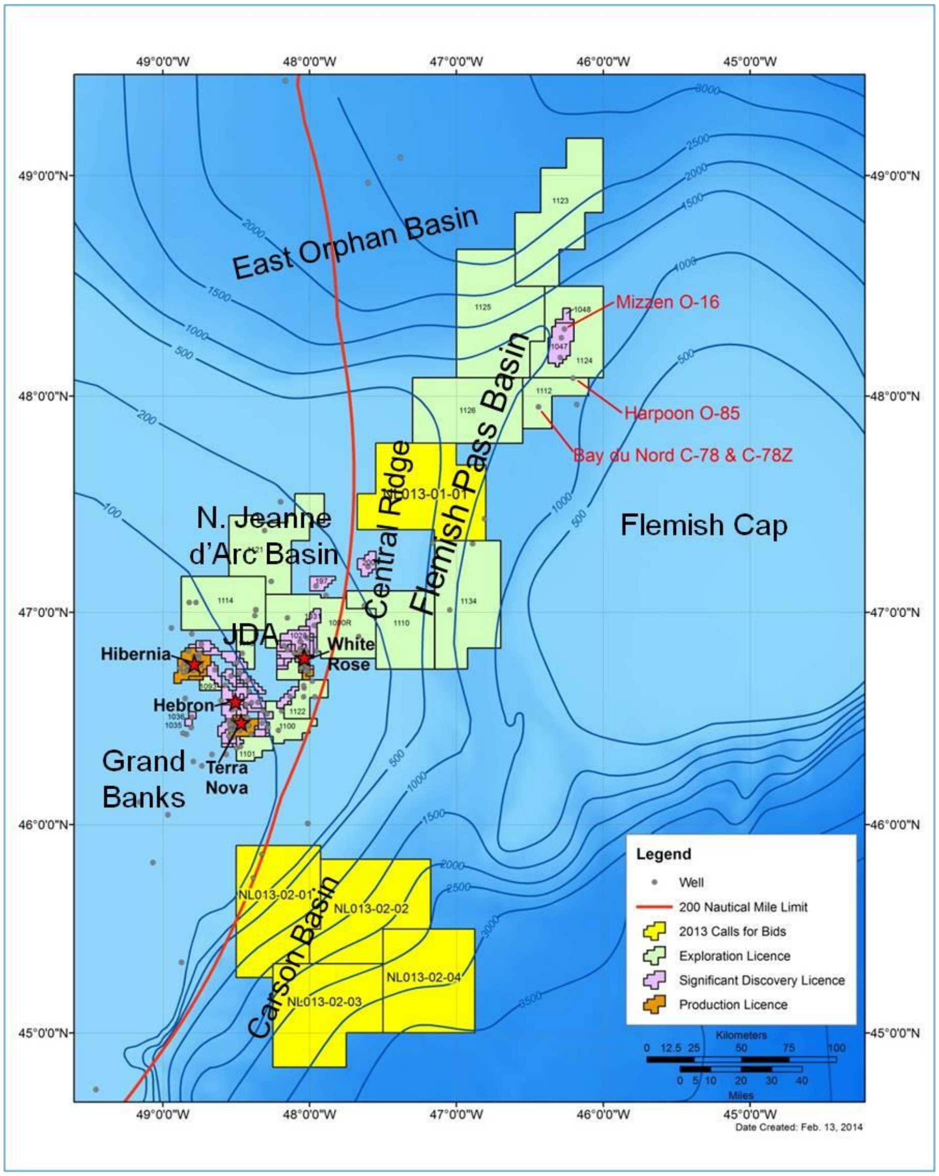


Figure 3. Location map of the Call for Bids NL13-01-01 in Flemish Pass Basin. The active Exploration Licences in the Jeanne d'Arc and Flemish Pass basins and the Carson Basin's Call for Bids NL13-02 parcels 1 to 4, are also shown. The map shows producing oil fields in the Jeanne d'Arc Basin: Hibernia, Terra Nova, White Rose and North Amethyst and the Hebron field currently under development. The recent oil discoveries in Flemish Pass Basin, Mizzen, Harpoon and Bay du Nord, are indicated in magenta. JDA = Jeanne d'Arc Basin.

The Flemish Pass Basin is a high-risk/high-reward exploration area. Most of its large structural plays are situated in water depths between 800 and 1200 m. The Flemish Pass Basin is currently not a producing basin, but with the significant discovery at Mizzen O-16 (100-200 mmbbls) and the recently announced discoveries at Bay du Nord (300-600 mmbbls) and Harpoon (not yet evaluated), has a very good chance to become the second oil producing basin offshore NL. Since the start of its exploration campaign in the Flemish Pass Basin, Statoil has drilled three discovery wells (including a sidetrack) and a wet delineation well F-09, for an astonishing 75% success ratio.

The Flemish Pass Basin is close to the major producing fields of the Jeanne d'Arc Basin and also close to North America and Europe's largest petroleum markets. With a high success ratio for a Frontier basin (30% counting all the wells, 50% since 3D seismic surveys were used to locate exploration wells), this underexplored basin presents further substantial opportunities. This SW-NE elongated Mesozoic rift basin has a similar petroleum system evolution with the Jeanne d'Arc Basin, is under-explored and provides a great potential for petroleum exploration.

The geology of the Grand Banks with discussion on the Flemish Pass Basin and its petroleum potential was illustrated in numerous publications and web presentations of previous workers (Keen et al., 1987; Enachescu, 1987, 1988 and 1992a and b; Tankard and Welsink, 1988 and 1989; Sinclair, 1988; Grant et al., 1988; Grant (compilation), 1988; Ziegler, 1989; Grant and McAlpine, 1990; Keen and Williams, 1990; Hiscott et al., 1990a and b; Sinclair et al., 1992; Taylor et al., 1992; Srivastava and Verhoef, 1992; Foster and Robinson, 1993; DeSilva, 1999; Atkinson and Fagan, 2000; GSC, 2001; Edwards et al., 2003; Tucholke et al, 2007a and b; Enachescu and Fagan, 2004, 2005a and b, and 2009; Enachescu and Hogg, 2005; Solvason, 2006; Hogg and Enachescu, 2004, 2007 and 2008; Enachescu, 2006, 2008, 2009, 2010a and b, 2011, 2012 and 2013; Enachescu et al, 2005a and b, 2010 and 2012; Sibuet et al 2007; Lowe et al., 2011; Welford et al., 2010; Withjack et al., 2012; GeoArctic, 2013; Cody et al., 2013).

Comprehensive accounts on the exploration and production on the East Coast of Newfoundland and Labrador and the regional geology of the Grand Banks and adjacent basins including their hydrocarbon prospectivity are contained in several recent reports and PowerPoint presentations available from http://www.nr.gov.nl.ca/nr/invest/energy.html. This includes the recently updated account on regional NL offshore exploration contained in the report related to the Call for Bids NL13-02 (Enachescu, 2013; http://www.nr.gov.nl.ca/nr/invest/PetExOpCarsonNL1302.pdf).

The most recent web publications that discuss the history of exploration, tectonic and structural setting, regional and specific stratigraphy, petroleum geology, well results, potential of previous Call for Bids parcels and illustrative seismic sections are posted on the NL DNR website at:
http://www.nr.gov.nl.ca/nr/invest/enachescuNL100203.pdf,
http://www.nr.gov.nl.ca/nr/invest/enachescu_NL1102Flemish.pdf, and
http://www.nr.gov.nl.ca/nr/invest/call_bids_petro_exploration_enachescu%20.pdf.

As most of the detailed accounts on the Flemish Pass Basin can be retrieved from the above web publications, the present 2013 report provides only specific:

1) Information on current petroleum exploration in the basin,
2) Comments on the recent discoveries in the basin and exploration efforts, and

3) Description of the local geology and petroleum potential of the parcel offered in the Call for Bids NL13-01.

Parcel NL13-01 is located within the shallow water of the Central Ridge and intermediate water depth of the southern part of the Flemish Pass Basin. In this parcel and vicinity, thick Mesozoic synrift and postrift sequences were identified on seismic data and were intersected by the drilled wells.

More information on the geology of the Newfoundland and Labrador offshore basins' petroleum potential 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 specifically on the Flemish Pass Basin are provided at the end of this report.

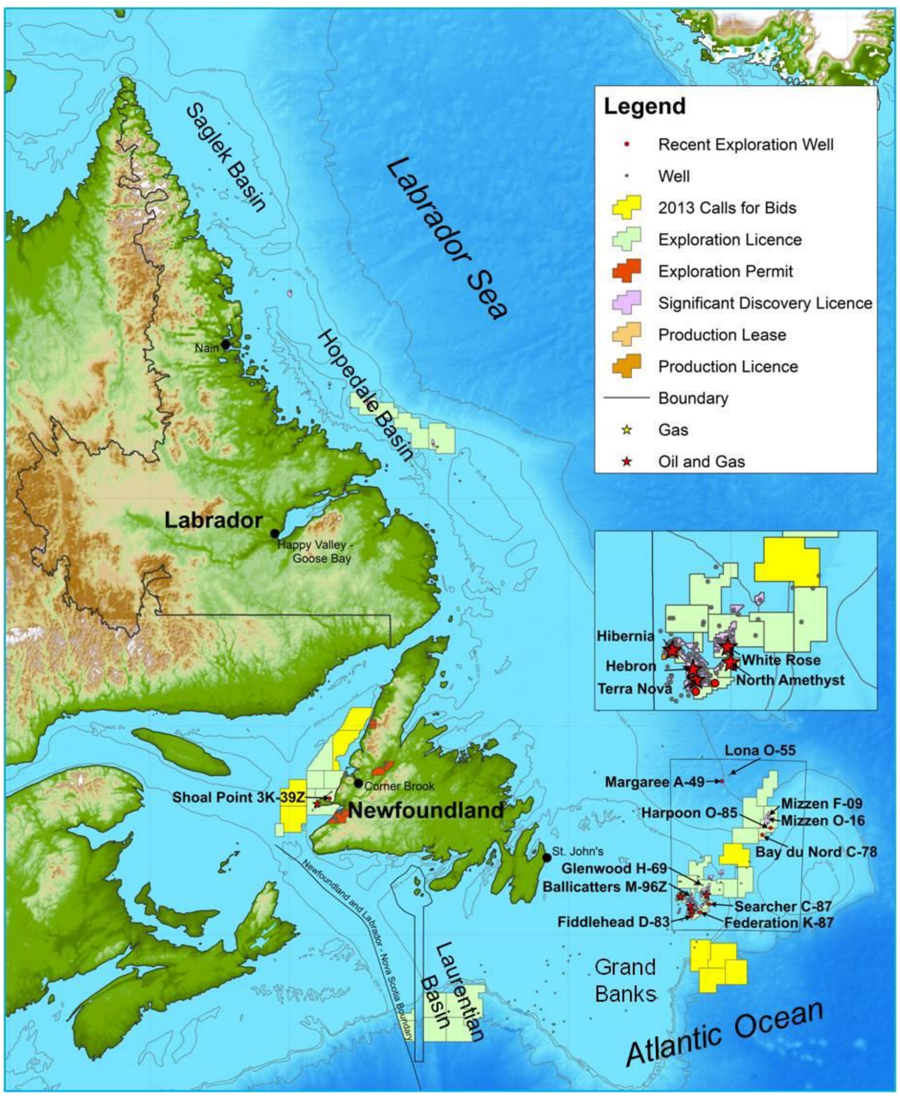


Figure 4. Location map of active Exploration Licences (in green) and Call for Bids NL13-01,-02 and-03 (in yellow) offshore Newfoundland and Labrador (as spring of 2014).

2. Exploration and Development Background

This chapter is adapted and updated from the CFB NL13-02 Carson Basin report available at: http://www.nr.gov.nl.ca/nr/invest/PetExOpCarsonNL1302.pdf

The Canadian province of Newfoundland and Labrador (NL) is the sole North American Atlantic Margin offshore area north of Florida containing giant producing oil fields. Nova Scotia and NL are the only jurisdictions allowing petroleum exploration on the Atlantic continental shelf and slope. Approximately 1,000,000 km^2 of Tertiary Mesozoic and Paleozoic areas with oil and gas potential are distributed around the province of Newfoundland and Labrador, in an area larger than the Gulf of Mexico or the North Sea (Figure 4).

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 by industry, the Geological Survey of Canada, Atlantic Canada Universities and research institutes in Canada, USA and Europe. Exploration offshore NL is regulated by the C-NLOPB but promoted by NL-DNR. Numerous NL-DNR publications and presentations discuss the geological setting, petroleum system and exploration potential, exploration history of the East Coast of NL and the make-up of its oil and gas fields (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 conventional light oil and more than 85% of Atlantic Canada's 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, North Amethyst fields and their satellites, located in the Jeanne d'Arc Basin. Production drilling using extended reach techniques from the Hibernia Platform and semi-submersibles at the White Rose and Terra Nova fields continued during 2012-13. 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 7th largest oil producer among all American states and Canadian provinces (after TX, Alaska, CA, ND, and in Canada AB and SK). In 2011 NL produced 97.3 mmbbls amounting to a daily average of 266,494 bopd. In 2012, production fell to 197,216 bopd for a total annual production of 72.2 mmbbls due to extended maintenance programs at the Terra Nova, White Rose and North Amethyst fields. An average of 229,000 bopd was produced during the 2013 for a total of 83.58 Million barrels.

Over 1.45 billion barrels have been produced to date from the NL offshore area. Taking into account the recent increase in reserve estimation for the Terra Nova field, and the Ballicaters new field wildcat discovery on the Grand Banks, approximately 2.18 billion barrels of proven remaining recoverable reserves/resources exist. More than 7.9 tcf of natural gas was discovered on the Grand Banks, but there is no gas production on a commercial basis yet. The Jeanne d'Arc Basin's developments are the only East Coast North America producing oilfields. The next offshore project Hebron, estimated to contain 707 mmbbls reserves, is being developed by ExxonMobil and its partners, with first oil expected in 2017. Its peak production is estimated to be between 150,000 and 170,000 bopd.

The latest Significant Discovery Licence for an oil discovery was awarded by the C-NLOPB to Statoil and Husky for the Mizzen O-16 well which successfully tested 3,774 bopd of 21-22° API oil from a 25 m section of porous and permeable sandstone. This Tithonian aged sandstone (Ti-3) (Haynes et al., 2012 and 2013; Gruschwitz et al., 2013; Cody et al., 2013) was encountered from 3201 to 3245 m. The Mizzen field is located at the border between Flemish Pass and East Orphan Basin, approximately 60 – 80 km north of the CFB NL13-01 parcel. In June 2013, Statoil announced a light oil discovery at the Harpoon O-85 well in the Flemish Pass Basin approximately 10 km southeast of the Mizzen discovery. This was immediately followed up with the announcement of another discovery at the Bay du Nord C-78 well in August, 2013. Bay du Nord was announced as a 300-600 mmbbls recoverable light oil (34° API) accumulation, while Harpoon's resources remain to be evaluated and disclosed.

2.2. Recent Production, Development and Exploration Activity. Oil and gas exploration in NL's offshore started in the early 1960s. A total of 398 exploration, delineation and development wells have been drilled offshore NL up to the end of 2013. The first exploration well, Tors Cove D-52, was spud in 1966 within the South Whale Basin, the last one Bay du Nord C-78Z sidetrack, was spudded in September 2013 within the Flemish Pass Basin and suspended in October 2013. The total number of NL offshore exploration wells to date is 155.

The major fields of the Grand Banks (oil and gas) and Offshore Labrador (gas) were discovered during the late 1970s and early 1980s when high commodity prices, government incentives and industry interests produced the highest ever drilling rate in the basins (7-10 wells a year). Outlined below are current offshore NL statistics and discussions on oil production, new field development, recent exploration and research. Recent offshore drilling results in the Jeanne d'Arc, Flemish Pass and East Orphan basins and exploration trends are emphasized.

2.2.1. Oil Production. In 2011 the oil fields of the Jeanne d'Arc Basin produced 97,270,161 barrels. During 2012, the Terra Nova FPSO, White Rose FPSO and parts of the Hibernia Production Platform underwent, for different intervals of time, refits and maintenance work (e.g. http://www.noia.ca/Portals/0/NN2012_Q4_FINAL_WEB.pdf). As a consequence the annual production decreased substantially and the daily average production went under 200,000 bopd for the first time in the previous 10 years. The annual oil flow was down 25.8 per cent in 2012 compared to the same period in 2011. Thus, the yearly production influenced by natural field production decline and by deferred production during repairs, reached a total of 72,181,119 barrels, a level unseen since 2001. With all fields producing near capacity during 2013, the NL output reached 83.585 Million barrels (229,000 bopd) an annual production increase of 18.6 % over 2012.

2.2.2. Delineation and Development Drilling. A total of 57 delineation and 186 development wells have been drilled offshore NL, with the great majority located in the Hibernia, Terra Nova, White Rose and North Amethyst fields (GSC, 2013; C-NLOPB, 2014; as end of 2013). In the past few years, new development wells were drilled in the producing fields keeping NL production above the 200,000-250,000 bopd level.

Eight development wells and five delineation wells were drilled during 2013. Nine of these wells were drilled within the Terra Nova, White Rose and North Amethyst structures.

2.2.3. Producing Fields. There are three large stand-alone producing fields offshore Newfoundland: Hibernia (GBS), Terra Nova (FPSO) and White Rose (FPSO), all located in the central part of the Jeanne d'Arc Basin. The smaller North Amethyst field (68 mmbbls) produces via a subsea tieback to the White Rose FPSO, the first such satellite field development offshore in Canada. In addition, Hibernia (Hibernia Southern Extension) and White Rose (White Rose Southern Extension) have satellite fields being developed using the existing infrastructure.

Hibernia Field. This field is one of the largest conventional fields developed in North America (Arthur et al., 1982; Tankard and Welsink, 1987 and 1989; Brown et al., 1989; Mackay and Tankard, 1990; Hurley et al., 1992; Sinclair et al., 1999; Ainsworth et al., 2005). Two principal sandstone reservoirs of Early Cretaceous age are produced - the Hibernia and Ben Nevis-Avalon reservoirs - located at average depths of 3,700 and 2,400 m respectively. The field produces from the world's largest ice reinforced concrete platform and is operated by Hibernia Management and Development Company Ltd. (HMDC), with ExxonMobil as the largest interest holder. Production started in the fall of 1997 with an initial production of 50,000 bopd from a then estimated recoverable reserve of 522 mmbbls. The peak production of 222,549 bopd was attained during May 2004. The most recent recoverable reserve estimate for the field climbed to 1,395 mmbbls. The increase is due to improvements in reservoir monitoring, extended reach drilling, discovery of adjacent fault blocks with reservoired oil and a deeper than prognosed oil water contact providing producible reservoir beds. The Hibernia South Extension (HSE Unit) that started producing in 2011 has estimated recoverable reserves of 215 million barrels, which will extend the life of the Hibernia project by 5-10 years. It is anticipated that Hibernia will continue to produce well into the 2040s. In addition, the Ben Nevis-Avalon reservoir with estimated reserves of 182 mmbbls is proving to be a valuable secondary reservoir, contributing 14,645 bopd in 2013 representing 12.2% of the fields' production. For the first time in the field history a small amount of oil was produced from the Catalina reservoir (251,253 barrels). This reservoir's production started in May 2013 and will probably increase in the future years.

Terra Nova Field. Discovered in 1984 by Petro-Canada, this field was the second field to be developed and started producing in 2002. Suncor, Canada's largest oil and gas producer, is the operator of the field. The Late Jurassic Jeanne d'Arc Formation contains the producing sand intervals (Wilcox et al., 1991; Enachescu et al. 1994; Atkinson and Fagan, 2000; Skaug et al., 2001; Richards et al., 2010). During 2012, the Terra Nova FPSO was taken offline for 6 months for repairs which included the replacement of a water injection swivel and replacement of subsea flow lines and risers. As a result of these upgrades to the FPSO and flowlines and risers an additional 87 mmbbls of reserves have been confirmed (C-NLOPB). Thus, the regulator has estimated that recoverable reserves from the field have increased from 419 mmbbls to 506 mmbbls. This will extend the field's production life for another seven years (i.e. from 2020 to 2027). Additionally, the field's gas resource estimate has increased to 64 billion standard cubic feet from 53.3 billion, while the reserve for natural gas liquids has increased to 4.6 million barrels from 3.8 million. The Terra Nova field produced 13.8 mmbbls in 2013 which represents a 62% increase over the 2012 level. There was no field production during October and November 2013, as the Terra Nova FPSO underwent maintenance. The latest well in the field, Terra Nova E-19 was a delineation well drilled in the Western Flank of the structure that was wet.

White Rose Field. Several publications and presentations and the Development Application describe this field (http://www.cnlopb.nl.ca/pdfs/wrda_vol2.pdf; Enachescu, 1997, 2006 and 2009; Kaderali et al., 2007; Hawkins et al., 2008). The latest development support well (gas injector) on record offshore NL is the White Rose J-05 1 drilled in the summer of 2012 in the southern White Rose field. The field has three satellite tie-backs: South White Rose Extension (SWRX) West White Rose Extension (WREP) and North Amethyst (see below). Two delineation wells, White Rose H-70 and H-70Z were drilled during the fall of 2013, in the West WR pool, and encountered both oil and gas. The WREP started with the excavation of a subsea drill centre at the SWRX in preparation for project sanction with first oil planned in 2014. The SWRX was approved in June 2013. The subsea equipment for the SWRX project is expected to be installed during the summer of 2014 and first oil is expected in the fourth quarter of 2014. A sanction decision for further expansion into the western portion of the White Rose field is targeted for the second half of 2014 (http://www.marketwired.com/press-release/suncor-energy-reports-2013-fourth-quarter-results-tsx-su-1875258.htm).

Development concepts, including a wellhead platform supported by a concrete gravity structure, are being evaluated for the WREP in anticipation of production in the 2016/17 timeframe (http://www.cnlopb.nl.ca/environment/whiterose.shtml). This project was released from environmental assessment and a benefits agreement was signed with the province during October 2013. Husky has awarded a five-year contract for a new harsh environment semi-submersible drilling rig, the *West Mira*, scheduled for delivery in 2015. This vessel will be fully dedicated to Grand Banks and environs exploration, delineation and development drilling.

North Amethyst Field. This is the first satellite field development at White Rose and was brought into production in 2010 (Hawkins et al., 2008; http://www.cnlopb.nl.ca/pdfs/naplan.pdf). Its development, less than four years after discovery represents the first subsea tie-back project in Canada. With production partially shut off or down for four months, the field produced only 6.9 mmbbls during 2012. The production from the Ben Nevis/Avalon reservoir increased to 8.3 mmbbls during 2013 (a 20% increase). Plans called for development of the Hibernia reservoir during 2013. The delineation well North Amethyst E-18 12A was the last well of 2013 in the Jeanne d'Arc Basin.

Hebron Development. Discovered in 1980 and delineated throughout the 1980s and 1990s, Hebron is both a heavy and light oil field estimated to have 707 mmbbls of recoverable resources (http://www.cnlopb.nl.ca/pdfs/disc_rr.pdf; http://www.cnlopb.nl.ca/news/pdfs/sahebdevplan.pdf; http://www.hebronproject.com/media/3908/hda_vol_2.pdf; Rees and Spratt, 2005). The interest owners are ExxonMobil Canada Properties (36%, operator), Chevron Canada Limited (26.7%), Suncor Energy Inc. (22.7%), Statoil Canada (9.7%) and Nalcor Energy (4.9%). The Hebron project consists of three fields: the Hebron field, the West Ben Nevis field and the Ben Nevis field. These fields encompass four Significant Discovery Licenses (SDLs: the Hebron SDL 1006, Hebron SDL 1007, Ben Nevis SDL 1009 and West Ben Nevis SDL 1010).

The field is located in the Jeanne d'Arc Basin, approximately 340 km offshore to the east of St. John's, Newfoundland. The average water depth at Hebron is approximately 92 metres. The field is situated approximately 9 km north of the Terra Nova project, 32 km southeast of the Hibernia project and 46 kilometres from the White Rose project. Hebron is a 30-year project that will use a stand-alone gravity-base structure (GBS), designed to withstand sea ice, icebergs and harsh Atlantic Ocean conditions. The Hebron project will tap four reservoirs: the Early Cretaceous Ben Nevis, Avalon and Hibernia reservoirs and the Late Jurassic Jeanne d'Arc reservoir. The mix of medium and light gravity crude oil production will be enhanced using water injection, while the produced gas will be used for artificial lift.

The field's GBS is designed to store approximately 1.2 mmbbls of crude oil (Figure 5). The GBS and some of the topsides facilities will be built at the Bull Arm Site in NL. Hebron development commenced in 2012 with the initial construction of the GBS and continued into 2013 with the cutting of the first steel associated with topsides fabrication. First oil is planned for 2017 and the field will flow 150,000 to 170,000 bopd at its peak production.

Figure 5. Hebron GBS is being built at the Bull Arm Site in Newfoundland (photo courtesy of Darrell Spurrell, NL DNR).

2.2.4. Exploration Drilling. There are a total of 155 exploration wells drilled to date offshore NL. The wells are unevenly distributed geographically, with the majority situated in the Jeanne d'Arc Basin/Central Ridge area, where all large oil discoveries are located. Currently there are six exploration wells in the Saglek Basin (in NL waters), 21 in the Hopedale Basin (from which only 16 are significant wells), seven in the West Orphan Basin, three in the East Orphan Basin, ten and a sidetrack in the Flemish Pass Basin, four in the Carson Basin, over 30 in the South Grand Banks basins, two wells in the Laurentian Basin (one in French territory), and six in Paleozoic Magdalen/Anticosti basins. An average of two exploration wells per year was drilled in the past decade, which is a low drilling rate for such an enormous prospective offshore area. However 2013, broke this trend with five exploration (including a sidetrack) wells being drilled.

During 2013, several rigs were active offshore NL and five exploration wells were drilled including the two new discoveries in the Flemish Pass Basin (Figures 3 and 4). While the Jeanne d'Arc Basin is still the focus of exploration and production in the NL offshore, an increasing number of important wells were drilled in the past years within the East Orphan/northern Flemish Pass basinal area. The 2013 exploration wells were: a) Margaree A-49 located in the East Orphan Basin on EL 1074R which was drilled and abandoned by Statoil in late 2013, b) Harpoon O-85 drilled by Statoil southeast of Mizzen O-16 oil discovery, c) Federation K-87 spud in June 2013 in the central Jeanne d'Arc and operated by Statoil and d) Bay du Nord C-78 and the sidetrack C-78Z, both operated by Statoil (Figures 3 and 4).

Harpoon O-85 and Bay du Nord C-78/C-78Z were announced as light oil discoveries. The individual test results of these wells are currently confidential. The Bay du Nord discovery has been estimated as being 300 to 600 mmbbls by Statoil or 400 mmbbls recoverable by partner Husky (http://www.statoil.com/en/NewsAndMedia/News/2013/Pages/26Sep_exploration.aspx and respectively http://www.infomine.com/index/pr/PB360680.PDF). The sidetrack Bay du Nord C-78Z was probably drilled to directionally follow the reservoir downdip or to cross into an adjacent fault block. Statoil has a 65% interest in the discovery and surrounding EL while partner Husky has a 35% interest.

Several other exploration wells are planned for 2014 by Husky and partners in the Jeanne d'Arc Basin/Central Ridge area with several drill ready prospects identified (http://www.cnlopb.nl.ca/pdfs/hejdarc/eaupdaterev.pdf) while Statoil and partners will further drill the Flemish Pass area (http://www.cnlopb.nl.ca/pdfs/nhdrill/ea2012update.pdf).

2.2.5. Seismic data. Over 708,000 km of 2D seismic lines and approximately 1.78 million CMP km of 3D data have 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. The 3D coverage is limited in the Laurentian, Carson and Orphan basins while other basins (e.g. Labrador basins, Sydney, Magdalen and Anticosti basins) have no 3D coverage. Additional 3D data were collected in 2012 and 2013 in the North Grand Banks and Flemish Pass Basin, where large prospects and leads were previously identified with 2D grids. In 2012, Statoil Canada, along with partners Chevron and Repsol E&P Canada, concluded a 5,774 km^2 3D seismic program in the Flemish Pass Basin. During 2012 TGS in partnership with PGS acquired 11,572 line kilometres of 2D seismic data on the Labrador continental shelf, slope and rise (e.g. Carter et al., 2013) and 7,957 line kilometres on Newfoundland's Northeast slope, which includes the Orphan, Flemish Pass and northern Jeanne d'Arc basins.

During 2013, TGS in collaboration with PGS acquired a further 17,292.4 linear km of quality 2D data in the Labrador Sea and Northeast Grand Banks, including parts of the Central Ridge and Flemish Pass Basin where the Call for Bids Parcel 1 is located. ION Geophysical's GXT division recorded a significant part of their planned Labrador SPAN consisting of 6574.7 km of long streamer, shallow to deep crustal recording.

2.2.6. 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 (e.g. Verhoef and Srivastava, 1989; Verhoef et al., 1996; Oakey and Dehler, 2004). 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. GSI Labrador regional survey and the TGS/PGS/Nalcor 2011-13 multi-client survey). Satellite gravity data is also available from the National Oceanic and Atmospheric Administration (NOAA).

2.2.7. Other Petroleum Discoveries. Besides the four producing oil fields discussed above, there are 14 oil discoveries and 7 gas discoveries onshore and offshore NL, distributed as follows: one light oil discovery in the Paleozoic basins of Western Newfoundland (Garden Hill South that has a Production Lease since 2002 and partially renewed in 2012), 12 discoveries in the Jeanne d'Arc Basin (including Hebron, the largest, which is approved for development and Ballicatters, the most recent), 3 discoveries on the Central Ridge (South Tempest, Trave and North Dana), three oil discoveries in the Flemish Pass Basin (Mizzen) and 5 gas discoveries in the Hopedale Basin (Snorri, Hopedale, North Bjarni, Bjarni and Gudrid) (Hawkins et al., 2008). Several of these discoveries are more than 30 years old. While several of the gas discoveries are significant in size, no gas development project is yet envisaged for the Grand Banks or offshore Labrador. Little it is known about the geoscience of the newest oil discoveries at Harpoon O-85 and Bay du Nord C-78 and C-78Z. Two Statoil official communications characterize these discoveries as light oil, situated only 10, and 40 km respectively south of the Mizzen SDL awarded by C-NLOPB in 2011. A 300-600 mmbbls recoverable volume was given for the Bay du Nord oil discovery (http://www.statoil.com/en/NewsAndMedia/News/2013/Pages/19Jun_Canada.aspx).

2.2.8. Production Licences. Currently there are 11 Production Licences (PLs) awarded in the Mesozoic Jeanne d'Arc Basin to Hibernia (PLs 1001, 1005 and 1011), Terra Nova (PLs 1002, 1003 and 1004), White Rose (PLs 1006, 1007, 1009 and 1010) and North Amethyst (PL1008) oil fields. As mentioned before, these fields produced 229,000 bopd during 2013. It is expected that the next major offshore project to obtain a Production Licence will be the Hebron oil field.

2.2.9 Exploration Licences. A total of 48,309 km^2 (11,937,495 acres) are licensed by the C-NLOPB for offshore exploration in three areas: Grand Banks and vicinity (24 ELs), Labrador Sea (3 ELs) and Western Newfoundland (6 ELs). As of the spring of 2014 there are 23 active ELs in the Grand Banks and vicinity distributed in 4 basins: 7 in the Laurentian Basin, 6 in the now oil proven Flemish Pass Basin (two of which are partially situated in south East Orphan Basin) and 11 in the oil producing Jeanne d'Arc/Central Ridge area (including the large consolidated EL 1090 R) (Figures 3 and 5). The total licensed exploration acreage in Grand Banks and vicinity amounts to 3.2 Million hectares. For the first time in a decade there are no ELs located in the Orphan Basin, a very large basin with remaining hydrocarbon potential.

As a result of the 2012 Call for Bids when the company was the successful bidder in five parcels, Shell is the largest single exploration interest holder in this area with over 1.3 Million hectares. Five other companies, Husky (7 ELs), Statoil (7 ELs), Suncor (1 EL), ConocoPhillips (2 ELs), and ExxonMobil (1 EL), are operating ELs in the Grand Banks and vicinity (Figures 3 and 5). Husky Oil is a leading player in both the Grand Banks and Labrador Sea, with full or partial interests and operatorship in over 1.17 million hectares. Two other companies, Chevron and Repsol, while not operating, have vast interests in the area.

Six of the licences in the area have been validated through the drilling of an exploration well while 13 ELs are presently not validated, being still in Period I of the nine year licence. For two ELs, the operator has posted a drilling deposit to extend Period I to early 2015. In the case of two other ELs, the operator is "diligently pursuing a well beyond the 9 year term" (http://www.cnlopb.nl.ca/pdfs/elgbr.pdf). Six site surveys were completed in recent years by Husky and Statoil indicative of plans to conduct further exploration drilling in the Jeanne d'Arc, Central Ridge, and Flemish Pass/East Orphan Basin. Statoil has plans for a 18-month drilling campaign in the Flemish Pass Basin starting in the summer or fall of 2014 (http://www.globalpost.com/dispatch/news/the-canadian-press/140207/statoil-says-exploration-drilling-begin-newfoundland-summer).

In the Labrador Sea there are 3 large active ELs, totalling 7,072.18 km^2 (1,747,573 acres). The three ELs located in the Hopedale Basin were awarded in 2008 and remain undrilled as of the spring of 2014. Husky (2 ELs) and Investcan are operators of these licences. No well was yet licensed for the Labrador acreage, and these ELs will face expiration at the end of 2014. A large amount of new, high quality seismic, oil slick data and sea bottom coring in the Labrador Sea's basins will allow a better evaluation of the petroleum prospectivity of the area that contains very large, undrilled structures.

Six ELs are active in Western Newfoundland distributed in both the Anticosti and Magdalen basins. Up to recently, Ptarmigan Energy was the largest acreage holder in the area. A new entrant in the region, Black Spruce Energy (BSE) has signed farm-in agreements with Ptarmigan, Enegi and Shoal Point Energy becoming the dominant explorer for both conventional and unconventional resources in the area, controlling 809,223 ha as the main interest holder. The other remaining operator in the region, Corridor Resources operates the Magdalen Basin EL 1105 containing the Old Harry structural prospect.

A strong indicator of the excellent exploration potential offshore Newfoundland is the high number of active Exploration Licences - 33, distributed in four areas covering seven basins. More than half of these ELs have to be drilled in the next few years to meet licensing requirements (Figures 3 and 5).

However, the offshore NL acreage presently licensed by the C-NLOPB represents less than 5% of the offshore petroleum potential area of over one million square km distributed along an extensive coast line of 2,500 km in length. While the Call for Bids NL13-01 is located in a high activity area, other basins such as the Labrador, Laurentian and Carson are in an incipient phase of exploration on the slope and deepwater.

3. Flemish Pass Basin Exploration

3.1. History of Exploration in Flemish Pass Basin. In the late 1970s and early 1980s 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 and international scientists involved in research of the North Atlantic evolution and continental margin formation (Figures 2 and 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 recovered cores indicated the presence of Cretaceous and Jurassic sediments on the knoll (Laughton et al. 1972, Ruffman and van Hinte, 1973). Shallow cores and drag sample from the Flemish Cap, a shallow continental block, have recovered granodiorites, granites, dacites and Precambrian age sediments of Avalon terrain origin (King, 1985).

A region of deeper water (500 to 1500 m) when compared to the shelfal Jeanne d'Arc Basin, the Flemish Pass Basin has only 7 exploration wells drilled to date (C-78 and C-78Z sidetrack are considered here as a single well location). This low number results in a well density of one well per 2000 km^2 (Figures 3, 5 and 6).

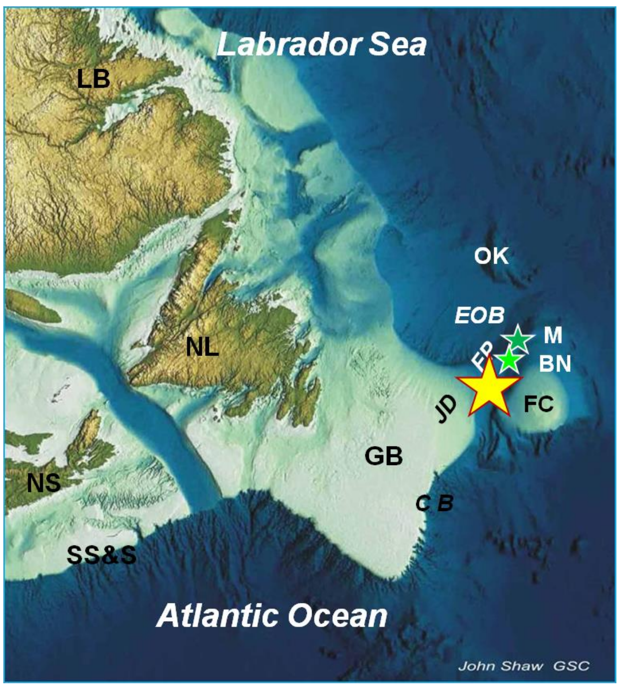


Figure 6. Location of Flemish Pass Basin (FP), Mizzen SDLs (green star) and Call for Bids Parcel 1 (yellow star) on the Newfoundland and Labrador continental margin (bathymetry map from GSC). Annotations are: NL = Newfoundland and Labrador, NS = Nova Scotia, SS&S = Scotian Shelf and Slope basins, GB = Grand Banks, JD = Jeanne d'Arc Basin, EOB = East Orphan Basin, FC = Flemish Cap, OK = Orphan Knoll, CB = Carson Basin, M =Mizzen field and BN = Bay du Nord discovery.

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.

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 7).

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 in 1986, the Baccalieu I-78 well 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 7). 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 7). Also abandoned, the well encountered both Late Jurassic sandstones and Kimmeridgian source rocks. The Kyle L-11 well operated by Esso and drilled in 1986, is the southernmost well in the basin (well 4 in Figure 7). 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 underwent a renewal of activity related to large discoveries in intermediate and deep waters of the Atlantic margins. During the late 1990 and early 2000s, several large ELs were licensed in the basin to Petro Canada and partners Norsk Hydro 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 the Early Cretaceous and Late Jurassic sections (well 5 in Figure 7). The well indicated 5 m of light oil pay on logs dated as early Cretaceous (Baccalieu Sandstone) but was not flow 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 7). 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.

Cycle 4. The present exploration cycle started in 2008. The exploration in this basin has seen a spectacular revival after Statoil took over operatorship of several older ELs inherited from Norsk Hydro's Canadian assets (including Mizzen and Bay du Nord ELs) and then acquired Petro Canada’s and Encana’s interests in the Mizzen Exploration Licence. Statoil and partners also won several large ELs at the consecutive Call for Bids NL08-01, NL10-02 and NL 11-02.

Since 2008, Statoil has become the lead explorer in the basin. Together with Husky as minority partner, Statoil drilled the Mizzen O-16 discovery well in 2009 (well 7 in Figure 7). 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. Also in 2011, the delineation well Mizzen F-09 (well 8 in Figure 7) 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 contained between 100 and 200 mmbbls recoverable oil.

Two wells, Harpoon O-85 (well 9 in Figure 7) and Bay du Nord C-78 and its sidetrack C-78Z (together considered as well 10 in the basin) were drilled in 2013 in the northern part of the basin. After more than 40 years of intermittent activity in the Flemish Pass Basin, the exploration efforts were rewarded with a large light oil discovery. Statoil announced the Bay du Nord discovery that ranks in the North American giant category and may be comparable in size with the Terra Nova and White Rose fields. For purpose of registering a reliable drilling success ratio for the basin, the C-78 and C-78Z wells are considered in this report as a single discovery well for the Flemish Pass Basin.

The most recent EL in the basin was awarded to Husky and partners in 2012 (EL 1134). This EL is situated just south of Parcel NL13-01.

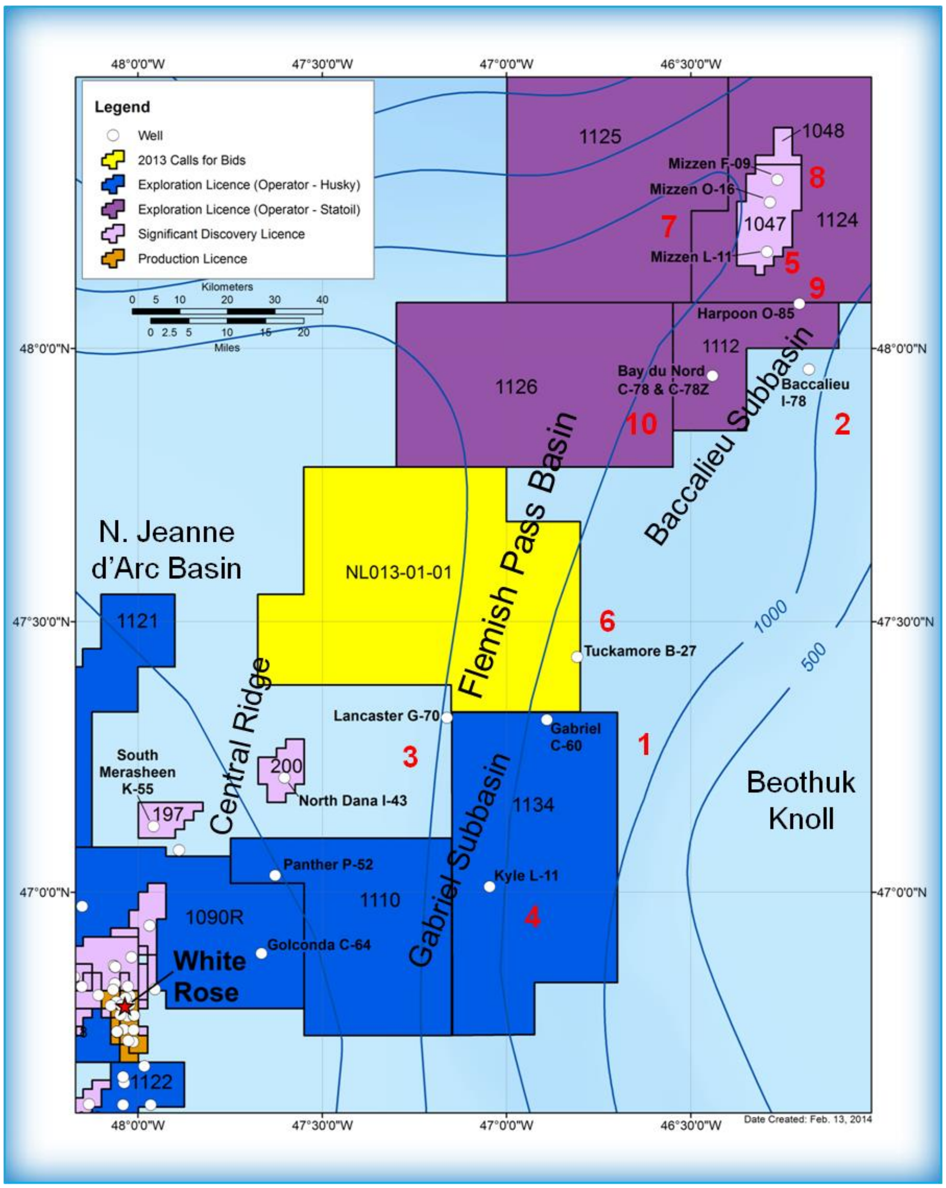


Figure 7. Location of Flemish Pass Basin's and Central Ridge's current Exploration Licences and Call for Bids NL13-01 Parcel 1 (in yellow). In the south, ELs 1090R, 1010, 1111 and 1134 are operated by Husky and in the north ELs 1124, 1125 and 1126 and Mizzen SDLs 1047 and 1048 are operated by Statoil. Red numbers 1 to 10 indicate the order of drilling in the basin starting with Gabriel C-60 (1st well) in the south and ending with the most recent discovery Bay du Nord (10th well).

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,

3.2 Recent Exploration Activity in Flemish Pass Basin. The most recent hydrocarbon exploration offshore Newfoundland and Labrador took place during the late 2000s to early 2010s when the exploration drilling focus moved toward the Flemish Pass Basin. In this basin several very large, medium depth anticlinal features, were delineated by modern 3D surveys (ttp://www.cnlopb.nl.ca/pdfs/nl1301historic.pdf).

The most recent successful exploration activity offshore NL was sparked by Statoil and its partner Husky in the Flemish Pass Basin (Figure 7). The Mizzen oil field (discovered by Statoil in 2011) and the recent Harpoon and Bay du Nord oil discoveries (2013), are located in intermediate water depths (around 1100 m) just 50 km north-northeast of the Call for Bids NL13-01. These recent discoveries place the Parcel NL13-01-01 under a very favourable light for the possibility of encountering oil accumulations of significant size. The 2013 Bay du Nord discovery by Statoil was described as the largest light oil find in 2013 and the largest in North America in the past five years.

3.3. Crustal Studies and Scientific Drilling. As soon as it was recognized that a pivotal plate triple junction existed at the northeastern tip of the Flemish Cap and that the Grand Banks and Iberia and Northeast Grand Banks and Southwest Ireland (Orphan Basin and Porcupine Basin) form conjugate margins, the Canadian offshore area that includes the Call for Bids parcel has become the focus of major geoscientific interest. For the past 40 years, the Canadian and International research community interest in the East Coast of Newfoundland continued unabated. On Newfoundland's continental margin, the nature of crust in front of the Grand Banks, the constitution of the Flemish Cap and the time of continental breakup between NL and Iberia and Newfoundland and Ireland have been the focus of many international scientific organizations, marine institutes and universities.

During the past decade, a special importance was given by proponents and group to pre-, during and post-drilling investigations of the IODP Leg 210 located on the continental rise, south of the Flemish Cap and southeast of the Flemish Pass Basin (Figure 2). Due to lack of volcanics on the margins and abundance of geophysical and geological data, this area in particular, and the Newfoundland-Iberia transect in general, have become favourite grounds for Atlantic-type conjugate margin studies.

During Leg 210 (2003) the Integrated Ocean Drilling Project (IODP) drilled two sites south of the Flemish Cap: site 1276 bottomed on transitional crust and site 1277 terminated on ultraslow emplaced oceanic crust (Tucholke, B.E., Sibuet, J.-C., and Klaus, A. (Eds.), 2007a; doi:10.2973/odp.proc.sr.210.2007). The two sites are situated just southeast of the Flemish Pass Basin (Figure 2). These continuous cored drill holes intersected Cretaceous organic shales (Late Albian to Turonian aged) and several thin turbidite reservoirs. The geoscientific findings of Leg 210 including discussions on the logged and cored source and reservoirs rocks are detailed in the

Scientific Results Proceedings (Tucholke, B.E., Sibuet, J.-C., and Klaus, A. (Eds.), 2007a, and individual chapters by Arnaboldi and Meyers, 2006; Hiscott, 2007; and Marsaglia et al., 2007).

Numerous other scientific papers were published after a new round of reflection seismic programs acquired in the region and integration of the IODP Leg 210 results. These papers consider the NL history of rifting, dating of drilled geological formations, emplacement of transitional crust and reconstruction of the pre-breakup geological profile between the NL and Iberia conjugate margin. Several of the published papers discuss the crustal profile of the conjugate margins, models of multiphase rifting, the rotation of Flemish Cap, crustal hyperextension, transitional and oceanic crust development, non-volcanic margins and the asymmetry between the continental margin of Newfoundland and Iberia, (Funck et al., 2003; Hopper et al., 2004 and 2006; Tucholke et al., 2004 and 2007a and b; Enachescu et al., 2005; Shillington et al., 2006; Lau et al., 2006a and b; van Avendonk et al., 2006 and 2009; Robertson, 2007; Sibuet et al., 2007a and b and 2011 and 2013; Karner et al., 2007; Manatschal et al., 2007; Peron-Pinvidic et al., 2007; Tucholke and Sibuet, 2007; Peron-Pinvidic and Manatschal, 2008 and 2009; Reston, 2009; Demeer et al., 2009; Welford et al., 2010 and 2012; Ady and Whittaker, 2010 and 2012; Welsink and Tankard, 2012; Sibuet and Tucholke, 2012; Karner et al., 2012; GeoArctic, 2013; Sutra et al., 2013). The content of these papers has significant implications for the formation and geodynamic evolution of the Flemish Pass Basin.

3.4. Recent Research and Exploration Projects. Several large research and exploration (R&E) projects were initiated and are jointly administered by Nalcor and Newfoundland and Labrador Department of Natural Resources through programs such as the Petroleum Exploration Enhancement Program (PEEP) and the Offshore Geoscience Data Program (OGDP). More details of these research programs can be found at http://www.nr.gov.nl.ca/nr/energy/index.html.

The government of NL provided $20 million to fund the OGDP, including programs such as the offshore Newfoundland and Labrador Seep Mapping and new acquisition of regional reflection data on Labrador shelf, slope and rise and other deep water basins such as East Orphan, West Orphan and Flemish Pass basins (http://www.nalcorenergy.com/uploads/newsreleaseseismicsurvey13.09.11.pdf).

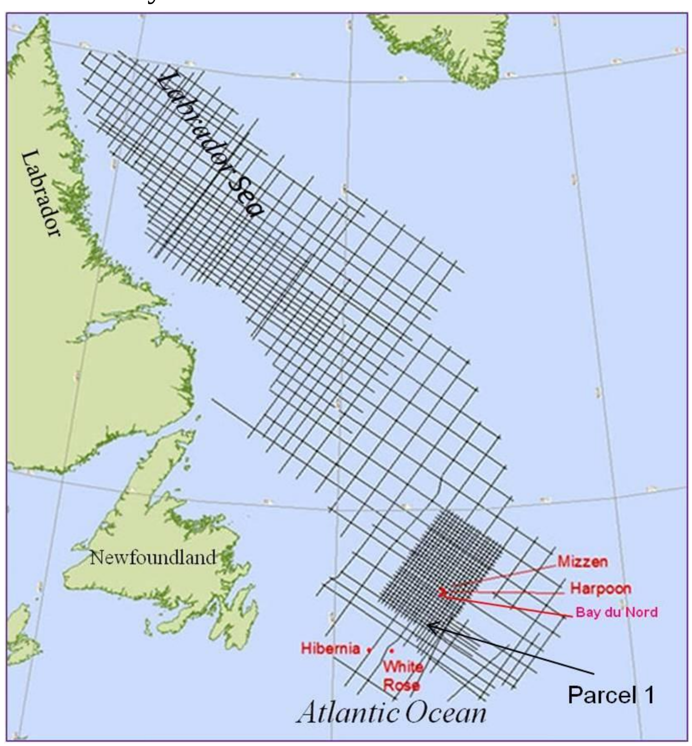


Figure 8. Location of multi-year 2D seismic program collected by TGS in collaboration with PGS in the Labrador Sea, Grand Banks of Newfoundland and adjacent deep water basins. The program includes seismic lines over the Flemish Pass Basin including the Call for Bids NL13-01 Parcel.

This multi-client grid now covers significant parts of the Flemish Pass Basin and includes coverage over the CFB NL13-01 Parcel 1 (Figure 8). The continuation of this regional survey over the Grand Banks and environs basins is planned for 2014.

A regional oil seep mapping and interpretation study offshore NL was performed during 2010-2012 by Nalcor who contracted the GEO-Information division of Astrium Services on a non-exclusive basis (http://www.nr.gov.nl.ca/nr/publications/energy/nalcor_astrium_oil_seeps.pdf). This survey part of the OGDP program consists of mapping and classifying offshore oil slicks based on satellite data from various providers. The method is a cost-effective de-risking tool used to evaluate exploration potential for under-explored basins such as the Flemish Pass and Orphan basins and locate new dense 2D or 3D seismic grids. The data can be licensed by oil companies and is delivered as a "plug and go" GIS product (Enachescu, 2012)

A New Kinematic Plate Reconstruction of the North Atlantic between Ireland and Canada was recently carried out. This research project jointly funded by the Irish Shelf Petroleum Studies Group (ISPSG) and Nalcor Energy (on behalf of the Offshore Geoscience Data Program with the Government of Newfoundland and Labrador) was performed by GeoArctic of Calgary during 2010-2012 (Ady et al., 2010; Whittaker et al., 2011; Ady and Whittaker, 2012; Enachescu, 2012). The kinematic plate reconstruction project had academic and technical input from the universities, industry and government scientists from Canada, Ireland, France and Norway (http://napsaresearch.org/page/16).

The kinematic (deformable) plate reconstruction was focused on:

1) Evolution of the North Atlantic,
2) Formation of sedimentary basins on the Iberia, Newfoundland and Irish margins from Late Triassic to present time,
3) Investigation of depositional setting, and
4) Presence of petroleum systems in these extensional basins (Ady and Whittaker, 2012; Whittaker et al., 2011).

The GeoArctic modeling includes the Grand Banks/Iberia and Grand Banks/Western Ireland separation and through kinematic animation describes Grand Banks, Carson, Flemish Pass and Orphan basins formation. The final report of this study completed in 2013 is available to interested oil and gas companies who sponsored the research and as a licence to companies which want to know more about the basin geology and petroleum potential of NL offshore.

Approximately $30 MM has been invested in petroleum related geoscience research over 4 years by the Province of NL and Nalcor, the provincial energy company. Led by Nalcor, these programs include Satellite Slick Mapping (finished in 2012), Regional Pore Pressure Study, Seabed Core Analysis, Biostratigraphic Analysis, Regional Rock Physics Study (all finished in 2013, Source Rock Studies and Metocean Studies (started in 2014) (Atkinson et al., 2013). Pan-Atlantic petroleum geoscience research is carried out between the Atlantic Canada and Irish partners within the framework of the North Atlantic Petroleum Systems Assessment (NAPSA) (http://www.pip.ie/page/240). The results of these research programs will be made available to interested parties and largely disseminated through papers and presentations at Canadian and International geoscience conferences.

3.5. Call for Bids History. During the late 1970s, ESSO and Petro-Canada operated Exploration Licences in the Flemish Pass Basin. A more recent round of exploration started in 1998 when the oil industry recognized the presence of Late Jurassic source rock and large undrilled structures in the basin. Two large exploration blocks were obtained from the 1998 Call for Bids by the partnership of Chevron, Petro-Canada, Mobil and Norsk Hydro (ELs 1039 and 1040). With the 1999 Call for Bids, four more parcels were awarded, three to the partnership Petro-Canada/Norsk Hydro (ELs 1049, 1050 and 1051) and one to PanCanadian (EL 1052) (Figure 9).

Following this land licensing, two extensive 3D surveys were conducted covering the north-central part of the basin. In 2001, the same three partners licensed one more parcel in the basin (EL 1064) (Figure 9). After Chevron and Mobil dropped out from the area in 2002, the remaining exploration partners, Petro-Canada and Norsk Hydro, and farm-in partner PanCanadian (Encana since 2002) drilled two exploration wells including the Mizzen L-11 (on EL 1049) and Tuckamore B-27 (on EL 1051). Mizzen L-11 proved the presence of oil on logs and the existence of source rock in the northern part of the basin. Following the unsuccessful drilling of the L-11 and B-27 wells, the focus of the multinationals moved to exploration in the deepwater Orphan Basin. Other players such as Petro-Canada and Husky concentrated their resources on developing the Terra Nova and White Rose fields, while PanCanadian focused on unconventional resources. Only EL 1048 remained active with Norsk Hydro as the sole interested party.

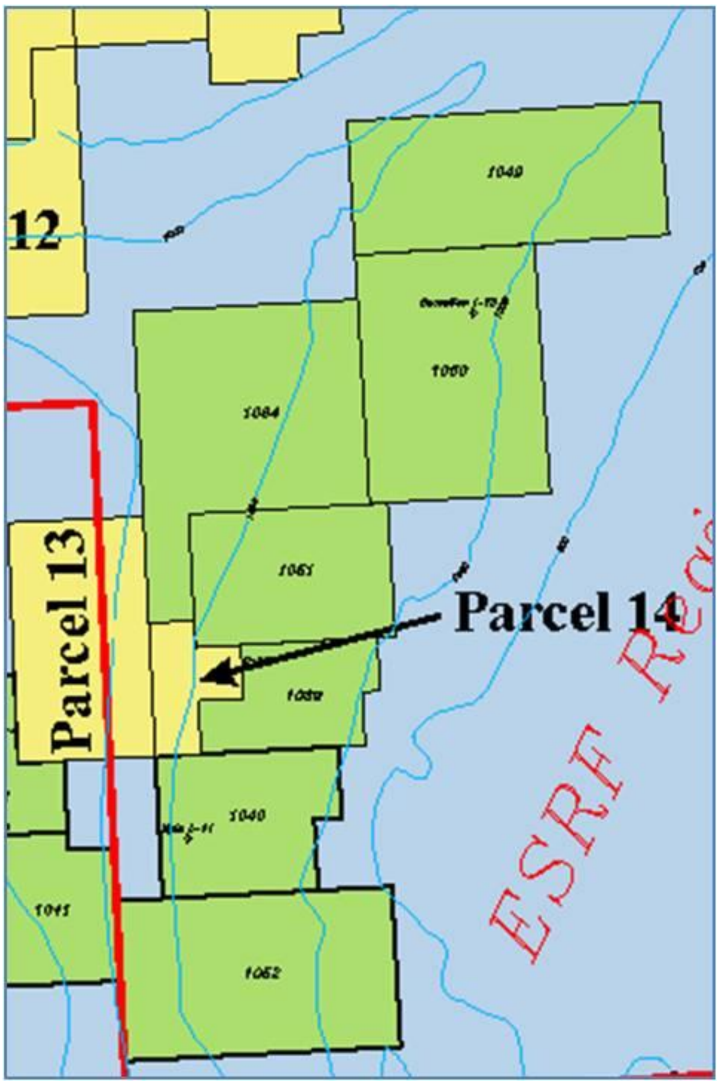


Figure 9. Land situation in the Flemish Pass Basin and environs at the end of 2003. Active ELs are shown in green and Call for Bids NL03 parcels are shown in yellow. At this landsale, several parcels (9, 13 and 14) partially situated on the western flank of the basin did not received bids. At the end of 2003 most of the Flemish Pass Basin area was licensed. However no other exploration wells were drilled until 2009.

During 2002-2008, an eight year gap in land posting and licensing occurred in the basin. At the end of this period, the remaining active company, Norsk Hydro, was merged into Statoil. Since then Statoil became the most active company in the area.

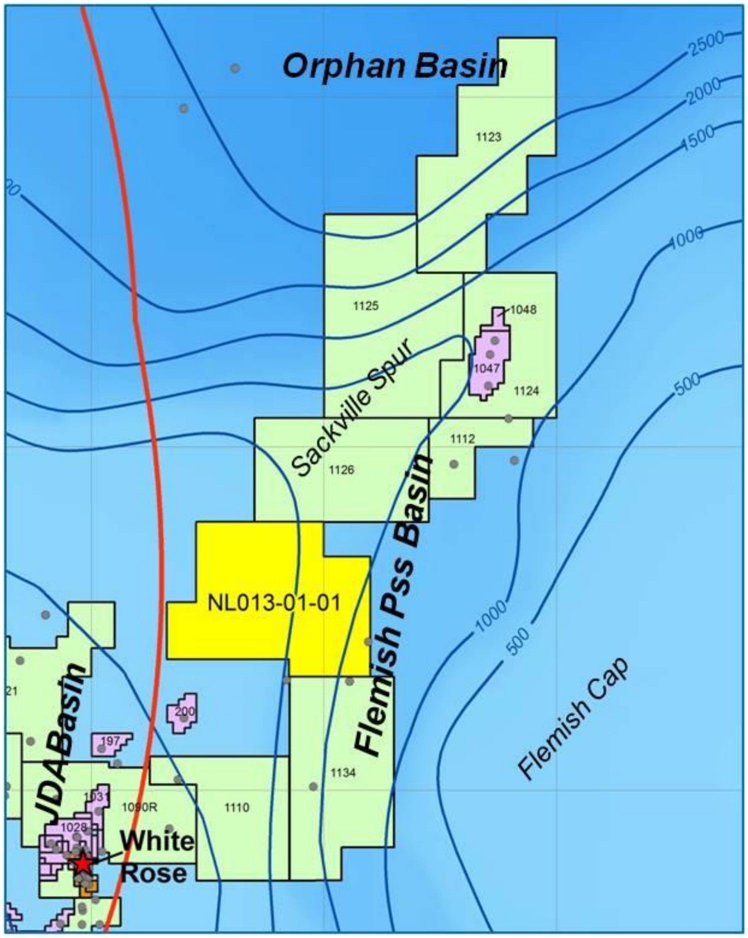


Figure 10. Land situation in the Flemish Pass Basin and environs at the end of 2013. Active ELs are shown in light green and Call for Bids NL13-01-01 parcel is shown in yellow. The map shows that only a small part of the oil proven Flemish Pass Basin remains unlicensed.

The most recent licensing round in the Flemish Pass Basin started in 2008 when one parcel located south of the Mizzen L-11 well was awarded to the new partnership Statoil/Husky (EL 1112) and two parcels only partially situated on the western flank of the Basin were awarded to Husky and partners (ELs 1110 and 1111, the latter expired since) (Figure 10). With this Call for Bids, a new entrant, Repsol, joined in the NL offshore exploration effort by partnering with Husky.

ELs 1123 and 1124 located in the northern basin were awarded in 2010 to Statoil who partnered with Repsol and Husky, respectively. This was followed in 2011 by the award of ELs 1025 and 1026 operated again by Statoil that partnered with Chevron and Repsol. The last award in the basin was EL 1134, located in its southern part, just south of the CFB NL13-01-01 parcel (Figure 10). This EL is operated by Husky with partners Suncor and Repsol.

3.6. Land Situation. There are six ELs currently active in the basin and one other in the general vicinity (Table I). The Mizzen O-16 oil discovery is covered by two SDLs (Table II), one of which is the largest SDL area ever awarded in the Canadian offshore. SDLs have yet to be awarded to the announced Bay du Nord and Harpoon discoveries.

No	EL	Basin	Area (Ha)	Area (a)	Bid Size $	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 MM	2011	Statoil	Repsol
3	1124	Flemish Pass	125,421	309,922	20 MM	2011	Statoil	Husky
4	1125	Flemish Pass/ East Orphan	247,016	610,390	202.2 MM	2012	Statoil	Chevron/Repsol
5	1126	Flemish Pass /Central Ridge	186,780	461,543	145.6 MM	2012	Statoil	Chevron/Repsol
	1134	Flemish Pass	208,899	516.201	19,9 MM	2013	Husky	Suncor/Repsol
6	1110	North Central Ridge	138,200	341,500	18.6 MM	2009	Husky	Suncor/Repsol

Table I. Active ELs and their particulars in the Flemish Pass Basin and environs (as of spring 2014).

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.

Table II. Significant Discovery Licences and their particulars in the Flemish Pass Basin and environs (as of spring 2014).

It is noteworthy that in the past four 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 five active ELs in the basin and has Chevron, Repsol and Husky as partners (Table I). They also are the operator (65% interest) of the Mizzen SDLs where Husky (35% interest) is their partner in the oil discovery (Table II).

Significant for the 2013 Call for Bids NL13-01 is the presence of two large ELs operated by Husky to the south of Parcel 1 and an EL operated by Statoil to the north of this parcel. 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 and on the western flank of the Flemish Pass Basin.

4. Flemish Pass Basin Subdivisions.

Situated geographically in the bathymetric low between the Grand Banks of Newfoundland and the Flemish Cap basement high, the Flemish Pass Basin is a branch of the North Atlantic Mesozoic rift network (Figures 11 and 12). This network includes the Jeanne d'Arc Basin to the south and west and the East Orphan Basin to the northwest.

A significant amount of exploration and production activity has been ongoing for the past 10 years in the deeper basin in front of the northeastern Grand Banks of Newfoundland including East Orphan and Flemish Pass basins. Since 2003, 6 wells have been drilled in the intermediate waters (1050-1170 m) of the Flemish Pass Basin (Mizzen L-11, Tuckamore B-27, Mizzen O-16, Mizzen F-09, Harpoon O-85 and Bay du Nord C-78Z).

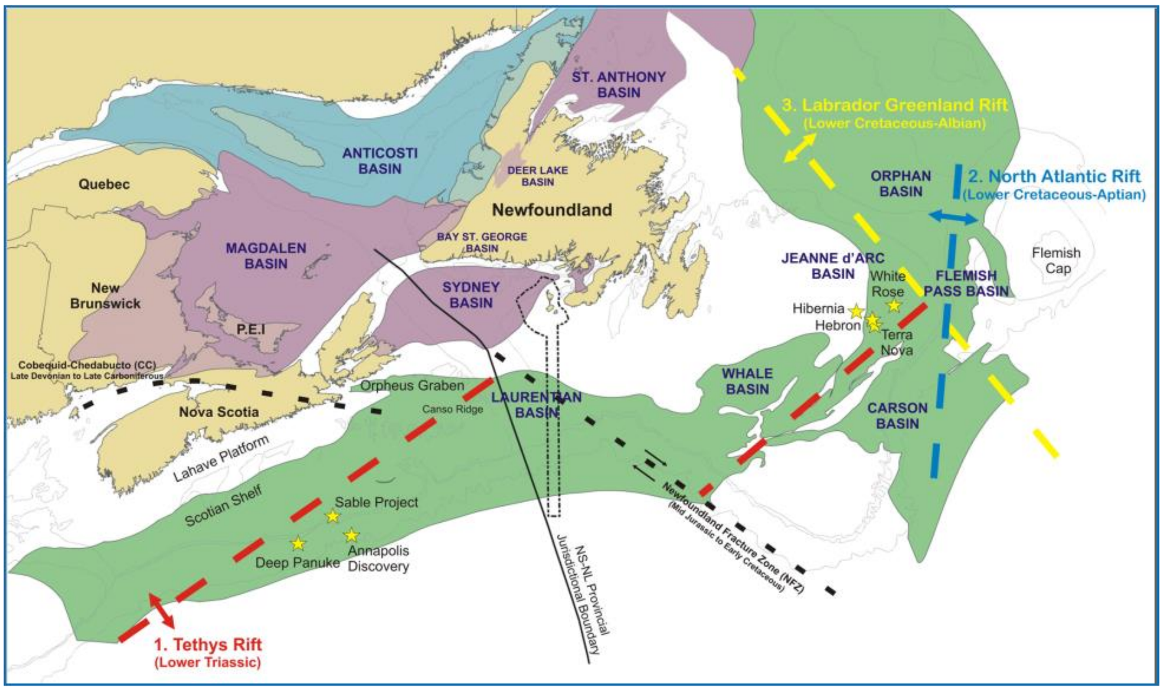


Figure 11. Formation of East Coast Canada sedimentary basins through multiphase, multidirectional rifting (from Enachescu and Fagan, 2006). During their synrift evolution, there was structural and stratigraphic continuity between the Jeanne d'Arc Basin and the Flemish Pass Basin. However, due to local geomorphology and differences in provenance area the source and reservoir rocks are not totally similar.

Newfoundland and Labrador's Atlantic basins, including the Flemish Pass Basin, were developed during the breakup of Pangea and the birth of the Atlantic Ocean. Presently the basins are situated on continental and transitional crust and extend to the first occurrence of oceanic crust, usually located beyond the present exclusive economic zone.

The margins of the Mesozoic Flemish Pass Basin are loosely defined. Along the strike, the basin is bounded by major, en-echelon, deep penetrating listric normal faults. To the south, the basin is bounded by a series of Precambrian basement highs but a connection to the Carson Basin that was opened during the synrift stages is mappable. To the west, the Flemish Pass is bordered by a series of sedimented ridges (the Morgiana Anticlinorium, Central Ridge, Northern Ridge) having several rift stage connections to the Jeanne d'Arc Basin. On its eastern side, the basin is faulted down from or abutting on the Flemish Cap continental block and the Beothuk Knoll. To the north, the Flemish Pass Basin joins the deepwater East Orphan Basin just across the Sackville Spur (Enachescu, 1987, 1988 and 1992a and b; Figure 13).

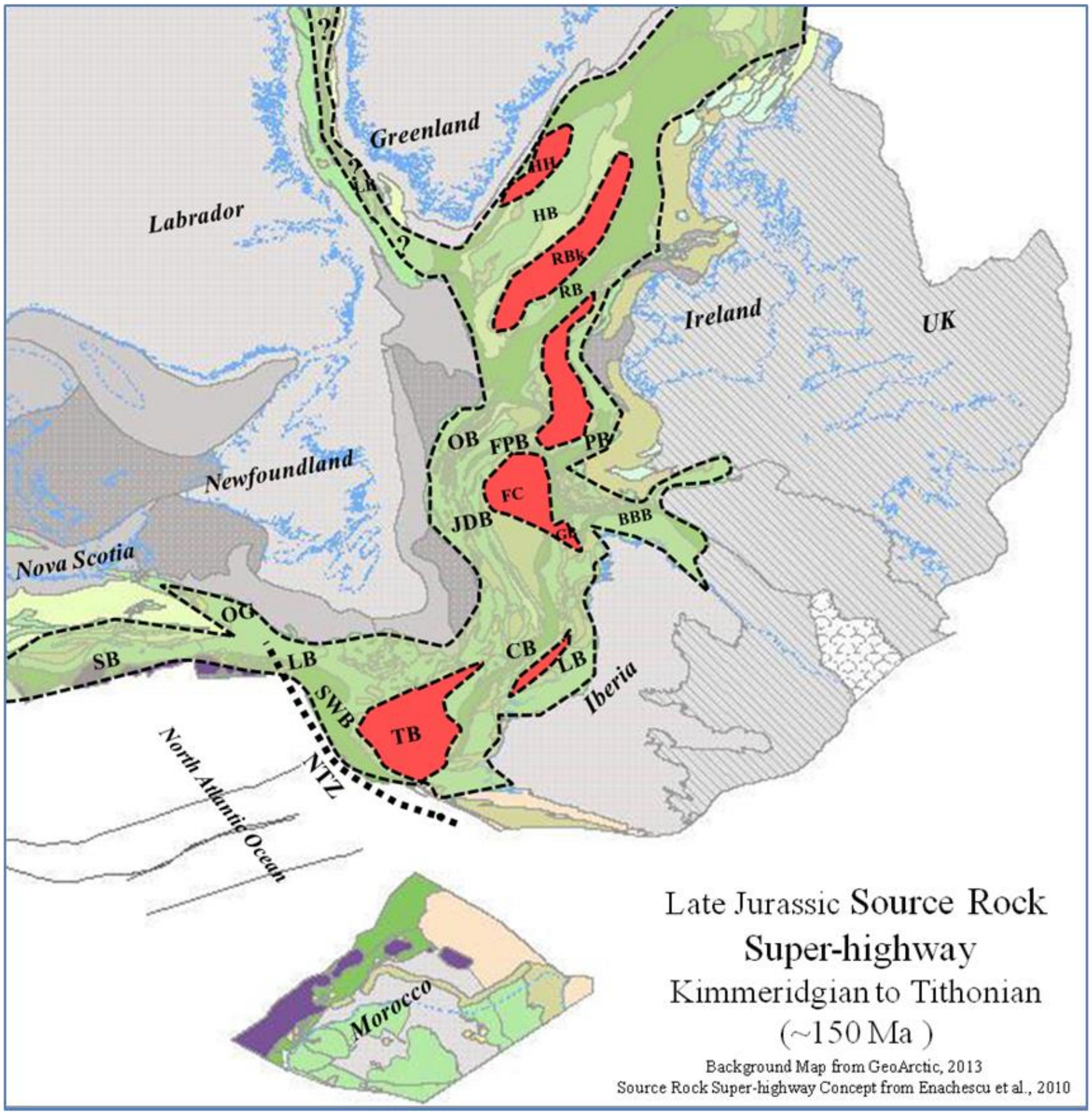


Figure 12. North Atlantic plate margins reconstruction at 150 Ma (Kimmeridgian to Tithonian) showing the rifting between Newfoundland and Labrador and Europe (modified after GeoArctic, 2013). Notations are: SB = Scotian Shelf and Slope Basin, OG = Orpheus Graben, LB = Laurentian Basin, SWB = South Whale Basin, NTZ = Newfoundland Transform Fault Zone, TB = Tail of the Bank, CB = Carson Basin, LB = Lusitanian Basin, JDB = Jeanne D'Arc Basin, FC = Flemish Cap, GB = Galicia Bank, FPB= Flemish Pass Basin, BBB = Bay of Biscay Basin, OB = Orphan Basin, PB = Porcupine Basin, RB = Rockall Basin, RBk = Rockall Bank, HB =Hatton Basin, HH = Hatton High. Colors legend is: grey shades represent older continental terranes, green shades represent different depths during the Atlantic Ocean incursion into the intra-continental Late Jurassic rift, red colour represents intra-basinal ridges and highs and orange/peach shades represent marginal and intra-rift platforms.

The Flemish Pass Basin started its evolution together with Jeanne d'Arc Basin during Late Triassic in a double failed rift configuration (Enachescu 1987 and 1988). The two basins are now separated by a northerly trending Central Ridge, which considerably uplifted during late Early Cretaceous to Early Tertiary. Based on tectonics, structural setting, and composition of sedimentary fill, the Flemish Pass Basin can be divided into two distinct sectors or subbasins (Figure 13, Enachescu, 2011 and 2012):

1. **The Gabriel Subbasin.** This sector is located south of the Transfer Zone. Parcel NL13-01-01 is located in the northern part of the Gabriel Subbasin, which is deep in the north and its basement becomes increasingly shallower in the south. The Gabriel Subbasin is named after the Gabriel C-60 well that intersected a thick Cretaceous section. The subbasin is separated from the Jeanne d'Arc Basin by the Central Ridge which trends approximately north-south. In the south the subbasin becomes narrower and shallower, terminating south of the Kyle High on basement ridges. These ridges are mapped under the shelf break and delineate the Flemish Pass Basin. To the east the subbasin borders on a Precambrian high (the Beothuk Knoll) and connects with a younger rifted arm, the Flemish Pass Graben, which contains only Cretaceous to Tertiary fill. Most of the Grand Banks' typical Late Triassic to Quaternary formations were intersected and logged in this sector of the basin by the earlier three wells shown in Figure 7. In the southern part of the subbasin the Late Jurassic source rocks are missing at the Kyle L-11 well location, probably due to non-deposition on this basement high or erosion on and in the proximity of the basement high. In the subbasins' northern part, where the Jurassic successions are clearly seen on seismic data, all three exploration wells Gabriel C-60, Lancaster G-70 and Tuckamore B-27 have bottomed in Cretaceous formations without drilling further into Jurassic. However, based on a) interpretation of the modern seismic coverage and b) results of adjacent wells located on the Central Ridge (Panther P-52 and North Dana I-43), Parcel NL13-01-01 should be underlain by a complete synrift sequence including the Late Jurassic organic shales.

2. **The Baccalieu Subbasin.** This sector located north of the Transfer Zone was named from the Baccalieu I-78 well shown in Figure 7. This well drilled both through reservoirs and source rocks. This sector is separated from the Central Ridge by a complex fault zone trending NE-SW. To the north the Baccalieu Subbasin plunges into the deepwater and joins with the East Orphan Basin structures. An arbitrary 1500 m bathymetric level can be considered as a soft limit between the Baccalieu Subbasin and East Orphan Basin. In the northwest the basin stretches over the Sackville Spur. The eastern border is a tectonic line separating the basin from the elevated block known as the Flemish Cap. Large and complex structures dissected by two main fault systems can be seen in the seismic data, which also shows the presence of a Late Jurassic "hot shale" interval. Out of the six wells drilled in this subbasin three were discoveries (Mizzen O-16, Bay du Nord C-78/C-78Z and Harpoon O-85), one had an untested oil accumulation (Mizzen L-11) and two were dry (Baccalieu I-78 and Mizzen F-09).

The basin configuration and its subdivisions were better defined after the emergence of the modern 2D and the availability of 3D data. The basin's tectonic and structural elements should be further described after the new TGS operated seismic survey over the area is available to interpreters. The Call for Bids NL13-01 Parcel 1 is located in the Gabriel Subbasin, immediately south of the Transfer Zone, and partially on the Central Ridge (Figure 13). The most recent oil discoveries in the offshore Newfoundland are the Mizzen, Harpoon and Bay du Nord wells located in the Flemish Pass Basin, just north of the Call for Bids Parcel 1 (Figures 7 and 13).

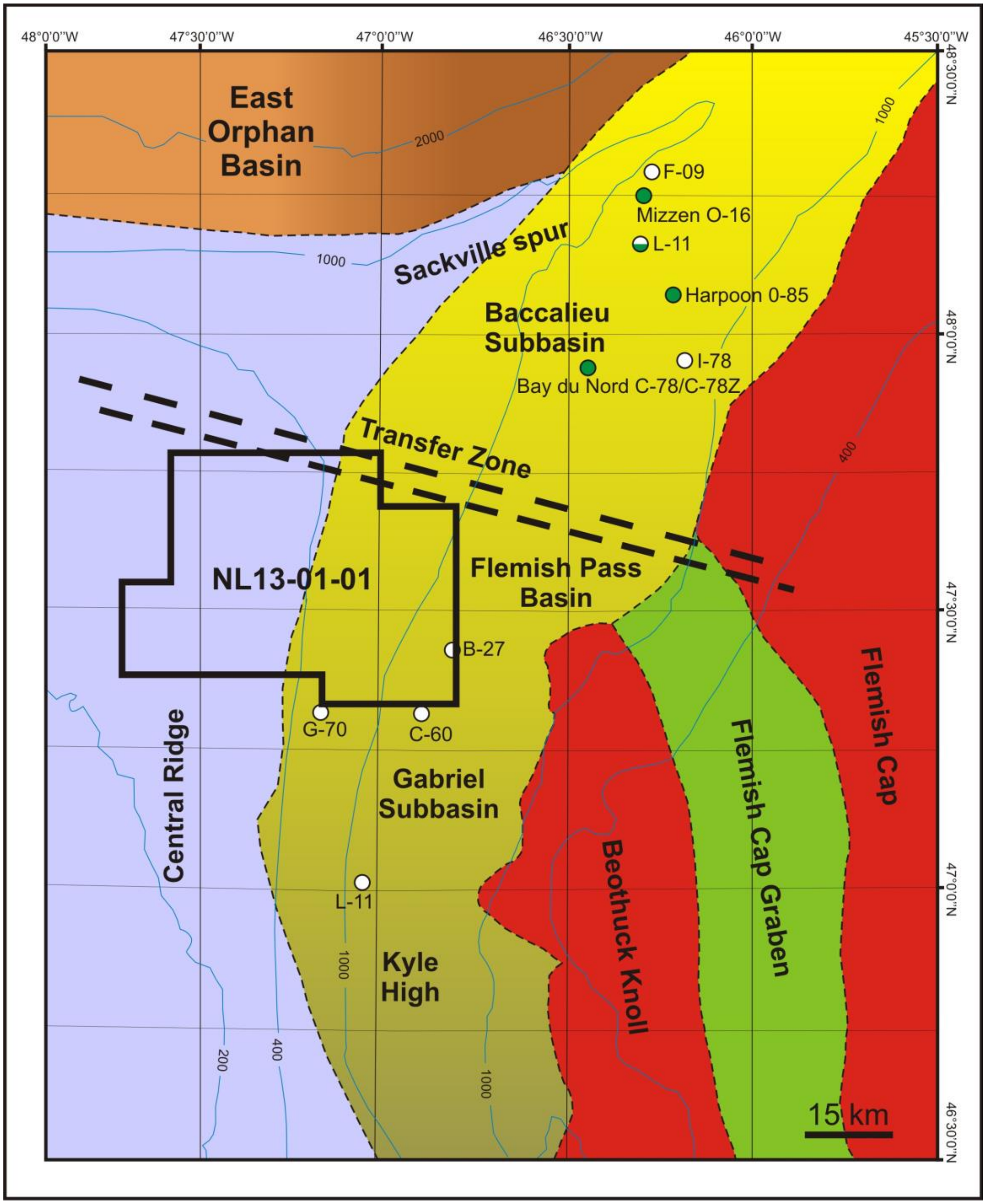


Figure 13. Flemish Pass Basin structural subdivisions Gabriel and Baccalieu subbasins and surrounding structural units (modified after Enachescu, 1988, 1992a and b and 2012). From south to north exploration wells are Kyle L-11, Gabriel C-60, Lancaster G-70, Tuckamore B-27, Bay du Nord C-78/C-78Z, Harpoon O-85, Baccalieu I-78, Mizzen L-11, Mizzen O-16 and Mizzen F-09. Call for Bids Parcel NL13-01 is located in the Gabriel Subbasin and on the Central Ridge, south of a major Transfer Zone.

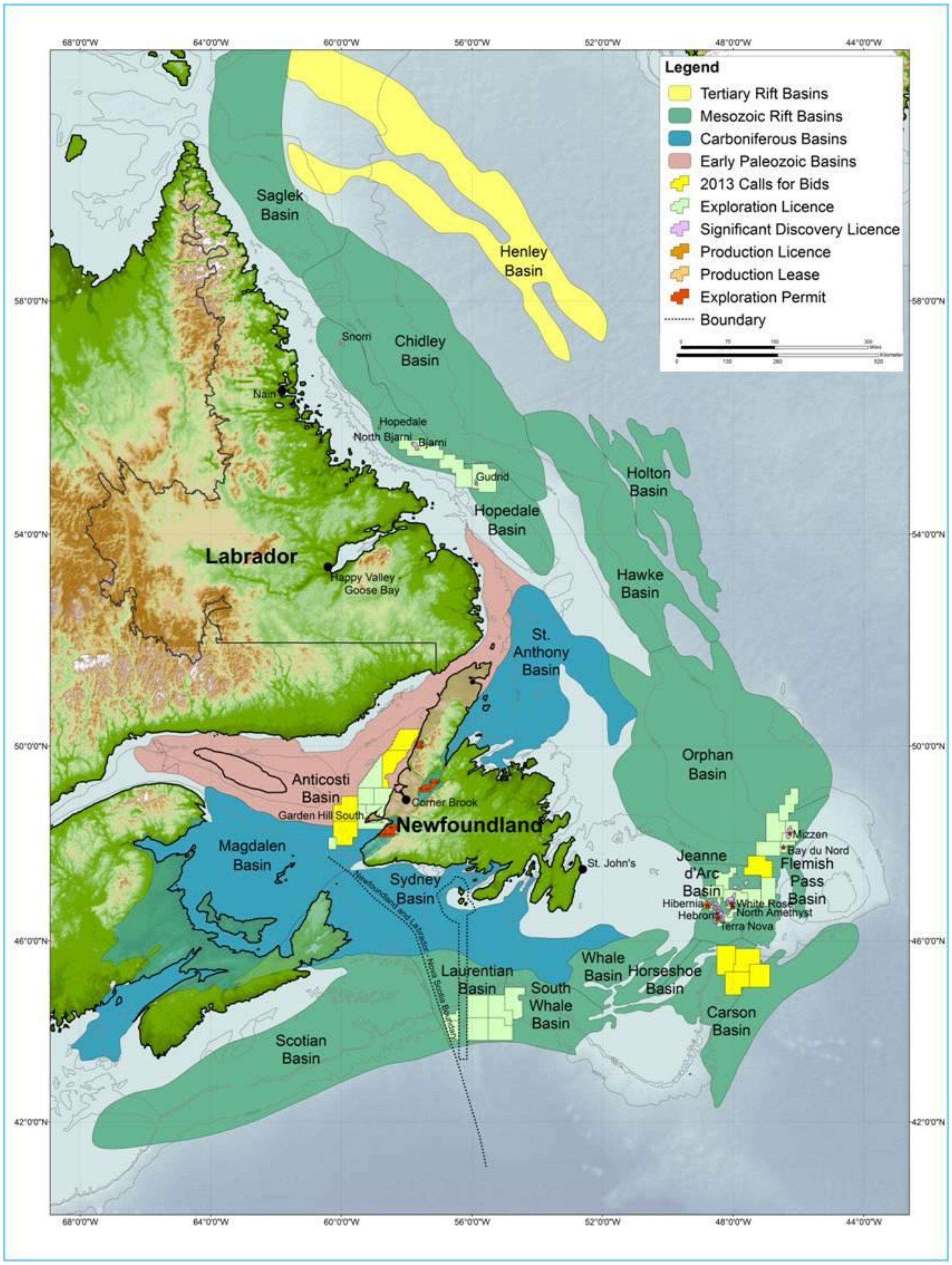


Figure 14. East Coast of Canada Basin Map. This map contain Paleozoic (in blue and pink), Mesozoic (in green) and Tertiary (in yellow) sedimentary basins with petroleum potential (map modified after GSC, DNR, Enachescu (2006); Labrador basins configuration after Nalcor (2013)). Map shows offshore Newfoundland and Labrador's Exploration Licences in light green and Call for Bids NL13 parcels in yellow.

As seen from the East Coast Canada Basins map an immense NL offshore area remains unexplored (Figure 14).

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

The North Atlantic continental margins are occupied by a complicated network of sedimentary basins, subbasins and troughs formed by extension during the breakup of Pangea and opening of the Atlantic Ocean during the Late Triassic to mid-Cretaceous (AMOCO, 1973; Enachescu, 1987, 1988, 2008 and 2009; Grant, 1988; Tankard and Welsink 1987 and 1989; Tankard and Balkwill, 1989; Ziegler, 1989; Sinclair, 1988 and 1993; Mackay and Tankard, 1990; Atkinson and Fagan, 2000; Sibuet et al., 2007; Withjack et al., 2012; Geo Arctic, 2013 and Figures 12 and 14). On the Newfoundland margin the basins and subbasins are today either in continuity of structure or separated by Proterozoic basement highs, volcanic chains and sedimented ridges (Enachescu, 1992a and b; Edwards et al., 2003; GSC, 2001). In their Mesozoic past, all the basins were in communication at various stages during their geodynamic evolution as proven by the widespread presence of similar sedimentary deposits such as the Late Triassic salt, mid and Late Jurassic carbonate platforms, deposition of Late Jurassic source rocks, widespread distribution of cherty limestone beds, etc. Certain basins are now situated within the continental plate (e.g. Jeanne d'Arc and Flemish Pass basins) while others occupy a divergent margin position and extend all the way to the continent-ocean boundary (e.g. Laurentian, Carson basins).

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 (Figures 7, 13 and 15). Modern seismic data also indicates that the Flemish Pass Basin is in structural continuity to the north with the East Orphan Basin (Enachescu, 1992a and b; 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 15).

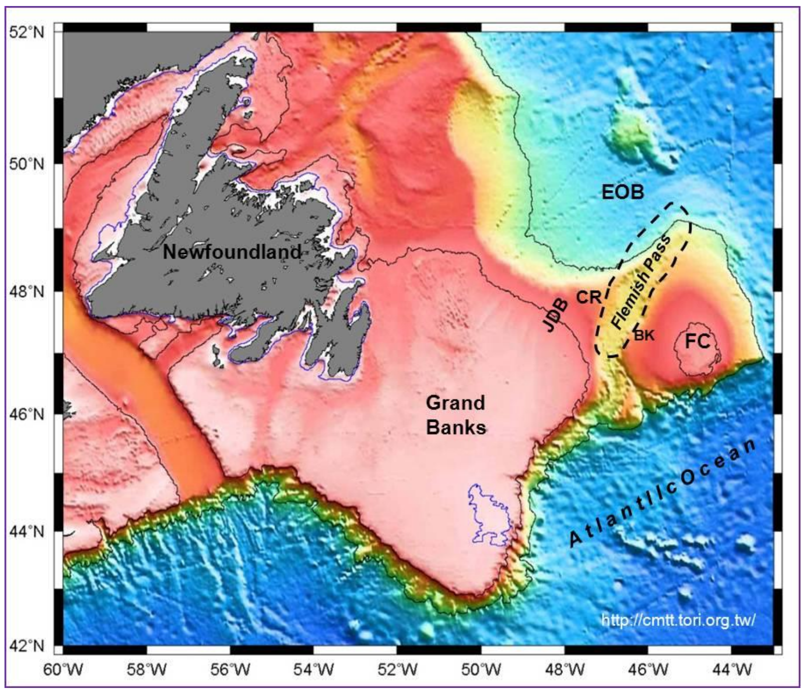


Figure 15. Bathymetric and physiographic features in the vicinity of the Flemish Pass Basin. The basin mostly occupies the bathymetric low known as the Flemish Pass (approximately 500 to 1500 m water depth) located between the Central Ridge (CR) and Beothuk Knoll (BK) and Flemish Cap (FC) and plunging toward the deep waters of the East Orphan Basin.

The Flemish Pass contains a Mesozoic-Tertiary basin that was intersected by three discovery wells (Mizzen O-16, Bay du Nord C-78 and Harpoon O-85) and another well with a noteworthy oil show (Mizzen L-11). Several other wells in the basin have intersected high quality sandstone reservoir and/or good quality source rocks within Late Jurassic to Early Cretaceous formations (e.g. Mizzen L-11, Gabriel C-60 and Baccalieu I-78).

5.1. Adjacent Basins and Highs.

Central Ridge. 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 and 1988; 1992a and b). 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, high quality source rock intervals (Kimmeridgian Egret Member of the Rankin Formation). The ridge contains mainly extensional and salt induced structures and is heavily compartmentalized by two fault systems. Transtension has also created inverted structures in several places. EL 1110, located mostly on the Central Ridge and partially on the western flank of the Flemish Pass Basin together with the consolidated EL1090R extending to the Ridge from the Jeanne d'Arc Basin, remain to be drilled in the next years to meet licensing agreements (Figures 7 and 10).

Flemish Cap. Towards the east, the basin is surrounded by a large shallow high, devoid of sediments, known as the Flemish Cap which has been a local source for coarse sediments transported into the basin (Figures 7, 10 to 15). There is no hydrocarbon potential on the Flemish Cap, although its down faulted flank contains several unexplored structures and large sedimentary fans onlapping the eroded Precambrian basement in places.

Jeanne d'Arc Basin. Just west of the Central Ridge is the Jeanne d'Arc Basin, the only North American East Coast basin containing giant producing oil fields (Figures 3, 4, 8 and 10). The fields produce light crude (30 to 35º API) from Late Jurassic-Early Cretaceous sandstones. Formed by repeated extension, thermal subsidence and transtension supplemented by salt tectonics, the basin is rich in structural, stratigraphic and combination traps. While explored for over 40 years, the northern part of the basin has seen little drilling activity. In the basin, there are four fields and satellites being produced, one oil field in development (Hebron) and several other oil and gas accumulations covered by SDLs. The latest SDLs were awarded in September 2013 to Suncor and Statoil for the discovery of gas (1.14 Tcf) and condensate (21 mmbbls) at the Ballicatters M-96Z well, located north of Hibernia. The reservoirs of the Ballicatters discovery are several sandstones of the Albo-Aptian age Avalon Formation. According to the C-NLOPB the Ballicatters M-96Z well "tested a 23 meter interval and flowed oil and gas at sustained rates of 698 b/d (43º API) and 38.6 MMScf/d respectively on a 60/64th inch choke during a 27 hour flow period and associated 39 hour shut-in period". There are currently 10 ELs in the Jeanne d'Arc Basin and vicinity that must be drilled in the next few 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 (Enachescu et al., 2005; Enachescu, 2009 and 2010).

East Orphan Basin. Toward the north, the Flemish Pass Basin is in contact with the stratigraphically deeper East Orphan Basin which is an underexplored Mesozoic basin (Smee et al., 2003; Enachescu et al., 2005a and b) (Figures 3, 6, 10, 13 and 15). 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. Numerous extensional and transtensional structures have been mapped with 2D and 3D seismic surveys. 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 (Controlled Source Electomagnetics) surveys have been conducted. Two deep wells were drilled in the first exploration term, but were unsuccessful (Great Barasway F-66 and Lona O-55). The abandoned F-66 and O-55 wells intersected a thick Late Jurassic clastic succession including reservoirs and some intervals with good quality source rock. After the drilling of these wells and partial land relinquishment, a large consolidated exploration licence, EL 1074R, was granted. Two of the initial interest holders, ExxonMobil and Shell, opted out and new partners were found. In 2013, Chevron and new partners Repsol and Statoil drilled the Margaree A-49, the third deepwater well in the basin. The A-49 well was abandoned and is still confidential. The acreage was recently returned to the Crown. This basin still contains numerous large undrilled structures but a proven petroleum system has eluded explorers to date. According to several geodynamic models, the Late Jurassic source rocks should be preserved in some of the elongated troughs which can be seismically mapped in the basin. Three of the active exploration blocks in the Flemish Pass Basin located close to the Mizzen SDL partially extend into the southern East Orphan Basin (ELs 1124, 1125 and 1126) and seismic correlation indicates the presence of Late Jurassic formation with possible source rock intervals plunging into the deepwater basin.

5.2. Geodynamic Evolution.

Newfoundland and Labrador offshore basins underwent successive extensional episodes during the northerly propagation of the Tethys, Atlantic and Labrador rifting stages (Enachescu, 1987, 1988 and 1992a and b, Tankard and Welsink, 1987, 1989 and 2012, Grant et al., 1988; Grant and McAlpine, 1990; Dehler and Keen, 1993; Sinclair et al., 1992 and 1994; Driscoll et al., 1995; Atkinson and Fagan, 2000; Edwards et al, 2003; Enachescu et al., 2005b and 2012; Ady and Whittaker, 2012). Four continental rifting phases occurred in the North Atlantic region (Enachescu, 2011):

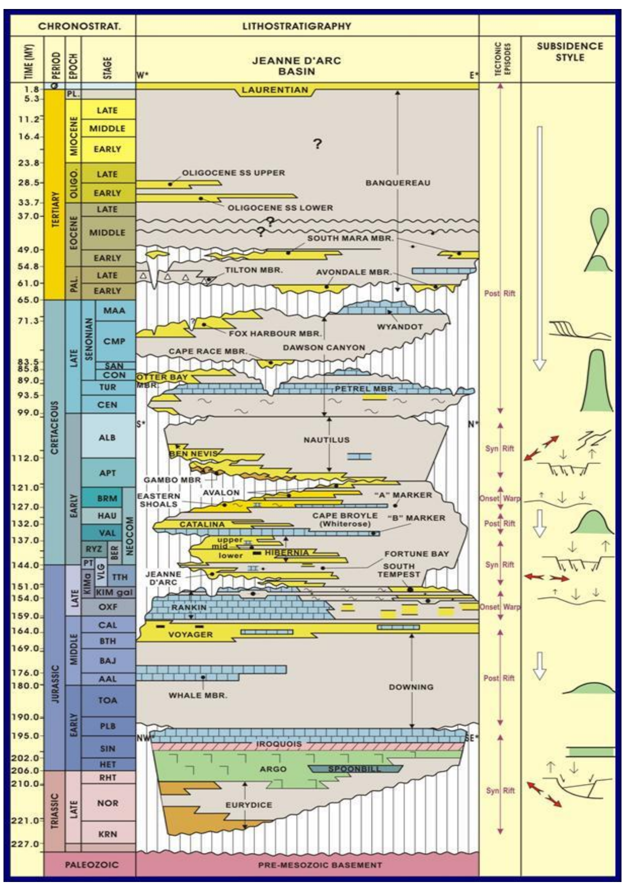
1. Tethys rift phase during Late Triassic to Early Jurassic,
2. North Atlantic Rift phase during Late Jurassic to Berriasian,
3. Labrador Sea Rift phase during Berriasian to Albian, and
4. Greenland/Europe rift phase during Late Cretaceous-Eocene.

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 in turn underlain 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, 2006). Compressional stress was generated by changes in the direction of extension or strike-slip. Triassic salt is not as abundant in this basin. Salt pillows and detached salt may play a role in 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, 2006; Enachescu, 2010 and 2011). Some of the faults show inversion and several “flower structures” created by strike-slip movement can be identified on seismic data. Major subsidence in Late Cretaceous and especially during Tertiary provides an undeformed, relatively thick (1 to 2.5 km) cover of fine grained sediments, protecting the deeper synrift structures. More on tectonic and structural evolution of the basin can be found in the NL DNR web publications of the last five years at http://www.nr.gov.nl.ca/nr/invest/energy.html#offshore.

5.3. Lithostratigraphic and Tectonic Charts.

The Flemish Pass Basin has been described as the ocean-ward member of a double failed rift system that includes the westerly Jeanne d’Arc Basin and the Central Ridge (Enachescu, 1987, 1988 and 1992a and b). The double rift system is compartmentalized by major basement detachment faults, but the two basins and the ridge share a common evolution and arguably, comparable stratigraphy (Enachescu, 2010 and 2011; Enachescu et al., 2010; Hogg, 2001). There was continuity of deposition during the Late Triassic and Jurassic between the two basins, as the Central Ridge intra-basinal high, 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 the rotation of Flemish Cap (Enachescu et al., 2005a and b; Sibuet et al., 2007; GeoArctic, 2013; and Figures 11 and 12), the basin has suffered several changes in the direction of the extension vector resulting in transtension, flower structures and inversion of rotated blocks during the Cretaceous.



The Flemish Pass Basin has seen little regional stratigraphic research that includes information from the latest wells. The Jeanne d’Arc Basin tectono-stratigraphic and tectonic charts published by Tankard and Welsink (1987 and 1989), Enachescu (1987, 1988 and 1992a and b), Tankard et al. (1989), Grant and McAlpine (1990), McAlpine (1989 and 1990), Hiscott et al. (1990a and b), Driscoll and Hogg (1995), Sinclair (1993 and 1995), Foster and Robinson (1993), Edwards et al. (2003), Deptuk et al. (2003) and 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).

Figure 15. Jeanne d’Arc Basin Lithostratigraphy, Tectonics, Subsidence and Petroleum Geology Chart. This chart was often used as a guide for the Flemish Bass Basin (modified from C-NLOPB and Sinclair, 1993).

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 the 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.

The Jeanne d'Arc Basin Lithostratigraphy, Tectonics, Subsidence and Petroleum Geology Chart used by C-NLOPB (shown on previous page) was often used for the Flemish Bass Basin seismic stratigraphy and well prognosis. 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 and 2013; Cody et al., 2013). 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, 2004 and 2007; Figure 16). Hogg (2001 and 2002) has presented a comparative stratigraphic chart between the Jeanne d'Arc and Flemish Pass basins established on the correlation of the pre-Mizzen L-11 wells drilled in the basin (Figure 16).

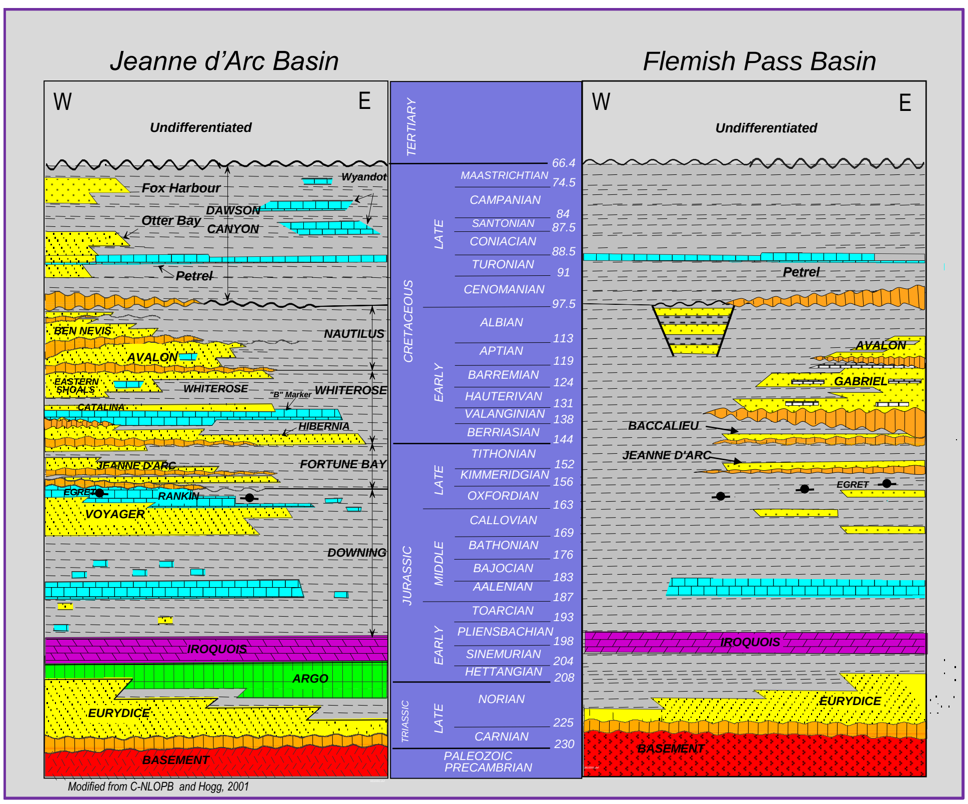


Figure 16. Comparative Stratigraphy of the Jeanne d'Arc and Flemish Pass basins (modified from C-NLOPB and Hogg, 2001). This Flemish Pass Basin chart is based on correlation of wells drilled up to 2001 in the basin and interpretation of 3D seismic data.

The Argo salt was not drilled in the 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.

No significant volcanics have been drilled in the basin and no indications of presence of subaerial or intrusive volcanic rocks are seen on seismic on seismic data. Volcanic rocks may be present in the melange of the extruded continental mantle rocks identified in the Transition Zone in the northeastern extremity of the basin where it connects to the deepwater, outer East Orphan Basin.

On most of the structural highs drilled in the basin, the Late Cretaceous-aged succession is either very thin or was severely eroded at the Base Tertiary Unconformity, due to significant uplift and inversion of earlier structures. When encountered by drilling, with the exception of the Petrel limestone, the section is predominately marine shale with minor siltstones.

The Baccalieu sandstone that was found to have good reservoir properties in several Flemish Pass wells consists of several stacked sandstone layers. The sandstone is described as being coeval with the Hibernia Formation and Berriasian in age, but in other publications it is shown as straddling the Tithonian and Berriasian boundary (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 Formation 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 and 2013; Cody et al., 2013), 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 terranes), the Iberia peninsula and locally from the Flemish Cap granodiorites.

The most recent stratigraphic communications in the basin (Haynes et al., 2012 and 2013; Gruschwitz et al., 2013; Cody et al., 2013), have introduced the informal terms of Ti-0, Ti-1, Ti-2 and Ti-3 for four Tithonian sandstones intervals encountered in the Mizzen wells. Described as braided fluvial sandstone encased in shale and limey mudstone, this rock package was informally termed the “Bodhrán Formation” by Haynes et al. (2013). The unit is time equivalent and sedimentologically similar to the Jeanne d’Arc Formation within the Jeanne d’Arc Basin. According to Cody et al., 2013, the Bodhrán Formation sandstones were sourced from a north and northeast direction.

A new stratigraphic chart specific to the Flemish Pass Basin, that includes the results of the latest wells in the basin, is needed.

6. Overview of Petroleum Geology of the Flemish Pass Basin

An integral part of the network of Late Triassic-Early Jurassic series of basins stretching across Pangea from Nova Scotia to the Norwegian Sea, the Flemish Pass Basin had a common tectono-stratigraphic evolution as other North Atlantic petroliferous basins and the Central Ridge area. Due to its setting, it is expected that the Flemish Pass Basin has a similar petroleum system to the better known Jeanne d'Arc Basin. The public domain data and past and recent publications and presentations generally support this assumption, however differences between the geochemistry and basin evolution exist (e.g., McCracken, 2000; Hogg, 2002; Magoon et al., 2005; Fowler et al., 2007; Enachescu et al., 2010; Statoil, 2011 and 2012).

6.1. Source Rocks. The most significant source rock in the basin is believed to be the Egret Member of the Rankin Formation of Kimmeridgian to Tithonian age or its equivalent. 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. This unit is the prolific source rock that sourced all the discoveries of the Jeanne d'Arc Basin.

The Egret source rock is an oil prone, marine-derived Type II carbonaceous shale with up to 9% (average 4.5%) Total Organic Carbon (TOC). Over 25 exploration wells have penetrated the Egret Member source in the Grand Banks and environs (Powell, 1985; Creaney and Allison, 1987; von der Dick, 1989; Fowler et al., 1990; Williamson, 1992; Taylor et al., 1992; Fowler and McAlpine, 1995; Huang et al., 1994 and 1996; Bateman, 1995; Williamson et al., 1996; DeSilva, 1999; McCracken et al., 2000; Fowler and Obermajer, 2001; Magoon et al., 2005; Wielens et al., 2004 and 2006; Enachescu et al., 2010 and 2011). The Kimmeridgian Egret shale, deposited in semi-silled epeiric basins, is the best known marine source rock within the North American Atlantic rift system.

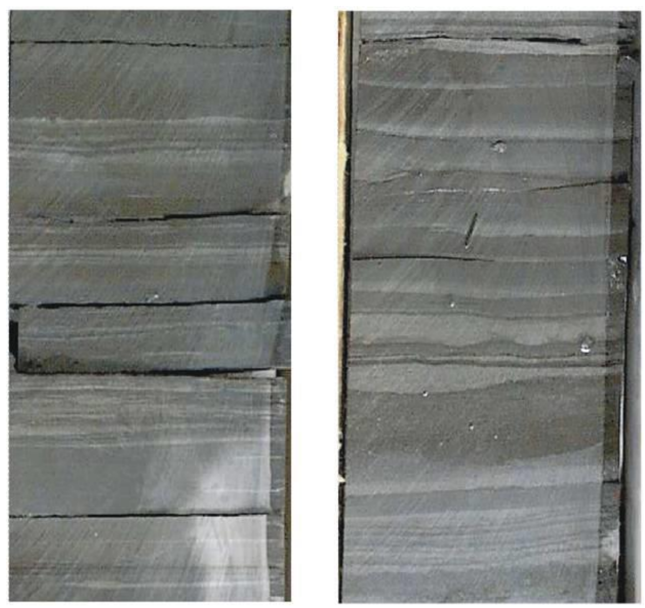


Figure 15. Kimmeridgian source rock (Egret Member of the Rankin Formation) cored in Baccalieu I-78 well, in the north-central Flemish Pass Basin. The cored interval is comprised of black shales and mudstones (photo provided by J. McCracken).

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. Several wells in the Flemish Pass-Central Ridge area have also encountered Egret sections containing Type I-II kerogen. The Egret beds in the Flemish Pass Basin average 130 m thick,

Table III. 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; Gruschwitz et al., 2013; Cody et al., 2013), presentations, communiqués and well reports in public domain (Statoil, 2011 and 2012).

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?
Harpoon O-85	Flemish Pass B	CONFIDENTIAL			Yes	CONFIDENTIAL		
Bay du Nord C-78	Flemish Pass B	CONFIDENTIAL			Yes	CONFIDENTIAL		
Bay du Nord C-78Z	Flemish Pass B	CONFIDENTIAL			Yes	CONFIDENTIAL		
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	7 intervals 3468 to 4117 Tempest ss	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 4437-4548	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

have a TOC range between 1.9 and 13% (2.3% average) and a Hydrocarbon Index range of 197-586 (328 average) (McCracken et al., 2000). Other source rock intervals have been identified in the Tithonian and Oxfordian shale formations. It was suggested that the Mizzen O-16 heavier field oil (22° API) in the northern Flemish Pass Basin was sourced from an immature to marginally mature source rock within the Tithonian sequence (Table III). The marine shales that separate the Tithonian reservoirs in the Mizzen oil field have 8 - 12% TOC (Haynes et al., 2012). An earlier well on the structure, Mizzen L-11, drilled in 2003 encountered 5 m of pay (light oil) that may be generated from a mature source rock. Incidentally, the Harpoon and Bay du Nord light oil finds have been announced as being contained in Jurassic reservoirs and it is presumed that they were generated by a Late Jurassic source rock.

In a Geological Survey of Canada study, Fowler et al. (2007) indicated that samples of oil from Mizzen L-11 showed some characteristics similar to the Egret Member sourced oils from the Jeanne d'Arc Basin but there were also some differences. These could reflect changes in the Egret Member organic facies when moving into the Flemish Pass or the mixing of hydrocarbons from multiple sources, explaining the variations in thermal maturity indicated by different classes of compounds (Table III).

The closest well that penetrated the Egret source rock is Lancaster G-70, located just south of Parcel 1, 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 (C-NLOPB, 2014). As indicated in the lower part of the Panther P-52 well situated in the western flank of the basin approximately 60 km southwest of Parcel 1, several intervals of older Late Jurassic shales (Callovian and Oxfordian) have good petroleum source properties (Enachescu, 2012; Table III). Three other wells in the vicinity, North Dana I-43, South Tempest G-88 and Trave E-87, also encountered Egret Member of the Rankin Formation.

Another possible source rock for the Flemish Pass Basin is the Turonian to Albian black shale intervals drilled by IODP at sites #1276 and #1277 during the Leg 210 (Arnaboldi and Mayers, 2007). These sites were located 60 km south east of the Flemish Pass Basin. This fine grained succession is stratigraphically equivalent to the Hatteras Formation described at multiple drill sites in the western North Atlantic and with the Nautilus Formation drilled in the Grand Banks basins (Tucholke et al., 2004; Arnaboldi and Meyers, 2007). Five dark-colored intervals that contain up to 13% TOC of both marine and terrestrial provenance were identified in the Site #1276 sequence (Mayers and Arnaboldi, 2011). This interval showed rich, marine organic content and had high HI in places (Figure 16). These shales may be thicker and mature in the deeper sedimentary troughs of the Flemish Pass Basin such as those seen on seismic sections presented in this report.

The Flemish Pass Basin experienced an early marine incursion in the Early Jurassic similar to other Atlantic margin basins (e.g. Scotian Basin, Laurentian Basin). During this period, an interior, hypersaline shallow sea, situated at warm latitudes occupied parts of the newly formed rift basin. Continuous salt deposits and stratified salt formations were accumulated during this time. It is possible that an algal, oil prone source rock was deposited in the southern Flemish Pass Basin, during the Sinemurian-Pliensbachian in the earliest post-rift, hypersaline to carbonate marine environment, in a similar manner as proposed for the Scotian Basin and discussed in the comprehensive Nova Scotia Play Fairway Analysis, available on the web or from CNSOPB (http://www.novascotiaoffshore.com/analysis#atlas; NSDE, 2011; discussed also in Enachescu, 2012).

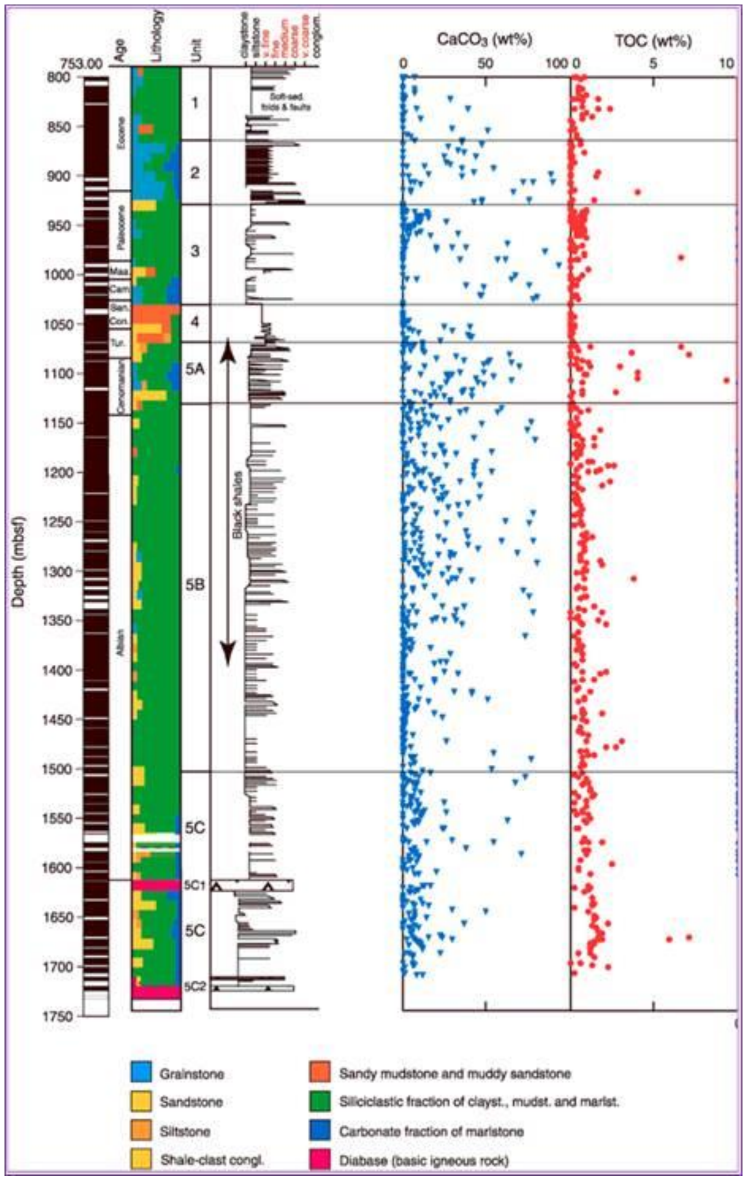


Figure 16. The Aptian to Eocene stratigraphic successions drilled by IODP during Leg 210 (2003), age and lithology of rocks, their calcium carbonate percentage and TOC (total organic carbon) (modified after IODP, Tucholke, B.E., Sibuet, J.-C., and Klaus, A. (Eds.), 2007a).

In some areas of the basin where the Paleozoic forms the basin floor, a Paleozoic source rock similar to sources found in the adjacent Maritimes Basin may also be a contributor, especially to gas/condensate generation in the basin. While the Tertiary shales have shown high TOC intervals in the drilled wells, they remain yet unproven source rocks. However, Tertiary shales may be mature in several deep grabens where the Tertiary succession surpasses 3 km.

6.2. Reservoir Rocks. Reservoir rocks in the Flemish Pass Basin should be predominantly sandstones of Late Jurassic to late-Early Cretaceous age encountered in the neighbouring basins and proven in several of the wells drilled in the basin (Beaudreau et al., 1986; Enachescu, 1988; Tankard and Welsink, 1989; Tankard and Balkwill, 1989; Brown et al., 1989; McAlpine, 1989, 1990 and 1995; Williams et al., 1990; Hiscott et al. 1990a and b, 2008; Sinclair et al., 1992; Hurley et al., 1992; Driscoll and Hogg, 1995; Noseworthy, 2003; Dearin, 2007; Lowe et al., 2011; Haynes et al., 2012 and 2013; Gruschwitz et al., 2013; Cody et al., 2013). Additionally, turbidite sands of Late Cretaceous-early Tertiary age should be present on the continental slope and deepwater in the northeastern part of the basin, (e.g. Hogg, 2001 and 2002; Enachescu and Hogg, 2005; Enachescu et al, 2005a and b). Porous matrix or dolomitized carbonates of Jurassic and Early Cretaceous age may be locally developed in the basin, similar to reservoirs encountered at the Deep Panuke gas field in the Scotian Basin, or the large Cretaceous Dunquin prospect recently drilled in Ireland's offshore Porcupine Basin which is situated conjugate to the Flemish Pass Basin (http://www.provideneresources.com/uploads/operationalupdate-dunquinnorthwell-22july2013.pdf).

In the Jeanne d'Arc Basin the main reservoirs are sandstones of the Jeanne d'Arc Formation (Kimmeridgian-Tithonian), Hibernia Formation (Valanginian-Berriassian) and Avalon-Ben Nevis Formation (Barremian-Aptian). Additional reservoirs were found in the Voyager (Bathonian-Calovian), Rankin (Calovian-Oxfordian) formations and in the Catalina (Valanginian-Hauterivian), Otter Bay (Turonian-Coniacian) and Fox Harbour (Campanian-Maastrichtian) members (Tankard and Welsink, 1987 and 1989; Enachescu, 1987, 19888, 1992a and b, 2000, 2007 2011 and 2012; Harding, 1988; Brown et al., 1989; McAlpine, 1990 and 1995; Wade and MacLean, 1990; Sinclair et al., 1992; Driscoll and Hogg, 1995; Agrawal et al., 1995; Atkinson and Fagan, 2000; Deptuk et al., 2003). These reservoirs show excellent qualities and contain oil, gas or both in numerous producing fields and undeveloped discoveries. In the Flemish Pass Basin excellent reservoirs have been drilled in the Tithonian, Kimmeridgian and Early Cretaceous formations (Enachescu, 2010b, 2011 and 2012a; Enachescu et al., 2010 and 2012; Lowe et al., 2011; Haynes et al., 2012 and 2013; Gruschwitz et al., 2013; Cody et al., 2013).

Reservoir rocks in the Flemish Pass Basin are high porosity - high permeability sandstones of Late Jurassic to Early Cretaceous age. Up to now, no noteworthy Late Cretaceous or Early Tertiary sandstone intervals were encountered in the basin (Table III).

The only published positive test in the basin was obtained from a Tithonian sandstone in the Mizzen O-16 well, which flowed 3800 bopd from the interval 3213-3224 m (Table III). A total of 26 m of pay was logged in this well (Cody et al., 2013). 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 informally named Ti-1 to Ti-4, as units of Statoil's informally-described Bodhrán Formation (Haynes et al., 2013; Cody et al., 2013). The Ti-3 sandstone was also encountered in the Mizzen L-11 well where it had 5 m of oil pay on logs and in the F-09 well where it had water and traces of oil.

Statoil as operator and partner Husky, have communicated very little publically about the reservoir characteristics, flow tests and depth of test interval(s) at the Bay du Nord and Harpoon discoveries. However, Statoil, the operator, has described both as light oil discoveries found in "excellent Jurassic reservoirs with high porosity and high permeabilities" http://www.statoil.com/en/NewsAndMedia/News/2013/Pages/26Sep_exploration.aspx.

The Gabriel Sandstone was intersected in both Gabriel C-60 (just outside of Parcel 1) and Tuckamore B-27 (eastern side of parcel) wells straddling the center axis of the Gabriel Subbasin (Table III). In the C-60 well the Gabriel Sandstone occurs in a Hibernia Formation equivalent section (Esso et al., 1981; Figures 7 and 13). 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 was reported as bleeding oil along a sand/shale interface. Just south of Parcel 1 (Figures 7 and 13), the Lancaster G-70 well intersected several beds of porous Tempest sandstone. This sandstone unit, part of the Kimmeridgian Rankin Formation, has flowed hydrocarbons from several adjacent wells located on the Central Ridge.

6.3. Seals. Seal should not be a problem for hydrocarbon traps within the Flemish Pass Basin as the Extensional and Thermal Subsidence stages contain regionally distributed successions of very fine clastics, tight sandstones and regional tight carbonate beds. Good seal intervals such as the Downing, Rankin, Fortune Bay, Whiterose and Nautilus formations or their equivalents were found in the wells drilled in the basin. The younger shales of the Dawson Canyon and Banquereau Formation form excellent regional seals.

The main seal of the Mizzen field is the marine shale of Berriasian-Valaninian age. The accumulation's many faults are sealed by the White Rose, Nautilus and Dawson Canyon shales.

6.4. Hydrocarbon Traps. The numerous structural traps found in Flemish Pass Basin and on the Central Ridge are associated with 1) basement highs due to recurring rifting of the Atlantic Margin, 2) rotated basement and/or early synrift sedimented blocks, 3) gravity faulting, 4) transtension and inversion features, 5) differential subsidence and tilting, and 6) in the southern region, possible movement of the Argo/Osprey evaporites.

A variety of traps have been found to be successful in the Jeanne d'Arc Basin, Central Ridge and Flemish Pass Basin (Enachescu, 2010, 2011 and 2012). The traps were usually created during the rift stage or early 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 or modified the initially extensional features. In the Jeanne d'Arc Basin, the largest petroleum accumulations were found in structural and combination traps. From the published seismic maps of the Mizzen structure, it seems that this is also a combination trap, related to the distribution of Tithonian sandstones over a faulted anticline (Haynes et al., 2012 and 2013; Cody et al., 2013).

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 anticlines
- Salt induced anticlines in the Gabriel Subbasin, and
- Transtensional, multi-side faulted anticlines in the Baccalieu Subbasin.

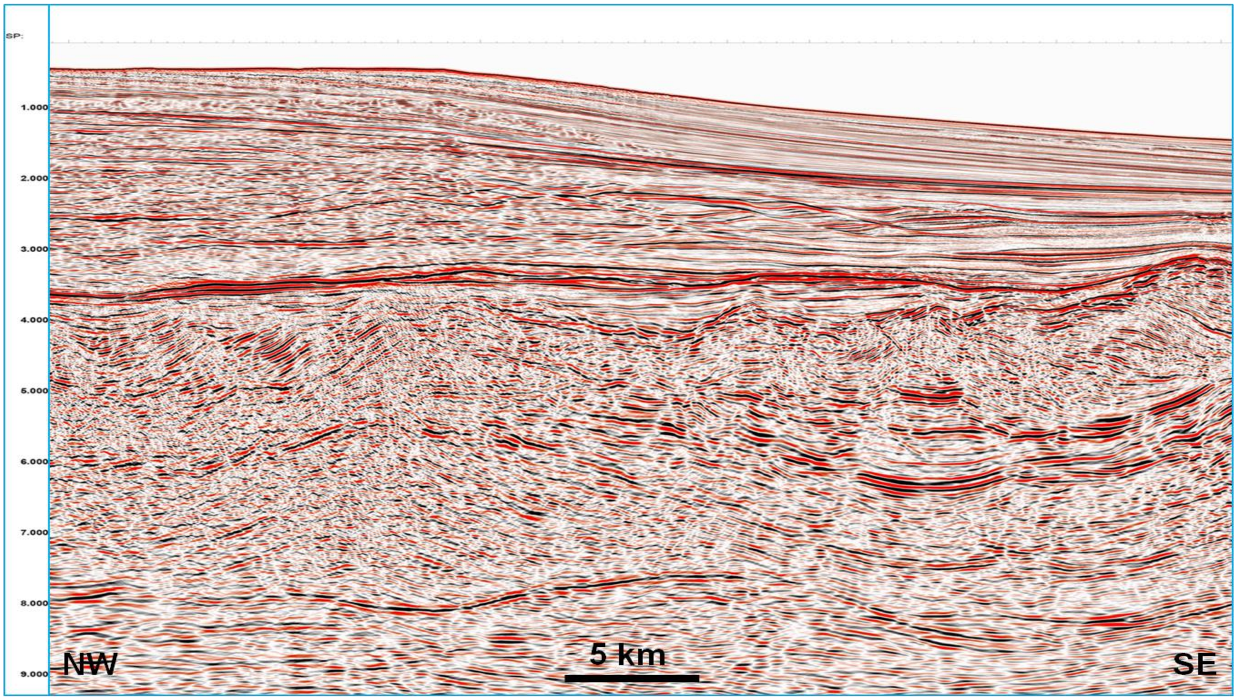


Figure 17. Uninterpreted 2D dip seismic line with examples of structural and stratigraphic traps in the southern Flemish Pass Basin, Gabriel Subbasin (seismic line courtesy of TGS in collaboration with PGS and Nalcor).

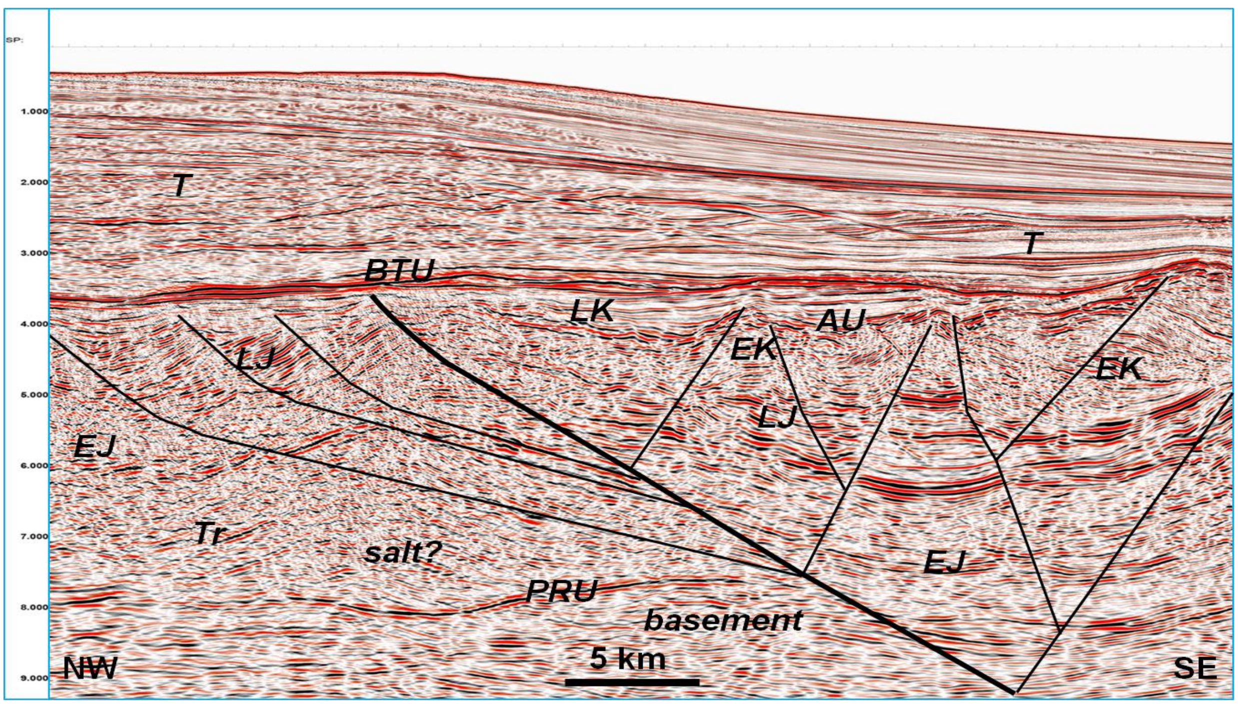


Figure 18. Interpreted 2D dip seismic line with examples of structural and stratigraphic traps in the southern Flemish Pass Basin, Gabriel Subbasin (seismic line courtesy of TGS, PGS and Nalcor). Notations are: PRU = Pre-rift unconformity, AU =Avalon Unconformity, Tr = Triassic, EJ = Jurassic, LJ = Late Jurassic, EK = Early Cretaceous, LK = Late Cretaceous, T = Tertiary, BTU = Base Tertiary Unconformity.

The main structural trap types are extensional anticlines, roll-overs, faulted anticlines, faulted and tilted blocks and elongated horsts that may involve the basement or are restricted to the synrift sequences (Figures 17 and 18). As shown by seismic reflection lines, the greatest majority of extensional faults are listric normal faults, but fault inversion is also observed. Together with several transfer faults these discontinuities form horsts, ridges, fault fans and trap-door features. The most favourable structural traps contain synrift sandstone reservoirs.

Salt-induced structures such as pillows and domes are present only on the Central Ridge and Gabriel Subbasin affecting both the synrift and post rift sequences (Figures 17 and 18). Drape anticlines are also present and observed from Late Cretaceous up to the mid-Tertiary stratigraphic levels.

Paleo-valleys, basin margin and basin floor fans are observed on seismic (e.g. Figures 17 and 18) but up to now, no significant occurrence of sandstone has been drilled. Sub-unconformity traps, produced mainly by the Avalon and Base Tertiary unconformities, are also abundant.

6.5. Petroleum System(s). At present, the only proven petroleum system in 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 the Tithonian shales have charged the oil accumulation in the Mizzen structure (Fowler et al., 2007; Statoil, 2010 and 2011). 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 basin are needed to confirm the distribution and quality of the Egret shales and the importance of the Tithonian shales (Fortune Bay equivalent?) as a source rock.

6.6. Maturation and Migration. The Egret Member source rock is stratigraphically positioned just below the Tithonian Unconformity. It is presumed that wherever a thick section of the Rankin Formation can be identified and mapped below the Tithonian, the Kimmeridgian (Egret Member) and Oxfordian high organic content shale sections are preserved. Wherever seismically mapped in the Grand Banks and adjacent basins, the Late Jurassic source rock intervals are characterized by strong amplitude reflectors.

In the adjacent Jeanne d'Arc Basin, the oil window occurs at burial depths between 2.5 km and 4 km (MacKay and Tankard, 1990: Williamson, 1992; Sinclair et al., 1992; Fowler and McAlpine, 1995; McCracken et al., 2000; Magoon et al., 2005; Enachescu et al., 2010; Enachescu 2011 and

2012). The Egret Member shale maturation started in the mid-Early Cretaceous and continued into the Tertiary. Petroleum expulsion in the Flemish Pass Basin started at a burial depth of 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 and also using sand carrier beds.

The low API oil found in the Mizzen reservoir appears to be derived from an early oil window mature source rock or a mixture of more mature and marginally mature source (e.g. Fowler et al. 2007; Statoil, 2010). The oil window starts at 3000 m below the mud line. Increasingly mature source rock should be located away from the Mizzen structural high, in the vast synclines developed toward the northeast and the south.

Drilling adjacent to Parcel 1 has proved that the Late Jurassic sequence containing high TOC and high Hydrogen Index intervals is preserved on the Central Ridge and in the Flemish Pass Basin (Table III). In the author's opinion the Egret Member should be present both on the eastern flank of the Central Ridge and in the Flemish Pass Basin within Parcel 1 (Figures 13, 17, 18).

The timing of hydrocarbon generation in the Grand Banks and environs was during the Late Cretaceous and prior to the Tertiary (Bell and Campbell, 1990; Fowler and McAlpine, 1995; McCracken et al., 2000; Magoon et al., 2005; Wielens et al. 2006; Baur et al., 2009). Therefore, the synrift traps had a higher chance of being filled while the younger traps, mostly of stratigraphic type, had a lower chance of charging, unless deep erosion brought source rocks closer to the younger reservoirs. Presence of leaking fault seals and thief zones may preclude filling of reservoirs to the spill-point as is the case at Mizzen field.

The oils generated in the Flemish Pass Basin by the potential Egret or an equivalent source rock should generally have similar characteristics to those presently being produced on the Grand Banks. These light oils (30°-37° API) with high aromatics content are in high demand for the refineries of East Coast US and Central Canada.

6.7. Hydrocarbon Plays and Risks. The main hydrocarbon play expected to be successful in Flemish Pass Basin will be:

- Anchored by a late Jurassic source rock such as the Egret Member or equivalent; Tithonian, Callovian or Oxfordian organic shales, or a blend of several of these sources,
- Reservoired most likely in synrift Late Jurassic, or Early Cretaceous sandstones, and
- Trapped in extensional/salt related faulted anticlines with faults provided near source kitchen migration conduits.

This play has provided giant oil accumulations in the Jeanne d'Arc Basin and recently proved significant discoveries at Mizzen, Harpoon and Bay du Nord in the Flemish Pass Basin. Conventional plays recognized in the Flemish Pass Basin (e.g. Foster and Robinson, 1993; McCracken et al., 2000; Hogg and Enachescu 2004, 2007 and 2008, DeSilva 2001, Enachescu, 2010, 2011 and 2012; Gruschwitz, et al., 2013, Lowe et al., 2011; McDonough et al., 2010, Haynes et al., 2012 and 2013; Cody et al., 2013) are:

- Late Jurassic (Tithonian) Sandstone (Bodhrán Formation) 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 to Tithonian?) sandstone on the western margin of the basin and eastern side of the Central Ridge.

These reservoir sandstones are trapped in roll-over anticlines, listric fault bounded blocks, multi-fault closures, basement cored anticlines or ridges, and/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.

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

There is also a risk of finding lower API oils present in shallower reservoirs. This is a situation encountered in the Jeanne d'Arc and northern Flemish Pass basins where several accumulations were found to contain biodegraded oil or where heavier oils were generated by a marginally mature source rock. When source rocks are buried too deep, there is an increased chance of drilling gas accumulations.

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. Nalcor Energy, the provincial energy corporation, has commissioned Ikon Geoscience to undertake a bespoke regional Geopressure Study under the Offshore Geoscience Data Program funded through the Province. The study will be publically available in 2014.

6.8. Resource Potential. In a joint study, the C-NLOPB and GSC (2004) estimated that the Flemish Pass Basin's undiscovered petroleum resources were in the range of 1.7 billion barrels at a 50 percent probability, and with expected field sizes ranging from 528 to 44 million barrels. This study is available from: http://www.cnlopb.nl.ca/news/nr20040520eng.shtml. However, this work did not take into account the possibility of multiple source rocks and did not extend to the northern part of the basin, in water depths exceeding 1100 m, and in the bordering area with the East Orphan Basin and Central Ridge.

When the estimate was released in 2004, the Flemish Pass Basin, (comparable in size to the Jeanne d'Arc Basin) had only been explored by five wells, none of which encountered hydrocarbons. The Hydrocarbon Potential of the Flemish Pass Basin, Offshore Newfoundland and Labrador report was based on an interpreted loose grid of older public domain 2D seismic data with no access to 3D surveys.

It is expected that a more current resource estimate, computed utilizing modern 2D and 3D seismic data and recent well results, that show the presence of high porosity and permeability oil filled reservoirs and multiple Late Jurassic intervals with possible source rocks, will show a much higher resource estimates for the basin.

7. Petroleum Potential of Call for Bids NL13-01 Parcels 1

The C-NLOPB Call for Bids NL13-01 was issued in the spring of 2013 for a large parcel situated offshore Newfoundland, on the Grand Banks and Flemish Pass bathymetric features (http://www.cnlopb.nl.ca/pdfs/nl1301.pdf and Figures 19 and 20). The parcel contains one dry exploration well (Tuckamore B-27) and two other unsuccessful wells just south of its border (Gabriel C-60 and Lancaster G-70). However, medium to large size oil and gas discoveries have been drilled to the northeast and southwest of the parcel.

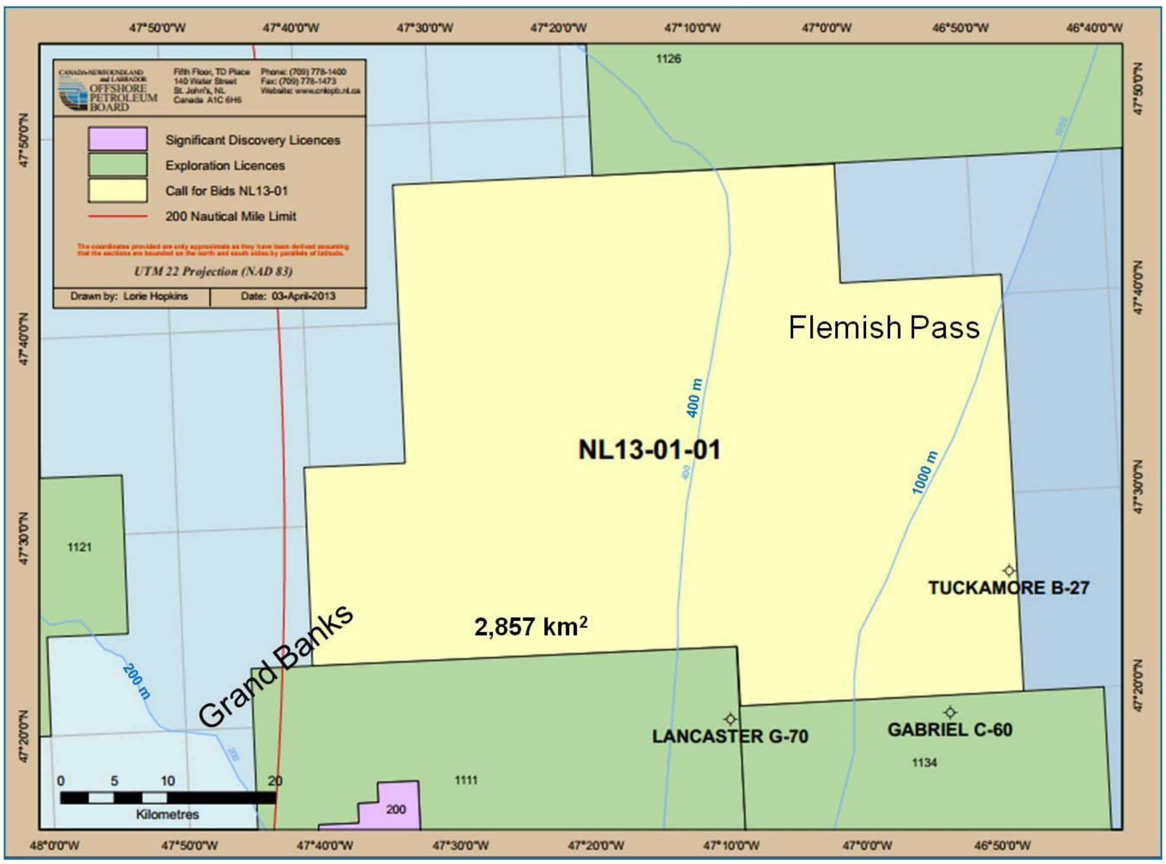


Figure 19. Call for Bids NL-01 Parcel 1 located in Flemish Pass Basin and Central Ridge (after C-NLOPB).

This chapter contains a description of the CFB NL13-01 Parcel 1 located in Flemish Pass Basin (Gabriel Subbasin) and Central Ridge, summarizes the well results in the basin and vicinity, identifies the available seismic coverage of the exploration parcel, introduces elements of seismic interpretation on two representative seismic lines and provides a description of the parcel's petroleum potential.

7.1. Parcel Description. 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 and this is the case for Parcel 1.

The Parcel 1 is located in the southern part of the Flemish Pass Basin (Gabriel Subbasin in Figures 13, 19 and 20) abutting the Husky operated EL 1134 in the south, and Statoil operated EL 1126 in the north. The parcel is located in shallow to intermediate water depths, on the Central Ridge and Flemish Pass, both hydrocarbon proven structural units of the Mesozoic rift system (Figure 20). The parcel covers 2,857 km^2 (706,385 acres) and is 122.6 times greater than a standard Gulf of Mexico exploration tract. Parcel 1 contains one large Mesozoic prospect and several leads and is covered by a dense 2D seismic grid of both old and new data and partially by a 2001 3D survey (http://www.cnlopb.nl.ca/pdfs/nl1301.pdf).

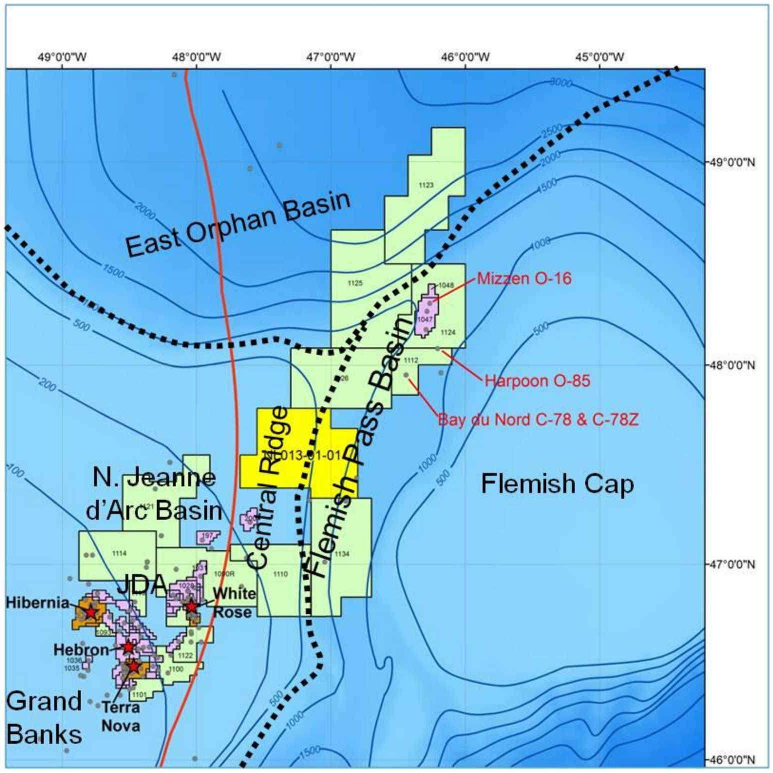


Figure 20. Location of the NL13-01-01 parcel within the Mesozoic Flemish Pass Basin and Central Ridge. The dashed black line represents a tentative border between the Flemish Pass Basin, East Orphan Basin and Grand Banks structural units.

Call for Bids	**Area**	**Area**	**Area**	**GOM tract**
CFB NL13-01	hectares	sq km	acres	multiples
Parcel 1	**285,864**	**2,857**	**706,385**	**122.6**

Table IV. Call for Bids NL13-01 Parcel 1 area statistics.

It is worthy to highlight the areal extent of the parcel and the fact that it is perfectly aligned in a NE-SW direction with the Jeanne d'Arc and Flemish Pass oil fields and discoveries. This is the direction of the Late Jurassic rifting and the general distribution of the prolific source rocks on the Atlantic Margin.

7.2. Significant Wells. 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.). These companies and their predecessors or affiliates have drilled in the Flemish Pass Basin or on the adjacent Central Ridge (Tables I and II; Figures 2 and 3). Nine exploration wells (if the C-78 and C-78Z are considered as a single location), and one delineation well have been drilled in the Flemish Pass Basin (Figures 7 and 13, Tables III and V).

Well	**Location**	**Drilled**	**Water**	**Status**	**TD m**
Exploration		**year**	**Depth m**		
Gabriel C-60	Flemish Pass B	1979	1109	Aband.	5171
Baccalieu I-78	Flemish Pass B	1985	1093	Aband.	5135
Kyle L-11	Flemish Pass B	1986	1119	Aband.	4050
Lancaster G-70	Flemish Pass B	1986	726	Aband.	5701
Tuckamore B-27	Flemish Pass B	2003	1134	Aband.	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
Harpoon O-85	Flemish Pass B	2013	1161	Suspended oil?	3377
Bay du Nord C-78	Flemish Pass B	2013	1166	Aband. oil?	3510
Bay du Nord C78Z	Flemish Pass B	2013	1172	Suspended oil?	3664
Delineation					
Mizzen F-09	Flemish Pass B	2011	1067	Aband.	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

Table V. Exploration and delineation wells in the Flemish Pass Basin and environs (as of spring of 2014). The Harpoon and two Bay du Nord wells drilled in 2013 were publically announced as oil discoveries but are still confidential wells (the question mark behind their status reflects this situation; B = Basin; N = North).

More information on the ten wells are found in the C-NLOPB's Schedule of Wells (2014) (http://www.cnlopb.nl.ca/well_alpha.shtml) and in Natural Resources Canada's (NRCAN) Basin Database (http://basin.gdr.nrcan.gc.ca/wells/index_e.php).

The only NL offshore deepwater oil discovery made in 2009 was at the Mizzen O-16 well in the northern Flemish Pass Basin (Baccalieu Subbasin; Figure 11 and Tables III). The primary objectives for the Mizzen O-16 and F-09 wells were the Early Cretaceous and the Tithonian-aged 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 discovery well and F-09 delineation well.

The Mizzen O-16 well tested at 3774 bopd of 21-22° API oil from a 25 m section of Tithonian sandstone (Ti-3) encountered from 3201 to 3245 m. This prolific sandstone has an average porosity of 21% (15 to 32% range) and average permeability of 1.2 Darcy (Gruschwitz et al., 2013). While thickly bedded and showing excellent reservoir properties, 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 delineation well, Mizzen F-09, was drilled in 2011 approximately 5 km northeast of O-16. The well intersected four water bearing Tithonian quality reservoirs and then terminated in Tithonian shale. The producible Ti-3 reservoir encountered water and residual oil.

Exploration wells Harpoon O-85, Bay du Nord C-78 and C-78Z were all drilled in 2013 and encountered light oil (Figure 11 and Table III). According to the C-NLOPB Schedule of Wells all were deviated wells, which is probably due to the fact the wells were targeting multiple reservoirs and/or straddling two or more fault blocks/exploration licences.

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

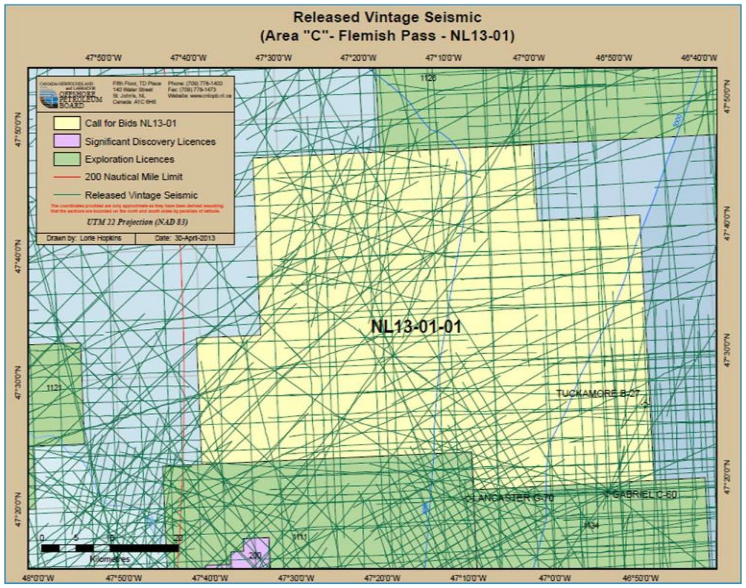
An older oil discovery at South Tempest G-88 on the Central Ridge flow-tested 1250 bopd of 42° API oil from the interval informally named “Tempest” sandstones. These sandstones are Kimmeridgian in age, and are intercalated with source rock intervals, which may exist above, between or below the sandstone layers. The 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 the Early Cretaceous Hibernia sandstone and the North Dana I-43 flowed 12.8 mmcfd and 292 bcd from the Lower Tempest sandstones.

7.3. Seismic Data Coverage, Quality and Availability. The Call for Bids NL13-01 parcel has good coverage through a relatively dense 2D seismic grid and partial coverage by a 3D survey. The grids evenly cover the shelf, the slope break (300-600 m), and the intermediate deep water (600 to 1150 m). Based on the lengths of the streamer used and application of modern migration algorithms, two vintage classes of seismic surveys exist in the basin:

1) the pre-modern data acquisition (pre-1998 or vintage data) and
2) the modern data acquisition (post-1998).

1. The pre-modern data acquisition (pre-1998) is characterised by the use of shorter cables, usually less than 4.5 km, a large space group interval and reduced number of channels. EM navigation was used on data collected in the seventies and eighties. The streamer was not steerable having only frontal and tail sensors at best. As such, feathering was quite a problem both during acquisition and data processing. Pre-1981 data was not migrated; data collected after 1981 was post stack time migrated for structural imaging. A basemap of the released vintage seismic data available on Parcel 1 and environs is obtainable from the C-NLOPB at http://www.cnlopb.nl.ca/pdfs/nl1301vintage.pdf.



Data quality for these surveys varies from poor to good. The seismic data deteriorates significantly under the post-rift unconformity with basement rotated blocks poorly imaged. Choppy or discontinuous reflectors abound. The fault planes and possible salt walls are not well rendered by these data vintages. Repeated water bottom and peg leg multiples are present under the shelf break and continental slope obscuring the synrift structures.

Figure 21. Pre-1998 released 2D seismic data over the NL13-01-01 parcel and adjacent lands (adapted from C-NLOPB). Large scale map and details of individual grids are available at http://www.cnlopb.nl.ca/pdfs/nl1301vintage.pdf.

Older seismic lines, acquired 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. 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 its successor HGS. These surveys were used to locate and drill the early wells in the Gabriel and Baccalieu subbasins and Central Ridge area. Some of these grids have been reprocessed in the past decade and are available for licensing.

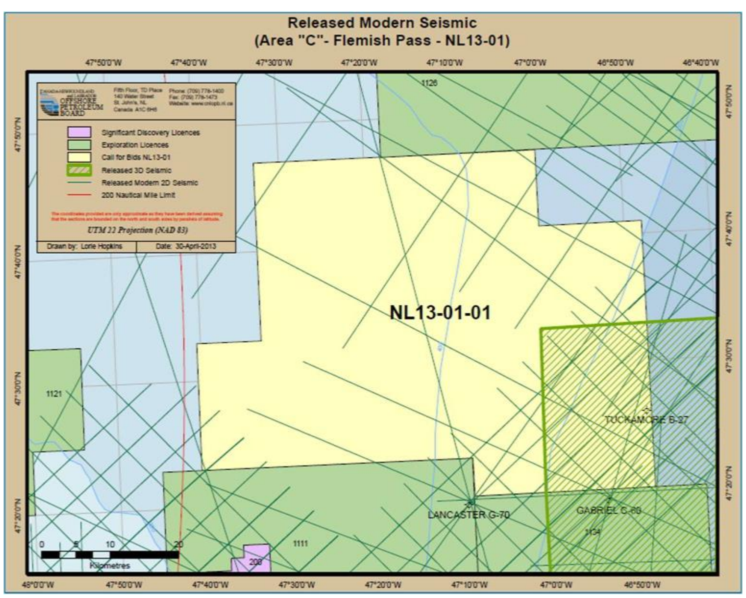


Figure 22. Post-1998 released 2D seismic data over the NL13-01-01 parcel and adjacent lands (adapted from C-NLOPB). This basemap can be found at http://www.cnlopb.nl.ca/pdfs/nl1301modern.pdf and details of individual seismic grids can be found at http://www.cnlopb.nl.ca/cfb1301.shtml

2. The modern data acquisition (post-1998) is characterised by the use of extended cables, usually longer than 4.5 km, a dense space group interval and a large number of channels (more than 240). GPS navigation is used throughout the survey. The streamer has an increased degree of steerability and multiple sensors are placed along it and, as such, feathering was not a major problem during acquisition and data processing. All modern data is at a minimum prestack time migrated and optionally depth migrated. A complete list of the released modern seismic data located on Parcel 1 and environs, together with survey details is available from http://www.cnlopb.nl.ca/cfb1301.shtml.

Additional 2D seismic data that are not shown in Figure 22 may be available from oil companies that were active in the area in the past decade (e.g. Chevron, Statoil, Husky, Exxon, BP and Encana) or from seismic contractors. In the southern corner of the parcel, a 3D seismic grid around the Tuckamore B-27 well is also available for licensing from Chevron and partners.

Data quality for these surveys varies from good to excellent. The longer cable allows better penetration and imaging of the synrift unconformity, synrift deformed infill and extended basement. The reflectors show better continuity. The fault planes, salt walls and salt bottom are much better represented after careful processing by these new data grids. The water bottom and peg leg multiples are better suppressed under the shelf break and continental slope allowing for better imaging of the synrift structures.

A list of exclusive and non-exclusive seismic surveys that are released and available from the data archive in analogue format is posted on the C-NLOPB website (e.g. http://www.cnlopb.nl.ca/cfb1301.shtml). Both company owned (exclusive surveys) and seismic contractor acquired surveys (non-exclusive, multi-client or speculative) are available for licensing to carry out regional and prospect seismic interpretation in the Flemish Pass Basin. The digital seismic files can be obtained from the data owners which can be: a) a single or a group of oil companies (e.g. Suncor, Statoil, Chevron, BP Canada, ExxonMobil, Imperial Oil, etc.), b) seismic vendors (e.g. Jebco, GSI, TGS, etc.), and 3) research organizations, which have been active in the area (usually GSC, or GSC partnership with foreign research groups).

Gravity, magnetic, satellite and wide-angle refraction, heat flow data, seafloor topography are also available, usually at the cost of reproduction, from various scientific organizations such as GSC, Canadian, US and European Universities, National Oceanic and Atmospheric Administration (NOAA).

Most recently (2011-2013), TGS and PGS (through Multi Klient Invest AS) with investment from Nalcor (the consortium) collected modern reflection data in under-explored basins such as the Labrador Sea, Orphan and Flemish Pass and licences the selected data to interested companies to encourage exploration in these areas (Carter et al., 2013). The regional survey operated by TGS covers the entire Flemish Pass Basin including Parcel 1 and the deep water regions east and south of the Flemish Cap (Figures 8 and 23).

This massive seismic program is managed and operated by TGS in partnership with PGS, both well-known global seismic contractors that have worked several large programs in the East Coast waters of Canada (see also Figures 8 and 23). The survey builds on a regional satellite seeps study carried out by EADS subsidiary Astrium GEO-Information Services (http://www.nr.gov.nl.ca/nr/publications/energy/nalcor_astrium_oil_seeps.pdf; Enachescu, 2011 and 2012; Atkinson et al, 2013). This satellite seeps survey was completed in the spring of 2011 and is available to interested parties directly from Astrium.

The seismic acquisition was carried out using the Norwegian seismic ship *M/V Sanco Spirit* built in 2009 and contracted by TGS. This vessel possesses modern S&E, navigation and seismic equipment. It uses the advanced PGS GeoStreamer® technology that has dual-sensors (hydrophones collocated with geosensors), recording both pressure wave and particle motion which allows reducing receiver-side multiples (http://www.pgs.com/en/Geophysical-Services/GeoStreamer-GS/).

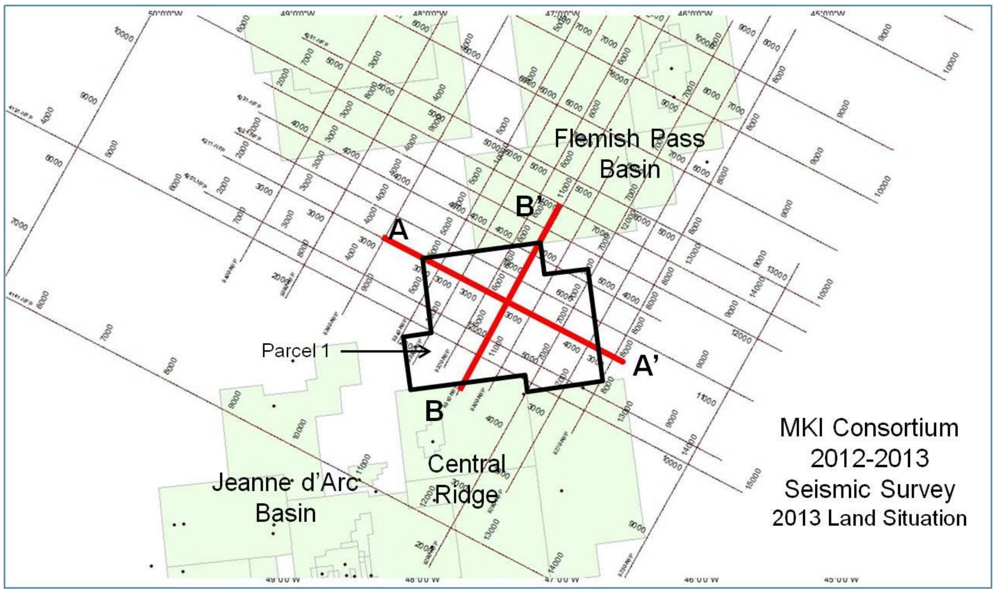


Figure 23. Modern seismic grid (2012-2013) over Parcel 1 and environs (land situation for fall 2013). The joint venture is composed of TGS, PGS (through MKI) with Nalcor as investor. Red lines indicate the location of seismic lines used to illustrate this report. Map and seismic lines in Figures 24 to 28 are courtesy of TGS in partnership with PGS.

In the first stage of processing the NL regional survey, PGS is applying a swell attenuation step followed by despike, linear noise attenuation and wave field separation. In the second processing stage performed by TGS special attention is given to multiple attenuation. The sequence includes: Tau-P decon for Water Bottom < 1500 ms, SRME, High resolution Radon demultiple, High resolution Tau-P demultiple, Residual demultiple on selected lines with steep drop off from shallow to deepwater and Radon demultiple. A final Kirchoff Pre-Stack Time Migration (PSTM) is applied (PGS personal communication).

Planning is underway to extend the regional survey to the central Grand Banks and Carson Basin in 2014. For data continuity, similar processing parameters and algorithms will be used for the 2014 survey. On completion, TGS, PGS and Nalcor will have circa 80,000 km multi-client data bank over the Newfoundland and Labrador offshore region, covering oil proven basins and other lightly explored but prospective basins. Gravity data is recorded simultaneously with seismic reflection data on regional long length seismic lines.

The vintage and modern seismic grids described and shown in Figures 21 to 23 can be used by industry geoscience professionals to tie reservoir and source rock markers to discovery wells, regionally map the subsurface and define prospects and leads in Parcel 1. A sample of modern reflection lines (2013) with basic interpretation will be presented in this report to illustrate exploration opportunities in the parcel (see Figures 18 and 19 and sub-section 7.5.).

7.4. Seismic Data Ownership. Call for Bids NL13-01 Parcel 1 has great coverage through a relatively dense 2D seismic pre-1998, post-1998 and recent grids (2009-2013). More than 15,000 km of 2D lines of various vintages are positioned on or in vicinity of the parcel. The maps in Figures 21 and 22 contain only the publicly released lines which are available by request in analogue format (paper prints) from the C-NLOPB (http://www.cnlopb.nl.ca/cfb1301.shtml).

In the Flemish Pass Basin, oil company 2D digital data is owned mainly by ExxonMobil (inheriting Mobil and Imperial databases), Suncor (inheriting the Petro-Canada data base), BP Canada (inheriting the Amoco database) and Husky (inheriting Husky/BowValley and Canterra databases). The older surveys recorded in the 1970s and early 1980s were used to locate the four initial wells drilled in the basin (Figure 7). Some of these surveys have been or can be reprocessed for improved resolution in the synrift sequence and better imaging of the prerift basement shape and the linked fault system.

Pre- and Post-1998 multi-client seismic data of good quality and with high penetration are available from several seismic contractors such as GSI, Jebco, TGS, Geco (now WesternGeco), Veritas (now CGG). Modern seismic data were collected and processed to pre or post-stack migration by these companies (http://www.cnlopb.nl.ca/cfb1301.shtml).

The most recent surveys executed by TGS in collaboration with PGS consists of long, dual streamer recording and lengthy listening time (18 seconds for long lines 10 seconds for shorter lines) and lengthy processing time (8 or 10 seconds). Therefore, the depth of imaging varies between 15 and 20 km depending on the sedimentary rocks' ages under the Base Tertiary Unconformity and basement constitution. This new data grid can help project source and reservoir markers from known discovery wells to less known basins, parts of the basins or individual exploration blocks such as parcel NL13-01-01.

When including all the historical lines, the extant 2D grid in Parcel 1 has a variable 1 to 2 km spacing in the dip direction and 2 to 4 km spacing in the strike direction (Figures 21 to 23). Portions of the parcel have even denser coverage. There are two main seismic grid sets in the parcel; one oriented NW-SE in the dip direction and a second one oriented W-E in the dip direction, with both grids having perpendicular strike lines. The only 3D survey in the basin acquired by Chevron in 2001 covers approximately 420 km^2 of the parcel's southeastern corner where the relatively shallow Tuckamore B-27 well (TD at 2903 m) is located (Figure 22).

Substantial additional data exists in digital format and is available from oil companies, geoscience organizations and seismic contractors (see also section 7.3.). These organizations can provide basemaps with proprietary seismic coverage and lists of prices for data licensing. Most contractors have their basin coverage on their website including availability of seismic data in the posted lands of the Flemish Pass Basin.

7.5. Seismic Interpretation. The C-NLOPB Call for Bids NL13-01 parcels 1 is located off the east coast of the Province of Newfoundland and Labrador, Canada, in a region designated as Area "C" – Flemish Pass Basin, at the time of issuance but now located in the Eastern Newfoundland region of the Scheduled Land Tenure Regime. This parcel includes parts of the Central Ridge, Flemish Pass Basin and the slope area between the two.

The parcel is situated in water depths ranging from 230 to 1140 m. The sheer size of the parcel (2,857 km^2 or 706,385 acres, which is 122.6 times greater than a standard Gulf of Mexico exploration tract) makes this Call for Bids one of the largest current offering on the Atlantic margins abutting known oil discoveries (Figures 20). If one superimposes the parcel outline over the Jeanne d'Arc Basin, the surface will cover the Hibernia, Terra Nova, Hebron and several other medium and small size oil fields and discoveries (Figure 24). This is large even using offshore Canada Frontier standards!

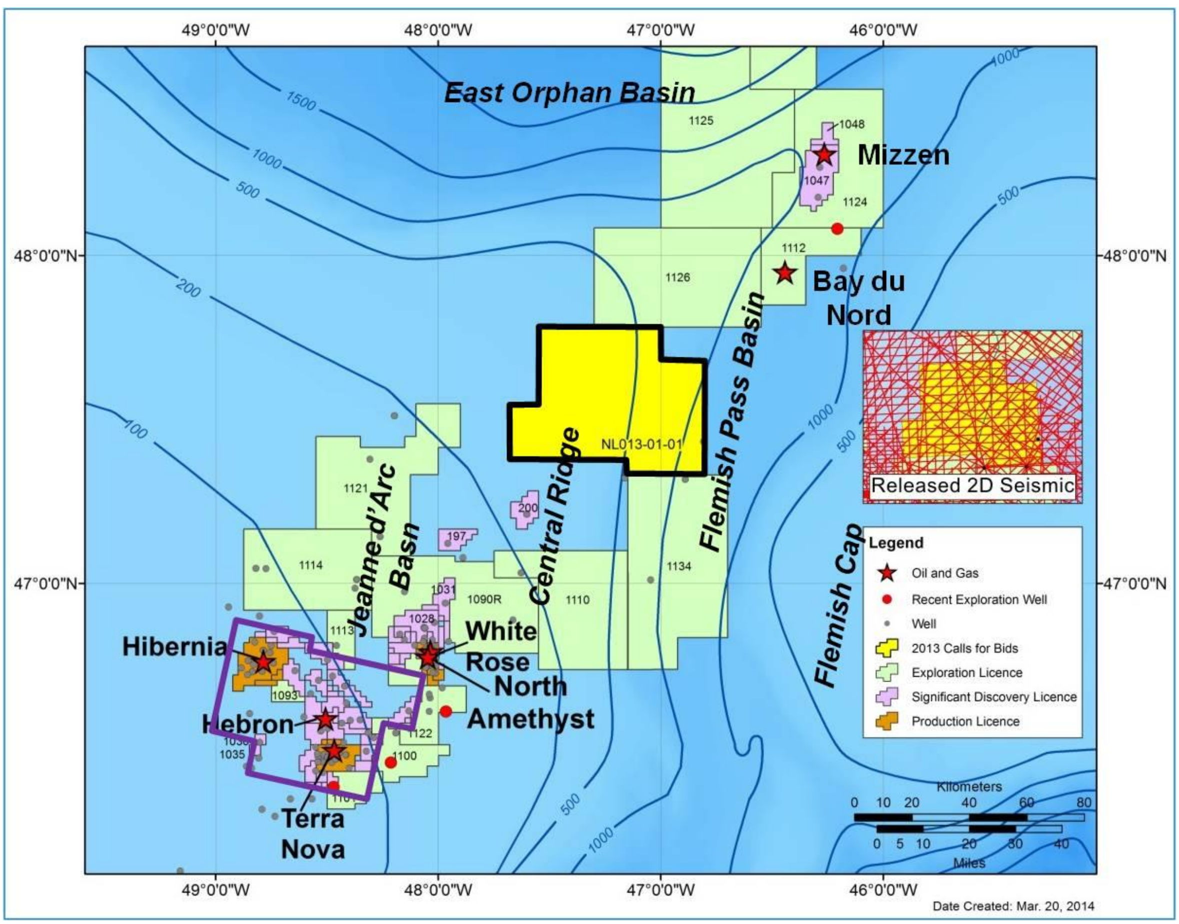


Figure 24. Size comparison between the CFB NL13-01-01 parcel and south Jeanne d'Arc Basin (JDB) including giant oil fields Hibernia, Terra Nova and Hebron, and several other medium and small fields (purple polygon represents Parcel 1)

Active Exploration Licences are juxtaposed to the north (EL 1126) and south (EL 1134) of Parcel 1. Both the basin and the ridge have working petroleum systems as proven by large oil discoveries found northeast of the parcel (Bay du Nord, Harpoon, and Mizzen) and oil and gas discoveries found to the southeast of the parcel (North Dana, South Tempest, and Trave).

The parcel comprises thick Mesozoic successions and contains large petroleum prospects and leads which are covered by a relatively dense 2D seismic grid and only partially by a 3D survey. Good to excellent quality seismic coverage exists for Parcel 1 (Figures 21, 22 and 23), allowing the interpretation of several regional markers and the mapping of large, drillable features.

Previously published seismic sections and geological cross-sections in the Flemish Pass Basin show the presence of a thick synrift sequence (Late Triassic to Early Cretaceous) which fills the grabens and overlies the horsts, ridges and, in the south, salt diapirs (e.g., Grant et al., 1988; Enachescu 1987, 1988, 1992a and b, 2010, 2011 and 2012; Keen et al., 1987; Keen and de Voogd, 1988; Tankard and Welsink, 1989; Atkinson and Fagan, 2000; Foster and Robinson, 1993; McCracken et al., 2000; Louden, 2002; Edwards et al., 2003; Enachescu and Fagan, 2005; Enachescu et al., 2005a and b; Hogg and Enachescu, 2008; Lowe et al., 2011; Enachescu et al., 2012; GeoArctic, 2013).

The published regional seismic lines demonstrate that the synrift sedimentary sequence in the Flemish Pass Basin is deformed by extension, transtension, and salt tectonics (in the south only) and is segmented by a high number of linked faults. Numerous faulted anticlines, roll-overs and basement cored anticlines are imaged (e.g. Figures 25, 26 to 29). The postrift sequence is contained within an elongated NNE-SSW saucer-like depression located between the Central Ridge and Flemish Cap basement highs. The Central Ridge is covered by at least 10 km of sediments while the Flemish Cap is a bald and shallow basement high.

The two seismic lines A-A’ and B-B’ illustrated in this report were tied with synthetic seismograms to several exploration wells in the Flemish Pass Basin and Central Ridge area. Due to thick, deformed and faulted sedimentary cover, the prerift basement (likely Precambrian, possibly early Paleozoic in places) is difficult to interpret on both older and modern data.

All Grand Banks’ archetypal Mesozoic successions (Late Triassic to Quaternary) are present in the Call for Bids parcel. To date no salt has been penetrated in the Flemish Pass Basin but indications of the presence of Argo salt exists in certain parts of the seismic sections from the Gabriel Subbasin and the Central Ridge. Several regional unconformities are prominent (e.g. Base Tertiary, Cenomanian, Avalon, Tithonian, etc.). On the seismic sections illustrated, only a few markers and ages of seismic sequences are indicated. These are marked on the representative sections and displayed together with the major faults (e.g. Figures 18, 19, 21, and 25 to 29). The Avalon Unconformity is a reasonable marker that allows approximate separation of the synrift and postrift sedimentary sequences. Seismic data quality is good to excellent in the Late Jurassic to Tertiary sequences but deteriorates in the Late Triassic - Late Jurassic interval.

The interpretation of the vintage and modern seismic grids over the parcel shows the presence of the Late Jurassic seismic sequence that contains the source rock. This sequence is most evident in several depocenters located both on the slope and in the Flemish Pass (Figure 25 to 29).

Occasionally, on top of rotated blocks and horsts and on the Central Ridge, the uppermost Jurassic rocks are eroded by the Avalon Unconformity. Several crustal penetrating listric normal faults affect the basement and the synrift sequence accompanied by numerous secondary faults (Figures 18 and 19). The resulting rotated blocks create large anticlinal features and horsts which are the main exploration targets in the area. The major and secondary faults are easily traceable on quality seismic data.

As the Flemish Pass Basin local stratigraphy is not well defined due to lack of wells in deeper water and concentration of past drilled wells on highs, the Jeanne d'Arc Lithostratigraphy Chart may be used to identify seismic stratigraphic sequences in the Call for Bids area (Figure 15). A more specific, locally applicable litho-stratigraphy was introduced by Hogg (2001) which was developed prior to the drilling of Mizzen L-11. A more updated lithostratigraphy focused on the northern Flemish Basin (Baccalieu Subbasin) that may be used for identifying the seismic markers in Parcel 1 was presented by Statoil (e.g. Cody et al., 2013).

High quality multi-client 2D grids and the lone exclusive 3D seismic survey allow for mapping of several unconformities, formation tops, carbonate intervals, salt and sandstone markers such as: Base Tertiary, Petrel, Avalon Unconformity, "O" Marker, Gabriel Sandstone, Top Jurassic, Middle Jurassic and Lower Jurassic. In this report, the Argo Salt and the Economic Basement are mostly ghosted on the interpreted lines. Some of the seismic markers are widespread and have good quality; some are poor in places and have to be tentatively traced.

As subsurface mapping was beyond the scope of this report, only a tentative interpretation of two representative seismic lines with assigned age of geological units is used mainly to emphasize the presence, type and size of the hydrocarbon traps (Figures 23, 25 to 29).

A portion of a 2D regional dip line (A-A') and a portion of a 2D regional strike line (B-B') is used to illustrate the structural style, seismic stratigraphy and trap potential on the parcel. The two portions of lines utilized are segments of longer regional lines centred in Parcel 1 both acquired and processed by TGS and PGS. These lines were selected from the extensive modern grid that allows subsurface mapping of Late Jurassic-Early Cretaceous coarse intervals and adjacent migration kitchens.

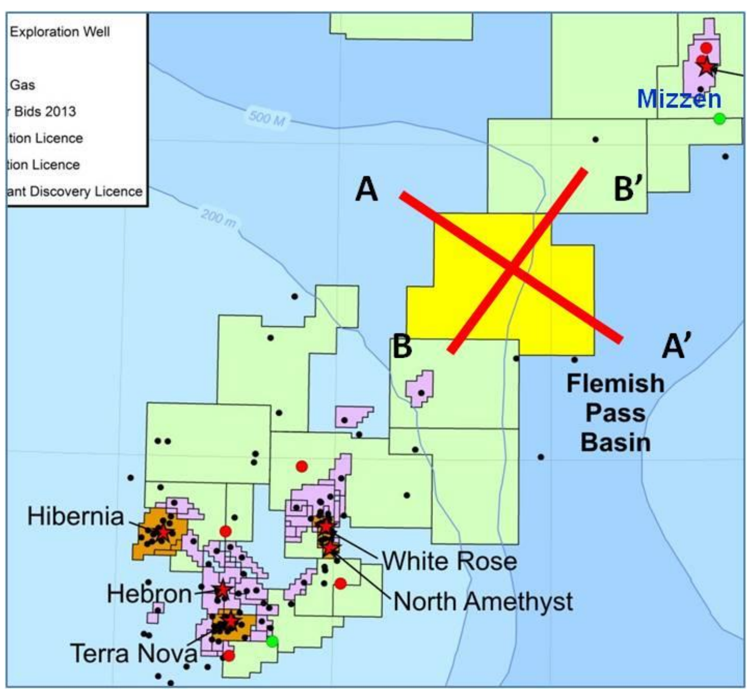


Figure 25. Location of two representative regional seismic lines A-A' and B-B' used to illustrate the petroleum potential of the Call for Bids Parcel 1 (red lines). The uninterpreted and interpreted variants of these sections are shown in the following Figures 26 to 29.

To evaluate the potential of the Call for Bids parcel, the seismic data can be purchased from seismic contractors and vendors ("spec companies"), brokers or oil company owners as digital SEG-Y files. Certain older data can be obtained in hardcopy (paper) format from the C-NLOPB office in St John's, NL.

7.6. Call for Bids NL13-01 Parcel 1 Hydrocarbon Potential. The parcel is located off the east coast of the Province of Newfoundland and Labrador, Canada (Figures 2, 3 4, 7, 10, 13, 14, 19, 20, and 24). This region is administered by the C-NLOPB on behalf of the Province of NL and the Federal Government (http://www.cnlopb.nl.ca/pdfs/nl1302.pdf).

Active ELs exist both to the north and south and oil and gas discoveries were found to the north (Mizzen, Harpoon and Bay du Nord) and south (South Tempest, North Dana, and White Rose) of the parcel. Moreover the Parcel is located on a NW-SE trend that connects the large oil fields of the Jeanne d'Arc Basin and the new discoveries of the Flemish Pass Basin.

Parcel 1, located in the northwestern part of the basin, contains 285,864 hectares (706,385 acres) which is 122.6 times larger than a GOM OCS tract (3 x 3 square miles). The parcel is situated east of the Jeanne d'Arc Basin, within the Central Ridge and Flemish Pass Basin structural units, on the Grand Banks shelf and upper slope, and in the Flemish Pass bathymetric deep (maximum depth 1150 m) (Figures 20 and 24).

The parcel comprises thick Mesozoic successions and contains large petroleum prospects and leads which are covered by a relatively dense 2D seismic grid and partially by a 3D survey acquired in 2001 by WesternGeco on behalf of Chevron and its partners. More opportunities exist in the unlicensed region east of the present Call for Bids parcels.

The public domain and multi-client 2D seismic coverage is very good for this parcel (Figure 21 and 22). Only a small portion in its southeastern part is covered by 3D data. One well, Tuckamore B-27, was drilled in 2003 in the easternmost part of the parcel by the Petro-Canada (Suncor), Encana and Norsk Hydro (now Statoil) partnership targeting a Cretaceous rollover truncated by the Base Tertiary Unconformity in the downthrown block of a deep penetrating fault. The Avalon/Ben Nevis equivalent sequence was eroded at the location. The well encountered good reservoir between 2511 and 2875 m within the Gabriel Sandstone unit but was wet. The well bottomed at 2903 m in Valanginian shale (Whiterose Formation equivalent) without continuing to older reservoirs (Baccalieu, Jeanne d'Arc, etc.) or source rock depth (Kimmeridgian Egret Member).

There were two wells previously drilled in the basin just south of the parcel. The Gabriel C-60 well was the first well drilled in the Flemish Pass Basin in 1979 by Esso Resources (subsidiary of ExxonMobil). It was abandoned after encountering Early Cretaceous reservoir, later informally known as the Gabriel Sandstone, a time equivalent to the Hibernia Formation (Esso et al., 1981). A core cut in the interval 4436.5 to 4452m within a Gabriel sandstone reservoir, exhibits porosity in the 10-20% range and showed bleeding oil. When analyzed this oil indicated a Kimmeridgian source (Esso et al., 1981). The C-60 well TD'd in Fortune Bay shales, just short of encountering the Tithonian aged sandstone or Kimmeridgian source rock.

Drilled by Petro-Canada in 1986 on a high located on the slope between the Central Ridge and Flemish Pass Basin (water depth 726m), the Lancaster G-70 well missed the entire Cretaceous section. The Late Jurassic sequences starting with the Rankin Formation are located directly under the Base Tertiary Unconformity and contain a number of good porosity reservoir intervals within the Tempest Sandstone Member (3764 to 3789 m). Several other sandstones show porosity reduction due to cementation. The well penetrated two thick Kimmeridgian shale intervals separated by Tempest sandstones and then terminated in the older Voyager Formation shales (Callovian-Oxfordian).These three significant wells combined with other wells drilled in the vicinity (Table III), clearly indicate that good reservoirs and source rock intervals should be present in the parcel on offer.

The seismic data illustrating the petroleum potential of Parcel 1 was acquired by TGS with partners PGS and Nalcor during 2012. The acquisition parameters include: 2 ms sample rate, 10 second recording length, 25 m shot interval, 8.1 km streamer length resulting in a 162 nominal fold. Data is processed to Kirchhoff pre-stack time migration, with PSTM, angle stacks and PSTM gathers available for licensing. Gravity raw data and attributes are also available. Two portions of lines were made available by TGS in partnership with PGS for use in this report.

Seismic Dip Line A-A'. Segment A-A' of the multiclient regional grid is used to illustrate the basin setting and petroleum potential of Parcel 1 (Figures 25 and 26). The seismic dip line segment is oriented NW-SE. It starts in the west on unlicensed lands (250 m water depth) and crosses Parcel 1 diagonally, intersecting the Tuckamore B-27 location. The section then exits the parcel on the east and terminates close to the axis of the Flemish Pass bathymetric low (1050 m water depth). Recorded and processed in 2013, the line has excellent quality, allowing structural and stratigraphic interpretations of the synrift and post rift sequences.

The uninterpreted line (Figure 26) shows the deformation style in the dip direction within the synrift sequence on the Central Ridge, the Gabriel Subbasin and the intermediate slope between the two. Major, basement involved, down-to-basin listric normal faults and their imbricates create large segmented rollovers, rotated blocks and horsts that contain successions aged from Late Triassic to Late Cretaceous.

On the western part of section A-A' crossing Parcel 1, several exploration leads can be identified in the downthrown side of a major low angle listric fault originating on the Central Ridge. From west to east, a westerly dipping rotated block, a trap-door syncline and a horst can be interpreted (Figures 26 and 27). There is little chance of encountering Early Cretaceous beds in this sector of the parcel, but Late Jurassic sequences should be present. Similarly, three rotated blocks formed by upper imbricates of a major basement involved fault, may have in places, some but most likely a totally missing Cretaceous section under the Base Tertiary Unconformity.

The easterly dipping main fault, which straddles the slope domain, is probably the western bounding fault of the Flemish Pass Basin (Figures 26 and 27). In the hanging wall of this deep crustal basin-bounding fault, there are several compartments that have preserved a relatively thin Late Cretaceous sequence above the Avalon Unconformity. Early Cretaceous beds and a thick Jurassic sequence can be identified above what may be a Late Triassic synrift succession that may include stratified evaporites and salt pillows.

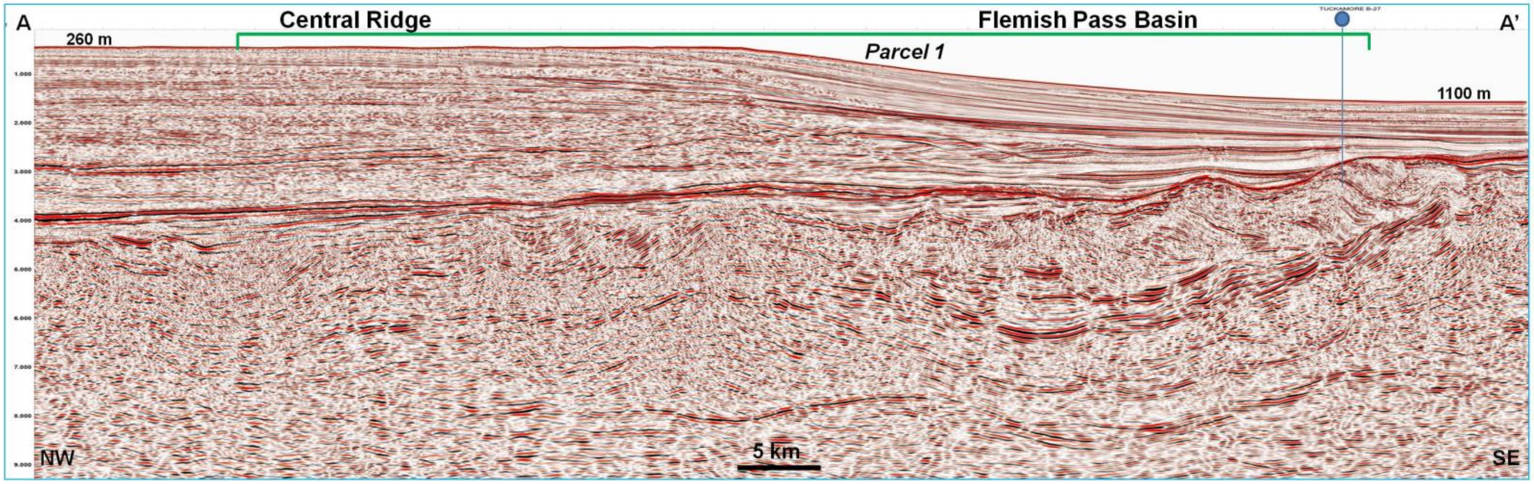


Figure 26. Uninterpreted 2D seismic line A-A' crossing all CFB NL13-01 Parcel 1 showing structural, tectonics and stratigraphic characteristics and possible drilling leads. For approximate line location see Figures 23 and 25. Line source: TGS in collaboration with PGS.

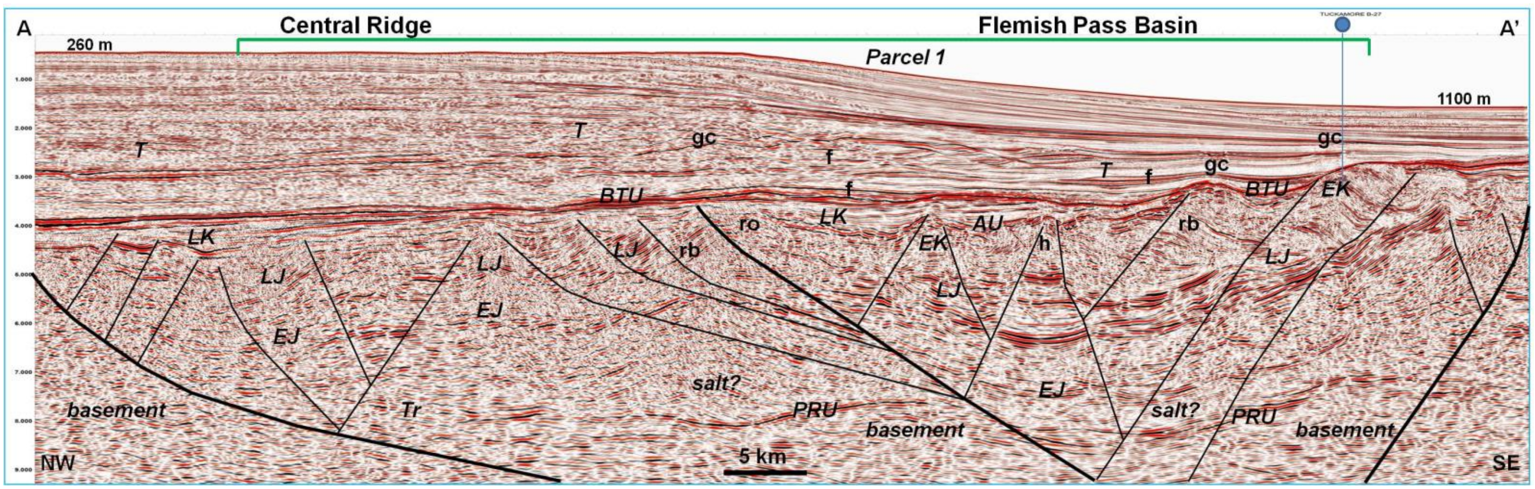


Figure 27. Interpreted 2D seismic line A-A' crossing CFB NL13-01 Parcel 1. The line shows the presence of several exploration leads such as horsts, roll-over anticlines and rotated blocks in the synrift sequences. Notations are similar to Figure 18. Additional notations are: ro = roll-over anticline, rb = rotated block, h = horst, f= sedimentary fan and gc = gas chimney. For approximate line location see Figures 23 and 25. Line source: TGS in collaboration with PGS.

A roll-over and two horsts are interpreted on the western flank of the basin (Figures 26 and 27). At least two large rotated blocks that have positive relief on the Base Tertiary Unconformity, can be mapped on the eastern part of the parcel. These blocks have Early Cretaceous beds truncated by the unconformity and the beds are normal faulted by down-to-basin faults. The easternmost block was drilled by the Tuckamore B-27 well that intersected a Gabriel sandstone immediately under the unconformity and bottomed before encountering the Jurassic sequence. The Tuckamore prospect remains undrilled for the Late Jurassic reservoirs and source rock intervals are likely present bellow the bottom of the B-27 well location.

Indications of Eocene basin floor and basin margin sedimentary fans of considerable size that may contain porous sandstone are seen on the dip line A-A' (marked with f) (Figures 26 and 27). However, up to now no significant Tertiary sandstone, porous limestone or chalk reservoir has been drilled in Flemish Pass Basin. The structural leads are 5-10 km wide and if they are well developed in a strike direction they can have a significant areal extent (25 to 100 km^2). Some of the structural leads have associated fluid indicators such as gas chimneys (gc).

Seismic Strike Line B-B'. The segment B-B' of the multiclient regional grid is used to illustrate the basin configuration and identify petroleum leads within Parcel 1 (Figures 28 and 29). The seismic strike line segment is oriented SW-NE (Figures 23 and 25). It starts just north of SDL 200 (North Dana I-43) in 350 m water depth, in a recently relinquished EL. The section then diagonally crosses Parcel 1, after which it exits the parcel on the northeastern corner and terminates in EL 1126 on the Sackville Spur bathymetric nose (1050 m water depth). The line was recorded and processed in 2013. Segment B-B' shows excellent quality when compared with older 2D lines in the area, allowing structural and stratigraphic interpretations of the synrift and post rift sequences.

The uninterpreted line (Figure 28) shows the deformation style in the strike direction within the synrift sequence on the Central Ridge, the Gabriel Subbasin and the Transfer Zone bounding the subbasin. A major, basement involved, down-to-basin listric normal fault and its associated synthetic and antithetic faults creates a large segmented rollover. This roll-over has several rotated blocks, horsts and grabens that contain successions aged from Late Triassic to Late Cretaceous. Near the northern end of the parcel, dense high angle faults mark the border of the Gabriel and Baccalieu subbasins and identify it as a Transform Zone (Figure 28).

On the interpreted line (Figure 29) only the crustal penetrating fault and their major antithetic and synthetic faults are shown. The large detachment starting in the southern part of the line creates a complexly faulted rotated block that might have a salt pillow or stratified evaporites in its core. Salt has not been drilled in this part of the basin, but salt related features are identified on the neighbouring Central Ridge and Morgiana Anticlinorium (Enachescu 1987, 1988 and 1992).

A faulted graben is identified in shallow water, in the immediate hanging wall of the crustal detachment. Several rotated blocks with Cretaceous cover are located under the prominent Base Tertiary Unconformity. In the core of the extensional duplex created by the low angle detachment, lies a large segmented horst, which contains a thick Jurassic succession. The rotated block and the central horst have a topographic expression at the Base Tertiary Unconformity and an associated gas chimney extends above the unconformity. The horst represents a significant exploration lead that aligns well with previous oil and gas discoveries.

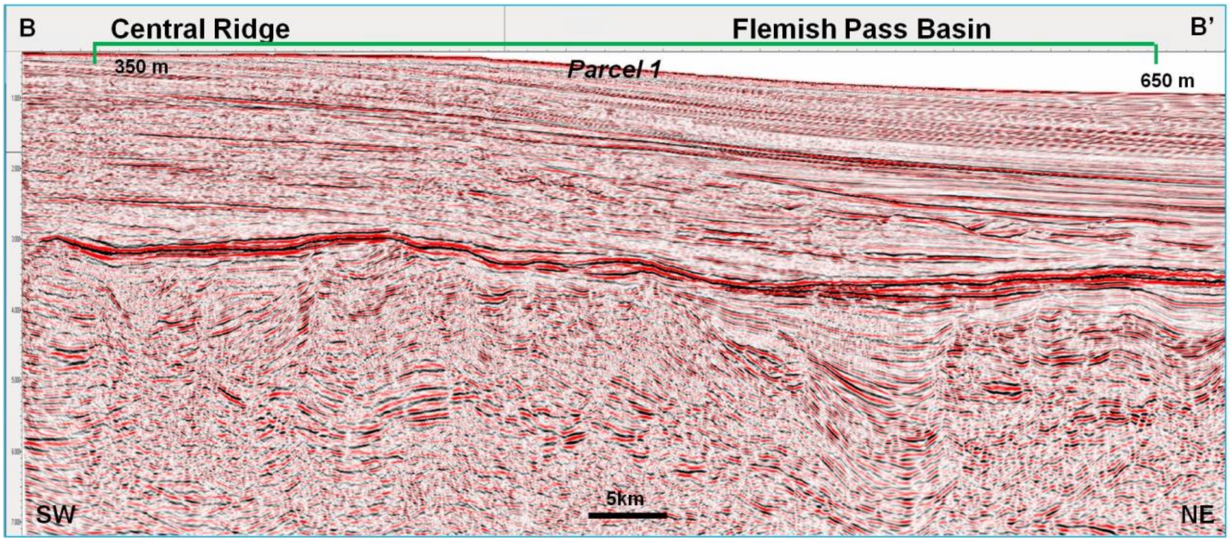


Figure 28. Uninterpreted 2D seismic strike line B-B' crossing all of CFB NL13-01 Parcel 1 showing structural, tectonic and stratigraphic characteristics and possible drilling leads. For approximate line location see Figures 22 to 25. Line source: C-NLOPB.

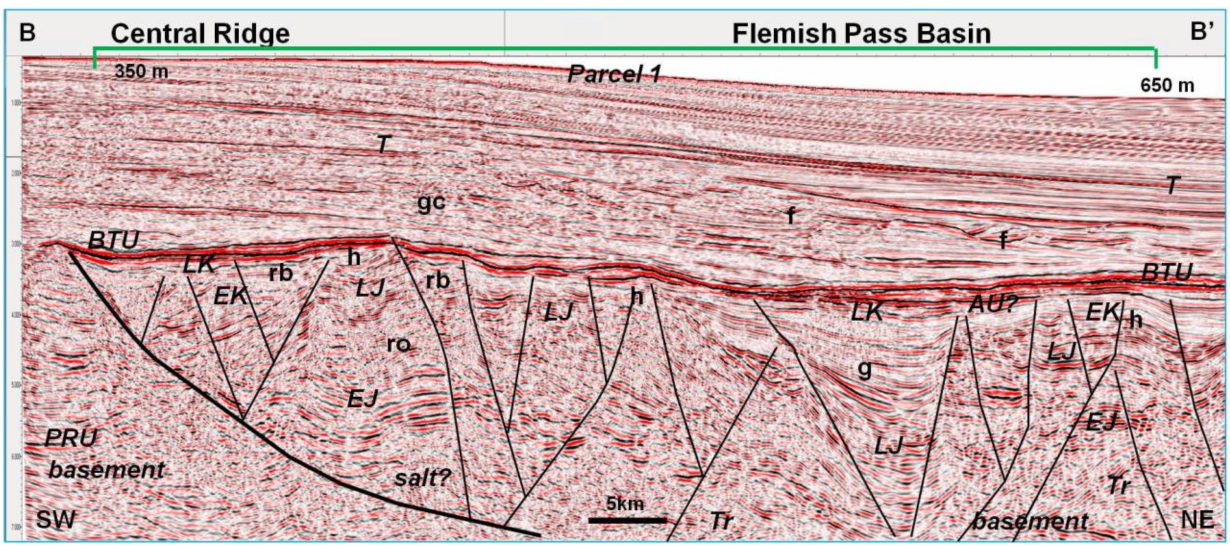


Figure 29. Interpreted 2D seismic strike line B-B' crossing all of CFB NL13-01 Parcel 1. The line shows the presence of several structural leads such as horsts, rotated blocks and trap-door synclines in the synrift sedimentary sequence. Notations are similar to Figures 18 and 27; additionally g = graben. For approximate line location see Figures 22 to 25. Line source: C-NLOPB.

The lower side of the detachment, also shown by the relief of the Base Tertiary Unconformity, forms the proper Flemish Pass Basin. The basin is dissected by at least two intersecting system of faults. These faults created numerous smaller structures that can be assembled in larger rotated blocks, horsts and grabens. A deeper graben occupies the north-central part of the section. The graben (g) contains mainly Late Jurassic and Early Cretaceous successions with minor amount of Late Cretaceous sediments sandwiched between the Avalon and Base Tertiary unconformities. This graben constitutes an excellent source rock kitchen for the Late Jurassic organic shale (Oxfordian to Tithonian aged).

The line terminates on its northeastern side in the Transform Zone marked by a NW-SE high belt (Figure 13). Before exiting the parcel, the seismic line shows a 15 km wide high block segmented by several high angle faults. The individual blocks and the entire anticlinal assemblage that ressamble a massive flower structure, contain Late Jurassic-Early Cretaceous beds and constitute an excellent lead. This large lead also aligns very well with many oil and gas discoveries in the Jeanne d'Arc Basin, Central Ridge and northern Flemish Pass Basin. There are strong Amplitude Anomalies at the apex of this anticlinal feature both in the Late Cretaceous thin cover and at the Base of Tertiary.

Several stratigraphic leads are interpreted within the Late Cretaceous and Early Tertiary sequences that may contain sandstone units, but this play is unproven to date.

7.7. Prospects and Leads. Several considerable size leads can be interpreted within the Late Jurassic to Early Tertiary basin fill in Parcel 1 using the available seismic grid. The two representative seismic lines discussed in this report (Figures 23, and 25 to 29) are part of several regular regional grids that together with other more irregular grids and the 3D survey (covering just the parcel's southeast corner) should allow adequate recognition and mapping of prospects and leads located in the parcel. 3D seismic data might be necessary to properly delineate the drilling targets.

With the limited 2D lines available, only several large leads and the Tuckamore Jurassic prospect were identified and discussed in the parcel (section 7.6.). Additional seismic coverage obtained from seismic vendors or oil companies will help interested companies to confirm the prospects and leads illustrated in Figures 26 to 29.

The most encouraging aspect for successful exploration of this parcel is the presence of a thick Late Jurassic sequence in the rotated blocks and in inter-ridge grabens that may contain mature source rocks and good quality Late Jurassic and Early Cretaceous reservoirs.

From the seismic examples, it is evident that several leads have significant lateral and vertical dimensions. Based on regional considerations, a multi-pay play is possible for some of these leads. The exploration leads visible on the two lines are 5 to 10 km wide and, if closed in both the dip and strike directions, they can contain large volumes of hydrocarbons. Using the available 2D seismic grid (Figures 5, 7, 20 and 23) it can be estimated that leads may be as large as 25-100 km^2. They benefit from two to three kilometers of Tertiary cover that should be sufficient for trap preservation and source rock maturity, as demonstrated by the new discovery found in the Baccalieu Subbasin situated immediately to the north of Parcel 1.

The typical hydrocarbon play in the basin and parcel is ***a structural high (extensional anticline, roll-over anticline, horst, rotated block, faulted anticline, salt anticline or drape anticline), with any of the Bodhrán (Jeanne d'Arc time equivalent), Baccalieu, Gabriel sandstones***

(primary target) and/or Late Cretaceous and Paleocene sandstone (secondary target) sourced from Late Jurassic (Oxfordian, Kimmeridgian, Tithonian-aged) marine source rocks).

The Flemish Pass Basin's main hydrocarbon play is structural. As shown by the previous discoveries in the basin and the seismic examples presented in this report, the play involves porous mid-Jurassic to Early Cretaceous sandstones trapped by listric fault triggered rotated blocks and roll-over anticlines. The leads described in Parcel 1 allow this play to be tested (Figures 25 to 29). The oblique slip experienced by the sedimentary fill complicate the anticlinal structures but also creates numerous migration pathways. Drape over the Jurassic anticlines of the Cretaceous formations may also contribute reservoirs.

The only known prospect in the parcel was drilled by the Tuckamore B-27 well that intersected wet Gabriel sandstone reservoirs immediately under the unconformity. The Late Jurassic potential of this prospect remains to be evaluate by drilling a 5 km deep well on the structure.

Stratigraphic leads in the synrift sequence are represented by possible reservoir beds being truncated by the Avalon or Base Tertiary unconformities, onlap of sand prone sequences on the sides of anticlinal features and porous sandstone lenses and ribbons within paleo-drainage systems. Within the post rift sequence, basin margin and floor fans within Late Cretaceous and Paleogene are plausible.

Source rocks are found at expulsion depths of 3000-6000 m beneath the mud line in deep basement grabens. Large structural closures in the parcel can be tested with a 3.5-5.5 km deep well that can intersect the most-likely reservoirs in the synrift sequence and also the potential of any shallower, postrift sandstone play.

Seals should not be a problem in the 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 this parcel are the quality of the reservoir and access to sufficient oil prone, mature source rock. These risks should be mitigated by the large size of the structural leads identified on the Parcel 1.

From the seismic examples presented it is evident that several leads have significant lateral and vertical dimensions. Based on regional considerations, a multi-pay play is possible for some of these leads. Using the available 2D seismic grid (Figures 21 to 23) one can estimate that leads will be as large as 25-100 km^2. They benefit from two to three km of Tertiary cover that should be sufficient for trap preservation and source rock maturity, as was recently demonstrated by the oil discoveries found in the Baccalieu Subbasin situated immediately to the north of Parcel 1.

The most encouraging indications for successful exploration of this parcel is the presence of a thick Late Jurassic sequence in inter-ridge basins that may contain mature source rocks and high porosity, high permeability reservoirs. Significantly, more structural exploration opportunities exist in the unlicensed region east and south of the present Call for Bid parcel, which will be beneficial to any company wishing to build an exploration prospect portfolio in this basin.

8. Discussion

The Flemish Pass Basin is an under-explored basin that has a drilling density of one well per 2000 km^2. Despite the recently announced light oil discoveries and the large SDL assigned to the Mizzen discovery, the basin is still at an early frontier stage of exploration. Only 10 wells have been drilled in the basin with about half being drilled using modern 3D seismic data.

All wells drilled have intersected various good reservoir intervals ranging in age from Late Jurassic to Early Cretaceous. Late Jurassic sandstones ranging in age from Tithonian to Kimmeridgian age were drilled at the Mizzen L-11, O-16 and F-09, Lancaster G-70 and Baccalieu I-78 wells. It is conceivable that the Bay du Nord C-78 and Harpoon O-85 wells, located on the same exploration trend with the Mizzen structure, have oil reservoirs in similar Tithonian sandstones as described for the Mizzen field. The Berriasian-aged Baccalieu sandstones were intersected by the Kyle L-11 and Baccalieu I-78 wells, while the Valanginian to Barremian-aged Gabriel Sandstone was logged in the Gabriel C-60 and Tuckamore B-27 wells. The younger Albo-Aptian Avalon sandstone was seen in both the Baccalieu I-78 and Kyle L-11 wells (Table III).

With the exception of the Kyle L-11 well located on a basement ridge, all the deep wells in the basin have penetrated good quality source rocks of Kimmeridgian and/or Tithonian age (Table III). The distribution of the Late Jurassic can be mapped around the basin and on the eastern flank of the Central Ridge. The Panther P-52 well located on the Central Ridge's slope logged one of the thickest intervals of high quality source rock (Egret Member of the Rankin Formation) ever drilled on the Grand Banks.

The parcel on offer is 122.6 times larger than a Gulf of Mexico standard tract (Table IV). Good post-1998, high quality 2D seismic coverage in the parcel is publicly available to image and map hydrocarbon traps. Additional high quality digital seismic data is available from seismic contractors. Parcel 1 has partial 3D coverage over the Tuckamore deep Jurassic prospect. The parcel needs further 3D coverage to map in detail all leads previously identified with 2D data.

The parcel is located in a region with large extensional and oblique-slip induced traps, known reservoirs, mature source rocks and proven migration paths. The parcel contains multiple reservoir targets within synrift/syndrift sandstone reservoirs at 3000-5500 m depth that can be drilled and tested using semi-submersible rigs or drill ships.

The recent on-trend, large size light oil discoveries in the intermediate deep waters of the neighbouring Baccalieu Subbasin at the Mizzen, Harpoon and especially Bay du Nord wells shine a new light on this underexplored part of the Flemish Pass Basin and on its favourable setting in the Late Jurassic marine source rock depositional belt.

Key exploration risks are recognized in regard to reservoir quality, source rock quality and fault sealing. With five ELs located to the north in the Flemish Pass Basin and several on the Central Ridge that contain undrilled prospects, the exploration logistics can be coordinated and the costs of mob/demobing drilling rigs or seismic vessels could be shared.

The cost of an offshore well in the parcel would likely be in the range of CAD $50- 80 million depending on the depth to the target. Additional costs will be incurred to test a discovery.

The Flemish Pass Basin in offshore Newfoundland still awaits its first oil field development. More exploration and delineation drilling around the discoveries are planned. Discussions on a possible Statoil/Husky championed project have already started. The basin is close to the industrial regions of Central Canada, Eastern United States and Western Europe holding one of the world's largest oil petroleum markets. Canada is a country with a stable political and financial system and has a long tradition in oil and gas exploration.

The Canadian province of Newfoundland and Labrador has a marine petroleum exploration tradition of more than 45 years. The Province has more than 15 years offshore oil production expertise that includes both Gravity Based Structures (at Hibernia and in construction for Hebron) and Floating Production Storage and Offloading Systems (Terra Nova and White Rose). The Province's royalty regime is well established and can be viewed at http://www.nr.gov.nl.ca/nr/energy/petroleum/offshore/offroyalties.html.

The Province obtains approximately 30% of its 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.

9. Conclusions

- Call for Bids NL13-01 Parcel 1 is located in the slightly explored eastern Central Ridge and within the Gabriel Subbasin of the Flemish Pass Basin
- The Flemish Pass Basin shows a similar tectonic and structural evolution to the adjacent Jeanne d'Arc Basin, including basement extension, synrift sediment deformation and salt diapirism.
- Basin fill and stratigraphic divisions are also similar to the neighbouring Jeanne d'Arc Basin and include equivalent reservoir and source rock formations; to date only the Late Jurassic reservoirs have been proven as prolific and they exhibit high porosity and excellent permeability.
- A proven petroleum system exists in the Flemish Pass Basin confirmed by the recent world-class discovery at Bay du Nord and the Mizzen SDL, situated north of Parcel 1.
- The structural make up of the basin includes deep basement penetrating faults, synthetic and antithetic extensional faults, highly rotated fault blocks, deep half-grabens and asymmetric horsts, all affecting the basement and the synrift sedimentary infill.
- Numerous structural traps are interpreted in the Gabriel Subbasin of the southern Flemish Pass Basin associated with 1) basement fragmentation and rotation due to recurring rifting of the Atlantic Margin and 2) oblique slip and partial inversion of extensional features. On the Central Ridge alongside extensional tectonics the movement of the Argo/Osprey evaporites have created or enhanced certain anticlinal features.

- Stratigraphic trap types such as slope and basin floor fans, sub-unconformity truncations and onlaps of sandstones on anticlinal flanks abound in the parcel.
- If quality reservoirs are discovered, these structural, stratigraphic and combination traps could contain reserves in the range of hundreds of millions to a billion barrels.
- Based on relation and continuity of sedimentation with Grand Banks basins and on the quality of the oil in the recent discovery, the Egret Member equivalent or/and other Late Jurassic source rocks should be present in the basin and when below 3000 m mud line, generate significant quantities of oil.
- The Gabriel Subbasin containing Parcel 1, is directly located on the predicted Late Jurassic source rock superhighway trend connecting the Grand Banks with Ireland and Northwest Europe offshore fields.
- Amplitude anomalies observed in the seismic sections in the Cretaceous and Tertiary successions are related to several of the identified structural or stratigraphic traps.
- The oils produced from the Grand Banks and tested from the recent Bay Du Nord and Harpoon discoveries are generally light sweet crude, with a density of 30-37° API, having a high percentage of aromatics and low sulphur content.
- A structural high (roll-over anticline, horst, rotated block, faulted anticline, flower structure or drape over anticline), with any of the Tithonian sandstone (Jeanne d'Arc equivalent), Baccalieu, Gabriel and Avalon sandstones (primary target) sourced from Late Jurassic marine source rocks (mainly Egret Member equivalent) is the main hydrocarbon play in the basin.
- Modern and older 2D and a portion of the 3D seismic coverage exist in the parcel for evaluating potential drilling targets. New data recorded with multiple attenuating dual sensor streamers by the TGS and PGS partnership can serve as a framework grid to tie the source beds and reservoir markers.
- In a joint study, the C-NLOPB and the GSC (2004) estimated that the Flemish Pass Basin's undiscovered petroleum resources were in the range of 1.7 billion barrels at a 50 percent probability, and with expected field sizes ranging from 528 to 44 million barrels. However, this study was performed on 1980s vintage, low quality seismic data and probably underestimates the basin's resource potential. Moreover the estimation did not include the eastern flank of the Central Ridge nor the region in the northern basin, where the border between the Flemish Pass and East Orphan basins is unclear.
- Interpretation of 2D and 3D seismic data in the parcel suggests that several undrilled leads as large as 25 to 100 km^2 (~ 6,180 to 34,595 acres) are present.
- The areal extent of Parcel 1 (approximately 122.6 times bigger than the Gulf of Mexico standard block) offered in this call, allows oil companies entrance in a lightly explored Atlantic margin basin, located in vicinity of large producing fields and recent discoveries and close to huge North American and European oil markets.
- This is a high-risk, high-reward, frontier exploration opportunity not unlike the acreage already licensed to the north in the Baccalieu Subbasin where high impact discoveries were made by the Statoil/Husky partnership.
- The Call for Bids NL13-01 Parcel 1 contains a variety of large and very large oil prospects and leads that can improve any oil company's portfolio of highly prospective drilling targets.

10. Further Reading

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Additional sources of information:

C-NLOPB website HYPERLINK: http://www.cnlopb.nl.ca

Newfoundland and Labrador Department of Natural Resources website HYPERLINK: http://www.nr.gov.nl.ca/nr/energy/index.html

C-NSOPB HYPERLINK http://www.cnsopb.ns.ca

IODP Information HYPERLINKS
http://www-odp.tamu.edu/publications/citations/cite210.html
http://www-odp.tamu.edu/publications/prelim/210_prel/210toc.html

GeoArctic, 2013 North Atlantic Plate Deformation Report

GeoArctic, 2013. A New Kinematic Plate Reconstruction between Ireland and Canada, Final Project Report, May, 2013 © *Irish Shelf Petroleum Studies Group (ISPSG) and Nalcor Energy*.

According to the report foreword "This study was carried out by GeoArctic Ltd and its subcontractors for PIPCO RSG Limited". The project was jointly funded by the Irish Shelf Petroleum Studies Group (ISPSG) of the Petroleum Infrastructure Programme (PIP) and Nalcor Energy, on behalf of the Offshore Geoscience Data Program (OGDP) with the Government of Newfoundland and Labrador. The report is copyrighted by ISPG and Nalcor Energy.

More information on this kinematic (deformable) plate reconstruction project and its deliverable can be obtained by contacting Nalcor Oil and Gas (http://www.nalcorenergy.com/oil-and-gas.asp), NL Department of Natural Resources (http://www.nr.gov.nl.ca/nr/energy/index.html), both in St John's, NL, Petroleum Infrastructure Programme (PIP) (http://www.pip.ie/page/1) in Dublin, Ireland or GeoArctic (http://www.geoarctic.com) in Calgary, AB.

GSC Atlas, Updated 2012

During the 1960s to early 1990s, additional geoscience studies were performed by researchers from the GSC Atlantic (Bedford Institute). They produced several regional papers which included the Flemish Pass Basin. The results were also entered into their comprehensive East Coast Atlas Series, Grand Banks of Newfoundland, published on the web between 1997 and 2004, updated in 2012 and available on the web from GeoGratis.

End Report