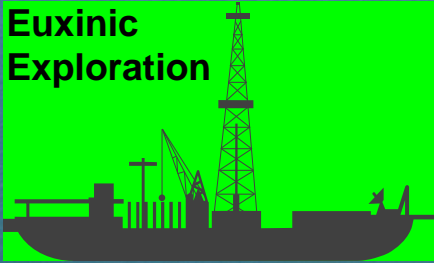


Petroleum Exploration Opportunities in Flemish Pass and Orphan Basins, Call for Bids NL10-02 and NL10-03 (Area “C” Flemish Pass/Central Ridge)

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P Geoph, P Geo
Euxinic Exploration**

**On Behalf of NL DNR
November 2010**

**Euxinic
Exploration**





Acknowledgements

- Wes Foote, Darrell Spurrell, David Middleton and Larry Hicks, for edits and suggestions
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- MUN, Pan-Atlantic Petroleum Systems Consortium (PPSC) , PR-AC
- GSC Atlantic
- Husky Energy, GSI, Landmark-Halliburton, Canstrat and IHS
- This work could not have been performed without public domain information kindly provided by GSC Atlantic, Government of Newfoundland and Labrador Department of Natural Resources and C-NLOPB



★ = approximate position of CFB NL10-02-01 and -02 and NL10-03-01 parcels

2010 Call For Bids Flemish Pass/Central Ridge Parcels NL10-02 & 03

- This is a power point presentation of the petroleum potential of Parcels NL10-02-01, NL10-02-02 & NL10-03-01 located in deep and ultra deep water in the Flemish Pass and East Orphan basins and offered for bid with the 2010 C-NLOPB Call for Bids as follows:
 - **Parcel NL10-02-01 (Parcel 1)** is situated in the southern part of the East Orphan Basin (Enachescu et al., 2004 and 2005)
 - **Parcel NL10-02-02 (Parcel 2)** is situated in the southern part the East Orphan Basin and northern Flemish Pass Basin
 - **Parcel NL10-03-01 (Parcel 3)** is situated in the northern Flemish Pass Basin

Observation. References introduced in this power point are listed in Section 2 of this presentation and are also contained in the earlier Call for Bids reports posted on the website:

<http://www.nr.gov.nl.ca/mines&en/oil/>

Presentation Content

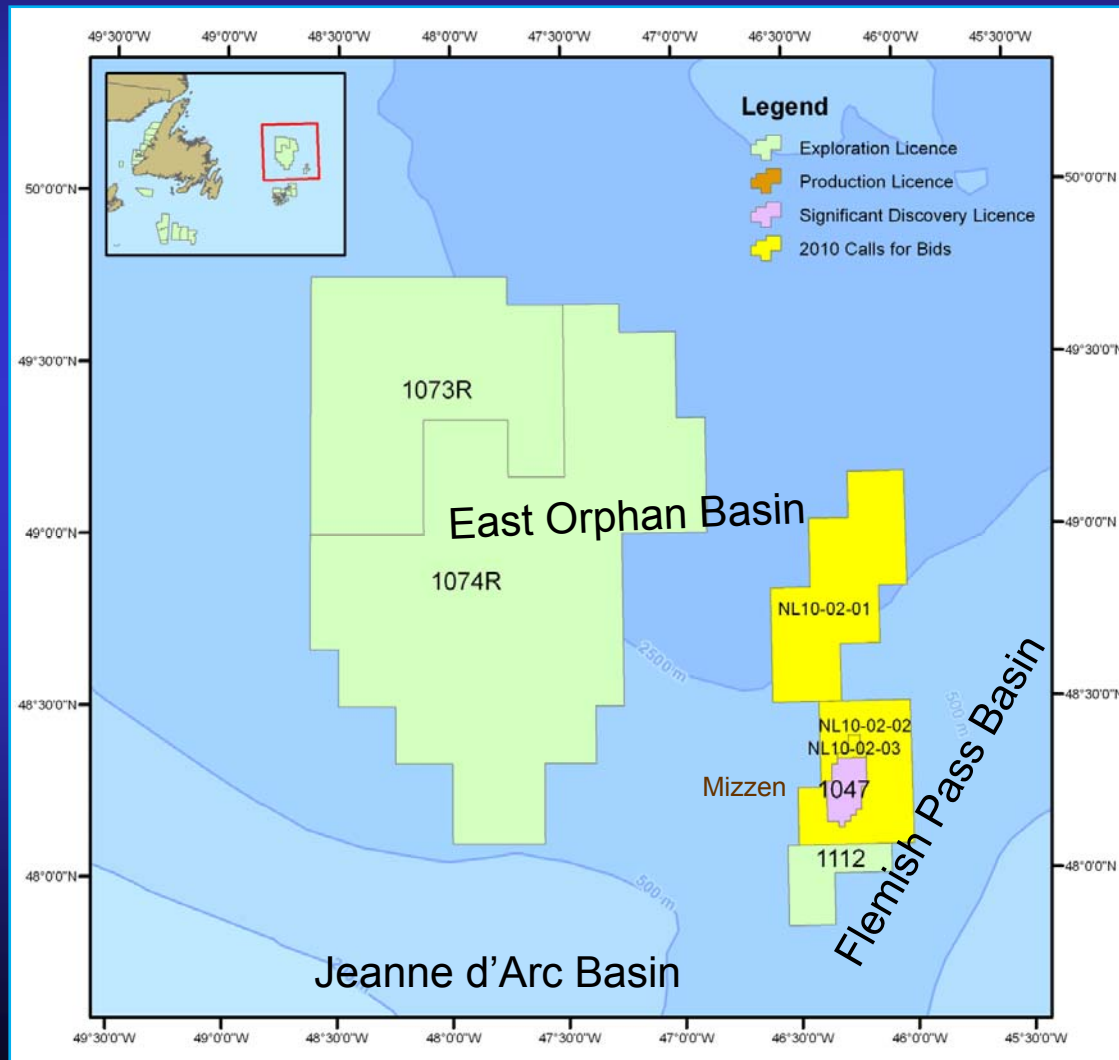
1. Introduction
2. Call For Bids Location
3. Exploration and Development Background
4. Geology Overview of Flemish Pass and Orphan basins
5. Petroleum Geology of Flemish Pass and Orphan basins
6. Petroleum Potential Call for Bids NL10-02
 - Parcel 1
 - Parcel 2
7. Petroleum Potential Call for Bids NL10-03
 - Parcel 3
8. General Discussion
9. Conclusions

Observation. Permission has been granted to use GSI seismic sections for this presentation. All plotting of wells on seismic sections and maps is approximate and all interpretations are that of the author

1. Introduction

- **CFB NL10-02-01 & 02-02** parcels offered at 2010 Call for Bids are two very large offshore blocks located in the northern Flemish Pass Basin and southern East Orphan Basin
 - **The NL10-02-01** parcel is located less than 20 km north of the Mizzen SDL 1047
 - **The NL10-02-02** parcel is located around the Mizzen SDL 1047
- The **NL10-03-01** is a small parcel located adjacent to the recent Mizzen SDL 1047
- In 2010, the SDL 1047 encompassing 22,006 hectares was awarded by C-NLOPB to Statoil (65%) and Husky Oil (35%) based on the results of the Mizzen O-16 well drilled in 2009 in the previous EL 1049
- The closest ELs to these parcels are located
 - Immediately south: EL 1112 (Statoil 65%/Husky35%)
 - To the northwest, in the East Orphan Basin: ELs 1073R and 1074R (Chevron operator 50%, EM/Imperial 30% and Shell 20%)

Flemish Pass/Central Ridge 2010 Call for Bids Location



- **CFB NL10-02:** consists of two large parcels located in deep and ultra deep waters of Flemish Pass and East Orphan basins northeast of Jeanne d'Arc Basin (JDB)
- **CFB NL10-03:** consists of one small parcel in continuation of SDL 1047 and located in deep waters of Flemish Pass Basin (FPB)
- **Call for Bids closes November 30, 2010 at 4 p.m. NL time**

Call for Bids NL10-02

- **NL10-02: Two Bid Parcels.**

Call for Bids NL10-02 contains two very large parcels located in the Area “C” Flemish Pass Basin (FPB)/Central Ridge offshore Newfoundland and Labrador:

- NL10-02-01 of 201,951 hectares (499,032 acres), located in 1900-3000 m water depth within the southern East Orphan Basin
- NL10-02-02 of 125,421 hectares (309,922 acres), located in 1000-1900 m water depth within the northern Flemish Pass Basin-southern East Orphan Basin

- **Call for Bids Closure.** The bid for these parcels will be concluded on **November 30, 2010 at 4 p.m. NL time**

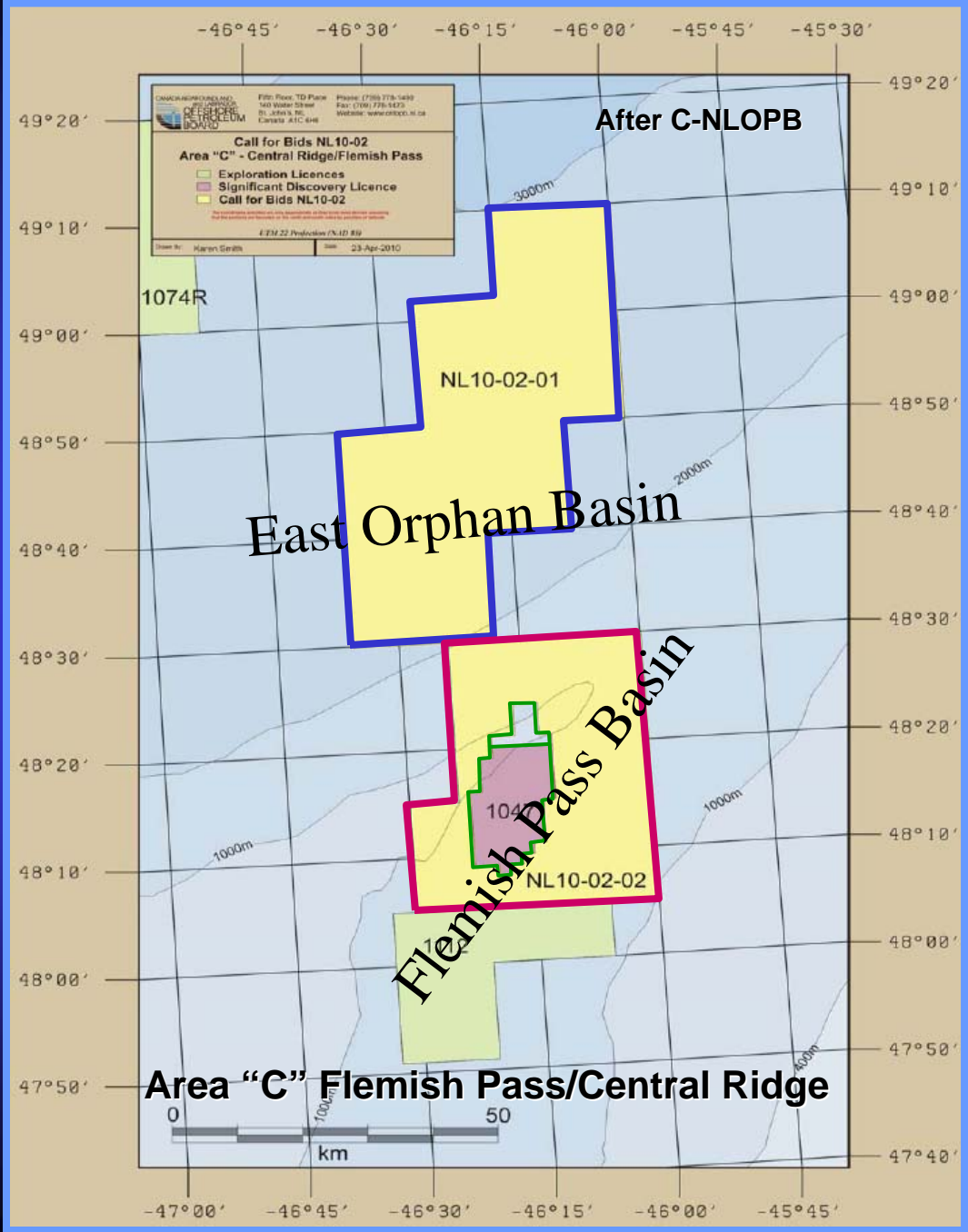
- **Minimum Bid: CAN \$ 1,000,000 (one million)** for each of **NL10-02** parcels in the Central Ridge/Flemish Pass area

More information on this Call for Bids can be found at:

http://www.cnlopb.nl.ca/news/pdfs/cfb10_02.pdf

Call for Bids NL10-02

Geologically, the
NL10-02-01 and
NL10-02-02 parcels
are located within the
northern Flemish Pass
Basin and southern
East Orphan Basin



Call for Bids NL10-03

- **NL10-03: One Bid Parcel.**

Call for Bids NL10-03 contains a small parcel located in the Area “C” Flemish Pass Basin (FPB)/Central Ridge offshore Newfoundland and Labrador:

- NL10-03-01 of 3,773 hectares (9,323 acres), located in about 1000 m water depth within the northern Flemish Pass Basin-southern East Orphan Basin

- **Call for Bids Closure.** The bid for these will be concluded on **November 30, 2010 at 4 p.m. NL time**

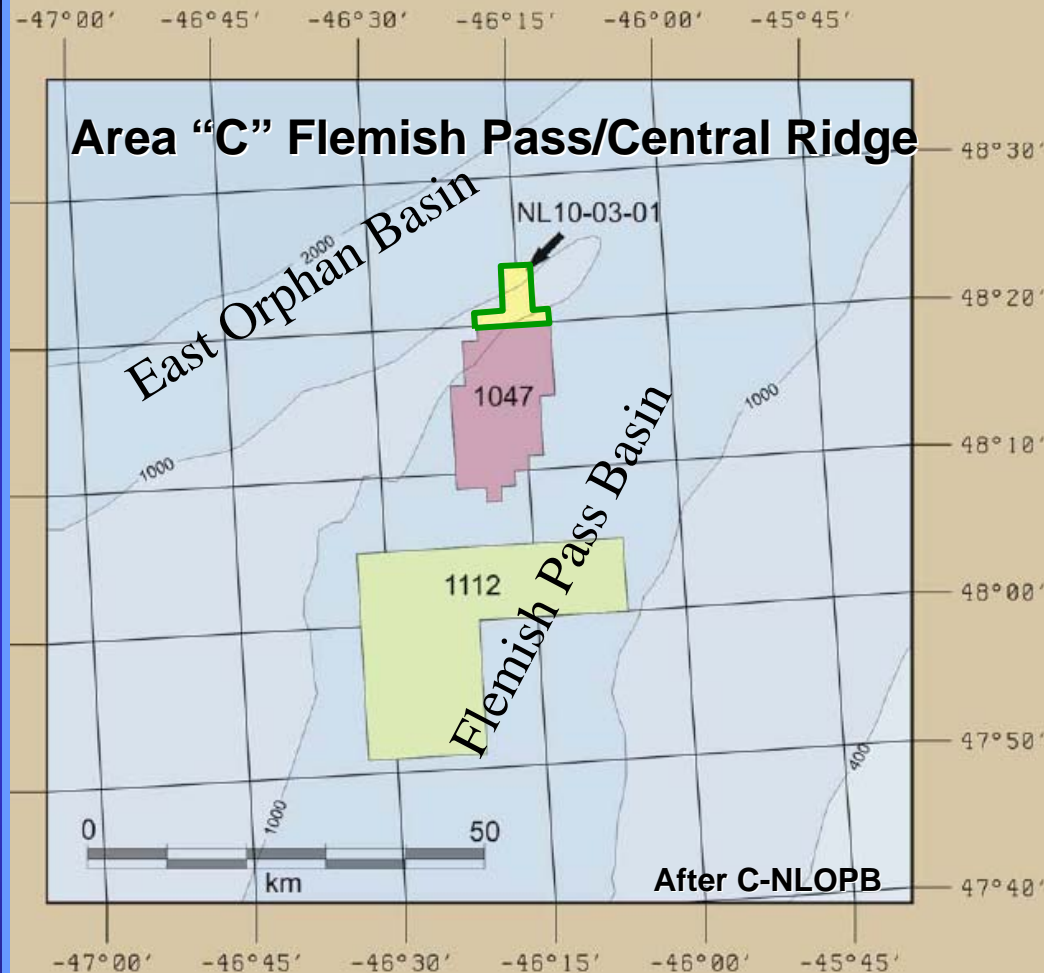
- **Minimum Bid: CAN \$ 1,000,000 (one million)** for Flemish Pass/Central Ridge Parcel 1

More information on this Call for Bids can be found at:

http://www.cnlopb.nl.ca/news/pdfs/cfb10_03.pdf

Call for Bids NL10-03

Geologically, the
NL10-03-01 parcel is
located in the border
area between northern
Flemish Pass Basin
and southern East
Orphan Basin



After C-NLOPB

CANADIAN PETROLEUM BOARD
OFFSHORE PETROLEUM BOARD

F28 Floor TD Place
140 Water Street
St. John's, NL
Canada A1C 0H8

Phone: (809) 779-1400
Fax: (709) 778-5473
Website: www.oopb-nl.ca

Call for Bids NL10-03
Area "C" - Central Ridge/Flemish Pass

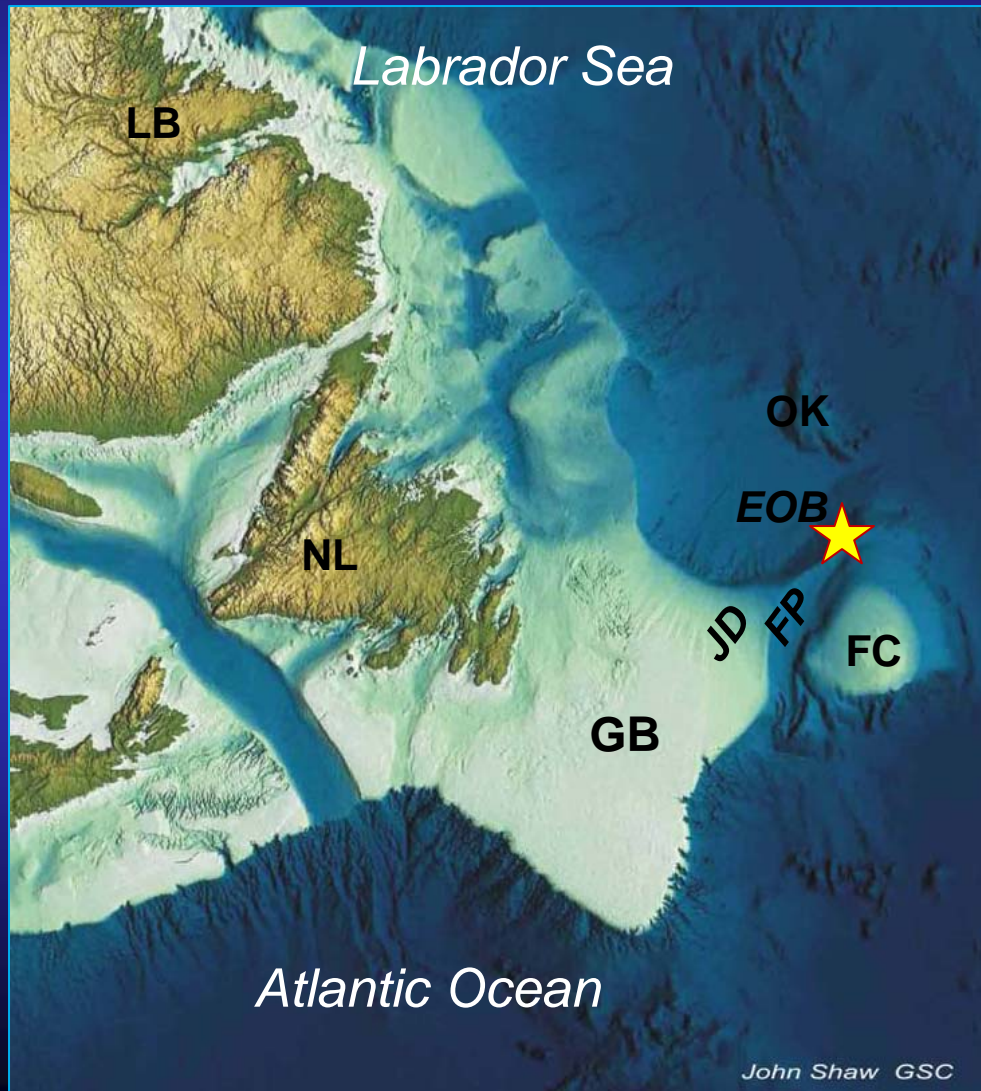
- Exploration Licence
- Significant Discovery Licence
- NL10-03 Parcel 1

The information provided on this map is for general information only and does not constitute an offer of any financial product or service. The information is provided for general information only.

ETM 22 Projective (N48 R1)

Drawn by: Karan Smith Date: 28-Apr-2010

2. Call For Bids Location



Location of NL10-02 & NL10-03 parcels on bathymetry map

NL = Newfoundland

LB = Labrador

GB = Grand Banks

FC = Flemish Cap

OK = Orphan Knoll

JD = Jeanne d'Arc Basin

FP = Flemish Pass Basin

EOB = East Orphan Basin

★ = Approximate location of NL10-02 & NL10-03 parcels

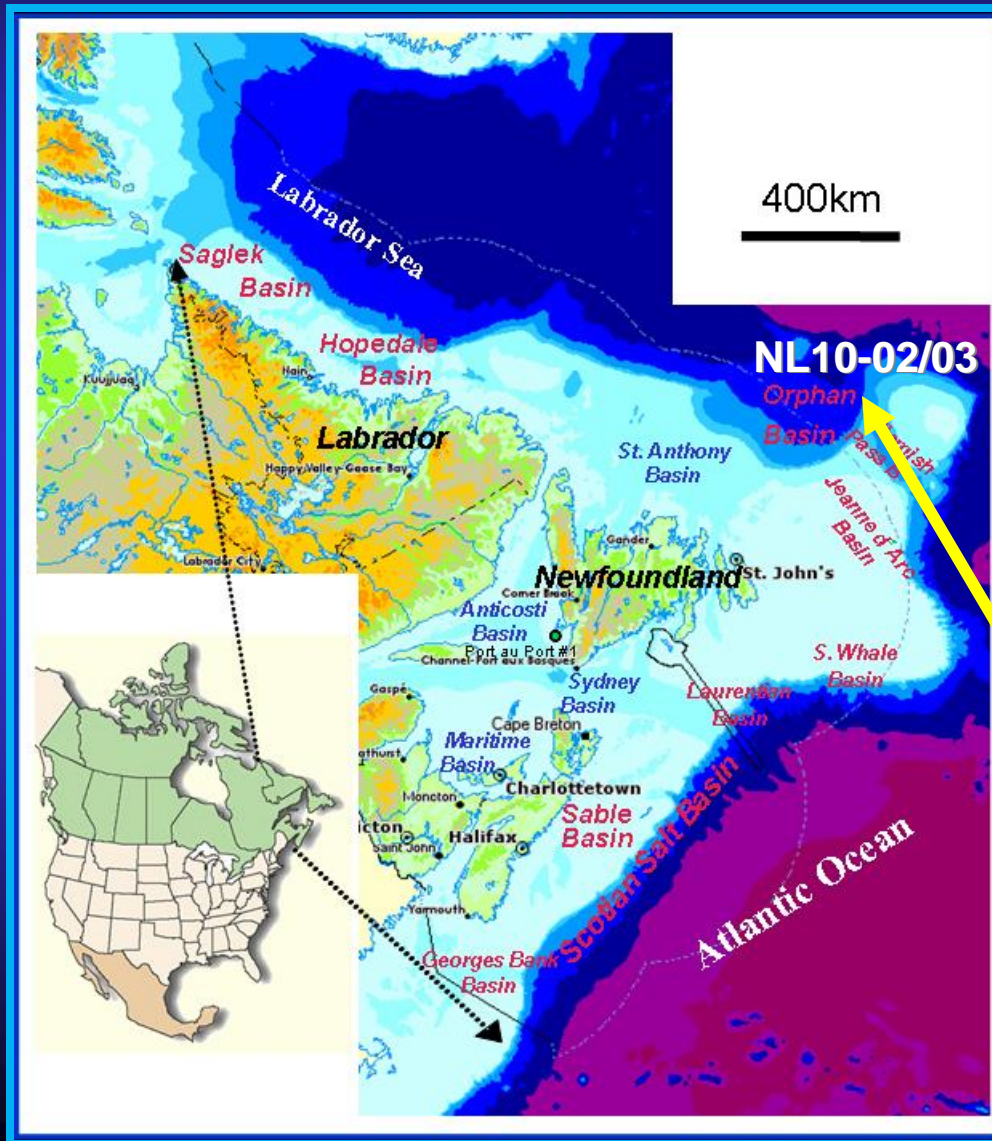
Comment on Parcels Location

- C-NLOPB Area designation for the bid location is: Area “C” - Flemish Pass/Central Ridge
- Geologically, the Parcel NL10-02-01 is located inside the East Orphan Basin while the Parcels NL10-02-02 and NL10-03-01 are located in the Flemish Pass/East Orphan basins border area. While the posting area was designated by C-NLOPB as Area “C” - Flemish Pass/Central Ridge, the parcels are not structurally situated in the Central Ridge area (see Enachescu, 1987), but within the two above mentioned basins which are in continuity of structural setting and stratigraphy and can be separated only based on bathymetry
- Thus, Flemish Pass Basin occupies the area situated in water depth between 1000 to about 1500 m, while East Orphan Basin lies in water depth greater than 1500 m

Call for Bids NL10-02 and 10-03

- **Flemish Pass is a proven petroleum basin.** This Mesozoic-Tertiary basin contains 1 discovery well (Mizzen O-16), 1 well with a significant oil show (Mizzen L-11) and a Significant Discovery Licence (SDL 1047)
- **East Orphan is a basin with petroleum potential.** East Orphan is an underexplored basin. Only two wells were drilled in this large rift basin, one abandoned (Great Barasway F-66) and one with results not yet in the public domain (Lona O-55). Late Jurassic and Early Cretaceous reservoir rocks have been intersected in F-66. Also seismic correlations indicate presence of Late Jurassic rocks northwest of Mizzen SDL
- **Exploration and Production Activity.** There are a) one active Exploration Licence (EL) in Flemish Pass Basin (EL 1112) and b) two consolidated ELs in Orphan Basin (1073R and 1074R)
- **Production.** There is no production in either basins
- **Strategic Environmental Assessment (SEA).** The Board has previously conducted a SEA for the Call for Bids NL10-02 and 03 area

Atlantic Canada Offshore Basins



On the map:

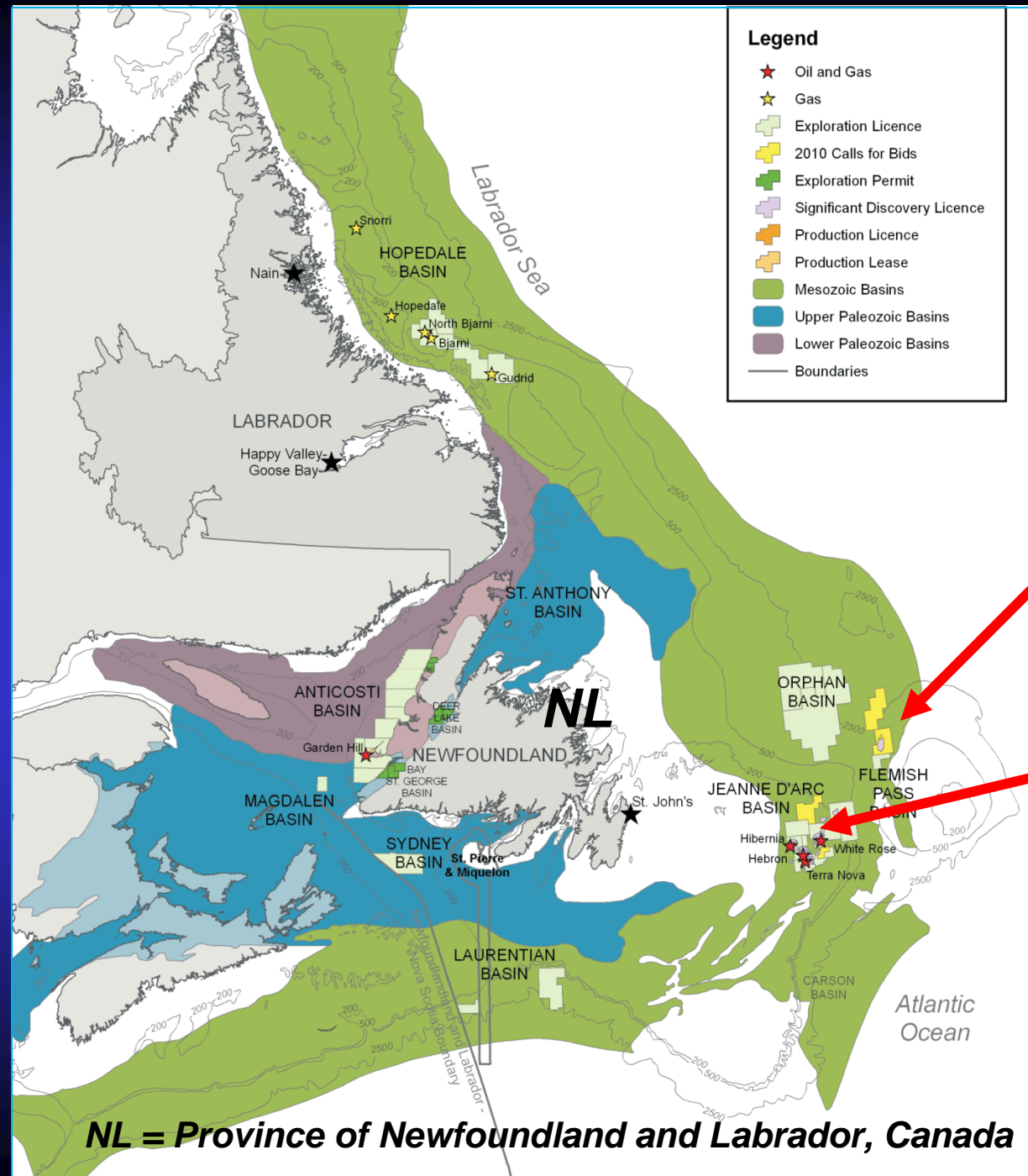
Blue text = Paleozoic Basins

Magenta text = Mesozoic Basins

NL Mesozoic Basins

- Laurentian Basin
- S. Whale Basin
- Jeanne d'Arc Basin
- Flemish Pass Basin
- Orphan Basin
- Hopedale Basin
- Saglek Basin

Yellow in list = Mesozoic Basins with ongoing exploration



CFB 2010: Three Call for Bids in Three Basins

•CFB NL10-02 and
•CFB NL10-03
in Flemish Pass
and Orphan Basins

•CFB NL10-01
Jeanne d'Arc Basin
(discussed in an accompanying
Power Point
[http://www.nr.gov.nl.ca/mines
&en/oil/EnachescuNL10_1Parc
el1and2.pdf](http://www.nr.gov.nl.ca/mines&en/oil/EnachescuNL10_1Parcel1and2.pdf))

3. Exploration and Development Background

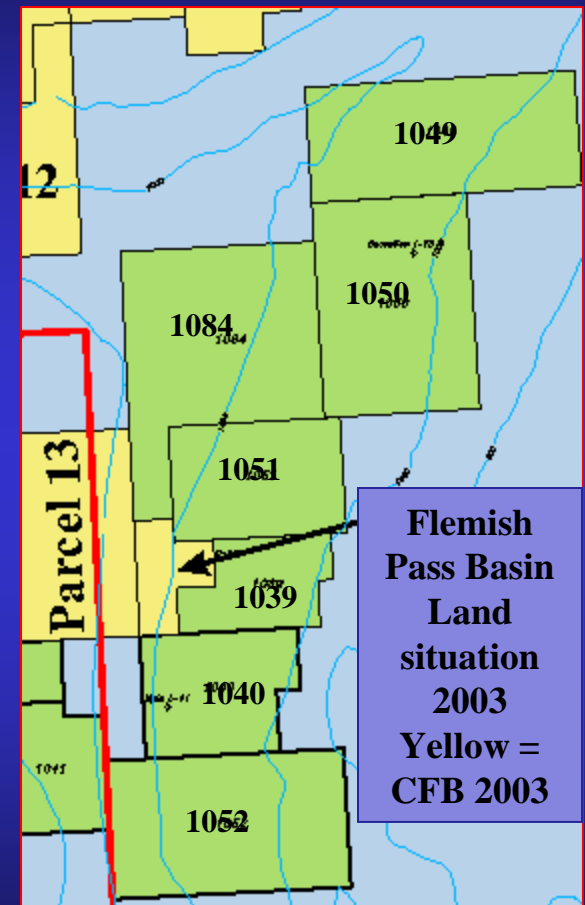
- NL Petroleum Production
- Emergence of Nalcor Energy
- Large Mesozoic Under Explored Basins
- Grand Banks Exploration History
- Recommended References
- Newfoundland and Labrador Petroleum Industry
- Recent E&P Activity in Atlantic Mesozoic Basins
- **Recent Call for Bids and Exploration Activity in Flemish Pass and Orphan basins**

Observation. Parts of this section was discussed in detail in the accompanying power point posted on the web at:

[http://www.nr.gov.nl.ca/mines&en/oil/EnachescuNL10_1Parcel1and2.pdf /](http://www.nr.gov.nl.ca/mines&en/oil/EnachescuNL10_1Parcel1and2.pdf)

Recent Call for Bids in Flemish Pass Basin

- Several ELs were active in the late seventies-early eighties when 4 wells were drilled in the basin
- At the first modern C-NLOPB Call for Bids in 1998, 2 blocks were licensed by Mobil (30%), Chevron (30%), Petro-Canada (20%), and Norsk Hydro (20%), for \$127 MM (ELs 1039 and 1040)
- At the 1999 CFB three parcels in the north received bids for a total of \$190.7 MM from Petro-Canada and Norsk Hydro (ELs 1049, 1050 and 1051) and one parcel in the south from PanCanadian. (EL 1052)
- In 2001 one parcel received bids (\$4.6MM) from Petro-Canada/Norsk Hydro/PanCanadian (EL 1084)
- Thus, during 2002-2003 there were 7 very large ELs active in the Flemish Pass Basin and environs. Only EL 1049 was drilled in 2003 by the partnership Petro-Canada, Norsk Hydro and PanCanadian (who farmed in)
- More recently, EL1112 (55,954 ha) was licensed in 2009 by the partnership Statoil (65%)/Husky Oil for \$18.72 MM



Observation. Reports and presentations on the potential of Call for Bids NL98 to NL09 are available from:

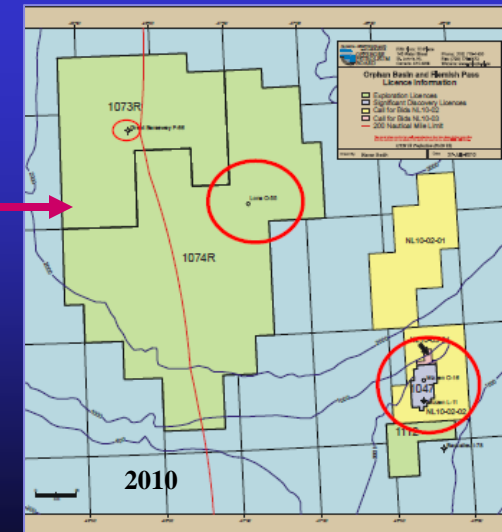
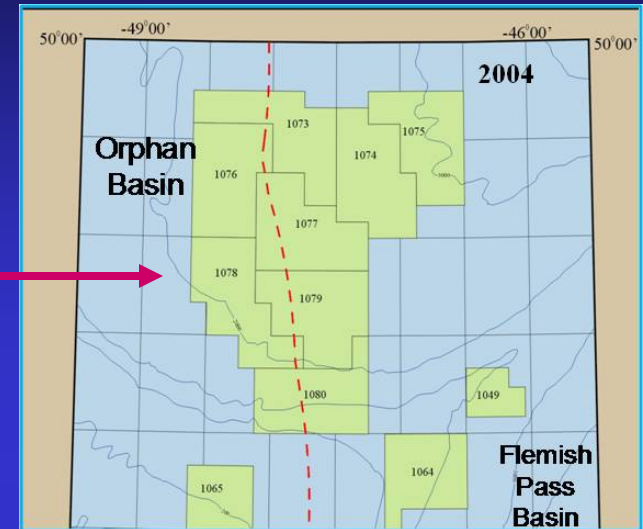
<http://www.nr.gov.nl.ca/mines&en/oil/>

Exploration Activity in Flemish Pass Basin

- The late 1970s-early 1980s cycle of exploration in the basin resulted in four wells being drilled (Baccalieu I-78, Gabriel C-60, Kyle L-11, Lancaster G-70) that demonstrated presence of both source and reservoir rocks in the basin
- Exploration activity in the basins located north and east of Grand Banks was at a low level during 1982 to 1999
- Deep water exploration offshore NL was restarted with a Flemish Pass Basin Call for Bids in 1998, followed by several other CFB in successive years.
- Seven large ELs were awarded; however due to low commodity prices, only 2 wells were drilled: Tuckamore B-27 (dry hole) in EL 1051 and Mizzen L-11. Six parcels were relinquished, five without drilling, after the first exploration cycle.
- Following the acquisition of a large 3D seismic survey, Mizzen L-11 was drilled in 2003 and validated EL1049; after the drilling of Mizzen L-11, Petro-Canada and Encana (previously PanCanadian) abandoned their rights to Norsk Hydro. Statoil merged with Hydro in 2006 and became operator of the EL 1049
- EL 1112 was awarded in 2008 to Statoil/Husky and remains to be drilled
- After farming out to Husky, Statoil drilled Mizzen O-16 in 2009 and discovered “hydrocarbons” according to a Statoil communiqué
- A Significant Discovery Licence (SDL 1047), the first in this basin and first deepwater SDL in Canada, was awarded encompassing the Mizzen structure

Recent Call for Bids in East Orphan Basin

- First modern Licence Round in the basin took place in 2003: twelve large parcels were offered, eight received bids for a total of US \$550 MM (CAN\$ 672 MM). This was the most successful land sale in the history of the NL offshore.
- The eight ELs (1073 to 1081) covering 21,250 km² were awarded to Chevron Canada (50%) /ExxonMobil Canada (EMC) (25%)/Imperial Oil (IO) (25%).
- In 2005, Shell Canada took a 20% interest in the eight ELs from EMC and IO
- A consolidation of the Chevron and EMC operated lands into two ELs (EL1073R and EL1074R) took place in 2008; at the time EL 1075 and the north-eastern part of EL 1080 were relinquished
- Presently there are two consolidated and reconfigured ELs 1073R and 1074R, with Chevron (50%) as operator and ExxonMobil/Imperial Oil (30%) and Shell (20%) as partners; each of these two ELs have validation and/or surrender options and both ELs expire January 15, 2013; only lands issued under a SDL will continue thereafter
- No other CFB took place in the Orphan Basin since 2003; CFB NL10-2 includes a parcel (-01) in continuation with the Mizzen structural lineament that can be considered as an Orphan Basin offer



Observations: Circles show recent drilling locations

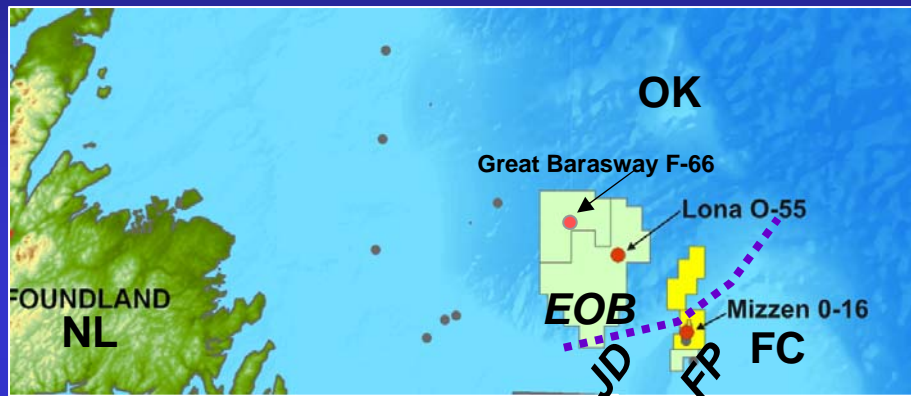
Exploration Activity in East Orphan Basin

- The West Orphan Basin and adjacent Cumberland Belt Zone were explored between 1974-1985 when there were several large active ELs and 7 wells drilled (one well per 21,400 km²); only one dry well, Blue H-28, was drilled in deepwater in 1979. While good reservoirs were found in these wells, no Late Jurassic marine source rocks were encountered
- Modern regional 2D seismic data was recorded during 1999-2003 covering the entire Orphan Basin
- During 2004-2008, two large 3D surveys and several CSEM surveys were carried out over the basin's largest structural features
- Great Barasway F-66 well was drilled and abandoned in 2007, and validated EL 1076
- A consolidation of ELs took place in 2008 when several blocks and sections were dropped by the partnership. The consolidated ELs are: EL 1073R and 1074R
- Lona O-55 was drilled in 2009; both EL 1073R and EL 1074R are presently set to expire in 2013

Present Exploration Activity in the Basins

- There is ongoing exploration activity in EL 1112 and around SDL 1047 (Flemish Pass Basin) and in ELs 1073R and 1074R (East Orphan Basin)
- A large amount of 2D and 3D seismic reflection data and CSEM survey data is being evaluated for future drilling targets in both basins
- As of the fall of 2010, there are significant exploration commitments to be undertaken by interest owners
- There is also ongoing scientific investigations including:
 - New OBS surveys, potential field modeling, crustal studies
 - A Plate Tectonics Reconstruction of the North Atlantic Margins Project funded through NL Offshore Geoscience Data Program (OGDP), carried out in partnership with Ireland's Petroleum Infrastructure Project (PIP) and Petroleum Affairs Directorate (PAD) and executed by GeoArctic of Calgary

Exploration Activity in Flemish Pass and East Orphan Basins



NL = Newfoundland
 FC = Flemish Cap
 OK = Orphan Knoll
 JD = Jeanne d'Arc Basin
 FP = Flemish Pass Basin
 EOB = East Orphan Basin
 = Informal border
 between basins

Wells Drilled (to 2010)

	8
Exploration FP	6
Exploration EOB	2
Delineation	None
Development	None

Hydrocarbon Discoveries **1**

Current Holdings

Exploration Licences (ELs)	3
Significant Discovery Licences (SDLs)	1
Production Licences (PLs)/Leases	None

Recent Exploration Activity in Flemish Pass and Orphan Basins

- Flemish Pass Basin
 - A 3D seismic survey was carried out in 2000
 - Based on mapping this survey Petro-Canada et al. drilled Mizzen L-11 in EL 1049 during 2003
- East Orphan Basin
 - Large 2D surveys conducted by GSI and TGS during 2000-2003
 - During 2004-2009 the partnership conducted several large seismic 3D and CSEM surveys on their licences
 - Great Barasway F-66 well operated by Chevron was drilled in 2006/7 in EL 1076. This well set a Canadian record for deep water drilling in a water depth of 2338 m; the well TD'd and was abandoned at 6749.9 m
 - The exploration well Lona O-55 was drilled during summer of 2010 to TD, with results confidential until 2012

Observation. Results of 2006, 2008 and 2009 Jeanne d'Arc and Environs Call for Bids are found on the website: <http://www.nr.gov.nl.ca/mines&en/oil/>

Exploration Wells Drilled in Flemish Pass/East Orphan Basins During 2000-2010

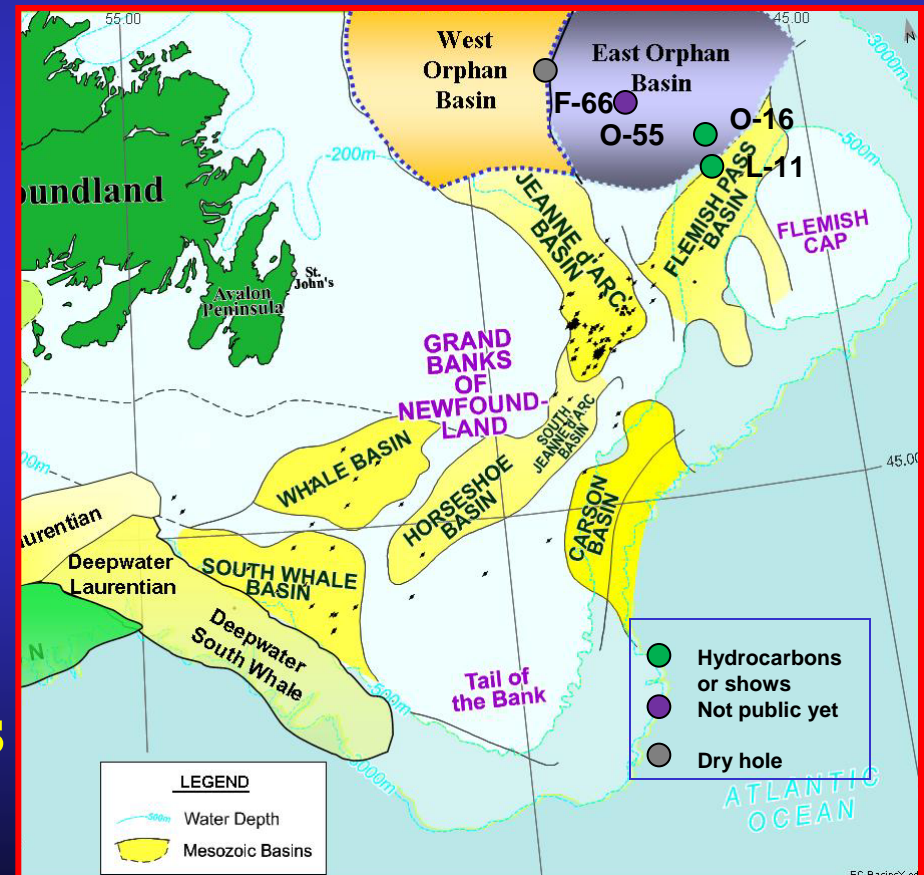
•East Orphan Basin

Great Barasway F-66 (Late Jurassic rocks intersected)
Lona O-55 (results are not public)

•Flemish Pass Basin

Mizzen L-11 (significant oil show)
Mizzen O-16 (significant discovery)

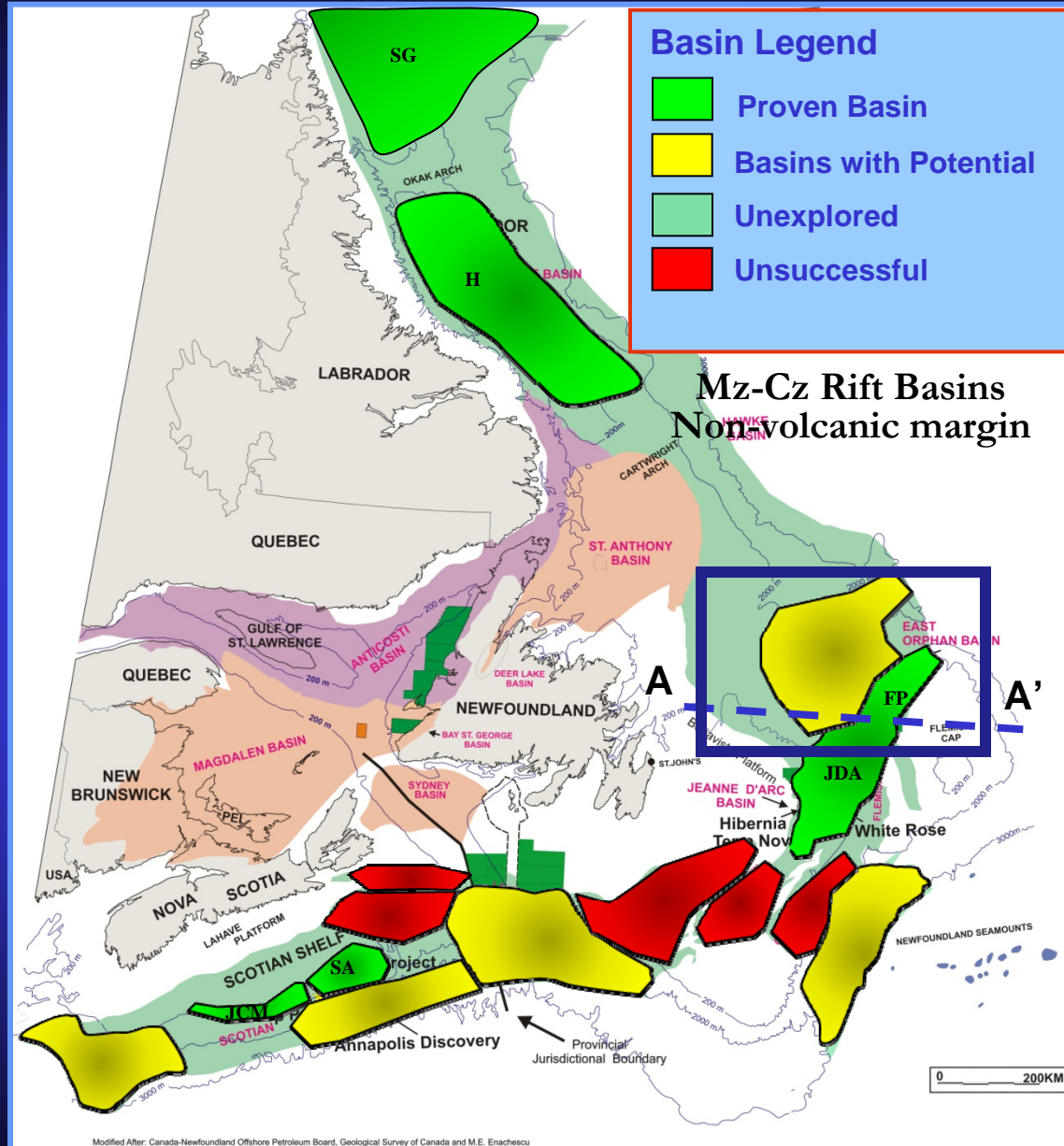
TOTAL: 4 Exploration Wells



4.

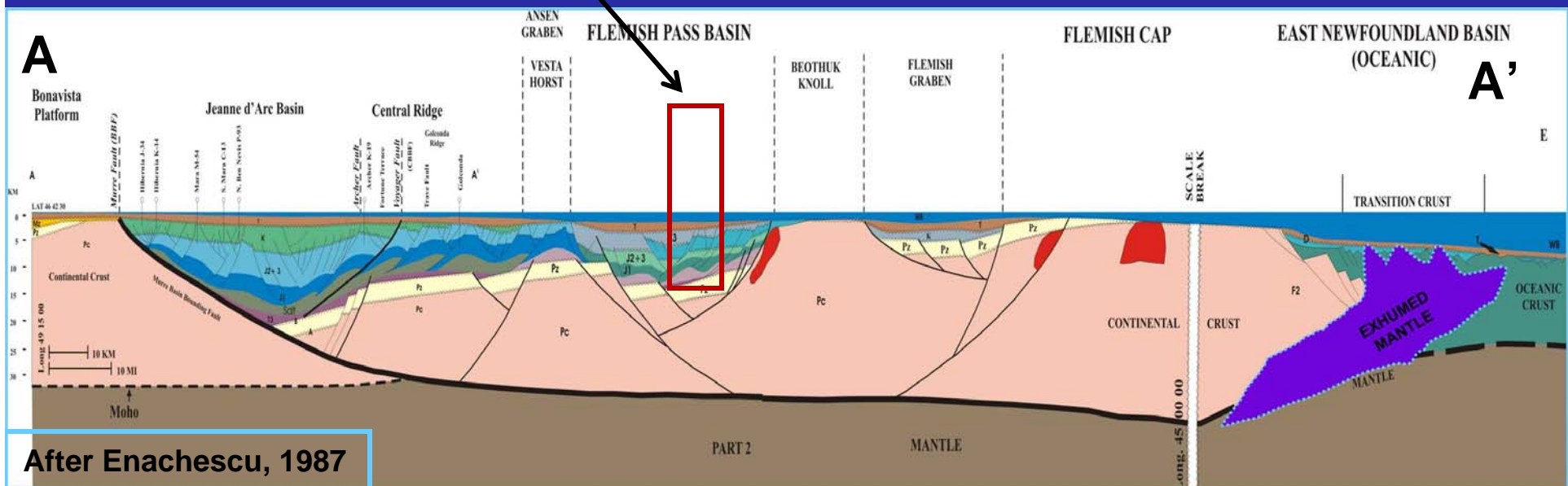
Overview of Geology of Flemish Pass and Orphan basins

Connected extensional basins formed during the break-up of Pangea and opening of the Atlantic Ocean



W-E offshore NL Structural Profile

Approximate Structural Position of
NL10-02 and 03 parcels



Parcels NL10-02-02 and NL10-03-01 are located in Flemish Pass Basin in a structural position indicated by arrow; Parcel NL10-02-01 is located to the north, inside the East Orphan Basin

Recommended Literature on Grand Banks and Flemish Pass/Orphan basins

Jansa and Wade 1975; Purcell et al., 1980; Arthur et al., 1982; Hubbard et al., 1985; Parson et al., 1985; Mason and Miles, 1986; Grant and McAlpine, 1986; Srivastava and Tapscott, 1986; King et al., 1986; Grant and McAlpine, 1986; Ziegler, 1987; Enachescu 1987, 1988, 1992, 1993 ; Enachescu et al., 1993; 2005; 2006; Tankard and Welsink, 1987; Keen et al., 1987; Fowler and Snowden, 1988; Grant et al., 1988; Sinclair, 1988, 1993 and 1995; Koning et al., 1988; Ziegler, 1989; Balkwill and Legall, 1989; Tankard et al., 1989; Brown et al., 1989; Bell and Howie, 1989; Tucholke et al., 1989; McAlpine, 1989, 1990; 1991; Verhoef and Srivastava, 1989; Hiscott et al., 1990; Mackey and Tankard, 1990; Srivastava et al., 1990; Wade and MacLean, 1990; Grant and McAlpine, 1990; Keen and Williams, 1990; Sinclair et al., 1992; Maclean and Wade, 1992; Srivastava and Verhoef, 1992; **Foster and Robinson, 1993**; Desilva, 1993, 1994 and 1999; Enachescu and Dunning, 1994; Fowler and McAlpine, 1995; Driscoll and Hogg, 1995; Driscoll et al., 1995; Bateman, 1995; **Drummond, 1998**; Hubbard, 1998; Williams et al., 1999; Srivastava et al., 2000; Prokoph and Agterberg, 200; Atkinson and Fagan, 2000; Hogg and Enachescu, 2001; Loudon, 2002; Deptuck et al., 2003; **Smee et al., 2003**; Enachescu and Hogg, 2005; **Enachescu et al., 2005**; Magoon et al., 2005; Sibuet et al., 2007; Tucholke et al., 2007; Hogg and Enachescu, 2007; Hardy, 2007 (M Sc Thesis); Fagan and Enachescu, 2008; HMDS, 2008; Enachescu, 2009; Bauer et al., 2009; Fagan, 2010 (M Sc Thesis); Lowe, 2010 (M Sc Thesis); Enachescu et al., 2010.

Observation: This list is not all inclusive

Enachescu, NL DNR 2010

Government of Newfoundland and Labrador Reports and Presentations

- The regional geoscience of Newfoundland and Labrador offshore and the petroleum potential of the Mesozoic rift basins were covered in detail in previous Government of Newfoundland and Labrador Reports
- In this Power Point presentation only a short geoscience overview of the Flemish Pass and East Orphan basins is provided. More geoscience information is included with reports and presentations available from the:

<http://www.nr.gov.nl.ca/mines&en/publications/offshore/>

and

<http://www.nr.gov.nl.ca/mines&en/oil/>

- The presentation also includes a discussion of the petroleum potential of the bid parcels (NL10-02 and NL10-03)

List of Reports and Presentations Available from the Government of NL Website:

Atkinson and Fagan, 2000;

<http://www.gov.nl.ca/mines&en/oil>

Smee, 2003;

<http://www.nr.gov.nl.ca/mines&en/oil/callforbids/basin.pdf>

Fagan and Hicks, 2003;

<http://www.nr.gov.nl.ca/mines&en/oil/callforbids/flemishpass.pdf>

Enachescu and Fagan, 2004, 2005 and 2009;

http://www.gov.nl.ca/mines&en/oil/call_for_bids_nf04_01.stm

http://www.nr.gov.nl.ca/mines&en/call_for_bids/NL05.pdf

http://www.nr.gov.nl.ca/mines&en/oil/callforbids/Final_Laurentian_Basin_Presentation.pdf

Enachescu and Foote, 2009;

<http://www.nr.gov.nl.ca/mines&en/oil/CallforBidsNL09-03.pdf>

Enachescu 2006a and b;

http://www.nr.gov.nl.ca/mines%26en/call_for_bids/cfb_nl06-1_%20enachescu_report.pdf

http://www.nr.gov.nl.ca/mines%26en/call_for_bids/CFBNL06-1_presentation.pdf

Enachescu, 2009;

http://www.nr.gov.nl.ca/mines&en/oil/Jeanne_D_Arc_Presentation.pdf

Enachescu, 2010;

http://www.nr.gov.nl.ca/mines&en/oil/EnachescuNL10_1Parcel1and2.pdf

Regional Geology of the Grand Banks of Newfoundland and Environs

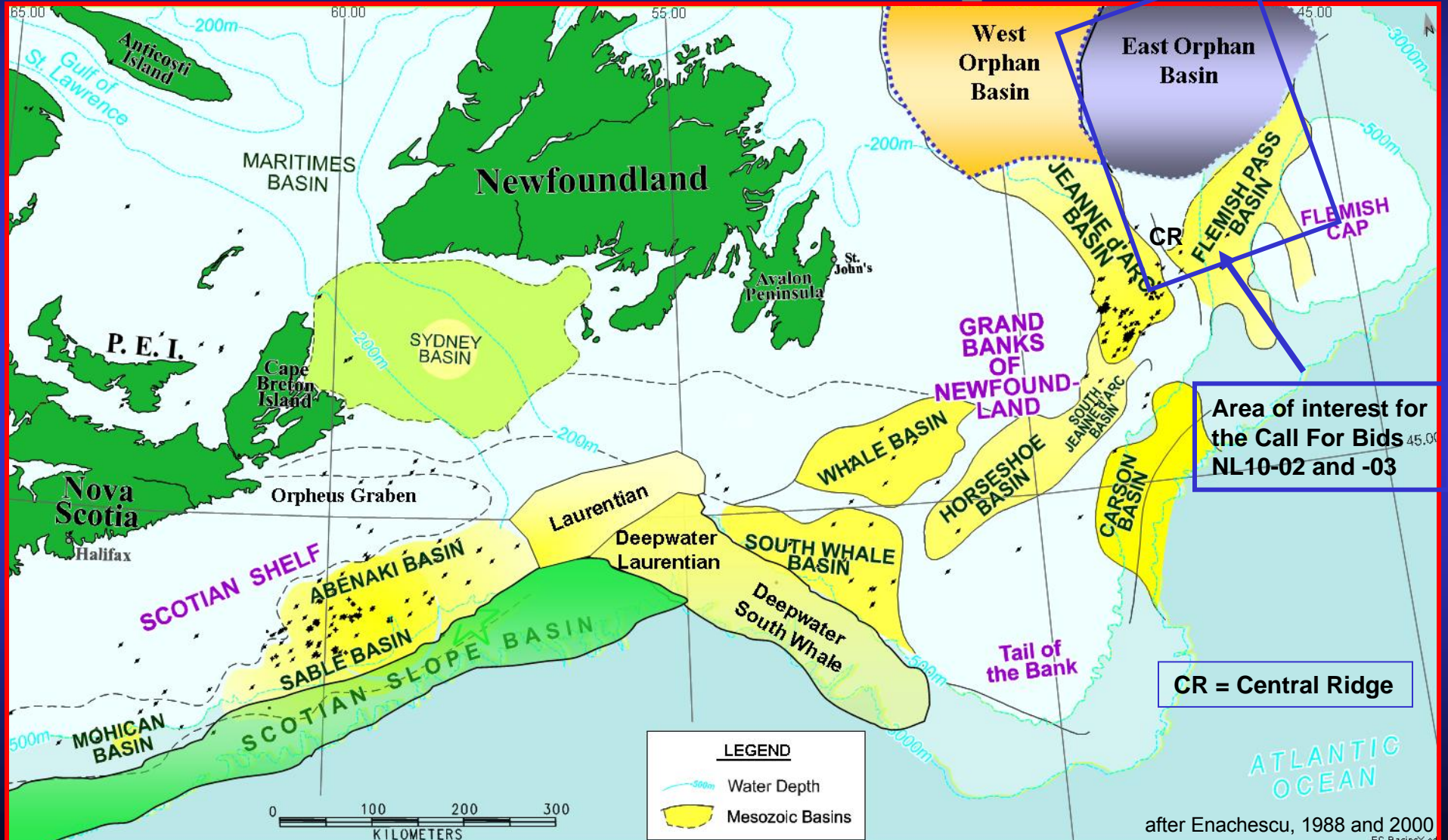
- East Coast Newfoundland and Labrador is a significant part of the eastern N. America to N. Europe extensive, once continuous Gulf of Mexico to Barents Sea, Mesozoic aged rift system developed during the Pangea intra-continental rifting and Atlantic Ocean opening
- The Grand Banks and environs basins evolved through the latest Atlantic Wilson cycle, starting 230 million years ago (Late Triassic) and continuing today
- Up to now Grand Banks and environs (including the Central Ridge and Flemish Pass Basin) is the only area along the East Coast of North America containing large oil fields that are producing close to the world's largest consumer market (Central Canada and Eastern USA)

Regional Geology of the Grand Banks of Newfoundland and Environs

The geologic subdivisions of Grand Banks record the development of:

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

Location of Mesozoic Basins Including Flemish Pass and East Orphan Basins



Overview of the Geology of Mesozoic Grand Banks and Environs

- About a dozen Mesozoic basins, subbasins, trough and sedimented ridges are petroleum prospective on the Grand Banks and environs
- These structural units and subunits were formed during breakup of Pangea and subsequent Atlantic Ocean opening
- The area is dominated by extensional tectonics and complicated by salt tectonics and transtensional movements
- All ingredients for petroleum formation and accumulation in large structural, stratigraphic and combination traps exist for the basins that have confirmed Late Jurassic high TOC/ high HI source rock (JDB, CR and FPB)
- In other Grand Banks basins the existence of a viable petroleum system remains to be proven by drilling (e.g. East Orphan Basin)
- Areas of petroleum potential extend from the shallow waters of the Grand Banks into the deeper waters of the continental slope, as well as to ultra-deep-water areas such as the Orphan and Laurentian basins
- For now, Jeanne d'Arc is the only producing basin in the area, while Flemish Pass Basin is now a proven hydrocarbon province

East Orphan Basin (EOB)

- Orphan Basin is a widely stretched Mesozoic rifted area located north of Grand Banks of Newfoundland. The shallow part of the basin was unsuccessfully explored in the late seventies-early eighties when 5 wells were drilled on basement highs close to the basin margin
- A deep water well, Blue H-28, was drilled in 1979 in a large rotated block. This block proved to be bald of Late Jurassic-Early Cretaceous rocks and the well was abandoned without encountering hydrocarbons
- Based on new 2D seismic interpretation recorded during early 2000s, the drilled eastern part of the basin is considered more prospective for gas while the East Orphan Basin situated in deep and super deep water has good oil potential (Enachescu et al., 2004 and 2005)
- The East Orphan Basin was an earlier Mesozoic rift and was connected during Late Jurassic to the Jeanne d'Arc, Flemish Pass and W. Ireland basins

East Orphan Basin (EOB)

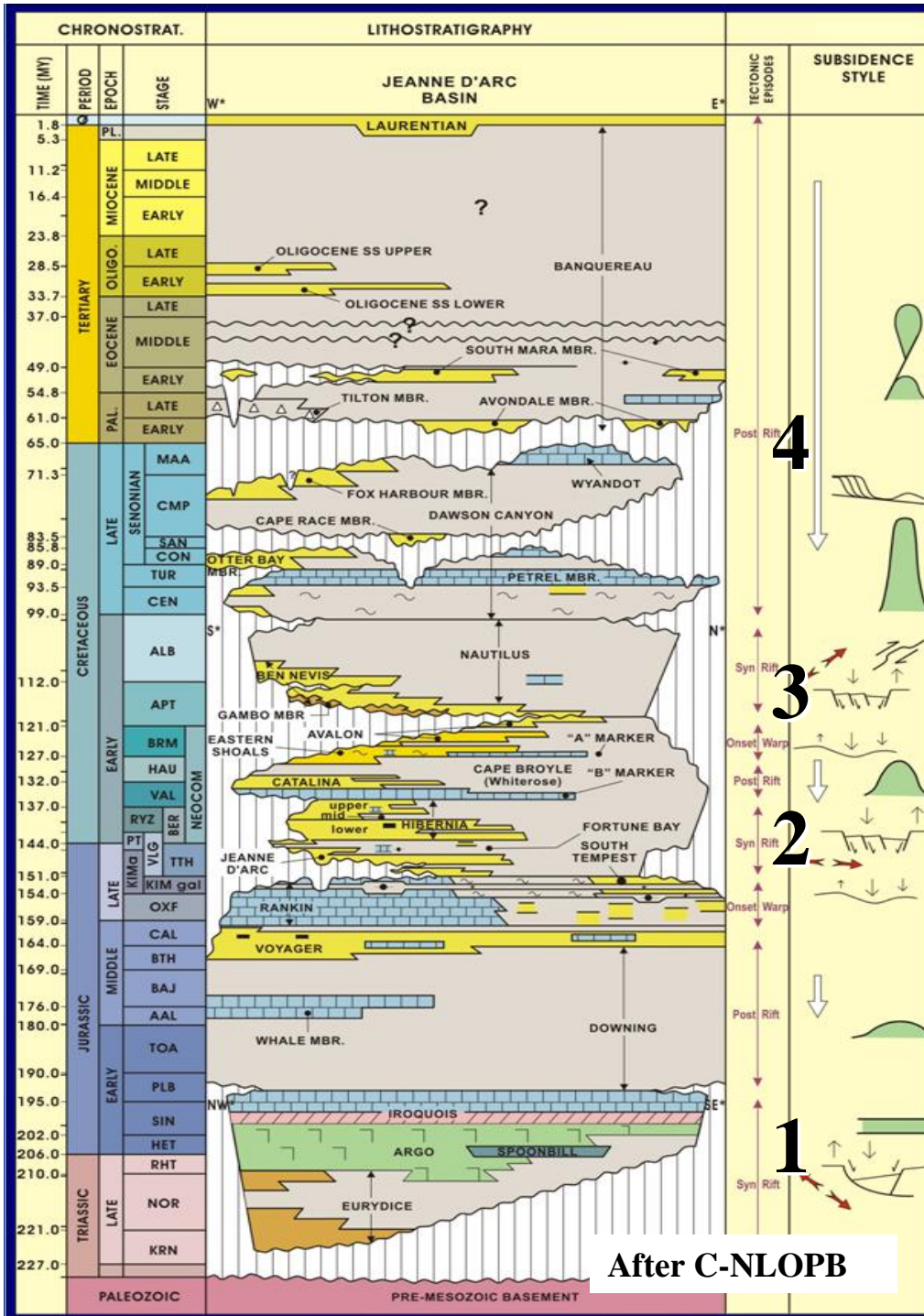
- Great Barasway F-66 well operated by Chevron was drilled in 2006/7 in EL 1076 in 2338 m water depth; the well TD'd and was abandoned at 6749.9 m
- Great Barasway F-66 well found good Late Jurassic-Early Cretaceous reservoirs. However, the reservoirs were wet and only several shows were encountered. Shale intervals have been logged within the Late Jurassic; certain intervals have high organic content and other contain coals
- The exploration well Lona O-55 was drilled during summer of 2010 but results are not publicly available until 2012
- At least a dozen other large structural traps were identified with the several dense 2D seismic grids existing in the basin, several of which were delineated with two large proprietary 3D surveys and EM surveys. Many of these prospects remain to be drilled
- A large part of the petroleum prospective basin remains un-licensed and open for company land posting. A large parcel located just north of the Mizzen O-16 discovery and stretching the border between Flemish Pass and East Orphan basins is offered at the **CFB NL10-02-01**

Summary of the Geology of Flemish Pass and East Orphan Basins

Similar to the Jeanne d'Arc Basin, the basin fill can be divided into two major stratigraphic sequences that are clearly recognizable on seismic data:

- 1. An extensional stage sedimentary sequence* (Late Triassic to late Early Cretaceous) that is strongly compartmentalised by normal fault systems and contains numerous structures
- 2. A thermal subsidence stage sedimentary sequence* (Late Albian to Present) that is tectonically undisturbed (i.e. no extension), but contains remarkable depositional and erosional features, including basin margin and floor fans

Alongside extensional tectonics, transtension due mostly to repeated change of the direction of the extensional vector played an important role in basin evolution and architecture. Only minor halokinesis and halotectonics is observed in the East Orphan and North Flemish Pass area



Jeanne d'Arc Basin Lithostratigraphy and Tectonic Evolution can be applied to the Call for Bids area

• 3 to 4 stages of extension

1, 2, 3, (4 in EOB)

• Several stages of
transtension

2, 3 (4 in EOB)

• 1 to 2 stages of inversion

3 and (4 in EOB)

How Much Oil & Gas offshore NL?

- More than **1.8 Bbbls** proven remaining recoverable reserves/resources exists in the Jeanne d'Arc Basin; approximately 11 Tcf of gas has been discovered of which **6.8 Tcf** of gas reside in JDB; however no gas sales to date

- Geoscience data indicate that a further **6 Bbbls** and **60 Tcf** undiscovered resources remain offshore Newfoundland and Labrador

- A good portion of these estimated reserves were attributed to the Flemish Pass and Orphan basins

Reserve Estimates Flemish Pass and Orphan Basins

- In 2004 the Canada-Newfoundland Offshore Petroleum Board released an estimate of the Undiscovered Hydrocarbon Resources in the Flemish Pass Basin. The estimate was carried out by the Board with assistance from the Geological Survey of Canada. The Undiscovered Hydrocarbon Resources in the basin was calculated at 273 million m³ (1.7 billion barrels) at a 50 percent probability with expected field sizes ranging from 528 to 44 million barrels (<http://www.cnlopb.nl.ca/news/nr20040520eng.shtml>)

- Noteworthy, a significant accumulation of hydrocarbons has been found at Mizzen O-16 in 2009 in a closed fault block. The fault block is part of a complexly faulted structure that stretches the border area between the Flemish Pass and Orphan basins (see slide 61)

- Based on comparison with Jeanne d'Arc Basin petroleum geology and using the same Egret anchored petroleum system, the Orphan Basin is estimated to contain between six and eight billion barrels of oil (unrisked resources; Smee, 2003) <http://www.nr.gov.nl.ca/mines&en/oil/callforbids/basin.pdf>

Petroleum Geology

- Offshore Newfoundland contains the Jeanne d'Arc Basin which is a prolific hydrocarbon basin containing almost exclusively all the oil volumes discovered to date offshore Newfoundland
- JDB had a common structural and tectonic evolution and was in communication with the adjacent Flemish Pass and East Orphan basins situated to the north and east (Enachescu et al., 2005)
- The basins' infill contains structured synrift rock successions (including red beds, evaporites, carbonates and coarse and fine clastics) ranging in age from Late Triassic to late Early Cretaceous (Extensional Stage sedimentary sequence)
- Oil prone source rocks are present in Late Jurassic (Callovian, Oxfordian and especially Kimmeridgian) in the Flemish Pass Basin and inferred in the East Orphan Basin; the potential for other source rocks is recognized within the Early (Albian) and Late Cretaceous and Tertiary
- Synrift sequences contain good reservoir intervals in both basins. The earliest postrift sedimentary sequences may contain coarse clastics. Especially in the Orphan Basin, the early postrift sequence is deformed by late transtension and inversion

Kimmeridgian Source Rock

Abundant Type II, oil prone source rock with up to 9% TOC

- Over 25 exploration wells have penetrated the Egret Mbr. source rock on the Grand Banks and environs; **this is the best marine source rock within the North Atlantic rift system**
- Thickness of Egret Mbr ranges from 50 m to well over 500 m at **Panther P-52**, located in the area between the Central Ridge and Flemish Pass Basin
- Proven distribution in Jeanne d'Arc Basin in the south where main fields are producing and to the northeast (**Panther, S. Tempest, Bonanza**) close to Flemish Pass Basin
- Proven distribution in northern Flemish Pass Basin (**Baccalieu I-78, Mizzen L-11 and probably in Mizzen O-16 area**) (McCracken et al., 2000; Enachescu et al., 2010)
- Based on the fact that wells were targeted to Late Jurassic intervals there is hope that source rock may be present in the two wells drilled in the Orphan Basin, Great Basinsway F-66 and Lona O-55. However F-66 was dry and O-55 results remain confidential. Geochemical results are not yet available for either well
- When present on the Grand Banks, source rock occurs within north-south and/or northeast-southwest trending deep sub-basins

Reservoirs

Reservoir rocks in the neighbouring Jeanne d'Arc Basin are predominantly sandstone of Late Jurassic to late Early Cretaceous age. Mizzen L-11 well has encountered several reservoirs of similar age

- Stacked sandstone intervals within the Jeanne d'Arc, Hibernia, Catalina and Avalon/Ben Nevis formations are proven quality reservoirs in JDB. Most of these reservoirs are alluvial or deltaic
- It is expected that equivalent reservoirs are developed in the Flemish Pass and East Orphan basins; also basin margin and floor fans of late Cretaceous-Early Tertiary age are interpreted on seismic data
- Mizzen L-11 has encountered 2 excellent reservoirs in Late Jurassic (equivalent to Jeanne d'Arc SS) and an oil filled 5 m reservoir interval in Early Cretaceous (Baccalieu SS) reservoir
- Flemish Pass reservoirs are sourced either from the south (Avalon Uplift area), east (Flemish Cap region), west (reworked earlier sands on the Central Ridge and Cumberland Belt highs) or from basement intra-basinal ridges
- Great Barasway F-66 has encountered coarse clastics, some with good reservoir quality, contained throughout most of the 2 km plus of Late Jurassic sequence

Seals

Finding good seals should not be difficult in the Flemish Pass and Orphan basins as the extensional and thermal subsidence stages contains a succession of very fine clastics, tight sandstones and carbonates

- Oil and gas accumulations are sealed by thick overlying shales abundant during the Late Jurassic to Late Cretaceous (e.g. Fortune Bay, Cape Broyle (White Rose), and Nautilus equivalent shales)
- Also intra-formational shales are widespread within the rift stage clastic sequences, especially in the deep water deposits
- Excellent regional seals are provided by fine grained Late Cretaceous Dawson Canyon Fm. and the Tertiary fine clastics of Banquereau Fm
- Cross-faults sealing risk exist throughout the rift basins
- Breaching of structures through inversion exist especially in the East Orphan Basin

Hydrocarbon Traps

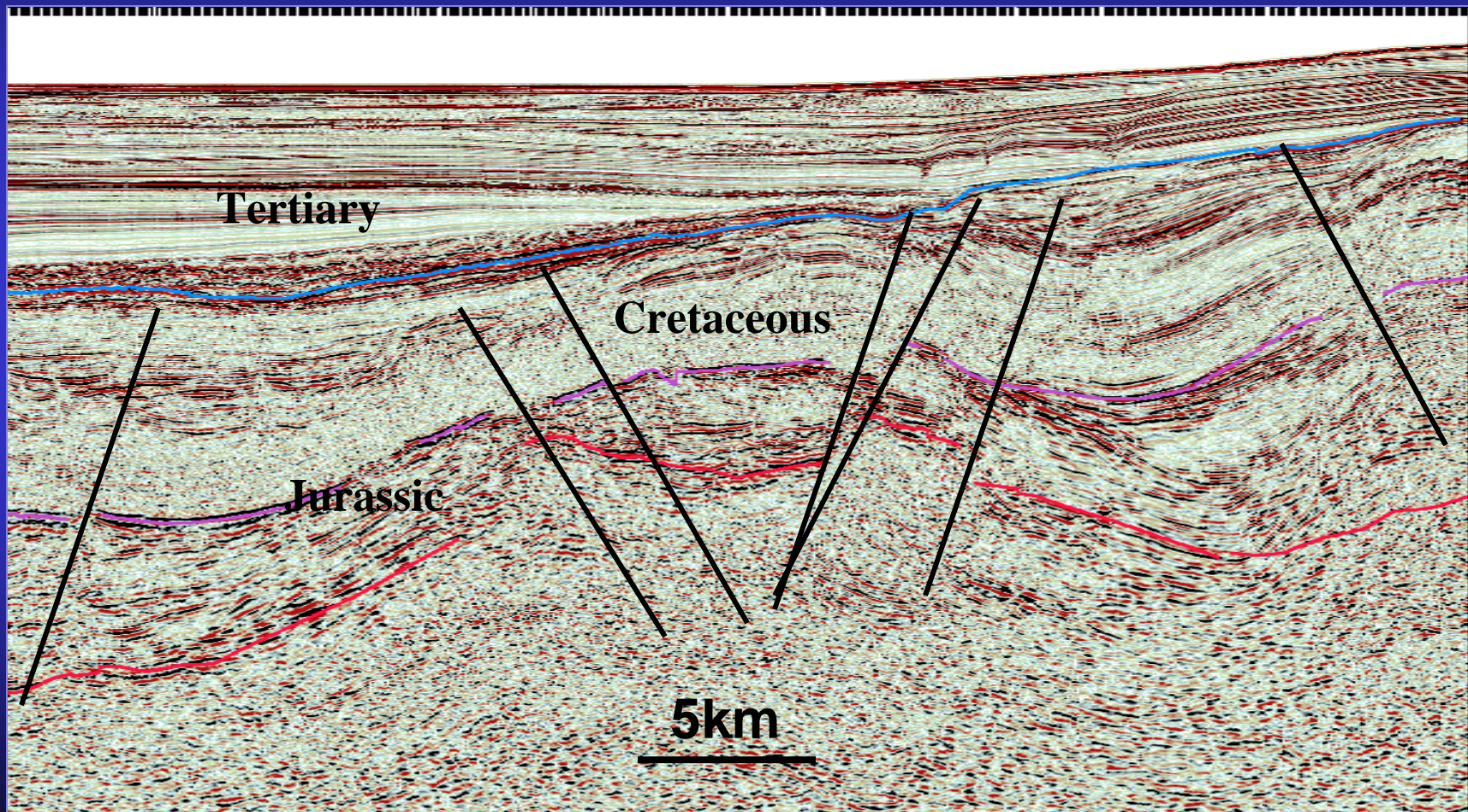
Structural traps in the Flemish Pass and Orphan basins are associated with rifting of the Newfoundland Margin, subsidence and formation of the deep extensional basin that are modified by transtension

- Some of the largest undrilled structures on the Canadian margin, extensional anticlines, roll-overs, faulted anticlines, faulted and tilted blocks and elongated horsts are located in the FP and EO basins
- Salt induced structures may exist in the southern Flemish Pass Basin, but are not present in the East Orphan Basin
- The great majority of faults are listric normal faults, but some transfer faults, accommodation zones and local inverted faults due to transtension and halokinesis (in Flemish Pass Basin) are also present and bound most of the traps

Hydrocarbon Traps

- Combination traps have also been identified
- Due to repeated transtension 2 and 3 system of faults usually dissect the large asymmetric anticlines
- Stratigraphic traps are widespread. Paleo-valleys, basin margin and basin floor fans are abundant in the basins especially in Late Cretaceous-Early Tertiary successions
- Compression modified extensional structures (CMES) are common in Orphan Basin
- Numerous amplitude anomalies indicate trapping of gas in the basin

Structural Trap Style in Flemish Pass Basin



Line Source: GSI

Fault blocks within large anticline

Enachescu, NL DNR 2010

Maturation and Migration

- Maturation of Late Jurassic source rock in the neighboring JDB starts in mid-Early Cretaceous and continues into Tertiary
- Petroleum expulsion starts at approximately 3800 m and ends at 5800 m; in the FPB and especially EOB, the presence of deep water and thin Tertiary cover may push down these expulsion limits identified from the JDB
- Expulsed hydrocarbons have migrated mainly vertically, predominantly along the numerous extensional faults
- Some lateral migration may have occurred locally along basin flanks, major faults etc., but long path migration is not common
- Late migration of hydrocarbons occurred within the Late Cretaceous-Early Tertiary basin marginal fans and sand filled canyons

Hydrocarbon Plays

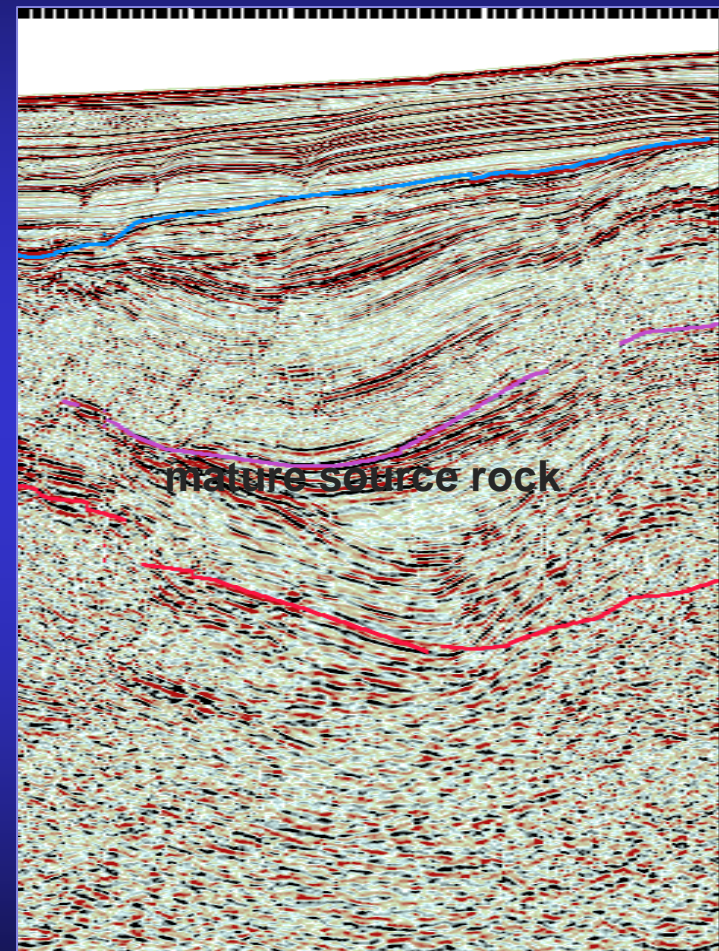
- Three main conventional plays recognized in Jeanne d'Arc Basin should be valid in the FP and EO basins (Enachescu, 1987, and 2007; Tankard and Welsink, 1987; Grant and McAlpine, 1987; Enachescu et al./ 2005 and 2010):
 - 1) Late Jurassic Jeanne d'Arc SS equivalent,
 - 2) Early Cretaceous Hibernia SS equivalent,
 - 3) late Early Cretaceous Avalon/Ben Nevis SS equivalent
- Other Jurassic, Cretaceous and Early Tertiary SS make secondary plays in the basins
- Sandstones are trapped in faulted blocks, parts of large, rotated blocks, large faulted domes or ridges and in numerous stratigraphic traps disposed on flanks of anticlines, elongated ridges and as basin floor fans

Hydrocarbon Risks

Risks may exist regarding

- presence and quality of source rock
- quality of reservoir
- sealing across faults
- breaching of reservoirs during Early Tertiary

Late Jurassic source rocks should exist within and near the Parcels NL10-02 (01 and 02) and NL10-03-01



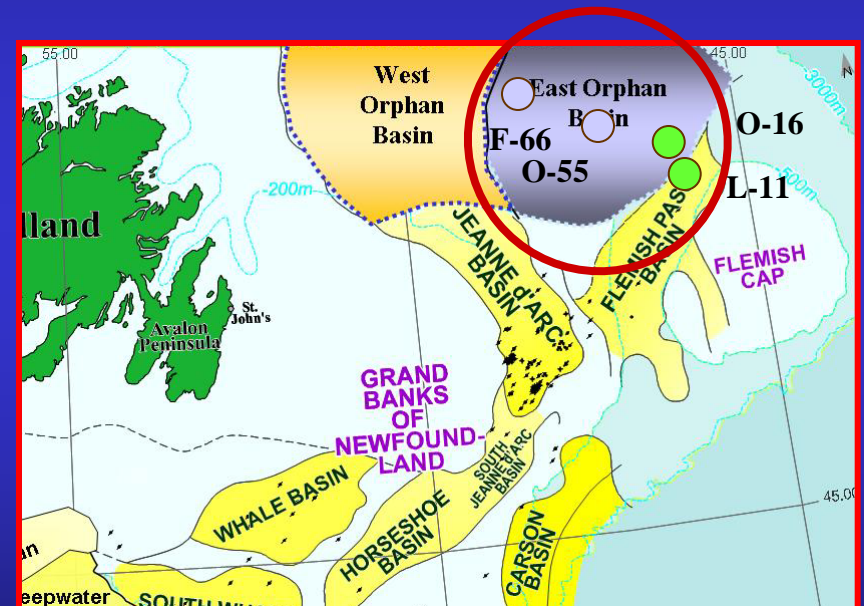
Line Source: GSI

Egret Petroleum System

- Egret Mbr of the Rankin Formation (Kimmeridgian aged) anchors a rich, proven petroleum system on the Grand Banks and environs (including the Call for Bids area)
- All prerequisites for the formation of large oil and gas accumulations have been identified and confirmed in the Jeanne d'Arc and Flemish Pass basins
- Based on seismic correlation and limited drilling results it is mostly likely that East Orphan Basin (or parts of it) has similar characteristics regarding presence of source rocks
- South of Mizzen structure, Baccalieu I-78 has intercepted 164 m of upper Kimmeridgian source rocks with 2.2 to 3.6 percent TOC and a Hydrogen Index of 395 to 391, indicative of a Type II (marine) kerogen

Exploration Wells Drilled during 2000-10 in Flemish Pass and East Orphan basins

- 1. Mizzen L-11** TD 3823 m
-Targeted a clean, large, rotated block contained in the large faulted anticline located in the northern FPB (Baccalieu subbasin). It had a significant oil show
- 2. Great Barasway F-66** TD 6749 m
-Targeted a large rollover anticline, east of White Sail Fault Zone and south of Orphan High in EOB. The well was D&A
- 3. Mizzen O-16** TD 3756 m
-Targeted the highest horst of the Mizzen complex anticline, 11 km up dip from Mizzen L-11 oil show. It was a hydrocarbon discovery and may have penetrated hydrocarbons in Early Cretaceous or Late Jurassic reservoirs
- 4. Lona O-55** TD 5580 m
-Targeted a large rollover anticline located in the central EOB. It was abandoned and its results are not yet in public domain



Significant Wells near Parcels 1, 2 and 3

Well	Drilled	WD m	Status	Location	TD m	Ben Nevis m	Avalon m	Baccalieu ss m	Late Jurassic ss m	Test	Producer	Source rocks
Mizzen L-11	2003	1153	Abandoned Oil Show	SDL 1047	3823	No	No	3335	3598	No	No	Yes
Great Barasway F-66	2007	2338	Abandoned	200 km NW	6751	No	No	possible	possible	No	No	Possible
Mizzen O-16	2009	1095	Abandoned hydrocarbon discovery	SDL 1047	3756	Not released yet				Yes	Not Known yet	Possible
Lona O-55	2010	2602	Abandoned	100 km NW	5580	Not released yet				No	No	Not known yet

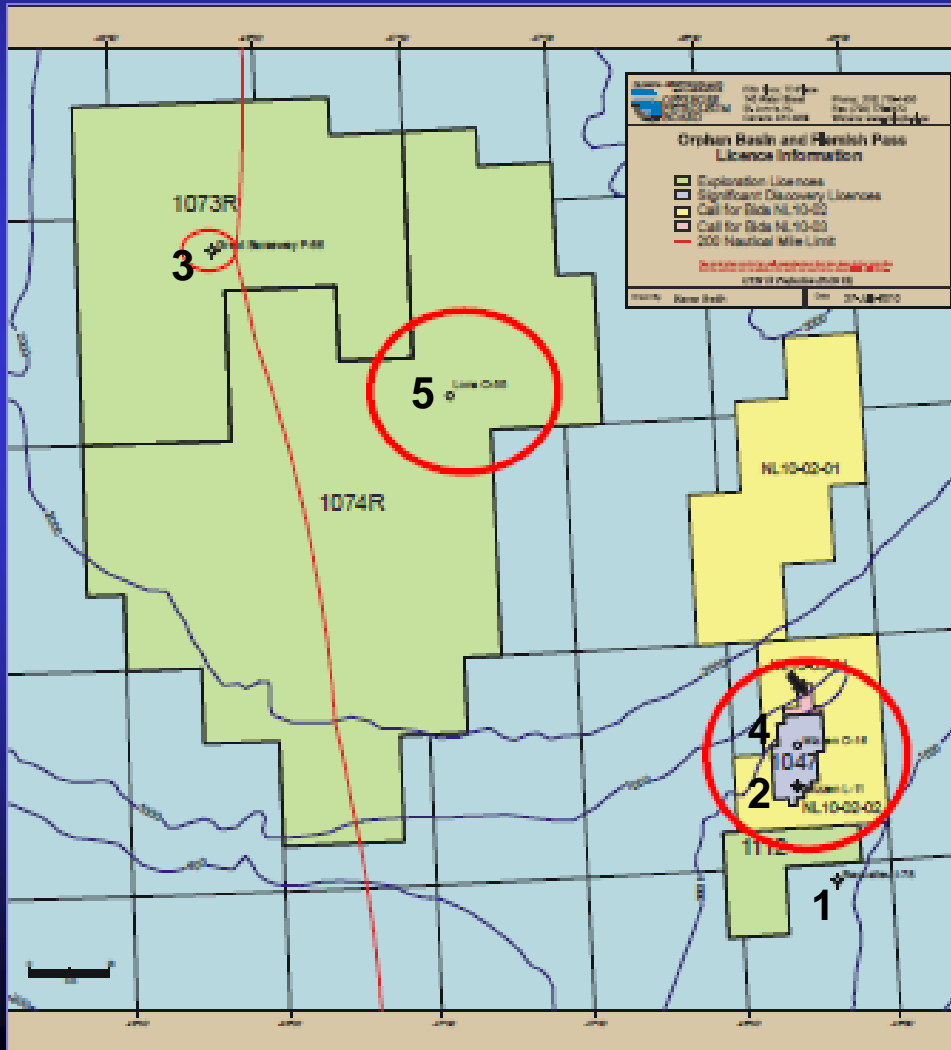
Observation. Other significant wells for the area are Baccalieu, Tuckamore and Gabriel in Flemish Pass Basin and North Dana, South Tempest and Panther on the Central Ridge that have penetrated good reservoirs and source rock intervals. These wells have been discussed in previous Call for Bids presentations available from:

<http://www.nr.gov.nl.ca/mines&en/publications/offshore/>

and

<http://www.nr.gov.nl.ca/mines&en/oil/>

Significant Wells and Land Situation in Flemish and East Orphan Basins and land situation (fall 2010)

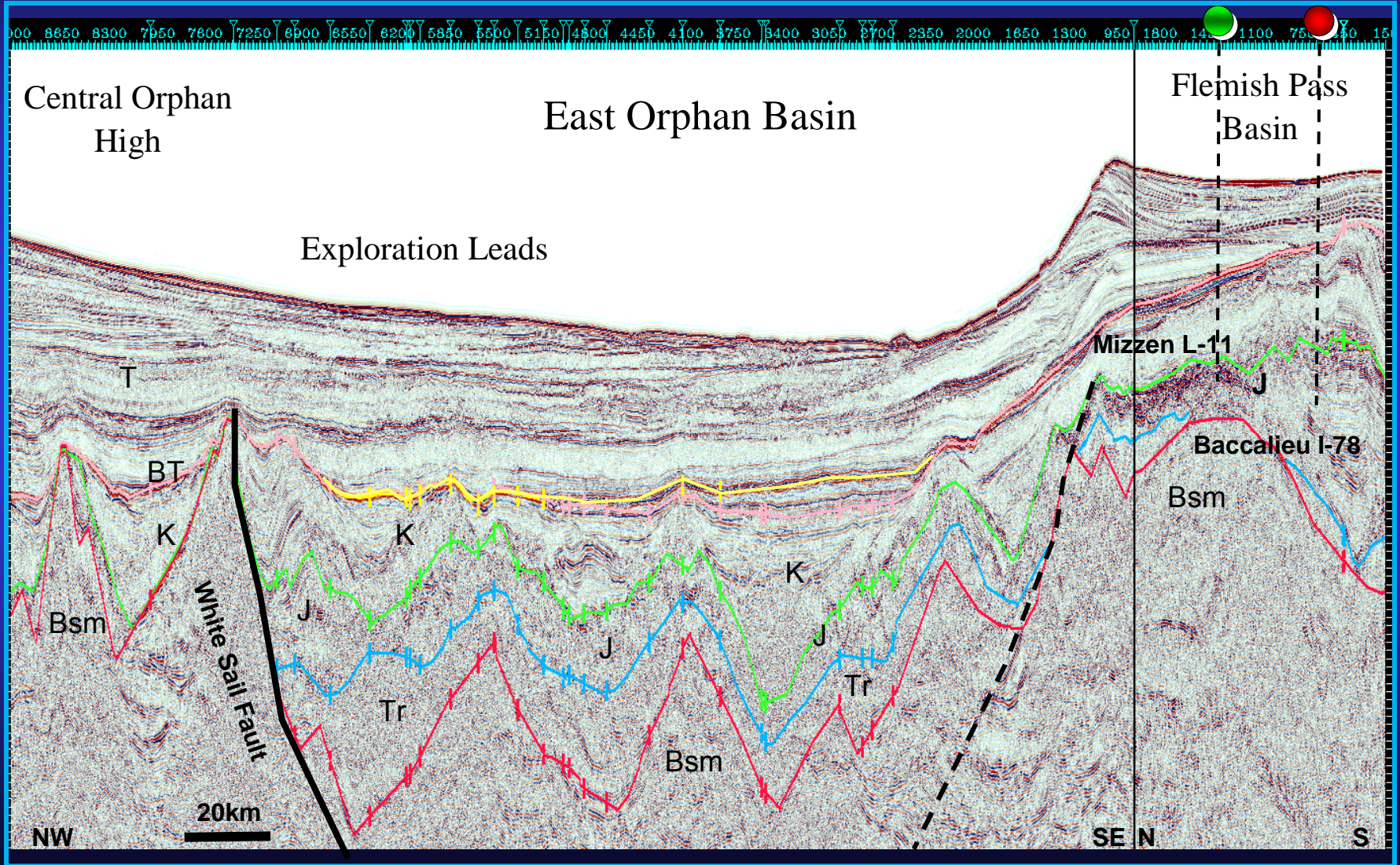


1. Baccalieu I-78
2. Mizzen L-11
3. Great Barasway F-66
4. Mizzen O-16
5. Lona O-55

Significant Wells Discussion

- There is little information available in the public domain on the 4 new wells drilled in the two basins during 2000-2010
- Due to their position in deep water (1110-2550 m) and high drilling cost, all 4 wells were located on large structural closures defined with quality 3D seismic data. Additionally the two Orphan Basin wells had CSEM surveys
- **Mizzen L-11** targeted a “clean “ rotated block within a densely faulted large anticline and found a 6 m oil show on logs in an Early Cretaceous sandstone and several other small shows; the well was not tested but proved that light oil was generated and is reservoired in Flemish Pass Basin. Information from Baccalieu I-78 well was essential for drilling Mizzen structure
- **Great Barasway F-66**, targeted a large roll-over close to the Orphan High. The well was declared dry and abandoned, but according to released logs good reservoirs and several possible source rock intervals were encountered
- **Mizzen O-16** targeted the apical part of the “Mizzen” anticline and encountered hydrocarbons. An SDL based on this discovery was awarded to Statoil/Husky in 2010. No other information is yet in public domain
- **Lona O-55** was drilled into a large and gentle rollover anticline located in the central part of the Orphan Basin. The well was abandoned without testing. No other information is yet in public domain

Late Jurassic Source Correlation from Baccalieu I-78 to Mizzen L-11 and into EOB



Courtesy of GSI

Enachescu et al., 2005

Enachescu, NL DNR 2010

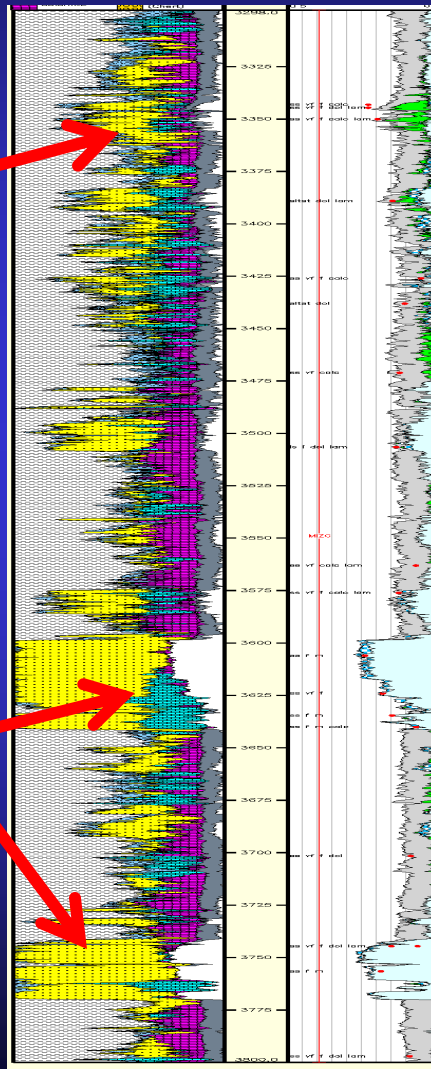
Mizzen L-11

Early Cretaceous Reservoirs

Net Pay
6 m of oil pay
Sw 25%

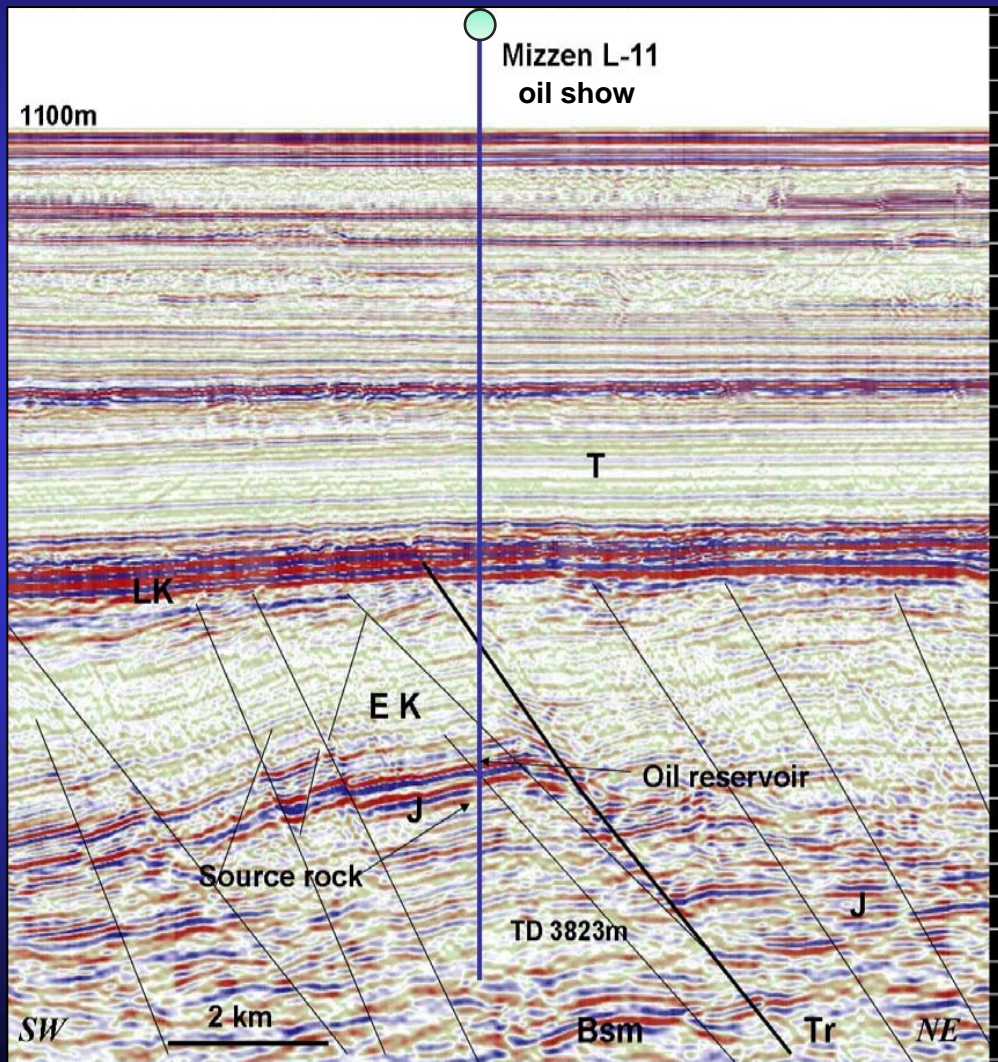
Late Jurassic Reservoirs

Gross Thickness:
70 m
Sw 95%
Avg Porosity: 20%



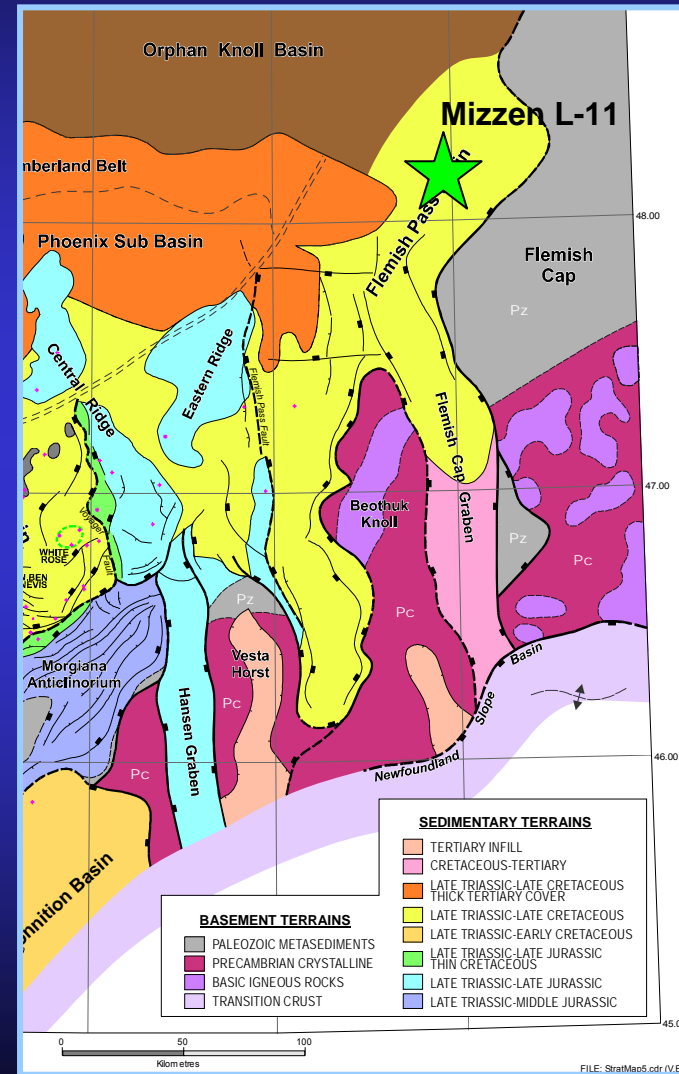
- Drilled in the Flemish Pass Basin in 1153 m water depth by Petro-Canada/EnCana/Norsk Hydro
- Location was selected based on a large 3D covering most of EL 1049
- Found an oil charged zone and intersected thick source rock
- The Baccalieu sandstone had poor reservoir but included a 6 m oil pay
- Excellent reservoirs were found in Late Jurassic sandstones at 3598 and 3741 m

Location of Mizzen L-11



Enachescu, 2006

Courtesy of GSI

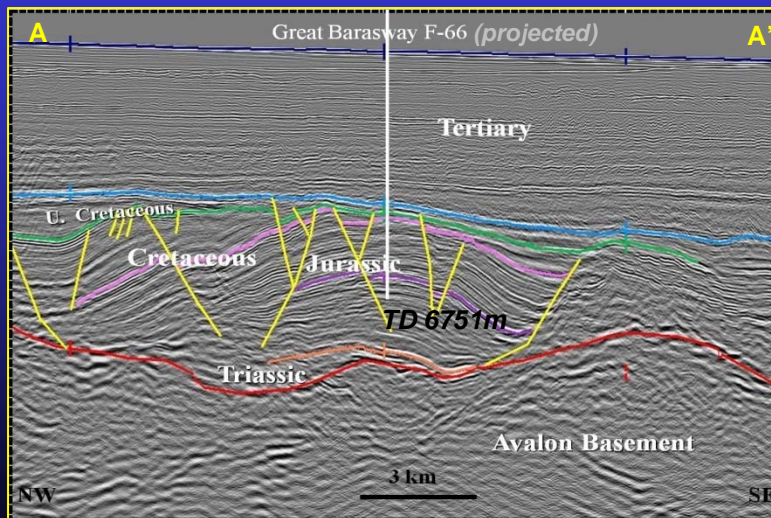
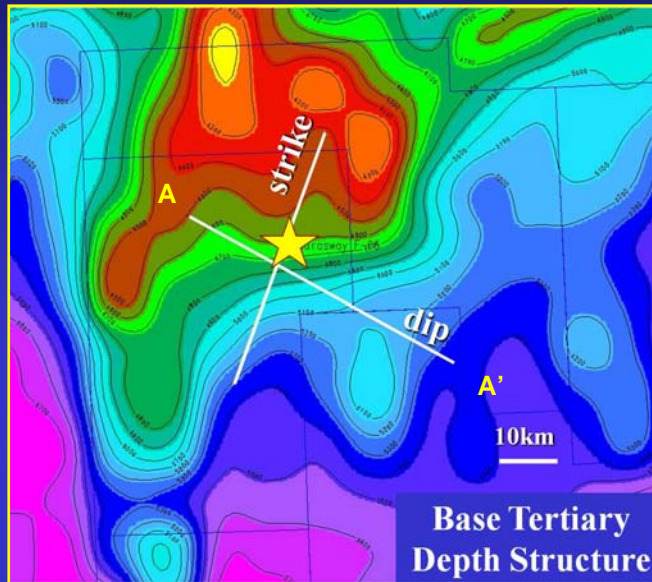


Enachescu, NL DNR 2010

Mizzen L-11 Reservoirs

Depth m	Lithology	Age	Hydro- carbons	Reservoir Properties
3345-3355	Sandstone	Early Cretaceous Baccalieu eq.	Oil 6m net	$\Phi=20\%$ Sw 25%
3410-3430	Sandstone	Late Jurassic Kimmeridge	No/Wet	$\Phi=20\%$
3740-3770	Sandstone	Late Jurassic Tithonian	No/Wet	$\Phi=20\%$

Great Barasway F-66

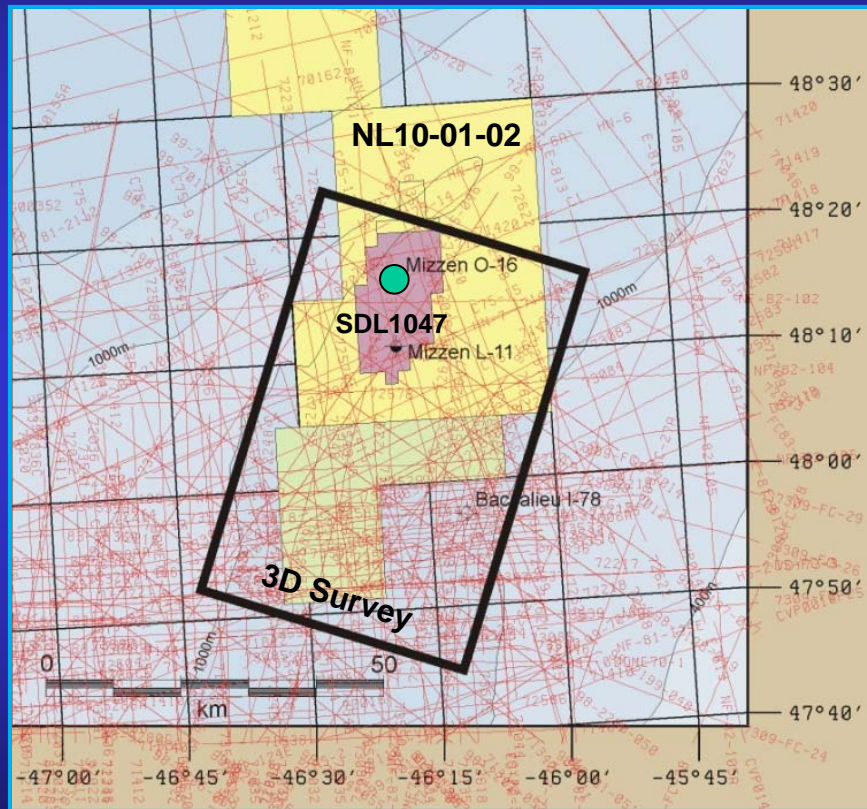


Courtesy of GSI

- First well drilled in the East Orphan Basin in 2338 m water depth by Chevron (50%)/EM - Imperial Oil (30%) /Shell (20%)
- Located in EL 1076
- TD'd at 6751 m
- It was abandoned without testing
- It targeted Cretaceous and Late Jurassic sandstones
- According to logs and lithological information the well encountered several good reservoir and possible Late Jurassic source intervals
- No geochemical results are available yet to evaluate the source rock properties, but source rock of unknown quality was certainly penetrated

Enachescu, NL DNR 2010

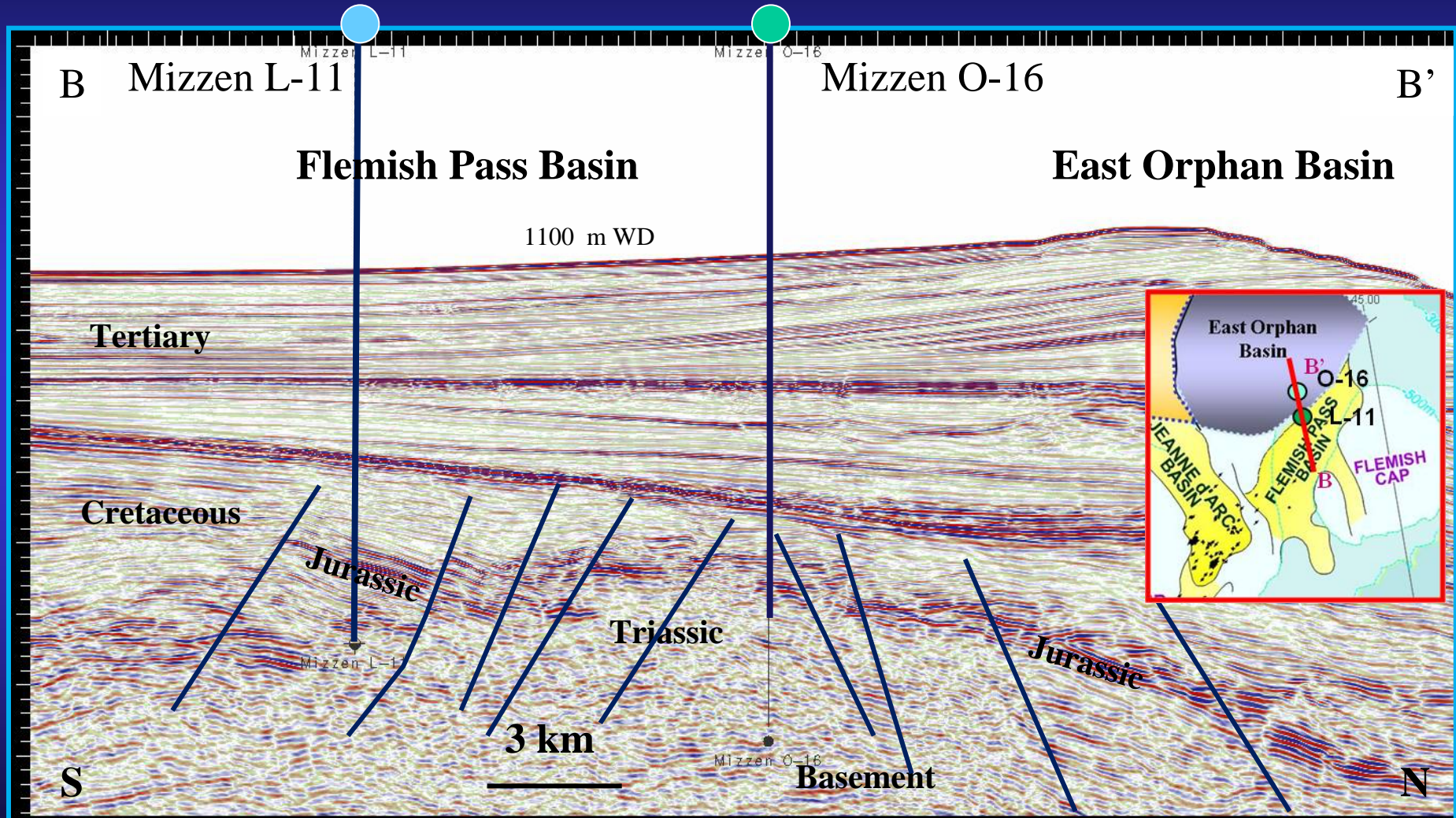
Mizzen O-16



Modified from C-NLOPB

- Drilled in the Flemish Pass Basin in 1095 m water depth by Statoil (65%)/Husky Energy (35%)
- Located in EL 1049, 11 km north of L-11, based on a 3D seismic survey
- TD'd at 3756 m
- It was declared a hydrocarbon discovery by the operator
- Based on seismic correlation, it probably targeted Late Jurassic and Early Cretaceous sandstones
- The operator applied and in 2010 the partnership was granted a Significant Discovery Licence (therefore, hydrocarbons were tested that have potential for sustained production)

Mizzen Wells Correlation

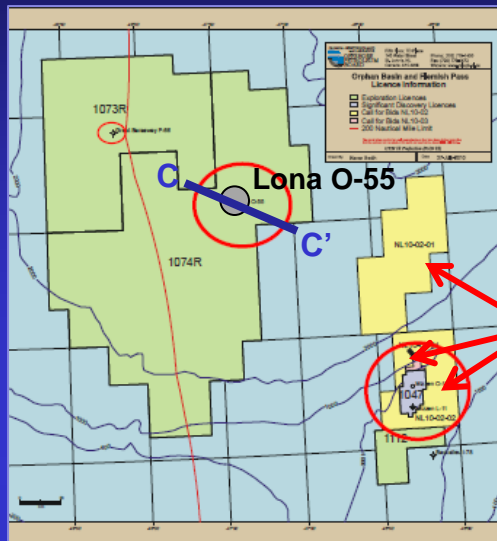


Courtesy of GSI

Enachescu et al., 2009

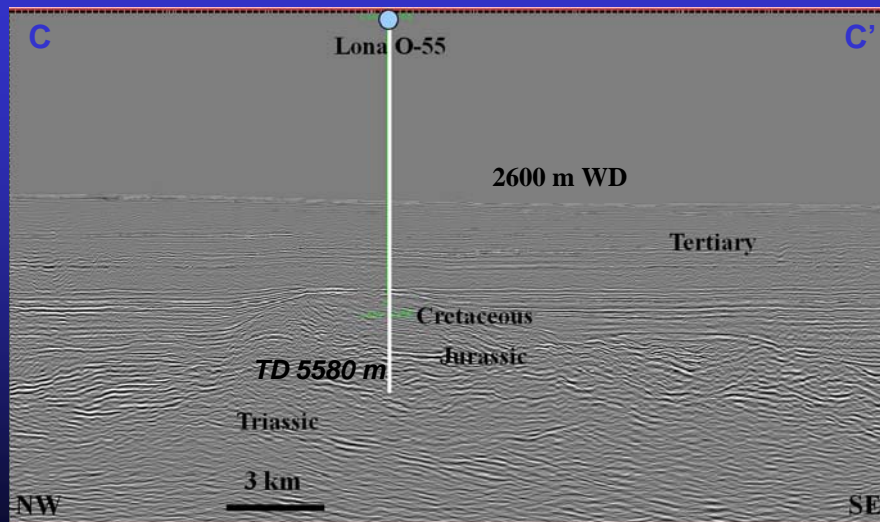
Enachescu, NL DNR 2010

Lona O-55



**Call for
Bids
NL10
Parcels**

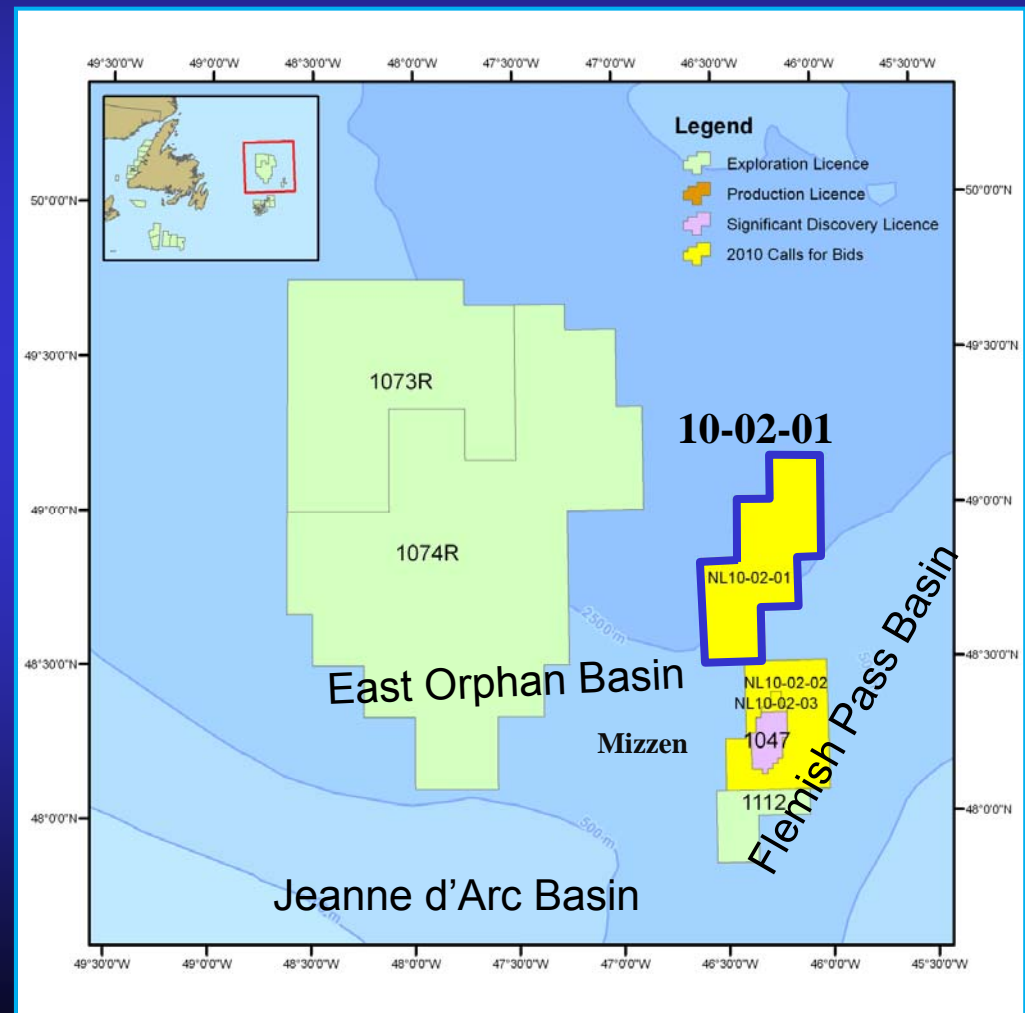
- Located in reconfigured and consolidated EL 1074R that is located approximately 100 km northwest of Mizzen SDL
- TD'd at 5580 m (C-NLOPB)
- Well was abandoned in the summer of 2010 without testing
- It targeted possible Cretaceous and Late Jurassic sandstones in a large, faulted anticline
- The results of this well will be in public domain in 2012
- Second well drilled in the East Orphan Basin in 2600 m water depth by Chevron (50%)/EM (15%) - IO (15%)/Shell (20%) partnership



Courtesy of GSI

6.1. Petroleum Potential of Call for Bids NL10-02 Parcel 1

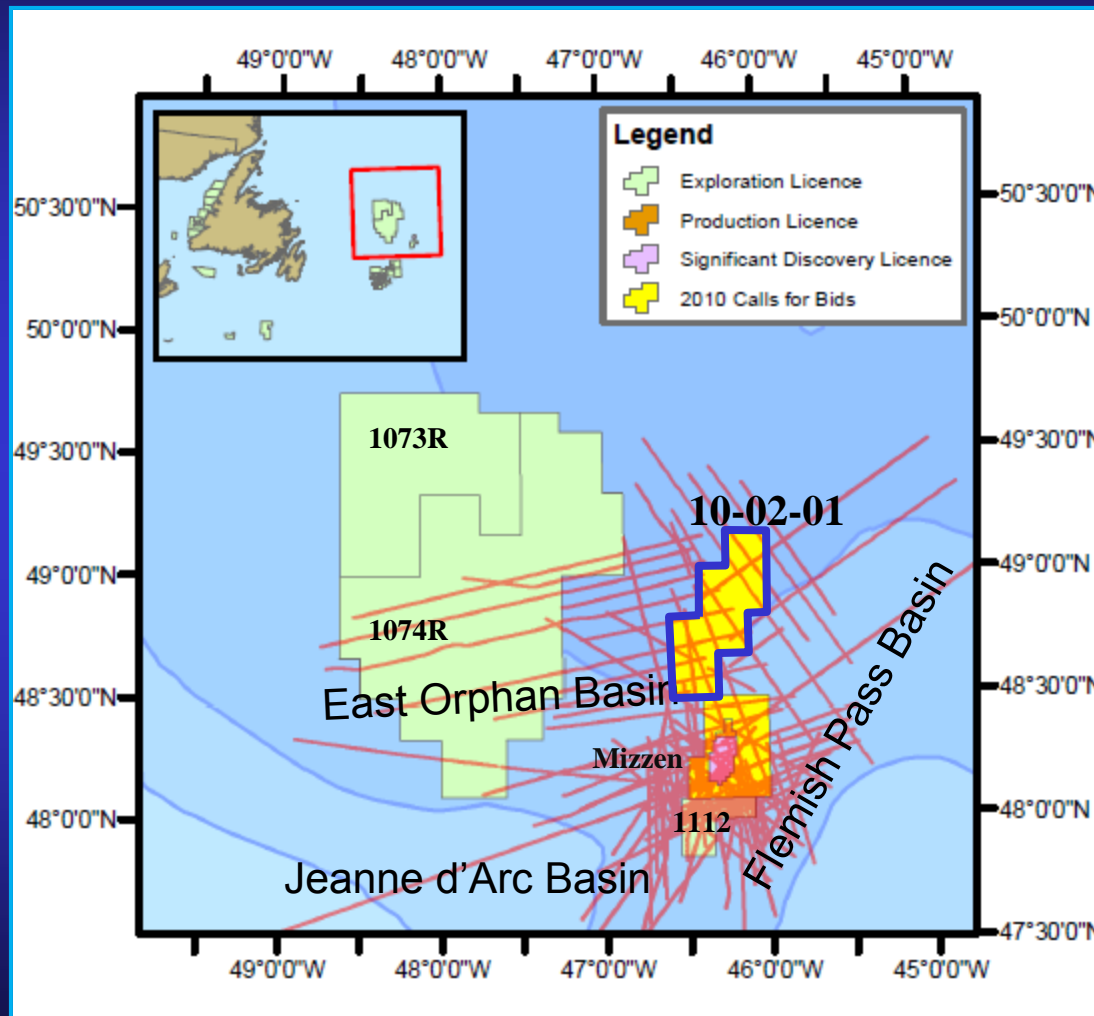
- Parcel 1 covers a very large area of 201,951 hectares (499,032 acres), situated in the deep water of the southeastern part of the East Orphan Basin
- This deep and ultra deep water parcel (1900 to 3000 m WD) is located approximately 100 km north northeast of White Rose and northeast of Hibernia oil producing fields
- Parcel is situated 25 km north of Mizzen O-16
- Structurally, the parcel is located within the complexly structured East Orphan Basin, where both postrift and synrift sediments are present



Seismic Coverage

- More than 1000 km of high quality 2D data is available for petroleum evaluation of this parcel
- The 2D seismic grid has 0.5-3 km spacing in the dip direction and 2-4 km spacing in the strike direction
- Older digital data covering the parcel and environs is owned by oil companies that acquired the data when they had exploration licenses over the area in the late 1970s-early 1980s (ExxonMobil, Suncor (Petro-Canada), Texaco, etc.) and from seismic companies that had non-exclusive programs in the area (GSI, TGS, JEBSCO, etc.)
- The most recent data sets (2000-2003) are available in digital format for licensing from seismic companies (GSI and TGS)
- No 3D data was collected in this part of the basin. Two large 3D proprietary seismic surveys exist in the central part of the basin covering parts of ELs 1073R and 1074R. A large 3D also exists in Flemish Pass Basin just south of Parcel 1

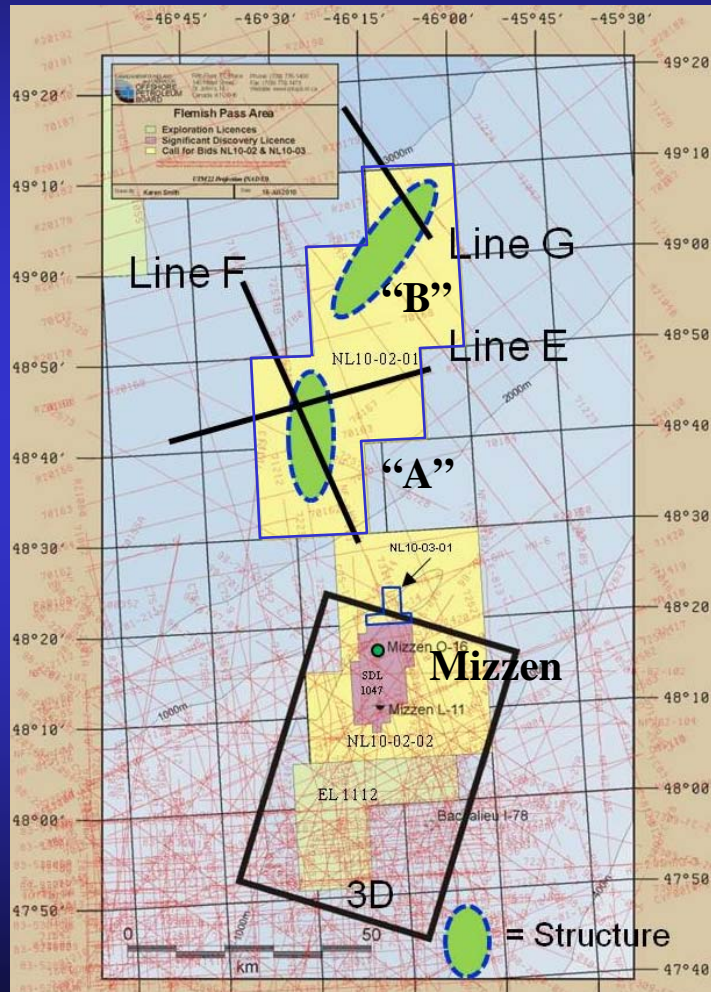
2D Seismic Data Quality



- Seismic data quality is good to excellent for Parcel 1 and environs
- Older data than 1980 has poor quality and is usually unmigrated
- Majority of lines are post-stack time migrated; most recent data and some reprocessed lines have pre-stack time migration applied
- Marine data was acquired with a 3-4.5 km streamer length during late 1970s-early 1980s and with a 6 km length during late 1990s-early 2000s
- The regional 2D grid is oriented NW-SE or W-E (dip lines) intersecting NE-SW or N-S tie lines (strike direction)

CFB NL10-02 Parcel 1, adjacent Exploration Licenses, SDL and current seismic coverage

Petroleum Potential - Parcel 1



Modified from C-NLOPB

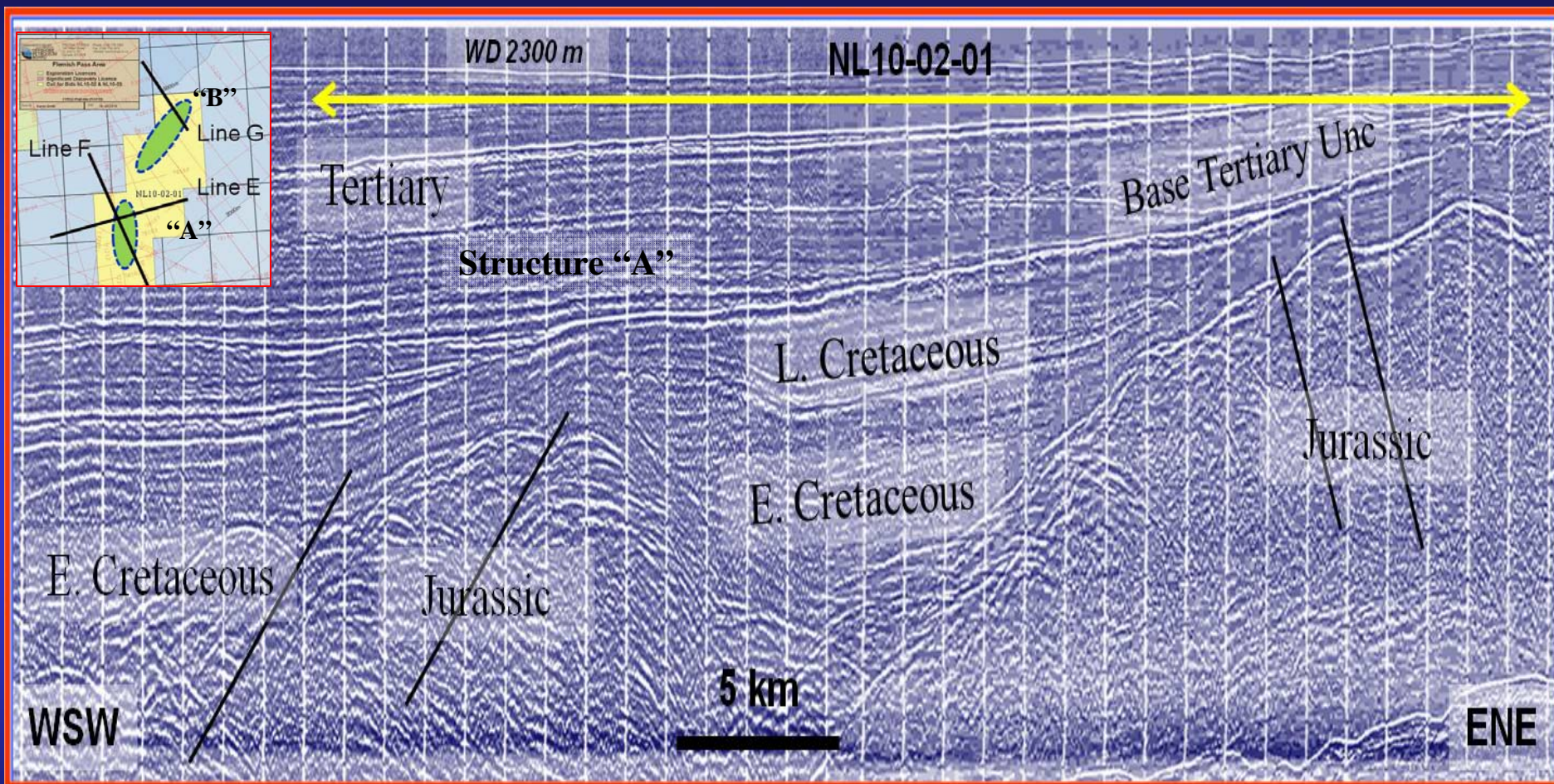
- Two large structural closures, each encompassing more than 100 km², were mapped on older seismic lines; C-NLOPB has archived exploration maps in the area. New data confirm the presence of these structures
- These structures also contain fringing stratigraphic trapping possibilities
- For both structures multiple exploration plays ranging from Late Jurassic to Early Tertiary are possible
- Amplitude Anomalies are present above and around the structures
- Existence of mature source rocks and hydrocarbon accumulations is proven 25 km to the south at Mizzen O-16. Mizzen hydrocarbons may be sourced from the syncline between the Mizzen and “A” structures

Seismic Interpretation-Parcel 1

The following three seismic sections illustrate the presence of two large structural leads (represented by ‘A” and “B” on location map). While these were older, unmigrated data, the lines E, F and G show the characteristics of the two features that were mapped in the late 70’s by companies active in the area.

Observation: Due to confidentiality issues, no new digital data was available to illustrate the potential of this parcel. Confidential, non-exclusive data from various data vendors is available for inspection and licensing from seismic companies and data brokers.

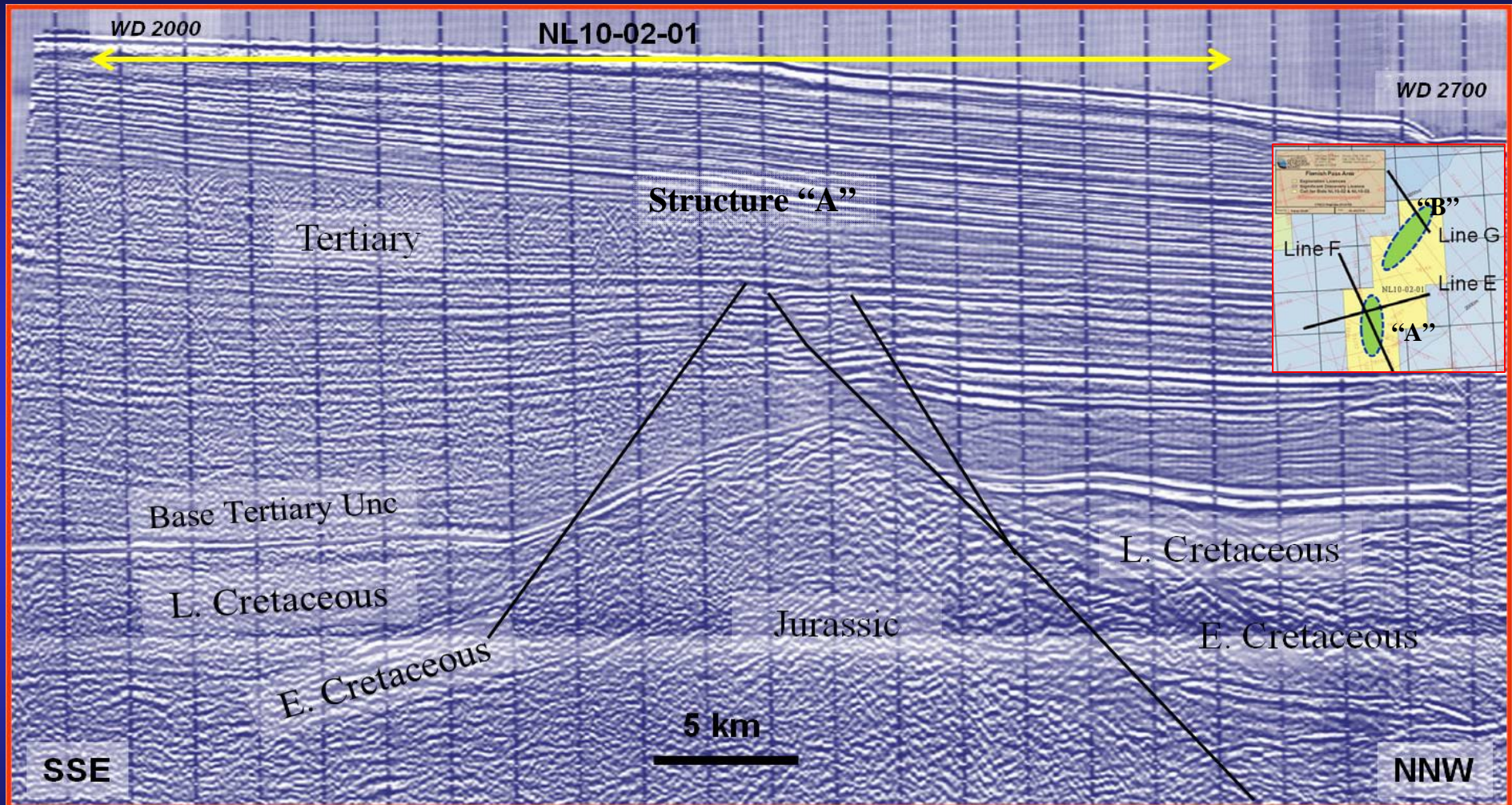
WSW-ENE Seismic 2D Line E



Line Source: C-NLOPB

Interpreted dip 2D seismic line within parcel NL10-02-01 and environs. Several large rotated blocks bound by normal faults are interpreted in Structure “A”. Structural traps exist in Late Jurassic and Early Cretaceous sequences. Stratigraphic or combination traps are present in Late Cretaceous and Early Tertiary successions

SSE-NNW Seismic 2D Line F

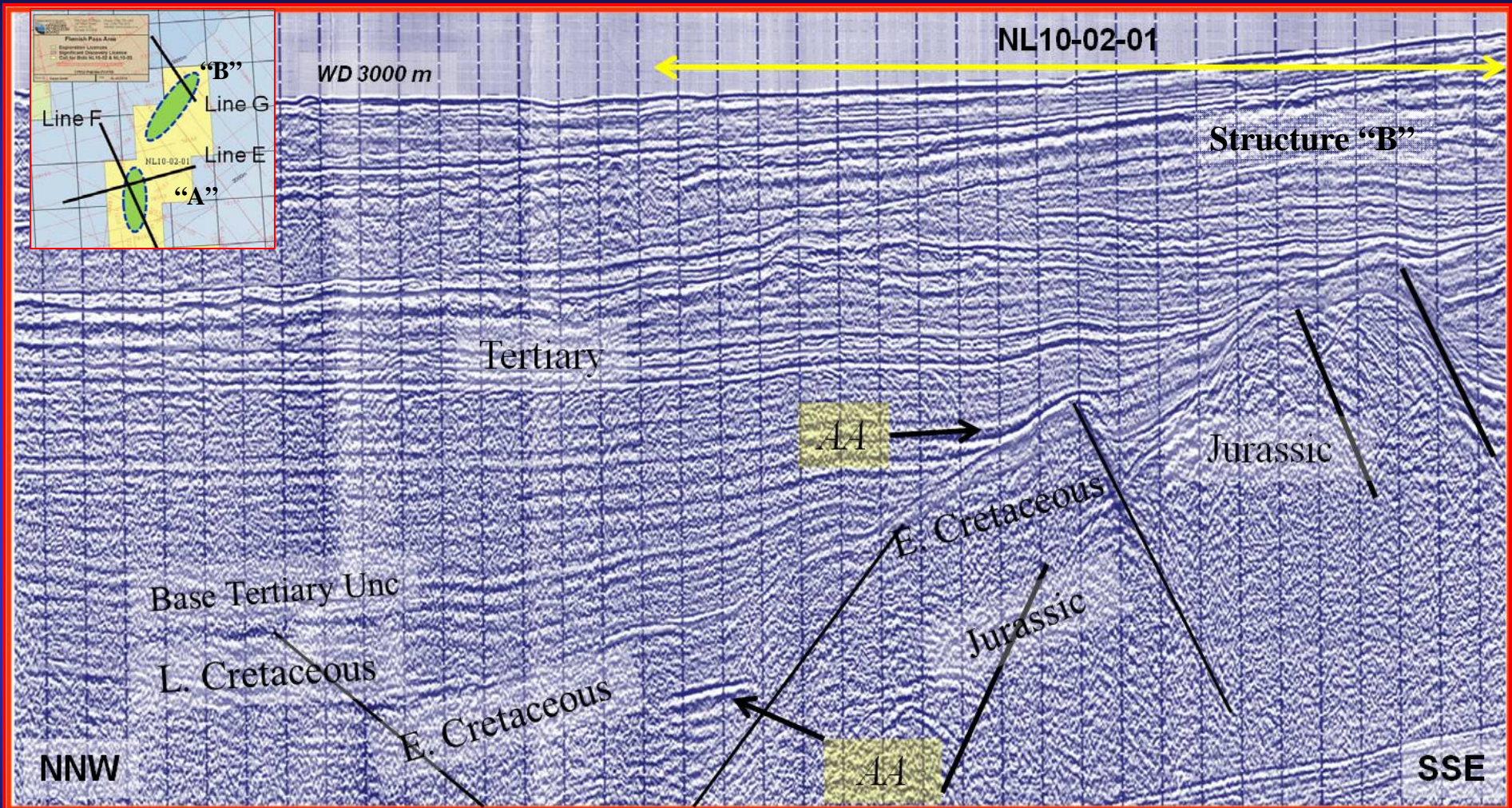


Line Source: C-NLOPB

Interpreted strike 2D seismic line within parcel NL10-02-01 and environs. One large rotated block bounded by normal faults is interpreted containing Jurassic and probably Early Cretaceous beds. A drape over, faulted anticline exists in Early Tertiary succession

Enachescu, NL DNR 2010

NNW-SSE Seismic 2D Line G



Line Source: C-NLOPB

Interpreted dip 2D seismic line within parcel NL10-02-01 and environs. Several large rotated blocks bounded by normal faults are present in the Structure "B". Amplitude Anomalies (AA) are interpreted on the northern flank of the Structure "B"

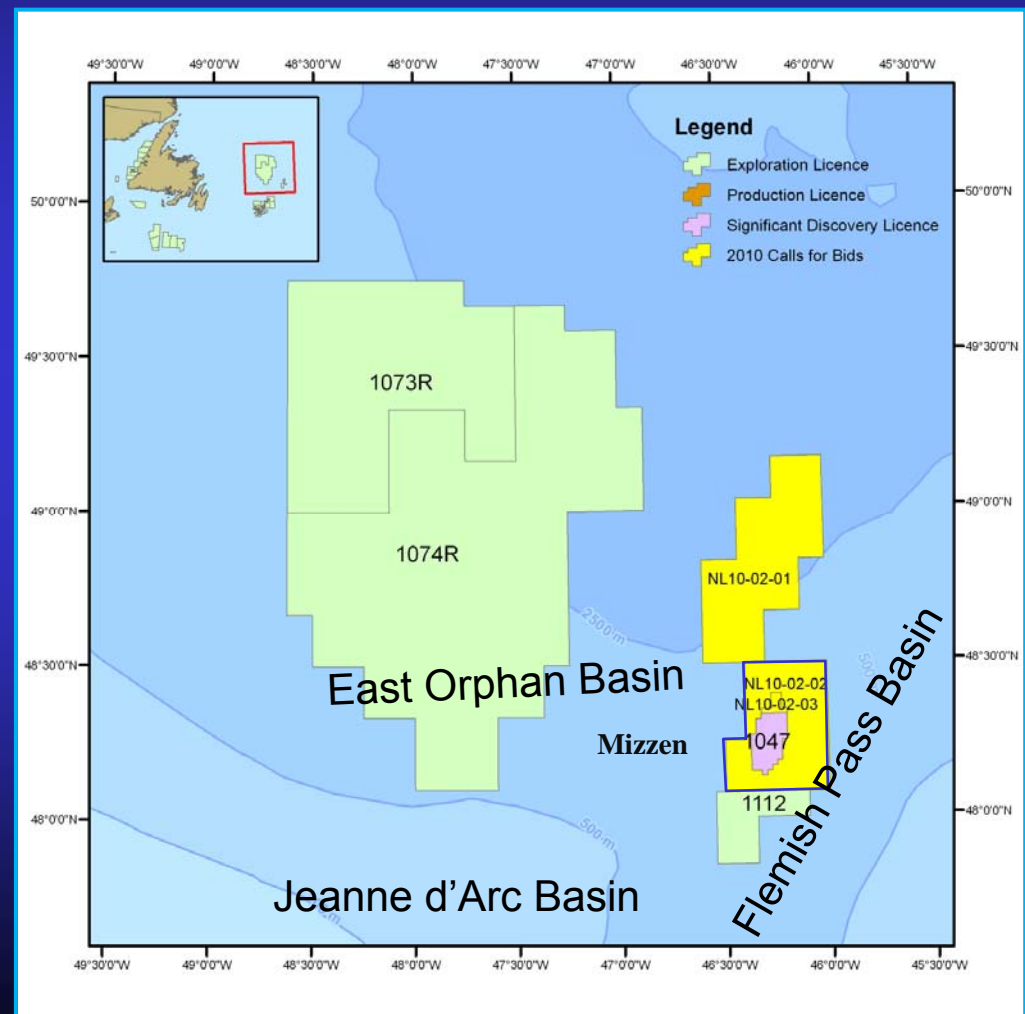
Enachescu, NL DNR 2010

Hydrocarbon Traps and Potential-Parcel 1

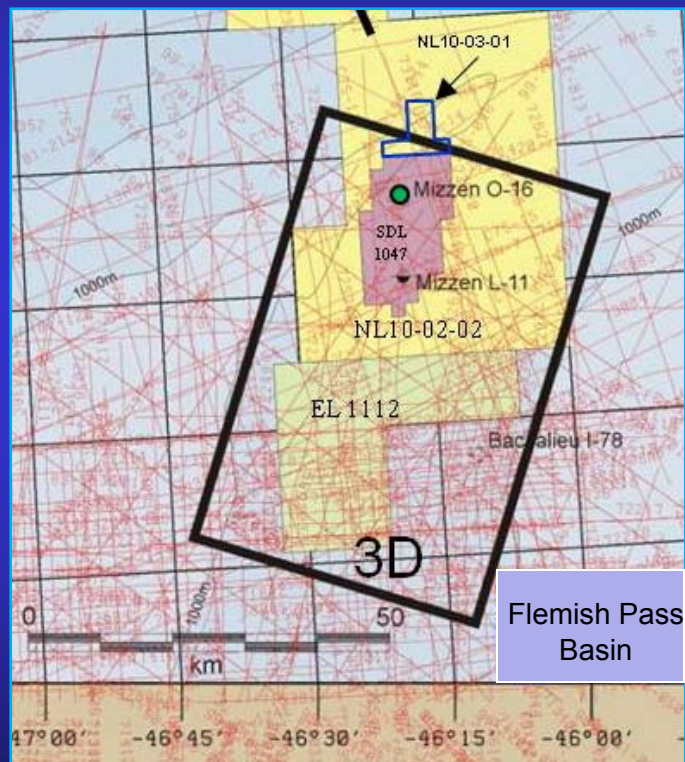
- Two very large, elongated structural traps exist in the parcel: Structure “A” oriented N-S and Structure “B” oriented NE-SW
- In both structures, the synrift sequence is segmented by faults into several blocks; the postrift sequence shows faulting and closure only in the strike direction
- If charged, each of the two structures can contain in excess of 1 Billion barrels or several Tcf of gas
- Individual traps are fault dependent and are bound by multiple faults (1 to 3 faults)
- In this sector of the East Orphan Basin, these traps may contain Late Jurassic to late Early Cretaceous coarse clastics (as shown by the Mizzen and Baccalieu wells located to the south)
- The postrift sequence contains numerous stratigraphic traps
- On the southern slope of the EOB, coarse sediments from the Flemish Cap area have been shed into the basin forming several thick, south-westerly dipping wedges of Late Cretaceous-Early Tertiary sediments

6.2. Petroleum Potential of Call for Bids NL10-02 Parcel 2

- Parcel 2 covers a very large area of 125,421 hectares (309,922 acres), situated in the northernmost part of the Flemish Pass Basin
- This medium deep water parcel (1000 to 2000 m WD) is located approximately 80 km north northeast of White Rose and northeast of Hibernia oil producing fields
- Parcel is situated around SDL 1047 and north of EL 1112
- Structurally, the parcel is located in Flemish Pass Basin and contains both postrift and synrift sediments. The synrift sediments plunge northwardly toward the East Orphan Basin



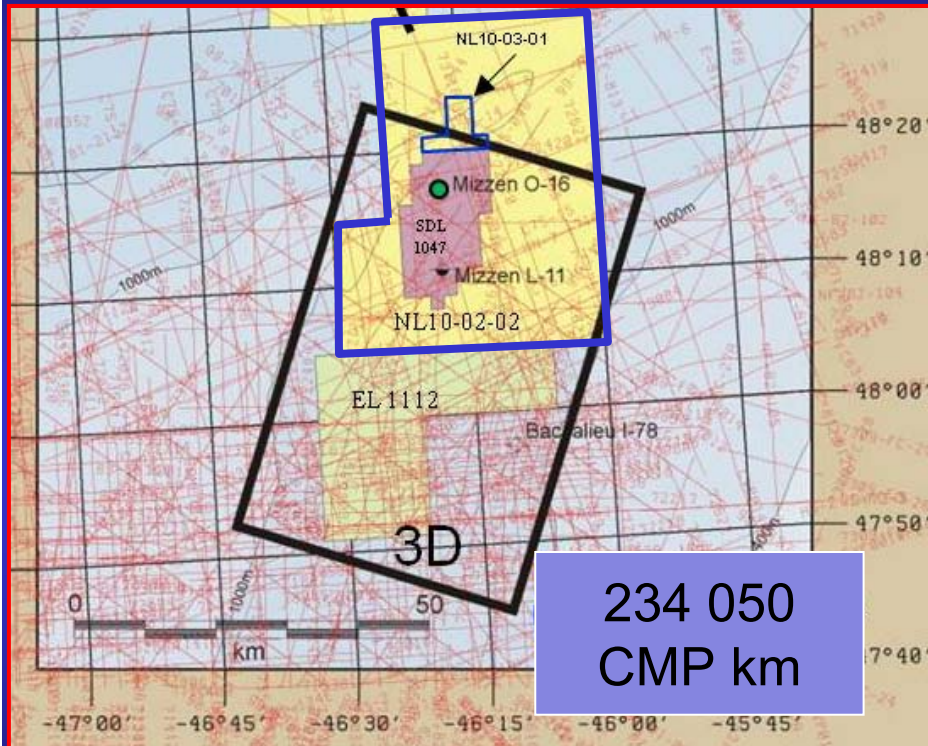
2D Seismic Coverage



Modified from C-NLOPB

- More than 2500 km of high quality 2D is available for petroleum evaluation of this parcel
- The 2D seismic grid has 0.5-2 km spacing in the dip direction and 1-3 km spacing in the strike direction
- Older digital data covering the parcel and environs is held by oil companies that acquired the data when they had exploration licenses over the area in the late 1970s-early 1980s (ExxonMobil, Suncor (Petro-Canada), etc.) and from seismic companies that had non-exclusive programs in the area (GSI, TGS, CGGVeritas)
- The most recent data sets (late 1990s-early 2000s) are available in digital format for licensing from the seismic companies GSI and TGS

3D Seismic Coverage

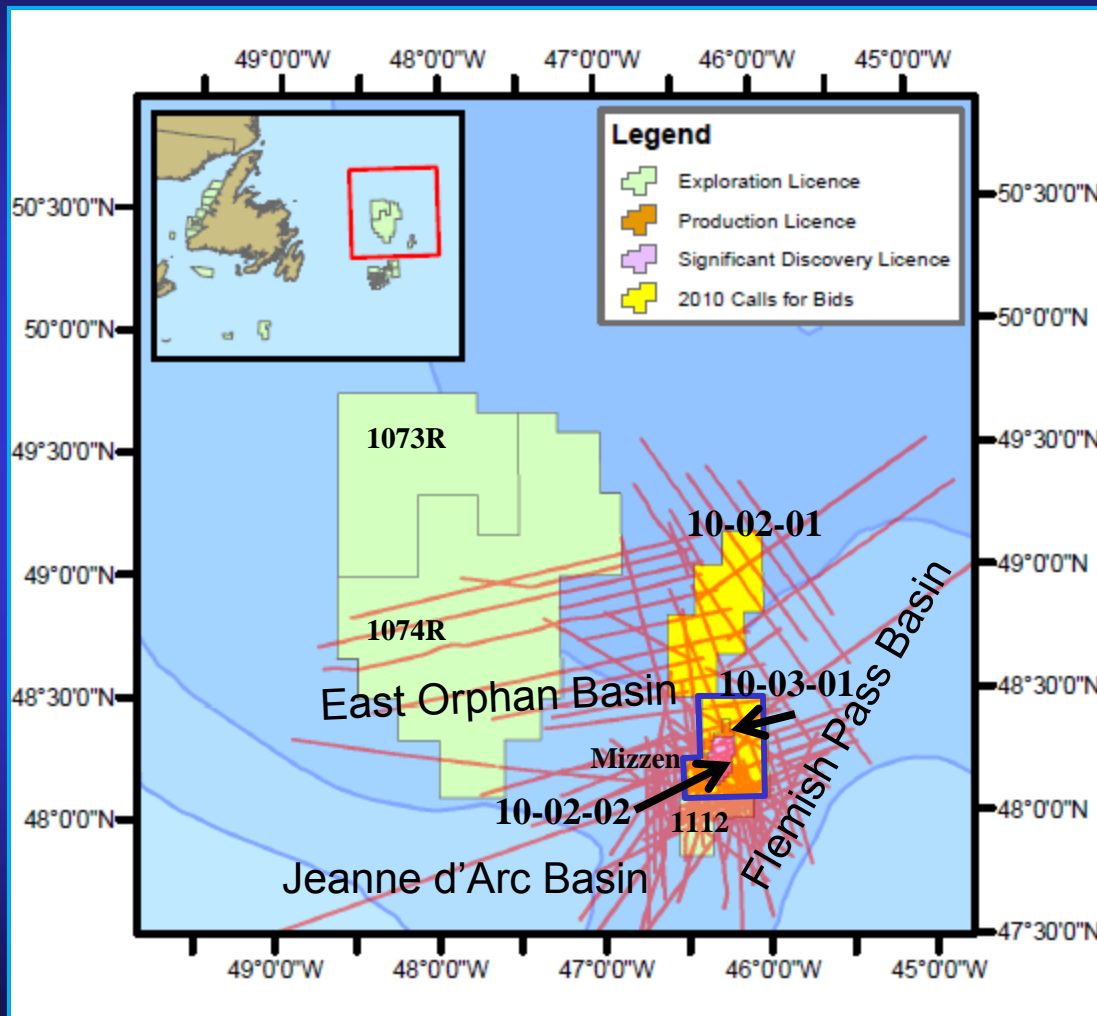


Modified from C-NLOPB

Flemish Pass approximate
location of the Baynord
3D Seismic Survey

- A large 3D survey was collected in this part of the basin during 2000
- The survey was acquired with dual source and ten, 5-km long streamers and covers the southern two-thirds of parcel
- Petro-Canada, as operator contracted WesternGeco to carry out this 234 050 CMP km survey, covering most of the now expired ELs 1049 and 1050
- The survey called Baynord was processed by Veritas in 2001 to pre-stack migration and has 25 m line spacing
- Once acquired from owners, modern 2D and 3D lines and well information can be used to tie main seismic markers from the Baccalieu I-78 to the Mizzen L-11 and to the southern Tuckmore B-27, both drilled in 2003 by the partnership Petro-Canada/Norsk Hydro /PanCanadian

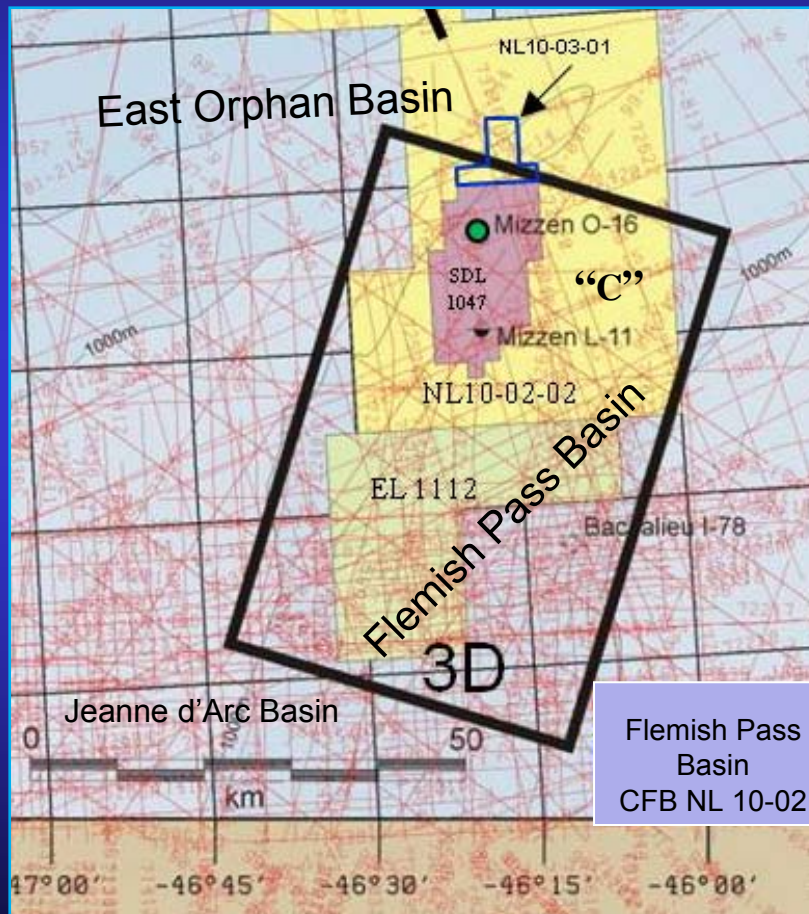
2D and 3D Seismic Data Quality



CFB NL10-02 Parcels 1 and 2, CFB NL10-03, adjacent Exploration Licenses and current seismic coverage

- Seismic data quality is good to excellent for Parcel 2 and environs
- Older data than 1980 has poor quality and is usually unmigrated
- Majority of 1990s lines are post-stack time migrated; most recent data and some reprocessed lines have pre-stack time migration applied
- Marine data was acquired with a 3-4.5 km streamer length during late 1970s-early 1980s and with a 6 km length during late 1990s-early 2000s
- The regional 2D grid is oriented NW-SE or W-E (dip lines) intersecting NE-SW or N-S tie lines (strike direction)
- The Baynord 3D survey covering most of Parcel 2 has excellent quality

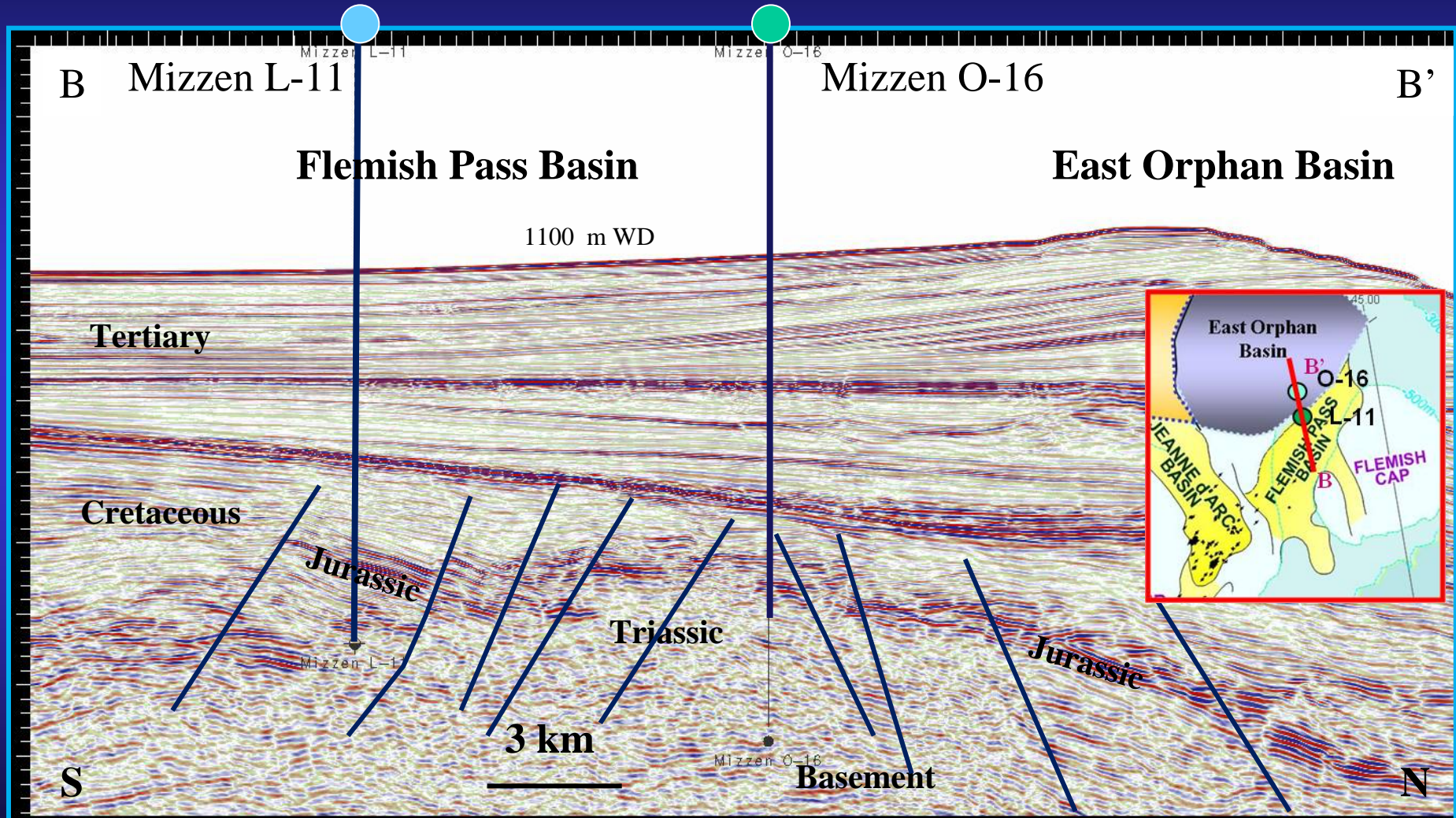
Seismic Interpretation NL10-02 Parcel 2



Modified from C-NLOPB

- 2D seismic lines over Parcel 2 indicate the presence of medium size rotated blocks associated with the Mizzen structure and shows a large structural trap in the eastern part of the block, represented by “C” on the location map
- These modern and older seismic lines are part of the dense data set covering the Parcel 2 and also the Parcel NL10-03-01
- An approximate north-south section shows several potential rotated blocks. Only main seismic sequences, unconformities and major faults are shown on this line. Well and seismic section locations are approximate

Mizzen Wells Correlation



Courtesy of GSI

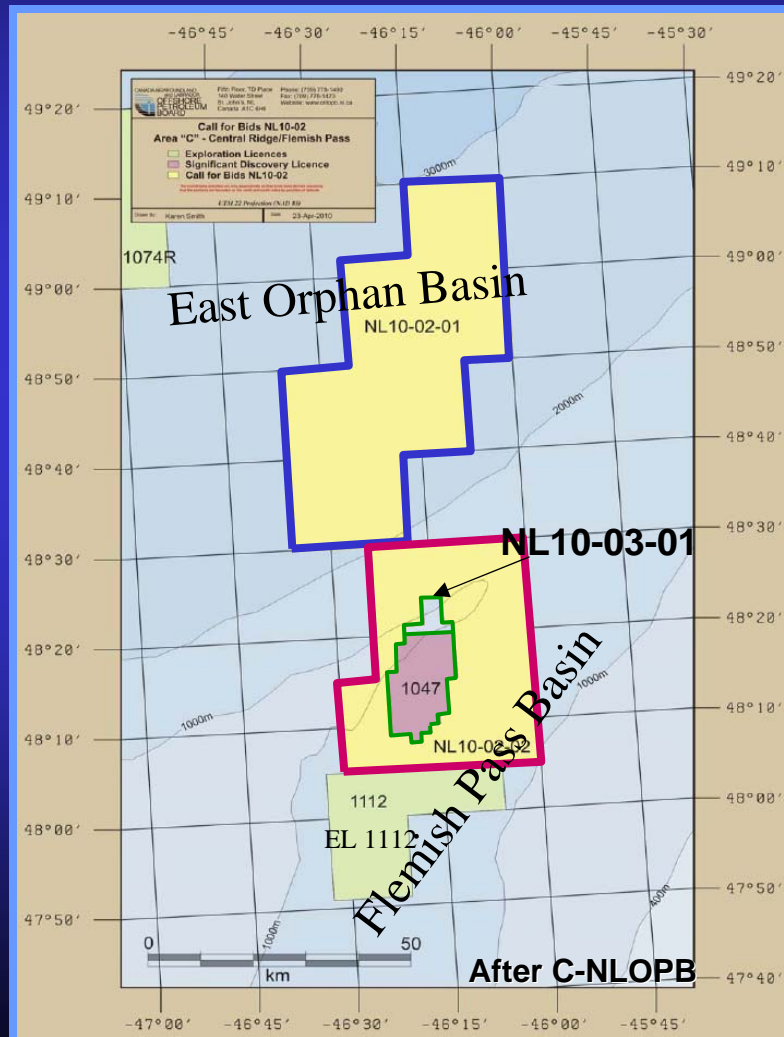
Enachescu et al., 2009

Enachescu, NL DNR 2010

Hydrocarbon Traps and Potential-Parcel 2

- The Mizzen structure which has been already drilled and confirmed as a hydrocarbon discovery occupies the central, fenced SDL 1047, and also extends into the surrounding Parcel NL10-02-02
- Numerous other undrilled rotated fault blocks are mapped downdip, on both eastern and western flanks of the Mizzen structure. These blocks can add significant quantities of oil and gas to the Mizzen discovery
- Also a separate deeper rollover, segmented by faults was identified on dip 2D lines east of the Mizzen O-16 (marked as Structure “C”)
- These structures contain multiple fault bounded plays in sandstones ranging in age from Late Jurassic to Early Tertiary
- Seismic data also show several combination and purely stratigraphic trapping possibilities
- Amplitude Anomalies are present within, above and around the structures and in the postrift succession
- Existence of mature source rocks and hydrocarbon accumulation are proven at Mizzen L-11 and hydrocarbon have been tested at O-16. Mizzen hydrocarbons may be sourced from the synclines surrounding the Mizzen structure. Other deeper closed blocks may also contain hydrocarbons

7.1. Petroleum Potential of Call for Bids NL10-03 Parcels 1



- Parcel NL10-03-01 is a small block covering 3,773 hectares (9,323 acres), in the northern part of the Flemish Pass Basin
- Parcel is located in 1000 m water depth, immediately north of SDL 1047 and about 10 km north of the Mizzen O-16 discovery well
- The parcel is covered by high quality 2D and 3D seismic data
- Parcel NL10-03-01 has the potential to add supplementary reserves to the Mizzen discovery

Maturation and Migration in Call for Bids NL10-02 and NL10-03 Parcels

- In all of 2010 CFB parcels the Late Jurassic rocks should be at depths between 3 and 6 km; thus the Egret source rock and older organic shales should be in the mature range
- In several parts of the parcels the source rock may be even deeper and therefore overmature and may have generated both oil and gas
- The Baccalieu and Mizzen L-11 wells proved that mature source rock exists in the area and migration of oil into fault dependent traps took place in the FPB; no concrete source rock evidence exists for the EOB, however seismic correlation may indicate presence of Late Jurassic in the basin
- After trap formation during the synrift stage, there were direct migration routes through porous sandstone beds and numerous normal faults from Late Jurassic organic shale into younger sandstone reservoirs
- Migration might also take place into Late Cretaceous-Early Tertiary basin margin and basin floor fans present in the parcels

Seismic Interpretation Discussion Parcels: NL10-02 -01 and -02 and NL10-03

- Regional seismic data can easily be tied with synthetic seismograms to Mizzen, Baccalieu and Tukamore exploration wells situated inside the SDL 1047 or close to all three Call for Bids parcels
- Full synrift sequence including reservoir sandstone of Late Jurassic to late Early Cretaceous exist in all parcels
- Potential reservoirs in the synrift sequence include the proven Baccalieu and Gabriel reservoirs, equivalent with highly productive reservoirs in the Jeanne d'Arc Basin;
- The Rankin Formation containing the Egret source rock can be seismically tied to the Baccalieu and Mizzen wells
- The Postrift sequence is thick and shows high amplitude character for some of the Late Cretaceous and Early Tertiary seismic markers
- Faults dissect the synrift sequence; only several major faults are affecting the thermal subsidence sequence
- The potential reservoirs beds can be drilled with 3000 to 4500 m deep wells

Observation: On the illustrative seismic sections only a few markers, unconformities and faults are displayed

8. General Discussion

- There is no production infrastructure in this part of the basin
- The closest production exists on the Grand Banks at the White Rose field, which has four glory holes and producing wells tied back to the Sea Rose FPSO
- An oil field larger than 300-400 million barrels recoverable found in these parcels can probably be a candidate for a stand alone development; smaller fields may be clustered into a single development
- Exploration in this part of the Flemish Pass and East Orphan basins is light
- Numerous large to medium size leads are visible on seismic data; some are already mapped using older data, some can be mapped only with modern 2D and 3D data
- Older prospect and lead maps are contained in Exploration Reports deposited by previous operators in the C-NLOPB library
- Parcels are well covered by good quality speculative 2D and partially by 3D seismic data (Parcels NL10-02-01 and NL10-03-01)
- These data can be licensed from data owners or seismic brokers

8. General Discussion

- The presence of Mizzen hydrocarbon discovery in the vicinity and of several large oil and gas fields producing on the Grand Banks provides encouragement for the potential of the three parcels contained in CFB NL10-02 and -03
- CFB NL10-02 parcels are many times larger when compared with a Gulf of Mexico standard block or North Sea offerings
- All three parcels are located in an area with large extensional traps, some known reservoirs, confirmed or seismically correlated source rocks and proven migration paths
- However, risks are recognized in regard to reservoir quality and fault sealing as well as presence and quality of source rock for Parcel NL10-02-01
- All parcels contain multiple reservoir targets within synrift sandstones reservoirs located at 2500-4500 m depth that can be drilled year round and tested using drill ship or semi-submersible rigs
- Existence of 3D coverage for parcels NL10-02-01 and NL10-03-01 and presence of hydrocarbon in the SDL1047 considerably lowers the risk of exploration
- Cost of an offshore well in these parcels would likely be in the order of CDN \$100 million depending on the depth to the target and season of drilling

9. Conclusions

- Two large parcels, NL10-02-01 and NL10-02-02, and one very small size parcel, NL10-03-01, located within the hydrocarbon proven Flemish Pass-South East Orphan basins border area are available for licensing in the C-NLOPB's Call for Bids NL10-02 and -03 which closes on November 30, 2010, 4 p.m. NL time
- 1.16 Billion barrels of oil were produced to date from the JDB just 100 km south of the bidding parcels; it is estimated that 6 Bbbls of oil and 60 Tcf of gas remain to be uncovered offshore Newfoundland and Labrador including the areas where parcels are offered
- Parcel NL10-02-01 is located only 20 km north and on trend with the recently awarded SDL 1047 (Mizzen), Parcel NL10-02-01 surrounds this SDL and Parcel NL10-03-01 contains three sections just north of the Mizzen SDL

9. Conclusions

- **Parcel NL10-02-01** is a deep water parcel located in the southern East Orphan Basin that contains at least two large untested closures “A” and “B” of rotated fault block type
- Parcel 1 structures can each hold in excess of 1 Bbbls of oil and 3-5 Tcf of gas if thick reservoirs are developed in the parcel and hydrocarbons are trapped; several other structural and stratigraphic possibilities exist in the parcel
- **Parcel NL10-02-02** is a deep water parcel, mainly located within the Flemish Pass Basin that encompasses many undrilled fault blocks; the acreage is located on the flanks of the large, complex structure (Mizzen) drilled by both Mizzen wells and also includes a deeper rollover structure “C”; good reservoirs and trapped hydrocarbons were encountered in the Mizzen structure and hydrocarbon potential should extend eastward into the Structure “C”
- As all producing fields in the Jeanne d’Arc Basin are intensely faulted and faults were used for migration, it is expected that certain lower blocks on the Mizzen structure may also contain hydrocarbons
- **Parcel NL10-03-01** is a very small, deep water parcel, carved out of the Parcel NL10-02-02 and in direct continuation with SDL 1047. Parcel contains the northern plunge of Mizzen structure

9. Conclusions

- In both Call for Bids NL-02 parcels, there are large, favourable structural closures in Late Jurassic-Early Cretaceous synrift beds and stratigraphic trapping possibilities for Late Cretaceous and Early Tertiary sandstone reservoirs
- Main source rock for the area - the Egret Member – is proven at L-11, correlated seismically in this part of the basin and should be in the mature range within the identified tilted blocks or in adjacent depressions, close to the Mizzen structure
- Good quality and dense 2D, and 3D seismic coverage is available in the parcels to image and adequately map hydrocarbon traps
- Recognized risks in regard to reservoir and source quality and fault seal are mitigated by the presence of large, multiple undrilled features and the presence of adjacent Mizzen L-11 oil show and Mizzen O-16 hydrocarbon discovery
- Geological risk can also be reduced by using pre-stack and post-stack seismic analysis and CSEM methods
- All the prospects and leads in the parcels are located in deep water
- Prospects in the three offered parcels can be drilled with semisubmersible rigs or drillships

9. Conclusions

- A large size hydrocarbon discovery in CFB NL10-02 Parcel 1 and additional reserves discovered in Parcel 2 and/or parcel NL10-03-01 would provide for the first deep water development in Canadian waters
- A large, new discovery may be developed as a stand alone field; several small and medium size discoveries may be bound together into a single development project
- Acquiring either parcel will give a new entrant operator in the area an excellent opportunity of participating in a proven hydrocarbon play located in the most rewarding East Coast petroleum province
- For an existing operator or non-operating company, licensing either parcels will provide a great opportunity to increase its prospective portfolio and add significant petroleum reserves
- The Government of Newfoundland and Labrador actively encourages oil and gas exploration in the area with utmost regards for safety and environmental protection
- The C-NLOPB 2010 Flemish Pass Basin/Central Ridge Call for Bids provides oil companies with a great opportunity to participate in exploration and acquire large tracts of exploration lands in a proven petroleum province where a further **6 Bbbls** and **60 Tcf of** offshore undiscovered resources remain to be uncovered

**Thank You for your Attention and
Good Luck Exploring!**



**Euxinic
Exploration**



**Newfoundland
Labrador**