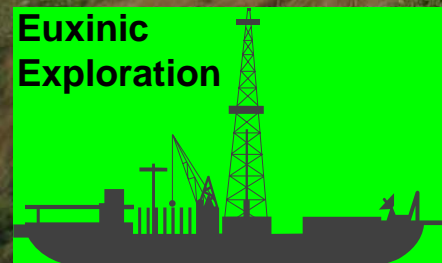


# Petroleum Exploration Opportunities in Anticosti Basin, Offshore Western Newfoundland and Labrador - Call for Bids NL09-3

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NL Department of Natural Resources

**On Behalf of NL DNR  
October 2009**





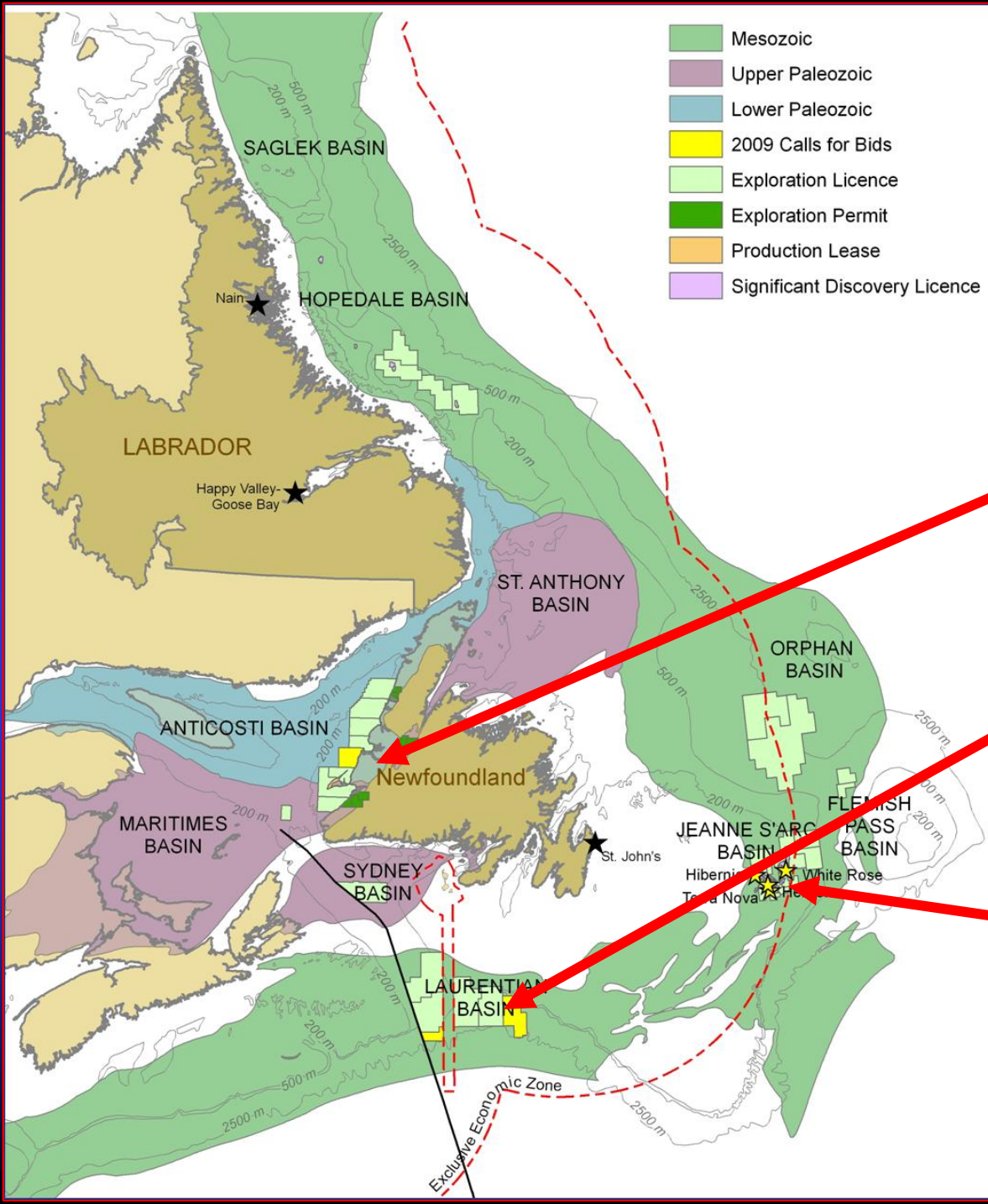
# Acknowledgements

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- MUN, Pan-Atlantic Petroleum Systems Consortium (PPSC), PR-AC;
- GSC Atlantic;
- Landmark-Halliburton, Canstrat and HIS;
- This work could not have been performed without information provided by C-NLOPB, Government of Newfoundland and Labrador Department of Natural Resources.



★ = position of CFB NL09-03 Parcel





# CFB 2009: Three landsales in three basins

• CFB NL09-03  
Anticosti Basin

• CFB NL09-02  
Laurentian Basin

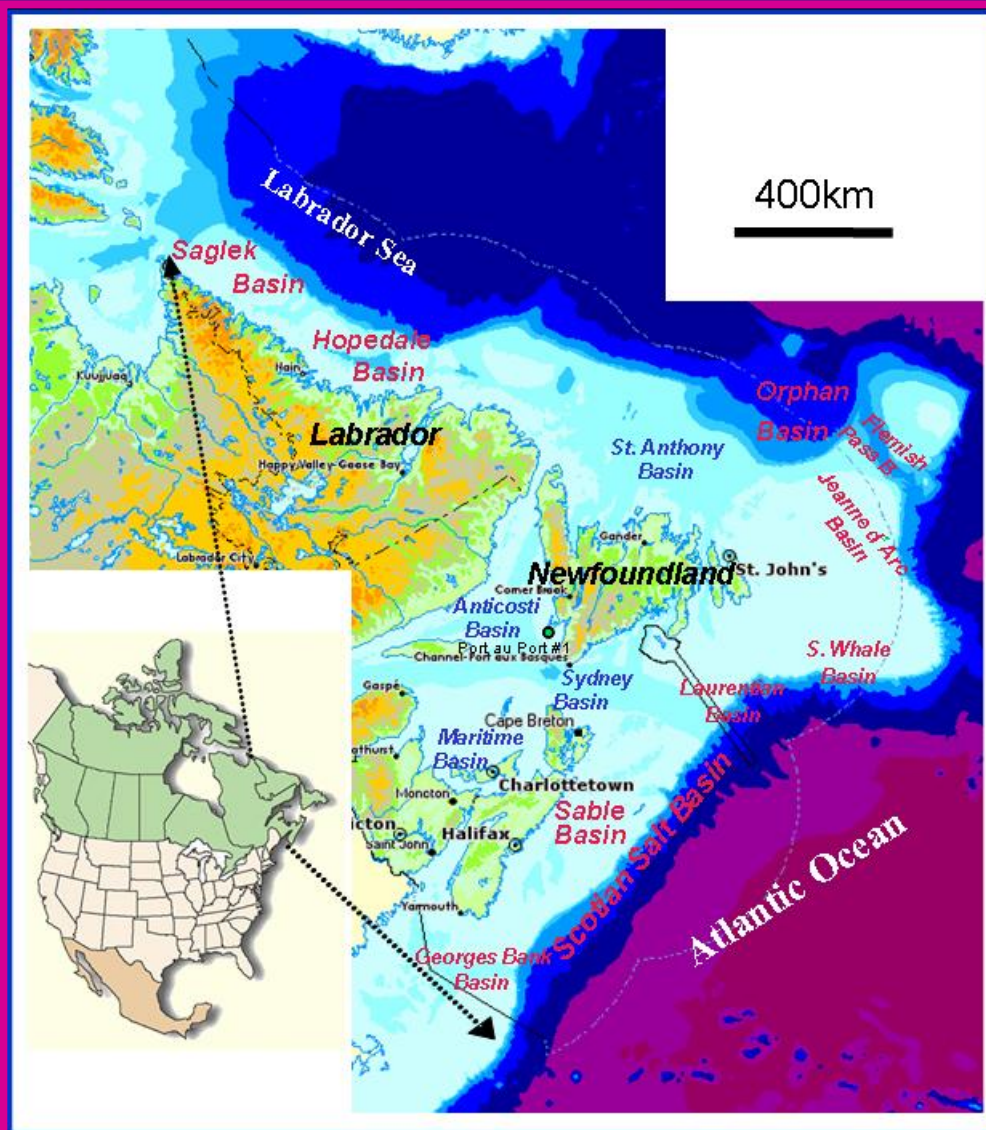
• CFB NL09-01  
Jeanne d'Arc Basin

# Presentation Content

1. Introduction
2. Exploration and Development Background
3. Regional Geology of the Western Newfoundland Basins
4. Petroleum Geology of the Anticosti Basin
5. Petroleum Potential Call for Bids  
NL09-03 Parcels 1
6. Discussion
7. Conclusions



# Atlantic Canada Offshore Basins



Blue = Paleozoic Basins

Magenta = Mesozoic Basins

## NL Paleozoic Basins

- Sydney Basin
- Maritime (Magdalen) Basin
- **Anticosti Basin**
- St. Anthony Basin

# 1. Introduction

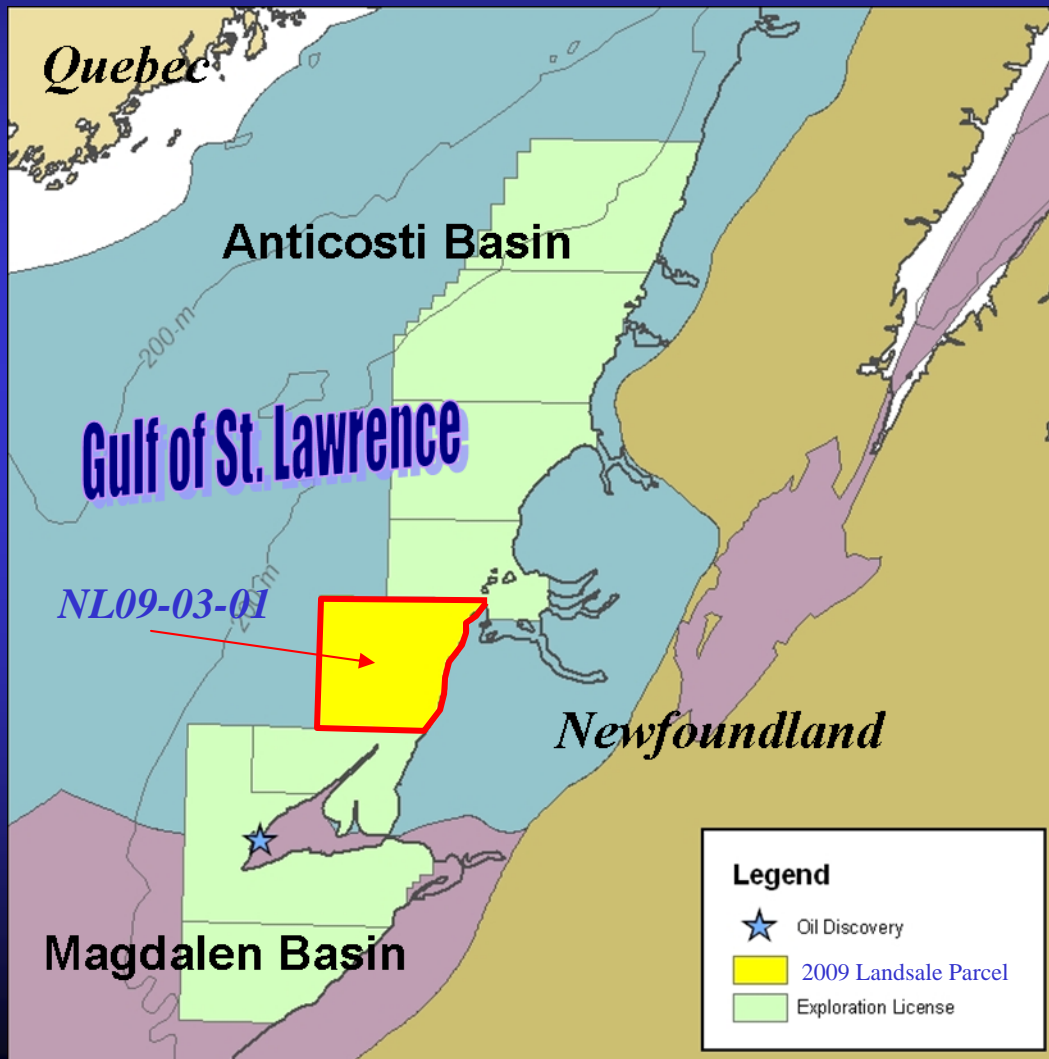
- CFB NL09-03-01 offered parcel is one of the few remaining unlicensed offshore blocks along the western coast of Newfoundland
- Parcel is situated north of and on trend with the Port au Port Peninsula where light oil and gas were tested at significant flow rates from the Port au Port #1 well in 1995
- The parcel lies adjacent to several active Exploration Licenses both on land and offshore where there is ongoing exploration activity consisting of acquisition of 3D and 2D seismic reflection, aeromagnetic data and exploration drilling

**\*Observation. References introduced in this presentation are listed in the associated report posted on the website:**

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



# Western Newfoundland and Labrador 2009 Landsale



- **CFB NL09-3** consists of one large parcel
- Parcel is located in shallow waters of Gulf of St. Lawrence
- **Landsale closes November 19, 2009 at 4 p.m. NL time**

## **2. Exploration and Development Background**

- **NL Petroleum Production**
- **The Emergence of Nalcor Energy**
- **Large Paleozoic Offshore Under Explored Basins**
- **E&P Activity in Atlantic Paleozoic Basins**
- **West Coast Newfoundland Exploration History**
- **Recent Western NL Offshore Landsales and Exploration Results**



# NL Petroleum Production

- Three large fields - Hibernia, Terra Nova and White Rose- have been developed in the shelfal Jeanne d'Arc Basin
- These fields have produced in each of the past 5 years in the range of 300,000 to 360,000 barrels per day of light crude (30 to 35° API) from Mesozoic sandstones
- NL delivers about 37% of the light oil produced in Canada from these fields representing more than 80 % of the Atlantic Canada's hydrocarbon production
- NL is now the second largest hydrocarbon producing province in Canada
- Over 1 Bbbls produced to date from the Jeanne d'Arc Basin; more than 1.8 Bbbls proven remaining recoverable reserves/resources exists
- Jeanne d'Arc Basin developments are the only producing offshore oilfields on the Atlantic coast of North America
- A fourth large field - Hebron-Ben Nevis- estimated to contain 731 million barrels recoverable reserves/resources will be developed starting in 2012 with first oil expected in 2015
- Satellites of larger fields are added to production

# Emergence of Nalcor Energy

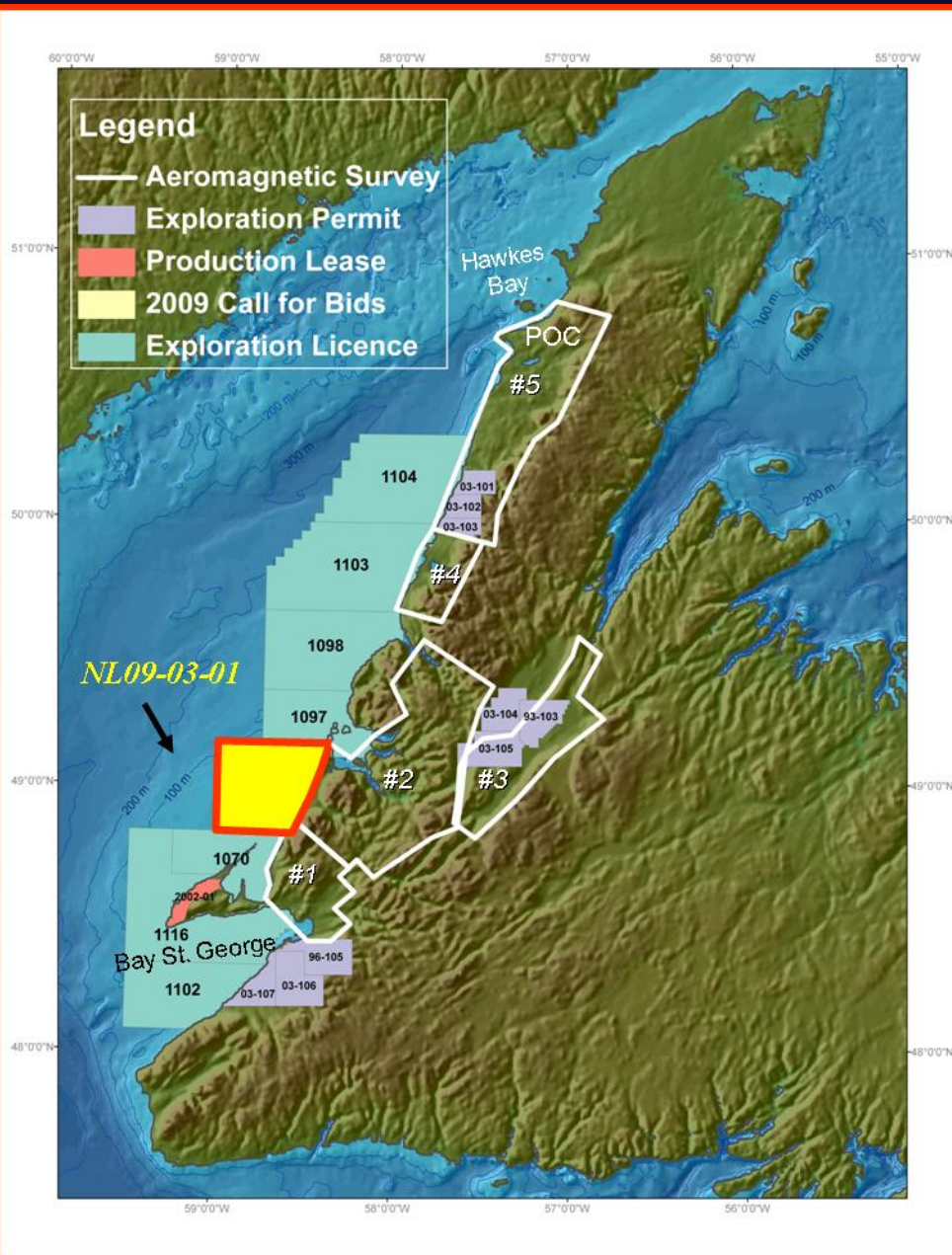
- Legislation to create the province's energy corporation, Nalcor Energy, wholly owned by the Province  
<http://www.nalcorenergy.com>
- Through Nalcor, Province negotiated equity positions in the Hebron Project (4.9%) and White Rose Growth Projects (5%)
- Fall 2007, the NL Government released the provincial Energy Plan “Focusing our Energy” that established new policies for oil and gas exploration and production in the Province's onshore and offshore regions.
- Energy Plan available at:  
<http://www.nr.gov.nl.ca/energyplan/EnergyReport.pdf>
- Energy Plan implementation of an Offshore Natural Gas Royalty Regime and introduced the concept of a “pioneer project”



# Emergence of Nalcor Energy

- Formation in 1997 of Nalcor Oil and Gas Inc. subsidiary that acquired interest in several offshore fields: North Amethyst, West White Rose and South White Rose Extension (6.5%), Hebron (4.9%) Hibernia South (10%)
- Summer 2009, Nalcor farms into the “Parson Pond” Exploration Permits located onshore in the Appalachian Paleozoic trend
- Petroleum Exploration Enhancement Program (PEEP) financed in 2008-9 an aeromagnetic regional survey over West Newfoundland onshore
- PEEP is an initiative of the Energy Plan and is focused on improving geoscience knowledge of Western Newfoundland onshore; \$20 million was provided to fund the Offshore Geoscience Data Project

# Aeromagnetic Survey



- The survey is a joint venture between
  - NL Department of Natural Resources – Petroleum Development sections #1, 3, 4, 5
  - NL DNR Geological Survey section #2
  - Nalcor Energy Oil and Gas Inc.
- Data (total intensity and 1st derivative as ASKII and Oasis files) available to the public in the fall 2009
- Nalcor Energy's component of the survey was funded under the PEEP
- This high resolution survey was flown with 200 m line spacing and by gently draping over the relief at approximately 90 m altitude
- It will considerably help petroleum exploration onshore Western Newfoundland
- Aeromag maps allows for more adequate selection of drilling targets and better location of seismic lines



# Large Paleozoic Under Explored Basins

- Atlantic Provinces including Newfoundland and Labrador were affected by an older Wilson cycle that was initiated during Early Paleozoic and culminated with the build up of the Appalachian foldbelt and its corresponding foredeep
- This cycle ended with the Alleghenian Orogeny which was accompanied by formation of several Carboniferous successor basins - the largest being the Maritimes (Magdalen) Basin
- The Appalachian Orogen extends from the southern US into the Western Newfoundland onshore and offshore areas
- The Anticosti Basin of Ordovician to Silurian age (510-415 million years old), underlies the northern part of the Gulf
- The Magdalen Basin of Pennsylvanian (Late Carboniferous to Permian age - approximately 350-250 million years old), underlies the south. The Bay St. George Basin is an arm of the predominantly Carboniferous Magdalen Basin

# Large Paleozoic Under Explored Basins

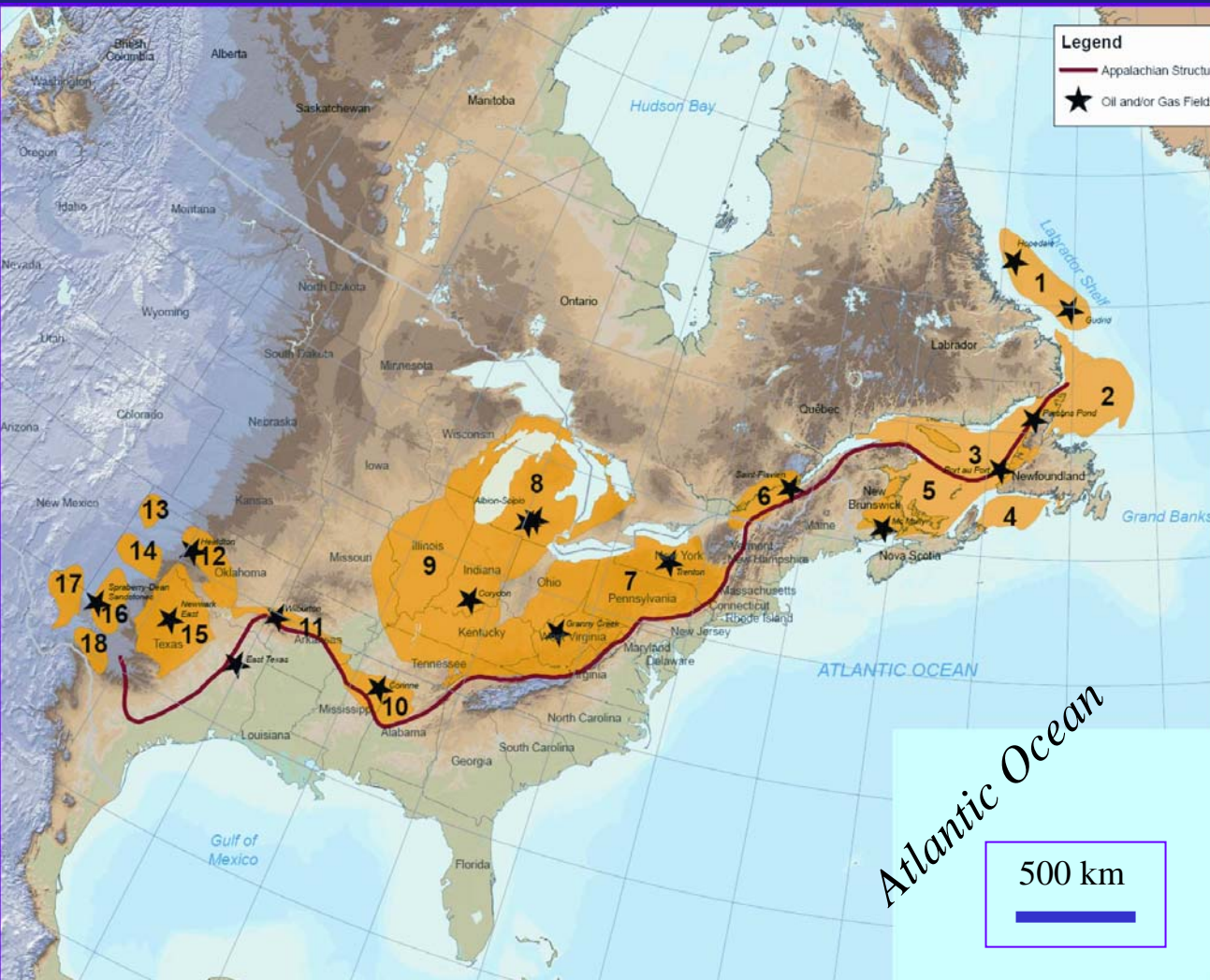
- Only 6 wells were drilled for Paleozoic plays in the Western Newfoundland offshore basins
- A dozen wells have penetrated Paleozoic strata, including good quality reservoirs while drilling for Mesozoic synrift targets on the Grand Banks, Orphan and Labrador basins
- Paleozoic offshore basins are located in the Gulf of St. Lawrence area, surround the island of Newfoundland (Sydney Basin to the S, St. Anthony Basin to the N and Bonavista Platform to the E) and form the upper part of the pre-rift basement of the Grand Banks and Labrador Sea
- Western NL is part of continental wide Appalachian Structural Front. This front stretches from Texas through the eastern US seaboard, the New England states, through Quebec and the Atlantic provinces and into Western Newfoundland and contains more than 20 proven petroleum basins

# Large Paleozoic Under Explored Basins

- Some of the largest and most productive USA oil & gas fields are located along the ancient Paleozoic continental margin and the Appalachian foldbelt
- Anticosti Basin of Cambro-Ordovician to Silurian age (510-415 MMy old) is in the northern part of Gulf St. Lawrence; Magdalen Basin of Late Carboniferous to Permian age (350-250 MMy old) underlies the south
- Together, the Anticosti and Magdalen basins cover an area about the size of New Mexico or half of the Canadian Province of Alberta
- Significant volumes of clastic sediments were accumulated during the Paleozoic cycle of ocean opening and closing including excellent source and reservoir rocks
- Canada has a large part of its light oil and gas production from Paleozoic sedimentary rocks and over 20% of world oil reserves originate in Paleozoic strata



# North America Appalachian Basins



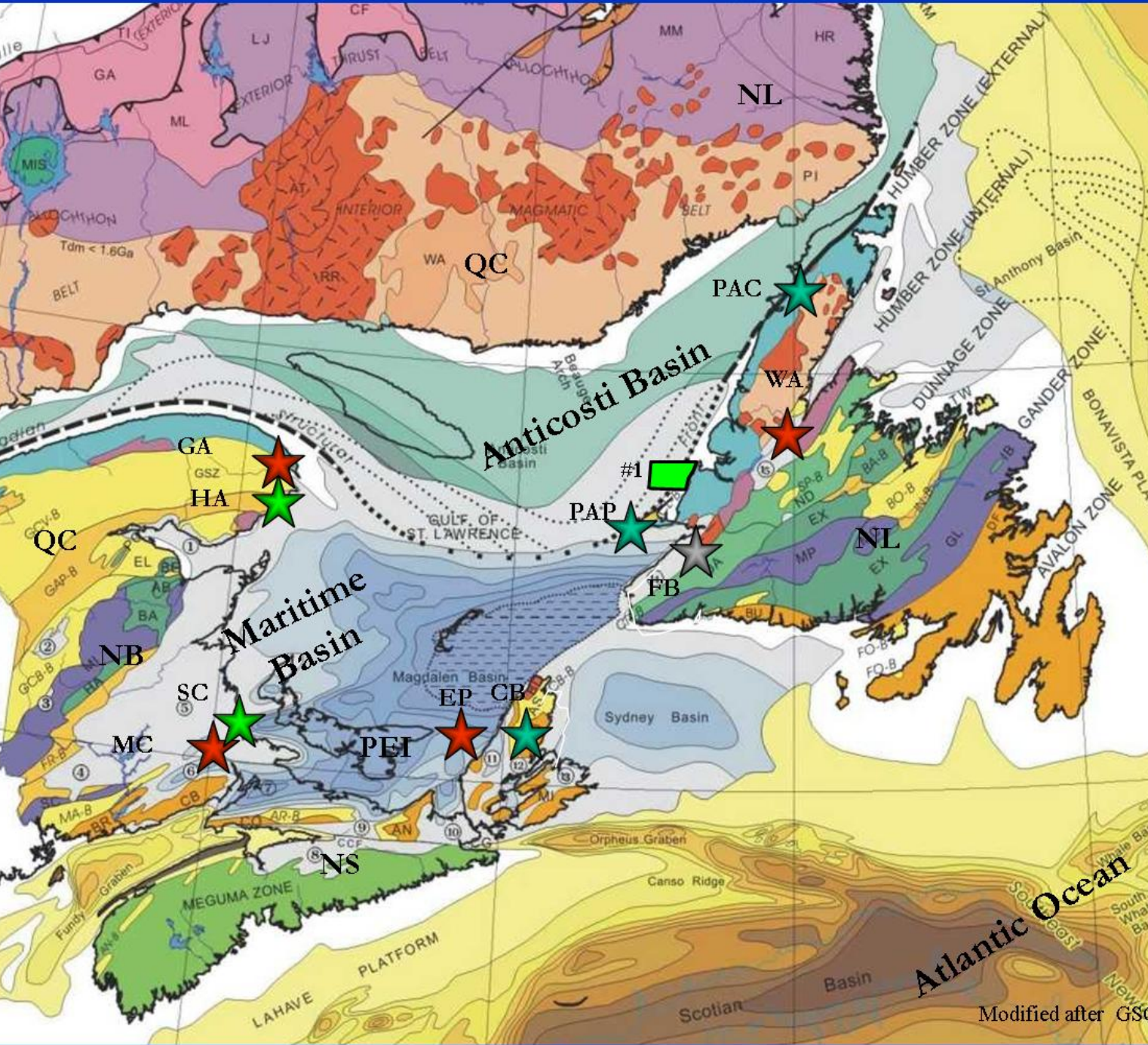
1. Hopedale (Labrador)
2. St. Anthony
3. Anticosti
4. Sydney
5. Maritime
6. St Lawrence Lowlands
7. Appalachian
8. Michigan
9. Illinois
10. Black Warrior
11. Arkoma
12. Anadarko
13. Dalhart
14. Palo Duro
15. Forth Worth
16. Midland
17. Delaware
18. Val Verde

# E&P Activity in Atlantic Paleozoic Basins - Onshore

- **New Brunswick.** The McCully gas development presently produces about 23 mmcfd from a 400 hectare (12,000 acre) fractured anticline estimated to contain about 1 Tcf proven and probable gas resource in Carboniferous sandstone; Corridor also discovered 45° API oil at the South Branch G-36 well, 3 km SE of McCully gas field
- **Prince Edward Island.** In 2007 Corridor drilled Green Gable #3 and found gas in the Bradelle sandstones but encountered problems during stimulation operations; at present, the well is suspended
- **Quebec.** Petroleum systems have been identified in the St. Lawrence and Gaspé basins and 3 gas accumulations were discovered within Paleozoic reservoirs. Two in the St. Lawrence Lowlands Basin are now depleted and used as gas storage reservoirs: Pointe-du-Lac (produced of 2.5 Bcf) and Saint-Flavien (produced 5.7 Bcf). Exploration in this basin has mainly focused on the Trenton Black-River sedimentary zone. In the Gaspé Basin, Junex developed the Galt gas field discovered in the early eighties. Production is stimulated by fracturing and commercialized by trucking of CNG. The field is estimated to contain about 1 Bcf gas within an oil and gas bearing Devonian dolomite/carbonate formation (HDT) situated at about 2000 m subsurface



# Regional Geology Map Atlantic Canada



**Location**  
of Call for Bids  
NL 09-03-01  
parcel = #1

**Hydrocarbon  
fields**  
MC = McCully  
SC = Stoney  
Creek  
GA = Galt

**Discoveries**  
EP = East Point  
HA = Haldimand  
CB =Cape Breton  
seeps and shows

Modified after GSC



# E&P Activity in Atlantic Paleozoic Basins - Onshore

- **Quebec.** Just east-southeast of Galt, the Haldimand field operated by Pétrolia tested 34 bopd of light crude (50° API) from Devonian sandstones at depths of approximate 1000 m. This “first Quebec“ - oil discovery is being delineated using 3D seismic, geochemical studies and further drilling to 1000 + m. Quebec is today a hot spot for nonconventional gas exploration; more than 90 per cent of the known exploration zone in the St. Lawrence basin is already claimed by petroleum companies
- **Nova Scotia.** All of the large oil and gas discoveries and production from Nova Scotia is from offshore Late Jurassic-Cretaceous sandstones. The onshore extensions to offshore Paleozoic basins are part of the Appalachian Orogeny or the Carboniferous successor basin stage. These areas have seen only modest exploration for conventional hydrocarbons. Only about 30 wells were drilled deeper than 1000 m. No significant discovery was made to date, but oil and gas shows have been recorded in the Sydney, Cape Breton, Antigonish, Cumberland and Minas basins. Triangle Petroleum of Calgary had success exploring for shale gas at its site in the Kennetcook area, about 70 kilometres north of Halifax. In April 2009, the provincial government approved Triangle’s 10-year production lease, which requires the company to drill seven wells at the site by 2014

# E&P Activity in Atlantic Paleozoic Basins - Offshore

- In an early exploration phase the East Point E-49 well- drilled in 1970 - flow tested at 5 mmcfd. This well was/is estimated to contain in-place gas reserves of 60-70 bcf in Carboniferous sandstone.
- The most active phase of exploration in Gulf of St. Lawrence waters on the Newfoundland side took place in the early-late nineties when several large Exploration Licences were operated by large companies such as Hunt, PanCanadian, Talisman, BHP and Mobil, and 5 wells were drilled including the PAP #1 oil discovery
- A number of large leads and prospects have been defined in the Gulf of St. Lawrence, but remain undrilled. One of these prospects is the Old Harry mapped by Corridor
- Several ELs were awarded in the Anticosti and Maritime basins in Quebec's jurisdictional waters. Exploration plans were cancelled after the government raised environmental concerns about blue whales. Offshore exploration is now under a moratorium
- Currently there is no seismic acquisition work or offshore drilling in any of the Paleozoic basins of the Atlantic Provinces outside of NL

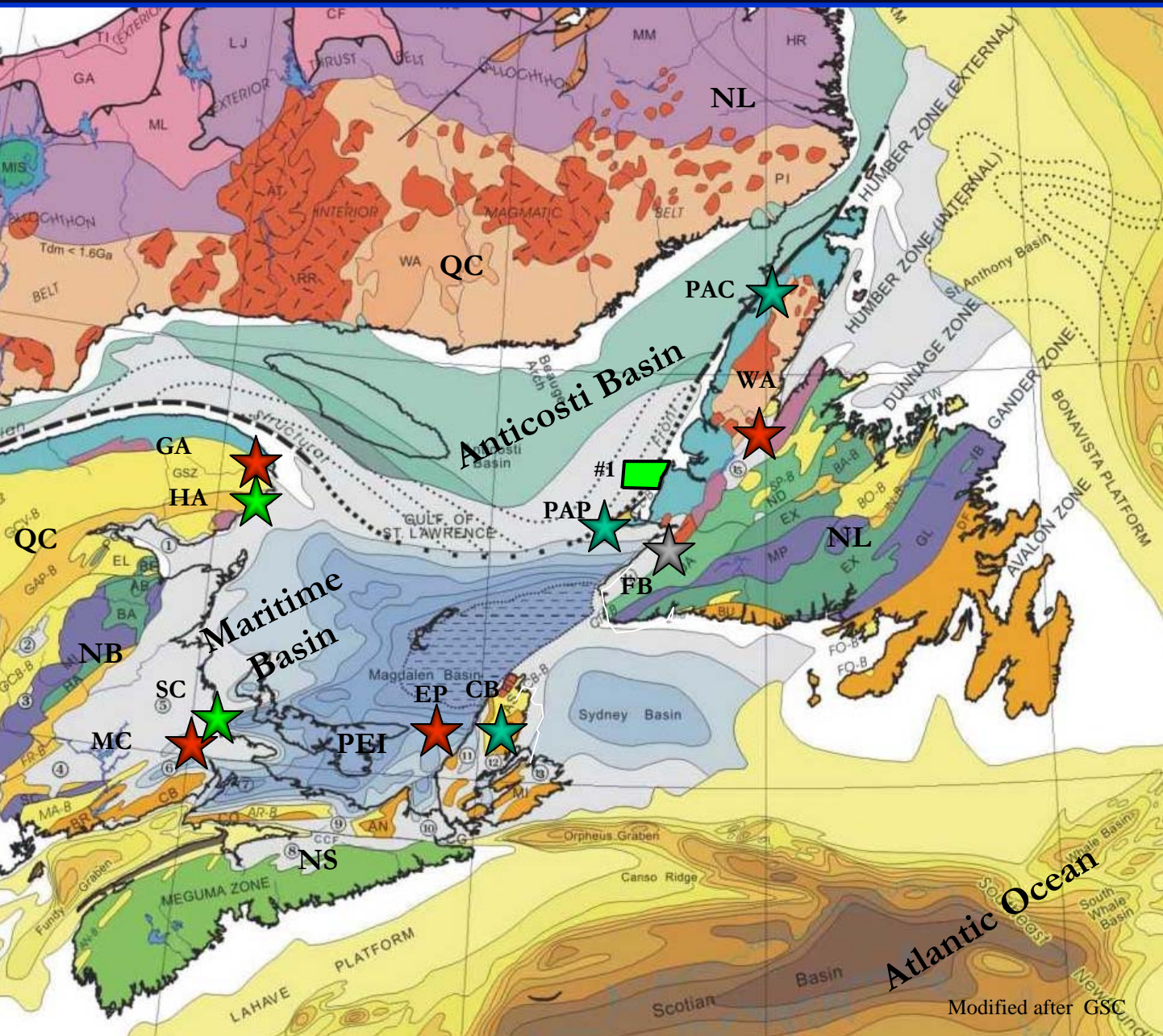


# Regional Geology Map Atlantic Canada

## Newfoundland

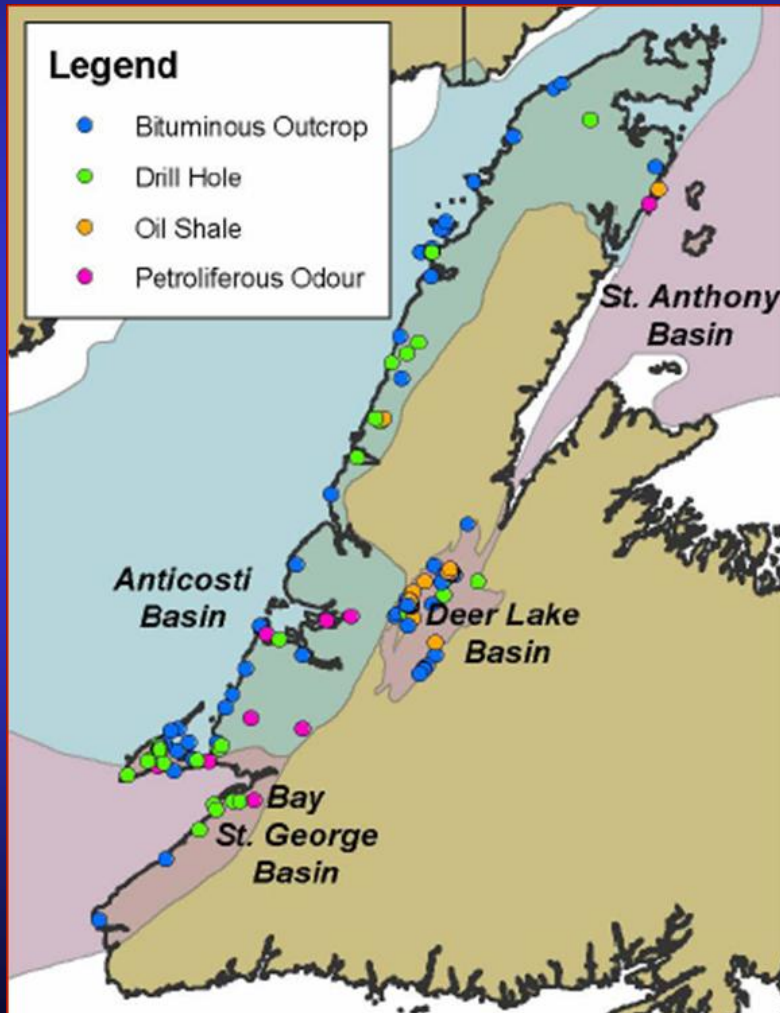
FB=Flat Bay wells  
that intersected  
tight oil zone

WA = West  
Adventure #1 gas  
flow;  
PAP = Port au Port  
#1 Oil Discovery  
PAC = Port au  
Choix exhumed oil  
field





# West Coast Newfoundland Exploration History



- Numerous hydrocarbon seeps, oil shows in historical wells and some early light oil production are reported in the Paleozoic of Western Newfoundland
- Sporadic episodes of petroleum exploration in the Appalachian fold belt and foreland ongoing since 1867
- These efforts have been rewarded only by excellent hydrocarbon shows or hard to evaluate finds, and only minor commercial production during the early part of the twentieth century
- Recently (1995 to present) production tests and tracking of oil was done from the Port au Port #1 well and its sidetracks
- A small gas flow was obtained from Western Adventure #1 well in Deer Lake Basin

# West Coast Newfoundland

## Exploration History

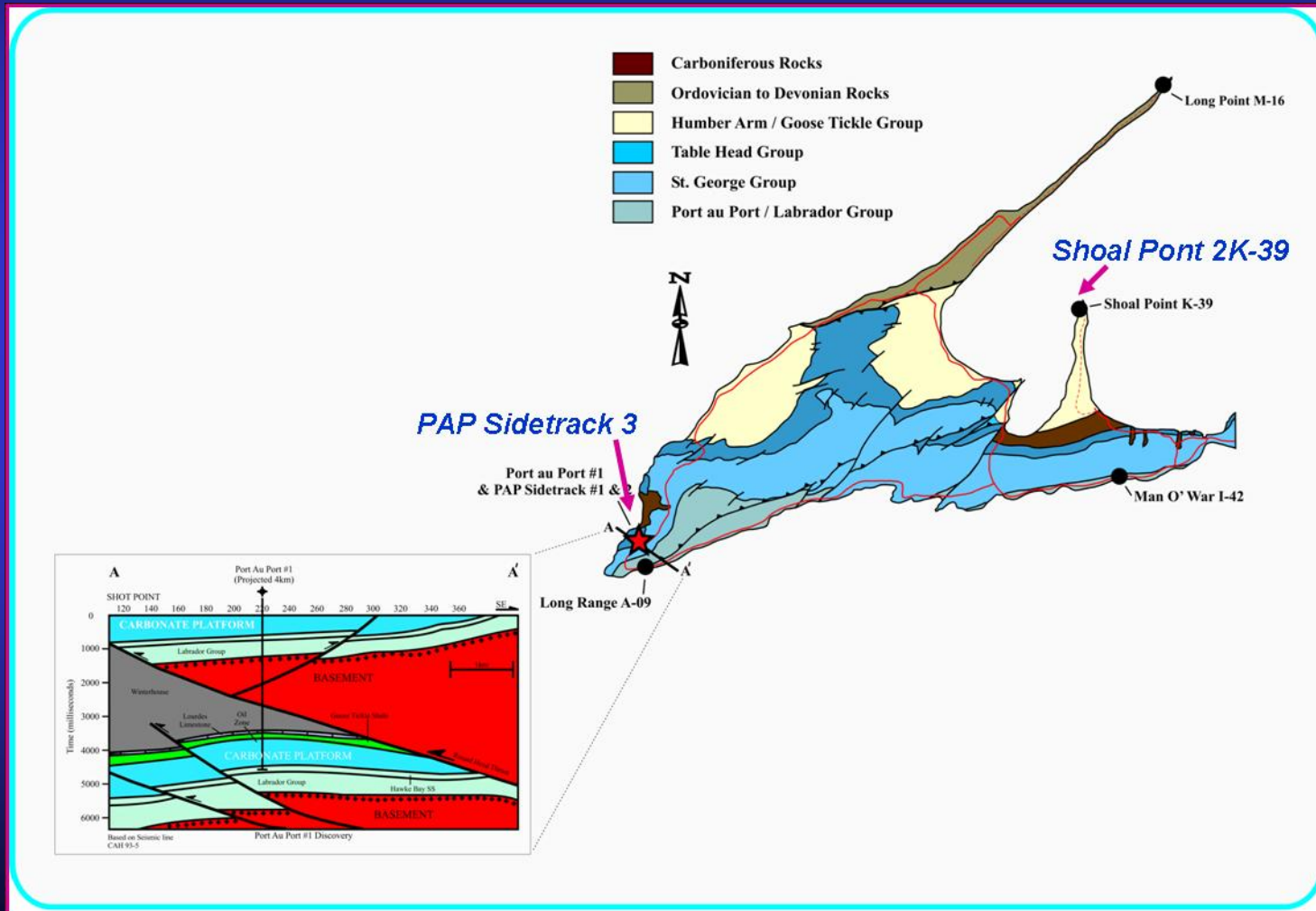
- Last decade exploration activity carried out by homegrown junior oil and gas companies that held lands and explored both Ordovician and Carboniferous formations
- Interest in a regional hydrothermal dolomite play has recently been given a boost by success in similar rocks in New York State and exploration of the trend elsewhere in Atlantic Canada - on the Gaspé Peninsula (Galt), New Brunswick (away from the McCully field) and on Anticosti Island
- Up to 2008, only 2D data has been recorded in Western Newfoundland; a small exploration 3D was collected by GSI for NWest that has now been processed and interpreted
- 1990s marine seismic data is good to fair quality; about 5,000 km acquired provides good imaging of the subsurface and is available from C-NLOPB in hardcopy for the cost of reproduction and for sale in digital form from the data owners
- Older data acquired prior to 1989 is of poor to fair quality

# West Coast Newfoundland Exploration History

- Six offshore wells have been drilled in the Western Newfoundland jurisdiction, of which five were directionally drilled from land and one had to be abandoned due to operational problems
- All of these mid 1990s wells were located in the vicinity of the Hunt PanCanadian Port au Port #1 discovery
- Subsequent test of the carbonate reservoirs: Long Point M-16 (drilled in 1995-6, TD at 3810 m in Port au Port Group), Long Range A-09 (drilled in 1996, TD at 3685 m in Watts Bight Formation), Shoal Point K-39 (drilled in 1999, TD at 3035 m in Hawke Bay Formation), encountered only shows. Man O' War I-42 (drilled in 1998, TD at 667 m in Forteau Formation) was terminated due to mechanical problems
- The offshore St. George's Bay A-36 well (drilled in 1996, TD at 3240 m in Forteau Formation) located in shallow water, 6 km south-west of the PAP Peninsula, contained several zones of good to excellent vuggy and cavernous porosity as well as bitumen and minor live oil shows



# Exploration and Delineation Drilling On Port au Port Peninsula





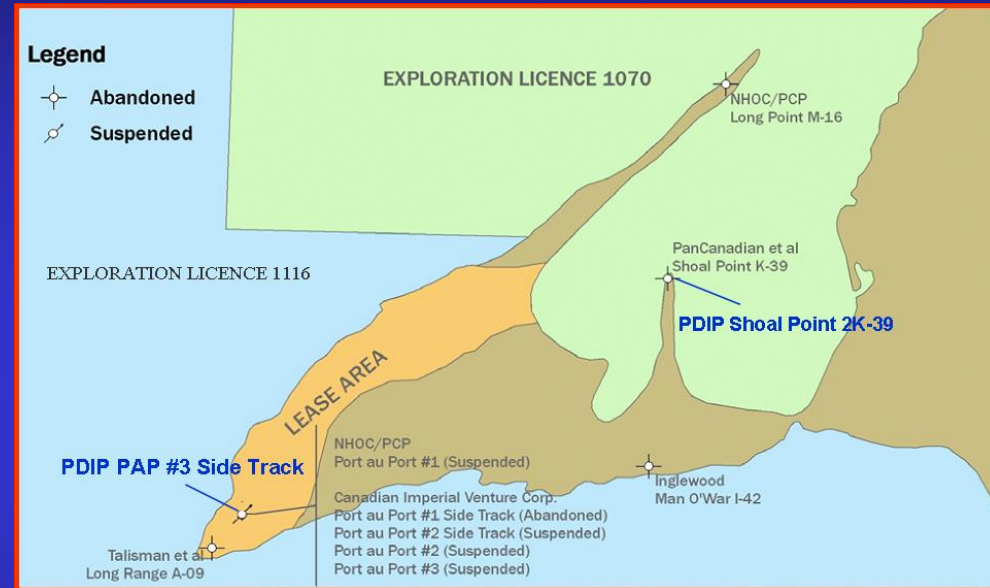
# Onshore West Newfoundland

- **Production**
  - PDIP
  - Garden Hill South Field
- **Exploration**
  - Vulcan/Investcan
  - Deer Lake O&G
  - Nalcor Energy et al.

Onshore exploration is administered and regulated by the Government of Newfoundland Department of Natural Resources, Energy Branch

# Garden Hill Field

- In Port au Port #1 two platformal Aguathuna Fm zones, believed to be in communication, tested at rates of about 1500 bopd of light oil, with gas rates of about 2.5 mmcf/d
- Extended testing showed the pressure to be dropping
- Subsequent sidetrack drilling by farmin operators (CIVC, then PDIP) indicates a complex reservoir near the wellbore



- PDIP acquired 100% interest in the Lease and continue to fulfill the conditions of the extension agreement

There is oil contained in the Garden Hill structure but questions remain as to the size of the accumulation and how to commercially produce the oil contained in HTD



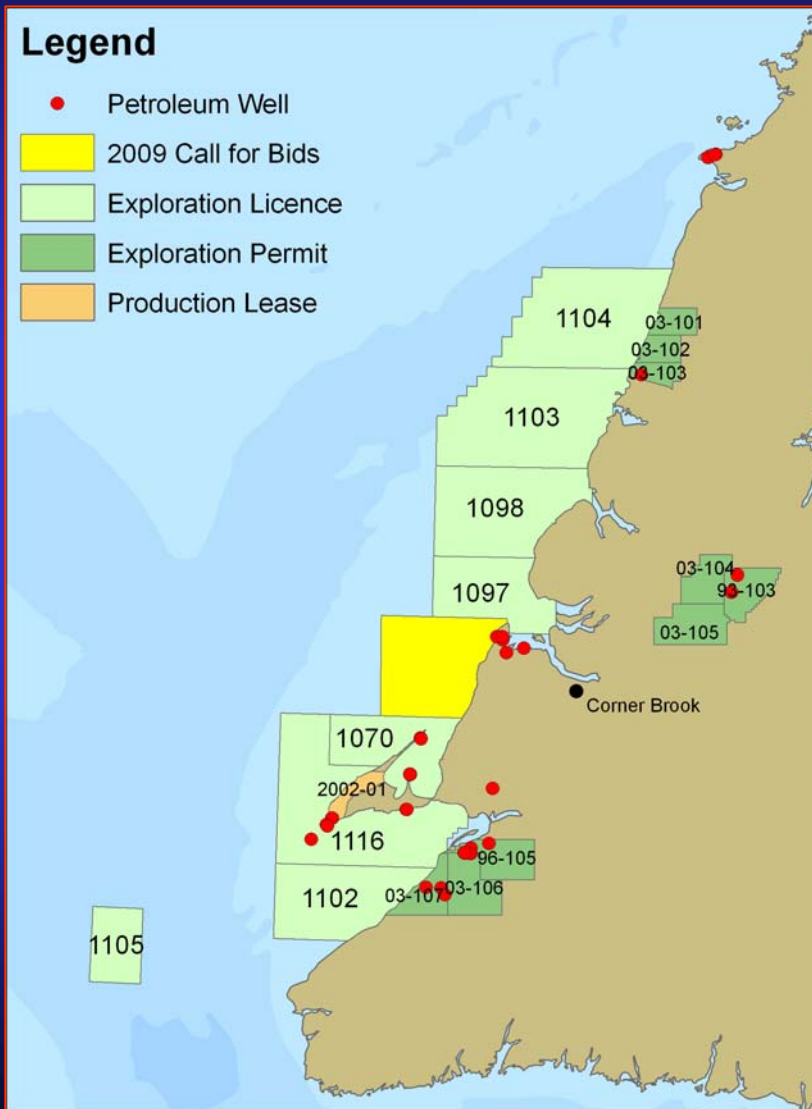
# Other Onshore Activity

- **Bay St. George Basin.** Vulcan drilled 8 shallow wells, acquired 4 seismic surveys and compiled all existent geoscience data in the basin
- In Flat Bay area, Vulcan encountered a thick 34° API oil zone in a shallow, low perm reservoir (Anguille conglomeratic sandstone) in several wells
- In early 2008 Vulcan farmed out 50% of their onshore Bay St. George Basin EPs ( 236,000 acres) to Investcan Energy Inc., a French company
- In the summer of 2009 the Robinson's #1 well was spudded and planned to drill a 3600 m hole into a fault-bounded anticline. This will be the first deep well in the underexplored Bay St. George Basin. No results are available yet
- **Deer Lake Basin.** Based on results from Western Adventure #1, DLOG submitted a Development Plan Application to the NL DNR in 2003
- However, in 2005 it re-entered the well, perforated and tested two upper zones with no flow; additional work is needed. No lease has been issued
- In the past few years DLOG has concentrated in finding partners as it plans 2 shallow wells to test Carboniferous reservoirs in the 03-104 and 03-105 blocks that without drilling are to expire in 2010
- A shallow hole, shale gas, program is also planned for the Deer Lake Basin Exploration Permits

# Other Onshore Activity

- **Parsons Pond Basin.** During the early 1990s, 300 km of high fold seismic data was collected. In 2004 Contact Exploration and partners drilled the Parsons Pond #1 well to test a Middle Ordovician dolomite play. The well reached TD at 1062 m within the first thrust sheet of the Appalachian fold and thrust belt but was short about 150 m of its target. Parsons Pond #1 encountered only oil and gas shows in fracture zones and was not tested
- Based on seismic reprocessing and mapping several platform located anticlines and fault blocks have been identified. Exploration will require deep wells (3,000 m +) to test several closures within the Carbonate Platform
- In 2008 Leprechaun Resources acquired Contact's interest in the PP permits, did further seismic and geological studies, preparing for a 2009 drilling
- In the summer of 2009, Nalcor Energy, Oil and Gas acquired an average interest of 67% in the EPs 03-101, -102 and -103 and became an operator of exploration lands
- A first deep well in the basin is planned for late 2009 pending the Environmental Assessment approval. The well is part of an exploration program operated by Nalcor and financed by the partnership that will include two other wells. This drilling program will validate all three permits and extend them for a secondary term of 2 years. Other partners in the permits are Leprechaun, Vulcan/Investcan and DLOG accounting for the remaining 37% interest in the 3 blocks.
- Drilling this well will test simple and fault-bounded structural closures with up to 300 m vertical closure that may contain hydrocarbons at several levels in the Cambro-Ordovician sequence

# Offshore Western Newfoundland



- During 1990s five wells were drilled and a 12,203 line km seismic grid was collected
- No new offshore drilling or large 2D seismic programs have occurred in Western Newfoundland since late 1990s
- Eight large ELs issued by C-NLOPB are active and exploration activity is picking up
- This should be conducive to more shallow water (30 to 80 m) drilling in the next few years
- The size of these parcels ranges up to 205,000 ha (or about 84 GOM tracts)

**Offshore Newfoundland and Labrador exploration areas are licensed by the C-NLOPB to the party submitting the highest bid in the form of work commitments**



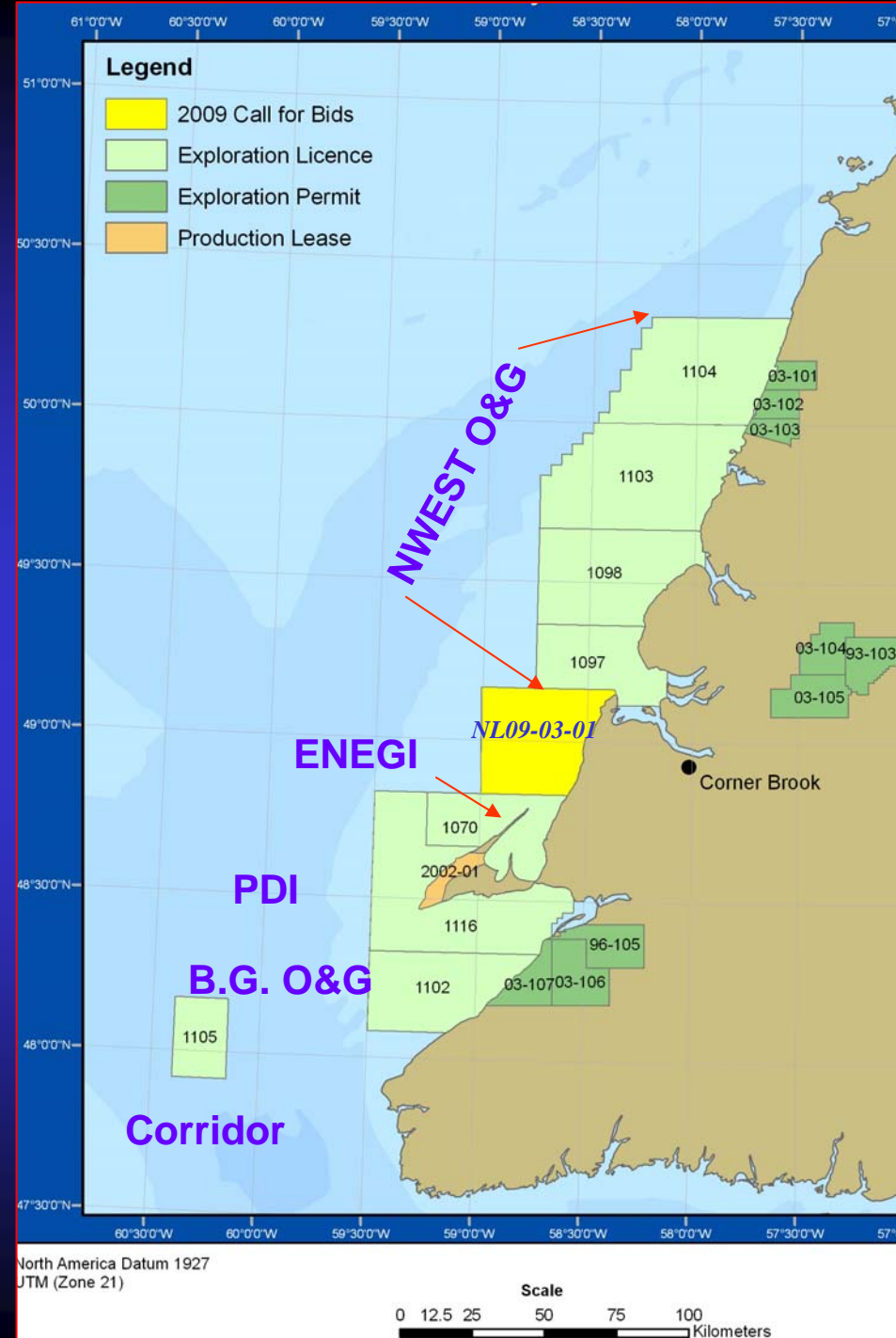
# Offshore West Newfoundland ELs

EL No.	Basin	Size (ha)	Date Issued	Bid Size \$	Operator	Other Partners
1097	Anticosti	96,100	2006	260,000	NWEST Oil and Gas Inc.	Vulcan (19%)
1098	Anticosti	159,872	2006	512,012	NWEST Oil and Gas Inc.	Vulcan (19%)
1103	Anticosti	216,164	2007	275,004	NWEST Oil and Gas Inc.	Vulcan (19%)
1104	Anticosti	187,744	2007	275,004	NWEST Oil and Gas Inc.	Vulcan (19%)
1070	Anticosti	103,040	2002	278,621	ENEGL Inc.	Shoal Point Energy, CIVC, Gestion
1116	Bay St. George Anticosti	211,987	2009	600,000	PDI Production Inc.	CIVC CC (10%)
1102	Bay St. George	124,320	2007	406,000	B.G. Oil & Gas Ltd.	DLOG (25%)
1105	Magdalen	51,780	2008	1,521,000	Corridor Resources Inc.	

Offshore Western Newfoundland Active Exploration Licences, Historic Bid Sizes and Parcels' Particulars.

# Offshore Western Newfoundland

- Recent Drilling
  - **PDIP**  
Shoal Point 2K-39
- Recent Exploration
  - **NWEST**  
Dense 2D data over ELs 1098&1097
  - **B.G. O&G**  
Defined a salt induced closure
  - **Corridor**  
Waiting for EAS in Quebec



# Recent offshore Western NL Landsales and Exploration Results

- Except for the older, validated and extended EL 1070, all the active offshore ELs were issued in the past 3-4 years: 2 in 2006 (both in Anticosti Basin), 3 in 2007 (2 in Anticosti Basin and one in Bay St. George Basin), 1 in 2008 (in Magdalen Basin) and 1 in 2009 (spreading in both Anticosti and Bay St. George basins)
- The eight licences cover a total of 1,121,007 ha (see Table). A new round of offshore drilling is anticipated in the near future in order to evaluate these licences
- NWest Energy Inc. holds about 659,880 ha (1.6 million acres) of prospective property over four blocks off the Newfoundland's west coast ELs 1097, 1098, 1103 and 1104. In EL 1098, "T"-a shallow water prospect covered by a GSI exploration 3D is ready to drill
- In EL 1102, B.G. Oil and Gas and DLOG, using older 2D seismic data have reconfirmed the presence of a salt induced anticline that forms a large closure for potential Carboniferous sandstone reservoirs. This structure nicknamed "Young Harry", has the drilling target at approximately 2000 m and lies in the shallow waters of the Bay St. George Basin



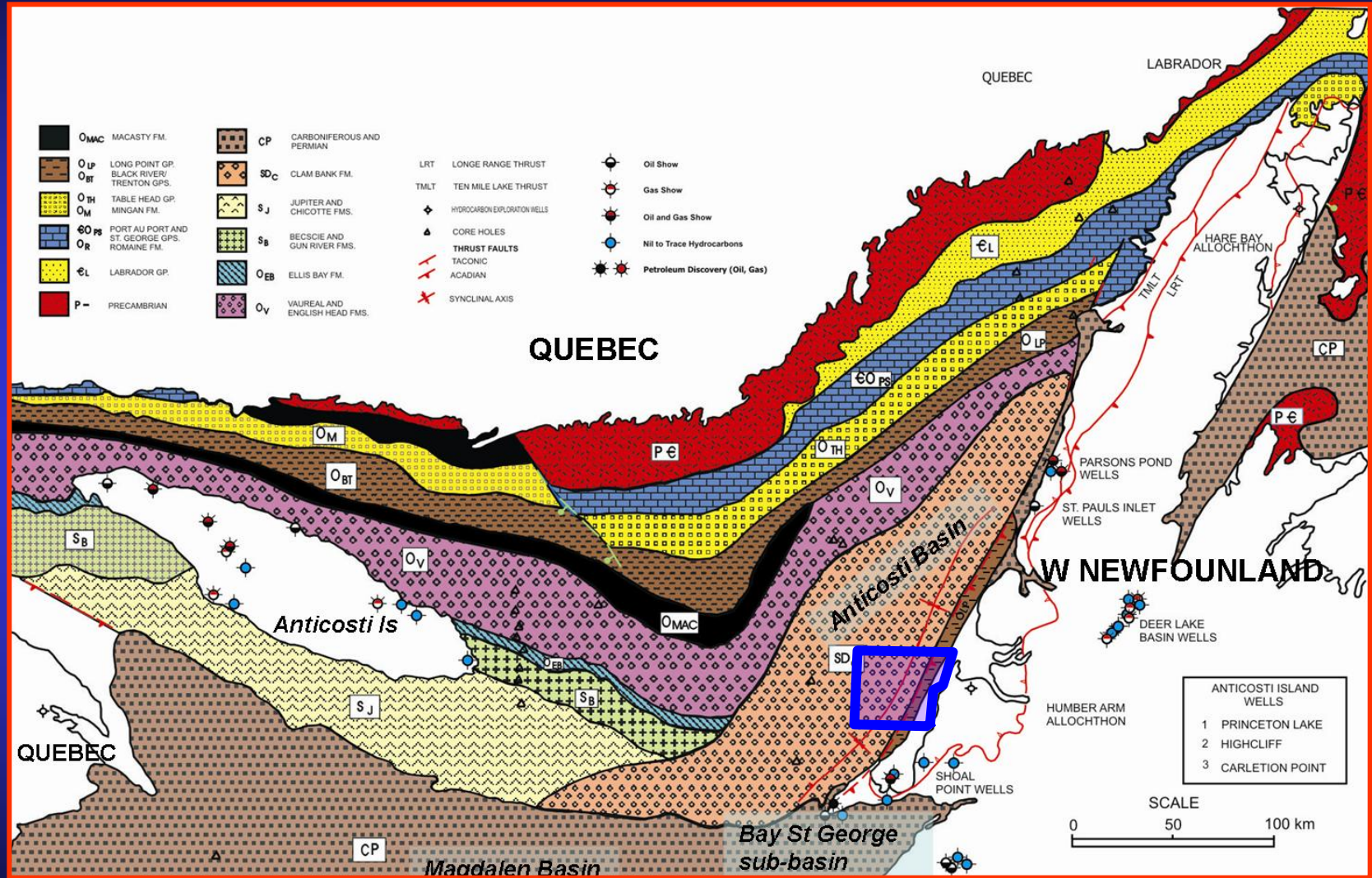


# 3. Regional Geology of the Western Newfoundland Basins

- Newfoundland and Hopedale Basin in Labrador forms the north-eastern N. American end of an extensive, once continuous Texas to Northern Europe, Paleozoic aged mountain chain developed during the Appalachian Orogen
- The Appalachian Orogen evolved through a Wilson cycle, starting 600 million years ago and closing with continental collision and the formation of Pangea approximately 300 Ma ago. The geologic subdivisions of Newfoundland record the development of the:
  - Lower Paleozoic continental margins,
  - intra-continental rifts,
  - Iapetus oceanic basement,
  - terrains resulting from the docking of several island chains and
  - final continent-continent collision (Laurentia and Gondwana)



# Bedrock Geology of Anticosti Basin



Sea bottom outcrop of Silurian Clam Bank Fm and Ordovician Long Point in Parcel NL09-03-01  
(modified after Sinclair, 1990)



# Basin Evolution

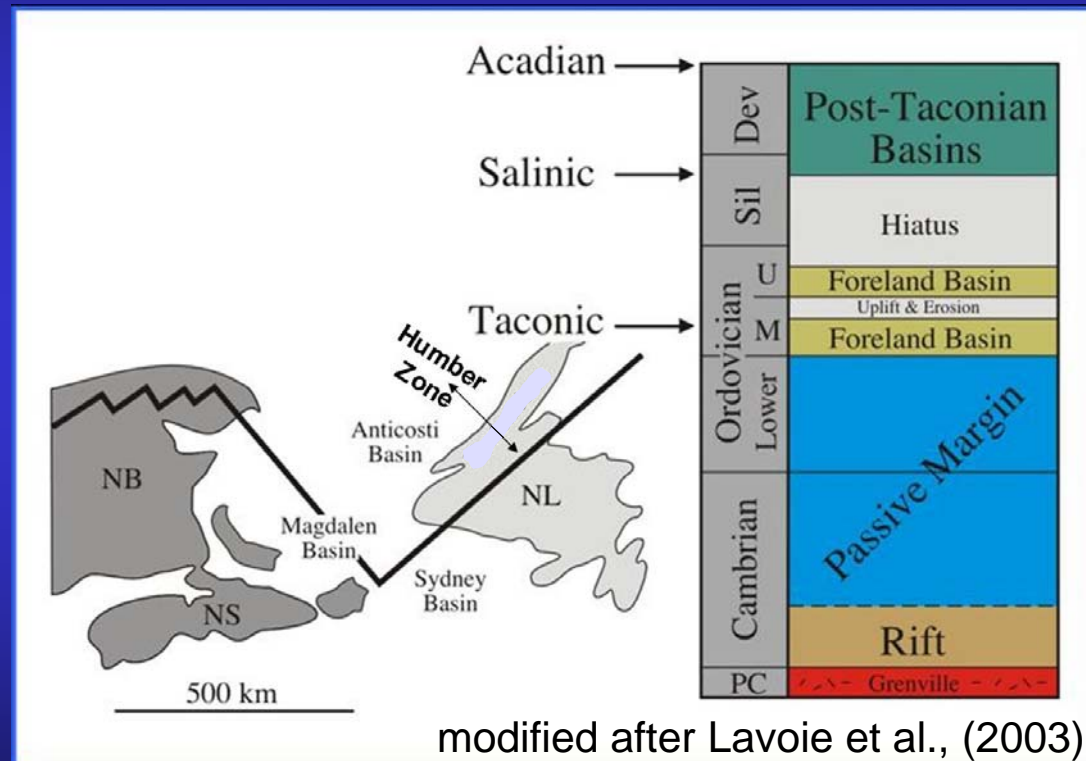
Using information from various sources Cooper et al. (2001) has divided the Paleozoic strata of the Humber zone into 6 tectono-stratigraphic megasequences:

1. *Siliciclastic synrift sediments* (Late Proterozoic-Early Cambrian) deposited as the Iapetus Ocean opened up;
2. *Passive margin strata* (latest Early Cambrian-Early Ordovician) that consists of shallow water carbonates passing eastward into basinal shales;
3. *Flexural forebulge sediments* of the Taconic foreland basin that migrated westward through the region (latest Early Ordovician to earliest Mid-Ordovician). A Mid-Ordovician sequence of sub-tidal carbonates and shales was deposited;
4. *Culmination of Taconic orogeny sequence*. This episode resulted in the westward overthrusting of basinal sediments (Humber Arm allochthon) and ophiolites. During this period, siliciclastic shallow marine sediments were deposited in the quiescent Taconic foreland basin (Late Ordovician to Salinic);
5. *Emplacement of Taconic allochthon sequence*. Silurian Salinic orogeny caused more displacement of the orogenic belt toward the west and exposure and erosion of the metamorphosed hinterland. Sedimentation in the Salinic foreland basin and deformation of the Cambro-Ordovician carbonate platform took place;
6. *Successor basin fill*. Transtensional dextral reactivation of preexisting major basement faults followed the compressional deformation of the Late Devonian Acadian orogeny, creating successor basins with thick Carboniferous clastic fill.

# Schematic Paleozoic evolution of Western Newfoundland

After the Early Paleozoic North American continental margin rifted in early Middle Ordovician, the Western Newfoundland area was formed during three orogenic phases:

- 1.) **Taconic** (late Middle Ordovician),
- 2.) **Salinic** (Late Silurian),
- 3.) **Acadian** (Devonian).



**\*Note:** Comprehensive accounts of NL Paleozoic regional geology, petroleum potential and seismic examples are given by Atkinson and Fagan, 2000; Fagan and Hicks, 2005; Enachescu (2006a, b and 2008) and is available at: <http://www.nr.gov.nl.ca/mines&en/oil/>

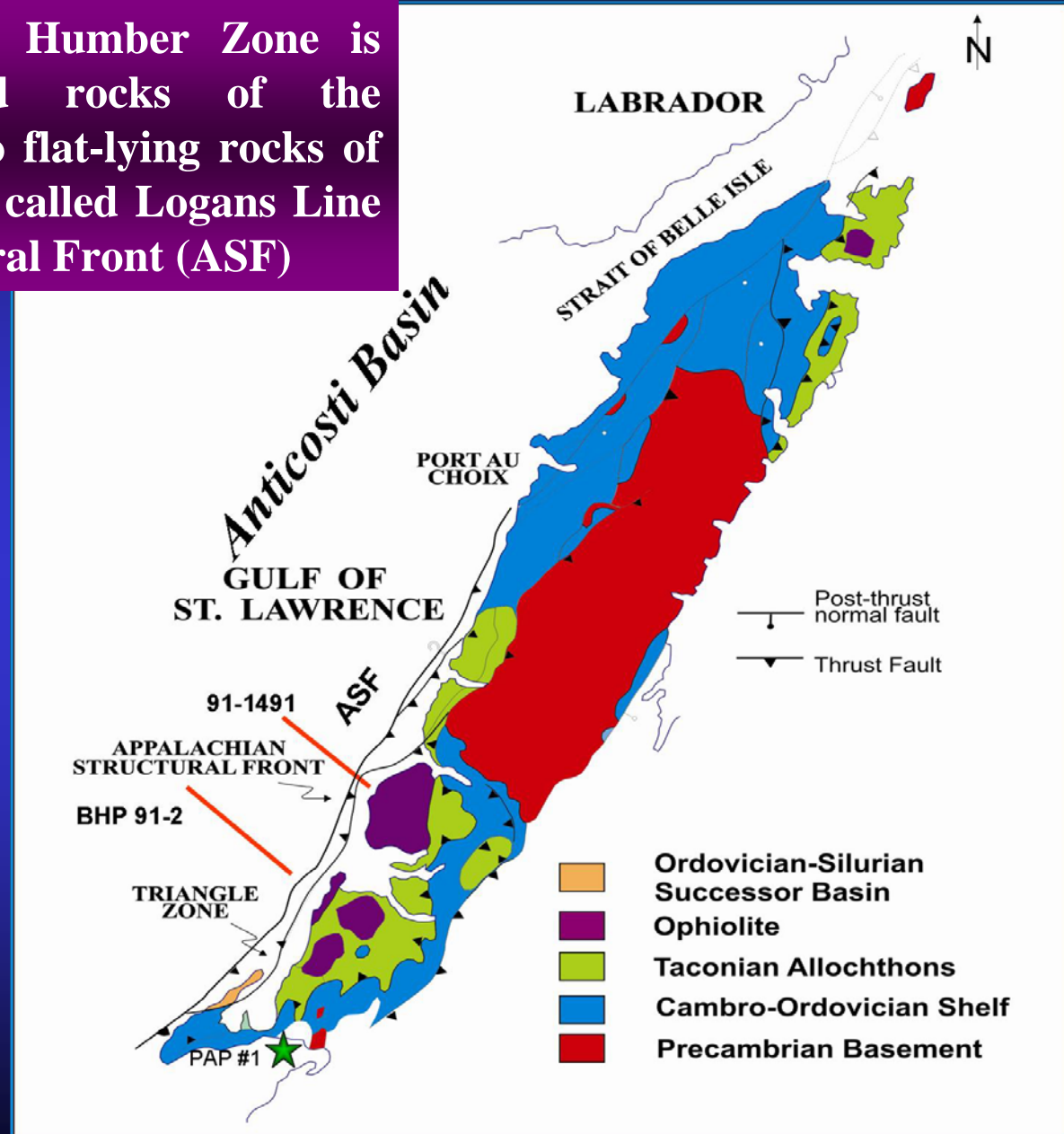
The western limit of the Humber Zone is located where deformed rocks of the Appalachians belt pass into flat-lying rocks of the Anticosti Basin. This is called Logans Line or the Appalachian Structural Front (ASF)

Geologic successions found on land continue offshore all the way to the Appalachian structural deformation front (ASF)

- A Carbonate Platform with a veneer of Carboniferous rocks forms the Appalachian foreland

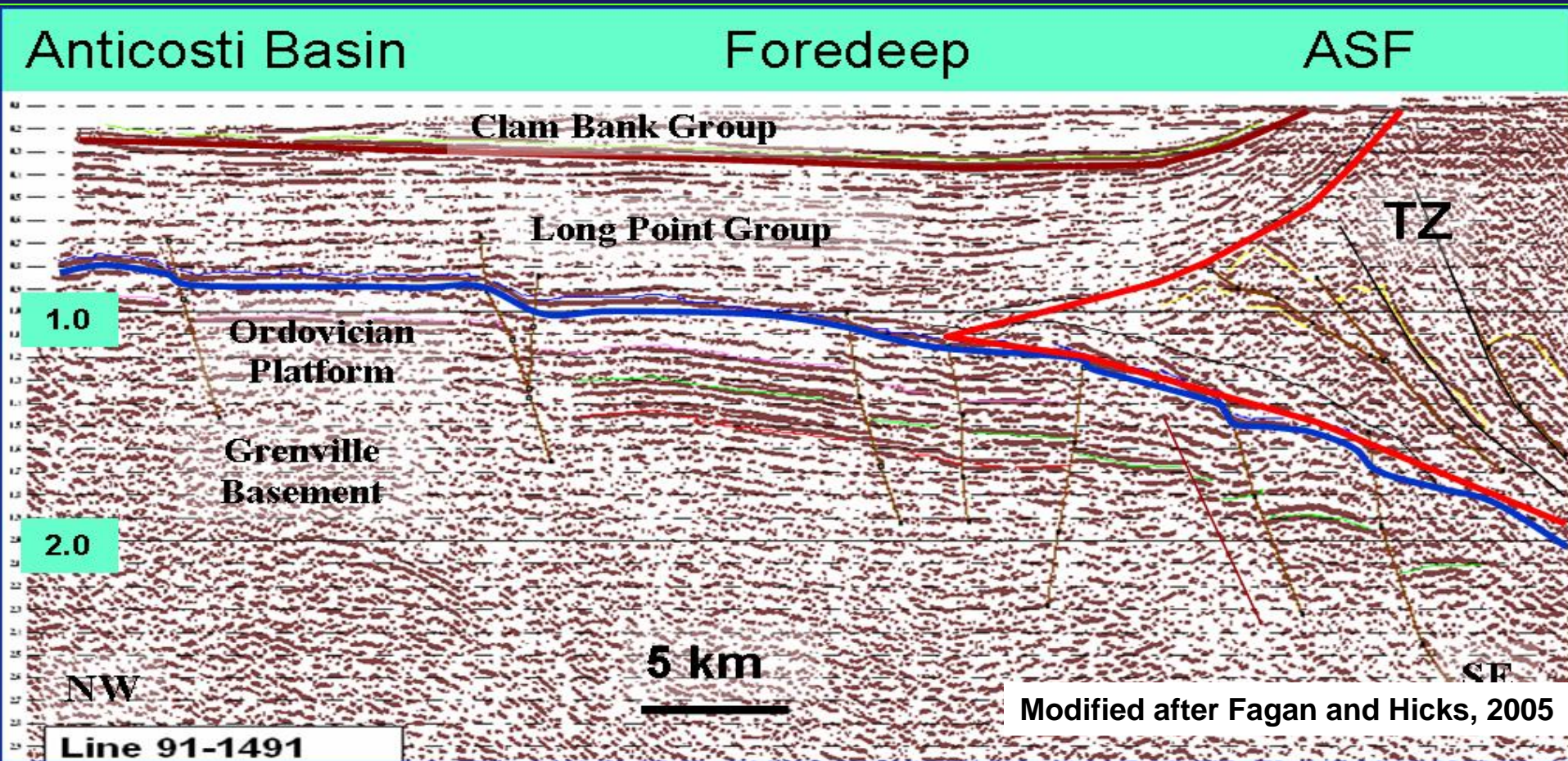
- Also shown are locations of the seismic lines 91-1491 and BHP 91-2 illustrating structural setting

Geology map of the onshore Anticosti Basin (Humber Zone).





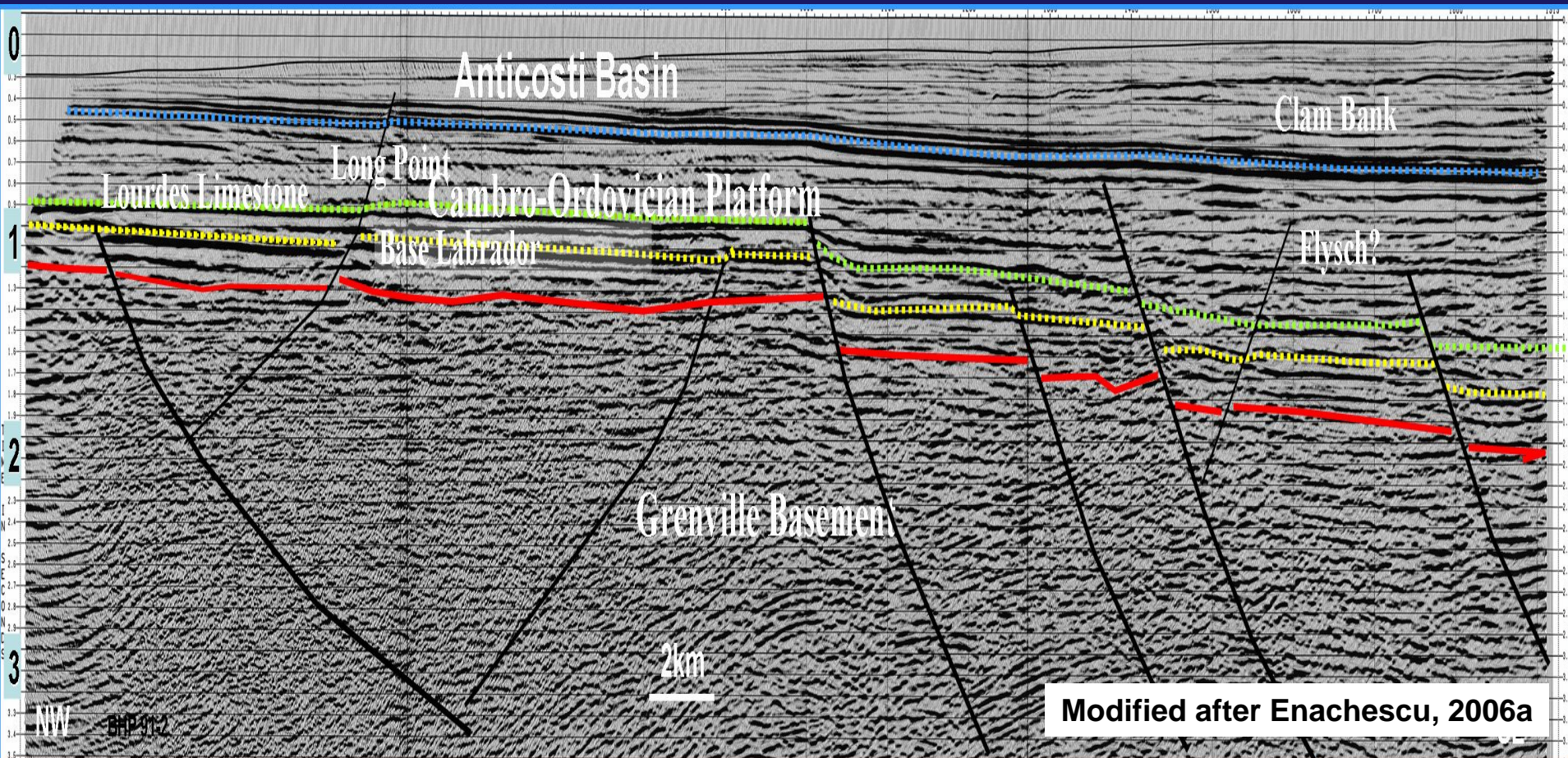
# Seismic Dip Line 1502



Representative marine seismic line from offshore Western Newfoundland, showing the axial part of the Anticosti Basin, the faulted Cambro-Ordovician Carbonate Platform, the Siluro-Devonian almost flat laying layers, the Foredeep, the Appalachian Structural Front (ASF) and the Triangle Zone (TZ) including several thrust sheets.



# Seismic Dip Line BHB 91-2

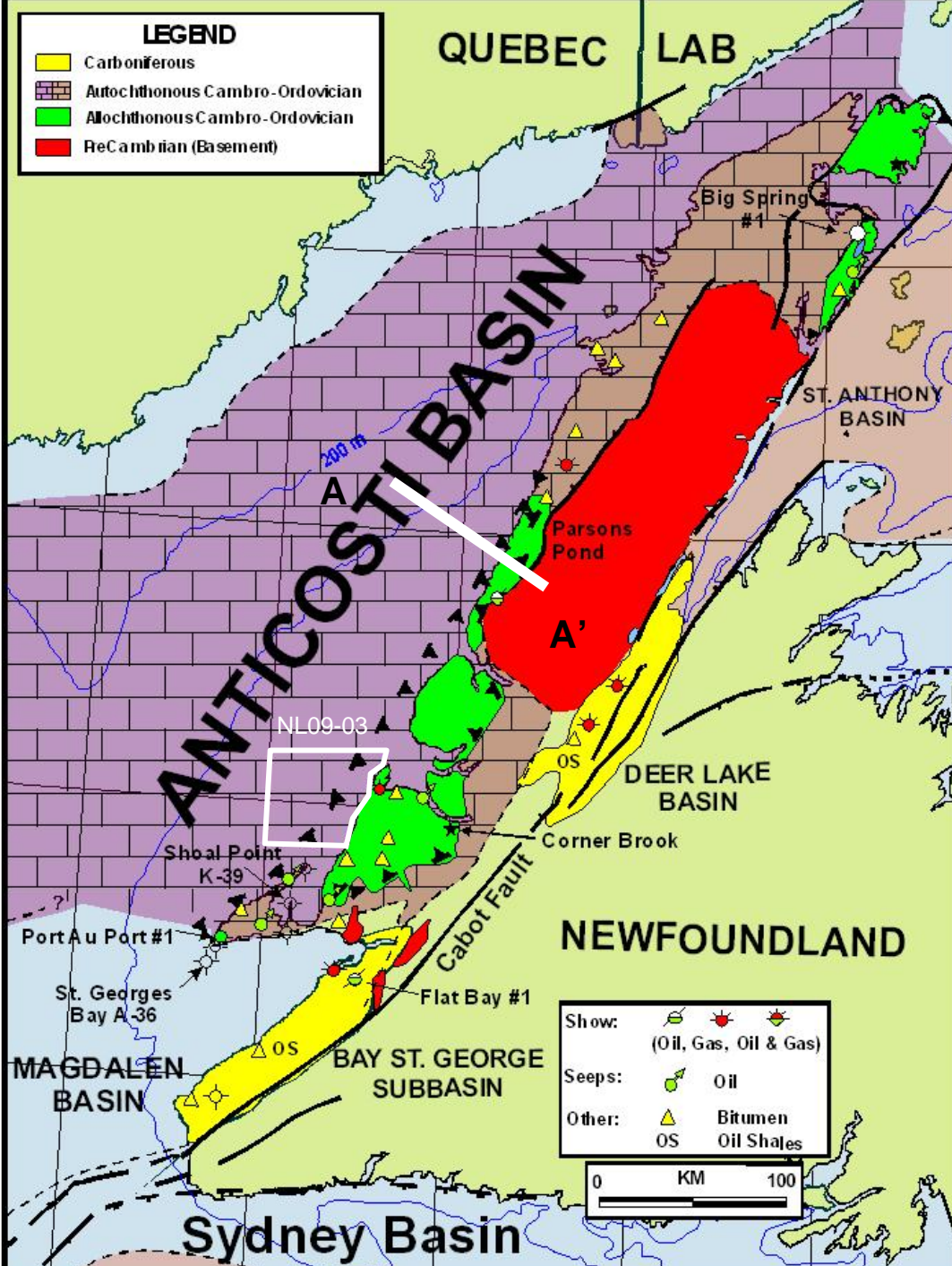


Marine seismic line from offshore Anticosti Basin located in the northern part of Parcel CFB NL09-03. Line illustrates the faulted Cambro-Ordovician Carbonate Platform. Several rotated blocks and a horst are potential plays. Late Ordovician and Silurian groups (Long Point and Clam Bank) overlay the Carbonate Platform.

# Anticosti Basin Overview

- The Early Paleozoic Anticosti Basin is one of several basins that preserve Cambrian to Ordovician shelf and foreland basin rocks along the Appalachian trend of eastern North America
- Except for wells drilled from Anticosti Island, Port au Port Peninsula and shallow wells drilled on land in the Parsons Pond area, no other wells have been drilled in this basin
- Cambrian and Ordovician rocks of the Anticosti Basin include sandstones and carbonates that were deposited along the continental shelf and slope that bordered the ancient continent of Laurentia
- The Appalachian Structural Front (ASF) is a major thrust zone separating moderate to intensely deformed, transported rock (on the south-eastern side of the fault in the Anticosti Basin) from their non-deformed to weakly deformed, non-transported equivalents (to the north-western side of the fault)





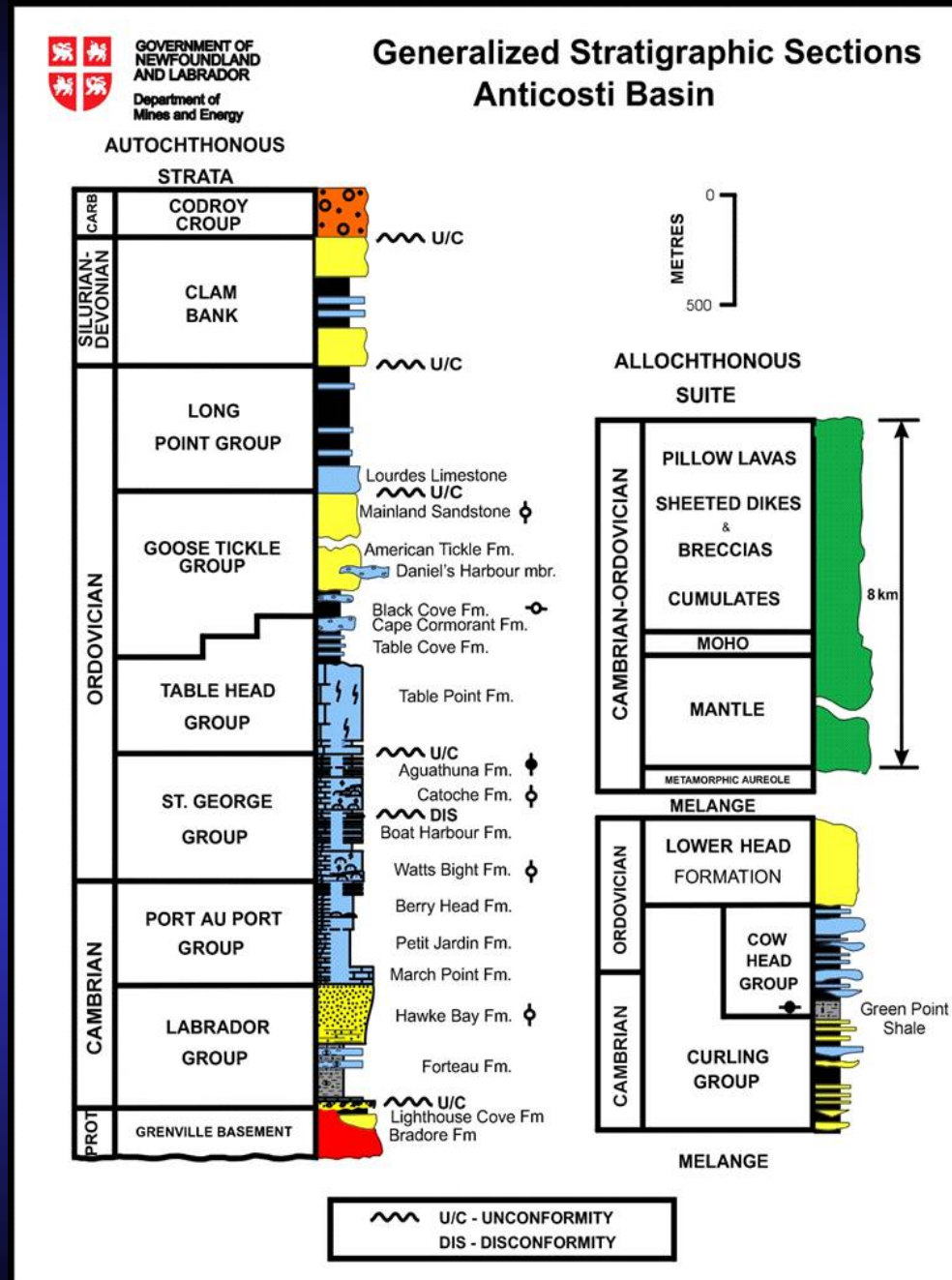
# Anticosti Basin

Today the Early Paleozoic shelf is preserved in western Newfoundland as a lightly deformed, mainly carbonate, autochthonous platform sequence that is locally overlain (onshore and nearshore western Newfoundland) by transported slope to basin sediments and ophiolites that were thrust westward during continental collision

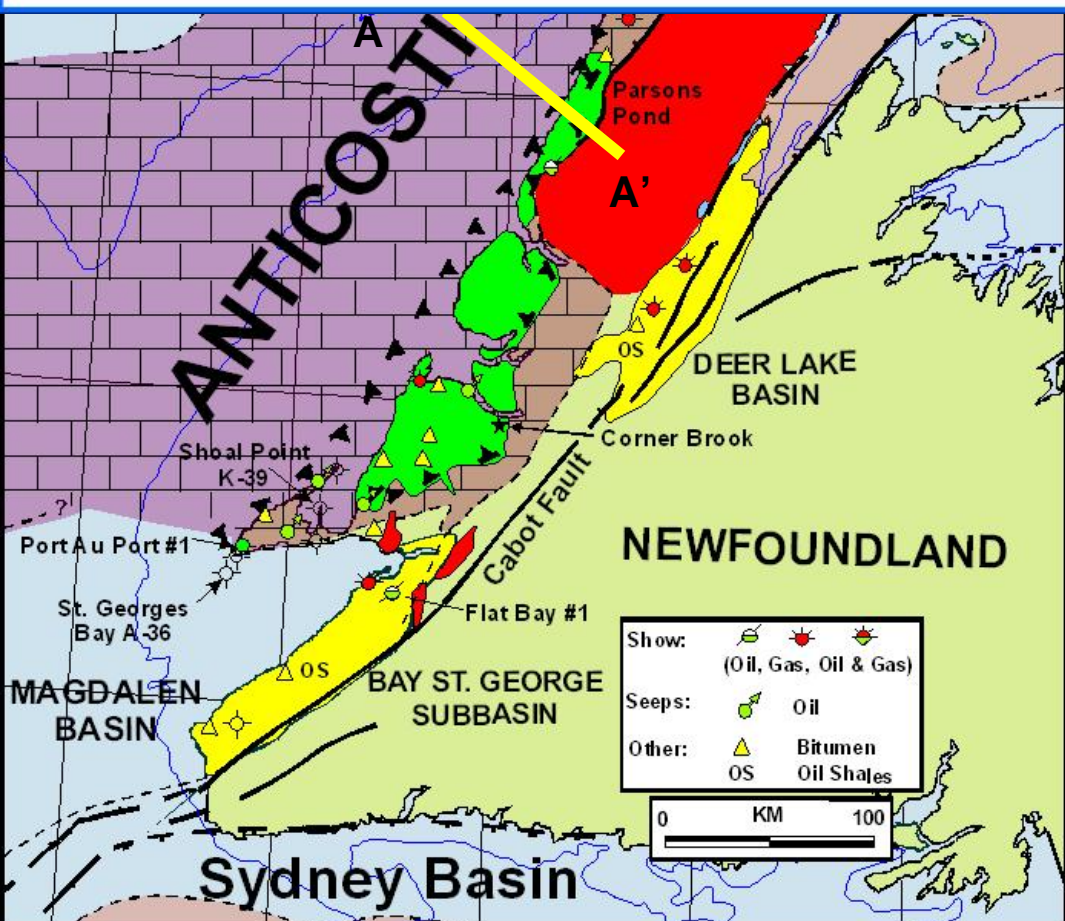
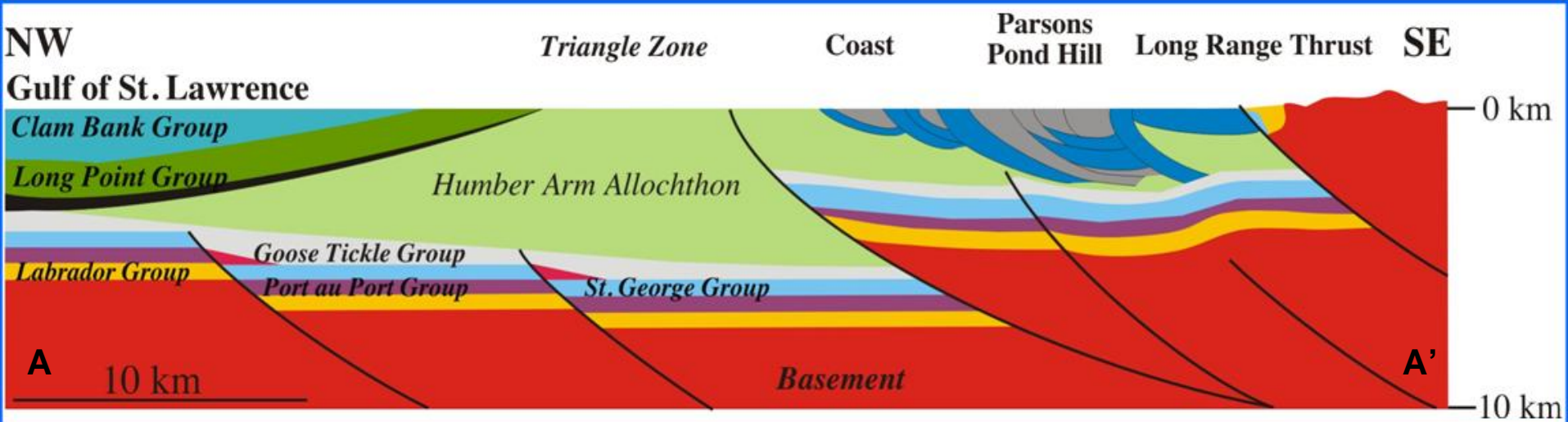
Geological map of the offshore Lower Paleozoic Anticosti and Magdalen basins and the onshore Appalachian belt including sedimentary sub-basins and oil and gas shows and seeps (modified after Cooper et al., 2001). Locations of NL09-03-01 parcel and the cross-section AA' are indicated.



Generalized stratigraphy of the autochthonous and allochthonous sequences forming the Lower Paleozoic Anticosti Basin extending offshore and onshore Western Newfoundland (after GNL DNR). Unconformities, source and reservoir rocks are highlighted.







**Geological Cross-section AA'** of the Anticosti Basin and Appalachian Triangle Zone within the Humber Arm structural unit above and **Geological map** of the onshore and offshore Anticosti Basin.  
(modified after Cooper et al., 2001)



# 4. Petroleum Geology of the Anticosti Basin

Source Rocks

Reservoir Rocks

Seals

Hydrocarbon Traps

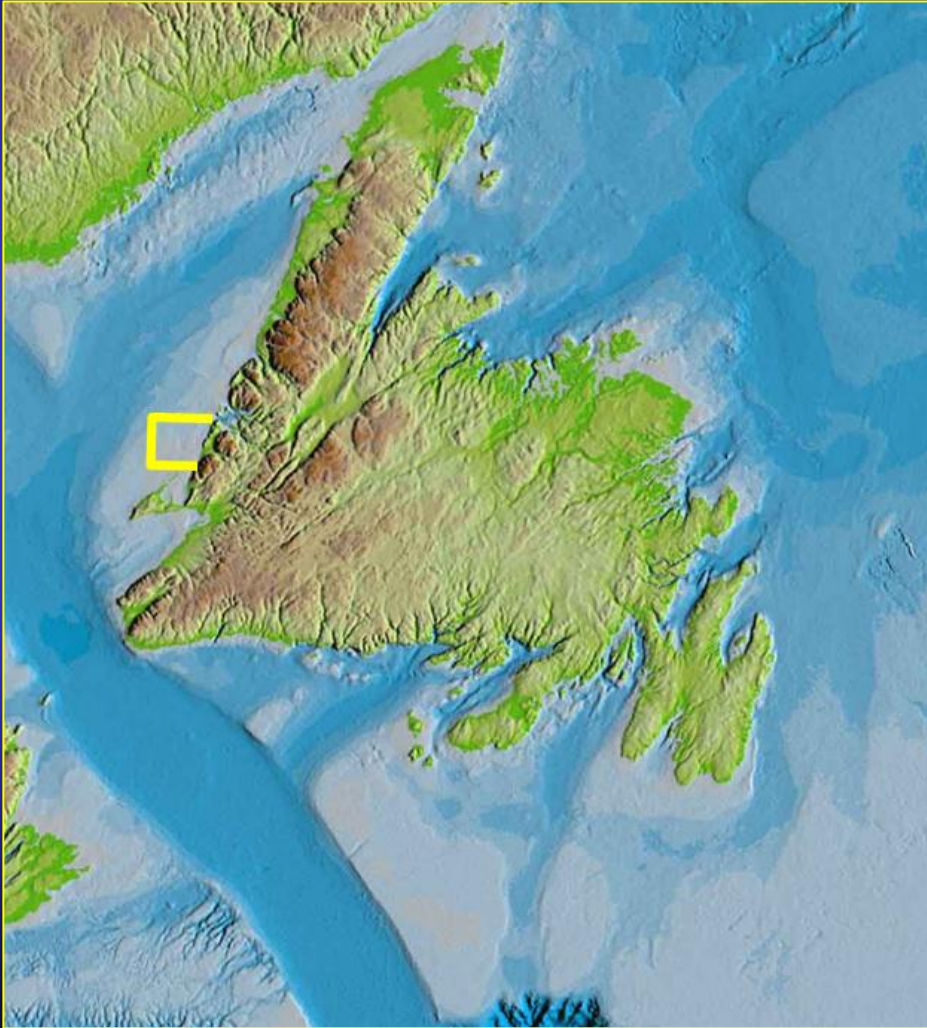
Maturation and Migration

Trenton-Black River Exploration Model

Petroleum Prospect Risks



# Petroleum Geology



- Systematic geochemical investigations and regional geological studies performed in the Anticosti Basin have shown that all prerequisites for viable hydrocarbon systems are clearly satisfied
- In spite of the PAP #1 discovery, this basin and particularly its north-eastern side, is mostly unexplored and contains “high risk - high reward” frontier type plays

# Petroleum Geology

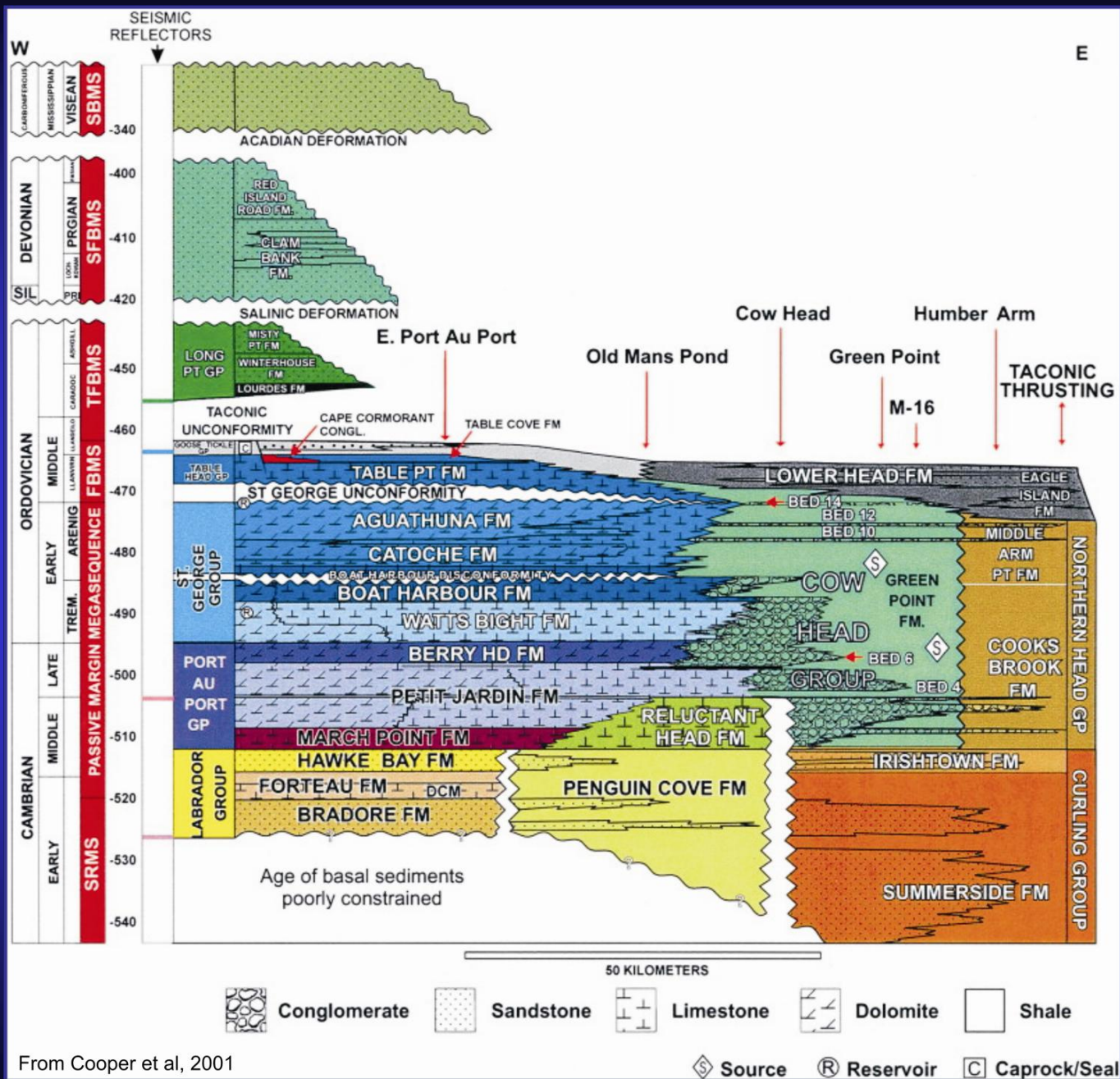
- Anticosti Basin is the largest of the Western Newfoundland Paleozoic basins, covering vast areas both offshore and onshore
- The basin contains rock sequences ranging in age from Lower Cambrian to Devonian, with a sliver of overlying Carboniferous clastics. The Cambrian-Ordovician shallow marine platform and coeval deep water facies occupies the Gulf of St. Lawrence
- The Appalachian Triangle Zone is located near the shoreline while its larger overthrust belt is located nearshore and on land in the relatively low lying coastal area and is also constituted from Cambro-Ordovician beds



# Hydrocarbon Plays

**Six conventional plays are recognized in Gulf of St. Lawrence Cambro-Ordovician strata that are valid offshore Western Newfoundland (GSC, Lavoie et al., 2009):**

- 1) Cambrian rift sandstones,
- 2) Lower Ordovician hydrothermal dolomite (HTD),
- 3) Carbonate thrust slices at the Appalachian structural front,
- 4) Middle-Upper Ordovician HTD,
- 5) Passive margin slope clastics, and
- 6) Foreland sandstones and carbonates



**Generalized litho-stratigraphy of the autochthonous and allochthonous sequences forming the Lower Paleozoic Anticosti Basin of Western Newfoundland (after Cooper et al., 2001).**

From Cooper et al, 2001

# Hydrocarbon Plays

- In Western Newfoundland:

- 1) Lower Ordovician and Mid-Upper Ordovician HTD,
- 2) Carbonate thrust slice, and
- 3) Lower Devonian sandstone

have either oil and gas production, significant shows or exploration data indicating possible hydrocarbon accumulations

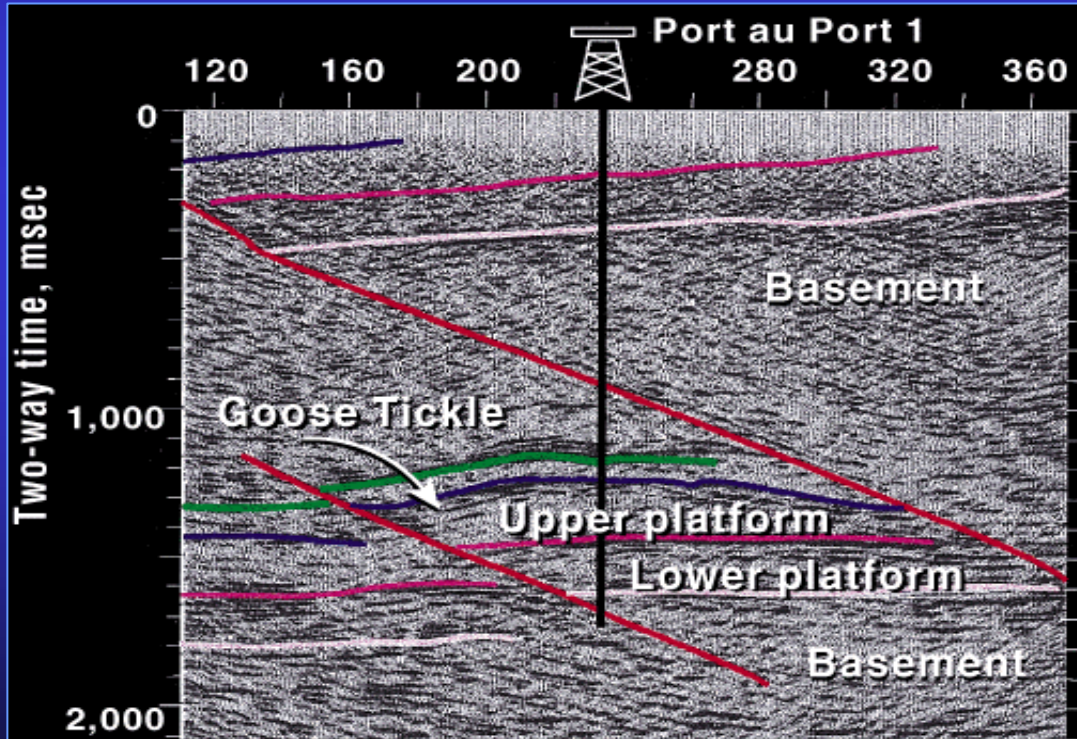
- The Silurian-Devonian successor basin beds are usually shallow and relatively flat-lying. While good sandstone reservoirs are present in the Siluro-Devonian aged Clam Bank Formation these are not considered viable targets
- 1995 PAP discovery in Lower Ordovician HTD has brought greater attention to the petroleum potential of the Anticosti Basin where CFB NL09-03-01 is located



# Hydrocarbon Plays

The Port au Port discovery proved a working petroleum system represented by

**the Green Point source rock and the Lower Ordovician Aguathuna HTD reservoir**



After Weissenberger and Cook, 1999

# Source Rock

Several Paleozoic intervals with medium to rich source rocks have been recognized from drilling and outcrop sampling:

**1. Green Point shale (Late Cambrian).** The proven source rock for the Anticosti Basin onshore Western Newfoundland is present in the Humber Arm allochthonous sedimentary suite

Green Point samples yielded a **TOC** of 1.74% to 3.04% (C-NLOPB), but values up to 10% were also reported by Fowler et al. (1995) and Cooper et al. (2001). **HI** of 367-451 and **OI** of 4-26 were reported (Sinclair, 1990). Fowler et al., (1995) indicate that Green Point strata are significant **Type I/II** source rocks

Geochemical fingerprinting has identified the Green Point shale as the source rock for the oil shows at Parsons Pond and for the PAP #1 discovery. Average thickness for the Green Point shale is 50 m, however thicker intervals were logged. The source rock is marginally mature to mature when sampled in outcrop

# Source Rock

**2. McCasty shale (Late Ordovician).** This shale is the recognized source rock on Anticosti Island. The McCasty shale has not been encountered in Western Newfoundland but may be present in the undrilled offshore foreland basin. Seismic data indicates that Parcels 1 would contain the foreland basin sequences including the McCasty source rock

**3. Black Cove-Cape Cormorant shale (Mid-Ordovician).** This formation, part of the autochthonous suite has been sampled from outcrop and should be present in the offshore foreland basin. Outcrop samples yielded an average TOC of 1.2% by (C-NLOPB); values up to 8% were reported (Atkinson and Wright, 2006). The shales have a HI of 246 and an OI of 18 (Sinclair, 1990)

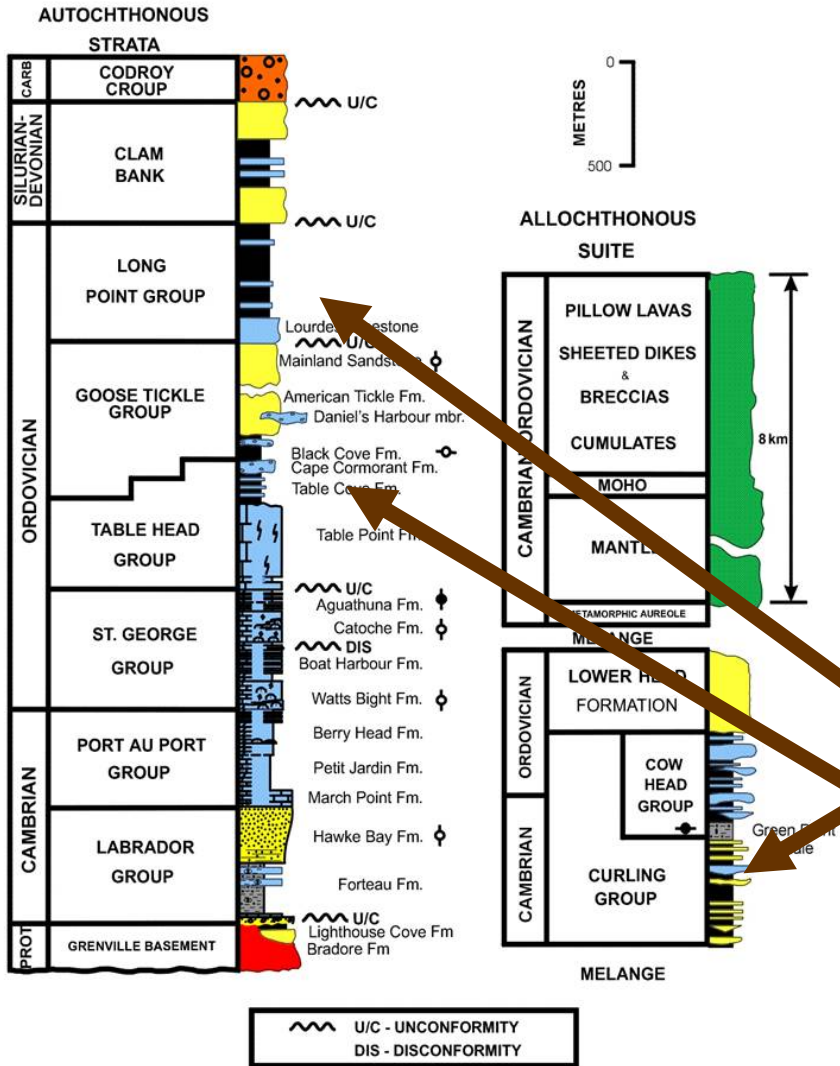
**An important distinction between the Green Point shales and the Black Cove/Cape Cormorant and McCasty sequences is that the latter are present in the autochthonous foreland basin, and should therefore be widespread throughout the Gulf of St. Lawrence (Sinclair, 1990)**





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## Generalized Stratigraphic Sections Anticosti Basin



Lower Paleozoic intervals with medium to rich source rocks have been recognized from drilling and outcrop sampling

- *Green Point shale*
- *McCasty shale*
- *Black Cove-Cape Cormorant shale*

# Reservoir Rock

Reservoir rocks in the Anticosti Basin are predominantly dolomitized carbonate rocks and sandstone. Both primary and secondary porosity have been encountered in wells and outcrop

**1. St. George Group (*Early Ordovician*) and Port au Port Group (Mid- to Late Cambrian) carbonates.** Well and outcrop information indicates that all of the Ordovician carbonate reservoirs are within dolostones of the Early Ordovician St. George Group and Middle to Late Cambrian Port au Port Group. Factors controlling porosity within the Aguathuna Formation (the productive zone at Port au Port #1) are not well understood and the porosity appears to be highly variable

Deeper reservoirs such as the Watts Bight and Catoche formations may provide more regional and predictable dolostone targets. The Catoche Formation has been mapped in outcrop by Knight (2008) who indicates broad-based occurrence of Catoche porosity in Western Newfoundland. All these carbonates are included in the early Ordovician St. George Group





# Reservoir Rock

- 400 km north of the CFB NL09-03 block, in the Port au Choix area, the Ordovician Carbonates (including the Catoche, Aguathuana and Spring Inlet dolomites) are inundated with bitumen and Cooper et al. (2001) concluded that the Port au Choix Peninsula contains a large exhumed oil field
- Dolomite porosity may be microcrystalline, inter-crystalline and vuggular
- Secondary porosity creation in Ordovician carbonates depends on exposure and karstification of the platform carbonates during extension and rotation in Middle Ordovician as well as fracturing, solution injection and preferential dolomitization of previously karsted and high energy grainstones zones during the Devonian (Cooper et al., 2001)

# Reservoir Rock

**2. Lower Paleozoic sandstones.** The Hawke Bay Sandstone (Cambrian aged Labrador Group) was porous in the hanging wall at PAP #1 but was tight in the repeated section in the footwall. Additional reservoir potential is recognized within the autochthonous Late Ordovician Goose Tickle Formation that contains Mainland and American Tickle sandstones

**3. Other reservoirs.** Also contained in the Goose Tickle Group are dolomitized carbonate conglomerates of the Daniels Harbour Member and calcarenites carried in hanging wall thrusts (Knight – pers. comm.).

Other reservoir intervals were encountered in the Watts Bight Formation.

The Late Ordovician Long Point Group and Silurian-Devonian Clam Bank groups are not widely outcropped in Western Newfoundland but may be drilled offshore. More likely the Long Point Group will be dominated by shales with minor limestones. The Clam Bank sequence offshore may also present unexplored porous clastic and carbonate zones. Other mentioned clastic reservoirs are Eagle Island Sandstone, Blow-Me-Down Brook Sandstone and the Misty Point Fm in the Long Point Group (16% porosity in outcrop reported by Quinn et al., 1999)

# Reservoir Rock

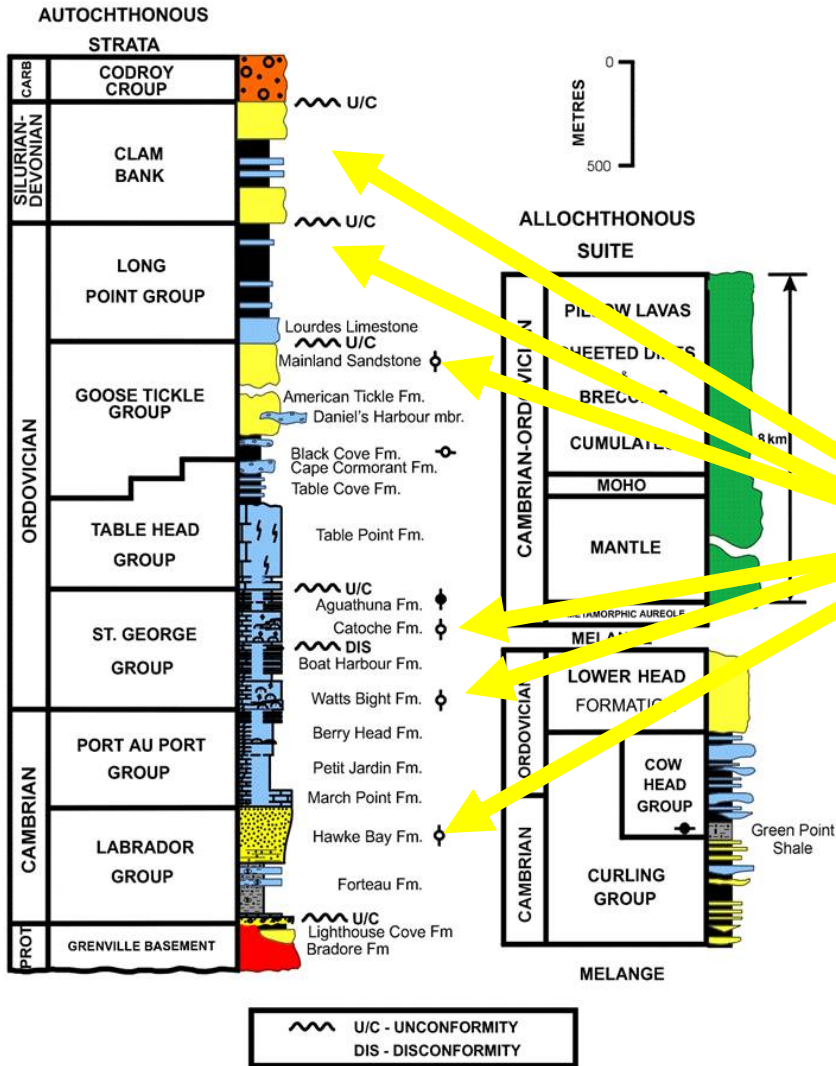
- Porosity is most extensive in the upper Catoche Formation, spottier in the peritidal Aguathuna and Spring Inlet Member, and extends as high as the lower Table Point Formation
- The possibility of directly mapping hydrothermal dolomite porosity on high quality 3D seismic data and fluid indicators seismic attributes in this area remains to be explored
- Both source and reservoir rocks may be present in places within the synrift sequences present under the Carbonate Platform. These rocks have never been penetrated in the Anticosti Basin but similar Early Paleozoic synrift sequences are productive in other Paleozoic basins. An example is the Cambrian of the Mackenzie Corridor in NWT





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## Generalized Stratigraphic Sections Anticosti Basin



Reservoirs predominantly dolomitized carbonate rocks and sandstone with both primary and secondary porosity

- *Ordovician carbonates*
- *Lower Paleozoic sandstones*
- *Other reservoirs: Daniels Harbour Mbr, Watts Bight Fm, Long Point Group, Clam Bank Gr; Eagle Island Sandstone, Blow-Me-Down Brook Sandstone, Misty Point Fm of the Long Point Gr, Catoche Fm, Aguathuna and Spring Inlet Mbrs, lower Table Point Fm*





# Seals

**Finding good seals should not be a problem in the Anticosti Basin as the Lower Paleozoic succession contains a number of tight shales and carbonates**

- Tight intervals are present in both allochthonous and autochthonous successions represented by shales, carbonates and various evaporite intervals
- The Middle Ordovician *Black Cove Shale* is a regional top seal for the foreland Carbonate Platform



# Hydrocarbon Traps

**Structural traps in the Anticosti Basin are associated with deformation of the platform in front of and along the ASF**

North of Port au Port area the deformation front is a classic Triangle Zone with trapping possibilities in the overlying thrust sheets and underlying faulted and tightly folded autochthonous platform

- Traps in the autochthonous or foreland Carbonate Platform are rotated fault blocks or inverted fault blocks including footwall shortcuts of the thick skinned thrusts. This deformation zone should be present in the eastern, shallower water part of the Anticosti parcel NL09-03-01
- Cambro-Ordovician Platform and its cover deepens eastward through numerous steps, creating horsts and rotated blocks bounded by basement penetrating faults. While these faults are predominantly normal faults, minor inversion is observed in places

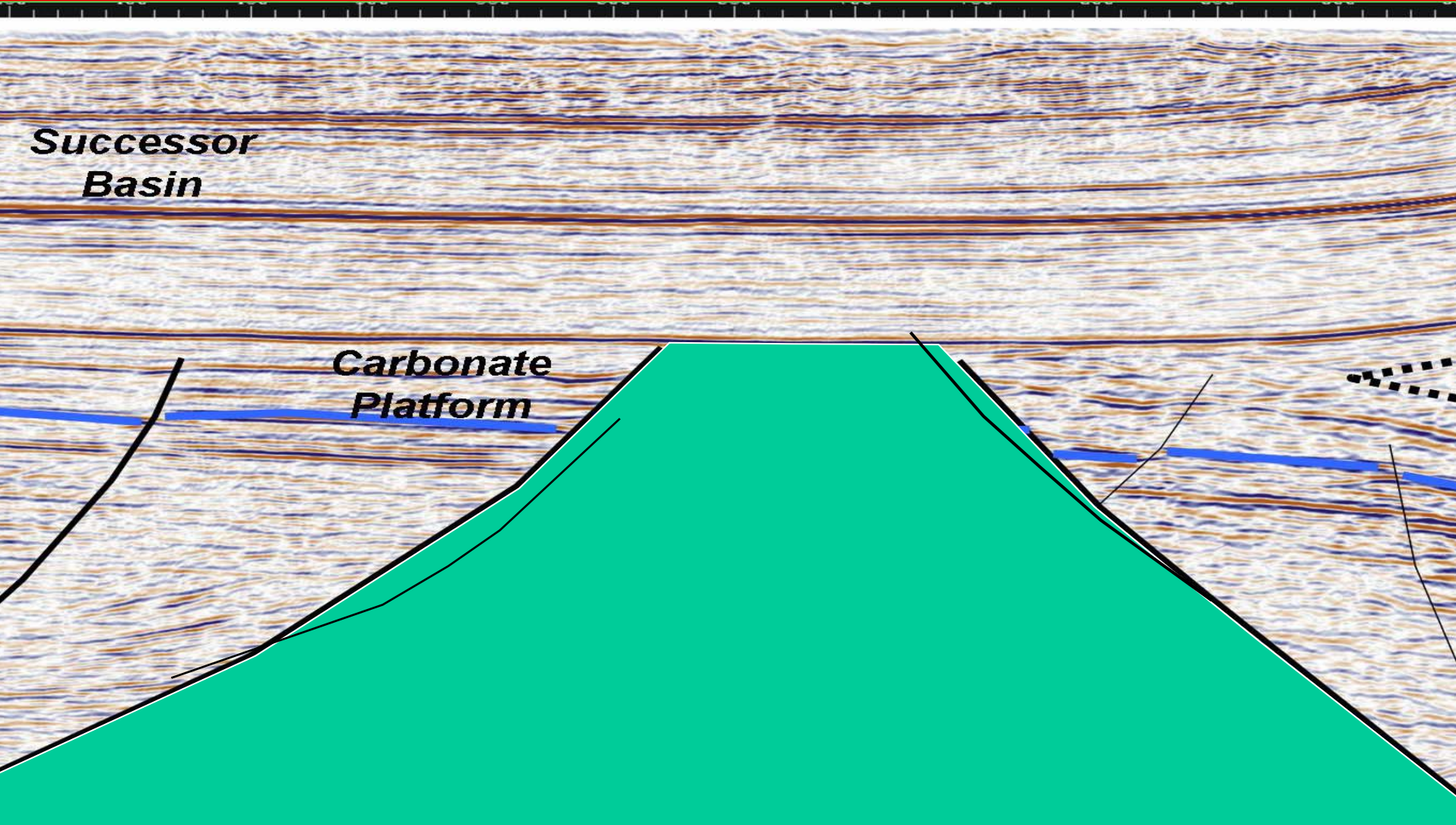
# Hydrocarbon Traps

**Both thin and thick skinned structures are present in the Humber Arm Allochthon**

Cooper et al., (2001) and Atkinson (2005a and b) summarized all possibilities of

- a) Structural traps: horst blocks, tilted fault blocks, thrust sheet slices
  - b) Stratigraphic traps: sand lenses, pinchouts, fans, erosional edges, karstified and leached carbonates, dolomitized carbonates
- Enachescu (2006a and 2008) has shown possibilities of two-, three- and four - way fault bounded closures in the Anticosti Basins parcels north of Port au Port Peninsula in numerous interpreted seismic sections

# Structural Trap: Horst





# Maturation and Migration

**The Paleozoic source rocks should be all in the mature to overmature range**

- Port au Port #1 oil and gas tests and the presence of oil in seeps and drilled wells demonstrate that source rocks are mature and that oil and gas were generated and migrated into traps
- After trap formation there were direct migration routes through porous beds or/and faults from the Green Point shale into allochthonous reservoirs

# Trenton-Black River Exploration Model

**Trenton-Black River reservoir is a successful hydrocarbon exploration trend in the Appalachian Basin**

Exploration model including four prerequisites for porosity development in carbonate rocks (Smith, 2004):

1. Appropriate tectonic settings such as basement-rooted intra-platform wrench faults and fault intersections, fault-controlled margins, and the first carbonates deposited on newly-rifted/heavily-faulted continental;
2. Fault movement soon after deposition; much of the alteration takes place in the first kilometre of burial, so faults with minor vertical offset at the time of alteration may be in the best locations;
3. Indication for breccification; breccias may be either karst or hydraulic, so look for saddle dolomite-cemented breccias;
4. Petrographic evidence of hydrothermal alteration in cores and cuttings

# Trenton-Black River Exploration Model

All prerequisites for the formation of HTD have been identified and confirmed in the carbonates and dolomites encountered in drilling and in the outcrops within the Anticosti Basin providing strong arguments that a similar play is present offshore Western Newfoundland!





# Petroleum Prospect Risks

**Port au Port #1 oil and gas tests, presence of oil in seeps and drilled wells demonstrate that source rocks are mature and that oil and gas were generated and migrated into traps**

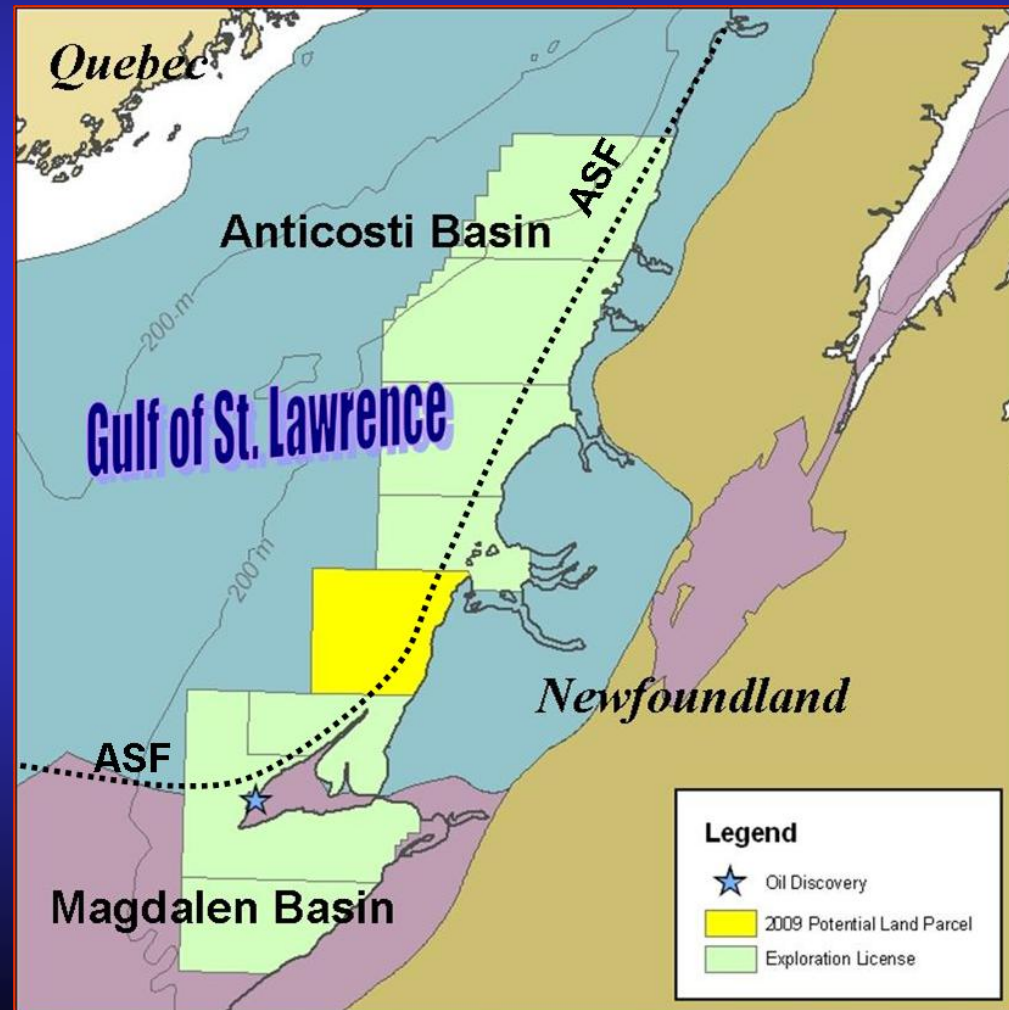
After trap formation there were direct migration routes through porous beds or/and faults from the Green Point shale into allochthonous reservoirs

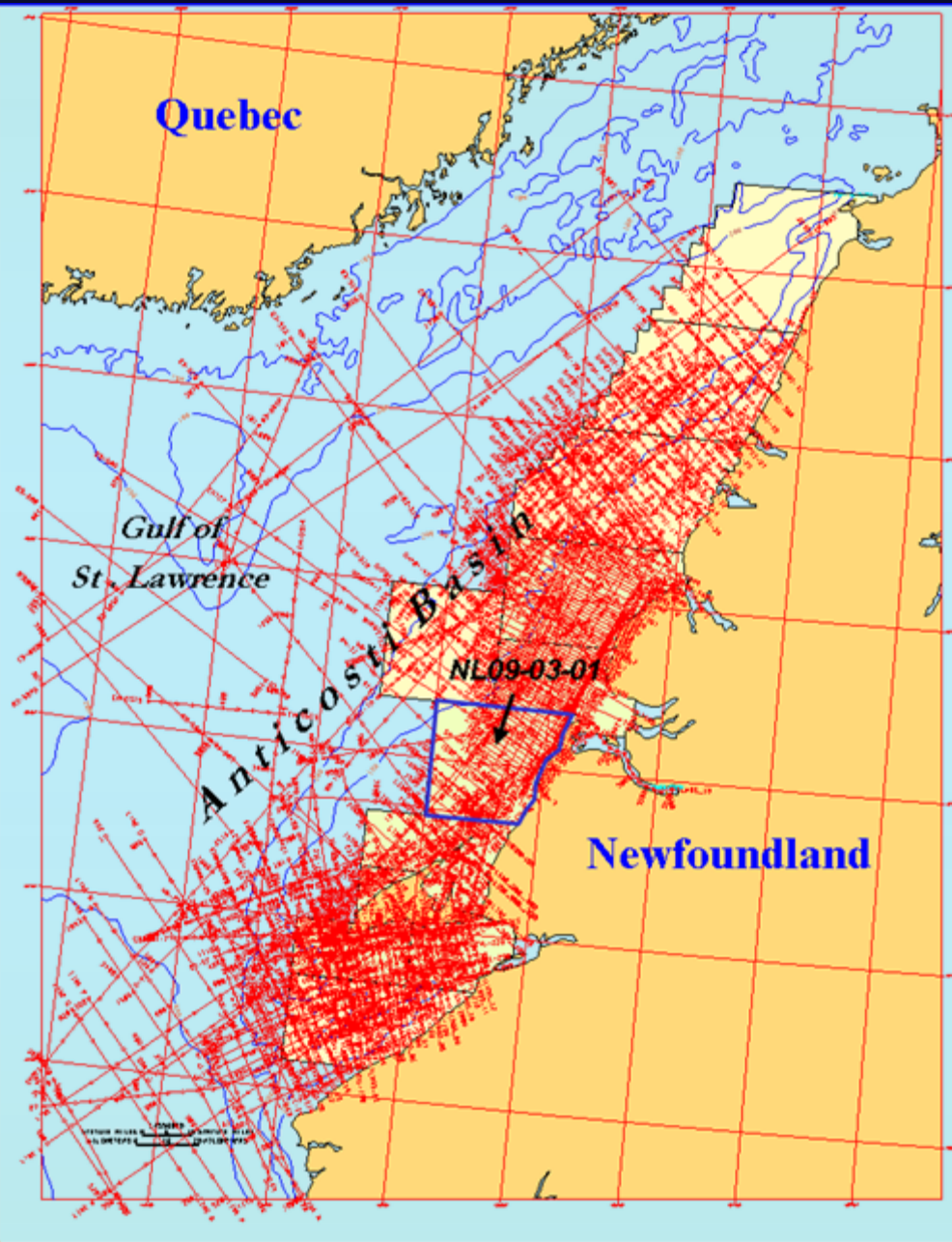
With source rocks in the oil window or dry gas window, **trap preservation and presence of adequate reservoir remains the main risk factors in the Anticosti Basin.** One example of field destruction is the Port au Choix exhumed oilfield located on shore north of offered parcel

**•Offshore, where prospective section is expected to be buried under thick Middle Ordovician beds, the risk of trap preservation should be lower**

# 5. Petroleum Potential of Call for Bids NL09-03 Parcels 1

- Parcel covers 140,210 ha (346,465 acres) in the eastern part of the Anticosti Basin
- This shallow water parcel (0-150 m WD) is close to Western Newfoundland coastline, in vicinity of proven hydrocarbon occurrences on the Port au Port Peninsula, and Bay St. George, Parsons Pond, Deer Lake & Port of Choix areas
- Parcel is located on the foreland, foredeep and deformation front of the Appalachian Foldbelt

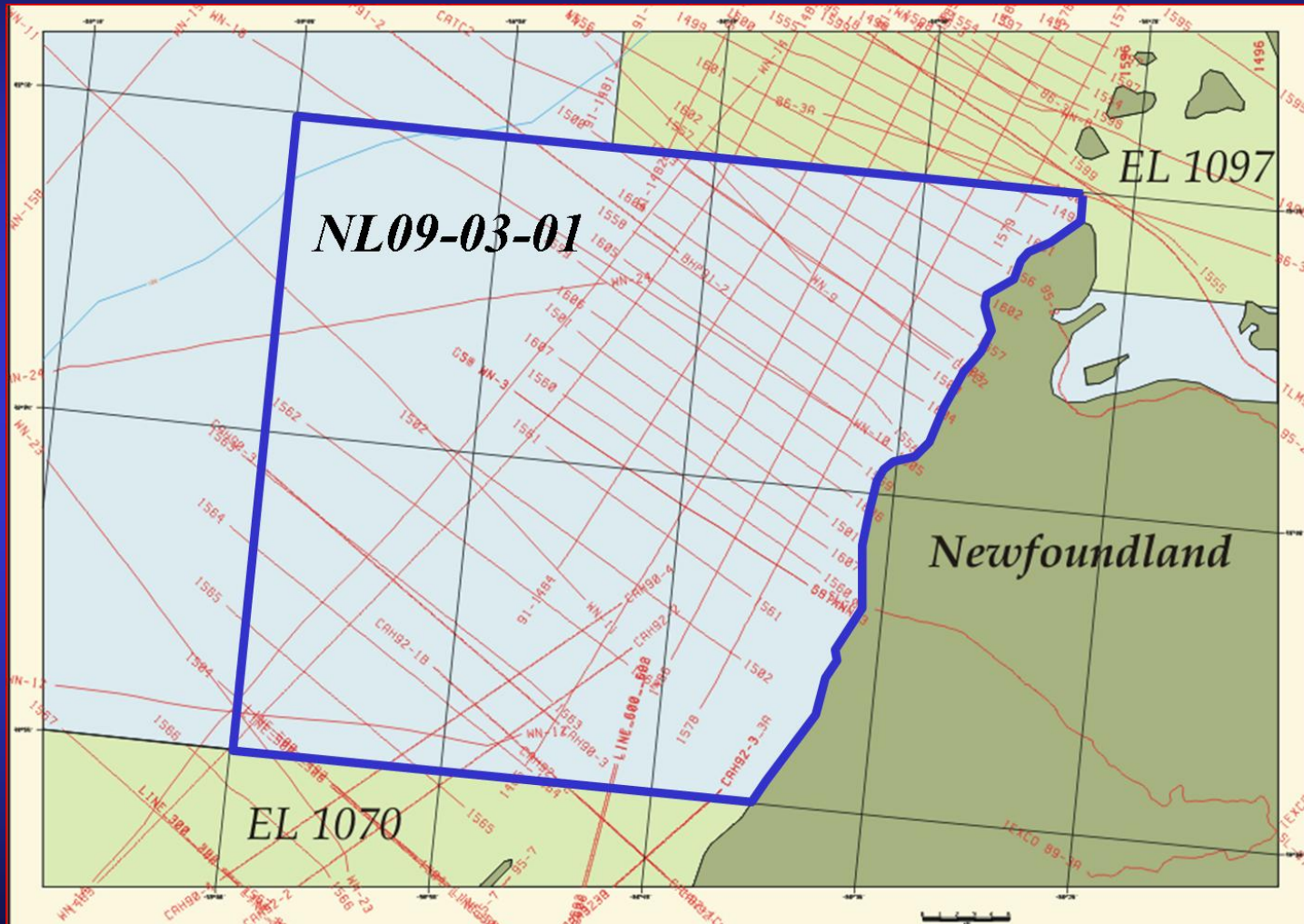




- Seismic data quality is good to very good for the Parcel NL09-03
- Marine data was acquired during the early 1990s with a 3-4.5 Km length streamer in a regional grid that is denser in the dip direction
- The water bottom is a very strong reflector/ refractor
- Energy penetration and sea bottom multiples can be a challenge due to this hard bottom. Several strong seismic impedance contrasts are created at major unconformities and this creates peg leg multiples
- Acquired with smaller length streamers than used today, data can be reprocessed with modern multiple suppression algorithms with improvement of imaging
- Generally seismic lines have good quality and allows for mapping of several foredeep formation tops and unconformities.
- Seismic imaging is more challenging in the more complexly deformed areas such as within the Appalachian Structural Front, where the Humber Arm Allochthonous nappes and overlying flysch layers lie close to the surface



# Seismic Coverage

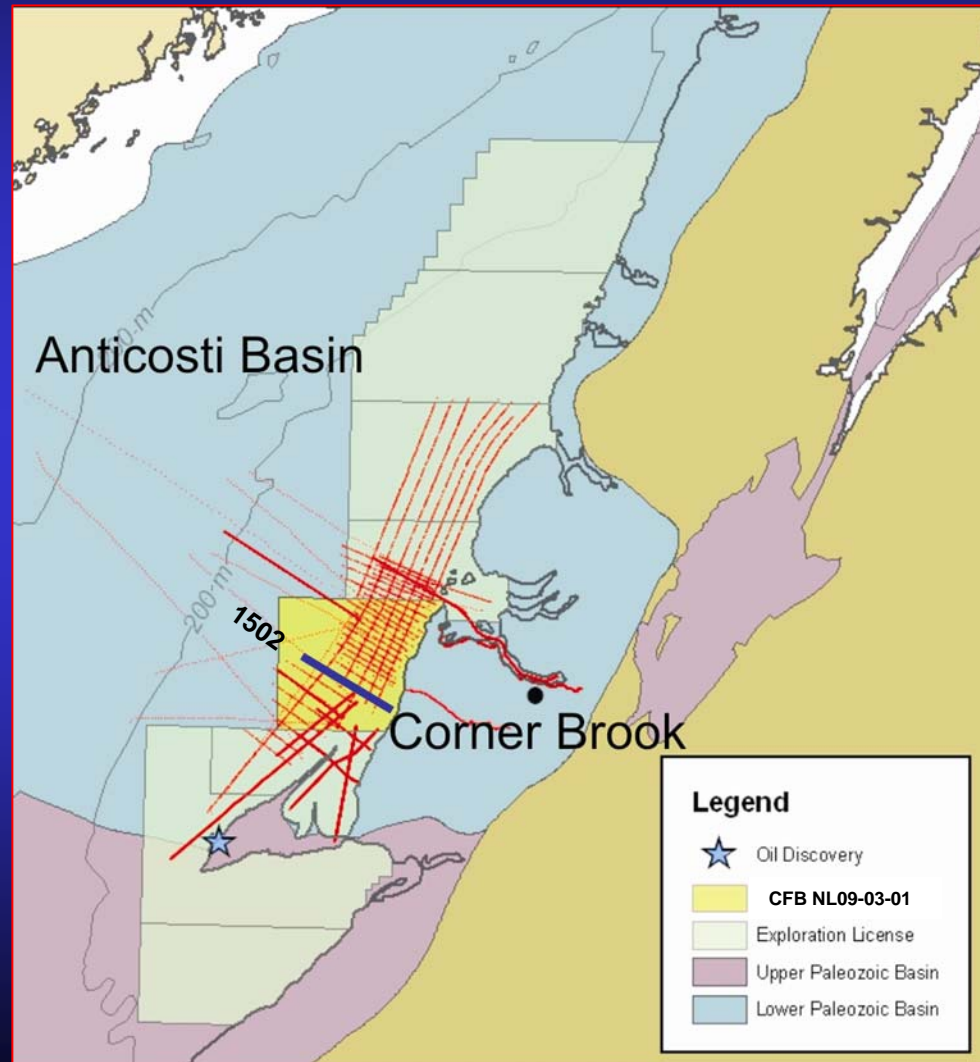


CFB NL09-03 Parcel 1, adjacent Exploration Licenses and current seismic coverage

# Seismic Coverage

- Parcel is relatively well covered by a 2D seismic grid that has 1.5-2.5 km spacing in the dip direction and 3-5 km spacing in the strike direction
- 1500 km of 2D data is available for petroleum evaluation of this parcel
- Digital data is owned by ExxonMobil and Hunt who collected the data covering the parcel and environs during the early to mid 1990s
- Mobil grid represents majority of the seismic lines in the parcel and was collected during the largest seismic regional survey completed in 1991
- A Western Geophysical vessel was used equipped with a sleeve gun array source with a 4500 cu in volume. A fibre optic, 3000 m long, 240 channels digital cable was towed
- Seismic data processing was done by HGS and has signature applied in shot domain, F-K demultiple and gapped deconvolution after stack. Most Mobil lines are 80 fold, processed to finite difference migration and show fair to excellent quality in the foredeep area. Mobil simultaneously recorded shipborne gravity

# Seismic Coverage



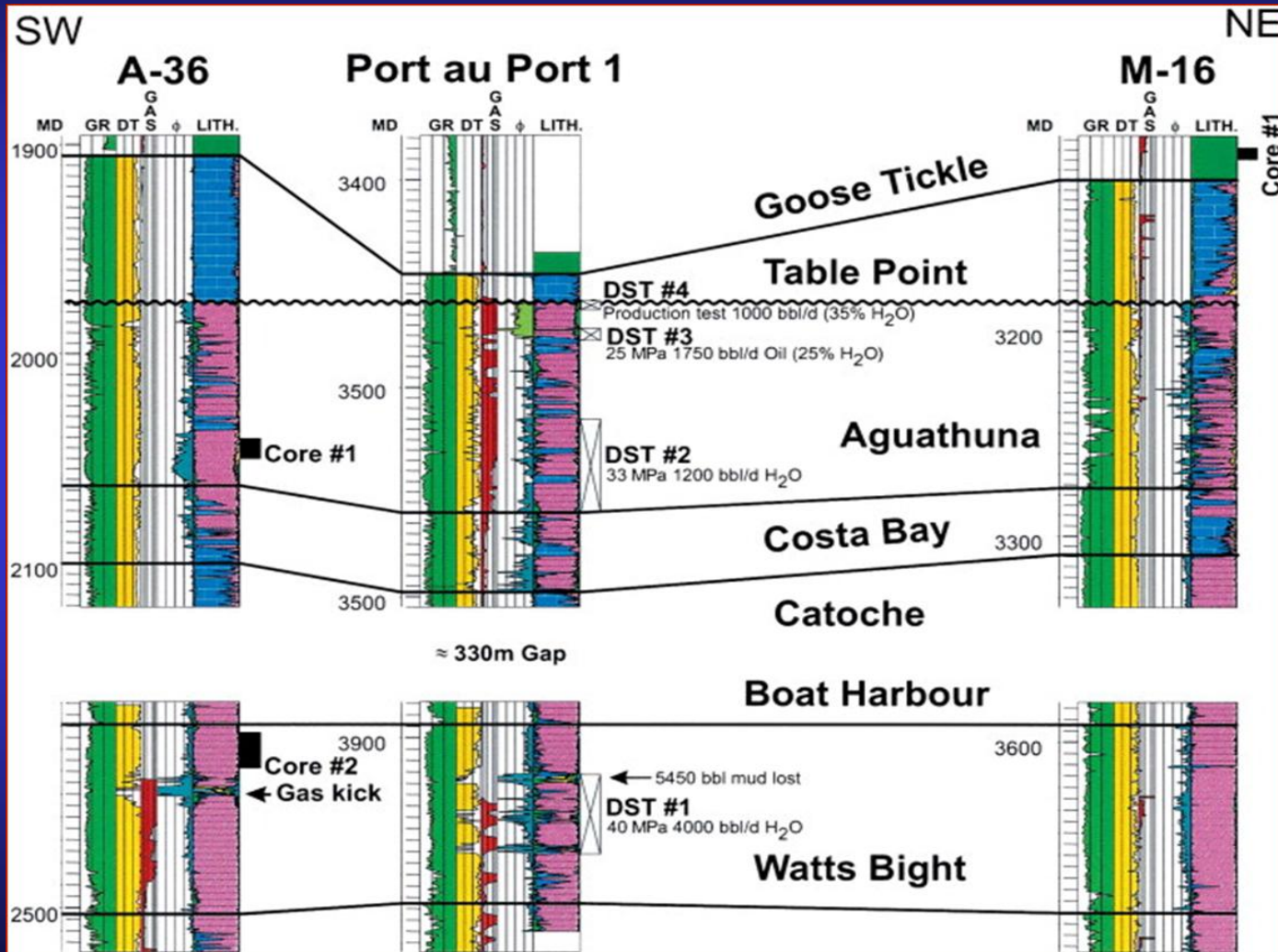
- Parcel NL 09-03 seismic coverage can be purchased as digital data from Exxon or data brokers in Calgary and as hard copies only for the nominal cost of reproduction from C-NLOPB in St John's
- Data grids older than 1980s are available from C-NLOPB only as individual seismic line hard copy or in microfiche



# Significant Wells

- Most significant well for the area, the Port au Port #1, was drilled approximately 40 km south of the Parcel 1. The well tested oil and gas from two Aguathuna Formation intervals at an initial rate of 1,700 bopd and 2.3 mmcfd, and was suspended as a potential oil well
- The well penetrated a higher imbricate block set by a footwall thrust, situated under the main Round Head Thrust. This thrust sets a large basement block above the platform carbonates
- Both pressure and GOR declined during a 6 day extended test. No cores were taken. Subsequently, several PAP sidetrack holes were drilled by Canadian Imperial Venture Corp. who initially farmed into the project, and by PDIP, the present operator of the Petroleum Lease. Reservoir and oil flows have been recorded in some of the sidetracks and partners have plans for future delineation of this discovery estimated to contain mean unrisks reserves of 8.6 mmboe
- Parson Pond #1 well drilled on land in 2004 penetrated a thrust sheet of Cow Head Group, TD'ed above a major thrust fault, and encountered oil shows in fractures. Many of the earlier Parsons Pond wells, situated on land just northeast from the Parcel had either oil or gas or both

# Port au Port #1



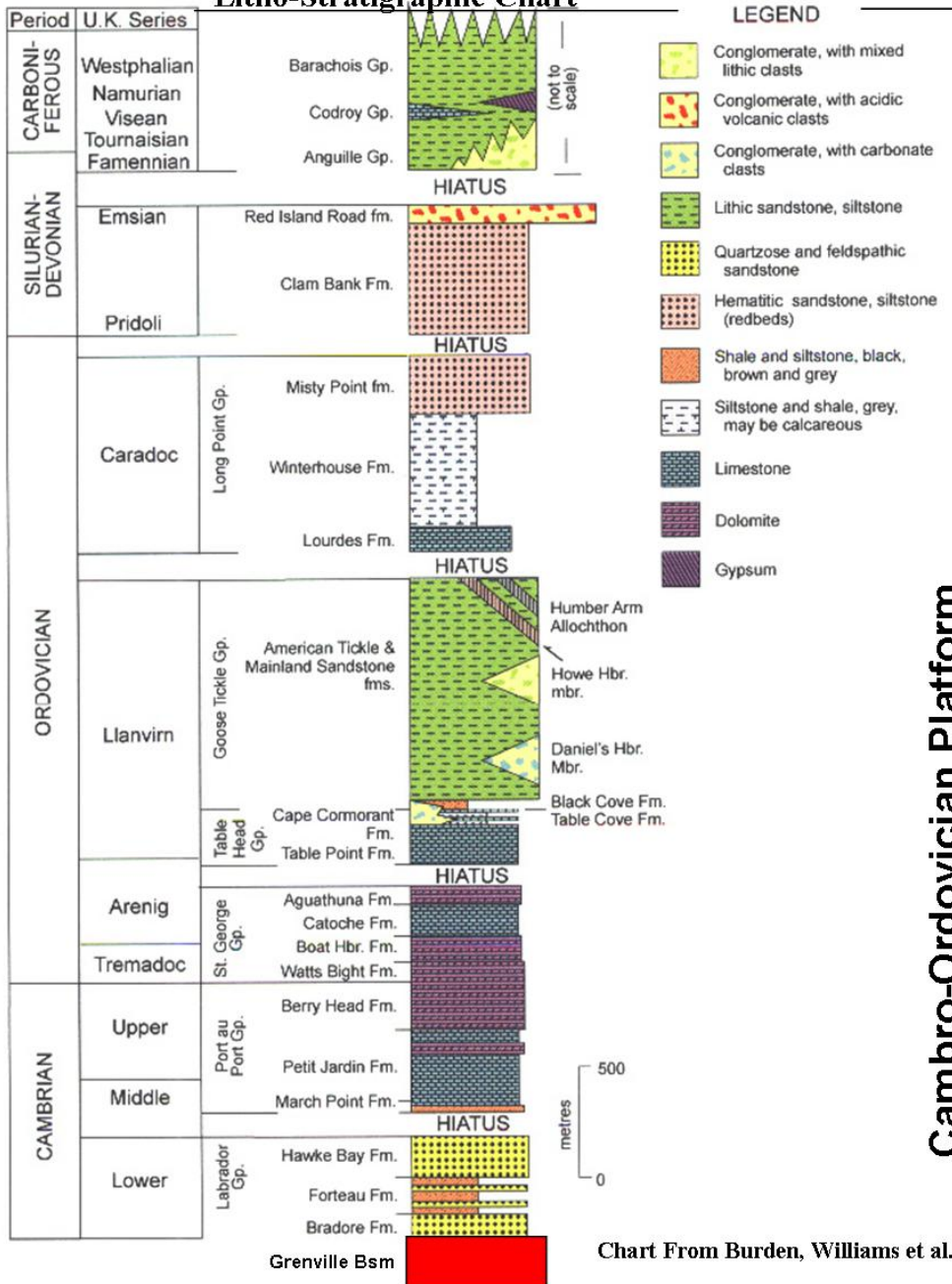
Log correlation of stratigraphic formations between the St. George's Bay A-36, Port au Port #1 and Long Point M-16 wells.

# Seismic Interpretation

- Regional seismic data was tied with synthetic seismograms to several exploration wells in the Port au Port area and jump tied to the geologic units present on land
- Full Cambrian to Devonian sequence described from outcrops and cores is present in blocks north of PAP Peninsula including the Parcel NL09-03
- On the illustrative seismic sections only a few markers and formations are displayed
- Seismic lines in the parcel show the basin as a monocline, dipping and thickening toward the southeast, interrupted by thick-skinned normal faults affecting the platform and the Grenville basement
- Deformation of the overlying Silurian and Carboniferous layers is minimal; however several major faults penetrate these sequences
- Small strike-slip or reverse displacement is observed on some faults, but the main hydrocarbon play in the basin is set by rotation of blocks due to movement on deep penetrating normal faults

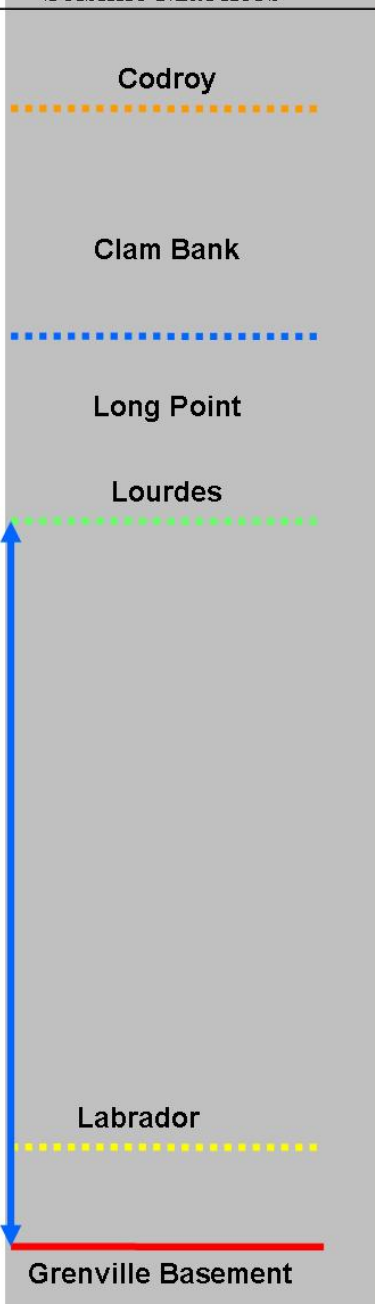


# Litho-Stratigraphic Chart



# Seismic Markers

Cambro-Ordovician Platform



# Anticosti Basin Lithostrat Chart & Seismic Markers

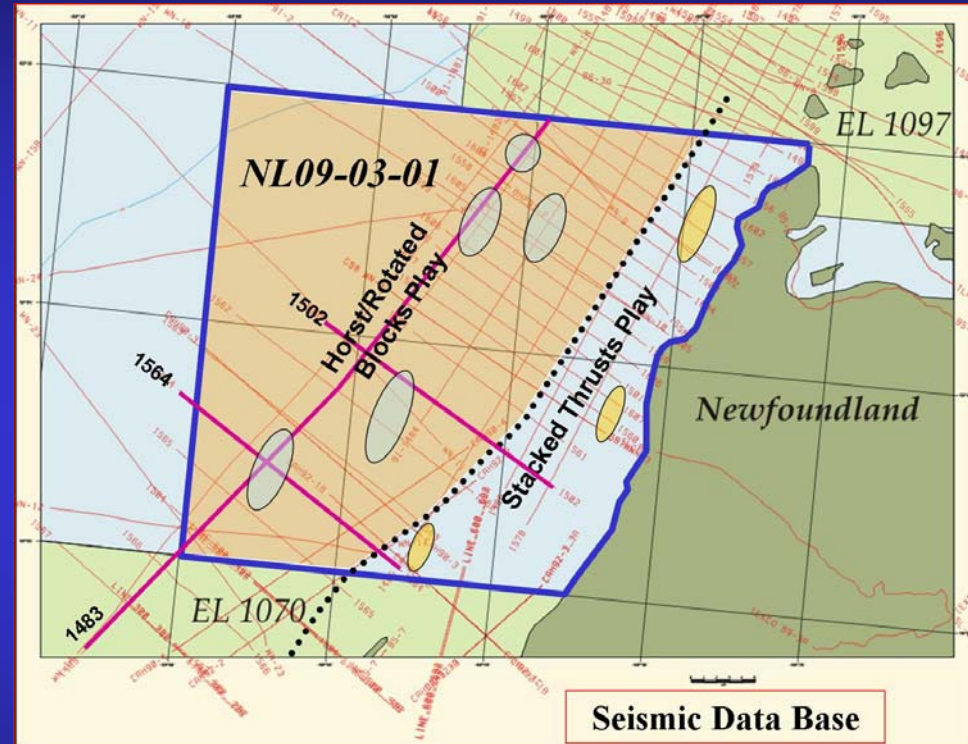
Chart From Burden, Williams et al.

# Seismic Interpretation

Using the available seismic grid, two play fairways can be interpreted within the Cambro-Ordovician of Parcel 1:

- 1.) *the Stacked Thrusts Play* in the eastern third of the parcel, and
- 2.) *the Horst/Rotated Block Play* in the central and western part of the parcel

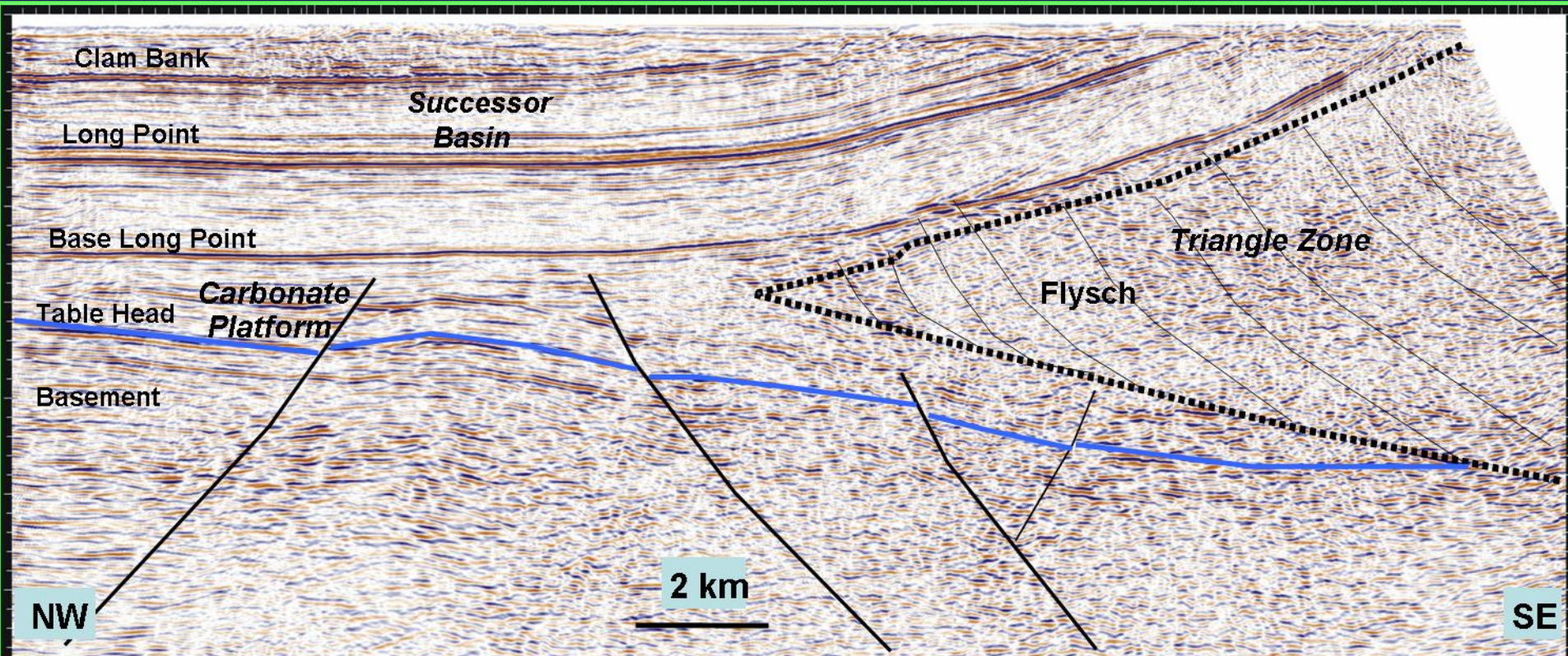
The boundary between the two fairways approximately follows the coast line. The Horst/Rotated Block play, however, exists further eastward under the Triangle Zone. There are locations, where with deeper wells (4 to 5 km), both play trends can be tested



**Hydrocarbon Play Fairways in Parcel NL-09-03. Blue and orange ellipses indicate the schematic locations of several leads identified on the available 2D seismic grid (not to actual size).**



# Seismic Dip Line 1502



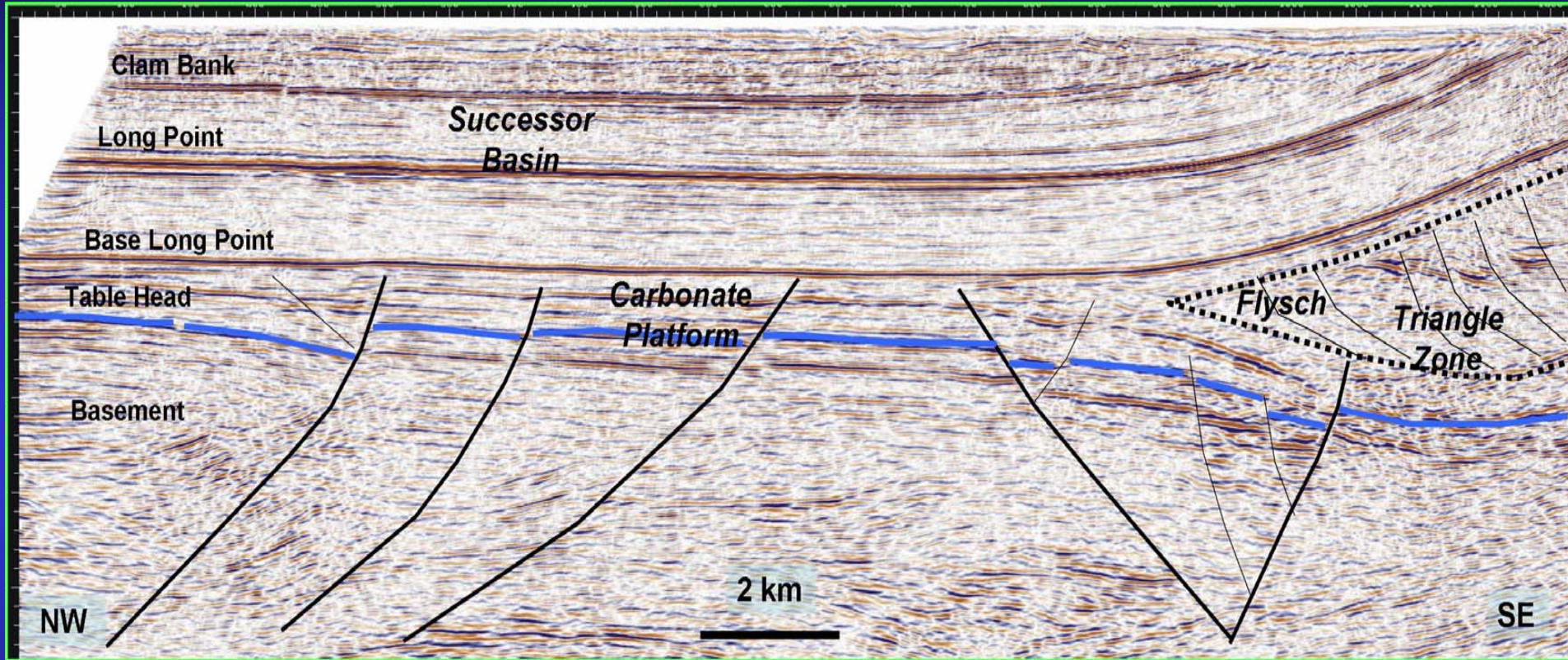
Interpreted dip seismic section 1502 within parcel NL09-03. Note the Carbonate Platform generally deepening toward south-east and affected by normal faults and the Triangle Zone formed by numerous stacked thrusts of Lower Paleozoic beds (line courtesy of C-NLOPB).



# *Seismic Line 1502*

- This dip line (NW-SE) is located over the foredeep and the Triangle Zone of the Appalachian Foldbelt
- The prerift basement and the Carbonate Platform deepens south eastward and is segmented by deep-penetrating normal faults
- Two major faults with throws larger than 50 m and opposite dips delineate a **large horst at the Basement and Carbonate Platform levels**. This may constitute large structural trap if closure can be proven by intersecting strike lines
- Potential reservoirs in Cambro-Ordovician including the proven St. George's Group can be tested with a 2500 to 3500 m deep well
- Other Carbonate Platform targets on this line are rotated blocks closer and immediately under the Triangle Zone
- Other trapping possibilities are within the Long Point and Clam Banks sequences and the thrust sheets forming the large Triangle Zone, where HTD reservoir and source rocks are present, but where seismic data generally has poor quality. Data processing to pre-stack depth migration and new acquired data is needed to better delineate this play that has the advantage of being reachable from land based drilling locations

# Seismic Dip Line 1564



Interpreted dip seismic section 1564 within parcel NL09-03. The Carbonate Platform deepens toward south-east segmented by normal faults. The Triangle Zone formed by numerous stacked thrusts of Lower Paleozoic beds is wedged between the Carbonate Platform and the Successor Basin sequences (seismic line courtesy of C-NLOPB ).

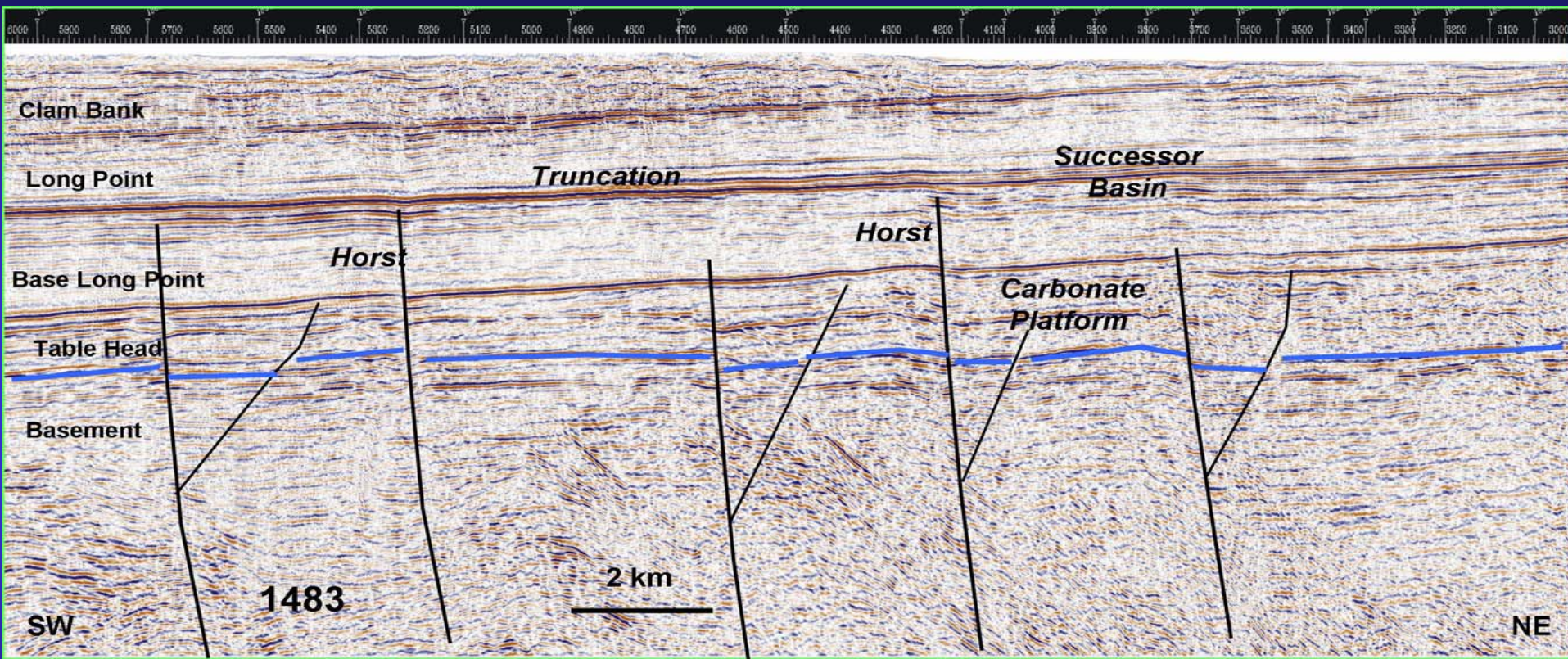


# *Seismic Line 1564*

- This is a dip line (NW-SE) located over the foredeep and the Triangle Zone of the Appalachian Foldbelt, in the southern portion of the parcel
- Prerift Basement and Carbonate Platform deepen toward the southeast; several deep penetrating normal faults segment this sequence
- Faults usually terminate at the pre-Long Point Group Unconformity that is a high quality reflector
- Post-Long Point sequence of the Successor Late Ordovician-Silurian basin is formed by parallel, almost horizontal reflectors within the basin, generally following the Carbonate Platform structure
- To the east, the Late Ordovician-Silurian groups are slightly curving upward, pushed by the stacked thrusts of the Triangle Zone
- Certain litho-stratigraphic configurations, may allow the formation of stratigraphic traps in the Long Point and Clam Bank groups. These can be identified using the high quality seismic data over the interval
- Two major faults with throws larger than 80 m and opposite dips delineate a large horst at the basement and Carbonate Platform levels. This may form a large fault bounded structural trap in the Cambro-Ordovician, sealed by Long Point shales



# Seismic Strike Line

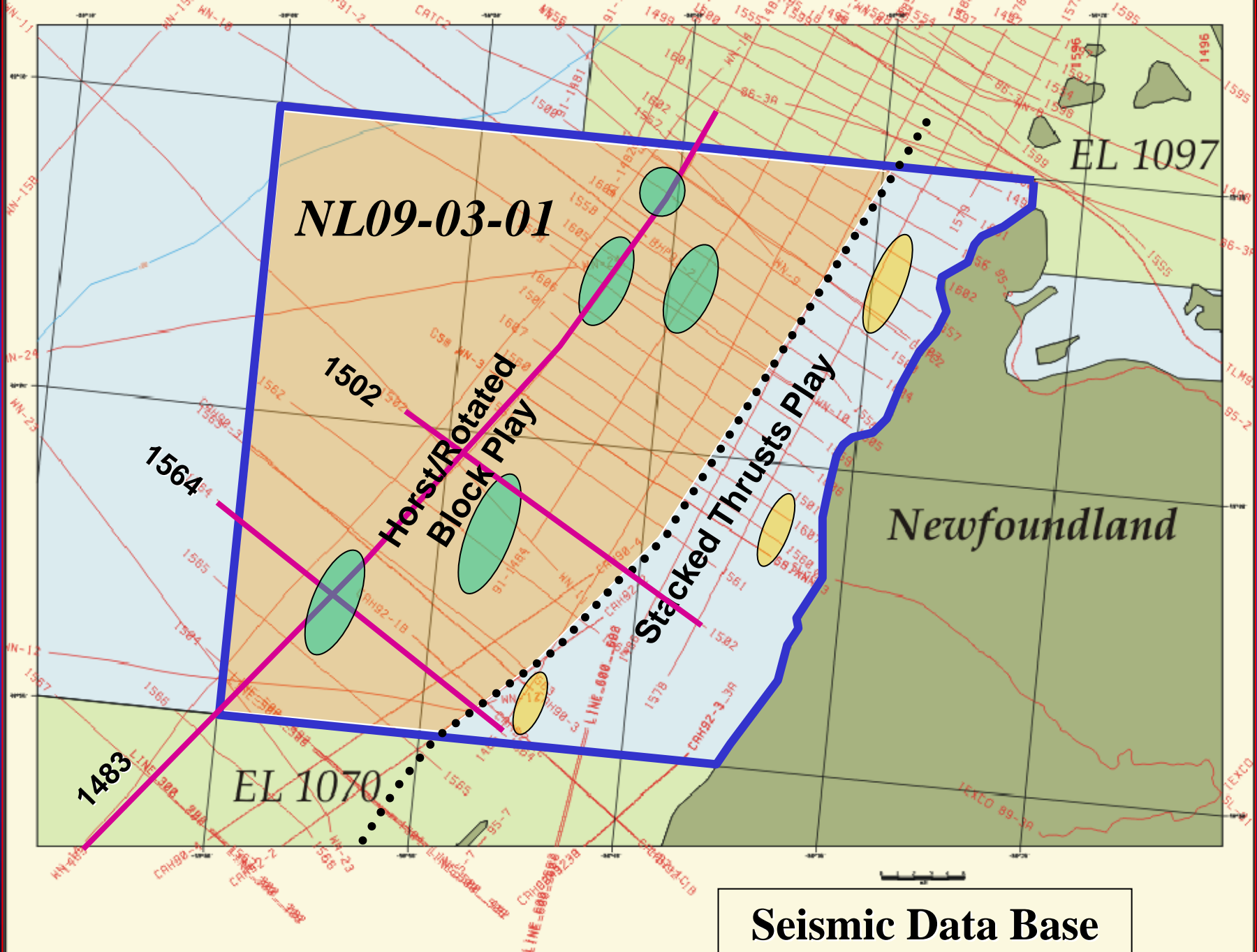


Interpreted strike seismic section 1483 within parcel NL09-03. The Carbonate Platform deepens toward south-west segmented by normal faults. Carbonate Platform is thicker toward northeast (line courtesy of of C-NLOPB ). Several horsts are mapped.

# Seismic Interpretation

- The horsts shown by the two dip seismic sections can be tested with a 2500 to 3500 m drillhole
- Other Carbonate Platform targets are rotated blocks visible on both sides of the large horsts or situated closer and immediately under the Triangle Zone overthrust wedge
- Trapping possibilities also exist within the thrust sheets forming the Triangle Zone, where HTD reservoir and source rocks should be present. Seismic data quality on this line allows the mapping of individual thrust sheets. However pre-stack depth migration and new acquired data is needed to better delineate Triangle Zone traps
- Depth to the top of the Carbonate Platform in the parcel varies from 2 km in the northwest to about 4 km in the southeast





**Seismic Data Base**



# Prospects and Leads

- Area's main hydrocarbon play is structural; it involves porous Lower Paleozoic carbonates, dolomites or sandstones (Goose Tickle Sandstones & Limestone, Aguathuna Fm, Watts Bight, Catoche Dolomite and various Lower Paleozoic clastics) within large fault bounded highs. This play may have a stratigraphic component
- A half dozen fault dependent closures can be mapped within the Parcel; closures are capable of holding several hundred million barrels of oil or several tcf of natural gas
- Overlying Silurian-Devonian sandstones provide secondary targets
- Source rocks may be found in the synrift sequence above the Grenville basement, in the shales and carbonates and within organic shales contained in the flysch and overthrust sequences of the structural front
- Seismic amplitude variations are seen in the Lower – Middle Paleozoic sequences. The variation of seismic amplitude along the Carbonate Platform markers and amplitude anomalies around faults may indicate flow of hydrothermal solutions and dolomitization

# Prospects and Leads

- Good seals such as tight sandstones and carbonates, and shales are present in the parcel
- Several large petroleum leads within the Carbonate Platform were mapped by Mobil Oil in the early 1990s
- A Mobil seismic interpretation report and annexed time structural and isochron maps at several horizons for area including CFB NL09-03, is available from the C-NLOPB archive and can be inspected and copied for bid evaluation
- Mobil relinquished its offshore ELs without developing the leads into prospects and without drilling any of them
- Main geological risks on this parcel are the quality of the reservoir and access to sufficient source rock. These risks should be mitigated by the large size of the structural traps identified in this parcel

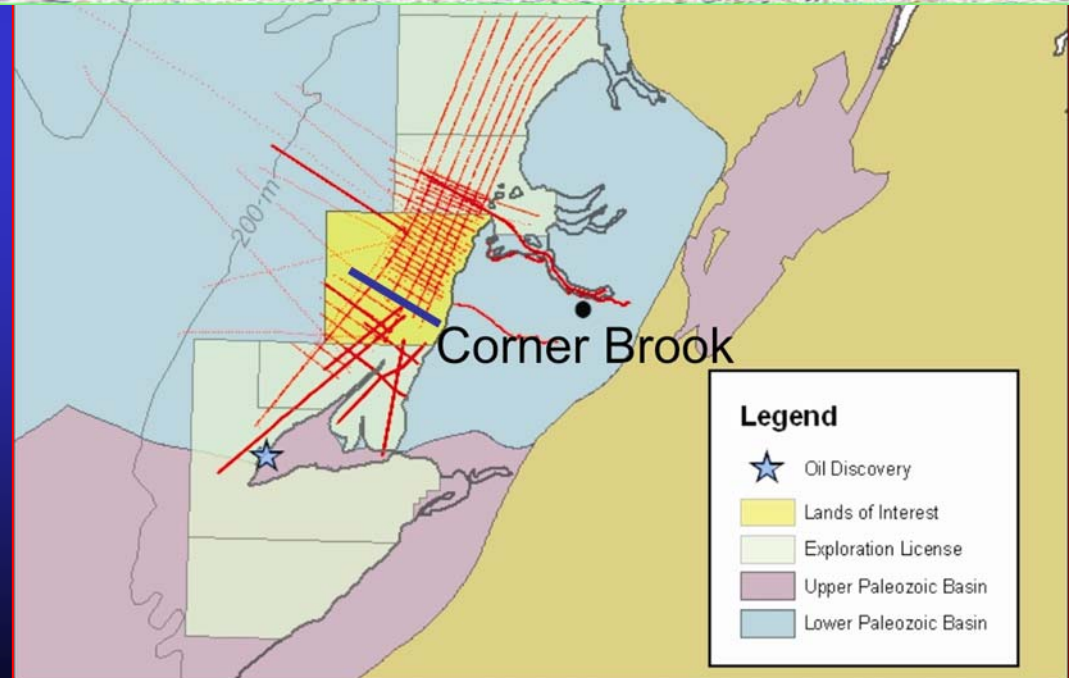
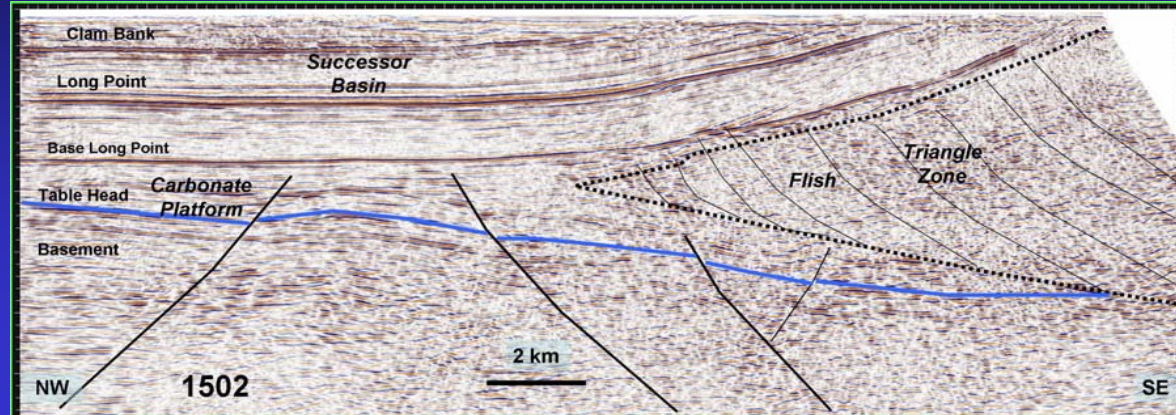
# Prospects and Leads

- Ptarmigan Resources Ltd. of St John's, NL was the representative of the now-expired EL 1069 during 2002-2007 ( extended to 2008)
- Ptarmigan mapped four prospects within the Ordovician Carbonate Platform in the Foreland Basin, and farmed out the drilling to Tekoil
- Ptarmigan also mapped two prospects in the hanging wall of the regional main thrust, comprised of the same Ordovician carbonate reservoir systems
- Martin & Brusset Associates (MBA), provided Ptarmigan with a risked economic assessment of the prospects. Using a Monte Carlo simulation MBA modelled the range of possible outcomes
- The risked Estimated Ultimate Recovery (EUR) potential of the six combined prospects associated with Ptarmigan's acreage was 67 mmstb (million standard barrels "oil") for the low case, 256 mmstb for the best case (most likely) and 463 mmstb for the high case
- Assuming the same reservoir parameters, this translates into 377 bcf to 2.5 tcf unrisked reserves of natural gas. If one lowers the porosity and permeability values which is the norm for gas reservoirs, the leads can contain even higher resources than introduced above



# Large Prospects not Drilled

- A well location, Glori E-67, was selected in the fall of 2008 for drilling onshore-to-offshore to minimum 2,000 m TD, but due to financial problems, Tekoil did not drill this location
- A 2008 planned 3D seismic program over some of the prospects and leads was also cancelled
- Therefore the EL was relinquished as it was not drilled in Period I according to C-NLOPB current land tenure regulations and it is now offered for CFB NL09-03



# 6. Discussions

- Anticosti Basin is close to industrially developed regions of Central Canada, Eastern United States and Western Europe
- However, exploration in the Gulf of St. Lawrence region is still at a very early frontier stage
- Numerous oil and gas prospects and leads identified with modern seismic data are still waiting to be explored and drilled
- Good 1990s regional 2D grid exists over the Newfoundland's Anticosti Basin but the seismic data needs reprocessing
- First dense 2D (exploration 3D) seismic survey carried out in the ELs 1098 and 1103 during 2008 is available as speculative data from GSI of Calgary
- Eight ELs are active offshore Newfoundland, some of them close to surrender if no wells are drilled in the next 1 to 3 years
- Parcel NL09-03 is located in the Anticosti Basin and includes the foredeep and the Triangle Zone of the Appalachian Foldbelt

# Discussions

- McCully field, in New Brunswick (about 1 tcf gas in place) and the recent Haldimand oil discovery in Quebec provides encouragement
- Large gas discoveries in Ordovician carbonates have also occurred offshore Labrador (Gudrid – 924 bcf recoverable, Hopedale – 105 bcf recoverable), with flow rates of up to 28 mmcfd
- Gas discoveries in similar rocks within the USA north-eastern basins and Quebec's St. Lawrence Lowlands in the past decade also provide reason for optimism for a similar strike in Western Newfoundland
- CFB NL09-03 Parcel is very large when compared with a Gulf of Mexico standard block (60 times larger) or Grand Banks offerings
- Parcel is in a region with large extensional and compressional traps, known reservoirs, mature source rocks and proven migration paths
- Risks are recognized in regard to reservoir quality and continuity and the preservation of traps since Paleozoic time
- Parcel contains multiple reservoir targets within Paleozoic carbonate and sandstones reservoirs at 2000-3500 m that can be tested by using jack-ups or semi-submersible rigs



# Discussions

- Risks are recognized in regard to reservoir quality and continuity and the preservation of traps since Paleozoic time
- Offshore prospects have fully risked recoverable resource estimates of between 100 to 200 million barrels (Atkinson and Wright, 2006) and 1 to 3 tcf
- New mapping with reprocessed and newly acquired data may lower the geological risk
- Location of prospects in a shallow water environment with less severe climate certainly lowers the economic risk
- Seismic identification of porosity and gas filled porosity within older carbonate sequences can be challenging but it is occurring in areas such as New York State and the Western Canadian Sedimentary Basin
- Geological risk associated with the Paleozoic is considered higher with regard to hydrocarbon migration, oil biodegradation, and lateral seal
- This risk can also be minimized by regional evaluation, dynamic modelling of the petroleum system, and the use of high quality seismic data, which can allow for the direct detection of porosity and fluid type
- Onshore deep wells planned for 2009-2010 in Western Newfoundland will provide additional valuable information for the Parcel NL09-03

# Discussions

- Metocean conditions are fair; the ocean has a one-year ice cover for about 3 months (February to early May)
- Cost of an offshore well in the Gulf of St. Lawrence would likely be in the range of Can \$20 - \$30 million depending on the water depth, depth to the target and distance from shore
- Fields can be developed using tie back to shore processing facility, gravity based structures, bottom founded caisson, sub-bottom completion with FPSO (*Atkinson and Wright, 2006; Wright, 2007; Klassen, Foote 2008 and 2009; Hicks, 2009*)
- Royalty regime is well established and places offshore NL in the middle to upper tier of world's favorable areas for petroleum exploration and production.
- Canada is one of the countries with the most stable political and financial system and has a long tradition in oil and gas exploration
- The Province obtains 36% of the nominal GDP from the oil and gas industry and is actively encouraging exploration of offshore areas and especially Western Newfoundland



# 7. Conclusions



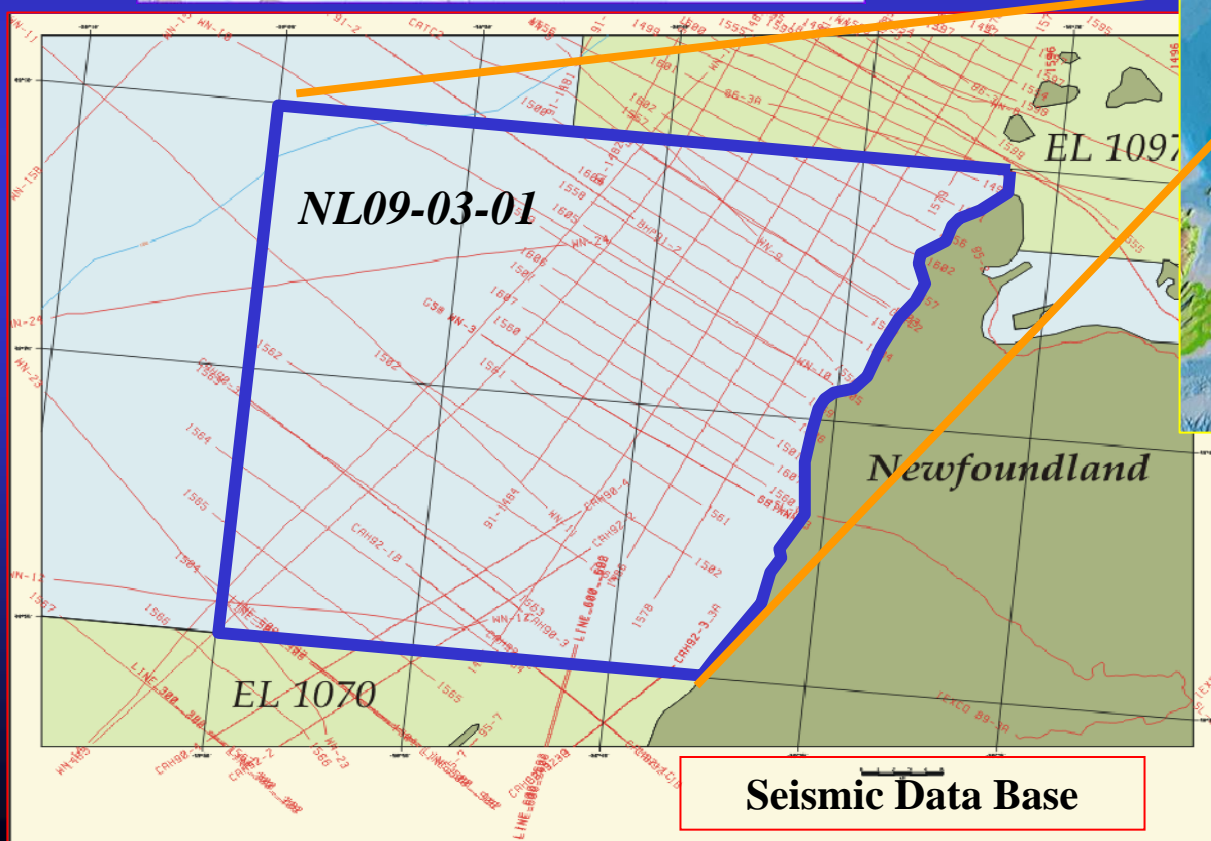
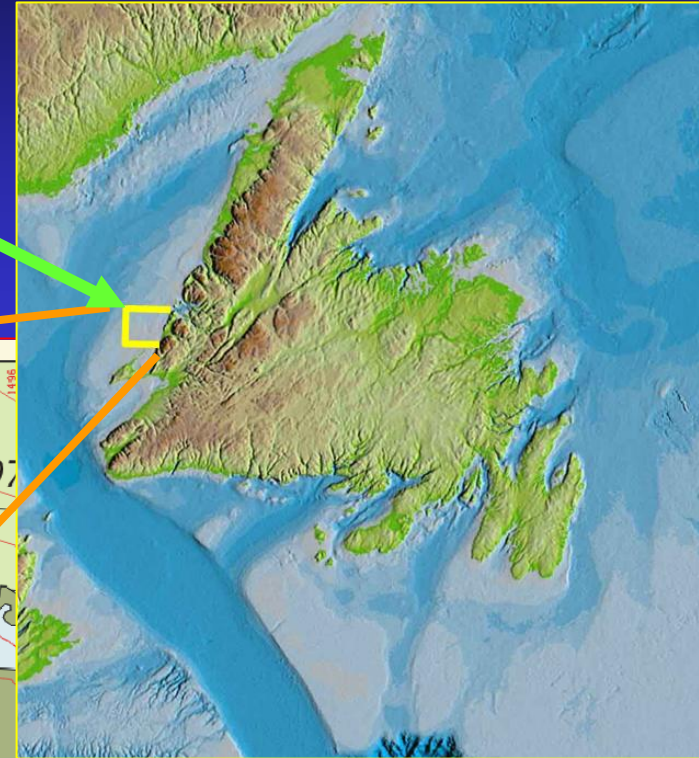


# Conclusions

- One large parcel located offshore Western Newfoundland, at the approximate latitude of the town of Corner Brook is available for licensing in the C-NLOPB's **Call for Bids NL09-03** which closes on **November 19, 2009, 4 p.m. NL time**
- Parcel contains Cambro-Ordovician Carbonate Platform rocks of the Anticosti foredeep basin and formations of the Appalachian fold and thrust belt
- This basin has all the prerequisites to become an important petroleum province
- Carbonate sequences of similar age and setting were found to be productive elsewhere in the North American Appalachian trend
- Closer to the landsale area, carbonate rocks flow-tested oil and gas at the Port au Port #1 discovery well (presently known as Garden Hill Field)
- Large fault-bounded blocks such as horsts and tilted blocks, at the Cambrian and Ordovician Carbonate Platform levels provide sizable targets on the offered parcel. Platform sequence is overlain by predominantly clastic sequences of the Long Point and Clam Bank groups which may provide additional reservoir potential. Additional targets may be found within the overthrust Ordovician sequences, part of the Triangle Zone that forms the easternmost part of Parcel 1

# Conclusions

- Main source rock for the area is the Green Point shale located within the thrust sequence. This shale may provide lateral charge to the foreland basin structures and a more direct charge into the thrust sequences
- Other potential source rocks such as the autochthonous Cape Cormorant/Black Cove and the McCasty shales are likely to be present in the foreland basin. Both source and reservoir rocks may exist within the synrift sequences present under the Cambro-Ordovician Carbonate Platform
- Good quality and relatively dense 2D seismic coverage is available in the parcel to image and map hydrocarbon traps within the platform and overthrust
- Using existing seismic grid, four large leads were mapped on the platform and two leads were contoured in the Deformation Front, by previous acreage owners. Other leads were identified, but due to lack of coverage could not be evaluated
- All these leads are located in water depth varying between 90 m and the coastline. Several leads are located at distances of 20 to 10 km from the shore line. Other leads are situated very close to the coastline
- The half dozen + leads located in Parcel NL09-03 are situated in a practically unexplored basin, but close to NE American and Canadian markets





# Conclusions

- Recognized risks in regard to reservoir quality and source rock are mitigated by the presence of very large undrilled features. Presence of an 80 square km (as exposed on land) exhumed oilfield on trend at Port au Choix with paleo-pay thicknesses of up to 100 m demonstrates the presence of a significant petroleum system that was likely charged from the east
- Seismic data indicates that reservoir and source rocks are preserved at depth in large rotated fault blocks within the foreland basin
- Drilling thus far both onshore and offshore has only occurred within the more disturbed rocks of the thrust belt while the essentially undisturbed rocks of the foreland basin have never been drilled offshore Western Newfoundland
- This parcel constitutes a very large exploration block situated in shallow water suitable for jack-ups and in an area where drilling can be performed year-round. Some drilling can be performed with deviated wells from land based locations
- Estimated sizes of unrisks reserves (up to half billion barrels of oil or several tcf of natural gas) that may be present in the NL09-03 structural leads strongly encourages the acquisition of this parcel and allocation of funds for new seismic data collection and exploration drilling in an underexplored basin

# Thank You for your Attention!

