



# OFFSHORE OPPORTUNITY - 2012 LICENCE ROUND

## CALL FOR BIDS NL12-01, LAURENTIAN BASIN, OFFSHORE NEWFOUNDLAND

### EXECUTIVE SUMMARY

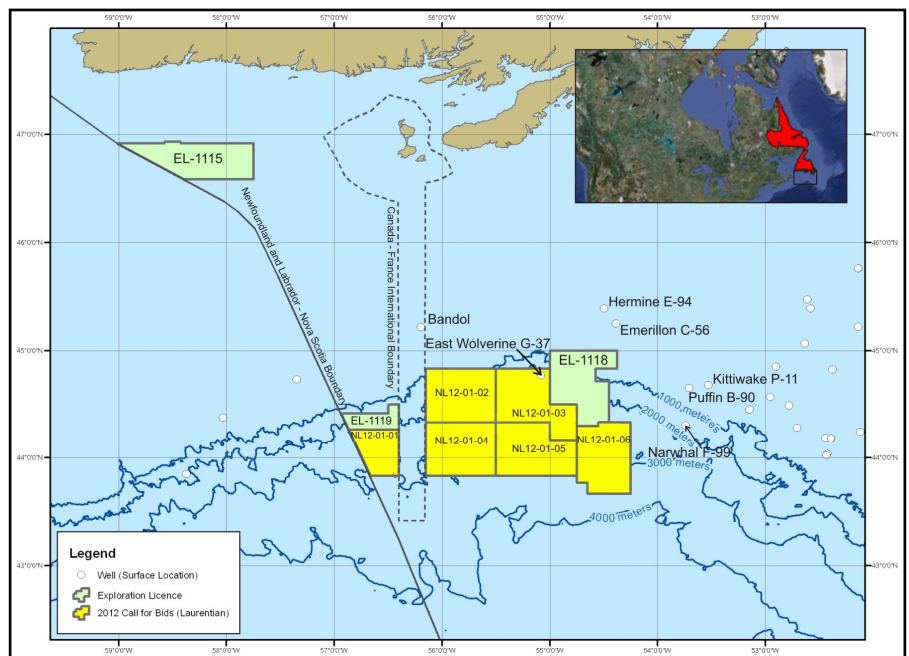
On April 5th 2012, the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) announced the 2012 Call for Bids for six parcels in the Laurentian Basin, off the south coast of the island of Newfoundland, Eastern Canada. This area is considered highly prospective for hydrocarbons, and represents part of the Scotian Basin, which will be the focus of increasing petroleum exploration activity in the immediate future. Despite good seismic coverage, the area remains hugely underexplored with only eight wells in the immediate vicinity. Bids are sought by November 1st, 2012 for this potentially prolific hydrocarbon region.

### OVERVIEW

Located on Canada's East Coast, the Province of Newfoundland and Labrador has sustained significant levels of industry interest in its highly prospective offshore and onshore basins. Since first oil in November 1997, the province's four producing fields of Hibernia, Terra Nova, White Rose and North Amethyst have produced in excess of 1.3 billion barrels of oil.

Hebron, expected to be the province's fifth producing field, is being designed as a Gravity Based Structure (GBS) with first oil expected in 2017.

With substantial undiscovered resources estimated at 6 billion barrels of oil and 60 trillion cubic feet of natural gas, the region holds great potential. Land available in the 2012 Call for Bids offers all explorers excellent opportunities for more significant discoveries.



LAURENTIAN BASIN, OFFSHORE SOUTHERN NEWFOUNDLAND, CANADA

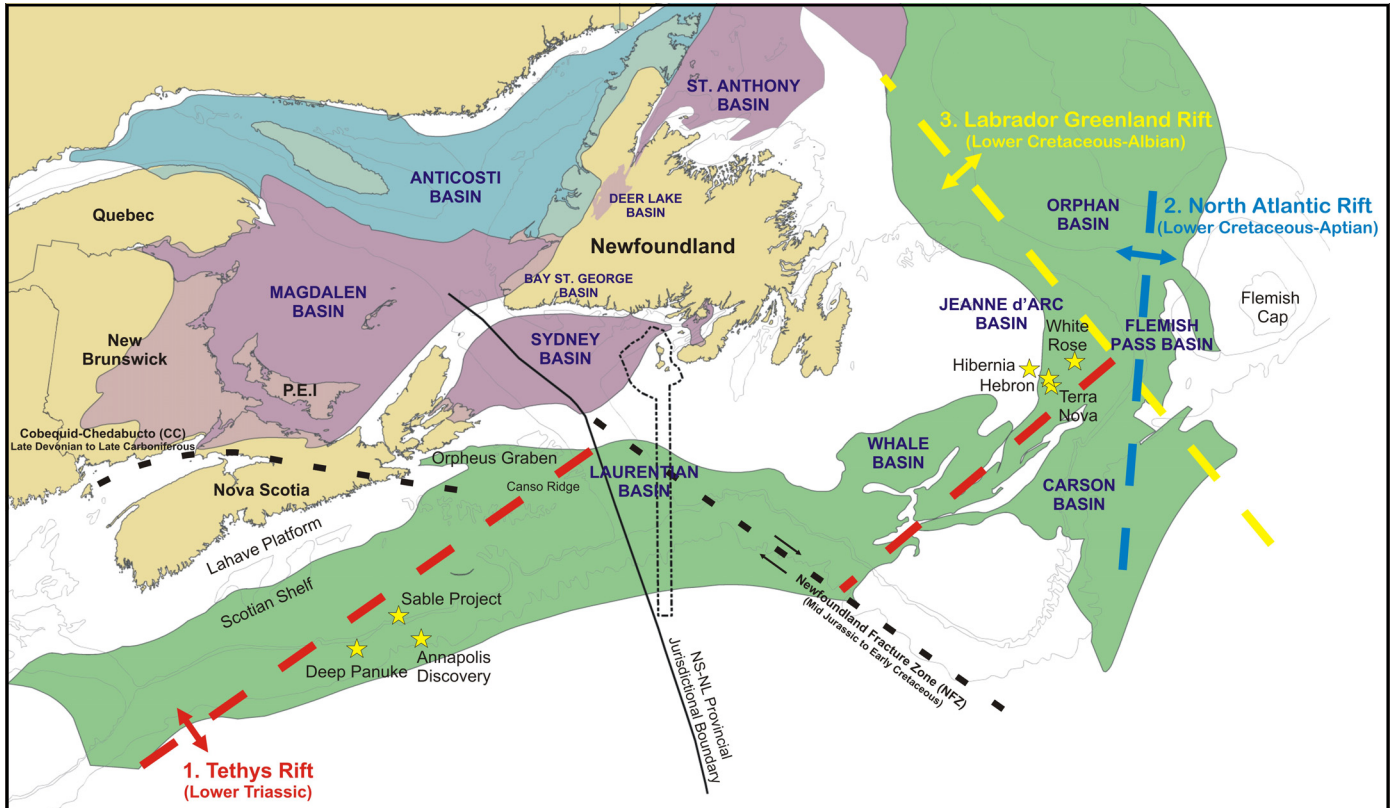
### KEY ATTRIBUTES

- Six large parcels totaling 1,589,738 hectares (3,928,328 acres or 15,897 km<sup>2</sup>). Parcel size ranges from 143,588 hectares (354,814 acres or 1,436 km<sup>2</sup>) to 296,530 hectares (732,742 acres or 2,965 km<sup>2</sup>).
- Located in intermediate to deep water of the Laurentian Basin, south of the island of Newfoundland. Water depth ranges from 480m to 3,750m.
- Competitive fiscal regime with very low political risk.
- Proximity to both North American and European markets.
- Open and transparent land management and bid processing system.
- Winning bidder granted exploration rights on work commitment basis.
- Deadline for submission is 4PM NST, November 1st, 2012.
- For more information, see [www.cnlopb.nl.ca/news/nr20120309.shtml](http://www.cnlopb.nl.ca/news/nr20120309.shtml).



## ATLANTIC MARGIN BASINS REGIONAL GEOLOGY

- The approximately 60,000km<sup>2</sup> Laurentian Basin is a Mesozoic extensional basin developed over stretched Precambrian and Paleozoic basement on the North American Atlantic Margin.
- Late Triassic to Early Jurassic rifting of Pangea created a chain of NE-SW oriented intracratonic basins extending from the Gulf of Mexico to the Barents Sea. Oblique and perpendicular rift branches (e.g. Bay of Fundy, Orpheus Graben, Aquitaine Basin, Viking Graben, Labrador Sea and others) were also formed during this series of tectonic events.
- In eastern Canada, the Tethys rift basin chain starts with the George's Bank Basin offshore New England, stretches through the Scotian shelf and slope basins and subbasins, and continues with the Laurentian Basin. The system continues NE with the shallow-water Grand Banks Basins before extending to the deep water Flemish Pass and Orphan basins, and likely branches into the Labrador Sea.
- In neighbouring Nova Scotia, the largest basins are situated on a plate margin setting which have been directly opened to the North Atlantic since the Middle Jurassic.



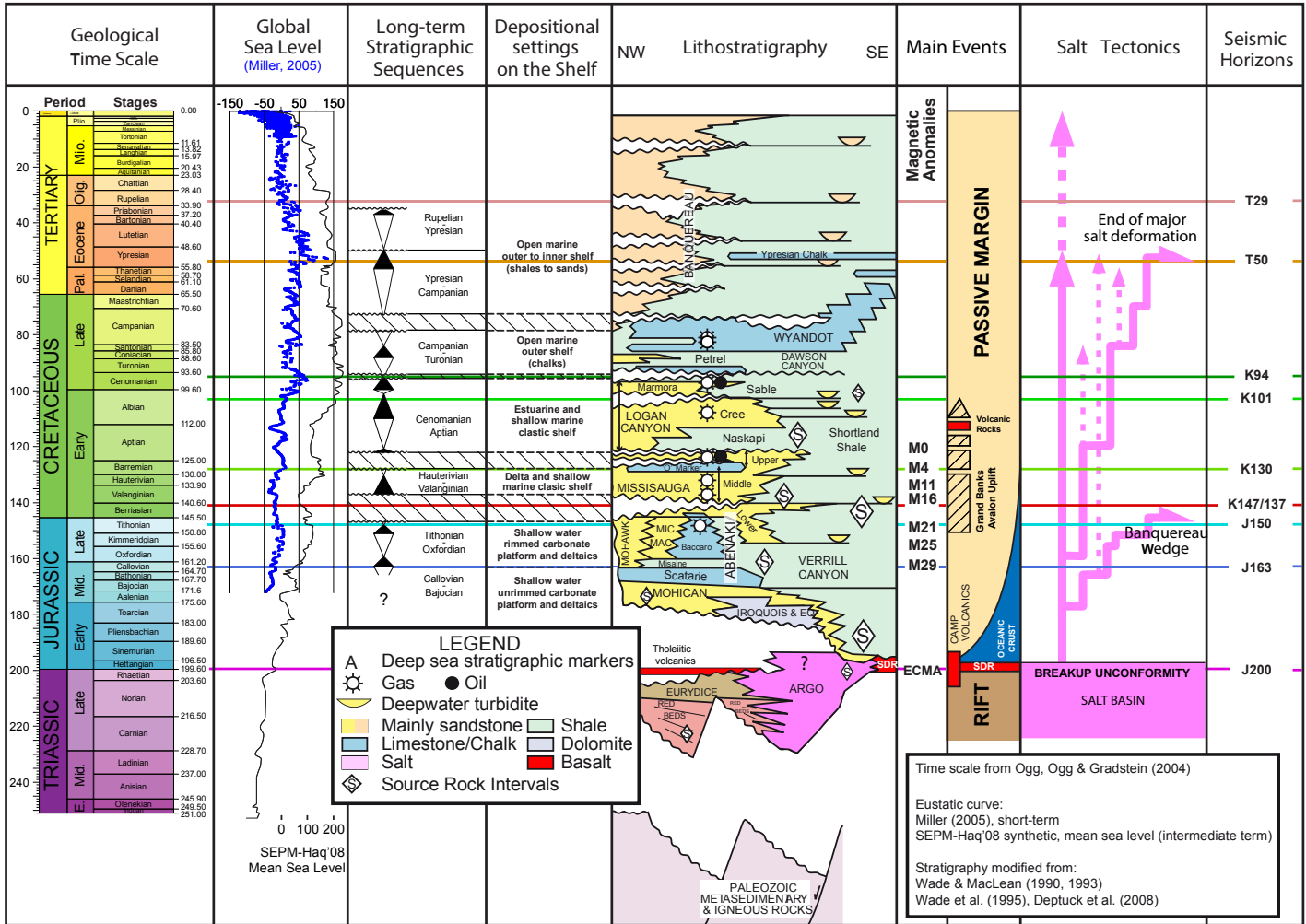
REGIONAL GEOLOGY OF THE CANADIAN ATLANTIC MARGIN, SHOWING MAJOR TECTONIC ELEMENTS

## LAURENTIAN BASIN GEOLOGY

- The Mesozoic-rifted Laurentian Basin represents the northeastern extension of the greater Scotian Basin, with which it shares a similar basin history. Specifically, the two areas share a common structural evolution and depositional regime throughout the Late Triassic to Middle Jurassic. The Laurentian Basin is separated from the predominantly Paleozoic Sydney Basin by a major basin-bounding fault/hinge zone.
- The Laurentian Basin is located close to, and largely situated upon, an important ocean/continent transform margin initiated in the Middle Jurassic and active into the Middle Cretaceous.
- Basin evolution was largely characterized by repeated intra-continental Mesozoic rift stages, intermediary rift episodes and post-rift thermal sag.
- In the Middle Jurassic - Early Cretaceous, the Laurentian Basin was situated on a transform margin undergoing extension, transtension and subsidence at the junction between the Nova Scotia margin and the continental crust of the Grand Banks of Newfoundland. The final rift became oceanic during the Middle Jurassic in the Scotian Basin to the SW and in the Middle Cretaceous (Aptian-Albian) in the Grand Banks to the NE.
- The northern basin boundary is formed by the east-west trending Cobequid-Chedabucto (CC) fault system and a branch thereof along the Newfoundland Fracture Zone (NFZ) transform fault system.
- Sediment deformation is mainly due to extension and salt movement. Inversion was a late-stage event in the region and is only a secondary mechanism for trap formation. Late Triassic to Early Jurassic salt is generally thick and pervasive.
- Deposition of coarse clastics was widespread, especially within deltaic episodes during the Late Jurassic to Early Cretaceous.

# LAURENTIAN BASIN GEOLOGY CONTINUED

- In the northern part of the basin, the Mesozoic - Cenozoic cover is thin and large Paleozoic compressional, extensional and transtensional structures can be mapped under the Prerift Unconformity.
- The northern basin margin was influenced by strike-slip movements along the CC fault system and its imbricates. A southeast trending, en echelon ridge and fault system is shown by seismic and potential field data.
- Further south, a large ridge (or alternatively a series of coalescing smaller ridges) trends roughly W-E near the modern shelf edge.
- Under the slope the prerift section drops off to greater depths. Large and complex Mesozoic structural and stratigraphic features are observed; a number of structures are salt cored.
- Jurassic sedimentary succession is anomalously thick in this basin when compared to other Atlantic Margin basins.
- The Bandol #1 well was drilled in 2001 on a shelf location and in French territory. While it was said to have found “hundreds of meters” of reservoir, the well remained confidential until summer of 2011. Despite this, no publicly released logs are yet available. Bandol #1 remains the the only existing well in the shelfal-inner slope part of the basin.



SCOTIAN BASIN STRATIGRAPHIC CHART, AFTER OFFSHORE ENERGY TECHNICAL RESEARCH ASSOCIATION, 2011

# LAURENTIAN BASIN: TWO GEOLOGICAL PROVINCES

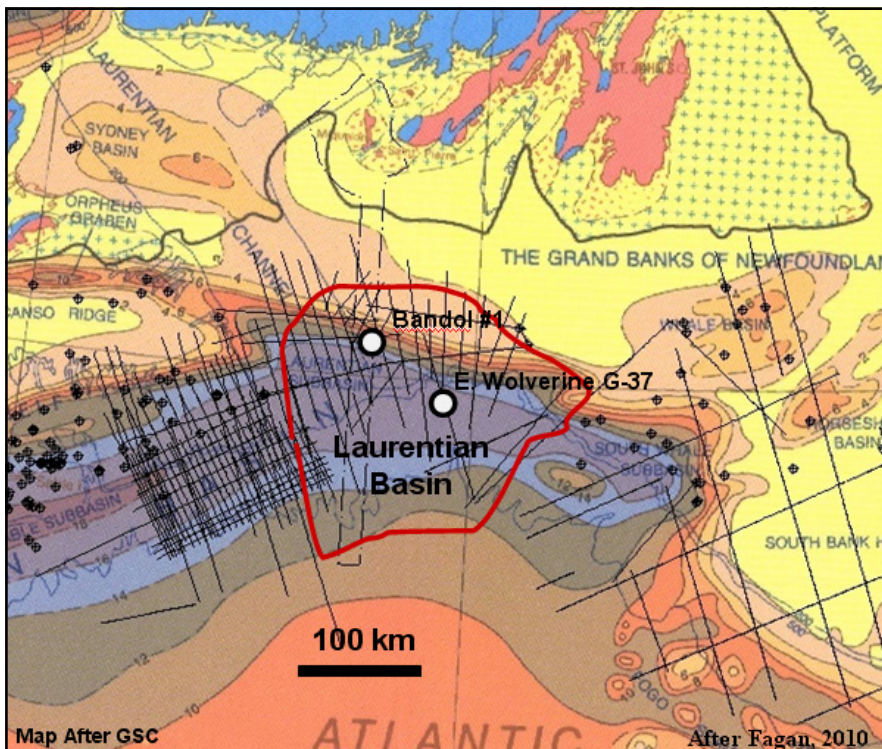
The Laurentian Basin can be divided into two distinct sectors:

- **Paleozoic Basin:** This sector is located north of an approximately W-E trending hinge line traced by a series of basinward-dipping faults that coincide with the CC fault system. North of the hinge zone there is a thin Mesozoic cover over a well-imaged Carboniferous sequence. The Mesozoic is in turn overlain by a Cenozoic wedge that thickens basinward from a zero edge. In this sector there are many large Paleozoic prospects and leads, some of which are salt-cored.
- **Mesozoic Basin:** This sector is located south of the CC fault system. This Mesozoic-dominated area south of the hinge zone is deep and complexly structured. The Mesozoic basin was formed by extensional tectonics during rifting of the Nova Scotian margin and during transtension along the NTZ. The Mesozoic to Cenozoic extensional structures in this area have been subsequently deformed by localized strike-slip movement, inversion, oblique extension and salt tectonism. A Carboniferous succession may be present under the deformed Mesozoic basin. This Mesozoic basin is where the current Call for Bids parcels are located, and contains large Jurassic and Cretaceous prospects and leads.

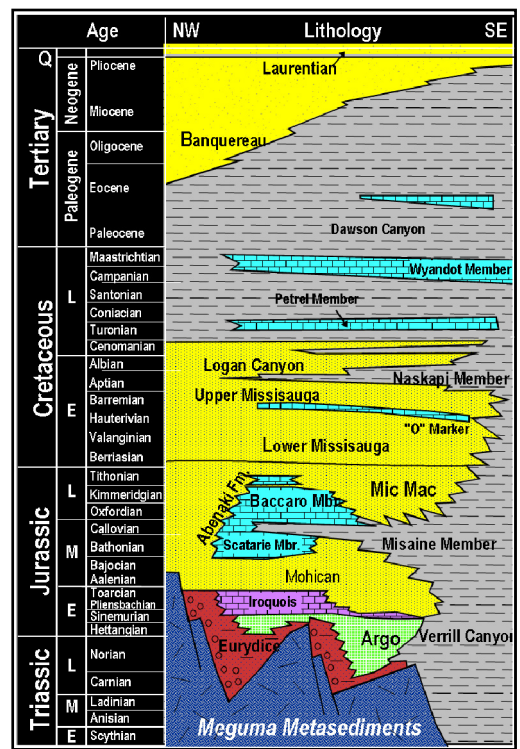


## PETROLEUM GEOLOGY: OVERVIEW

- As described earlier, the Laurentian Basin can be considered a part of the Scotian Basin which is a proven petroleum system for oil and especially for gas.
- Despite being adjacent to the producing Scotian Shelf area, the Laurentian Basin remained unexplored due to a long-lived exploration moratorium which has only recently been lifted.
- Basin infill consists of a structured synrift succession of coarse and fine clastics, carbonates and evaporites ranging in age from Late Triassic to Middle Jurassic. This was overlain by a Late Jurassic to Mid-Cretaceous (Albian) succession developed during the basin's transtensional stage, which is also structured by halokinetics. Finally, the Late Cretaceous to Tertiary section contains a relatively thick, parallel-bedded cover of mainly fine clastics and carbonates, representing the early thermal subsidence stage in basin evolution.
- The early basin fill contains the Triassic Argo Salt which later became mobile, creating intrusions and salt-induced structures in the overlying sediments. The Carboniferous Windsor salt also created deformation in the synrift sequence and basement.
- A multitude of hydrocarbon traps were formed during extension/transtension and prolonged salt tectonics.
- Reservoir rocks are present in all stages, although good quality clastic and carbonate reservoirs can be localized. The best quality sandstone reservoirs were encountered on the shelf in the Sable Basin. Thick reservoir sands were encountered in Bandol #1 and several wells near the basin.
- Oil & gas prone source rocks are present in the Late Jurassic. The potential for other source rocks is recognized in the Paleozoic, Early Jurassic, Early and Late Cretaceous and Early Tertiary sequences.



TOTAL SEDIMENT ISOPACH MAP WITH SELECTED SEISMIC COVERAGE



SCOTIAN BASIN LITHOSTRATIGRAPHY

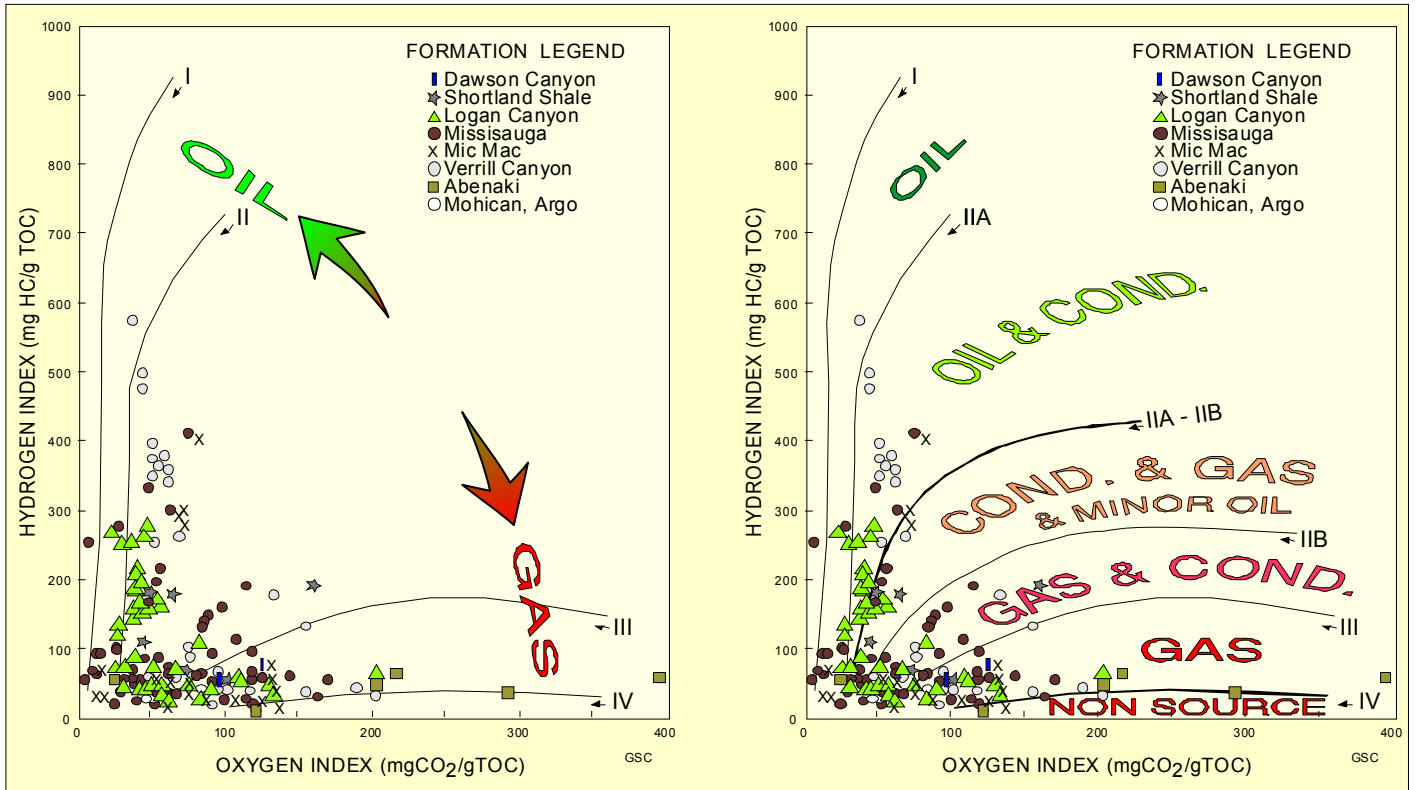
## PETROLEUM GEOLOGY: RESERVOIRS AND SEALS

- Reservoir rocks in the Scotian Basin are predominantly high-porosity/high-permeability sandstones of Late Jurassic to Cretaceous age. Similar reservoirs and turbidite sands should also be present in the Laurentian Basin, which is a major coarse clastics depocentre.
- Stacked sandstone intervals within the Jurassic Mic Mac and Cretaceous Lower and Upper Missisauga and Logan Canyon Formations are proven quality reservoirs. Most of these reservoirs are alluvial to deltaic on the shelf and slope.
- The targets in the area of interest are equivalents of these sandstones and deposited as turbidites, slope and basin floor fans, mini-basins, channels etc. They are situated either between salt swells or deformed by later salt movements.
- Good reservoirs are found in the Scotian Basin at the carbonate platform margin where reefal development took place. Porosities range from 3-40%, permeabilities from 1mD to several Darcies, with net pay ranging from 30-100m. This "Deep Panuke" type reservoir should be present in parts of the Laurentian Basin.
- The Early Tertiary sequence has a real and effectively untested potential for large oil & gas pools, especially in the deepwater area.
- Seals are expected to be abundant in the Laurentian Basin as the extensional, transtensional and thermal subsidence stages contain successions of very fine clastics and carbonates.
- Numerous good seal intervals were encountered in Scotian Basin wells. These petroleum accumulations are sealed by Misaine Mbr, Naskapi Mbr, as well as numerous intraformational seals. Excellent regional seals are provided by Dawson Canyon mudstones, and also by the "O" Marker, Petrel and Wyandot tight carbonates. The Argo salt also forms a perfect seal as hanging walls and canopies.

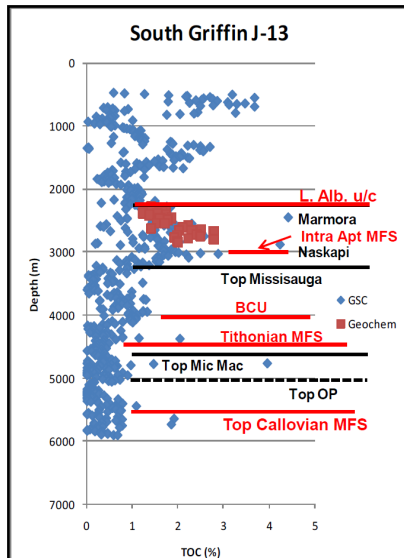
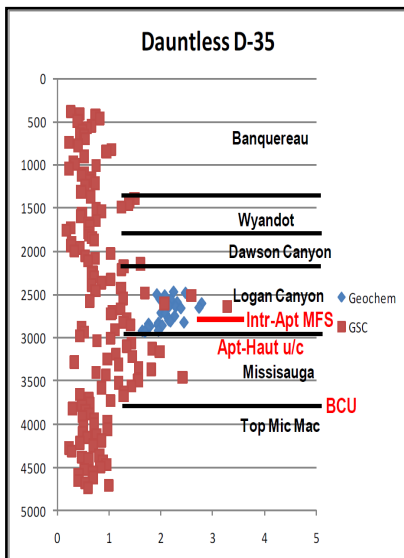


# PETROLEUM GEOLOGY: SOURCE ROCKS

- A recent \$15MM Play Fairway Analysis conducted in neighbouring Nova Scotia demonstrated the presence of abundant Type III and Type II source rocks. The study identified five source rock intervals that may be present in the Scotian Basin, including the Laurentian Basin of Lower Jurassic (Liassic) to Lower Cretaceous (Aptian) age.
- The most significant source rock is likely to be the Late Jurassic Verrill Canyon source rock. This unit is likely equivalent to the prolific Kimmeridgian source rocks of numerous Atlantic Margin basins, including the Jeanne d'Arc and Flemish Pass basins.
- Verrill Canyon source rock is mostly shale with 2-4% Total Organic Carbon (TOC). Basin modeling and geochemistry demonstrate that this source rock has generated most of the oil, condensate and gas found in the Scotian Basin to date.
- Predominant kerogen in the Verrill Canyon unit is type III and therefore gas-prone. However, there are oil fields and significant oil shows offshore Nova Scotia which indicate the presence of pockets of more marine type II, oil-prone source rocks. Several wells in this area encountered oil-prone, type II source rocks with an average TOC of 3%.



VAN KREVELEN DIAGRAMS OF SCOTIAN SHELF SOURCE ROCKS. AFTER MUKHOPADHYAY & WADE, PERS COMM



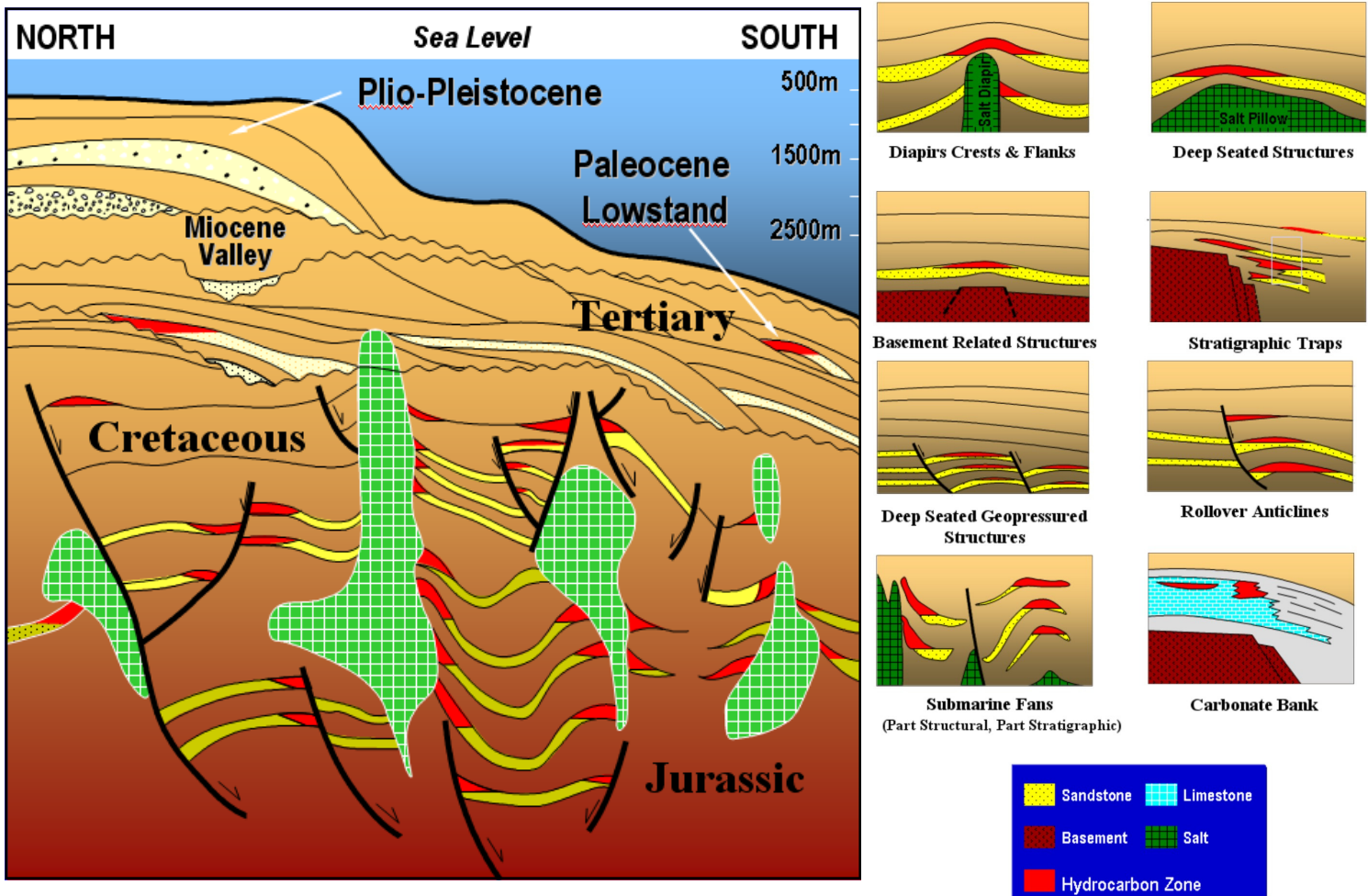
EXAMPLES OF TOC VS DEPTH, AFTER OETR 2011

## SOURCE ROCKS CONTINUED

- Within the Laurentian Basin there may be early postrift (Early Jurassic) minibasins that accumulated a marine oil-prone source rock similar to the Late Jurassic Essaouira oil in Morocco.
- Late Jurassic depressions that were isolated from the main ocean during transcurrent movements on the NFZ may contain Kimmeridgian (Egret Mbr) type II or type II-III source rocks.
- In some areas a Paleozoic source rock (similar to sources in the adjacent Maritimes Basin) may also be a contributor to gas generation.
- Light oil has been encountered in reservoirs in Scotian Shelf wells and produced at the Cohasset-Panuke (COPAN) project. Other wells have intersected oil-filled beds.

## PETROLEUM GEOLOGY: TRAP STYLES

- Structural traps in the Laurentian Basin are associated with rifting of the Atlantic Margin, transtension and inversion, subsidence/tilting and halokinesis of the Argo Salt.
- Main structural trap types are extensional anticlines, rollovers, faulted anticlines, faulted/tilted blocks and elongated horsts.
- Numerous salt-induced structures such as pillows, domes, diapirs, ridges, allochthonous “teardrops”, turtle anticlines and salt canopies are common.
- The main CC fault and its associates are strike-slip faults and serve as the northern boundaries to the basin. Several ridges and anticlines are mapped along this major lineament.
- The great majority of faults in the basin are down-to-basin listric normal faults, but some transfer faults form horsts, ridges and trap-door features.
- Local inversion due to transtension and halokinesis is also a trap-forming mechanism.
- Stratigraphic traps are widespread. Paleo-valleys, basin margin and basin floor fans are abundant in the Scotian Basin and contain some discovered resources.



LAURENTIAN BASIN PLAY CONCEPTS AND TRAP STYLES, AFTER HOGG ET AL 1999

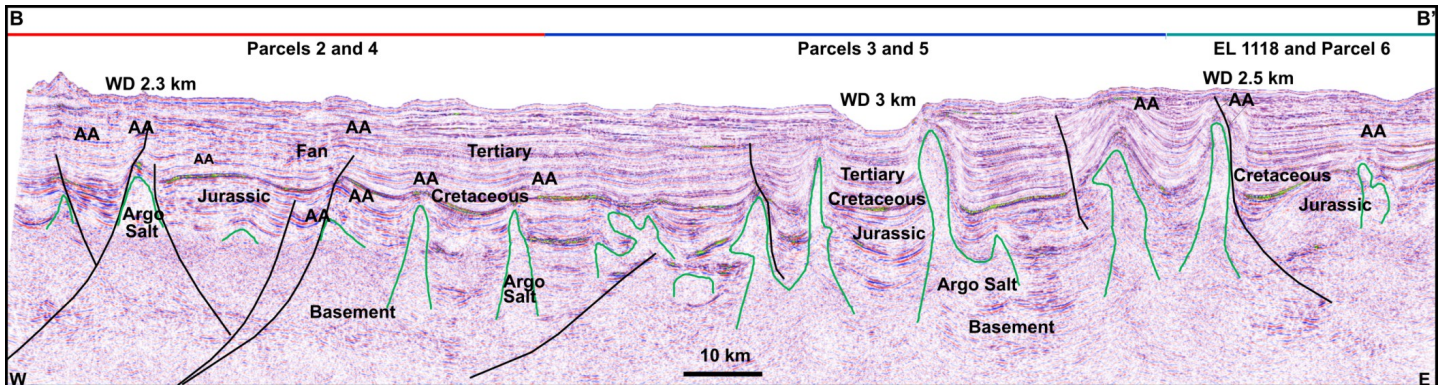
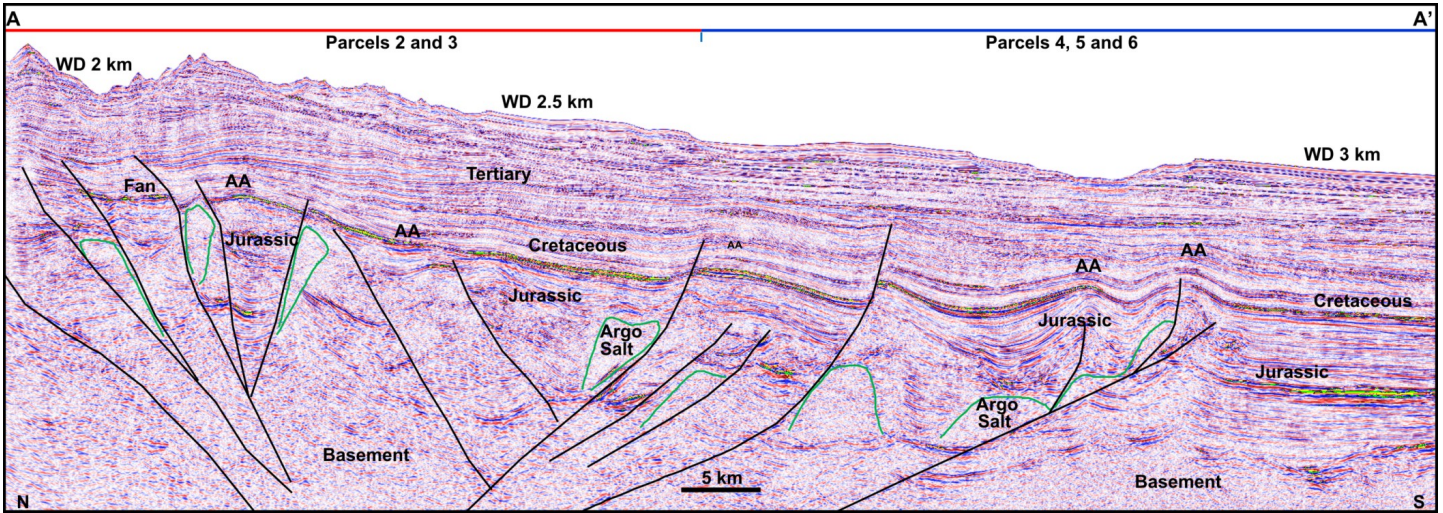
## PETROLEUM GEOLOGY: PLAYS

- Multiple play types are conceptualized in the deepwater Laurentian Basin. They include large structural fault-bounded closures, salt-induced anticlines, structural/stratigraphic salt-related rollers and mini-basin traps, Cretaceous fans, Tertiary lowstand submarine fans and channel complexes, salt wall stratigraphic traps and deep subsalt plays.
- Conventional plays that exist in the greater Scotian Basin and expected implicitly in the Laurentian Basin include:
  - 1) Late Jurassic Mic Mac Sandstone,
  - 2) Early Cretaceous Lower and Upper Missisauga Sandstone, and
  - 3) Late Early Cretaceous Logan Canyon Sandstone.
- These plays are formed by the above reservoirs trapped in roll-over anticlines, listric fault bounded blocks, multi-fault closures, salt-cored anticlines, and drapes over salt pillows or basement highs.
- Late Jurassic to Cretaceous and Early Tertiary lowstand clastics are expected to have significant play potential on the slope and upper rise.

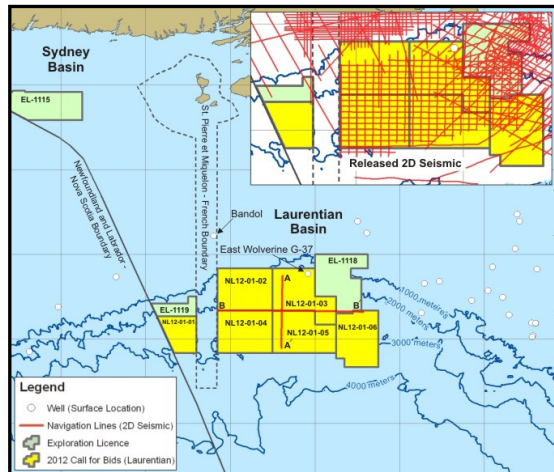


# SEISMIC AND WELL DATA

- Good to excellent seismic coverage exists for parcels 2 to 6, however parcel 1 has poor coverage.
- Seismic quality is excellent in the Late Jurassic to Tertiary sequence but deteriorates from the Late Jurassic to Late Triassic interval.
- High quality regional seismic markers such as carbonate intervals within clastics and widespread unconformities exist. Good local markers are also easily mapped. Main and secondary faults are readily traceable, and salt walls/welds are well imaged in places.
- Five wells have been drilled offshore Newfoundland within or on the margins of the Laurentian Basin: Hermine, Emerillon, Lewis Hill (shallow water), Narwhal and East Wolverine (deep water). Two significant wells were drilled offshore Nova Scotia in the vicinity of the basin, Dauntless (shallow water) and Tantallon (deep water).
- Bandol was drilled in the French territory on the shelf in the central Laurentian Basin. Little has been reported on this well except that it encountered thick reservoirs in the Late Jurassic - Early Cretaceous section.
- Deep wells encountered Verrill Canyon source rocks that were only marginally mature in the shelfal area, although shows were encountered and gas sands were present in Tantallon. These well results point toward targeting exploration in deeper basinal areas, where source rocks may be mature and geophysical anomalies may indicate sand fairways and/or the presence of hydrocarbons.



SELECTED SEISMIC LINES A-A' AND B-B' AS SHOWN ON LOWER LEFT MAP, SOURCE C-NLOPB



Well	Drilled	WD m	Status	Location	TD m	Prerift unc	TD in	Reservoir	Source rock
Hermine E-84	1971	87	Aband	Grand Banks shelf	3267	1636 m	Carboniferous Windsor Salt	No	Not penetrated
Emerillon C-56	1974	120	Aband	Grand Banks shelf	3277	3118 m	Carboniferous Windsor Salt	Eider 1786 m Mic Mac 2088 m	Not penetrated
Dauntless D-35	1971	119.5	Aband	Nova Scotia shelf	4741	No	Mic Mac Fm	Yes	Interpreted
Bandol #1 French Territory	2001	119	Aband	On shelf in Laurentian B	4046	Not Available			
Lewis Hill G-85	2003	100	Aband	In S. Whale Basin	3218	2779 m	Missisauga	Yes	Not penetrated
Narwhal F-99	1987	1577	Aband	Grand Banks South Slope	4585	4491 m	Basalt	No	Yes
Tantallon M-41	1986	1516	Aband	Nova Scotia slope	5602	No	L Missisauga-Verrill Canyon	L Missisauga Gas sands	Yes
East Wolverine G-37	2009/10	1890	Aband	In Laurentian Basin	6957	Under Confidentiality			

SIGNIFICANT WELLS IN VICINITY OF CALL FOR BIDS BLOCKS

## INFORMATION AND CONTACTS

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## MANDATE AND ROLES

The Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) is mandated to apply the provisions of the Atlantic Accord and the Atlantic Accord Implementation Acts to all activities of operators in the Newfoundland and Labrador Offshore Area. Their role is to facilitate the exploration for and development of the hydrocarbon resources, including effective management of land tenure, in a manner that conforms to the statutory provisions set out in the Acts. As offshore regulator and administrator for the Call For Bids, the C-NLOPB are the primary contact for participation in this resource opportunity. They operate a registry to record exploration, significant discovery and production licences and information related to these interests for public review. They are also the curators of all geoscientific data pertaining to the Newfoundland and Labrador Offshore Area. The C-NLOPB has no active role in promotion of the Province's hydrocarbon resources.

The Government of Newfoundland and Labrador, Department of Natural Resources, is responsible for providing marketing and promotional services to foster the exploration, development and production of the Province's hydrocarbon resources. It is also responsible for promoting the maximization of fiscal and industrial benefits through the negotiation, development, administration and monitoring of petroleum project agreements and legislation.

