

Profile

Issue 3
Spring 2011

OETR Offshore Energy
Technical
Research
Association

Play Fairway Analysis

A Study of Nova Scotia's
Offshore Basin

www.offshoreenergyresearch.ca

Play Fairway Analysis: Creating a New Understanding of Nova Scotia's Offshore Petroleum Potential

In this issue of 'Profile' OETR Association (OETR) is pleased to present information on the roll-out of the OETR Play Fairway Analysis (PFA) Program. The following pages discuss results from the now complete analysis, final review meetings including the industry review that took place in Paris, France, as well as presentation of the research through a peer reviewed special edition journal.

PFA Key Results

All technical components of the PFA have been completed and include science and technical integration and analysis completed by Beicip-Franlab. The project has resulted in some profound results and has identified significant hydrocarbon potential offshore Nova Scotia. This potential has diverse characteristics and scale, which is described further in the following pages. In present day shallow water there is a substantial opportunity in mostly small-scale traps with potential for both oil and gas.

The PFA has also identified and mapped large-scale potential traps that could contain gas, condensate and/or oil. Large-scale gas/condensate opportunities exist along the North Eastern part of the margin in deep water. It is predicted that there is a primarily oil charged play in the South West of the margin.

Specifically, there are four important conclusions to share; three address the geological risk and the fourth conclusion concerns the potential for hydrocarbon volumes. These outcomes are discussed on the following pages.

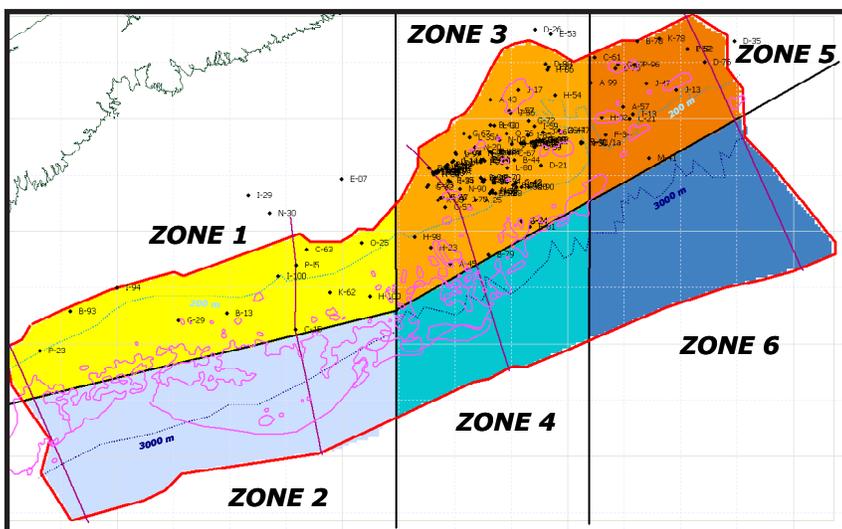


Figure 1: Nova Scotia Play Fairway Zones

Note: Purple lines indicate diapirs contours within Jurassic layers.

Source Rocks

The distribution of existing hydrocarbon production is confined to the Sable sub-basin. Previous analysis of the source rocks penetrated and the discovered hydrocarbons suggested that the hydrocarbons were locally sourced (associated with early Cretaceous deltaic sequences). The PFA has developed a model that shows the potential for a more regional Lower Jurassic source rock that extends beyond the Sable sub-basin and underlies the whole margin. The presence of this regional source rock is confirmed by isotope and molecular analysis of the oils discovered in piston cores taken along the length of the margin. Analysis of these oils proves the presence of a distinct separate regional source rock. The presence of oil in the piston cores suggests that the source rock is oil prone in the Western half of the Scotian margin. The eastern half is gas dominated, as demonstrated by the existing production (although there is an oil story in the Sable sub-basin as well).

Reservoir Rocks

The presence of reservoir rocks in the Sable area is proven; however, predicting their extent away from the core production areas is a problem. To address this, a detailed sequence stratigraphy, along with seismic analysis, has developed predictive models for four reservoirs that form the main play fairways for the margin:

- Mic Mac Upper Jurassic Delta sequence in the North East of the margin;
- Abenaki Carbonate Bank forms the reservoir for the Deep Panuke field. This reservoir extends to the west along the 'shelf edge'. A carbonate special project is developing a theory that predicts fluid phase and rock type using seismic attributes;
- Two Lower Cretaceous Delta sequences are the producing reservoirs in the Sable sub-basin. The PFA has developed a

model to predict reservoir/seal distribution in the Sable region itself, and with the use of sediment distribution models combined with seismic attributes, can predict reservoir into the deep offshore.

These four play fairways are proven in the PFA's new source rock model. In addition to these plays, the PFA has identified untested reservoirs in the Western part of the basin in the area of the oil prone source rock. These include:

- The offshore extension of the Middle Jurassic Mohican delta in the Albatross/ Shelburne region.
- Mid Jurassic carbonate oolite reservoirs that were found in the Shelburne well.
- Upper Jurassic and Lower Cretaceous delta sequences have been identified on Georges Bank. These shed sediment that could form reservoirs in the Southwest area of the margin (in the area outside the moratorium zone).

Petroleum Systems Modeling

The 3D petroleum systems model identifies target areas by determining source rock type and maturity at the present day. The following two statements can be made as a result of this modeling:

1. The Lower Jurassic source rock is generating oil today in the Southwest part of the margin. In the Eastern part of the margin it is generating gas which could have sourced the Deep Panuke gas reservoir (oil generation occurred before the Deep Panuke reservoirs were sealed).
2. The main source rocks for the Sable sub-basin fields is the upper Jurassic Tithonian sequence and is in the gas window today. The basin shallows at the margins and in the shallow region of the basin, the source rock is in the oil window. Therefore, there is the potential for

an oil rim around the Sable delta. Evidence for this is provided by the Cohasset and Penobscot oil discoveries and oil shows in wells to the North East of Sable. This is a credible oil play, which exists in shallow water and is under-explored.

Yet-to-Find and Prospect Sizes

The confident identification of two source rocks enables an assessment of the volumes of hydrocarbons generated. Although the work is not complete, the indications are that multi TCF/Billion barrels of hydrocarbons have been generated. The potential of offshore Nova Scotia could be three times previous estimates; there may be upwards of 121 Trillion Cubic Feet (Tcf) of natural gas and 8.15 billion barrels (Mbb) of oil (see Figures 1 & 2). However, more technical assessment is required to quantify these findings prior to the release of the PFA atlas. We do know that the volumes of generated hydrocarbons are substantial and sufficient to fill the several large structures that can be seen on the seismic data.

These large numbers, along with the diversity of the opportunity set, makes Nova Scotia of interest to a wide range of oil companies. Combined with the proximity to the world's largest market and the political stability of a G8 nation, this makes offshore Nova Scotia a very valuable investment opportunity for the oil industry.

Industry Review

Part of assessing the PFA's quality and standard of science was to implement a

thorough review by industry experts. An industry workshop was held in Paris, France over a two day period in late January, 2011, where five leading international exploration companies conducted an external review of the PFA. The results of the work to date, including integration of the projects, was presented to industry for evaluation of preliminary findings.

Company representatives deemed the science within this PFA to be of excellent quality and critical to telling the story of Nova Scotia's offshore. In particular, reviewers noted that the PFA has brought a wide range of material together to make a compelling case. The industry review process concluded that the scientific and technical work has been delivered at a standard that would be performed by a super-major oil and gas exploration company. OETR is confident that the PFA research is of world-class calibre and that it is poised to become an invaluable exploration tool to inform, attract and retain explorers.

As well as offering praise for the high quality work completed, the industry reviewers also identified some important areas needing attention such as ensuring the geological mapping, well failure analysis and geochemistry are more tightly tied to revised sequence framework and seismic mapping. Since the

By ZONE	TOTAL GAS volume in surface (Tcf) IN PLACE UNRISKED	TOTAL OIL volume in surface (Mbb) IN PLACE UNRISKED	TOTAL OIL EQUIVALENT volume in surface (Mbble) IN PLACE UNRISKED
ZONE 1	14	2470	4400
ZONE 3	35	1130	6300
ZONE 5	27	1650	5500
ZONE 6	26	1090	5000
ZONE 4	16	990	3300
ZONE 2	4.2	820	1400
Whole Basin	121	8150	25900

Figure 2: Predicted Hydrocarbon Volume by Zone. Note: These numbers correspond to resources, not reserves, calculated with Temis technology. They are not the final Yet-to-Find values, which will be released in the PFA Atlas.

PFA Partners



industry review, OETR has worked on these identified gaps, which has included: improving well failure analysis; improving the geological view of sediment dispersal systems from wells and seismic in advance of forward modeling; further work on oil/source correlation, piston core data, satellite seep data, kerogen typing and isotope analysis; ensuring the individual studies are more tightly integrated; integrating the known (published) play systems offshore Morocco into the analysis on success/failure in Nova Scotia.

Next Steps

PFA Atlas

A final review of the PFA was held March 31st and April 1st, 2011 in Paris, France. This was the first time that the complete research story was presented and the content of the PFA Atlas reviewed. As a major deliverable of the PFA Program an atlas is being assembled for an expected delivery of early June 2011, which will present the results of the analysis of all the work completed in this study including the special projects. The atlas will be made available to the public and may be of interest to industry explorers and academics. The final steps of the project will include refinement of the present work and completion of work which includes a Phase 2 Jurassic Carbonate Bank Analysis.

June Symposium

The local roll out of the PFA is slated for June 2, 2011, in Halifax and will be the point of handover of the research results from OETR to the Nova Scotia Department of Energy. A presentation of the PFA results, and how they were achieved, will be given by Beicip-Franlab and RPS Energy. The Province will provide a discussion in regard to what's next for the marketing of the PFA and will share how they plan to introduce the PFA results with exploration interests at an international level.

Another subject at the June Symposium will be plans of moving forward with the creation of a peer reviewed special edition journal.

Special Edition Journal

The PFA research is intended for publication in a special edition of a peer reviewed journal. PFA team members are engaging in discussion surrounding factors that will influence the planning of this significant project: an appropriate journal, timeframes and deadlines, contributors/authors and article topics. Selection of the journal will be important, as to incorporate the broad topic areas of subprojects and themes the PFA encompasses. The special edition journal remains in early stages of planning and will be a major undertaking. However, in late March 2011, we received a very favourable initial response from a leading Canadian Geosciences journal and are in discussions with potential contributing authors. Further details will be forthcoming as planning continues to take place over the next few weeks.



For more information about the Play Fairway Analysis Program contact:

Jennifer Matthews

j.matthews@offshoreenergyresearch.ca
5151 George Street, Suite 400, PO Box 2664
Halifax, Nova Scotia B3J 3P7 Canada
P: (902) 424-2493 • F: (902) 428-2200

OETR is a not-for-profit corporation dedicated to fostering geoscience research that will enhance Nova Scotia's offshore petroleum exploration and development. OETR's members include the Nova Scotia Department of Energy, Dalhousie University and Saint Mary's University.

A Thank-you to our PFA Partners

In 2009, the Province of Nova Scotia commissioned OETR Association (OETR) to initiate a \$15 million Play Fairway Analysis program on Nova Scotia's offshore. Over the past two years, OETR has established an extensive network of partners who have played a significant role in achieving this world-class research. OETR has worked closely with over 25 research companies worldwide (Canada, United States, France, UK, Germany and more), over 100 researchers from Canadian and international research labs, universities, and industry. OETR has also partnered with federal and provincial research facilities, and over 30 researchers from local universities, and exploration contractors and specialists within regulatory organizations.

OETR would like to thank all of our collaborators for their dedicated efforts. The high quality and variety of expertise combined with excellent team work has led to a finished project of unmatched magnitude and scope. Contributing companies, consultants, researchers and the program management committee are listed below.

A Special Thank-you to our Program and Technical Management Teams

RPS Energy

- Tony LaPierre, Programme Manager
- Hamish Wilson, Principal Consultant
- Matt Luheshi, Exploration Advisor
- Dave Roberts, Exploration Advisor

Beicip-Franlab

- Bernard Colletta, Exploration Project Director
- Stefan Doublet, Project Manager
- Frederic Monnier, Deputy Project Manager

Companies & Institutions

Association BioGeosciences
Beicip-Franlab
Biostratigraphic Associates International
Canada-Nova Scotia Offshore Petroleum Board
Dalhousie University
Fugro Gravity & Magnetic Services Inc.
GeoPro GmbH
Geoprojects Canada
Geo Tours Consulting Inc.
Global Geolab
IHS Energy
ION GX Technology
JEBSCO
Lynx Canada Information Systems Ltd.
Marcos Zentilli Geoscience Inc.
Natural Resources Canada, Geological Survey of Canada - Atlantic
Nova Scotia Department of Energy
RPS Energy
Saint Mary's University
Superport Marine Services Limited
TGS-NOPEC
Weatherford Laboratories

Featuring our Local Partners

Canada-Nova Scotia Offshore Petroleum Board

- Brent Smith, Senior Petroleum Geophysicist
- Dr. Mark Deptuck, Petroleum Geologist
- David Brown, Senior Petroleum Geologist
- Kris Kendall, Petroleum Geophysicist
- Carl Makrides, Geologist and Petrophysicist
- Steve Bigelow, Director, Resources & Rights, Chief Conservation Officer

Dalhousie University

- Dr. Christopher Beaumont, Principal Investigator, Department of Oceanography
- Dr. Steven Ings, Research Associate, Department of Oceanography
- Dr. Rajesh Goteti, Post-Doctoral Fellow
- Douglas Guptill, Department of Oceanography
- Dr. Keith Loudon, Principal Investigator Department of Oceanography
- Dr. Helen Lau, Post-Doctorate Research Associate, Department of Oceanography
- Dr. Mladen Nedimovic, Associate Professor, Department of Earth Sciences
- Dr. Matthias Delescluse, Academic Post-Doctoral Fellow, Department of Oceanography

Natural Resources Canada, Geological Survey of Canada - Atlantic

- Dr. Sonya Dehler, Subdivision Head
- Dr. Rob Fensome, Research Scientist
- Dr. Graham Williams, Research Scientist
- Dr. Charlotte Keen, Emeritus Scientist, Geophysicist

Nova Scotia Department of Energy

- Sandy MacMullin, Director, Petroleum Resources
- Kim Doane, Manager, Petroleum Resources
- Adam MacDonald, Petroleum GeoPhysicist, Petroleum Resources
- Paul Harvey, Senior Petroleum GeoPhysicist, Petroleum Resources
- Scott Weldon, Petroleum Geologist, Petroleum Resources
- Brenda Kenty, Secretary, Petroleum Resources

- Danielle Finlayson-Bourque, Petroleum Administrator, Petroleum Resources

Saint Mary's University

- Dr. Jacob Hanley, Principal Investigator, Department of Geology
- Dr. Andrew MacRae, Principal Investigator, Department of Geology
- Dr. Georgia Pe-Piper, Principal Investigator, Department of Geology
- Dr. Atika Karim, Post-Doctorate Researcher, Department of Geology
- Dr. David Piper (GSC - Atlantic), Adjunct Faculty, Department of Geology

Geoprojects Canada

Geo Tours Consulting Inc.

Marcos Zentilli Geoscience Inc.

Superport Marine Services Limited

Dr. Yawooz Kettanah

* This list does not include students involved with the project.

PFA Program Management Committee

- Dr. Wayne St-Amour (Chair), OEER/OETR Associations
- Sandy MacMullin, Nova Scotia Department of Energy
- Dr. Sonya Dehler, Geological Survey of Canada - Atlantic
- Brent Smith, CNSOPB
- Dr. Deborah Buszard, Dalhousie University
- Dr. Robert McCalla, Saint Mary's University