Canada-Nova Scotia Offshore Petroleum Board

NOVA SCOTIA DEEPWATER POST-DRILL ANALYSIS 1982-2004

Arthur G. Kidston
Brenton M. Smith
David E. Brown
Carl Makrides
Brian Altheim

October, 2007
Halifax, Nova Scotia

THE CANADA-NOVA SCOTIA OFFSHORE PETROLEUM BOARD

The Board is the independent joint agency of the Governments of Canada and Nova Scotia responsible for the regulation of petroleum activities in the Nova Scotia Offshore Area, including:

- management and conservation of offshore petroleum resources,
- issuance of licences for offshore exploration and development,
- resource evaluation, data collection, curation and distribution,
- protection of the environment during offshore petroleum activities,
- health and safety for offshore workers, and
- compliance with the provisions of the Accord Acts that deal with Canada-Nova Scotia employment and industrial benefits.

Canada-Nova Scotia Offshore Petroleum Board
1791 Barrington Street
Halifax, Nova Scotia
B3J 3K9
CANADA

Tel: (902) 422-5588
Fax: (902) 422-1799
http://www.cnsopb.ns.ca

CONFIDENTIALITY

This Report was originally created by the Canada-Nova Scotia Offshore Petroleum Board for its exclusive internal use. This version has been edited for public release, as the original work contained portions of well, seismic, and other information currently held under confidentiality agreements. Most of the figures that were included in the original Report are included herein, and where appropriate, with the express permission of the data owners.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the CNSOPB, especially Steve Bigelow, Manager-Resources & Rights, for providing the vision, encouragement and resources required for a study of this nature. We also thank our Board colleagues, Andrew McBoyle for his insightful comments and Troy MacDonald for timely computer systems support. We sincerely thank Dianna Lee Dalton, Chair and CEO, for her approval of this project.

Special thanks and recognition for the use of proprietary information and data is warmly extended to Mike Coolen (Canadian Superior Energy), Matthew Bognar (CGGVeritas), P.J. (Paul) Vatour (Chevron Canada Resources), David Kopperson (EnCana Corporation), Glenn Scott and John Eastwood (ExxonMobil Canada Properties), Paul Einarsson (Geophysical Service Incorporated), Michael J. Peacock (Imperial Oil), Kevin P. Williams (Marathon Canada Petroleum), Jim Fenton (Robertson Research International) and Kim Abdallah (TGS-NOPC). Paul J. Post of the US Minerals Management Service is thanked for his commentaries and discussions on several topics covered by this report. Without their generous support and guidance, and their recognition of the importance of the CNSOPB's efforts on this topic, this report could not have been published.

EXECUTIVE SUMMARY

Between 2002 and 2004 industry drilled seven deepwater wells on the Scotian Slope with one gas discovery (Annapolis), one gas show (Newburn) and four dry wells (Balvenie, Crimson, Weymouth and Torbrook). The seventh well, Annapolis B-24, was a precursor to the discovery well that was abandoned due to a shallow gas kick. Four previous wells were drilled between 1982-1986 that were dry and abandoned, and are included in this analysis (Shubenacadie, Shelburne, Evangeline and Tantallon).

Whether successful or not, all wells provide important calibration for the relationship between seismic and geology. The focus of this study was to undertake a post-drill analysis of all ten deepwater wells by compiling all available data and information, studying and interpreting these data, and drawing conclusions related to the following broad headings:

- Pre-Drill Objectives
- Post-Drill Results
- Geological Implications
- Operations and Costs
- Impact on 2002 CNSOPB Resource Assessment

The Scotian Basin is a passive margin and has proven petroleum systems with past production from the Cohasset-Panuke oil fields, ongoing gas production from the Sable Project and the undeveloped Deep Panuke gas field, all on the shallow Scotian Shelf. Recently, exploration focus shifted to the deepwater Scotian Slope because of the impressive hydrocarbon discoveries and high success rates in deepwater of other circum-Atlantic basins such as the Gulf of Mexico, offshore Brazil and West Africa, and recently Northwest Africa (Mauritania).

The Scotian Slope is 850km long and has an area of 80,000km^2 containing only the aforementioned ten wells that are either clustered or widely distributed within a long and narrow belt. The degree of basin evaluation for these wells as determined by geographic location, successions penetrated, total depth and thickness of target section cannot be considered comprehensive.

Exploration in the deepwater habitat requires high quality 2D and 3D seismic data and the application of sophisticated processing and interpretation. The reservoir targets are deepwater submarine fan sands that are transported from the shelf and deposited on the slope coeval with major changes in relative sea-level (lowstands). This process can create erosional submarine canyons which act as conduits for the transport of vast quantities of sediments.

The analysis of seismic character attributes and the application of seismic sequence stratigraphy has been proven successful in the detection of reservoirs in the Tertiary sediments of the Gulf of Mexico, offshore Brazil, West Africa and Mauritania. Thus far, the application of these techniques has met with little success in the older Cretaceous age section offshore Nova Scotia.

The cost of recent deepwater drilling off Nova Scotia was exacerbated by equipment difficulties and incorrect prediction of the geopressure regime. However, as Marathon demonstrated, after their Annapolis well, the learning curve was steep and costs for their second well at Crimson were significantly reduced.

Discovered gas in the Annapolis and Newburn wells confirms an active slope petroleum system. Annapolis found a cumulative 27m of generally thin gas-bearing sands, and Newburn encountered several thin (2-3m) gas-bearing sands. Furthermore, many of the gas-bearing sands were encountered unexpectedly below 5000m with average porosities from 14-19% which expands the zone of prospectivity. A significant insight, based on paleoenvironmental interpretations from available well biostratigraphic data, indicates that the presumed Cretaceous age deep water sediments were actually deposited in the shallow waters of the outer shelf and upper slope. This knowledge will have a profound, but ultimately positive impact on future exploration.

In 2002 the Board completed a deepwater resource assessment prior to results from the recent seven wells (Kidston et al., 2002). The assessment consisted of 12 geostatistical computation runs to capture the diversity of play areas and play types. The recent drilling results affect three of those twelve runs by altering input parameters particularly regarding the presence and quality of reservoir.

The impact of the recent deepwater well results on the undiscovered gas and oil potential is minimal. The comparison is shown in the following table, with gas potential reduced only by several Tcf and oil potential by fractions of billions of barrels. The Scotian Slope thus remains a virtually unexplored deep water frontier basin with a confirmed petroleum system and the potential for significant hydrocarbon discoveries.

Assessment	Potential GAS (Tcf)	Potential OIL (BB)
2002 Report	**15 – 41**	**1.7 – 4.7**
2007 Revision	**12 – 39**	**1.3 – 4.5**