Petroleum system modeling offshore Nova Scotia, Canada: an insight on its hydrocarbon potential

EMERSON MARFISI[1], FRANCKY SAINT-ANGE[1], LAURENT CUILHE[1], ADAM MACDONALD[2], AND MATT LUHESHI[3]

1. Beicip-Franlab 232, avenue Napoleon Bonaparte BP 213, Rueil-Malmaison 95202, France
2. Nova Scotia Department of Energy, Halifax, Nova Scotia B3J 3P7, Canada
3. Leptis E&P Ltd., Watford, Hertfordshire WD17 4QX, United Kingdom

The presence of an active petroleum system in the Central Scotian Shelf (CSS) has been known since 1969 with the first discoveries of oil and gas in the Sable Island area. Since that time, 31 significant discoveries have been reported from 123 exploration wells drilled mostly on the CSS. Seven deepwater wells were drilled on the slope finding gas-bearing reservoir sands. Two found gas: Annapolis G-24 (27.3 m net pay) and Newburn H-23 (5.5 m net pay), thus confirming an active slope petroleum system exists but remains poorly understood.

Since 2009, a number of studies evaluated the hydrocarbon potential of the entire Scotian Basin petroleum system and deep offshore areas. Numerical petroleum system models were generated in the framework of each of these studies. Potential source rock (SR) intervals defined in these models included: Early Jurassic (Sinemurian–Pliensbachian– Toarcian), Middle Jurassic (Callovian), Late Jurassic (Tithonian), and Early Cretaceous (Valanginian-Aptian).

There is currently no strong evidence for the presence of the Early Jurassic SR in offshore Nova Scotia but evidence of their presence in Morocco supports this possibility. A kinetic reaction for a Type II kerogen was assigned to the Early Jurassic SR with 2.5–5% TOC and HI = 600 mg HC/g TOC. middle to late Jurassic SRs were considered as a mix Type II–III kerogen with 2–3 % TOC and HI = 424 mg HC/g TOC. The Valanginian and Aptian SRs were set as predominantly Type III kerogen with 1–2 % TOC and HI = 235 mg HC/g TOC.

A number of fluid carrier and reservoir units were defined from the Abenaki (Scatarie Mb.) to Logan Canyon and Wyandot formations. SR maturation was simulated using a coupled crustal-sedimentary cover thermal model reproducing heat-flow from 200 Ma to present-day. Thermal results shown that the Early–Middle Jurassic SRs, if present, would reach the oil window as early as 180–160 Ma and over-maturity ~140–100 Ma through the northeast and central areas of the Nova Scotia Margin decreasing in maturity to the Shelburne Sub-basin to oil/wet-gas window. The Tithonian SR reached the oil window at 120–80 Ma in the northeast-central the part of the margin with favorable conditions to expel liquid hydrocarbons and gas all along the slope. The risk for suitable HC generation conditions seems to be low in the Scotian Basin for Jurassic SRs, and locally Early Cretaceous sources. Present challenges are oriented to a better understanding of the sedimentary architecture in the slope and basin areas.

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