



## Petroleum Resource Potential of the Carboniferous Maritimes Basin, Eastern Canada

James Dietrich\*, Peter Hannigan and Kezhen Hu

Geological Survey of Canada, 3303 33St NW, Calgary, Alberta., T2L 2A7

[jdietric@nrcan.gc.ca](mailto:jdietric@nrcan.gc.ca)

and

Peter Giles

Geological Survey of Canada, 1 Challenger Drive, Dartmouth, Nova Scotia, B2Y 4A2

### Summary

The Carboniferous Maritimes Basin in eastern Canada contains the key petroleum-system elements for a significant petroleum resource potential, including widespread reservoir rocks, thick shale and evaporite sections (seals), large volumes of thermally mature hydrocarbon source rocks, and abundant and diverse trap types. Regional quantitative play assessments indicate the Maritimes Basin has low to moderate oil potential and high natural gas potential. The most prospective gas play occurs in Upper Carboniferous sandstones in salt-structure traps in the eastern Gulf of St. Lawrence region.

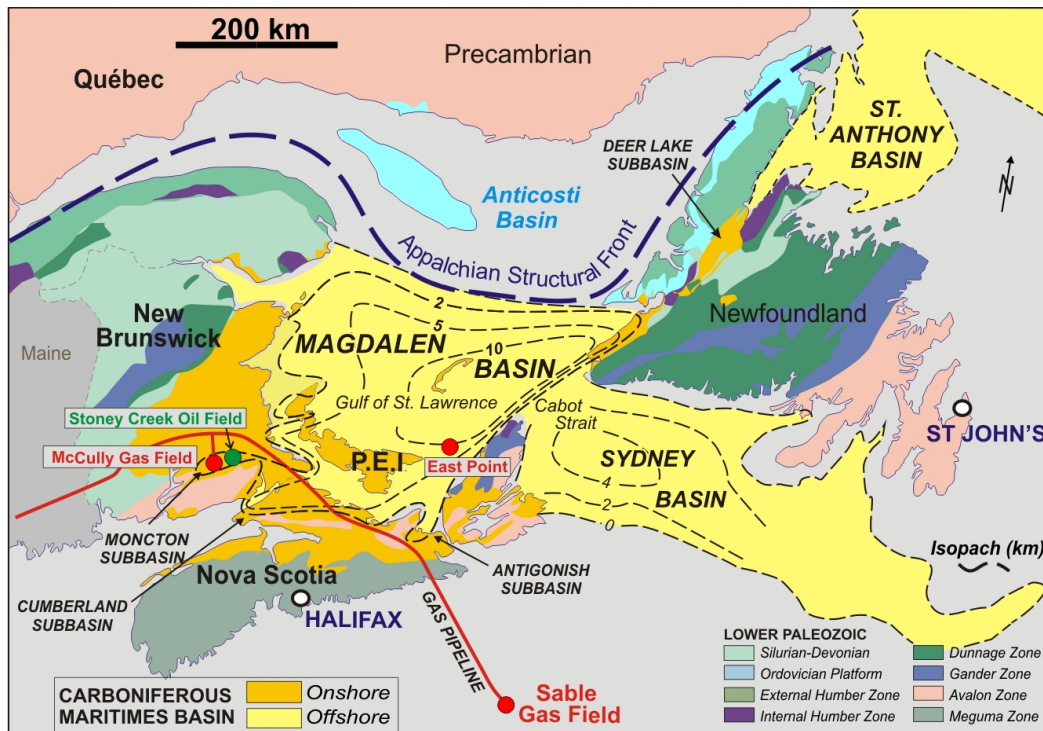


Figure 1. Tectonic assemblage map of eastern Canada, with outlines of Carboniferous basins and locations of oil/gas fields.

## Introduction

The Carboniferous Maritimes Basin underlies the southern Gulf of St. Lawrence, Cabot Strait, the continental shelves offshore southern and northeastern Newfoundland, and adjacent onshore areas of the five eastern Canada provinces (Figure 1). The Maritimes Basin is a late Paleozoic (post-Acadian orogeny) successor basin overlying a collage of lower Paleozoic continental margin basins and Appalachian tectonic zones (Figure 1). The basin encompasses an area of about 250,000 km<sup>2</sup> and contains three major depocenters; the Magdalen, Sydney and St. Anthony basins. The Carboniferous basins developed in intracontinental strike-slip and foreland tectonic settings, prior to and during the Alleghanian Orogeny .

## Geological Setting and Petroleum Systems

The Carboniferous petroleum-system framework is mainly derived from the Magdalen Basin, the most extensively explored and studied of the three basin areas. The Magdalen Basin contains up to 12 kilometres of Late Devonian-Early Permian continental and shallow marine strata deposited in three main tectono-stratigraphic packages (Figure 2): an Upper Devonian-Lower Carboniferous (Tournaisian) succession of alluvial and lacustrine clastics and volcanic rocks in deep, fault-bounded subbasins (Horton Group); a widespread Lower Carboniferous (Visean) succession of marine carbonates and evaporites and nonmarine clastics (Windsor Group) capped by nonmarine fine-grained strata of the Mabou Group; and a thick Upper Carboniferous to Permian succession of alluvial, fluvial and estuarine clastics (Cumberland and Pictou groups). Coal-bearing sections (coal measures) are abundant in the Namurian -Westphalian Cumberland and Pictou groups. Cumberland Group strata occur in fault sub-basins in the southern Magdalen Basin. The Pictou Group is up to 9000m thick in the central Magdalen Basin in the eastern Gulf of St. Lawrence. Basin structures are associated with rift faulting, strike-slip related inversion tectonics, and salt diapirism (Figure 3). Hydrocarbon source rocks occur in lacustrine shales in the middle Horton Group (Type I-II organic matter) and Upper Carboniferous coal measures (Type II-III organic matter). The gas-prone coal measures are the most widespread source rocks.

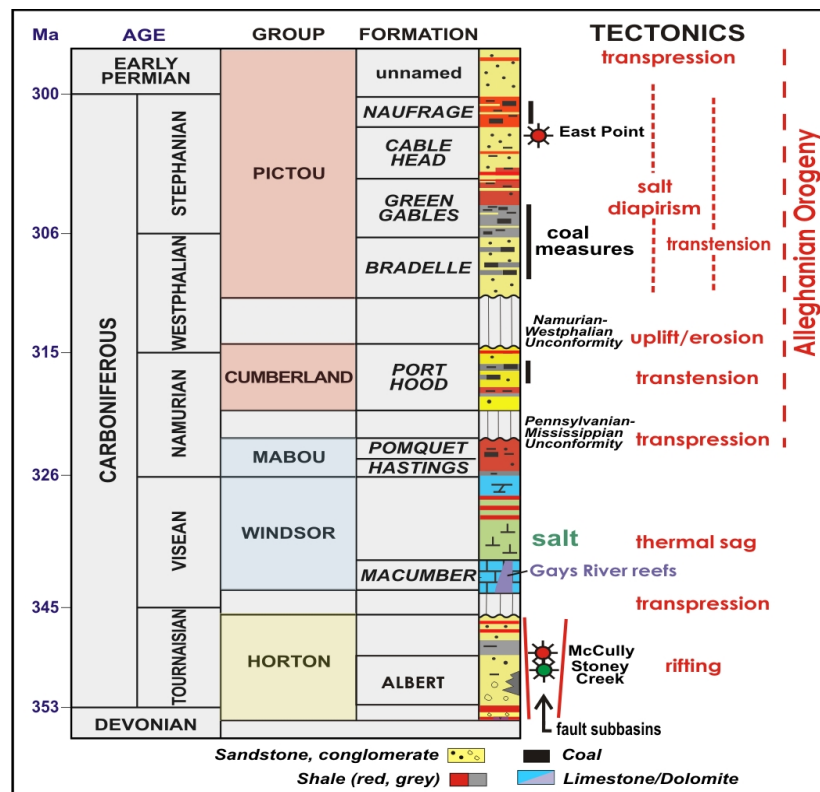


Figure 2. Magdalen Basin stratigraphic column with indicated unconformities, tectonic phases, and oil/gas fields.

## Petroleum Plays

The primary exploration plays in the Maritimes Basin involve Lower Carboniferous sandstones or conglomerates in combined structural-stratigraphic traps, Windsor Group carbonate reefs, and Upper Carboniferous fluvial sandstones in fault block and salt structure traps (salt withdrawal anticlines, salt pillows, salt-diapir flanks, and sub-salt traps; Figure 3). The Upper Carboniferous salt-structure play contains the largest number of known prospects in the basin. The sub-salt play locally includes Horton Group reservoir strata. The Windsor play is the most conceptual, as little is currently known about the regional distribution or sizes of carbonate reefs.

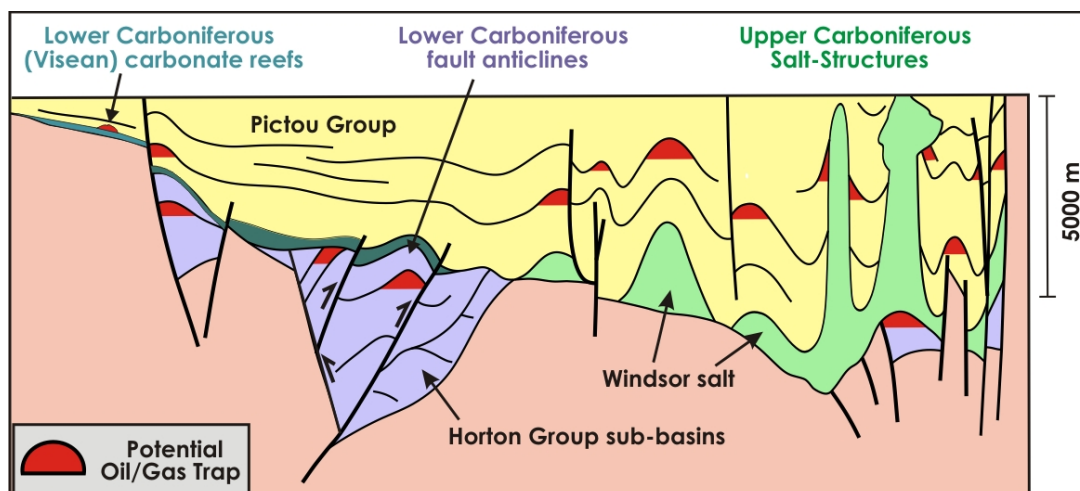


Figure 3. Schematic cross-section illustrating petroleum play types in the central (offshore) Magdalen Basin.

## Exploration Risks

The main exploration risks for the Carboniferous clastic plays are associated with reservoir quality and trap preservation. Although Carboniferous sandstones have generally low porosity and permeability, fair to good quality reservoir intervals (porosity of 10% or more) are present in most stratigraphic units over a wide range of basin depths. The best quality sandstone reservoirs occur in the Upper Carboniferous Pictou Group in the northern Magdalen Basin. The trap preservation risk is related to the timing of hydrocarbon generation. The peak period of hydrocarbon generation for basin source rocks occurred in the Late Carboniferous to Early Permian, prior to (Mesozoic) uplift and erosion of upper parts of the basin fill. Long-term preservation or sealing of early-charged hydrocarbon traps may be problematic. Nonetheless, the known presence of hydrocarbon accumulations in the basin attests to the local effectiveness of trap sealing.

## Known and Indicated Petroleum Resources

There are two producing hydrocarbon fields in Lower Carboniferous strata in the onshore portion of the southern Magdalen Basin: the Stoney Creek oil field and the McCully gas field (Figure 1). There is one offshore gas field in Upper Carboniferous strata (East Point) that has not been developed but is designated with significant discovery status. Several other exploration wells have recovered natural gas in drill-stem tests, albeit at low reported flow rates. Most wells have encountered mud-log or wireline-log indications of hydrocarbons. Possible hydrocarbon indicators are apparent in many reflection seismic profiles.

## Petroleum Resource Potential

Quantitative assessments of the major clastic petroleum plays indicate the Maritimes Basin has low to moderate oil potential and high natural gas potential. Further exploration will likely result in more gas discoveries, with the potential for large (Tcf +) gas fields. One of the most prospective plays involves Upper Carboniferous (Pictou Group) sandstones in the eastern Magdalen Basin. This area contains a thick succession of Upper Carboniferous reservoir and source rocks, and a multitude of large salt structures.