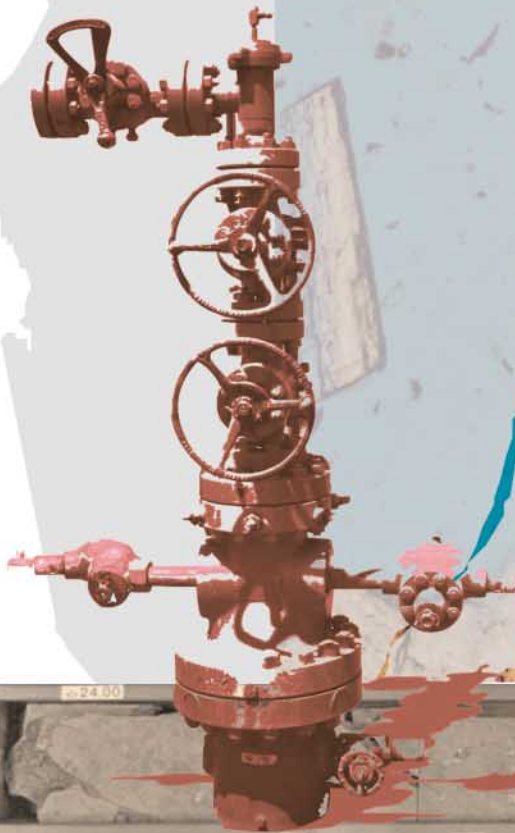




QUÉBEC

A PETROLEUM REGION
TO BE DISCOVERED



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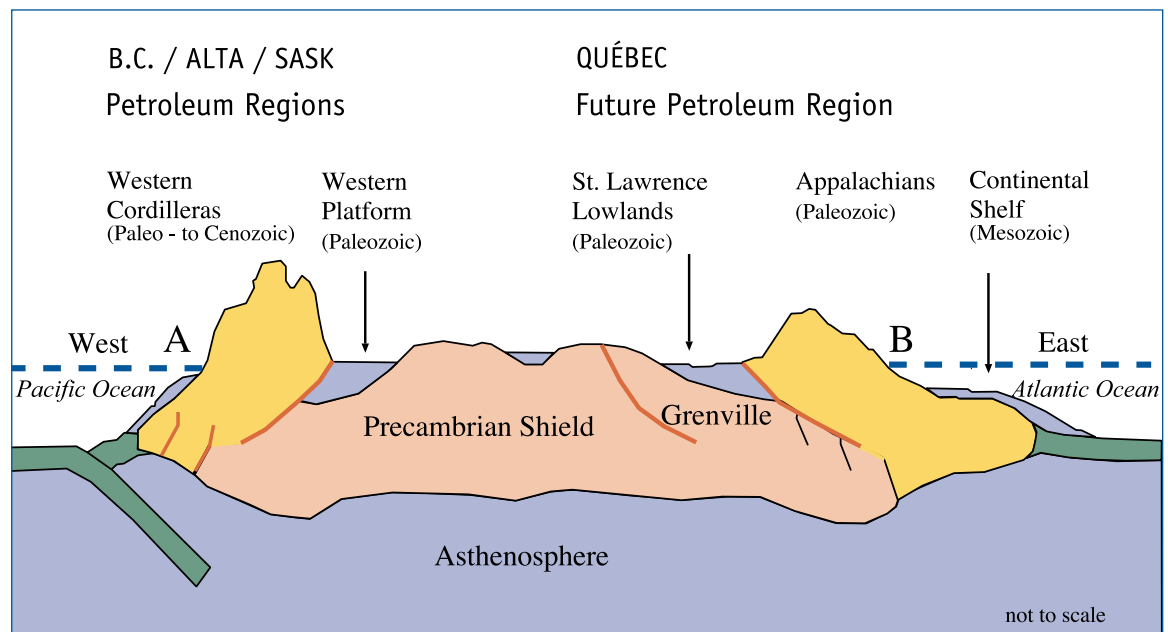
A PETROLEUM REGION TO BE DISCOVERED

Hydrocarbons currently account for 57% of Québec's energy consumption, with oil accounting for 40.4% and natural gas, 16.7%. According to statistical studies, forecasted demand will remain relatively stable for the next decade.

Québec has a total surface area of close to 1.7 million km². The greatest potential for hydrocarbon discovery is in its sedimentary zone, which covers 225,000 km², 57% of which is marine. This zone extends over the whole southern section of the province along the line of the St. Lawrence River, stretching from the border with Ontario to that with Newfoundland. These basins are part of a long sedimentary basin extending from

Texas to Newfoundland, comprising an ancient coastline along which carbonates were deposited.

For more than 10 years now, based on these geological concepts, a series of discoveries ranging from 50 to 500 BCF have been made along this line of sedimentary basins. At present, two natural gas fields have been discovered in Québec, the first being at Point-du-Lac and the second, at St-Flavien. The Québec sub-surface is still largely unexplored in comparison to other sedimentary basins in Canada and the United States. Nonetheless, previous work has made it possible to target the geological zones with the best hydrocarbon potential.

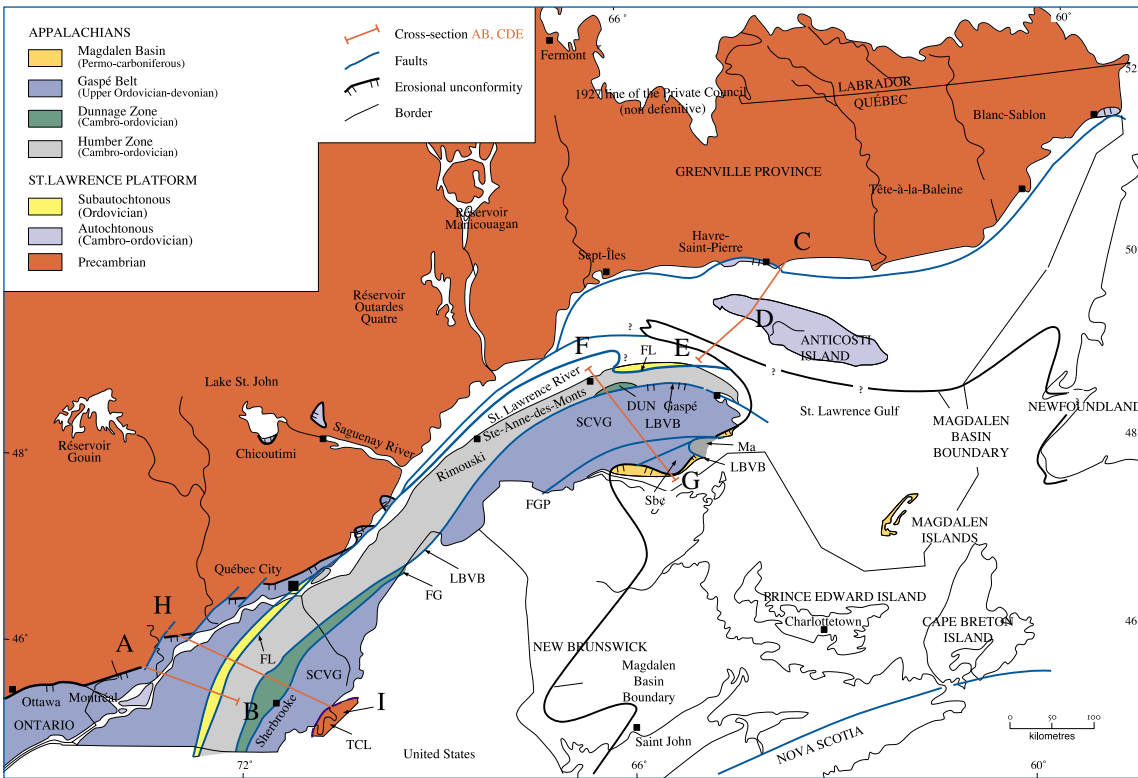


This document discusses Québec geology in its North American context so as to be able to draw an analogy with the petroleum basins in Western Canada (see preceding figure). A west-to-east cross-section from Vancouver (A) to the Gaspé Peninsula (B), passing through James Bay, provides a simplified description of the relationship between the major geological structures. North America is composed of a central core, that is the Precambrian Shield, flanked by two large mountain chains, the Cordilleras and the Appalachians.

All the elements that constitute the continental framework, namely the Archean core, the Proterozoic regions, the St. Lawrence Platform and the Appalachians, are found in Québec. The geology of the St. Lawrence platform and the Appalachians only contains sediments from the Paleozoic geological system, of which 51% stem from the Cambro-Ordovician. Presently, 26% of petroleum fields in the world originate in the Paleozoic era.

The Appalachian geological province is to the south of the Precambrian Shield and is composed of deformed rocks dating from the Cambrian to the Carboniferous. In the Magdalen Islands, certain rocks even date from the Permian. Situated between the Shield and the Appalachians, the St. Lawrence Platform geological province (Cambro-Ordovician) is composed of rocks which are virtually undeformed within the triangle

delimited by Québec and the Ontario and American borders. Farther east, Anticosti Island is composed of Ordovician and Silurian rocks, while the Mingan Archipelago is composed of Ordovician rocks. Ordovician rock in-layers can be found between Québec and the Mingan Islands on the north shore of the St. Lawrence and in the Saguenay – Lac Saint-Jean region.



Simplified geological map of the Appalachians and the St. Lawrence Platform in Québec

A simplified north-west – south-east cross-section (AB and CDEFG) shows the main elements of the St. Lawrence Platform – Appalachian pair (see above figure). The autochthonous layers of the St. Lawrence Platform geological province (blue) are unconformable with their basement, namely the one-billion-year-old metamorphic rocks of the Grenville province (red) of the Precambrian Shield. Along a Montréal-Eastern Townships cross-section (AB), the Platform rocks date back to the Cambrian and Ordovician periods. On the

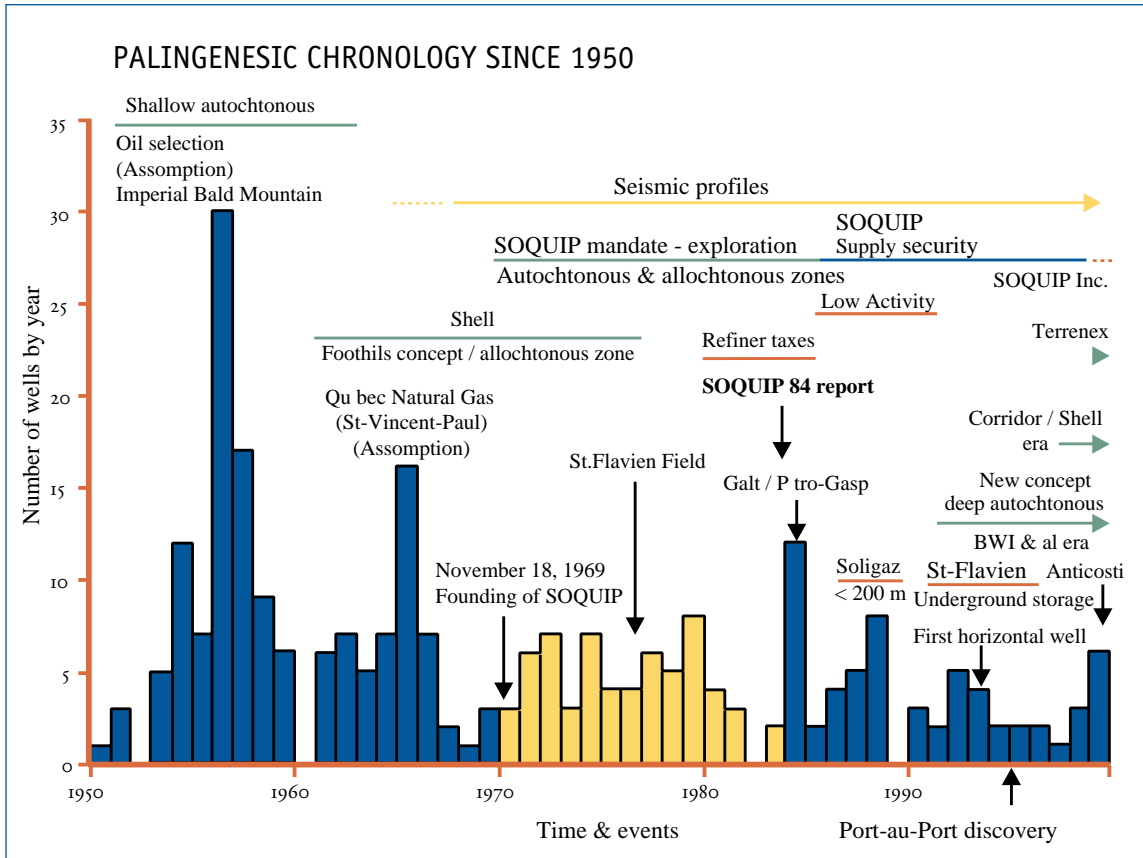
other hand, a Mingan – Anticosti – Gaspé Peninsula cross-section (CDE) shows formations that date from the Ordovician to the Silurian, and probably even to the Devonian under the Gulf waters.

The highly deformed rocks of the Appalachian province comprise numerous folds and faults. These rocks overlap layers of the St. Lawrence Platform and the Grenville due to the Logan Fault (LF), a major fault with a slight inclination. The Appalachians is composed of three major types of rocks. The first group

(grey and green) is composed of sedimentary and volcanic rock dating from the Cambrian and Ordovician. This rock, where many of the major folds and faults are found, was formed from ancient deposits in an oceanic basin and most likely constitutes the first phase in the building of the Appalachians. This allochthonous rock is from the Taconic Orogeny and is identified by the Humber and Dunnage zones. A second group (dark blue) is in angular unconformability with the first group. It is composed of sedimentary and volcanic rocks from the Silurian and Devonian periods and is less deformed than the first group. The rocks were formed in a shallower marine basin that succeeded the previous basin. These sedimentary rocks correspond to the second phase in the formation of the Appalachians (Acadian Orogeny). These rocks cannot be described as allochthonous since this Siluro-Devonian group did not undergo significant tectonic displacement but rather developed directly on top of the Taconic allochthonous rock as a successive basin. Finally, the third group (orange), which is only found in the south and south-east of the Gaspé Peninsula, the Magdalen Islands and the Gulf, is composed of sedimentary rocks that have undergone very little deformation. These rocks, which date from the Carboniferous and Permian periods, were deposited on land and have an angular unconformability with the two preceding rock groups. The layers thus formed represent deposits stemming from the erosion of mountain chains.

There is a wedge (pale yellow) constituting a parautochthonous segment between the autochthonous St. Lawrence Platform and the allochthonous Appalachians. Québec geologists include this thin wedge in the autochthonous mass since the composition of the wedge rocks is similar to the sedimentary sequence of the St. Lawrence Platform.

The wells drilled in each of these basins have revealed the presence of hydrocarbons in the form of oil or natural gas. In all, the search for oil, natural gas and underground reservoirs has led to 381 wells being drilled in the Palaeozoic sediments of Québec since 1860. Moreover, it is well known that there are Quaternary unconsolidated deposits in the St. Lawrence Lowlands basin that contain relatively sizeable quantities of natural gas. One such example is the Pointe-du-Lac gas field (3.2 BCF), which has now been converted into an underground reservoir. Since the beginning of hydrocarbon exploration in Québec, this limited activity in the unconsolidated deposits of the St. Lawrence Lowlands has involved the drilling and recording of 302 shallow wells (< 150 m) in the *Répertoire des puits forés pour la recherche de pétrole et de gaz naturel au Québec*, section *Sol non consolidé*.



The St. Lawrence Lowlands and, to a lesser degree, the eastern Gaspé Peninsula are the two regions that have seen the most active exploration. The 381 wells in the sedimentary basins of Québec have been drilled over a 140-year period. However, the first 100 years saw little drilling activity. Indeed, before the 1950s, 112 wells were drilled and almost all of them were drilled in the eastern Gaspé Peninsula on visually discovered oil seepage lying on the ground.

Exploration began in earnest after the eruption, in 1955, of a “handyman’s” well drilled by the Brothers of a religious order at Pointe-du-Lac. It was then that exploration moved from the Gaspé Peninsula to the St. Lawrence Lowlands. The drilling was conducted on the shallow, carbonate platform. The figure below provides a list of modern hydrocarbon exploration as well as the related palingenetic cycles.

Palingenetic Chronology

- 1950-1960** Shallow platform, horst, 1,500 m and less, surface geology.
- 1960-1969** Shell period, “Foothills” concept, overlapping thrust sheets.
First use of seismic tools, 2D sub-surface images.
- 1969-1984** Creation of SOQUIP, State-owned corporation, mandated to evaluate petroleum potential.
Concepts from 1950s and Shell (one discovery, i.e. Saint Flavien).
Drill holes concentrated in the St. Lawrence Lowlands and the eastern Gaspé Peninsula.
SOQUIP 84 report, analysis of hydrocarbon potential in Québec.
- 1984-1990** Little exploration conducted. Petro-Gaspé and Soligaz (mining and geotechnical drilling).

Beginning of a New Era

- 1990** BWI and BHP consortium.
New geological concept of the deep autochthonous rock, > 4,000 m below overlaps.
Discovery of oil in 1995 at Port-au-Port, Newfoundland.

The Boom

- 1996** Analogy with several American basins (ancient coast line).
Corridor / Shell / Pan Canadian period (hydrothermal dolomites).
Terrenex, 1999 (hydrothermal dolomites – flower structure).
Several new geological concepts (DHT – FC – Newfoundland discovery).

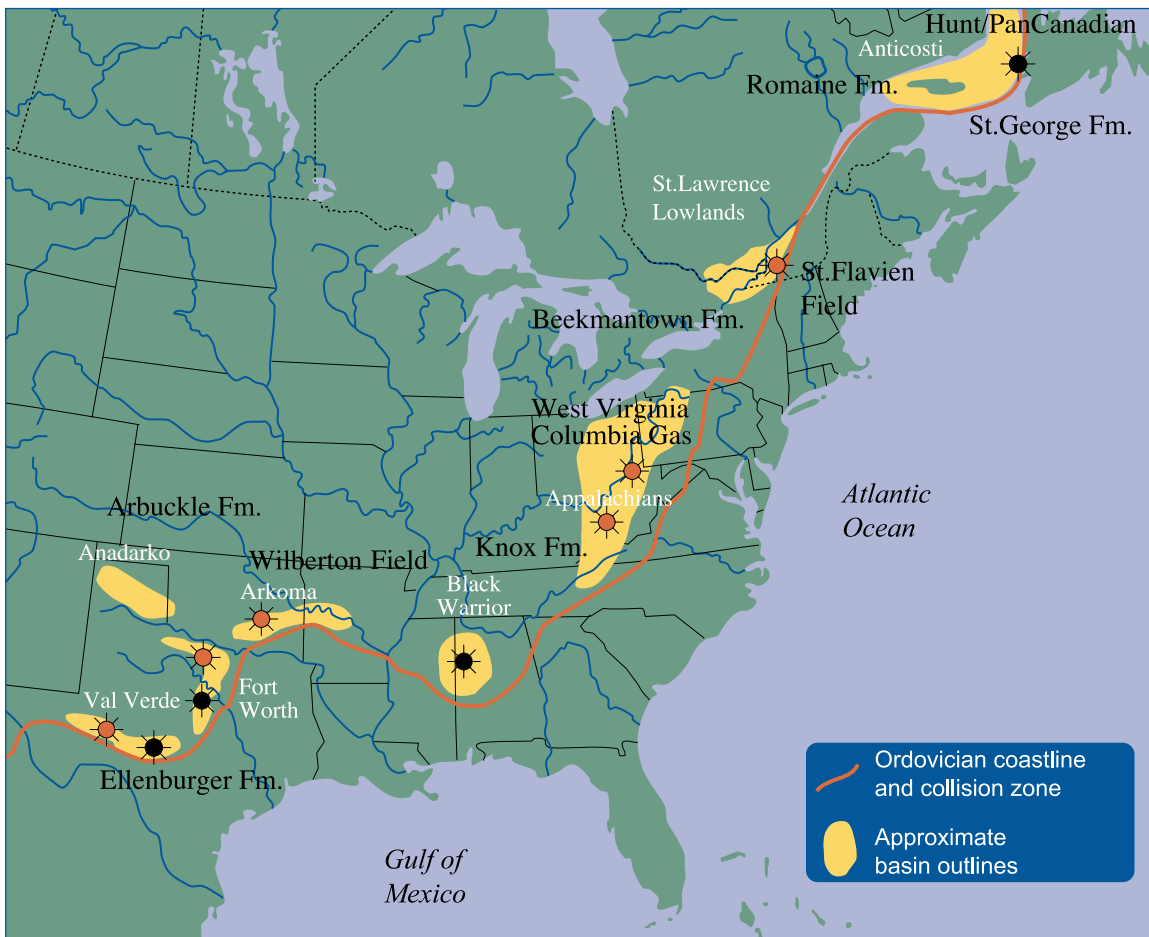
Since the beginning of the 1960s, drilling has allowed us to target certain sedimentary zones and to deepen our geological and geophysical knowledge of Québec. Nonetheless, of the 381 wells drilled, only 78 were located using seismic reflection. Of these, 55 were located in the St. Lawrence Lowlands, 10 in the Gaspé Peninsula, 3 in the lower St. Lawrence, 2 in the St. Lawrence Gulf and 8 on Anticosti Island, including 5 recently in 1998-99. Despite the SOQUIP period, the arrival of seismic 2D and given the fact that few geological concepts were verified between 1950 and 1984, Québec’s sedimentary basins remain under-explored in comparison to other basins in Eastern Canada.

Since 1990, there has been a renewal of oil and gas exploration in Québec. During the last decade, the total amount spent by those participating in this exploration in Québec was close to \$100 M. The drilling programs and seismic surveys, which totalled more than \$50 M and which were undertaken from 1990 to 1996 by the BWI consortium in the St. Lawrence Lowlands and by Shell and Encal Energy on Anticosti Island, confirm this tendency. The total surface area of the province for which there are currently hydrocarbon exploration permits also bears witness to the growing interest. Following the discovery of the Newfoundland field, the surface area under oil and gas exploration licences reached, in 1998, an amount that has not been seen since SOQUIP’s active period. Indeed, exploration licences have now been granted for 4.1 million hectares.

In addition to the very promising developments that have recently occurred in Eastern Canada, the renewal in interest for Québec's hydrocarbon potential can in large part be attributed to the striking similarities between certain sedimentary zones in Québec and several prolific basins in the United States. One only has to think of the Arkoma basin and Wilberton field (600 BCF), the Black Warrior basin, the basins in northern and western Texas, the Appalachian basin,

that of Illinois and Ohio, and, closer to us, that of western Newfoundland. Indeed, these sedimentary zones all date from the Ordovician period, have the same type of deposition (carbonate slope), and have fields situated along the Cambro-Ordovician paleoshore. This paleoshore stretches from Texas to Newfoundland and passes through Québec's sedimentary basins.

ANCIENT CAMBRO-ORDOVICIAN COASTLINE



The next decade could be very promising for the petroleum exploration industry in Québec. The petroleum potential has only been partially evaluated. New geological concepts and technologies, distribution infrastructures and prospects for the natural gas market are essential factors in the pursuit of exploration activities in Québec, which undoubtedly holds economical and profitable hydrocarbon accumulations.

Given recent petroleum discoveries made on the edge of the St. Lawrence Gulf and exploration programs that

are underway, the discovery of sizeable hydrocarbon fields in Québec can no longer be excluded. Consequently, the evaluation of the petroleum potential of Québec's Paleozoic sedimentary deposits must become one of the main priorities of the petroleum exploration industry.

Permits for land-based oil and gas exploration can be obtained on a free mining basis without competitive bidding. However, in a marine environment such as the St. Lawrence Gulf, a public call for tenders is required.

N.B.

In order to make it easier to invest in oil and natural gas exploration in Québec, the Government has introduced a refundable tax credit. This credit's base rate is 20%. This rate is increased to 40% of admissible costs when a company is not operating any oil or natural gas wells.

Québec 
Ministère des
Ressources naturelles

