

## **OIL AND NATURAL GAS IN NEW BRUNSWICK: HISTORICAL AND CURRENT INDUSTRY-RELATED ACTIVITIES**

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### **ON-LAND**

New Brunswick is one of the oldest 'oil provinces' in the world. One of the first oil wells in North America was drilled here in 1859 about 15 km southeast of Moncton on the east side of the Petitcodiac River near the village of Dover (Figure 1). The well, along with three others, was drilled by H. C. Tweedal, a refiner from Pittsburgh. The four shallow wells produced a small quantity of oil (Hea, 1974).

The oil wells put down in the Dover area by Tweedel were in Lower Carboniferous lacustrine sandstones of the Albert Formation. This would prove to be a significant find, because since that time most of the exploration for oil and gas in New Brunswick has concentrated on the Albert Formation in the Moncton Subbasin (Figure 2).

From 1876 to 1879, several wells were drilled in the Dover and Saint Joseph areas (Figure 1) by the St. Joseph Company and the Emory Oil Company. The wells were between 300 and 600 m deep; a few of them produced limited quantities of oil.

In 1899, the New Brunswick Petroleum Company was granted a 5-year lease (called Lease 115) on 46 000 km<sup>2</sup> of land, which covered nearly the entire area underlain by Carboniferous strata in New Brunswick (Figure 2).

The land holding was later reduced to 25 600 km<sup>2</sup> (Henderson, 1940) but the Lease 115 term was extended to 99 years. From 1903 to 1905, the company put down 77 shallow wells (100–200 m deep) in the Dover–Saint Joseph area. Some of the wells produced a few barrels of oil; the best well had an initial flow of 50 barrels per day (Hea, 1974). It is estimated that about 3000 barrels of oil were taken from the Dover Field during this period.

In 1908, J. A. L. Henderson of London, England purchased Lease 115 and formed Maritime Oilfields Ltd. (MOL). In July 1909, Henderson's company discovered the Stoney Creek Field (Figure 1) on the western side of the Petitcodiac River about 15 km south of Moncton. Stoney Creek is directly across the river and on strike with the Dover Field. The discovery well, Maritime Oilfields Ltd. No. 4, had an initial flow of 500 mcf per day and several barrels of oil. The next well, Maritime Oilfields No. 5, had a flow of 1 mmcf per day. By 1912 Henderson had built pipelines and was supplying gas to Moncton and the nearby community of Hillsborough (Figure 1).

In 1915, a new company, New Brunswick Gas and Oilfields Ltd. (NBGO), with head office in Edinburgh, Scotland, acquired the Maritime Oilfields Ltd. Lease 115 and with it the Stoney Creek Field.

In 1918, NBGO entered a special arrangement with the D'Arcy Exploration Company (a subsidiary of the Anglo-Persian Oil Company). It was agreed that D'Arcy would drill several deep holes on Lease 115 and that those wells would be outside the producing Stoney Creek Field (see New Brunswick DNRE annual report for 1919). Between 1919 and 1921 under this farm-in on Lease 115, D'Arcy drilled ten wells with an aggregate length of 6660 m. Three of the wells were in the Moncton Subbasin east of Stoney Creek Field, two were in the Sackville Subbasin and the other five were northeast and north of Moncton and outside the Moncton Subbasin (Figure 2). None of the D'Arcy wells encountered any significant hydrocarbons (Gussow, 1953).

By 1940, NBGO and its predecessor MOL had drilled 126 wells. There were 27 exploratory and 99 production wells, and from those, 73 were producers in the Stoney Creek Field (Figures 3 and 4) (Henderson, 1940).

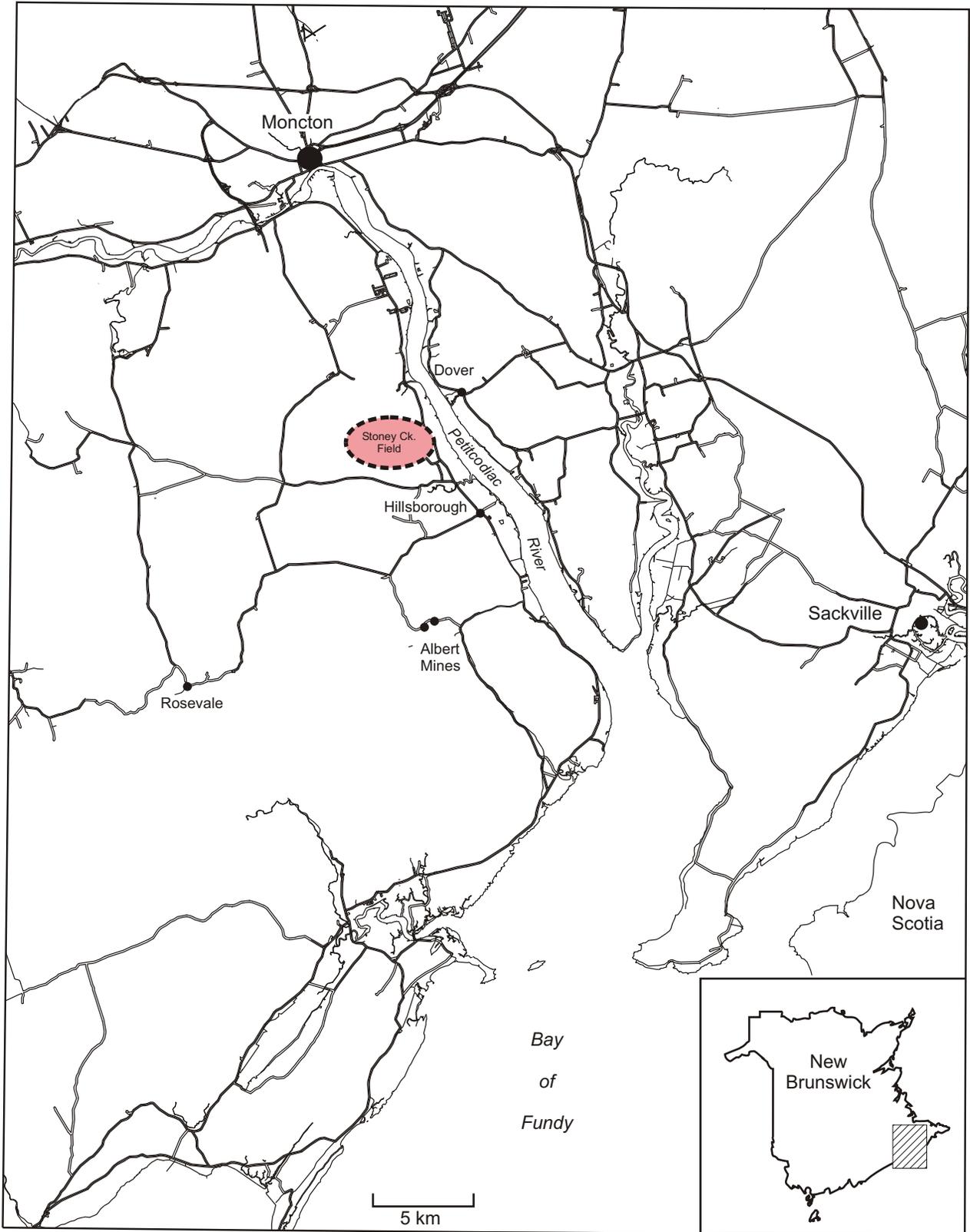


Figure 1. Southern New Brunswick showing the Stoney Creek field.

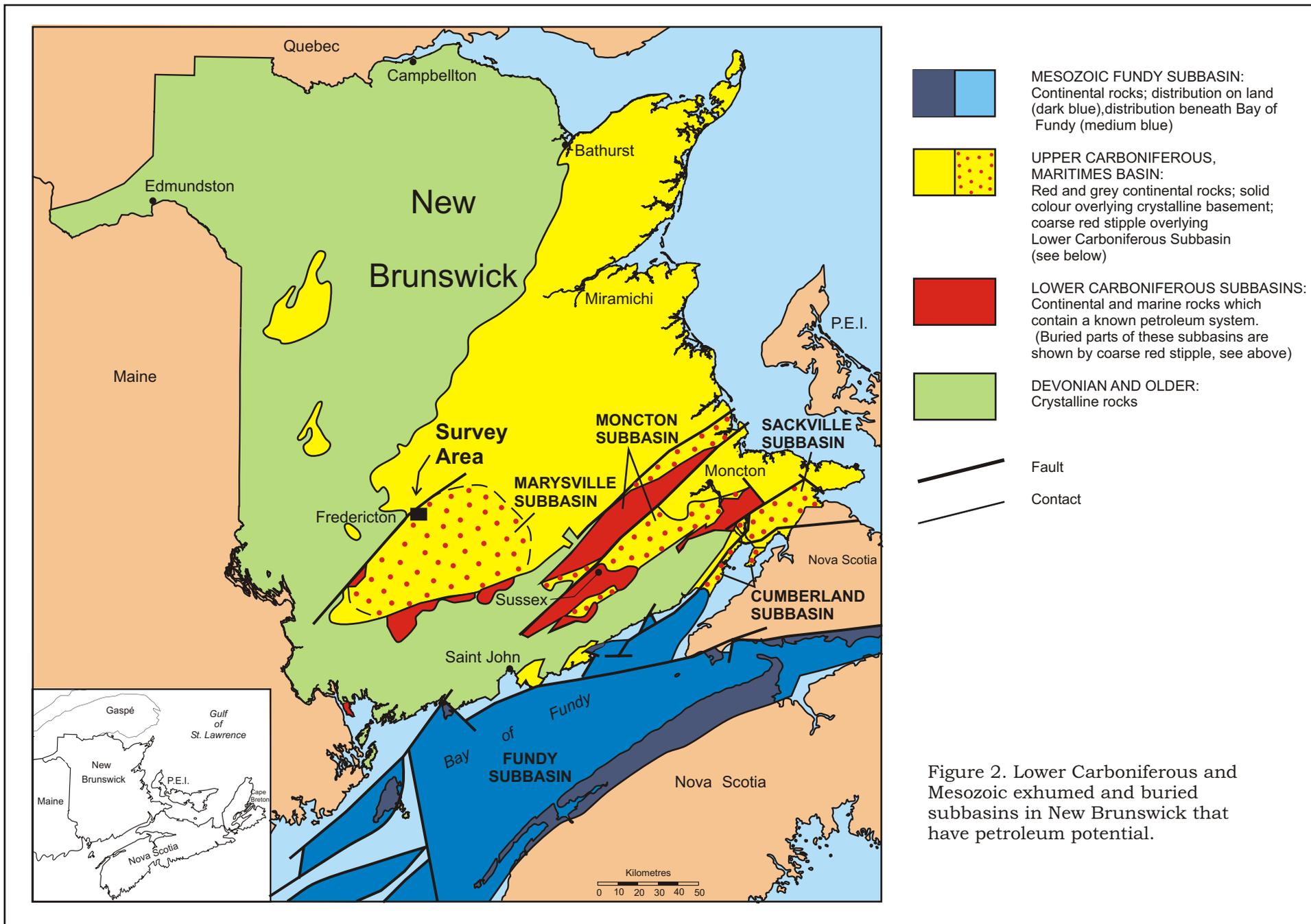




Figure 3. Oil well in Stoney Creek Field, 1938.



Figure 4. Fracturing Stoney Creek Field well with nitroglycerin, circa 1940.

In 1947, New Brunswick Gas and Oilfields Ltd. was purchased by New Brunswick Oilfields Ltd. (NBO), which farmed-out part of its Lease 115 rights to Shell Oil Company. Shell was the first major petroleum company to enter New Brunswick. Between 1947 and 1950, Shell carried out extensive geological and gravity studies and limited seismic surveys. The geological results were published in a paper by Gussow (1953), which for nearly 30 years was considered the only necessary reference on New Brunswick Carboniferous geology. In its tenure in the province, Shell drilled five exploration wells, but no commercial production was achieved.

In 1957, Imperial Oil Ltd. entered a partnership agreement with New Brunswick Oilfields Ltd. on a 40 000 ha tract within Lease 115 in the southeastern part of the province, exclusive of the Stoney Creek Field. Imperial undertook gravity and 128 km of seismic reflection surveys from which it spudded six exploration wells. No significant discovery was made from the Imperial work. Imperial had chosen its prospects mainly on the basis of seismic definition. In retrospect, seismic reflection in the 1950's was probably not capable of defining prospects in terrestrial basins as structurally deformed (inverted) as the Moncton Subbasin is, and therefore it is not surprising that no discovery was made.

In 1962, Western Decalta Petroleum Limited purchased New Brunswick Oilfields Ltd. and assumed the rights to Lease 115. Western Decalta retained New Brunswick Oilfields Ltd. as a separate company to continue looking after its New Brunswick interests. In 1967, Western Decalta undertook a secondary recovery water flood of the Stoney Creek field. The water flood did achieve a short term increase in oil production, but some of the better oil wells were in part watered out and the project was therefore abandoned (Foley, 1989).

Western Decalta drilled in 1973 a wildcat well, NBO Urney 72-1, at Urney about 10 km southeast of Sussex (Figure 2). Later in 1973, the company granted Weaver Oil and Gas Corporation of Houston a seismic and drilling option. Weaver put together a three-company consortium composed of Home Oil Co. Ltd., Kerr-McGee Corporation, and Pan-Canadian Petroleum Ltd. They conducted 112 km of seismic reflection profiling on 14 lines in the Moncton Subbasin (Three-D GeoConsultants Limited, 1990). In 1975, Kerr-McGee drilled a well at Urney and in 1976 the

three-company consortium drilled a well in the Urney area named MacLeod Brook No. 1. Minor shows of oil were noted in the wells, but no significant discovery was made (Wilson and Ball, 1983).

Western Decalta sold the Stoney Creek Field lease in 1974 to Aldis Petroleum who in turn sold it to Eastern Canada Hydrocarbons in 1977. Irving Oil Ltd. acquired the production lease from Eastern Canada Hydrocarbons in 1979. Irving still holds the production rights to the Stoney Creek Field (Figure 5).

In 1965, Hudson's Bay Oil and Gas Company Limited (HBOG) started an exploration program in eastern Canada by acquiring 7 on-land exploration licences comprising about 233 100 ha east and southeast of Bathurst (Figure 2). Between 1965 and the voluntary cancellation of the company's licences in 1968, HBOG drilled 4 holes with depths of 650–740 m. Two of the holes intersected crystalline basement rocks. Records are not clear on what geological or geophysical evidence the company used to decide on drilling targets. There was no known seismic or gravity data available in the area at the time. The magnetic maps available suggest targets were drill on highs as well as lows.

In 1979, the large tract of land held under Lease 115 by Western Decalta Petroleum Limited and its affiliate New Brunswick Oilfields Ltd. terminated. Western Decalta applied to the provincial government to have the historical lease converted to a series of exploration licences to search in compliance with New Brunswick's new Oil and Natural Gas Act, Chapter O-2.1 (1976). This request was granted in 1980 and 29 licences to search with a total area of 679 330 ha were issued covering nearly all of the Carboniferous Maritimes Basin in southern New Brunswick (Figure 2). In 1981, Irving Oil Ltd. and Chevron Canada Resources Ltd. formed a partnership and signed a farm-in agreement on the 29 licences to search held by Western Decalta Petroleum. Under that agreement, Chevron undertook 1906 km of seismic reflection studies on-land in southeastern New Brunswick from 1981 to 1984 (St. Peter and Phillips, 2000). The Irving/Chevron partnership drilled three exploration wells in the Moncton Subbasin in the early to mid-1980's based on seismically defined targets in the Albert Formation. A sub-commercial natural gas discovery was made south of the Stoney Creek Field in their Hillsborough No. 1 well in 1985. The partners decided not to produce the Hillsborough well; they cemented and abandoned it in 1993.

Irving/Chevron also drilled two wells on Irving's Stoney Creek lease during 1985. They used one of the wells, East Stoney Creek No. 1, to conduct a single cycle steam injection secondary recovery scheme with the hope of increasing oil production from the well. The project was cost shared with the Federal Government and the province of New Brunswick under the 1984–1989 Mineral Development Agreement. The major conclusions from the steam recovery trial were: (1) the Stoney Creek oil contains about 19.5% wax; it has a high pour point (15°C) and a low cloud point (23°C), and thus oil recovery is very temperature sensitive, (2) the cyclic mechanism of steam injection is not suited to the Stoney Creek reservoir due to the lack of reservoir energy to drive the fluids to the well bore after the injection phase is completed, and (3) any further enhanced recovery techniques will have to increase pressure in the reservoir as well as supply heat.

In 1987, the 29 licences of Western Decalta Petroleum Limited expired. Prior to their expiration, the licence area south and east of the Stoney Creek Field was converted to three leases with an aggregate area of 1135 ha. Western Decalta cancelled the three leases in 1992. However, in doing so, the farm-in partners, Irving Oil Ltd. and Chevron Canada Resources retained the rights to the Irving/Chevron Hillsborough No. 1 well.

In 1991, J. A. Seglund Inc. of Louisiana acquired a licence to search on 10 058 ha of land south and east of the Stoney Creek Field. In 1993 and 1995, Seglund added to his holdings by gaining the rights to two adjacent licences to search comprising 19 053 ha (Figure 5). In 1997, Seglund signed a farm-out agreement on his licences with MariCo Oil and Gas Corporation. Under this agreement, in 1998 MariCo drilled a well, MariCo Downey No. 1, in which a potentially commercial quantity of natural gas was discovered (Figure 6). The Downey No. 1 well is only 100 m from the

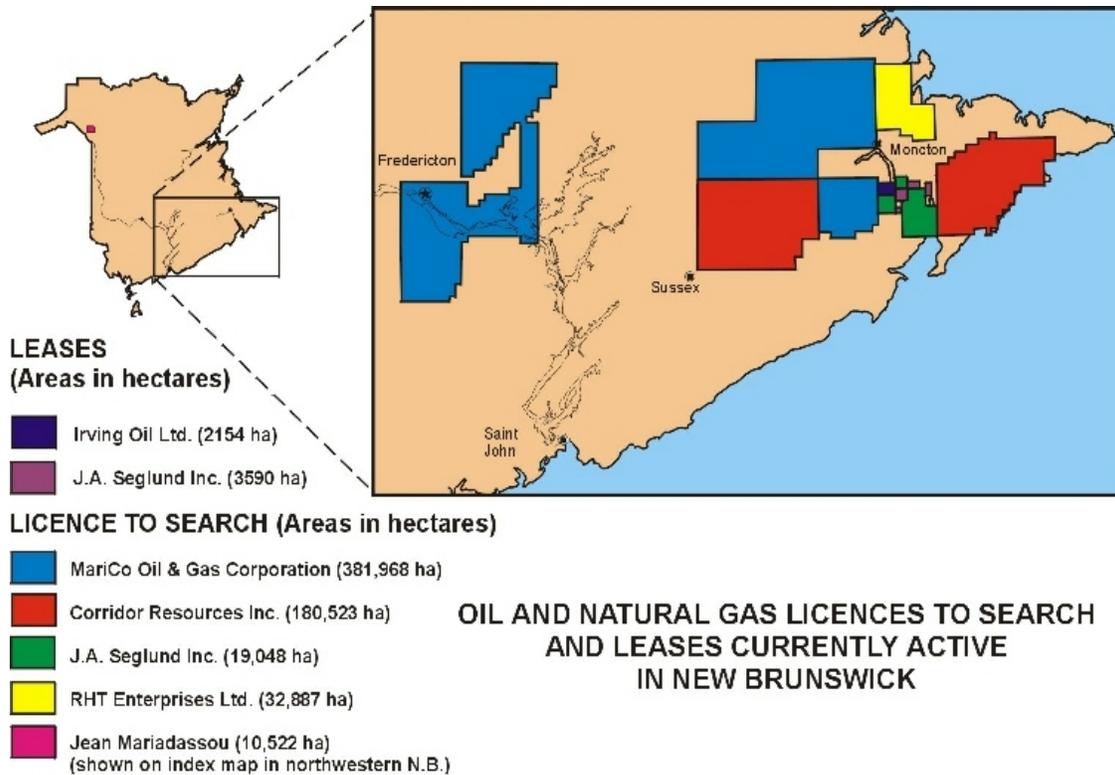


Figure 5. Oil and natural gas Licences to Search and Leases currently active in New Brunswick.

former Irving/Chevron Hillsborough No. 1 well. The Downey well is presently shut in. MariCo fracked the well in early 2000. The results of that work have not been released yet. A step-out well, MariCo Bull Creek No. 1, was drilled 850 m southeast of Downey No. 1 in 1999. The step-out well had to be abandoned short of its target depth when the bit got stuck in the hole. Additional development wells are planned for the “Downey Structure” in the near future.

In 1992, RHT Enterprises Ltd. of Moncton, took out two oil and gas licences to search (33 886 ha) northeast of Moncton and outside of the Moncton Subbasin (Figures 2 and 5). The company has drilled two dry holes on its licences. The second hole, RHT Lakeside No. 2, cut a section of Upper Carboniferous strata setting on crystalline basement at a depth of 960 m. The RHT wells suggests there is very limited petroleum potential in this extra-basinal area.



Figure 6. Discovery crew and gas flare at MariCo’s Downey No. 1 well, 1998.

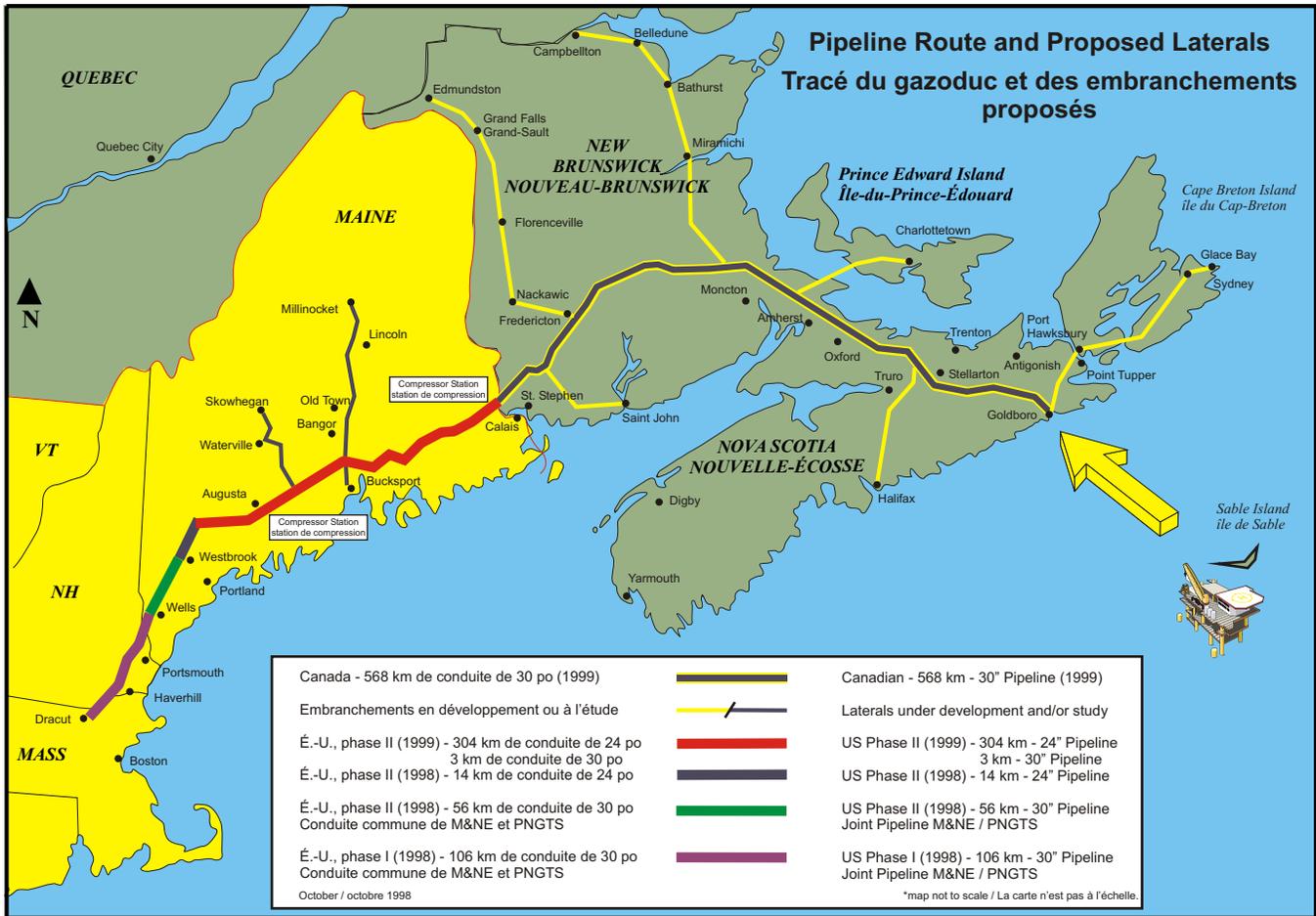


Figure 7. Maritimes and Northeast Pipeline route in eastern North America.

In 1993, Ardent Resources Inc. of Buffalo, New York acquired a licence to search on a 33 412 ha block about 20 km south of Moncton and immediately west of the Stoney Creek Field. The company undertook geological studies, geological modeling and a review of available Irving/Chevron seismic reflection lines. In 1997, Ardent transferred its licence to search to a newly formed New Brunswick subsidiary, MariCo Oil and Gas Corporation. MariCo drilled two dry wells on its licence near Steeves Mills in 1997. In early 1998, MariCo spudded a third well, MariCo Downey No. 1, under a farm-in on J. A. Seglund Inc. land and made a significant gas discovery (Figure 6).

In 1997, considerable excitement was generated in eastern Canada by the anticipated announcement of the construction of the Maritimes and Northeast Pipeline that would bring Sable Island gas through New Brunswick to New England (Figure 7). Buoyed by the potential development possibilities, MariCo acquired the rights to two large blocks of land in New Brunswick. In 1997, the company purchased five licences totaling 160 978 ha north, west and southwest of Moncton. In 1998, MariCo picked up eight licences with a total area of 187 610 ha in the Marysville Subbasin near Fredericton (Figures 2 and 5).

In 1999, MariCo formed a joint venture arrangement with Columbia Natural Resources Canada Limited by which Columbia acquired a 50 percent working interest in all of MariCo's New Brunswick licences and a 50 percent interest in the Downey No. 1 discovery well. At the time of this writing, MariCo and Columbia had drilled two exploration wells in the Taylor Village and Albert Mines areas (Figure 1). The wells were located adjacent to oil shale holes previously put down by Shell Canada Limited in 1998. Encouraging oil shows have been noted in the cores recovered by Shell.

Corridor Resources of Halifax, Nova Scotia has successfully bid on three land sales in New Brunswick in the 1990's. In 1995, the company picked up four licences (78 774 ha) in the Sackville Subbasin (Figures 2 and 5). In 1997, Corridor took out three licences (65 763 hectares) about

40 km southwest of Moncton and in 1998 the company won two more licences (35 985 ha) just southwest of their 1997 blocks (Figure 5). In the fall of 1999, Corridor drilled a deep well (2644 m), Corridor/Columbia Will DeMille No. 1, on its 1997 licence area. The well was dry. Also in 1999, Corridor signed a joint venture Agreement with Columbia Natural Resources Limited by which Columbia purchased a 50 percent working interest in Corridor's licences in the Sackville and Moncton subbasins.

**Stoney Creek Field:** A brief review of the discovery and exploration history of the Stoney Creek Oil and Gas Field is given in the section above. The objective of this section is to provide a summary account of the geology of the field and offer some data on reservoir characteristics and production history.

The significant geological reports on the Stoney Creek Field are given by Henderson (1940), Gussow (1953), Howie (1968), Hea (1974) and Foley (1989). A few additional notes are given by St. Peter (1992) on the interpreted environment of deposition of the reservoir sandstones and accompanying interbedded mudrocks and oil shales.

The Stoney Creek Field lies 15 km south of Moncton and immediately west of the Petitcodiac River. The formerly productive reservoir had an east-west strike length of 3.6 km and a dip width of about 2 km. The field is within the Lower Carboniferous Albert Formation, which in this area dips 15–20° south towards the axis of the Weldon Syncline. The Albert Formation is conformably underlain by the Memramcook Formation redbeds which lie upon crystalline rocks of the largely buried Westmorland Uplift. The Albert Formation at Stoney Creek is conformably overlain by redbeds of the Weldon Formation along the southern half of the field. The tilted up-dip edge of the Albert and Weldon formations are unconformably overlain by nearly horizontally disposed redbeds of the Hopewell Cape Formation. The Hopewell beds are in turn succeeded by quartzose conglomerates and sandstones of the Upper Carboniferous Boss Point Formation.

The Albert Formation at Stoney Creek comprises grey mudstones and siltstones with lesser interbedded kerogenous mudstones, oil shales and fine- to coarse-grained sandstones. The sandstones are the reservoir beds. They comprise amalgamated sandstone-dominated sections which occur as lenticular bodies within the mudrocks. Individual sandstone lenses are up to 30 m thick (Howie, 1968; Foley, 1989; St. Peter, 1992). The lateral dimensions of individual sandstone lenses are less clear. For example, a three-D seismic survey has never been shot over the field. However, there have been 163 wells drilled within or closely adjacent to the field. Drill logs for these wells and 'virgin' pressures in wells drilled as close as 300 m to producing wells, suggested to Henderson (1940) that the sand lenses are probably in the order of 300–800 m in lateral extent (Foley, 1989).

The oil and/or gas producing sand lenses at Stoney Creek occur over a stratigraphic interval of about 800 m (Howie, 1968, his figure 10). The oil-producing sands were restricted to the southeastern part of the field and to the lower one-third of the formation. The oil sands are overlain by a widespread kerogenous mudstone and oil shale interval. Above the oil shales there are two main gas-producing sandstone packages which have been crudely correlated throughout the field (Henderson, 1940; Howie, 1968; Foley, 1989).

Correlation of lithologic logs from wells in the field indicate the Stoney Creek reservoir is in part a structural and in part a stratigraphic trap. It is structural in the sense that it dips gently to the south, and it is stratigraphic in that the sand lenses appear to pinch out up-dip into mudstones (Howie, 1968; Foley, 1989).

Porosity of Albert Formation sandstones in general vary up to 20 percent. Porosity measurements on numerous sandstones in the Irving/Chevron East Stoney Creek No. 1 well via the Helium

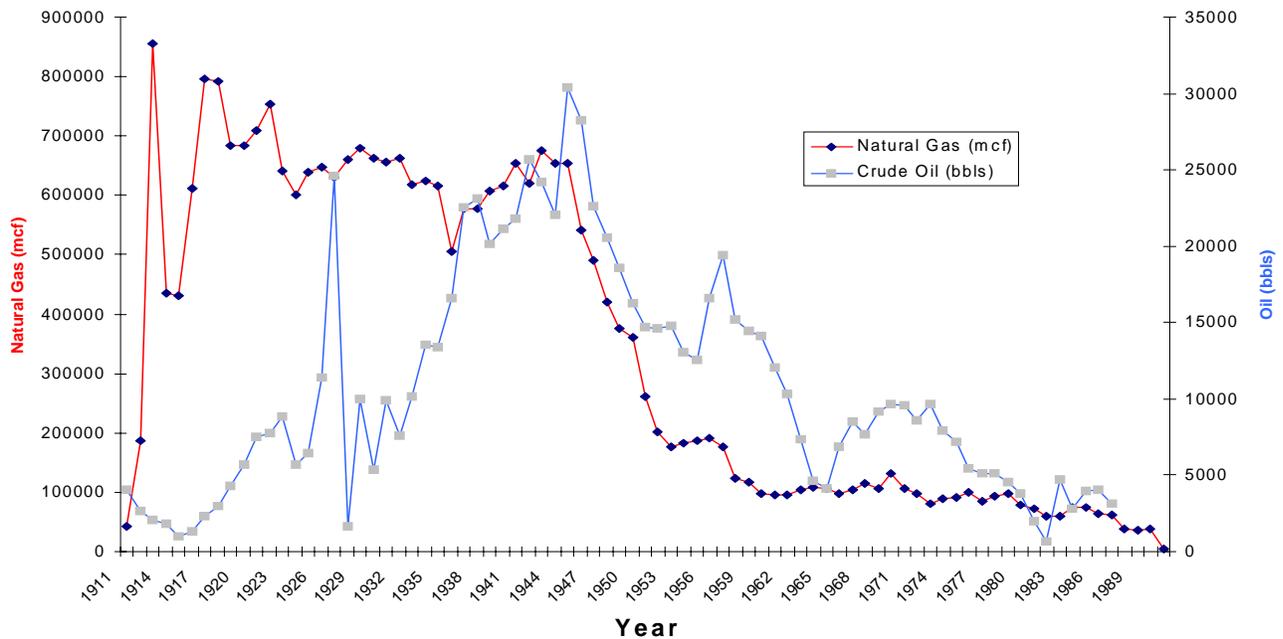


Figure 8. Annual oil and gas production, Stoney Creek Field.

method and by Density Logs show a range of values from 8 to 20 percent (Chowdhury and Noble, 1992). Well data submitted by Irving and Chevron for their Stoney Creek No. 1 and East Stoney No. 1 wells also give porosities for the cleaner Albert sandstones of 10–20 percent. Permeability of Stoney Creek sandstones are reported in the well files for Irving/Chevron Stoney Creek No. 1 and East Stoney Creek No. 1 as ranging up to 100 millidarcies. Similar values have been reported by Chowdhury and Noble (1992).

The composition of a natural gas sample from the Stoney Creek Field pipeline is given in Henderson (1940) as methane (75.4 %), ethane (23.2 %), oxygen (0.2 %), nitrogen (1.2 %) and carbon dioxide (nil). Analyses of gas from six wells in the field are quoted in Howie (1968) with the following ranges: methane (73.4–82.1 %), ethane (14.5–20.4 %), oxygen (0–0.7 %), nitrogen (1.1–7.3 %), carbon dioxide (0–0.7 %), helium (0.001–0.069 %) and hydrogen sulphide (undetected).

An analysis of Stoney Creek crude from a storage tank at the field is given in Hume (1932): Specific Gravity at 60° F = 0.8388, API Gravity at 60° F = 37.2, Viscosity at 70° F = 277 seconds, Sulphur 0–0.2 %, and Nitrogen 0.2 %. Very similar values, except for viscosity, are given for a sample described by Henderson (1940). He gives a Saybolt viscosity at 70° = 127 seconds.

Samples of crude from three wells at Stoney Creek were submitted to the CANMET Laboratory of Energy, Mines and Resources Canada in 1984 (St. Peter, unpublished data). The following results were obtained: Water content (0.05–4.5 vol. %), Emulsion content (0.15–10.5 vol. %), and emulsion free oil: API Gravity at 60° F (32.7–35.2), Kinematic viscosity (cSt) at 77° F (30.6–33.4) and at 100° F (19.0–21.5), Pour point (45–60° F), Vanadium (0.2–0.4 ppm), Nickel (1.6–1.9 ppm), Carbon (83.2–86.6 wt. %), Hydrogen (13.4–14.1 wt. %), Nitrogen (0.07–0.09 wt. %), Oxygen (0.5–1.3 wt. %), Total sulphur (0.05–1.3 wt. %). The major organic groups in the same three oil samples were: Paraffins (68.4–72.8 wt. %), Olefins (3.7–8.7 wt. %), Naphthenes (13.7–22.0 wt. %), and Aromatics (4.8–6.3 wt. %).

The annual oil and natural gas production records held by the New Brunswick Department of Natural Resources for individual wells at Stoney Creek are incomplete. Anecdotal information is given in Hume (1932), Henderson (1940), Gussow (1953), and Howie (1968). Hume states that a

number of the better gas wells had an initial production of 10 000 mcf per day and the best well had an initial flow of 18 000 mcf per day (Henderson, 1940). Several oil wells had initial production greater than 30 barrels per day. The best well yielded 110 barrels per day (Hume, 1932; Henderson, 1940).

The annual oil and gas production history of Stoney Creek Field is summarized in Figure 8. It is apparent that the gas production very quickly climbed to a peak by 1914 and remained fairly constant at 600 000–700 000 mcf per year until 1947. During this time wells were being drilled to offset the decline in production of earlier producers. By the late 1940's the reservoir had been quite thoroughly drilled. During the 1950's the field underwent a very rapid decline in gas production. From about 1962 to closure in 1991 the total gas output was at about 100 000 mcf per year. The total natural gas production from Stoney Creek is estimated at 28 704 186 mcf (28.7 bcf).

The history of oil production from Stoney Creek assumed a more typical bell-shape distribution (Figure 8). Production gradually grew from 1021 barrels in 1915 to a high of 30 370 barrels in 1945. Like the trend with gas, oil suffered a major decline in production in the late 1940's and 1950's. By 1965 the annual output had slumped to 4103 barrels. In the late 1960's and 1970's oil production saw a modest rejuvenation. In 1988 the few remaining active oil wells were shut-in and no production has been taken since. The total oil production from the field is recorded at 803 809 barrels.

### **OFF-SHORE (BAY OF FUNDY)**

Mobil Oil Canada Ltd. was issued 19 oil and natural gas licences to search in the Mesozoic Fundy Subbasin beneath the Bay of Fundy in 1973 (Figure 2). The licences covered an area of 508 560 ha in the New Brunswick part of the Bay. Prior to the issuance of the licences, Mobil had carried out 4 seismic reflection surveys in the Bay of Fundy between 1968 and 1973. The seismic lines were shot in both the New Brunswick and Nova Scotia parts of the Bay and comprised a total of 2710 line kilometres (St. Peter and Phillips, 2000). By 1975, Mobil Oil Canada Ltd. had formed a partnership arrangement with a group of companies, and the consortium drilled a deep well (3664 m) in the Bay 50 km southwest of Saint John (Figure 2). The well, Mobil-Gulf Chinampas N-37, cut a Mesozoic sequence of redbeds and a terrestrial basalt.

Chevron Canada Resources Limited as one of the partners in the Mobil consortium undertook three separate seismic reflection surveys in the Bay of Fundy in 1981, 1982 and 1983. The three surveys comprised 1919 km and were shot in both the New Brunswick and Nova Scotia parts of the Bay.

In 1983, the consortium with Chevron Canada Resources Limited as the licence operator drilled a second well in the Fundy Subbasin. This well, Irving/Chevron Cape Spencer No. 1, was drilled southeast of Saint John and just off shore. It was put down to a depth of 2587 m; it was dry and intersected Mesozoic continental rocks lying on crystalline basement.

In 1985, the 19 Mobil licences were transferred to the consortium of eight companies. Among those companies were Chevron Canada Resources Limited (as the operator of the licences) and Irving Oil Limited. Later in 1985, the licences were converted to 8 leases with a total area of 44 268 ha. The leases were issued to Chevron Canada Resources Ltd., who cancelled the leases in 1987. In the past twelve years there has been no exploration activity in the Fundy Subbasin.

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