THE GEOLOGICAL SURVEY OF CANADA and THE PETROLEUM INDUSTRY - A PARTNERSHIP OF DISCOVERY

by
William R. S. McLellan
President, The Petroleum History Society

A Paper Delivered to The Petroleum History Society at the Luncheon Meeting of September 25, 1992; and at the Glenbow Museum Library as part of the GSC's 150th Anniversary Celebrations on September 30, 1992.

The Geological Survey of Canada is older than the country itself and has served Canada with distinction for 150 years now, making it one of the country's oldest and most valued institutions. From its beginnings in Upper and Lower Canada in 1842, the Survey has grown into one of the world's most prestigeous scientific organizations. In addition to its extensive scientific contributions to Canada and the world, the Survey, with its systematic search to reveal Canada's extensive mineral and energy resources, lead the way in explor ing and mapping this vast land.

The Geological Survey of Canada arose 9 years after Doctor Rae, a member of the Parliament of Upper Canada, petitioned for financial assistance to conduct a resource survey of Upper and Lower Canada. Widely supported by political notables of the day, a petition was placed before the first United Parliament of Upper and Lower Canada following the Act of Union in 1840. The parliament debated the petition and on September 10, 1841, resolved:

> "that a sum of money not exceeding 1500 Pounds Sterling, be granted to Her Majesty to defray the probable expense in causing a Geological Survey of the Province of Canada".

In 1842, the Government appointed William E. Logan as Director and the Geological Survey of Canada was born. Under Logan's 27-year leadership, in addition to extensive geological mapping of the embryonic Canada, the Gaspe Peninsula and the Maritimes were surveyed. The coal measures of Nova

Scotia were investigated in considerable detail.

In the earliest years, and even to a considerable but somewhat lesser extent today, geologists with the Survey were jacks-of all-trades. Often penetrating areas of the Canadian wilderness that no white man had been before, they were true "explorers" in the 19th Century meaning of the word, acting as geographers, topographers, biologists, and ethnologists (ethnology is the study of human races and their characteristics). They collected information on weather, flora and fauna, water power and agricultural potential; as well as natural waterways for navigation, often mapping rivers and lakes for the first time. They conducted the earliest systematic exploration of the northern half of the North American continent and the islands of the Arctic beyond, recording for the first time the history and customs of many native North American cultures.

As the importance of mineral wealth, including petroleum, in any part of the country became an important consideration of businesmen or politicians, the officers of the Survey played a critical role in the initial investigations and appraisals. The Geological Survey of Canada continues to do this today, particularily in the remote northern regions of the mainland and in the Arctic Islands.
The partnership between the Geological Survey of Canada and the Canadian petroleum industry began long before the epoc-making discovery of oil in Western Canada at Leduc in 1947 or even the first significant gas discovery at Bow Island in 1908.

It began decades earlier with the pioneering explorations of the intrepid Survey geologists and their field party assisants, many of whom went on to illustrious careers in the burgeoning petroleum industry. As exploration for oil and gas in Canada took the industry beyond the plains of Western Canada into the Rocky Mountain foothills, the mainland Northwest Territories and the Yukon, then the Arctic Islands and into the marine areas off Canada's eastern, western and northern coasts, the geoscientists of the Survey led the way - on foot, snowshoe, or horseback; by truck, canoe, ship, aircraft, or satellite.

Today, the partnership between the petroleum industry and the Survey is personified in the Geological Survey's Institute of Sedimentary and Petroleum Geology here in Calgary. All in all, the partnership has been a very fruitful one, with many major scientific, economic, and social accomplishments.

Let us now look more closely at the history of the Survey and its relationship with the petroleum industry, set within the context of significant events in the history of the petroleum industry and of Western Canada. I will focus, primerily, on events and accomplishments prior to 1900.

While the young Geological Survey was engaged in actively evaluating the mineral assets of Upper and Lower Canada, and the maritime areas to the east, the explosive settlement of the American West was causing considerable concern to those living in or responsible for the vast regions of British North America to the west, particularily Rupert's Land then owned by the Hudson's Bay Company.

In 1846, the International Boundary was established along the 49th parallel of latitude, extending all the way from the Lake of the Woods to the Pacific Coast just south of the frontier town of Vancouver. The boundary, however, would not be surveyed until many years later, beginning in 1873.

In 1846, very little was known of the economic potential of the north-west frontier and very little was done to expand this knowledge-base until the British and Canadian Governments both launched independant explorations of the area in 1857.

Captain John Palliser was commissioned by the British Government and the Royal Geographical Society to lead the first scientific expedition into the west with instructions to explore "that portion of British North America which lies between the northern branch of the River Saskachewan and the Frontier of the United States and between the Red River and the Rockies". With Palliser was Dr. James Hector, surgeon and geologist, who produced the first geological maps of the areas later to become western Saskatchewan and Alberta.

In July of the same year, 1857, the Canadian Government organized and dispatched an expedition led by Henry Youle Hind, Professor of Chemistry and Geology at Toronto's Trinity College. This expedition examined "the country between Lake Superior and the Red River of the North". The following year, Professor Hind returned to explore the area west of the Red River and south of the Saskatchewan River as far as the elbow of the South Branch of the Saskatchewan River.

In Professor Hind's detailed instructions from the Provincial Secretary, he was told to:

> "In relation to its geology, you will be guided by the memorandum furnished you by Sir William Logan; giving especial attention, as far as lies within your power, to the following points:
>
> 1. The boundaries of formations.
> 2. The distribution of limestone,
> 3. The collection of fossils.

4. The occurrence of economic minerals (petroleum would be included here).
5. The exact position of all facts, and the attitude of the rocks."

Professor Hind's final reports, published in Toronto and London, included, not suprisingly, detailed geological maps and cross sections, as well as rock and fossil descriptions.

Also in 1857, a Mr. J. M. Williams bought the land and petroleum rights to the Ontario gum beds of Charles Nelson Tripp, who had founded the first oil company in North America to produce asphalt. On his newly acquired property, Williams hand-dug and cribbed a well 49 feet deep upon the advice of Geological Survey geologists, Sir William Logan and Thomas Sterry Hunt. The well was completed in 1858. It produced as much as 150 gallons of crude oil per hour by hand pump.
The crude oil was refined for illuminating oil and lubricants.

This success led to Canada's first oilfield at Petrolia, Ontario.
The long and rewarding relationship between the petroleum industry and the GSC was born !

The Drake well on Oil Creek near Titusville, Pennsylvania launched the first North American oil boom the following year.

In 1861, Thomas Sterry Hunt of the Survey, formulated the anticlinal theory of oil and gas accumulation. Over the next four years, he determined that oil and gas fields required: a petroleum source bed, the proper attitude of the strata, porous rocks to provide a reservoir for the fluids, and impervious beds above the reservoir to trap or contain these fluids. Eastern Canadian oilmen did not readily accept this radical new theory until American geologist I. C. White demonstrated success using the theory while exploring for natural gas in West Virginia. Officers of the GSC and American oilmen brought this practical scientific concept to Western Canada some years later.

As the North American petroleum industry was being launched, so too were significant political steps occuring that would change the political face of the continent profoundly. The enactment of the British North America Act of 1867 resulted in the Confederation of Canada, and included the provision for the new country to assume administration for Rupert's Land. Three years after Confederation, in May of 1870, the Government of Canada finally completed the purchase of Rupert's Land from the Hudson's Bay Company and the next day created the province of Manitoba. With British Columbia entering Confederation in 1871, Canada had assumed responsibility for all lands to the north and west of The

Lake of the Woods as far as the Pacific and Arctic Oceans, excluding of course, Alaska. Within this vast territory would soon be found the oil and gas riches we know of today.
As settlement both south and north of the 49th parallel expanded westward, it was obvious that the international boundary would have to be surveyed and deliniated on the ground. The International Boundary Commission was named and George Mercer Dawson was appointed geologist. Dawson, who was later to join the GSC and become its Director from 1895 to 1901, noted in his report of 1875, mineral pitch in the Athabasca area where

> "there is every possibility that flowing wells might be obtained without going to any great depth"

and that Devonian rock in Western Canada

> "where it is to a great extent covered by Cretaceous rocks, would if properly explored, be found to yield mineral oil as well as salt."

Dawson was one of Canada's foremost explorers and map makers. He strenghthened the traditions of the Geological Survey of Canada and laid a firm foundation for subsequent geological surveys in the west, by both the GSC and the emerging petroleum industry.

In 1874, while working with the Boundary Commission, Dawson engaged a packer with the Commission, a John George Brown - the colourful Kootenai Brown as he is now fondly remembered. Kootenai was asked to approach the Indians in the area of what is now Waterton National Park and ask if they had seen any oil seepages. Just what sparked Dawson to seek an answer to this question is not known. However, Brown was to learn that the Indians indeed knew of seepages on Cameron Brook, and had used the oil for medicinal purposes for generations. Once publicised, the presence of these seepages was to attract oilmen to the Waterton area for many years, founding the ephemeral centre of Oil City.

Much of Dawson's reconnaissance work was done in British Columbia, some of it with A. R. C. Selwyn when Selwyn was Director of the Survey. Following Selwyn's first trip to British Columbia in 1871, he spent the next two summers getting aquainted with the Northwest Territories. On his field trip of July to October, 1873, Selwyn covered some 2,350 miles between Fort Garry and Rocky Mountain House. During his travels he added to his repertoire of modes of transport. While in B.C. he had used pack trains, canoes and folding canvas boats. On the prairies he added Red River carts, buckboards, and Hudson's Bay batteaux. For measuring distances, he attached an odometer to a wagon wheel. He recorded

that while crossing the prairies to Edmonton, his party averaged over 26 miles a day.

These field trips on the prairies were very frustrating to the geologist. Days might pass without sighting a single rock outcrop. However, Selwyn did record the presence of coal seams west of Fort Edmonton, and that the chances for oil and salt on the prairies were excellent.

Dr. Robert Bell of the Survey was also in the field during these years. He too was frustrated by the thick glacial drift masking the underlying geology. His work in 1873 took him into what is now southeastern Saskatchewan, between Qu'Appelle and the International Border. He was alarmed at the unrest prevailing in the Indians and Metis of the area and suggested that government activities should avoid that area until agreements were made with the Indians there. No doubt this unrest was fueled by the senseless and savage mass killing of a band of Assiniboine Indians in the Cypress Hills by white American traders from Fort Benson, Montana.

The only good thing to arise from this shameful event was a Canadian determination that such an atrocity would never again occur on Canadian soil. In May 1873, the Parliament of Canada passed an act providing for the North West Mounted Police. The great police cavalcade across the prairies left Fort Garry in July of the next year.

Dr. Bell also returned to the prairies on behalf of the Survey in the summer of 1874. No doubt feeling somewhat safer ! This time, in addition to doing the usual reconnaissance work, he undertook the first well drilling program in Western Canada.

It was hoped that these well borings would answer some of the many questions geologists had regarding the nature of the bedrock under the thick glacial drift of the prairies. Chances were considered to be good for the discovery of artesian water, coal, salt and petroleum. With the aid of an oil well driller from Petrolia, Ontario, one well reached a respectable 501 feet using a small, portable drilling outfit. In all, three wells were drilled that year. A fourth and deeper test, slated for a location near Elbow, was postponed until the next season.

In the next season, 1875, while moving the rig which had been stored at Fort Ellice over the winter, R. W. Ells of the Survey, with a driller named John Highman, had an accident. While crossing the Qu'Appelle River, the scow bearing the boiler shipped water and sank. The boiler was retrieved with considerable difficulty and repaired. As the party continued to press westward, they were halted by a party of Indians who opposed government projects in the area until a treaty had been signed. The Indian

leader advised that to continue further would be dangerous. Ells, rather than loose a drilling season, retreated to Fort Carlton on the North Saskatchewan River, where he drilled a 175 foot test hole.

Although this pioneering drilling program failed to find oil or gas, it provided very useful geological information and pioneered prairie drilling practices.

Back in Eastern Canada, while all this was going on, the flegling Canadian petroleum industry was encountering troubles. The Imperial Oil Company Limited was founded in 1880 to counteract the overwhelming competition to Canadian oil being applied by American companies. In the 10 years since the Drake well at Titusville in 1859, the Canadian oil industry based in Ontario lost its lead in oil production to the United States. By 1873, the US oil industry was supplying Europe and was even making sales in Canada. Only 3 years earlier, the 100 refineries in Ontario had satisfied the domestic market and shipped 60% of their output to Europe.

Part 1 ↑

Part 2 (continued) ↓

The stage was being set for a concentrated exploration for oil and natural gas in Western Canada.

In Western Canada, Dr. Robert Bell of the Survey continued his explorations. During the summer seasons of 1882 and 1884, Bell investigated the oil sands along the Athabasca River that had been reported to him by letter in 1873 from a Reverend Father Petitot, who travelled extensively in the region. Bell reported that along the banks of the Athabasca River that reach heights of over 200 feet,

> "over an area of at least 25 leagues (approximately 75 miles), these schistose hills exude asphalt from top to bottom. The rocks are all black with it and the banks are formed by this bituminous mass, mixed with sand and hardened by time. This liquid mineral fills the higher marshes and would be a rich mine to work."

Bell proposed that, independent of the construction of a railroad into the Athabasca area,

> "an outlet for the oil to foreign markets might be found by conveying it by steamers.....from the Athabasca River to the eastern extremity of the lake of the same name, and thence by a pipe to Churchill Harbour on Hudson Bay."

A very progressive idea. Unfortunately, getting the oil separated from the sand has proven to be much more difficult and expensive than Bell could ever have imagined.

The Canadian Pacific Railway was being built across the prairies at this time, and had reached Calgary in 1883. The steam locomotives of the day required considerable volumes of water. Consequently, the CPR was engaged in drilling water wells all along its right-of-way.

Such a well being drilled for water at Langevin Station, Alberta (now called Alderson) failed to find a worthwhile supply of water, but did produce a large flow of natural gas from a depth of 1,155 feet. The gas ignited almost immediately, destroying the drilling rig. A second well was drilled only 8 feet from the first in 1884, using gas from the first to fire the boiler. This well produced an estimated 50 thousand cubic feet of gas per day from a sand at a depth of 1,151 feet. Although the discovery was of no immediate importance to the Railway, it was the first significant natural gas find in Western Canada and encouraged the search for an economic domestic fuel for towns and cities.

A few years later, G. M. Dawson collected the data on several of these early wells in a paper entitled: "On Certain Borings in Manitoba and the Northwest Territories". In the section on the Langevin wells he prophetically noted:

> " They have demonstrated the very important fact that a large supply of natural combustable gas exists in the district....." and " it is probable that a similar supply will be met with over a great area of this part of the Northwest, and that it may become in the near future a factor of economic importance."

Also in 1884, Dawson and R. G. McConnell of the Geological Survey described the anticline on Sheep Creek in Alberta that was later to be be found to contain the Turner Valley oilfield. While they mapped the structure and prepared a detailed cross-section, they made no mention of the oil and natural gas seepages which were later to be found in the area. First recorded by black cattleman John Ware in 1888, these seepages led to William Herron's actions that eventually culminated in the first petroleum discovery of real consequence in Western Canada. It was not until the Dingman #1 discovery well in 1913 that the GSC sent Dr. D. B. Dowling and S. E. Slipper to do further work in this area.

The scientific investigation of western Canada in 1884 was taking place as a political and military drama was being enacted - the second, but this time unsuccessful, Metis rebellion in western Canada, led by Louis Riel and Gabriel Dumont.

In 1885, the Survey published Dawson and McConnell's landmark report entitled " Report on the Region in the Vacinity of the Bow and Belly Rivers, NWT". This was the first regional report on a part of Western Canada and is historically significant in that it marks the transition period from long traverses to regional surveys as policy of the Survey. These regional surveys would become, in later years, the invaluable reference tools of petroleum geologists as they followed Survey geologists into new areas for hydrocarbon exploration.

The very first well in Western Canada exploring specifically for oil was drilled in Manitoba in 1887. Early explorers, GSC geologists and several local individuals reported very petroliferous shales along the Vermilion River, describing them as having a greasy, cheese-like texture and a strong bituminous odour. W.R. Baker, the superintendent of the Manitoba and Northwestern Railway, was sufficiently interested in this discovery to found the Manitoba Oil Company. The company drilled several wells in the area, but encountered no oil. However, sufficient natural gas "shows" were encountered to provide kitchen fuel to nearby farmsteads for many years.

In 1890, R. G. McConnell carried out a geological reconnaissance of the Athabasca and Peace River areas, describing the immense deposits of oil sand exposed downstream from Fort McMurray for some 50 miles. McConnell made the first comments on practical uses for these oil sands:

> "Among the uses to which it is adapted, may be mentioned roofing, paving, insulating electrical wires, and it might also be mixed with the lignite which occurs in the neighbourhood, and pressed into briquettes for fuel."

Like Bell and Dawson, McConnell believed the oil in the oil sands originated from the underlying Devonian limestones. In 1893, McConnell joined Dawson in recommending that the Dominion Government undertake a drilling program to discover the liquid oil associated with the oil sands. The recommendation was approved and $7,000 was voted for the venture. The program, directed by the Geological Survey, commenced in August of 1893, but was abandoned without success the next year.

In 1897, the rig that was used on the aborted exploration project was moved to Pelican Portage. The well drilled at this new location encountered only a small amount of heavy liquid oil, but a tremendous volume of natural gas. Engineers and rig hands could not cope with the flows of gas and the well was temporarily abandoned.

In 1898, work resumed, but soon a tremendous flow of gas to the surface forced permanent

abandonment of the project. The flow was calculated at 8.5 million cubic feet per day and blew unabated for 21 years ! The flow was finally halted in 1918 when Survey geologist S. E. Slipper and oilman C. W. Dingman succeded in killing the well.

While the Survey was busy defining the oil sands, oil enterpreneurs were busy staking oil claims in the Twin Butte area east of Pincer Creek, creating an oil boom. The excitement generated reached Ottawa and Dr. Alfred Selwyn, Director of the Survey, travelled west to investigate. Selwyn reported that there was little in the way of fact to support the optimism being generated. In fact, it was not until 1948 that the dreams of riches were realized, with Gulf Oil's discovery of the Pincer Creek gas field.

By the year 1900, Officers of the Geological Survey had outlined the basic geological framework of the Western Canadian Sedimentary Basin and proved the existance of vast reserves of oil sand on the Athabasca River. Gas had been discovered in considerable volume and it seemed probable that commercial pools of petroleum would soon be found. Private citizens and companies had taken up the search in the last 10 years of the Century and had followed Survey geologists into every petroliferous area these scientists reported, drilling wells on the prairies, in the foothills and in the mountains.

Officers of the Geological Survey continued to take a keen interest in the activities of these individuals and companies, and assisted the operators in numerous ways, not the least of which was by continuing to map new areas in the West where petroleum and natural gas could occur. Today, we owe these dedicated scientists a debt for preserving, in their reports, detailed records of the earliest drilling and production activities.

While scientists at the Survey continued doggedly to explore and map our vast country, ever watchful for signs of oil and gas as they moved into more northerly and remote regions, for most of the first half of the 20th Century, the Canadian petroleum industry progressed haltingly, with enthusiasm and success alternately ebbing and flowing:

- in 1902, the first oil produced in Alberta came from a well drilled on Cameron Brook in the Waterton area;

- in 1909, former Survey geologist Eugene Coste made a significant natural gas discovery near Bow Island, Alberta - named "Old Glory" by area settlers;

- in 1913, the Dingman #1 well came in with a roar, producing 4 million cubic feet of gas per day and launching the first of the three Turner Valley oil booms;

- in 1923, the Royalite #4 well at Turner Valley ushered in the field's second oil boom; and

- in June of 1936, Turner Valley Royalties #1 flowed 850 barrels of oil per day and launched the Turner Valley field on its third and biggets boom of its long history.

Finally, the discovery of oil by Imperial Oil at Leduc in 1947 marked the end of the adolescence of Canada's petroleum industry - we had arrived!

Interestingly, in 1886, J. B. Tyrell of the Geological Survey, after whom the Museum of Paleontology at Drumheller is named, while mapping the rocks along the North Saskatchewan River from Rocky Mountain House to Edmonton noted, but did not recognize the significance of, the "drape" of younger sedimentary rocks over the Leduc reef.

Following the Leduc discovery, the rapid expansion of the industry, centred largely in Alberta, resulted in an unprescedented demand for geological information about this energy-rich region.

To meet this demand, the Geological Survey opened an office in Calgary in 1950. This was replaced in 1967 with a facility - the Institute of Sedimentary and Petroleum Geology - designed expressly to meet the specialized research requirements of the Survey and of the petroleum industry. In the 25 years since its establishment, the Institute has become a key source of information to the petroleum industry on the geology, geophysics, geochemistry, and resources of western and northern Canada.

The Institute's program involves multidisciplinary investigations of oil and natural gas in the sedimentary basins of western and northern Canada. These studies help scientists working in the petroleum industry to assess the country's undiscovered petroleum potential. They also generate new ideas and foster learned debate on the origin and occurence of oil and gas deposits, and generate important information that assists in the discovery and development of these deposits.

Today the Institute is involved in a number of projects of direct interest and value to Canada's

petroleum industry, including:

- a computer-based petroleum resource assessment system providing estimates of the potential oil and natural gas reserves in the various sedimentary basins in Canada,

- a study into the nature, origin, and hydrocarbon prospects of a geological area called the Peace River Arch in northwesten Alberta and adjacent B.C., and

- a joint petroleum industry - GSC venture to complete the coverage of aeromagnetic data over the Western Canada Basin.

The Institute's organic geochemical laboratory is unigue in Canada, and conducts basin-wide studies that are world renowned. The Institute's Core and Sample Repository houses cores, drill cuttings, rock samples, geophysical logs and well history files from all exploration wells in the Yukon and Northwest Territories and from many other localities by special arrangement with the provinces. These materials form the raw data for geological and engineering studies performed by both the GSC and industry, as well as by universities and provincial government agencies.

I hope this paper has shown clearly the often fortuitous relationship between the Geological Survey of Canada and the Canadian oil and gas industry. You have ~~heard~~ read of the intrepid Survey geologists as they explored the vastness of Canada, often the first people of European descent to do so, just a little ahead, sometimes "moments" behind, equally intrepid industry geologists engaged in their insatiable search for oil and natural gas.

In the early years of petroleum exploration in a region, be it the prairies, the Arctic mainland or islands, or the offshore east or west coasts, the Survey has lead the way. Industry geologists, armed with Survey maps and reports were able to target specific areas of interest, thereby saving incalculable time and expense.

In the hayday of the petroleum industry in Canada, particularily during the late '70's, many companies invested tremendous resources in their own research and reconnaissance exploration programmes. Some built lavish research facilities and were able to undertake projects rivalling those of the Survey, particularily in the far north and offshore. To some extent, the industry took over the lead held by the

GSC for so long.

Those days are gone. Perhaps forever. Today, few oil companies can afford the luxury of their own research facilities staffed with expensive experts conducting far-ranging projects.

As the industry once again becomes populated with a larger proportion of small, lean, fast-paced oil exploration companies, as it was in the earliest years, the industry must once again rely extensively on the Survey to lead the way in their mutually benefitial **partnership of discovery**.