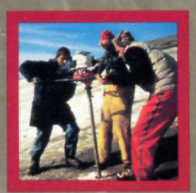
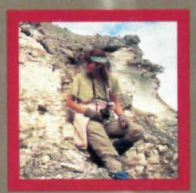
NO STONE UNTURNED

The First 150 Years
of the Geological Survey of Canada





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CANADA 1842 GEOLOGICAL SURVEY - COMMISSION GÉOLOGIQUE 1992 ANNIVERSARY 150 ANNIVERSAIRE

THE ENERGY OF OUR RESOURCES

THE POWER OF OUR IDEAS

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The First 150 Years of the Geological Survey of Canada

Christy Vodden

1992

Table of Contents

Acknowledgements

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Introduction

CANADA HAS THE SECOND LARGEST LAND AREA (AFTER THE USSR), THE LONGEST COASTLINE OF ANY NATION, AS WELL AS AN IMMENSE AREA OF CONTINENTAL SHELF. ITS POPULATION IS SMALL; THE NATURAL RESOURCES VAST.

The Canadian Encyclopedia, 1988, p.890, V.2

A comprehensive knowledge of the geoscience of the Canadian landmass and its offshore is fundamental to economic development, public safety, environmental protection and national sovereignty. To acquire, interpret and make available that information to all Canadians is the mission of the Geological Survey of Canada.

It is an immense and challenging task that encompasses four billion years of geological history. It takes the staff of the Survey to the farthest frontiers of our huge country and keeps them at the forefront of scientific knowledge and technology.

The Survey celebrates its 150th anniversary in 1992. The limits of space allow this booklet to give only a glimpse of the remarkable history and many achievements of this unique Canadian scientific agency over the past century-and-a-half and to introduce but a few of the dedicated people who shaped its course. Interested readers wishing to delve deeper into the story of the Geological Survey of Canada should turn to "Reading the Rocks" by Morris Zaslow.

The anniversary logo: the geological hammers superimposed on the map of Canada signify the importance of geology to the exploration and development of our country.

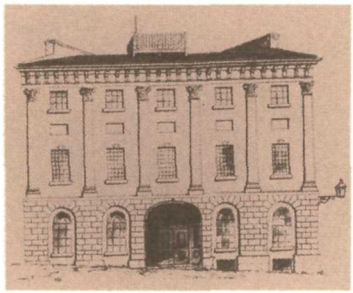
The Exploration Years

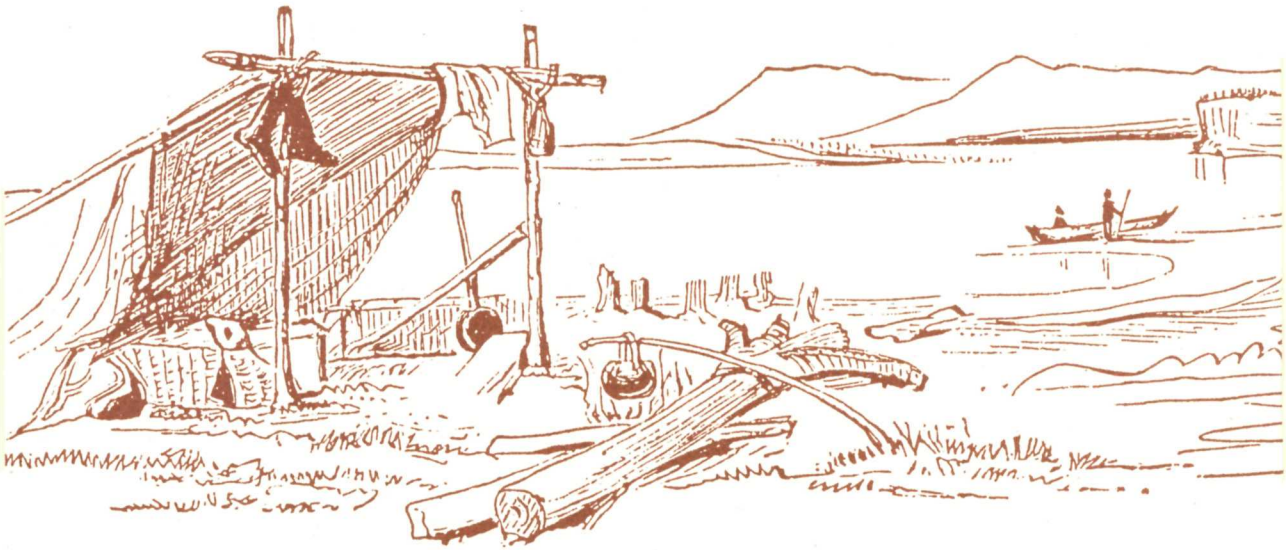
In September 1841, the Legislature of the Province of Canada (the area that is now the southern parts of Ontario and Quebec) passed a resolution "that a sum not exceeding £1,500 sterling be granted to Her Majesty to defray the probable expense in causing a Geological Survey of the Province to be made." This simple resolution gave birth the following year to the Geological Survey of Canada (known widely as the Survey or GSC), Canada's first scientific agency and one of its oldest government organizations.

The decision to undertake a geological survey of the fledgling nation was based on the realization that the development of an industrial economy in Canada — an economy that could compete with those in Europe and the United States — would depend to a considerable extent on a viable mining industry. The question was: did the Province of Canada have the resource base to support such an industry? The answer would depend for the most part on a thorough geological assessment of the landmass.

At the time, many viewed the proposed survey as a short-term way to stimulate the mining industry, thereby enriching the provincial coffers. As events unfolded, however, the Province of Canada became the Dominion of Canada, eventually stretching 5514 kilometres between its Atlantic and Pacific coasts, and 4634 kilometres from the south to the very top of Ellesmere Island. Canada now also has a vast offshore. With this growth in territory came a commensurate increase in work for the Survey.

Alexander Murray described the Survey's original home in Montreal as a "small and dark room". In 1852, Logan and his staff moved into this more spacious building which was to be their base for almost 30 years. For Logan it was also his home, as he lived in the same room that he used as an office when not in the field. The building was demolished in the 1960s to make way for a provincial courthouse.





"It will be an arduous undertaking. In the spring and summer, mosquitoes and black flies are a perfect torment in the woods where the provincial geologist will have to spend the chief part of his year, as but a small part of the Country is yet cleared. In addition to the geological features of the Country he will have to exhibit to the world the geographical. That is to say he will have to make a map of the rivers and mountains. No correct one exists."

Logan writing about the work of the fledgling Survey to H.T De la Beche, Director of the Geological Survey of Great Britain and Ireland, October 19, 1841. Image is a drawing from Logan's 1843 field journal.

Canada's huge landmass and offshore, its growing population and shifting national priorities when combined with the development of new scientific concepts and dramatic technological change have resulted in an ever-increasing demand to this day for the services provided by the Geological Survey.

William Logan and the new Survey

News that the Province of Canada planned a geological survey reached William Edmond Logan as he visited Montreal in 1841, and he quickly let his interest in the job be known. Born in Montreal and educated in Scotland, Logan began his career in his uncle's counting house in London. In 1831, his uncle had sent him to Wales to manage a copper-smelting company. Here Logan's keen interest in geology was triggered. He not only learned the business of processing ores and mining coal, but became an enthusiastic amateur geologist. Indeed, a geological map he prepared was widely acclaimed by the scientists of the day.

Logan's knowledge of geology — and his reputation in that field — increased steadily throughout the 1830s. His bid for the Canadian position was bolstered by recommendations from prominent scientists in England, and he was appointed as the Survey's first director on April 14, 1842. Four months later, Logan arrived in Kingston, then the seat of the Provincial Legislature. There, he laid the groundwork for the Survey by compiling what knowledge already existed on the geology of Canada.

The following spring he established the Survey's headquarters in a "small and dark room" in Montreal. He was joined there by Alexander Murray, a former naval officer appointed as his assistant. The work now began in earnest.

The search for coal

The rapid industrial advances in England since the late Eighteenth Century had shown how essential coal was to economic expansion. With the accepted belief that North America's destiny lay in applying industrial technology to rich natural resources, the search for coal became the Survey's first priority.

The 1843 field season saw Logan working between Pictou, Nova Scotia and the Gaspé, and Murray between Lake Erie and Lake Huron in Ontario. This established a tradition of research in the field that continues to this day. The following year, Logan, Murray and a larger party mapped the north shore of the Gaspé Peninsula and then explored inland. Their travels brought them to the mountains along the Cap Chat River, the highest of which was named in Logan's

honour by his assistants (this Mount Logan is not to be confused with Canada's highest mountain, which is located in the Yukon and also named for him).

Based on information gathered during the first two field seasons, Logan was able to report that no coal deposits were to be found in either Upper or Lower Canada. Even though the entire Province of Canada had not been searched, it was clear to him that all the rocks it contained were older than the earliest known coal-bearing formations. Consequently, there was no possibility of such deposits being found. This was disappointing inasmuch as coal was considered to be vital to the development of an industrial economy. Nevertheless, Logan's conclusion undoubtedly prevented a squandering of government and industry money on pointless and expensive exploration activities.

Logan, however, did make many important discoveries in the early days of the Survey. For example, he identified several broad geological divisions: folded rocks covering Quebec's Gaspé Peninsula and Eastern Townships; the nearly flat-lying limestones that extend west from Montreal to Lake Huron; and much older crystalline rocks extending north an unknown distance from Kingston, Ottawa and Montreal. The last soon proved to be the southernmost exposed section of the great Canadian, or Precambrian, Shield — a mineral treasure chest of unflagging interest to prospectors and resource geologists to this day.

The decision to continue

By the end of 1844 the £1,500 allocated by the government for the survey work had been spent, along with some of Logan's own money. The results of the first two years had clearly demonstrated the benefits of a systematic geological survey. As a result, in 1845, the mandate of the Geological Survey of Canada was renewed with funding of £2,000 a year guaranteed for five years.

Logan then made a pivotal decision to remain as its director rather than accept an attractive and challenging appointment in India. A colourful, well-liked man with a knack for hiring dedicated and competent people and for inspiring them with enthusiasm for geological work, Logan went on to direct the Survey for another quarter-century. In so doing, he guided the organization through its formative years and laid the foundation for decades of further work.

OCTOBER 6, 1843 — THE CAPITAL OF THE PROVINCE OF CANADA MOVES FROM KINGSTON TO MONTREAL.

Rounding out the organization

As the young Survey took root, Logan was gradually able to expand its staff. T. Sterry Hunt, a brilliant chemist, was hired in the early days and, in 1856, Elkanah Billings, a paleontologist, came on staff, thus reducing the need to send collections abroad for identification. As information was accumulated over the first decade of field studies and through other research, Logan began to envisage the systematic publication of maps. Robert Barlow became the Survey's first draftsman in 1856 and other support staff were added. By the late 1850s the Survey was a well-rounded organization capable of conducting rigorous exploration, making maps, producing reports and maintaining a public museum.

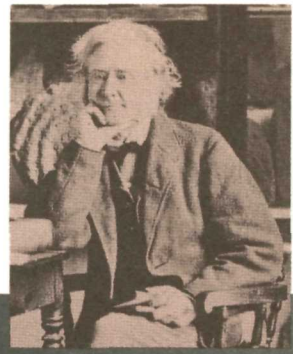
International recognition

During the 1850s, Logan and officers of the Survey put together the first major collection of Canadian mineral samples the world had ever seen as Canada's very popular contribution to the "Exhibition of the Industry of All Nations", the famous 1851 world fair in London, England. A second similar opportunity to make the world aware of Canada's great mineral wealth came in 1855 with the Universal Exposition in Paris. The GSC collections were very well-received and, in 1856, Logan was authorized to "establish a Geological Museum at some convenient place which shall be open at all seasonable hours to the public" — which he did at the Survey's headquarters in Montreal.

Canada's participation in these events stimulated international interest in Canadian minerals and brought personal honours to Logan. He was made a Fellow of the Royal Geological Society of London and later received its highest honour — the Wollaston Palladium Medal. From France he received the Cross of the Legion of Honour. However, Logan's greatest honour was his knighthood, bestowed by Queen Victoria at Windsor Castle in 1856.

Canada's first geological assessment

One of the most important accomplishments of the Survey under Logan was the publication in 1863 of the *Geology of Canada*. Representing all the work of the Survey up to that date, this 983-page book recorded everything known about Canadian geology. It received national and international acclaim for its content, style and precision. Sir William Dawson, Principal of McGill University, in his review in the Toronto *Leader* on May 6, 1864 wrote: "The value of



Self-portrait of a world acclaimed scientist, knighted by Queen Victoria and made a Chevalier of the Legion of Honour by the Emperor of France. "I fancy I cut the nearest resemblance to a scare-crow. What with hair matted with spruce-gum, a beard three months old...a pair of cracked spectacles...[and] a waistcoat with patches on the left pocket where some sulphuric acid, which I carry in a small vial to try for the presence of lime in the rocks, had leaked through."

William E. Logan

Odometer used by Logan to measure distances in flat terrain.

this work to Canada can scarcely be over-estimated.... The practical man has all that is known of what our country produces in every description of mineral wealth; and has thus a reliable guide to mining enterprise, and a protection against imposture. Even in the case of new discoveries of useful minerals which may be made, or may be claimed to be made after the publication of this Report, it gives the means of testing their probable nature and values, as compared with those previously known."

In 1869, Logan's magnificent geological map of Canada was published (the map is actually dated 1866). On a scale of 1 inch to 25 miles, it showed the geology and geography of southeastern Canada as far west as Manitoba and as far north as lakes St. John, Timiskaming, Nipigon and St. Joseph. In 1864, a smaller scale version of this same map (1 inch to 125 miles) had been printed in atlas form, making it the first comprehensive illustration of the geology of what is today the southern part of Ontario and Quebec.

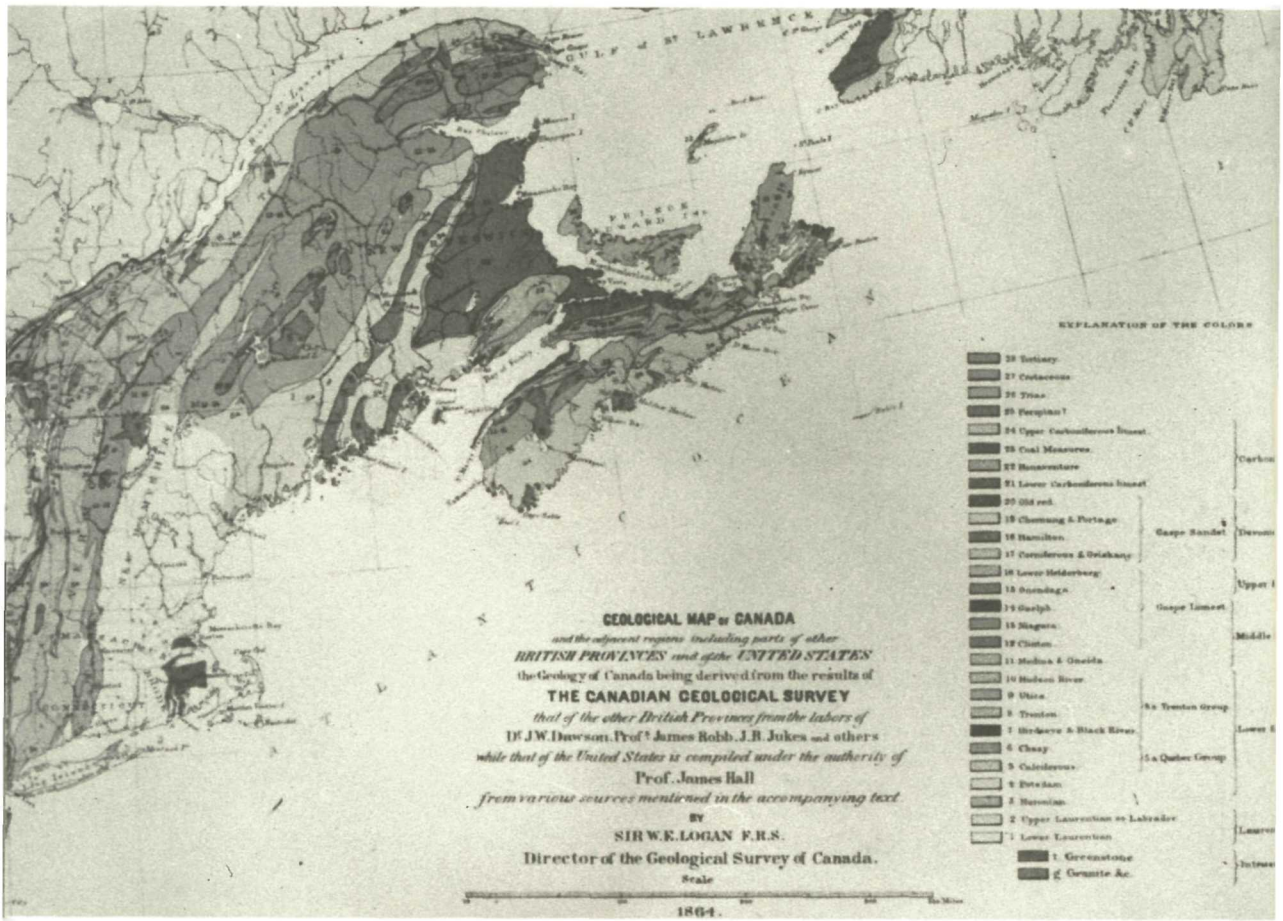
T. Sterry Hunt, North America's first geochemist, was one of the most versatile scientists of his time and one of the great geochemists and mineralogists of all time. The laboratory he established in Montreal introduced experimental chemistry in Canada; he was instrumental in the founding of the Royal Society of Canada; he even invented the green ink used to print Canadian and U.S. bank notes.

It was no doubt with a mixture of pride and sadness that Logan relinquished the reins of the Geological Survey of Canada in 1869. Approaching 70 years of age, he realized that the task of surveying the greatly expanded territory that Canada had become after Confederation must fall to a younger man. This man was Alfred R.C. Selwyn, an Englishman who from 1852 to 1869 had headed up the Geological Survey of Victoria in Australia.

Logan's contribution was summed up in the eulogy delivered to the Natural History Society of Montreal following his death in 1875. "No man has done as much to bring Canada before the notice of the outside world and no man is more deserving of being held in remembrance by the people. Just as statesmen and generals have risen up at the moment of greatest need to frame laws or fight battles for their countries, so Sir William Logan appeared to reveal to us the hidden treasures of nature just at a time when Canada needed to know her wealth in order to appreciate her greatness."

MAY 19, 1845 — THE FRANKLIN EXPEDITION LEAVES LONDON, ENGLAND SEEKING A NORTHWEST PASSAGE THROUGH THE ARCTIC.

The production of Canada's earliest maps was an arduous undertaking involving rigourous field work and painstaking hand colouring. Shown here a detail from Logan's 1864 map.



Growing with a New Canada

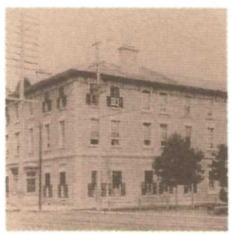
The Post-Confederation Years

By the time of Confederation in 1867 the Geological Survey was widely recognized as the main contributor to the establishment of a viable mining industry in Canada. Yet for nearly 30 years, the Survey had performed its job without any funding stability.

Securing the yearly allocation of money — or working to ensure that one of several five-year parliamentary acts was passed — represented a considerable administrative task for the small Survey staff. Finally, in 1877, Parliament conferred permanent status and the promise of continued funding on the Survey, thus enabling it to chart longer range plans.

The move to Ottawa

Recognition of the Geological Survey as a part of the government brought pressure for relocation from Montreal to Ottawa, Canada's new capital. The intention was to bring the Survey into closer association with Parliament and other government organizations. There was strong opposition to the move from the mining industry (which was then headquartered in Montreal) and from others such as McGill University. Nevertheless, by 1878 the government purchased a new home for the Survey in Ottawa — a former hotel a few blocks east of the Parliament Buildings. By 1881, the move to this building had been completed, and it served as headquarters for the Survey until 1910.



The Survey's new home in Ottawa at the corner of Sussex Drive and George Street, 1881-1910.

The packhorse was a mainstay of geological field work in the early days of the Survey. In fact, for the more rugged mountainous parts of the country, packhorses were used right up to the 1960s.

"The evidence... points to the existence in the Athabaska and Mackenzie Valleys of the most extensive petroleum field in America, if not in the world.... it is probable this great petroleum field will assume an enormous value in the near future and will rank among [Canada's] chief assets." Excerpt from GSC report to a Senate Committee in 1888. The drill rig shown here was used by the GSC at Victoria, Alberta in 1898 in an early attempt to locate commercial quantities of oil and gas in the Prairies.

Exploring the West

Confederation in 1867 brought together the existing Province of Canada, Nova Scotia and New Brunswick as the new Dominion of Canada, with Manitoba, British Columbia and Prince Edward Island joining within the next decade. The addition of these vast new lands dramatically increased the Survey's realm of operations. Although some information was known about the geology of the new eastern provinces, the immense territory to the west — a land of rugged mountains, endless forests, turbulent rivers and rolling prairies — was essentially unexplored. In many regards, this task fell to the Geological Survey.

Alfred Selwyn, following in Logan's footsteps, directed the Survey mainly from the field. As a student in Switzerland, he had become an accomplished mountain climber — a skill that proved invaluable to his extensive work in Canada's rugged new "Alpine province", British Columbia. As a condition of joining Canada in 1871, British Columbia had insisted on the construction of a railroad to link it to eastern Canada. In 1871 Selwyn, as his first task as Director of the Survey, mounted an expedition to investigate the geology and mineral resources along the proposed railroad routes.

Alfred Selwyn, Director (1869-95).

This marked the beginning of a great surge of exploratory surveys, mainly in the west and the north. It was an extraordinary challenge demanding extraordinary talents. Field work in remote uncharted wildernesses required superb frontier survival skills coupled with the eclectic scientific background necessary to record the geology, topography, the flora and fauna of the new lands being explored. Danger was a constant: J.B. Tyrrell, famous for his major fossil discoveries in Alberta, explored the vast stretches of the infamous Barren Lands, west of Hudson Bay, which were rumoured to be "swarming with cannibals". Although Selwyn's reaction to a hungry horse eating his painstakingly gathered field notes is not recorded, a sense of humour was no doubt another valuable asset.

To carry out this far-ranging work, a larger staff was required and, with the newly secured funding of the Survey, Selwyn was able to build up his staff from six parties in the field in 1870 to fourteen in 1890. That same year, Parliament passed an act making the Geological Survey a separate department of the government, reporting to the Minister of the Interior. This was solid recognition of the Survey's growing importance to the expansion of Canada's economy. The act also stipulated that scientific officers of the Survey

should normally have post-secondary training in science, thus laying the groundwork for the professional, highly-qualified scientific organization that is the GSC today.

The Klondike years

In 1895, after 26 years in the Director's chair, Selwyn was succeeded by George M. Dawson, a versatile and highly-respected scientist who had joined the Survey in 1875. Geology ran in the Dawson family. His father, Sir William Dawson, was Principal of McGill University and a noted geologist.

George Dawson's reputation was to rival that of his father's, and his importance to the exploration of Canada's north-west permanently recognized in the naming of that great metropolis of the Gold Rush, Dawson City, in his honour. Nicknamed "Klondike Dawson" by his contemporaries, he was exploring the Yukon nearly a decade before the Klondike gold discovery of 1896. Indeed, the prospectors of the Gold Rush used his maps to blaze their trails.

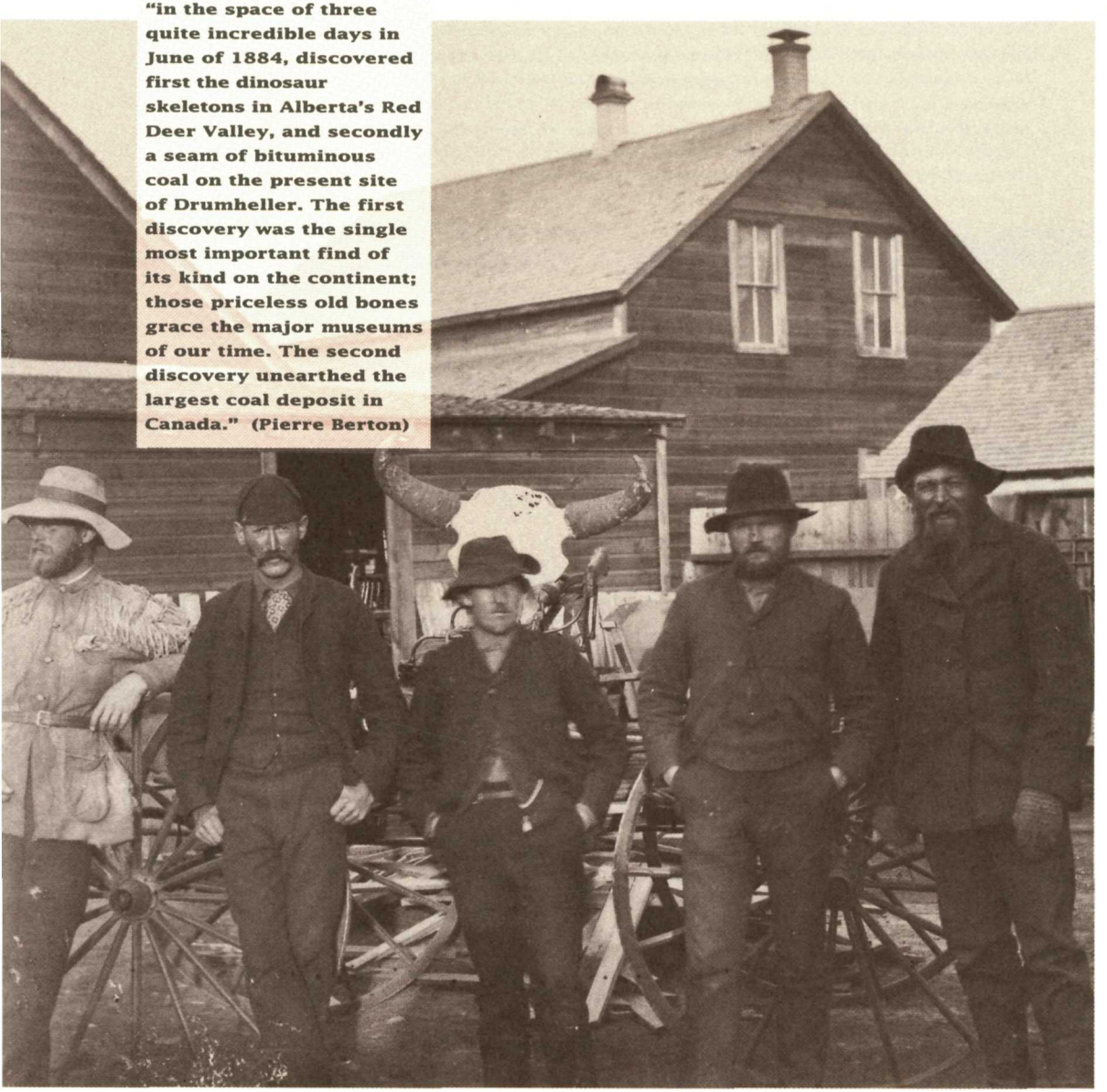
The incredible field season of 1887 saw Dawson and his assistant R.G. McConnell exploring northern British Columbia and the headwaters of the Yukon River, during which they made an arduous circuit by separate routes, on foot and by boat, of an area of 63,200 square miles (164 320 km^2) that had been previously unknown except for the accounts of a few prospectors and Indians.

Dawson's achievements seem even more remarkable given his physical condition. As a result of a childhood illness, the man who charted the Yukon's "trailless wilds" was no bigger than a boy of 12, had weak lungs, and a bent and hunched back. Dawson also carried out groundbreaking work in describing the mineral riches and geology of British Columbia. A report he published in 1877 marked a milestone in interpreting the geology of Western Canada.

In addition to his geological work, Dawson was keenly interested in the languages and cultures of North American Indians. While studying the coal deposits of the Queen Charlotte Islands in 1878, he prepared a comprehensive report on the Haida Indians. Photographs he made at that time are treasured today. Dawson also published papers about the Indians of the Yukon and northern British Columbia, the Kwakiutl people of Vancouver Island and the Shuswap people of central British Columbia.

OCTOBER 20, 1865 — THE PARLIAMENT OF THE PROVINCE OF CANADA IS MOVED TO OTTAWA.

Dawson (centre, standing) with his field party at Fort McLeod, British Columbia in 1879. "What the name of Logan signifies in relation to the geology of eastern Canada, that of Dawson stands for in the West." (F.J. Alcock) Dawson's brilliant and trail-blazing work in the Cordilleran region of northern British Columbia and the Yukon, provided a foundation for the work of many future geologists.



Joseph Tyrrell (at far left) "in the space of three quite incredible days in June of 1884, discovered first the dinosaur skeletons in Alberta's Red Deer Valley, and secondly a seam of bituminous coal on the present site of Drumheller. The first discovery was the single most important find of its kind on the continent; those priceless old bones grace the major museums of our time. The second discovery unearthed the largest coal deposit in Canada." (Pierre Berton)

Dawson was not unique in his far-ranging interests. From 1879 to 1889 the Survey was actually the "Geological and Natural History Survey of Canada", and the work of many of its officers helped build the museum's collections and the country's knowledge about itself.

Looking to the North

George Dawson died very suddenly in 1901 and was replaced by Robert Bell. Bell's association with the Survey went back to 1857, when at the age of 15 he had taken part in his first field trip in the Gaspé Peninsula. Throughout his half century of service with the Survey, he led exploration parties to all parts of Canada. He ranged as far afield as the prairies of Saskatchewan, the oil sands of the Athabasca, and north to Great Slave Lake and Baffin Island. During his lifetime he saw his extensive body of field work put to a significant purpose. The planners of the third trans-continental railway, the Grand Trunk Pacific, were able to use the vast compendium of information found in Bell's reports as the preliminary reconnaissance work required to plan the route of the track from Quebec to Winnipeg.

In 1870 Canada purchased Rupert's Land from the Hudson's Bay Company. This immense area stretched across the country from Ontario to the Rockies and north to the Arctic. Bell was a key figure in its exploration. In 1884 and 1885 he joined marine expeditions to assess the navigability of Hudson Strait and Hudson Bay. As an indication of the versatility required of Survey staff, Bell served as the parties' medical officer, in addition to which he was instructed to collect observations on geology, botany and zoology.

Under Bell's leadership, increasing attention was paid to the mineral potential of the country; Survey reports of the period looked at the nickel and copper deposits of Sudbury, the oil fields of the Gaspé and the gold deposits of Nova Scotia, to give but a few examples.

Albert P. Low succeeded Bell in 1906 and served as Director for only 18 months before being struck by severe illness. He is best remembered for his contributions to northern exploration and surveying. Undoubtedly his most important scientific work was his expedition to study the vast, unexplored Labrador Peninsula in 1894 and 1895. These surveys, on foot and by canoe, totalled 8,000 miles (12 800 km). Low's report on the expedition records the

AUGUST 10, 1876 — ALEXANDER GRAHAM BELL SENDS THE FIRST TELEPHONE MESSAGE.

John Macoun (centre) who headed up the Survey's Natural History section was very influential in the choice of the "southern" route of the Canadian Pacific Railway. Because of his conviction that the southwest Prairies were suitable for growing grain, he recommended it be routed through less valuable land. This was in opposition to other official recommendations, but was fortunately accepted by the government.

conditions his party faced: "Having with great difficulty gained the head of the Big River, we carried the survey down it, and in so doing had to pass for 50 miles (80 km) through a narrow gorge where it was impossible to make portages, and where the river... formed a continuous rapid." One of Low's men drowned as a result of a canoe spill in that treacherous gorge.

During these expeditions, Low discovered the vast iron ore deposits of the Labrador Trough. He immediately recognized and reported their economic potential, although development work did not begin for more than half a century.

Low's other major contribution to the scientific work of the Survey was in 1903-04, when he was put in charge of the Canadian Government Expedition to Hudson Bay and the Arctic Islands. Broader in scope than those Bell took part in, this marine expedition was Canada's first clear exercise of authority over its newly acquired northern lands.

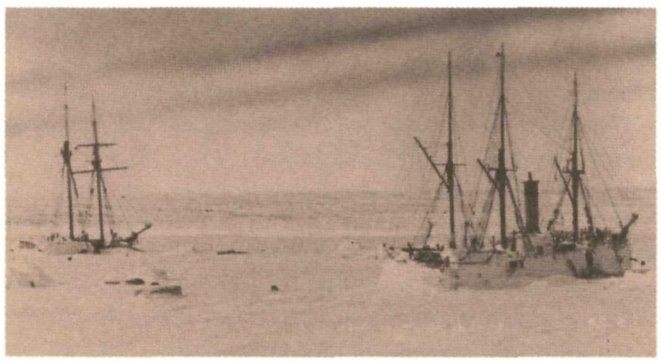
The pride of Newfoundland's sealing fleet, the steamship *Neptune*, was home for 15 months to the expedition party which included scientific staff and Northwest Mounted Police. After surveying more than 625 miles (1000 km) of the west coast of Hudson Bay and part of the west coast of Southampton Island, the expedition sailed to Ellesmere Island in the summer of 1904 and took formal possession of it for Canada. The flag was also raised on Beechey and Somerset islands before the *Neptune* returned to Halifax. Low's published account of the voyage "The Cruise of the Neptune" is a treasure house of information and photographs of the Arctic peoples they met and the new scientific knowledge they gathered about the area's geology, weather, plants and animals.

On an administrative level, Low oversaw the creation of the Department of Mines in 1907 when the *Mines Act* was passed by Parliament. The new department included the Geological Survey and the Mines Branch, an organization set up six years earlier to compile mining statistics, examine technical processes and publicize opportunities in Canadian mining. Low was appointed to head this new organization, but illness soon forced him to retire.

NOVEMBER 7, 1885 — DONALD SMITH DRIVES THE CEREMONIAL LAST SPIKE OF THE CANADIAN PACIFIC RAILWAY AT EAGLE PASS, BRITISH COLUMBIA.

Albert Low (left) during the exploration of Labrador, 1894.

The Hudson Bay Expedition of 1885 photographed by Robert Bell.



The *Neptune* (right) at Cape Fullerton, Hudson Bay in 1904.

The age of exploration draws to a close

In many ways, the cruise of the *Neptune* marked the end of an era for the Geological Survey. For more than 60 years, officers of the Survey had been as much explorers as geologists, preceding settlers, mining companies and other developments into many areas of the country. Thanks to their work, much was known about the more remote parts of the budding nation.

In the words of historian Morris Zaslow, "Wherever the geologists had gone, they had carefully mapped the physical features of the districts traversed, and had contributed immeasurably to the map of Canada's territory... The reconnaissances provided concrete information on people, resources, and conditions of many corners of the country, and produced inventories of pockets of arable land, forests, fish and game, waterpowers, climatic conditions, and transportation facilities and routes for a large part of Canada, in addition to more specific reports on the presence, possible occurrence, or likely absence, of mineral wealth. The Geological Survey and its officers did more than any other group or agency during the quarter-century after 1881 to make Canadian conditions and opportunities known to the nation and the world."

The Survey's contribution to Canadian scientific knowledge and economic development had helped chart the development of a strong and increasingly prosperous nation. Indeed, the first 50 years of the Survey's existence can be seen as a mirror to that of the nation's. Both had experienced a remarkable growth in size, visibility and prestige — and both were coming face to face with the opportunities and complexities of the Twentieth Century.

SEPTEMBER 10, 1897 — BEGINNING OF THE KLONDIKE GOLD RUSH IN DAWSON CITY, YUKON.

New Challenges for the Twentieth Century

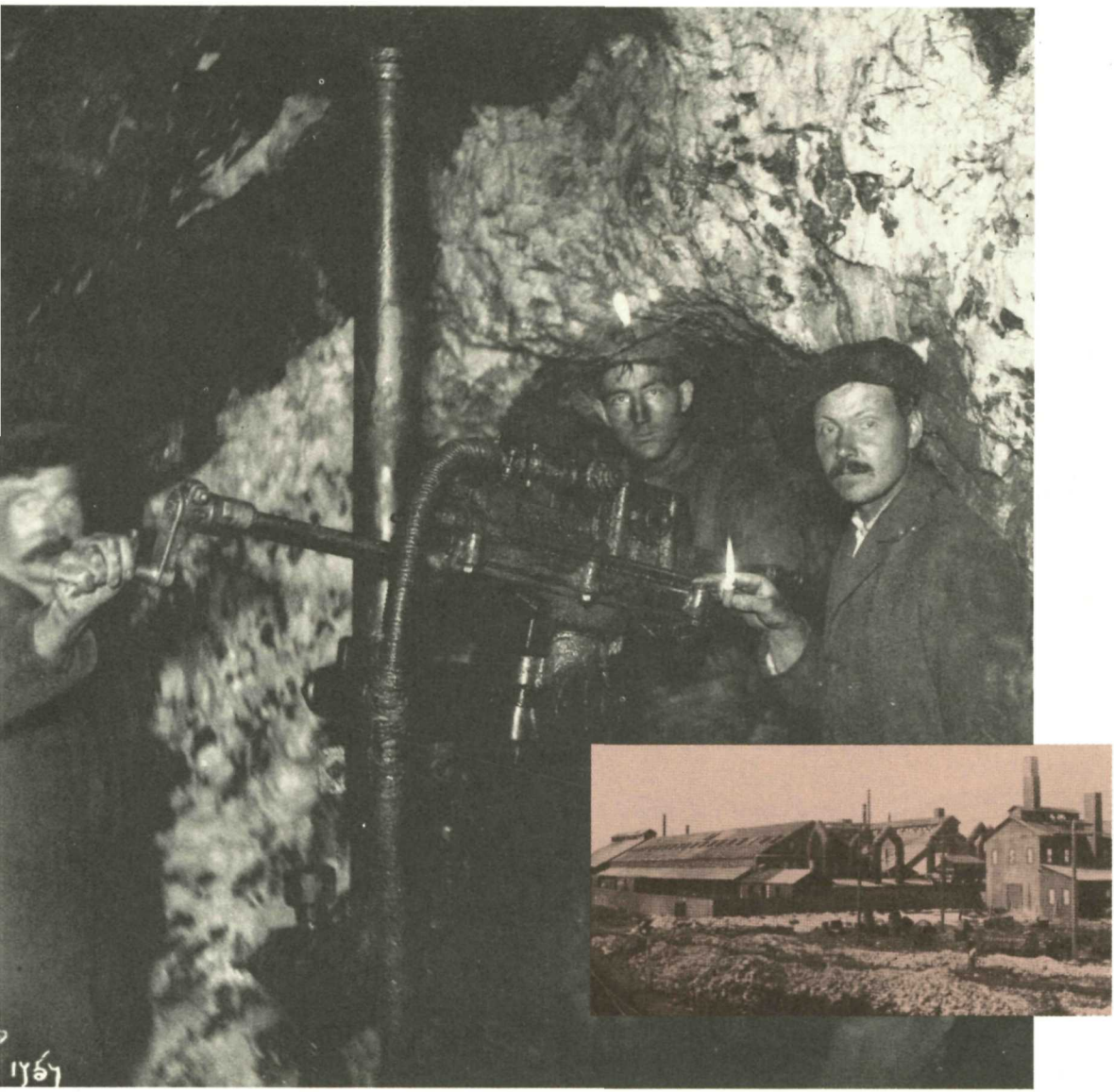
The Twentieth Century has been called Canada's century, and aptly so. For as the century matured, so did Canada. At the turn of the new century, Canada had left behind its dependent colonial existence and was coming into its own right as a nation — one that would command attention on the world stage and whose moderate voice would come to shape international affairs.

Canada had pretty well assumed its contemporary boundaries by 1905 when Alberta and Saskatchewan were given provincial status - only Newfoundland remained to be added in 1949. The population nearly doubled in the 20-year period between 1891 and 1911, and economic development was surging. Manufacturing centres were well established, while the natural resource industries were booming.

Redefining the Survey's course

Canada's mining industry now rivalled forestry and agriculture as a source of export earnings, giving it considerable political clout. From its earliest days, the work of the Survey had been firmly rooted in providing the geological information needed to develop Canada's mineral riches.

Entering the new century, however, the Survey's permanent staff numbered only about 30 and the funds available for field work seldom exceeded $60,000 a year. This naturally put constraints on the number of studies that the Survey could carry out, at a time when demands for new and better geological maps and interpretations were rapidly increasing from the mining industry. Adding to this, there



By the turn of the century, mining was rivalling forestry and agriculture as a source of export earnings for Canada. Shown here Nova Scotian miners, 1897 and (inset) lead refinery at Trail, British Columbia in 1907.

were some who felt that the Survey had lost track of its original objectives of mapping and assisting the mining industry in every possible way.

Economics over science vs. science over economics

The controversy boiled down to a fundamental question. How to reach the proper balance between research aimed at satisfying the country's economic needs and research required to spark completely new discoveries or to give us a new understanding of our universe? This question has underpinned every decision made since about the Survey's scope of research.

Robert Bell was clearly responding to this in a report to Parliament in which he stressed: "Care has been taken to give prominence to any discoveries which may have an economic bearing. This is done in response to the general desire for early information on all points which may be of immediate value to the public although the scientific discoveries may ultimately prove of greater practical importance."

Setting staff standards of excellence

Reginald Brock, a native of Perth, Ontario, was Low's successor in 1907, and under his leadership a new sort of organization took shape. He "cast in stone" a policy initiated by Low that made educational excellence a basic staffing requirement. All new appointees to scientific positions now had to have a doctorate degree in geology or its equivalent. This exacting focus on individual excellence remains a cornerstone of today's Survey. Survey officers are widely recognized as being among the best-trained and most knowledgeable scientists in Canada, and in the world.

Reginald Brock, Director (1907-14)

Brock also laid the groundwork for the Survey's role as a training ground for the Canadian geoscience community. Students interested in geology received guidance and practical experience through their employment as field assistants to GSC scientists. Today the Survey provides field experience to about 300 geology students each summer, and Survey scientists are active across the country in providing thesis guidance to students working on higher degrees.

Under Brock the age of the specialist began in earnest for the Survey. Special attention was given to Precambrian geology, as about two-thirds of Canada is underlain by rocks of that age. He also created a separate topographical unit that would prepare the maps needed as a base for geological information, thus freeing the geologists from doing this as part of their field work. The topographical unit left the Survey in 1947, but remains closely linked as part of Energy, Mines and Resources Canada.

He also oversaw the Survey's move into the Victoria Memorial Museum Building in 1911 — the Survey's home until the late 1950s.

World War I

Brock was succeeded by R.G. McConnell as head of the Department of Mines in the early days of the war. McConnell was a well respected senior member of the Survey and his pioneer explorations in Western Canada were second in importance only to G.M. Dawson's. He chose William McInnes to head up the Survey under him.

Despite strong leadership, the war years and the 1920s were a period of disruption and difficulty for the Survey. Survey staff left en masse to join the war, as did a large number of the geology students the Survey used as field assistants — many not to return. Ironically too, the Survey was a victim of its own excellence. The high standards set for Survey employees, coupled with low government salaries, resulted in raiding of staff by industry. Even before World War I ended, mining and oil exploration companies and universities were approaching GSC staff with offers far more attractive than the Survey could match.

The situation became so acute that professional associations and provincial governments brought pressure to bear on the Canadian Government. This finally brought results in April 1920. A new salary scale was instituted, providing raises and promotions — men who had many years of experience as field assistants were finally given commensurate positions.

To compound its operational problems, the Survey also lost its home during the First World War. On February 3, 1916, the main Parliament Building burned to the ground, and the House of Commons and the Senate moved into the Victoria Memorial Museum Building. Survey staff had to make do from temporary quarters spread throughout Ottawa until the new Parliament Building was ready in early 1920.

Although the operations of the Survey were curtailed by the war, its work was directed, even more than in the past, along lines promising to lead to economic results. Special efforts were essential to locate deposits of strategic materials vital to the war effort and those whose supply had been cut off by the war. Molybdenum, tungsten, chromite, platinum, mercury, magnesite, fossils fuels and base metals were all the focus of this practical work.

MAY 7, 1920 —FIRST EXHIBITION OF THE GROUP OF SEVEN OPENS AT THE ART GALLERY OF ONTARIO IN TORONTO.

Canada's national museums trace their roots to the Geological Survey. The museum started in the mid-1840s by the Survey's pioneering geologists has since evolved into three distinct and highly acclaimed institutions — the Canadian museums of Nature, Civilization, and Science and Technology. Shown here the museum at Survey headquarters in Ottawa at the turn of the century.

The Geological Survey was a major participant in the Canadian Arctic Expedition 1913-18 led by the Arctic explorer, Vilhjalmur Stefansson. The expedition explored the Western Arctic and Beaufort Sea and brought back much new information about the geography, geology and inhabitants of this remote part of Canada. Shown here the scientific staff of the expedition at Nome, Alaska in 1913, eight of whom were from the Survey, and the headquarters camp of the expedition's southern party at Bernard Harbour.

A devastating fire in February 1916 destroyed the main Parliament Building. The Survey's headquarters since 1911, the Victoria Memorial Building, became the temporary home of the Senate and the House of Commons until 1920 when the new Parliament Buildings were completed. Shown here, the funeral cortege of Sir Wilfred Laurier leaving the building in February 1919.

A Geological Survey field party hauling a scow up the Athabaska River, Alberta, in 1914.

The Roaring Twenties

The new decade brought with it new leaders. William Collins took over the Survey in 1920, under Charles Camsell, the newly appointed head of the Department of Mines.

During the Twenties, Canada was building up the mining and manufacturing side of its mineral industry. Attracting capital to develop the nation's mineral resources was one of the government's top priorities, and this gave greater prominence to the Survey's more economically oriented sister organization, the Mines Branch.

For its part, the Survey continued to stress field mapping in support of these new economic priorities. Its nation-wide mapping programs, particularly in the mineral-rich Precambrian Shield, were of great value to mineral exploration.

Collins himself, notwithstanding his responsibilities as Director, carried out field studies in the Elliot Lake and Sudbury nickel areas of Ontario, where he made significant contributions to geological knowledge and economic development. His maps of the Elliot Lake area later proved to be of critical importance in the tracking, staking and subsequent development of what became known as the $30 Billion Uranium Field.

Another enduring legacy of the Twenties was two of the Survey's most popular general publications, "Prospecting in Canada" and the "Geology and Economic Minerals of Canada" series, which trace their roots to this period and clearly reflect the interests of the day.

Nevertheless, the Canadian political environment was plagued with uncertainty and concern over the national debt. Funding for the Survey steadily decreased during the 1920s as economy became the watchword in government circles.

The Great Depression

As Canada entered the Great Depression, the need for mineral development work became even more pressing. The worsening economic situation, however, prevented much activity as the government was forced to make drastic cuts to it budgets. To avoid releasing staff, the Survey reduced its field activities to a mere fraction of the number of parties once sent out. This work was tightly focused in the vicinity of mines or areas promising new discoveries of immediate value.

DECEMBER 8,1921 — AGNES MACPHAIL BECOMES THE FIRST WOMAN ELECTED TO THE HOUSE OF COMMONS.

Faced with an election in 1935, Prime Minister R.B. Bennett decided to follow the example of President Roosevelt of the United States, who in 1933 had launched massive public

An important legacy of the McConnell-McInnes era was the opening of district offices in British Columbia and Alberta. This allowed more efficient control of field work in the west and made the Survey more accessible, and hence more helpful, to local mining and petroleum interests. The Alberta office closed in 1920, not to re-open until the start of Western Canada's oil boom in the late 1940s. The Vancouver office (shown here), however, has remained in operation to this day, and plays an important part in increasing our understanding of the unique environment, natural hazards and mineral wealth of the Canadian Cordillera.

Transportation for field work remained a major challenge in the 1930s, and with the tight economy often required some innovation. Shown here a flotilla of scows used to cross Great Slave Lake, Northwest Territories, and the "Bennett buggy".

Alice Wilson, the Survey's first female geologist and first woman fellow of the Royal Society of Canada. During her remarkable half century of service (1913-63) with the Geological Survey, she had to overcome many difficulties in establishing herself on a par with the male scientific staff. Women now make up a quarter of all undergraduates studying geology at Canadian universities.

The airplane revolutionized field work. It enabled quick and cheap access to even the most remote corners of Canada — areas that had previously been reached, if at all, by long and arduous journeys by foot, horse or boat. Even more valuable, the airplane and aerial photography permitted geologists to see large tracts of land at a glance, speeding up the mapping process and allowing for faster solutions of geological problems.

works schemes to generate employment and stimulate the economy. The Geological Survey was one of the beneficiaries of this new approach. It received an incredible $1 million at the very last moment for the 1935 field season — 10 times the amount that had originally been budgeted.

As a result of this dramatic about-face and the huge sum of money involved, within a matter of months the Survey had to pull together a completely new field program. Its twin objectives were to create employment and assist the mining industry. By mid-June, more than 4,000 applications had been received, of which 1,005 were accepted. These men were organized into 188 field parties, compared to the 24 sent out the previous year.

The enormous scope of the 1935 field season presented the Survey with a range of problems. For example, vast amounts of new equipment had to be found and purchased on very short notice. Even more difficult was the challenge of finding experienced personnel to direct the field parties, which consisted largely of men with little geological training. In many cases, experienced Survey staff had to supervise sub-parties headed by untrained university students. One officer working in northern Saskatchewan directed seven parties in addition to his own, using aircraft to maintain contact.

Despite these and other efforts to kick-start the economy, R.B. Bennett's government was soundly defeated in the October 1935 federal election. Although the Survey could undoubtedly have achieved much greater results with more warning of Bennett's plans, the program had tremendous benefits. The GSC had increased its field mapping tenfold and obtained valuable new data. Equally important, the employment offered during that hectic summer enabled many graduate students to continue their studies — several of whom later joined the Survey as permanent staff.

The funds available to the Survey also enabled it to indulge for the first time in the large-scale use of aircraft. This revolutionized field work for the Survey and brought it truly into the Twentieth Century.

In 1936 the departments of Mines, Interior, Immigration and Colonization, and Indian Affairs were amalgamated into a single organization headed by Charles Camsell — the new Department of Mines and Resources. This arrangement, with minor alterations, lasted until after World

FEBRUARY 11, 1922 — DRS. BANTING AND BEST AT THE UNIVERSITY OF TORONTO DETERMINE THAT THE PANCREAS IS THE BODY'S SOURCE OF INSULIN, GIVING HOPE TO THE VICTIMS OF DIABETES.

War II. During most of this period, the Survey was guided by its Chief Geologist, George Young.

World War II

The economic tragedy of the Depression faded into memory with the onslaught of the Second World War. The human tragedy that replaced it was played out against a booming economy driven by the demand for war materials.

Such huge quantities of metals and minerals were needed to build tanks, ships, aircraft and weapons that mines worked around the clock. The war also closed Canada's access to many strategic minerals previously purchased from other countries, and there was much urgency attached to locating domestic sources.

In view of the expertise of its staff, this crucial task was assigned to the Survey. Throughout the war years, the regular work of the Survey was put on the backburner while its field officers sought the metals and minerals (such as chromium, manganese, tin and mercury) necessary to keep Canada's armed forces supplied. Mercury deposits discovered by the Survey in British Columbia as a result of these efforts were rushed into production and became the largest source of mercury in the British Commonwealth. Secret investigations of radioactive minerals were also conducted for the Allied government's atomic weaponry program

George Hanson, the Survey's Chief Geologist (1946-53) and later Director (1953-56).

Coal and oil were equally vital to the war effort. Locating domestic fuel and energy sources became another wartime priority for the Survey, seeing as before the war Canada had imported 90 per cent of its petroleum. The work of the Survey relating to energy resources took firm root at this time and continues to be a major part of its contribution to this day.

As a result of the war, the Survey put off the celebration of its centennial anniversary until 1947. Looking ahead at that time, George Hanson, the Survey's Chief Geologist (1946-1953) and later Director (1953-1956) calculated that only 11 per cent of Canada had yet been adequately mapped geologically, and that at the current rate of progress it would take several hundred years to complete the task. New post-war technologies and concepts, however, drastically altered this prediction.

Revolutions in Thought and Technology

Following World War II, Canada entered a period of peace, prosperity and growth. Interest in Canada's mineral and energy resources grew rapidly, with the 1950s seeing the development of Western Canada's vast oil and gas reserves and Labrador's huge iron ore deposits discovered in the late Nineteenth Century by A.P. Low. At the same time, there was a growing awareness of the importance of science to Canada's development. The blossoming of government scientific agencies, such as the Geological Survey, was a natural offshoot.

The goverment emphasized the crucial importance of the mining and energy industries by creating, in early 1950, a Department of Mines and Technical Surveys in their support. The new department was designed specifically to provide technological assistance for the development of Canada's mineral and energy resources. It included the Geological Survey of Canada, the Mines Branch, the Surveys and Mapping Branch, the Dominion Observatories and the Geographical Branch.

A period of unimagined growth

The 1950s were a time of scientific and technological growth unimagined only a few years earlier. Leadership of the Survey had passed to Walter Bell in 1950, and in 1953 George Hanson was promoted from his long-standing position of Chief Geologist to the Director's chair. His successor, James Merritt Harrison (1956-64), brought to the Survey a vigourous, outward-looking leadership that was in perfect harmony with the times.

Unhindered by the economic restraint of earlier years, the Survey was now able to expand its research into fundamental geological problems, outfit its laboratories with the best new technology available thus increasing their analytical capability, and undertake ambitious field work. Bright new graduates were recruited, and the Survey's budget quadrupled from the tight wartime budgets.

A new home

George Hanson was instrumental in pulling together preliminary plans for a modern new home for the Survey, and Jim Harrison brought them to fruition. Specially designed to house a dynamic scientific agency, the new building, on Booth Street in Ottawa, was a great improvement over the overcrowded Victoria Memorial Museum Building, which had been constructed in 1910 to house a much smaller Survey and its museum.

It was a proud time, indeed, for the Survey when in 1959 it moved into its brand new home.

New tools and new theories

The use of the airplane and aerial photography as basic tools for geological mapping was firmly entrenched by this time. In the 1950s they were supplemented by helicopters, and this increased the pace of geological mapping at a spectacular rate. Clifford Lord, the Survey's Chief Geologist (1954-73) conducted a study on the impact of the helicopter. He reported that within the span of six short years, 1952 to 1958, the Survey had mapped about half as much of Canada at a reconnaissance scale as had been mapped in the previous 110 years — due mainly to the helicopter. He summed up this achievement as "the first major breakthrough in the Survey's century of effort to complete the initial or reconnaissance phase of the geological mapping of Canada." Less than a decade before it had looked as though a century or two would be required to complete this phase.

As a result of its new airborne capability, the Survey was able to mount numerous large-scale multidisciplinary reconnaissance operations during the 1950s and 1960s. The most ambitious was the 1955 "Operation Franklin" in the Arctic. Headed by Yves Fortier who was later to become Director of the Survey (1964 - 1973), the 28-person expedition, in a single field season, studied strategic locations and mapped almost 260,000 square kilometres of the High Arctic. The results of the work showed potential for oil in this remote part of Canada and triggered industry interest

JUNE 26, 1959 — ST. LAWRENCE SEAWAY OFFICIALLY OPENED.

The airplane and the helicopter have been the workhorses of modern geological mapping since the 1950s. Prior to their use most reconnaissance work had to follow Canada's main waterways and established trails. Air-supported reconnaissance mapping enabled the Survey to fill in many blanks in the geological map of Canada. Shown here the Sikorsky helicopter used in the 1950s for Arctic field work.

The new building brought the entire staff of the Geological Survey under one roof for the first time in years and gave them sophisticated laboratories to do the analytical work necessary to support modern field research. It was also equipped with in-house editing, cartographic and graphics facilities to streamline the publication of maps and reports. The library remains Canada's premier collection of earth science literature.

Yves Fortier, Director (1964-73)

in northern oil and gas exploration. "Operation Franklin" also demonstrated how extremely productive joint research using modern technology could be.

Aeromagnetic mapping, carried out jointly under contract by the Survey and its provincial counterparts, was also started during this period. The results of these geophysical surveys were of great value to mineral exploration and subsequently to accurate regional compilations (interpretations) of the Precambrian Shield. A striking practical example of the value of these techniques occurred in the 1950s when a survey jointly sponsored by the Ontario Department of Mines located an exceptionally strong magnetic anomaly that led to the discovery of the Marmora iron works. The Survey became a world leader in the development of techniques and technologies in this field, and its aeromagnetic maps were eagerly sought by mining and petroleum companies to guide their exploration programs.

Fundamental geoscientific theory underwent a revolution in the 1960s, one that has triggered controversy and debate even up to present time. The new concept of plate tectonics and continental drift sparked a significant advance in Survey's work. It provided a broader context for understanding the geological forces at work in Canada and gave new insight into mineral exploration. J. Tuzo Wilson, the great Canadian advocate of the plate tectonics theory, summarized its implications: "The replacement of ideas about a relatively stable earth with fixed continents by ideas about a highly mobile one with moving continents will profoundly affect many ideas about the origin, sources and distribution of ore-bodies and petroleum deposits."

Expanding into new areas

World War II spawned many new technologies that radically changed the world and placed new demands on the Survey. The realization that atomic fission had a peaceful application as a source of energy led to prospecting for uranium in boom proportions in the 1950s. High priority was given to Survey field and laboratory work related to locating and evaluating radioactive deposits, especially uranium. This was later followed by work to assess uranium resources for export purposes. An important side-benefit of this effort was a greatly increased knowledge of the general geology of the Precambrian Shield.

JULY 30, 1963 – TRANS-CANADA HIGHWAY OPENED, LINKING CANADA FROM ST. JOHN'S, NEWFOUNDLAND, TO VICTORIA, BRITISH COLUMBIA.

James Merritt Harrison, Director (1956-64).

The post-war period saw, for the first time, the Survey contributing geological information and expertise to aid in the construction of large-scale public works projects. The St. Lawrence Seaway and the Red River floodway around Winnipeg are just two examples of this application.

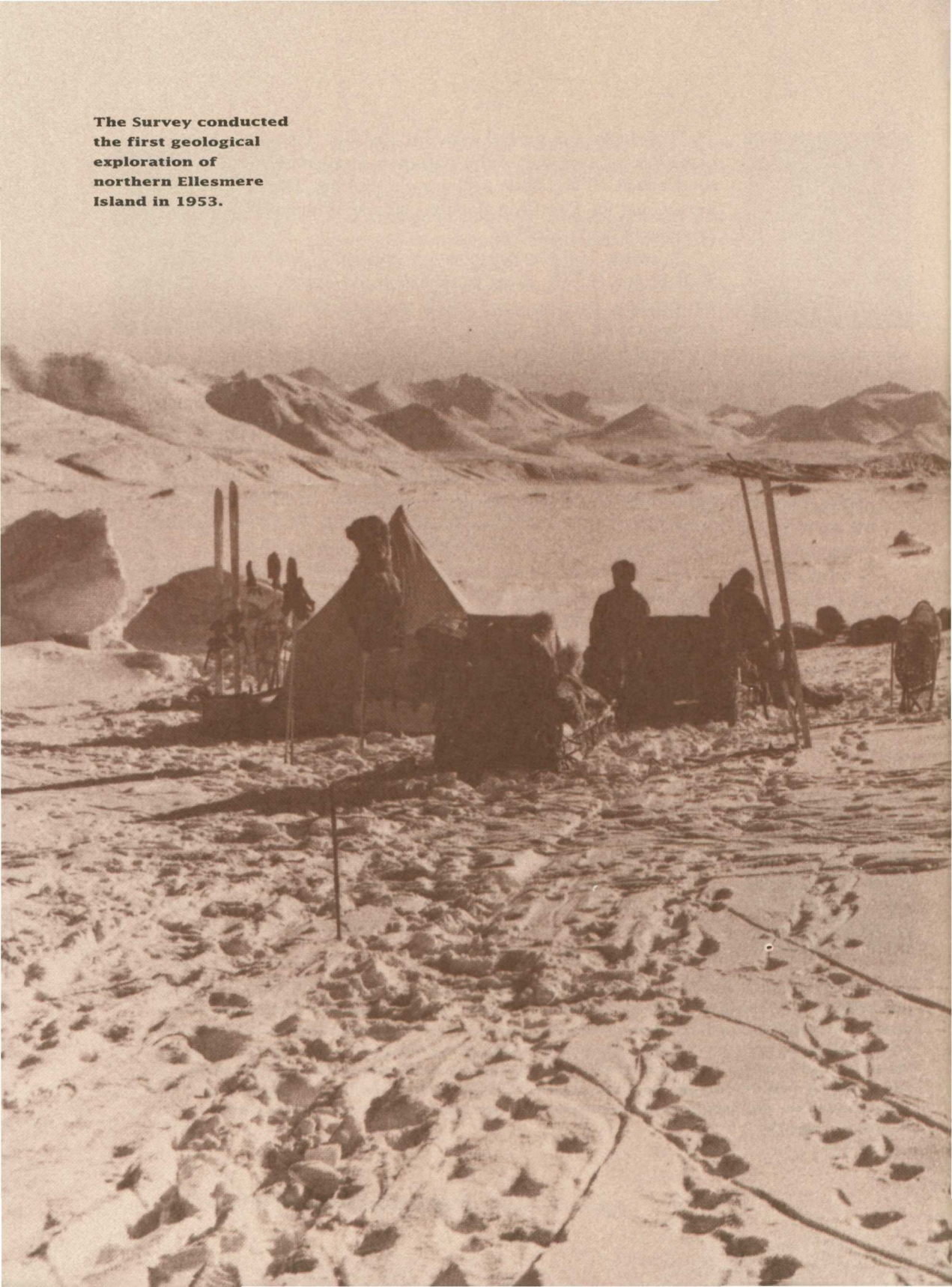
A unique logistics organization called the Polar Continental Shelf Project (PCSP) traces its origins to the late 1950s when there was growing pressure for Canada to assert sovereignty over its northernmost lands and an increasing demand for scientific information about them. The PCSP was the perfect solution. By providing shared transportation and a communications safety net for scientific researchers working throughout the High Arctic, PCSP was able to "show the flag" for Canada. Much of the planning of this organization was done by Survey scientists who, through their pioneering work with air-supported geological mapping, had become world leaders in the field and, at the same time, experts in mounting Arctic expeditions. PCSP has had close ties with the Survey since its founding in 1958, and is still administratively linked with it.

In 1959 the Survey also established a specialized marine geology research group to accommodate growing interest in Canada's huge offshore area. In 1972, this group was set up as the Atlantic Geoscience Centre at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. Today it continues as part of the Survey to carry out crucial geological mapping and studies of Canada's East Coast.

The 1950s also saw the true beginnings of the Survey's dedicated contribution to international geoscientific activities, much of which can be traced to the determined effort of Jim Harrison. The very successful International Geophysical Year (1957) had clearly demonstrated the need and opportunity for global cooperative studies. Harrison was instrumental in establishing the International Union of Geological Sciences in 1961 and was its first president. The Survey's tradition of providing international leadership and support to global geoscience initiatives remains a hallmark of today's Survey, and has brought Canada much credit.

In 1947 there was a landmark oil strike south of Edmonton at the Leduc field. This marked the beginning of western Canada's oil boom, and it generated a unprecedented demand by industry and government for geological information about this energy-rich region. In response, the Survey opened an office in Calgary in 1950. This was replaced in 1967 with a full-scale research establishment, the Institute of Sedimentary and Petroleum Geology, (shown here) which today is a key source of information on the energy and coal resources and the geology of western and northern Canada.

The Survey conducted the first geological exploration of northern Ellesmere Island in 1953.



Towards Today's Survey

Reorganization was again the order of the day in 1966, when Parliament created the Department of Energy, Mines and Resources of which the Geological Survey of Canada today is part. The new department carried on the scientific responsibilities of its predecessor, the Department of Mines and Technical Surveys, but through its new mandate to plan Canada's energy needs, was transformed into an important policy-making department.

As a direct result of this new focus on energy policy, the Survey became heavily involved in resource appraisal. National energy planning during the 1970s required quantitative estimates of Canada's reserves and resources of oil and gas, coal and uranium. To provide this fundamental information, the Survey pioneered new methodologies of resource appraisal that have earned international praise and widespread application. An inventory of Canada's metals and minerals was also required, and the Survey, working with other agencies, provided estimates of the national reserves of nickel, copper, zinc, lead, molybdenum and iron ore.

At the same time, the ground rules for government agencies were changing drastically. The days of virtually unlimited expansion ended as inflation began to cut deeper into budgets. Greater accountability to the taxpayer brought in more elaborate reporting procedures and a heavier administrative load for scientific staff. However, the demand on the Survey from industry for information and expertise in support of exploration efforts continued to increase steadily — as it did too from all levels of government as a foundation for planning and policy-making.

Milestones and new directions in mapping Canada

The 1970s witnessed, after more than a century of determined effort, the Survey's completion of the bedrock map of Canada at the reconnaissance level. The next step started up immediately: to go back and revise map areas in which the information had become largely obsolete. Revision mapping requires more detailed studies than the earlier reconnaisance so the pace is two to three times slower than the reconnaissance work.

During this period, the Survey also became heavily involved in terrain mapping, that is to say, mapping of the unconsolidated surficial materials overlying the bedrock. As early as the 1970s the work had a decidedly environmental slant and was concentrated mainly along the Mackenzie Valley pipeline route, the polar gas corridor west of Hudson Bay, and in the Arctic Islands. Results were used to evaluate the environmental impact of development in these fragile areas.

Looking to the offshore

Starting in the 1970s, international debate centering on the ownership of the oceans' resources required the Survey to provide geoscientific information necessary to support Canada's claims to an offshore "economic zone". New boundary areas came into dispute, for example, the Gulf of Maine and the Grand Banks off St. Pierre-Miquelon in the east and the Straits of Juan de Fuca off the West Coast. Canada's offshore boundaries eventually extended 200 miles (320 km) from the coast (or beyond, to the edge of the continental shelf). This immense area was, in effect, added to the Survey's field of operation.

Another major offshore initiative stemmed from growing concerns for the security of energy supplies and indications that the offshore contained valuable new resources. In response, the government charged the Survey in 1984 with establishing a knowledge base from which the oil and gas potential of the offshore regions and the Arctic could be determined. The work, carried out under the Frontier Geoscience Energy Program, is now firmly entrenched as part of the Survey's marine responsibilities.

Revolutionary ideas were emerging at this time from studies of the ocean floor. Recognizing their importance to better understanding global, and hence Canadian geology, the Survey led

efforts to secure Canada's membership in the international Ocean Drilling Program (ODP) in 1984. As a result, Canadian scientists now work closely with colleagues from other member nations such as the United States, France, Germany, Australia and Japan aboard the ODP's sophisticated research vessel, the *JOIDES Resolution*. These studies are resulting in new information about the geological processes at work beneath the world's deepest oceans, as well as better ways to identify the mineral and energy resources they conceal and new exploration and development techniques.

Cost-sharing, collaboration and mergers

Greater accountability to the taxpayer and increasingly complex administrative demands were continuing trends through the 1980s. Coupled with government spending restraint and high inflation, the Survey was often restricted to meeting short-term objectives to accommodate rapidly changing priorities. The Survey adapted by moving more and more into cost-sharing, cooperative ventures that involved the participation of other governments, industry and universities at both national and international levels.

Streamlining of operations was another measure taken. In April 1986, the Earth Physics Branch of Energy, Mines and Resources was merged with the Geological Survey of Canada. The Earth Physics Branch was the direct descendent of the former Dominion Observatories, an illustrious organization with a long and fascinating history. The merger added a major geophysical arm to the Survey that includes Canada-wide seismology and geomagnetic observatory networks and systematic gravity surveys. The following year, the Polar Continental Shelf Project became administratively linked with the Survey.

Since this reorganization, the Geological Survey of Canada has been headed by its own Assistant Deputy Minister, first Raymond A. Price (1987-88) who had been the Survey's Director since 1982, then Elkanah Babcock (1988-present).

DECEMBER 15, 1964 — CANADA ADOPTS A NEW FLAG.

In the tradition of GSC Director Jim Harrison, later GSC directors assumed strong leadership roles in the national and international scientific community: (left) Digby McLaren (1973-80) went on to head the Royal Society of Canada, and (right) William Watt Hutchison (1980-81) was president of the International Union of Geological Sciences.

The Survey's marine geoscience expertise is housed in sister research agencies on the East and West Coasts. The Atlantic Geoscience Centre in Dartmouth, Nova Scotia was set up in 1972, and the Pacific Geoscience Centre (inset) on Vancouver Island opened in 1976.

Working with the provinces and territories

In 1984, in an effort to stimulate regional economic development, the federal government entered into agreements with several provinces. Because a key objective was to encourage mineral resource exploration, the component Mineral Development Agreements resulted in the Survey working closely with participating provinces on a range of geoscience surveys and mapping projects. The techniques of high resolution geophysical and geochemical airborne surveys, developed by the Survey, were widely applied in many regions. Mineral Development Agreements have been recently renewed with many provinces, while others are under renegotiation.

The Survey also has signed "Principles of Cooperation" with many of the provincial geological surveys. These agreements are designed to formalise joint planning and the execution of work in areas of mutual interest and responsibility. They complement an existing network of liaison committees with all provinces and territories.

Environment comes to the fore

The "green" revolution of the 1980s gave new urgency to research with an environmental slant. Traditionally the Survey had contributed to understanding the geological properties and history of the Canadian landmass and provided information fundamental to land-use planning. During the 1970s the Survey had a major program that carried out environmental impact assessments of large-scale developments such as the Mackenzie Valley pipeline. Priority is now being given to questions relating to global change, and a new environmental geochemical program is looking at natural radioactivity, hydrogeology and baseline geochemical data.

Through a wide range of research that looks at natural hazards such as earthquakes, landslides, "magnetic storms", volcanoes, tsunami, floods and ground instability, the Survey also contributes to a better understanding of how the environment affects us. The results are used to set building standards and for emergency planning.

APRIL 12, 1980 — RUNNER TERRY FOX SETS OUT FROM ST. JOHN'S NEWFOUNDLAND ON HIS "MARATHON OF HOPE" IN AN EFFORT TO RAISE MONEY FOR CANCER RESEARCH.

Looking deep inside the Earth

The Survey was one of the originators of LITHOPROBE, the largest geoscientific research program ever undertaken in Canada. Established in 1984, this innovative program traces its beginnings back to deep earth studies, such as the Upper Mantle Project, of the 1960s. LITHOPROBE allows scientists to "see" into the earth, to incredible depths of up to 50 kilometres. Besides giving scientists dazzling new information about our planet's structure, LITHOPROBE contributes to mineral and energy exploration and to our understanding of earthquakes and volcanic activity.

The Survey continues to be a very active partner in LITHOPROBE. The program now involves more than 300 scientists from universities, government and the petroleum and mining industries. It is widely regarded as one of the most successful scientific research projects in the country and, indeed, in the world.

A national mapping program

Mapping has always been one of the Survey's core activities. By the early 1990s it became clear that the Survey's basic geological mapping programs had been seriously eroded over the past two decades in the face of other priorities. In response, the Survey took a lead role in developing a new National Geoscience Mapping Program. Very much a national cooperative effort, the program involves federal, provincial and territorial surveys as well as Canadian universities, private industry and other interested groups. Its aim is to improve the quality, relevance and completeness of bedrock and surficial geological maps and to coordinate mapping activities of different organizations.

A new program framework for the 1990s

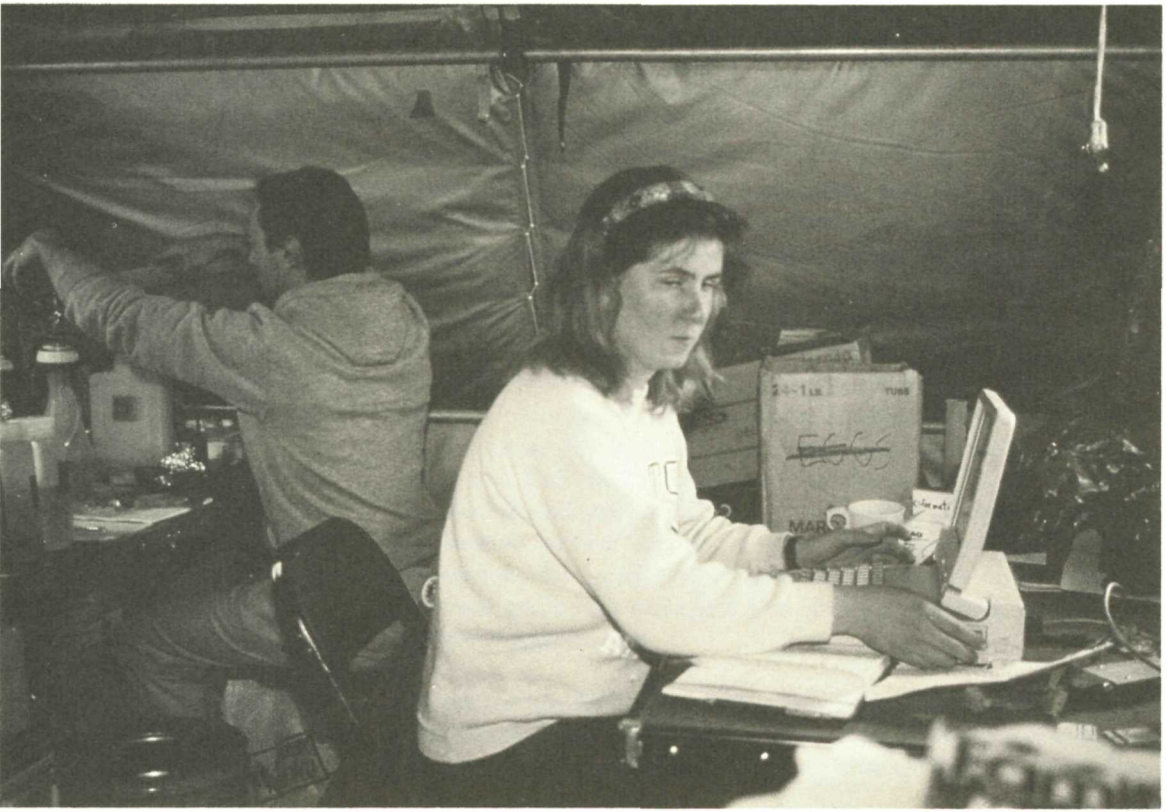
As the Survey entered the 1990s, it was apparent that the growing complexity of its activities demanded a refocusing of its program so as to provide a clear and logical link with the needs of its clients. Five broad areas were identified:

- the Geoscience Surveys Program is the foundation for much of the understanding of the nature and evolution of the Canadian landmass. It maps the geology of the country, interprets Canada's tectonic evolution and studies fundamental geological processes that formed the land and its mineral and fossil fuel resources.

- the Minerals Program assesses domestic mineral resource and competitive foreign resource potential, develops new technologies and concepts for mineral exploration and provides analytical expertise.
- the Energy Program analyzes the fossil fuel resource potential of Canada's onshore and offshore and provides national resource estimates for oil, gas and coal.
- the Environmental Geoscience Program provides the geoscience information required to understand natural hazards and processes and to solve environmental problems.
- the Geoscience Information Program makes available to users the Survey's steadily growing body of information in the form of maps, publications, data files or reference material.

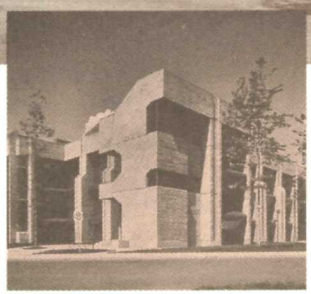
JULY 27, 1980 — "O CANADA" IS MADE CANADA'S OFFICIAL NATIONAL ANTHEM.

The Survey's storehouse of geoscientific information is proving a valuable resource for environmental researchers. Why? Because, the geological record is a crucial, and often the only, baseline from which we can reconstruct past changes to our planet, monitor contemporary changes, and predict future trends. Shown here, a field laboratory at the Survey's global change "observatory" at Hot Weather Creek on Ellesmere Island.

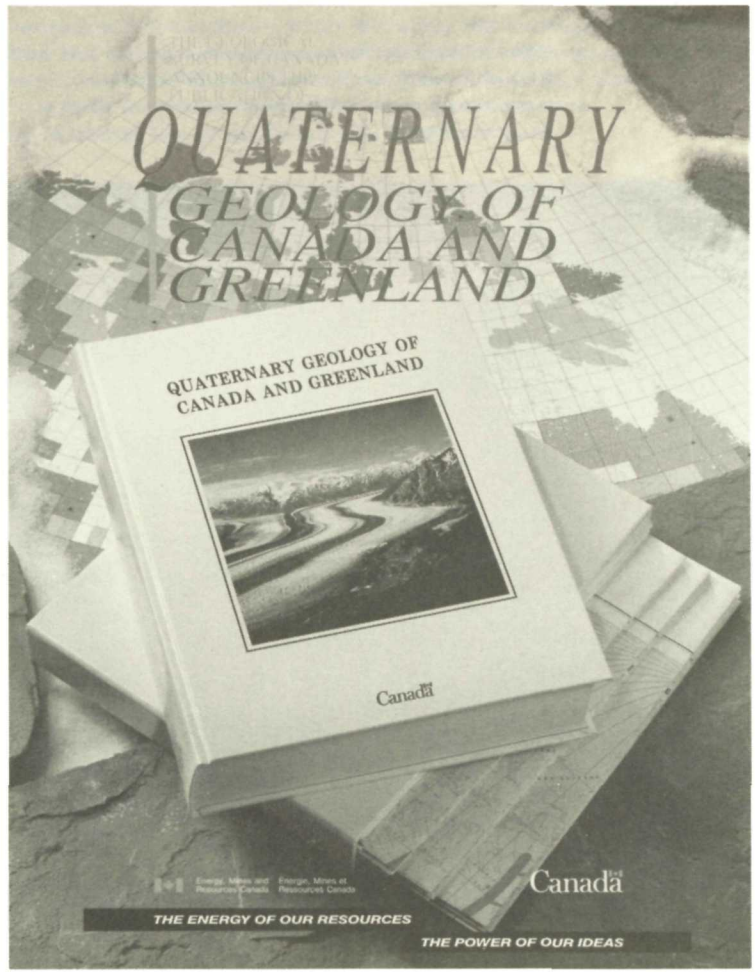


D. St-Onge

The Dominion Observatory, one of Ottawa's most picturesque buildings, is home to many of the Survey's geophysicists.



The Survey opened its newest regional office at Sainte-Foy, Quebec, in 1988. The Quebec Geoscience Centre (right) is a joint venture with l'Institut national de la recherche scientifique-géoressources. It carries out research programs mainly in Eastern Canada in the fields of regional geology, metallogeny and Quaternary studies. About 40 per cent of Survey staff work out of regional offices in Nova Scotia, Quebec, Alberta and British Columbia.



In 1863, the Survey published the first edition of the "Geology of Canada", a compendium of everything known on the subject. Today, 150 years later, the Survey is working on the seventh edition. An ambitious publishing challenge, the new "Geology of Canada" series will include nine volumes and many new maps and will be the definitive reference on Canadian geology for years to come.

The Survey Today

The computerized Geological Survey of the 1990s is, of course, a very different organization from the one established by Sir William Logan 150 years ago. Nevertheless, similarities between the Survey of today and of yesteryear are obvious. The mining and petroleum industries continue to be major clients, and mapping the geology of Canada remains a primary concern. However, geoscientific information is becoming increasingly important to environmental questions as it provides a crucial baseline against which we can measure and assess contemporary environmental changes. As well, the Survey, because of its reputation for excellence, continues to attract gifted scientists and staff who share a unique *esprit de corps* and provide an irreplaceable source of expertise that is one of Canada's scientific treasures.

A century-and-a-half after Logan set out on his first field trip, the immense task of a comprehensive geological examination of Canada is still not complete. Today, however, we recognize that the task may never end. As new theories and needs emerge, and as new technologies are rapidly developed, the surveying of Canada's onshore and offshore will challenge scientists for many decades to

come. And as the Geological Survey of Canada continues to accept new responsibilities and to develop new areas of expertise, its contribution to the next 150 years of Canada's development should be as important, colourful and exciting as in the past.

APRIL 17, 1982 — ELIZABETH II SIGNS THE ROYAL PROCLAMATION OF THE CANADIAN CONSTITUTION.

"WE SHALL NOT CEASE FROM EXPLORATION
AND THE END OF ALL OUR EXPLORING
WILL BE TO ARRIVE WHERE WE STARTED
AND KNOW THE PLACE FOR THE FIRST TIME"

T.S. Eliot, Little Gidding

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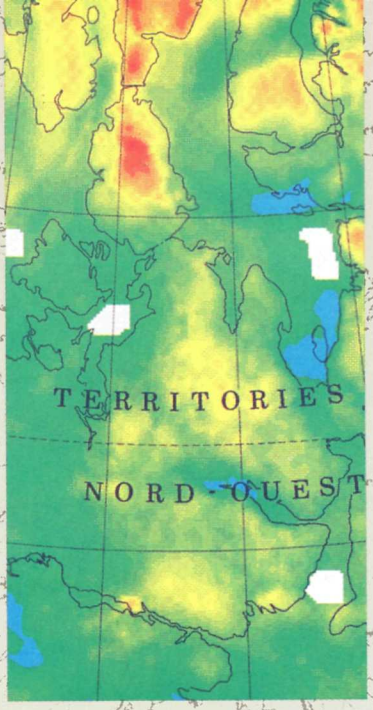
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