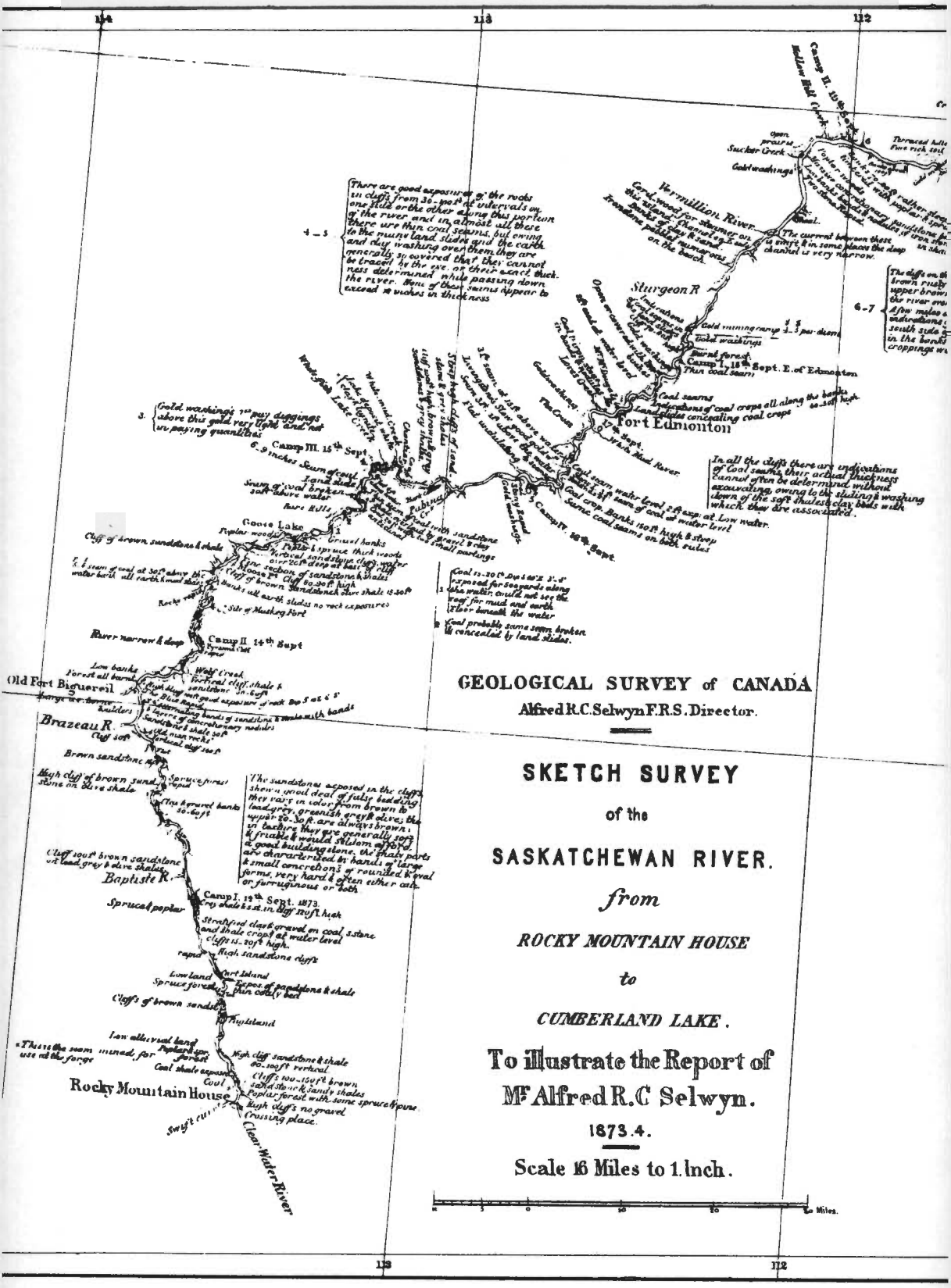
The Geological Survey of Canada

Past and Present

Canada


114
113
112
Camp II. 13th Sept.
Hollow Bluff Creek
Open prairie
Sucker Creek
Gold washings
Terraced hills
Vermillion River
Good wood for steamers
Sturgeon R
Gold washings
Gold mining range 1.5 per diem
Camp I. 18th Sept. E. of Edmonton
Thin coal seam
Fort Edmonton
Coal seams
Sandstones concealing coal crops
Camp III. 15th Sept.
6.9 inches Seam of coal
Seam of coal broken
Gold washings, no pay diggings above this gold very light and not in paying quantities
Goose Lake
Poplar woods
Cliffs of brown sandstone & shale
Camp II. 14th Sept
Old Fort Bigoureil
Brazeau R.
Baptiste R.
Camp I. 13th Sept. 1873.
Rocky Mountain House
Clear Water River
There are good exposures of the rocks in cliffs from 30 to 80 ft at intervals on one side or the other along this portion of the river and in almost all these there are thin coal seams, but owing to the many land slides and the earth and clay washing over them they are generally so covered that they cannot be traced by the eye, or their exact thickness determined while passing down the river. None of these seams appear to exceed 18 inches in thickness
In all the cliffs there are indications of Coal seams, their actual thickness cannot often be determined without excavating, owing to the sliding & washing down of the soft shales & clay beds with which they are associated.
The sandstones exposed in the cliffs shown would deal of fully bedding they vary in color from brown to lead grey, greenish grey & olive; the upper 20-30 ft are always brown; in texture they are generally soft & friable & would seldom afford a good building stone, the shaly parts are characterised in hands of large small concretions of rounded & oval forms, very hard & often either calcareous or ferruginous or both
GEOLOGICAL SURVEY of CANADA
Alfred R.C. Selwyn F.R.S. Director.
SKETCH SURVEY
of the
SASKATCHEWAN RIVER.
from
ROCKY MOUNTAIN HOUSE
to
CUMBERLAND LAKE.
To illustrate the Report of
Mr Alfred R.C Selwyn.
1873.4.
Scale 16 Miles to 1 Inch.
Miles.

THE GEOLOGICAL SURVEY OF CANADA

PAST AND PRESENT

Miscellaneous Report 45

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Preface

As one of the oldest government organizations and the first science service in Canada the Geological Survey has played a significant role not only in the growth of science but also in the development of the country. Descriptions of the opening of the Canadian Northwest, the Yukon and more recently the Arctic abound with references to the work of Tyrrell, Ogilvie, Bell, Low and many other officers of the Survey. To mark the centenary of the founding of the Geological Survey (1942) which because of the Second World War was not celebrated until 1947 when the Geological Society of America held their 60th Annual Meeting in Ottawa, a short history was prepared by Dr. F.J. Alcock, Curator of the National Museum of Canada and a former field geologist. This, like earlier works of a similar nature, was mainly descriptive and only discussed briefly the larger theme – the Survey and the growth of Canada.

In 1965 it was decided to have a definitive history of the Geological Survey of Canada prepared. The 1960s were a time of growth, the Survey was expanding into new fields, and science was again a subject of widespread public interest. Rather than assign the task to a staff member, whose perceptions and conclusions would inevitably be coloured by long association with the organization, the decision was made that the time had come to have the Survey looked at from the outside.

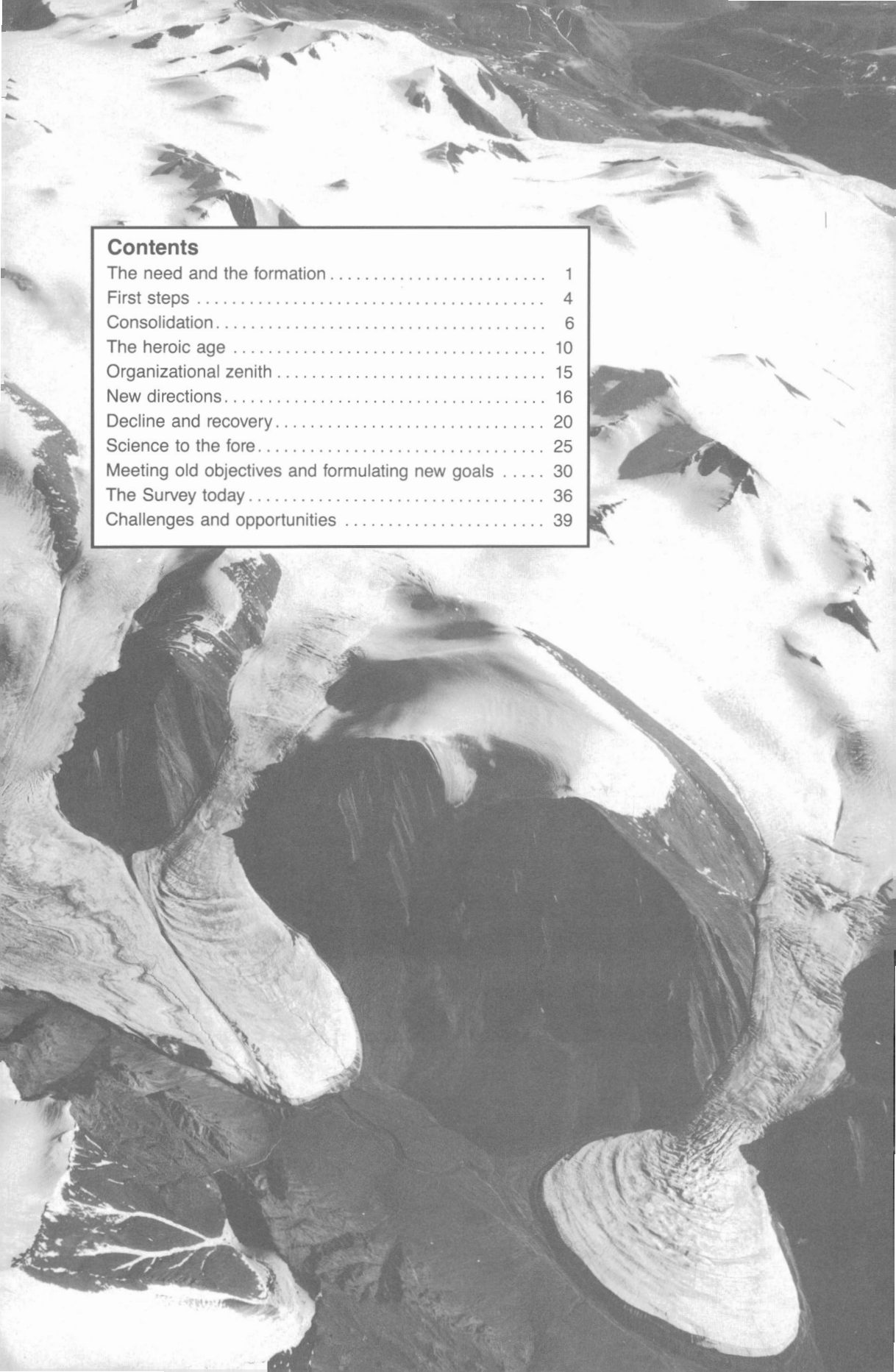
Advice was sought from Canadian historians and other academics. Many suggested that Morris Zaslow be approached to undertake the study. Dr. Zaslow, Professor of History at the University of Western Ontario since 1965, had by that time a well established reputation as one deeply interested in the history of northern Canada. He had been struck by recurring references to the Geological Survey in his work and was delighted to have the opportunity to research the role of the Survey in the development of Canada. The result was "Reading the Rocks – The story of the Geological Survey of Canada 1842-1972" published in June 1975 by the Macmillan Company of Canada and the Department of Energy, Mines and Resources.

Professor Zaslow had hoped to prepare a much abbreviated version of his scholarly work, a version that would incorporate highlights of the Survey's story and which would lend itself to general distribution. However other commitments intervened and the task fell to R.G. Blackadar, at that time Chief Scientific Editor of the Geological Survey and who, as a member of the Branch Historical Committee, had worked closely with Dr. Zaslow during the time that research for "Reading the Rocks" was being done. This booklet, "The Geological Survey of Canada – Past Achievements and Future Goals" was published in 1976. It drew extensively on Dr. Zaslow's work but was not a condensation and included material not found in "Reading the Rocks". Since Dr. Blackadar prepared it the Survey has continued to develop in response to changing national needs and it seemed appropriate for him to prepare a revised edition at this time. To convey within a limited space the achievements, frustrations, interests and personalities of an organization, which in 1992 will celebrate its 150th anniversary, is not an easy task; in these pages Dr. Blackadar has, I believe, succeeded in highlighting some of the more significant events of the Survey's story, events that in many instances, are reflected in today's activities.

Members of the Geological Survey are proud of the contribution their organization has made and is continuing to make to Canada and I hope that this booklet will help to make this contribution more widely known and that it will encourage those more deeply interested in this aspect of Canadian history to read Dr. Zaslow's excellent, and scholarly study.

R.A. Price
Director General
Geological Survey of Canada

Part of Viking Ice Cap, Ellesmere Island. NAPL T404L-56



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81. *Resolved*—That a sum not exceeding one thousand five hundred pounds, sterling, be granted to Her Majesty to defray the probable expense in causing a Geological Survey of the Province to be made. 81st Resolution: £1,500, st'g, Geological Survey.

ANNO OCTAVO

VICTORIÆ REGINÆ.

CAP. XVI.

An Act to make provision for a Geological Survey of this Province.

[17*th March*, 1845.]

WHEREAS a Geological Survey of this Province of Canada has been instituted for ascertaining the Mineral Resources thereof; And whereas the sum of fifteen hundred pounds, already granted to Her Majesty to defray the probable expenses of the same, has been found inadequate for the effectual investigation of so extensive a Territory as is comprised within the limits of the Province; And whereas it is expedient that the said Survey should be continued to a completion: Be it therefore enacted by the Queen's Most Excellent Majesty, by and with the advice and consent of the Legislative Council and of the Legislative Assembly of the Province of Canada, constituted and assembled by virtue of and under the authority of an Act passed in the Parliament of the United Kingdom of Great Britain and Ireland, and intituled, *An Act to Re-unite the Provinces of Upper and Lower Canada, and for the Government of Canada*, and it is hereby enacted by the authority of the same, That it shall and may be lawful for the Governor of this Province, in Council, to employ a suitable number of competent persons, whose duty it shall be, under the direction of the Governor in Council, to make an accurate and complete Geological Survey of this Province, and furnish a full and scientific description of its Rocks, Soils and Minerals, which shall be accompanied with proper Maps, Diagrams, and Drawings, together with a collection of Specimens to illustrate the same; which Maps, Diagrams, Drawings and Specimens shall be deposited in some suitable place which the Governor in Council shall appoint, and shall serve as a Provincial collection, and duplicates of the same, after they have served the purposes of the Survey, shall be deposited in such of the Literary and Educational Institutions of the Eastern and Western divisions of the Province, as by the same authority shall be deemed most advantageous. Preamble. The Governor in Council may appoint proper persons to make a Geological Survey of this Province.

II. And be it enacted, That from the unappropriated public monies of the Province, a sum not exceeding two thousand pounds, shall be annually applied, for a term of years not exceeding five years from the passing of this Act, to defray the expenses of the said Survey, or any arrears of expenditure already incurred, which sum shall be paid at such times and in such manner as the Governor in Council may direct. A sum appropriated annually during five years for the said purpose.

III. And be it enacted, That the person or persons employed by the Governor in Council for the purposes mentioned in the first section of this Act, shall make a report to the Governor of this Province on or before the first day of May in each year, setting forth generally the progress made in the Survey hereby authorized. Reports to be made to the Governor.

IV. And be it enacted, That the words "Governor in Council," wheresoever they occur in this Act, shall be understood to mean the Governor, Lieutenant-Governor, or person administering the Government of this Province, acting by and with the advice of the Executive Council thereof. Interpretation clause.

V. And be it enacted, That the due application of the monies hereby appropriated shall be accounted for to Her Majesty, Her Heirs and Successors, through the Lords Commissioners of Her Majesty's Treasury, in such manner and form as Her Majesty, Her Heirs and Successors shall direct; and an account thereof shall be laid before the Provincial Legislature at the then next Session thereof. Accounting clause.

MONTREAL:—Printed by STEWART DERBISHIRE and GEORGE DESBARATS,
Law Printer to the Queen's Most Excellent Majesty.

The Need and the Formation

When in September 1841 the Legislature of the Province of Canada (formed the previous year by uniting Upper and Lower Canada) passed the Resolution "that a sum not exceeding one thousand five hundred pounds sterling be granted to Her Majesty to defray the probable expense in causing a Geological Survey of the Province to be made" none of the members present could have imagined that more than 140 years later the 'survey' would still be in progress. What was envisioned as an activity soon became an organization almost at times with a life of its own. What at least some legislators imagined would be a quick thrust that would stimulate the mining industry thereby enriching the provincial coffers became a service that has played a significant role in the development of Canada. Indeed the history of the Geological Survey of Canada reflects many of the milestones of Canadian history – the surveys that preceded the building of the Canadian Pacific Railway, northern exploration, Canada's claim to the Arctic Archipelago, attempts to stimulate the economy during the Depression of the 1930's and, more recently, concerns such as developing a national energy policy.

Random studies reflecting the intense interest in natural history that had been aroused in the early 19th century stimulated the legislators to develop the original vote of funds by supporting the formation of the Geological Survey of Canada in 1842 and by passing an Act in 1845. Informative observations on geology had been made by men such as Dr. John J. Bigsby a British army surgeon who, following the War of 1812, took part in the survey that fixed the boundary between Canada and the United States from the Great Lakes to Lake of the Woods, or Capt. H.W. Bayfield, R.N. who carried out hydrographic surveys from the Gulf of St. Lawrence to the upper Great Lakes.

Considerable geological information resulted from the Arctic explorations carried out under the auspices of the British Admiralty after 1818. Expeditions headed by men such as Sir John Ross, Sir Edward Parry or Sir John Franklin usually carried a surgeon who also had some interest in natural history and most of the reports of this period carried brief notes on geology, zoology and related subjects. Closer to Canada Dr. Abraham Gesner had carried out geological studies in Nova Scotia and New Brunswick and state geological surveys had been undertaken in Massachusetts, New York and Pennsylvania and Michigan.

It had become apparent that if Canada was to expand beyond being a mere agricultural colony whose main exports were lumber and wheat (and in fact in the 1820's wood ash for leach was the principal export) then an industrial economy was needed, an economy that would depend to a considerable extent on a viable mineral industry. The rapid economic advances in England since the late 18th century had shown how essential coal was to industrial expansion. Unbridled enthusiasm for industrial progress was sweeping the populations of the eastern cities of North America during this time. Progress was felt to be inevitable and the heady prose of the journalists and publicists did nothing to discourage the fervour with which the people accepted the belief that America's destiny would be attained by applying industrial technology to rich natural resources. Given the technical resources of the time many of the engineering accomplishments were indeed impressive. By 1840 industrial centres such as Pittsburg were well on their way to forming the nerve centres of the United States. It was in this climate that the first resolutions and petitions were presented to the Canadian authorities, an activity that eventually resulted in the succinct but successful resolution of 1841.

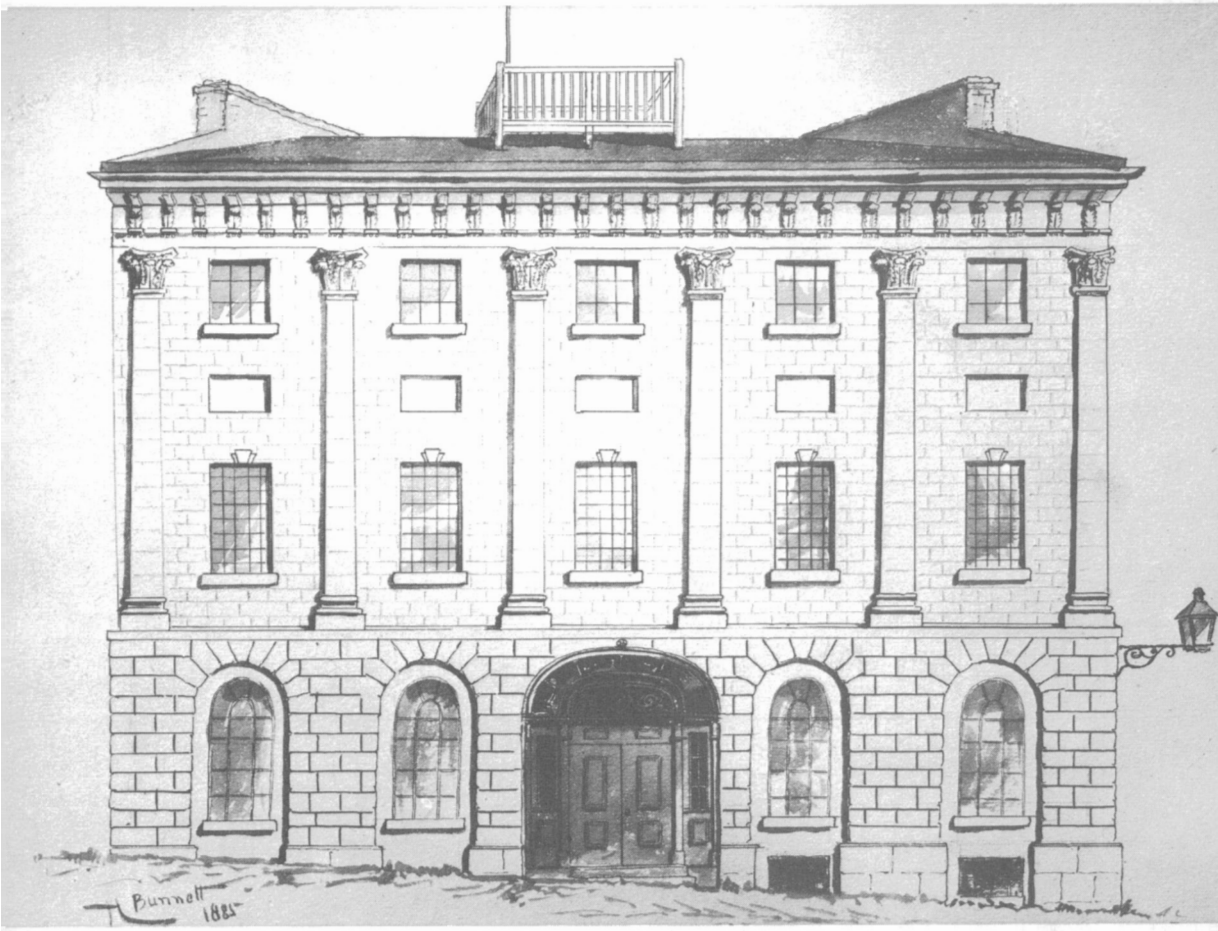
The provision of funds to carry out a survey made possible the appointment of an officer to undertake the task and as a result of recommendations from highly respected scientists in England the choice fell on William Edmond Logan. Born in Montreal and educated in Edinburgh, his interest in geology had developed from his association with family business activity in South Wales. News of the planned geological survey came to

Logan as he was commencing a tour of the coalfields of Pennsylvania and Nova Scotia but his interest was aroused and he let it be known that he would consider the position. His appointment was made the following year and by August 1842 Logan reached Kingston, then the seat of the peripatetic Provincial Legislature. Alexander Murray, a young man trained in the navy, was appointed to assist Logan. Like most men of the time he had no formal background in geology but when it appeared that he would be offered the position on the Canadian survey he undertook training in land surveying and geology, some with Logan himself in South Wales.

In Kingston, Logan discussed the form his survey would take, compiled what knowledge existed on the geology of Canada, planned the future and returned to England for the winter. In the spring of 1843 he returned to Canada and established the headquarters of the Survey in part of a warehouse on Montreal's St. Gabriel Street. The Geological Survey of Canada's first field season during 1843 involved two geologists: one, Logan, worked between Pictou, N.S. and Gaspé, the other, Murray, examined the country between Lake Erie and Lake Huron. Every year since field parties of the Survey have gone out – currently more than 200 each year – and the Survey has grown from a staff of two to about 995 and a budget of more than 90 million rather than the £1500 allotted Logan.

Sir William Logan

Alexander Murray



The Survey's Montreal Home, 1852-1881.

Logan proved a good choice but like most good leaders he was not malleable in the hands of his superiors. He had undertaken a two-year commission to carry out a geological survey but he knew that this could be but the start and thus from the first he embarked with a definite strategy: prove the value of the survey to government and thereby ensure its eventual continuity. To do this he emphasized the practical aspects of the work.

The Geological Survey had been established primarily to advance the mining economy of the province. The main economic conclusion of the first two years of field work was negative – the coal-bearing formations of Pennsylvania did not extend into Canada. This was disappointing inasmuch as coal was then *the* energy source essential to the development of an industrial economy but this conclusion undoubtedly prevented the squandering of many thousands of dollars of government and private money. It was an opinion based on field studies carried out first by Logan and later by Murray in Gaspé, and by Murray in what is now southwestern Ontario.

The first year's field work had enabled Logan to erect several broad geological divisions – folded Paleozoic rocks covering Gaspé and the Eastern Townships, the all but flat-lying Paleozoic rocks extending west from Montreal to Lake Huron, and a third division of much older rocks that extended north an unknown distance from Kingston, Ottawa and Montreal, rocks that soon proved to be but the southernmost exposed limit of the great Precambrian Shield.

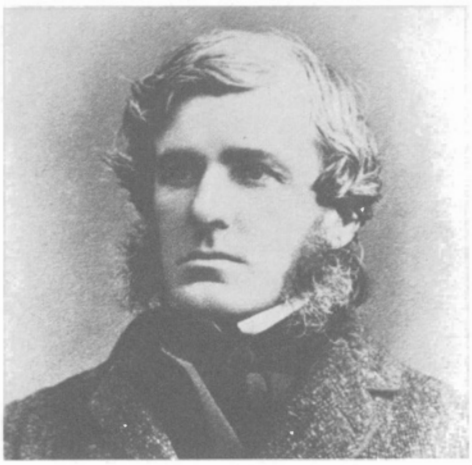
In 1845 Logan, in making a traverse along the Ottawa River to the head of Lake Temiskiming and westward to Lake Nipissing, began a study that has absorbed the interest of hundreds of his successors, the study of the very old and complex rocks of the Canadian Shield whose history has been all but obliterated by the intensity of the geological changes to which they have been subjected.

The infant Survey was soon faced with a delicate problem: what is the nature of the relationship between a government agency and private enterprise? A copper mining boom in northern Michigan in 1845 spread to the north shore of Lake Superior. Logan accompanied by Murray and James Richardson (a farmer and school teacher who had a long, fruitful career with the Survey and made its first photographs) carried out studies in the northwest of the province around Fort William, Michipicoten, and Mamainse Point, and inland up such rivers as the Michipicoten and Kaministikwia. By 1847 interest had shifted to the north shore of Lake Huron and indeed copper mining began at Bruce Mines. Murray examined the area between Sault Ste. Marie and French River and in 1848 Logan carried out detailed studies of mineral occurrences between Bruce Mines and the Soo. Many companies felt that the Survey should be doing work to advance their particular interests and at times Logan seems to have had difficulty in carrying his point that the Survey's role was not that of a private consultant but rather one of establishing the general geological setting as a base on which industry could plan further exploration.

These forays into direct economic activities were, as so often they would prove to be in the future, a diversion from the Survey's systematic studies. Murray traced the entire Canadian coast of Lake Huron in 1849 and in 1850 and 1855 examined the Paleozoic strata of what is now southwestern Ontario, assessing potential economic minerals and examining the petroleum occurrences in Mosa and Enniskillen townships. In 1851 and 1852 he traced the southern boundary of the Canadian Shield in eastern Ontario and examined the geology along the Moira and Trent waterways. Between 1853 and 1855 he explored the Shield area between Georgian Bay and the Ottawa River and from the Trent watershed to Lake Nipissing.

The Survey was taking root and Logan was gradually able to expand. A chemist had been added early to the staff. Now in 1856 Elkanah Billings joined the staff as paleontologist thus increasing the Survey's effectiveness and reducing

the need to send collections abroad for identification. The accumulating information also made it possible to envisage the publication of maps and Robert Barlow was appointed chief draftsman, a post he held until his death in 1881 when he was succeeded by his equally competent son, Scott, who served until 1894. Other support staff were added and by the late 1850's, the Survey was a well-rounded organization capable of conducting rigorous exploration, making maps, producing reports, maintaining a museum for the use of the public and supported by studies in chemistry, mineralogy and paleontology.



Elkanah Billings

Scott Barlow

The rapid industrialization of England in the first part of the 19th century was reflected in a major change in the interests of the middle class. Mechanical things generated great popular enthusiasm. The building and launching of a vessel such as the "Great Eastern" attracted throngs. Interest in natural history became respectable and not just the whim of eccentric clergymen. These new interests first found focus in the "Exhibition of the Industry of all Nations" (1851) which to a large degree was the inspiration of Prince Albert, husband of Queen Victoria, and which was held in the Crystal Palace, London, a building whose very appearance epitomized the new ideas. Canada's contribution, it was decided, would be a well-organized collection of mineral samples that would be a stimulus to trade. Logan spent much of the summer of 1850 collecting suitable material and was given considerable public support particularly by the Montreal business community. The specimens were arranged according to their uses, a style that was most successful and which became the standard format for many future mineral exhibits. Further opportunities for publicity came with the Universal Exposition in Paris in 1855. Although preparations for these exhibitions were time-consuming, they were salutary in that they directed the interest of the Survey to the display or museum aspects of its work.

The Act of 1856, renewing the Survey for another 5-year term had made specific mention of the museum and empowered Logan to "establish a Geological Museum at some convenient place which shall be open at all seasonable hours to the public". Fortunately some additional funds were granted at this time and Logan was able to hire two new employees to assist in the museum work which was carried out in conjunction with the Survey's other activities in the Montreal warehouse.

Consolidation

Twenty years after its formation the Survey was able to publish a report that brought together the results of the Survey's efforts to date. The idea of a "Geology of Canada" was not new. It had been proposed in 1854 by the legislature which even appropriated funds for printing. Although the original plan was delayed, a large manuscript geological map was prepared to accompany the extensive collection of rocks and minerals exhibited in Paris at the Exposition Universelle – 1855. What Logan called "a little essay in french" (Esquisse géologique du Canada – 100 pages long!) accompanied by a coloured, lithographed geological map on the scale of 150 miles to 1 inch was published in Paris at the same time. A similar report, "A Descriptive Catalogue of the Collection of Economic Minerals and Crystalline Rocks of Canada", was prepared to accompany the display sent to the London International Exhibition (1862). This contained much information about the geology of the Province of Canada much of which was incorporated in the much more ambitious "Geology of Canada" published soon after.*

In the words of M. Zaslow, the *Geology of Canada* "completed the original commission with which he (Logan) had been charged – to make a geological survey of Canada....The Survey had disproved the occurrence of coal in Canada (as it was then comprised) and had explained where to look for petroleum; it had shown the types of formations in which metallic minerals occur. It had devoted a great deal of attention to the locations and uses of many deposits of minerals, whether they occurred in veins, beds, or alluvial gravels". Although the text was published in 1863, the magnificent map on a scale of 1 inch to 25 miles was not published until 1869 although dated 1866. In addition to the map four smaller scale maps accompanied the text. One of these was the first map of the surficial geology of Canada. In addition there were 4 plates comprising numerous cross-sections. Most of the maps, compiled by Robert Barlow aided by his son Scott were engraved on copper or steel by A.W. Graham of Montreal. These were subsequently transferred to stone and the colour printing was done in London. The engraving and printing of the coloured sections and the woodcuts used for the uncoloured illustrations were done entirely in Montreal. The principal map was engraved and printed in Paris. The other maps together with a reduction of the geological map to a scale of 1 inch to 125 miles were printed in atlas form in 1865 and thus the reduced geological map became the first comprehensive illustration of the geology of what is the southern third of present-day Ontario and Quebec.

Confederation of Canada in 1867 increased the area of the Survey's operations tenfold but it also meant a reorganization that could accommodate an expanded staff. Twenty-five years after the foundation of the Survey many of the original staff members had reached retirement age. Logan retired in 1869 and was succeeded by A.R.C. Selywn, an Englishman who served as Director of the Geological Survey of Victoria, Australia from 1852 to 1869. Murray had left to develop a geological survey in Newfoundland where his reports stimulated great interest and were directly responsible for the initiation of several copper mining areas. During the sixties the emphasis was once again on economic geology. Studies on the iron ore potential of Hastings County, Ontario were carried out to assist government in making decisions in connection with proposed railway land grants; coal resources were evaluated in Nova Scotia and copper distribution in eastern Canada was described.

That there was during this period little reconnaissance work reflected more the fact that a viable mining industry had at last been established in Canada than any disregard for the fundamental need for regional studies.

*Although the earlier compilations were useful and major effort was needed to bring such a major effort to fruition, the bulk of this work was done between 1861 and 1862 although it appears that Logan had been compiling and checking various parts of the report for nearly a decade.

Funding the Survey

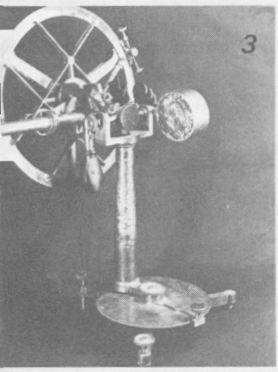
For nearly 30 years the Geological Survey lacked any guarantee of continuity. The first parliamentary resolution had provided £1500 for a two-year survey. A sum of £2000 per annum was granted in 1845 for a five-year period. When the term expired in 1850, Logan found that a political crisis for a time seriously threatened any consideration being given to renewal of the Survey's mandate. However, eventually the 1845 act was renewed – £2000 per annum.

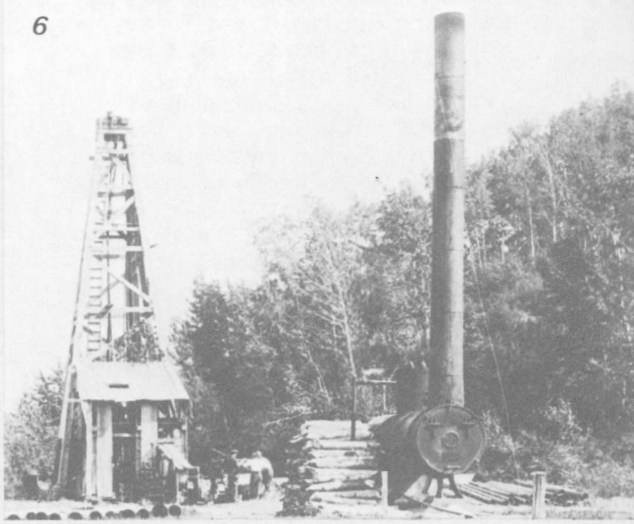
Again in 1855 the same problem was encountered. Logan was obliged to drum up support from all sides – the Governor General, scientists at the University of Toronto, the Anglican bishop and John A. Macdonald. A new bill was passed which increased the appropriation to £5000 but once again the term was for five years only, thus leaving the future of the organization at the whim of the legislature. However, the purse strings were somewhat loosened in 1854 and an additional £2000 was granted to permit publication of a geological map and condensed report on the geology of Canada. In 1859 the £5000 grant was cut in half but by 1860 the Survey was back to $20 000 (or £5000; conversion from sterling to dollars took place in 1859). The Act again expired in 1861 and due to a political crisis caused by the American Civil War it was not renewed. For the next few years Logan had to go each year to the government for the annual $20 000 appropriation and thus was more exposed to the threat of an empty treasury than he had been at any time since the commencement of the Survey.

Confederation in 1867 greatly extended the Survey's area of responsibility and in 1868 a new five-year act giving $30 000 per year, retroactive to July 1, 1867 was passed. The Survey which had reported through the Secretary of State for the Provinces became a responsibility of the Department of the Interior, an arrangement that lasted from 1873 to 1890. When the act came up for renewal in 1877, the Survey was defined as a "branch of the Department of the Interior known as the Geological Survey Branch", operating in the "several Provinces and Territories of the Dominion". At last it had permanent status, continuing funding, and could entertain long-range plans. It also meant that the permanent staff came under the provisions of the Civil Service Act which, for the first time, gave a reasonable pension security to long service employees.

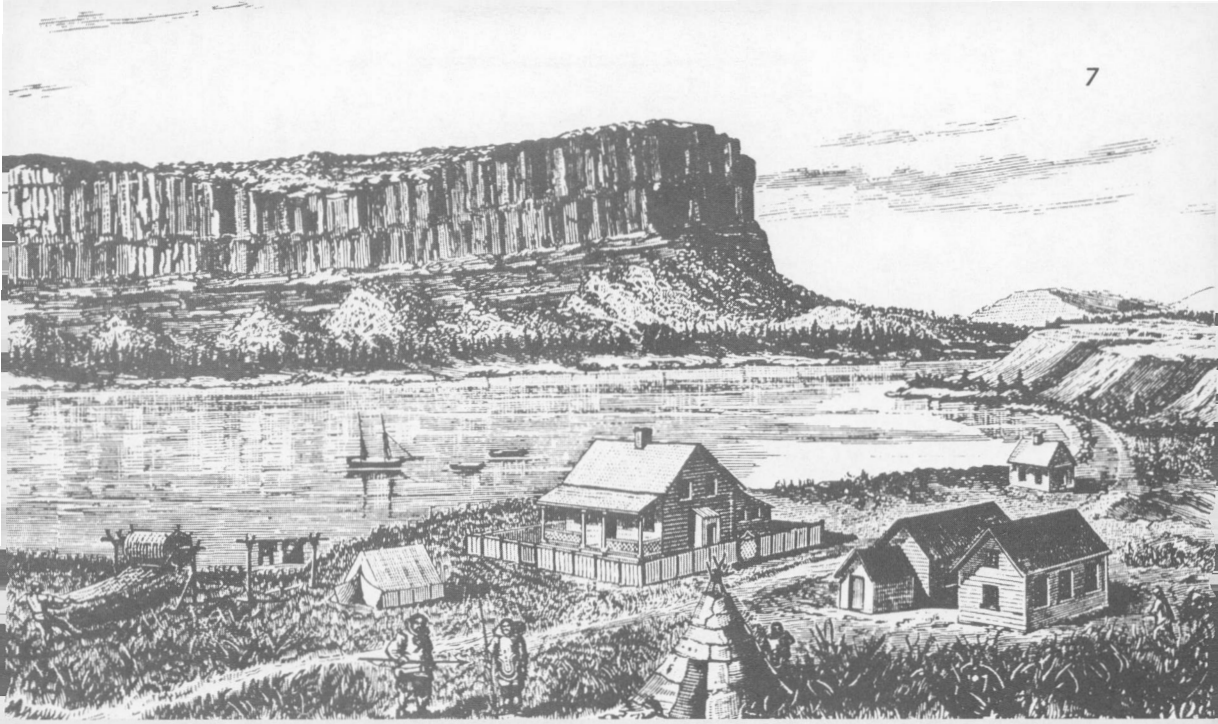
Move to Ottawa

For years the rather unique status of the Geological Survey – in some ways it resembled today's Crown Corporations, in others a contract agency – had protected it from centralizing influences so common in governments but when in 1877 it became a Branch of the Department of the Interior, pressure began to be applied for its removal from Montreal to the capital city of the Dominion. Naturally there was strong opposition from McGill University, the mining industry then centred in Montreal and other groups but by 1878 the government had purchased for $20 000 a former "luxury" hotel a few blocks east of the Parliament Buildings. Despite a rearguard action, the move was completed in May 1881 thus fulfilling the intention of the government that the Survey be brought into closer relations with Cabinet and Parliament, and with other government departments. As recently as 1959 some officers in the Survey occupied offices in the historic building that had been the Survey's headquarters from 1881 to 1910 when, as described in a later section, growth demanded enlarged quarters and the Survey moved to the specially designed Victoria Memorial Museum Building.





1 *The Survey's Ottawa Home 1881-1910. This building at the corner of Sussex and George streets, later occupied by the Mines Branch, still stands.*
2 *Horace S. Smith, artist to the Geological Survey.*
3 *A repeating circle used by Robert Bell in surveying.*
4 *Whaleboats at Cape Fullerton, 1904. A.P. Low and* ***Neptune*** *wintered here 1903-04.*
5 *T. Sterry Hunt, the Survey's chemist and analyst, 1848-1872.*
6 *Drilling rig used in early GSC attempt to find commercial oil and gas. Victoria (Alberta) 1898.*
7 *An illustration from an early report.*
8 *Odometer used by Logan to measure distances in flat terrain.*
9 *Boat used by J.B. Tyrrell during coastal survey of Lake Winnipegosis, 1889.*
10 *Big Bear's camp, Maple Creek (Sask.) 1883.*



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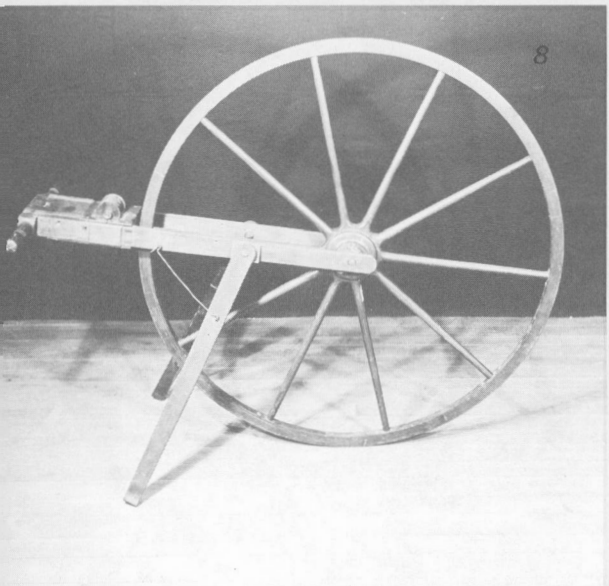

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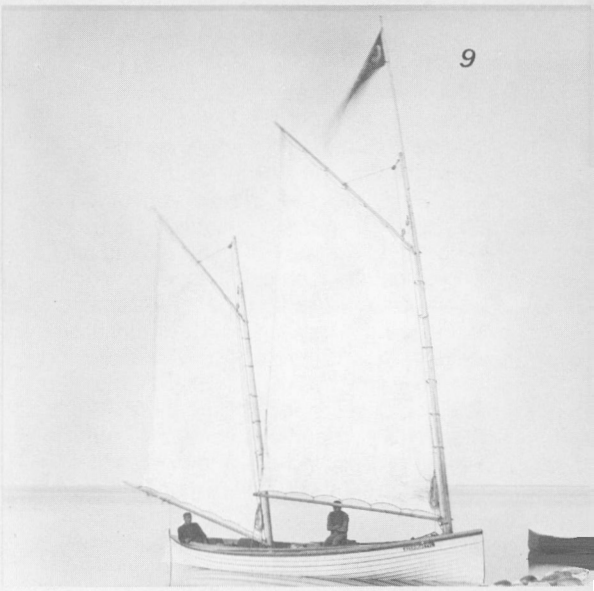

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The Heroic Age

The year 1871 saw the start of a second great surge of exploratory surveys. Selwyn, although now serving as the Survey's second director (1869-1895), made a rigorous trip across British Columbia in 1871, travelled from Lake Superior to Lake Winnipeg by canoe in 1872, and in 1873 crossed the prairies by Red River cart. The addition to Canada of Rupert's Land in 1870 and of the North West Territory in 1871 added a vast and virtually unexplored land – a land of rugged mountains, endless forests, turbulent rivers and vast prairies. The cession in 1880 by Great Britain of the Arctic Islands added still further to the area for which the Geological Survey was responsible although it was not until the early 20th century that this latter challenge was taken up to any degree.

The principal explorations of the 1870's were in western Canada and here as in the region of the Great Lakes, the Survey's studies resulted in the first scientific appraisal of the country.

G. M. Dawson, Director from 1895 to 1901, was a versatile scientist who soon recognized that the attempt to correlate geological units across Canada was doomed to failure and that the first step in mapping a new area was to establish units of local significance. While studying the coal deposits of the Queen Charlotte Islands, Dawson found time in 1878 to prepare a comprehensive report on the Haida Indians and the photographs he made then are of continuing importance to anthropologists. Indeed a broad interest in natural history characterized many Survey officers of the time and this in turn was reflected in the growth of the museum as part of the Survey's work. Dawson's work in western Canada, especially in the Cordilleran region, formed the foundation for the work of many future geologists. His work in the Yukon predated the discovery of gold in the Klondike by nearly a decade and it was fitting that his name should have been given to the town that sprang up as a result of the discovery of gold in 1896 and that was for a brief time the largest city in North America north of San Francisco.

Robert Bell, who was Acting Director from 1901 to 1906, had been associated with the Survey since 1859 when he headed his first field party. For 34 years he led exploration parties into the north and west of Canada. In 1875 he mapped part of the east coast of Hudson Bay and continued this work in 1879. In 1881 and 1882 he carried out reconnaissance between Lake Superior and Lake of the Woods. In 1884 he travelled aboard the *Neptune* as a member of an expedition sponsored by the department of Marine and Fisheries and in 1885 was aboard the *Alert* carrying out similar work. Bell explored the southern coast of Baffin Island during the summer of 1897 at the same time as A. P. Low, another future director, was doing similar work on the south coast of Hudson Strait.

En route to Benton (Alta) 1881.

Low had worked with the Survey in Gaspé in 1881 and 1882 but in 1884 as a young man of 23, he too entered the arena of northern exploration. He participated in a joint Canadian-Quebec exploration of the Lake Mistassini area, a trip made memorable by the fact that when a disagreement arose between Low and his Quebec counterpart, Low had no hesitation in snowshoeing out to a railroad, travelling to Ottawa where he

received clarification of his instructions and then returning to the field. The trip, to clear up a disagreement, lasted from early March to the end of April. In the 1880's Low worked mainly in the region between Lake Winnipeg and Hudson Bay but returned to Labrador in 1892 where he accomplished his greatest work. Undoubtedly his most important scientific contribution was his study in 1894 and 1895 of central Labrador and eastern Ungava, an area of 440 000 km^2 that contains the vast iron ore deposits of the Labrador Trough. Low recognized the potential and economic significance of these deposits and although more than half a century was to pass before they became of direct importance to our economy, the significance of the information derived from Low's work was immediately recognized. Low, assisted by his nephew, G. A. Young (Chief Geologist of the Survey 1924-43) mapped the entire east coast of Hudson Bay in 1898-99 wintering at Great Whale River.

Low's last major contribution to the scientific work of the Survey was in 1903-04 when the government offered him command of the Dominion Government Expedition to Hudson Bay and the Arctic Islands. This was Canada's first

Hon. Judy Erola, Minister of State (Mines) unveiling plaque commemorating Robert Bell at GSC Headquarters, September 1981. J. Mackintosh Bell, great nephew of Robert Bell on right.

A.P. Low and D.I.V. Eaton, Churchill River Labrador, 1894.

*The **Neptune**, Cape Fullerton, Hudson Bay, 1904.*

overt exercise of authority over her most northern lands and in addition to the scientific staff, the expedition included six members of the Northwest Mounted Police.

The expedition sailed from Halifax aboard the DGS *Neptune* in August 1903 and returned in mid-October 1904. After visiting Cumberland Sound on the east coast of Baffin Island, winter quarters were established on the northwest coast of Hudson Bay. In the course of the winter, surveys were made of more than 1 000 km of the west coast from Chesterfield Inlet to Wager Bay and of part of the west coast of Southampton Island. During the summer of 1904 the *Neptune* sailed part way up the east coast to Ellesmere Island taking formal possession of the land for Canada. Returning south they entered Lancaster Sound, landed at Beechey Island where Franklin had wintered in 1845-46 and where Canada's sovereignty was again proclaimed, proceeded south to Somerset Island where the flag was again shown, then south along the east and south coasts of Baffin Island to their winter quarters of the previous year and thence retraced their route east through Hudson Strait and down the Labrador coast to Halifax.

While the cruise of the Neptune did not mark in any dramatic way the end of the Survey's heroic age, it was in some ways the end of an era. For more than 30 years officers of the Geological Survey had been in the forefront of obtaining information about Canada's landmass. They were commonly as much explorers as geologists. As the political frontiers were expanded so the field of activities of the Survey expanded. As the last quarter of the 19th century opened, the staff had been involved in geological exploration along the International Boundary with the United States, and in evaluating the potential of the unknown lands across which a projected transcontinental railway might pass. As the 20th century began the Canadian Pacific Railway had been linking the Atlantic and Pacific for more than 15 years and much was known about the more remote parts of the Dominion. In the words of M. Zaslow (p. 175):

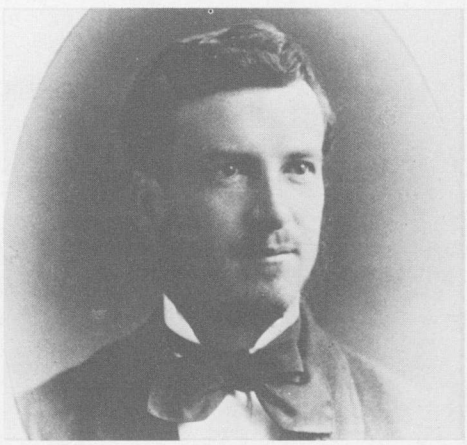
> "In less than 25 years, reconnaissance activities had been extended northward from the Alberta foothills all the way to Great Bear Lake and the Mackenzie delta, from Rainy River to Foxe Basin, from Lake St. John to Ellesmere Island. Wherever the geologists had gone, they had carefully mapped the physical features of the districts traversed, and had contributed immeasurably to the map of Canada's territory.
>
> "The expanding operations of the Survey yielded broader and fuller insights into the variety and scale of Canada's geography and natural history, as well as into the sweep of her geological evolution from the continent-building movements to the immense changes wrought in recent times by great ice sheets and the regular erosive forces of water and air.
>
> "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 exploration of the country west of Hudson Bay was continued in 1887 and 1892 by J. B. Tyrrell who in 1893 and 1894 made two celebrated journeys into and through the Barren Islands of Keewatin, an area previously explored only by Samuel Hearne in 1171. In 1893 Tyrrell, accompanied by his brother James, who had also taken part in

Inuit kayaks, Kazan River, 1894.

previous survey work, travelled from Edmonton to Lake Athabasca which they traversed, thence by way of Black Lake and Selwyn Lake to the Dubwant River. They descended the Dubwant to Baker Lake and Chesterfield Inlet which they reached on September 12. Already the short summer season was long finished. The low-lying, reef-studded western coast of Hudson Bay is seldom pleasant – in the autumn it offers appalling travel conditions due to frequent storms, freezing temperatures and decreasing daylight. As Tyrrell and his party inched their way towards Churchill, food ran out and illness and frostbite appeared. Finally dogteams sent from Churchill reached them and after a month's rest in Churchill, the party left on November 6 by dogteam and snowshoe reaching Selkirk, Manitoba at the New Year. Tyrrell returned by train to Ottawa, prepared his report and in the spring of 1894 was again in Keewatin. The trip this year led from Reindeer Lake, the Kazan River, Ennadai Lake, Fergusson Lake and down the Fergusson River to Hudson Bay. Churchill was reached on October 1 after a trip almost as appalling as that of the previous year and after a two-month stay there the party left for the south reaching Selkirk on January 7, 1895.

Rock at Churchill, Man. bearing the name of the explorer Samuel Hearne



Hugh Fletcher

Waterfront at Dawson, Yukon, 1898.

The discovery of placer gold in 1896 in the Klondike district of the Yukon resulted in an urgent need for specialized geological information on the nature of the deposits and the possibilities of finding the "Mother Lode" or of finding similar deposits elsewhere in the Yukon. Dawson's work of 1887 had provided the groundwork but much more was needed. In 1898 Tyrrell undertook a reconnaissance survey of southwestern Yukon west of the Yukon River and south of the latitude of the Pelly River. During the same period R. G. McConnell undertook similar work east of the Yukon River. Both McConnell and Tyrrell also visited the Klondike and prepared a short descriptive report. McConnell continued the study of the Klondike area during the next few years by which time the gold rush had peaked and interest was being diverted elsewhere.

As the new century began, exploration in the northwest continued. J. Mackintosh Bell's exploration of Great Bear Lake in 1900 provided one of the more exciting episodes in Survey history including the apparent loss of a party member who, surviving abandonment, turned up in Edmonton nine months later. Besides exploring virtually unknown country and making observations that led eventually to the discovery of Port Radium deposits the expedition was also significant in that it brought into the Survey Charles Camsell, a "Son of the North", who would become Director and also Deputy Minister and Commissioner of the Northwest Territories.

Klondike-bound Charles Camsell (second from left) on Liard River January 1898.

Organizational Zenith

As the 19th century drew to a close the organization for which its legislative initiators had expected a two-year life, had changed enormously. No longer did the threat of dissolution due to legislative inaction hang over the Survey and no longer was the Director obliged to lobby members of the government every five years to assure the continuance of salary and operational money. The Act of 1877 had brought the Survey under the provisions of the Civil Service Act and now for the first time it became an integral part of a government department – the Department of the Interior. In this act specific mention was made to the Survey's curatorial responsibilities. The branch was instructed to "continue to collect the necessary materials for a Canadian museum of natural history, mineralogy and geology" and in addition botanical and zoological surveys were added. Indeed from 1879 to 1889 the organization was known as the "Geological and Natural History Survey of Canada".

On May 16, 1890 all this was changed by an Act of Parliament that stated "There shall be a Department of the Civil Service which shall be called "The Geological Survey" over which the Minister of the Interior shall preside...."

Half a century had indeed seen a remarkable growth in the visible prestige of the Survey, from a 2-man organization to a department of government with its own, albeit shared, Cabinet spokesman.

The next half century would witness an equally remarkable decline until by the end of the Second World War the Survey had so dropped in organizational importance that bureaucrats were hard pressed to find an organizational term whereby to designate its lowly status. Organizational arrangements may not necessarily reflect the intrinsic value of the work being carried out but they most certainly do reflect the importance placed on an activity by government. The Act of 1890 reflected the importance placed on the Survey's work in expanding Canada's economy. Recognizing this importance the framers of the Act added the provision that officers who were engaged in scientific work should normally be science graduates of a Canadian or foreign university, the Mining School of London, the Ecole des Mines of Paris, other comparable schools or the Royal Military College. Herein was laid the groundwork on which has been built the professional, highly qualified scientific organization of today.

Between 1909 and 1911 uniforms and military discipline were introduced to the topographical division by Maj. R.H. Chapman, a U.S. Army surveyor. These buttons and the belt buckle recall this period.

The Mines Branch and a Department of Mines

Despite the importance implied by departmental status the period was not without its problems. The election of Sir Wilfred Laurier's Liberal government in 1896 ending nearly 20 years of unbroken Conservative rule was bound to affect the department. As was common at the time the government wished to make certain appointments to the Public Service on the basis of party loyalty. The new government showed little inclination to increase the Survey's funds and the staff remained at about 30 (plus 15 or 20 casuals) and the funds available for field work seldom exceeded $60 000 a year.

Both Selwyn and Dawson emphasized what might be called a "pure science" approach. The emphasis on academic qualifications and the nature of many of the studies undertaken reflect this. Others felt that too often the Survey lost track of its original practical objectives of mapping and assisting the mining industry in every possible way. The Act of 1890 had included as one of the Survey's objectives the collection and publication of statistics concerning Canada's mineral production and the mining and metallurgical industries. By the end of the 19th century mining with its annual $100 million per year production rivalled forestry and agriculture as a source of export earnings. This importance gave the industry political clout as well and the Survey began to feel this pressure.

There appeared to be little desire on the Survey's part to become more involved in the mining field. In view of its reluctance to undertake new work in this field, Sir Clifford Sifton, the dynamic Manitoban who had been Minister of the Interior since the Liberal victory, decided to expand the office of the Superintendent of Mines in his ministry to include responsibility for compiling mining statistics, examining technical processes, preparing reports on particular industries, and publicizing the opportunities in Canadian mining. This proposal came into the open when the estimates of the Department of the Interior were tabled. An item of $10 000 for expenses and salaries of the Mines Branch opened the door for considerable debate. In answer to queries from the floor, the Prime Minister indicated that the proposed branch would comprise mining geologists and clerks who would collect data, provide assays and analyses of economic minerals and prepare reports. However, as is the case with governments with substantial majorities, the estimates were passed despite the opposition's queries, the Mines Branch came into existence and in August 1901 Sifton's nominee for branch head, Dr. Eugene Haanel, was sworn into office.

The Survey reacted to the creation of the Mines Branch by making great efforts to show that its Section of Mines could do, and indeed already was doing, the work of its rival. The unexpected death of G. M. Dawson in March 1901 at the age of 52 placed Robert Bell in the position of Acting Director. Bell was a practical man who had long been critical of what he considered the Survey's neglect of the mining industry and who felt that he rather than Selwyn or Dawson was the rightful successor to Logan. In his first Annual Report as Acting Director, Bell emphasized the practical. "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".

This rivalry continued with duplication of effort inevitable as a result of the Survey's Section of Mines and the Department of the Interior's Mines Branch both having the same objective. The issue was further complicated by the reluctance of the government to appoint Bell Director of the Survey and Bell's persistent lobbying for the position. The situation resulted in considerable editorializing in the mining press and finally the government moved. Bell was notified that effective April 1, 1906 he would revert to the rank of Assistant Director with the title of chief geologist and that

A. P. Low would become Director. In the next 12 months a complete reorganization of the Department of the Geological Survey took place and in March 1907 a bill to create a Department of Mines was introduced in Parliament and was passed a month later. The new department comprised two branches, Geological Survey and Mines Branch. Low, after one year as director of the Survey was appointed Deputy Minister of this new department, a position he held only briefly before an illness, already manifest in 1907, became so debilitating that he had to leave the management of his department to others and, ultimately in 1914, to retire completely. R. W. Brock who succeeded Low as Deputy Minister, had been Acting Director of the Survey since 1907.

The Mines Act of 1907 clearly defined the functions of the Geological Survey and the Mines Branch. The latter was responsible for collecting and publishing statistics on the mining industry, and for data regarding economic minerals and their utilization. It was also responsible for studies of mining camps, orebodies and areas of economic mineralization and for carrying out chemical, mechanical and metallurgical investigations on behalf of the mining industry. The Geological Survey retained its earlier responsibilities. In addition to what today would be called earth sciences, specific mention was made of water supply, forest resources and ethnology and of the responsibility for maintaining a Museum of Geology and Natural History. Although the reorganization and creation of the Department of Mines, distressed many steeped in the traditions of the Survey, in retrospect the creation of the Mines Branch removed from the Survey an embarrassing responsibility which had diverted its effort from other activities yet never satisfied its critics. The result, as is so often the case with a compromise, satisfied neither side and, as noted, resulted from time to time in bitter and harmful attacks on the Survey.

The solution of forming a new agency to carry out specific activities would be used again and again. In the nearly 70 years since the creation of the Mines Branch, many activities carried out by the Survey have been transferred to other agencies. Some, such as anthropology, ethnology, botany and zoology were relinquished willingly when conditions permitted the establishment of an independent National Museum. Others such as groundwater studies were let go reluctantly because of the interlocking nature of such studies with geology and a fear that the geological implications would be neglected. Still other studies such as seismology, gravity and magnetism had not been extensively undertaken by the government. When the need for federally-supported studies in these fields

Monument to G.M. Dawson

developed, they were grouped together in a new branch rather than being added to the existing Survey establishment. Perhaps the traumatic experience the Survey underwent between 1896 and 1907 was instructive because successive managements in the main have resisted the temptation of attempting to create an all embracing geoscience survey. Similar decisions will have to be made in the future. How diverse can any agency become without losing coherence and to what extent can an existing agency embark on new, technically complex, and expensive studies without prejudice to its prime function?

The National Museum

The Act of 1845 directed that the Geological Survey should "furnish a full and scientific description of its Rocks, Soils and Minerals...together with a collection of Specimens to illustrate the same...which shall be deposited in some suitable place...and shall serve as the Provincial Collection...." As the Survey's objectives were broadened, botanical, anthropological and ethnological collections were added to the original geological and mineralogical collections. It is somewhat surprising to see the name of G. M. Dawson, the third director, attached to collections of the West Coast Indian material but this merely reflects the Survey's acceptance as the Geological and Natural History Survey of Canada. When the move from Montreal to Ottawa took place in 1881 the collections moved exceeded 140 tons. The museum occupied space in the building at the corner of Sussex and George streets which for 30 years was the Survey's Ottawa home. In the turbulent years that preceded the formation of the Mines Branch, museum work was not prominent in the activities carried out although the collections kept growing and from time to time public pressure was applied on the government to provide more adequate accommodation for the display of the collections as well as for the other work of the Survey.

At long last, after years of planning and years of construction, a monumental structure, the Victoria Memorial Museum, was erected at the corner of McLeod and Metcalfe Streets, a building that since 1910 has been an Ottawa landmark. A total renovation of the interior was carried out between 1969 and 1974 and new techniques for display made it possible for the Museum to serve the public more fully.

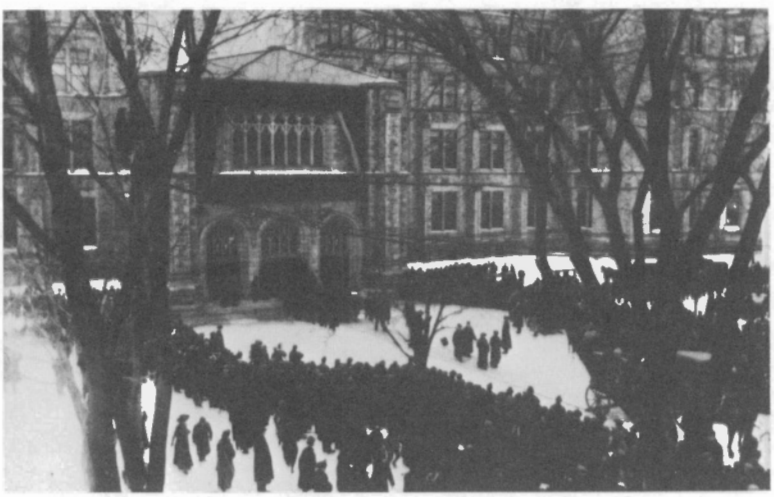
The move to this building in 1910 allowed the Survey to expand and plans were made to expand the collections of the various divisions – mineralogy and geology, biology and anthropology. Brock, the Director, planned to limit the collections mainly to Canadian material with the aim of developing collections unsurpassed in their fields. The professional staff, especially in anthropology and biology, was expanded and a new series – Museum Bulletins – was added to the Survey's publication program. Any further expansion was halted by the First World War and the requisition in February 1916 of the Museum Building by Parliament as a temporary meeting place to replace the Parliament Buildings which had been destroyed by fire. Almost all the museum collections were placed in storage, some material was lost in the upheaval, and all related research came to a virtual standstill.

It is ironic that the museum building, built at great cost and to be occupied by the Geological Survey, should have been constructed on a site not subject to any geotechnical studies, a site that proved to be most unstable and which for years caused major foundation problems. The site is underlain by 140 feet of unconsolidated blue "Leda" clay. The outer walls, resting on piles driven into the clay, settled more quickly than the floors which were supported by inner walls. The result was distortion and shearing of internal partitions. A massive tower that formed the main entrance developed such a list that it was demolished in 1916. Problems of settling, sloping floors, and massive cracks in pavements continued to plague this building until the recent renovation when the entire building was floated on a

slab of concrete thus distributing the weight of the massive masonry walls more equally.

From 1920 a theoretical separation existed between the administration of the Museum and the Survey for in that year William McInness, who in 1915 had been appointed "Directing Geologist" in succession to R. W. Brock, who had resigned the previous year as Director and Deputy Minister, to head the Faculty of Applied Science at the newly formed University of British Columbia, became Director of the Victoria Memorial Museum and W. H. Collins was appointed Director of the Survey. This separation was, however, only apparent and when in 1925 McInness died, Collins became Acting Director of the Museum. With changing departmental organization the direction of the Museum gradually moved from the immediate control of the Geological Survey until finally in 1950 it became part of the newly formed Department of Resources and Development whereas the Geological Survey became a branch of the Department of Mines and Technical Surveys. In 1958 the Museum was divided into two parts, Human History and Natural History and in 1966 a Science and Technology branch was added. All three units were brought under the new National Museums of Canada in 1968. This is a departmental corporation which reports through the Secretary of State and which comprises the National Museums of Man, Natural Science, Science and Technology and the National Gallery of Canada.

Although the Museum and the Survey were administratively separate from 1950 it was not until the Geological Survey moved into its new Booth Street building in 1959 that the day-to-day contact between the two staffs terminated and with this ended what to many Survey officers had been a fruitful and stimulating exposure to scientists in other fields. Today few Survey scientists have any close association with the Museum – in the field of paleontology there is some contact because whereas the Survey is responsible for the study of invertebrates, the Museum carries on research in vertebrate paleontology. The Survey maintains the reference part of Canada's National Mineral Collection and thus members of the Mineralogy Section work closely with museum mineralogists on certain projects.



When the Parliament buildings were destroyed by fire in 1916, the National Museum was used for meetings of Parliament and the Geological Survey and National Museum were displaced. This photo shows the funeral cortege of Sir Wilfred Laurier leaving the buildings in February 1919.

Decline and Recovery

The Survey entered the post-war period with a fine foundation and direction. The legacy of educational excellence first intimated in the Act of 1890 had been brought to a new level by Brock who insisted on graduate training and degrees equivalent to those that would qualify a man for a professorship. In order to assist in this training, summer employment opportunities were expanded and better pay scales instituted for such work. The Survey also assisted in providing thesis topics and undertook to publish the thesis results usually in the memoir series. Not until after World War II when some universities felt that the regional mapping topics then inherent in many Survey projects no longer provided acceptable thesis material was there any major change in this approach to graduate training.

The divisions are the medium whereby the Survey's various activities are carried out, its objectives met and its programs fulfilled.

The quality of the Survey staff was soon recognized in a way that the organization could well have done without. No sooner had the war ended, and in fact even before, than mining and oil exploration companies and the universities approached staff members with offers far more attractive than the Survey could offer particularly in view of the strictures imposed by a revised Civil Service Act that had attempted to impose uniformity across the public service. In the interest of securing uniformity, certain government organizations suffered and those involved in science were especially hard hit. Those officers who entered the field of higher education were not completely lost to the Survey for many continued summer work but those who went to industry were lost although some returned to the Survey after varying lengths of time in the "outside world". So obvious were the inroads that organizations such as the Canadian Mining Institute made strong representations to the government regarding the salary disparity and indeed the legislature of the Province of British Columbia passed a resolution deploring the depletion of the Survey staff and affirming the Survey's value to the mining industry.

The extent to which the federal government is, under the terms of British Columbia's entry into Confederation in 1871, responsible for geological studies was raised during this debate – a point that for many years has, to some extent, influenced the Survey's program in the far west.

Surprisingly this agitation had some results – a new salary scale was instituted in April 1920; this provided substantial raises and even some reclassifications, thus greatly improving morale. During the next 12 months vacant positions were filled, often by men who had had many years of experience as student assistants. Men who later served in senior administrative positions joined at this time – W. A. Bell (Director, 1949-1953), George Hanson (Director, 1953-1956) and G. S. Hume (directing 1947-1949, and Director General of Scientific Services 1950-1956). Others who

Alice Wilson, Canada's first professional woman geologist.

for many years contributed to the scientific program also came at this time including F. H. McLearn, W. E. Cockfield and T. L. Tanton.

Canada's first professional woman geologist, Alice Wilson, had joined the staff in 1909. Although she formally retired in 1946, she retained an office and continued her studies of the Paleozoic strata of the Ottawa region almost to the time of her death in 1964 at the age of 83.

It was fortunate that the staff had been built up in 1920-21 because the twenties saw the start of a long decline in the Survey's relative importance and prestige. The Mines Act of 1907 had created two virtually autonomous units reporting to a common minister. Each branch developed its own programs with little reference to the other. By the twenties, however, the departmental management was exerting its policy-making authority and was intent on using the branches as the vehicle for implementing government policy. Government policy at this time was directed towards building up the mining and manufacturing side of the mineral industry and greater and greater emphasis was placed on the activities of the Mines Branch. At the start of the twenties the Survey's budget was twice that of the Mines Branch, by the end of the decade they were about equal and by the thirties expenditures by the Mines Branch far exceeded those of the Survey.

R. G. McConnell had in 1920 been succeeded as deputy minister by Charles Camsell and W. H. Collins succeeded William McInness as director of the Survey on the latter's transfer to the Museum directorship. Camsell, although born in the Northwest Territories and a man experienced in Survey field work and cognizant of the need for northern geological exploration, threw himself completely behind the government's efforts to build up a powerful mining industry by attracting capital to exploit the nation's mineral resources. Many of his long-term Survey associates felt a certain sense of betrayal so completely did the new deputy minister appear to relegate the value of geological surveys to the background. The government's approach was spread over many years and because the Survey's management did not come forward with any dramatic programs to counterbalance the undoubted valuable work being initiated by the Mines Branch and the public visibility this work received, the Survey's relative importance declined. It may sometimes be thought that senior management can little influence the direction an organization's work takes and that an organization such as the Survey with decades of activity behind it is carried forward by its own momentum. The events of the twenties disprove such an idea. Not only did Collins' cautious approach and lack of dramatic flair contribute to the increasing dominance of the Mines Branch but within the Survey itself his stress on the traditional, Logan-style approach – field mapping – tended to restrain the growth of those units that did not contribute directly to areal mapping. Paleontology in particular appeared to meet with little favour and from time to time members of the Paleontology Division were diverted to regional mapping activities.

As Canada along with the rest of the western world entered the thirties and the Great Depression, the need for the practical became even more obvious. Studies having economic objectives became predominant. The reorganization of the department, described elsewhere, reflected the increasing emphasis on economic subjects. Between 1930-1935 the government was forced to reduce drastically the funds voted to the various departments. In order to stay within its reduced estimates and in order not to have to release staff (as was done in the Department of the Interior) field activities were reduced until only a fraction of the number of parties once sent out were being maintained. Those in the mining industry naturally felt that their only salvation lay in more and more government-supported field studies that would disclose new areas for exploration and development. Caught as it was in this cleft stick the Survey could only maintain a holding operation knowing full well that

the areas in the North that should be undergoing mineral exploration, especially in view of the historically high price to which gold had risen, were geologically all but unknown and, in view of the critical shortage of funds and their remoteness, were all but inaccessible.

The Conservative government of R. B. Bennett, elected in 1930, tried unsuccessfully to alleviate the effects of the Depression. Across the border was the example of Franklin Roosevelt who, once he had been inaugurated as President in March 1933, launched massive public works schemes to provide employment. Faced in 1935 with an election and an obviously unhappy electorate, Bennett, in an abrupt about-face, tried the same approach. The Geological Survey was one of the beneficiaries albeit almost reluctantly, for so sudden was the move and so large the sum that it was all but impossible to develop proper programs.

The $1 000 000 granted was ten times the planned expenditure for the 1935 season. The program announced in mid-April indicated that the area of concern was the North but in the end most of the effort was in the northern parts of British Columbia, Ontario and the Prairie Provinces. It was designed to create employment, especially for young people and to assist the mining industry. By mid-June more than 4000 applications had been received by the Survey; 1005 were accepted. These men were organized into 188 field parties. When compared to the 24 parties sent out in 1934 or the 48 that were organized in 1936, an idea of the problems can be gained. The main difficulty of course was to find trained personnel to direct such large numbers. Vast amounts of new equipment had also to be purchased and until well into the fifties a great array of technical stores still bore the imprint of the "Million Dollar Year" – a serial number beginning with the numerals "35".

Naturally such a crash program created innumerable problems. Although two-thirds of those hired were university students, few had geological training.

L.J. Weeks on Baffin Island, 1926.

Aircraft used to move GSC party, Sandbeach Lake (Sask.) 1934.

Experienced staff had to supervise subparties headed by green untrained students. One officer working in northern Saskatchewan directed seven parties in addition to his own, using aircraft to maintain contact.

The results of this "New Deal" approach were varied. Despite its apparent conversion to cautious socialism, the Conservative government was decisively defeated in the October election but the Geological Survey had obtained much new data. Indeed so voluminous were the data obtained on the groundwater resources of the Prairies that years passed before they were collated into publishable form. The employment offered during the hectic summer enabled some graduate students to continue their studies and several joined the staff of the Survey soon after, thereby starting careers that continued into the present decade. The relatively unlimited funds also enabled the Survey to indulge in the use of aircraft on a large scale. Until this time little use had been made of aircraft although by the mid-twenties industry had made extensive use of them and several major far northern projects had been undertaken. Undoubtedly had prior planning been possible, much more could have been obtained from the expenditure of a million dollars but scientific returns had to take second place to political demands. On balance the frantic exercise of 1935 probably had a salutary effect on the Survey. At least it felt wanted.

Organizational Nadir

By the 1930's the palmy days of the Department of the Geological Survey were gone. By the Act of 1907, the Survey had become a branch. As the Depression deepened and as it became both politically expedient and undoubtedly practical to devote a major part of the effort of the Department of Mines to economic concerns, a Bureau of Economic Geology was created and together with the Mines Branch formed the department. Within the bureau the concept of a Geological Survey continued. On December 1, 1936 a government reorganization created a new department, the Department of Mines and Resources by placing under one minister the former departments of Mines, Interior, Indian Affairs and Immigration and part of the Department of Marine. One of the five constituent branches, the Mines and Geology Branch, was the former Mines Department. This branch was responsible for "The undertaking of scientific, technical, and other investigations designed to further the development of the mining, metallurgical and related industries in the Dominion;...the investigation of matters relating to a national fuel policy; and the administration of legislation providing assistance to the Canadian coal industry; and the maintenance of the National Museum of Canada".

This arrangement, with minor alterations was the departmental structure until after the end of Second World War and

was the organizational nadir of the Survey – what had been a department headed by a minister of the Crown was now part of a bureau, its name no longer appearing on the departmental organizational chart and no longer headed by a director but by a chief geologist. It had lost administrative direction of the technical survey activities such as Topographical Survey and its drafting and cartographic work was now carried out by a separate section of the bureau.

Reorganizations

With the end of the war some minor administrative changes were made reflecting perhaps a growing awareness of the role science had played in the war effort and the fact that government would have to become more deeply involved in many diverse scientific activities. The Mines and Geology Branch was replaced on November 1, 1947 by the Mines, Forests and Scientific Services Branch which brought together agencies engaged in resource studies. In this reorganization the Survey regained control of its own drafting services, the nucleus of the present Cartographic Section. G. S. Hume, who during the war had served as technical adviser to the Oil Controller, became Chief of the Geological Survey as his position of Chief of the Bureau of Geology and Topography had disappeared in the reorganization. Hume was thus in essence director of the Survey although it was not until his appointment in early 1950 as Director General of Scientific Services in yet another reorganization that the title "Director" was revived, W. A. Bell being the first to hold it.

GSC packtrain, Yukon, 1934.

The Departments of Mines and Technical Surveys and Energy, Mines and Resources

The Department of Mines and Resources, a creation of the depression had brought together under one cabinet minister diverse activities that lacked a unifying theme. Rapid economic expansion followed the Second World War and the need for data to support the expanding search for mineral resources was apparent. However a minister who headed a department responsible among other things for Canadian Immigration policy, Indian Affairs, and the administration of the Northwest Territories and the Yukon, and Canada's wildlife including migratory birds, could hardly devote much time to its Mines and Geology Branch, a unit that included, in addition to all geoscience activity, the Dominion Forest Service, the Dominion Water and Power Bureau and that perennial orphan the National Museum.

The interest in Canada's mineral resources that expanded so greatly after the war, developed along with an increasing awareness of the importance of all aspects of science to Canada's development. As a result of these and other influences, government reorganization in early 1950 saw the formation of a Department of Mines and Technical Surveys. In the words of the new department's first annual report, "The Department was established in view of the growing feeling, particularly among those interested in mining, that the importance of the mineral industry and of the Government's relations with the industry was such that there might well be a Minister of the Crown who would devote his full attention to the fields of mines and mining". The new department, comprising the Mines Branch, the Geological Survey, Surveys and Mapping Branch, Dominion Observatories and Geographical Branch, was to be an integrated organization with the primary function of providing technological assistance in the development of Canada's mineral resources. The services provided by the Mines Branch were especially in demand as the mineral industry expanded. Tests and research on various Canadian ores were made to help industry reduce operational costs. In the first year of the new department 68 maps pertaining to Canada's coal resources were published by the Geological Survey, an example of the direct application of the Survey's scientific work.

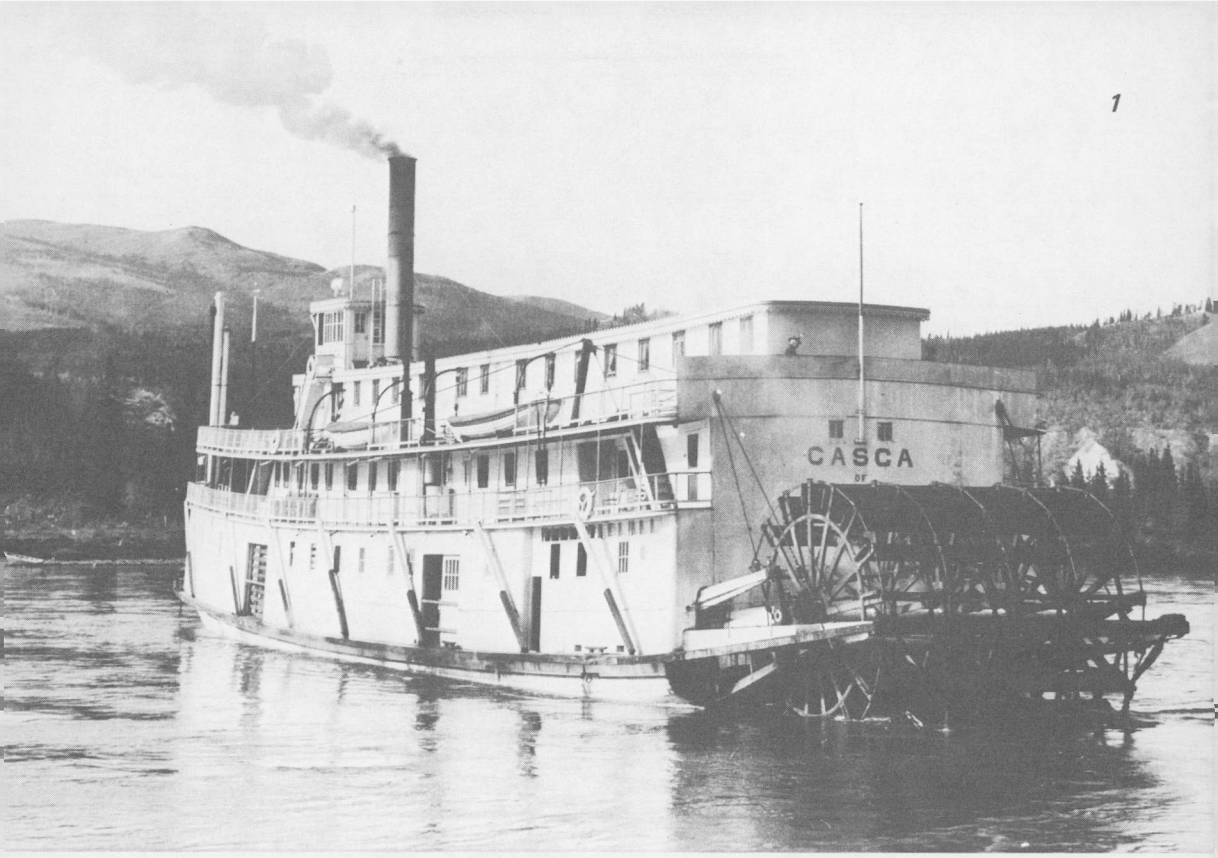
Late in 1949 W. A. Bell was appointed Director of the Survey. A man whose scientific career covered many fields in geology and paleontology, especially those related to the Carboniferous rocks of the Maritime Provinces, he had not evinced any great interest in administration and his appointment surprised some but in view of the rapidly expanding interest in the petroleum possibilities of western Canada at that time, it was logical that G. S. Hume, an acknowledged expert in the petroleum field should have been followed by another "soft-rock" man. Even as director Bell never abandoned his research interest and in 1953 he decided to devote all his time to his studies in paleobotany and stepped down from the director's position to become chief geological consultant, a position he held until his official retirement in 1956.

George Hanson who succeeded to the directorship had served as Chief Geologist since 1943. By training he was a "hard-rock" geologist having carried out most of his field work in British Columbia and he brought to his administrative task a deep interest in economic geology. He was succeeded as Chief Geologist by C. S. Lord who for the next 19 years was the guiding genius of the Survey's ever expanding field programs and whose two-decade period of leadership saw tremendous strides in the understanding of the geology of Canada.

Hanson retired in 1956 and was succeeded by J. M. Harrison who at the age of 41 became one of the Survey's youngest directors. Harrison, a graduate of the University of Manitoba and Queen's University, was a Precambrian specialist and thus brought yet another background to the director's office. His administrative talents are reflected in the

Field camp circa 1960.

Down-hole geophysical logging vehicle.



*1 Steamer **Casca**, Yukon, 1934.*
2 Piper Super cub with low pressure tires used for landing on unprepared sites in Arctic.
3 Arctic campsite used in helicopter-supported reconnaissance project.

many new activities undertaken during his time of office. The Survey became much more involved in international scientific activities and hosted numerous scientific conferences in Ottawa. It took the lead in developing co-operative projects with the provinces, universities and industry and a greatly expanded program of scientific exchanges was initiated. The fifties became a time of scientific and technical growth unimagined a few years before and a time looked back upon with a certain nostalgia.

The new department was not hampered by the fiscal restraints that had plagued its predecessor and, reflecting a growing public support for scientific research, funds were made available to the Survey to permit it to undertake research into fundamental geological problems, expand its laboratory work and to undertake a far more ambitious field program. The staff was greatly increased and financial support rose from about $1 million in 1950 to more than $4 million a decade later.

It was now possible to make firm plans to design and erect a new building for the Survey, a building in which all activities would be integrated. The resulting building was a great improvement over the monolithic Victoria Memorial Museum building and the satellite offices scattered across Ottawa. However when in the mid-1960's new facilities were being planned for the Western Office (now the Institute of Sedimentary and Petroleum Geology) a building even more suited to the research requirements of the organization was designed. In this building research scientists were assigned office space on the perimeter of the building but the laboratory facilities were centred in a core area permitting sophisticated equipment and services to be centralized.

Possibly the most visible measure of the extent to which the Survey was supported in the fifties and sixties was the dramatic increase in reconnaissance bedrock map coverage of Canada. In 1950 less than one-quarter of the country had been mapped – by 1975 only a few scattered, isolated areas remained to be examined. The field programs and staff lists of the period show where the emphasis lay. In 1958 there were 76 field parties; bedrock mapping accounted for 43 of these, mineral deposits only 6. The emphasis was still south of 60°N. There were only 11 parties in the Territories in contrast to the 17 assigned to projects in the Atlantic Provinces or the 13 who worked in British Columbia. By 1975 less than 25 per cent of the Survey's effort was devoted to systematic surveys or regional syntheses and that effort was almost totally directed to areas north of 60°N.

In the light of the concern of the mid-1970's – energy supply and resource adequacy – the framers of the government reorganization bill of 1966, the bill that created the Department of Energy, Mines and Resources, seem to have had considerable foresight. What had been essentially a science-oriented grouping was, by the addition of overall responsibility for planning for Canada's energy needs, transformed into a policy making department. It was a department whose expanding mission soon attracted and held the interest of cabinet and to head the new department became a sign of considerable cabinet prestige.

Since its formation the department has somewhat altered. Although all responsibilities for water resource inventory and planning were transformed in 1971 to the newly formed Department of the Environment and the astronomical studies of the Observatories Branch to the National Research Council, other aspects of the department's mission have greatly expanded. The Energy group established to study, recommend and coordinate federal policies related to energy development, is filling a role of increasing importance as concern for Canada's energy supplies deepens. Like any policy making group those concerned with policy development in EMR draw extensively on other parts of the organization for data on which to base policy recommendations. The information collected, compiled and interpreted by the Geological Survey is fundamental to most departmental objectives. To formulate

energy policy there must be adequate information on conventional oil and gas resources and reserves, on uranium and heavy oils and on coal. This is the type of information that the Geological Survey has been and is collecting. Formulation of mineral policy depends in part on up-to-date reserve and resouce assessments which the Geological Survey is equipped to carry out. Development of sensible policies to protect the surface of the land depend in large part on adequate knowledge of terrain characteristics, for example slope stability – knowledge that is derived from studies carried out by the Geological Survey of Canada.

By the latter part of the sixties the halcyon years appeared to be over for the Survey. Although annual budgets showed a steady increase the steady increase in inflation began to cut ever deeper and the period of virtually unlimited expansion was over. Some projects had to be postponed or curtailed. Some exciting new avenues of research had to be left to other agencies. Many of the problems that began at this time, problems that still affect the Survey's operations, resulted from a growing desire on the part of government to increase its management role. More elaborate accounting procedures were initiated in attempts to evaluate the efficiency of the programs and to justify manpower allocations; the contracting out of research was encouraged and new agencies such as the Ministry of State for Science and Technology began to require significant input from the Survey to meet the needs of their studies, analyses and projections. Scientific managers in the Survey were called upon to meet the ever expanding administrative load, often to the detriment of their scientific roles and to their personal frustration. The period was one of change – change in organization to reflect change in departmental policies and change in program to meet changing objectives.

Further administrative changes followed. In 1979 J. O. Wheeler who had, in 1973 been appointed Deputy Director succeeding C. S. Lord as Chief Geologist, returned to a scientific career and J. G. Fyles became Chief Geologist. D. J. McLaren was appointed Assistant Deputy Minister, Science and Technology in late 1980 and was succeeded as Director General by W. W. Hutchison who in turn moved on to become Assistant Deputy Minister of the Earth Sciences Sector which was formed when the Science and Technology sector was split into two parts the other being the Research and Technology Sector. In January 1981 R. A. Price, Professor of Geology at Queen's University, Kingston until 1981, became the sixteenth Director of the Survey.

The trend to increasing administrative demands noted in the 1970s has continued into the 1980s. The Branch has redeployed resources both human and fiscal to meet short-term objectives such as mineral and energy resource assessments, transportation route hazards, and assessments in connection with the establishment of new National Parks and those needed to support comprehensive land claim settlements with native people.

To assist the Branch in evaluating the effectiveness of its multifaceted program the Canadian Geoscience Council was asked in 1979 to conduct a study of the outputs of the Geological Survey with respect to quality, relevance, usefulness, timeliness and efficiency of production. This report, received in 1983, included conclusions and recommendations the latter proving most helpful in modifying existing procedures and activities.

GSC Skyvan aircraft.

Meeting Old Objectives and Formulating New Goals

At its inception the stated objective of the Geological Survey was to make an accurate and complete geological survey of Canada in order to ascertain the country's mineral resources, and to do this it was necessary to make studies in all parts of the country the results of which would be representative of large areas. One way of making data so acquired available is in the form of maps and thus one of the first products of the Survey was maps. Progress in meeting the first objective can be measured by evaluating the number of square miles mapped in relation to given standards of reliability. Obviously a very generalized geological map of an area can be produced on the basis of random sampling but the more rigid the criteria the greater will be the accuracy of the map.

The closing decades of the 19th century were the heyday of the explorer-geologist. Large areas of Canada were for the first time seen by those able to evaluate the land in terms of geology and who could assess possible mineral wealth. However, travel in these heretofore unexplored regions was commonly difficult and sometimes appalling and observations were in general restricted to the travel routes. As a result, although maps were available, they commonly gave only the most rudimentary information. In the first years of the 20th century, geological work, in more settled parts of Canada, became more and more directed to detailed topical problems; although some major reconnaissance programs were carried out in the Northwest Territories it was not until the late 1920's that a 4-mile reconnaissance mapping program in the northern parts of the western provinces and in the territories began to take shape. H. S. Bostock began a mapping program in the central Yukon that resulted in the completion of five 4-mile sheets between 1931 and 1948 (during the war years of course the search for strategic minerals postponed reconnaissance studies). Similar work also started in those parts of the District of Mackenzie, Saskatchewan and Manitoba underlain by Precambrian rocks.

Travel to and from these areas was commonly time-consuming. To reach his field areas Bostock had to travel by train to Vancouver, by ship to Skagway, Alaska, by narrow-gauge railway to Whitehorse and by steamboat down the Yukon River. Within the area his party moved by pack-horse, a mode of travel widely used throughout western Canada. In the Shield areas the canoe still remained the main vehicle consequently certain parts of an area remained all but inaccessible. In 1944 George Hanson, Chief Geologist, estimated that only 11 per cent of Canada had been adequately mapped geologically.

The end of World War II meant that the Survey could resume its task of mapping Canada and plans were made to begin mapping in the Arctic Islands.

In 1949 Y. O. Fortier began the reconnaissance mapping of southern Baffin Island using boats for coastal travel and backpacking traverses to reach inland. This work was continued by W. L. Davison and R. G. Blackadar both of whom later made the first geological reconnaissance of northern Baffin Island in 1954 using Eskimo-manned dogsleds and boats for travel. Coastal travel was limited, however, and it was obvious that it would be quite impossible in the far north. A new approach was needed.

Although the use of aircraft to support mineral exploration studies in the north had been pioneered in the late 1920's, notably by mining exploration companies, the Geological Survey did not fully exploit this new technique. Possibly financial restrictions were the cause because the Survey did make frequent requests to the Department of National Defence for flights into remote northern areas and early appreciated the potential of air photography but certainly no effort was made to use commercially available aircraft in the field.

One of the stated aims of the Survey was to complete the geological reconnaissance of Canada yet by 1950, after more than a century of work, only about one-quarter of the country had been covered. It was obvious that an entirely

new approach to the problem was required, an approach that would increase manyfold the efficiency of one geologist, an approach that would enable him to spend most of his working day making geological observations instead of on unproductive travel.

Fortunately when a new tool, the helicopter, appeared in commercial form after World War II the Survey had the staff who were eager to exploit its potential to the full. The first trial survey in 1952, code named Operation Keewatin, was planned and directed by C. S. Lord, later Chief Geologist, and resulted in the mapping of 148 000 km^2 of the barren grounds at a scale of 1:506 880. Based on this experience G. M. Wright directed two more operations west of Hudson Bay resulting in another 330 000 km^2 being covered.

In 1955 the first comprehensive geological mapping of the Arctic Islands was undertaken. Air photographs of the Arctic taken during the War by the United States Air Force had disclosed the existence of a new structural province whose diverse features led geologists from the Survey to postulate in 1954 that several large areas appeared to have similarities to other regions in the world that produce or that are known to have large petroleum reserves. To provide the data needed to prove or disprove this hypothesis Y. O. Fortier directed a reconnaissance survey of the Arctic Islands in 1955. The area covered was about 520 000 km^2 about half of which is covered by the many channels, straits and bays of the archipelago. Because of the remoteness and difficult terrain camp moves had to be by helicopter and for the first time the Survey used helicopters much heavier than those used in the Barren ground operations. Eleven geologists and 10 geological assistants comprised the scientific staff. Advance parties were at work in early May. The helicopter-supported field work lasted from June 13 to early September by which time 520 helicopter flying hours had been logged and about 260 000 km^2 of geologically unknown terrain had been examined. The data obtained and the subsequent report formed the foundation on which later more detailed studies were based and were the basis for the great surge in exploratory surveys by the petroleum industry in the late 1960's and early 1970's. Subsequent operations used

Reconnaissance mapping in the Canadian Shield circa 1930.

Sikorsky helicopter used during Operation Franklin, 1955.

much the same operational techniques as those of the early 1950's although the proven capability of light aircraft equipped with over-sized, under-inflated tires to operate out of unprepared landing sites in the north resulted in projects on which helicopters and light aircraft were used in combination.

As early as 1953 light helicopters were used in mountainous, all but inaccessible, areas of coastal British Columbia. The primary use was to take a geologist to areas critical to making correct geological interpretations and thus obviating the laborious, non-productive climbs so characteristic of foot and packtrain geological reconnaissance that had been used since the days of G. M. Dawson.

By 1973 much of the north had been covered by airborne geological reconnaissance programs and the Survey had all but completed a task that twenty years earlier had seemed all but impossible. At last data essential to making first order predictions of mineral endowment were available, although more refined predictions will require a much expanded data base.

Another field in which the advances made by the aircraft industry during and immediately after the War led to a great and rapid increase in earth science information and thus to completing the mapping of Canada, was in the field of airborne geophysics. As early as 1948 the Geological Survey in co-operation with provincial mining departments in Ontario and Quebec had begun aeromagnetic surveys using techniques developed only a few years earlier by industry and government in the United States. At first the Survey provided supervision, compilation and publication services and did much of the flying using its own equipment. Most parts of the Maritime Provinces were covered in this way in the 1950's. In 1961 the federal

government signed contracts for federal-provincial aeromagnetic surveys of the Canadian Shield.

The aeromagnetic program was later extended to cover similar federal surveys in the Yukon and Northwest Territories. The information gained from this program coupled with the results of ground geological surveys has been invaluable in delimiting areas favourable for mineral occurrences, a subject of growing concern as Canada attempts to determine her mineral endowment and to develop a strategy for its wise exploitation. By the end of 1983 about 8 240 000 line kilometres had been flown. The results of these surveys are available in the form of 8 326 one inch to one mile or 1:50 000 maps and 557 one inch to four mile or 1:250 000 maps. The expertise gained by the GSC in this work is recognized internationally and for some years the Survey has been asked to design and monitor various types of airborne geophysical surveys on behalf of the Canadian International Development Agency (CIDA).

Surveys have been carried out in Brazil, Cameroon, Guyana, Ivory Coast, Niger, Pakistan, Rwanda, Thailand, Upper Volta and Zimbabwe and by the end of 1983 the GSC had monitored contracts under which nearly 1.7 million line kilometres had been flown.

The first geological exploration of northern Ellesmere Island, 1953.

Objectives of the Geological Survey of Canada

Expressed in formal terms the objective of the Geological Survey is to ensure the availability of comprehensive knowledge, technology, and expertise pertaining to the geology of the Canadian landmass and offshore areas, including mineral and energy resources and conditions affecting land and seabed use, as required for effective exploitation of mineral and energy resources, effective use of land, estimation of the resource base of Canada, and formulation of policies.

This objective is fulfilled by:

- conducting geological, geophysical and geochemical research and surveys,
- estimating mineral and mineral fuel energy resources,
- investigating geological phenomena affecting engineering works and the environment,
- maintaining national standards and correlations,
- developing mineral exploration and other geoscience technologies,
- co-operating with provincial geoscience agencies and other federal departments concerned with earth science,
- fostering Canadian geoscience and participating in international activities,
- maintaining the national geoscience library and an effective publication program; and
- maintaining national geoscience data files and national reference collections of rocks, minerals, fossils, drill cores and ores.

In an increasingly competitive world government more than ever before requires accurate and timely information on the Canadian landmass. This information may be required on short notice to meet planning decisions but the process of obtaining such information may be long and involved. The best means of acquiring such knowledge is through an integrated organization where a wide range of expertise is available and where there is a continuity of investigations. A national survey such as the Geological Survey with its country-wide scope of activity imparts a breadth of experience not always available to more regionally oriented groups.

In its more than 140-year history, management has from time to time had to defend the Survey's value and the need for its continuance. Today more than ever before government requires timely, accurate information on the landmass of Canada. The best means of acquiring that knowledge is through an integrated organization where a wide range of expertise is available, an organization whose country-wide activities impart a breadth of vision not always available to more regionally oriented groups. A national geological survey is able to provide the national government with a pool of expertise whose varied experiences enable them to advise and inform planners and policy makers on the geology of all parts of Canada.

The federal government is concerned with establishing a better balance in the distribution of people and wealth between the regions of Canada, for more rational use of our resources and for accepting new international responsibilities for sharing our natural resources with other countries. To formulate and implement policies to meet these concerns there must be accurate comprehensive evaluations of available resources. A continuing national Geological Survey can meet these demands. The use of geological information by other federal government departments has grown greatly in the past few years and the value of an integrated, federally-sponsored geoscience centre has been increasingly recognized.

Although it may have been thought when the Geological Survey was established in 1842 that a short-term activity was being proposed, an activity that would be completed by the preparation and publication of hard-copy documentation, the reality was far different. Indeed it could not have been otherwise given the

immensity of the task of "causing a Geological Survey of the Province to be made" for a country as large as Canada and the fact that geology is to a large degree a descriptive and interpretive science. Some data can be measured objectively but many observations depend on human evaluation which in turn is affected by hypotheses and theories proposed to account for geological phenomena. A new theory may require different information for its substantiation and in a time span of as little as a decade, quite different types of data may be needed. This fact and changing needs render many geological maps obsolete in 25 years or less and thus a geological mapping program is never complete – milestones may be established and passed but the end of the road is ever receding.

As the Department of Energy, Mines and Resources has become more and more involved in policy development, increasing demands have been made on the Survey for evaluation of our mineral and fuel resources; as government and industry rapidly expand their activities into areas possessing relatively fragile environments, the Survey is called upon increasingly for assessments of terrain hazards and land sensitivity; as the nations of the world look increasingly to the seaward extensions of the continents for new resources so the Survey's fields of interest expand – marine geology and geophysics and the possible mineral potential of the seabed. With such challenges the Geological Survey of Canada will in the future be faced with new goals and objectives that will be as demanding as those of the past.

The Survey Today

The Geological Survey in the 1980s is in many ways a very different organization than that established in Montréal by Sir William Logan more than 140 years before yet its basic activities remain the same. It was formed in response to a need to stimulate the mineral industry by providing information on the geology of Canada. Today the mineral and non-renewable resource industries remain significant users of our results. Logan commenced his task by mapping. Today "mapping" continues to be of prime concern although some of the concepts portrayed on these maps – geophysical or geochemical interpretations for example – would surprise early GSC workers. From its inception the Survey was highly regarded and it continues to attract and retain scientists as gifted and as individualistic as its founder. Within a few years of its formation an esprit-de corps appears to have developed which, despite the sometimes heavy hand inevitable in a large bureaucracy, continues and gives the Survey a refreshing individuality.

On 1 April 1986 a major reorganization of the Survey took place with the integration of the Earth Physics Branch into the Geological Survey. The Earth Physics Branch had been formed on 1 April 1970 when the former Observatories Branch was dissolved with the transfer to the National Research Council of responsibility for most astronomical studies. The new Branch comprised gravity, seismology and geomagnetism divisions and was later expanded to include geothermal studies. The Observatories Branch itself had had a long history of service to Canada. For practical purposes it can be said to have been initiated with the

Observatory building.

appointment in June 1890 of Dr. W.F. King as Chief Astronomer of Canada in response to the need for precise position data to support the rapidly expanding topographical mapping of Canada.

By 1905 the Observatory had its own building in Ottawa and included a Geophysics Unit headed by O.J. Klotz which was organized into Seismology, Terrestrial Magnetism and Gravity sections. By 1907 a systematic magnetic survey of Canada was underway and this and related national surveys in gravity and seismology continue to the present.

The relationships between pure and applied geophysics are well demonstrated by the cooperative investigations carried out in 1928 and later by A.H. Miller of the Gravity Division of the Observatories Branch and the Geological Survey into aspects of gravitational and magnetic methods of mineral prospecting.

The three principal activities of the original Geophysics Unit continued and continue despite organizational changes. For more than 30 years the work in seismology was directed by Dr. E.A. Hodgson who was succeeded in 1951 by his son Dr. John Hodgson later to be director of the Branch. By 1947 the Magnetics Division was operating four magnetic observatories in support of the work of preparing maps showing the direction and intensity of the earth's magnetic field. The network of gravity stations established by the Gravity Division along highways was rapidly expanded after the Second World War by the use of light aircraft and helicopters particularly in the Arctic and by 1968 it was possible to publish a Bouguer Gravity Anomaly Map of Canada although coverage for many areas was incomplete.

As outlined previously the Geological Survey of Canada is part of the Department of Energy, Mines and Resources, a large organization which includes two science-oriented components, the Earth Sciences Sector and the Research and Technology Sector. The Survey is part of the former which also includes the Surveys and Mapping Branch, and the Polar Continental Shelf Project. It will be apparent to the reader that the Earth Sciences Sector is a direct descendant of the original Survey comprising as it does the main topographical and geological mapping activities carried out by the Government of Canada.

Unlike many government agencies the Branch is relatively decentralized and its offices reach from sea to sea. Their locations reflect regional scientific interests thus the Atlantic Geoscience Centre in Dartmouth NS was established to facilitate offshore studies and to develop co-operative studies with agencies of the Department of Fisheries and Oceans at the Bedford Institute of Oceanography. The Institute of Sedimentary and Petroleum Geology in Calgary reflects the Survey's involvement with hydrocarbon resources, and the office in Vancouver was established to assist the mineral exploration industry in British Columbia and Yukon but expanded with the setting up of a unit of the Pacific Geoscience Centre north of Victoria, as interest in the West Coast Offshore areas developed.

The integration of the Earth Physics Branch broadened the regional presence of the GSC. The Canadian seismograph network comprises 16 standard and 44 regional stations an 12 magnetic observatories provide up-to-date information on the magnetic field across Canada.

The Survey is organised on the basis of divisions which reflect either disciplinary or regional concerns. Divisional organization is not static and from time to time reorganizations are made both within divisions or within the Branch as a whole in order that the Survey may respond most effectively to the demands placed upon it. In 1986 following the integration of the Earth Physics Branch the Geological Survey comprised eight divisions plus the Offices of the Director General and Deputy Director General.

Atlantic Geoscience Centre

This division is housed at the Bedford Institute of Oceanography in Dartmouth N.S. and is responsible for providing geological information and expertise for the Atlantic and Arctic Offshore areas. Geological, geophysical and geochemical surveys are conducted including studies in surficial marine geology. The group is also closely involved in the assessment of Canada's hydrocarbon resources.

Cordilleran and Pacific Margin Division

Staff of this division including the Pacific Geoscience Centre provide geological and geophysical information on the mainland and offshore areas including studies of recent tectonic activities and seismic risks. Liaison is maintained with the mineral industry particularly through the Vancouver office and many studies are designed to meet industry's needs.

Geoscience Information Division

The principal aims of this division are to communicate the results of the Branch scientific programs to users and potential users and the maintenance of the earth science arm of the National Library. The division maintains capabilities in scientific editing, publication production, cartography and informatics.

Geophysics Division

This division is concerned with solid earth geophysics including national programs in seismicity, geomagnetics, geodynamics and aeromagnetic and gravity mapping. Specialized geophysical studies are also conducted in part in support of other GSC projects.

Lithosphere and Canadian Shield Division

In addition to regional studies of the geology of the Precambrian Shield staff of this division carry out studies in petrology, geochronology, paleomagnetics, seismology, magnetics, gravity and the geology of the Appalachian region.

Mineral Resources Division

Staff of this division examine the nature, origin and distribution of non-hydrocarbon mineral resources. Studies in geochemistry and stable isotope analyses are carried out, resource assessment techniques are developed including the application of geomathematics, databanks are maintained and applications of geophysical techniques to mineral exploration are developed.

Institute of Sedimentary and Petroleum Geology

This division is in Calgary and is the division responsible for the study of Canada's western and Arctic sedimentary basins which contain much of our known oil, gas and coal resources. The division is also the focal point for studies in paleobiology and includes a section responsible for assessments of fossil fuels on a Canada-wide basis.

Terrain Sciences Division

The staff of this division provide geological, geomorphological and geotechnical information on Canada's terrain in order to identify and assess natural hazards and facilitate maintenance and restoration of the physical environment. In addition to regional terrain surveys studies in engineering geology, glaciology, and terrain geophysics are conducted including the effects of permafrost, techniques for the use of glacial drift in prospecting are developed and evaluated, and geochronological and paleoecological studies are made.

Headquarters

The Headquarters staff include the offices of the Director General, Deputy Director General and Chief Geophysicist and supporting administrative services. In addition coordinators and staff for several special projects report through this office. These include the Director of New Technology and International Programs, the Frontier Geoscience Program, the Mineral Development Program, Office of Energy Research and Development projects, the Program and Planning Office and the Office of Special Projects and Grants.

Although it may have been thought when the Geological Survey was established in 1842 that a short-term activity was being proposed, an activity that would be completed by the preparation and publication of hard-copy documentation, the reality was far different. Indeed it could not have been otherwise given the immensity of the task of "causing a Geological Survey of the Province to be made" for a country as large as Canada and the fact that geology is to a large degree a descriptive and interpretive science. Some data can be measured objectively but many observations depend on human evaluation which in turn is affected by hypotheses and theories proposed to account for geological phenomena. A new theory may require different information for its substantiation and in a time span of as little as a decade, quite different types of data may be needed. This fact and changing needs render many geological maps obsolete in 25 years or less and thus a geological mapping program is never complete – milestones may be established and passed but the end of the road is ever receding.

A major challenge in the 1980s is that although economic conditions have led to restraint in government operations there has been no equivalent restraint on needs or demands for geological information. Industrial growth environmental concerns, government strategies to stimulate economic growth, energy supplies, projected long-term demands for mineral commodities to meet a growing population (national and worldwide) all contribute to the increasing demands for geoscience information about our landmass, its resources and the constraints and hazards related to their development. The cost of obtaining new information is escalating. The offshore, where most future hydrocarbon resources are thought to be, is far more costly to explore than the plains of Alberta. The equipment used is becoming very expensive and this poses the challenge of developing co-operative programs whether with a university to share the costs of specialized instruments or with other agencies to share ship-time for offshore exploration or deep-sea drilling.

Earth science is faced with several major challenges in the last decades of the century. Although geophysical techniques have been used to probe the geology of the offshore continental shelves there is a pressing need for "hands on" observations. Techniques for obtaining drill cores from increasingly greater water depths are being perfected but data derived in this manner will still be many orders of magnitude less than that obtained by for example 1:50 000 geological mapping on land.

On land although geological coverage of Canada at 1:250 000 scale is nearing completion and more detailed mapping is being done where more data are needed to elucidate critical problems, little is known of the deeper levels of the crust. The challenge of "deep geology" will require input from many disciplines and because of high costs will depend on co-operative programs. By the early 1980s the Survey was involved in studies of the Canadian Shield in co-operation with the Earth Physics Branch, in the Atlantic Offshore with Canadian and United States academic institutions and on a national basis in a program "Lithoprobe" co-ordinated by the National Sciences and Engineering Research Council of Canada. This program is based mainly on the application of seismic imaging but also includes drilling, and geophysical and geochemical techniques. The first studies are being undertaken on the deep geological structures below Vancouver Island and beneath the Canadian Shield in northern Ontario.

The extension of interest to offshore areas has focused attention on the seaward extension of our national boundaries and in April 1984 Canada's claims for the offshore location of the Canada-U.S.A. boundary in the Gulf of Main reached the International Court. Other areas of concern are the Beaufort Sea, the Straits of Juan de Fuca and St. Pierre et Miquelon. Those responsible for preparing Canada's claims in these areas are using earth science information and the Geological Survey has in the past few years devoted considerable attention to obtaining the requisite data.

The interest in the offshore reflects the realization that such areas have great economic potential for both renewable resources, such as the fishery, and non-renewable resources, such as oil and gas, metallic minerals and aggregate for the construction industry. Recent discoveries of exhalative hydrothermal sulphide deposits on the Juan de Fuca ridge have led to an on-going co-operative studies by the Geological Survey, university scientists and agencies of the U.S. government not only because mineral deposits of possible economic value may be found but because here one can see mineral deposits forming. The information gained will be invaluable in understanding how similar terrestrial deposits formed and will have direct application to the search for new deposits.

As part of the Government of Canada's initiative to stimulate economic development a series of Economic Regional Development Agreements were arranged with several provinces during 1984. An important component of these involves stimulating mineral resource exploration and the Geological Survey is co-ordinating with the participating provinces multifaceted projects using contract specialists from the private sector and the academic community. By the end of the 1980s the results of these programs will have added greatly to our understanding of the geology of Canada.

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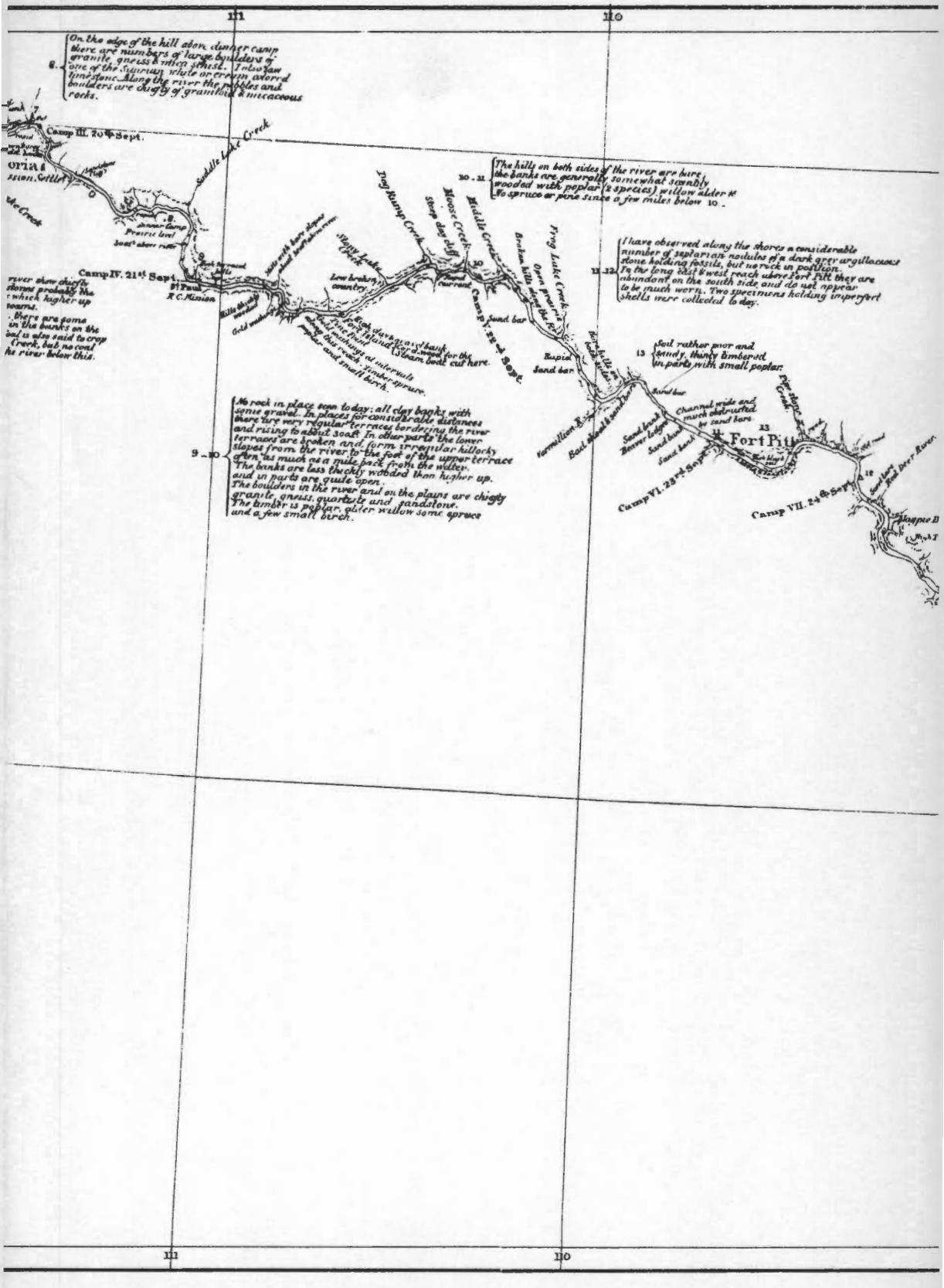
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110
On the edge of the hill above dinner camp there are numbers of large boulders of granite, gneiss & mica schist. I also saw one of the Silurian white and cream coloured limestone. Along the river the pebbles and boulders are chiefly of granitoid & micaceous rocks.
8
Camp III. 20th Sept.
Saddle Lake Creek
Trout Swamp Creek
Steep bed cliff
Moose Creek
Middle Creek
Broken hills above the River
Flying Lake Creek
Open spruce
The hills on both sides of the river are here low, the banks are generally somewhat sandy, wooded with poplar (2 species) willow alder &c No spruce or pine since a few miles below 10.
10 . 11
I have observed along the shores a considerable number of septarian nodules of a dark grey argillaceous stone holding fossils, but no rock in position. In the long east & west reach where Fort Pitt they are in abundance on the south side and do not appear to be much worn. Two specimens holding imperfect shells were collected to day.
11 12
Camp IV. 21st Sept.
Fort Pitt
R.C. Mission
Low broken country
Sand bar
Camp V. 22nd Sept.
Rapid
Sand bar
13
Soil rather poor and sandy, thinly timbered in parts with small poplar.
Sand bar
Fine slope
Creek
Vermilion R.
Red Shoal & sand bar
Sand beach
Beaver Lodges
Channel wide and much obstructed by sand bars
Sand beach
Fort Pitt
Old road
Camp VI. 23rd Sept.
Camp VII. 24th Sept.
Sand bar
Red Deer River
Magpie R.
No rock in place seen to day: all clay banks with some gravel. In places for considerable distances there are very regular terraces bordering the river and rising to about 30 ft. In other parts the lower terraces are broken and form irregular hillocky open as much as a mile back from the water. The banks are less thickly wooded than higher up, and in parts are quite open. The boulders in the river and on the plains are chiefly granite, gneiss, quartzite and sandstone. The timber is poplar, glizer willow some spruce and a few small birch.
9 - 10
111
110

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