by Christy Vodden

150 years in the history of the Geological Survey of Canada

Created in 1842, the Geological Survey of Canada (GSC) has been the driving force behind the geological mapping of Canada's nearly 10 million km^2 of land and freshwater lakes and of Canada's more than 6 million km^2 of continental margin and coastal boundaries.

The GSC is one of Canada's oldest scientific agencies and is among the world's first national geological surveys. Such surveys were still uncommon when it began, although France and Britain had established theirs in the 1830s.

The exploration years

In September 1841, the Province of Canada, which encompassed the southern parts of Ontario and Quebec, passed a resolution "that a sum not exceeding £1,500 sterling be granted to Her Majesty to defray the probable expense in causing a Geological Survey of the Province to be made." The decision to undertake a geological survey rested on the realization that the development of an industrial economy in Canada would depend heavily on a viable mining industry.

The news of the planned survey reached William Edmond Logan, a Montrealer who had gained considerable fame as a geologist working in Wales. He quickly let his interest in the job be known and was appointed as the first Director of the GSC on April 14, 1842 (fig. 1). During 1842, Logan laid the groundwork for the Survey by compiling all that already was known about the geology of Canada. The first fieldwork started in 1843 with parties working between Pictou, Nova Scotia, and the Gaspé in Quebec and between Lake Erie and Lake Huron in Ontario.

Because the rapid industrial advances in England since the late 18th century had shown how important coal was to economic expansion, the search for a Canadian supply of coal became the Survey's first priority. On the basis of information gathered during the first two field seasons, Logan was able to report that no coal deposits were to be found in what was then Canada.

Logan's early fieldwork did result, however, in many significant discoveries. He identified for the first time several broad geological divisions, the most important of which soon proved to be the southernmost exposed section of the great Canadian, or Precambrian, Shield—a mineral treasure chest of unflagging interest to prospectors and resource geologists to this day. Logan's work also paid handsome dividends far into the future; for example, a copper-producing area that he discovered near Sherbrooke, Quebec, earned about $165 million between 1855 and 1966.

The results of the first 2 years clearly demonstrated the benefits of a systematic geological survey, and the Survey's mandate was renewed. By the late 1850s, the Survey was a well-rounded organization that was capable of conducting rigorous exploration, making maps, producing reports, and maintaining a public museum.

Logan and officers of the Survey put together the first major collections of Canadian mineral samples that the world had ever seen for the famous 1851 Crystal Palace Exhibition in London, England, and later in 1855 for the Universal Exposition in Paris, France. The GSC's collections stimulated considerable international interest in Canadian minerals and brought personal honors, most notably a knighthood, to Logan.

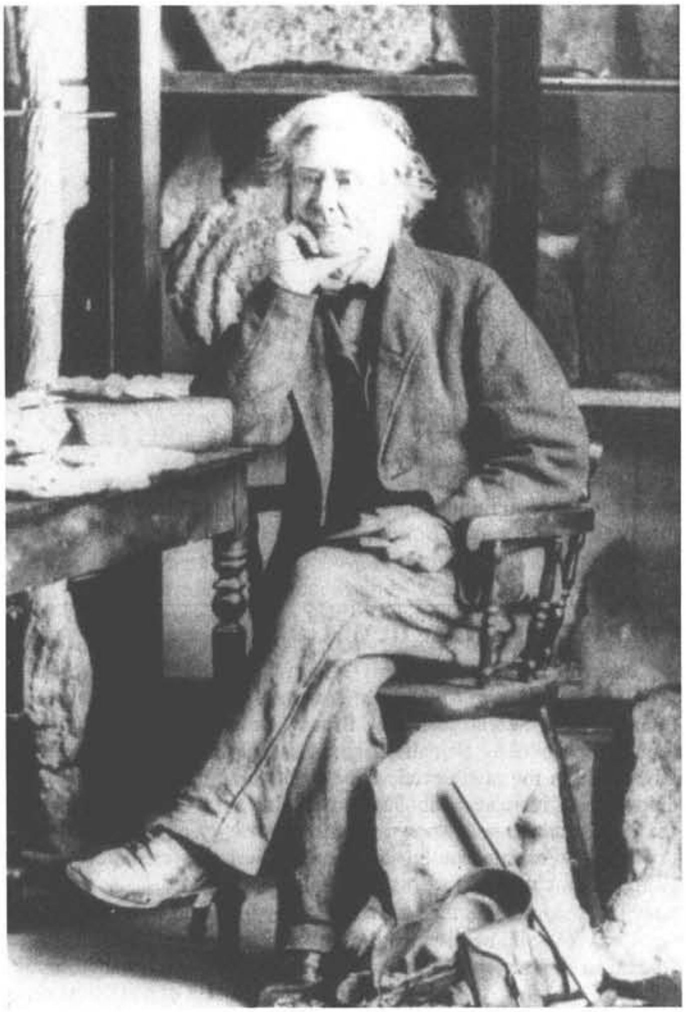

Figure 1.—Sir William Edmond Logan, the founder and first Director of the Geological Survey of Canada.

One of the most important accomplishments of the Survey under Logan was the publication in 1863 of the "Geology of Canada." This acclaimed 983-page book and its hand-colored maps recorded everything that was known about Canadian geology (fig. 2). One of Canada's leading geologists of the day, Sir William Dawson, wrote: "The value of this work to Canada can scarcely be overestimated. . . . The practical man has all that is known of what our country produces in every description of mineral wealth, and has thus

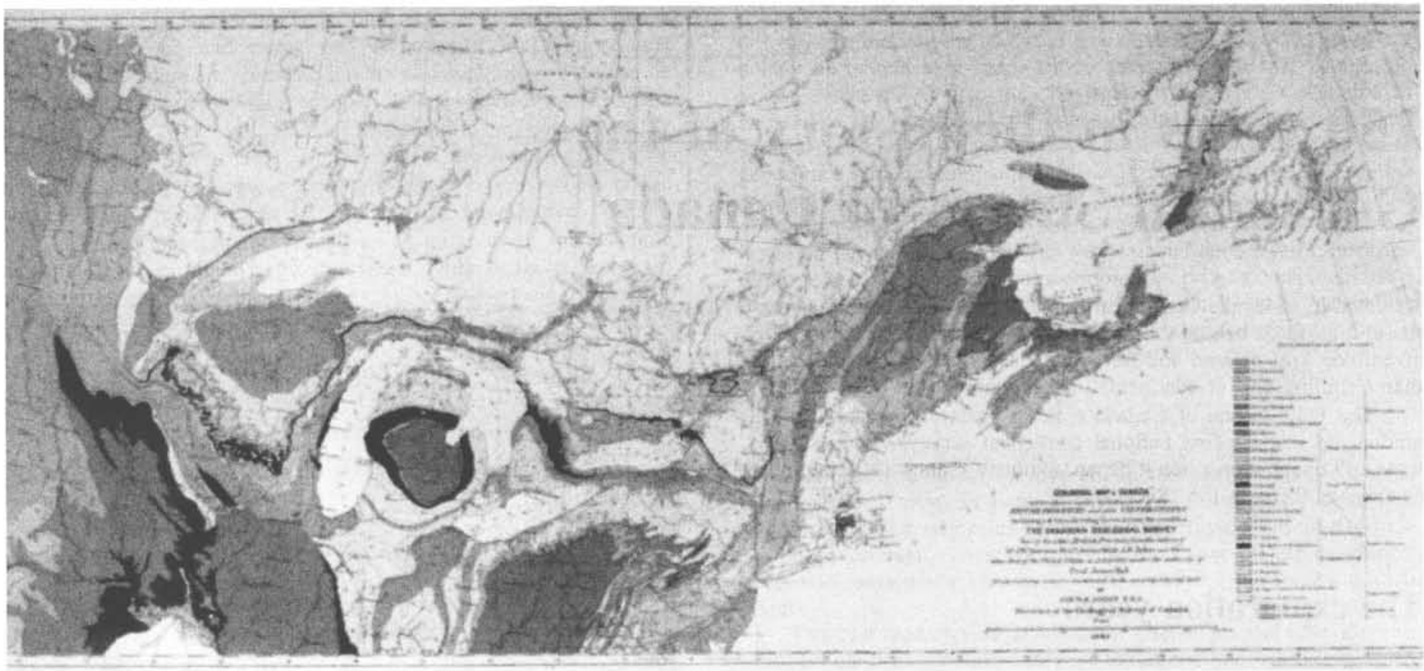

Figure 2.—William Logan's 1864 geological map of Canada.

a reliable guide to mining enterprise, and a protection against imposture." (Toronto Leader, May 6, 1864)

Growing with a new Canada

Confederation in 1867 brought together the existing Province of Canada, Nova Scotia, and New Brunswick as the new Dominion of Canada. Manitoba, British Columbia, and Prince Edward Island joined within the next decade. The addition of these vast new lands dramatically increased the Survey's realm of operations. Although some information was known about the geology of the new eastern Provinces, the immense territory to the west was essentially unexplored. In many regards, this task fell to the Survey.

The second Director, Alfred Selwyn, followed in Logan's footsteps in 1869, and he directed the Survey mainly from the field. As a student in Switzerland, Selwyn had become an accomplished mountain climber—a skill that proved invaluable to his extensive work in Canada's rugged new "Alpine Province," British Columbia (fig. 3). As a condition of its joining Canada in 1871, British Columbia had insisted on the construction of a railroad to link it to eastern Canada. As his first task while Director of the Survey, Selwyn mounted an expedition in 1871 to investigate the geology and mineral resources along the proposed railroad routes.

The 1871 expedition marked the beginning of a great surge of exploratory surveys, mainly in the west and in the north. This was an extraordinary challenge demanding extraordinary talents. Fieldwork in remote, uncharted wildernesses required superb frontier survival skills coupled with the eclectic scientific background that was necessary to record the geology, topography, flora, and fauna of the new lands being explored. Danger was a constant: J.B. Tyrrell (fig. 4), famous for his major fossil discoveries in Alberta, explored the vast stretches of the Barren Lands west of Hudson Bay, which were rumored to be "swarming with cannibals." Although Selwyn's reaction to a horse's eating his painstakingly gathered field notes is not recorded, a sense of humor was no doubt another valuable asset.

Figure 3.—The packhorse was the mainstay of geological fieldwork in the early days of the GSC. In fact, in the more rugged, mountainous parts of the country, packhorses were used right up until the 1960s.

In order to carry out this far-ranging work, Selwyn built up his staff from 6 parties in the field in 1870 to 14 in 1890. That same year, the Survey was made a separate Department of the Government—solid recognition, indeed, of its increasing importance to the growth of Canada.

In 1895, Selwyn was succeeded by George M. Dawson. Nicknamed "Klondike Dawson," he explored the Yukon nearly a decade before the famous gold discovery of 1896. In fact, the prospectors of

Figure 4.—J.B. Tyrrell (far left) and some of his party in 1886.

Figure 5.—The GSC's Director from 1895 to 1901, George Mercer Dawson (center, standing) with his field party at Fort McLeod (nicknamed Fort Misery), British Columbia, in 1879.

the Gold Rush used his maps to blaze their trails, and Dawson City, the hub of the Gold Rush, is named in his honor.

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

Dawson's achievements seem even more remarkable given his physical condition. As a result of a childhood illness, he was no bigger than a boy of 12 and had weak lungs and a bent and hunched back (fig. 5). Dawson also carried out ground-breaking work describing the mineral riches and geology of British Columbia. A report that he published in 1877 marked a milestone in interpreting the geology of western Canada. While studying the coal deposits of the Queen Charlotte Islands in 1878, he prepared a comprehensive report, amongst others, on the Haida Indians, and the photographs he made at that time are treasured today (fig. 6).

Dawson was not unique in his far-ranging interests. From 1879 to 1889, the Survey was actually the "Geological and Natural History Survey of Canada," and the work of many of its officers helped build the museum's collections and the country's knowledge about itself. The museum that was started in the middle 1840s by the Survey's pioneering geologists has since evolved into three distinct national institutions—the Canadian museums of Nature, Civilization, and Science and Technology.

The Survey's next Director, Robert Bell, was appointed in 1901. In the tradition of the day, he had led exploration parties to all parts of Canada, ranging as far afield as the prairies of Saskatchewan, the oil sands of the Athabasca, and north to Great Slave Lake and Baffin Island (fig. 7). During his lifetime, he saw his extensive body of fieldwork put to a significant purpose—the planners of the third transcontinental railway, the Grand Trunk Pacific, used his reports to plan the route of the track from Quebec to Winnipeg.

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

Albert P. Low succeeded Bell in 1906 and served as Director for only 18 months before being struck by severe illness. Undoubtedly his most important scientific work was his exploration, on foot and by canoe, of the Labrador Peninsula in 1894 and 1895 (fig. 8). His report records the conditions his party faced: "Having with great difficulty gained the head of the Big River, we carried the survey down it, and in so doing had to pass for 50 miles [80 km] through a narrow gorge where it was impossible to make portages, and where the river . . . formed a continuous rapid." One of Low's men drowned as a result of a canoe spill in that treacherous gorge.

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

Low's other major contribution to the scientific work of the Survey was in 1903 and 1904, when he was put in charge of the Canadian Government's expedition to Hudson Bay and the Canadian Arctic Islands. This marine expedition was Canada's first clear exercise of authority over its newly acquired northern lands.

The steamship *Neptune* was home for 15 months to the expedition party, which included scientific staff and Northwest Mounted Police. After surveying parts of the coasts of Hudson Bay and Southampton Island, the expedition sailed to Ellesmere Island in the summer of 1904 and took formal possession of it for Canada. The flag was also raised on Beechey and Somerset islands (fig. 9).

In many ways, the cruise of the *Neptune* marked the end of an era for the GSC. For more than 60 years, officers of the Survey had been as much explorers as geologists and had preceded settlers, mining companies, and other development into many areas of the country. Their work also had helped clearly chart the economic development of a strong and increasingly prosperous nation.

New challenges for the 20th century

Canada had pretty well assumed its contemporary boundaries by 1905 when Alberta and Saskatchewan were given Provincial status—only Newfoundland remained to be added in 1949. The population nearly doubled between 1891 and 1911, and economic development

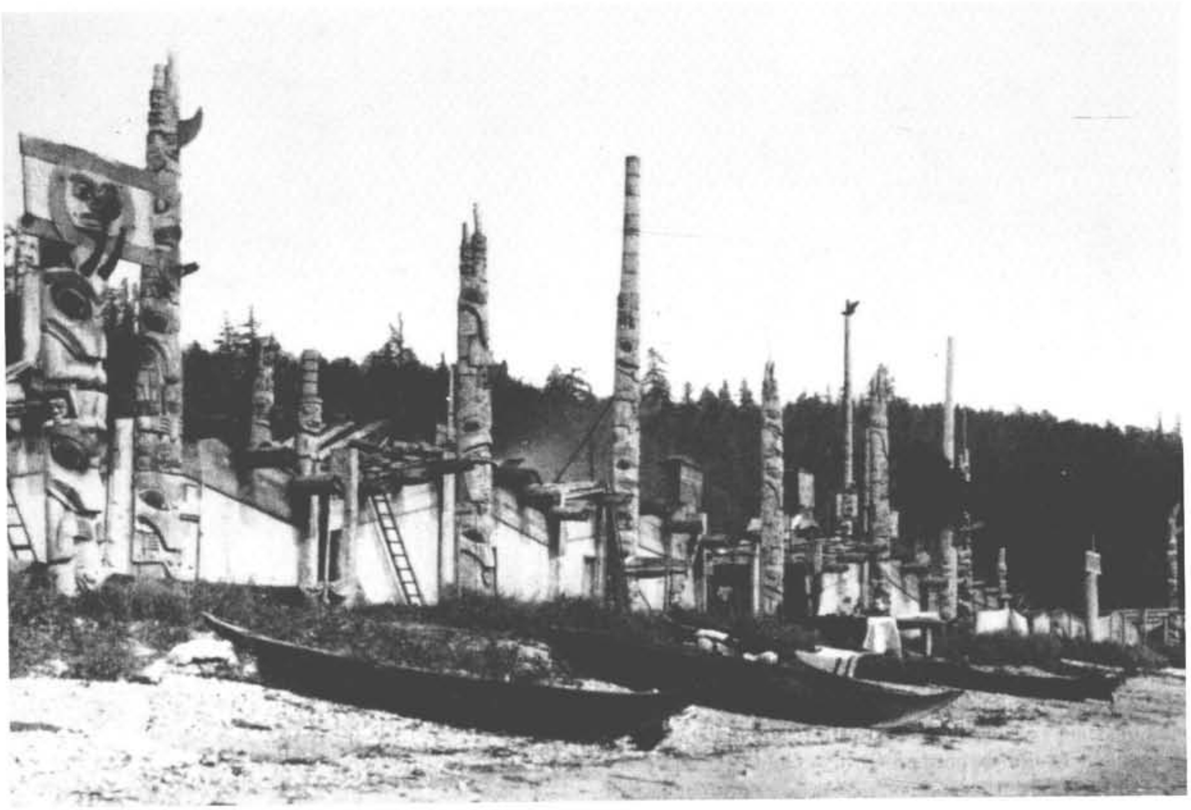

Figure 6.—Dawson's studies of west coast natives earned him the title "Father of Canadian Anthropology." Shown here is Dawson's photograph of a Skidgate Indian village, Queen Charlotte Islands, 1878.

Figure 7.—The drill rig shown here was used by the GSC at Victoria, Alberta, in 1898 in an early attempt to locate commercial quantities of oil and gas in the prairies. ▶

was surging. Manufacturing centers were well established, while the natural resource industries were booming. Canada's mining industry rivaled forestry and agriculture as a source of export earnings and gave it considerable political clout.

Reginald Brock was Low's successor in 1907, and under his leadership, a new sort of organization took shape. He "etched in stone" a policy that made educational excellence a basic staffing requirement. All new appointees to scientific positions now had to have a doctoral degree in geology or its equivalent. Brock also laid the groundwork for the Survey's role as a training ground for the Canadian geoscience community. Students interested in geology received guidance and practical experience through their employment as field assistants to GSC scientists.

Brock was succeeded by R.G. McConnell as head of the Department of Mines in the early days of World War I, and he chose William McInnes to head up the Survey under him. Despite strong leadership, the war years and the 1920s were a difficult period. Staff left in mass to join the war—many not to return. Ironically too, the Survey was a victim of its own excellence. Its high educational standards, coupled with low government salaries, resulted in raiding of staff by industry.

Although Survey operations were curtailed, special efforts were made to locate deposits of strategic materials. An important legacy of this period was the opening of district offices in British Columbia and

Figure 8.—Albert Peter Low (left) during the exploration of Labrador in 1894. Low's surveys of the Labrador Peninsula, on foot and by canoe, totaled an incredible 12,870 km.

Figure 9.—In 1903, Low commanded a Canadian Government expedition to northern waters in order to lay formal claim to the Canadian Arctic Islands. By 1904, he also had mapped over 4,800 km of coastline from Hudson Bay to the Arctic Islands in his ship, the **Neptune.**

Alberta. This allowed more efficient control of fieldwork in the west and made the Survey more accessible, and hence more helpful, to local mining and petroleum interests. The Alberta office closed in 1920, not to reopen until the start of western Canada's oil boom in the late 1940s. The Vancouver office, however, has remained in continuous operation to this day.

William Collins took over the Survey in 1920. During this decade, Canada was building up the mining and manufacturing side of its mineral industry. Attracting capital to develop the nation's mineral resources was one of the Government's top priorities. The Survey continued to stress field mapping in support of these new economic priorities, and its nationwide mapping programs, particularly in the Precambrian Shield, were of great value to mineral exploration.

Figure 10.—Transportation for fieldwork remained a major challenge in the 1930s, and because of the tight economy, it often required some innovation. Shown here is a "Bennett buggy," named for Prime Minister R.B. Bennett.

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

As Canada entered the Great Depression, the need for mineral development work became even more pressing. The worsening economic situation, however, prevented much activity as the Government was forced to make drastic cuts in its budgets (fig. 10). To avoid releasing staff, the Survey reduced its field activities to a mere fraction, and work was focused tightly in the vicinity of mines or areas that promised new discoveries of immediate value.

Faced with an election in 1935, Prime Minister R.B. Bennett decided to follow President Roosevelt's example of massive public works schemes aimed at generating employment and stimulating the economy. As a result, the Survey received an incredible $1 million for the 1935 field season—10 times the amount originally budgeted.

Within a matter of months, the Survey had to pull together a completely new field program. Over 1,000 men were organized into 188 field parties, compared to the 24 sent out the previous year. Vast amounts of new equipment had to be found and purchased on very short notice. Even more difficult was the challenge of finding experienced personnel to direct the field parties, which consisted largely of men with little geological training. One Survey officer directed seven parties in addition to his own by using aircraft to maintain contact.

The extra funding had tremendous benefits. For one, field mapping was increased tenfold, so that valuable new data were obtained. Similarly, the employment offered during that hectic summer enabled many graduate students to continue their studies, and several later joined the Survey as permanent staff. Most important, it enabled the Survey to indulge for the first time in the large-scale use of aircraft (fig. 11).

World War II brought new priorities and a booming economy that was driven by the demand for war materials. Such huge quanti-

Figure 11.—The airplane revolutionized fieldwork. It enabled quick and cheap access to even the most remote corners of Canada, areas that previously had been reached, if at all, by long and arduous journeys by foot, horse, or boat.

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

In view of its expertise, this crucial task was assigned to the Survey, and the search for strategic metals and minerals became the focus of all its efforts. Mercury deposits discovered by the Survey in British Columbia were rushed into production and became the largest source in the British Commonwealth. Secret investigations of radioactive minerals also were conducted for the Allied Governments' atomic weaponry program. Coal and oil were equally vital to the war effort, so locating domestic fuel and energy sources (prewar Canada had imported 90 percent of its petroleum) became another priority.

Figure 12.—James Merritt Harrison, Director of the GSC from 1956 to 1964.

Revolutions in thought and technology

A period of peace, prosperity, and growth followed World War II, and interest in Canada's mineral and energy resources grew rapidly. In 1947, a landmark oil strike south of Edmonton, Alberta, at the Leduc field marked the beginning of western Canada's oil boom. This generated an unprecedented demand by industry and Government for geological information about this energy-rich region. In response, the Survey opened an office in Calgary in 1950, which was replaced in 1967 by a full-scale research establishment, the Institute of Sedimentary and Petroleum Geology.

Similarly, the realization that atomic fission had a peaceful application as a source of energy led to prospecting for uranium in boom proportions in the 1950s. High priority was given to Survey fieldwork and laboratory work that was related to locating and evaluating radioactive deposits, especially uranium. An important side-benefit of this effort was a greatly increased knowledge of the general geology of the Precambrian Shield.

The 1950s and 1960s were a time of scientific and technological growth unimagined only a few years earlier. At the same time, there was a growing awareness of the importance of science to Canada's development. The blossoming of the Government's scientific agencies, such as the GSC, was a natural offshoot.

Leadership of the Survey passed to Walter Bell in 1950, and in 1953, George Hanson was promoted from his long-standing position of Chief Geologist to the Director's chair. His successor, James Merritt Harrison (1956–1964), brought to the Survey a vigorous, outward-looking leadership that was in perfect harmony with the times (fig. 12). The Survey's tradition of providing international leadership and support for global geoscience initiatives was entrenched firmly under Harrison, who became first President of the International Union of Geological Sciences in 1961 and President of the International Council of Scientific Unions in 1966.

Unhindered by the economic restraint of earlier years, the Survey now was able to expand its research into fundamental geological problems, to outfit its laboratories with the best new technology available and thus increase their analytical capability, and to undertake ambitious fieldwork.

In the 1950s, the airplane and aerial photography were supplemented with helicopters as basic tools for geological mapping, and this increased the pace of geological mapping at a spectacular rate. A study on the benefit of the helicopter showed that within the span of 6 short years from 1952 to 1958, the Survey had mapped about one-half as much of Canada at a reconnaissance scale as had been mapped in the previous 110 years, this being due mainly to helicopter support (fig. 13).

During this period, the Survey mounted large-scale air-supported multidisciplinary reconnaissance operations. The most ambitious was the 1955 "Operation Franklin" in the Arctic. Headed by Yves Fortier, who was later to become Director of the Survey (1964–1973), the 28-person expedition, in a single field season, studied strategic locations and mapped almost 260,000 km^2 of the High Arctic. The results of the work triggered industry interest in northern oil and gas exploration.

Systematic aeromagnetic mapping also started at this time, and these geophysical surveys were of great value to mineral exploration. The Survey became a world leader in the development of techniques and technologies in this field, and its aeromagnetic maps were sought eagerly by mining and petroleum companies to guide their exploration programs.

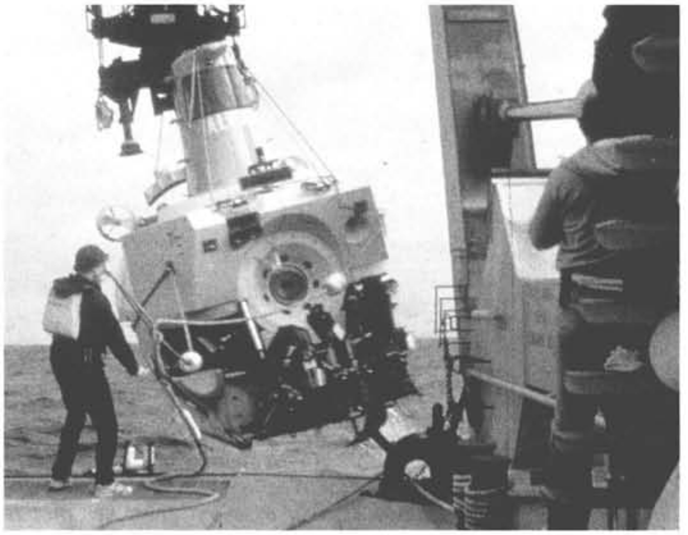

Figure 14.—The mysteries of the sea floor can be examined now first hand because of deep-diving craft. Shown here is the U.S. submersible **Alvin** *after a joint United States and Canada expedition to study the Juan de Fuca Ridge off the west coast of North America.*

Toward today's Survey

In 1966, the Survey became part of a new Department of Energy, Mines and Resources, which had a mandate for national energy planning. In support of this, the GSC had to produce quantitative estimates of Canada's reserves and resources of oil and gas, coal, and uranium. An inventory of Canada's metals and minerals also was required, and the Survey, working with other agencies, provided estimates of the national reserves of nickel, copper, zinc, lead, molybdenum, and iron ore.

In the early 1970s, inflation began to cut deeper into budgets. Greater accountability to the taxpayer brought in more elaborate reporting procedures and a heavier administrative load for scientific staff. However, demands on the Survey from industry and Government for information and expertise in support of exploration efforts and policy making continued to increase steadily.

The 1970s witnessed the Survey's completion of the bedrock map of Canada at the reconnaissance level. The next step started immediately: to go back and revise map areas in which the information had become largely obsolete. The Survey also became heavily involved at this time in the mapping of surficial deposits. Results were used to evaluate the environmental impact of development in fragile areas like the Arctic.

Figure 13.—Helicopter over a field camp about 1960.

Also, starting in the 1970s, international debate centering on the ownership of the ocean's resources required the Survey to provide the geoscientific information that was necessary to support Canada's claim to an offshore "economic zone." Canada's offshore boundaries eventually extended 320 km (200 mi) from the coast (or beyond to the edge of the continental shelf). After this immense area was, in effect, added to the Survey's field of operation, marine research groups were established on both coasts: the Atlantic Geoscience Centre at Dartmouth, Nova Scotia, and the Pacific Geoscience Centre on Vancouver Island (fig. 14).

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

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

In April 1986, the Earth Physics Branch of Energy, Mines and Resources was merged with the GSC. This added a major geophysical arm that includes Canada-wide seismology and geomagnetic observatory networks and systematic gravity surveys. The following year the Polar Continental Shelf Project, an Arctic logistics organization, became linked administratively with the Survey.

By the early 1990s, it became clear that the Survey's core geological mapping programs had been eroded over the past two decades in the face of other priorities. In response, the Survey took a lead role in developing a new National Geoscience Mapping Program

Figure 15.—A field assistant works in the field laboratory of GSC's Global Change Observatory at Hot Weather Creek, Ellesmere Island, entering soil hydrology data in a laptop computer that is charged by solar panels.

(NATMAP). Very much a national cooperative effort, the program involves Federal, Provincial, and Territorial surveys, as well as Canadian universities, private industry, and other interest groups. Its aim is to improve the quality, relevance, and completeness of bedrock and surficial geological maps and to coordinate mapping activities of different organizations.

The Survey today

The computerized GSC of the 1990s is, of course, very different than the one established by Sir William Logan 150 years ago. Nevertheless, similarities are obvious. The mining and petroleum industries continue to be major clients, and mapping the geology of Canada remains a primary concern. Of increasing importance is the research that is linked to environmental questions (fig. 15). The Survey continues to attract gifted scientists and staff who share a unique esprit de corps and provide an irreplaceable source of expertise.

A century-and-a-half after Logan set out on his first field trip, the immense task of a comprehensive geological examination of Canada is still not complete. Today, however, as the GSC marks its 150th anniversary, we have a growing recognition that the task may never end. As new theories and needs emerge and as new technologies are developed rapidly, the study of Canada's onshore and offshore areas will challenge scientists for many decades to come. And as the Geological Survey of Canada continues to accept new responsibilities and to develop new areas of expertise, its contribution to the next 150 years of Canada's development should be as important, colorful, and exciting as in the past.

A complimentary copy of "No Stone Unturned," a popular history of the Geological Survey of Canada, may be obtained by writing to the Geological Survey of Canada, 150th Anniversary Office, 601 Booth Street, Ottawa, Ontario K1A OE8, Canada.□

Christy Vodden *is Communications Officer for the Geological Survey of Canada and has responsibility for the coordination and delivery of public information programs. Her communications background includes experience in international relations and corporate policy, and she has a particular interest in the popularization of scientific information.*