



Natural Resources  
Canada

Ressources naturelles  
Canada



# Geological Survey of Canada

## STRATEGIC PLAN

### 2018–2023

Canada





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**Cover photograph:** Glacier technician measures maximum summer ice melt at stakes drilled into the glacier on Place Glacier near Pemberton British Columbia.

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Cat. No. M184-3/2018E-PDF (Online)

ISBN 978-0-660-28480-4

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*Aussi disponible en français sous le titre : Commission géologique du Canada PLAN STRATÉGIQUE 2018-2023*

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## INTRODUCTION

The Geological Survey of Canada (GSC) is an integral part of Natural Resources Canada's (NRCan) Lands and Minerals sector. This national organization for science and technology research is dedicated to providing authoritative geoscience expertise, knowledge and products in support of decision making about Canada's lands and resources.

The GSC's five-year strategic plan (2018–2023) sets the organization on the path toward its 200th anniversary in 2042. Building on the GSC's long history and its deep connection to Canada's growth as a nation, we will continue to chart the course of a modern geological survey, responding to the social and technological challenges of the day.

We face a world of astounding scientific advances, breakneck technological innovation and instant information sharing. Global trends on renewable energy, clean growth and sustainable development of resources oblige the GSC to be innovative and nimble as an organization.

The Canadian government's priorities of social inclusion, Indigenous reconciliation and transparency require new

approaches to integrating science with policy. Citizens demand and use both scientific and non-scientific information to advocate on issues related to land use, resource development and protection of the environment. Canadians need protection from climate change and natural hazards.

As a science organization, the GSC must always be guided by the core value of serving the public good. Our challenge is to identify the areas where research and geoscientific information can contribute to decision making by a wide range of players, ranging from individuals to large organizations.

This document articulates the strategic priorities for 2018–2023 that will guide the GSC in supporting a healthy, resilient and prosperous Canada for current and future generations.



A GSC technician records centimetre-level positions at a landslide to monitor and map the slide near a critical rail corridor in the Thompson River Valley, British Columbia.

# GEOLOGICAL SURVEY OF CANADA – WHO WE ARE

The GSC is Canada's national agency for geoscientific information and research, recognized worldwide for our focus on geoscience for the public good. We have



**\$74** million  
annual budget in the  
2017–18 fiscal year



**over 30** specialized science laboratories,  
including inorganic geochemistry ICP-  
MS labs, the Marine Core XCT scanning  
facility, the Delta light stable isotope lab,  
and the ion microprobe (SHRIMP) lab



**over 400** scientists and  
support staff in seven  
centres across Canada



a modern workforce comprising full-  
and part-time staff, Emeritus scientists,  
post-doctoral research scientists,  
students and volunteers

The GSC co-leads the Canada-Nunavut Geoscience Office and works with dozens of universities and research institutes, industry organizations, other federal departments, provinces, territories and municipalities in Canada and across the world. In particular, we work closely with other geological survey organizations in Canada through the unique Intergovernmental Geoscience Accord.

Every year, we publish hundreds of maps, Open Files, peer-reviewed papers and other reports. Our scientists are recognized worldwide and sought after for their expert advice on locating mineral, energy and groundwater resources, reducing risk from natural hazards and reviewing environmental assessments.

Glaciologists monitor annual glacial mass balance, as part of the GSC's Climate Change Geoscience Program here at the Bologna Glacier, Nahanni National Park and Reserve, Northwest Territories.



## FUTURE CHALLENGES – THE GSC IN A CHANGING WORLD

The world depends on natural resource development. Minerals and energy are essential ingredients of advanced economies, providing the raw materials for the technological advances and products that sustain growth. The exploration for minerals and energy becomes increasingly difficult as existing resources are exhausted and the search goes deeper underground or further offshore.

At the same time, it is unacceptable to exploit natural resources without regard to the environment and the people who live and work in the area. As populations become more urbanized, the effects of natural disasters and climate change become more intense, affecting larger numbers of people and disrupting national economies to an unprecedented degree. The GSC's research plays an important role in addressing these global challenges to maintain the supply of mineral and energy resources in an environmentally sustainable way and to protect our people and our economy from catastrophic events.

Technology is also changing our world. Advances in robotics, computing and communication systems have opened the door to a world where vast quantities of data are generated and shared instantly. The use of this “big data” is still in its infancy but provides new opportunities to understand the physical environment around us. Paradoxically, it also creates a world where there are blurred boundaries between real information and fabricated information, between objective evidence and ideologically derived pseudo-facts and between certainty and uncertainty.



Bedrock mapping near McQuesten, Yukon, as part of the GSC Geo-mapping for Energy and Minerals program.

In Canada, as in many parts of the world, these contradictions manifest into acrimony around land-use decisions, particularly for resource development projects such as mines, petroleum development and pipelines. Communities are often split on whether the proposed environmental measures are sufficient to balance the perceived risks and are worth the anticipated economic benefits.

Both the uncertainties of how these projects will affect the future of people and the environment and the polarization of the public through political and media opinion drive the perception of risk and represent major challenges.





In this context, the GSC has produced authoritative baseline geoscience information and research to inform the public debate, to develop appropriate private- and public-sector mitigation measures, and to inform evidence-based decision making.

Issue-driven research conducted in the last five years includes studies of fracking-related earthquakes in northeast British Columbia, groundwater contamination risks near petroleum wells in Quebec, and sediment transport and geohazards on the ocean floor near proposed marine infrastructures on the Pacific coast. These innovative studies brought new light to pressing issues and have been welcomed by communities, regulators and developers alike, in informing the public debate around important decisions.

In the area of natural hazards, we are faced with uncertainty about where and when an earthquake, flood or landslide may occur. Risk and uncertainty can never be reduced to zero so land-use and mitigation decisions have to be made by weighing both risk and benefit. The risks can be recognized and mitigated when scientific evidence is available.

The challenge for the GSC in this context is to remain objective, yet authoritative, while providing the scientific evidence to support decision making about land use.

One final important challenge is to change the relationship with Indigenous people in Canada. Indigenous communities experience all the issues described here very directly when resource projects are proposed for their lands. The GSC recognizes the traditional lands of Canada's Indigenous people and respects the nation-to-nation relationships with Canada required for reconciliation. We will work in this spirit of reconciliation to explore how to combine traditional and scientific evidence in land-use decision making.

Bedrock mapping and mineral deposit studies, as part of the Targeted Geoscience Initiative, Selwyn Basin, Yukon.



## The mission

Provide authoritative geoscience knowledge to inform the stewardship of Canada's onshore and offshore lands, to sustain responsible resource development for future generations and to keep Canadians safe from natural hazards and related risks.

## GSC values

GSC values align with the NRCan values as described in the Department Values and Ethics Code (2012).

**Respect for democracy:** We provide objective, non-partisan scientific evidence to support decision making on issues of Canadian public policy, especially in supporting the Minister of Natural Resources and other ministers in carrying out their duties in accordance with legislation and policies. In particular, much of the mandate of the GSC is derived from the *Resources and Technical Surveys Act* and the *Department of Natural Resources Act*. We provide decision makers with the information, analysis and advice they need, always striving to be open, candid and impartial.

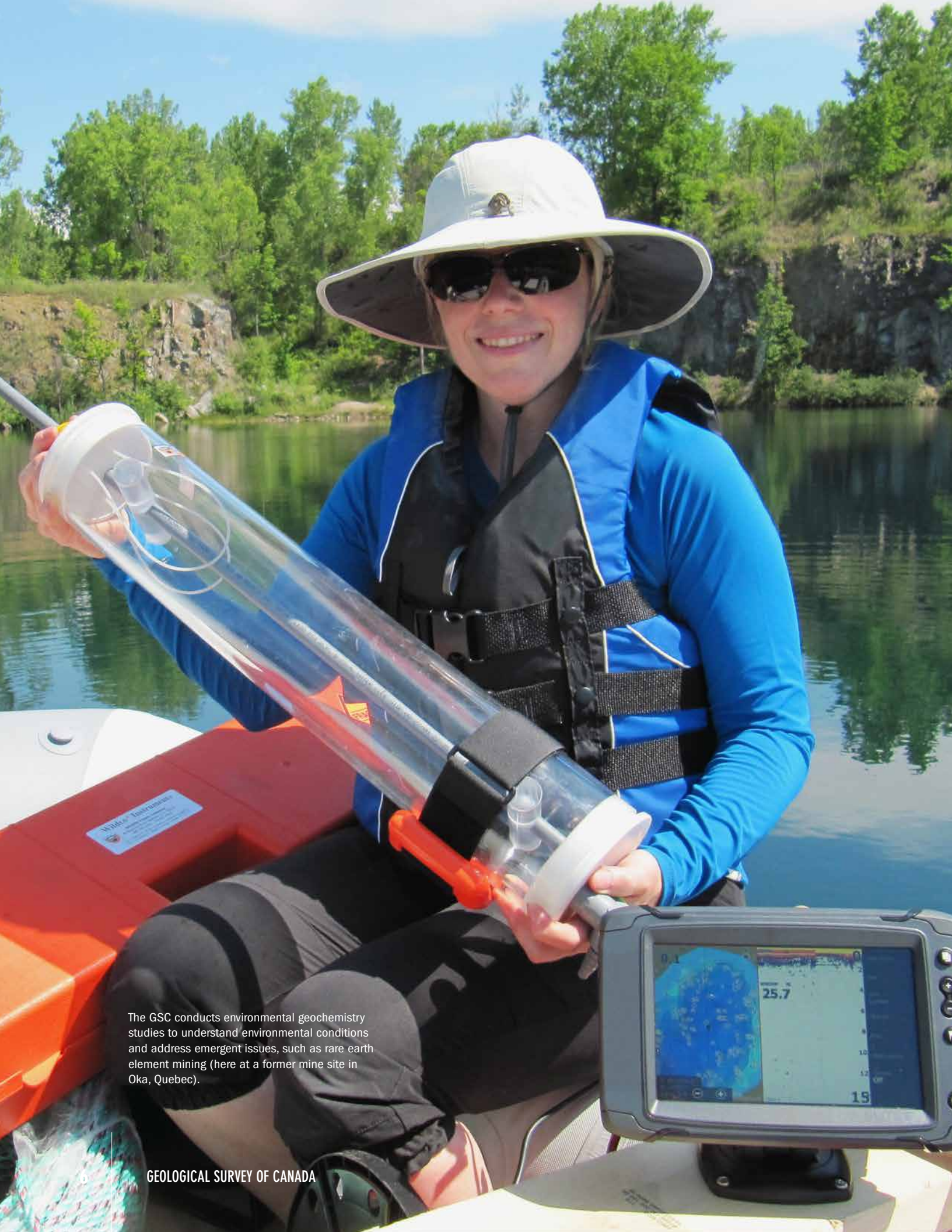
**Respect for people:** We respect human dignity and the value of every person by treating every person with respect and fairness; valuing diversity and the benefit of combining the unique qualities and strengths inherent in a diverse workforce; helping to create and maintain safe and healthy workplaces that are free from harassment and discrimination; and working together in a spirit of openness, honesty and transparency that encourages engagement, collaboration and respectful communication. We recognize and respect the rights of Indigenous people and will prioritize robust, meaningful engagement drawing on Traditional Knowledge.

**Integrity:** GSC personnel strive to meet high standards of integrity. We will act at all times with integrity and in a manner that will bear the closest public scrutiny; never use our official roles to inappropriately obtain an advantage for ourselves or to advantage or disadvantage others; take all possible steps to prevent and resolve any real, apparent or potential conflicts of interest between our official responsibilities and our private affairs in favour of the public interest; and act in such a way as to maintain our employer's trust.

**Stewardship:** The GSC uses resources responsibly by using the public money, property and resources we manage effectively and efficiently; considering the present and long-term effects that our actions have on people and on the environment; and acquiring, preserving and sharing knowledge and information as appropriate. This value is particularly important in guiding the direction that the GSC is taking in supporting the sustainable development of natural resources, keeping Canada safe, and increasing efforts to reach a broader group of decision makers to make use of geoscience information to address critical societal issues.

**Excellence:** The GSC has a long and proud tradition of scientific and professional excellence. We provide fair, timely, efficient and effective geoscience expertise, ensuring that our publications are peer-reviewed and meet high scientific standards. We strive to continually improve the quality of our scientific programs and services and foster a dynamic work environment that promotes teamwork, learning and innovation through our nationally distributed geoscience offices and laboratories and our constantly changing and complex exploratory field surveys, expeditions and research across Canada.





The GSC conducts environmental geochemistry studies to understand environmental conditions and address emergent issues, such as rare earth element mining (here at a former mine site in Oka, Quebec).



## STRATEGIC PRIORITIES

In this strategic plan, the GSC has attempted to plot a course through this changing, uncertain world.


First, we identify three core areas of persistent scientific endeavour, which reflect stable, long-term needs of society:

- **Geological knowledge for Canada's onshore and offshore lands** – the need to use modern concepts to explore and map the vast terrestrial and offshore lands of Canada
- **Geoscience for sustainable development** – the need to improve geoscientific models to support mineral and energy exploration while also informing environmental protection with robust and innovative geoscientific evidence about the land and resources
- **Geoscience for keeping Canada safe** – the need to understand the impacts and risk of natural hazards and climate change to protect Canadians from disastrous events

Next, we outline a new, fourth area of endeavour, **Geoscience for society**, which is the need to address the uncertainties of the changing world by expanding the reach and impact of geoscience knowledge in land-use decision making and in efforts to reduce the risk of disasters.

Finally, we recognize that our strength lies in a fifth area of endeavour, **Our people, Our science**, which we need to nurture to maintain a high-performing workforce capable of world-leading innovative geoscience for the benefit of Canada.

These strategic priorities align with the Departmental Results Framework and the Lands and Minerals sector's key business lines.



Ocean bottom seismometers deployed here in the Beaufort Sea, Northwest Territories, help to better understand sea floor geology and hazards.



## PRIORITY 1. Geological knowledge for Canada's onshore and offshore lands

Geoscientific knowledge is fundamental to managing our onshore and offshore lands and their abundant resources. With its 10 million km<sup>2</sup> of onshore land and an additional 7 million km<sup>2</sup> of ocean estate, Canada is a vast country and a core mission of the GSC is to map and understand the land and its resources. Our Geo-mapping for Energy and Minerals (GEM) program continues to advance our knowledge of the North and by 2020 will complete a first mapping of surface geology at a coarse scale.

In the offshore lands, our geoscience knowledge also serves to confirm the farthest extents of the Canadian territory. Our joint program with Global Affairs Canada and Fisheries and Oceans Canada to delineate the outer limits of the continental shelf in the Atlantic and Arctic Oceans will reach a critical milestone in 2019. The program will file its Arctic submission under the United Nations Convention on the Law of the Sea (UNCLOS).

This submission will follow more than a decade of ship and airborne surveys that form the scientific arguments that those areas are the extension of the Canadian continental land mass. These vast offshore areas may contain significant, yet largely underdetermined mineral and energy resources, economic potential, vulnerability to natural hazards, environmental susceptibility and biodiversity. All these elements will require geoscience in the future to be resolved.

Framework geoscience (or the core knowledge that is derived from mapping and related geoscientific studies) is also critical to the overall management of our onshore lands. As the North develops its resources and infrastructure, the territorial governments, local communities and Indigenous organizations need geoscience information for making land use decisions. For example, such information is needed to plan site infrastructure in complex permafrost terrain and to avoid areas of extreme coastal erosion.

In offshore land, it is equally important to know the geological character of the seabed for siting telecommunication cables, tidal energy converters or marine conservation areas.

Framework geoscience includes the third and fourth dimensions, namely the subsurface structure and knowledge of earth systems through time. Land management issues commonly require an integrative approach to determine the geological structure below ground and dynamic processes such as groundwater flow, earthquake-generating fault motions and their interactions.

The geological map of the 21st century will need to be fully 3-dimensional, requiring the acquisition, processing and interpretation of vast quantities of data.

Acquiring these data systematically will continue to be a challenge, but technological advances in observatories, remote sensing techniques and robotics, such as autonomous underwater vehicles, will likely accelerate data coverage. The GSC will focus on storing, distributing and analyzing big data while developing analytical methods with artificial intelligence and 3-D representation techniques to display the data for a broader audience.

On a practical level, our GEM program, which has provided significant funds for framework geoscience fieldwork, will end in 2020. Through Canada's Arctic Policy Framework, the federal government and its partners will co-develop a long-term vision for the Canadian Arctic and Canada's role in the circumpolar Arctic. The groups co-developing include national and regional Indigenous organizations; Indigenous treaty partners and governments; and the governments of Yukon, the Northwest Territories, Nunavut, Manitoba, Quebec, and Newfoundland and Labrador. This will provide an opportunity for the GSC to develop new geoscience programming to support this vision.

## Goals

- When the GEM-2 program ends in 2020, we will publish new knowledge of Canada's geology in frontier areas of Arctic onshore and offshore land. The knowledge will supply critical information to decision makers to ensure that future management of lands and resources in the North is guided by scientific evidence.
- Through our contribution to the completion of Canada's UNCLOS submission for the Arctic by 2019, we will complete the delineation of the outer limits of Canada's extended continental shelf, thus fostering international recognition of Canada's last frontier.
- We will implement new programs, including a program to respond to the Arctic Policy Framework, as well as tools and methods to discover, model, visualize and interpret the 3-D geology of Canada's lands. In both onshore and offshore domains, we will integrate traditional mapping of the land surface and seabed with geophysical survey and observatory data from below ground. This work will help us to develop 3-D models of Canada's geological framework and a deeper understanding of earth processes.



The GSC studies the sea floor of the Arctic to understand its geology and geohazards. Here a small craft surveys the bottom of Southwind Fjord (Baffin Island, N Nunavut).

## PRIORITY 2. Geoscience for sustainable development

Since its beginning in 1842, the GSC has focused on locating and delineating the natural resources of this vast country. Natural resources remain a critical part of Canada's economy, accounting for 17% of GDP and 1.7 million jobs in 2016.

However, both the energy and minerals sectors are in a state of transition as global trends toward renewable energy and environmentally sustainable development gain momentum. One of these challenges is the growing importance and market availability of emerging commodities such as lithium, graphite and rare earth elements, especially for the fast growing renewable energy and information technology sectors. Meeting the challenges of these transitions is an important goal for the GSC.

In the Lands and Minerals sector, Canada is working with provincial and territorial governments, Indigenous communities, and industry to develop the Canadian Minerals and Metals Plan. This plan will significantly influence GSC's work in the future, as we develop programming to follow the present phase of the Targeted Geoscience Initiative beyond 2020.

Finding new resources remains a major challenge. Many near-surface deposits have been discovered in Canada, but significant mineral resources remain to be found in less accessible regions and at depths below the surface. Finding new resources requires systematic, intensive and innovative methods to assess the mineral potential in remote locations. It requires searching beneath overburden cover, imaging the 3-D structure of the earth and understanding the geological processes that lead to concentration of minerals in certain locations.

For the GSC, this means advancing the knowledge, methodologies and models that would complement and enhance the mineral industry's innovative exploration technologies to develop the mineral prospects of the future.

A second challenge for the Lands and Minerals sector is the growing imperative that resource extraction must take place with a full understanding of the environmental risks associated with development. Communities, including Indigenous communities, recognize the economic benefits that accrue from resource development but have concerns about the health of the land and water on which they depend.

It is incumbent on the GSC and key partners to generate geoscientific knowledge that integrates water quality and cumulative effects so it can be used for evidence-based decision making on resource developments.

For the Energy sector, the greatest challenge is in the transition to a low-carbon economy. Although global fossil fuel use is likely to continue to grow over the foreseeable future, the trend will likely be at a decreasing rate. Canada has an abundant supply of conventional and unconventional (oil sands and shale) oil and gas, so development in frontier areas is likely to be slow. In addition, the government has placed a moratorium on exploration activity in the Arctic offshore lands.

In light of these facts and decisions, the GSC will reassess and redirect our research efforts on frontier petroleum basins toward other energy-related research. The research includes exploring new energy sources such as geothermal and marine renewables and contributing to efforts to ensure that shale oil and gas can be safely extracted with minimal impact on the environment.



## Goals

- We will develop new mineral deposit models through research on how geological processes in ore-generating systems evolve through time. We will also support technological innovation within the exploration industry, with the combined aim of stimulating the discovery of new subsurface deposits.
- We will advance research to combine knowledge of groundwater aquifers and their links with surface water systems to build integrated models of water systems for sound, comprehensive water management by the provinces and territories.
- We will continue to deliver authoritative geoscience, including research on cumulative effects, to support land-use planning and environmentally sound resource development, both on land and in our coastal and offshore waters.
- To facilitate development of low-carbon energy sources, we will support the fledgling geothermal industry and other renewable energy industries to assess resource potential, enhance energy recoverability and support environmental assessments.
- We will develop methodology to better characterize shale-hosted resources and transfer knowledge to industry, regulators and other stakeholders.



GSC geologists near the Heiberg Formation in northern Ellesmere Island (NU) as part of the Geo-mapping for Energy and Minerals program. This formation is the primary host of major gas accumulations in the Canadian High Arctic.

## PRIORITY 3. Geoscience for keeping Canada safe

Canada, like most countries, is vulnerable to the effects of both major natural disasters and climate change. For example, experts estimate expected losses from a plausible magnitude 9.0 earthquake on Canada's west coast to be \$75 billion. They also estimate that a magnitude 7.1 earthquake in the St. Lawrence River Valley between Montréal and Québec would result in losses of \$60 billion. By comparison, the 2013 Alberta floods were the costliest disaster in Canadian history and resulted in losses of about \$1.7 billion.

Climate change is already being felt in many regions of Canada, especially the North, where degrading permafrost and coastal erosion are directly affecting critical infrastructure and the well-being of Canadians.

Canada is preparing to meet our climate change obligations of the Paris Agreement through the adaptation and climate resilience provisions of the Pan-Canadian Framework on Clean Growth and Climate Change. The GSC has provided a strong, scientific foundation for climate change adaptation within regions and communities.

The GSC will continue to work on understanding how landscapes will change, how infrastructure will be affected and how resilience to climate change can be built into new infrastructure. Climate change will likely have a significant impact on the water cycle. GSC research will shed light on the risk to potable water supplies, hydroelectric power generation, and hazards from floods and drought.

Canada is also party to the United Nations Sendai Framework for Disaster Risk Reduction, which calls on countries to adopt a whole-of-society approach to strengthening national resilience to natural hazards.

In Canada, federal and provincial public safety ministers recently endorsed the revitalization of an emergency management strategy. The GSC is recognized by Public Safety Canada as a key source of science-based information about natural hazards and risk and will participate fully in this new initiative.

However, natural hazard science is a relatively young science. There is much to be gained from fundamental research into the causative mechanisms of earthquakes, tsunamis and landslides, both terrestrial and submarine. GSC expertise will continue to be applied to quantifying where and how frequently natural hazards will occur, but we will put new emphasis on quantifying the risk to Canadians, taking into account the exposure, vulnerability and resilience of regions and communities. Once these risks are understood, mitigation measures can be targeted and resilience increased so that losses are minimized when a hazardous event occurs.

A new challenge for the GSC and the government public safety agencies will be how to bring lessons from disaster risk reduction and climate change adaptation together into a coherent approach. Although time scales differ between short-term natural hazard events and longer term climate change, the two are intimately linked, with climate change potentially increasing the frequency of catastrophic events. The key objective for both should be to increase societal resilience through improved scientific understanding, smart land planning and appropriate building codes.



## Goals

- We will develop advanced hazard models for earthquakes, tsunamis, landslides and space weather to support regular updates of building codes and emergency planning.
- We will assess the impacts of climate change on the water cycle, permafrost, and coastal erosion and inundation to enable planning of resilient communities and infrastructure.
- We will continue to work with the Canadian Hazard Information Service and Ocean Networks Canada to build an earthquake early warning system for southern British Columbia.
- We will integrate our geoscience with socioeconomic analysis and engineering data to provide a comprehensive understanding of risk from natural hazards and climate change to critical infrastructure and urban centres.
- We will focus on transferring this knowledge of hazards and risk to a wide range of stakeholders, including the provinces and territories, professional associations, and the insurance industry, to support actions that will decrease Canada's exposure to natural disaster and climate change.



The GSC conducts climate change studies, here documenting the effects of fast melting permafrost leading to extreme coastal erosion on Pelly Island, NT.

# PRIORITY 4

## PRIORITY 4. Geoscience for society

The landscape for resource development in Canada is changing rapidly. In the past, resource development decisions, including the environmental assessment process, were made on a project-by-project basis. In many areas, communities are trying to manage multiple resource projects related to mining, forestry and energy at the same time and in close proximity.

The effects of these projects on land and water may be cumulative, and consequently, project-by-project assessments may not be effective. Rather, integrated land-use planning will be the better method. As the federal government and other levels of jurisdiction reconsider their approach to making decisions for resource development, so too must the GSC think about how to support integrated land-use planning.

A critical part of this change in approach involves Indigenous reconciliation. In many parts of the country, Indigenous nations are facing these same issues related to land use and resource development on their traditional lands. From its earliest days, the GSC has benefited from a collaborative relationship with Indigenous people. We will continue to increase the strong efforts invested in recent years to collaborate with Indigenous groups on mapping and research activities on traditional lands.

The scientific knowledge required to assess cumulative effects is broad. The complex interactions between land use, water management and waste management require an integrated approach at a landscape scale. The GSC is a national provider of information on both land (surficial and solid geology) and water, including the integration of surface water and groundwater into the complete water cycle.

The clients for such information have become increasingly diverse and now include other agencies at all levels of government, Indigenous nations, professional clients such as engineers and planners, advocacy groups, and the general public. We must seek new ways to both compile the technical information into a useable format and to disseminate it effectively.

The GSC recognizes that this area of endeavour involves inherent complexities and that our goals in this area will be to some degree aspirational. However, we will investigate new ways of planning our programs, undertaking our fieldwork, interacting with key stakeholders, and communicating our expert knowledge in ways that contribute positively to decision making about resource development.

## Goals

- We will establish a governance structure to manage geoscience information through best practices and processes based on recognized standards. Through this approach, we will document, store and manage the GSC's data. We will ensure that we have a robust and modern data infrastructure that will ensure sustainability and will work effectively with external tools such as the Federal Geospatial Platform and the open data initiative. The infrastructure will also facilitate the discovery and dissemination of our data.
- In the spirit of Canada's open science initiative, we will establish a modern publication process that incorporates open science principles and is responsive to client needs. We will work with provincial and territorial surveys to synthesize Canada's geoscience knowledge and data and develop open and dynamic web portals to share geoscientific information.
- We will develop an approach to land-use planning that is informed by geoscience by initiating dialogue and building relationships with federal, provincial and territorial counterparts, Indigenous groups and non-governmental professional organizations. Through pilot projects, we will build a methodological framework for providing accessible multidisciplinary geoscience to inform land-use planning.
- We will build on past engagement to facilitate and guide our relationships with Indigenous communities based on recognition of traditional knowledge, respect and cooperation. Based on needs identified by Indigenous communities, we will put special emphasis on working with several of those communities to co-develop prototype projects by using traditional and geoscientific knowledge for land-use planning, management and decision making. With provinces, territories, universities and professional associations, we will investigate ways to build geoscience capacity within Indigenous communities to enhance incorporating geoscience knowledge into land management decision making by communities.



The GSC conducts geohazard studies to reduce risks to people and infrastructure, here installing equipment to monitor landslide activity above a critical railway corridor in central BC.



# PRIORITY 5

## PRIORITY 5. Our people | Our science

As a science organization within the federal government, the GSC's mandate is to conduct world-class science to inform public decision making. The Canadian government has articulated and adopted the principle of evidence-based decision making and reaffirmed the need for government science to be objective and non-partisan.

Producing world-class science means continuously renewing, strengthening and developing our workforce to be at the leading edge of scientific fields, embracing new technologies and providing state-of-the-art laboratory facilities. It also means being at the centre of a thriving Canadian and international geoscience ecosystem.

The GSC's science priorities need a broader range of skill sets but also a mastery of some key specializations. Balancing these needs in a tightening fiscal situation will be a challenge that we will meet through strategic staffing, continuous learning and developing partnerships with universities, industry and other government agencies. Our greater emphasis on geoscience for society will require our staff to acquire skills related to facilitation, communication and mediation.

To remain at the leading edge, our scientists need to work with a variety of partners. We need to reinforce the central role that the GSC plays in the Canadian geoscience community by building networks of collaboration, fully participating in national geoscience initiatives, and advocating for Canadian geoscience at the international level.



Among many celebratory activities for the GSC's 175th anniversary in 2017, the GSC held a Rock and Fossil Exhibit, at its site at the Bedford Institute of Oceanography (Dartmouth, NS), as part of a two-day open-house event, where more than 20,000 visitors participated.

## Goals

- We will proactively support and develop a resilient, high-performing and diverse workforce skilled in emerging and traditional areas of geoscience research by encouraging cutting-edge skill sets and continuous learning. We will modernized our workforce and acknowledge the continued efforts of our staff to advance public geoscience in Canada.
- We will foster a modern work environment that balances sound scientific infrastructure and a healthy workplace; offers world-class laboratories, collections and facilities; and provides opportunities for employees to contribute meaningfully to the development of Canada.
- We will lead and advance the geoscience research agenda in Canada and internationally by advancing a scientific research agenda that demonstrates scientific and technical leadership, challenges paradigms and makes a difference to Canadian society.
- We will serve as the hub of geoscience research in Canada through collaboration with other federal departments, other levels of government, universities, the private sector and international research institutes.



An autonomous underwater vehicle (AUV), is being deployed here as part of a collaborative project with the Government of Nova Scotia to map possible natural oil and gas seeps on the seabed in water depths greater than 2000 metres, offshore NS.






## MOVING FORWARD

Some of the objectives and goals that the GSC has set represent familiar territory for a national geoscience organization, but many others will pull us out of our comfort zone. We will take the time to better understand the challenges of delivering objective, non-partisan science to support evidence-based decision making in Canada at a time of great technological and social change.

We will not be able to do this alone, so we look forward to strengthening our ties to other federal departments, provinces and territories, universities, Indigenous organizations, the private sector and civil society as a whole.

We ask all our stakeholders to contact us, to challenge us and, most importantly, to join with us to assure the future of Canada through thoughtful, respectful dialogue about the land we live on, its resources and its future.



Joint Canadian/German (GSC/BGR) field mapping camp on northern Ellesmere Island, looking west as the fog covered sea ice of Yelverton Inlet, 2017.

## EXPLORING CANADA

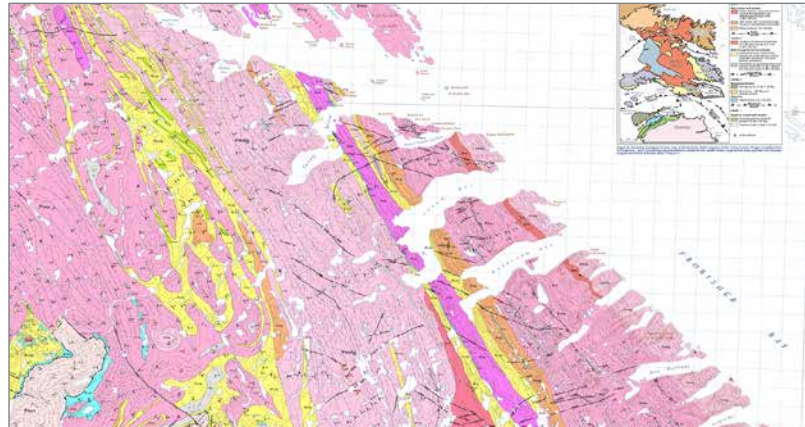
In 2017, the GSC celebrated its 175th anniversary. Indeed, the GSC is older than Confederation and played a foundational role in the development of our country. Before 1842, Indigenous people helped European explorers discover the lands we now call Canada, and early settlers lived in a harvesting economy based on agriculture, forest products, fur and fisheries.

With the industrial revolution in its early stages in Europe, the GSC's founder, William Logan, was granted resources to survey in Canada. Logan was directed to "cause a geological survey of the Province [of Canada] to be made" – explicitly to identify the coal resources to support an industrial economy in the new colony.

Through its history, the GSC has been responsible for mapping the land mass of Canada, which supported the integration of the western provinces and northern territories into the country that we have today. The limit of Canada's offshore territory is still being extended today though surveys conducted by the GSC and the Canadian Hydrographic Service.

The mapping of Canada's land mass also led to numerous discoveries of natural resources by the private sector that guided and built the prosperity of the country. The GSC has always been a player in the exploration of the nation. George "Klondike" Dawson worked for the GSC in Yukon before gold was discovered in 1896, and his maps were used by prospectors during the Gold Rush. In the same period, GSC mapped the extent of the oil sands in Alberta and identified iron ore in Labrador.

In more recent years, the GSC helped find the first economic diamond deposit in the Northwest Territories, leading to the expansion of diamond mining in Canada. These are only a few of the key GSC achievements that



The Grinnell Glacier area geological map (NU) was produced as the first GSC map translated to Inuktitut to ensure geoscience knowledge is accessible to northern communities.

have built our knowledge of Canada's lands and provided the building blocks of its natural resource economy.

Today, exploration of this vast land is still reaping its natural resource rewards. The search for natural resources is difficult, akin to looking for a needle in a haystack.

The GSC's GEM program is exploring vast tracts of Canada's North, a land mass roughly equivalent to the combined areas of Quebec, Ontario and Manitoba, to find the "haystacks" with resource potential. This information is shared with the provinces and territories, as well as the private sector, so that the search for the "needles" can continue. The information is also critical to inform land-use planning.



In November 2016, the Royal Canadian Geographical Society (RCGS) awarded its prestigious Gold Medal to the GSC in recognition of the Survey's outstanding contribution to the development of Canada on the occasion of its 175th anniversary.

For example, our new knowledge on uranium potential in the Kivalliq region of Nunavut was taken into account when determining the boundary of an expansion of the Ukkusiksalik National Park. Informed by GEM geoscience information, an exchange of land between the Government of Canada and the Kivalliq Inuit Association was concluded. The result is that land that is culturally and archaeologically significant will be conserved while other areas will be kept open for resource exploration and development, to the benefit of all Inuit and Nunavummiut.

Field exploration and the synthesis of geoscientific information into geological and geophysical maps and cross-sections have always been and will continue to be the cornerstone of GSC discoveries. Remarkably, after only 22 years of exploring this vast country on horseback and by birchbark canoe, Logan and a small team of colleagues published the first Geological Map of Canada in 1864. Since that publication, GSC scientists have continued to explore and survey the land mass of Canada, producing ever more complete and detailed maps.

The GSC began to explore the submerged lands of Canada's three oceans and continental shelves in the second half of the twentieth century, leading the way to discovery of significant oil and gas resources. While modern survey methods are more sophisticated, the spirit of exploration and discovery remains.

In 2003, Canada filed its submission to the UNCLOS to define the outer limits of its extended continental shelf beyond 200 nautical miles in the Atlantic offshore region. The GSC continues to analyze data we collected in the Arctic offshore region for an upcoming UNCLOS submission by 2019.

Over the last 30 years, the GSC explored ever deeper into the continental crust of Canada, providing key support for the *LITHOPROBE* project, which pioneered deep seismic profiling to unravel the complex crustal structure of ancient geological terranes. The GSC continues to explore in 3-D and use geoscientific synthesis to address a range of government priorities, including both traditional natural resource discovery and new areas such as groundwater, environmental impacts and natural hazards.

In 2014, the GSC led the development and publication of *Canada's Groundwater Resources*, a comprehensive assessment that includes primers on groundwater

geoscience, groundwater sustainability and reviews of groundwater systems in the various regions of Canada.

Similarly, the GSC's geophysical imaging of the 3-D structure of the continental margin of British Columbia, from the offshore region to the continental interior, has improved understanding of how and when major earthquakes occur in this seismically active region. This knowledge is synthesized and used in updates of the National Building Code of Canada, most recently in 2015, ensuring that buildings and infrastructure are built to standards that resist earthquake shaking.

Continuing in the spirit of 3-D exploration and synthesis, the GSC and the provincial and territorial geological surveys recently initiated a new project, *Canada in 3-D*, which aims to synthesize geoscience knowledge and data generated by the partners.

The GSC created the Canadian Hazard Information Service (CHIS), which provides 24/7 monitoring of and alerts for earthquakes and space weather through a nationally distributed system of sensors. Canadians and the Canadian media frequently access this service and interview GSC scientists to learn about such events when they occur. Although the CHIS now reports to the Hazards, Adaptation and Operations branch of the Lands and Minerals sector of NRCan, it remains intimately related to the GSC as a service provider and close research collaborator.

The CHIS is the most recent of several important scientific organizations that were created from the GSC, including the Canada Centre for Remote Sensing, the Canadian Museum of Nature, and the Polar Continental Shelf Project.

Logan was a canny promoter of the Geological Survey and recognized early on that communicating the results of his work to the public was important to his efforts to survey the country. He put together geological collections for the Great Exhibitions of London 1851 and of Paris 1852, which went a great distance to maintaining interest and funding for his efforts.

This tradition continued through the years. The GSC prepared rock and mineral collections for Canadian schools, produced Geoscape posters and publications to introduce the public to Canadian landscapes. Most recently, we contributed to the landmark book, *Four Billion Years and*






*Counting: Canada's Geological Heritage.* The GSC continues to be guided by the principles of open geoscience.

Logan could not have imagined the Canada of today. What would he have made of our sophisticated remote sensing mapping techniques, of our ability to examine sedimentary layers below our continental shelves, and of climate change and its impact on our land, water and people?

Our societal issues are different, but he would recognize the need for continued scientific exploration of the land mass both onshore and offshore, for data synthesis and for good communication of the resulting knowledge in service of the public good. Natural resources are still the foundation of the Canadian economy and geoscientific exploration is still the key to discovering areas of resource potential. Safe and sustainable development starts with smart land-use planning, which in turn starts with knowledge of the land, its water and its resources.

Knowledge is key to a country's well-being. Indigenous peoples are deeply rooted in the land and have much traditional knowledge to teach us. The Great Law of the Haudenosaunee, the founding document of the Iroquois Confederacy, eloquently calls on us to consider the impacts of our decisions on the next seven generations.

The GSC's history extends over many generations and has built the scientific understanding of Canada's geological structure and landscape. As we move forward from our 175th anniversary and Canada moves toward reconciliation with its Indigenous peoples, it is fitting that the GSC, one of Canada's oldest institutions, continues its traditions of exploration and building knowledge of our land and our natural heritage for the benefit of generations to come.



GSC scientists have conducted paleotsunami investigations at various coastal sites, such as here on the shore of Douglas Channel, BC, in order to understand regional earthquake cycles and submarine landslide hazards.

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\* The Canada-Nunavut Geoscience Office is a partnership between the government of Nunavut, Natural Resources Canada, and Indigenous and Northern Affairs Canada. Nunavut Tunngavik Incorporated is an ex officio member of the office.





The on-going collaboration with the Canadian Coast Guard and the CCGS Hudson oceanographic vessel has continued in 2018, with a another important expedition, here at Cape Dyer, NT, to study seafloor geohazards.





GSC-Calgary staff visit Horseshoe Canyon to learn about the Cretaceous strata of the Drumheller region. The Red Deer River incised and exposed the spectacular present day stratigraphy.







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