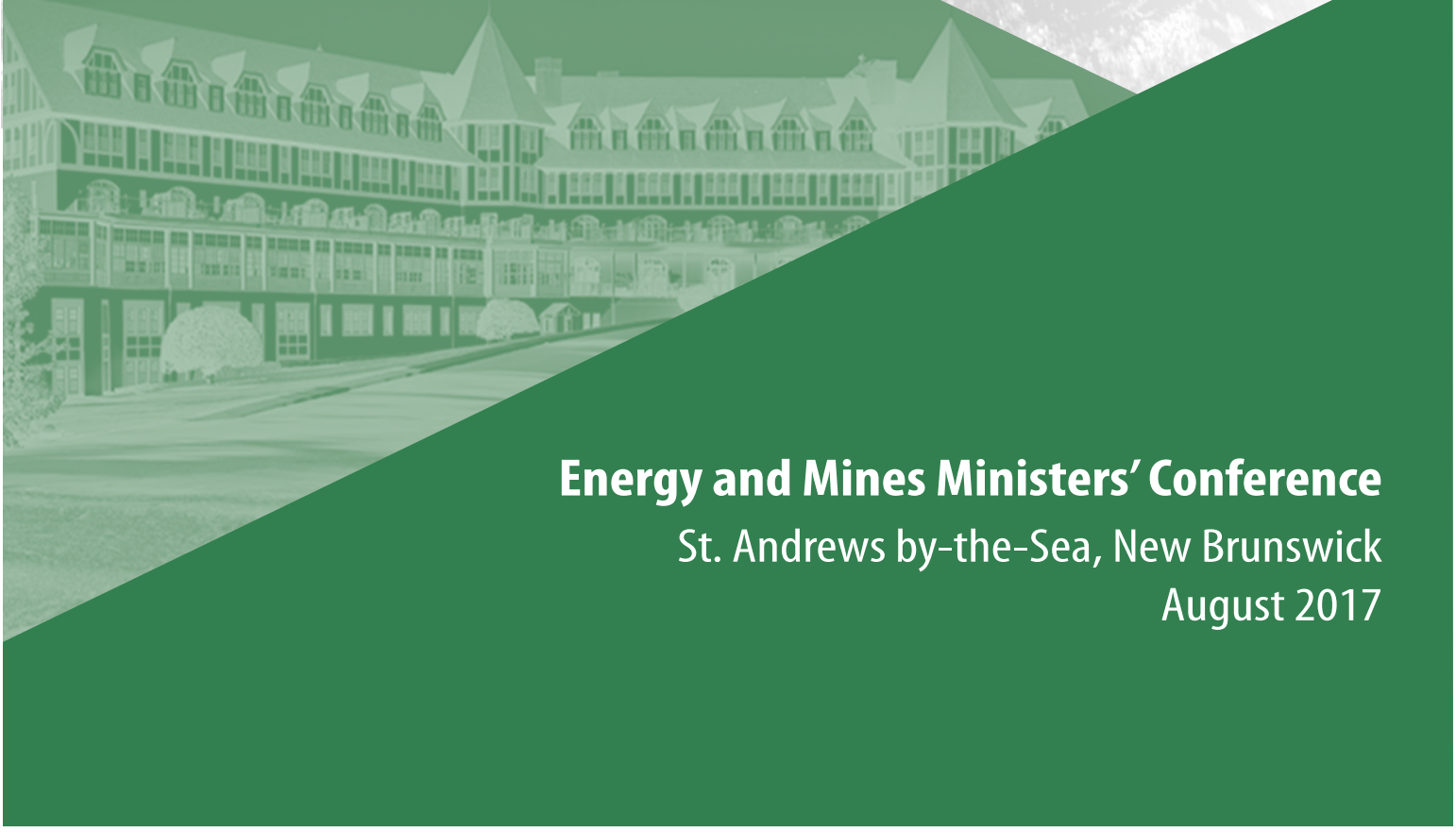
Collaborative Public Geoscience to Support the Junior Mineral Exploration Sector



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Innovating for a Strong Canadian Energy and Mining Sector

Collaborative Public Geoscience to Support the Junior Mineral Exploration Sector

A Report Prepared by the National Geological Surveys Committee

for

Energy and Mines Ministers' Conference

August 2017

Table of Contents

Executive Summary

Recognizing the fundamental role of public geoscience in supporting Canada's mineral exploration industry, the Mines Ministers, at the 2016 Energy and Mines Ministers' Conference (EMMC), recommended that the Mines Intergovernmental Working Group's (IGWG) National Geological Surveys Committee (NGSC) return to EMMC 2017 with concrete options to collaborate on the next generation of public geoscience. It was advised that the work plan should include "analysis of past and present collaborative Federal-Provincial-Territorial minerals geoscience programs, and options to acquire public geoscience data and knowledge that could facilitate exploration by juniors."

As noted at EMMC 2016, in Canada and globally, the decline in the number of new mineral discoveries, the challenges associated with the delineation of new mineral resources, and the drawdown of mineral reserves at operating mines are contributing to the slow contraction of the Canadian mining industry and are diminishing the social and economic benefits associated with mining. The junior mineral exploration sector, which carries out the bulk of grassroots exploration in Canada, is having difficulty raising investment capital needed for that exploration which is the necessary precursor to new mineral discoveries. With mineral resources accounting for 19% of Canada's total merchandise exports in 2015 and directly sustaining over 373,000 jobs, sustainability of the mineral sector is important to Canada's economic well-being.

Canada's public geoscience, which is equally and readily accessible to everyone independent of ability to pay, enables mineral exploration companies to spend their exploration dollars in areas with the highest probability of success. Reducing risk associated with mineral discovery increases the effectiveness of exploration efforts, encourages private sector investment, informs land-use planning and promotes a globally competitive mineral industry. In reducing these risks, public geoscience supports exploration and sustainable development of natural resources in the over 100 mining dependent communities across Canada.

The Evolution of Collaborative Public Geoscience that Supports the Mineral Exploration Industry:

Since 1996, the Intergovernmental Geoscience Accord (IGA) has provided the basis for provision of public geoscience in Canada. This Ministerial-level document outlines the framework for collaboration between federal, provincial and territorial (FPT) geological surveys in order to minimize overlap and duplication; enhance synergies among jurisdictions to resolve regional geoscience problems; and facilitate optimal utilization of resources.

In preparing this report, the NGSC reviewed programs that were precursors to the IGA (1985-1996 - Mineral Development Agreements (MDA) projects), those that bridged the implementation of the IGA (1991-2004 National Mapping (NATMAP) and Exploration Technology (EXTECH) Programs) and those that operated under the IGA framework (2008-2020 - Geo-Mapping for Energy and Minerals (GEM) and 2000-2020 - Targeted Geoscience Initiative (TGI) programs).

From the analysis, it was determined that there has been consistent progress towards more efficient and stronger FPT collaboration on delivery of national geoscience programs, particularly as roles and responsibilities became codified under the IGA. Furthermore, the heightened collaborations have led to better local and national outcomes of supporting and strengthening the exploration sector in Canada.

It was determined that successful programs were founded on three key principles:

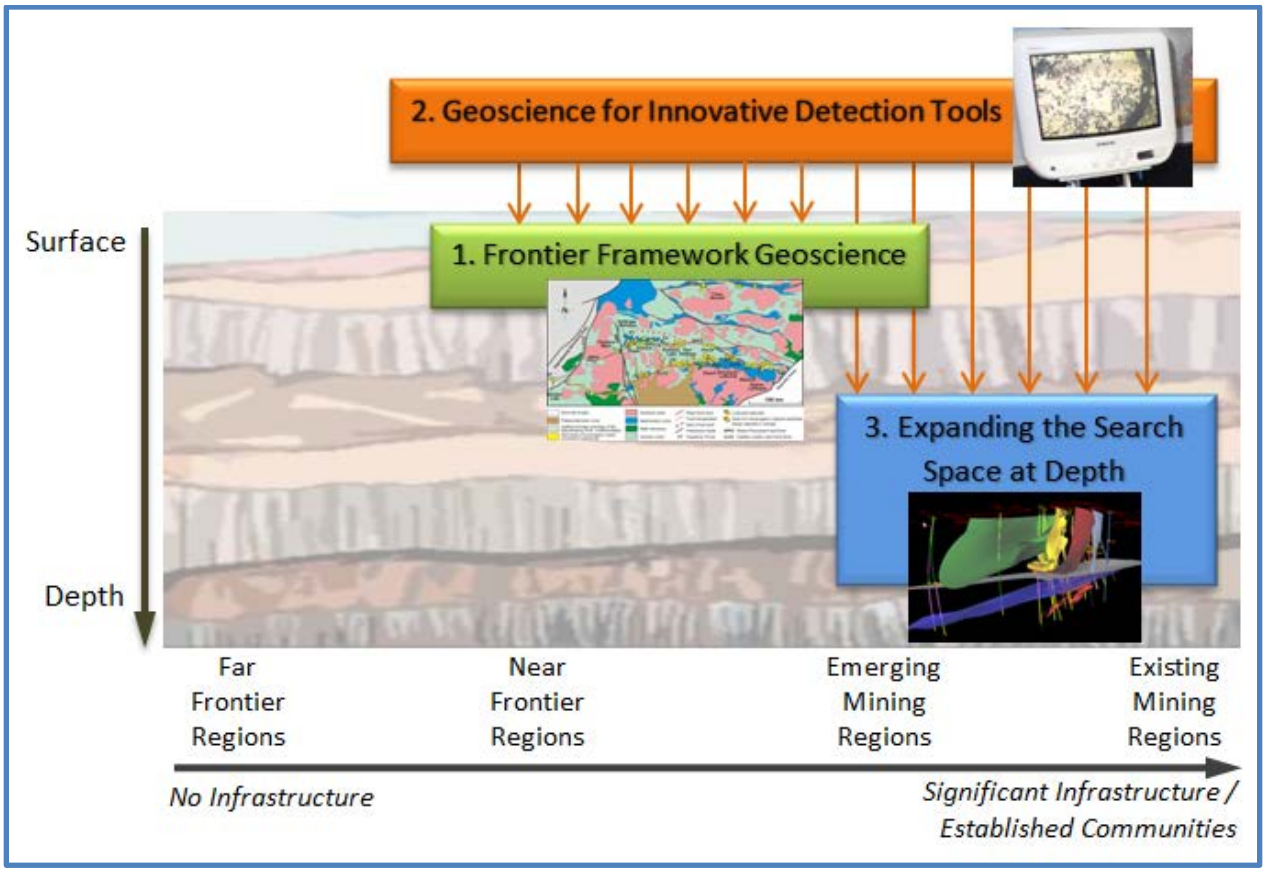
1. New data acquisition provides a geographically-constrained, immediate increase of exploration activities by highlighting anomalies determined through the use of existing methodologies.
2. Scientific analysis of the data provides national, longer-term industry sustainability and fosters re-interpretation of results leading to development of new ore deposit models and the creation of new methodologies.
3. Easy access to data and knowledge is paramount to ensuring uptake and use by industry so that they can innovate their exploration approaches and maintain a globally competitive position.

Options for Public Geoscience Programs that Support the Junior Sector:

Building on the strengths of past and current programs (Annex 1: List of Past and Current Mineral Programs) and incorporating input from industry, NGSC is recommending a collaborative FPT focus of "Expanding Mineral Discovery Space" to support the junior mining industry going forward. Within this proposal, three end-member themes can be blended to address particular jurisdictional or national issues and promote both immediate and longer-term success of the junior industry:

1. Frontier Framework Geoscience: Centered in the near-surface regions extending from mines and known mineral potential, this theme will provide foundational geoscience that supports exploration in the frontier regions that are within reach of the infrastructure of existing communities.
2. Geoscience for Innovative Detection Tools: This theme would promote a more innovative and competitive Canadian exploration service industry (e.g. geophysical surveying companies) that would support juniors by creating novel, cutting-edge tools and technologies to better detect new mineral deposits.
3. Expanding the Search Space at Depth: This theme responds to the emerging need to search deeper for *new* deposits near *known* deposits, by focusing on developing better subsurface modelling methods and applying these to existing and emerging mineral camps.

This report provides an in-depth examination of past and present collaborative public geoscience programs in Canada, as well as how their evolution leads to the recommendations herein that will support the junior mineral exploration sector in Canada.



Infographic illustrating the unique spatial positioning of the three themes supporting the junior exploration industry, as well as their complementary relationships.

1. The Evolving Nature of Collaborative Public Geoscience to Support the Mineral Exploration Industry

Canada is a resource nation and its minerals industry has helped make it a global resource powerhouse. The minerals industry contributed over $71 billion in taxes and royalties to Canadian governments between 2003 and 2012, and created significant economic opportunities for residents of remote, rural and Aboriginal communities.[1] In addition, the mining industry sources many of its inputs from Canadian suppliers and in turn, its outputs are the source of significant value-added increases when used by Canadian manufacturers.

> *It is interesting times in the mining industry: more interesting than many of us expected. China's economic rebalancing is causing exceptional disruption. Commodity prices are taking much longer to recover than anticipated. To my mind, this makes innovation even more imperative. Rather than being optional, being bold may be the prerequisite to survival."*
>
> -Glenn Ives, Americas Mining Leader, Deloitte Canada 2016

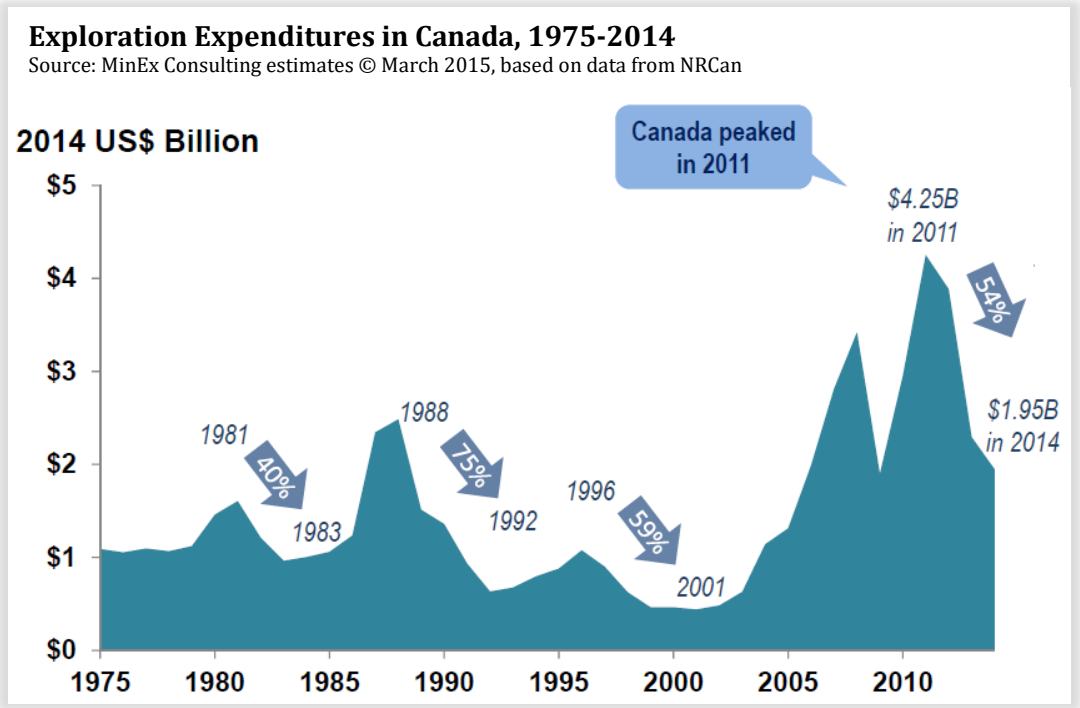
Most mineral resources are public assets and governments have generally determined that the responsible development of these assets is in the public interest[2]. Public geoscience, by its nature, is:

- equally and readily accessible to everyone independent of ability to pay;
- characterized by "use by one agent does not diminish the use by others"; and
- provided on a cost-effective basis.

For the mineral exploration industry, public geoscience allow companies to spend their high risk exploration dollars in areas where good geological knowledge is available and that suggest an acceptable probability of success.

[1] Mining Association of Canada. *Facts and Figures 2012,* 2012. mining.ca/sites/default/files/documents/FactsandFigures2012Eng.pdfmining.ca/sites/default/files/documents/FactsandFigures2012Eng.pdf

[2] Duke, J.M.. *Measuring the Impact of Government Geoscience on Exploration Success*, Study prepared for Natural Resources Canada, 2012



Figures for 2015 indicate that all mining and mineral exploration companies in Canada spent $1.84 billion on exploration and deposit appraisal projects in Canada, down from the peak value of $4.22 billion in 2011. Preliminary spending estimates for 2016 indicate a further decline to $1.56 billion[3].

Mining companies require continual discovery of new ore bodies to maintain mineral reserves, yet over the past few decades, discovery costs have escalated while discovery rates have decreased, pointing to a need for industry to replace or modify their traditional exploration strategies.

Canada's junior mining sector plays an important role in the discovery and development of mineral projects, which may become mines and contribute to the regional, provincial/territorial and national economies. The sector is comprised of small, flexible, and innovative junior mining companies that have the ability and agility to efficiently analyze new minerals geoscience data

What is a Junior?

No set definition, but some criteria include:

- Little or no revenues from production
- A small company that is currently developing or seeking to develop a natural resource deposit or field
- The focus is on exploration, not mining,
- The company raises risk capital by selling shares
- Shareholder reward is share price increase if the company makes new discoveries, not in dividends
- High percentage of technical people
- Management has vested interest - management and workers often one and the same

[3] Natural Resources Canada. Based on the annual *Survey of Exploration, Deposit Appraisal and Mine Complex Development Expenditures*, 2017.

and deploy innovative, cost-effective mineral exploration programs, including deposit appraisal activities that range from regional reconnaissance to the delimitation and definition of specific mineral deposits. Metals Economics Group noted in March 2012[4] that junior companies have accounted for close to half of annual mineral exploration spending in recent years, and often shoulder the biggest exploration risks in conducting "greenfield" exploration, scouring the countryside for minerals in often far-flung, hard-to-reach places. Promising projects that cannot be developed by the junior company on its own, for financial and/or technical reasons, may attract joint-venture partners, strategic investors, or buyers that will allow the project to continue towards a production decision.[5]

Junior mining companies do not have internally generated revenue and must raise funds to finance their exploration activities.[6] As the potential of their developments are not yet proven, they are working with the potential of, rather than the certainty of a profit, and they rely heavily on equity investors who must weigh the possibility of high reward against the risk that nothing valuable may be found.[7] Yet senior mining companies increasingly look to the junior mining sector to accept the exploration risk, make discoveries, and undertake initial deposit evaluations.

Canada is known for its large contingent of junior mining companies – the largest in the world – which traditionally account for the majority of exploration and deposit appraisal activity in Canada. These companies propelled increased exploration and deposit appraisal investment in the years preceding the economic downturn, at times accounting for up to 60% of total

Exploration and Deposit Appraisal Expenditures by Junior Companies, 2006-16(p)

Year	Junior Companies ($ millions)
2006	1,238.0
2007	1,904.4
2008	2,117.8
2009	1,110.7
2010	1,546.7
2011	2,047.7
2012	1,847.0
2013	965.1
2014	814.3
2015	577.7
2016 (p)	582.5

Source: Natural Resources Canada, based on the annual Survey of Exploration, Deposit Appraisal and Mine Complex Development Expenditures. (p) Preliminary.

[4] SNL Metals Economics Group. *World Exploration Trends, March 201*2, Presentation to PDAC, 2013. go.snl.com/rs/snlfinanciallc/images/WETReport_0114.pdf

[5] Intergovernmental Working Group on the Mineral Industry. *Canada's Junior Mining Sector in 2014: A Diagnostique of the Junior Mining Sector's Context and Issues,* Report prepared for Energy and Mines Ministers Conference, August 2014.

[6] Mines IGWG Junior Mining Sector Working Group. *A Report on Canada's Junior Mining Sector*, Report prepared for Intergovernmental Working Group on the Mineral Industry, August 2016.

[7] Prospectors and Developers Association of Canada. *The Mineral Exploration Tax Credit and the Future of the Mining Industry in Canada,* 2016. http://www.pdac.ca/docs/default-source/public-affairs/finance-taxation---pdac-research-paper.pdf?sfvrsn=6

expenditures.

Due to their reliance on equity market conditions, junior companies traditionally lead increases and decreases in exploration spending[8]. In 2016, junior mining companies alone spent $0.6 billion on exploration and deposit appraisal activities, a 72% decline from 2011 and a 28% decline from 2014, because of a continued challenging market outlook that affected access to capital. In 2016, precious metals, particularly gold, remained the leading target for exploration spending ($0.8 billion), accounting for 45.4% of total spending.[9]

At the 2014 EMMC, Ministers were presented with *Canada's Junior Mining Sector in 2014 - Diagnostique of the Junior Mining Sector's Context and Issues.* The Diagnostique documented the difficult operating context of the junior mining sector. The negative minerals and metals market outlook, worldwide economic uncertainty, and investor risk aversion were identified as key challenges facing the sector then, and remain so now.

At the 2015 EMMC, the Mines IGWG's presentation, "*Junior Mining Sector Framework*", identified nine policy areas in which actions by Mines Ministers could contribute to promoting the long-term competitiveness of Canada's junior mining sector, thereby ensuring the long-term viability of Canada's mineral industry. Three policy areas – land access, duty to consult, and enabling infrastructure – were identified as requiring the most immediate attention on a national basis or offering the most potential for long-term benefits. Following from that, at the 2016 EMMC, the Ministers reaffirmed the fundamental importance of Canada's exploration, mining and mineral processing industry to Canada's economy, financial sector and to its remote and indigenous communities.

Analysis of past and present collaborative FPT minerals geoscience programs

Public Geoscience in Canada

Public geoscience broadly refers to geological, geophysical, and geochemical data, maps, information, and knowledge provided by governments as a public good. The availability of such data and information has long played an important role in fostering a strong mineral investment climate in Canada

> *"Public geoscience is the lifeblood of mineral exploration."*
> -Prospectors and Developers Association of Canada, 2014

[8] Natural Resources Canada. Based on the annual *Survey of Exploration, Deposit Appraisal and Mine Complex Development Expenditures*, 2017.
[9] Natural Resources Canada. *Mineral and Metals Fact Book- 2016,* 2016. http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/mineralsmetals/pdf/mms-smm/Minerals%20and%20Metals_factbook_En.pdf

and is widely acknowledged to be one of Canada's competitive advantages in attracting mineral exploration, which has contributed to the country's standing as a leading exploration target and mineral producer.

The availability of public geoscience data and analysis enables exploration companies to make informed decisions regarding their exploration plans. Modern pre-competitive minerals geoscience data and knowledge are essential components of an investment climate that promotes effective grassroots exploration and viable junior mining companies. These companies leverage government geoscience data, including both historical and newly released information, to identify areas of favourable mineral potential.

By having a better understanding of geological environments through pre-competitive maps, databases, tools, and models, mineral exploration can be focused on areas of higher prospectivity, and investment risk can be reduced.

Public Geoscience

1. Attracts exploration investment by allowing industry to identify areas of favourable mineral potential.
2. Increases exploration efficiency by making it unnecessary for individual companies to duplicate common information or to spend money on non-prospective ground.
3. Increases exploration effectiveness by providing key information inputs to risk-based decision-making.
4. Supports a critical mass of knowledgeable experts that can innovate and create exploration approaches that maintain Canada's world-leading position in mineral discovery and development.

In 2012/13 (the latest year for which data are available for all jurisdictions), total public geoscience expenditures were $161.2 million, a 3.5% increase over the 2004/05 value of $155.8 million. Federal government expenditures in 2012/13 totaled $76.3 million, representing 47.3% of total expenditures. Over the period, the federal government routinely accounted for approximately one half of total expenditures. [10]

Geoscience information is utilized by governments to develop public policy and regulations to provide oversight in resource development, environmental protection, public health and safety, land use, and infrastructure planning. All the provinces and territories in Canada, with the exception of Prince Edward Island, have established geological survey organizations to meet their geoscience needs, and the majority of these are integral parts of government departments. The provincial, territorial, and federal geological surveys cooperate and collaborate under the auspices of the ministerial-level Intergovernmental Geoscience Accord (IGA), which outlines the respective roles and responsibilities of these organizations in order to ensure efficient and effective generation and delivery of geoscience knowledge to Canadians.

[10] Natural Resources Canada. *Mining Sector Performance Report 2006-2015,* 2016. http://www.nrcan.gc.ca/mining-materials/publications/18912

Framework for Collaborative Public Geoscience- The Intergovernmental Geoscience Accord (IGA) (1997-2017)

> *If you are thinking about your exploration strategy for the next 10 to 15 years, the availability of pre-competitive data starts to become a first order factor.*
>
> -Jon Hronsky, principal of Western Mining Services, (AUS) in key note address to PDAC 2017

The IGA (Annex 2) is a Ministerial accord that defines distinct and complementary roles and responsibilities for the federal Geological Survey of Canada (GSC) and provincial/territorial geological survey (PTGS) organizations across Canada. Since 1996, the IGA has ensured that overlap and duplication are eliminated from government geoscience programming and that cooperation and collaboration between the two levels of government are maximized. The IGA has provided a mechanism for the development of successful national initiatives, such as mineral-based programs like the Targeted Geoscience Initiative and Geo-mapping for Energy and Minerals, but also in other program areas such as groundwater and environmental geoscience.

The Accord was developed by the National Geological Surveys Committee (NGSC), which comprises senior representatives of the Lands and Minerals Sector (LMS) at NRCan and the heads of the provincial and territorial geological surveys. The Accord was first signed in 1996 by all Mines Ministers except Prince Edward Island, which does not operate a geological survey and Quebec, which declined to sign but has been a full and willing participant in the development and implementation of every accord. The Accord was renewed for a fourth five-year term in 2012.

With the IGA in place, the data collection-centric, systematic description of the geology of the provinces or territories became the primary role of PTGS, while thematic, pan-Canadian, science generation-centric aspects became the primary role of the GSC who carries out geoscience programs that are typically thematically based and of multijurisdictional to pan-Canadian significance. Nevertheless, all jurisdictions host, share and leverage their own expertise in data collection or geoscience knowledge generation.

Under the auspices of the IGA, the way that public geoscience is generated and delivered has evolved from the patchwork of bi-lateral, primarily locally-focused projects under Mineral Development Agreements, to regionally grouped programs of NATMAP and EXTECH to the northern-focused GEM and the national-scale TGI program. The defined roles and responsibilities of the Federal-Provincial-Territorial geological surveys have also increased their efficient interaction, to not only enhance government-to-government collaboration, but to also foster stronger collaborations with academia, industry, policy-makers and other stakeholders. In the process, public programs have become better at providing core geoscience that enables industry to develop innovative exploration approaches, regardless of the locale where they may be exploring.

Precursors to IGA (1985-1996): Establishing formal joint planning of minerals-focused geoscience programs

Mineral Development Agreements (MDA): Initial forays into collaboration frameworks

The MDAs were developed as sector-specific outgrowths of General Development Agreements (GDA) in the former federal Department of Regional Economic Expansion (DREE). These agreements, oriented towards strengthening and diversifying the mineral industry across Canada, were developed on a project-by-project basis as an umbrella GDA was put in place with each jurisdiction. Each program specified a level of shared funding, ranging from equal parts federal-provincial to 90% federal, with 10% provincial. As such, these agreements represented the first foray into formal shared-cost programs to deliver public geoscience and their success was the foundation for all future programs. Because of the cost-shared nature of the funding, each MDA project was managed through a bi-lateral federal-provincial (or territorial) steering committee which jointly determined the allocation of funds.

Significantly, the need for public geoscience was driven by the need to update the geoscience framework of Canada in an era of anticipated raw material shortages. With the profound scientific revolution of the 1970s that was presented by the emerging theory of plate tectonics, geology was no longer local and static, but rather represented a complex, dynamic system that operated at regional, national and global scales. As such, modernizing and contextualizing Canada's geology – and the ability of stakeholders to leverage that knowledge into a sustainable future – required a fundamental shift from simply describing Canada's geology to understanding the processes responsible for creating that geology. The MDAs helped to support this changing paradigm by bringing on new scientific staff trained in the latest theories at the GSC and PTGS, but also by supporting the transformation of many PTGS into geoscience-forward organizations that could position the geology of their jurisdiction within a global context. The multi-year nature of the agreements also helped foster a new approach that allowed production of finer-scale regional geological maps and geoscience research results, both of which are difficult to plan for under an annual funding cycle.

In spite of the progress made through these agreements, outputs from the MDAs were uneven and depended on the individual agreements themselves. These ranged from disparate internal and external scientific publications and maps, final publications that simply listed the publications generated during the agreement to more meaningful wrap-up publications that synthesized the science. Nevertheless, many of these publications continued to be foundations for continued scientific analysis within new MDAs, within other programs and within academia. MDAs also fostered the development of select standardized national data structure to capture and retrieve key geoscience data, many of which remain in use today. As well, because MDAs were structured as bi-lateral agreements, there was significant variation in their application, results and approaches across jurisdictions. Apart from the increasing difficulty of managing the proliferating agreements, there was no consistent objective that supported the exploration industry on a national basis. In addition, as PTGS grew their capability and capacity with

the support of MDAs, it brought to the forefront the divergent opinions on what the respective roles of PTGS and GSC should be. This started the difficult discussions, which ultimately defined the respective roles of GSC and PTGS.

Bridging to IGA (1991-2004): National Mapping (NATMAP) and Exploration Technology (EXTECH)

NATMAP

With the end of the MDAs and as the structure and objectives of the PTGS and GSC progressed, there was a realization that significant deficiencies remained in realizing a modernized geoscience framework for Canada. As such, and using existing base funding, the GSC embarked on a systematic program of framework geological mapping in concert with PTGS. The National Geoscience Mapping Program (NATMAP) was started in 1991 to support Canada's natural resources industry by filling gaps in the fundamental geoscience database. The 12-year, multi-million dollar program operated through close cooperation between GSC and the provincial and territorial geoscience agencies, with participation from universities and some support from industry. Projects ranged from mapping and assessing the surficial geology of the Oak Ridges Moraine in Greater Toronto, documenting the geological framework of the gold and base-metal rich areas of the Northwest Territories and researching the evolution of oil and gas in the Magdalen Basin of Canada's east coast.

Under NATMAP, new geological maps and structural cross-sections from the Eastern Cordilleran project in Alberta greatly assisted industry in developing and successfully exploring new plays for oil and gas. In the Triangle Zone, 55 new wells, at an average cost of $2.3 million, resulted in the discovery of 974 million m3 of gas reserves.

A wealth of new, high quality geoscience knowledge was acquired for various areas across Canada in the form of new geological maps, internal and external peer reviewed publications and selected project-based synthesis volumes. Although still currently accessible, these were often not generated until well after the end of the project, limiting their wider impact.

NATMAP led to the establishment of a new framework under which cooperative and collaborative geoscience was designed and conducted by GSC and PTGS. The organization of NATMAP also became the first step in the evolution of geoscience programs designed to meet the varying geoscience needs of Canadians. Although some projects were bi-lateral, NATMAP introduced the first multi-lateral geoscience projects involving multiple PTGS and the GSC. Selection of projects was carried out by a National Coordinating Committee led by PTGS and GSC co-chairs, but included industry and academia with the purpose of directing funding available from existing GSC and PTGS allocations. Similar to MDAs, projects were geographically focused, albeit at a more regional scale. Nevertheless, for the first time, consistent principles of collaboration were adopted across all projects and a modicum of mapping standards was established between projects. The program also increased working level collaboration

amongst the staff of the geological surveys. As levels of collaboration continued to develop, the need for an overarching, ministerial-level agreement that defined the respective roles and responsibilities of the GSC and PTGS became evident.

The program, whose thirteen projects included components in nine provinces and three territories, came to a successful end in 2004.

EXTECH

The Exploration Science & Technology (EXTECH) Program was developed concurrently to the NATMAP program, but rather than being focused on geological mapping, it focussed on improving knowledge of key mineral deposits in Canada. This collaborative program was directed at aiding exploration companies in their search for new mineral deposits. The overarching goal was to develop and improve the regional detailed geoscience framework and integrated deposit model by incorporating geological, geophysical and geochemical signatures of deposits into new exploration models. Between 1989 and 2004, bi-lateral and multilateral steering committees were established in each of the four projects, each of which focused on a different mining camp:

- Flin-Flon, MB and SK – Base metals
- Bathurst, NB – Base metals
- Yellowknife, NT – Gold
- Athabasca Basin, SK - Uranium

The Camelback Zn-Pb-Cu volcanogenic massive sulfide deposit, located in the west-central part of the Bathurst Mining Camp, in New Brunswick was discovered in 1996 by Noranda Mining and Exploration. The deposit was discovered during follow-up work on airborne geophysical anomalies delineated by a multi-parameter, high-resolution survey conducted by the New Brunswick and Federal governments as part of the Exploration Technology (EXTECH-II) project

As with NATMAP, the program was geographically focused and with a heavy data acquisition focus to the program, the short-term impacts were felt primarily within that region. As such, the main short-term beneficiaries tended to be companies actively exploring within the study areas. However, the transformation of the new data into knowledge and ongoing efforts to integrate that knowledge meant that the new ways of using that knowledge to determine the prospectivity of a particular geological environment made its way into general use by exploration companies.

Unlike NATMAP, a significant part of the efforts went into developing new technologies such as enhanced airborne geophysical surveying techniques or regional geochemistry survey techniques. Grounded in geoscience studies that helped direct technical advancements needed to discover new deposits, many of these technologies were adopted for commercial use by exploration service industries and are now contracted by not only Canadian junior and senior exploration companies, but also by other global companies exploring around the world.

NATMAP and EXTECH programs both relied on an increasing collaboration between PTGS and the GSC. As these organizations became more comfortable with the idea of collaborative delivery, through either pooling of resources or simply by looking for efficiencies via leveraging each other's capacities, agreement on respective roles, responsibilities and collaboration principles became achievable. Ultimately, most Mines Ministers agreed to codify these elements within the IGA, first signed in 1996. Since that time, PTGS and the GSC, working through the National Geological Surveys Committee have developed initiatives that adhere to this accord.

Collaborations under IGA (2000-2020): Geo-Mapping for Energy and Minerals (GEM) and Targeted Geoscience Initiative (TGI)

GEM

In 2007, the Federal Government committed to a Northern Strategy focussed on strengthening Canada's sovereignty, protecting our environmental heritage, promoting economic and social development, and devolving governance in order to provide northerners with greater control over their destinies. The GEM Program is a key deliverable under that Strategy, providing the geoscience knowledge base to Northerners in order to stimulate private sector exploration for minerals and energy.

It was recognized that geological knowledge could further inform decision making related to land-use planning in the North to enable Northerners to make informed choices about their future prosperity and well-being. By understanding which areas have a higher or lower likelihood of resource potential, communities are enabled to make informed land use decisions that balance different considerations. As an example, to meet its conservation objectives, a community could define the area with lower likelihood for resource potential as a protected area and define the higher resource potential area as available for resource development. The regional geological knowledge would have informed the community's decision, thereby enabling the accommodation of both conservation and resource development goals.

In 2010, Alianza Minerals (previously Tarsis Resources) used analysis of the GEM geophysical and stream-sediment geochemistry data to identify targets and accelerate their exploration program at their White River Gold-Copper-Silver property, in the southwest Yukon.

Given that, in 2007, approximately two thirds of the North had not been assessed to modern geological standards, the GEM program developed and used modern geological methods and techniques to map Canada's northern resource potential. Systematic regional mapping generally aligns with PTGS roles under the IGA, but here approximately 75 percent of GEM funding came from the federal government in the three territories and the balance was invested on a federal-provincial cost-share basis in northern parts of six provinces. An Advisory Group of Northerners was established to inform the department's engagement with regional residents on all phases of the program: planning, delivery, and dissemination of results. GEM was originally envisioned as a ten-year initiative, and with the successful completion of

the first phase in 2013, funding was renewed for an additional seven years to bring the program to its conclusion in 2020.

GEM has successfully prompted a number of new private sector activities in the North with immediate benefits to Northerners through direct employment and purchasing required for the delivery of the GEM program. Additional long-term benefits will accrue through creation of subsequent private sector employment and sustained economic development. A direct correlation can already be made between new knowledge created by GEM and industry exploration. To-date, the program has directly stimulated a minimum of $120M in private-sector investments in both energy and mineral exploration projects.

Some of the new private sector activities in the North that have been prompted by GEM include:

- On the Melville Peninsula (NU) at least two major firms (Vale, Anglo-American), one junior firm (Advanced Explorations), and one prospector are using GEM data in major nickel exploration programs stemming from the 2012 discovery of the Adamson River nickel showing. GEM data were also used by Advanced Explorations to discover additional iron resources (the Tuktu deposit), and attract international investment.
- $50M Chinese-Canadian joint venture to advance development of an iron ore deposit on the Melville Peninsula, Nunavut;
- $3M in diamond exploration activities on Boothia Peninsula, Nunavut;
- Staking of 114 diamond prospecting permits on southeast Baffin, Nunavut; and
- Discovery of significant copper-gold-silver prospects in the Yukon.

TGI (Phase 1 to 3; 2000-2010)

The Targeted Geoscience Initiative (TGI) Program was first launched in 2000 with a goal of increasing the level and cost-effectiveness of private sector exploration for mineral resources.

Each renewal of TGI has been used as an opportunity to strategically focus the program on the most pressing needs of mineral exploration:

- TGI-1 (2000-2003) and TGI-2 (2003-2005) focused on promoting exploration in underexplored areas of Canada.
- TGI-3 (2005-2010) altered the focus to “mapping to help sustain the reserves of base metals in established mining communities”.
- TGI-4 (2010-2015) and TGI-5 (2015-2020) are focused on stimulating innovation by industry in their exploration approaches, particularly for deeply-buried deposits in existing and emerging mining camps that are necessary to sustain overall industry success.

The first three phases of TGI were geographically focused. TGI-1 and 2 were organized around individual projects similar in scale and scope to “miniature” MDA projects, albeit under one program umbrella. These projects were generally small scale with local impact.

Under TGI-3, the GSC has established a highly successful cooperative public geoscience program with provincial partners across Canada (BC, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, and Newfoundland & Labrador). In the cases of Quebec and Ontario, and Manitoba and Saskatchewan, this cooperation is multi-jurisdictional and transcends the provincial borders. Quebec has described the tripartite partnership with Ontario and the federal survey as “historic”. Across Canada, university-based researchers and their students formed an integral part of TGI-3.

TGI-3 moved from working in numerous smaller project areas, identified four key regional areas in which regional studies took place and focused on enhancing the geoscience knowledge necessary to discover new base metal deposits. These areas, in the Abitibi of Ontario and Quebec, the Atlantic Provinces, Flin Flon area of Saskatchewan and Manitoba and the Southern Cordillera of British Columbia and Alberta represented areas of known base metal potential.

With the collaboration of provincial and industry partners, TGI-3 compiled and integrated existing government and industry data for geological regions containing clusters of base metal mining districts. It also compiled and integrated data available on the sub-surface geology, geochemistry and geophysical characteristics of base metal mining districts in order to develop "Deep Search" methods to focus exploration for hidden deposits, including below 200 m depth.

As an example of the impact of TGI-3 work, the Program was credited with helping lead HudBay Minerals to discover a new buried ore body worth over $220 million. More importantly, at the end of TGI-3 in 2010, the company publicly stated that the data generated at Flin Flon, MB, would be used as the basis for their exploration for at least a decade. Additionally, exploration industry spending increased by over $240 million in mining regions across Canada following the conclusion of phase 3 of TGI in 2010.

TGI (Phase 4 to 5; 2010-2020)

TGI-4 represented the first step of a fundamental shift from a regional-geography-based program to a national, thematic program by implementing a novel ore-systems approach. By aligning with clear federal roles and responsibilities under the IGA, this new approach focuses on the processes of ore formation (i.e. the ore system) and not on the more traditional approach of characterizing and cataloguing individual ore deposits. Consequently, public geoscience knowledge is generated that can be applied to exploration for the particular commodity across Canada rather than just in a specific region where TGI has conducted field research. Systematic data collection activities, apart from those that support geoscience knowledge generation, are not part of the program.

TGI-4 concentrated its activities on understanding end-stage, geological processes that deposit metals at the mine site and the resulting dispersal of indicator minerals and geochemical markers that occur

above buried deposits. Understanding these indicators and markers and how they relate to the mineable ore body helps industry refine their search.

TGI-5 took the next logical step by focusing on improving fundamental geoscience knowledge about the remaining part of the ore-forming process, from the processes that liberate metal from source rocks, transport them through the earth's crust and eventually concentrate them in a mineable ore body. As such, TGI-5 has evolved from TGI-4's deposit-scale focus to a more comprehensive source-to-ore approach in order to provide knowledge of the full temporal and spatial spectrum of ore formation processes, including the identification of new ore indicators. This will foster innovation in the mineral exploration industry by creating more effective and efficient multi-scale methods and exploration approaches that target buried mineral deposits.

TGI-4 resulted in over 45 innovations that were used by the exploration industry in their programs. For example, TGI-4 research identified such things as: a key geological element that must be present to form gold deposits, a new high resolution gravity survey that was used to define base metal deposits in the Ring of Fire, and new research describing geological structures that led to the formation of nickel, copper, zinc, lead and uranium deposits across Canada.

These two most recent phases of TGI are firmly grounded within the federal role under the IGA of delivering national, thematic programs and because of this, are principally delivered by the federal government. Nevertheless, the GSC and PTGS, adhering to the commitment under the IGA to collaborate and cooperate on the delivery of public geoscience programs, have leveraged their respective expertise and resources to mutually support both PTGS programs and TGI. Enhanced integration of academia, students and industry under TGI-4 resulted in a national research network of 43 NRCan scientists, 58 collaborating companies, 47 provincial-territorial participants and 63 academic partners and trained 133 students (83 of which were at the post-graduate level).

The Impact of Public Geoscience Programs in Canada

An example of the type of return that comes from public geoscience includes the Brucejack gold mine nearing commercial production this year, near Stewart, BC. It is a $900 million project that is employing 900 workers during construction and, when completed, will provide decades of wealth generation for 300 permanent workers, governments and the company.

A study of the economic potential of base metal and gold mining in Newfoundland and Labrador (Mackenzie et al, 1989) compared five regional development mechanisms: 1) geologic data base development, 2) direct exploration assistance, 3) support for new mine development, 4) mine production incentives and 5) end-of-mine assistance. The study concluded that geologic data base development would have the greatest return on enhancing future economic performance. [11] Subsequent studies during the last 20 years, both domestic and international, consistently support the conclusion that public geoscience generates

[11] Mackenzie, B., Bilodeau, M. & Doggett, M.. *Economic potential of base metal and gold mining in Newfoundland: assessing the impact of regional development policy options*, 1989.

economic value. A sampling of these is given next.

Various reports have tried to quantify the multiplier effect of public geoscience to the economy. As outlined in Duke (2010)[12], MDA project evaluation showed that 58 per cent of the 265 MDA projects generated new exploration within the final year of the projects. To inform the development of the TGI program, Boulton (1999) carried out a cost, benefit and impact analysis[13] of Canadian and international geoscience programs, concluding that every dollar of public geoscience spending resulted in five dollars of private sector exploration spending and ultimately one hundred and twenty five dollars of in ground resources (1:5:125). Results of this study have subsequently been upheld by similar studies carried out in jurisdictions from British Columbia to Australia to Bolivia to Senegal. A recent report in Western Australia showed that the economic impact of investing $1 million in public geoscience programs over a three-year time horizon was $23.7M, of which $6.2M was in the form of royalties and taxes. [14]

Unfortunately, two issues hinder development of quantitative metrics that could demonstrate the full value of public geoscience to Canadians and the Canadian economy. The first is the decadal lag between exploration and extraction, which makes it difficult to connect the inputs to discovery with the resultant economic value. Secondly, anecdotal evidence suggests that the knowledge generated, especially the thematic knowledge of recent programs, is used in proprietary ways to underpin corporate strategies in creating a competitive advantage during the exploration stage, thereby adding to the difficulty of measuring impact.

Trying to leverage the inherent non-quantitative nature of the inputs, Duke (2014) used anecdotal and interview evidence from the exploration industry to create a performance story for TGI-4.[15] He noted that industry highlighted 45 TGI-4 scientific knowledge innovations that had been generated in the program. Additionally, at that time of the interviews prior to the end of the program in 2015, 75% of the respondents were already using TGI-4 results in their exploration programs and 100% of respondents indicated that they expect to use these results in their future programs. In response to a question about impact of the results, 79% of the companies interviewed said that TGI-4 had already allowed them to improve their exploration strategy.

It is also worth noting that geoscience information is utilized directly by governments to develop public policy and regulations that provide oversight in resource development, environmental protection, public health and safety, land use, and infrastructure planning.

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[12] Duke, J.M.. *Government geoscience to support mineral exploration: public policy, rational and impact*, 2010. http://www.pdac.ca/pdf-viewer?doc=/docs/default-source/public-affairs/geoscience---reports.pdf

[13] Boulton, R.B.. *Refinement and validation of a costs, benefits and impact model for TGI*, Unpublished report for the Geological Survey of Canada, 1999.

[14] ACIL Allen Consulting. *Exploration Incentive Scheme Economic Impact Study.* Report for the Government of Western Australia, 2015.

[15] Duke, J.M.. *Impact of TGI-4 on Exploration Success: Interim Contribution Analysis,* Report for Natural Resources Canada, 2014.

2. Principles of a Successful Public Geoscience Program

The review of this past programming highlights that there has been consistent progress towards more efficient and stronger FPT collaboration on delivery of national geoscience programs, particularly as roles and responsibilities have become better defined under the IGA. Starting with the MDAs, the federal, provincial and territorial surveys have worked together to ensure that all stakeholders are engaged within the geoscience programs, ensuring that everyone is fully capable of efficiently using the latest ideas and knowledge.

Successful programs have effectively linked three key principles to form a **data-knowledge-access** triad:

1. New data acquisition that provides a geographically-constrained, immediate increase of exploration activities by highlighting anomalies determined through the use of existing methodologies.

2. Scientific analysis of the data provides national, longer-term industry sustainability and fosters re-interpretation of results, leading to development of new ore deposit models and the creation of new methodologies.

3. Easy access to data and knowledge is paramount to ensuring uptake and use by industry to innovate their exploration approaches and to maintain a globally competitive industry.

The history of the Canadian Malartic project is a perfect example of how applying new metallogenic models to already mined areas can lead to success and world class discoveries. Beginning in early 2004, Osisko Exploration Ltd., a junior company at the time, concentrated its exploration efforts on the Québec part of the Superior Geological Province. By compiling public geoscience data, accessible through the Québec government's online geoscience database (SIGEOM), they were able immediately to identify areas with high potential of gold-bearing systems. Analysis and research identified the former Canadian Malartic mine site as a high-priority target. Seven years after acquiring the initial claim block, drilling more than 750,000 metres, filing a positive feasibility study (November 2008), obtaining government permitting for the project (August 2009), and raising a billion dollars in financing, the construction and start-up of the Canadian Malartic open pit gold mine was finally completed in late 2010. Commercial production, at 60% of capacity, was reached in May 2011 and has led to the Malartic mine becoming one of Canada's largest gold mines.

Principle 1: New Regional Geoscience Data Immediately Boosts the Junior Sector's Activities in the Area

For the purposes herein, data is defined as "being discrete, objective measurements or observations, which may be organized/ processed as long as the processing is applied equally to all data points and without prejudice." An example would be quantitative data of airborne geophysical surveys, in which correction algorithms related to aircraft elevation, the Earth's magnetic field, et cetera, are systematically applied to each point. Furthermore, the use and application of the correction methods are explicitly stated as part of the processing methodology. Similarly, observational data generated by geological mapping may contain observer bias, but this bias is systematic and inherent at every location. As such, data is complementary or additive to other data and has no meaning or value until context and interpretation is applied through analysis.

Data generation in the context of regional (as opposed to thematic) geoscience and absent additional advanced analysis typically has two characteristics: 1) it is geographically constrained (i.e. relevant only to the geographic area it was collected in) and 2) new data can provide immediate response by providing new, self-evident interpretations/anomalies. In this regard, typical public data generation exercises, such as geological, geophysical and geochemical maps, lead to juniors competing for the land access to take advantage of the availability of new data that helps inform their exploration decisions.

> "Junior Companies are the *exploration division* of the mining industry"
> -Ascot Resources Ltd, 2008

Government geological surveys can efficiently provide this new data so that it is available to all potential end-users, regardless of their ability to pay. Given that it is easy to measure increases in staking or exploration activity within a given area, many of the impact studies use these metrics to show that the immediate benefits tend to accrue to the region where the data was generated. However, *where* this new data can (or should) be generated is a complex question and in this regard, most PTGS have common criteria used to determine where to orient their new data collection activities:

- Alignment: all jurisdictions require that a project must be in alignment with government priorities, strategies and objectives.
- Scientific Merit: all jurisdictions require a project to address a gap (knowledge, data or area) or geological problem and must be designed to effectively address the gap/problem.
- Technical Merit: the study area must be suitable and the design of the proposal must be relevant to the gap/problem being addressed.
- Societal & Economic Impact: all jurisdictions require that a project must be relevant to client groups; such as stimulating mineral exploration, investment and growth; demonstrating "value for money" through short- and long-term impacts; providing relevance to other applications (e.g. land-use planning and mineral resource assessment); enhancing scientific and technological understanding by broad dissemination of results.

Regardless of the limitations of immediate impact of new data collection, its true long-term value comes through integration with other data sets and ongoing analysis and reinterpretation. It is through the cycle of collection-analysis-dissemination that industry creates their new models and technical innovations that underpin their competitive advantage relative to others.

Principle 2: New Geoscience Knowledge Fuels the Junior Sector's Long-term Success

New knowledge, grounded in the analysis and interpretation of data is the engine for ideas that lead to innovative approaches and help ensure that geoscience data is reusable for the long-term. The acquisition of new data and its geoscientific interpretation that supports the development of innovative public geoscience for equal use by large and small exploration firms is widely acknowledged to be one of Canada's competitive advantages in attracting mineral exploration and maintaining Canada's status as a leading mineral producer. Geological mapping, geophysical and geochemical surveys and remotely-sensed data acquisitions are all examples of data sets that underpin the generation of new models, ideas and innovation delivered by public geoscience.

Canada's success in leveraging its robust foundational geoscience is grounded in the ability of GSC and PTGS to lead and coordinate the interplay between the significant, but immediate impacts of newly acquired data and the slower-developing, but longer-lasting benefit of the geoscience knowledge derived from that data. In return, the gaps identified in developing the new geoscience knowledge directs the next generation of data acquisition which creates the virtuous cycle that promotes Canadian exploration industry innovation.

One of the key advantages of new geoscience knowledge is that instead of being geographically-constrained, it can be applied anywhere to similar exploration contexts. New interpretations of deposit formation models cycles back through the identification of the key data that supports use of such models elsewhere. This, in turn, generates the new technologies and approaches that support an innovative industry that remains at the competitive forefront of a global industry.

Principle 3: Easy Access to New Geoscience Data and Knowledge Sustains the Junior Sector

The GSC and PTGS are also critical conduits for disseminating the knowledge and underpinning data in an open and accessible manner that fosters its uptake and use by exploration firms. By ensuring equal access for use by all stakeholders, junior exploration firms share and benefit equally from the new knowledge. With their smaller size, these firms are often the ones most able to quickly leverage the new information into a revised exploration model, creating innovative new approaches to discovery of mineral deposits.

There has been a steady progression with each new program, to wider and quicker dissemination of results. Nevertheless, in the modern, media-rich world, new dissemination mechanisms need to be adopted by government surveys. It is no longer enough to simply provide the information – surveys must also provide a shortcut to the information's context so that end-users, be they industry or other stakeholders, can immediately assess the relevancy of the information to their needs. This not only entails additional effort in developing and providing the context, but also in shaping it to the multiple discovery channels, from the web, to Twitter, to flyers at trade shows and conferences.

In general, all FPT surveys are adept at serving up their data and knowledge without prejudice and without cost. However, their distribution systems were built from processes developed for the production and distribution of traditional paper-based products and navigation to the source is often difficult. Additionally, while FPT Surveys have worked to provide as seamless access as possible, cross-jurisdictional, one-stop access has not yet been achieved.

> *What's come through clearly…in various meetings and visits across the country, is that exploration and extraction are knowledge-based industries. We need to stay at the cutting edge, help our science and technology initiatives to get to market, find new mineral resources, and bring solutions that help companies stay competitive here at home and abroad.*
>
> -Minister Jim Carr's address to the Energy and Mines Ministers' Conference in Winnipeg

As part of any program option, modernized, streamlined dissemination and access needs to be at the centre. This modernized framework also needs to accept citizen-based input to incorporate external inputs into the results, thereby fostering continual improvement and community-wide ownership. Finally, other stakeholders, such as communities, need to be able to use and understand the often-complex technical information so that they can make informed land-use decisions. GEM is an example of a program that gives multidisciplinary grants to community-based initiatives with the express purpose of building capacity that can reformat and use the scientific knowledge generated under the umbrella program.

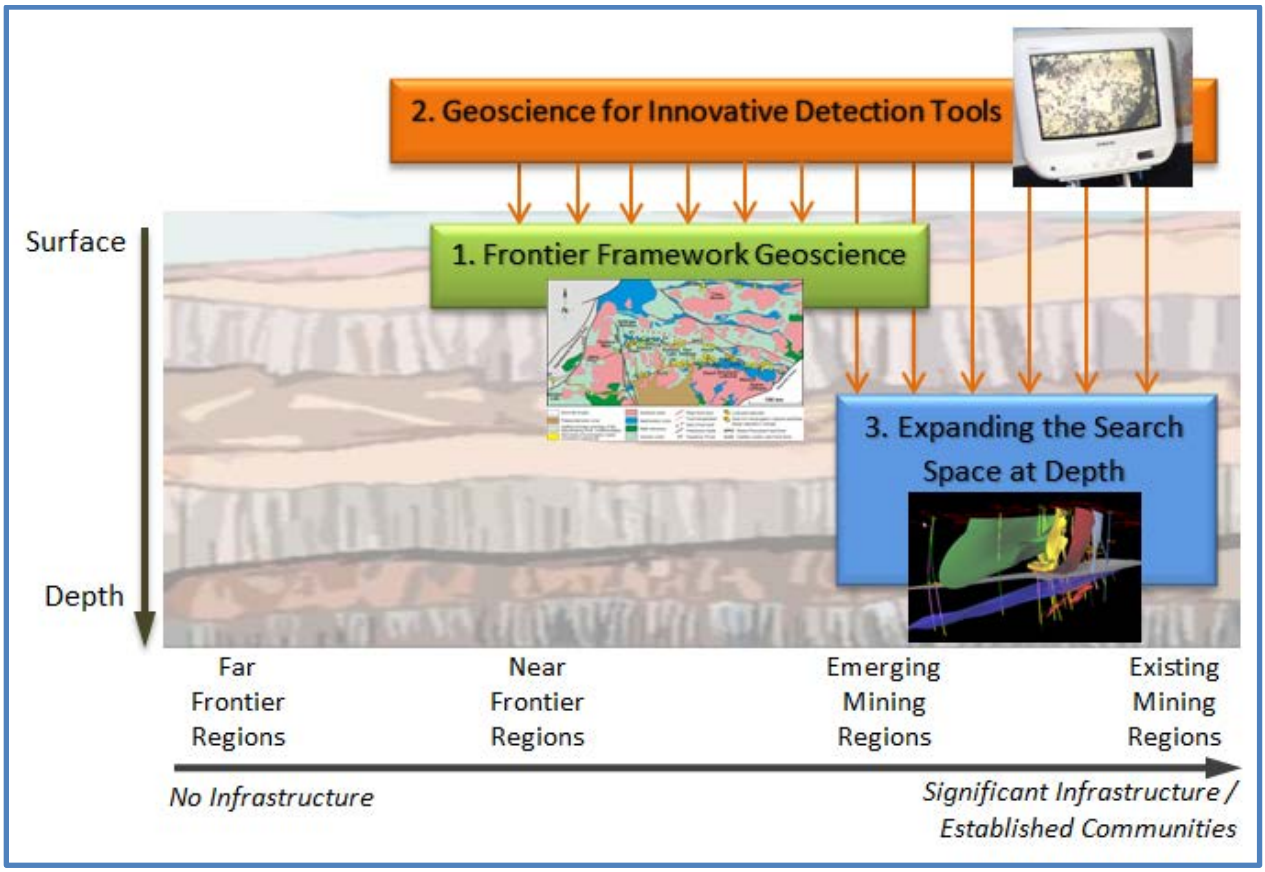
In short, by developing systems that allow more targeted, quicker public geoscience delivery, and that incorporate ongoing feedback, encourages industry to participate in the virtuous cycle of data generation and scientific analysis, thereby generating the next generation of scientific innovation.

3. Options for Public Geoscience Programs that Support the Junior Sector

Based on the analysis of past programming and the needs of the junior mining sector in Canada, this report recommends a program focus of "Expanding Mineral Discovery Space" which could contain one, two, or all of the following themes: 1) Frontier Framework Geology, 2) Geoscience for Innovative Detection Tools and 3) Expanding the Search Space at Depth.

In addition to the analysis of past and present collaborative programs, NGSC members also leveraged the results of recent input and advice through their respective, formal industry advisory groups, as well as incorporating feedback from local and national exploration industry networks. Moreover, submissions to IGWG and NGSC by the national industry associations, including the Mining Association of Canada (MAC), Canadian Institute of Mining and Metallurgy (CIM) and The Prospectors and Developers Association of Canada (PDAC) guided the development of the complementary themes.

These themes address knowledge gaps that were not part of previous FPT programs, as well as the differing gaps that exist across jurisdictions. Although the themes are generally distinct, there is considerable synergy between the three, which allows for leveraging results from one theme towards realization of results of another. In addition, the themes range from a primary focus on more traditional data collection to provide an immediate impact (Theme 1), to thematic studies that will sustain the longer-term competitive edge of the exploration industry (Theme 2), as well as export possibilities for new services and technologies. The third theme expands physical space for discovery of new mineral deposits, but which necessitates a more limited geographic application and the development of new exploration mechanisms by industry. Ensuring application of the three overriding principles of data, knowledge and access within each theme, the immediate and long-term benefits, as well as the geographic breadth of impact, can be realized.



Theme 1: Frontier Framework Geoscience

Centered in the near-surface regions extending from mines and known mineral potential, this theme pushes exploration to new territory, yet remains within reach of infrastructure of existing communities. This theme would focus on new data collection and scientific study to provide improved regional geological frameworks, permit the junior industry to better target its discoveries of high potential areas within those regions and increase the likelihood of mine development success.

As recently quantified by Schodde (2016), access to infrastructure is recognized as a major factor in the ultimate economic viability of turning a discovery into a mine.[16] While gold discoveries are less susceptible to these impacts, due to the high-value, small-volume mine product, viability of base metal deposits are highly sensitive to distance from road and electrical infrastructure. As such, this theme addresses a need to foster exploration in regions that are prospective in the near surface space, but that are beneficially located to reach and build from existing infrastructure. Previous program experience, notably in MDA, NATMAP, TGI 1-3 and, more recently GEM in the north, highlight that new, systematic data collection, be it geophysical, geochemical or geological surveying, fosters additional exploration by junior companies by highlighting new targets in the geographic area surveyed.

Within this theme, it is anticipated that the largest immediate impact would come from more widely available survey technologies that are optimized for detecting anomalies within the near-surface and can be readily interpreted within existing exploration approaches. Prioritization of geographic regions to carry out framework surveying and geological mapping would follow from the common PTGS criteria. Nevertheless, as previously outlined, realizing sustained value from these data requires the addition of knowledge by geoscientific analysis to allow for future reinterpretation and foster integration of the knowledge to promote new exploration approaches in the future. With a slight reorientation of part of this theme towards slightly higher-risk, novel data collection approaches and development of the corresponding interpretive mechanisms, this theme would simultaneously support the objectives of Theme 2: Geoscience for Innovative Detection Tools. Similarly, a portion of the program could leverage or add to methods developed under Theme 3 to create the knowledge needed to explore for deeper-seated deposits in these near-frontier areas.

Theme 2: Geoscience for Innovative Detection Tools

This theme would promote a more innovative and competitive Canadian exploration service industry (e.g. geophysical surveying companies) that would support juniors by creating novel, cutting-edge methods, tools and technologies to better detect new mineral deposits. This theme would focus on providing broad-based geoscientific support and data collection that fosters creation and use of new technologies and methodologies by industry. For example, new understanding of how ore deposition alters surrounding rocks would define geochemical markers that indicate to exploration companies that

[16] Schodde, RC. *Unlocking Northern Resource Potential: The Role of Infrastructure,* Report commissioned by PDAC, 2016. http://www.pdac.ca/pdf-viewer?doc=/docs/default-source/publications---papers-and-presentations/pdac-national-infrastructure-study.pdf

they are within the footprint of an ore deposit. By using such information, geochemical analysis firms would optimize their analytical solutions to be most efficient at delineating these markers, thereby providing exploration firms with a more efficient method of making exploration decisions. Additionally, the intellectual property and patents generated would be exportable to other exploration companies on a global basis.

More than 3,700 firms in Canada provide technical, legal, financial, environmental and other expertise to the mining industry. Most of these suppliers are located in Ontario and British Columbia, followed by Alberta, Quebec, Saskatchewan and Manitoba. A recent study by the Canadian Association of Mining Equipment and Services for Export found that 913 companies identify as mining suppliers in Ontario alone. Together, they provide 68,000 additional jobs across the province, and generate 1% of provincial GDP and $1.5 billion in government tax revenue.[17] Similar indirect contributions are made to the governments of other mining provinces.

One of Canada's competitive advantages in exploration stems from its access to these specialized and innovative geoscience service providers where many new techniques were developed and perfected under collaborative geoscience programs. For example, fundamental science research, and its technical integration on airborne geophysical systems under EXTECH, demonstrated the viability of these methods and their integration into exploration programs. Innovative research on new, cheaper and lower-environmental impact seismic methods at Flin Flon, Manitoba under TGI-4 has highlighted new possibilities to search at depth for new deposits.

The last decade has witnessed a steady shift in exploration from primarily geology-based, in-house approaches to contracted-out, multidisciplinary approaches. As such, the ability of an exploration company to access cost-effective, leading-edge methods is critical to maintaining not only exploration success, but also a globally competitive position. Innovative technologies that are accessible and useable underpin a strong junior exploration industry in Canada, but also develop a strong service industry selling their unique methods around the world.

Unlike EXTECH and TGI, under which federal government scientists carried out both the scientific research and the technical development, this second theme focuses on providing the platform of scientific knowledge needed by the service industry to develop the next generation of prospecting tools. For example, by providing a firm understanding how ore-bearing fluids interact with rocks to concentrate metals, new, subtle geochemical markers in those rocks can be predicted. These publicly available scientific findings then support the development through the R&D arms of service companies of multiple technological solutions for identification of the markers. The result is a faster cycle for development of innovative technologies and their commercial availability for use by exploration companies.

[17] Canadian Association of Mining Equipment and Services for Export. *Pan Ontario mining supply and services sector economic impact study*, 2014. http://www.camese.org/uploads/Pan-Ontario_mining_supply_and_services_sector_economic_impact_study_-_October_22nd_2014.pdf.

Theme 3: Expanding the Search Space at Depth

To respond to the need to search deeper for new ore bodies near known deposits, this theme will focus on developing better subsurface modelling methods and applying these to existing and emerging mineral camps. This theme could also include development of robust images of the deeper subsurface that provide better targeting methods for deep exploration.

Most industry participants and industry organizations have recognized that new discoveries are increasingly occuring at depths greater than 200 metres. However, current exploration methodologies tend to be optimized for near-surface discovery. Very few collaborative programs have focused on developing better models for representing the subsurface, with notable exceptions being TGI-4 and TGI-5. These latter phases of TGI focused on developing better conceptual models that describe the mineralizing process which were used by industry to develop better exploration models. The next step is to expand on, and translate this knowledge into mechanisms of producing new 3D maps of the subsurface to guide exploration and development.

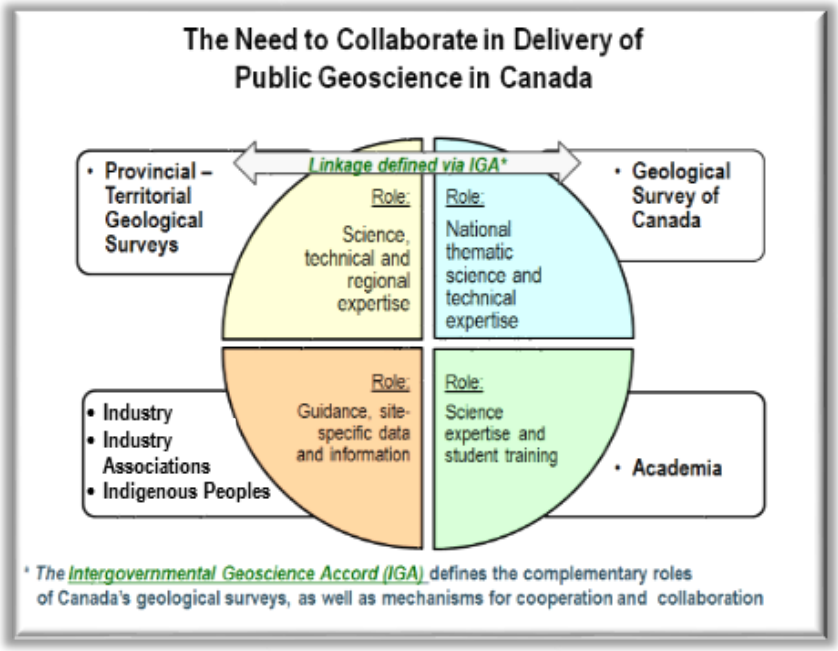
Concurrent with TGI 4-5 programming, individual FPT jurisdictions were developing methods, tools and models of the subsurface, but these initiatives were funded (and focused) internally to the respective organization. Since 2016, however, NGSC members have committed to a more structured and collaborative approach in order to guide development of a national, digital subsurface model. This nascent initiative, called “Canada in 3D,” is currently funded similarly to the NATMAP model, via coordination of small amounts of existing funding from each jusrisdiction. This initiative is expected to produce a high level subsurface geology map of Canada, but there remains a need to develop mechanisms for generating the subsurface models at the scale of exploration camps that is of use to the industry. The third theme will focus efforts on developing the knowledge and IT/IM tools and technologies needed to generate more robust models of the subsurface and at this scale will support exploration companies by both identifying subsurface regions of higher mineral potential, and by developing new approaches for development of these models by industry itself. As such, this theme contains elements of both Theme 1 and Theme 2, albeit directed towards illuminating the exploration space of the future.

The Intergovernmental Geoscience Accord (IGA) as a Framework for Collaborative Delivery of Future Programs

As noted previously, the IGA was created to define clearly the unique roles and responsibilities of the federal, provincial and territorial geological surveys and to promote collaboration. In developing a program of “Expanding Mineral Discovery Space” under the IGA framework, the GSC and the PTGS serve as critical conduits for disseminating the knowledge and underpinning data in an open and accessible manner that fosters its development, uptake and use by exploration firms.

More importantly, as evidenced by the evolution of collaborative programs towards those with a more focused intent, the programs have better-defined outcomes along with heightened cooperation in delivering public geoscience. The IGA reinforces who has the role for delivering on these outcomes. With

clarity on the FPT roles and responsibilities as key providers of public geoscience in Canada, the IGA also guides the appropriate mechanisms for FPT collaboration, whether they are cooperative, advisory or cost-shared partnership models.



In addition to the formal governmental linkages regarding geoscience programing that are established under the IGA, the Agreement also provides a notional framework for broader collaborations with Indigenous Peoples, as well as other key stakeholders including industry, industry associations, small-medium enterprises and academia. The IGA is supportive of all jurisdictions to work collectively and transparently by respecting stakeholders through robust, meaningful engagement. This is consistent with the interests of all government organizations, including FPT Geological Surveys to respect and include the unique circumstances, opportunities, and traditional knowledge of Indigenous Peoples. Geological Surveys must also be cognizant of the needs of remote, northern and mining dependent communities as they design and carry out their geoscience programs.

It promotes seamless access and use of geoscience information by industry and government decision-makers; regardless of the source of the information. It serves as an instrument for collaboration with the mineral exploration industry and its associated service sector.

The IGA also supports the GSC and the PTGS in their work with the academic and research community, such as with Metal Earth (see sidebar) as well as industry research associations such as Canadian Mining Innovation Council and its five-year "Footprints" project, which integrated with TGI-4.

The IGA also supports the GSC and the PTGS' work with non-governmental agencies and industry associations. For example, Geoscience BC has been working closely with the BC provincial government over the last four years to secure long-term predictable funding that provides the non-profit organization with the financial stability and certainty needed to support the ongoing earth science research.

4. Summary and Conclusions

For over 30 years, FPT Geological Surveys have demonstrated to the world the value of collaborative public geoscience in fostering a robust, innovative mineral exploration industry in Canada. As the analysis of past and present minerals geoscience programs demonstrates, the strength and impact of these programs is principally founded in the FPT recognition of the shared responsibilities that were formalized in the 1997 signing of the first Intergovernmental Geoscience Accord (IGA). The IGA underpins the role of FPT geological surveys as the primary conduits for creating, collating, analyzing and disseminating the latest geoscience knowledge of relevance to the mineral exploration industry.

While the IGA is central to the shared commitment to national good, it has also promoted the culture of periodic program review and analysis that has ensured that new programs target the most pressing mineral industry needs. Additionally, by engaging academia (including student), companies, industry and Indigenous Peoples, these programs have become more sophisticated in their ability to simultaneously address national, regional and local knowledge gaps. This is evidenced by the evolution of programs that were primarily collections of locally focused projects to the regional programs of NATMAP and EXTECH to the more recent, national, thematic programs of TGI phases 4 and 5.

The FPT geological surveys maintain the principles that trigger the virtuous cycle of data-knowledge-access to create long-term value to government and industry through the reuse and reinterpretation of data. The generation of accessible, new knowledge from new data not only promotes industry innovation in exploration, but guides the collection of new data that will be most impactful in reconciling remaining information gaps. Most importantly, public access to data and knowledge ensures an equal ability of all stakeholders to use it, regardless of ability to pay, helping the junior exploration industry to equally share and benefit from this geoscience.

With funding from the Canada First Research Excellence Fund and federal/ provincial/ industry partners, the $104M Metal Earth initiative is a strategic consortium of Canadian researchers. This applied R&D program led by Laurentian University, is the largest mineral exploration research project undertaken in Canada. Over the next seven years, it will transform our understanding of Earth's early evolution and the fundamental processes that govern metal enrichment through time, as well as increasing our understanding of the evolution of our planet's hydrosphere and atmosphere.

Analysis of past programs, coupled with industry input, have identified three intersecting and overlapping themes that define the next generation of geoscience. The themes of: 1) Frontier Framework Geoscience, 2) Geoscience for Innovative Detection Tools and 3) Expanding the Search Space at Depth represent end-members that can be blended to provide data and knowledge that support industry needs. With a focus on shortening the time to discovery of new deposits, they also ensure that these new discoveries are located in regions with the greatest probability of having them become productive mines.

It is for this reason that the first theme is centred in the "near-frontier", those areas within reach of the existing infrastructure of communities, so that new near-surface discoveries in greenfield regions can leverage nearby human and infrastructure resources during development. The second theme targets the exploration service industry to foster development of new tools, technologies and methods that will maintain current leadership in innovative exploration while continuing to advance a robust exploration service industry centred in Canada. Finally, the third theme will open the new frontier of deposits at depth, recognizing that successful exploration for these deposits requires more robust models of subsurface geology and new approaches and tools for exploration that differ from those in the near-surface environment.

The themes under Expanding Mineral Discovery Space align with, and derive from knowledge gaps and emerging issues defined by the exploration industry and its associations. No matter which theme or combination thereof is pursued, the current practice of actively engaging the widespread Canadian mineral geoscience community would continue. Taken together, a new program (or programs) that focus on one or all of these themes should provide a platform from which the junior exploration industry can maintain long-term success, while benefitting from public geoscience that can provide an immediate impact. The fundamental principles of new data acquisition, the addition of foundational knowledge and their effective distribution and use in discovering new mineable deposits remains at the heart of Canada's well-recognized global leadership in exploration and mining.

Annex 1:
List of Past and Current Mineral Programs

Annex 1: List of Collaborative Public Geoscience Programs 1984-Present

Umbrella Program	Program	Objective	Duration	Federal Funding	Funding Source	Management Structure
Mineral Development Agreements [MDAs]	Canada-Newfoundland Cooperation Agreement on Mineral Development	To undertake programs of applied geoscience in order to provide high quality geological information that is intended to stimulate mineral exploration by the private sector in general and junior mining companies in particular.	1984-1989	$16.6M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
			1990-1994	$9.0M		
			1994-1996	$1.6M		
	Canada-Nova Scotia Cooperation Agreement on Mineral Development	To undertake programs of applied geoscience in order to provide high quality geological information that is intended to stimulate mineral exploration by the private sector in general and junior mining companies in particular.	1984-1989	$15.7M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
			1990-1992	$3.1M		
			1992-1995	$3.7M		
	Canada-New-Brunswick Cooperation Agreement on Mineral Development	To undertake programs of applied geoscience in order to provide high quality geological information that is intended to stimulate mineral exploration by the private sector in general and junior mining companies in particular.	1984-1989	$12.4M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
			1990-1995	$3.9M		
	Federal Asbestos Initiatives Geoscience Research Program	In order to help diversify the mineral industry of Quebec's Eastern townships, which are largely dependant on a single commodity (asbestos), the program was designed to provide industry with new geoscientific data that would stimulate mineral exploration in the area, and improve the likelihood of finding new economic mineral deposits.	1984-1987	$1.5M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
	Special Geoscience Program in Gaspé	In order to strengthen the mineral sector and economy of the region, provide geoscience data that supports and encourages enhanced mineral exploration and development.	1992-1993	$250K		
	Special Assistance Program for the Mining Sector of the Chapais-Chibougamau		1992-1995	$12.5M		
	Federal Geoscience Program	Provision of geoscience data that supports and encourages enhanced mineral exploration and development in Quebec and in turn supports the economic development of mining-dependant communities.	1983-1989	$4.0M		
	Subsidiary Agreement on Mineral Development		1985-1990	$34.7M		
	Agreement on Mineral Development		1992-1998	$44M		
	Canada-Ontario Mineral Development Agreement	Increase the commercial development of Ontario's mineral resources by means of geoscientitic activities designed to stimulate mineral exploration and development by industry. Activities are to be focused on identifying geological environments favourable for the discovery of new supplies of traditional mineral resources, and at diversifying the mineral base of communities that have depended historically upon a narrow range of mineral commodities.	1985-1990	$20M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
	Canada-Ontario Northern Ontario Development Agreement	Identification of geological environments favourable for exploration, with emphasis to be placed on increasing the understanding of base-metal sulphide deposits, particularly those located in mining-dependent areas that have significant potential for the discovery and development of additional similar resources.	1991-1995	$9.0M		
	Canada-Manitoba Agreement on Mineral Development	Improve the geoscientific knowledge base and thus stimulate the level and effectiveness of mineral exploration activity to ultimately result in the development of mineral deposits.	1984-1990	$13M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
	Canada-Manitoba Partnership Agreement on Mineral Development		1990-1995	$5.5M		
	Canada-Saskatchewan Mineral Development Agreement	Generate government geoscience that supports the industry's efforts to explore for gold and, to a lesser extent, base metals thus diversifying the Province's mining industry, which relies entirely on uranium.	1984-1989	$5.1M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
	Canada-Saskatchewan Partnership Agreement on Mineral Development	Completion of geoscience surveys and studies that provide fundamental data and interpretations which can be used by industry in planning and carrying out mineral exploration.	1990-1995	$7.3M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
	Canada-Alberta Partnership Agreement on Mineral Development	To broaden and diversity the economic base of Alberta by developing and enhancing the non-petroleum mineral industry (i.e. Metallic and industrial minerals).	1992-1995	$5.8M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
	Canada-British Columbia Agreement on Mineral Development	Improve the geoscientific database for the purpose of enhancing the level, effectiveness, and efficiency of mineral exploration by the private sector in both active and under-explored areas of the province.	1985-1990	$6.6M	Cost-Shared Federal-Provincial	Bi-lateral Federal-Provincial Steering Committee
		Through geological mapping, geochemistry surveys, geophysics and improved geoscience data systems, guide and stimulate exploration, primarily for base metals (i.e. enhance industry's effectiveness in identifying high mineral potential areas for the development of new mines).	1991-1995	$5.0M		
	Canada-Northwest Territories Mineral Development Subsidiary Agreement	Accelerate the rate of geoscientific mapping in the Territories, in order to augment the information base required and stimulate increased private sector exploration and mineral development activities.	1987-1991	$5.9M	Cost-Shared Federal-Territorial	Bi-lateral Federal-Territorial Steering Committee
		Support geological field projects designed to increase the knowledge of Northwest Territories resources.	1991-1996	$7.8M		
	Canada-Yukon Mineral Development Agreement	Through geological mapping, geochemistry surveys, geophysics and improved geoscience data systems, guide and enhance industry's effectiveness in identifying high mineral potential areas for the development of new mines.	1985-1989	$3.2M	Cost-Shared Federal-Territorial	Bi-lateral Federal-Territorial Steering Committee
	Canada-Yukon Mineral Resource Development Cooperation Agreement		1991-1996	$6.3M		
	Shield Margin NATMAP	Enhance the geoscience knowledge of a broad swath, some 100km wide, of complexly deformed Precambrian age rocks extending east-west across the central part of Manitoba into Saskatchewan (i.e. Flin Flon-Snow Lake-Hanson Lake greenstone belt).	1991-1996	$1.3M	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Slave Province NATMAP	To update and upgrade the map-based geoscience knowledge of a large part of the Slave Craton and to advance understanding of the Slave Province in support of mineral exploration activities.	1991-1996	$1.3M	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Studies of the Surficial Geology of the Southern Canadian Prairies - NATMAP	Focused on two areas, considered to be typical of the entire southern Prairie Provinces, (i.e. 'Virden', which covers ~ 10,000km2 and extends north from the US border to 50° N latitude and straddles the Manitoba-Saskatchewan boundary, and SE Manitoba which is south and east of Winnipeg, that extends from 49° to 50° N latitude, and includes a sliver of western Ontario), develop field and laboratory prtocols and GIS and computer database handling techniques that could be used as standards for future surficial geology work; develop an integrated model for the Quaternary deposits of the southern Prairie Provinces, and update the surficial geology of the study areas.	1992-1998	$902K	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Eastern Cordilleran Geologic Mapping in Southern Alberta NATMAP	Remapping the geology of a portion of the southeastern edge of the Canadian Cordillera (swath in the Rocky Mountain Foothills some 50-100km in width extending north-northwest 200km from the Canada-US border) that has significant reserves and resource potential for natural gas, oil, sulphur, thermal coal, and coal bed methane and significant groundwater concerns.	1993-1998	$838K	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Surfical Geology of the Oak Ridges Moraine and Greater Toronto Area NATMAP	The objective of this multi-faceted project is to understand the moraine's geomorphology and its interior structure in suffienct detail to identify the geologic elements controlling groundwater recharge, flow and discharge.	1993-1998	$692K	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee

NATional Geoscience MAPping Program [NATMAP]	Origin and evolution of the Devonian to Carboniferous Magdalen Basin, Eastern Canada NATMAP	To bring together the scientific elements and expertise required to thoroughly understand this 12-km-thick, 600km by 300km, sedimentary sequence of continental and shallow marine strata that is centered roughly on the Magdalen Islands of the Gulf of St. Lawrence and are known to host important deposits of salt, potash, gypsum and coal and have high potential for base metals and possible hydrocarbons, most notably coal-bed methane.	1992-1998	$832K	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Nechako Project, British Columbia NATMAP	Test the hypothesis that the Interior/Chilcotin Plateau Tertiary Extensional Complex represents the tectonic-magmatic expression of a regional Eocene extentional event. Understanding the regional Eocene tectonics associated with the contact zone between the upper and lower plates will also provide insight into the precious metal epithermal mineral deposit potential of the contact zone.	1995-2000	$1.09M	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Western Churchill NATMAP	Produce modern geological maps of late Archean greenstone belts in a part of the Candain Shield with great mineral potential, but lacking an adequate geoscientific infrastructure.	1997-2000	$1.1M	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Western Superior:Tectonic evolution, mineral potential of Archean continental and oceanic blocks NATMAP	Contribute to understanding the tectonic evolution and mineral potential of the Western Superior Province by determining the distribution and contact realtionships between old (pre-2.8 Ga) continental and younger (ca 2.7 Ga) oceanic/arc crustal fragments.	1996-2003	$1.1M	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Geology of the Winnipeg Region NATMAP	To produce new digital surficial and bedrock geological maps of NTS 62H (west half), 62I, and 52L (west half) and to enhance understanding of the geological history of the area, including better definition of flood risk.	1997-2001	$530K	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Central Foreland Geoscience Transect	To better understand the geological history and resource potential of a unique area of the Candian Cordillera (i.e. geological (bedrock and surficial) mapping (1:50,000 and 1:250,000 scales)) and associated studies of the Trutch - NTS 94G and Toad NTS-94N map ares in northeastern British Columbia, and the Fort Liard-NTS 95B and La Biche-NTS 95 map areas in the southern Territories.	1998-2003	$1.1M	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Ancient Pacific Margin NATMAP	To provide a comprehensive analysis of a belt of complexly deformed and metamorphosed rocks that extends roughly 2000 kilometres north-northwest from southern British Columbia through Yukon Territoriy into east-central Alaska. The project was in response to industry's demands for a new synthesis of the belt's poorly understood component terranes and the discovery of high-grade volcaogenic massive sulphide deposits near Finlayson Lake, Yukon in the mid-1990.	1998-2003	$1.1M	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
	Appalachian Foreland and St. Lawrence Platform Structures NATMAP	Provide a modern synthesis of the evolution of the Laurentian Paleozoic continental margin leading to meaningful new geoscience knowledge for resource exploration/management and to upgrade the current information infrastructure.	1999-2003	$982K	Cost-Shared Federal-Provincial, Leveraged academic, industry funding	Federal-Provincial-Territorial-Industry-Academia Steering Committee
EXploration Science and TECHnology Program [EXTECH]	EXTECH I: Massive Sulphide Research in the Rusty Lake-Snow Lake Greenstone Belts, Manitoba	Through the integration of the traditional disciplines of geology, geochemistry and geophysics, improve concepts and technologies applicable to exploration in two established base metal camps: Rusty Lake - Snow Lake, of Northwestern Manitoba.	1989-1994	$1.5M	Federal with leveraged PTGS, Industry and Academic funding	Bi-lateral Federal-Provincial Steering Committee
	EXTECH II: Bathurst Mining Camp, New Brunswick	Development and testing of exploration methods and technology for the discovery of concealed massive sulfide deposits in the Bathrust Mining Camp, Northeastern New Brunswick.	1994-1999	$3.2M	Federal with leveraged PTGS, Industry and Academic funding	Bi-lateral Federal-Provincial Steering Committee
	EXTECH III: Yellowknife Gold Belt	In order to develop a more comprehensive understanding of the mineralization at the two operating mines within the Yellowknife Camp (i.e. Con and Giant), conduct a multidisciplinary, multi-agency geoscience program focused on gold mineralization and gold exploration technologies.	1999-2003	$1.3M	Federal with leveraged PTGS, Industry and Academic funding	Bi-lateral Federal-Provincial Steering Committee
	EXTECH IV: Athabasca Basin Uranium	In order to maintain the attractiveness of the Athabasca Basin of northern Saskatchewan and Alberta as the premier region to explore for large tonnage, high-grade deeply-buried unconformity-associated uranium deposits, develop/produce regional and detailed geoscience compliations and new or improved exploration methods.	2000-2004	$1.5M	Federal with leveraged PTGS, Industry and Academic funding	Bi-lateral Federal-Provincial Steering Committee
Targeted Geoscience Initiative [TGI]	Targeted Geoscience Initiative (TGI-1)	Improve the quality and quantity of geoscience information available in support of mineral exploration and accelerate the dissemination of this information on the Internet.	2000-2003	$15M	Federal	Federal with collaborative PTGS delivery
	Targeted Geoscience Initiative - Extension (TGI-2)	Consistent with 2003 Budget announcement and the recommendations made by the Northern Mines Ministers' Industry-Government Overview Committee to invest in the territories economic future by providing much needed geoscience information, ESS interpreted this to mean that TGI2 should continue to operate much as it did for the previous 3 years, except that it should now include some projects focused on energy resources in the North.	2003-2005	$10M	Federal	Federal with collaborative PTGS delivery
	Targeted Geoscience Initiative - Phase 3 (TGI-	Help sustain the reserves of base metals around established mining communities.	2005-2010	$25M	Federal	Federal with collaborative PTGS delivery
	Targeted Geoscience Initiative - Phase 4 (TGI4)	Help the mineral exploration industry be more effective in finding deeply buried mineral deposits in mineral producing regions of Canada thereby reducing business risk, increasing industry competitiveness, creating jobs, sustaining communities, and generating economic growth.	2010-2015	$25M	Federal	Federal with collaborative PTGS delivery
	Targeted Geoscience Initiative Phase 5 (TGI-5)	Sustain the economic viability of existing and emerging mining camps by generating new geoscience knowledge and novel methodologies that support innovative exploration practices by the mineral resources sector to enhance discovery rates for deeply-buried mineral deposits.	2015-2020	$23.3M	Federal	Federal with collaborative PTGS delivery, PTGS and Industry advisory groups
Geomapping for Energy and Minerals [GEM]	Geo-mapping for Energy and Minerals [GEM-1)	Accelerate the activities of the GSC to provide the public geoscience knowledge base needed to support increased economic prosperity of norther Canada through stable, long term investment in resource development. GEM aims to provide a modern, regional-scale, geological knowledge base in Canada's territories to the minimum level needed for effective private sector exploration. Similarly, GEM will also work with the provincial governments to fill critical gaps in knowledge base needed to increase the effectiveness of exploration investment in the provinces.	2008-2013	$100M	Federal (Territories), Federal cost-matching (Provinces)	Federal -Northerner Steering Committee, PTGS advisory group
	Phase 2 of Geo-mapping for Energy and Minerals [GEM-2]	GEM Phase 2 will complete: 1) the provision of a geoscience knowledge base in Canada's territories to the minimum level needed for effective private sector exploration; and 2) work with the provincial governments to fill critical gaps in the knowledge base needed to increase the exploration investment in the northern parts of the provinces.	2014-2020	$100M	Federal (Territories), Federal cost-matching (Provinces)	Federal -Northerner Steering Committee, PTGS advisory group

Annex 2:
Intergovernmental Geoscience Accord (2017)

INTERGOVERNMENTAL GEOSCIENCE ACCORD

ACCORD GÉOSCIENTIFIQUE INTERGOUVERNEMENTAL

August 2017 / Août 2017

INTERGOVERNMENTAL GEOSCIENCE ACCORD

INTRODUCTION

Geological surveys are among the oldest organizations of Canada's federal, provincial and territorial governments. Initially established to encourage and regulate the development of mineral and energy resources, the geological surveys in the 21st century deliver public geoscience programs that contribute to a broad spectrum of economic, health and safety, environmental, and other public policy issues. The Intergovernmental Geoscience Accord, first signed in 1996 and renewed in 2002, 2007 and 2012, provides a framework for cooperation and collaboration among the federal, provincial and territorial geological surveys. Cooperation and collaboration minimize overlap and duplication, enhance synergies among jurisdictions to resolve regional geoscience problems, and facilitate optimal utilization of resources. This, the fifth Intergovernmental Geoscience Accord, has been approved by Ministers responsible for the geological surveys to ensure that these benefits continue.

1. PURPOSE

The purpose of the Intergovernmental Geoscience Accord (hereinafter, the Accord) is to focus the strengths and increase the effectiveness of government geological surveys in Canada by:

- defining the different, but complementary, roles and responsibilities of the federal, provincial and territorial geological surveys;
- defining principles of cooperation to optimize utilization of human and fiscal resources among the geological surveys; and,
- establishing mechanisms to optimize cooperation and collaboration among the geological surveys.

2. ROLES AND RESPONSIBILITIES

ACCORD GÉOSCIENTIFIQUE INTERGOUVERNEMENTAL

INTRODUCTION

Les commissions géologiques comptent parmi les plus anciennes organisations des gouvernements fédéral, provinciaux, territoriaux du Canada. Fondées à l'origine pour stimuler et réglementer la mise en valeur des ressources minérales et énergétiques, elles s'emploient, au XXIe siècle, à exécuter des programmes géoscientifiques publics qui contribuent à résoudre un large éventail de questions liées à l'économie, à la santé, à la sécurité, à l'environnement et à d'autres domaines de la politique publique. L'Accord géoscientifique intergouvernemental, signé en 1996 et renouvelé en 2002, 2007 et en 2012, encadre la coopération et la collaboration entre les commissions géologiques fédérale, provinciales et territoriales. La coopération et la collaboration limitent les chevauchements et les dédoublements, renforcent la synergie des actions menées par les gouvernements pour résoudre des problèmes géoscientifiques régionaux et facilitent l'utilisation optimale des ressources. Les ministres responsables des commissions géologiques ont approuvé ce cinquième Accord géoscientifique intergouvernemental pour assurer la pérennité de ces avantages.

1. BUT

L'Accord géoscientifique intergouvernemental (ci-après l'« Accord ») a pour but de concentrer les forces et d'accroître l'efficacité des commissions géologiques du Canada. À cette fin :

- il définit les rôles et les responsabilités des commissions géologiques fédérale, provinciales et territoriales, qui sont différents mais complémentaires;
- il pose des principes de coopération et de collaboration pour optimiser l'utilisation des ressources humaines et financières des commissions géologiques;
- il établit des mécanismes qui permettront d'optimiser la coopération et la collaboration entre les commissions géologiques.

2. RÔLES ET RESPONSABILITÉS

Canada's government geological surveys provide the fundamental geoscience information and expertise required to inform and contribute to the formulation of public policies and to the stewardship of a jurisdiction's natural resources. Public geoscience activities provide information that is used by global investors as a foundation for the exploration and responsible development of Canada's onshore and offshore mineral, energy and water resources. As well, public geoscience contributes to the awareness, prevention and resolution of environmental and health and safety issues resulting from natural geologic hazards and from natural and anthropogenic contaminants in the environment, including surface and ground waters. Public geoscience information is also applicable to a wide range of land use and land management issues.

Les commissions géologiques procurent aux gouvernements du Canada l'information géoscientifique fondamentale et l'expertise dont ils ont besoin pour élaborer les politiques publiques et gérer les ressources naturelles dont ils sont les fiduciaires. Partout dans le monde, on se fie à l'information découlant des activités géoscientifiques publiques pour investir dans la recherche et la mise en valeur responsable des ressources minérales, énergétiques et hydriques des régions continentales et extracôtières du Canada. En outre, les programmes géoscientifiques publics aident à comprendre, à prévenir et à résoudre les problèmes d'environnement, de santé et de sécurité qui résultent des aléas géologiques et de la présence de contaminants naturels et anthropiques dans l'environnement, y compris dans les eaux superficielles et souterraines. L'information géoscientifique publique sert également à régler un large éventail de questions liées à l'aménagement du territoire et à la gestion des terres.

The Accord recognizes the following complementary roles of the federal and the provincial and territorial geological surveys in delivering these services to governments, industry and the public:

Dans la prestation de ces services aux gouvernements, à l'industrie et au public, les commissions géologiques fédérale, provinciales et territoriales jouent les rôles complémentaires suivants :

2.1 The Geological Survey of Canada (GSC) is responsible for providing Canada with a comprehensive geoscience knowledge base that contributes to economic development, public safety, and environmental protection. It does so by acquiring, interpreting and disseminating geoscience information concerning Canada's landmass and the offshore. The GSC carries out geoscience programs that are typically thematically based and with multijurisdictional to pan-Canadian significance. Unlike the provincial and territorial surveys, whose activities are geographically constrained to their own jurisdiction, the GSC operates across all provinces and territories. The GSC also carries out marine studies that are unique among the geological surveys, and has a leadership role in representing Canada in international geoscience activities.

2.1 La Commission géologique du Canada (CGC) dote le Canada d'une base de connaissances géoscientifiques exhaustive, qui contribue au développement économique, à la sécurité publique et la protection de l'environnement. À cette fin, elle acquiert, interprète et diffuse de l'information géoscientifique concernant la masse continentale et le territoire extracôtier du Canada. La CGC entreprend des programmes géoscientifiques qui sont pour la plupart thématiques et de nature multi-juridictionnelle ou pancanadienne. Contrairement aux commissions provinciales et territoriales, qui concentrent leurs activités dans leurs provinces ou territoires respectifs, la CGC exerce les siennes dans toutes les provinces et dans tous les territoires. En outre, elle mène des études extracôtières qui n'ont pas d'équivalent dans les autres commissions géologiques. Elle a aussi pour fonction de représenter le Canada sur la scène géoscientifique internationale.

2.2 The provincial and territorial geological surveys are the principal stewards of and resident authorities for public geoscience in their jurisdiction, and carry out most of the public geoscience programs within their jurisdiction. These programs are operated at scales appropriate to addressing provincial or territorial geoscience priorities. They contribute to a systematic description of the geology of the province or territory, which may include its mineral, energy and groundwater endowment. Although the programs of the provincial and territorial geological surveys have traditionally been directed primarily toward development and management of mineral and energy resources, the information and knowledge resulting from these programs are increasingly being used to assist in the resolution of land use, environmental and public health and safety issues.

Dans leurs provinces ou territoires respectifs, les commissions géologiques sont les principales gardiennes de l'information géoscientifique publique ainsi que les autorités en la matière, et exécutent la majeure partie des programmes géoscientifiques publics. Ces programmes sont exécutés à une échelle d'étude qui répond le mieux aux priorités géoscientifiques de la province ou du territoire. Ils contribuent à la description systématique de la géologie de la province ou du territoire, ce qui peut inclure ses ressources potentielles en minéraux, en énergie et en eaux souterraines. Ils sont surtout axés sur la mise en valeur et la gestion des ressources minérales et énergétiques, mais l'information et les connaissances qui en découlent sont de plus en plus employées à résoudre des questions d'utilisation des terres, d'environnement, de santé publique et de sécurité publique.

3. PRINCIPLES OF COOPERATION

The following principles shall guide federal-provincial/territorial cooperation in geoscience programs:

3.1 Geoscience activities undertaken by the GSC that are directly relevant to provincial or territorial responsibilities as defined in Clause 2.2 will be conducted with the agreement of the relevant provincial or territorial geological survey and in a collaborative manner. In cases where the geological survey is not the lead provincial or territorial agency for an activity, the GSC will keep the geological survey informed.

3.2 Geoscience activities undertaken by the GSC at the request of a province or territory and that have the characteristics of a provincial or territorial program, as specified in Clause 2.2, will be conducted with the agreement of the province or territory and in a collaborative manner.

3.3 Geoscience activities undertaken by a province or territory that are directly relevant to federal responsibilities as defined in Clause 2.1 will be conducted with the agreement of the GSC and in a collaborative manner.

3. PRINCIPES DE COLLABORATION

Les principes suivants guideront la collaboration fédérale-provinciale/territoriale aux programmes géoscientifiques :

3.1 Quand elle mènera des activités géoscientifiques qui ont un lien direct avec les responsabilités d'une province ou d'un territoire décrites à l'article 2.2, la CGC les réalisera avec l'accord de la commission géologique de la province ou du territoire et en collaboration avec elle. Si la commission géologique d'une province ou d'un territoire n'est pas l'organisme provincial ou territorial responsable d'une activité donnée, la CGC la tiendra informée.

3.2 Les activités géoscientifiques que la CGC réalise à la demande d'une province ou d'un territoire et qui présentent le caractère d'un programme provincial ou territorial décrit à l'article 2.2 seront menées avec l'accord de la province ou du territoire, et ce de façon collaborative.

3.3 Les activités géoscientifiques entreprises par une province ou un territoire qui sont de responsabilités fédérales telles que décrites à l'article 2.1 seront exécutées avec l'accord de la CGC et ce de façon collaborative

3.4 The GSC and the provincial and territorial geological surveys endorse the efficacious sharing of all of their geoscientific data, information and knowledge that are not restricted.

4. MECHANISMS FOR COOPERATION AND COLLABORATION

Cooperation and collaboration will be achieved through the following:

4.1 The National Geological Surveys Committee (NGSC) is a federal-provincial/territorial consultative body for public geoscience on which the geological surveys of the federal, provincial and territorial governments of Canada are represented.

4.2 The GSC and the provincial and territorial geological surveys will inform each other of their annual work plans in a timely fashion so as to identify opportunities for collaborative activities.

4.3 The NGSC will review the geoscience priorities of all of the geological surveys at regular intervals to identify opportunities for collaboration in specific activities.

4.4 The NGSC will facilitate sharing of the information of the geological surveys to encourage easy access to information for all Canadians.

4.5 Supplemental agreements to this Accord may be negotiated among the geological surveys, where mutually desired, to define mechanisms for specific collaborative geoscientific activities. Such agreements should subscribe to the objectives, principles and mechanisms of the Accord.

5. ACCOUNTABILITY

The following mechanisms will be used to monitor and report on progress in the implementation of the Accord:

3.4 La CGC et les commissions géologiques provinciales et territoriales souscrivent au principe du partage mutuel et efficace de toutes les données géoscientifiques, de l'information et des connaissances dont la diffusion n’est pas restreinte.

4. MÉCANISMES DE COOPÉRATION ET DE COLLABORATION

La coopération et la collaboration s'effectueront au moyen des mécanismes suivants :

4.1 Le Comité national des commissions géologiques (CNCG) est un organisme consultatif fédéral-provincial-territorial concernant les activités géoscientifiques publiques auquel siègent les gouvernements fédéral, provinciaux et territoriaux du Canada.

4.2 La CGC et les commissions géologiques provinciales et territoriales se tiendront mutuellement au courant de leurs plans de travail annuels en temps opportun, afin de relever les possibilités de collaboration.

4.3 Le CNCG examinera les priorités géoscientifiques de toutes les commissions géologiques à intervalles réguliers pour relever les possibilités de collaboration à des activités précises.

4.4 Le CNCG favorisera la communication des renseignements des commissions géologiques pour que tous les Canadiens aient facilement accès à cette information.

4.5 Les commissions géologiques pourront négocier des ententes supplémentaires en complément du présent Accord, afin de définir des mécanismes de collaboration à des activités géoscientifiques précises. Lesdites ententes supplémentaires devraient respecter les objectifs, les principes et les mécanismes de l’Accord.

5. RESPONSABILISATION

Les commissions géologiques utiliseront les mécanismes suivants pour contrôler l’application de l’Accord et rendre compte

5.1 The NGSC is accountable for implementation of the Accord.

5.2 The NGSC shall report at least once annually to Mines Ministers on progress in implementation of the Accord through the Intergovernmental Working Group on the Mineral Industry (IGWG). When necessary, other ministers shall be apprised of relevant progress using appropriate Ministry officials.

5.3 The term of the Accord is five years.

5.4 The Accord imposes no responsibility to assume any additional scientific program costs on any of the parties.

5.5 The Accord does not create legally binding obligations among the parties, but expresses their desire to cooperate and collaborate in planning and delivering their geoscience programs.

5.6 The Accord is entered into, and may be amended, renewed or terminated, by Ministers responsible for geological surveys.

des progrès accomplis :

5.1 Le CNCG est responsable de l'application de l'Accord.

5.2 Au moins une fois par année, le CNCG fait rapport aux ministres des Mines des progrès accomplis dans l'application de l'Accord, par l'entremise du Groupe de travail intergouvernemental sur l'industrie minérale (GTIGIM). Au besoin, d'autres ministres doivent être informés des progrès pertinents par les personnes responsables de leur ministère.

5.3 L'Accord a une durée de cinq ans.

5.4 L'Accord n'impose aux parties aucune responsabilité quant aux coûts additionnels qui pourraient découler de programmes scientifiques.

5.5 L'Accord ne crée aucune obligation légale entre les parties. Il ne fait qu'exprimer leur volonté de coopérer et de collaborer à la planification et à la réalisation de leurs programmes géoscientifiques.

5.6 L'Accord est conclu par les ministres responsables des commissions géologiques, qui peuvent aussi le modifier, le renouveler ou le résilier.