NATURAL RESOURCES CANADA - INVENTIVE BY NATURE
RESSOURCES NATURELLES CANADA - DE NATURE INVENTIVE

Geological Survey of Canada

2017 Update

Celebrating 175 yrs
Célébrons 175 ans

Presentation to:

Committee of Chairs of Canadian Earth Science Departments

October 12, 2017

Presentation Outline

GSC new organizational structure

GSC Strategic Priorities and Program Updates

Collaboration with Academia

Updates on GSC Grants (GEM and TGI)

Geological Survey of Canada

Mission

"The Geological Survey of Canada provides public geoscience knowledge to sustain the exploration effectiveness and international competitiveness of the mineral and energy sectors, inform the stewardship of onshore and offshore lands, and increase the safety and security of Canadians."

Vision

"To sustain and extend Canadian prosperity and well-being through internationally authoritative and accessible geoscience, anchored in a continuously improved understanding of earth dynamics and natural resources."

Geological Survey of Canada (GSC)

4

DG	Daniel Lebel
Divisions	GSC – Atlantic: Stephen Locke, Director GSC – Quebec: Andrée Bolduc, Director GSC – Central Canada: Mike Villeneuve, Director GSC – UNCLOS Program: Mary-Lynn Dickson, Director GSC – Northern Canada: Louise Laverdure, Director GSC – Calgary: Sonia Dehler, Director GSC – Pacific: Philip Hill, Director Canada-Nunavut Geoscience Office: Linda Ham, Chief Geologist
Locations	Ottawa ON Dartmouth NS Québec City QC Calgary AB Vancouver BC Sydney BC Iqaluit NU
Expertise/ Key Files	**Geo-mapping for Energy and Minerals (GEM)**: Filling critical geoscience knowledge gaps on the likelihood of resource potential in targeted areas of the North and provides the regional geoscience knowledge that Northerners can use for land-use planning and resource development decisions. **Targeted Geoscience Initiative (TGI)**: A collaborative federal geoscience program that provides industry with the next generation of geoscience knowledge and innovative techniques, which will result in more effective targeting of buried mineral deposits. **Geoscience for New Energy Supply (GNES)**: Analyses and assessments of energy resources in Canada's frontier basins for characterization of sedimentary basins and the geological parameters that underpin new energy development. **Environmental Geoscience Studies and Assessments**: Contribution to establish natural baselines, to understand geochemical cycles in the environment, and to develop methodologies for environmental characterization. Provision of expert technical review for the federal Environmental Assessment process and resource assessments. **Climate Change Geoscience**: Contribution to assess climate change risk to land-based infrastructure in the North. **Groundwater Geoscience**: In close collaboration with provinces, contribution to assess 30 key aquifers, develops methods that are being more widely applied by provinces, and data and information integration and dissemination. **Public Safety Geoscience**: Scientific understanding of the underlying causes and impacts of geohazards and their probability of occurrence in Canada's onshore and offshore lands. **United Nations Convention on the Law of the Sea (UNCLOS)**: Establishing the outer limits of the continental shelf beyond 200 nautical miles as an obligation of the Government of Canada and an important foundation in the Northern Strategy to delineate Canada's last international boundary. **Open Geoscience**: Ensuring Canadians have freely available access to our geoscience data, information, and knowledge.

Our Business Lines

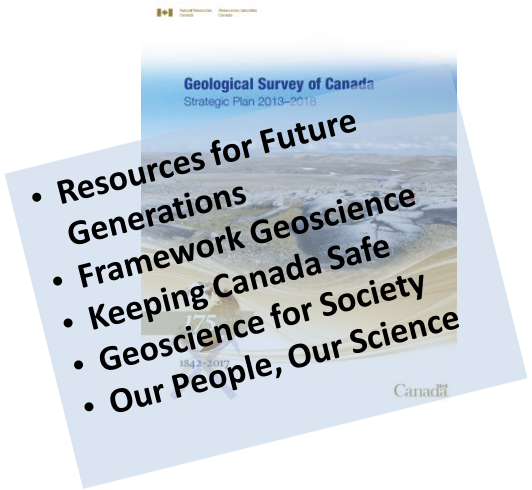
We build the foundation for modern lands governance that supports Canada's economy, sustains the environment, and advances our standard of living.

Our science and economic expertise helps ensure that mineral and natural resource development remains a source of opportunity and prosperity for Canadians.

Our sector works with governments, communities, civil society and the private sector to anticipate, prevent and/or manage natural and anthropogenic risks.

GSC Strategic Plan 2018-23

- Five themes:
  - Resources for Future Generations
  - Framework Mapping
  - Keeping Canada Safe
  - Geoscience for Society
  - Our People, Our Science



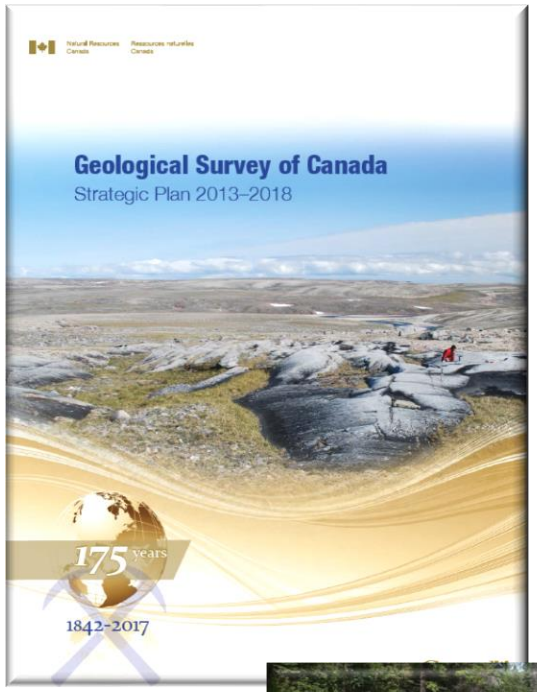
The GSC's five strategic priorities for 2018-2023

What the GSC will do…..

Priority 1. Framework Mapping

Priority 2. Resources for Future Generations

Priority 3. Keeping Canada Safe



How the GSC will do it….

Priority 4. Geoscience for Society

Priority 5. Excellence in our People and Science

Priority 1. Framework Mapping

Strategic objective - Enhance the exploration effectiveness and international competiveness of Canada's energy and mineral industries and support wise land-use decisions by providing geoscience knowledge.

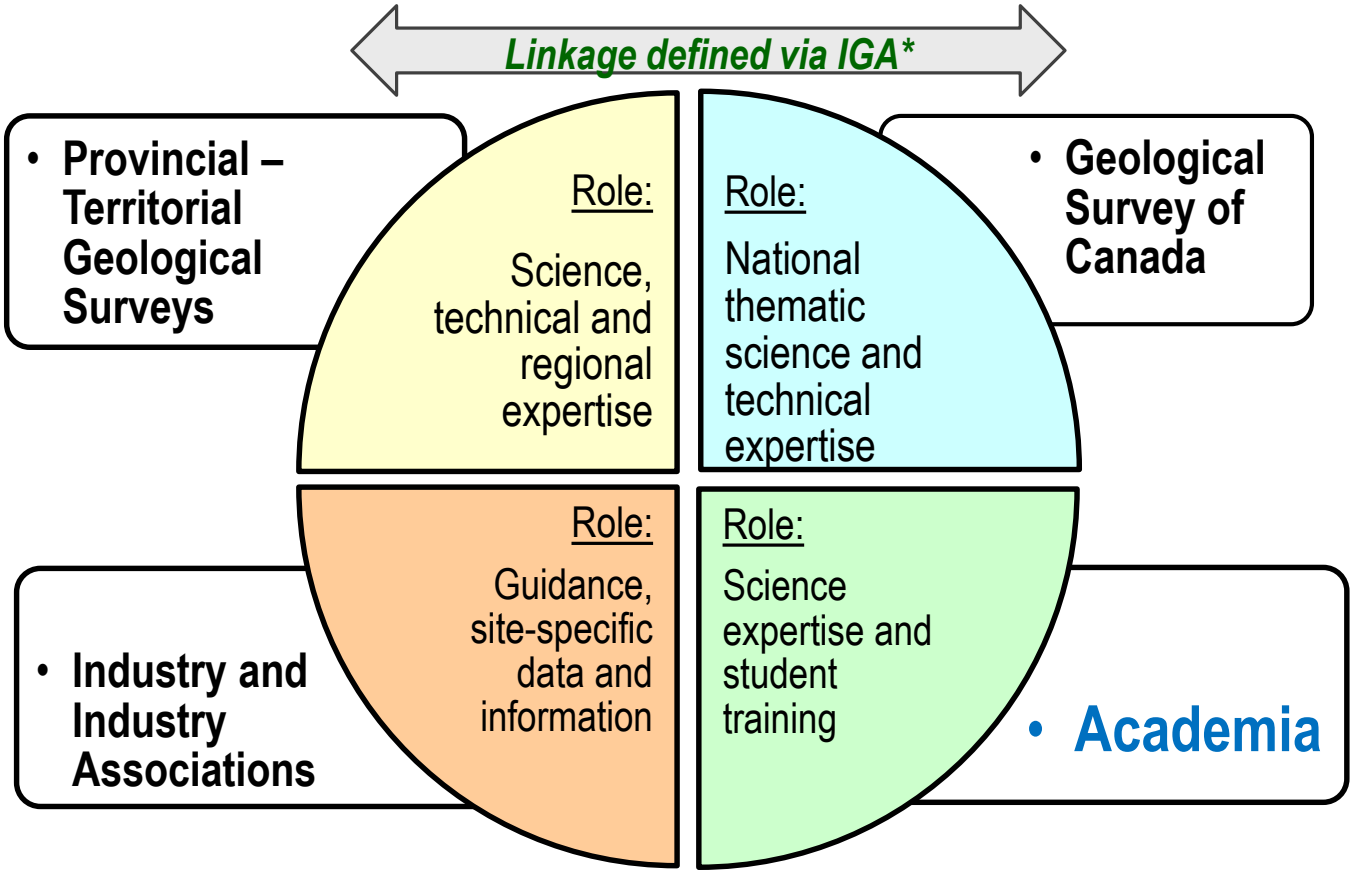
- Geoscientific data collection, analysis and interpretation in frontier areas (Arctic, offshore, and onshore) and at depth are used to define new resource potential.

- GSC delineates the outer limits of the continental shelf in the Atlantic and Arctic oceans together with the scientific arguments to support the extension of the Canadian continental landmass.

- Canadians and decision makers are aware of geoscience information on Canada's onshore and offshore lands.

GEM-2, TGI-5, GNES, UNCLOS

Collaborating in our Delivery of Public Geoscience in Canada



* *The Intergovernmental Geoscience Accord (IGA)* defines the complementary roles of Canada's geological surveys, as well as mechanisms for cooperation and collaboration

Geo-mapping for Energy and Minerals (GEM)

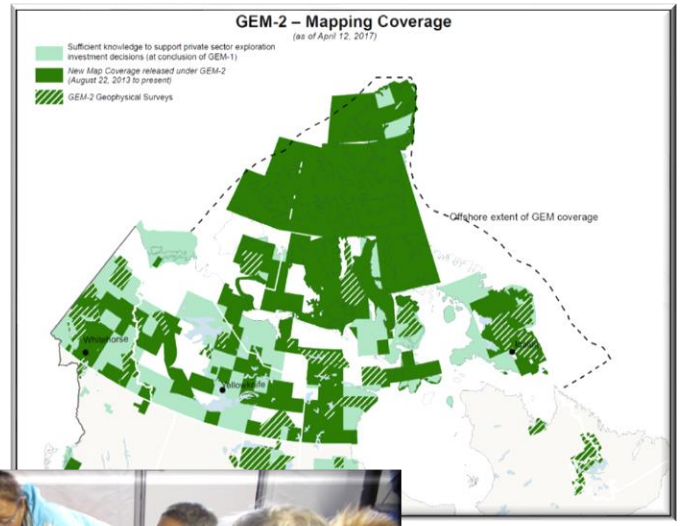
- The GEM program is a 12-year (2008-2020), $200-million initiative to complete modern regional-scale geological maps and data sets for Canada's North.
- GSC research activities target areas of the North to fill critical geoscience knowledge gaps on the likelihood of resource potential.
- GEM research activities provide the regional geoscience knowledge that Northerners can use for land use planning and resource development decisions

Key elements of the GEM-2 program

Ensuring the delivery of high-quality integrated geoscience	**Collaboration to ensure research quality and accessibility**	**Maximizing benefits for Northerners**

Geo-Mapping for Energy and Minerals (GEM-2) 2013-2020

- GEM-2 data continues to guide mineral exploration
- Full suite of research activities have been identified across six regions of interest
- Strong collaboration with provincial/ territorial geological surveys and local communities
- New surficial geological data was used to assess infrastructure
- Training opportunities
- 3-level synthesis underway

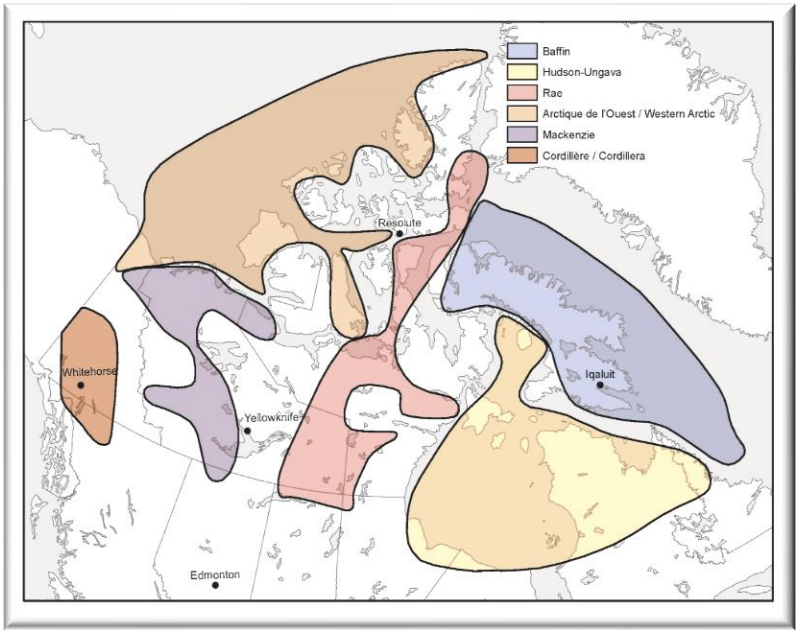


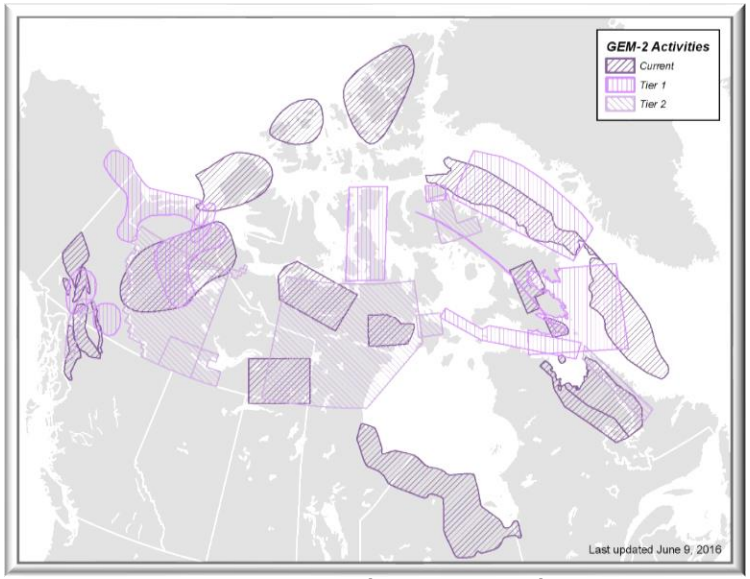
GEM (2008-2020): *To date…*

- 68 research activities / 1,250 publications
- 55 regional geophysical surveys (2.15M km)
- 775+ geological & geophysical maps (different scales)
- 1,100+ technical info sessions to industry, gov’ts & NGOS

GEM-2 Program Update, cont.

- 17 on-going field and desktop studies
- 13 fieldcamps this summer
- 226 engagement letters sent to 69 identified communities, 13 communities visits took place



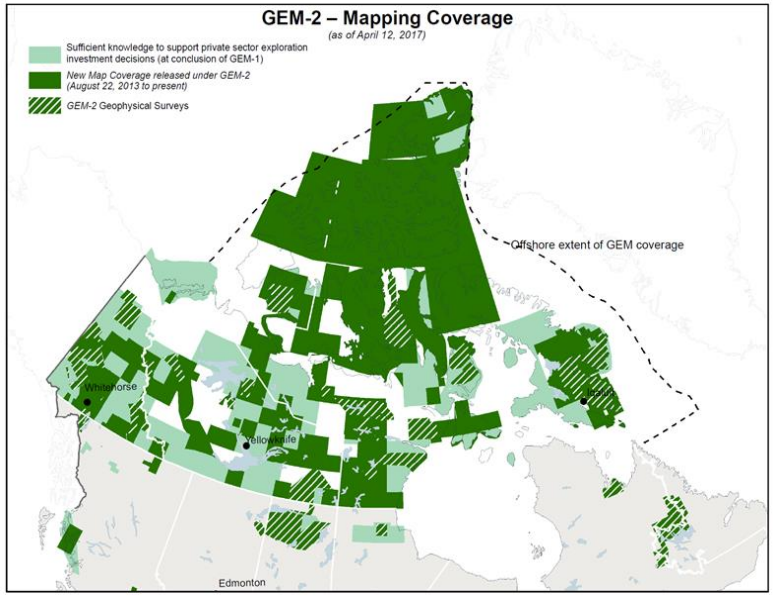


The GEM-2 program (2013-2020) undertook long-term planning for the remaining projects activities until 2020

- 51 students (RAP, FSWEP, casual) hired by GEM activities
- Hiring gap – attracting Northern students to work on GEM
- 37 task-shared agreements (completed for 2017-18)
- 47 publications released through GEOSCAN

Geo-mapping for Energy & Minerals

- **Modern, regional-scale, geological knowledge of the North**
- **Collaborates with provinces/territories per Intergovernmental Geoscience Accord**
- **Advisory Group of Northerners: representatives from territorial governments, private sector and Aboriginal socio-economic development organizations**



Milestones:

- **International mining giant investing in nickel exploration in the Melville Peninsula (Nunavut)**
- **Extensive staking of diamond prospecting permits on southeast Baffin Island (Nunavut)**
- **Industry discovery of significant copper-gold-silver deposits in the Yukon**

GEM (2008-2020): *To date…*

- 68 research activities / 1,250 publications
- 55 regional geophysical surveys (2.15M km)
- 775+ geological & geophysical maps (different scales)
- 1,100+ technical info sessions to industry, gov'ts & NGOS

Targeted Geoscience Initiative (TGI)

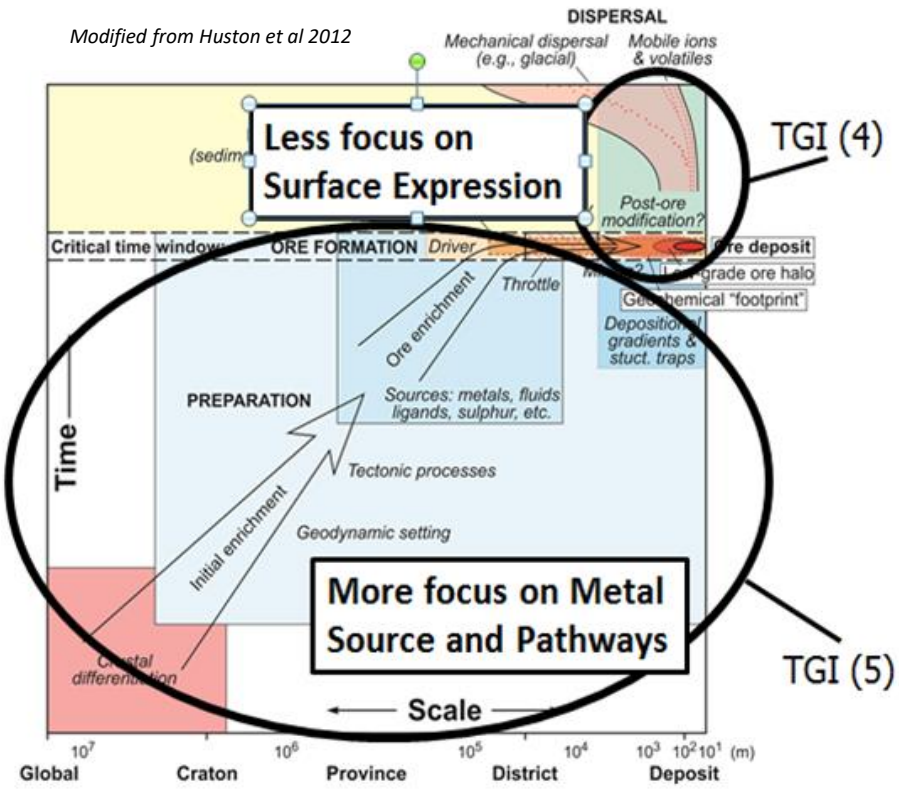
- TGI, currently in its 5th iteration, is a 5-year (2015-2020), ~$23-million initiative focused on generating geoscience to enhance effectiveness of deep exploration for Canada's key economic minerals

- TGI is intended to be a driver of innovation in the mineral exploration industry, that will help to reduce some of the risks of mineral exploration which ultimately serves to improve Canada's global competitiveness and supports Canadian mining-dependent communities.

Key elements of the TGI program

Develop new knowledge, methodologies and models that will enhance the exploration industry's ability to detect buried ore deposits	Integrate multi-scale scientific knowledge of sources of metals and the pathways they take to become an ore deposit that can be used by industry to innovate their exploration approaches	Participate in the training and mentoring of students to increase the number of HQP available to the mineral industry

Targeted Geoscience Program (TGI-5)



- Identification of a major new Cr-Ni-Cu-PGE "Chrome Superdomain" (metallotect) from Manitoba to Eastern Quebec
- New exploration methods to innovate approaches in areas including ON's Ring of Fire region, SK's Athabasca Basin & NB's Bathurst region
- 50+ innovations already adopted by industries
- Since 2010: 900+ geoscience publications with 15,000+ downloads available

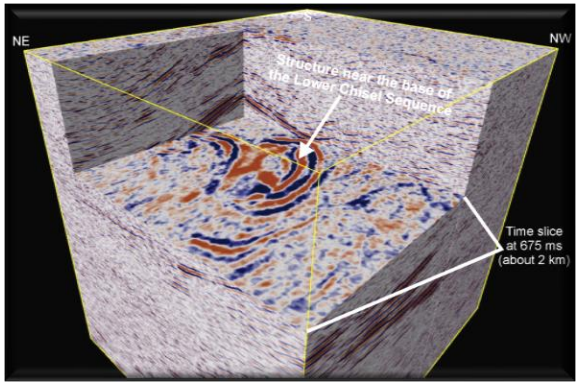
- **Defining news areas of prospectivity**
- **Improved ore system models**
- **New knowledge and methodologies**

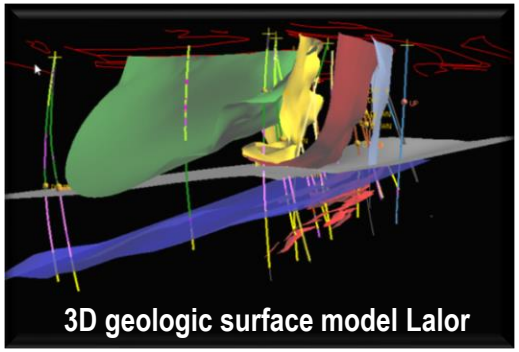
Targeted Geoscience Program (TGI-5, cont. .

Develop new knowledge, methodologies and models that will enhance the exploration industry's ability to detect buried ore deposits

New Knowledge & Methodologies

- New interpretations and models of incorporating structure, geochronology and lithostratigraphy
- 3D map-model as a 'realization' in which to better interpret and test structural-stratigraphic tectonic models
- 3D/3C seismic reflection data acquisition standards and processing techniques applied to VMS exploration
- Multivariate 3D grid modeling methods to systematically reconcile geological, geochemical and geophysical data and interpretations of ore systems at different scales



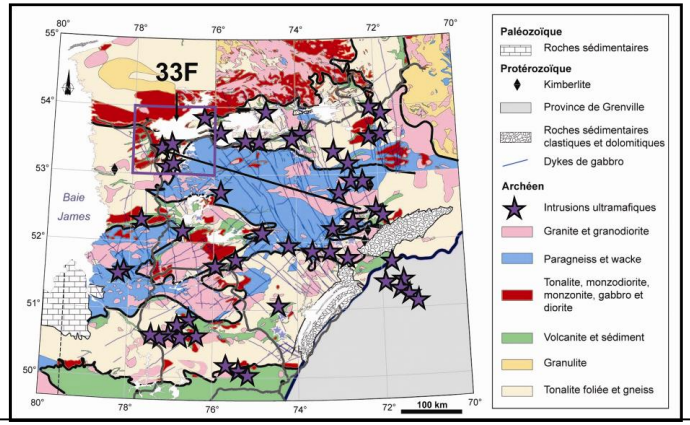


Targeted Geoscience Program (TGI-5, cont. .

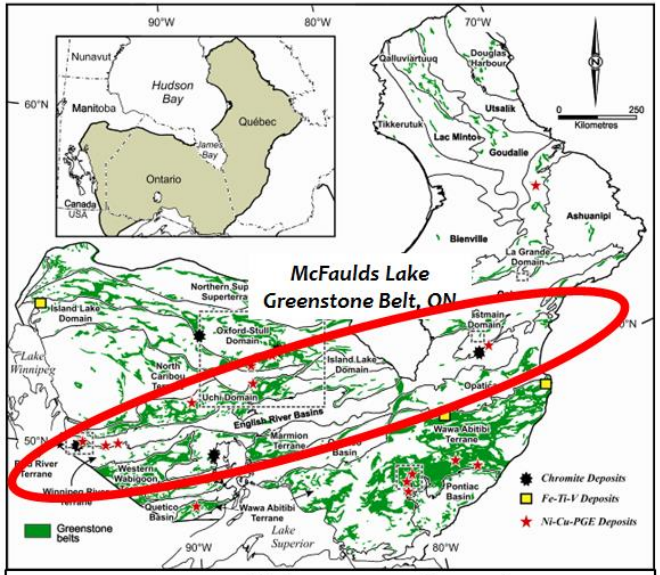
Defining New Areas of Prospectivity

- Recognition of Oxford-Stull-La Grande Superdomain that hosts mineralization similar to that of the McFaulds Lake area
- Identification of a major new Cr-Ni-Cu-PGE "Chrome Superdomain" (metallotect) that stretches from Manitoba to Eastern Quebec
- New model for chromite deposits in Ontario's Ring of Fire region

Integrate multi-scale scientific knowledge of sources of metals and the pathways they take to become an ore deposit that can be used by industry to innovate their exploration approaches



Oxford-Stull-LaGrande Superdomain



Potential "Chrome Superdomain"

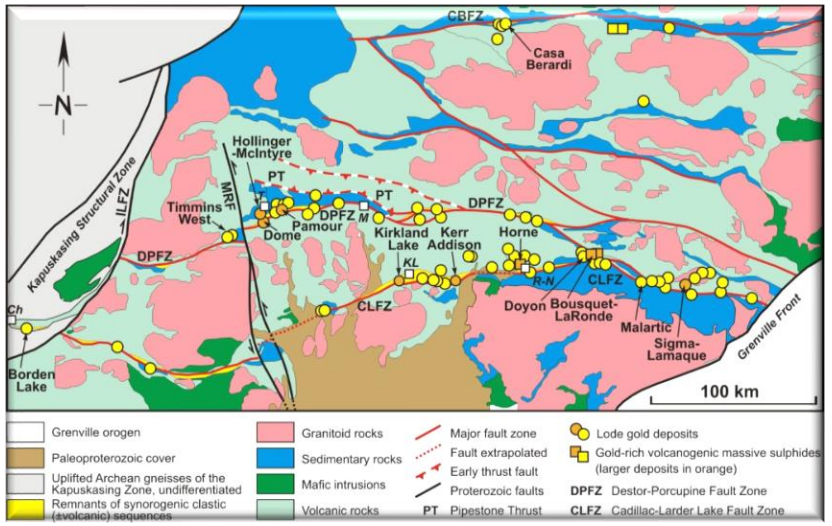
Targeted Geoscience Program (TGI-5, cont. .

Improved Ore System Models

Revised geological models of Archean intrusion-related and synvolcanic gold systems provide better exploration opportunities in regions such as the Abitibi of Quebec, Rice Lake area of Manitoba and Yellowknife area of the Northwest Territories:

- Synorogenic extension, not compression is the overall "engine" that leads to gold deposits;
- Plausible explanation why > 99% of historic Au production is from north of the fault (i.e. the structural footwall)

Integrate multi-scale scientific knowledge of sources of metals and the pathways they take to become an ore deposit that can be used by industry to innovate their exploration approaches



Science Laboratory Network (SLN): Underpining Innovative Research at the GSC

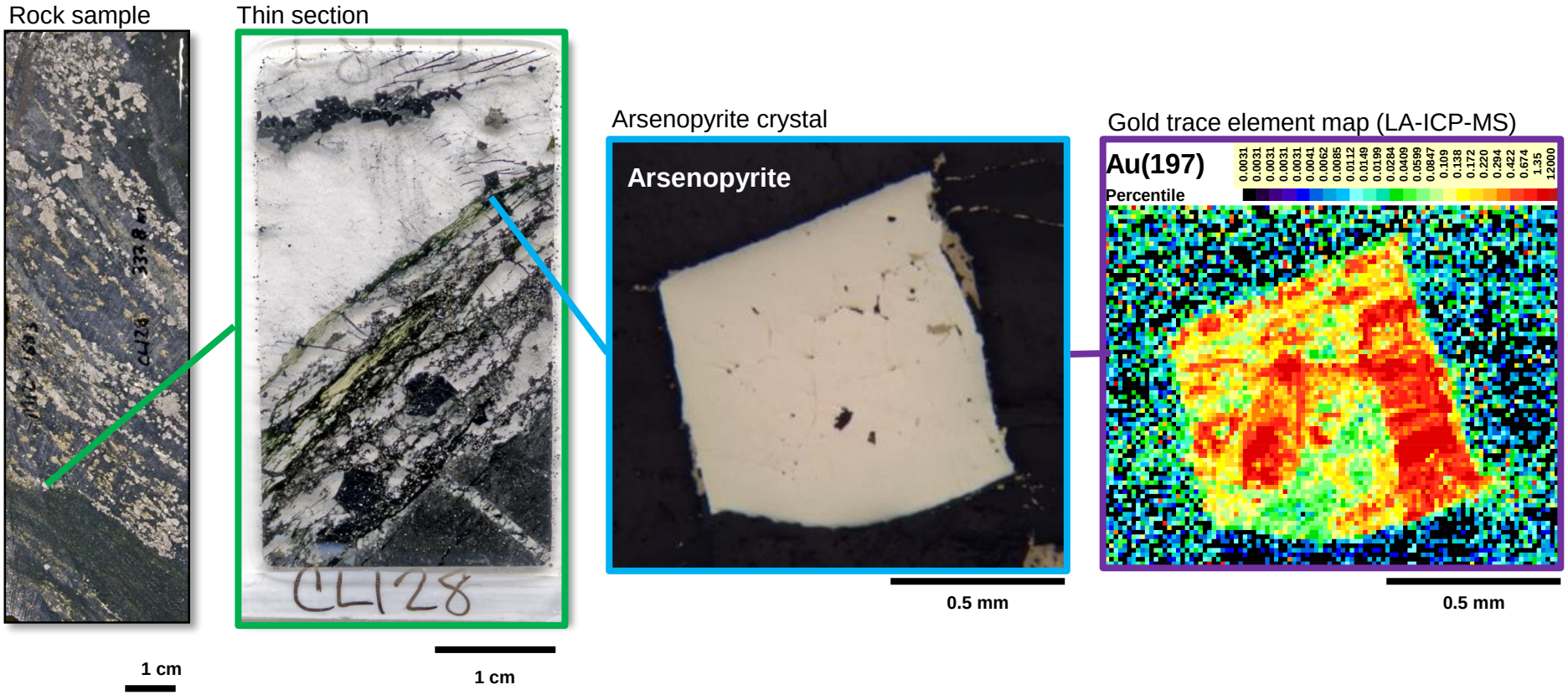
- Provide high-value laboratory research leadership for all LMS-GSC Programs – particularly innovative, specialized analysis and interpretation.
  Contributing to:
  Framework Mapping, Resources for Future Generations, Geoscience for Society
- Promote effective scientific advances in laboratory techniques through collaborations with other Canadian geoscience laboratories.
  Contributing to:
  Excellence in People and Science
- Provide open access to analytical results and ensure quality of laboratory data.
  Contributing to:
  Open Geoscience

Science Lab Network: lab-based scientific expertise

LAB GROUP	Inorganic Geochemistry Research Lab Group (IGRL)	Paleontology Lab Group (PaleoLab)	Mineralogy and Rock Properties Group (MPP)	Isotope Geochemistry and Geochronology Group (IGGG)	Organic Geochemistry and Petrology group (OGPet)
RESEARCH EXPERTISE	Innovative geochemical research and analysis (isotope systems, metal species) strongly contributing to mineral deposit and environmental research.	Expertise and research in paleontology, high resolution biostratigraphy / paleoenvironment for hydrocarbon, mineral resource research; understanding climate cycles and biological responses to climate variability and land-use change.	Quantitative mineralogical analysis including elemental composition and physical characterization of earth materials contributing to all programs.	Research in stable and radiogenic isotope-based analysis for tracing crustal, environmental, and marine processes; geochronology research in minerals deposits, basin analysis, tectonic and thermal histories.	Geochemical and organic petrology research and analysis of petroleum and unconventional energy systems contributing to energy resource research.

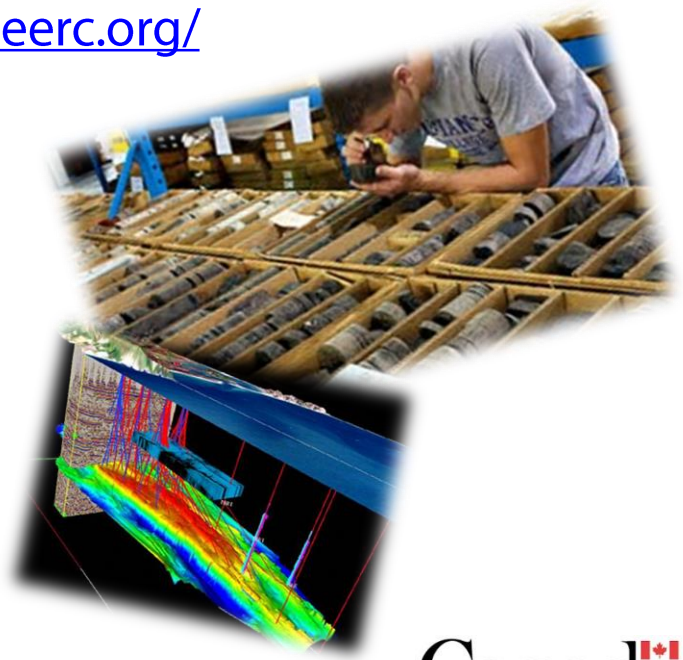
Example of SLN Research:

Innovative and specialized laboratory analysis and data interpretation



Geoscience for New Energy Supply Program (GNES)

- Strong collaboration with the Tight Oil and Gas Consortium based out of the University of Calgary. http://www.tightoilconsortium.com/
- Collaboration with University of Alberta in Basin Modeling and Stratigraphy and Sedimentology.
- Collaboration with University of Wisconsin (Molybdenum chemistry)
- Collaboration with University of North Dakota (via Energy and Environmental Research Center) http://www.undeerc.org/
  - University Student Engagement:
    - 6 FSWEP Students (FY2017-18)
    - 5 RAP students (FY 2017-18)
  - Exploring collaborations with Technical University of Crete, Mineral Resource Engineering Department (MRED).
  - Exploring collaborations with University of Aarhus, Denmark.



UNCLOS Program

- PhD student is completing their dissertation using geophysical data collected in the Arctic Ocean during UNCLOS surveys
- MSc student is employed on a part-time basis by the program
- An undergraduate student participated on three UNCLOS surveys in the Arctic Ocean and used data for their Honours thesis
- A coop student spent a work term with a GIS specialist involved in the program
- Contracts have been issued to several Earth Science Departments to prepare and undertake geochemical and isotopic analyses of dredged rock samples from the Arctic Ocean. Some of these rocks are the first samples collected from an area a third of the size of Ontario. The data will be used in Canada's submission and in peer-reviewed scientific publications with academic co-authors

Priority 2. Resources for Future Generations

Strategic objective - Improve regulatory efficiency and reduce the environmental risks of resource development by providing reliable geoscience information.

- Geoscience supporting innovation to discover and develop new mineral resources including new knowledge, methodologies and models to guide the development of new resource models that exploration industries use to discover new deposits and make technological innovations.

- Geoscientific knowledge integrates water research and cumulative impacts of resource development on the environment for evidence-based decision-making.

- Geoscience supports the transition from conventional fossil fuels to low carbon energy sources to assess and facilitate development of low-carbon energy sources and identify possible sources of critical metals needed in low-carbon energy production.

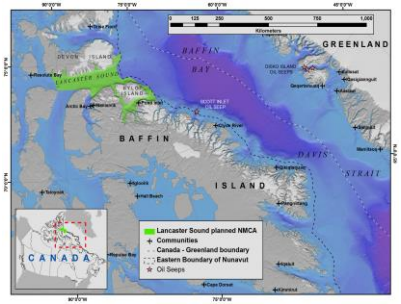
EGP, CCGP, GGP, EA

Environmental Geoscience Studies & Assessments

Science Activities

- Targeted field work, and laboratory analyses to establish natural baselines, to understand geochemical cycles in the environment (air-soil-rock-water) and to develop methodologies for environmental characterization
- Expert technical review for the federal Environmental Assessment process
- Resource assessments for proposed protected areas

Lancaster Sound Oil & Gas Assessment

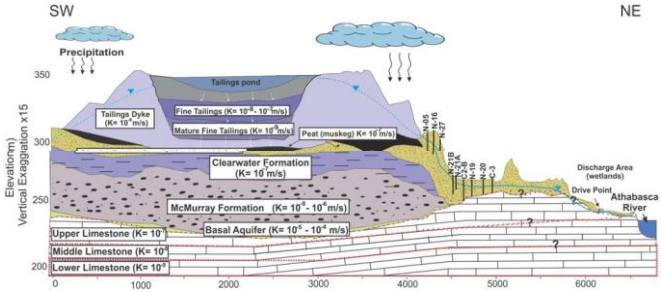


In 2014-15 , GSC published a variety of articles on hydrogeology, induced seismicity, and environmental geochemistry on metal mining remediation.

In 2013, GSC published a comprehensive oil & gas resource assessment for the proposed Lancaster Sound National Marine Conservation Area.

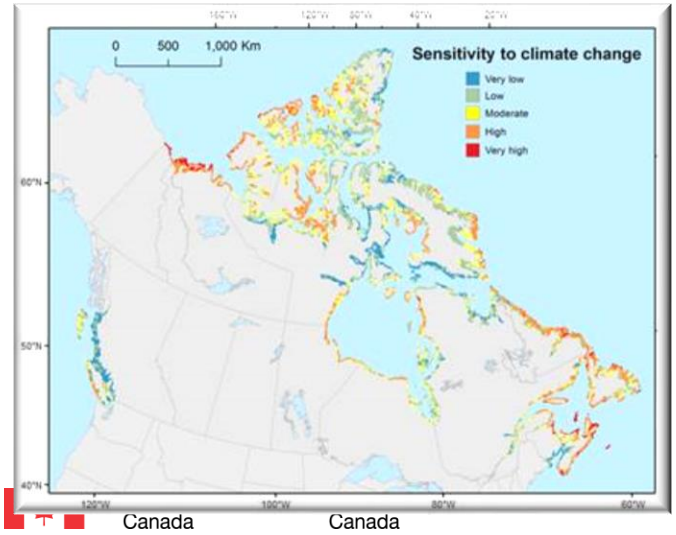
In 2012, GSC published innovative new methods for distinguishing between natural and anthropogenic contaminants in the oil sands region.

Anthropogenic vs. Natural Contaminants in the Oil Sands Region



Climate Change Geoscience Program (CCGP)

- Aligned with the *Pan Canadian Framework on Clean Growth and Change*
- CCGP works with government, Indigenous and academic partners to produce geoscience based information and tools to:
  - support decision makers in the identification of priorities for preparedness and adaptation activities in Canada's northern and coastal regions
  - improve Canada's understanding of permafrost-infrastructure-climate interactions; and,
  - develop climate change adaptation strategies in the vicinity of major existing and proposed transportation routes and natural resource development in both Arctic and sub-Arctic environments.
- Academic partners include Yukon College, Aurora College, Carleton, Universities of Ottawa, Lethbridge, Victoria, Alberta, McGill and Laval.



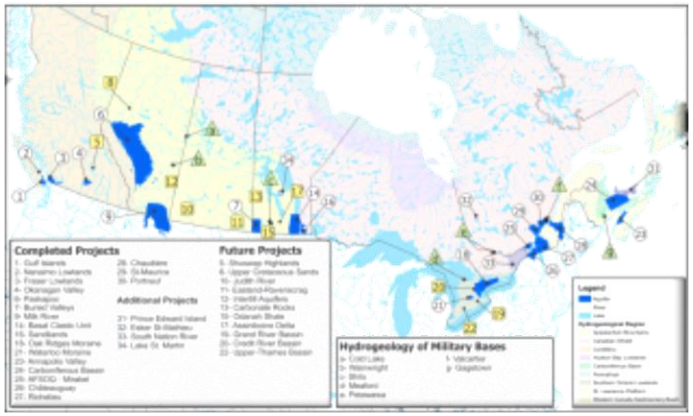
- CCGP researchers and partners are also working to improve our understanding of the susceptibility and vulnerability of coastal regions across Canada to inform the development of effective adaptation strategies related to existing and proposed infrastructure and communities.
- Academic partners include Memorial, St Mary's, Simon Fraser and Universities of Victoria, Newfoundland and Manitoba.

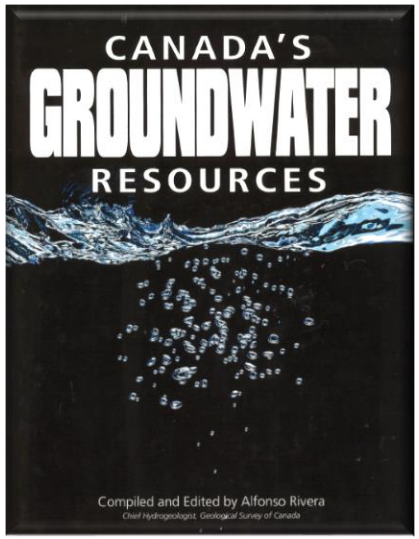
Canada

Groundwater Geoscience Program

- Mapped and assessed **19** of the 30 Key Canadian aquifers
  - in 8 provinces and 6 of the 8 hydrogeological regions
  - covering 7 granular aquifers, 9 fractured aquifers and 3 G/F aquifers in 15 geological contexts
- Groundwater information Network
  - National database infrastructure, data model and web portal for data delivery at the leading edge of international standards
- Generated a long list of innovations and thematic studies
- Collaborations with:
  - Acadia, St.FX, INRS, Polytechnique, Carleton, Simon Fraser and Universities of Ottawa, Toronto, Guelph, Waterloo, Western, Manitoba, Saskatchewan, British Columbia, New Brunswick and Laval

Key Canadian aquifer systems mapped by the Groundwater Geoscience Program





Priority 3. Keeping Canada Safe

Strategic Objective: Reduce the economic, social and environmental impacts from natural hazard events in Canada.

- Understanding hazards (seismic, slope failures, space weather) – geoscience provides an understanding of natural and human-induced hazards, including those related to climate change.

- Assessing risk including the evolution of options to mitigate and reduce risk – Geoscience integrated with socioeconomic analysis and engineering data provides a comprehensive understanding of risk from natural hazards and climate change.

PSG

- Preparing Canada for climate change adaptation and disaster risk reduction - geoscience knowledge is used by provinces and territories, municipalities, industry and Indigenous people to mitigate risk in vulnerable areas

Public Safety Geoscience Program

- Scientific research program which conducts focussed investigations of natural hazards and the risks they pose with the goal of reducing their economic, social and environmental impacts; hazards investigated include earthquakes, tsunamis, space weather, volcanoes, and marine & terrestrial landslides.
- Program employs 2 post-doctoral fellows (including the Alice Wilson pdf), and approximately 6 students per year.
- Student positions are both in the field and in desktop research.
- Many program researchers are adjunct professors at various universities and supervise post-grad research that contributes to program outcomes.
- Over 300 publications since 2015, available at www.geoscan.nrcan.gc.ca

Damage to masonry building, 2011 Christchurch earthquake (Becker Fraser photos)

Eruption of Mt.St.Helens, 1980 (AFP)

Priority 4. Geoscience For Society

Commitment: To address the uncertainties of the changing world by expanding the reach and impact of geoscience knowledge in land use decision-making and disaster risk reduction efforts.

- GSC's data and knowledge products are freely accessible and responsive to client needs.
- Deeper engagement and knowledge exchange with Indigenous communities around resource potential, environmental impacts and natural hazard to enable Indigenous communities to make informed decisions about land management and land use planning.

- Within the federal **Open Government Initiative**, develop and implement an Open Geoscience Information Management and Technology (IMT) plan.
- Acquire, manage and disseminate all geoscience data by using internationally accepted, web-enabled methods for quality, authority, timeliness and accessibility
- Modernize and web-enable all key ESS geoscience datasets and publications, including metadata of rock collections and archive material.

Priority 5. Excellence in our People and Science

Commitment: To renew, strengthen and develop our workforce in order to be at the leading edge of scientific fields, embracing new technologies and providing state-of-the-art laboratory facilities.

- **People**: Define, cultivate and reward excellence, innovation and focus, and ensure recognition of work contributing to our goals
- **Partnership**: Seek out, maintain and enhance internal and external collaborations for mutually beneficial access to the best resources
- **Programming**: Ensure the continuing alignment of our geoscience with current government priorities and responsiveness to emerging needs.
- **Organization**: Through efficient internal partnerships, ensure that staff has free and timely access to the data, information and knowledge that are necessary to deliver our objectives and that is necessary for professional development

Collaboration with Academia

GSC Collaborates with Academia via:

Direct Collaborations (e.g. Task-Shared Agreements, Research contracts)

Grant Programs (e.g. GEM-2, TGI -5)

- Specific application, proposal assessment and timeline requirements, tied to GSC Program outcomes

Student Bursary Programs (RAP)

- Set amount ($17,500/yr for MSc, $21,000/yr for PhD) for students working on multi-year research project co-supervised by GSC staff

Adjunct Professorships

- GSC staff cannot gain compensation additional to their salary; Estimated time required and duties must be approved by their manager

Other Avenues

- Student hiring programs (FSWEP and CO-OP), visiting fellowship program, co-organization of events, contracts for services, revenue agreements, public servant-in-residence program etc

GSC and Institut National de la Recherche Scientifique Research Partnership

Unique government-university partnership between GSC-Québec and INRS (centre Eau Terre Environnement) since 1988

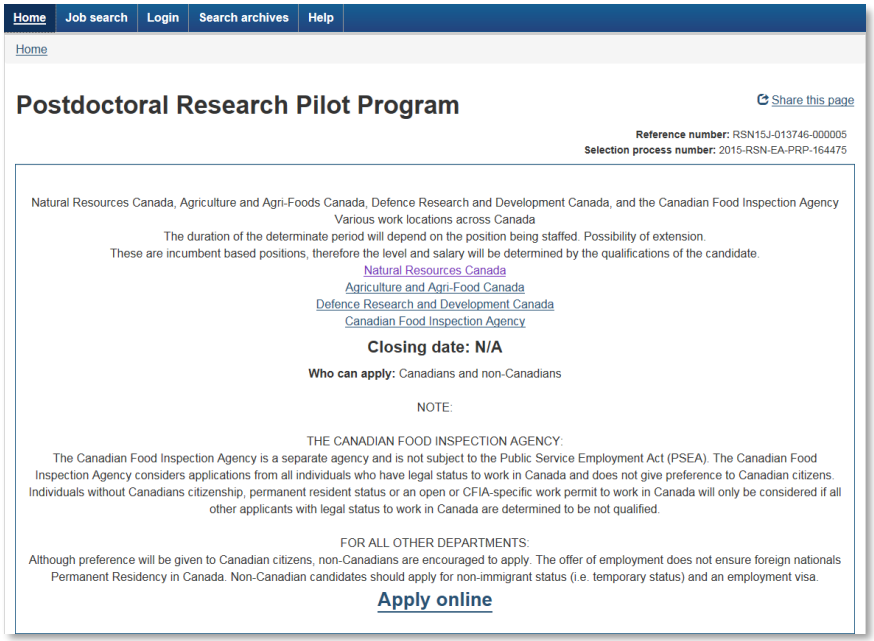
Helps deliver programs and services that contribute to the achievement of NRCan's raison d'être, strategic outcomes and responsibilities

Postdoctoral Research Program (PRP)

- Developed to replace NSERC's Visiting Fellowship in Government Laboratories Program (VFP) and to provide scientists with the opportunity to work with research groups in Canadian government laboratories and research institutions

- Natural Resources Canada, Agriculture and Agri-Foods Canada, Defence Research and Development Canada, and the Canadian Food Inspection Agency are participating in this new pilot program. **Positions are available in various work locations across Canada**

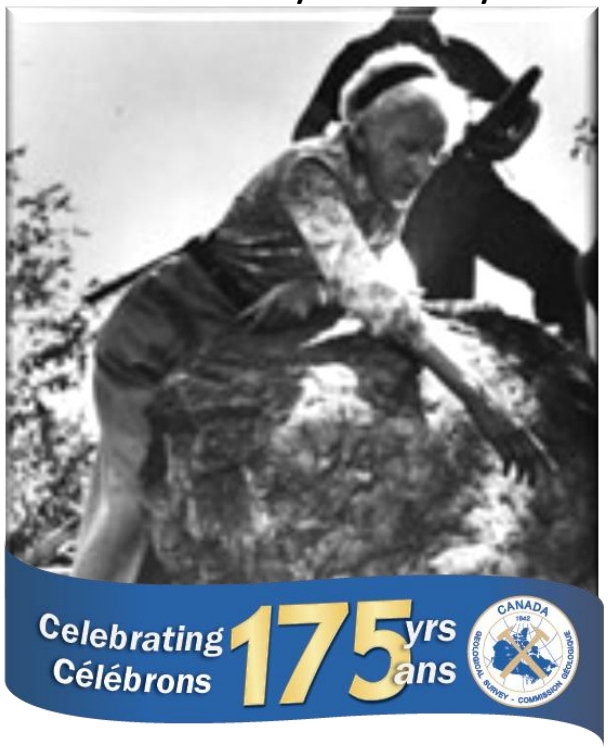
- **Must be within 36 months of graduation from PhD**



- The PRP inventory is advertised on **jobs.gc.ca** with and applications are held for one year (renewable), can also contact **nrcan.PRP.rncan@canada.ca**

The GSC's Alice Wilson Fellowship

In celebration of the 175th anniversary of the GSC, the Survey has launched the **Alice Wilson Fellowship**, named after the GSC's first female geologist and first woman to be elected to the Royal Society of Canada



- In honour of her pioneering spirit the GSC has established a new fellowship targeted at **talented women scientists** who are interested in pursuing a post-doctoral research position in the field of earth sciences

- We currently have 3 positions filled:
  - Marit Heideman, Public Safety Geoscience Program, in GSC-Pacific
  - Stéphanie Larmagnat, Environmental Geoscience Program, in GSC-Québec
  - Dianne Skipton, GEM in the Northern Division

- Candidates must be currently enrolled in the PRP Program and will be selected through a transparent process, on the basis of excellence and impact of research area upon the program

Collaboration with Academia – GSC Grants

The GSC uses grants to academia as a way to complement our existing expertise

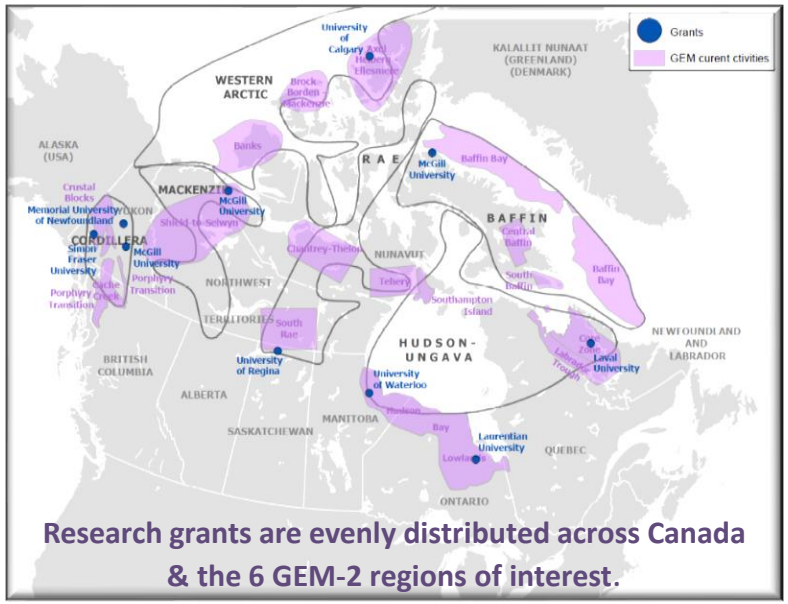
Development of strategic collaborations with the Canadian academic community (professors and students) will:

- help complement existing scientific and/or technical expertise to address GSC research objectives to generate improved mineral system models and new methods and technologies
- Contribute to long-term Canadian research capacity
- Provide opportunity for innovation in the development of ideas and methods that are applicable to industry needs.
- $multi-year agreements involving academic institutions, federal contributions will be limited to 95% of total project costs.

GEM-2 Grants Update

Geoscience Grants:

- 36 Geoscience research projects have been funded to date
- 2-year geoscience grants 2017-19
  - $1.1M in total funds awarded to fund 9 projects at 7 Canadian universities in 8 provinces



Research grants are evenly distributed across Canada & the 6 GEM-2 regions of interest.

Multi-Disciplinary Grants:

- Fund innovative approaches and tools to facilitate uptake of GEM knowledge by Northerners
- 9 multiyear Multidisciplinary grants are currently under consideration for 2017-19

Targeted Geoscience Initiative (TGI)-5 Grant Update

- $1.2M of grants with 11 Universities; 2nd round new grants 2018 – 2020 announced, deadline is October 13 2017
- Advocate and participation in NRCan PRP Pilot Program (8 PRP)
- Support more than 24 RAP Bursary students
- TGI has trained 133 students, 83 at the post-graduate level
- TGI Ore system synthesis volumes and new Report of Activities represent a "GSC Best Practice" that directly supports GSC Priority 4 = Open Geoscience
- Since 2010, production of > 900 geoscience publications with over 15,000 downloads available at geoscan.nrcan.gc.ca


Thank you