Natural Resources Canada | Ressources naturelles Canada

Advancing next generation geoscience through collaboration

A Geological Survey of Canada (GSC) Update

Presentation to Council of Chairs of Canadian Earth Science Departments
October 28, 2021 – Daniel Lebel, DG GSC, NRCan

Canada

A quick recap of familiar programs & some new developments

- The Geological Survey of Canada (GSC) within Canada's public geoscience ecosystem
- Working with partners towards next generation geoscience: what's new in GSC priorities, programs and research:
  - **Pan-Canadian Geoscience Strategy (PGS)**
  - **GeoMapping for Energy and Minerals (GEM-GeoNorth)**
  - **Targeted Geoscience Initiative (TGI-6)**
  - **Laboratories Canada/TerraCanada**
  - **International Geoscience Diplomacy**
- What's next? For more information…and opportunities for collaboration

A strategic asset since 1842, the GSC has transformed to meet Canada's evolving public geoscience and policy needs, to turn knowledge to reality and decisions

GSC 8.0 Vision: Integrated 4D geoscience to maximise policy outcomes from the past, to the present and for the future

GSC Creation 1842

A Canadian Ideal!

Nation-Building	National Growth	National Resilience	Recovery & Reconciliation	
Maps Geoscience Surveys & Synthetic Views	**Models** Geoscience Research for Models & Integration	**Platforms** Predictive Geoscience & Systems	**Integrated Science and Policy** Next Generation Geoscience	**Outcomes** Economic, Social, Environmental Benefits for Canadians
GSC@25 -1867 Canada 2D!	GSC@100 -1942 Canada 3D!	GSC@150 -1992 Canada 4D!	GSC@200 -2042 Canada 4D Everywhere!	**Geoscience for Society**

Next Generation Geoscience can address the most daunting challenges of our time if we position ourselves to address challenges and seize opportunities.

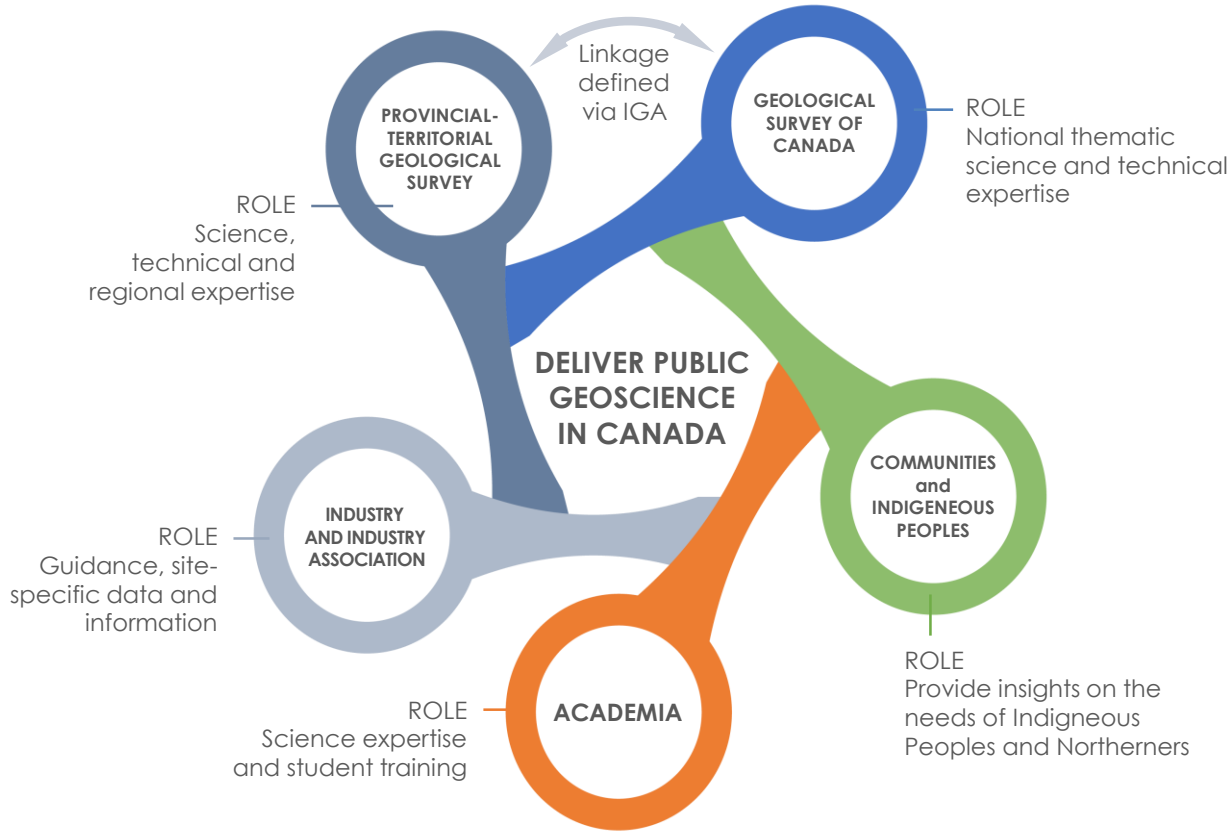
The GSC is an essential partner in Canada's public geoscience ecosystem

Canada's national geoscience organization

- Responding to policy and client needs, GSC carries geoscience research, and provides open data, grants to advance knowledge of Canada's onshore and offshore lands, mineral, energy, groundwater resources and reduce risks from geohazards and climate change.

Collaborative work

- **Provinces & territories** through the Intergovernmental Geoscience Accord (IGA) and the National Geological Survey Committee (NGSC), joint projects and the **new Pan-Canadian Geoscience Strategy**
- **With Academia** through provision of grants, direct collaboration in joint projects, student employement and graduate supervision, Research Associate Program (RAP), IODP support, conference organisation**.**
- **With Communities:** Through field work employment, community engagement, GEM grants, project focus (e.g. regional geohazards studies)
- **Industry:** Cost-recovery or shared-cost projects, access to data and sites, project responsive on broad needs for risk reduction, fast data release to guide exploration.



GSC science activities are guided by its Strategic Plan 2018-23 and align with federal priorities

Geological Knowledge On- and Off-Shore

Driving the economy, de-risking investment & safeguarding sovereignty

Geoscience for Sustainable Development

Contributing to a cleaner, low carbon future

Geoscience for Keeping Canada Safe

Building resilience to natural hazards and climate change

Geoscience for Society

Unlocking the value of geoscience data for everyone

INNOVATION – GEOSCIENCE 4.0

Our Science, Our People

Developing and delivering world class expertise in world class facilities

The Pan-Canadian Geoscience Strategy (PGS) establishes 5 priority areas for better coordination of public geoscience…

- Driven by federal, provincial and territorial mines Ministers
- Responds to increased policy and stakeholder demands for public geoscience
- Will maximize government investments and cooperation towards next generation geoscience
- Support the responsible development of Canadian geological resources, including for critical minerals

…informed by academia, industry, and Indigenous organizations

PRIORITY AREAS FOR COLLABORATIVE NATIONAL ACTION:

MISSION STATEMENTS SUPPORT:

- Competitiveness
- Public safety
- Land use decisions
- Inclusivity

LONG-TERM VISION:

Provide geoscience information that underpins the responsible development of Canada's geological resources and serves the public good

Technical-focused priority areas for collaboration focus on improving data, quality and access

Advancing FRAMEWORK GEOSCIENCE

Purpose:

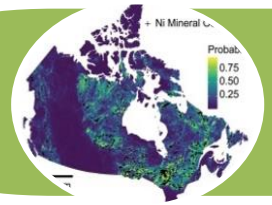
- Develop a comprehensive four-dimensional geoscience framework for Canada

Problematique:

- Inconsistencies (e.g. in datasets, analytical methods)

Example of potential action:

- Collaborate to develop shared methodologies for producing geological compilations at national and regional scales



Advancing MINERAL AND ENERGY POTENTIAL MODELLING

Purpose:

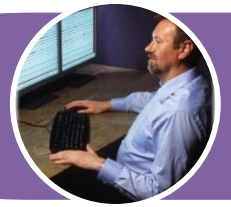
- Coordinate the next generation of mineral and energy potential modelling

Problematique:

- Inefficiencies (e.g. case-specific approaches)

Example of potential action:

- Examine current best practices for mineral and energy potential modelling across jurisdictions and at the international level



Facilitating ACCESS TO ONLINE DATA

Purpose:

- Ensure data are FAIR (findable, accessible, interoperable, reusable). Work towards developing an online portal or similar that will connect existing data sources across jurisdictions.

Problematique:

- Fragmented data (e.g. location, format, availability)

Example of potential action:

- Build data source transformation connections between jurisdiction-managed data assets

People-focused priority areas for collaboration focus on developing and equipping people - specialists and generalists - to better understand and use geoscience data and information

Supporting the training of NEXT GENERATION GEOSCIENTISTS

Purpose:

- Play an active role in attracting and training newcomers to geoscience in Canada

Problematique:

- Availability of personnel; requirements for next-gen skillsets

Examples of potential actions:

- Compile a list of hands-on training best practices
- Leverage ongoing work under the CMMP regarding local procurement (particularly Indigenous procurement) to inform hiring practices
- Develop an online national repository of geoscience training opportunities

Enhancing PUBLIC LITERACY IN GEOSCIENCE

Purpose:

- Public awareness/trust of geoscience

Problematique:

- Misinformation/misunderstanding

Potential early actions:

- Build partnerships with existing science outreach organizations
- Continue to develop plain-language materials about geoscience projects

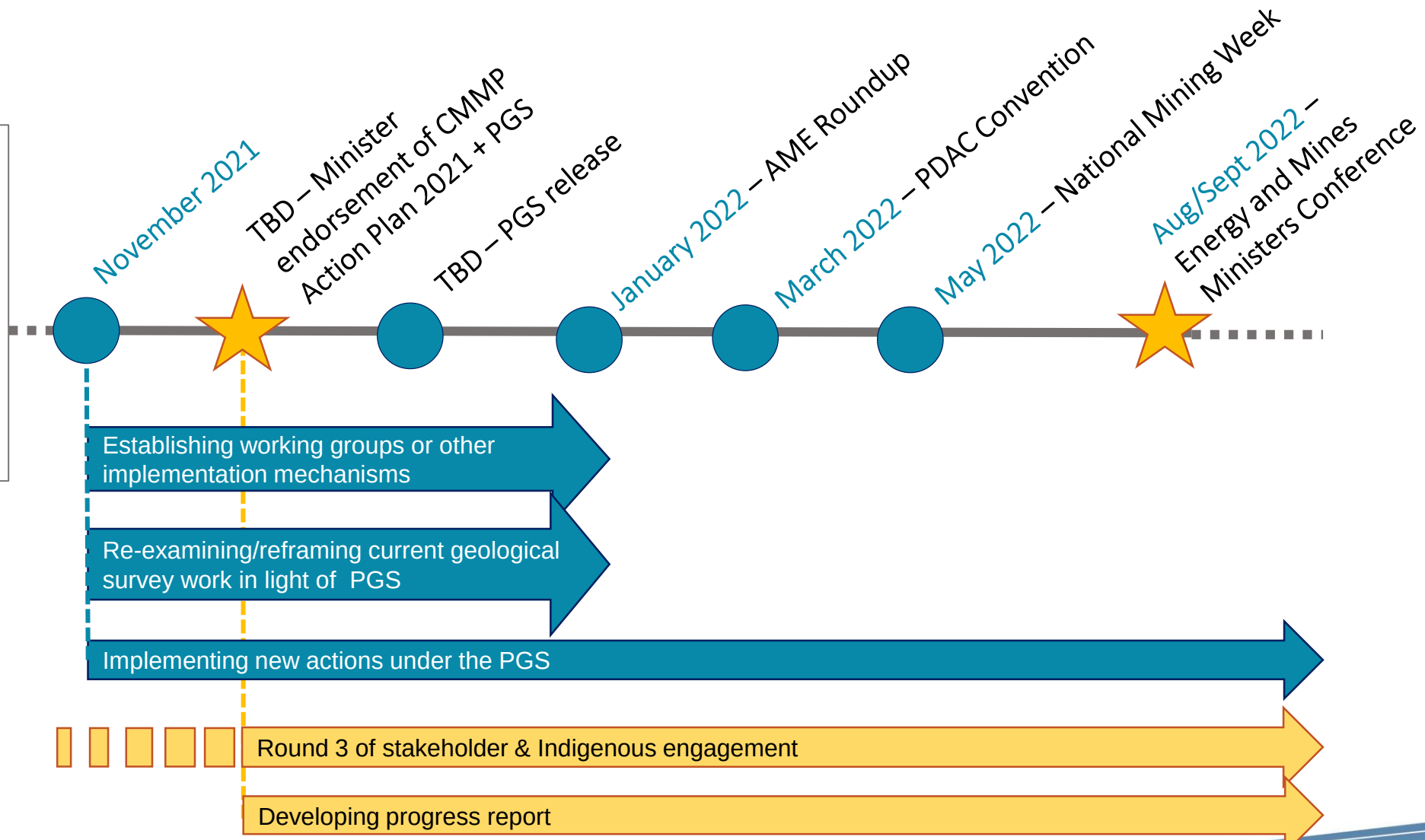
We're moving towards PGS implementation with the help of stakeholders & collaborators

In 2019, Ministers tasked NGSC with the creation of a **Pan-Canadian Geoscience Strategy (PGS)** to support the development and deployment of next generation, world-leading geoscience for **mineral exploration**

In 2020, Ministers endorsed a **"minerals plus" vision and mission** to encompass geoscience contributions to the **energy sector** and to **other societal needs**

The NGSC developed and verified **priority areas** for collaboration in consultation with a cross-section of geoscience end-users*

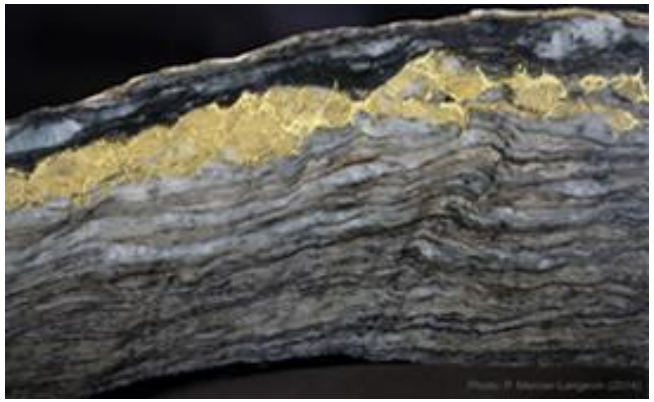
**Final endorsement by Ministers pending.*



GSC geoscience approaches to unlock mineral development potential

Geo-Mapping for Energy and Minerals (GEM)

- **Stimulate exploration** in data-poor areas
- Advance foundational geoscience knowledge to inform mineral resource opportunities in the context of a changing climate.
- Regional focus (**North**)

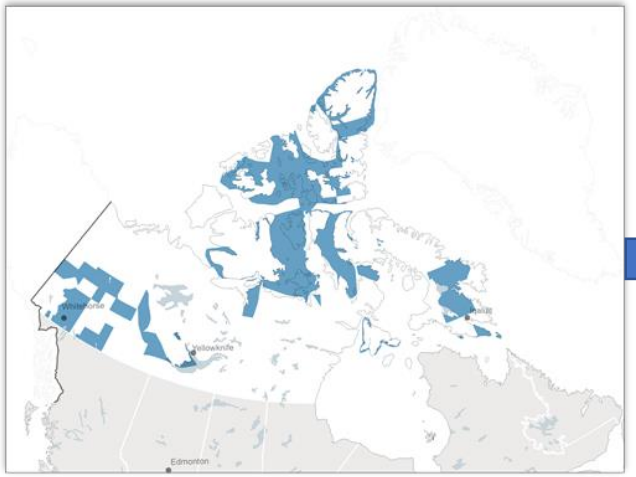


Targeted Geoscience Initiative (TGI)

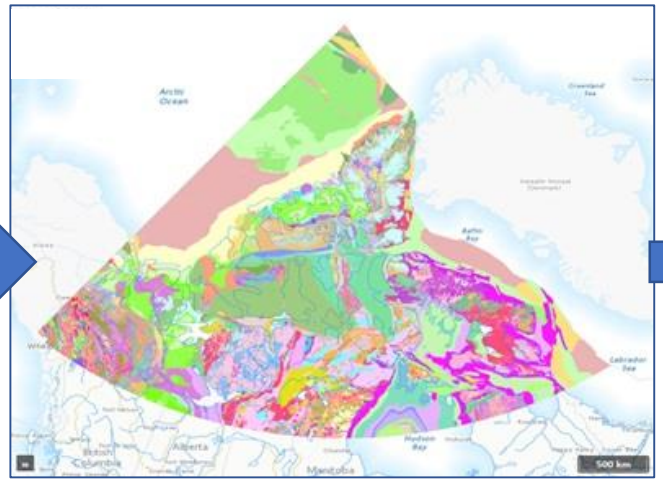
- **Innovate exploration** in data-rich areas
- Generate geoscience knowledge and develop innovative techniques to understand geological systems (how deposits form, and how can this help us predict where to find more)
- **National impact**

GEM-GeoNorth: $300 M over 20 years to update northern geoscience knowledge

- GEM was first launched in 2008 to bridge the significant knowledge gap in Canada's North
- In collaboration with the provinces and territories, GEM developed the **first integrated digital maps of Canada's North**:



Pre-GEM



GEM ($200M, 2008-2020):

- Updated geoscience knowledge of the North to minimum modern standards
- First digital bedrock map of the North

GEM-GeoNorth ($100M, 2020-2027)

- More focus in areas of likely development
- Consider current and future infrastructure: Climate change effects on Northern permafrost

GEM-GeoNorth is co-developing research priorities with P/Ts and Indigenous partners

- Since fall 2020, the territories have actively participated in GEM-GeoNorth's new process to **co-develop research priorities** with territories, provinces, and Indigenous governance organizations
  - Alignment with Northern priorities will help **maximize benefits for Northerners** and generate economic opportunities
  - The dialogue will continue for the duration of GEM-GeoNorth, to continuously inform program delivery and contribute to the design of future program iterations

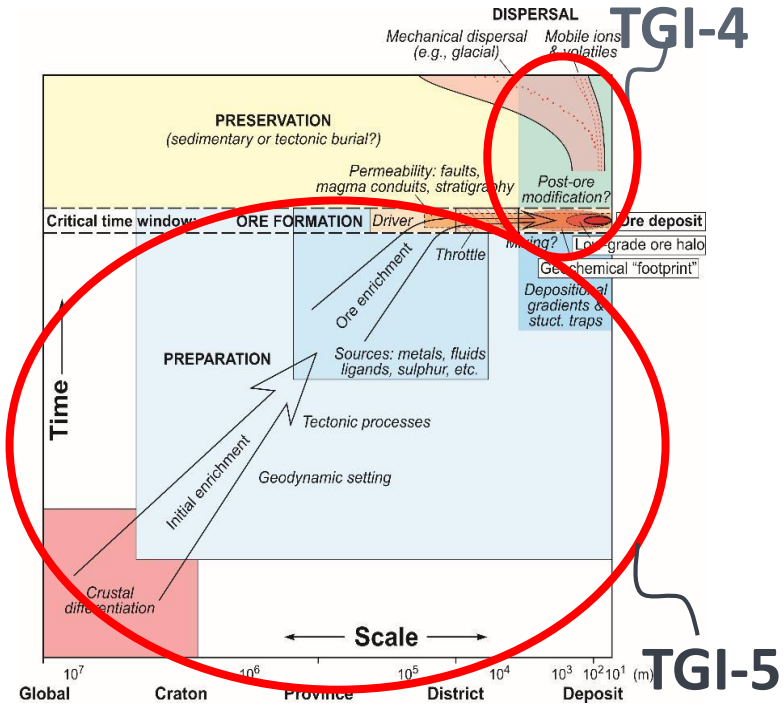
Priority-setting
Dialogue with P/Ts & over 78 Indigenous Governance organizations

TGI-6 is developing next-generation models of ore deposits to guide mineral exploration

- TGI was first launched in 2000 with the goal of stimulating cost-effective private sector exploration for mineral resources.

- Collaborative work with the provinces and territories to:
  - Developed the **next-generation models of ore deposits** to guide mineral exploration.
  - Identified a **new Cr-Ni-Cu-PGE "Chrome Superdomain"** (metallotect) from Manitoba to Eastern Quebec
  - Developed **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

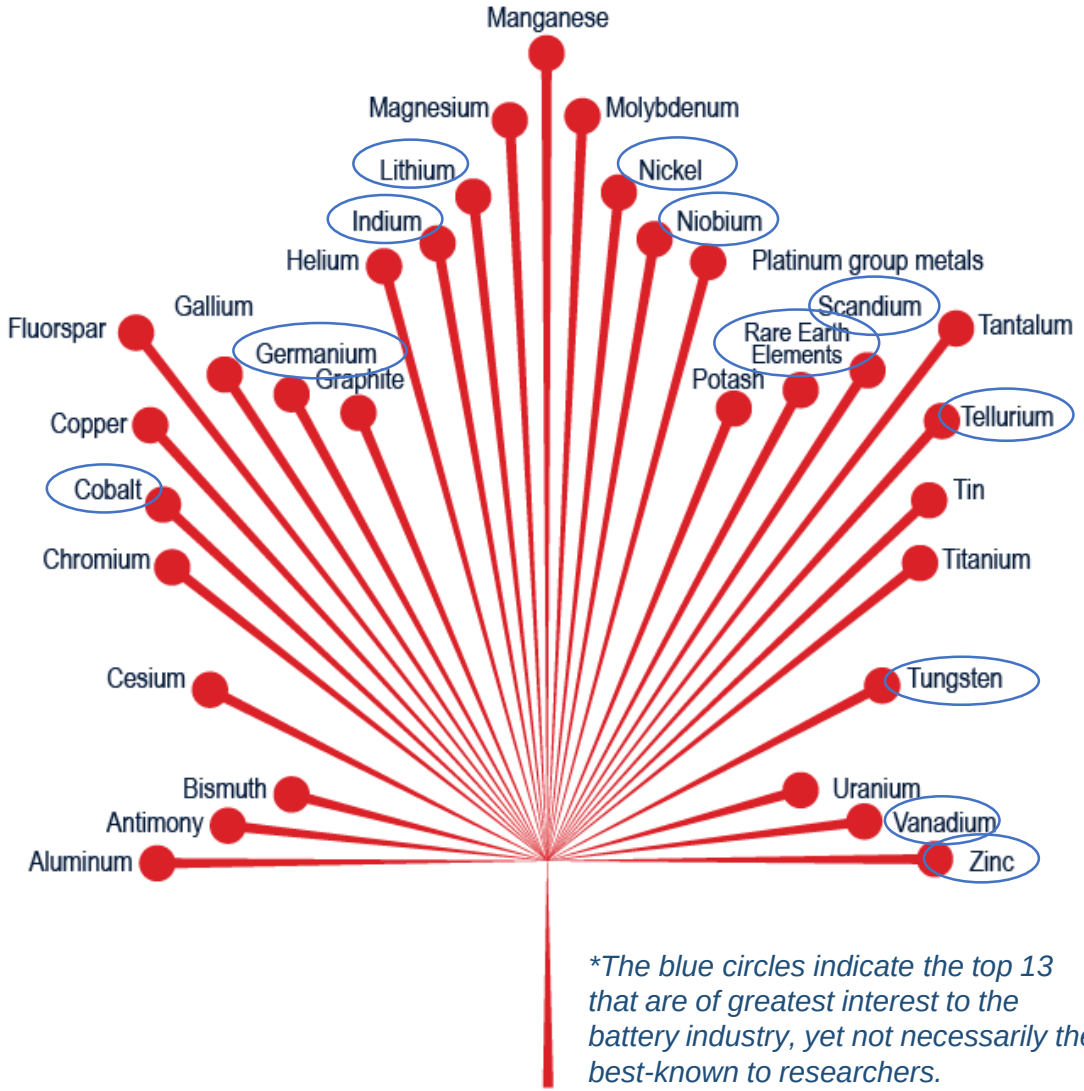


TGI-6 ($25M, 2020-2025)

- Focus on critical minerals
- Target deeply buried mineral deposits
- Leverage technologies such as AI and 3D visualization tools

Society's need for critical minerals pose new geoscience research challenges

- Canada has identified 31 minerals as critical to our nation.
- Geoscience is essential to answer key questions for developing these resources:
  - Where are they?
  - In what quantity?
  - How to access them?
- Both programs will improve knowledge to unlock critical minerals exploration:
  - GEM: mapping the North
  - TGI: developing models and tools



**The blue circles indicate the top 13 that are of greatest interest to the battery industry, yet not necessarily the best-known to researchers.*

TGI-6* focuses on critical minerals and other important metals and minerals

- 35 sub-activities / 11 field-based in summer 2021
- 25 out of ‘official list’ of 31 critical metals targeted, + gold
- 10 two-year Grants awarded to Canadian university researchers

Targeted Geoscience Initiative

Ore Systems Project	Digital Geoscience and Method Development Project
Activities:	**Activities:**
Hydrothermal Ore Systems (10)	AI and 3D Earth Modelling* (1)
Magmatic Ore Systems (10)	Method Development* (7)
Orogenic Ore Systems (6)	Spatial Data Infrastructure (1)

**See Annex for TGI project and grant details*

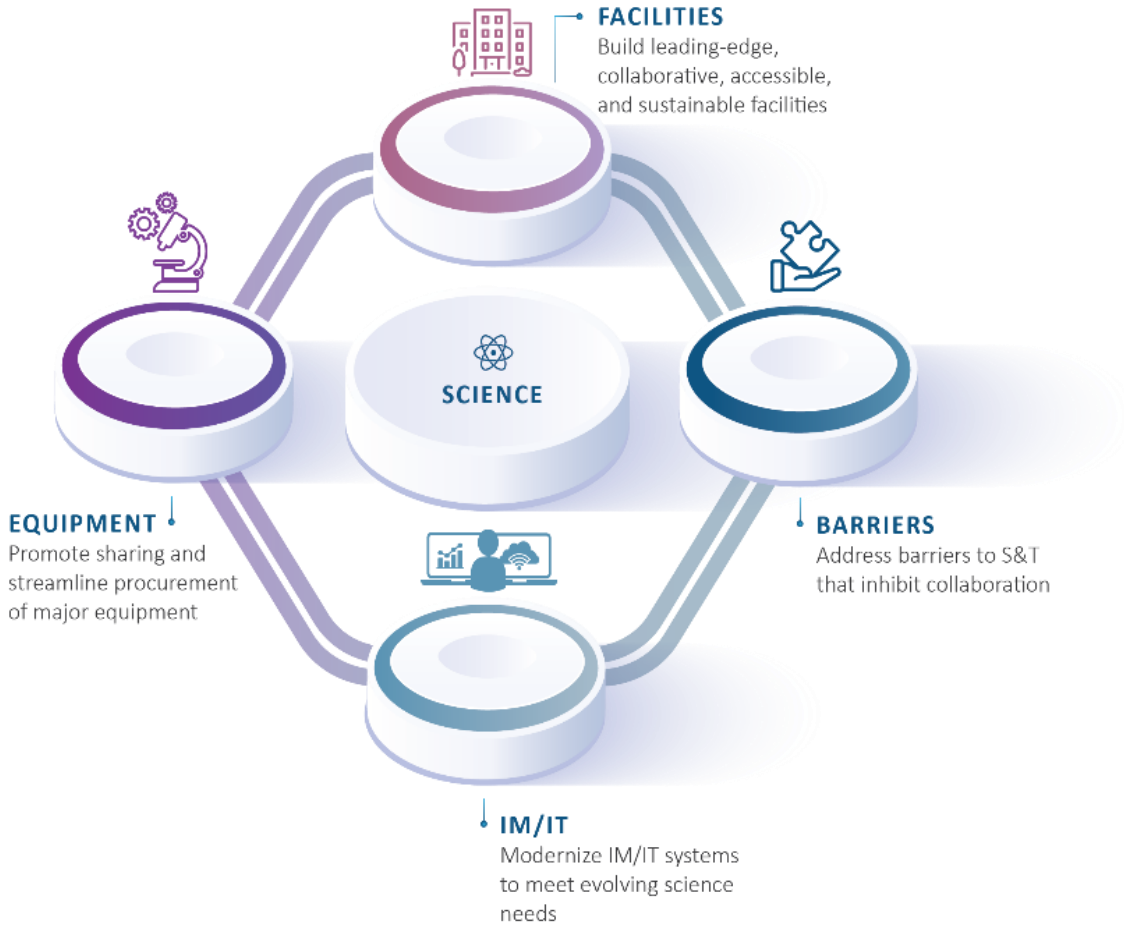
Data in the US-AU-Canada Critical Minerals and Mapping Initiative (CMMI) online repository helps predict new sources of critical minerals

- Companies don't report critical minerals that occur as bi-products in most cases
- The absence of public geochemical data is a major issue for assessing supply chain vulnerabilities and for identifying new sources of critical minerals
- The critical mineral portal addresses that data gap and is unique because it combines geochemistry with a new deposit classification for each sample
- The combined database can be used to predict the most favourable geological settings for a broad suite of critical minerals

Screen capture of the critical mineral portal (www.criticalminerals.org). This free online tool allows users to view, interact, and download critical mineral data from a large number of deposits around the world., https://portal.ga.gov.au/persona/cmmi

Laboratories Canada offers a once-in-a-generation opportunity to strengthen federal science…

- 25-year whole-of-government strategy to strengthen federal science (science.gc.ca)
- Aims to advance collaborative, multidisciplinary research through 4 pillars, with science as the key driver
- **Phase 1 (2018-2023):** $2.8 billion towards building world-class, collaborative, accessible, and sustainable science facilities



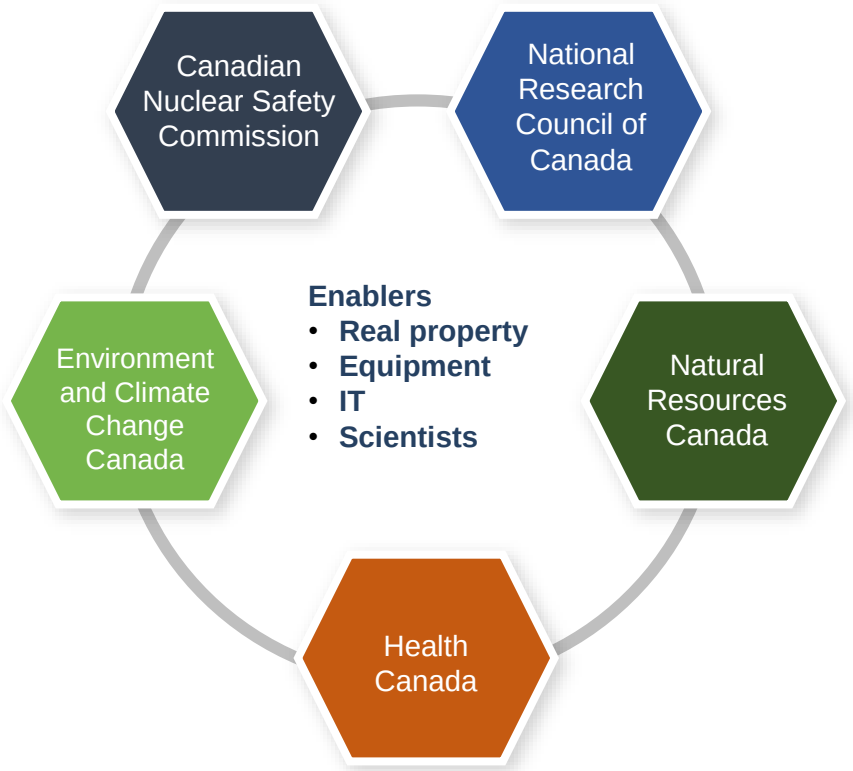
…and increase collaboration with regionally-based players

TerraCanada is one of several “hubs” within Phase 1 of Laboratories Canada

- Brings together over 1,700 employees from five federal science-based departments and agencies to:
  - Enable shared research agendas and infrastructure;
  - Promote transdisciplinary R&D and innovation;
  - Foster scientific excellence; and
  - Support evidence-based decision-making

TerraCanada science themes:

- Sustainable Land and Resources Development
- Low Carbon Economy
- Safety and Health for Canadians

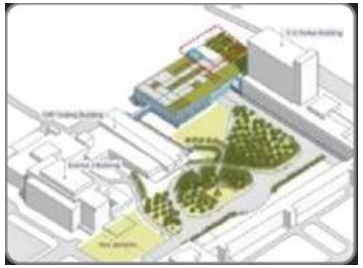


TerraCanada will have a network of science locations including the NCR & five regional offices

- Regional sites were identified based on existing synergies and enhancing collaboration with universities through co-location on campuses

Université du Québec en Abitibi-Témiscamingue, Val-d'Or Campus

L'Institut national de la recherche scientifique



Laurentian University

NRC Advanced Materials Research Facility

International Geoscience Diplomacy

- **International Union of Geological Science (IUGS)**
  - GSC DG Lebel and Canadian Federation of Earth Science Katherine Boggs co-chair Canada Committee for IUGS (CC-IUGS)
  - Represented Canada at IUGS Special assembly in Oct. 2020- New President elect is John Ludden
  - Looking at ways to increase Canadian presence in IUGS commissions, IGCP, etc
  - Organising a special session on 'Canadian Geoscience Diplomacy' at GAC/MAC 2022 – Halifax
    - Inviting contributions to celebrate success and future IUGS (@60 in 2021), IGCP (@50 in 2022), Global Geoparks Program
- **World Community of Geological Surveys**
  - Started in 2020 by GSC, USGS, Eurogeosurveys, reaching out to more than 150 Geological Survey Organisations worldwide- OAGS, ASGMI, CCOP, SP-GEM
  - Three free webinars held on Critical Minerals, Post Covid, 3 D geoscience
  - Ramping up free webinars focused on science for policy issues, sharing best practices

- **Others:** Critical Mineral Mapping Initiative, Global Earthquake Model, UNCLOS, IODP support, OneGeology, Digital Deep Earth (DDE), many MOUs with foreign GSOs, institutes (e.g. KOPRI, JAMSTEC).

For more information…and opportunities for collaboration

GEM GEO-NORTH

- G&C Call for proposals **ending Oct 29**
- Support development of HQP through hiring salary RAP students and post-doctoral fellows
- **Oct 26th to Dec 10th**, NRCan scientists will be invited to propose up to 3-year research activities – with P/T, academia, industry, Indigenous organizations, and community collaborators

For information: nrcan.gem-geonorth-gem-geonord.rncan@nrcan-rncan.gc.ca

WORLD COMMUNITY OF GEOLOGICAL SURVEYS (WCOGs)

- Participate in upcoming WCOGs-sponsored international geoscience events

Ask to join the mailing list: wcogs-scmsg@nrcan-rncan.gc.ca

PAN-CANADIAN GEO-SCIENCE STRATEGY (PGS)

- Participate in engagement sessions or working groups to shape PGS actions (COMING SOON)

Next Generation Geoscientists

Public Literacy in Geoscience

For information or to get involved: ngsc-cncg@nrcan-rncan.gc.ca

TARGETED GEOSCIENCE INITIATIVE (TGI-6)

- HQP development through mentoring and hiring bursary & salary RAP students, post-doctoral fellows, FSWEP, Co-op, Casuals and Post-doc recruitment program
- Grants program for successful academic and P/T applicants in research areas that align with TGI priorities (last call Feb 2021; not currently accepting submissions)

For information: NRCan.tgi-igc.RNCan@canada.ca

CRITICAL MINERALS MAPPING INITIATIVE (CMMI)

Visit the Critical Minerals Portal: https://portal.ga.gov.au/persona/cmmi

LABORATORIES CANADA / TERRACANADA

Learn more at: https://science.gc.ca/eic/site/063.nsf/eng/h_97809.html

GSC ANNUAL REPORT 2019-20

Download the report

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WCOGs: together, we're bringing the knowledge of the global geoscience community to bear on some of society's most pressing issues

The World Community of Geological Surveys (WCOGs) Mission:

WCOGs is a best practice community of national and regional geological survey organizations that will connect leaders, generate synergy, and provide mutual support with the aim of promoting a global dialogue on the place of geoscience in addressing national and global issues.

- Connecting geological surveys and the broader geoscience community through WCOGs-sponsored events:
  - **June 2020:** *How Geological Survey Organizations can support national and international post-Covid recovery*
  - **Nov 2020:** *Responding to societal needs through 3D geology: an international perspective*
  - **Feb 2021:** *Critical Minerals Forum: advances in critical minerals research*
  - Planning is underway for an event in 2022…

World Community of Geological Surveys

TGI-6 Ore Systems Project: **Hydrothermal** Ore Systems Activity (10 projects)

Lead	Project
James Kidder	Hydrogeochemical methods for critical metal exploration
Beth McClenaghan	Indicator mineral chemistry to assess prospectivity for critical metals
Suzanne Paradis	Paleozoic western continental margin of North America–hunting ground for critical minerals in carbonate-hosted mineral deposits
Jan Peter	Controls on critical metals in volcanogenic massive sulfide deposits and seafloor massive sulfide modern analogues
Alain Plouffe	Epidote trace element chemistry: a vector towards porphyry Cu deposit discovery
Victoria Tschirhart	Deep uranium fluid pathways
Michael Gadd	Metallogeny and critical mineral potential of middle Cretaceous manganiferous, phosphatic ironstones of the Rapid Creek Formation, Yukon
Louise Corriveau	Metasomatic iron and alkali-calcic systems with iron oxide-copper-gold (IOCG) and critical metal deposits
Heather Crow	New applications of borehole fluid profiling techniques in support of ore systems research
Stephen Grasby	REE potential of sedimentary phosphorites

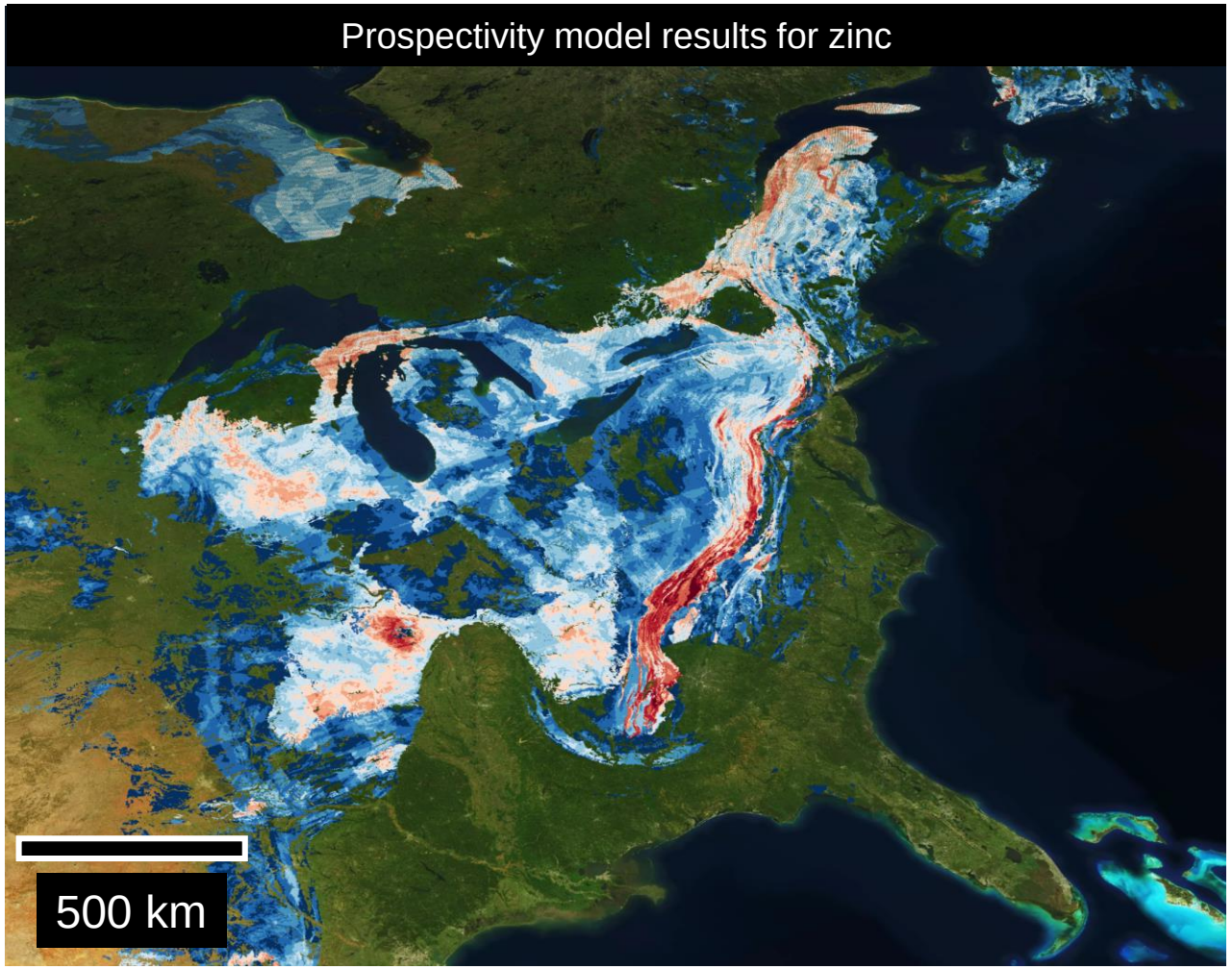
TGI-6 Ore Systems Project: **Magmatic** Ore Systems Activity

Lead	Sub-activity title
Jean Bédard	Chromite & PGM in Ophiolitic complexes using the Bay of Islands Complex (BOIC) as a natural laboratory
Wouter Bleeker	Advancing the understanding of the globally significant Circum-Superior mineral system
Michel Houlé	Large mafic and ultramafic magmatic events in the Superior Province: Insights in their critical metals potential
Bruce Kjarsgaard	Carbonatite Rare Metal Mineralization
Chris Lawley	Lithospheric footprints of the Golden Triangle, northwest British Columbia
Dejan Milidragovic	Petrology of Ni-Cr-Cu-PGE mineralization in Alaskan-type intrusions
Alex Zagorevski	Post-collisional porphyry mineralization in the Cordillera
Neil Rogers	Appalachian Deep Time Machine
Anne-Aurelie Sappin	Critical minerals within carbonatitic, syenitic, and allied peralkaline-alkaline intrusions in Canada: where, when and how were they formed
Jennifer Smith-Holder	Ni-Cu-Co-PGE and other critical metal deposits of North America's 1.1. Ga failed Mid-Continent Rift

Example: Support critical mineral discovery (Chris Lawley)

Zinc Modelling

- Climate change, COVID, and critical mineral supply chains are all reminders that the Earth is an interconnected system of systems.
- Public geoscience and artificial intelligence-based methods can be used to map some of the interactions between water, air, rock, and living things that combine to form critical mineral deposits.
- Predictive models generated from this systems approach leverage public geoscience across borders for mutual benefit and support critical mineral discovery.



Sediment-hosted prospectivity model for eastern North America showing the most geologically favourable areas for zinc mineralization and associated critical minerals (e.g., cadmium, gallium, germanium, indium, antimony).

TGI-6 Ore Systems Project: **Orogenic** Ore Systems

Lead	Projects
Sébastien Castonguay	Geological setting and metallogeny of the Detour-Harricana-Turgeon belt and Fenelon deposit, NW Abitibi, Quebec and Ontario
Ian Honsberger	Orogenic gold systems of the Canadian Appalachians: Central Newfoundland and beyond
Patrick Mercier-Langevin	Orogenic gold deposits: A closer look at the diversity of types, styles and ages of gold deposits in greenstone belts
Jean-Luc Pilote	Metallogeny of auriferous systems in the Urban-Barry orogenic belt, NE Abitibi Subprovince, Quebec
Nicolas Pinet	Time-temperature history of faults
Rob Rainbird	Huronian Paleoplacer Gold

TGI-6 : **AI and 3D** Modelling Activity

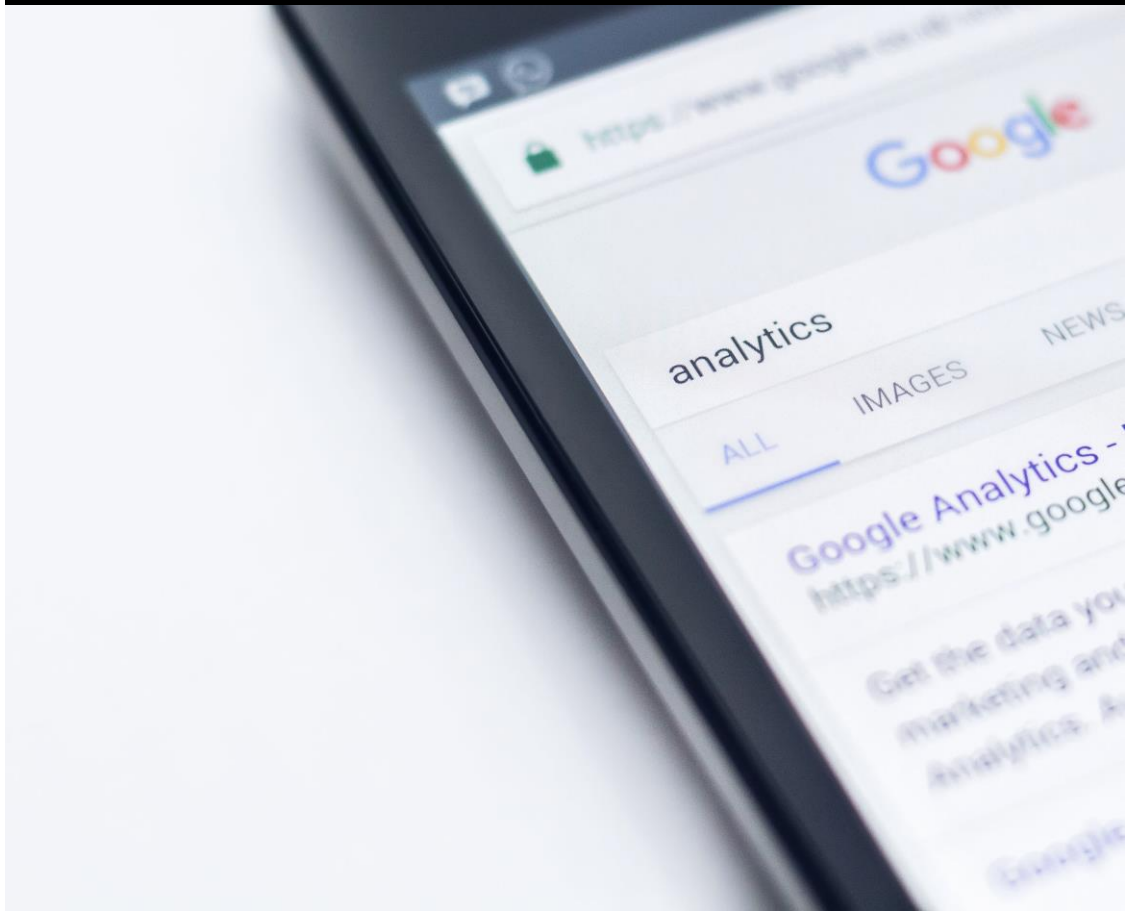
Lead	Projects
Nicolas Pinet	Reconnaissance automatique des fractures à partir de photos de forages : développements méthodologiques et applications géologiques

Example: AI-Based Research - New geoscience language models

AI-Based Research

- Language models are the foundation for the predictive text tools that billions of people use on their phones everyday.
- However, language models are often trained on vast quantities of general text (e.g., Wikipedia).
- In collaboration with ServiceNow, geological text was harvested from public scientific documents (e.g., GEOSCAN) to re-train the latest language models for geoscience applications.
- The new language models perform better and are being applied to provide new keyword prediction tools and advanced search functions for improved access to our public geoscience.

Have you ever used predictive text?



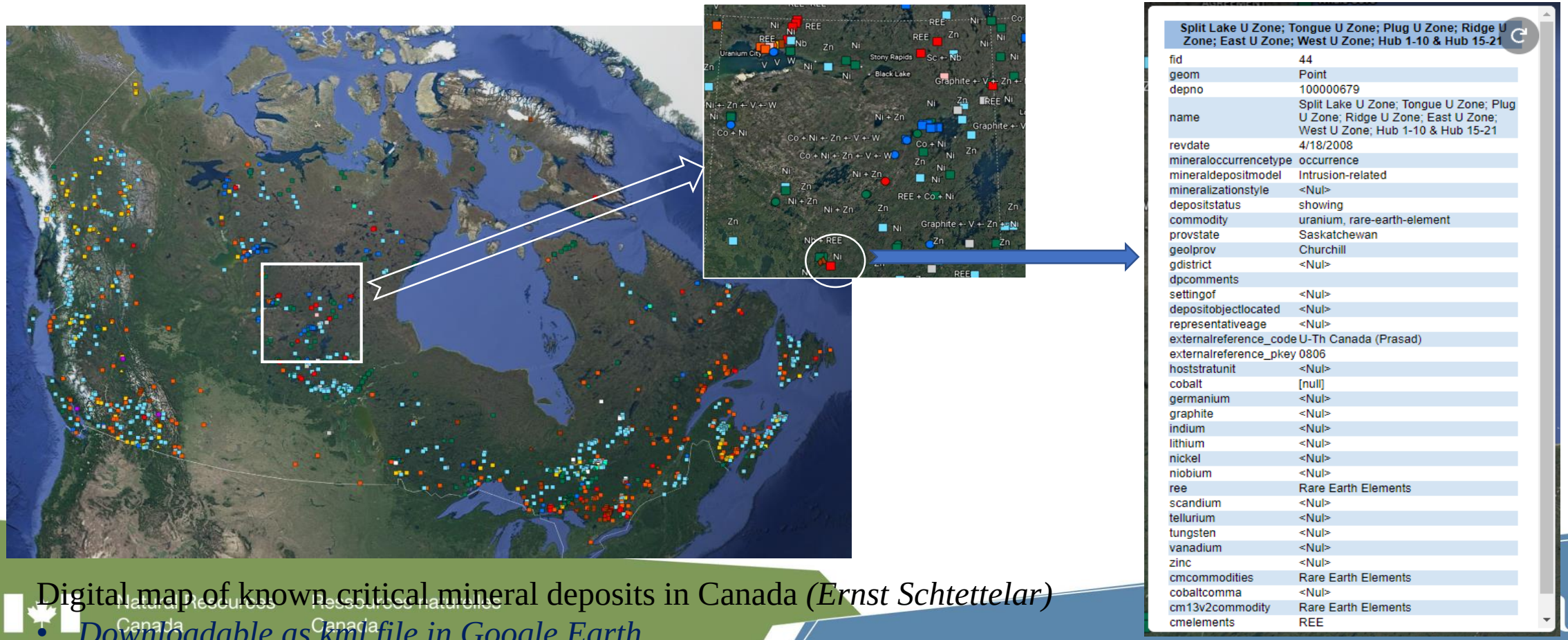
Language models are behind many of the digital tools we use everyday (e.g., prediction, search, translation).

TGI-6: Method development

PI(s)	Sub-activity title
Bill Davis	Tracking metal sources in ore systems: High precision Pb isotopic analyses of ore minerals at low Pb concentrations by LA-MC-ICP-MS
Bill Davis and Duane Petts	Unconventional Geochronometry Tools
Simon Jackson	Development of microbeam sulphide reference materials
Jeanne B. Percival	Detecting Rare Earth Element Minerals in Rocks Using a Field Portable Infrared Spectrometer
Jeremy Powell	Linking Geochemistry and Structure at the Microscale to Regional Fluid Pathways
Natasha Wodicka	ID-TIMS development work in support of ore deposit studies: U-Pb geochronology of ore-associated oxide minerals and zircon petrochronology
Zhaoping Yang	Germanium stable isotopic signatures in sphalerites

TGI-6 : **Spatial Data Infrastructure**

PI	Sub-activity title	Comments
Ernst Schetselaar	Spatial data infrastructure (SDI) for TGI-6	Activity-level work to support data management and dissemination for the entire program



Digital map of known critical mineral deposits in Canada *(Ernst Schtettelar)*

- *Downloadable as kml file in Google Earth*

TGI-6 Grants

PI	Institution	Sub-activity title
Alan Anderson	St- F.X.	The thermal reconstruction of pegmatite fields at the time of dike propagation and emplacement: A guide for targeting concealed lithium and tantalum deposits
James Brenan	Dalhousie U.	Tracking critical metals in felsic igneous systems: Tools and Applications
Anton Chakmouradian	U. Manitoba	Carbonatite magmatism and rare-earth potential of the Superior Boundary Zone, Manitoba
Daniel Gregory	U. Toronto	The geology and geochemistry of stratabound high grade V, Ni, Mo, Cu, and PGE mineralization, in Yukon, NWT, and BC
Jacob Hanley	St-Mary's	Experimental evaluation of the thermodynamic properties of cobalt minerals and aqueous species, for modelling hydrothermal Co ore formation
Lori Kennedy	UBC	Structural evolution of the Galore Creek alkalic porphyry Cu-Au deposit (northwestern British Columbia): Implications for exploration
C. Lafrenière-Bérubé	Polytechnique	Unlocking deep learning capabilities for mineral prospectivity mapping with novel geoscience data augmentation techniques
Pilar Lecumberri-Sanchez	U. Alberta	Tungsten metallogeny in the MacKenzie Mountains
James Mungall	Carleton U.	Camp-scale to thin-section-scale controls on Pd mineralization at Lac Des Iles Mine, Canada's only primary Pd mine
Anthony Williams-Jones	McGill U.	Experimental evaluation of the thermodynamic properties of cobalt minerals and aqueous species, for modelling hydrothermal Co ore formation

- A total of $500K/year allotted over FY 2021-22 and 2022-23