QUÉBEC GEOSCIENCE CENTRE

ANNUAL REPORT 2020-2021

Resources and the Environment: Bridging two worlds

INRS Institut national de la recherche scientifique

Canada

Annual report from May 1, 2020 to April 30, 2021

Available in electronic format: cgq-qgc.ca/en/annual-reviews

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MESSAGE FROM THE DIRECTORS

A year of adaptation and resilience

COVID-19

The year 2020-2021, marked by the COVID-19 pandemic, has forced us to rethink our practices and reinvent ourselves. The impact of the pandemic on our lives and our work is unprecedented. Starting with our workplace. To address the issues associated with COVID-19 and minimize the impacts, the Joint Health and Safety Committee has been hard at work. Several key individuals coordinated access to the building and the delivery of protective equipment, completed numerous documents required for return to the workplace and trained employees. This collaborative effort put in place the tools and sanitary rules to reduce the risk of spreading the virus within the community, even though many people were telecommuting for most of the year.

QGC

Distance and virtual mode have not prevented the members of the Québec Geoscience Centre (QGC) from standing out and continuing their quest for excellence. It is a valuable asset for a federal research agency, such as the Geological Survey of Canada (GSC), and a university, such as the Institut national de la recherche scientifique (INRS) to be able to work in collaboration. An asset that must be preserved and developed in order to respond to the current challenges of our society while being at the forefront of geoscience research.

Team

With more than 20 years of experience at the GSC, Réjean Couture becomes the new Director of the GSC-Quebec (GSC-Q) in August 2020, succeeding Andrée Bolduc who had headed the office for 8 years. Last April, Louise Hénault-Ethier became the new Director of the Eau Terre Environnement Research Centre (ETE) of INRS. André St-Hilaire returned to his full-time teaching position after having served as interim director of the Centre for 12 months.

Geoscience

A pivotal year for science programs as well. At the GSC, the Geo-mapping for Energy and Minerals program, renamed GEM-GeoNorth (2020-2027), and the Targeted Geoscience Initiative (TGI; ongoing) were renewed, bringing new perspectives to the partnership. The TerraCanada initiative has also been launched and will expand the geoinformatics and geoenvironmental teams and infrastructure. The ETE Centre of INRS presented its new five-year scientific program to reflect the evolution of research activities for the coming years.

Thanks to all and congratulations!

Réjean Couture
Director of the Geological Survey of Canada in Quebec

André St-Hilaire
Interim Director of the Eau Terre Environnement Research Center of INRS

QUÉBEC GEOSCIENCE CENTRE

Who are we?

- A unique partnership between a university centre (Eau Terre Environnement Research Centre - ETE of the Institut national de la recherche scientifique - INRS) and a government agency (Quebec Division of the Geological Survey of Canada - GSC-Q of Natural Resources Canada - NRCan)

Our mission

- Respond to relevant socio-economic issues by developing knowledge of regional geology, georesources and environmental geosciences

Our vision

- Collaborate to be a focal point of excellence in geoscience, open to all, while ensuring the cooperation and participation of Canadian governments, agencies and universities

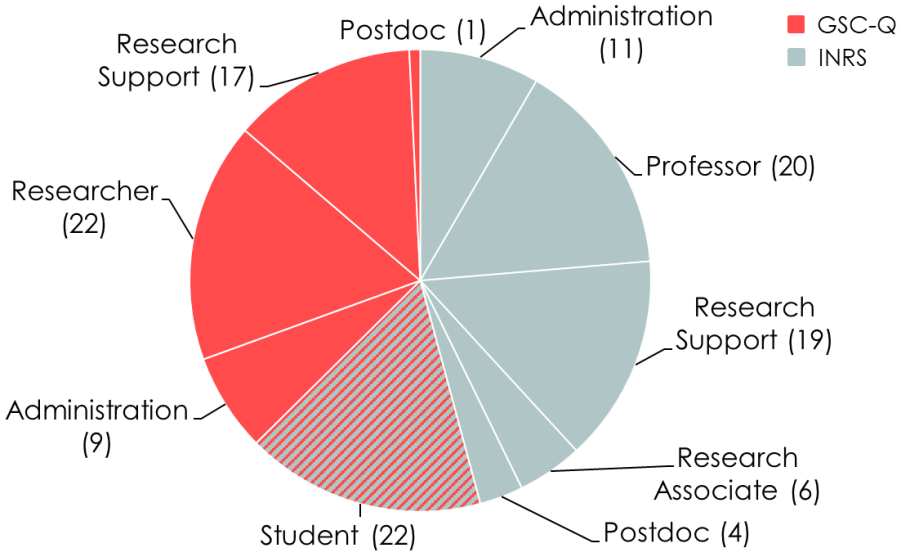
Our objectives

- Foster scientific collaboration between the ETE Centre and the GSC-Q
- Raise awareness of the general public to the Earth Sciences and to contribute to arouse the interest of the youngest
- Publish outreach materials and organize special events to engage and support youth interest in science
- Train the next generation of scientists through the inter-university graduate program in Earth Sciences offered jointly by INRS and the Department of Geology and Geological Engineering of Laval University

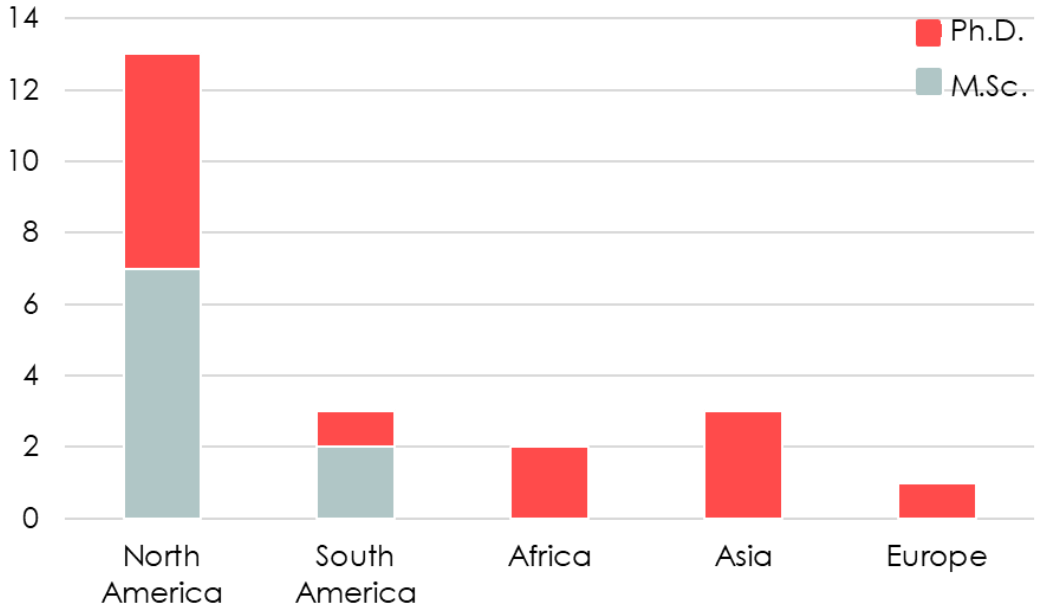
One of Canada's largest multi-disciplinary earth science research clusters

THE QGC IN A FEW FIGURES

Our members



Country of origin of our students



3 Research Chairs

30 Awards

19 Joint Projects

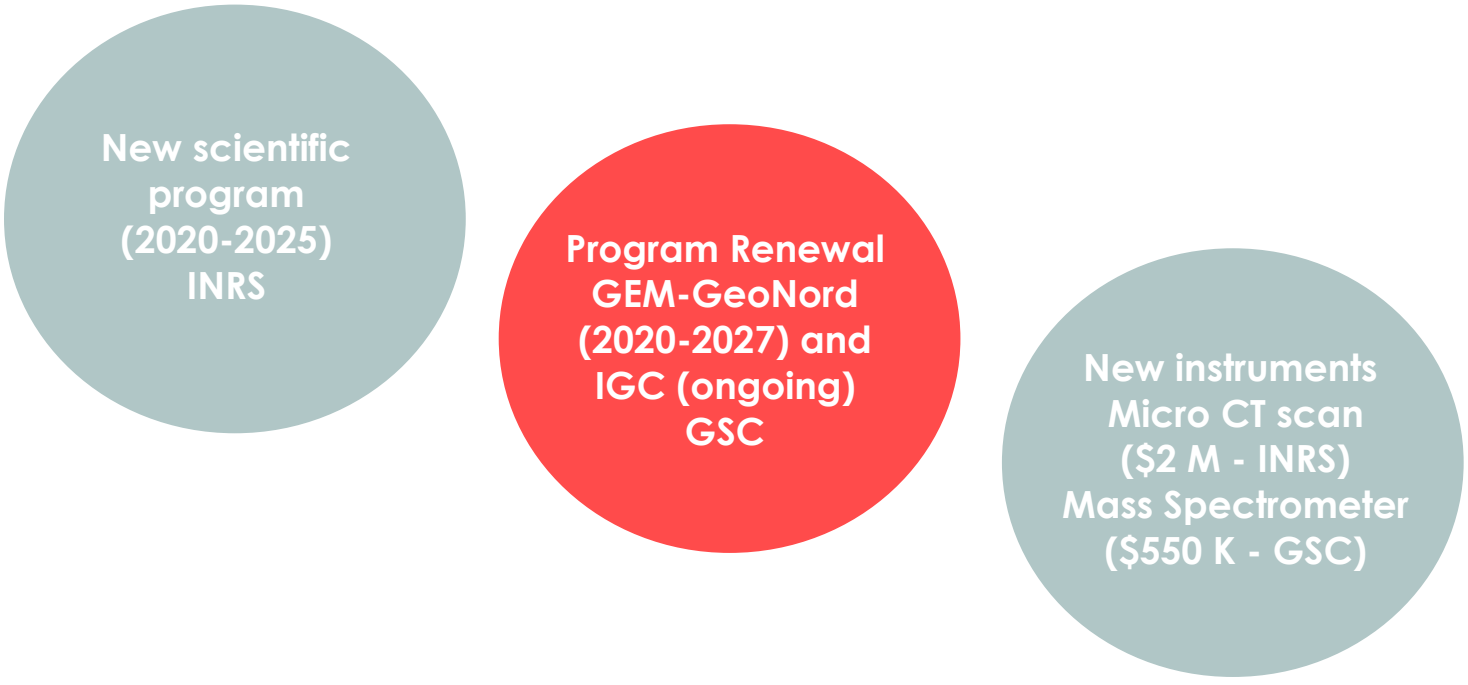
HIGHLIGHTS

Reinventing the QGC

Over the past year, consultations were held within our two organizations to discuss the future of the QGC. Several ideas were put forward to increase member involvement, sense of belonging and visibility. To this end, a joint committee of professors/researchers, research assistants/professionals, technicians and students will be formed in the fall of 2021 to reinvent the QGC and maximize its potential.

TerraCanada

TerraCanada is one of several "science clusters" in Phase 1 of the Laboratories Canada strategy led by Public Services and Procurement Canada. This initiative brings together more than 1,600 scientists from five federal departments, including NRCan, to strengthen federal science and renew laboratory infrastructure. It has a direct impact on the QGC through the expansion of geoinformatics and geoenvironmental teams and infrastructure. Its goals include (1) leveraging expertise in artificial intelligence to develop technologies and management systems to support geoscience, and (2) better monitor environmental contaminants throughout the resource development cycle.



GEOSCIENCES AT THE SERVICE OF ECONOMIC DEVELOPMENT AND THE ENVIRONMENT

GSC Team	INRS Team	Expertises	For more information
Define the geological framework to guide mineral exploration			
Jean Bédard	**Lyal Harris**	Tectonics	**Bédard, J.** (2020) From the LIPS of a serial killer: Endogenic retardation of biological evolution on unstable stagnant-lid planets. Planetary and Space Science 192, 105068. doi.org/10.1016/j.pss.2020.105068
Patrick Mercier-Langevin, Benoît Dubé, Jean-Luc Pilote, Kathleen Lauzière, Valérie Bécu	Pierre-Simon Ross, Liam Maw (M. Sc.), Émile Boily-Auclair (M.Sc.), Octavio Vite Sanchez (Ph.D.)	Metallogeny Gitology Volcanology	**Boily-Auclair, É. *et al.*** (2020) Stratigraphic setting of the LZ5 and Ellison mineralized zones, LaRonde Zone 5 Project, Doyon-Bousquet-LaRonde mining camp, Abitibi, Quebec; in Targeted Geoscience Initiative 5: Contributions to the Understanding of Canadian Gold Systems, (ed.) P. Mercier-Langevin, C.J.M. Lawley, and S. Castonguay; Geological Survey of Canada, Open File 8712, p. 57–73. doi:10.4095/323665 (1)
Patrick Mercier-Langevin, Benoît Dubé, Sébastien Castonguay, Kathleen Lauzière, Valérie Bécu	Michel Malo, Brayden St-Pierre (M.Sc.)	Metallogeny Gitology Structural geology	**St-Pierre, B. *et al.*** (2020) Structural controls and relative timing of gold mineralization of the banded iron formation-associated Tiriganiaq deposit, Meliadine district, Rankin Inlet greenstone belt, Nunavut; in Targeted Geoscience Initiative 5: Contributions to the Understanding of Canadian Gold Systems, (ed.) P. Mercier-Langevin, C.J.M. Lawley, and S. Castonguay; Geological Survey of Canada, Open File 8712, p. 237–250. doi:10.4095/326041 (2)
Patrick Mercier-Langevin, Kathleen Lauzière, Valérie Bécu	Pierre-Simon Ross, Simon Tremblay-Hébert (M.Sc.),	Metallogeny Volcanology	**Project**: Géologie des indices aurifères de la zone Caniapiscau-Koksoak de l'Orogène du Nouveau Québec (Fosse du Labrador) (3)
Support the development of sustainable energy solutions			
Stéphanie Larmagnat	**Jasmin Raymond**, Michel Malo, Mirah Rajaobelison (Ph.D.)	Geothermal energy Structural geology Petrography Petrophysics Thermostratigraphy	**Rajaobelison, M. *et al.*** Assessment of Petrophysical Rock Properties in North Madagascar: Implications for Geothermal Resource Exploration. Natural Resources Research. doi.org/10.1007/s11053-021-09875-9 (4)
Stéphanie Larmagnat	**Jasmin Raymond**, Maria José Oviedo Valencia (M.Sc.)	Geothermal energy Petrophysics Tomodensitometry	**Project**: Testing artificial fracture effects on rock properties (porosity, permeability, thermal conductivity) (5)
Daniel Paradis	**Erwan Gloaguen**, Jasmin Raymond, Benyamin Shariatinik (Ph.D.)	Geothermal energy Hydrogeology Geophysics Data assimilation	**Project**: Optimisation des systèmes de géothermie (6)
Christine Rivard, Stéphanie Larmagnat	Jasmin Raymond, Pierre Francus, Damien Pham Van Bang, Félix-Antoine Comeau, Mathieu Des Roches, Louis-Frédéric Daigle, Philippe Lettelier, Abdelkader Hammouti, Violaine Gascuel (Ph.D.)	Geothermal energy Structural geology Petrography Petrophysics Thermostratigraphy Tomodensitometry Physical and numerical modelling Hydraulics	**Gascuel, V. *et al.*** (2020) Heat production from sedimentary basins: a modelling study of the Bécancour area in the St Lawrence Lowlands, Québec, Canada. GSA online connects, virtual, 26-29 October (7)

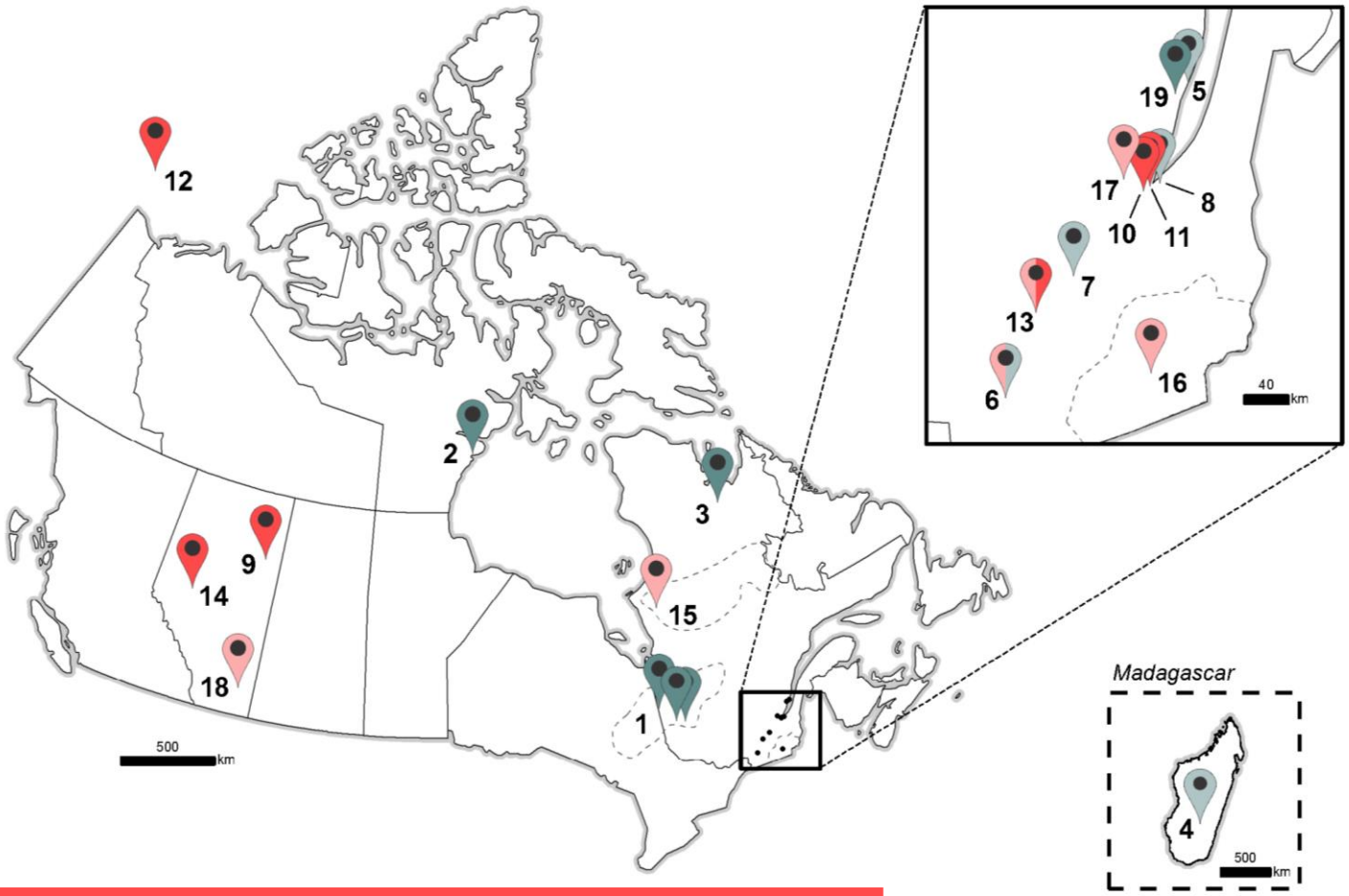
Christine Rivard, Michel Parent, Vincent Tremblay	Jasmin Raymond, René Lefebvre, Jérôme Comte, Felix-Antoine Comeau, Geneviève Bordeleau, Victoria Lee (M.Sc.), Charis Wong (Ph.D.), Oleksandra Pedchenko (Postoc)	Geothermal energy Hydrogeology Geochemistry Microbial ecology Numerical modelling	Lee, V. (2020) Groundwater Heat Pump (GWHP) Systems to Fight Urban Heat Islands: A Solution for Canada's Major Cities. Master's project proposal, INRS, 21 pages (8)
Understand the impact of human activities on the environment			
Jason Ahad, Jade Bergeron, Marc Luzincourt, Hooshang Pakdel, Anna Smirnoff, Leah Mindorff	Valérie Langlois, Richard Martel, Luc Trépanier, Scott Hepditch (Ph.D.)	Isotopic geochemistry Organic geochemistry	**Ahad, J.M.E., *et al.*** (2020) Understanding the behaviour and fate of diluted bitumen in shallow groundwater systems. SETAC North America 41st Annual Meeting, virtual, 15-19 November (9)
Jason Ahad, Jade Bergeron, Hooshang Pakdel, Anna Smirnoff, Leah Mindorff	**Pierre Francus**, Claude Fortin, Arnaud De Coninck, Léo Chassiot (Postdoc)	Environmental sedimentology Geochemistry of metals Organic geochemistry	**Project**: Dynamiques spatio-temporelles des contaminations anthropiques au sein des sédiments de la rivière Saint-Charles (Québec, QC, Canada)(10)
Mathieu J. Duchesne	**Bernard Giroux**, Pierre Francus, Mathieu Des Roches, Philippe Letellier, Louis-Frédéric Daigle, Ehsan Vosoughi (Ph.D.)	Applied geophysics Environmental sedimentology	**Project**: Caractérisation tomodensimétrique, électrique et acoustique de la dégradation du pergélisol (11)
Mathieu J. Duchesne	**Jasmin Raymond**, Félix-Antoine Comeau, Nicolò Giordano (Postdoc)	Applied geophysics Geothermal energy	**Project**: Caractérisation géothermique pour la simulation numérique de la dégradation du pergélisol sous-marin (12)
Daniel Paradis	Erwan Gloaguen, René Lefebvre, André St-Hilaire, Lemuel Carlos Ramos Arzola (Ph.D.)	Hydrogeology Hydrology Heat transfer Numerical modelling Digital inversion	**Project**: Modélisation hydrothermique couplée des ressources en eau de surface et souterraine (bassin de la rivière Yamaska) (13)
Christine Rivard, Vincent Tremblay	Claudio Paniconi, Geneviève Bordeleau, Bernard Giroux, Laura Isabel Guarin-Martinez (M.Sc.), Barbara Javiera Meneses Vega (Ph.D.)	Hydrogeology Geology Geochemistry Geophysics	**Rivard, C. *et al.*** (2020) Overview of a project aiming to assess environmental impacts of oil and gas activities in the Fox Creek area (AB). GeoConvention 2020, virtual, 21-23 September (14) **Guarin-Martinez, L.I.** (2020) Application of a Distributed Model to Study Surface/Subsurface Flow Interactions in the Fox Creek Area, Alberta. Master's project proposal, INRS, 61 pages
Characterize water resources			
Christian Bégin, Martine M. Savard, Joëlle Marion	Yves Bégin, Pierre Francus	Dendrogeochemistry Dendrochronology Environmental sedimentology	Bégin, C. *et al.* (2021) Utilisation des archives naturelles pour la reconstitution du passé hydro-climatique. Commission géologique du Canada, Dossier public 8768, 211 p. doi.org/10.4095/328045 (15)
Daniel Paradis	Erwan Gloaguen, Xiao Xia Liang (Ph.D.),	Hydrogeology Hydrology Data assimilation	Project: Assimilation de données hydro-climatiques pour la prédiction de l'état et la qualité des ressources en eau (Yamaska et Mercier) (13)
Daniel Paradis	René Lefebvre, Raphaël Mathis (M.Sc.)	Hydrogeology Geochemistry Numerical modelling	Project: Modélisation des patrons d'écoulement et du temps de résidence de l'eau souterraine pour un système aquifère rocheux et de vallées enfouies (16)
Daniel Paradis	René Lefebvre, Jasmin Raymond, Jean-Marc Ballard, Cynthia Lee (M.Sc.)	Hydrogeology	Lee, C. *et al.* (2020) Inferring high-resolution aquifer hydraulic conductivity and groundwater fluxes by active heat tracer using direct push fiber optics. EGU2020-9709, virtual, May 4-8 (17)

Daniel Paradis	**René Lefebvre**, Aymen Nefzi (Ph.D.)	Hydrogeology Numerical modelling	**Project:** Évaluation du potentiel de la tomographie hydraulique oscillatoire pour la caractérisation de l'hétérogénéité des aquifères granulaires (6)
Michel Parent	**Richard Martel**, Thomas Robert, Luc Trépanier, Marco Boutin, Karine Bédard, Jean-Sébastien Gosselin, Marc-Alexandre Fillion (Ph.D.), Jean-Philippe Drolet (Postdoc)	Hydrogeology Quaternary	**Project**: Groundwater characterization of Canadian range training areas (18)
Adapt to natural hazards			
Didier Perret	**Damien Pham Van Bang**, Marc Richer-Laflèche, Jacob Stolle	Coastal engineering Hydraulics Soil mechanics Seismic geotechnics	**Project**: INtercomparaison d'Échelle et de Dimensionalité d'outils de prévision multi-risques: érosion, submersion côtière, Inondation par Embacle (INÉDINE) (19)

In bold: project leader(s)

(*): Project location number on the map

Location of our projects for the year 2020-2021



Supporting mineral resource exploration while helping environmental protection

KNOWLEDGE DISSEMINATION

Characterize water resources

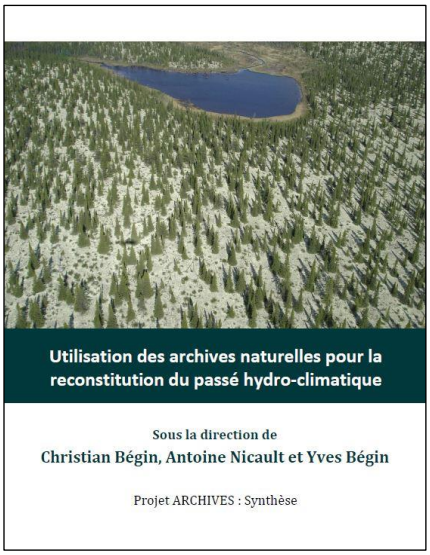
Publication of the synthesis report ARCHIVES

Context

The ARCHIVES project, which ran from 2008 to 2014, was a collaboration between GSC-Quebec (Christian Bégin and Martine Savard) and INRS (Yves Bégin and Pierre Francus). It involved several universities in Quebec (UQAR, UQAM, Laval University) and Europe as well as Hydro-Québec and OURANOS as partners. This project's goal was to develop and use climate-sensitive indicators to reconstruct the long-term natural variability of hydro-climatic parameters determining water supply in basins of interest for hydroelectric production in northeastern North America. These indicators are natural archives derived from dendrochronology, dendroisotopy and lake sedimentology. At the end of the project, managers of hydroelectric resources as well as authorities concerned with climate change benefit from a better knowledge of the spatio-temporal evolution of hydro-climatic conditions. This knowledge will facilitate the development of future hydrological scenarios appropriate for this region, which is sensitive in many ways to climate change.

Product

The most important findings of this colossal work carried out by the ARCHIVES team of researchers has just been published by the GSC in the form of an open access synthesis report (Bégin, C. *et al.*, 2021). The 21 chapters of this impressive 211-page document will certainly constitute a reference in the field of paleoclimatology. In addition, Christian Bégin, Martine Savard and Joëlle Marion received the Logan Award from the GSC Director for their work in dendrogeochemistry over the past 25 years.



Synthesis report of ARCHIVES project

Understand the impact of human activities on the environment

Understand the environmental impact of diluted bitumen

Context

Alberta oil sands are one of the largest bitumen reserves in the world. Unlike conventional crude oil, bitumen is a highly degraded viscous oil. To transport it by pipeline, it must be mixed with lighter hydrocarbon fractions, resulting in a less viscous diluted bitumen (called 'dilbit'). Although pipelines are considered safer than other means of transportation, major spills have occurred. As a result, approvals for new pipelines have raised public concern about the environmental impacts of potential dilbit spills.

Objectives

Although a growing number of studies address the behaviour and toxicity of dilbit in fresh and salt water environments, few detail the fate and transport of dilbit in the vadose zone and groundwater. To address this knowledge gap, GSC (Jason Ahad) and INRS (Valérie Langlois, Richard Martel) teams are collaborating to better understand the degradation and toxicity of dilbit in shallow groundwater systems. The results of this research will be used to better inform the public as to whether spilled dilbit poses a greater, equal or lesser threat to aquifers than conventional crude oil spills.

Soil core sampling during a controlled dilbit spill

Method

To this end, Ph.D. candidate Scott Hepditch is conducting separate controlled spill experiments with dilbit and a comparative sample of a conventional crude oil blend with similar physical and chemical properties. These spills were conducted in large unsaturated soil columns. Column leachate and soil core samples have been collected to determine a range of toxicological, geochemical, and microbial parameters. The next steps will involve working with saturated soil tanks.

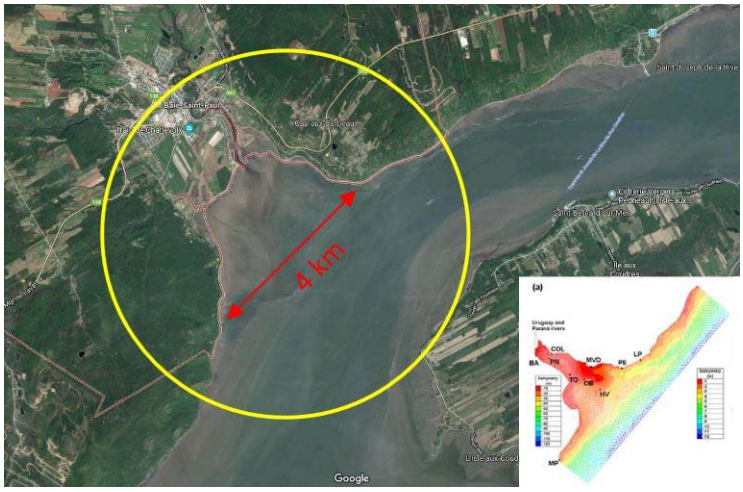
Adapt to natural hazards

Approaches to sustainable management of the Baie-Saint-Paul's coastline

Context The Baie-Saint-Paul's area is located in a steep transition zone between the mountain and the sea. The area is known to be subject to several natural hazards such as landslides, high tides and ice jams.

Objectives As part of the INÉDINE project, teams from INRS (Damien Pham Van Bang, Marc Richer-Laflèche and Jacob Stolle) and the GSC (Didier Perret) are analyzing the geological and hydrological risks to which Baie-Saint-Paul and the Upper St. Lawrence Estuary are exposed. The main objective is to develop sustainable approaches to coastal management to help counteract erosion caused by climate change and to address the vulnerability of this coastal area and its community.

Method Field work was conducted during the summers of 2020 and 2021 to collect sediment samples, measure current velocity and wave amplitude, and document the beach profile. This data will be used for numerical and physical modelling in the wave flume Environmental Hydraulics Laboratory. This 120 m long flume enables the simulation of waves, tides and high flow currents. A replica of the Baie-Saint-Paul beach profile has been reconstructed to study how and at what speed the beach erodes. The next steps will be to see if vegetation is able to slow the erosion. In September 2021, high-resolution seismic reflection surveys will be conducted in Baie-Saint-Paul to estimate the temporal recurrence of massive sedimentary inputs associated with large earthquake-induced movements in the Gouffre Valley. These surveys should also help to clarify the activity of the St. Lawrence Fault during the Holocene.



Morphodynamic study in Baie-Saint-Paul

RESEARCH FACILITIES

A diversified range of first-class geoscience laboratories

Laboratory	Contact(s)	Expertise
Delta-Lab	Jason Ahad	Analysis of stable isotopes (H, C, N and O) applied to hydrogeological, environmental and mineral studies.
Dendrochronology and Dendrogeochemistry	Christian Bégin	Analysis of the physical and geochemical parameters of tree ring sequences.
Geochemistry, Imagery and Radiography of Sediments (GIRAS)	Pierre Francus	Non-destructive radiography analyses coupled with micro-x-ray fluorescence chemical analysis of rocks, soil and sediment.
Contaminant Hydrogeology	Richard Martel	Study of soil and groundwater contaminants and development of *in situ* treatment processes at the intermediary level between the laboratory and the field.
Hydrogeology and Environmental Characterization	Daniel Paradis	Field equipment for groundwater characterization and numerical modelling equipment.
INRS-GSC joint laboratory	Stéfane Prémont and Kathleen Lauzière	Geochemical characterization of rocks, sediments, soil horizons and tree rings.
Digital Cartography and Photogrammetry (LCNP)	Kathleen Lauzière	Acquisition, management, analysis and dissemination of geoscientific data.
Applied Geoscience (LGA)	Marc Richer-Laflèche	Geophysical studies applied to mineral, gas and oil exploration, geotechnics and archaeology.
Environmental Hydraulics (LHE)	Damien Pham Van Bang	Large-scale flume simulations of waves, tides and strong river currents for the development of sustainable approaches to coastal management.
Geophysical Imaging and Measurements (LIAMG)	Erwan Gloaguen	Applied work mainly for the characterization of reservoirs for CO_2 sequestration, hydrogeology and oil.
Geothermal Energy (LOG)	Jasmin Raymond	Open laboratory for measuring the thermal and hydraulic properties of geological materials.
Physical, Numerical and Geophysical Simulation	Lyal Harris	Numerical analyses combining CT-assisted analog simulation methods with geophysical, remote sensing and field data interpretations.
Multidisciplinary CT-Scan	Pierre Francus and Damien Pham Van Bang	Non-destructive dynamic 4D measurements of internal density variations on static bodies (internal structure, porosity, etc.) or of dynamic phenomena, mainly in hydrology.

For more information: cgq-qgc.ca/en/facilities

COMMUNICATION AND ANIMATION

Joint participation in geoscience conferences (virtual)

October 19-23: XPLOR 2020
October 26-27: EMP 2020 – Exploration, Mining and Petroleum New Brunswick Conference
November 16-18 : Québec Mines + Énergie 2020

Joint participation in internal and external activities (virtual)

November 5-6: INRS Student conference Eau Terre Environnement
January 27: Career Day in Science and Engineering at Laval University
February 6: INRS Open House
March 8: International Women's Day: presentation of the film Picture a scientist
April 22: Earth Day: presentation of the film River's End

MANAGEMENT, KNOWLEDGE DISSEMINATION AND PUBLICATIONS

INRS Eau Terre Environnement Research Centre

INRS Specialized Documentation and Information Service (SDIS - link)

Reports and theses (link)

Scientific articles (professor profiles - link)

Geological Survey of Canada

Federal Science Libraries Network (link)

Geoscan database (link)

Natural Resources Canada publications and reports (link)

Directory of scientists and professionals (link)

STUDENT PORTAL

Inter-university programs in Earth Sciences

Master and PhD programs at the ETE Centre (link)

Master and PhD projects available at INRS (link)

University internships

INRS Undergraduate Summer Research Internships (link)

INRS Research internships (link)

Federal Student Work Experience Program (link)

Federal Research Affiliate Program (link)

Postdoctoral internships

INRS Postdoctoral Fellowships (link)

Federal Postdoctoral Research Program (link)

INRS-GSC Graduates 2020-2021 codirection

Master
Ronan Abhervé
(René Lefebvre, Daniel Paradis)

PhD
Guillaume Légaré-Couture
(Michel Parent, René Lefebvre)

CONTACT US

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