Ressources naturelles Canada | Natural Resources Canada

Geological Survey of Canada
Scientific Presentation 103

Public presentations of May 21st, 2019: Environmental Geoscience Program, current status of research projects for the 2019-2024 program cycle

N. Jacob, M. Bringué, J.M. Galloway, P.R. Gammon, P.M. Outridge, A.J. Desbarats, C. Rivard, J.M.E. Ahad, and M.J. Duchesne

2019

Canada

Ressources naturelles Canada
Natural Resources Canada

Public presentations of May 21st, 2019: Environmental Geoscience Program, current status of research projects for the 2019-2024 program cycle

Date presented: May 2019

Permanent link: https://doi.org/10.4095/314907

This publication is available for free download through GEOSCAN (https://geoscan.nrcan.gc.ca/).

Recommended citation

Jacob, N., Bringué, M., Galloway, J.M., Gammon, P.R., Outridge, P.M., Desbarats, A.J., Rivard, C., Ahad, J.M.E., and Duchesne, M.J., 2019. Public presentations of May 21st, 2019: Environmental Geoscience Program, current status of research projects for the 2019-2024 program cycle; Geological Survey of Canada, Scientific Presentation 103, 51 p. https://doi.org/10.4095/314907

Ressources naturelles Canada | Natural Resources Canada

Environmental Geoscience Program (EGP)
Public presentation of project plans for 2019-2024

To increase awareness of EGP projects within NRCan, a public science presentation took place on May 21, 2019 to summarize plans for the 2019-2024 program cycle. Project leaders presented a brief overview of the research to be undertaken over the next five years.

All eight of the PowerPoint presentations provided on May 21st, 2019 are included in this report. You can also look at the videos via this link: https://gcdocs.gc.ca/nrcan-rncan/llisapi.dll/link/41983142

Key words: Oil spills, climate change, Mackenzie River Basin, permafrost geochemistry, volcanoes, mercury, cobalt, cumulative effects, aquifer impacts, diluted bitumen, permafrost thaw

Canada

Ressources naturelles Canada | Natural Resources Canada

Environmental Geoscience Program (EGP)
Public presentations for the 2019-2024 program cycle

Canada

Ressources naturelles Canada | Natural Resources Canada

Marine Oil Spill Studies (MOSS)

Études sur les déversements pétroliers marins (EDPM)

Manuel Bringué

May 21st, 2019

Canada

ABSTRACT

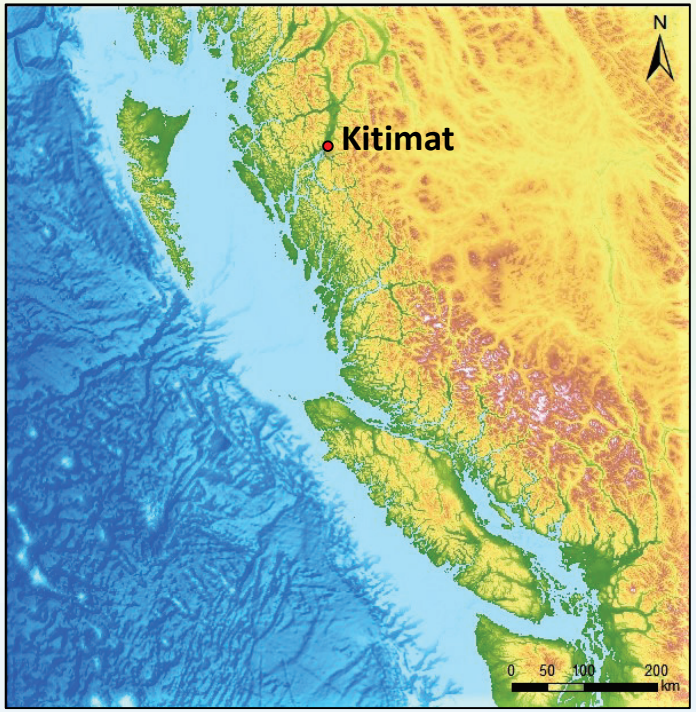
Context

Active port of **Kitimat** (BC's North Coast) is a gateway for the export of Canada's **energy** resources (LNG, dilbit) to international markets. Current and future projects translate into dramatically **increased tanker traffic** in Douglas Channel for decades to come.

Knowledge gaps / Objectives

- Baseline of **natural variability** in Douglas Channel (e.g., temperature, O_2, productivity) on seasonal to millennial time scales

- Capacity of in-situ microbial communities to mitigate accidentally-released petroleum products **under reduced O_2 and lower pH conditions**



PROJECT MEMBERS

- Manuel Bringué (PL), Jennifer Galloway, Omid Ardakani (GSC-Calgary)
- Jason Ahad (GSC-Québec)
- Michael Parsons (GSC-Atlantic)
- Paul Gammon (GSC-Ottawa)
- Gwyn Lintern, Cooper Stacey (GSC-Pacific)
- Heather Dettman (CanmetENERGY-Devon)

- Sophia Johannessen (DFO, IOS Sidney)
- Kenneth Lee (DFO, BIO Dartmouth)
- Charles Greer (NRC, Montréal)
- Vera Pospelova (U. of Victoria / U. of Minnesota)

PROJECT OVERVIEW

1. **Sediment trap** component

To assess **seasonal variability** in phytoplankton communities and geochemical indicators (**calibration**)

2. **Sediment cores** component

- Short (box) cores: to **reconstruct past environmental variability** and trace possible **human impacts** over the last ~ 120 yrs
- Long (piston) core(s): to reconstruct past variability over the last ~ 4000 years, for context.

3. **Microcosm** experiments

Lab-based experiments testing the capacity of in-situ microbial communities (water + sediment) to degrade petroleum products **under a range of reconstructed and forecast O_2 and pH conditions**

1.

2.

3.

CONTACT INFORMATION

- Manuel Bringué
- (403) 471-1727
- manuel.bringue@canada.ca

Also:

- Jason Ahad (PL of over-arching ‘oil spill’ project)
- (418) 654-2615
- Jason.ahad@canada.ca

THANK YOU!

Ressources naturelles Canada | Natural Resources Canada

Long-term hydrological dynamics of Canada's largest watershed: Climate controls on water quantity of the Mackenzie River Basin

Dynamique hydrologique à long terme du plus grand bassin versant du Canada : Contrôle du climat sur la quantité d'eau du bassin du fleuve Mackenzie

Manuel Bringué for Jennifer Galloway

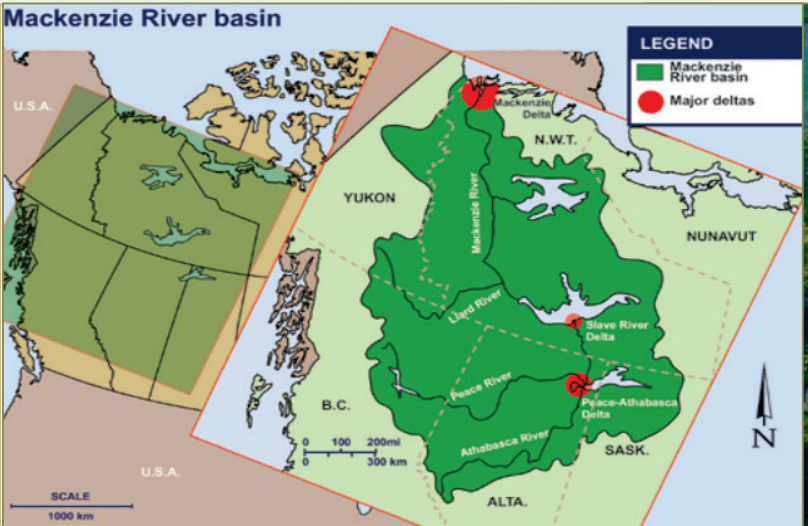
May 21st, 2019

Canada

ABSTRACT

The Mackenzie River Basin (MRB) is one of the largest cold-water, intact boreal ecosystems in the world and has unique Earth-system's processes associated with sea ice formation, global circulation of deep ocean currents, carbon storage, and biogeochemical cycling. The stability and integrity of the unique cryospheric, hydrologic, ecologic, and climatological processes of the MRB are threatened by cumulative impacts of climate change (the highest degree of warming has occurred there) and natural resource development.

Is water quantity in the MRB affected by synoptic-scale climate phenomena? What could the impacts of that natural variability be combined with 21st. c climate change on ecosystem services of the MRB?



PROJECT MEMBERS

- Jennifer Galloway (PL), Steve Grasby, Thomas Hadlari, Omid Ardakani, Steve Wolfe, Peter Morse, Mike Parsons, Dustin Whalen (GSC-Calgary, Ottawa, and Atlantic)

- Environment and Climate Change Canada
- Northwest Territories Geological Survey
- Government of the Northwest Territories
- McMaster University, University of Victoria, Ottawa, & Alberta, Carleton University, Central Michigan University, University of Leeds, University of Lodz
- Gwich'in Tribal Council Department of Cultural Heritage, Gwich'in Renewable Resources Board
- Aurora College and Aurora Research Institute
- Co-funded by ArcticNet grant (2019-2022)

INTEGRATED APPROACH

We have herein designed a networked and integrated research approach involving paleoecology (micropaleontology, sedimentology, isotope, element, organic, and molecular geochemistry), instrumental records, Traditional Knowledge held by Project Partners the Gwich'in Tribal Council, and citizen science on long-term changes in water level in the MRB. We will attempt to link those changes to late Holocene climate variability using a variety of methods (e.g., spectral and wavelet analysis). We will then use our hind-casting approach to model future hydrological change.




CONTACT INFORMATION

- Jennifer Galloway, on leave, currently at Aarhus Institute of Advanced Studies and Department of Geosciences, Aarhus University, Aarhus, Denmark; otherwise GSC-Calgary.

- Jennifer.Galloway@aias.au.dk and after Feb. 01 2020 Jennifer.Galloway@canada.ca

THANK YOU!

Ressources naturelles Canada | Natural Resources Canada

Permafrost Geochemistry

Géochimie du pergélisol

Paul Gammon

May 21st, 2019

Canada

ABSTRACT

- **Permafrost geochemistry:** Our limited understanding of process-based geochemistry within permafrost terrains represents a substantial knowledge gap that undermines environmental risk assessment in Canada's permafrost terrains. This activity aims to address this knowledge gap.
- **Environmental Risk:** Building of the Inuvik to Tuktoyaktuk Highway (ITH) from 2014-2017 has generated solute release that represents an environmental risk. This proposal aims to determine the environmental geochemistry (i.e. source, transport mechanisms, receiving environment) of this solute release and thus generate knowledge to help quantify this specific environmental risk, and in general build knowledge of the environmental risks of infrastructure development within permafrost terrains.
- **Seasonal Hydrology:** The role of hydrology, and particularly the seasonality of groundwater hydrology, in solute mobilisation, movement and fixation is virtually unknown for permafrost terrains. Active hydrological cycle processes will be investigated in this project to determine their relationship to process geochemistry.

PROJECT MEMBERS

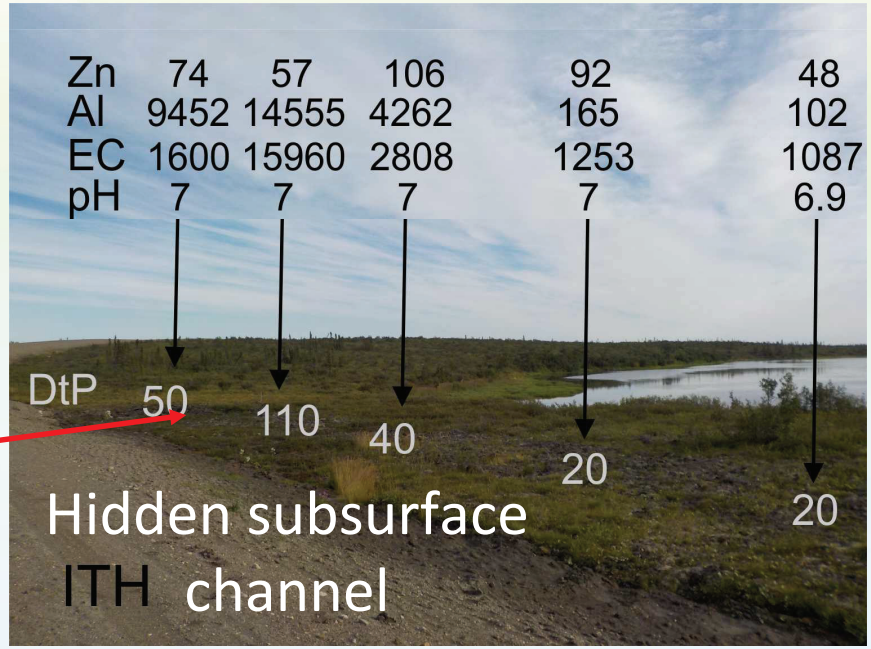
Team Member Name	Affiliation	Role and Expertise	Time Commitment (months/year)
Dr. Paul Gammon (Project lead)	NRCan, GSC Ottawa (GCSO)	Project Lead, inorganic geochemistry	4
Dr. Jason Ahad	NRCan, GSC Quebec (GSCQ)	Organic geochemistry	1
Dr. Peter Morse	NRCan, GSC Ottawa (GSCO)	Permafrost characterisation	1
Dr. James Zheng	NRCan, GSC Ottawa (GSCO)	Colloid chemistry	4
Prof. Phillip Marsh	Wilfred Laurier University	Hydrology and climate change	1
Dean Ahmet	NWT Department of Infrastructure	Infrastructure and development regulations, logistics	?
Dr. John Hedley	Environment and Climate Change Canada	Molecular characterisation	1
Brian Zytaruk	First Nations engagement/oversight/participation	Inuvialuit Fisheries joint Management Committee.	1
IGRL Staff	NRCan, GSC Ottawa (GCSO)	Inorganic analysis	10
Delta Lab Staff	NRCan, GSC Quebec (GSCQ)	Organic isotopic analysis	3

Strange ITH Geochemistry

Subsurface Pathways

Extreme geochemistry

What environmental risk?

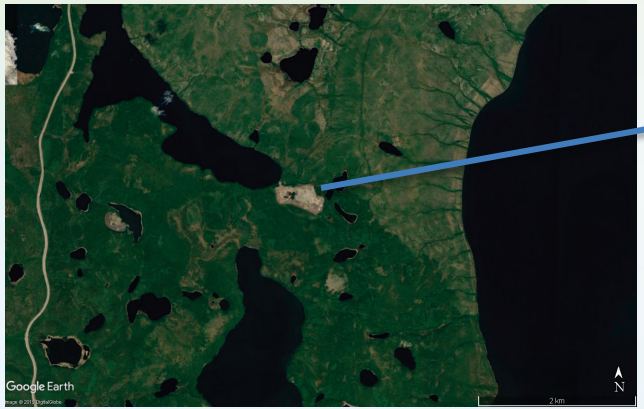


ITH Borrow Pits

What environmental risk?

Process geochemistry:

Source? Transport? Fixation?



CONTACT INFORMATION

- Paul Gammon
- 613-995-4909
- Paul.Gammon@Canada.ca

THANK YOU!

Ressources naturelles Canada | Natural Resources Canada

Volcanic mercury contribution to the global mercury budget

Contribution du mercure volcanique au budget global du mercure

P.M. Outridge, May 21st, 2019

Canada

ABSTRACT

- Most of Canada's Hg comes from global sources, both natural and anthropogenic;
- 1000s of CDNs impacted by Hg in wild fish & marine mammals;
- Large uncertainties re natural sources to global atmosphere;
- Impacts reliability of global budget and modeling;
- Project will measure Icelandic volcanic Hg fluxes, and understand geological/geochemical controls;
- Part of planned multinational consortium led by Sanei (Denmark).

PROJECT MEMBERS

- PI: Peter Outridge, GSC Northern
- NRCan RAP PhD student: Brock Edwards
- Academic co-supervisor: Feiyue Wang, Industrial Research Chair, U. Manitoba
- Other contributors: Melissa Pfeffer (Icelandic Met. Office), Bruce Kjarsgaard (GSC Central); Hamed Sanei (Aarhus U., Denmark)

CONTACT INFORMATION

- Peter Outridge
- (613) 807-9800 (c), (613) 996-3958 (o)
- Peter.outridge@canada.ca

THANK YOU!

Ressources naturelles Canada | Natural Resources Canada

Cumulative Effects of Resource Development on Mining-Impacted Watersheds

Effets cumulatifs du développement minier dans les bassins versants contaminés

Alexandre Desbarats

May 21st, 2019

Canada

ABSTRACT

Renewed exploration or development in historical mining districts, such as Cobalt, presents unique challenges for proponents and government regulators because of the cumulative nature of environmental impacts. To increase their capacity to carry out or review environmental assessments, this project will develop geoscience methods for distinguishing environmental effects of new mining activity from complex existing background conditions in affected watersheds. Specifically, the project will develop means of unraveling the history of accumulated polymetallic contamination from multiple sources over multiple periods. This information and new data from mine wastes and mine drainage will be synthesized in the first geoenvironmental model for Ag-Ni-Co-As vein type deposits. Project results will be disseminated to key end users in order to improve their capacity to carry out or review environmental assessments and to ensure that decision makers have a better understanding of the cumulative nature of environmental impacts for the sustainable development of natural resources.

PROJECT MEMBERS

- Alexandre Desbarats (GSC-NC)
- Paul Gammon (GSC-NC)
- Michael Parsons (GSC-ATL)
- Jeanne Percival (GSC-CC)
- Katherine Venance (GSC-CC)
- Jennifer Galloway (GSC-Cal)
- Suzanne Beauchemin (CANMET-CMIN)
- Tom Al (University of Ottawa)
- Heather Jamieson (Queen’s University)

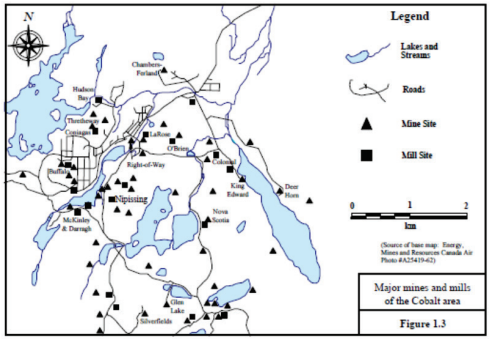
Cumulative Effects Assessment in a Historical Mining Camp undergoing a new Exploration Boom: Cobalt, Abitibi region, Ontario

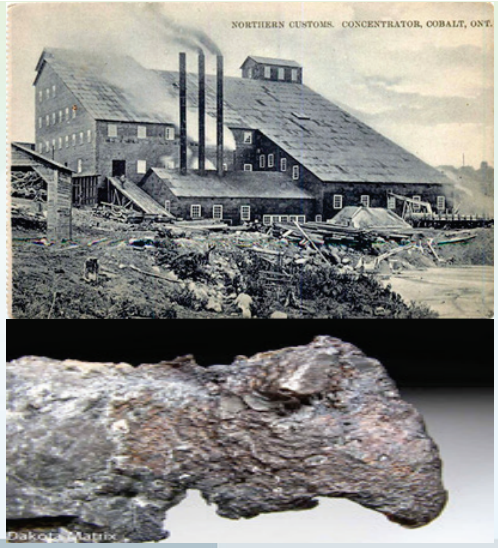
- **Background**
  - Rich silver veins containing cobalt (Co), nickel (Ni), and arsenic (As) minerals were discovered near the present town of Cobalt in 1903
  - By 1911, Cobalt was the third largest silver mining centre in the world
  - Declining production from 1915 onwards with the last mine shutting in 1989
  - Legacy of dozens of mine sites and 18 uncontained tailings disposal areas
  - Pervasive As, Ni, and Co contamination in regional watersheds

- **Current situation**
  - Economically depressed region with some tourism and logging
  - New exploration boom focusing on Co for rechargeable batteries used in electric vehicles and green energy storage

Need for Cumulative Effects (CE) Assessment

- **Current environmental regulations**
  - Ill-suited to resource development in “brownfield” historically-impacted watersheds
  - Mining companies are discouraged from assuming environmental liabilities or reprocessing old mine wastes
  - Need for a more holistic and regional approach to EAs
- **Stakeholders**
  - Mining companies (First Cobalt, Agnico-Eagle)
  - Regional community of the Tri-Town area
  - Temagami and Timiskaming First Nations
- **Concerns**
  - Protecting potable water supplies
  - Remobilization of contamination sequestered in tailings due to new mining or climate change related extreme flow events





EGP Project Objectives – Scientific Questions

- How to assess environmental impact of new mining development against a brownfield legacy of pervasive contamination due to 90 years of un-regulated mining activity?
- What was the pre-mining (bio)geochemical signature of the soils, sediments, vegetation, and waters of the mineralized watersheds?
- Has the existing environment reached a new geochemical equilibrium after historical resource development activities?
- Are there geochemical thresholds (tipping points) that need to be considered in assessing cumulative effects?
- Can lake sediment cores or tree rings provide a reliable chronology of different phases of resource development in a mining-impacted watershed?
- With reference to climate change, what effects will the environment have on past, current, and future resource development projects?

CONTACT INFORMATION

- Project leader: Alexandre Desbarats
- 613-995-5512
- Alexandre.Desbarats@Canada.ca

THANK YOU!

Ressources naturelles Canada | Natural Resources Canada

Assessment of non-saline aquifers and potential impacts of oil and gas development activities, including induced seismicity, on these aquifers in the Fox Creek area (AB)

Évaluation des aquifères non salins et des impacts potentiels des activités liées à l'exploitation des hydrocarbures, dont les séismes induits, sur ces aquifères dans la région de Fox Creek (AB)

Christine Rivard

May 21st, 2019

Canada

ABSTRACT

Environmental concerns related to unconventional resource development have arisen in the last decade. These concerns are notably related to water contamination and depletion, and induced seismicity, and they were largely related to hydraulic fracturing (HF). The Fox Creek area, in Alberta, was selected for this study because it is one of the most active regions for unconventional resource production in Canada, with growing demands for water supply.

The objective of this project is to study potential impacts of hydrocarbon development in a very active production area. The project will include non-saline aquifer characterization, drilling of several monitoring wells, a study of the mechanisms that could affect pressures in shallow aquifers during HF and re-injection, an analysis of the influence of induced seismic events on shallow aquifers through co-monitoring of seismicity, water levels and physico-chemical parameters, coupled surface water / groundwater water numerical models, a geomechanical model, as well as detailed groundwater geochemical analyses that will include multiple isotopes. The acquired knowledge will allow for an evaluation of current water management practices and policies regarding unconventional resource development, especially HF and deep wastewater injection.

PROJECT MEMBERS

Team member name, Affiliation, Role and expertise	
Christine Rivard, GSC – Québec, Hydrogeology, project leader	Erwan Gloaguen, INRS-ETE, Artificial intelligence and reservoir modelling
Honn Kao, CGC – Sidney, Induced seismicity	Bernard Giroux, INRS-ETE, Geophysics and passive seismic monitoring
Denis Lavoie, GSC – Québec, Sedimentology and petroleum geology	Claudio Paniconi, INRS-ETE, Surface water / groundwater interaction modelling
Xavier Malet, GSC-Québec, DB manager and technician	René Lefebvre, INRS-ETE, Hydrogeology
Geneviève Bordeleau, GSC-Québec, Geochemist	Elena Konstantinovskaya, U of Alberta, Reservoir structural geology and geomechanics
Steve Grasby, GSC – Calgary, Geochemistry and deep circulation	Grant Ferguson, U of Sask and GWF, Groundwater modeling
Heather Crow, GSC – Ottawa, Borehole geophysics	Rick Chalaturnyk, U of Alberta, Geomechanical engineering
Dennis Jiang, GSC-Calgary, Hydrocarbon geochemistry	Gonzalo Zambrano, U of Alberta, Geomechanical engineering
Omid Haeri Ardakani, GSC-Calgary, Sedimentology and petroleum geology	Jeffrey Gu, U of Alberta, Induced seismicity
Jim Roy, ECCC – Burlington, Geochemist	Nicholas Utting, Canmet Energy – Devon, geochemistry
Dan Palombi, AER / AGS, Hydrogeology and GW conditions	Todd Shipman, AER / AGS, Induced seismicity
Brian Smerdon, AER / AGS, Hydrogeology and GWconditions	Cynthia McClain, AEP, Groundwater monitoring
Ryan Schultz, AER / AGS, Induced seismicity	Judit Deri-Takacs, AEP, Groundwater monitoring

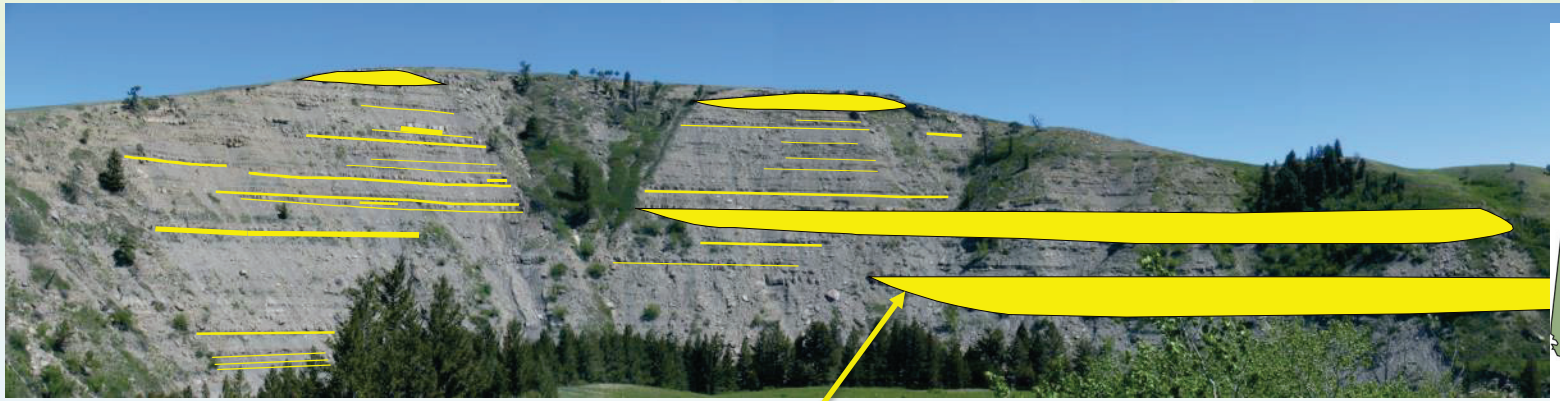
1 post-doc, 2 PhD students and 3 MSc students

Project objectives

- To characterize shallow aquifers in a sub-watershed of the Fox Creek area;
- To investigate potential upward migration pathways, which could have been enhanced by hydraulic fracturing, to assess aquifer vulnerability;
- To assess cumulative effects (impacts) in this region where intensive industrial activities take place.

Study area: Fox Creek, West-central Alberta

One of the most active regions for unconventional resource production in Canada
It has experienced some of the largest induced seismic events (M_L>4.5)



> 60% mudstone on average

Paskapoo Fm is the most important groundwater supply in the province and the most important aquifer system in the Canadian Prairies.

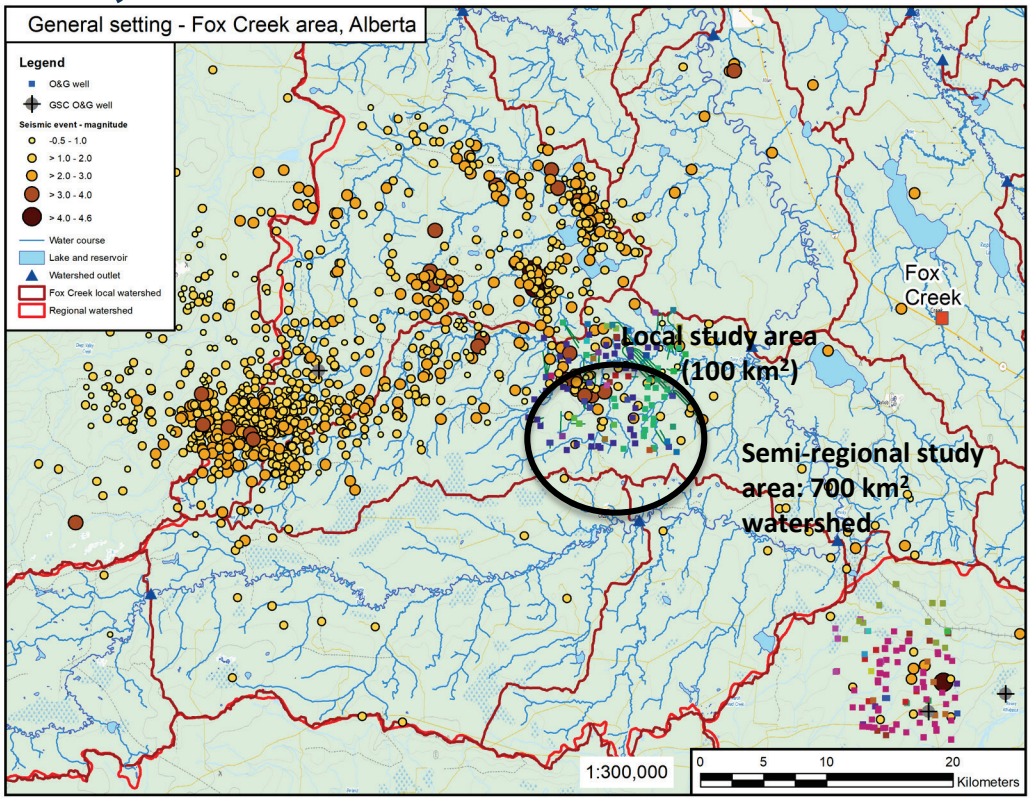
Study area: Fox Creek, West-central Alberta

Watershed to be studied: 700 km^2

In the Paskapoo Fm

Mean water-well depth in the Paskapoo Fm: 50 m

Mean O&G well depth: 2400 m



Fieldwork for 2019-2020

Drilling of monitoring wells : depths from 100 to 150 m
using both core and percussion drilling

- Rock and GW samples
- Porosity and permeability values on core samples
- Installation of water level loggers and different sensors (TDGP and physico-chemical parameters)
- Hydraulic (« slug ») tests → K in rock aquifers

Permeability tests using Guelph permeameters → K in surficial sediments

GW monitoring in both observation and existing wells

CONTACT INFORMATION

- Christine Rivard
- 418-654-3173
- christine.rivard@canada.ca

THANK YOU!

Ressources naturelles Canada | Natural Resources Canada

Environmental impact of diluted bitumen

Impact environnemental du bitume dilué

Dr. Jason M. E. Ahad

May 21st, 2019

Canada

ABSTRACT

- To transport bitumen via pipeline, it is blended with lighter hydrocarbon fractions, yielding a less viscous, diluted bitumen (‘**dilbit**’)
- Although often considered safer than other means of transport (i.e., railways, barges), incidents such as the one that occurred near the Kalamazoo River (Michigan, USA) in June 2010 have highlighted the potential environment risk caused by dilbit pipeline rupture
- There are few detailed investigations into the fate and transport of dilbit in the vadose zone and groundwater – a knowledge gap identified over five years ago…

OBJECTIVES

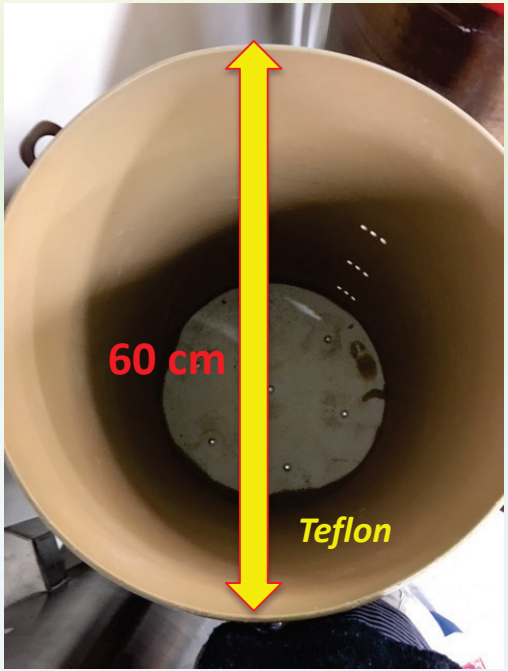
1. To better understand the relationships between ***geochemistry***, ***hydrogeology, microbiology*** and ***toxicology*** during natural attenuation (e.g., biodegradation, photodegradation) of dilbit in shallow groundwater systems
   - ➢ Utilising large column experiments (Phase I) and larger mesocosms (Phase II – funding not yet secured)

2. To examine microbial uptake of spilled dilbit in lake sediments via a series of controlled releases in the Experimental Lakes Area of NW Ontario

PROJECT MEMBERS

- **GSC:** Jason Ahad (Project Leader), Paul Gammon, Anna Smirnoff, Patrick Watt, Jade Bergeron, Hooshang Pakdel, Marc Luzincourt, Nicolas Benoit
- **INRS:** Valérie Langlois, Richard Martel, Scott Hepditch (PhD candidate)
- **McGill:** Nagissa Mahmoudi, Leah Mindorff (MSc candidate)
- **CanmetENERGY:** Nicholas Utting
- **Ottawa U:** Jules Blais, Jose Luis Rodriguez Gil
- **ECCC:** John Headley, Kerry Peru

PHASE I OF OBJECTIVE 1: LARGE COLUMN EXPERIMENTS



CONTACT INFORMATION

- Dr. Jason M. E. Ahad
- 418-654-3721
- jason.ahad@Canada.ca

THANK YOU!

Ressources naturelles Canada | Natural Resources Canada

Environmental Impacts of permafrost degradation

Impact environnementaux de la dégradation du pergélisol

Mathieu J. Duchesne

May 21st, 2019

Canada

ABSTRACT

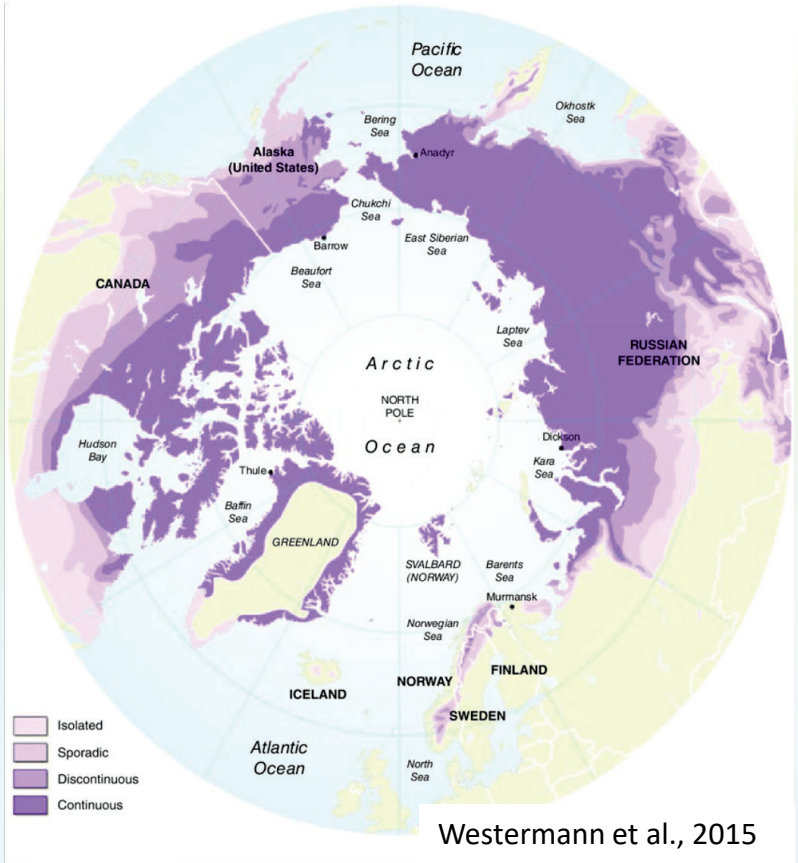
Permafrost underlies approximately **50% of the Canadian landmass** and is found in **offshore areas** beneath the **Arctic shelf**. Permafrost is warming at depth through taliks, along faults and methane leakage maybe enhanced from historical exploration wells and is also degrading in some areas as the surface active layer is thickening. **As permafrost warms and degrades**, contaminants including **heavy metals, trapped greenhouse gases and saline pore fluids are being naturally released into the environment** and the liberation of organic carbon through permafrost degradation stimulates microbial activity. Recent estimates also suggest that **permafrost represents the largest global reservoir of mercury**, with active pathways for migration and uptake in the food web. This project is striving to assess the environmental implications of warming terrestrial, coastal and offshore permafrost and therefore provide a baseline to better appraise the environmental consequences of resource development. Active permafrost-related geological processes and their impacts on the environment will be assessed using a broad and various suit of **geophysical, sampling and monitoring techniques**. **Key outcomes** will include; 1) **improved and adapted environmental practices** for resource development projects in permafrost settings allowing industry to follow safer and more cost efficient practices and regulators to better appraise development projects, 2) **improved environmental assessment of cumulative effects** of resource development, and 3) assessment of **permafrost environmental considerations** within the broad context of **human health**.

PROJECT MEMBERS

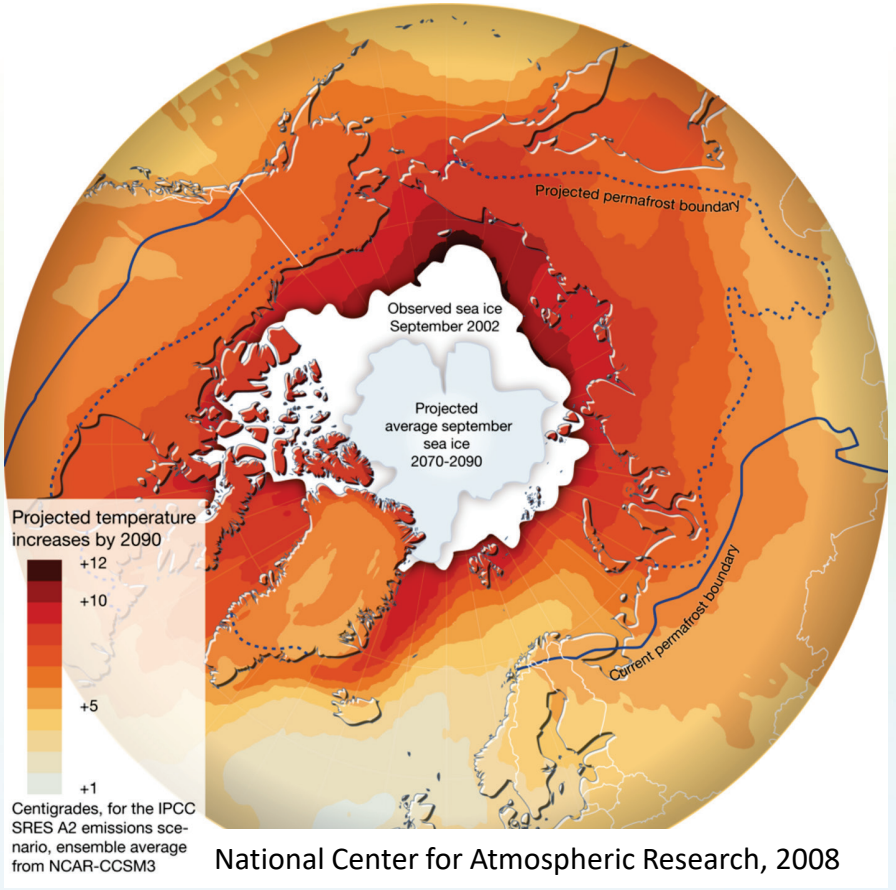
- GSC- Permafrost mapping and characterization: G. Bellefleur, V. I. Brake, Duchesne, M.J., Oldenburger, G., Pinet, N.

- GSC- Environmental Geochemistry: Outridge, P., Zheng, J., Côté, M., Dallimore, S., King, E., Morse, P., Wolfe, S., Normandeau, A.

- External collaborators: Giroux, B. (INRS), Fabien-Ouellet, G. (Polytechnique Mtl), Gwiazda, R. (MBARI), Greinert, J. (GEOMAR), Jin, Y. K. (KOPRI), Kang, S.-G., Lapham, L. (U. of Maryland), Orcutt, B. (Bigelow Lab.), Overduin, P. (AWI), Paull, C.K. (MBARI), Rhee, T. S. (KOPRI), Riedel, M. (GEOMAR)



Westermann et al., 2015



National Center for Atmospheric Research, 2008

CONTACT INFORMATION

- Mathieu J. Duchesne
- 418.654.2647
- mathieuj.duchesne@canada.gc.ca

THANK YOU!

For more information about the program or the projects, please contact:

Program director: Andree.Bolduc@Canada.ca
Acting Program manager: Eric.Boisvert@Canada.ca
Geoscience Planning Officer: Nathalie.Jacob@Canada.ca

Marine Oil Spill Project Leader: Manuel.Bringué@Canada.ca
Hydrological Dynamics of the Mackenzie Project Leader: Jennifer.Galloway@Canada.ca
Permafrost Geochemistry Project Leader: Paul.Gammon@Canada.ca
Volcanic Mercury Project Leader: Peter.Outridge@Canada.ca
Mining Impacted Watershed Project Leader: Alexandre.Desbarats@Canada.ca
Aquifers in Fox Creek Project Leader: Christine.Rivard@Canada.ca
Diluted Bitumen Impacts Project Leader: Jason.Ahad@Canada.ca
Permafrost Degradation Project Leader: Mathieuj.Duchesne@Canada.ca