



**PermafrostNet**  
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# NSERC PermafrostNet Themes



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# Theme 1



## Characterisation of permafrost



Daniel Fortier



Duane Froese

Co-PIs: Jocelyn Hayley (geotechnics), Stephan Gruber and Antoni Lewkowicz (geophysics)

## Characterisation of permafrost

### Sub-theme : Data handling

- Teddi Herring (PDF) – Canadian permafrost ERT survey next practices and database
  - Creation of ERT dataset from Yukon and integration in a new database of ERT surveys
- Michel Paquette (PDF) – Permafrost information network of ground observations
  - Data publication process and guidance, expert analysis of the ground ice map of Canada



### Sub-theme : Ground-ice characteristics

- Alexandre Chiasson (PhD) – Permafrost conditions in the Mackenzie valley and glacial lakes Mackenzie and McConnell
  - Datasets on ground ice conditions, ground ice maps based on terrain and thermokarst classification
- Mohammad Gamshad (PhD) – Ground ice of the eastern Canadian polar deserts
  - Ground ice distribution in polar deserts, polar desert response to climate change using climatic simulations
- Tabatha Rahman (PhD) – Permafrost and ground ice conditions in the Hudson Bay Lowlands
  - Creation of datasets of Ice volume, ice type and distribution in the Hudson Bay lowland
- Joe Young (MSc to PhD) – Syngenetic permafrost of unglaciated Yukon
  - Ground ice distribution mapping and mass wasting potential

## Characterisation of permafrost

### Sub-theme: Innovation

- Zakieh Mohammadi (Msc to PhD) – Strength and consolidation behavior of permafrost
  - Thaw settlement and consolidation tests used to predict thaw settlement properties of permafrost
- Khatereh Rgh (PhD) – Geomechanical properties of thawing permafrost
  - Creation of a geotechnical layer of the ground ice map of Canada and integration of geotechnical properties of permafrost in PINGO.

### Outcomes:

Permafrost data collection from discontinuous permafrost to the High Arctic

Data publication guidelines and queryable data products

Scaling solutions for permafrost properties and mapping



Permafrost exposure coring near Inuvik. Photo: A. Alvarez





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# Theme 2

## Monitoring of permafrost change



Trevor Lantz



Antoni Lewkowicz

## Monitoring of permafrost change

- Theme goals are to identify and quantify permafrost **change** in Canada, including its regional variation and land surface expression.
- Very active area of research internationally, especially in relation to remote sensing and AI (deep learning).
- 5 HQP active; 2 to be recruited for 2022. HQP projects (1 PDF, 4 PhD, 2 M.Sc.) involve observation/monitoring and ultimately, synthesis.
- Partners include Aurora Research Institute, Gwich'in Renewable Resources Board, CCRS, NTGS, Yukon U.
- Regular monthly meetings, including guest lectures (e.g., Genevieve George, Lingcao Huang).



### Monitoring of permafrost change

- Field data (including airborne remote sensing data) are vital contributions that will complement the large number of datasets being developed internationally.
- Broad range of techniques being employed to assess change, including optical remote sensing, SAR and community-based monitoring. Similarly broad range of backgrounds in HQP.
- The theme feeds into PermafrostNet by demonstrating ongoing environmental change, by involving communities and northern partners in observations and through the planned post-doctoral synthesis of disparate datasets to develop a national model of thaw sensitivity.

## Current Student Research



**Grant Francis.** Tracking permafrost landscape change with high resolution satellite imagery.



**Fereshteh Ghiami-Shomami.** Interpreting ground temperature and subsidence for better quantifying permafrost change.



**Usman Iqbal Ahmed.** - Airborne InSAR to monitor permafrost thaw near linear infrastructure.



**Emma Street.** Indigenous Knowledge of permafrost processes in the Beaufort Delta Region.



**Hana Travers-Smith.** Determinants of surface water dynamics in the western Canadian Arctic and Subarctic.



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# Theme 3



## Prediction of permafrost change



Claude Duguay



Joe Melton

## Prediction of permafrost change

- Projects are well underway
  - Develop new high-latitude specific land cover types for CLASSIC – Rose Lefevbre, (MSc start May 2022)
  - Excess ice simulation by CLASSIC – Amene Sharifi (PhD)
  - Thermokarst lake ice mapping – Maria Shaposhnikova **MSc completed Sept 2021!**
  - Optimizing soil carbon simulation – Charles Gauthier, MSc
  - Machine learning based ground ice mapping – Bingqian Zhang, PhD
  - Quantify confidence in permafrost simulations – Hannah MacDonell, **MSc (PhD option)**
  - Permafrost climate services – Galina Jonat, PhD

## Prediction of permafrost change

Maria's MSc thesis:

- Applied a temporal deep learning approach to thermokarst lake ice mapping (bedfast and floating ice) from SAR imagery, generated ice-regime maps, and analyzed changes over a 29-year period (1993-2021) in Old Crow Flats, Yukon
  - Well done Maria!

Our projects

- improve **the representation** of permafrost change **in models**;
  - Amene, Charles, Rose, Bingqian
- integrate information from observations (Theme 1/2) into new products/knowledge;
  - Bingqian, Charles, Amene, Maria, **Galina, Hannah**
- provide informative projections of permafrost change that are well characterized in terms of uncertainty and contribute to understanding of hazards and adaptation (Themes 4/5);
  - Hannah, Galina, Charles, Amene, Rose
- and contribute to Next Practices around presenting and producing permafrost projections
  - Galina, Hannah





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# Theme 4

## Hazards and impacts associated with permafrost thaw



Pascale Roy-Léveillé



Jocelyn Hayley

# Hazards and impacts associated with permafrost thaw

- Range of permafrost hazards studied
  - Mass-movements
  - Flooding
  - Biogeochemical cycling (mercury)
  - Changes in water quality
  - Terrain and vegetation changes in traditional territories
- New PostDoc!:
  - Permafrost Sci & Eng research in the context of permafrost hazard management



# Hazards and impacts associated with permafrost thaw

## What we contribute :

- Better understanding of stakeholder needs in relation to research (past and future directions)
- Improved knowledge, detection, and prediction of hazards in ways that support stakeholders

## How we are connected to other themes:

- Integrate knowledge from themes 1-3
- Produce tools and knowledge that support theme 5



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# Theme 5

## Adaptation to permafrost thaw



Chris Burn



Ryley Beddoe



# Adaptation to permafrost thaw

## Quick Glance

- **Purpose:** Theme 5 goals are to provide practical approaches to mitigating thaw and on managing the changing hydrologic regime near infrastructure
- **Activity:** 6 Active HQPs, 15 affiliated HQPs, partner organizations, and support networks, etc.
- **Staying Connected:** Regular weekly meetings (during term), varying from guest lectures (partners, academics, HQP), informal discussions and chats.

## Adaptation to permafrost thaw

### Fieldwork!

Mayo area



Snow compaction to reduce ground temperatures, central Yukon

Km 96,  
Dempster Highway



Yukon  
maintenance staff

Maintenance costs of highways  
built on permafrost



\$4M for 0.5 km of  
thermosyphons,  
Alaska Highway

## Adaptation to permafrost thaw

### Fieldwork!

Hudson Bay Railway  
with Arctic Gateway Group







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