Yellowknife Geoscience Forum

2024

2024 Yellowknife Geoscience Forum Abstract Volume

© 2024 Authors are responsible for the content of their abstracts and have the copyright on their results and text.

Distributed by:
Northwest Territories Geological Survey
Department of Industry, Tourism and Investment
Government of Northwest Territories
P.O. Box 1320,
4601-B 52nd Avenue
Yellowknife, Northwest Territories
X1A 2L9 Canada
867-767-9211
www.nwtgeoscience.ca

Front photograph:

Glacial striations on a granitic pegmatite in the Aylmer Lake area, Northwest Territories.
Philippe X. Normandeau
Northwest Territories Geological Survey

Back photograph:

Esker and location of recurring winter icings, or aufeis, north of Lockhart Lake, North Slave Region, Northwest Territories.
Niels Weiss
Northwest Territories Geological Survey

Reference:

Gervais, S.D. (compiler), 2024. 52nd Annual Yellowknife Geoscience Forum — Abstract Volume; Northwest Territories Geological Survey, Yellowknife, Northwest Territories. YKGSF Abstracts Volume 2024.

Charles Camsell Public Lecture Series

A Public Lecture Sponsored by the Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists (NAPEG).

Knock, knock - anybody home? Serpentinite-hosted springs, portals into the subsurface biosphere and their relevance to search for extra-terrestrial life

Looking for life on other bodies in the solar system requires selecting potential locations that are habitable and accessible, and that also preserve signatures of life. To help in the selection of these locations, we turn to the only planet where we know life exists: Earth. This talk examines whether water-rock reactions, *i.e*., serpentinization, in ultramafic rocks can support life and whether that life is detectable. Serpentinite-hosted springs provide access to the subsurface biosphere without extensive drilling and act as analogues for other ultramafic planetary bodies.

Penny Morrill
Professor
Department of Earth Sciences
Memorial University of Newfoundland

Penny Morrill is a professor in the Department of Earth Sciences at Memorial University of Newfoundland and Labrador. She received her PhD from the University of Toronto, where she studied the biodegradation of dry-cleaning fluids and other solvents in groundwater. Subsequently, she has worked at the Carnegie Institution for Science, McMaster University, and the Institute for the Study of Earth's Interior, Japan, studying organic synthesis and degradation and the isotopic fractionation associated with these processes.

Dr. Morrill leads the Diverse Environmental Laboratory and Terrestrial Analogue Studies (DELTAS) Research Group at Memorial University. The research group has focused on using biogeochemistry to solve environmental problems such as climate change mitigation, acid mine drainage remediation, and reservoir souring prevention. Dr. Morrill's research group also uses biogeochemistry to study life and its preservation at sites of serpentinization.

Keynote Presentations

Land-Water Linkages and the Effects of Permafrost Thaw in the Western Canadian Arctic

Permafrost thaw has wide-reaching consequences for Earth systems and social systems alike. From an Earth systems perspective, one fundamental result is the exposure of previously-frozen materials to contemporary processes, including transport through fluvial networks and active biogeochemical cycling. This talk will explore these effects through the lens of the Peel Plateau-Richardson Mountains region, where processes associated with the advance, and then retreat, of the Laurentide Ice Sheet have deposited extensive ice-rich glacial moraine that has been preserved by cold climate in permafrost. With warming, this region is transforming profoundly, as ground ice melt enables mass movement of substantial volumes of sediments and solutes downslope and downstream. The unweathered glacial tills that have been preserved in regional permafrost enable inorganic (*e.g.*, chemical weathering) and sediment transport-associated processes to dominate the biogeochemical response to this pronounced landscape change. This calls for an expansion of our current framework of processes critical to consider when constraining the effects of thaw on broad, biogeochemical cycles (*e.g.*, the carbon cycle), which has generally focused on biologically-driven processes (decomposition of permafrost-origin organic matter), while largely overlooking the critical importance of the geophysical and geochemical response.

Suzanne E. Tank
Associate Professor
Faculty of Science – Biological Sciences
University of Alberta

Suzanne E. Tank is an Associate Professor at the University of Alberta. She obtained her PhD from Simon Fraser University, where she studied the biogeochemistry and ecology of lakes in the Mackenzie Delta. Since her PhD, Dr. Tank has worked at the Marine Biological Laboratory in Woods Hole, MA, and at York University, in Toronto. She now leads a trainee- and collaboration focused research program that largely explores how global change affects the transport and cycling of biogeochemical constituents (carbon, nutrients, toxins) across landscape continua ranging from soil porewaters to the coastal ocean. Her work in the western Canadian Arctic specifically focuses on the effects of permafrost thaw. Dr. Tank has served as Associate Editor for the Journal of Geophysical Research: Biogeosciences since 2014, has been elected as a Fellow of the Association for the Sciences of Limnology and Oceanography, and is the recipient of the Great Supervisor Award from the University of Alberta's Faculty of Graduate Studies and Research.

Lithium Geology 101

Lithium is a soft, silvery metal. It has the lowest density of all metals and reacts vigorously with water. Lithium is one of the most important and most popular metals and has been dubbed *'white gold'* because of its market value, softness, silvery colour, and many uses. It is a key ingredient in many energy storage systems, including the rechargeable batteries used in modern devices such as electric vehicles, mobile phones, laptops, and hearing aids. Lithium is also used in ceramics, high-temperature lubricants, alloys, and medicine. It is classified as a critical metal by Canada and many other jurisdictions, including the United States, the European Union, the United Kingdom, Australia, and Japan.

Lithium is the 25th most abundant element and occurs in diverse types of deposits of different ages on almost every continent. In this talk, I will present an overview of lithium geology, including occurrence, deposit types, exploration approaches, mining, and processing methods. I will also comment on the potential environmental impacts of lithium mining and processing. The talk will focus on lithium pegmatite, as this is the main type of lithium deposit known to occur in the Northwest Territories. As the title suggests, this talk will be introductory in nature and scope, given the varied geologic background of the anticipated audience. However, there are plans to organise a lithium-focused workshop during one of the future Geoscience conferences. Moreover, experts in lithium pegmatite will be welcome to contribute their knowledge during the discussion period following the talk.

Gideon Lambiv Dzemua

Critical and Industrial Minerals Resource Geoscientist
Northwest Territories Geological Survey,
Government of Northwest Territories
Department of Industry, Tourism and Investment

Gideon Lambiv Dzemua is a Critical and Industrial Minerals Resource Geoscientist with the Northwest Territories Geological Survey, based in Yellowknife, Northwest Territories. He is currently leading research projects on a range of critical and industrial minerals, including geology, exploration strategies, and processing methods for granitic pegmatite-hosted lithium resources. Gideon has over 20 years of experience researching and exploring various mineral commodities in diverse deposit types across the globe, including lithium, cobalt, nickel, and high-purity quartz. His work experience spans the private sector, academia, government agencies, Indigenous governments/groups, and non-governmental organizations. He frequently serves as a member/lead in various technical committees and as a technical advisor on mineral resource issues to private and government agencies. Gideon is an adjunct professor at Dalhousie University and a peer reviewer for various journals. He has mentored numerous students and early career professionals. Gideon is a Professional Geologist with a PhD specialising in Economic Geology from the University of Alberta, a MSc in Physical Land Resources Analysis from Ghent University in Belgium, and a BSc in Geology and Environmental Sciences from the University of Buea in Cameroon.

Legacy of a Pioneer: Dr. Charles Stelck's Contributions to NWT Geology

Dr. Charles Richard Stelck (1917-2016) was a pioneering geologist whose contributions to stratigraphy, paleontology, and hydrocarbon exploration had a profound impact on the oil and gas industry in Canada. While much of his career was spent as an educator at the University of Alberta, where he inspired generations of geologists, his work in the Northwest Territories, particularly during the Canol Project, stands as a cornerstone of his legacy. Stelck's fieldwork in the Norman Wells and Upper Peel River areas led to the confirmation of the reefal origin of the Norman Wells oil field (Kee Scarp), which became instrumental in shaping Imperial Oil's exploration strategy. His stratigraphic and paleogeographic studies of the Devonian intervals in the NWT set the foundation for future oil discoveries in Alberta. This presentation explores Stelck's significance in the geological annals of the Northwest Territories and discusses recent research on the Canol and Imperial Formations that have been built on the pioneering work of Stelck and his contemporaries. His deep understanding of biostratigraphy, especially through his work with Devonian and Cretaceous faunas, demonstrated the importance of integrating fossil and sedimentology data with hydrocarbon exploration. Stelck's meticulous research in the NWT not only advanced scientific knowledge but also had significant commercial implications, particularly in identifying hydrocarbon-bearing structures in western Canada.

Murray K. Gingras
Professor & C.R. Stelck Chair in Petroleum Geology
University of Alberta

Dr. Murray K. Gingras is a Professor and the C.R. Stelck Chair in Petroleum Geology at the University of Alberta. A leading expert in ichnology, his research focuses on the interactions between animals and sedimentary environments, particularly through the study of trace fossils. With over 200 publications in international journals, Dr. Gingras' work has significantly advanced the understanding of ancient depositional environments and their applications to hydrocarbon exploration. His contributions have influenced the fields of sedimentology, stratigraphy, and geochemistry, with a particular emphasis on bay and estuary environments. Dr. Gingras has organized numerous international workshops and conferences, and his research has been recognized with multiple awards. In addition to his academic contributions, he actively trains the next generation of geologists, fostering their skills in sedimentary geology, ichnology, and geobiology.

Oral Presentations

Ordered by presenting author(s) last name
Student presentations denoted by *

Poster Presentations

Student Soap Box presentations denoted by *

Oral Presentations

Student presentations are denoted by *
Presenting author(s) are underlined

*Trace Fossil Assemblages of the Devonian Imperial Formation: A Comparative Analysis with Other Devonian Studies

Arzu Acikelli[1], Murray K. Gingras[1], Viktor Terlaky[2], Jonathan Y. Rocheleau[2] & Yaqub O. Adepoju[2]
[1]University of Alberta, Edmonton, Alberta, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
acikelli@ualberta.ca

The Devonian Imperial Formation exhibits distinctive trace fossil assemblages shaped by varying physicochemical factors such as hydraulic energy, oxygen levels, and nutrient input. Comparative studies of other Devonian formations reveal the influence of extinction events and the paleogeographic context on these trace fossil communities.

In the shallow marine environment deposits of the Imperial Formation, trace fossil suite shows high diversity and bioturbation intensity. These trace fossil suites correspond with the archetypal Cruziana Ichnofacies, predominantly featuring deposit-feeding ichnofossils like *Cruziana* isp., *Planolites* isp., and *Palaeophycus* isp. This is consistent with trace fossil assemblages from other Devonian shallow marine settings. However, the Imperial Formation displays slightly higher ichnodiversity, likely driven by its tropical paleogeographic location, which offered robust nutrient supplies and a greater variety of ecological niches, coupled with potentially higher oxygen levels at the seafloor.

Inner shelf turbidite deposits have moderate trace fossil diversity with trace fossil assemblages including *Chondrites* isp., *?Didymaulichnus* isp., *Oldhamia* isp., *Paleodictyon* isp., *Palaeophycus* isp., *Planolites* isp., *Psammichnites* isp., *Teichichnus* isp., *Thalassinoides* isp. These assemblages differ from other Devonian studies due to relatively higher ichnodiversity and the absence of *Zoophycos* isp. The elevated diversity may reflect increased oxygen levels, better nutrient availability, and longer colonization windows. The absence of *Zoophycos* isp. is possibly attributed to the Frasnian- Famennian extinction event, which likely occurred near the onset of the Imperial Formation.

The basinal turbidite deposits of the Imperial Formation show minimal, sporadically distributed bioturbation including the trace fossils *Arenicolites* isp., *Planolites* isp., *Chondrites* isp., *Palaeophycus* isp., with no evidence of graphoglyptids (farming traces): some other Devonian turbidites are characterized by graphoglyptid ichnofossils. This absence suggests persistently high sedimentation rates and strong hydraulic energy restricted infaunal colonization

Assessing Vegetation Components for Long-Term Stabilization of Processed Kimberlite in the Long Lake Containment Facility

Feyi Adebayo[1] & Wilf Petherbridge[2]
[1]Burgundy Diamond Mines Limited, Calgary, Alberta, Canada
[2]EcoSense Environmental Inc., Lethbridge, Alberta, Canada
feyi.adebayo@burgundydiamonds.com

The Ekati Diamond Mine, operated by Burgundy Diamond Mines in the Northwest Territories, generates substantial processed kimberlite (PK) that requires effective management and reclamation strategies. Since 1998, the Long Lake Containment Facility (LLCF) has been used for PK deposition in Cells A, B, and C, while Cells D and E are designated for water polishing. Initially, a rock cover was proposed for closure, but early revegetation results in Cell B shifted the focus to a combined rock and vegetation

cover approach. The primary objective of this research is to identify the vegetation components necessary for the LLCF's final cover system to stabilize the PK, ensuring long-term safety for wildlife and humans.

Initial field trials in Cell B assessed the feasibility of using vegetation for PK stabilization. Following positive results, research evolved to identify suitable plant types, enhance soil chemistry, and optimize rock placement. Since 2012, reclamation research has included various trials aimed at designing a long-term cover applicable to the entire LLCF. Key research components involve evaluations of rock /cover combinations, plant species trials, natural colonization, soil amendments, glacial till topdressing, cover crops, applications of mine-generated organic matter, mycorrhizae studies, and seed collection /distribution. In Cell A, plant growth conditions were assessed through soil sampling, while species trials were conducted with native grasses and forbs.

Results indicated that roto-tilling prepared a more favourable seedbed than harrowing, enhancing growth in roto-tilled areas. Natural colonization in Cell B increased significantly, with a 42.1 % rise in lower biomass growth from 2019 to 2021. By 2022, Boulder Fields achieved over 100 % total cover with Fult's native goosegrass. Organic amendments from 2021 improved grass establishment where moisture was available, while Mycorrhizae trials showed slight survival advantages for inoculated plants. Thick swards of goosegrass thrived despite upward salt migration from PK into the topdressing. For Arctic Coast Species, total cover was highest in Boulder Fields, followed by Rock Grids and Rock Rows. Non-vascular plants and soil bio-crusts established effectively while live alkali grass cover was greater in naturally colonized areas than in seeded areas. In Cell A, survival rates among grass seedling plugs were notably higher. These findings emphasize the importance of ongoing monitoring and diverse plant species integration to enhance reclamation efforts. Further species trials and monitoring will continue, to inform the final cover design for the LLCF and other PK containment areas across the Mine.

Assessment of Caprock Integrity for CO_2 Sequestration in the Moose Channel Formation: Evaluating Shale-Rich Sealing Potential and Thickness Variability

Yaqub O. Adepoju
Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
yaqub_adepoju@gov.nt.ca

The Moose Channel Formation, which spans approximately 7.4 km^2 beneath the central Mackenzie Delta and west of the Tuktoyaktuk Peninsula in the Northwest Territories (NWT), represents a potential site for carbon dioxide (CO_2) sequestration. This formation is overlain by deltaic sequences from the Paleogene and Neogene periods, including the Richard, Mackenzie Bay, and Akpak formations characterized by clay-rich units. These units are predominantly developed further north, near the Beaufort Sea, raising concerns regarding their effectiveness as caprocks for long-term CO_2 storage within the Moose Channel Formation. Ensuring the integrity of caprocks is critical for successful carbon sequestration, as they prevent the leakage of CO_2. This study evaluates the integrity of a caprock system with thicknesses ranging from 0 to 2,165 m and a variable composition consisting of approximately 50 % shale. The high shale content contributes to low permeability and enhances gas-trapping capabilities, positioning it as a potentially effective barrier for CO_2. However, the variability in caprock thickness poses challenges; thinner sections may be more susceptible to leakage, while thicker sections, in conjunction with high shale content, exhibit more substantial vertical sealing potential. A combination of geological analysis and detailed modeling was employed to assess the sealing ability of the caprock. This approach included petrophysical analysis of well logs, supplemented by field data and literature reviews, and evaluations of caprock thickness and continuity. Fault and fracture mapping were also conducted to identify potential leakage pathways, along with an analysis of the in-situ stress regime to predict the risk of fault reactivation during CO_2 injection. The geological assessment emphasizes the importance of characterizing the caprock's heterogeneity in thickness and coverage,

particularly in areas of reduced thickness, to ensure containment integrity. This study advances our understanding of caprock behaviour in large-scale CO_2 sequestration projects, providing insights that can enhance storage security and mitigate leakage risks.

Structurally Induced Secondary Hydraulic Conductivity Pathways and Sealing Potential of a CO_2 Storage Reservoir in the Northwest Territories, Canada: Moose Channel Formation Case Study

Yaqub O. Adepoju
Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
yaqub_adepoju@gov.nt.ca

This study estimates the contribution of fractures to the total porosity of the basal sandstone member of the Moose Channel Formation, which is exposed at a side-cut of Big Fish Creek, north of the Richardson Mountains. An extension of this formation lies approximately 1.8 km beneath the surface of the Mackenzie Delta in Canada's Northwest Territories. Geological structures, such as faults and fractures, are critical in determining the efficiency of carbon sequestration reservoirs in preventing CO_2 leakage. These features significantly influence the long-term integrity and containment of CO_2 storage. Depending on factors like orientation, displacement, and fault gouge properties, faults can either facilitate CO_2 leakage or function as effective seals, trapping fluids within low-permeability zones. Similarly, fractures—whether naturally occurring or induced by CO_2 injection—can increase reservoir permeability, potentially creating leakage pathways unless sealed by mineral precipitation or caprock layers. Therefore, understanding the interaction between faults, fractures, and overlying caprock is essential for effective CO_2 containment. Key factors such as in-situ stress regimes, pressure changes during injection, and the risk of fault reactivation must be thoroughly assessed.

Rock fracture properties were estimated by combining field measurements with desktop analyses, including seismic data interpretation, petrophysical analysis, and static reservoir modelling. Fracture porosity (ϕf) ranged from 0 % in shale-rich zones (Vshale near 100 %) to 16.17 % in cleaner sandstone zones (Vshale approaching zero). An empirical coefficient ($\alpha = 0.1431$), representing the reduction in fracture porosity due to shale content, was derived from the gradient of the ϕf vs. Vshale plot and used to model fracture porosity for the study interval. Combined fracture and matrix porosities yielded P10 and P90 values for total reservoir porosity (ϕt), ranging from 22.02 % to 32.35 %. While secondary porosity can enhance reservoir quality by improving fluid storage and flow, the processes that generate it—such as tectonic stresses, dissolution, and diagenetic alterations —can also reduce a formation's sealing capacity. These processes may lead to fractures and dissolution features that compromise impermeable barriers, facilitating fluid escape and reducing the overall effectiveness of CO_2 storage systems. A comprehensive understanding of these factors is crucial for effective reservoir management and the long-term security of CO_2 storage. This approach will be applied to other reservoirs selected for carbon sequestration studies, contributing to assessing the safety and feasibility of CO_2 storage projects in the Northwest Territories.

Leading at the Local Level. Why Local Leadership in the Mineral Industry Matters

Richard Aksawnee
Forum Energy Metals Corp., Nunavut Affairs, Baker Lake, Nunavut, Canada
aksawnee@forumenergymetals.com

As a lifelong resident of Baker Lake, Nunavut, I am proud to be actively involved in shaping our community's future through leadership roles. My late father, David Aksawnee, who served as mayor of Baker Lake, inspired my commitment to ensuring that our people and our Land thrive in the face of evolving opportunities. As mayor from 2019 to 2023 and chair of the Hunter and Trappers' Organization for 20 years, I've learned that leadership goes beyond management—it's about engaging the community, preserving our Inuit traditions, and fostering long-term benefits for future generations.

Today, as the Manager of Nunavut Affairs with Forum Energy Metals Corp., I see a unique opportunity in this senior role to further the goals of Indigenous leadership within the mineral industry. As the mining sector transitions from gold to diamond mining and now to critical mineral exploration, our role has evolved. Our voices and perspectives are integral to responsible development. In my work, I advocate for responsible uranium exploration near Baker Lake, focusing on aligning these activities with the cultural and environmental priorities of our community. I believe the mineral industry can play a role in helping achieve global climate action goals while creating much-needed jobs, training, and economic opportunities for our communities.

In my position with Forum, I act as a bridge between the company and my community, ensuring local priorities are central to decision-making. Indigenous leadership is key in maximizing the long-term benefits of mineral exploration, from education and training to employment and community investment. We want to ensure the exploration phase plants seeds for sustained development that supports future generations.

My personal connection to Baker Lake, where I have raised seven children and two granddaughters, influences everything I do. I want my children to have the same connection to the Land as I do, through hunting, fishing, and camping. This commitment to maintaining a balance between environmental stewardship and economic development is central. I aim to build pathways to help our young Inuit thrive while respecting our Lands and traditions.

This presentation will showcase how local Indigenous leadership can drive mineral development in a way that benefits both the industry and the community, and the thoughtful actions we are already taking.

Indigenous-led engagement, capacity building, and collaboration with the mineral sector are critical as we look ahead to a new generation of exploration and mining in the North. Our experiences in Baker Lake can serve as a model for successful partnerships between resource companies and Indigenous communities, proving that development can work for us, not against us, when grounded by local leadership.

2023 Pigeon Stream Diversion Monitoring Program: Assessing Habitat Compensation and Ecological Functionality

Leanne F. Baker[1] & Leslie C. Gault[2]
[1]ERM Consultants Canada Ltd., Yellowknife, Northwest Territories, Canada
[2]Burgundy Diamond Mines Limited, Calgary, Alberta, Canada
Leslie.Gault@burgundydiamonds.com

The Ekati Diamond Mine, operated by Burgundy Diamond Mines Ltd. in the Northwest Territories, features the Pigeon Stream Diversion (PSD), designed to compensate for stream habitat loss during the development of Pigeon Pit in accordance with Fisheries Act Authorization. The PSD aimed to create a new fish habitat at a habitat unit (HU) gain-to-loss ratio of 2:1. A ten-year post-construction monitoring program was established to assess whether the compensation habitat meets this ratio and functions as intended physically and ecologically. This study aimed to evaluate the post-construction physical and biological components of the Pigeon Stream and provide a final characterization of its status. Post-construction monitoring data was collected in 2014, 2015, 2017, 2021, and 2023 and compared to baseline data from 2005, 2006, 2007, and 2009 across three sections of Pigeon Stream. This comparison assessed pre- and post-construction conditions to determine the effectiveness of the PSD in supporting functional fish habitat. Results indicated that Pigeon Stream effectively supports functional fish habitat as defined in the Fisheries Act Authorization. It provides spawning, rearing, and feeding habitat for up to six fish species, including Arctic Grayling, and serves as a migration corridor for four species by maintaining connectivity between downstream and upstream water bodies. The area of fish habitat gained by the PSD ranged from 972 to 1395 m², corresponding to a median habitat unit gain of 456 HU, achieving a 2:1 habitat gain-to-loss ratio (456:220 HU) and fulfilling the compensatory habitat gain requirement specified in the Fisheries Act Authorization.

Optimizing Snow Compaction Cycles for Permafrost Protection: A Case Study on the ITH

Jay Cumming[1], M. Alice Wilson[2], Ryley Beddoe[1] & Greg Siemens[1]
[1]Royal Military College of Canada, Kingston, Ontario, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Inuvik, Northwest Territories, Canada
ryley.beddoe@rmc.ca

Minimizing permafrost thaw under a road is a highly complex challenge, and mitigation and adaptation techniques strive to decrease the consequences of thaw. One such mitigation technique is snow compaction. In this study, field studies investigating snow compaction were used to calibrate numerical models that investigated compaction as a viable long term permafrost thaw mitigation technique. Using climate, snow depth and density measurements from two sites along the Inuvik-Tuktoyaktuk Highway (ITH), the model was developed by iterating soil properties until model temperature outputs matched the recorded temperatures recorded at the two sites.

This study evaluated the impact of snow depth, snow compaction cycles (both monthly and annually), and the effect of snow accumulation at base of an embankment on the resulting thermal regime. The snow depth scenarios evaluated were simulated repeating snow depths, based on historical low, high, and average annual snow depths from the region. It was found that snow compaction works best for models experiencing 'average' snow depth and had minimal effect when applied to high or low snow depths. It was also found that snow compaction works best when applied multiple years in a row, as changes in ground temperature will revert to non-compacted conditions when snow is left undisturbed. The results of this study will allow for rapid assessment of this permafrost thaw mitigation technique for any site, and provide insight into the longterm feasibility of this technique for the ITH and other all-season permafrost roads.

*Distribution of Germanium in the Zn-Pb-Ag Praire Creek Deposit: Insights from Macro to Nano Scales

Juan D. Bello-Rodriguez[1], Dan Gregory[1], Merilie A. Reynolds[2] & Denis Fougerouse[3]
[1]University of Toronto, Toronto, Ontario, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[3]Curtin University, Bentley, Perth, Western Australia
jd.bellorodriguez@mail.utoronto.ca

Germanium (Ge) is crucial in advancing technology, especially fiber optics and high-efficiency solar cells. It is commonly recovered as a byproduct of zinc (Zn), which poses potential future supply risks, defining it as a critical mineral. Ge is frequently sourced from sediment-hosted Zn-Pb deposits but the deposit-scale distribution and enrichment mechanisms within these deposits remain poorly understood. To help fill this knowledge gap, we use macro- to nano-scale analytical methods to examine the Ge-bearing Zn-Pb-Ag Prairie Creek deposit in Northwest Territories, Canada. We aim to refine the genetic model of this deposit and identify key factors influencing Ge accumulation.

The Prairie Creek deposit exhibits two main mineralization styles: 1) stratiform and 2) quartz-carbonate vein, both hosted in Ordovician to Devonian sedimentary rocks. Using whole-rock geochemical analysis, we determined that only the stratiform style is significantly enriched in Ge (up to 300 ppm). The results show a strong correlation between Ge and Zn, indicating that Ge content is associated with Zn-bearing mineral phases. At least two generations of sphalerite (ZnS; Sp I and Sp II) occur in the stratiform mineralization. LA-ICP-MS analysis of sphalerite reveals significant Ge enrichment (up to 2,600 ppm) exclusively in Sp I, whereas Sp II exhibits much lower Ge concentrations (0.5 to 100 ppm). Trace element mapping shows a spatial correlation between Cu and Ge within sphalerite crystals, with spot analysis identifying a 2:1 Cu/Ge ratio. This suggests a possible relationship in their substitution mechanisms. Notwithstanding, atom probe tomography indicates that Ge primarily occurs as nano-inclusions — likely briartite ($Cu_2(Zn,Fe)GeS_4$)—in Sp I, rather than substituting for Zn within the sphalerite crystal lattice.

This work will provide valuable insights into the behavior of Ge in hydrothermal fluids within sedimentary basin environments, directly guiding strategies to enhance mineral exploration and extraction for Ge-bearing deposits. By refining these strategies, it aims to better meet global demand for Ge and contribute to a sustainable future.

A Community-Based Approach to a Fish-Out in West-Central Nunavut

Chris T. Chesworth[1], **Cameron Stevens**[2] **& Merle Keefe**[3]
[1]WSP Canada Inc., Calgary, Alberta, Canada
[2]WSP Canada Inc., Ottawa, Ontario, Canada
[3]B2Gold Corp–Nunavut, Vancouver, British Columbia, Canada
christopher.chesworth@wsp.com

Precious mineral and metal deposits are often located under fish-bearing waterbodies in northern Canada, requiring fish salvage or rescue mitigation prior to dewatering and mining of those deposits. Fishing efforts and methods for such mitigation in the North are typically prescribed under a Fisheries Act approval and in accordance with the General Fish-out Protocol for Lakes and Impoundments in Northwest Territories and Nunavut. Key objectives of the protocol are to engage and integrate community stakeholders in fish-out planning and execution, and when possible, to prepare harvestable fish (based on species and sizes) for consumption by the local communities. This paper summarizes the effective integration of Inuit community members for a fish-out of two small lakes at the B2Gold Back River Project in west-central Nunavut. A total of 11 community members from Cambridge Bay, Kugluktuk, Gjoa Haven, and Taloyoak participated. The community members took part in all aspects of the fish-out, including method selection and gear deployment, fish processing and fish selection for fillet harvesting, and provided input on when adequate fishing effort was completed to achieve sufficient fish depletion. Daily feedback on fish depletion from community members was generally in alignment with science-based guidelines and feedback from Fisheries and Oceans Canada. The community-based approach enabled effective decision making and improved the overall efficiency of the fish-out program.

Community-Scale Mapping (1:10,000) of Surficial Geology and Permafrost Conditions: Why Fine-Scale Mapping and Field Investigation Matter

Alexandre Chiasson[1,2], **Steven V. Kokelj**[1] **& Duane G. Froese**[2]
[1]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[2]University of Alberta, Edmonton, Alberta, Canada
Alexandre_Chiasson@gov.nt.ca

The Sahtu community of Tulit'a, located at the confluence of the Great Bear and Mackenzie Rivers, is built on fluvial and glaciofluvial terraces incised approximately ~30 to ~50 m above the current river levels. The glacio-fluvial sediments were deposited at the junction of the proglacial Lake Mackenzie and the paleo Great Bear River, which occupied the lowland areas of the central Mackenzie Valley following retreat of the Laurentide ice sheet. The paleo Mackenzie River later incised these deposits, forming the alluvial terraces observed along the valley today. A cooling Holocene climate resulted in the formation of permafrost, which can be ice-rich in fine-grained deposits. In 2021, the Northwest Territories Geological Survey supported the Permafrost Archives Science Laboratory (PACS labs, University of Alberta) to update surficial geology mapping at a 1:10,000 scale for communities in the Sahtu region. Spurred by interest from the community, this initial project focuses on mapping surficial geology, permafrost distribution, and ground ice conditions for the Hamlet of Tulit'a. The methodology involves discussions and workshops with the community, revision of past surficial geology maps, analysis of aerial photographs, and acquisition of geotechnical reports. To ground-truth the surficial geology and permafrost condition maps, soil sampling, permafrost coring, geophysical surveys, and the installation of ground temperature stations were conducted in 2022 and 2023. Frozen cores were analyzed for excess-ice content (EIC). Field investigations revealed that permafrost is present in fine-grained sediments such as alluvial, till, and glaciolacustrine deposits, but is generally absent in sandy gravel glaciofluvial deposits. Our investigations and maps indicate that Tulit'a is mainly built on alluvial sediments composed of silt and clay containing no or little excess-ice. However, the field investigations

revealed an ice-rich lacustrine basin extending beneath the new subdivision and the baseball fields. The EIC within this lacustrine basin ranges from 30 % to 90 % between the depths of 0.50 m and 3 m. In Tulit'a, the permafrost in alluvial terrain with an EIC typically below 5 % is comparatively thaw-stable. Aerial photographs and analysis suggest that the ice-rich terrain is associated with the wetland west of the community. In the 1970s, part of the wetland was artificially drained, facilitating the establishment of deciduous vegetation, typically related to ice-poor permafrost. This change obscured the surface expression of ice-rich permafrost, preventing its detection by conventional mapping or field observation without recovery. Our documentation of this geohazard highlights the importance of working closely with community members and practitioners to document the development history, field investigations to validate desktop-based surficial geology and permafrost maps, and the necessity of geotechnical studies prior to developing a new area.

Updates from the Mackenzie Valley Environmental Impact Review Board

Mark A. Cliffe-Phillips & Kate Mansfield
Mackenzie Valley Environmental Impact Review Board, Yellowknife, Northwest Territories, Canada
Mcliffephillips@reviewboard.ca

The Mackenzie Valley Review Board (Review Board) has been working on several guideline, policy and process improvements since the last NWT Geoscience Forum. This presentation is intended to highlight some of these initiatives.

The Review Board recently released its Guideline for an optional pathway for major projects to enter environmental assessment. This is intended to describe the information and process needed that allows a proponent who is looking to propose a new major development, such as a new mine or large infrastructure project to go directly to environmental assessment. This is intended to create a more timely, efficient and informed process.

The Review Board will highlight a new reference bulletin that outlines the process options available to meet the nine month shorter environmental assessment timeline described in the Mackenzie Valley Resource Management Act. This presentation will also describe several other reference bulletins released over the last year.

The Review Board will highlight the ongoing development of the project approval pathway online tool that it has been developing along with partners to provide a better understanding of the process, information and regulatory and other approvals needed to develop projects in the Mackenzie Valley of the NWT.

Continuing to develop guidelines, policy, reference bulletins and other tools is a key component to helping the Review Board meet its overall vision and goal to conduct fair, effective, timely and evidence-based environmental impact assessment processes that protect the environment, the well-being of residents, and considers the importance of conservation to the well-being and way of life of Indigenous peoples of the Mackenzie Valley.

Gone with the Wind; Audibility of Mine-Related Sound to Caribou

Daniel W. Coulton[1], Victor Young[2], Meghan Beale[3], Corey De La Mare[3], Sara Savoie[4] & Jade Robitaille[4]
[1]WSP Canada Inc., Victoria, British Columbia, Canada
[2]WSP Canada Inc., Calgary, Alberta, Canada
[3]WSP Canada Inc., Edmonton, Alberta, Canada
[4]Agnico Eagle Mines Limited, Toronto, Ontario, Canada
daniel.coulton@wsp.com

Sensory disturbances, such as sounds, from operating mines in the Arctic are hypothesized to indirectly degrade caribou habitat and lead to avoidance of near-mine areas. The Meliadine mine uses unique mitigation of reducing surface activities when caribou are within 5 km of the mine. Agnico Eagle Mines Limited and WSP collaborated to evaluate this mitigation and the spatial thresholds of Mine-related sound on caribou to address a community concern for caribou. Sound parameters of operational activities were modelled for spatial propagation for full and reduced operations. Published hearing thresholds for reindeer were applied from Perra *et al.* (2022) to evaluate how far away caribou might hear Mine-related sound. Baseline wind sound of the natural Arctic environment, which can mask mine-related sound, was also considered. The results

indicated that reduced surface activity does reduce sound emissions from the Mine (*i.e.*, reduced sound power levels). Based on conservative assumptions, the analysis indicated that when wind speeds are less than 8.2 km/hr during reduced operations mine sound is audible out to a maximum of 9.1 km. However, wind monitoring when caribou are typically present annually, indicates that very low wind speeds (<8.2 km/hr) are relatively rare (13.6 % days). Mean daily wind speeds from 8.2 km/hr to 21.6 km/hr occur 62.1 % of the time and mask audibility at distances beyond 3.5 km. Higher wind speeds (≥32.4 km/hr) limited audibility to within 500 m. How far away caribou can hear mine sound depends highly on the magnitude of natural sound. Audibility thresholds shown in our study do not represent disturbance thresholds and natural sounds may limit where caribou can hear and the distances where caribou respond to anthropogenic sounds may be much less than previously suggested.

Nunavut Exploration Overview 2024

Samuel J. de Beer
CIRNAC, Iqaluit, Nunavut, Canada
samuel.debeer@rcaanc-cirnac.gc.ca

2024's exploration season in Nunavut saw a continuation of last year's increased exploration in critical and battery metals. Canadian North Resources Inc. announced in October that the company had completed a LiDAR survey and 21,000 m of drilling at its Ferguson Lake nickel-copper-cobalt-PGE property in the Kivalliq, with 69 of 78 holes intersecting mineralization.

Also in the Ni-Cu-PGE sector, SPC Nickel Corp.'s program at its Muskox project in the western Kitikmeot confirmed widespread base and precious metal mineralization, with high-grade results in three target zones. Aston Bay and American West Metals announced high-grade intervals identified in drilling at the Chinook and Cyclone targets of the Storm copper project on Somerset Island. Aston Bay also completed airborne geophysics, mapping and sampling at the Epworth project in the Kitikmeot, a joint venture with Emerald Geological Services.

Uranium exploration continued in the Kivalliq region. In March, Atha Energy Corp. and Latitude Uranium Inc. announced that Atha would acquire 100 % of the common shares of Latitude and its Angilak project. In September Atha announced that it had acquired mineral tenure across the entire Lac 50 structural corridor and an additional parallel corridor, and had completed a 10,000-metre drill program. Also in the Kivalliq, Forum Energy Metals completed a 30-hole drill program of nearly 7,000 m on five previously identified gravity targets at its Aberdeen uranium project. Several new-to-Nunavut companies also acquired tenure for uranium exploration in the region.

In gold highlights for the territory, construction and development at B2Gold's Back River project are on track for an initial gold pour in Q2 2025, with commercial production expected in Q3. A 25,000-metre exploration drill program was planned for Back River for the 2024 field season.

Exploration continued at Agnico Eagle Mines Ltd.'s operations in Nunavut. At Hope Bay's Madrid deposit, 35 400 m was completed by July, with promising results from infill drilling at the Patch 7 target leading the company to approve a further 62,000 m of drilling for Madrid. Agnico Eagle also acquired the Oro mining leases, northeast of Hope Bay, from North Arrow Minerals Ltd.

Blue Star Gold Corp. completed an extensive program at Hood River, Ulu, and Roma. Throughout the summer the company announced high-grade drilling results from Mikigon and several other prospects. A new massive sulphide zone, Ataani, was identified, and returned promising copper-equivalent grades when assayed.

After an absence of several seasons, Fury Gold Mines reactivated their Committee Bay project, with a geological mapping and surficial and geochemical sampling program. Three of the five targets evaluated this season were considered to be drill-ready, and further exploration is planned on the property.

1,456 new mineral claims were acquired this year through the Nunavut Map Selection system as of October 2024. The new tenure covers a total area of over 2 million hectares, and was mainly selected in the Thelon Basin, in the western Kitikmeot, and on the northwestern part of Baffin Island adjacent to the Fury-Hecla Strait.

Office of the Regulator of Oil and Gas Operations (OROGO) Updates

Pauline de Jong & Brandon Bradbury
Office of the Regulator of Oil and Gas Operations, Yellowknife, Northwest Territories, Canada
pauline_dejong@gov.nt.ca

OROGO holds regulatory responsibility for oil and gas operations in the onshore Northwest Territories outside the Inuvialuit Settlement Region and federal areas. This presentation discusses OROGO's recent activities and includes information on the status of suspended wells in OROGO's jurisdiction, OROGO's compliance and enforcement activities, new guidelines available for public review, and planned improvements to public access to historical well and geophysical program data.

2024 Northwest Territories Mining and Exploration Overview

Barrett R. Elliott
Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
barrett_elliott@gov.nt.ca

This update covers April to October 2024; not all companies operating in the Northwest Territories (NWT) have reported on their activities. Diamond mines in the NWT continued to bring new deposits into production while work continued to develop new mine plans at the Ekati and Gacho Kué mines. Critical minerals exploration continued at reduced rates from the previous year. Natural Resources Canada reported preliminary exploration and deposit appraisal spending intentions of $147 million for the NWT in 2024, 3.5 % of the Canadian total.

Mining: Diavik Diamond Mine recently announced the commencement of commercial production at A21 underground allowing operations to continue at current levels until Diavik's projected closure in 2026. Mountain Province Diamonds filed an updated Ni 43-101 Technical Report for the Gacho Kué Mine, which extends mine production into 2031. Ekati Diamond Mine anticipates commercial production at the Point Lake open pit and the release of an updated mine plan in early 2025. 60 North Gold announced the commencement of mining operations at the Mon Gold Mine.

Critical Minerals: Osisko Metals filed a new Mineral Resource Estimate (MRE) for their Pine Point Project, which will form the basis of an upcoming feasibility study, and drilling was carried out on exploration targets. Vital Metals filed an updated MRE for the Tardiff Upper Zone at Nechalacho, with an additional MRE update planned later in 2024, including post-2022 drill results. Fortune Minerals was awarded $6.4 million (USD) from the United States Department of Defense, and the Government of Canada has agreed to provide up to $7.5 million (CAD) towards developing their Nico Project.

Lithium: LIFT filed an initial MRE for their Yellowknife Lithium Project based on 286 drill holes representing 49 548 m of drilling. Midas Minerals completed mapping and sampling at the Aylmer Project, identifying seventeen new spodumene-bearing pegmatite outcrops. Narryer Metals completed sampling and mapping programs on their recently acquired (70 %) Big Hill and Fran properties. Exploration at Trinex's Halo-Yuri Project discovered new areas with spodumene-bearing pegmatite mineralization.

Gold: Gold Terra's activities on their City Gold Project were focused on the Campbell Shear and the Con Mine Option Property. STLLR Gold continued drilling on their Colomac Gold Project, focused on the southern end of Colomac Main. Seabridge Gold filed an NI-43-101 Technical Report for their Courageous Lake project, including an updated Preliminary Feasibility Study and a new Preliminary Economic Assessment. Golden Pursuit conducted detailed structural geologic mapping, rock sampling, ground geophysics and photogrammetry surveys at their Gordon Lake Project. Rackla Metals drilled targets on the Astro Plutonic Complex, staked the Grad Property and completed soil sampling, rock sampling and photogrammetry surveys at their Flat and Black properties.

Diamond Exploration: Olivut Resources collected beach sands for caustic fusion analysis to determine potential diamond recovery on their Seahorse Project (JV with Talmora Diamonds).

Mining Incentive Program: The GNWT's Mining Incentive Program allocated $1.5 million in project funding in 2024/25 to eleven corporate exploration projects and four prospector-driven exploration projects.

Long-Term Caribou Movements in Proximity to Diavik and Ekati Mines

Grace E. Enns[1], Daniel W. Coulton[2] & John A. Virgl[3]
[1]WSP Canada Inc., Calgary, Alberta, Canada
[2]WSP Canada Inc., Victoria, British Columbia, Canada
[3]WSP Canada Inc., Saskatoon, Saskatchewan, Canada
grace.enns@wsp.com

Understanding the factors that influence wildlife movement in relation to mines is important to effectively monitor and adaptively manage potential effects on wildlife from mining activities. Existing studies indicate that caribou avoid the areas around active mine sites. Based on this, we predicted that caribou would move more quickly near the Diavik and Ekati mines and would avoid landscape features or disturbances near the mines. Alternatively, if the mines do not have a strong influence on caribou movements, we would expect caribou movements to be more influenced by natural factors, such as habitat type or season. We examined these predictions using high-resolution caribou GPS data from collared caribou in the Beverly/Ahiak and Bathurst herds, collected from 2010 to 2022. Movement metrics were calculated and compared within 3-kilometre (km) buffer zones around the Diavik-Ekati mine complex (up to 111 km) during summer and fall. Movement metrics included movement rate (km/hr) and proportion of hard turns (*i.e.*, turning angles ≥ 60 degrees). We then used generalized linear mixed-effects models to examine the relationship between the speed and proportion of hard turns of collared caribou and explanatory variables, including distance from the Diavik-Ekati mine complex, landcover type, season, herd, sex, and path duration, all of which were found to have a significant influence on caribou speed and hard turns. During summer and fall, caribou moved slowly, rather than quickly as predicted, and had a high proportion of hard turns when near the Ekati-Diavik mine complex, suggesting they made short, multi-directional movements, potentially to search for food in habitats near the mines. This could indicate the use of preferred habitats by caribou near the Diavik and Ekati mines (*e.g.,* habitats that provide available quality forage and/or lower predation risk). Alternatively, slower movement and a high proportion of hard turns may indicate that the mines act as a semi-permeable barrier to caribou movement. We evaluated caribou behaviour scan data collected near Diavik mine, which supported the alternative prediction that collared caribou behaviours are associated with feeding and resting near the mine, rather than hindered movements or avoidance of areas around the mine. Overall, this analysis revealed that movement behaviours of collared caribou in the Beverly/Ahiak and Bathurst herds are influenced by sex, herd, landcover type, season, path duration, and the distance from the Ekati-Diavik mine complex. Importantly, there was no apparent strong adverse response to the mines.

*Understanding Kimberlite Crystallisation and Emplacement: Insights from Reaction Products on Ilmenite and Chromite

Lydia R. Fairhurst[1], Yana Fedortchouk[1], Ingrid L. Chinn[2] & Philippe X. Normandeau[3]
[1]Dalhousie University, Halifax, Nova Scotia, Canada
[2]De Beers Group, Johannesburg, South Africa
[3]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
ly593526@dal.ca

Kimberlites, the primary host of diamond deposits, are enigmatic rocks with little consensus on their origin and formation. Despite their economic importance, there is still a general lack of consensus on the composition of primary kimberlite melts, which limits our understanding of their crystallization conditions and emplacement processes. Kimberlites entrain diamonds and other mantle minerals (*e.g.,* ilmenite, chromite, garnet) and transport them from the mantle to the surface inducing the development of diffusion-controlled compositional zoning and/or dissolution. Congruent dissolution forms resorption textures and incongruent dissolution produces secondary phases (*i.e.*, reaction rims). These reaction products depend on the conditions in the magma and can serve as a proxy for the crystallization conditions of the host kimberlite.

Previous studies demonstrated that dissolution features on diamonds are largely controlled by the presence and composition of fluid in kimberlite magma. This study uses reaction products on ilmenite and chromite to decipher variation in the composition and crystallization conditions of different kimberlite lithologies. This study uses samples from three kimberlite localities in the Northwest Territories of Canada: volcaniclastic and coherent kimberlite samples from Ekati kimberlites (Misery, Beartooth, Koala, Panda, Grizzly and Leslie), Gahcho Kue kimberlites, and the Snap Lake kimberlite dyke. We found that oxide macrocrysts are not preserved in Snap Lake; ilmenite preservation is better in Gahcho Kue, while chromite is better preserved in Ekati. We performed a detailed analyses of 71 ilmenite and 109 chromite macrocrysts from heavy mineral separates and thin-sections using scanning electron microscope and electron microprobe analyses. Three ilmenite reaction textures are observed: type 1 shows congruent dissolution; type 2 exhibits thick, compositionally distinct rims with sieve textures and inclusions; and type 3 displays thin compositional rims. Gahcho Kue and Ekati have type 2 rims with similar Ti- and Mg-rich, Fe-poor trends. Magnetite in Gahcho Kue ilmenite rims allows for temperature estimates between 550-790 °C, much lower than magmatic temperatures reported for similar reaction rims on ilmenites from Orapa kimberlite cluster (Botswana). Type 3 rims from Gahcho Kue show Fe-, Mn-rich rims indicating interaction with hydrothermal fluid, whereas Ekati shows Mg-enriched rims with perovskite likely formed at the magmatic stage. Type 1 chromites show congruent dissolution, type 2 exhibit different compositional changes based on locality but all show enriched Ti rims, and type 3 show localized zones of compositional change with sieve texture along fractures. Thermodynamic modelling indicates ilmenite stability increases in a kimberlite magma with H_2O-rich fluid, which could explain its preservation in Gahcho Kue, consistent with deep exsolution of fluids in class 1 pipes like Orapa, resulting in formation of deep, steep-sided pipes. The poorer preservation of ilmenite in Ekati could indicate later exsolution and/or more CO_2-rich fluids, leading to different pipe morphology from class 1 kimberlites, resulting in small, steep-sided pipes. The absence of oxide macrocrysts in Snap Lake may be a result of their instability due to interaction with trapped CO_2-rich fluid at low pressure after emplacement, which results in rare diamond resorption features from this locality.

Transforming Risk Assessment: A Simplified Approach for Oil and Gas Legacy Sites in Northern Canada

Rory F. Farrell
Moraine Consulting Inc., Calgary, Alberta, Canada
info@moraineconsulting.com

Risk ranking programs are essential tools for prioritizing contaminated sites in Canada, relying on various criteria to assess site risks. However, many existing tools employ numerous attributes, sometimes exceeding 25 in total, making them unmanageable and resulting in poor comparability due to gaps in data. Stakeholders also have diverse objectives, such as budget constraints, determining environmental impacts or attempting to understand site liabilities, complicating the early development of these tools. In northern Canada, applying risk ranking to legacy oil and gas sites has faced challenges due to significant information gaps, which hinder effective risk characterization and delay site prioritization for remediation and closure.

To address these issues, we developed a simplified risk ranking approach for a major producer, aiming to determine the comparative risk of their legacy oil and gas site program across northern Canada. These sites require substantial abandonment and decommissioning efforts, including the remediation of contaminated drilling waste disposal sumps, that contain elevated levels of petroleum hydrocarbons, salts, and metals. Our risk ranking tool aims to refine environmental liability models, evaluate remedial strategies, and outline pathways to closure through in-house risk certainty analysis methodologies.

Key site attributes and criteria were identified during a multi-stakeholder meeting to inform the risk ranking methodology. Essential criteria included site status, regulatory commitments, known and potential environmental receptors, logistical considerations, climate change implications, sustainable remediation practices, timelines to closure, and project economics. Sites were assessed based on these attributes, with results organized in a database tool for effective ranking.

The database tool enabled detailed site comparisons and risk evaluations. A certainty analysis for each site assessed

the reliability of the risk results and provided actionable recommendations for subsequent project phases. This simplified risk ranking approach facilitated effective comparisons, instilling confidence in the risk ranking process. Ultimately, 24 % of the sites were classified as high risk, 32 % as medium risk, and 44% as low risk. Risk results will be utilized in the next annual budget cycle, to allow fiscal responsibility and guide project planning processes.

The outcome of this risk ranking process demonstrated that a simplified approach can yield defensible and manageable comparative rankings. Sites were categorized into high, medium, or low risk, with measurable and reliable data ensuring an acceptable level of certainty. This risk ranking tool supports the development of contaminated site programs, prioritizing sites for further action in an efficient manner. The output goal is to establish a consistent, scientifically sound system for ranking contaminated sites, optimizing resource allocation for remediation and risk management. While successful for this subset of sites, the risk ranking tool requires further refinement to accommodate larger datasets and broaden the tool's applicability to various contaminated site categories, including mining, transportation, and military sites across Canada.

Update on the Land and Water Board's Engagement and Consultation Guidelines

Kathleen Racher[1], Ryan Fequet[2] & Jane Porter[3]
[1]Mackenzie Valley Land and Water Board, Yellowknife, Northwest Territories, Canada
[2]Wek'eezhii Land and Water Board, Yellowknife, Northwest Territories, Canada
[3]Bridge Building Group, Ottawa, Ontario, Canada
rfequet@wlwb.ca

In 2013, the Land and Water Boards of the Mackenzie Valley (LWBs) released our Engagement and Consultation Policy (the Policy) and the Engagement Guidelines for Applicants and Holders of Water Licences and Land Use Permits (the Guidelines). In January 2023, an updated Policy was implemented, and the LWBs are now also updating our Guidelines.

To update the Guidelines, we are gathering information from communities, governments, licensees/permittees, and other interested parties about practices that work and concerns that need to be addressed. Once we have engaged all these parties, we plan on releasing a What We Heard Report that will include conceptual changes to the Guidelines for review and comment.

In this talk, we will describe the process we are using to update the Guidelines and how Forum participants can share their engagement experiences to help in these updates.

Incorporating Local Inuit Knowledge into Caribou Management Strategies

Jennifer M. Foca[1], Morgan Skinner[2], Daniel W. Coulton[3], Corey De La Mare[1], Eric Haley[4], Robin Allard[4] & Marie-Pier Marcil[4]
[1]WSP Canada Inc., Edmonton, Alberta, Canada
[2]WSP Canada Inc., Calgary, Alberta, Canada
[3]WSP Canada Inc., Victoria, British Columbia, Canada
[4]Agnico Eagle Mines Limited, Meadowbank Division, Nunavut, Canada
jennifer.foca@wsp.com

Mitigating disturbance during caribou migration is a key objective of wildlife monitoring and mitigation programs at Meadowbank Mine (Mine) in Nunavut. During spring migration to calving grounds, caribou regularly migrate across mine infrastructure at the Mine such as the All-Weather Access Road (AWAR) and Whale Tail Haul Road (WTHR). In 2022, the Mine's Terrestrial Advisory Group (TAG) members recommended protecting lead caribou during spring migration to calving grounds. Inuit knowledge shared through the TAG indicates that mature pregnant female caribou lead the spring migration to calving grounds, and other herd members follow. Agnico Eagle worked with the TAG to develop lead caribou protection mitigation and implemented a pilot program in spring 2024. Various caribou monitoring metrics were evaluated to assess lead caribou protection effectiveness during spring 2024 and are presented. Regardless of effectiveness, the lead caribou mitigation strategy reflects a collaborative approach that integrates and acknowledges the value of local Inuit knowledge in applied biology.

Ecohydrological and Geological Controls on Contaminant Reservoirs in Degrading Permafrost Peatlands

Jennifer M. Galloway[1], Mariusz Gałka[2], Graeme T. Swindles[3], Michael Parsons[4], Liam Taylor[5], Omid Ardakani[1], Stephen A. Wolfe[6], Peter D. Morse[6], Matt J. Amesbury[7], R. Timothy Patterson[8], Hendrik Falck[9] & Michael J. Palmer[10]

[1]Geological Survey of Canada, Natural Resources Canada, Calgary, Alberta, Canada
[2]University of Łódz, Łódź, Poland
[3]Queen's University Belfast, Belfast, Northern Ireland, United Kingdom
[4]Geological Survey of Canada, Natural Resources Canada, Dartmouth, Nova Scotia, Canada
[5]University of Leeds, Leeds, England, United Kingdom
[6]Geological Survey of Canada, Natural Resources Canada, Ottawa, Ontario, Canada
[7]University of Exeter, Exeter, England, United Kingdom
[8]Carleton University, Ottawa, Ontario, Canada
[9]Diamonds Royalties and Financial Analysis, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[10]Aurora College, Yellowknife, Northwest Territories, Canada
Jennifer.Galloway@nrcan-rncan.gc.ca

Peatlands are important sinks and/or sources of carbon, solutes, and elements of potential concern (*e.g.*, Hg, As, Pb, Cu, Zn) to their surrounding environments. Minerogenic permafrost peatlands that receive input of elements from groundwater and weathering of bedrock and surficial materials accumulate substantial amounts of geogenic-derived elements over millennia, which are then frozen in place. As the Arctic cryosphere thaws due to 21st-century climate warming, understanding permafrost contaminant reservoirs and tracking their release is a growing challenge due to a lack of knowledge on the cumulative and interacting influences of bedrock and surficial geology, vegetation, climate, fire, and ecohydrology on contaminant accumulation in permafrost peatlands. We examined the Holocene history of two permafrost peatlands from the Northwest Territories, Canada, that are underlain by mineralized volcanic and metasedimentary (Daigle Lake peatland) and unmineralized granitoid (Handle Lake peatland) bedrock. Laboratory methods included pyrolytic speciation was used to determine the quality and quantity of solid organic matter; plant macrofossil and macroscopic charcoal analysis to reconstruct vegetation, peatland development, and fire history; testate amoebae to reconstruct the paleohydrological conditions; and inorganic geochemical analyses to determine elemental concentration over time. Both sites have undergone several marked and broadly coincident hydrological shifts and phases of ecohydro- logical development. During the early Holocene (*ca*. 8000-5000 cal BP) initial shallow lake environments at both sites transitioned to rich fen and was colonized by Picea. Elevated concentrations of Zn (up to 65 mg.kg^{-1}), Cu (up to 52 mg.kg^{-1}), As (up to 140 mg.kg^{-1}), and Cr (up to 65 mg.kg^{-1}) occur in the basal lacustrine sediments, particularly at the Daigle Lake peatland that is underlain by mineralized bedrock but are lower in overlying material that accumulated in a fen setting. Depth to water table increased by almost 30 cm in the Handle Lake peatland between *ca*. 5900 and 4900 cal BP, coincident with the Holocene Thermal Maximum. At this time, local fires were severe and frequent at both sites and associated with elevated Hg (up to 50 µg.kg^{-1}) in the peat. After this dry interval, the water table rose at *ca*. 3000 cal BP at the Handle Lake peatland and by *ca*. 2200 cal BP at the Daigle Lake peatland and fire occurrence declined, coincident with the relatively cool and wet conditions of the Neoglacial interval. A bog was established at both sites between 2700 and 2200 cal BP. Fire occurrence and the concentration of Hg (up to 175 µg.kg^{-1}), As (up to 300 mg.kg^{-1}), Zn (up to 50 mg.kg^{-1}) have increased over the past 1000 cal yrs, likely due to a combination of anthropogenic input of As and Hg associated with gold mining in the region and global industrialization as well as warming climate and permafrost thaw. This study illustrates the influence of ecohydrology and bedrock geology of permafrost peatlands on their chemical stores.

*Ore Mineralogy and Paragenesis of the Easter-Duffy Deposit, NWT, Canada

Cole R. Graham[1], Pilar Lecumberri-Sanchez[1], Merilie A. Reynolds[2] & Hendrik Falck[3]
[1]University of Alberta, Edmonton, Alberta, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[3]Diamonds Royalties and Financial Analysis, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
crgraham@ualberta.ca

As the demand for a greater transition to cleaner energy sources increases, Canada has turned its attention to increasing the development of critical minerals. Two of the six critical minerals prioritized by the government of Canada are nickel and cobalt, both of which (particularly cobalt) have historically been primarily mined from magmatic-sulfide deposits. In the NWT, both of these elements are also found in five-element (Ni-Co-As-Ag-Bi) vein-type deposits. When compared to magmatic-sulfide deposits, these deposits are known for very complex mineralogies and lower ore mineral grades, leading to metallurgical challenges. In addition, both concentrations and distribution of ore minerals between similar deposits vary greatly, leading to additional challenges with exploration and spatial predictions.

Located in the East Arm Region of the Great Slave Lake, the Easter-Duffy deposit is a five-element vein-type deposit hosted in metamorphosed Archean basement granitoids, spatially related to the Paleoproterozoic Simpson Island Dyke. Through electron microprobe analysis, over thirty opaque mineral phases have been identified at Easter-Duffy, appearing in dendritic and colloform-like textures and radiating aggregates, all hosted in carbonate veins. Mineralization follows a complex and cyclical paragenetic sequence, trending from native elements to multiple iterations of a cycle from arsenides to sulfarsenides and finally sulfide minerals. Paragenetic characterization aids in understanding this complex deposit, including the host and location of nickel and cobalt mineralization. This reduces the metallurgical and exploration challenges associated with this deposit type and helps place Easter-Duffy in context with other similar deposits in the East Arm Region.

*Investigation of the Striding Mylonite Zone, Northwest Territories

Kiera J. Hamel & Eric J. Thiessen
Memorial University of Newfoundland, St. John's, Newfoundland & Labrador, Canada
kjhamel@mun.ca

The Snowbird Tectonic Zone (STZ) is a geophysically defined, northeast-trending linear feature extending from Alberta to Hudson Bay, which approximately divides the Rae and Hearne Provinces. The STZ exhibits metamorphism and deformation at *ca*. 2.6 Ga and 1.9 Ga and is thought to represent the site of a continental collision between the Rae and Hearne. Within the STZ is the Striding Mylonite zone (SMz) in the Northwest Territories, a 5-10 km wide northeast-trending shear zone at the southeast boundary of the Rae Province. However, the SMz has not yet been studied in detail and it remains unclear if high-strain occurred here at *ca*. 2.6 Ga, 1.9 Ga, or both. By evaluating the structural, metamorphic, and temporal history of the SMz, a better understanding of the tectonic evolution of the southeastern Rae Province can be established.

Detailed field mapping of the region found porphyroclastic mylonite to ultramylonite of granite to granodiorite composition across the SMz. Much of the SMz also shows sub-vertical foliation, a strong sub-horizontal stretching lineation, as well as dominant dextral and minor sinistral kinematic indicators. Petrographic analysis reveals stable garnet and hornblende along the foliation, suggesting high-grade metamorphism during deformation. Protolith ages of mylonitic rocks are approximately 2.6 Ga from U-Pb zircon analysis. Furthermore, multiple generations of monazite reveal high-grade metamorphic events around both 2.6 Ga and 1.9 Ga. The younger 1.9 Ga monazite are correlated to garnet present in high-strain fabrics while the 2.6 Ga monazite can be found as inclusions in large porphyro-blastic garnet predating the high strain. The lower temperature history is determined by in-situ Rb-Sr biotite dating of units that transect the SMz and the broader South Rae. A pattern of rapid cooling following the high-grade metamorphism can be seen in the STZ with Rb-Sr biotite ages around 1.9 Ga, whereas further west the low-temperature ages become younger (around 1.8 Ga or younger). Additionally, even younger ages (approximately 1.5 Ga and 1.3 Ga) may be due to shear zone reactivation

and the growth of new minerals, however these ages may not reflect overall heating/cooling trends for the area. Sub-greenschist facies volcaniclastic units, likely related to the Baker Lake Group, also overlie the SMz, giving a youngest possible age of exhumation for the SMz to be ~1.83 Ga based on U-Pb zircon and Rb-Sr biotite dates.

*Remobilization of Legacy Arsenic Contamination in a Highly Mine-Impacted Subarctic Catchment Through Surface and Near Surface Water Flow

Abigail F. Harrison[1], Melissa Lafreniere[1], Michael J. Palmer[2], Heather E. Jamieson[1], Sean McHale[1], Marc Amyot[3], Nigel Rossouw[2] & Stanley Mackenzie[4]
[1]Queen's University, Kingston, Ontario, Canada
[2]Aurora Research Institute, Aurora College, Yellowknife, Northwest Territories, Canada
[3]Université de Montréal, Montréal, Québec, Canada
[4]Yellowknives Dene First Nation, Northwest Territories, Canada
22nwm@queensu.ca

From 1949-1999, Giant Mine in Yellowknife, Northwest Territories, Canada, produced approximately 257,000 tonnes of arsenic trioxide (As_2O_3) waste through roasting arsenopyrite ores. Uncontrolled emissions in the first 10 years of mine operation led to the atmospheric release and regional distribution of 20,000 tonnes of As_2O_3 as aerosolized dust. An environmental footprint persists in this region 60 years later, and concentrations of arsenic (As) in soils, lake waters, and sediments exceed national guidelines and pose ongoing environmental challenges, especially with shifting climate conditions affecting As mobility. This project investigates the status of As contamination in the heavily mine-impacted Pocket Lake catchment to discover the mechanisms and processes that control As mobility amongst different terrain types. Catchment and terrain unit delineations were accomplished through a drone survey derived elevation model. Surface runoff, soil porewaters, and lake profile samples were collected throughout the spring season. V-notch weirs were used to determine surface flow for each terrain type in the catchment. A full catchment soil survey was conducted to estimate surface soil (0-5 cm) As pool. Study outcomes suggest surface runoff, primarily from snowmelt, continues to be a significant source of As to regional lakes. Bedrock landscapes contribute less to lakes than peatlands and soil-filled valleys, likely due to their reduced soil reservoirs and lower surface water retention periods. Increasing As concentrations in surface waters throughout the snowmelt season imply that a combination of surface water flow and residency time, rather than soil As availability, are the limiting factors in As mobilization. This indicates that future climate driven alterations in surface water flow pathways and runoff volumes, including increased winter snowpack accumulation and higher projected incidence of rainfall leading to heightened saturation overland flow, have the potential to increase As mobilization. Biomethylation of As, either in snowmelt or saturated shallow soils during snowmelt, was observed in all terrain types, resulting in production of less toxic organic As species. Furthermore, observations to date suggest that As in snowmelt runoff is associated with other elements (iron, aluminum, and manganese) and dissolved organic matter, implicating these associations as critical mechanisms in mobility of As in this region.

Revisiting Historic Diamond Projects in the NWT and Nunavut – A Geological Guide for Explorationists

Casey M. Hetman[1], Amy L. Mailey[2] & Grete van Staden[1]
[1]SRK Consulting Inc., Vancouver, British Columbia, Canada
[2]University of British Columbia, Vancouver, British Columbia, Canada
chetman@srk.com

There are many success stories attributed to revisiting historic diamond projects that resulted in new resources and diamond mines. The Letseng mine in Lesotho was initially operated on a small scale by several major diamond mining companies starting in 1968. However, it was deemed uneconomic and subsequently shut down in 1982. It was not until 2006 that Gem Diamonds, the third company to undertake mining at the site, realized the full potential of the deposit and recovered significant quantities of some of the highest-value diamonds in the world. Another example would be the AK6 kimberlite in

Botswana which was evaluated in the early 1970s and deemed uneconomic by a major. It was only after 2010 that it was developed into the Karowe mine which produces the world's largest diamonds. Closer to home in the NWT, the Kennady North project was initially explored and discovered in the late 1990s by multiple companies that eventually left the ground. It was not until 2012 that Kennady Diamonds developed the geology of multiple pipes, ultimately proving up a resource of 20.97 million carats with an estimated value of 1.76 billion USD.

The two biggest challenges facing explorationists revisiting diamond projects in the NWT and Nunavut are the remote, pristine, and undeveloped nature of the environment and navigating through the large amount of data related to kimberlites compiled for more than 30 years. Revisiting kimberlite projects requires a prioritized approach, considering not only geological aspects but also economic factors, mining, and regulatory framework considerations. This contribution will focus specifically on the geological criteria.

When considering revisiting a historic diamond project area, the following should be considered: position on the craton and structural setting, neighbouring kimberlites, glacial geology and thickness of overburden, country rock geology, glacial sediment sampling results, and available geophysics. If kimberlites exist within the project area of interest, the distribution and representivity of the drillcores are extremely important as well as sampling methods (for microdiamonds, mineral chemistry, *etc.*). If bulk sampling has been completed and macrodiamond information is available, updated valuations of the diamonds must be completed.

Once the data for a particular area has been compiled, the reinterpretation exercise begins. Our understanding of geological processes, exploration methods, evaluation, and diamond mining has significantly evolved in the NWT and Nunavut over the last 30 years. The NWT and Nunavut are considered mature kimberlite mining districts where multiple successful mining operations (EKATI, Diavik and Gahcho Kue) have been developed as well as mining project failures (Jericho and Snap Lake), all of which have contributed significantly to our knowledge and understanding of what an economic diamond deposit looks like. Application of this knowledge and reinterpretation of the available historical data is where opportunities will be revealed, and our presentation will focus on specific geological developments that should be taken into consideration when reviewing historic projects.

Kivalliq Inter-Community Road Study and Preliminary Design

Kevin L.W. Hodgins[1], Walter J. Orr[1], Lesley Cabott[2], Forest Pearson[2], Katherine Pingree-Shippee[3], Manuel Verpaelst[4], Renyan Cheng[5], Aron Piamsalee[6], Arlen Foster[1], Warren McLeod[1], Erica Bonhomme[1] & Lynden Penner[7]
[1]Nunami Stantec Ltd., Yellowknife, Northwest Territories, Canada
[2]Nunami Stantec Ltd., Whitehorse, Yukon, Canada
[3]Nunami Stantec Ltd., Ottawa, Ontario, Canada
[4]Nunami Stantec Ltd., Laval, Québec, Canada
[5]Nunami Stantec Ltd., Edmonton, Alberta, Canada
[6]Nunami Stantec Ltd., Winnipeg, Manitoba, Canada
[7]JD Mollard and Associates Ltd., Regina, Saskatchewan, Canada
kevin.hodgins@stantec.com

Nunami Stantec (Nunami) is completing an inter-community road study and preliminary design for an all-season road connecting five communities in the Kivalliq region of Nunavut. The 725 km alignment connects Arviat, Whale Cove, Rankin Inlet, Chesterfield Inlet and Baker Lake and is being delivered to the Government of Nunavut.

Nunami conducted a Viability Assessment confirming the sustainability and viability of the alignment. Nunami reviewed bedrock and surficial geology mapping, air photos, satellite imagery, LiDAR data, and Digital Elevation Models. Terrain conditions were assessed along the centerline including identification of key terrain types, crossing locations, adverse topography, and sensitive permafrost areas. Potential granular and bedrock borrow sources were documented.

The alignment is based on the most direct and least costly route and considers high-quality, stable terrain and avoids visibly wet and polygonal terrain. The alignment avoids steep grades and crosses water bodies at best locations.

Nunami presented the corridor to the Nunavut Planning Commission (NPC) for their integration of the corridor into the Draft Nunavut Land Use Plan. Several community consultations were completed in the connected communities. The consultation process included a variety of engagement processes including online, in-person, questionnaires, and presentations delivered in English and Inuktitut. The consultation exercise considered improved family connections, economic development opportunities plus issues and challenges of the community members, regulators, and stakeholders. Stakeholders included hunters and trappers, community organizations, local businesses, Governments of Canada and Nunavut, Kivalliq Inuit Association, Nunavut Planning Commission, Chamber of Mines, and mining and exploration companies. During this phase of work, several discussions and consideration were made regarding the opportunities and benefits of integrating the road with the Kivalliq Hydro-Fibre Link.

Detailed terrain mapping was completed within a 1 km wide corridor centered on the proposed road alignment and within a 3 km wide corridor at major watercourse crossings. Mapping includes delineating and codifying homogeneous terrain units based on surficial material, surface expression, geomorphic processes, and depth to bedrock. Special attention was given to inventory and characterize the watercourse crossings, as well as delineate terrain constraints (*e.g.*, sensitive permafrost) and geohazards (*e.g.*, landslide) that have the potential to affect the construction and operation of the road. Potential granular and bedrock borrow source prospects were identified.

Recommendations were provided for appropriate design criteria using Transportation Association Canada standards. These include horizontal and vertical alignment require-ments; cross sections; minimum embankment heights; structural and thermal performance; and embankment heights for the different terrain types and conditions.

A greenhouse gas emissions assessment was completed comparing the estimated GHG emissions from the construction, maintenance, and ongoing utilization of the road network to the business-as-usual estimated emissions based on Infrastructure Canada's Climate Lens - General Guidance. Likewise, a Climate Change Resilience Assessment consistent with ISO 31000 Risk Management Standard and the Canadian Climate Lens was completed which included both current and future climate conditions and impacts.

A costing exercise was completed for the project including final design, construction, and order of magnitude estimates of the cost of ongoing administration, operation and maintenance of the road and structures.

Permafrost and Embankment Conditions Along the Inuvik-Tuktoyaktuk Highway, Northwest Territories

Jennifer K. Humphries[1], Steven V. Kokelj[2], M. Alice Wilson[3] & Peter D. Morse[4]
[1]Aurora Research Institute, Aurora College, Inuvik, Northwest Territories, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[3]Northwest Territories Geological Survey, Government of Northwest Territories, Inuvik, Northwest Territories, Canada
[4]Geological Survey of Canada, Natural Resources Canada, Ottawa, Ontario, Canada
jennifer.humphries@auroracollege.ca

The terminal link between the Arctic Coast and the national highway system – the Inuvik-Tuktoyaktyuk Highway – is a 138-km gravel road constructed over ice-rich terrain. In this region, widespread ice-wedge polygon terrain is susceptible to thaw and presents a potential challenge to maintaining embankment integrity over time. In 2017, government and community partners established two independent but complementary ground-temperature monitoring programs. The first program has advanced the regional baseline monitoring network by establishing 16 long- term monitoring sites in the tundra. The second monitors post-construction permafrost conditions and yielded 14 new sites within the road embankment. Both initiatives are sustained by coordinated efforts between the Aurora Research Institute (ARI) and the Government of Northwest Territories (GNWT). Additionally, an aerial survey was completed along the highway in August 2024 to document morphological changes of the road embankment

and adjacent terrain. The toe of the embankment is notably warmer than the centreline, with annual mean temperatures differing by 1 to 4 °C. In ice-wedge polygon terrain, surface deformations such as rutting and potholes, longitudinal cracking of the side slope, and ponding at the embankment toe were more common. The development of a digital survey hosted on ESRI Survey123 has been implemented to support the systematic collection of spatial information on permafrost-related road hazards.

*Soil Microbial Communities and Mineral Exploration in Glaciated Terrain

Bianca P. Iulianella Phillips
University of British Columbia, Vancouver, British Columbia, Canada
bphillips@eoas.ubc.ca

Mineral exploration in northern latitudes is becoming increasingly more challenging as undiscovered deposits are likely buried beneath appreciable glacial overburden and/or bedrock. The effectiveness of many existing mineral exploration tools is diminished as these approaches frequently fail to detect mineralization through thick surface materials. Therefore, the development of innovative exploration strategies and robust techniques to see through cover is imperative to future mineral deposit discovery success.

Microbial communities are sensitive to subtle environmental gradients, and they will reflect these gradients through spatial variability. Variations in microbial community profiles, induced by chemical and physical differences related to geology, are detectable and can be used to vector toward discrete geological features. Results to date demonstrate viability of microbial fingerprinting to directly identify the sub-crop of mineralization at two kimberlites in the Northwest Territories and several sulphide-bearing mineral deposits in Canada. Microbial community profiling of soils above these deposits reveals significant microbial community shifts with a distinct species-level community response, correlated with subsurface ore mineralization.

Outcomes from these deposit-scale studies have highlighted the potential of geomicrobiological tools and techniques for successful application to through-cover mineral exploration - explicitly, the use of microorganisms in soil as vectors for concealed mineral deposits. Therefore, to develop soil microbial community fingerprinting as a viable technique for broader application by the mineral exploration and mining industry, current research focuses on reducing fundamental unknowns about the behaviour and variation of microbial communities in the environment. Specifically, as they respond and adapt to a host of chemical and physical differences in their surroundings that are typical of the surface and subsurface in regions with high economic mineral potential. This includes assessing how microorganisms sense, navigate toward, and utilize minerals in their habitat; exploring microbial community composition and metabolic potential in northern soils in response to changes in temperature and water content; and assessing the impact of ultramafic rock on the carbon feedbacks of soil microbial communities. These investigations serve to support the use of micro-biological-based mineral exploration in different mineral systems, in various terrains and climates, and to provide valuable information about northern Canadian carbon budgets.

Ekwǫ̀ Nàxoèhdee K'è

Petter Jacobsen[1], Ete Zoe[2], Janelle Nitsiza[3], Stephanie Behrens[2]
[1]Tłı̨chǫ Government, Yellowknife, Northwest Territories, Canada
[2]Tłı̨chǫ Government, Behchokǫ̀, Northwest Territories, Canada
[3]Tłı̨chǫ Government, Gamètì, Northwest Territories, Canada
Janelle.nitsiza@tlicho.ca

Ekwǫ̀ Nàxoèhdee K'è is a Tłı̨chǫ Government created and led traditional knowledge caribou monitoring program. The program is based on the traditional knowledge of our Tłı̨chǫ Elders and harvesters; our objective is to collect critical field knowledge of the barrenground caribou herds and their habitat. The program's methodology "we watch everything", means the researchers identify and wait at specific water crossings and eskers and follow caribou

herds by boat and on foot to identify traditional knowledge indicators of a healthy environment by assessing caribou and habitat conditions, impacts from predators, insects, climate change and industrial activities. The program has been operating since 2016 and has now expanded to four camps. Three camps were in operation this summer and during the winter season of 23-24 we also did a pilot winter monitoring program. Our presentation will cover the results we have gathered from summer 2023-fall 2024.

*Unraveling the Mystery: Seasonal Changes and Bloom Risk in Jackfish Lake, NWT

Daniela Klicper[1], Jason Venkiteswaran[1], Helen Baulch[2] & Michael J. Palmer[3]
[1]Wilfrid Laurier University, Waterloo, Ontario, Canada
[2]University of Saskatchewan, Saskatoon, Saskatchewan, Canada
[3]Aurora Research Institute, Aurora College, Yellowknife, Northwest Territories, Canada
klic3198@mylaurier.ca

Harmful algal blooms (HABs) are becoming a significant concern in northern Canadian lakes, yet research on their causes and potential mitigation strategies remains scarce. Within the Taiga Shield region of the Northwest Territories, small, shallow lakes are common. Jackfish Lake, located in Yellowknife, is known for its annual HABs dominated by cyanobacteria that produce toxins harmful to humans and wildlife.

HABs are generally caused by two primary drivers: increased nutrient loading (from external or internal sources) and changes in water temperatures. These factors influence the thermal structure and biogeochemical nutrient cycling in lakes, creating conditions conducive to algal growth. Internal nutrient loading, particularly phosphorus release from sediments into the water column, can be exacerbated by warming surface temperatures and low oxygen levels at the sediment-water interface. Recent studies suggest that rising nutrient levels and climate change foster conditions promoting HABs in northern lakes. This study examined the seasonal phenology of bio-geochemical cycling, focusing on the interactions between temperature, nutrient availability, and phytoplankton composition. Through a three year long monitoring program we analyzed variations in key parameters such as dissolved oxygen, nutrient concentrations and primary productivity. Our results reveal distinct seasonal patterns between Jackfish and three nearby lakes, prolonged summer stratification lead to elevated phosphorus levels as a result of anoxic conditions or sediment disturbance in Jackfish Lake unlike in the comparative lakes. In contrast, winter conditions in Jackfish are relatively oxygenated throughout the water column leading to lower nutrient levels, a pattern not exhibited by the three comparative lakes. These findings highlight the critical role of seasonal dynamics in shaping both nutrient availability and physical conditions and the respective biological responses in Jackfish Lake.

Legal Developments Affecting the NWT Minerals Industry in 2024

Toby Kruger
Lawson Lundell LLP, Yellowknife, Northwest Territories, Canada
tkruger@lawsonlundell.com

This presentation will highlight some significant legal developments affecting the NWT minerals industry in 2024, including the following:

- Updates on the United Nations Declaration on the Rights of Indigenous Peoples Implementation Act
- Mackenzie Valley Land and Water Boards Reference Bulletin for Water Use
- The Land and Water Board's role in consultation: Gwich'in Tribal Council v KBL Environmental Ltd. *et al*, 2024 NWTSC 37
- A regulator's duty to disclose evidence regarding reclamation closure and security: Victoria Gold Corp. v Yukon Water Board, 2024 YKSC 49

***Note** the views in this presentation are the presenter's own and not necessarily those of Lawson Lundell clients.

*Investigating Permafrost Integrity in Drilling-Waste Sumps using Electrical Resistivity Tomography and Induced Polarization Techniques in the Sahtu Region, central Mackenzie Valley, NWT

Michelle Landry[1], Alexandre Chiasson[1,2], Keytash Moshtaghian[1], Alejandro Alvarez[1], Steven V. Kokelj[2] & Duane G. Froese[1]
[1]University of Alberta, Edmonton, Alberta, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
mtlandry@ualberta.ca

Drilling-waste sumps (DWS) in the Sahtu region of the central Mackenzie Valley are designed to immobilize saline drilling wastes produced by oil and gas exploration activities in large pits, constructed in permafrost. To this effect, a legacy of 188 wellsites exist in the Sahtu Region, constructed from the 1920s to the early 2010s.

Approximately 25 of these Sahtu Region wellsites publicly document drilling waste sumps constructed between 1985 to 2011, while DWS information for older wellsites remains poorly documented. Recent changes in climate are accelerating permafrost thaw, threatening the stability of sumps located in warm and thin permafrost areas of the central Mackenzie Valley. A loss of permafrost in drilling-waste sumps can result in elevated hydrological connectivity in subsurface soils, increasing the potential for contaminant mobility into undisturbed surrounding terrain. Direct current electrical resistivity tomography (DC-ERT) and induced polarization (IP) methods were employed in three DWS (Willow Lake sump B-62, Tate Lake sump G-18, and Bear Rock sump J-39) in the central Mackenzie Valley with differing permafrost and geological settings, constructed in 1986, 2000, and 2011, respectively. Our results indicate all three DWS have experienced a varying degree of permafrost degradation, namely localized disturbance such as thermokarst ponding, ground subsidence and sump cap sloughing or collapse. Direct current-ERT surveys indicate that permafrost is absent within and immediately adjacent to sumps (<100 Ω.m) and commonly degraded in lease areas cleared of vegetation (<300 Ω.m). However, in undisturbed areas outside the cleared lease areas of sumps B-62 and G-18, DC-ERT surveys indicate permafrost is present (>400 Ω.m). Induced polarization surveys indicate highly chargeable near-surface fluids directly adjacent to sumps J-39 and G-18 (6-25 msec.) and in undisturbed forested terrain (5-20 msec.), which compares to documented elevated soil sodium adsorption ratios (7.9-16.0) at these sites. Ground temperature station data in cleared lease areas of all studied sumps indicate that frozen ground is not present to a depth of 2.8 m year round. Together, these findings suggest waste disposed of in the studied drilling-waste sumps are not fully encapsulated by permafrost. Defining the relationship between sumps and permafrost conditions provides important information in assessing risk and remediation options associated with managing the impacts of drilling waste disposal on the local environment. Continued degradation of permafrost landscapes is projected, highlighting the need for monitoring and mitigation of drilling-waste sumps in the Sahtu, with approaches that are applicable to discontinuous permafrost drilling-waste sumps in the region.

Lithium Pegmatite Preconcentration Through Sensor-Based Sorting and Dense Media Separation

Zach Lang & Mike McCubbing
Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada
mike.mccubbing@src.sk.ca

The development of mineral resources in remote regions introduces specific challenges, particularly when compared to deposits located near established infrastructure such as power and water supplies. Recent technological advancements, such as sensor-based ore sorting, provide new opportunities to optimize processing circuits in these difficult environments. Many sensor-based sorting systems require little or no water and also reduce power consumption, making them especially suitable for lithium-bearing pegmatites. These smaller, lower-tonnage deposits often do not justify the high costs of large-scale infrastructure. By combining x-ray transmission sensor-based sorting with dense media separation, a high-grade lithium concentrate can be produced, which could then be

transported to centralized facilities that offer the infrastructure needed for further hydrometallurgical processing. This approach enables access to more favorable economies of scale. Additional advantages of preconcentration include reduced water and energy consumption, decreased infrastructure demands, and the generation of a coarser reject stream that facilitates waste management and reduces environmental impact.

This presentation will cover the fundamentals of preconcentration techniques, beginning with sensor-based sorting and the rigorous testwork required to determine optimal sorting parameters. It will emphasize the importance of comprehensive testing, from small-scale sample evaluations to full production-scale trials. This presentation also outlines the independent testing methodologies, demonstrating how detailed batch tests can be used to assess the suitability of sorting technologies. Further discussion will address how to improve sorter efficiency during large-scale operations through careful evaluation and adjustments. A case study will highlight the complete testing process applied to a lithium-bearing pegmatite deposit, showing the benefits of a preconcentration flow sheet. Mass balances and operational results from recent test programs will be reviewed, showcasing the potential for upgrading ore before secondary processing. The presentation will conclude by discussing the scalability of these preconcentration techniques and introducing modular processing plants that provide increased flexibility for remote or smaller deposits.

*Sedimentary provenance of the Sosan Group, Great Slave Lake Supergroup (Northwest Territories, Canada) Depicted Through Detrital Zircon Geochronology

Jade Lockie[1], Alessandro Ielpi[1], Rebecca Canam[2], Morgann G. Perrot[3], Joshua H.F.L. Davies[3] & Luke Ootes[4]
[1]University of British Columbia, Okanagan, British Columbia, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[3]Université du Québec à Montréal/ Geotop, Montréal, Québec, Canada
[4]British Columbia Geological Survey, Victoria, British Columbia, Canada
lockiej@mail.ubc.ca

Sedimentary basins developed adjacent to sites of collisional orogens can be used to investigate erosional histories through detrital mineral geochronology, especially during times of supercontinent accretion. Zircon is particularly useful as it is commonly preserved in siliciclastic rocks and can be used as a source-to-sink tracer for provenance; further, the youngest zircon grains serve as a proxy for the maximum depositional age of the sediment. The amalgamation of the ancestral Canadian Shield commenced *ca.* 2.0 Ga, as the Archean Slave and Rae cratons formed the nucleus of the Nuna supercontinent. The collision generated the Thelon and Taltson orogens along the suture, which are now exposed across a transect of nearly 1500 km from Nunavut to central Alberta and Saskatchewan. The East Arm Basin (Great Slave Lake, Northwest Territories) of the Slave craton is located west of the suture zone and contains the Union Island Group, Wilson Island Group, Great Slave Supergroup, and the Et-Then Group. The basal unit of the Great Slave Supergroup — the Sosan Group — is thought to have accumulated coevally with the unroofing of nearby collisional topography. Detrital zircon geochronology is used to establish that the primary detrital provenance of the Sosan Group is the Thelon tectonic zone, with a smaller contribution from the Taltson magmatic zone. In contrast to previous studies, the current dataset suggests a lesser contribution of detritus from the Slave craton. The new

data are also used to derive a new maximum depositional age for the basal formation of the Great Slave Supergroup, indicating that the Sosan Group may in fact be younger than the structurally isolated Wilson Island Group. Once compared to other published detrital zircon data from the Hottah terrane, Coronation margin, and Kilohigok basin, data presented here suggest novel correlations between the Slave-craton marginal deposits. Cumulatively, the amassed data from *ca.* 2.0-1.9 Ga supracrustal rocks across the Slave and Rae cratons can be used to assess erosional unroofing amidst the construction of the Nuna supercontinent.

Making the Case for a Systematic and Integrated Approach to Project Re-evaluations, Including the Incorporation of New Techniques, to Uncover Hidden Potential

Eileen Lyon
Aurora Geosciences Ltd., Yellowknife, Northwest Territories, Canada
eileen.lyon@aurorageosciences.com

The Northwest Territories, its government and population, has enjoyed the local economic benefits of operating diamond mines, but an end is in sight. Have all the kimberlites been discovered? The answer to that is firmly "no". Firstly, Ekati recently discovered two kimberlites using machine learning that were unrecognizable by previously applied geophysical methods. Secondly, two of the three mines hold ground that, in size, far exceeds what a modest exploration budget can adequately re-evaluate and explore. This fact, coupled with the realization that allocating funds for exploration at the expense of funds for mining operations is a task for only a great lobbyist, supports the notion that it would be naïve to think all kimberlites have been discovered.

Will economic opportunities remain in the ground after they all have closed? Without action (now), the answer to that question is undoubtedly "yes". It wasn't that long ago, in 2018, that an indicated resource of 8.5 million tonnes of kimberlite with a grade of 1.60 carats per tonne was confirmed which, just 6 years prior to that date, was believed to only be 40 m (dyke) intercept of inconsequence. That kimberlite, Kelvin, and its other proximal body (Faraday 2) which also enjoys an indicated resource status, will remain in the ground if the mine located 11 km to the southwest doesn't move to an underground operation and incorporate them, or if renewed efforts on the Kennady North Property aren't pushed to uncover the next neo-classical body that make a new stand-alone mine operation a possibility.

A systematic approach that involves re-evaluation and incorporation of emerging methods is the type of work needed to determine whether an area is truly sterilized. The Kelvin kimberlite is a prime example of how thinking differently and renewed exploration can have highly positive results. There are, however, other known kimberlite bodies that could use a second look. Big Blue kimberlite is one example of a poorly understood, under-explored, and possibly missed, opportunity. Even with a desktop analysis, gaps in the current understanding of the large negative magnetic anomaly in the Lac de Gras region are revealed. Is it really one kimberlite, or is it multiple kimberlites and the microdiamond information is not actually complete?

The incorporation of new techniques and the systematic re-evaluation of prior results works. All explorers should be awakened to the potential of overlooked kimberlites and, should time, funding and industry outlook allow, ensure that prior results have been fully evaluated and tested using the evolved toolsets now available.

Mineral Resources Act: Change Management for Introducing NEW! Regulations – A Work in Progress

Jessica V. Mace
Industry, Tourism and Investment, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
Jessica_Mace@gov.nt.ca

Change Management is a relatively new term for the practice of companies and governments and even family members taking action to embrace change. Change

Management respects people as individuals and understands that changes are much more effective if people understand the reasons behind them.

With the Mineral Resources Act (MRA), passed by the Government of the Northwest Territories (GNWT) Legislative Assembly in 2019, and the development of new regulations to support the Act, big change is coming.

The impacts to individuals and companies involved in the exploration and mining industry, Indigenous Governments and Organizations, and the GNWT itself are wide-reaching. The GNWT Department of Industry, Tourism and Investment has undertaken a Change Management approach to ensure that those impacted are understood and interest holders are supported through the changes as much as possible.

Some of the Change Management work the Department of Industry, Tourism and Investment has undertaken includes initiating meetings with Indigenous Governments (one-on-one, chief and council and community meetings), reaching out to individual representatives from industry to determine how the changes will impact them specifically, and holding regular engagement meetings with representatives from the industry to obtain direct feedback on how the approach will impact them. Internal work to prepare staff to support changes is underway. This is all just the beginning...

Colomac Gold Project Update: Recent Developments and Exploration Results of a Premier Northern Gold Deposit

John A. McBride
STLLR Gold Inc., Toronto, Ontario, Canada
jmcbride@stllrgold.com

STLLR Gold Inc. is a Canadian gold development company actively advancing two cornerstone gold projects in Canada: The Colomac Gold Project located north of Yellowknife, Northwest Territories and the Tower Gold Project in the Timmins Mining Camp in Ontario. Each of these two projects has the potential for a long-life and large-scale operation and are surrounded by exploration land with favourable upside potential. STLLR's experienced management team, with a track record of successfully advancing projects and operating mines, is working towards rapidly advancing these projects.

The Colomac Gold Project comprised of the Colomac Centre and satellite deposits, has a 2023 Mineral Resource Estimate of 70.4 million tonnes grading 1.50 g/t Au for 3.39 million ounces in the Indicated category and 24.3 million tonnes grading 2.17 g/t Au for 1.69 million ounces in the inferred category.

The 2023 Preliminary Economic Assessment for the Colomac Gold Project has favorable economics with the potential to deliver approximately 300,000 oz of annual conceptual gold production over a 10-year mine life. The Project achieves a C$1.2 billion NPV5% with an IRR of 35 %, after taxes using a US$1,600 / oz gold price. As such the Colomac Gold Project belongs to a rare class of global gold assets and there is a potential runway for the Project to continue to grow with additional exploration.

To extend the potential runway, the 2024 exploration season included drilling new structural and geological models to expand the near surface open pit mineralization and define additional underground resource of the Colomac Main Deposit.

New Paleoenvironmental and Paleobiological Insights from the 1.9 Billion-Year-Old Pethei Group

Akshay K. Mehra[1], Peter W. Crockford[2], Benjamin D. Barnes[3], Meghan E. King[1], Nabil A. Shawwa[2] & Elizabeth Sullivan[2]
[1]University of Washington, Seattle, Washington, United States
[2]Carleton University, Ottawa, Ontario, Canada
[3]Dartmouth College, Hanover, New Hampshire, United States
akmehra@uw.edu

Rocks of the Paleoproterozoic Pethei Group, which outcrop on the shores of Great Slave Lake, contain exceptionally preserved sedimentary strata that formed on an Earth

very different from today. Such strata encode critical and voluminous information about early organisms and paleoenvironmental conditions on our planet. For example, laterally extensive exposures of morphologically diverse stromatolites on Blanchet Island and near Pethei Peninsula provide an opportunity to quantify how the shape, size, and spatial distribution of microbially-mediated constructions are linked to hydrodynamic conditions.

Here, we present preliminary findings from two years of collaborative work on the Pethei Group. We share field observations, quantifications of drone-derived three-dimensional (3D) reconstructions, textural analyses, and geochemical measurements, all which have led us to new insights into Paleoproterozoic life and environment. Additionally, we discuss future directions for research on the Pethei Group, including opportunities for collaboration.

*Surface Chemistry of Montebrasite in the Presence of Water

Espoir M. Murhula[1], Gideon Lambiv Dzemua[2] & Charlotte E. Gibson[1]
[1]Queen's University, Kingston, Ontario, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
20emm6@queensu.ca

The amblygonite-montebrasite group of minerals is the most abundant lithium-bearing phosphate occurring in phosphorous-rich lithium-cesium-tantalum (LCT) pegmatites. The Moose II pegmatite deposit in the Northwest Territories of Canada is an example of such a deposit, containing abundant montebrasite in addition to spodumene. The separation of montebrasite from spodumene - the main lithium ore mineral - by flotation is necessary for effective downstream lithium extraction. Water molecules play an important role in froth flotation and other mineral-related processes such as chemical weathering. Understanding the interaction of water molecules and montebrasite is thus necessary to optimize its recovery by flotation and understand its behaviour during the chemical weathering of tailings.

In this study, the interaction between deionized neutral water and a montebrasite sample from the Moose II deposit was investigated using dissolution tests, ultraviolet, Fourier transform infrared, and X-ray photoelectron spectroscopies, supported by density functional theory calculations. Results show evidence of acid-base reactions, local hydrophobicity, and F-OH ion exchange at the mineral surface; all reactions which could affect solution chemistry and influence collector adsorption on the mineral surface during flotation. This work builds important knowledge related to montebrasite surface properties and the montebrasite-water interface which may help optimize montebrasite flotation protocols and improve understanding of the geochemical behavior of mine waste containing montebrasite.

Grad Property: Au-Bi-Te Discovery in Underexplored Territory

Douglas Murray
Gold Group Management Inc., Vancouver, British Columbia, Canada
dmurray@goldgroup.com

The Grad Property, part of Rackla Metals' portfolio, located in the Mackenzie Mountains within the Sahtu Dene and Metis Settlement Area, was staked in July 2024. The property was strategically staked based on the company's comprehensive analysis of historical stream sediment data, which revealed anomalous gold and bismuth values draining from an area with coincident magnetic anomalies and no documented previous exploration. This under-explored area, situated within the eastern Tombstone Gold Belt, presents significant potential for Reduced Intrusion-Related Gold System (RIRGS) mineralization.

The initial sampling of a mid-Cretaceous Mayo Suite granitic stock was highlighted by a high-grade grab sample, which returned an impressive 92.4 ppm gold with >1 % Bi and > 500 ppm Te. Following this, continuous chip-channel sampling near the showing was conducted, returning 38 m averaging 1.8 g/t gold, with the system remaining open at both ends. Two types of intrusion-hosted mineralization have been observed to carry the strong Au-Bi-Te values: stockwork and sheeted quartz-tourmaline veining, and

leached vuggy altered intrusive with disseminated bismuth-tellurium sulfides.

With the property's expansion to 5,525 hectares and the identification of additional mineralized zones, Rackla Metals is planning to conduct a significant exploration program in 2025. This presentation will cover the geological context, exploration methodology, and future plans for advancing this promising gold prospect in the Northwest Territories.

*Radioelement Surveying Using Handheld Gamma-Ray Spectrometer in the Aylmer Lake Area, Northwest Territories, Canada; A Potential Tool for LCT Pegmatite Prospecting

Gilles N. Ngoran[1], David Lentz[1] & Gideon Lambiv Dzemua[2]
[1]Department of Earth Sciences, University of New Brunswick, Fredericton, New Brunswick, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
gilles.ngoran@unb.ca

Gamma-ray spectroscopy offers a cheap and rapid geo-physical technique for analysing radioactive elements and can therefore be used in direct exploration, especially in granite-related ore deposits. This technique is particularly suitable for pegmatite exploration due to pegmatite enrichment in radioactive elements including K, U, and Th.

Pegmatites in the Aylmer Lake pegmatite field are hosted by metasedimentary rocks and in places by granitic rocks. The pegmatites occur as dykes, commonly obscured by vegetation and drift, which hinder exploration efforts. The pegmatites are characterised by muscovite, K-feldspar, albite and accessory apatite, garnet, which tend to contain trace to anomalous concentrations of K, U, and Th.

Geophysical methods are not widely used to explore pegmatite mineralization in the Slave Craton. This is probably due to their relatively small sizes, indistinct geophysical responses, and limited knowledge of their mineralogical and chemical characteristics. The objective of the study was to assess the use of portable gamma-ray spectroscopy in exploring rare-metal mineralization in pegmatites.

Over 109 spot radiometric responses were measured in aplite, granite, pegmatite, pegmatitic granite and in some metasedimentary phases using a handheld Super-Spec RS 125 gamma-ray spectrometer. All granitic phases were richer in U relative to Th, with eTh:eU values of ≤ 1. This indicates U enrichment relative to the global average value of 3.5 reported in granitic rocks. Peak eU concentrations were 46.9 ppm, 31.4 ppm, 91.1, and 29.9 ppm in aplite, granites, pegmatites, and pegmatitic granites respectively. Maximum eTh values were 6.1 ppm in aplite, 10.5 ppm in granites, 10.9 ppm in pegmatites, and 10.2 ppm in pegmatitic granites. Thorium values were, on the contrary, higher relative to those of U, in host metasedimentary units. The observed low eTh/eU values in the Aylmer Lake area suggest an increase in oxidation with fractionation and monazite and uranothorite saturation that depletes Th faster than U in the melts.

The most spodumene-enriched pegmatites have low K, owing to their albitic compositions, especially along the margins and cores. Equivalent U, eTh, and eU+eTh, as well as K/eU, K/eTh, and K/(eU+eTh) ratios can be used as effective indices of relative fertility in both ground and airborne geophysics.

These results highlight the importance of radioelements surveying for regional-scale assessment of rare metals mineralization in pegmatites.

Lake Sediment and Surface Water Sampling Program Over Parts of the Slave Geological Province

Philippe X. Normandeau[1], Scott R. Cairns[1], Rebecca Canam[1], Barrett R. Elliott[1], Nancy Ngo[2] & Gideon Lambiv Dzemua[1]
[1]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[2]WSP Canada Inc., Yellowknife, Northwest Territories, Canada
philippe_normandeau@gov.nt.ca

Since 2020, the Northwest Territories Geological Survey (NTGS) has carried out three helicopter-supported regional lake sediment and surface water sampling programs over parts of the Slave Geological Province. The generated data is useful in understanding background geological environment, targeting mineral exploration, and land use planning. Field observations and analytical data were collected using standard protocols developed by the National Geochemistry Reconnaissance (NGR) program.

Despite various research demonstrating the utility of deep lake sediment surveys for mineral exploration and environmental baseline information, little lake sediment geochemistry data exists for the Northwest Territories. The most extensive and similar study in the territory dates back to the 1970s, and involved a survey of nearshore lake sediment across the northern Bear and Slave Geological provinces. Deep lake sediment geochemistry was examined in another regional study focused on the Nonacho and Hill Island lakes region in the southeastern Northwest Territories.

The three sampling campaigns, which occurred in the summers of 2020 and 2022 and the winter of 2023, resulted in the collection of 717 lake sediment samples and 693 surface water samples. The combined study area straddles the tree line in the Coppermine River upland and extends south and westwards to include the Squalus alkaline-carbonatite complex. The location of these surveys coincides with the proposed all-season road development between Tibbett Lake and Grays Bay. This road corridor will facilitate access to the interior of the mineral-rich Slave Geological Province of Northwest Territories and Nunavut.

The 2023 winter sampling area partially overlapped the 2022 summer area to allow for the identification of any seasonal variability or data artifacts due to winter sampling. The samples from the first two surveys were digested with modified aqua regia and analyzed by Induction Coupled Plasma - Mass Spectroscopy (ICP-MS) / Induction Coupled Plasma - Optical Emission Spectroscopy (ICP-OES) at Bureau Veritas Laboratories in Vancouver, British Columbia. Filtered and acidified lake water samples were analyzed for major elements by ICP-OES and trace metals by ICP-MS. Anion concentrations were determined on filtered, non-acidified samples using a Dionex Ion ICS 2100 Ion Chromatograph at the Geological Survey of Canada Laboratories in Ottawa, Ontario. Analysis of the samples from the 2023 winter survey is in progress.

Field observations indicated a strong correlation between the presence of structural features, suggested by cliffs along a lake shore, and sample depth. Greater sample depth is linked to higher sample media quality, as shown through field sample characterization and higher ignition loss. Preliminary interpretation indicates the presence of elevated base, precious, and critical metals in areas with and without known showings. Lake sediment samples collected north-east of the Coppermine River system, in a region underlain by metasedimentary rocks and granites, have consistently higher lithium contents compared to samples collected south-west of the river where the bedrock geology is dominated by gneissic complexes. In contrast, the lithium content in the water samples displays isolated geochemical anomalies. Future work includes the upcoming release of the 2021 data and the processing of the 2023 samples.

Investigating the Impacts of the 2023 Wildfires on Permafrost Terrain Near Yellowknife, Northwest Territories

H. Brendan O'Neill[1], Niels Weiss[2], Stephen A. Wolfe[1], Wendy E. Sladen[1], Steven V. Kokelj[2], Jurjen van der Sluijs[3], Antoni Lewkowicz[4], Duane G. Froese[5], Joel Pumple[5] & Naomi Short[6]
[1]Geological Survey of Canada, Natural Resources Canada, Ottawa, Ontario, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[3]NWT Centre for Geomatics, Government of Northwest Territories, Yellowknife, Canada
[4]University of Ottawa, Ottawa, Ontario, Canada
[5]University of Alberta, Edmonton, Alberta, Canada
[6]Canada Centre for Mapping and Earth Observation, Natural Resources Canada, Ottawa, Ontario, Canada
hughbrendan.oneill@nrcan-rncan.gc.ca

The 2023 wildfire season consumed six times the typical annual area burned in Canada, equivalent to a total area larger than England. Many fires occurred in permafrost regions, and by the end of summer, 68% of the population of Northwest Territories had evacuated. In spring 2024, the Geological Survey of Canada initiated a project in collaboration with the Northwest Territories Geological Survey to assess the effects of wildfire and climate change on permafrost conditions near critical northern transportation routes. Instrumentation was installed at three burned sites along Highway 3 between Yellowknife and Behchokǫ̀ in June 2024 to enhance a jointly maintained regional monitoring network. The response of permafrost terrain to wildfires is being tracked with thermistors and moisture sensors installed in boreholes. Thawing across ice-rich landforms will be characterized in 2 dimensions using repeat electrical resistivity tomography (ERT) geophysical surveys. Ground ice and material conditions from cores drilled at the sites are being characterized in the laboratory using advanced multi-sensor core logging and other analyses and indicate significant potential for ground surface subsidence. Terrain subsidence is being monitored along the highway using in situ data, drone-based optical surveys, airborne light detection and ranging (LiDAR), and spaceborne differential interferometric synthetic aperture radar (DInSAR). Relations between these data and highway conditions will be explored to potentially link geoscience knowledge of evolving permafrost conditions with infrastructure monitoring and planning. This presentation will present early results on borehole stratigraphy, ground temperature comparisons from burned and unburned sites, and preliminary ERT surveys from September 2024.

*Beyond Oxygenation: The Impact of Aerator Installation on the Chemical and Biological Recovery of Frame Lake, Yellowknife

Madeline E. Patenall[1], Michael J. Palmer[2] & Derek K. Gray[1]
[1]Wilfrid Laurier University, Waterloo, Ontario, Canada
[2]Aurora Research Institute, Aurora College, Yellowknife, Northwest Territories, Canada
pate5220@mylaurier.ca

The contamination of freshwater resources from nutrient and metal(loid) pollution is a global concern. Recent interest has been placed on the influence of legacy pollutants, which can remobilize and have lasting effects on the recovery of aquatic systems. The remobilization of redox-sensitive nutrients and metal(loids) in aquatic systems is determined by several biogeochemical processes significantly altered by oxygen concentrations. Under oxic conditions, sediments can act as a sink, but in the absence of oxygen (anoxic), sediments act as a leaky reservoir of legacy nutrients and metal(loid)s, preventing rehabilitation. There is a need for arctic investigations on nutrient and contaminant dynamics due to substantial seasonal variation in biogeochemical processes, leading to complex trajectories for the recoveries of systems impacted by contamination. Frame Lake, in the Northwest Territories, provides an excellent case study for investigating legacy contaminant dynamics in the Arctic. Urbanization and mining in the region have led to the deposition of over half a century of nutrient and arsenic-bearing atmospheric emissions, resulting in eutrophication, contamination, winter anoxia, and reduced recreational value. However, efforts to rehabilitate Frame Lake have begun. The primary rehabilitation intervention injects oxygenated water into the deep region of the lake (hypolimnetic aeration), increasing winter oxygen concentrations. It is hypothesized

that increasing oxygen concentrations will prevent winter anoxia, mitigating the remobilization of redox-sensitive legacy elements, such as the nutrient phosphorus and the metal(loid) arsenic to the overlying water. Additionally, increased oxygen concentrations may promote the biological recovery of the lake by creating habitable overwintering conditions and improved water quality for organisms of the lower food web (zooplankton). This research will evaluate the effectiveness of hypolimnetic aeration in promoting chemical and biological recovery of Arctic lakes from legacy phosphorus and arsenic contamination. The specific objectives are to: 1) investigate the influence of hypolimnetic aeration on winter dissolved oxygen depletion rates spatially across Frame Lake, 2) elucidate if aeration mitigates the remobilization of phosphorus and arsenic from lake sediments to the overlying water, and 3) assess how aeration influences water quality and lake biology through the composition and abundance of the zooplankton community. With the projected effects of climate change in the Arctic, the prevalence and severity of anoxia in lakes are anticipated to increase in the coming decades, and identifying effective rehabilitation methods to mitigate the remobilization of contaminants is paramount.

Rare Earth Element Mineralization and Regional Context: Investigating the Tardiff Resource, NWT with a Mineral Systems Approach

Natalie Pietrzak-Renaud
Cheetah Resources Corp., London, Ontario, Canada
npietrzak-renaud@vitalmetals.com

Rare Earth Elements (REEs) such as neodymium (Nd) and praseodymium (Pr) are critical for the green energy and technology sectors. These elements are commonly hosted in REE deposits that range from ionic clays to igneous intrusions. Cheetah Resource Corp's Tardiff Resource contains approximately 213 Mt grading at 1.17 % TREO in measured and indicated categories, including more than 623,000 tonnes of NdPr.

The Tardiff resource is located adjacent to and under Thor Lake, NWT. It represents the upper portion of the Light Rare Earth Element (LREE) enriched layer that was previously Avalon's Nechalacho project. North T is a smaller satellite high-grade REE-mineralized body northwest of the Tardiff resource. A portion of the North T body was extracted and processed as a 2021 bulk sample.

Historically, the majority of exploration and development work has been completed on the portion of the resource below Tardiff, locally referred to as the Basal Zone; a Heavy Rare Earth Element (HREE) body that contains a significant quantity of REE-bearing zircon. The Nechalacho intrusion has historically been interpreted as a layered syenite with textures and lithologies representing cumulate growth hosting REEs, that appear to be, undeformed and relatively unaltered. The upper ~100 m that is Cheetah's Tardiff deposit, shows evidence of alteration to the precursor units. Is this all there is to know?

Cheetah has determined that the best course of action to understand and develop the REE projects on its properties is to take a "Mineral-Systems" approach. With the help of monies from the GNWT's Mining Incentive Program, Cheetah has expanded its technical program activities to investigate the broader context of REE mineralization within this Thor Lake area and to develop an updated, next-generation geological model for Tardiff and North T. These investigations include classifying and mapping alteration assemblages, identifying and collecting structural data, and establishing the timing of REE-mineralization relative to regional overprinting events.

Techniques include property scale mapping and sampling, relogging and resampling historic core for additional commodities, reevaluating the recent and historical geochemistry, and relogging the core with the target of collecting alteration and structural data. The first limited field phase has been completed which documented structural and alteration overprinting. For the next phase, a small select number of drill cores will be sampled for additional analyses for metallic commodities. This new data and subsequent phases of investigations will help establish the controls on mineralization and develop a broader context with which to advance REE exploration in the region.

Recording a Claim Under the NEW! Mineral Resource Act

Jen Potten & Jessica V. Mace
Industry, Tourism and Investment, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
jennifer_potten@gov.nt.ca

The Mineral Resources Act (MRA) was passed in 2019 in the Northwest Territories. Collaborative development of the supporting regulations has been underway since 2021 by Indigenous Governments and Organizations and the Government of the Northwest Territories. Representatives have spent hundreds of hours hearing expert presentations and discussing the pros and cons of options. Many of the regulations have been worked through and agreed upon, especially for the early stages of mineral exploration. This talk will focus on improvements and benefits anticipated at the early stage of exploration while companies hold mineral claims.

In this stage, many NEW improvements are anticipated with the following MRA goals in mind:

- Collecting geoscience to support future exploration and development
- Respecting Aboriginal and treaty rights
- Increased communication and collaboration between Indigenous Governments and Industry
- Merit based tenure issuance

The tools proposed at this stage to meet these goals consist of:

- The Prospector Awareness Course
- Various notices that will be shared with Indigenous Governments and Organizations
- Longer claim life to delineate the resource and the mine before entering into a mineral lease agreement
- Drilling and drill core reporting for preservation of geological information
- Removal of minerals approval and tracking process
- Implementation of the Mineral Administration and Registry System

*Assessing the Impact of Snow Accumulation on Lake Ice Development Near Yellowknife, NT

Alicia F. Pouw & Homa Kheyrollah Pour
Wilfrid Laurier University, Waterloo, Ontario, Canada
apouw@wlu.ca

The accumulation of snow on lake ice plays a crucial role in regulating ice growth due to its insulating characteristics. This snow cover induces variations in lake ice thickness, influenced by factors such as wind-driven snow redistribution, snowpack metamorphism, and the formation of uneven snow ice layers. As climate change increases the variability of seasonal snowfall patterns, the subsequent changes to these factors will directly influence lake ice formation, with implications for the sustainability of ice roads and recreational trails vital for transportation in northern communities. Considering the dynamic processes affecting snow cover throughout the ice-on season and their consequent impact on ice development, there is an urgent need for high-resolution spatial and temporal data on both snow and ice.

Between November 2023 and April 2024, monthly field campaigns were conducted to collect in-situ snow and ice data from five sub-Arctic lakes near Yellowknife, Northwest Territories, Canada, with spatial data collected across the entire surface of each lake. Preliminary results indicate that lakes freezing earlier in the season and experiencing minimal human activity showed a consistent increase in snow ice formation throughout the winter, ranging from 25 % to 45 % of total ice thickness, compared to 7 % to 25 % in other lakes. By March, however, total ice thickness across the studied lakes became comparable. Lakes that experienced less snowfall due to a later freeze-up demonstrated approximately 15 % more congelation ice growth. Furthermore, lakes subjected to regular snowmobiling throughout the season exhibited higher snow densities and minimal snow ice formation. These findings contribute to a deeper understanding of snow-lake ice dynamics, which is crucial for advancing lake ice research and informing local communities who rely on these lakes for transportation.

2024–25 Activity Update-Energy Geosciences Group

S.M. Talha Qadri
Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
Talha_Qadri@gov.nt.ca

The Energy Geosciences group conducts research and publishes geoscience data on energy in the Northwest Territories (NWT). The Energy Geosciences group's research progress for 2024–25 is highlighted in five projects: (1) Shale Basin Evolution in the Central Northwest Territories, (2) South Slave Geothermal Potential, (3) Phanerozoic Thermal Evolution of the SW Northwestern Territories, (4) Paleoenvironmental Reconstruction and Sequence Stratigraphy of the Imperial Formation, and (5) Mackenzie Delta Phanerozoic Geology project. These projects also support collaboration agreements with academic researchers and their students.

The Shale Basin Evolution Project focuses on characterizing unconventional oil and gas resources in the Central Mackenzie Valley. This project includes collaboration with researchers at the University of Alberta and has resulted in the completion of three M.Sc. and one Ph.D. thesis. In addition, the NTGS has developed a three-dimensional (3D) basin model as part of this project.

The Phanerozoic Thermal Evolution and the South Slave Geothermal projects work in synergy to characterize the geothermal potential of the Southwestern Northwest Territories. The Phanerozoic Thermal Evolution project, a collaboration with researchers at the University of Calgary supporting one PhD student, aims to understand the burial, thermal history, and exhumation of the sedimentary basin in the southern NWT. The ultimate goal of this project is to determine the source of heat anomaly in this region of the Northwest Territories. The South Slave geothermal project is a collaboration with Institut national de la recherche scientifique (INRS) and examines the reservoir quality and geothermal energy potential of source formations in the southwestern regions of the NWT. This project has supported one post-doc, and currently supports one MSc. student.

The Imperial Formation study aims to enhance our understanding of the stratigraphy, sedimentology, ichnology, and geochemistry of this regionally extensive geological unit, ranging from individual deposits to the broader region encompassing the margins of the Mackenzie Mountains, Central Mackenzie Valley, and southern Peel Plateau. A primary goal of the research is to create a comprehensive reconstruction of the paleoenvironment and sequence stratigraphy of the Imperial Formation. This study complements the Shale Basin Evolution Project and supports one PhD student at the University of Alberta, who will present their findings at this conference.

The Mackenzie Delta Phanerozoic Geology project started in 2023 and will be a 5-year investigation of the sedimentary rocks underlying the Mackenzie Delta and surrounding basins. The project has a multi-dimensional approach to identify and quantify the potential natural gas accumulations and sedimentary strata with high carbon storage potential in the Mackenzie Delta mainland through sedimentological, stratigraphic, structural and geochemical analyses. The Mackenzie Delta Phanerozoic Geology project also supports the Carbon Sequestration Project.

Regulatory Mythbusters Episode 1: Mineral Exploration

Kathleen Racher[1] & Ryan Fequet[2]
[1]Mackenzie Valley Land and Water Board, Yellowknife, Northwest Territories, Canada
[2]Wek'eezhii Land and Water Board, Yellowknife, Northwest Territories, Canada
kracher@mvlwb.com

We have all heard the rumours: the regulatory process in the NWT is too onerous, too slow, too confusing, and way too uncertain. The Land and Water Boards of the Mackenzie Valley (LWBs) have heard these sentiments for a long time and have tried to address them mainly through the publication of numerous guidelines, policies, and standard conditions. But, as identified in the 2020 NWT Environmental Audit, small exploration companies in particular continue to struggle with the application process and to meet the LWB requirements.

Knowing that we were definitely not trying to make anyone's life more difficult, we started challenging our friends in industry to tell us the specific issues or experiences that have led to unfavourable reviews by the public. These discussions with industry representatives have helped us to see that at least some problems experienced by mineral exploration companies are the result of persistent myths and miscommunications by and about the LWBs. In this talk, we will identify some of these myths, describe their impact on the regulatory process, and suggest ways to work together to improve the system. We will also provide some updates on new initiatives aimed at simplifying the application process for small exploration projects.

U-Pb-Hf and Morphological Evolution of Zircon from Granites Associated with World-Class Tungsten Skarn Deposits in the Northern Canadian Cordillera

Kirsten L. Rasmussen[1], Hendrik Falck[2], Yan Luo[1], D. Graham Pearson[1] & Pilar Lecumberri-Sanchez[1]
[1]University of Alberta, Edmonton, Alberta, Canada
[2]Diamonds Royalties and Financial Analysis, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
klrasmus@ualberta.ca

The northern Canadian Cordillera is the most important tungsten district in North America. There are two world-class tungsten skarn deposits—defined as >100,000 tonnes W—in this region: Mactung, globally the largest high-grade tungsten deposit (41.5 million tonnes grading 0.73 % WO_3); and, Cantung, the highest-grade tungsten deposit known (10.8 million tonnes grading 1.2 % WO_3). Both are associated with small, reduced, S-type biotite granite plutons belonging to the 96-102 Ma Tungsten plutonic suite (TPS), which were emplaced during a regional transition from transpressional to transtensional tectonics.

A detailed U-Pb-Hf and morphological study of magmatic zircon from the TPS plutons near Cantung (and Lened: a high-grade tungsten occurrence with <10,000 tonnes W) was undertaken to better understand magmatic processes leading to the generation of the tungsten deposits. U-Pb ages for antecrystic (*i.e.*, old magmatic) zircon grains indicate magmatic activity began *ca*. 117 Ma. This suggests the TPS magmas were active for up to 21 Myr prior to their upper crustal emplacement and final crystallization between 96-102 Ma, requiring a magma origin in the deep crust. As a whole, hafnium isotopic compositions in zircon form a non-radiogenic, univariate, and relatively wide-ranging population (ε_{Hfi} = −17.6 ± 4.5), but subtle U-Pb-Hf trends become apparent when the data are sub-divided into sample groups that share similar age, zircon morphology, and geographic location. These evolutionary trends in magmatic zircon are most simply explained by interactions between the parent melt and the dissolution of inherited zircon grains from the sedimentary source rocks, and along with changing zircon morphology, are consistent with gradual cooling and crystallization pathways typical of other S-type magmas. Zircon morphologies also suggest all sample groups include grains that equilibrated with hotter and more alkaline magmas at the latest stages of crystallization, but there is no evidence for mixing of magmas with widely different compositions.

An unconstrained inversion of local aeromagnetic data indicates reduced batholiths could be present 4-6$^+$ km below the plutons, and evidence for possible connecting feeder zones suggests the plutons are apophysies to (or, higher level injections from) these batholiths. Although the batholiths can only be short-term holding chambers for magmas ascending from deep crustal levels, they may have been important for the segregation and concentration of mineralizing fluids. Tungsten mineralization was possibly derived from the underlying batholiths instead of the adjacent, unaltered TPS plutons.

The prolonged magmatic activity for the TPS is similar to timeframes for magmas associated with numerous tungsten deposits in southern China. Long-lived deep magmatic activity may be an important control for the development of significant tungsten mineralization, allowing time for a large volume of crustally derived magma to gradually concentrate tungsten into smaller late-stage melts prior to their ascension to upper crustal levels, and crystallization as smaller batholiths and plutons. As in southern China, the emplacement of upper crustal batholiths and plutons in association with a more extensional tectonic regime suggests this transition is an important control for the timing of magma ascension and tungsten mineralization.

Shale-Hosted Vanadium Mineralization in the Selwyn Basin, Canadian Cordillera, Northwest Territories

Merilie A. Reynolds[1], Stefanie M. Brueckner[2], Daniel Gregory[3] & Kenneth A. Hickey[4]
[1]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[2]Laurentian University, Sudbury, Ontario, Canada
[3]University of Toronto, Toronto, Ontario, Canada
[4]University of British Columbia, Vancouver, British Columbia, Canada
Merilie_Reynolds@gov.nt.ca

Vanadium is a hardening agent in steel and an important component in vanadium redox flow batteries, an emerging technology for large-scale energy storage. Shale-hosted vanadium deposits typically contain large vanadium resources, although none are currently economically viable due to limitations in extraction technology. However, mining may become viable in the future as technology advances.

In the Northwest Territories, the Ordovician to Devonian Duo Lake Formation of the Selwyn Basin is a variably siliceous and calcareous organic-rich mudstone known to be locally enriched in vanadium, *e.g.*, the Flat Lakes area north of the Cantung mine, the Van Property is reported to contain 0.6 % V_2O_5 (3000 ppm) over 50 m of stratigraphy and extending along 700 m of strike. Approximately 60 km to the northwest, in the world-class Howard's Pass Zn-Pb district, vanadium occurs at concentrations ranging between 0.2-0.6 % V_2O_5 (1000-3000 ppm) over a 20 m stratigraphic interval about 10 m stratigraphically below the massive sulphide Zn-Pb mineralization.

This talk will provide an overview of shale-hosted vanadium deposit geology and a summary of what is known about this type of vanadium mineralization in the Canadian Cordillera of the Northwest Territories, including some recent research results from collaborations between the Northwest Territories Geological Survey (NTGS) and the universities of Manitoba and Toronto. The NTGS was recently awarded three years of funding (2024–2027) from Natural Resources Canada as part of the Critical Minerals Geoscience Data Initiative to continue this work.

A Regional Model of the Devonian Shale Basin, Central NWT

Jonathan Y. Rocheleau
Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
jonathan_rocheleau@gov.nt.ca

Building a hydrocarbon system model in a data-sparse region such as the Northwest Territories presents many challenges. The project area is vast, encompassing the Mackenzie Plain and adjacent portions of the Peel Plateau, Peel Plain, Franklin Mountains, and Mackenzie Mountains. The Devonian shale basin in this region comprises the Horn River Group, which includes the Hare Indian, Ramparts, and Canol Formations, and the Imperial Formation. This basin hosts the Norman Wells oilfield, the only producing field in the Northwest Territories.

A regional three-dimensional (3D) model, and smaller subsidiary models, were developed primarily using well data supplemented by interpreted seismic, outcrop, and sample data. These smaller models, built at the scale of an individual well, are designated as point models and were utilized to generate localized burial and exhumation histories. Additionally, an estimate of the timing, quantity, and mixture of hydrocarbons generated and expulsed from the Canol Formation was created for most point model locations. The regional model was constructed using a regional digital elevation model for the surface, accompanied by geological surfaces created from interpreted seismic lines. Subsequently, the point models were used to constrain some of these surfaces at a smaller scale. Regional pressure and temperature-depth curves were generated using data from drill stem tests.

Calibrating the point models utilizing existing vitrinite reflectance data from cuttings yields reasonable correlations between simulated depth/maturity curves and sample results. Similarly, the current iteration of the 3D regional model appears to predict known maturity trends in a broad sense based on the input data. However, the lack of continuity for certain surfaces (partly due to the software's interpolation limits) inhibits accurate resource accumulation prediction even though interesting trends can be observed. Most of these challenges can be traced

back to the relatively small and sparsely distributed dataset, as well as the extensive geographical area being modelled.

Generally, the model has confirmed regional maturity trends previously predicted in literature utilizing data from chip samples. The KinEx graphs for the point models potentially indicate more gas in the Devonian system than had been predicted prior to the most recent round of drilling. While the model has not yielded many novel predictions, the exercise was not without merit. The compilation of the regional model highlighted the challenges of attempting to simulate such a large area with limited data. Despite sparse data, the model pushed the limitations of the software and hardware available for the work. Therefore, any future work in this direction would likely benefit from a more limited scope, focusing on areas with full seismic coverage if possible. This would allow the geological surfaces to be more continuous without additional interpolation and would minimize additional sampling.

Building Post-Secondary Programming to Support the Northern Resources Development Sector

Sarah Rosolen & Jeff Turner
Aurora Research Institute, Aurora College, Fort Smith, Northwest Territories, Canada
srosolen@auroracollege.nt.ca

Indigenous Services Canada (ISC) is leading a Strategic Partnership Initiatives (SPI)-funded project to support the remediation economy and enhance Indigenous participation in major mining remediation projects in the Northwest Territories (NWT). There are several facets to the overall project. This work started in July 2023 and will take place over the next three years from 2023–2026.

Aurora College is leading the training and skills development component of the SPI. Starting from Environmental Remediation Skills Development Framework, stakeholder engagement began in October 2023 including industry, Indigenous businesses and Indigenous governments affected by mine closure with opportunities around Giant mine remediation. From this engagement, a representative Advisory Committee was formed.

The group gathering in February 2024 to review the Framework and develop a vision for training. The resulting work plan includes a diploma, certificate and several microcredentials.

Northern Industrial Project Specialist Diploma

- For individuals working at mines or wanting to begin a new career within industrial projects.
- Builds good technical understanding of industrial project life cycles and basis of the regulatory systems in the NWT.

Northern Environmental Project Coordinator Certificate

- Works with mining and industrial projects to ensure environmental risks are minimized and environmental and community commitments and responsibilities are met
- Prepares graduates to work with mining and industrial projects to ensure that environmental risks are minimized; environmental commitments and responsibilities are met.
- Includes industrial project life cycles, political and regulatory systems in the NWT, and transferable skills such as communications, data and records management, HR, and project management.

Microcredentials

- Climate change
- Regulatory landscape of the NWT
- Greenhouse operations for revegetation
- Community Economic Development
- Project management

This presentation will provide an overview of the progress to date on development of the training program, as well as provide an opportunity to engage with potential Subject Matter Experts who could may be able to contribute to aspects curriculum development.

Thaw-Driven Mass Wasting in the NWT

Ashley C.A. Rudy[1], Joseph M. Young[2], Seamus V. Daly[3], William Bender[4], Jurjen van der Sluijs[5], Duane G. Froese[2], William L. Quinton[4] & Steven V. Kokelj[1]
[1]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[2]University of Alberta, Edmonton, Alberta, Canada
[3]Aurora Research Institute, Aurora College, Yellowknife, Northwest Territories, Canada
[4]Wilfrid Laurier University, Waterloo, Ontario, Canada
[5]NWT Centre for Geomatics, Government of Northwest Territories, Yellowknife, Canada
ashley_rudy@gov.nt.ca

Climate change has accelerated permafrost thaw, altering slope stability thresholds and the geomorphic evolution of ice-rich permafrost terrain. The Northwest Territories (NWT), covering over 1.34 million km² in Canada's North, features a diverse array of geomorphic landscapes and ecoregions, including the country's most ice-rich permafrost. Thawing permafrost is a key factor driving climate-related landscape changes, significantly impacting ecosystems and infrastructure. This thawing process contributes to mass wasting, characterized by dynamic processes where the frequency and severity of landslides are influenced by geological, geomorphic, climatic, and disturbance factors. At the project's outset, comprehensive data on the nature and distribution of terrain impacted by landslides and mass wasting across the NWT was lacking.

The objectives of this presentation are to i) discuss the guidelines for classifying, identifying, and attributing thaw-driven landslides and mass wasting features, along with the benefits and limitations of the mapping inventory, ii) explore the knowledge gained from UAV monitoring of landslides and NWT wide oblique aerial surveys of landslides, and iii) summarize new information on the distribution of various mass wasting types affecting NWT landscapes. The mapping methodology considers features such as retrogressive thaw slumps, shallow and deep-seated landslides, debris flow fans, rock glaciers, and gullied terrain. These data and analyses can also inform spatial models to assess terrain susceptibility and evaluate risks posed by thawing slopes to communities and regions of interest.

Ekati Mine Effective Neutralization Potential Study: Practical Applications of Laboratory Studies

Kristin Salzsauler[1], Dan LaPorte[2], William Liu[3] & Feyi Adebayo[3]
[1]Geosyntec Consultants International Inc., Vancouver, British Columbia, Canada
[2]Geosyntec Consultants International Inc., Toronto, Ontario, Canada
[3]Burgundy Diamond Mines Limited, Calgary, Alberta, Canada
kristin.salzsauler@geosyntec.com

The Ekati Mine Effective Neutralization Potential study was a regulatory requirement as part of the interim closure and reclamation plan. A custom laboratory testing program was designed to answer questions about the effectiveness of silicate mineral neutralization potential through the mine life cycle. The laboratory study results provided useful insight as to the reactivity of metasediment and granite waste rock in site conditions. The key findings confirmed that silicate minerals are capable of contributing neutralization potential, particularly in cold site conditions. The outcomes highlight that accurate interpretation of laboratory NP values requires comprehensive knowledge of all silicate minerals and their field conditions when developing conceptual geochemical models for mine waste management facilities.

Diavik's Closure Journey: Integrated Mine Closure Planning and Progressive Reclamation

Sean Sinclair
Rio Tinto, Diavik Diamond Mines Inc., Yellowknife, Northwest Territories, Canada
sean.sinclair@riotinto.com

Diavik Diamond Mine's closure strategy represents a comprehensive approach to closure planning with a focus on self-executed progressive reclamation to manage environmental risk and maximize beneficial post-closure uses of a site under passive care. Developed with substantial input from local Indigenous communities, the

strategy considers reclamation of land and water to create a safe, stable and neutral site at closure. Significant emphasis has also been placed on reducing negative socioeconomic impacts of mine closure on local communities and employees.

Final closure goals for Diavik include physical and chemical stability, allowance for traditional Indigenous use, landforms based on pre-mining conditions, to the extent practical, neutrality towards wildlife, and maximization of Northern business opportunities during closure.

The closure of Diavik mine involves rigorous steps to ensure environmental safety. Mine workings will be cleared of hazardous substances and equipment, then safely and rapidly flooded with Lac de Gras water. Engineered covers are built to isolate processed kimberlite and all potentially acid-generating waste rock from the environment. All infrastructure will be removed or recycled if viable, while hazardous materials will be safely disposed of offsite.

Facilitated by early completion of key engineered source controls such as the rock pile cover, the site water management network will be progressively decommissioned, re-establishing pre-development drainage. Progressive reclamation work on the North Country Rock Pile (NCRP) started in 2017 and Diavik has now completed 95% of this important work. Execution of the NCRP project demonstrated that progressive reclamation can be efficiently integrated into mine operations resulting in cost-effective closure solutions on accelerated timelines. Building off the success of the NCRP project, Diavik commenced construction of a cover over the Processed Kimberlite Containment Area in 2023 with nearly 70% coverage by the end of 2024.

The Traditional Knowledge of local communities was incorporated through early planning processes and continues through the development of a Traditional Knowledge Monitoring Program. This initiative, led by members of Diavik's Indigenous Participation Agreement communities, will be a collaboratively designed, managed, and implemented monitoring program that complements the current and ongoing scientific approaches to closure performance assessment.

Additional closure processes seek to leave a positive Rio Tinto legacy of enduring community benefit in the North. Diavik's MyPath program has been developed to aid employees with the transition to mine closure, providing various career planning tools and support. Through development of a social closure plan with communities, businesses, governments and other stakeholders, Diavik intends to mitigate closure socioeconomic impacts and business risks, striving to become a positive example of well-executed mine closure in the North and across the industry.

With a closure plan drafted during the permitting process in the late 1990s and through continuous improvement processes over the last two decades, Diavik is proud of its final closure and reclamation plan.

Securing the Dig: Cyber Defense Strategies for the Exploration, Mining and Resource Industries

Matthew Smith
CasCom Ltd., Yellowknife, Northwest Territories, Canada
matthew.smith@cascom.ca

We will delve into the critical importance of cybersecurity within the resource, mining, and exploration sector. As these industries become increasingly digitized and interconnected, they also become more susceptible to cyber threats. We will explore the unique challenges faced by resource companies in safeguarding their operations, data, and infrastructure from cyberattacks. Through case studies, best practices, and interactive discussions, participants will gain insights into effective cyber defense strategies tailored specifically to the needs of the resource sector. From protecting sensitive geological data to securing remote mining sites, this session will provide practical guidance for ensuring the resilience of resource operations against cyber threats in the 21st century.

*Geothermal Potential of the South Slave Region (Northwest Territories, Canada); Project Update

Michaël Thibault[1], Félix-Antoine Comeau[1], Jasmin Raymond[1], Miora M. Rajaobelison[1], Viktor Terlaky[2] & S.M. Talha Qadri[2]
[1]Institut national de la recherche scientifique, Québec City, Québec, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
michael.thibault@inrs.ca

The South Slave Region (Northwest Territories, Canada) is known to have the highest heat flow (>100 mW m^{-2}) in the Western Canadian Sedimentary Basin. However, an analysis of deep geothermal resources has not been undertaken for communities in this region. This project aims to fill this gap by analyzing the geothermal resources of the region, with a focus on understanding the subsurface thermal properties to estimate temperatures at depth below the communities of Fort Providence, Kakisa, Hay River, and Enterprise. This presentation aims to review recent research efforts to better define the geothermal potential of these remote communities.

The Devonian sedimentary rock sequence on which the communities lie is thin (500 to 750 m) and has relatively low permeability (on average <10^{-14} m^2). Additionally, the lack of information on the Precambrian basement below Devonian sedimentary rocks limits the development of deep geothermal energy resources due to high uncertainty and risk. These factors pose significant challenges for the exploration and development of conventional geothermal systems, which typically rely on deep, permeable aquifers to extract heat efficiently.

Deep borehole heat exchangers (DBHE) could be an appealing technology for direct use of heat in this geological context. However, a comprehensive assessment requires a detailed understanding of the thermal properties of the rocks and accurate temperature estimates at depth to model such systems.

The first phase of the project focused on the sedimentary rock sequence. A total of 112 rock samples collected from cores and outcrops representing key geological formations within the stratigraphy were analyzed to determine their thermal properties. This allowed for creating a thermo-stratigraphic log for each community, defining the thermal characteristics of the sedimentary layers. Based on these data, geothermal gradients and heat flow values were calculated for each community using 1D temperature models derived from bottom-hole temperatures and well log data.

The next phase involved analyzing the Precambrian basement, which underlies the Devonian rocks. Ninety-one samples were collected in 2023 from outcrops and drill cores representing the main geological units, aiming to measure the anticipated range of thermal conductivity in Precambrian basement rocks. Fieldwork was expanded in 2024 to include temperature measurements in ground-water wells, refining estimates of the undisturbed ground temperature. The results were used to extrapolate the subsurface temperature in the basement until 10 km depth. Results allowed predicting temperature at the top of the Precambrian basement (500 to 750 m depth), expected to range from 30 to 36 °C under a surface heat flow between 99 to 157 mW/m². At 3 km depth, temperature is expected to vary from 100 to 156 °C, and at 10 km, from 303 to 511 °C. Among the studied communities, Hay River exhibits the highest geothermal gradient with significant potential for deep closed-loop systems.

Engagement with local communities was achieved, through efforts to share information about geothermal energy, including presentations in elementary and high schools. The current project phase focuses on modelling Deep Borehole Heat Exchanger (DBHE) systems to evaluate their thermal outputs for heating applications.

Our Land for the Future, a PFP Initiative for the NWT

Dahti Tsetso
Indigenous Leadership Initiative, Yellowknife, Northwest Territories, Canada
Dahti_Tsetso@ilinationhood.ca

An overview of the Indigenous-led conservation financing agreement known as NWT: Our Land for the Future.

Indigenous Community-Based Fish Monitoring Programs in the Northwest Territories, Canada

Paul Vecsei & Terell Knapton-Pain
Tłı̨chǫ Government, Behchokǫ̀, Northwest Territories, Canada
paul.vecsei@tlicho.ca

In northern Canada and specifically within the Tłı̨chǫ boundary of the Northwest Territories, the Tłı̨chǫ are engaged in long-term monitoring of their natural resources. The Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP) is a community-based monitoring program designed to determine whether fish, water, and sediment quality are changing over time, and whether fish and water are safe to consume. Background sources of heavy metals are naturally high in the region and are further increased by anthropogenic activities. Some metals like Mercury (Hg) are increasingly available for uptake by fish as climate change causes regional warming. The TAEMP rotates sampling through the Tłı̨chǫ communities so that every community has samples collected and analyzed once every four years. As a community-driven program, it involves community members in conducting contaminants-related monitoring, including the collection of samples and observations using both Tłı̨chǫ and scientific knowledge. The Marian Watershed Stewardship Program (MWSP) is also a community-based aquatic effects monitoring program but focused only on the Marian River Watershed. MWSP was initiated in 2013 and was designed to monitor cumulative effects of development, land disturbance, and climate change drawing on both science and traditional knowledge to obtain baseline conditions and potential changes over time. The Marian River is also of great importance because it is a travel corridor for Inconnu (*Stenodus leucichthys nelma*) that are migrating to their spawning grounds from Great Slave Lake to the La Martre River. Both programs use extensive laboratory analysis of samples collected. Results are annually presented to relevant communities.

A Simple and Inexpensive Way to Drastically Reduce Exploration Drill Water Use

Katsky Venter
RainCoast Environmental Services Ltd., Saltspring Island, British Columbia, Canada
katsky.venter@gmail.com

The evolution of what constitutes water use in the Territories has had a significant impact on the ability to carry out diamond drill-based exploration with more than one to two diamond drills without using quantities of water that necessitate a water licence. At the same time, there are a number of strong incentives for exploration companies to avoid obtaining a Type B water licence due to their significantly higher financial burden and regulatory requirements and constraints.

This presentation will outline a novel and easy-to-implement way to reliably reduce drill water use by up to 80% using inexpensive and readily available equipment. Case studies demonstrating the success and efficacy of this methodology in both the Northwest Territories and Nunavut will be provided, including the successful operation of up to six diamond drills below 100 m^3/day cumulative water use. Lessons learned from these case studies will be provided, as well as a brief discussion of the evolution of the regulatory interpretation of water ‘use’, its consequences on exploration, and the benefits of conducting initial exploration activities under a land use permit.

Evolving Legal Landscapes: The Future of Free Entry and Consultation in Mineral Exploration in BC and NWT

Joelle Walker & Erin L. Barnes
Miller Titerle + Company, Vancouver, British Columbia, Canada
ebarnes@millertiterle.com

Free entry has long been a defining feature of mineral exploration and tenure across Canada, allowing prospectors to stake and record claims with minimal

interference. However, recent developments in case law are reshaping the foundation of this system.

The Mineral Resources Act (MRA) in 2019 marked a significant shift in the Northwest Territories (NWT), Northern leaders are currently working through the Intergovernmental Council (IGC) to develop regulations required to implement the MRA. These regulations are expected to introduce changes to the mineral claim application process, including mandatory notification to Indigenous governments of mining claim applications and advance notice for intended work on new claims.

At the same time, the recent landmark legal cases, Ross River Dena Council v. Yukon, 2024 YKSC 1, and Gitxaala v. British Columbia, 2023 BCSC 1680, have also raised critical questions about the intersection of free entry mining and the Crown's duty to consult Indigenous peoples. The Gitxaala case, which is being partially appealed to the British Columbia Court of Appeal, holds significant implications for how the free entry system must evolve to balance industry interests while upholding the rights of Indigenous Nations. The case challenges the free entry system by considering whether the recording of a mineral claim itself triggers the duty to consult and whether the provincial government has an obligation to reform the mineral tenure system to be consistent with the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and the British Columbia Declaration of the Rights of Indigenous Peoples Act (DRIPA).

This presentation, led by legal counsel involved in the Gitxaala case, will explore the potential impacts of these evolving legal frameworks on mineral exploration in both British Columbia and the Northwest Territories. The presenters will discuss the implications of recent case law and regulatory changes within the NWT, highlighting how these legal shifts align with the broader objectives of the proposed NWT Mining Regulations. By drawing parallels between British Columbia and the Northwest Territories, this presentation will provide insights into the challenges and opportunities that lie ahead for both Indigenous Nations and the mining industry.

Mineral Resources Act – Status Update

Julie Ward
Industry, Tourism and Investment, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
julie_ward@gov.nt.ca

The *Mineral Resources Act* (MRA), Bill 34, was passed by the 18th Legislative Assembly of the Northwest Territories (NWT) in 2019, marking the first step towards a made-in-the-NWT approach to governing mineral development.

This presentation is a follow up to the status update presented last year. We have moved one year along on our journey to developing regulations to fulfill the MRA and we want to share our current status and let you know where we are headed. This presentation will summarize how we have arrived to this stage of the regulation's development and implementation.

We will also provide a high-level summary of outstanding steps required for coming into force.

A lot of work remains as we sift through complicated items such as:

- transition of current producing mines and exploration interests;
- completion of the collaborative legislative development process with Indigenous Governments;
- final input from public, interest groups and exploration and mining companies; and
- implementation activities of all new authorities and changes to existing processes.

We will also touch on what you can expect in subsequence amendments of the MRA regulations and how we anticipate that to be initiated (*e.g.*, zones, temporary restricted areas, and on-line map staking).

Come join us to find out the reality of developing complicated regulations in a truly collaborative way.

Investigating Habitat Connectivity Enhancement for an Arctic Char Population with Restricted Access to Spawning and Overwintering Habitat

Bernadette Weaver[1], Cameron Stevens[2], Edward Malindzak[3] & Alison Loeppky[4]
[1]WSP Canada Inc, Yellowknife, Northwest Territories, Canada
[2]WSP Canada Inc., Ottawa, Ontario, Canada
[3]Agnico Eagle Mines Limited, Toronto, Ontario, Canada
[4]WSP Canada Inc., Winnipeg, Manitoba, Canada
bernadette.weaver@wsp.com

The productivity of fisheries on naturally fragmented systems may be impaired when access is restricted for a proportion of the population migrating during specific seasonal windows. Migration delays can impact survival and fecundity through elevated energetic costs, increased predation risk, and disruption of key life cycle events. The study area is located at the transition from the freshwater to marine environment on Hudson's Bay where a series of step falls pose a natural partial barrier to sea-run Arctic Char (Salvelinus alpinus). The dynamic nature of flow and estuary tide conditions at the falls may significantly affect the navigability conditions such that the 'passability' of the falls (*i.e.*, the proportion of fish that can pass upstream) is reduced. Habitat enhancement measures (*i.e.*, 'fishway') have been proposed to improve upstream access to spawning and overwintering habitat above this migratory barrier. Proposed barrier remediation is expected to have significant benefits to Arctic Char populations based on demographic modelling. In 2023, baseline movement data were collected using a two-way fyke net installed at the base of the falls to capture staging Arctic Char and implant individuals with PIT tags, combined with two RFID antenna arrays installed above the falls. Preliminary results confirmed that upstream passability was low, and that timing of movements may be linked to high tide conditions. Continued monitoring in 2024 will confirm model assumptions and refine projections, which include an increase in annual biomass production by up to 8,000 kg per year, post-enhancement. Detailed design for the fishway is on-going.

Project Update, Mon Gold Mine, Yellowknife Gold Belt, NWT, Canada

Dave Webb
Sixty North Gold Mining Ltd., Yellowknife, Northwest Territories, Canada
dave@drwgcl.com

Sixty North Gold Mining Ltd. is developing the past-producing Mon Gold Mine, 45 km north of Yellowknife, in a manner different from the current standards and more in line with the methods that have proven to be successfully used in Yellowknife in the past. Current best practices have optimized a system that assumes a development path from discovery, diamond drilling definition, initial resource development (and expansions) typically using block modelling techniques with inverse distance or kriged interpolations, Preliminary Economic Assessment, Preliminary Feasibility Study, to Feasibility Study. This development path is now being adopted and used in Land Regulations. Words like "ore", "Reserves", and "Resources" are carefully regulated and specifically prohibited to be used except under defined situations.

The Yellowknife Gold Belt extends over 100 km from under the waters of Great Slave Lake to the south of Yellowknife and northward beyond the Nicholas Lake Deposit, 100 km to the north. It encompasses gold showings and occurrences with past producers including the Con Mine, Giant Mine, Mon Mine and Discovery Mine, and developments at Crestaurum, Clan Lake, Goodwin Lake, Morris Lake, and Ormsby. These are all structurally-controlled quartz veins and silicified zones associated with mafic igneous rocks.

In 2024, Sixty North Gold Mines Ltd. continued development of the North Ramp, extending it to 172 m in length and to an elevation of 210 m AMSL. A mineralized and altered quartz vein system referred to as the DD-Zone was encountered in the Main Ramp. The DD-Zone had been intersected by 12 diamond drill holes between 1963 and 1989 with values between 1 and 12 gpt over a 100 m strike length. It averages 2 m in width in the Main Ramp exposure where limited sampling ranges from nil to 62 gpt in continuous chips and muck samples.

A cross cut off of the Main Ramp at 211 m AMSL intersected the west and east limbs of the A-Zone, 18 m and 9 m below the past producing West and East Stopes respectively.

The East Limb can be traced for 115 m in strike, is open to the south and from surface, and is open to depth. It averaged 2 m in width where 2,085 tonnes grading 25.57 gpt gold was extracted from the East Stope. The West Limb has averaged 2 m in width in the West Stope where 13,000 tonnes was extracted at reconciled grades of 30.7 gpt. It can be traced for 100 m in strike, to a depth for 55 m, and is open to the north.

Sixty North Gold Mines Ltd. has permits to mine and mill at 100 tpd. Tests indicate >95 % recoveries can be expected. At historic grades, would yield 95 ounces of gold per day, with an anticipated 60 % to 85 % reporting in gravity concentrate and the balance to flotation concentrate. The tailings are non-acid generating, contain negligible deleterious elements, and are planned to be stored in a dry stack.

The North Slave Permafrost Monitoring Network: Observations of Permafrost Change in the North Slave Region, NWT

Niels Weiss[1], H. Brendan O'Neill[2], Wendy E. Sladen[2], Olivia Meier-Legault[3] & Steven V. Kokelj[1]
[1]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[2]Geological Survey of Canada, Natural Resources Canada, Ottawa, Ontario, Canada
[3]Carleton University, Ottawa, Ontario, Canada
niels_weiss@gov.nt.ca

Permafrost across the Northwest Territories (NWT) is changing. However, the rate and effects of change vary considerably. In addition to understanding permafrost landforms and subsurface characteristics, like surficial materials and ground ice content, long-term ground temperature records are essential to assess and anticipate change. Permafrost in the North Slave region of the NWT ranges from continuous to discontinuous, across treeline and major geologic units, and is commonly fragmented in diverse landscape units.

The NTGS works with the Geological Survey of Canada (GSC) and academic institutions to maintain a network of permafrost monitoring sites across the NWT. The monitoring network in the North Slave region is largely clustered around infrastructure corridors to discern impacts on the built environment and communities. Depending on site-specific research objectives, monitoring sites are often characterized in terms of geomorphological, ecological, and surficial geology in addition to collecting ground temperature records. Examples are geophysical survey techniques, such as electrical resistivity tomography (ERT) or ground penetrating radar (GPR), vegetation surveys, and permafrost carbon inventories. Moving forward, the NTGS aims to develop more standardized site characterization to increase the comparability and overall value of the generated data. Ground thermal and geotechnical data are publicly available as NTGS Open Reports or GSC Open Files, and will be published in the NWT Permafrost Database (currently in development by the NTGS).

Here, we provide an overview of the collective monitoring effort in the North Slave region and present a summary of recent observations and trends.

Snowpack Conditions and its Influence on Near-Surface Ground Temperatures Across Treeline in the Western Arctic

M. Alice Wilson[1], Ryan McLeod[2] & Steven V. Kokelj[3]
[1]Northwest Territories Geological Survey, Government of Northwest Territories, Inuvik, Northwest Territories, Canada
[2]Aurora Research Institute, Aurora College, Inuvik, Northwest Territories, Canada
[3]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
alice_wilson@gov.nt.ca

The western Arctic is one of the most rapidly warming regions in the circumpolar world, causing permafrost

temperatures and active layer thicknesses to increase, and near-surface ground ice thaw. Snow cover is a critical factor influencing ground temperatures. Thicker snow pack prolongs active-layer freeze back and results in higher ground temperatures. This study aims to investigate the variability of snow, the influence compactions have on its properties, and its impact on the relations between air and ground temperatures. Five years of snow depths and bulk snow densities have been collected at six sites across treeline along the Inuvik-Tuktoyaktuk Highway. Through a partnership with local industry, these sites are paired with manipulated sites where snow was compacted by snow cat three times a winter for first three winters of the study, beginning in December 2019. Average snow depth varied throughout the five winters; the first two winters had the lowest snow depths, and the fifth winter (2023/2024) had the deepest snowpack at all sites when regional snowfall was anomalously high. Investigating the variability in snow and ground temperatures between sites and years will further inform our understanding of how snow affects variation in ground temperatures and the potential of snow compaction as a mitigative measure for preserving permafrost around infrastructure.

*Constructing the Chemostratigraphy Sequence Around Zn-Pb Mineralization Using pXRF Analysis on Drill Core, Howard's Pass District

Jinglin Xu[1], Kenneth A. Hickey[1], Merilie A. Reynolds[2] & Darius Kamal[1]
[1]University of British Columbia, Vancouver, British Columbia, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
jxu@eoas.ubc.ca

The Howard's Pass district contains fifteen sediment-hosted massive sulphide Zn-Pb deposits that span the Yukon-Northwest Territories border. Mineralization at Howard's Pass is hosted in the Active Member (ACTM) of the Ordovician to Silurian Duo Lake Formation, which underwent shortening during the Cretaceous Cordilleran orogeny. The deposits are structurally complicated with mesoscopic folding and steeply dipping faults offsetting stratigraphy. Furthermore, drill holes commonly only intersect part of the Duo Lake, making it difficult to know whether any drill holes contain a continuous stratigraphic section.

Here, we present results from lithochemostratigraphic and structural analysis focused on the Duo Lake Formation in historical drill cores from the Howard's Pass district. Our study aims to define the chemostratigraphy through representative sections of the Duo Lake Formation and to investigate the evolution of the paleoenvironment in the district and the chemical and sedimentological conditions that accompanied the formation of the mineralization.

Structural, lithostratigraphic, and geochemical data were collected from select drill holes from the XYC, Don and Anniv deposits. Portable-XRF data was collected from samples approximately every 1.2 m downhole. Every third sample from selected holes was also analyzed using whole rock geochemical methods for comparison with pXRF results and analysis of elements below the detection limits of the pXRF. The cores were structurally reoriented using a steeply NNE-dipping regional S_1 cleavage that is axial planar to folding across the district. The fold geometry was determined from the re-oriented cleavage-bedding asymmetry and integrated with lithostratigraphic and geochemical markers to help determine the completeness of stratigraphic sections in drill holes.

Chemostratigraphy of a complete section of the Duo Lake Formation section and part of the overlying Steel and underlying Rabbitkettle Formations was constructed using data from three drill holes from XYC. Concentrations of aluminum are high below the ACTM and decrease uphole, reaching the lowest level in the ACTM before increasing again uphole. Excess silica increases uphole and is highest at the top of the ACTM which then drops to lower concentrations above the ACTM. Vanadium and uranium concentrations remain relatively consistent in the Duo Lake Formation and are low in the Steel Formation with some concentration peaks. Two common peaks between the two elements are found below and in the lower portion of the ACTM. Barium concentrations are low in the Duo Lake Formation but increase uphole gradually above the ACTM reaching high concentrations in the Steel Formation.

Geochemical results suggest that the Zn-Pb mineralization occurs in a biosiliceous sediment deposited during a period of decreased terrigenous deposition. Most of the Duo Lake Formation was deposited under suboxic to euxinic conditions, with two strongly euxinic periods in the lower ACTM and below ACTM. The environment was increasingly oxic in the upper Duo Lake Formation and became fully oxic in the Steel Formation. A preliminary comparison of pXRF data from XYC, Don and Anniv shows similar chemo-stratigraphic patterns, suggesting a consistent paleo-depositional environment across more than 20 km.

Preliminary Beneficiation Studies of Quartz Samples from the Northwest Territories, Canada

Hanyu Zhang[1], Gideon Lambiv Dzemua[2] & Qi Liu[1]
[1]University of Alberta, Edmonton, Alberta, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
hanyu7@ualberta.ca

Ten quartz-rich samples from Northwest Territories, Canada, were evaluated for their suitability as raw materials for the production of High-Purity Quartz (HPQ), an important component of the modern technology industry. HPQ is the primary feedstock for the manufacture of a wide range of products including semiconductors, photovoltaic cells, liquid crystal displays, optical fibre, optical glasses, silica ceramic, silica crucibles, and silicon metal - one of Canada's critical minerals. Production of HPQ requires raw materials with unique characteristics and current mining and production is highly concentrated geographically. Three of the samples used in the study were from a giant quartz vein in the Great Bear Magmatic Zone (GBMZ), four from the quartz zone in the Nechalacho rare earth deposits, and three from the Chedabucto silica sand along the western shore of the Northern Arm of the Great Bear Lake.

Grinding to -50 µm, separating with a wet high-intensity magnet, and leaching with sulfuric and oxalic acids increased the purity of the samples significantly. These treatments upgraded the samples from Whitebeach Point and Nechalacho to >99.9 wt. % SiO_2 and those from GBMZ to 99.0-99.5 wt. % SiO_2 (direct SiO_2 content analysis by ASTM C146). Reverse froth flotation and calcination followed by quenching had no significant impact on the SiO_2 grade.

According to whole rock XRF, Al_2O_3 is the main impurity and accounts for 0.35-0.65 wt. % in vein quartz samples. The Al_2O_3 occurs in both discrete Al-bearing mineral phases and quartz lattice. The discrete Al-bearing minerals may be removed by finer grinding followed by reverse flotation with stronger collectors and/or leaching with stronger acid.

This study underscores the territory's potential for high-quality quartz, which occurs in diverse deposit types, amenable to beneficiation to HPQ that can be used as feedstock for ultra-high purity quartz (>99.999 % SiO_2) and silicon metal.

Poster Presentations

Student Soap Box presentations denoted by *
The presenting author(s) underlined

Decadal Impact of Wildfire on Permafrost Degradation of a Peat Plateau - Scotty Creek, NT

Maude Auclair[1], William L. Quinton[1], Stephanie Wright[2], Oliver Sonnentag[3] & David Olefeldt[4]
[1]Wilfrid Laurier University, Waterloo, Ontario, Canada
[2]Queen's University, Kingston, Ontario, Canada
[3]Université de Montréal, Montréal, Québec, Canada
[4]University of Alberta, Edmonton, Alberta, Canada
mauclair@wlu.ca

As the climate warms and wildfire activity increases, permafrost in peatland-dominated regions of the southern Northwest Territories, Canada, becomes increasingly susceptible to thaw. While post-fire permafrost recovery has been observed to occur after several decades in this landscape, the likelihood of permafrost stabilization and recovery following contemporary wildfires is challenged by ongoing climate warming and changing fire regimes. We examined changes to the surface and subsurface properties of a partially burned peat plateau over the first 10 years following a low-severity wildfire in a thawing region, discontinuous permafrost. The wildfire's removal of the tree canopy eliminated the shading effect on the ground surface. Over the study period, net radiation and wind speeds became increasingly greater at the burned portion of the plateau than the unburned, transforming it into a higher energy environment. Increasing wind speeds were attributed to the gradual fall of standing dead trees. The lack of canopy shading enabled greater and more uniform inputs of energy and moisture to reach the ground surface. This led to greater and more uniform rates of seasonal active layer thaw and annual permafrost thaw depths that surpass the depth of annual refreeze, resulting in a near-continuous talik layer and thus, more rapid permafrost degradation. The thinner active layer at the Burn required less energy to thaw. Given this, and the greater net radiation at the Burn, a surplus of energy was available to drive other subsurface processes, such as increased ground temperatures and rates of permafrost thaw.

Preliminary Bedrock Mapping Results from Alcantara and Sorenson Lakes (NTS 75C16), Southwestern Rae Craton, Northwest Territories

Rebecca Canam[1], Kayla Sanderson[2], Vivian Cho[3] & Kelly L. Pierce[1]
[1]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[2]University of Victoria, Victoria, British Columbia, Canada
[3]University of Alberta, Edmonton, Alberta, Canada
rebecca_canam@gov.nt.ca

The Northwest Territories Geological Survey (NTGS) initiated a multi-year project to update the 1:250 000 scale Hill Island Lake map area (NTS 75C). This is part of the concerted effort to update mapping in the southeastern Northwest Territories, following the Geological Survey of Canada's - GEM2 2015-2018 South Rae mapping project and the NTGS's 2018-2021 Nonacho bedrock mapping project in the map sheets surrounding the Hill Island Lake area. Although parts of this area were re-mapped in the 1980s, most of the NTS 75C map sheet has not been updated since it was originally mapped in 1954. Following a 2023 field campaign in the Hill Island Lake area (NTS 75C05 and NTS 75C12), the NTGS completed 1:50 000 scale bedrock mapping of the Alcantara Lake map sheet (NTS 75C16) in 2024. Preliminary field observations and structural interpretations from the 2024 bedrock mapping program are reported herein.

The bedrock in the Alcantara Lake area consists of Archean to Paleoproterozoic, felsic and intermediate meta-plutonic rocks, including megacrystic K-feldspar granite, biotite granite, hornblende-biotite granite, garnet-biotite granite, biotite granodiorite and hornblende-biotite tonalite. Elongated bodies of diorite, plagioclase-phyric quartz diorite, monzonite and amphibolite are also common. Although a large quartzite and schist package was

previously reported in the area, no metasedimentary rocks were observed during the 2024 field season. The above rock units are deformed by several south to southwest-striking shear zones and display a strong, steeply-dipping foliation that parallels the orientation of the shear zones. The northwestern corner of the study area is deformed by the Howard Lake shear. whereas the rest of the region is deformed by splays of the McArthur Lake, Miller Lake or Howard Lake shears. The lithologies in this map sheet are consistent with those observed southeast of the Howard Lake shear zone in the Nonacho Lake map sheet (NTS 75F), and those within the Porter domain (NTS 75G and B) of the South Rae Craton. Samples were collected for U-Pb geochronology and whole rock geochemistry, and these analytical results will allow for more concrete regional correlations. Gossanous rocks were also sampled and will be sent for assay to assess the mineral potential of the Alcantara Lake area. Results from this project will be published as an NWT Open File, including a 1:50 000 scale map and a report.

Updated Bedrock Geology for the Hill Island Lake Area (Parts of NTS 75C05, 75C12, 75D08, and 75D09), Rae Craton, Northwest Territories

Rebecca Canam[1], Kelly L. Pierce[1], Jade Lockie[2] & Kenneth E. Ashton[3]
[1]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[2]University of British Columbia, Okanagan, British Columbia, Canada
[3]University of Regina, Regina, Saskatchewan, Canada
rebecca_canam@gov.nt.ca

The Hill Island Lake (HIL) area in the southeastern Northwest Territories is located in the poorly understood southwestern portion of the Rae Craton. As part of a concentrated effort to update existing knowledge of the southern Rae craton following the Geological Survey of Canada GEM-2 South Rae project (NTS 75A, B, G, H) and the Northwest Territories Geological Survey (NTGS) Nonacho project (NTS 75F), the NTGS has initiated a multi-year regional bedrock mapping project in the Hill Island Lake (HIL) map sheet (NTS 75C). This map presents the results obtained during the 2023 field season. Geological mapping was conducted at a scale of 1:50 000 around Hill Island Lake (parts of NTS 75C05, 75C12, 75D08, 75D09) and incorporates previous 1:250 000 scale mapping by H.H Bostock (2014).

The bedrock of the HIL area consists mainly of Archean to Paleoproterozoic basement granitoids and gneisses, <2.13 Ga Rutledge River paragneiss, <2.13 Ga Hill Island Lake assemblage (HILA), and *ca.* 1.93 Ga Natael granite. The basement rocks are comprised of upper-amphibolite facies, felsic to intermediate orthogneiss, foliated to gneissic, biotite ± hornblende granite to granodiorite, megacrystic biotite granite, minor amphibolite and minor leucogranite. The HILA consists of a greenschist facies, biotite porphyroblastic, interbedded sandstone and siltstone unit with rare actinolite-bearing calc-silicate lenses, and a lower-amphibolite facies garnet-muscovite-biotite ± andalusite ± staurolite schist unit.

The HIL area is structurally complex with at least four documented phases of deformation, including multiple periods of movement along the Tazin River shear zone (TRsz) which deforms both the HILA and basement granitoids. The intense attenuation of the basement granitoids and the development of porphyroclastic gneisses suggest an early, pre-HILA period of deformation localized along the TRsz. S_1 is a variably developed, steeply-dipping, bedding-parallel foliation that is best developed in the low-grade component of the HILA. This S_1 foliation is axial planar to rarely seen, tight to isoclinal fold hinges. Although megascopic F_1 folds were not recognized, their presence is suggested by minor reversals in the younging direction based on graded bedding. D_2 was a regional folding event that produced a regional, upright to northeast inclined, moderately southeast plunging antiform. This is supported by the development of open to close F_2 Z-folds in the northern portion of HIL, F_2 S-folds in the southern portion of HIL and a northwest-striking axial planar S_2 foliation is particularly well developed as a fracture cleavage in argillaceous components of the HILA. D_2 was also associated with dextral shearing along the TRsz and F_2 fold limbs outside the TRsz. D_3 was the latest reactivation of the TRsz with kinematic indicators (*i.e.*, CS fabric, shear bands, feldspar porphyroclasts, *etc.*) indicating sinistral strike-slip movement. D_4 is associated with east-west trending, gentle to open, upright folds.

During regional mapping, rock samples were collected for analytical work. Results from the geochronological and geochemical analyses will be published alongside the final 1:50 000 scale map of the Hill Island Lake area.

A Standardized Nomenclature for Permafrost and Thermokarst Features

Alexandre Chiasson[1,2], Ashley C.A. Rudy[1], M. Alice Wilson[3], Jurjen van der Sluijs[4], Wendy E. Sladen[5], Peter D. Morse[5], Duane G. Froese[2] & Steven V. Kokelj[1]

[1]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada

[2]University of Alberta, Edmonton, Alberta, Canada

[3]Northwest Territories Geological Survey, Government of Northwest Territories, Inuvik, Northwest Territories, Canada

[4]NWT Centre for Geomatics, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada

[5]Geological Survey of Canada, Natural Resources Canada, Ottawa, Ontario, Canada

alexandre.chiasson@gov.nt.ca

The Northwest Territories Thermokarst Mapping Collective (TMC) is a mapping project aimed at developing the first comprehensive inventory of thermokarst and thaw-sensitive terrain of the Northwest Territories using a grid cell mapping approach. This broad-scale approach describes 30 unique and mappable permafrost features that provides information on terrain conditions, thaw sensitivity and ground ice conditions. Building on the TMC model and recent fine-scale permafrost mapping by the Geological Surveys of Canada and the Northwest Territories along infrastructure corridors, we propose to develop nomenclature and symbology for describing and depicting permafrost landform characteristics on fine-resolution surficial and permafrost maps. This effort aims to enhance the Standardized Science Language of the Geological Survey of Canada's surficial geology data model by developing the tools to identify, document, and depict a wide range of mappable permafrost characteristics for enhancing Community Permafrost Mapping products. Our intentions extend beyond mapping permafrost features, to building a community of experts and stakeholders who are committed to advancing geoscience tools for climate change planning and adaptation. Currently, only a few permafrost features (*e.g.*, pingos and patterned ground) have designed symbology in the existing surficial mapping frameworks. However, with the increasing pressure to advance geoscience tools for northern community planning, there is an urgent need for a more comprehensive and standardized symbology system for mapping permafrost features. By developing permafrost and thermokarst landform conditions modifiers that can be linked to surficial mapping unit polygons and permafrost landform symbologies we establish tools that add value and enhance visualizations of permafrost mapping products. We plan to implement the protocols within a GIS framework (point, polyline, and polygon) and test the nomenclature and symbologies by implementing the methods in mapping around NWT communities in different permafrost settings. Development and refinement of the approach will involve iterative consultations with permafrost scientists, surficial mappers, GIS experts, and community members ensuring a comprehensive, credible, and usable approach. This collaboration allows for continuous refinement of symbol designs, feature inclusions, and scale displays for mapped features. There is also potential to engage Northern indigenous artists to develop clear, culturally relevant symbols for the maps. At this preliminary stage of our project, we are actively seeking comments and suggestions from the scientific community. As part of this process, we plan to host focused workshops, test usability by training mappers, and distribute draft versions of the nomenclature and symbology for peer review.

*Structural Study of the Tazin River Shear Zone in the Hill Island Lake Area, Southern Taltson Orogen, Northwest Territories

Connor A.C. Crook[1], Kathryne Bethune[1], Kenneth E. Ashton[1], Rebecca Canam[2], Nicholas Montenegro[1] & Jordan Deane[1]
[1]University of Regina, Regina, Saskatchewan, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
connor10.crook@gmail.com

The Tazin River shear zone (TRsz) is a major N-striking, ductile-brittle fault zone separating the Taltson basement complex from the Nonacho basement complex in the southern Taltson orogen of the western Canadian Shield. At Hill Island Lake, this shear zone is localized along low-grade supracrustal rocks of the Hill Island Lake assemblage (HILa). Fieldwork carried out in conjunction with the Northwest Territories Geological Survey focused on an E-W transect of the shear zone, emphasizing lakeshore lithostructural mapping and collecting a comprehensive suite of samples. Across this transect, the metasedimentary rocks of the HILa show a significant increase in metamorphic grade, from middle greenschist facies (biotite zone) in the west, to strongly foliated, middle amphibolite facies (garnet-staurolite-andalusite-bearing) schists within the shear zone. Basement orthogneisses exposed within, and east of, the shear zone contain older amphibolite-upper amphibolite facies assemblages. Three main episodes of deformation affected HILa rocks along the transect. D1 is expressed as rare bedding-parallel isoclinal folds along with an axial planar $S_{0/1}$ transposition foliation. D2 is manifest as a set of regional NW-trending, mainly Z-asymmetric folds with a well-defined axial planar cleavage in the HILa and is also developed in the basement rocks. Associated shearing took place in a dextral shear regime as evidenced by shear bands, rotated porphyroclasts and S-C' fabric. D3, in contrast, is represented by a set of NE-trending S-folds concentrated within the HILa schist along the eastern shore of Hill Island Lake; similarly, oriented S-folds are also present within basement gneisses. Sinistral shear sense was determined using asymmetric folds, rotated porphyroclasts, shear bands, rotated quartz veins, and S-C' fabric. The high degree of strain in the basement rocks of the TRsz relative to the HILA schist suggests that older basement structures have played a role in localizing younger deformation/reactivation. Future petro- graphic-microstructural study will characterize the mineral assemblages and be used to further evaluate the timing of mineral growth in relation to deformational events. *In situ* U-Pb dating will then be used to determine absolute ages associated with phases of mineral growth. Further characterization of the deformational events will be achieved using quartz c-axis fabric analysis/EBSD. These combined approaches will be used to determine the relationship between the three locally observed deform-ational phases and larger regional events recorded in the southern Taltson orogen.

Rates and Patterns of Permafrost Thaw-Induced Landcover Change in Discontinuous Permafrost Peatlands

Mason Dominico[1], William L. Quinton[1], Stephanie Wright[2] & Ryan F. Connon[3]
[1]Wilfrid Laurier University, Waterloo, Ontario, Canada
[2]Queens University, Kingston, Ontario, Canada
[3]Environment and Climate Change, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
mdominico@wlu.ca

The subarctic region of northwestern Canada is undergoing accelerated warming, impacting the stability and presence of permafrost. In peatland-dominated regions of sporadic and discontinuous permafrost, permafrost is often at disequilibrium with the current climate and increasingly susceptible to thaw. When permafrost thaws, the surrounding wetlands expand at the expense of permafrost supported forests. This landcover change is rapidly transforming the hydrology of these regions, impacting surface-ground water interactions altering the storage, transport and connectivity of water through northern basins. To understand the rates and patterns of permafrost thaw at the landscape scale, remote sensing techniques are employed to monitor the shifting areal proportions of permafrost across a 4 km^2 area of interest over 10- and 40-year period. Intensive in-situ monitoring and data collection on a representative permafrost body provide valuable

information to elucidate sub-grid processes influencing thaw rates on a point scale as well as refine numerical modelling efforts. This study seeks to integrate landscape and point scale data to improve the under- standing of the rates and patterns of permafrost thaw on the landscape. Combining these in-situ measurements with results from the remote sensing analysis show that the representative permafrost body has lost 13 % of perma- frost volume over the past decade. Of this loss, basal (5 %) and lateral (5 %) thaw were the two most significant factors. Should the observed rate of thaw be maintained, linear forecasts predict that this permafrost body will disappear by 2070.

*Geochemical Characterisation of the Colomac Gold Deposit, Indin Lake Greenstone Belt, NWT

Turner A.P. Green[1], Pete Hollings[1], John A. McBride[2], Riley Ledoux[3] & Chris Fozard[3]
[1]Lakehead University, Thunder Bay, Ontario, Canada
[2]STLLR Gold Inc., Toronto, Ontario, Canada
[3]GeoMinEx Consultants Inc., Vancouver, British Columbia, Canada
tgreen2@lakeheadu.ca

The Colomac Gold deposit is the largest gold deposit in the Indin Lake Supracrustal Belt. It was mined in the late 1980s and 1990s, producing 12.874 million tonnes (Mt) of ore and recovering 16.662 tonnes of gold. Currently, it contains an indicated resource of 70.4 Mt at 1.50 g/t for 96.1 tonnes of gold and an inferred resource of 24.4 Mt at 2.17 g/t for 48.19 tonnes of gold.

The Colomac Gold deposit is a sub-vertical mafic to felsic intrusive sill hosted in basaltic-to-andesitic volcanic rocks of the Leta Arm Group. From past studies and drilling, the Colomac sill comprises three primary lithologies: gabbro, quartz gabbro, and quartz diorite. The Colomac sill (2671 ± 10 Ma) is interpreted to be synvolcanic with the Leta Arm Group as it generally conforms to the stratigraphy. The entire belt and the Colomac sill have undergone two prograde metamorphic and five deformation events spanning through the Archean into the Paleoproterozoic.

Current research involves petrographic, geochemical, geochronological, structural, isotopic, and paragenetic characterisation of the mineralised units found within the Colomac deposit and comparing these findings to the Goldcrest deposit to the immediate southwest. Gold is hosted within or near the margins of quartz ± carbonate veins as free gold with increasing grade towards the centre of the sill where the quartz diorite unit dominates and there are more quartz ± carbonate veins. The majority of gold mineralisation occurs in extensional, low angle, stacked quartz ± carbonate veins. At Goldcrest, the veining is more stockwork-like and erratic compared to the more ordered veining at Colomac. Within Colomac, there is an observed correlation between gold and sulphides, primarily with arsenopyrite and pyrrhotite and secondarily with pyrite and magnetite. This relationship is also observed in Goldcrest samples, but gold is visually more closely associated with pyrite than pyrrhotite.

Four lithologies can be distinguished based on the geochemistry: gabbro, gabbroic diorite, diorite, and granodiorite. The Colomac sill is characterised by enriched LREE with $(La/Sm)_n$ values between 1.4 and 2.8, and $(Gd/Yb)_n$ values are between 1.0 and 1.6. Eu/Eu* values are between 0.6 and 1.4, and Nb/Nb* values are between 0.6 and 1.5. These geochemical values are consistent with magmas that formed in a suprasubduction setting (pending Sm/Nd isotope results) and similar to the intermediate volcanic rocks of the Leta Arm assemblage. Samples from Goldcrest show a similar geochemical signature for $(Gd/Yb)_n$ but $(La/Sm)_n$ values are constrained between 1.1 and 1.4; Eu/Eu* values are between 0.7 and 0.8; and Nb/Nb* values are elevated between 1.4 and 1.9. Research is still underway, with results for geochronology, Sm/Nd and Re/Os isotopes pending.

*Bedrock Geology of the Howard's Pass District, Yukon and Northwest Territories - New Insights into the Cordilleran Deformation of World-Class Sediment-Hosted Massive Sulfide Zn-Pb Deposits

Darius Kamal[1], Kenneth A. Hickey[1], Merilie A. Reynolds[2] & Jinglin Xu[1]
[1]University of British Columbia, Vancouver, British Columbia, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
dkamal@eoas.ubc.ca

The Howard's Pass sediment-hosted massive sulfide (SHMS) deposits, located in the siliciclastic Selwyn Basin on the border of the Yukon and Northwest Territories, are one of the largest undeveloped global reserves of zinc and lead. The district comprises 15 Silurian deposits that were deformed during their incorporation into the Selwyn Mountains Fold-and-Thrust (SFAT) Belt during the Cretaceous Cordilleran Orogeny. The SFAT Belt lies between the carbonate-dominated Mackenzie Mountains Fold-and-Thrust Belt to the NE and displaced allochthonous terranes to the SW.

Detailed mapping focused on the XY cluster of Zn-Pb deposits at Howard's Pass was first conducted in the 1970s by Placer Development and Morganti (1979). The structure and stratigraphy of the larger 105I Nahanni Map Sheet were mapped and compiled at 1:50,000 and 1:250,000 in the 1980s and published by Gordey and Anderson (1993). More recently, Martel *et al.* (2015) and Martel (2017) proposed a new structural model for the district. These workers hypothesize that the Howard's Pass district has been incorporated into a Cordilleran-age duplex structure, in which thrust faults, instead of folding, control the structural geometry of the district. This interpretation is a radical departure from the geometry outlined by Gordey and Anderson (1993). On the maps presented by Martel (2017), contacts are all tectonic, and stratigraphy has been disrupted by complex thrust imbrication.

Here, we present the results of a detailed structural study of the geometry and kinematic history of the Howard's Pass district with two detailed structural and lithostratigraphic maps for the areas surrounding the XY and OP Zn-Pb deposits mapped at 1:10,000. Two new cross-sections portray the effect of Cordilleran shortening on the stratigraphic sequence at Howard's Pass. Accompanying the detailed maps is an updated bedrock geology map compiled at 1:50,000. The map was completed using new structural data, internal data from Selwyn-Chihong Ltd., and legacy maps from the Geological Survey of Canada and the Yukon Geology Survey. The completed geologic maps differ from the duplex model of Martel *et al.* (2015) and Martel (2017) and are similar to the previous Gordey and Anderson (1993) interpretation, with folding exerting a primary control on the geometry of the district and the SHMS deposits.

During incorporation into the SFAT Belt, the Zn-Pb deposits and their host strata were folded into a series of regional gently NW plunging folds. This folding event (F_1) formed a pervasive axial planar cleavage (S_1) in the less competent lithostratigraphic units (*e.g.,* mudstones, siltstones, and limestones). S_1 appears as a slaty to spaced cleavage, comprising a penetrative dissolution seam sub-parallel to F_1 axial planes, and dipping steeply NE. In more competent units, such as the Devonian Earn Group's sandstones and conglomerates, shortening has been accommodated by large-scale parallel folds without forming an axial planar cleavage. Parallel folding of the competent strata plays a key role in shaping the structural geometry of the district by controlling the wavelength of regional folds. The enveloping wavelength of folded incompetent strata and the SHMS orebodies broadly conform to that of the parallel folds in the overlying units.

*Measuring Trace Element and Metal Distributions in Polymetamorphosed Banded Iron Formation Northeast of Rankin Inlet, NU; Connections to Gold Exploration

Trevor W. Matterson[1], Duane C. Petts[2], Daniele Regis[2], Desmond E. Moser[1] & Janina Czas[2]
[1]University of Western Ontario, London, Ontario, Canada
[2]Geological Survey of Canada, Natural Resources Canada, Ottawa, Ontario, Canada
tmatter@uwo.ca

The Kivalliq region in Nunavut contains banded iron formation (BIF) -hosted gold deposits, such as Meliadine and Meadowbank, that have been actively studied. Units of BIF northeast of Rankin Inlet (east of Meliadine) have received less attention. Our aims to develop a broader understanding of the evolution of BIF in this area, and in particular, metal mobilization during metamorphic episodes, will be presented. The region of interest sits in a complex transition zone of Archean and locally Paleoproterozoic deformation, containing greenschist-amphibolite facies rocks, between the Rae and Hearne cratons. The goal of this project is to gain insight into the relative timing and paragenesis of precious metal-bearing minerals in BIF, and any relationships between metal mobility and tectono-metamorphic processes that would inform exploration in the region. Preliminary results for representative samples collected during field mapping in 2023 show lower gold concentrations and decoration of grain boundaries with trace elements (*e.g.,* Ba, Ce, Cu). Moving from south to north, BIF samples were exposed to higher degrees of metamorphism, with the southern mica-rich BIF becoming more amphibole-rich further north. The trace element chemistry of magnetite and pyrite across grade will be presented along with any geochemical signatures related to primary and secondary formation processes. This work will increase the understanding of the paragenesis pf BIF-hosted metals in this previously unmapped area of a geologically complex region.

Geophysical Activities

Muhammad Asif Mirza
Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
asif_mirza@gov.nt.ca

The Northwest Territories Geological Survey (NTGS) holds a large industry and government geophysical data collection. Assessment reports containing the results of exploration work are submitted to the Government of Northwest Territories (GNWT) by members of the mineral exploration industry under the NWT Mining Regulations (and before April 2014, to the federal government under the Canada Mining Regulations). In the 1980s, geophysical surveys began appearing with assessment report submissions as manipulable digital data. The NTGS not only makes the raw data available to the public but is also using the submitted data to create useful enhanced products that were not provided in the original assessment report. These enhancements are produced according to industry-standard formats, and new interpretive and original grids are provided for the user's convenience.

Three-dimensional (3D) magnetic, electromagnetic inversions and enhancements of data from the assessment report 084457 (Aylmer Lake area) are presented in this poster. The 3D inversions were performed to enhance the visualization of structural features, and geophysical properties in the survey area. The airborne data was also transformed in to 3D models of magnetic susceptibility and conductivity below the surface. The inversion was carried out with no constraints and topography is included.

These enhancements can be used to constrain the geometrical signature and structural orientation of magnetic and conductivity anomalies that could be related to mineralization of interest, especially kimberlite, gold, and VMS occurrences. The complete enhancement methodology, 3D inversions parameters, and results are published as an NWT Open Report 2024-006.

Additionally, the NTGS has an upcoming high-resolution aeromagnetic survey planned in an area with high critical mineral potential to the south of Great Slave Lake, in the vicinity of the former Pine Point Pb-Zn mine, with funding

from the Canadian Northern Economic Development Agency (CanNor). This project will acquire approximately 30,000 line-km of airborne fixed-wing magnetic data, which will then be processed to determine the most prospective for economic mineralization.

This project is key in assisting critical mineral exploration work, as the only regional geophysical data in the proposed study area was collected at resolutions of 1,500 m line-spacing, which is too coarse to highlight subtle changes in lithology and structures. The proposed project will address the gap in geophysical coverage, enabling exploration companies to capitalize on the critical mineral potential present there and reveal important information about the structure, orientation, and relationships between different types of rocks.

Collaborative Studies to Appraise Methane Release from Degrading Permafrost, Western Canadian Arctic

H. Brenden O'Neill on behalf of **Peter D. Morse[1], Scott R. Dallimore[2], Jacqueline Goordial[3], Laura L. Lapham[4], Roger MacLeod[2], Lexi Mollica[3], Jalal Norooz Oliaee[5], Joost J. van der Sanden[6] & June Skeeter[7]**
[1]Geological Survey of Canada, Natural Resources Canada, Ottawa, Ontario, Canada
[2]Geological Survey of Canada, Natural Resources Canada, Sidney, British Columbia, Canada
[3]University of Guelph, Guelph, Ontario, Canada
[4]University of Maryland Center for Environmental Science, Cambridge, Maryland, United States
[5]Metrology Research Centre, National Research Council, Ottawa, Ontario, Canada
[6]Canada Centre for Remote Sensing, Natural Resources Canada, Ottawa, Ontario, Canada
[7]Geological Survey of Canada, Natural Resources Canada, Vancouver, British Columbia, Canada
peter.morse@NRCan-RNCan.gc.ca

Our multi-disciplinary research team is establishing regional infrastructure and using state of the art scientific methods and practices to measure changing terrestrial and aquatic ecosystem methane fluxes, Mackenzie Delta – Beaufort Sea region, NWT. Quaternary history, highly variable permafrost conditions, extensive wetlands adjacent to upland tundra, and the underlying sedimentary basin combine to produce an array of sources and pathways for natural methane emissions. Regional methane "hot spots" have been identified in remote sensing investigations, but there is no agreement on the locations or sources (biogenic *vs*. thermogenic). Large volumes of methane are trapped below and within permafrost as free gas or gas hydrate and there are many methane seeps at the surface. As permafrost degrades the conduits for gas transmission may grow and the corresponding flux of geologic methane to the atmosphere may increase. Permafrost also contains trapped organic matter, and microbial activity may increase biogenic methane production and release as permafrost warms and thaws. Insights gained on permafrost wetland and tundra methane fluxes are limited spatially and to the growing season, but cold season methane emissions may dominate the annual methane budget. Finally, high latitude lakes and ponds are loci for methane emissions *via* diffusion and ebullition from bottom sediments, but emissions from lakes in this study region are poorly constrained and include methane seeping from geologic sources. Legacy oil and gas infrastructure has the potential to add fugitive methane emissions to the background of natural methane emissions. We are conducting process-based field studies informed by a geological perspective to: (i) improve quantification and characterization of methane fluxes from diverse permafrost environments; (ii) distinguish thermogenic from biogenic sources and determine relative contributions to emissions; and (iii) define the associated microbial ecology of thawing permafrost including the liability of organic carbon that is controlled by geologic history. Our activities include: (i) helicopter surveying at low elevations (<1000 m a.s.l.) to measure subregional variations in methane concentration and collect air samples; (ii) developing chamber methods to determine methane fluxes from different cryostratigraphic units of permafrost; (iii) incubating permafrost at subfreezing temperatures to assess microbial ecology and activity; (iv) analyzing gases from lake ice bubbles to relate them to bubble morphology and aqueous geochemistry and link these to satellite radar lake ice mapping, and (v) developing an ultra-lightweight laser spectroscopic methane sensor deployed on a small UAV. Our initial findings suggest that: (i) emission locations may be "points" or diffuse; (ii) geologic gas is blocked by thick permafrost but passes through thin permafrost, thus emissions from thin warm permafrost include deep, thermogenic and

ancient biogenic methane sources in addition to modern biogenic methane, whereas hot spots in thick cold permafrost are predominantly modern biogenic methane; (iii) methane producing bacteria in permafrost are associated with high *in situ* methane, permafrost microbiota are active at sub-freezing temperatures, and permafrost does not need to thaw to release methane; and (iv) the distribution of tundra lakes with relatively high bubble densities may relate to terrain modified by thermokarst during the Holocene warm interval.

Measurement of Deep Ground Temperature in the Yellowknife Area

Scott R. Cairns[1], Niels Weiss[1], Aaron Doan[2] & Philippe X. Normandeau[1]
[1]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[2]Gold Terra Corp., Yellowknife, Northwest Territories, Canada
philippe_normandeau@gov.nt.ca

The geothermal energy potential of the flooded workings of the Con Mine was the subject of several studies in recent years. The City of Yellowknife commissioned a preliminary study from a contractor in 2006. In 2021, the Institut national de la recherche scientifique (INRS) and the Northwest Territories Geological Survey started a study which resulted in a geothermal resource assessment of the Con Mine geothermal energy potential based on temperature measurements and numerical modelling. A limitation of these studies was that the ground temperature at a depth greater than 300 metres below the surface was not measured. In 2023, Gold Terra Resource Corporation announced their intention to drill a deep hole designed to intersect the Campbell shear zone approximately 600 metres below the existing Campbell shear zone mine workings. The authors recognized the opportunity this new borehole presented to measure the temperature of the deep ground under Yellowknife.

A specially designed probe was used to carry two temperature loggers down Gold Terra diamond drill hole GTMC24-056. The probe carried two Hobo Data Logging Solutions Waterproof tidbit v2 temperature loggers. These loggers were selected because their electronics are fully potted in epoxy, making them robust under the hydrostatic head expected in the borehole. The probe carried one logger outside of its case, and another in a silicon-oil-filled pressure capsule constructed in-house. The pressure capsule was designed to fit securely in the core lifter spring of a standard NQ core tube. As the loggers were operating well outside their designed pressure regime, it was hoped the silicon-oil-filled pressure vessel would not allow brine or drill fluid into the logger if the epoxy potting around the electronics failed.

The loggers were calibrated by freezing in water and set to record a temperature reading every three minutes. The probe was placed in the core tube at the end of the shift on June 30th 2024, and the core tube was then pumped down against the drill bit to a depth of 2699 metres below ground. The probe was retrieved by the day shift the next morning after being downhole with no circulating drill fluids for approximately 12 hours. Both loggers performed identically in calibration, transportation and downhole. Temperature equilibrium at the bottom of the hole was established quickly at 42.6 °C. The temperature did not climb measurably over 12 hours, suggesting that the effect of fluid cooling on the rocks surrounding the borehole is minor.

Previous research suggested the Con Mine could be an excellent geothermal heat resource. These models were developed without heat measurements from deep workings, but assumed similar temperatures at depth. The current work provides an accurate measured temperature of 42.6 °C at a depth of approximately 2500 metres below sea level. This work may assist future models and plans to support the development of a geothermal resource in Yellowknife.

*Thermal History of the Pine Point Area: Insights into the Influence of the Great Slave Shear Zone on Geothermal Gradients

Taís F. Pinto[1], Eva Enkelmann[1], Viktor Terlaky[2] & S.M. Talha Qadri[2]
[1]University of Calgary, Calgary, Alberta, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
tais.fontespinto@ucalgary.ca

The Pine Point area in the southern Northwest Territories (NWT) is well known for its world-class Mississippi Valley Type (MVT) Pb-Zn deposits and, more recently, for its high geothermal gradient (*e.g.,* 55 °C/km at Fort Providence). Such economic resources are associated with processes that thermally affect rocks, such as faulting, hydrothermal activity, and sedimentary burial. The Pine Point area is part of the Western Canada Sedimentary Basin, and it consists of Early Paleozoic passive margin strata overlying the Precambrian Canadian Shield. The Great Slave Shear Zone (GSSZ) plays an important role in the geologic history of the area. It was responsible for the fluid flow that resulted in the Pine Point mineralization and controlled localized uplift and subsidence during its reactivation events (*e.g.*, late Cretaceous). However, it is unknown whether the GSSZ may have played a role in the development of today's enhanced geothermal gradient. Studies have shown that much of the thermal history of the region is mainly related to sedimentary burial and secondly to fault activity (*e.g.,* Arne 1991; Paradis *et al.* 2007). This stems from thermal history models that suggest that Late Cretaceous cooling was preceded by burial-related heating in the Cretaceous to 85–100 °C, sufficient for MVT mineralization (Arne 1991).

To investigate the thermal evolution of the region and its relation to the GSSZ and current geothermal gradient, we use apatite and zircon (U-Th)/He (AHe, ZHe) and apatite fission track (AFT) thermochronology. This allows us to quantify processes that thermally affect rocks over a temperature range of 55–80 °C (AHe), 60–120 °C (AFT), and 160–200 °C (ZHe). Our dataset consists of samples from two main areas: (1) within and immediately west of the GSSZ with Early Paleozoic strata and basement samples from boreholes, and (2) exposed basement outcrop east of the GSSZ area. In the area within the GSSZ, AHe dates collectively range from Miocene to Triassic, while AFT ages range from Cretaceous to Carboniferous. The wide date variation suggests a complex history that can stem from multiple heating/cooling events and/or long residence within 55–120 °C. Since the dates and ages are younger than the deposition, this implies that the rocks experienced post-depositional temperatures >120 °C. Preliminary thermal history modeling suggests a Jurassic slow cooling after peak burial/heating. Conversely, the AHe dates from the exposed basement range from Cretaceous to Neoproterozoic, while the AFT ages range from Early Permian to Late Carboniferous. Preliminary modeling suggests slow cooling and long residence between 55–80 °C throughout the Mesozoic. This spatial pattern may indicate that the GSSZ played a role in the Paleozoic-Mesozoic uplift and erosional history of the area, which in turn may provide insight into the geothermal gradients. To better constrain such an influence, the thermal histories will be refined and expanded using forthcoming ZHe data from all the dated samples. Further steps will include evaluating the stratigraphic record and geothermal patterns in the area to assess possible correlations between thermal histories and other geological features.

*Bathymetric Mapping on Ice-Covered Northern Lakes Using Ground Penetrating Radar

Alicia F. Pouw[1], Tate Meehan[2], William Bender[1], H.P. Marshall[3], Rick Walbourne[4] & Homa Kheyrollah Pour[1]
[1]Wilfrid Laurier University, Waterloo, Ontario, Canada
[2]Cold Regions Research and Engineering Laboratory, US Army Corps of Engineers, Hanover, New Hampshire, United States
[3]Boise State University, Boise, Idaho, United States
[4]Environment and Climate Change, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
apouw@wlu.ca

Lake bathymetry data are essential for assessing water levels and determining lake morphometry, particularly in

the Arctic and sub-Arctic regions of Canada, where lakes cover up to 40 % of the landscape. Understanding of watershed hydrology and lake ecosystems in these high-latitude regions depends heavily on such data. Traditionally, bathymetry assessments are conducted using sonar instruments aboard a watercraft during the open water season. However, accessing these remote locations during this period poses significant logistical challenges. Given that almost all these lakes are frozen for more than six months annually, snowmobiles provide a practical means of transportation in winter, facilitating access to these areas. Ground-Penetrating Radar (GPR), a technique commonly used in winter for snow and ice surveys, offers a feasible alternative for bathymetric mapping.

In January 2023 and 2024, approximately 25 km of 100 MHz GPR data were collected on Ryan, Landing, and Grace Lakes in the Northwest Territories, Canada, where lake depths range from 0.5 to 90 m. GPR-derived lake depth measurements showed strong agreement with in-situ sonar data collected during the open water season, with an average R^2 of 0.88 and a root mean square error (RMSE) of 0.64 m across 250 observations, with the maximum depth recorded in this study being 18 m. This study demonstrates that GPR provides an effective and reliable method for acquiring bathymetric data in remote, ice-covered regions. The technique enhances data availability critical for enhancing hydrological, limnological, and lake ice-related research, offering a viable alternative to traditional sonar-based methods in challenging environments.

*Geochemical Characterisation of the Hewitt Lake and Leta Arm Groups, Indin Lake Greenstone Belt, NWT

Tshepiso Sekhula[1], Peter Hollings[1], John A. McBride[2], Chris Fozard[3], Riley Ledoux[3] & Benjamin Beckie[3]
[1]Lakehead University, Thunder Bay, Ontario, Canada, [2]STLLR Gold Inc., Toronto, Ontario, Canada, [3]GeoMinEx Consultants Inc., Vancouver, British Columbia, Canada
tsekhula@lakeheadu.ca

Lithostratigraphic groups of the 2670-2629 Ma Indin Lake Supracrustal Belt (ILSB) in the western Slave Craton have been studied in the past to understand their nature and sequence of formation. However, geochronological and geochemical information is sparse. Our study presents preliminary results from the southwestern Hewitt Lake and Leta Arm groups to unravel processes involved in their petrogenesis. This was done by integrating geological mapping, petrology, whole-rock geochemistry, U-Pb zircon geochronology, and Sm/Nd isotope analysis.

Rocks of these assemblages are subalkaline mafic through felsic units with both tholeiitic and calc-alkaline characteristics. Basaltic rocks consist of clinopyroxene, plagioclase, amphibole and minor amounts of olivine, biotite, rutile and Fe-Ti oxides which decrease in andesites, dacites and rhyolites where feldspar and quartz dominate over amphibole. All assemblages are variably altered, metamorphosed and deformed. Metamorphism is consistent with greenschist to amphibolite facies characterized by amphibole-chlorite-biotite phases.

Mafic tholeiites of the Hewitt Lake and Leta Arm groups are characterized by broadly MORB-like Gd/Ybn (1.30-1.84) and La/Smn (1.03-2.71) values, although La/Smn ratios are higher than modern MORB. True MORB-like signatures are rare in the Archean and it is not clear if the mafic rocks represent Archean MORB or more plateau-like signatures. The variable negative Nb anomalies in the tholeiites could be caused by crustal contamination during emplacement or a subduction zone signature in the mantle source. Sm-Nd isotopes will be used to further assess this question.

Primitive mantle-normalized spider plots of intermediate to felsic rocks show LREE enrichment (La/Smn = 3.07-8.46), positive Th anomalies, negative Ti and Nb anomalies, as

well as both positive and negative Zr-Hf anomalies. These characteristics are typical of arc-type rocks formed by metasomatism of a mantle wedge above a subducting slab. Low Gd/Ybn values < 2.74 suggest melting at shallow depths in the absence of garnet, possibly suggesting an oceanic rather than continental arc setting. In the absence of Sm/Nd data, we propose that the Leta Arm sequence represents an evolving juvenile arc that resulted in the initial formation of tholeiites with minimal crust interaction and subsequent arc-type rocks by metasomatic melts coupled with possible increased crust interaction. This model will be tested with additional geochronology and isotope analysis.

*Numerical Modelling of Great Slave Lake Hydrodynamics Using the Nucleus for European Modelling of the Ocean

Jonas Stankevicius, Alain Pietroniro & Qi Zhou
University of Calgary, Calgary, Alberta, Canada
jonas.stankevicius@ucalgary.ca

The subarctic region of northern Canada, including Great Slave Lake (GSL) in the Northwest Territories, is experiencing unprecedented warming, with significant implications for regional hydrology, ecosystems, and human activities. Understanding how large northern freshwater systems like GSL will respond to ongoing climate change is critical for the region's communities. This study aims to enhance our understanding of the thermal regimes and water circulation in GSL through numerical simulation, providing a foundation for future research into the effects of climate change on lake circulation and ice phenology.

Despite GSL's status as one of the largest and deepest lakes in North America, comprehensive numerical modelling has been hindered by a lack of accurate bathymetric data. To address this, we collaborated with Fisheries and Oceans Canada (DFO) to develop the first complete bathymetric map of GSL tailored to the Nucleus for European Modelling of the Ocean (NEMO), by integrating historical naval charts with additional sounding data. The resulting model provides a three-dimensional simulation of lake circulation, thermodynamics, and ice dynamics. The model operates at a horizontal resolution of 1 km x 1 km with 10 vertical layers and covers the period 2012-2018. Atmospheric forcing is provided by the Regional Deterministic Reanalysis System (RDRS), while surface runoff is driven by the Community Environmental Modelling System – Surface & Hydrology (MESH) core modelling outputs from the Global Water Futures. The model outputs include three-dimensional fields of temperature and flow velocities.

Preliminary results indicate that GSL exhibits seasonal thermal stratification, consistent with dimictic behaviour, where full vertical mixing occurs twice annually. Wind-induced mixing significantly influences the distribution of oxygen and nutrients – critical indicators of the lake's ecological health. A counterclockwise circulation pattern is observed, with prominent gyres in the main basin of the lake. These findings highlight the essential role of accurate bathymetric and atmospheric data in understanding GSL's hydrodynamics and its response to environmental changes. Ongoing work focuses on refining model resolution and improving vertical mixing schemes. Validation against in-situ observations is underway, with the ultimate goal of creating a robust tool for predicting the impacts of climate change on the hydrodynamics and ecosystem dynamics of Great Slave Lake.

*Geothermal Potential of the South Slave Region (Northwest Territories, Canada); Project Update

Michaël Thibault[1], Félix-Antoine Comeau[1], Jasmin Raymond[1], Miora M. Rajaobelison[1], Viktor Terlaky[2] & S.M. Talha Qadri[2]
[1]Institut national de la recherche scientifique, Québec City, Québec, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
michael.thibault@inrs.ca

The South Slave Region (Northwest Territories, Canada) is known to have the highest heat flow (>100 mW m^{-2}) in the Western Canadian Sedimentary Basin. However, an analysis of deep geothermal resources has not been undertaken for communities in this region. This project aims to fill this gap by analyzing the geothermal resources

of the region, with a focus on understanding the subsurface thermal properties to estimate temperatures at depth below the communities of Fort Providence, Kakisa, Hay River, and Enterprise. This presentation aims to review recent research efforts to better define the geothermal potential of these remote communities.

The Devonian sedimentary rock sequence on which the communities lie is thin (500 to 750 m) and has relatively low permeability (on average $<10^{-14}$ m^2). Additionally, the lack of information on the Precambrian basement below Devonian sedimentary rocks limits the development of deep geothermal energy resources due to high uncertainty and risk. These factors pose significant challenges for the exploration and development of conventional geothermal systems, which typically rely on deep, permeable aquifers to extract heat efficiently.

Deep borehole heat exchangers (DBHE) could be an appealing technology for direct use of heat in this geological context. However, a comprehensive assessment requires a detailed understanding of the thermal properties of the rocks and accurate temperature estimates at depth to model such systems.

The first phase of the project focused on the sedimentary rock sequence. A total of 112 rock samples collected from cores and outcrops representing key geological formations within the stratigraphy were analyzed to determine their thermal properties. This allowed for creating a thermo-stratigraphic log for each community, defining the thermal characteristics of the sedimentary layers. Based on these data, geothermal gradients and heat flow values were calculated for each community using 1D temperature models derived from bottom-hole temperatures and well log data.

The next phase involved analyzing the Precambrian basement, which underlies the Devonian rocks. Ninety-one samples were collected in 2023 from outcrops and drill cores representing the main geological units, aiming to measure the anticipated range of thermal conductivity in Precambrian basement rocks. Fieldwork was expanded in 2024 to include temperature measurements in groundwater wells, refining estimates of the undisturbed ground temperature. The results were used to extrapolate the subsurface temperature in the basement until 10 km depth. Results allowed predicting temperature at the top of the Precambrian basement (500 to 750 m depth), expected to range from 30 to 36 °C under a surface heat flow between 99 to 157 mW/m². At 3 km depth, temperature is expected to vary from 100 to 156 °C, and at 10 km, from 303 to 511 °C. Among the studied communities, Hay River exhibits the highest geothermal gradient with significant potential for deep closed-loop systems.

Engagement with local communities was achieved, through efforts to share information about geothermal energy, including presentations in elementary and high schools. The current project phase focuses on modelling Deep Borehole Heat Exchanger (DBHE) systems to evaluate their thermal outputs for heating applications.

Systematic Aerial Inventory of Permafrost Landforms Indicate the Nature and Diversity of Thaw-Sensitive Terrain in the Northwest Territories

Jurjen van der Sluijs[1], Steven V. Kokelj[2], Ashley C.A. Rudy[2] & M. Alice Wilson[3]
[1]NWT Centre for Geomatics, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[2]Northwest Territories Geological Survey, Government of Northwest Territories, Yellowknife, Northwest Territories, Canada
[3]Northwest Territories Geological Survey, Government of Northwest Territories, Inuvik, Northwest Territories, Canada
jurjen_vandersluijs@gov.nt.ca

Thermokarst terrain develops due to the thawing of ice-rich permafrost, comprising a broad suite of landforms that can indicate ground ice conditions and the thaw-sensitivity of permafrost. For most of the circumpolar region there is limited empirical data that describe thermokarst landform patterns, which restricts understanding and extrapolation of environmental effects of permafrost thaw and limits evaluation of remote sensing and spatial modelling products intended to detect and predict thaw-driven changes. The Northwest Territories (NWT) Thermokarst Mapping Collective (TMC) produced a standardized mapping rubric and method to empirically inventory indicators of thaw-sensitive terrain using satellite imagery

interpretation of 7.5 × 7.5 km^2 grid cells for a 2 million km^2 region of northern Canada. The TMC approach enabled landscape assessments of 25 thermokarst and periglacial features and attributes, which were validated using NWT-wide helicopter-based inventories. Beyond validation, it was recognized that the aerial observations enabled a refinement of the TMC mapping rubric. The ability to observe detailed aspects drove a concurrent effort to deploy systematic aerial inventories across NWT. Specific goals were: (1) to develop a standardized permafrost assessment and data recording method, (2) to generate a systematic dataset documenting thermokarst features and periglacial landforms using empirical low-altitude observations, and (3) to examine whether the data can reveal insights on the distribution of permafrost landforms and thermokarst processes.

Surveys spanned across 14 degrees of latitude (37,429 km), enabling collection of 7,597 observations and 41,559 geo-tagged photos. Observations were captured using ESRI Survey123, deploying a custom logic model as a standardized template for identifying a broad suite of thermokarst features and permafrost landforms along with attributes organized under mass wasting, hydrological, and periglacial themes. Geotagged photos were acquired to provide a visual record and to act as a mechanism for quality control-assurance and gap-filling of attributes. The acquired dataset is novel in the sense of explicitedly linking point coordinates, extensive landform codes and attribute information, as well as a detailed visual reference of thermokarst and periglacial features. The dataset consisted of 4,088 periglacial samples (54 %), 1,971 hydrological samples (26 %), and 1,538 mass wasting samples (20 %).

Results highlight the nature and diversity of thermokarst and periglacial features in the NWT. Within the hydrological theme, results indicated that both lake lowering and expansion were dominant modifiers of lakes, while complete drainage and shoreline collapse were secondary in abundance. Here relative abundance of these four characteristics differed across ecoregions and latitudes, and in some cases all four lake dynamics were observed (*e.g.,* Mackenzie Delta). Periglacial observations most often included collapse scars and high- and low-centred polygons, along with patterned forest (stringbog). High- and low-centred polygons increased in abundance with latitude, collapse scars were prevalent throughout peatlands in discontinuous permafrost, and stringbogs were abundant in the transitional zone.

The extensive aerial surveys provide a novel window into the characteristics and dynamics of the warming permafrost environment. This dataset will provide new insight into the nature and diversity of permafrost landscapes, and a visual, spatially explicit product that can be explored by scientists and the public.

Mark your calendars!

2025 Yellowknife Geoscience Forum:

November 24th to 26th