Book of Abstracts
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Contents

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Keynote Talks

Canada's households and the zero carbon transition

R Das[a]

[a] *College of Interdisciplinary Studies, Royal Roads University*

Canada's energy transition is part of the global energy transition currently underway. Canada's energy system has been evolving, similar to that of other countries, but this time change is urgent to limit warming. In addition to addressing the climate crisis and promoting greater energy security, energy transitions and shifting to renewable energy systems have the potential to address interrelated challenges connected to fossil fuels. But even low carbon transitions can distribute the costs and benefits of transition unequally and calls are being made for the energy transition to be equitable so that it benefits everyone.

To date much of the focus in energy transition and in energy systems transformation has been on the supply side. There is less emphasis on end-users, the general public, and everyday households. However, Canada's residential sector plays an important role in the energy transition by way of their energy consumption and demand for energy. Canada's households are also important because climate change will impact their everyday lives.

There are many challenges facing the Canadian residential sector having to do with affordability, energy poverty, energy efficiency, and the adoption of technology, which are all critical to address. For example, in the current energy system, households are struggling with getting sufficient levels of energy services to meet their needs and maintain healthy indoor temperatures. The energy transition will increase the demand for electricity, as well as present potential upfront costs, which will be challenging for households that are already struggling to afford their energy needs. In this talk I ask: How can Canada's households energy transition equitably and sustainably? I will discuss some of the current challenges and solutions for advancing residential energy transition.

Corresponding author: runadas@gmail.com

Tracing lithosphere-scale fluid transprt in the Pannonian Basin (central Europe)

M Berkesi[a] and the MTA-EPSS Momentum FluidsByDepth Research Group[a]

[a]HUN-REN Institute of Earth Physics and Space Science, Sopron, Hungary

Among different natural volatiles, carbon dioxide flux of geological origin is intensely studied in the past years, however, there are still lot to be answered. Besides the obvious effect on recent climate, it is widely known that volatiles, particularly CO_2 and H_2O, are very important components in the Earth's interior driving processes such as melting, recrystallisation, deformation, volcanism, and earthquake triggering. These components are essential in making plate tectonism operational and also contributing largely to keeping Earth a living planet. In this keynote talk, an interdisciplinary approach is presented to better understand mantle degassing, considering fluid pathways through the lithosphere and thus the asthenosphere – lithosphere – atmosphere interactions by means of volatiles. Geofluid flow in the lithosphere and their upward transportation is investigated by our research group due to an interdisciplinary approach: fluid inclusion studies representing different lithosphere levels, thermo-mechano-chemical numerical modeling to decipher the stress/strain changes resulted from fluid/rock interaction, surface spatial analyses (GIS) and geostatistics, carbon and noble gas isotopic compositions of groundwaters and soil gases to look for the traces of deep lithospheric fluids, and thermal modeling of the lithosphere.

The study area is the Carpathian-Pannonian region (CPR, central Europe), an optimal natural laboratory, as geological processes are young and thus well preserved in most cases. Late Miocene Quaternary mafic volcanic rocks are sporadically found in CPR. The volcanic activity brought xenoliths from the upper mantle, lower crust, middle and upper crust to the surface. It therefore provides to study on detail the recent lithosphere-scale fluid transport processes.

The planned achievements of the MTA-EPSS FluidsByDepth Momentum Research Group are to aget the compositional and density distribution of the C-O-H-N-S fluids, of deeper origin, along by a vertical cross-section of the lithosphere including the changing δ^{13}C-CO2, δ^{18}O-CO_2 and noble gas isotope compositions. We can synthesize the data from fluid inclusions with the compositional variations – including C-isotope composition – in soil gas to estimate the extent of deep lithospheric contribution. We will discriminate stages of the fluid/rock interactions and model its effect on fluid transport and the isotope fractionation. The results could be readily extrapolated to intracontinental lithospheres in similar geodynamic settings and to refine the models on natural CO_2 degassing.

Corresponding author: berkesi.marta@epss.hun-ren.hu

Graduate Student Talks

Unveiling surface and subsurface contributions to evapotranspiration in in a snow-dominated watershed in western Canada

LC Serrano-Diaz[a], B Smerdon[a], DS Alessi[a], M Faramarzi[a]

[a] *Department of Earth and Atmospheric Sciences University of Alberta, Edmonton, Alberta, T6G 2E3, Canada*

Evapotranspiration (ET) plays a vital role in the global hydrological cycle, significantly influencing the water balance within ecosystems. In semi-arid regions, such as the temperate mid-to-high latitude zones of the world, the annual actual evapotranspiration (AET) can surpass annual precipitation, leading to potential impacts on the hydrologic budget and greater risk of groundwater resources depletion. Despite existing studies on spatiotemporal variations of AET and potential changes due to future climate change scenarios, the contributions of different water sources to AET are not well understood. A comprehensive understanding of water sources that contribute to AET, under historical and future climate change scenarios, will help in developing effective water resource management and adaptation plans.

AET refers to the water transferred from the Earth's surface and subsurface to the atmosphere and encompasses evaporation and transpiration processes. Evaporation refers to the conversion of liquid water into water vapor, stemming from two main sources: (1) surface water evaporation (SE) comprising lakes, rivers, and canopy storage, and (2) porous media evaporation (PME) originating from groundwater sources. Conversely, transpiration refers to the discharge of water vapor by plants through their leaves, supplied by water absorption from the root zone within the porous media (PMT).

In this study, we developed a fully distributed and physically process-based model for the North Saskatchewan River Basin (NSRB) to simulate the terrestrial segment of the hydrologic cycle. The NSRB is located in central Alberta and characterized by a semi-arid climate. The model enables a spatiotemporal assessment of AET, differentiating various sources of water that contribute to AET. More specifically, we analyzed AET variations and source contributions across three different regions including mountains, foothills, and plains, and among diverse land use types. Our preliminary results indicate that across all regions and most of the land use categories, PMT represents the largest contribution of water to supply annual AET, followed by PME, involving the release of stored water from soil and rocks, with SE making the smallest contribution in all regions. The fluctuation in water supply from PMT, PME, and SE to fulfill AET water demand varies noticeably with the seasons. PMT plays a more significant role during the plant growing season, while in colder months, the amount of water provided from these three components becomes more balanced. Furthermore, foothills regions exhibit the highest water loss via AET, followed by plains and mountains.

Corresponding author: serranod@ualberta.ca

Permafrost mass wasting in the Mackenzie Valley, NWT

JM Young[a], D Froese[a]

[a] *Department of Earth and Atmospheric Sciences University of Alberta, Edmonton, Alberta, T6G 2E3, Canada*

Permafrost landslides throughout the western Canadian Arctic have increased in magnitude and frequencyover the past ca. 20 years along with climate change. This non-linear acceleration has intensified landslide processes and feedbacks, increasing the diversity of landforms that pose emergent risk and hazards to infrastructure, water quality, and soil carbon. This presentation uses field and remote-sensing observations to provide a regional framework to highlight the influence of permafrost setting, landscape history, terrain conditions, and climate drivers on variations in thaw-driven landslide mechanics. In addition, we describe a continuum of landslide activity with a process-form model that involves top-down and bottom-up thawing, intermediated by internal thermal degradation altering slope properties. This includes a novel slope failure style that involves detachment at the base of relatively warm and thin permafrost, resulting in rapid large-scale (volumes up to 25 x $10^6 m^3$) landslides in areas previously thaw-stable. Collectively, regional characterizations of permafrost landslide types and their dominant failure mechanisms are critical in anticipating areas susceptible to thaw-driven slope failure in the future.

Corresponding author: jmyoung1@ualberta.ca

Constraining the Role of Authigenic Magnesium Rich Clays on Carbonate Precipitation in Alkaline Lacustrine Environments

ML Arizaleta*[a], MJ Raudsepp[a], N Zeyen[b], J Kenney[c], S Wilson[a]

[a]Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB, Canada;
[b]Département des sciences de la Terre, Université de Genève, Genève, Switzerland;
[c]Department of Physical Science, MacEwan University, Edmonton, AB, Canada

Authigenic Al-poor, Mg-rich phyllosilicates (*e.g.,* stevensite, sepiolite, kerolite, talc), are important components of sediments deposited in a wide array of environments, including alkaline lakes and siliceous marine environments. Mg-silicates are often associated with carbonates (*e.g.,* calcite, dolomite, magnesite) in modern and ancient sedimentary settings and it has been hypothesized that they can facilitate the precipitation of carbonate minerals.[1,2] The presence of specific microbial groups and metabolic processes (e.g., oxygenic photosynthesis, heterotrophy) is thought to promote the transformation of Mg-silicates to carbonates by aiding with silica removal, alkalinity generation and increasing cation availability.[3] Mg-silicate minerals may transform into carbonate phases via a process known as carbon mineralization, which involves the dissolution of silicate or hydroxide minerals followed by precipitation of carbonate minerals where dissolved CO_2 binds to free divalent cations, in this case Mg^{2+}.[3]

The purpose of this study is to test the hypothesis that authigenic, 2:1 Mg-silicates can transform into carbonates under alkaline conditions. A series of bench-top batch experiments was undertaken to study the reaction between a synthetic, poorly-crystalline Mg-silicate phase (stevensite-like), microbes and various natural filtered lake waters. Variables tested are aqueous Mg/Si ratio, alkalinity, pH, and the presence or absence of microbes. Results showed the precipitation of a hydrated magnesium carbonate mineral, dypingite, and Mg-rich silicate or hydroxide phases. Results from this study can contribute towards geochemical models of the environments where we observe carbonation of clay minerals, such as alkaline lakes, which can then be utilized for predicting evolution of these natural systems and serve as natural analogues for industrial uses such as in ultramafic mine tailings and consequently help improve industrial Carbon Dioxide Removal projects globally.

*Corresponding author: arizalet@ualberta.ca

[1]Pace A., et al. (2016). *Scientific Reports*. **6**, 31495
[2]Zeyen N., et al. (2022). *Frontiers in Climate.* 4:913632.
[3]Power I. M., et al. (2011). *Environmental Science and Technology*, **45,** 9061-9068.

Deriving Silicate Mineral Weathering Rates in Soils Across North America to Assess CCUS Potential from Enhanced Rock Weathering

J Spence[a], S Wilson[a], B Rivard[a], I Power[b], A Harrison[c]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*
[b] *School of the Environment, Trent University, ON, Canada*
[c] *Institut für Geologie, Universität Bern, Switzerland*

Enhanced Rock Weathering (ERW) is a Carbon Dioxide Removal (CDR) technology that involves the spreading of silicate rock powder on agricultural and agroforestry soils. ERW has been shown to result in agricultural benefits such as adding nutrients to the amended soils, and acting as a natural pesticide and fungicide. Further, ERW is used as a pH amendment to replace lime (CaO) while also removing CO_2 from the atmosphere. ERW works through the reaction of divalent cations (Ca, Mg) in the rock powder with the carbonic acid in rainfall, and it traps the dissolved CO2 as soil alkalinity and pedogenic carbonate minerals. ERW has gained traction largely due to its simplicity and low barrier to entry (the infrastructure necessary for ERW already exists); however, questions remain regarding the large-scale feasibility of ERW, and whether it can be used efficiently to reach the gigatonnes/year scale CDR rates needed to mitigate climate change.

One main concern with ERW is the rate at which the amended rock powders weather. Depending on the conditions of the soil (pH, moisture, temperature), and the specific mineral type amended, the timescale for significant weathering can range from a few years to multiple decades which has a vast impact on the feasibility of ERW as a climate change mitigation strategy. While this has been studied to some extent in individual greenhouse and field trials, very little research has gone into understanding potential weathering rates across large geographic regions. Here we assess the predicted weathering rates of four different rock types that have been proposed for ERW (wollastonite skarn, basalt, kimberlite, and serpentinite) across the soils of North America. This has been done using standard mineral dissolution equations with lab determined mineral-specific coefficients, and soil pH/temperature rasters for the continent. From this we hope to infer the potential CDR rates for each rock type and assess the best strategy for ERW deployment.

Corresponding author: jspence2@ualberta.ca

Investigating the role of cyclonic storms in deep water formation in the Labrador and Nordic Seas

R Whincup[1], **C Pennelly**[1], **and PG Myers**[1]

[1]*University of Alberta, Canada*

The Atlantic Meridional Overturning Circulation (AMOC) is a vital mechanism of heat transport in the climate system, but it has been suggested that its strength will change in the coming decades. Many factors contribute to its strength and variability, and understanding their effects is crucial to predicting its future behaviour. This research aims to deepen our understanding of one such factor: the role that cyclonic storms play in priming and initiating deep water formation in the Labrador Sea and Nordic Seas, where the overturning part of the AMOC mainly takes place. To do this, we used pressure and wind fields from two atmospheric datasets (ERA5 and Canadian Meteorological Centre's Global Deterministic Prediction System Reforecasts, or CGRF) to identify and track cyclones. We will then look at output from NEMO (Nucleus for European Modelling of the Ocean) model runs over 2002-2019 which were forced with the same datasets to evaluate what effects passing cyclones exert on properties throughout the water column. The key questions we aim to answer are whether there are spikes in convection associated with cyclones, how sea surface properties change in response to storms, and whether there are differences in the properties of deep water formed when influenced by storms relative to the 'background' qualities of that water mass. We expect to find greater surface heat loss and deeper mixed layer depth following cyclone passage, as well as lower heat content over the whole vertical profile, indicating a positive contribution to deep water formation. This effect should also be clearer after multiple cyclones transit in relatively short succession. While some research has been done into how cyclones affect ocean characteristics, few studies have examined these interactions in regions with deep convection. If the effect is significant, it may mean that storms are a necessary factor to consider when making predictions about deep water formation in the North Atlantic, particularly as cyclone characteristics themselves are expected to shift with continued climate change.

Corresponding author: zwhincup@ualberta.ca

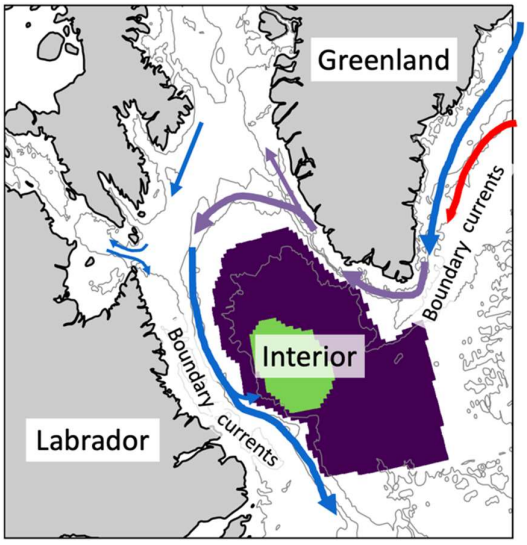
Tides, mixed layer eddies, and deep convection in the Labrador Sea: Simulations at resolutions consistent with coupled climate models

R Brown[a] and PG Myers[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

The Labrador Sea, in the subpolar North Atlantic, is among very few locations worldwide that experience deep convection, where surface waters lose buoyancy and sink to great depths. Deep convection occurs seasonally due to air-sea heat flux during the cold winter months, both densifying and supplementing the lower limb of the Atlantic Meridional Overturning Circulation. Hence, deep convection in the Labrador Sea is a potential driver of variability in the large-scale ocean circulation, suggesting an important link between the Labrador Sea and the global climate.

Within general circulation models, the representation of deep convection can be improved with finer grid resolutions, but this also increases computational costs. Consequently, many large-scale coupled ocean- atmosphere models (which are already computationally expensive to run) utilize coarse resolutions of 1/4° or lower. Here, we use a regional 1/4° coupled ocean-sea ice model to study the effects of two processes on deep convection in the Labrador Sea: (1) tidal forcing and (2) the submesoscale mixed layer eddy parameterization (SMLEP) for restratification. Preliminary results suggest that both tidal forcing and the SMLEP can inhibit deep convection and reduce mixed layer depths. One mechanism by which this occurs is altered boundary current-interior exchange, which is an important pathway for heat and freshwater to enter the convection region and increase stratification. Other potentially important mechanisms include accelerated springtime re-stratification and decreased vertical diffusivities. These results—that tidal forcing and the SMLEP can inhibit deep convection—imply that these might be inexpensive techniques for reducing mixed layer depth biases within global climate models, potentially improving their representation of the large-scale overturning circulation relative to observations.



Corresponding author: rowan.brown@ualberta.ca

Elevation-dependent variability of snowpack triple oxygen isotopes, St. Elias Mountains, Yukon

KM Holland[a], **AS Criscitiello**[a], **BR Markle**[b], **EJ Steig**[c], **and AJ Schauer**[c]

[a] *Department of Earth and Atmospheric Sciences, University of Alberta, AB, Canada*
[b] *Institute of Arctic and Alpine Research, University of Colorado Boulder, CO, USA*
[c] *Department of Earth and Space Sciences, University of Washington, WA, USA*

The preservation of the stable isotopic composition of meteoric water in glacial ice is a foundational principle of ice core science, allowing for the reconstruction of past atmospheric temperatures, hydroclimates, and modes of climate variability over the last few hundred thousand years. Historically, ice core climate reconstructions have relied on the isotopic ratios of $^{18}O/^{16}O$ and $^{2}H/^{1}H$, reported in delta notation as $\delta^{18}O$ and δD, respectively, of ice to reconstruct changes in condensation temperature and moisture source regimes at high latitudes. Recent developments in analytical methods have allowed for the measurement of a third oxygen isotope ratio, $\delta^{17}O$, and the calculation of a second-order parameter, $\Delta^{17}O$ (i.e., $^{17}O_{excess}$), which is sensitive to relative humidity at the moisture source region and comparatively insensitive to sea surface temperature relative to the more commonly used deuterium excess parameter. However, $\Delta^{17}O$ has been challenging to interpret in paleoclimate records and remains poorly understood, confounded by a lack of empirical data outside of Antarctica and Greenland resulting in a poor understanding of spatial and temporal variability. Here we present triple oxygen isotope measurements from a snow pit elevation transect in the St. Elias Mountains in the southwest Yukon. Snow pits (1.7-2.5m depth) were sampled at 10cm resolution every 200m in elevation from 1700 to 2900m above sea level (asl) from the Seward Glacier up the Quintino Sella Glacier (Mt. Logan). Snow pit samples were analyzed using a Picarro L2140-*i* and L2130-*i* (IsoLab, Univ. of Washington), with $\delta^{17}O$ measurements made in duplicate. Preliminary results reveal a stepwise shift in $\delta^{18}O$ by -2‰ at 2100m asl, and an overall similar lapse rate (-2.7‰/km) to the global average (-2.8‰/km), and no elevational trend in $\Delta^{17}O$. Our $\Delta^{17}O$ data reveal exceptionally high values with an average of 49.13 ± 17.99 per meg (n=187), with approximately 50% of the samples exhibiting values greater than 50 per meg (max=85.70 per meg). This study represents the first triple oxygen isotope measurements of snow in the Gulf of Alaska region, providing insight into local-scale variability in meteoric $\delta^{17}O$ and a foundation for the future triple isotope analysis of the 2022 Mt. Logan ice core.

Corresponding author: kmhollan@ualberta.ca

Determining tree diversity indicators in tropical forests using orbital hyperspectral sensors

PB O'Brien[a] **and A Sanchez-Azofeifa**[a]

[a]*Department of Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

The United Nations Convention on Biodiversity (CBD) has set an impetus for monitoring biodiversity globally to better understand the effects of ecosystem changes. Tropical forests are facing changes caused by human development and climate change but their remote locations and extensiveness limit data collection relating to biodiversity. Tropical Dry Forests (TDFs) are at particular risk of deforestation and biodiversity change but have traditionally been less studied than their wet counterparts. Utilizing data from orbital hyperspectral sensors (DESIS, EnMAP, and PRISMA), this research focuses on the Spectral Variation Hypothesis (SVH) which suggests that different tree species will have unique spectral signatures in their reflectance. This is paired with extensive inventory data as ground truth information that will be used to develop indicators for species richness in TDF plots. Various indicators have been developed to determine species diversity in less complex forests based on remote sensing data, but more complex tropical forests have not been well studied in this regard. Through analysis of the entire reflectance between 400 nm and 2500 nm, relationships between specific wavelength regions can be incorporated into the indicators for more accurate biodiversity identification. This research focuses on the TDFs found along the northwestern coast of Costa Rica in the Santa Rosa National Park, which covers an area of over 45000 hectares. While species richness will be considered, species of shared origins may have similar spectral signatures, so the classification of higher taxonomic levels (genus, family) will also be considered. To determine the robustness of these indicators, scans have been collected in the different seasons experienced in TDFs, which contain leaf-on, leaf-off, and transition periods. The successful prediction of tree diversity using indicators at the plot level will then be used to map the entire TDF region. By categorizing entire regions of TDFs, this approach enables effective long-term monitoring and early identification of changes resulting from diseases, pests, climate change, or human activities. This research aligns with the goals of the CBD, contributing valuable insights to the sustainable management and conservation of TDFs.

Corresponding author: pobrien@ualberta.ca

Understanding the atmospheric dynamics over high-altitude glaciated regions in the central Himalaya using high-resolution numerical simulations

U Tiwari[a], **ABG Bush**[a]

[a]*Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

The atmospheric dynamics over the higher Himalaya play a crucial role in controlling glacier variability. However, the scarcity of station observations makes exploring these atmospheric dynamics challenging. To address this issue, we employed the high-resolution Weather Research and Forecasting (WRF) model with a 2 km convection-permitting grid scale to simulate atmospheric variables over the central Himalaya.

The comparison between WRF precipitation and near-surface temperature with available high-altitude weather stations demonstrates good agreement. Further analysis of atmospheric variables is carried out over three high-altitude glaciated regions, namely Langtang, Rolwaling, and Everest, in the central Himalaya. Our study indicates that the highest precipitation accumulation over these glaciated regions occurs during the monsoon season (June - September), revealing significant spatial and temporal variability in monsoon precipitation. The comparison of precipitation accumulation between valleys and ridges indicates that the highest precipitation accumulations occur over the ridges in both the monsoon and winter seasons. Similarly, the assessment of along-valley monsoon precipitation accumulation reveals lower accumulation over narrower valleys compared to wider valleys. In contrast, during the winter season, the along-valley precipitation over the east-west oriented Langtang and Rolwaling valleys continuously increases with increasing elevation regardless the width of the valley. Overall, within high-altitude glaciated regions, the glacier-grid precipitation accumulation surpasses that of non-glacier grid areas, highlighting the complex spatial and temporal dynamic of precipitation in these high-altitude regions.

Corresponding author: utiwari@ualberta.ca

Holocene eruptive activity in northwestern British Columbia: an unacknowledged hazard

SH Woudstra[a], **B Jensen**[a]

[a] *Department of Earth and Atmospheric Sciences, University of Alberta, Canada*

The Northern Cordilleran Volcanic Province encompasses northwestern British Columbia, the eastern part of the Alaska panhandle, and central Yukon, and has been active for the past ~20 million years. Despite being home to the largest volcanic complexes and most recent volcanic eruptions in Canada, including three in the past few hundred years, the Holocene eruptive record of this region is poorly understood.

Work by Lakeman et al. (2008) found five previously undescribed tephras from lake cores in Northwestern British Columbia, most notably dated to 10,220–10,560, 9400, and 7000–8000 cal years before present. In 2021 we collected sediment cores from seven lakes along a ~300 km transect through the NCVP, in which cm-scale tephra layers are apparent. Some of these are significantly younger than those dated by Lakeman et al., including a tephra near the surface of a core collected in the community of Dease Lake. Major element geochemistry of the volcanic glass suggests that some of the tephra layers may be repeat eruptions from the same sources.

Despite the remoteness of the volcanic centers in the NCVP that would be considered recently active, there are a number of communities that would be affected by any further regional volcanic activity. A comprehensive study of the tephra products from these most recent eruptions is important to determine which of the many volcanic sources present the largest hazards.

Corresponding author: woudstra@ualberta.ca

Alaska ashes illuminate post-glacial eruption trends

MSM Bolton[1], BJL Jensen[1], and DS Kaufman[2]

[1] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*
[2] *Departments of Geology and Environmental Sciences, Northern Arizona University, Flagstaff, AZ, USA*

Volcanic eruptions are increasingly recognized as critical drivers of the Holocene's natural climate variability. Meanwhile, a growing body of evidence suggests a climate-volcano interplay, where climatic changes, such as those accompanying deglaciation, can influence volcanic activity. Physical records from volcanoes, such as tephra deposits, are essential for understanding eruption patterns, intensity, and timing and investigating climate-volcano interactions.

Alaska, one of the world's most volcanically active regions and a site of geologically recent glaciation provides an excellent natural laboratory for studying these connections. Over the past 15 years, we have built on earlier research to compile a database of over 500 tephra units from more than 20 sites with sedimentary deposits from the deglacial and Holocene periods (mainly peat and lake cores). This tephra collection provides new insights into eruption patterns from the end of the Pleistocene to the present day.

One substantial challenge is reconciling the numerous tephra occurrences and timelines across multiple sites. The remarkable activity of several volcanoes in Alaska and the strikingly similar geochemical compositions of some related tephra layers complicate the correlation and differentiation of tephras. This presentation will highlight innovative methods for correlating tephra populations from complex arrays of glass compositional data. It will also emphasize recent advancements towards a unified Bayesian age model for Alaska's Holocene tephras, which synchronizes independent records and enhances the precision of tephra dating. Our consolidation of multiple records reveals significant shifts in eruption patterns throughout the Holocene, including a notable peak around 8000 cal yr BP.

Finally, we use history-matched glacial system modelling to investigate whether observed temporal patterns of volcanic activity could be explained as a response to glacial unloading and changes in crustal stresses. In this endeavour, a robust, accurately dated multi-site tephrochronology in Alaska may prove instrumental in solving the eruption frequency-climate puzzle.

Corresponding author: bolton1@ualberta.ca

Ice core paleovolcanic records from Mount Logan, Yukon

HA Yousif[a], KM Holland[a], AS Criscitiello[a], and BJ Jensen[a]

[a] *Department of Earth and Atmospheric Sciences University of Alberta, Edmonton, Alberta, T6G 2E3, Canada*

Ice cores are exceptional repositories of paleovolcanic data and are invaluable in establishing tephrochronological frameworks during the Late Quaternary period. In contrast to other paleo archives, ice cores have the unique ability to preserve both the soluble (i.e. aerosols) and non-soluble components (i.e. tephra) of volcanic eruptions. The identification of volcanism in ice cores has traditionally relied on the glaciochemical record, with a particular focus on sulfate time series. It is less common for studies to determine the sources of low-concentration and ultra-fine volcanic ash layers. The glaciochemical record, however, is not diagnostic of a particular volcanic event, and tephra geochemistry is necessary to determine the source of anomalous sulfate signals. Tephra is preserved in ice cores with no alteration and the glass component retains its original geochemical composition that is representative of the parent magma composition. Thus, tephra layers in ice cores can be attributed to their source and correlated across multiple localities. Even cryptotephra, present in very low concentrations, can form stratigraphically distinct deposits in ice.

Mount Logan, in the Saint Elias Range of Northwestern Canada in the Yukon Territory, is proximal to active volcanic centres in Alaska and Kamchatka. It is likely that Mount Logan contains several recognised tephra horizons from these volcanic centres, and beyond. Previous research indicates that the Mount Logan (Northwest Col and Prospector-Russell) and Eclipse ice cores document sulfate signals from eruptions of both circum-arctic (e.g. Laki, 1783) and global (e.g. Tambora, 1816) significance. Still, Canadian ice cores are underexploited for their tephra potential. The newly recovered Mount Logan Summit Plateau Ice Core lacks visible ash-type deposits. Instead, our analysis is guided by a high-resolution glaciochemical time series. A multi-parameter approach, integrating traditional volcanic indicators (i.e. sulfate and electrical conductivity measurements) with insoluble particle counts, is aiding in the detection of tephra. The major and minor element compositions of tephra acquired through electron microprobe analysis is used to assign provenance. The largest peak in insoluble particle concentration is attributed to the Novarupta-Katmai eruption of 1912. The findings so far emphasise the importance of tephra in providing an independent method to validate annual layer chronologies. Volcanic eruptions serve as pivotal time markers for the development, validation, and alignment of ice-core chronologies. These findings have also brought attention to the challenges associated with sparse concentrations of tephra in ice.

Corresponding author: hayousif@ualberta.ca

The Olympic orocline, a mountain formation from orogen-parallel deformation

W Zhang[a, b*], ST Johnston[b], T Finley[c], B Wan[a]

[a] *Institute of Geology and Geophysics, CAS, Beijing, China*
[b] *Department of Earth & Atmospheric Sciences, University of Alberta, Edmonton, AB*
[c] *School of Earth and Ocean Sciences, University of Victoria, Victoria, BC*

The highly arcuate and elevated geometry of the Olympic Mountains, surrounded by the Crescent/Siletzia terrane, define a concave-seaward horseshoe shape (the Olympic orocline) east of and in the hangingwall of the Cascadia subduction zone. The curvature has been explained as a product of orogen/trench-normal deformation due to accretion and underplating or as a product of trench-parallel shortening due to subduction obliquity. Siletzia continues south of the Olympic orocline, underlying much of the 'Oregon forearc block'. Regional GPS and paleomagnetic studies demonstrate that the limbs of the Olympic orocline record opposing rotations during overall northward motion relative to cratonic North America. Here we compile paleomagnetic and structural data to show that the Olympic orocline is a vertical axis fold. We palinspastically undo the fold and restore the Oregon forearc block, showing that it rotated and was displaced to the north during orocline formation. Palinspastic restoration of the Olympic orocline shows that it is a product of 200 km of northward displacement. Our suggested sequence of events includes: 1.clockwise rotation and northward translation of the Oregon forearc block; 2. Siletzia north of the Oregon forearc block accommodates the northward translation by folding, forming the Olympic orocline and 3. bending of the upper plate resulted in its landward retreat from the trench resulting in the passive upward warping of the downgoing Juan de Fuca oceanic lithosphere beneath the growing orocline, elevating the Olympic Mountains. Our model provides a deformation sequence that explains the Olympic Mountains as a result of margin-parallel translation of Cascadia forearc.

*Corresponding author: wz2@ualberta.ca

Framing the human right to adequate housing: An analysis of United Nations Special Rapporteur country reports

L Bates[a], **and D Collins**[a]

[a] *Human Geography Program, University of Alberta, AB, Canada*

The United Nations Special Rapporteur (UNSR) for Housing is mandated with promoting and protecting the human right to adequate housing at the international level. However, their work has received limited academic attention. This paper seeks to understand how the UNSR for Housing identifies rights breaches and advocates for solutions across diverse contexts. I will present a framing analysis of 24 country reports published over 15 years (2007-2022) - a data set that includes 12 high-income countries and 12 low- and middle-income countries. This scope allows for a broad perspective on how housing problems and the right to housing are framed at the international scale. Findings reveal similarities across all 24 reports, which highlight pervasive issues identified by the UNSR for Housing. The vulnerability of certain groups to diverse housing problems, for example, was ubiquitous, with the composition of these groups and the specific challenges they face varying between countries. Ultimately, this analysis illuminates how the UNSR for Housing works to set international standards and contribute to progressive realization of the right to housing by encouraging and facilitating tangible improvements in housing, health and living standards both within and beyond the countries visited.

Corresponding author: lbates@ualberta.ca

Good Homes Take Work: Increasing the Accessibility of Edmonton's Community Housing

M Miller, D Collins[a], and J Evans[a]

[a]Earth and Atmospheric Sciences, University of Alberta, AB, Canada

This research focuses on the experiences of people with disabilities living in community housing (social and affordable housing), and whether this housing is accessible. In 2017, the National Housing Strategy identified people with disabilities as a priority group that is vulnerable to housing precarity in Canada. Disabled Canadians are more likely to live in community housing than the rest of the population. However, 38% of all buildings in this sector have no ccessibility features. Moreover, there is little consensus on what accessible housing entails. As such, a unit deemed accessible by a provider may not meet the needs of the person living in it. This research will be conducted in Edmonton, Alberta, which has a long-standing shortage of accessible and affordable housing. This research addresses the following questions in the Edmonton context: Is community housing accessible for people living with disabilities?; and How can the supply of accessible units that meet the needs of disabled tenants be increased? In doing so, it engages people with disabilities to explore how they interpret and experience accessibility, and involves them in the development of recommendations to improve community housing. Additionally, this research employs podcasting methods to centre the voices of disabled community housing tenants (key informants) in knowledge mobilization. The resulting podcast will potentially reach broader audiences and contribute to public understanding and dialogue around disability, accessibility and housing.

Corresponding author: mlmiller@ualberta.ca

The Agricultural Food System in Alberta: Exploring the Knowledge Systems

A Tymczak[a], **R Summers**[a], **K Van Assche**[a]

[a] *Department of Earth and Atmospheric Sciences University of Alberta, Edmonton, Alberta, T6G 2E3, Canada*

Knowledge has been identified as a key factor in the development of agriculture, as early as the first half of the 20th century. On the local level, a farmer's ability to acquire knowledge regarding production and processing methods not only plays a role in determining the productivity of their own farm, but is a distinguishing factor accounting for the differences in productivity between farms. On the regional scale, the level of knowledge and education is identified as a key variable that affects agricultural productivity and economic development. However, entering the farming industry is not an easy endeavour, as new entrants are often confronted with complex questions. This includes questions such as, which farming industry should be pursued; what scale of farming should one start at; how much financial capital is required and how should financial resources be allocated; which efficient production methods should be adopted; should land and infrastructure be owned or rented; and what are the best business practices to ensure long term sustainability and success. As a result, it has become a point of interest to explore how new entrants in the farming industry acquire the necessary knowledge and skills to navigate these complex questions and to pursue their operations successfully.

The knowledge systems were identified through semi-structured interviews and further analyzed using an inductive analysis process and the systems theory framework. Five overarching knowledge systems were identified by the participants: 1) personal one-on-one networking and skills sharing; 2) self-teaching through internet resources, books, etc.; 3) agricultural-based academic institutions; 4) outreach and consulting services; and; 5) government extension services. In addition to identifying which knowledge systems are available for new entrants, the perceived efficacy and effectiveness of these five knowledge systems was investigated, to understand if some systems allow for knowledge acquisition to occur faster and more efficiently for new entrants in comparison to others. Also, transitions within these knowledge systems were identified. We hope that our findings will allow for better understanding of the success rate of new entrants in the agricultural industry and also the institutional changes that could be implemented to improve knowledge acquisition by new entrants.

Corresponding author: atymczak@ualberta.ca

Creating future-ready bus stops: Promoting equity, safety, and climate resiliency in future bus stop planning guidelines

J Khalid[a]

[a] *Earth and Atmosphere Sciences, University of Alberta, AB, Canada*

A robust and efficient public transit (PT) system is the most efficient and environmentally sustainable means of transporting substantial volumes of individuals in an urban region. However, discussions around determinants of PT traditionally lean towards efficiency, infrastructure, and service levels, which overlooks the impacts of bus stop amenities on ridership as their effects are a challenge to empirically measure. Excellent bus stop design should be guided by principles of equity, safety, and climate-resilient design. Incorporating these principles is crucial as it helps promote social inclusion while addressing timely issues of rider safety and environmental sustainability via transit services. Through this project I aim to understand the experience of transit riders at bus stops in Edmonton using data collected by pop-up engagement activities and short surveys at transit hubs. Relevant secondary data (i.e. transit satisfaction surveys) will also be provided by the city to support our research. Engagement efforts will be supplemented with qualitative inputs from a representative advisory committee and facilitated focus groups to offer opportunities for various stakeholders and impacted communities to provide their input. Secondly, a review of best practices and emerging designs of bus stop amenities that promote enhanced safety, health of riders, and protection from natural elements will be conducted. Lastly, I will respond to this information by developing an enhanced bus stop design guideline that aims to synergistically apply the indicated principles. This resource will (1) identify best practices and approaches to bus stop amenity design and (2) recommend a comprehensive equity-based prioritization approach to future bus stop amenity investments.

Corresponding author: jkhalid@ualberta.ca

Whose mobility is enhanced? Analyzing the implications of GBA+ in new capital infrastructure projects – A case of the proposed BRT corridor in Edmonton, Canada.

P Jain[a], E Grisé[a], BKapatsila[a]

[a] School of Urban and Regional Planning, University of Alberta, AB, Canada

Decades of gender-neutral transportation planning have negatively affected equity-deserving groups and prevented them from fully participating in society due to gender disparities in transit planning and service provision. Women's travel satisfaction was much lower than men's, especially in the public transport user segments with perceptions of the built environment and safety concerns being important factors. Coupled with the gender pay gap, pink tax, and caregiving responsibilities, women are more likely to trip chain, take mid-day or off-peak trips, and travel shorter distances compared to men and face challenges such as high transportation costs, vulnerability to harassment, safety concerns and spend their time in a few preferred locations. These findings underscore the need for more gender-inclusive design policies in the transportation system. This research aims to enhance inclusivity in planning and decision-making processes for new capital infrastructure projects and to build industry capacity in applying Gender-Based Analysis Plus (GBA+) in both academia and the transportation profession. Focusing on addressing equity-deserving groups' transport challenges, the integration of gender-sensitive considerations into Bus Rapid Transit (BRT) planning emerges as a transformative approach.

Despite the intentions to prioritize the needs of marginalized groups in transportation infrastructure planning, existing methodologies often fall short in operationalizing these objectives for real-world application. In the context of Edmonton, integrating GBA+ analysis into long-range BRT planning represents a strategic step towards creating a transit system that caters to the diverse needs of the community. The proposed methodology involves identifying best practices and barriers to adopting GBA+ in transportation practice, employing both home-based and trip-based analyses. The home-based assessment calculates an equity score for each proposed BRT stop, considering various identity groups such as women, seniors, youth, Indigenous peoples, immigrants, low-income individuals, visible minorities, and people with disabilities. This helps identify stops along the BRT corridor that may have a significant impact on these groups. Conversely, the trip-based analysis evaluates improvements in accessibility to priority locations for equity-seeking groups before and after the implementation of BRT corridors, like employment centers outside downtown areas. This approach offers a scalable model for future studies in route or corridor-level planning, providing a framework for assessing equity and accessibility across diverse identity groups.

Corresponding author: poorva1@ualberta.ca

Evolving riders' preferences towards transit crowding in Metro Vancouver

B Kapatsila[a]

[a] *School of Urban and Regional Planning, University of Alberta, AB, Canada*

The COVID-19 pandemic had a profound impact on transit ridership around the world, including in Metro Vancouver, Canada. The regional transit agency there, TransLink, faced the challenge of not only tackling the sudden revenue loss but also ensuring the safety and comfort of its riders that could be affected by crowding. As the tide of restrictions subsided, and riders are gradually coming back to public transport, their feelings of safety and comfort must be ensured so that they do not deflect to other modes. To guide TransLink and agencies alike in this process, this study aimed to understand the factors that affected the decision to board a bus and level of comfort of riding it for different behavioral classes of transit riders before and during the COVID-19 pandemic. It employed a classification of transit riders based on their attitudes towards personal safety and flexibility both before and during the COVID-19 pandemic and investigated the effect of crowding on their decision to board and the comfort of boarding a bus at various crowding levels. The findings of this study are expected to guide the development of relevant policy interventions that can engage diverse groups of riders to continue using transit in a way that is convenient, comfortable, and safe for them.

Corresponding authors: kapatsil@ualberta.ca

Preferences and Patterns of Ordovician Sclerobionts between three brachiopod host species

GT Freeman Peters[a], CL Schneider[a], and LR Leighton[a]

[a] *Earth and Atmospheric Sciences. University of Alberta, AB, Canada*

Sclerobionts are organisms that encrust onto either biotic or abiotic substrates. They are excellent resources for palaeoecological studies as they preserve examples of in situ, relatively complete communities. Brachiopods are a commonly studied host for sclerobionts, but whether or not some sclerobionts have a preference for certain brachiopod host species over others is not fully clear. I examined the sclerobiont communities on three morphologically distinct brachiopod species (*Rafinesquina alternata, Vindlandostrophia* sp.*,* and *Hebertella occidentalis*) from the Ordovician Fairview formation of Indiana, Kentucky, and Ohio. Differences between these communities were visualized and quantified using the scores from a Polar Ordination. Diversity indices (richness, Shannon's index, Buzas and Gibson's evenness, and Margalef's diversity) were calculated for each sclerobiont community, and then averaged for each host brachiopod species for comparison. Additionally, bookstein shape coordinates were used to assess the positioning of sclerobionts on their host's valves and compared between host species.

Sclerobiont communities on *Vinlandostrophia* sp. were the most distinct, showing significant differences from those on *Rafinesquina alternata*, and being less speciose and less diverse than communities on the other hosts. *Rafinesquina alternata* and *Hebertella occidentalis* did not show significant differences in community structure or in diversity indices. Sclerobionts on *Vinlandostrophia* sp. tended to avoid the fold/sulcus, instead clustering on the sides of their host. This suggests that they may have been encrusting a living *Vinlandostrophia* sp. and taking advantage of its lateral inhalant current. Sclerobiont communities on *Rafinesquina alternata* showed no clustering patterns, but were significantly different between the pedicle and the brachial valve. Sclerobionts on *Hebertella occidentalis* clustered near the hinge line, indicating that the brachiopod was dead when encrusted. Most of the differences between the sclerobiont communities on these brachiopods were driven by minor members of the communities, whereas dominant members like bryozoans tended to be common on all three hosts.

Corresponding author: freemanp@ualberta.ca

Crabs vs. bivalves: Attack strategies and resulting damages

SJ Nicol[a]

[a]*Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

The invasive European green crab (*Carcinus maenas*), a recent invader of British Columbia, Canada, is a voracious predator of molluscs and has caused the decline of many species along its introduced ranges altering ecosystems and jeopardizing fisheries. In separate in-lab predation experiments, we compared the predatory capabilities of green crabs with the larger native red rock crab (*Cancer productus*) preying upon an important fisheries species, the native littleneck clam (*Leukoma staminea*). Red rock crabs and bivalves were collected from Bamfield Inlet, Barkley Sound, British Columbia, and the bivalves separated into 4 size categories: 11-18 cm^3, 18-22 cm^3, 22-28 cm^3, and 28-38 cm^3. Green crabs were collected from Clayoquat Sound, British Columbia. Experiments were performed in a circular sea table 125.7 cm in diameter and 68.6 cm deep under red light. In each trial, four bivalves (one from each size category to ensure a constant distribution of sizes between trials) were placed in a 2x2 grid and presented to one crab; the trial continued for 30 minutes or until the crab successfully killed a bivalve. There were 16 red rock and 15 green crab trials in which crabs attempted to take a bivalve. With one exception, all red rock crabs were able to crush a bivalve successfully, regardless of bivalve size, whereas none of the green crabs were able to fracture a bivalve. Crab chelae size is related to the size of the crab and larger muscle bundles indicate greater strength. Red rock crabs had a statistically significant relationship between muscle bundle height and grappling time (r^2 = 0.442; p = 0.005) with a decrease in grappling time as the chelae get larger. Green crabs overlapping in chelae size with red rock crabs were still unable to break into the bivalves. Green crabs are not able to prey on healthy adult *L. staminea* >11 cm^3 despite demonstrating with repeated attacks that they recognize this bivalve as prey. Each individual crab employed many attack strategies with each species displaying different approaches for breaking into shells. Successful red rock crabs created recognizable and characteristic damage on the bivalve shells which was repeatedly found in the field, and we should search for these examples of successful damage in the fossil record.

Corresponding author: sjnicol@ualberta.ca

Fantastic refugia and how to find them

NE Morley[a,b]

[a]*Earth and Atmospheric Sciences, University of Alberta, AB, Canada*
[b]*Biological Sciences, University of Alberta, AB, Canada*

When a population is threatened by adverse environmental conditions, refugia can provide a means for maintaining local biodiversity. Consequently, refugia have garnered interest from both paleontologists, who study refugia to understand species survivorship during mass extinctions, and conservation biologists, who study refugia to guide policymakers when establishing nature reserves. Yet despite their growing importance for science and policy, several studies have argued that existing models rely on working definitions of "refugia" that fail to consider their long-term success. This study proposes new historical definitions of "refugia," "refugial traps," and "relict populations" based on the long-term success of the population. Refugia shelter a population from extirpation and serve as the focal point for its re-expansion after the adverse conditions pass. Refugial traps initially shelter a population but ultimately succumb to changing environmental conditions that cause the population to become fully extirpated. Relict populations are populations that have been sheltered from extirpation but have never re-expanded. The method is tested using pollen preserved in lake cores from northern Alaska, USA over the past 20 kyr, which includes the end of the last glacial maximum and the onset of the present interglacial interval. Northern Alaska was unglaciated throughout the last glacial interval, so it provides an excellent region to observe plant responses to climate change without glacial interference. Lake core data were procured from the Neotoma Database. Heat maps were constructed using pollen from three ecologically divergent tree taxa – spruce (*Picea* spp.), willow (*Salix* spp.), and aspen (*Populus* spp.) – to visualise changes in their geographic distribution in response to climate change. This method provided a sufficient sampling grain to identify the geographic contraction, preservation, and subsequent re-expansion that distinguishes refugia from refugial traps and relict populations. Thus, these novel definitions for refugia, refugial traps, and relict populations have utility for identification in the fossil record. Using these methods to distinguish refugia from refugial traps and relict populations, accompanied by independent paleoenvironmental analysis of the refugia, will allow for a more nuanced understanding of species survivorship during ecological crises.

Corresponding author: nmorley@ualberta.ca

Petrology and geochronology of kimberlites from the Victoria Island field, NU/NT, Canada

AA Müller[a], C Sarkar[a], SJ Woodland[a], J LeBlanc[a], BA Kjarsgaard[a,b], DG Pearson[a]

[a] *Department of Earth and Atmospheric Sciences University of Alberta, Edmonton, Alberta, T6G 2E3, Canada*

[b] *Geological Survey of Canada Natural Resources Canada, Ottawa, Ontario, K1A0E8, Canada*

Kimberlites are unusual and rare igneous rocks that are Si-undersaturated, highly enriched in Mg and volatiles (CO_2 and H_2O), and incompatible trace elements. They are believed to originate from extreme depths exceeding 150 kilometers, making them the deepest known magmatic rocks. They are typically found in or around ancient and thick continental lithosphere – cratons - and occur as intrusive sheets or composite pipes, often clustered. Kimberlites contain numerous mantle fragments, providing valuable insights into the Earth's mantle and can be potentially diamondiferous.

Victoria Island, suggested to form the NW extremity of the Archean Slave craton, is home to four kimberlite clusters: Blue Ice, King Eider, Galaxy, and Snowy Owl. More than 30 kimberlite and kimberlite-related bodies were discovered in the 1990s. A few previous age determinations indicate Permian kimberlite activity (286 - 256 Ma) – a rather unusual time period that falls outside the main global emplacement epochs, with few kimberlites of similar age known. Here, we aim to better define the duration of kimberlite magmatism on Victoria Island with new Rb-Sr and U-Pb age determinations, as well as characterizing the mineral chemistry and geochemistry of a selection of hypabyssal kimberlites.

Forty new whole rock hypabyssal kimberlite samples were analyzed for this study, comprising samples from two dyke and pipe complexes of the King Eider cluster (Jaeger and King Eider) and three dyke and pipe complexes of the Galaxy cluster (Fornax, Snow Bunting, and Vega). The mineral chemistry of spinel (dominantly Trend 1) and phlogopite (phlogopite-eastonite trend) from Victoria Island kimberlites are consistent with a classification as kimberlite. Major element geochemistry aligns well with global kimberlite compositions, revealing minimal crustal and mantle contamination, typically some limestone clasts and few mantle xenoliths. Tracer isotope composition of Nd and Sr conform to the Pre-Mesozoic temporal trend for kimberlite sources.

New U-Pb perovskite and Rb-Sr mica ages considerably extend the range of emplacement ages in Victoria Island kimberlites into Middle Triassic times.

Corresponding author: aamuller@ualberta.ca

Magmatic expressions of the Mesoproterozoic Midcontinent Rift

F Clark[a], C Sarkar[a], T Stachel[a], HS Grütter[b], DG Pearson[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

[b] *SRK Consulting, Vancouver, BC, Canada*

The Superior craton in North America experienced a major tectonothermal disturbance during the ~1.1 Ga failed Midcontinent Rift, the timing of which broadly overlaps with low-volume mantle-derived ultramafic lamprophyre (UML) activity – one of the few rock types that can sample the diamonds stability field. These melts provide unique insights into the lithospheric and convecting mantle during the initial extensional phase of rift activity. Here we present the first detailed petrographic, mineral, and whole-rock geochemical results for the Kapuskasing UMLs. Dike and ice-rafted boulder samples consist of olivine and phlogopite phenocrysts set in a groundmass of clinopyroxene, apatite, phlogopite, spinel, perovskite, and carbonate. Combined with mineral chemistry results and whole-rock compositions, classification as UMLs is established. Whole-rock compositional variation diagrams suggest variable interplay between magmatic fractionation/accumulation of groundmass minerals and crustal contamination.

Primitive mantle normalized incompatible trace element diagrams and key inter-element ratios (La/Nb, Ba/Nb, Th/Nb, and Ce/Pb) are characteristic of global UMLs and their overlap with kimberlites and ocean island basalts suggest broadly similar convecting mantle sources. This is further confirmed by the range in whole-rock $^{87}Sr/^{86}Sr_i$ (0.702279 – 0.702966), and εNd_i (+2.6 to +3.7) and εHf_i data (+4.0 to +5.4), which plot along the mantle array. New U-Pb perovskite ages suggest UML emplacement occurred from ~1150-1120 Ma, supporting a strong convecting mantle input during the incipient stages of rift evolution, likely driven by plume magmatism. Plume impact appears to have negatively impacted diamond survival in the affected Superior Craton mantle root as the UMLs are not diamond exploration targets.

Corresponding author: fiona2@ualberta.ca

Sublithospheric Diamonds from DO27 Kimberlite, Slave Craton, Canada – Geochemistry, Age and Origin

Q Zhang[a], S Timmerman[b], T Stachel[a], R Luth[a], I Chinn[c], DG Pearson[a]

[a] *Department of Earth and Atmospheric Sciences University of Alberta, Edmonton, Alberta, T6G 2E3, Canada*

[b] *Institute of Geological Sciences, University of Bern, Bern, Switzerland*

[c] *De Beers Exploration, Johannesburg, South Africa*

Sublithospheric diamonds not only hold great economic values but academic interests as they encapsulate profound insights from Earth's deep mantle. Despite its importance, our rudimentary knowledge of sublithospheric diamond formation is related to the scarcity of these stones. However, infrared spectroscopy analyses on 435 diamonds from DO27 kimberlite in this study reveal that ~44% diamonds from this locality are either nitrogen-free (Type II) or contain fully-aggregated nitrogen (Type IaB), showing a much higher proportion of diamonds with a possible sublithospheric origin, which is further confirmed by a typical lower-mantle (>660 km) mineral association found in these Type II and Type IaB diamonds: Ca-silicates (retrogressed Ca-perovskite) ± enstatite (retrogressed bridgmanite) ± ferropericlase. High Mg# (molar Mg/(Mg+Fe)) of bridgmanite (median Mg#=94.7) and ferropericlase (median Mg#=85.9) implicate a harzburgitic host rock for the diamonds. This strongly melt-depleted signature contrasts with the high abundance of Ca-silicate inclusions, some of which are variably enriched in incompatible elements and have enriched Sr-Nd-Pb isotopic signatures that collectively indicate the host rock was metasomatized by carbonatitic melts/fluids released from a relatively cold subducting slab in the lower mantle. The U-Pb systematics of the Ca-silicates define two ages of diamond crystallisation: 998 Ma and 1679 Ma, the latter represents the oldest age reported of sublithospheric diamond formation so far. This the first direct chronological evidence coming from the lower mantle that places a minimum age for the onset of cold deep subduction at ~1.7 Ga, since which crustal carbonates have been recycled into Earth's deep mantle.

Corresponding author: qiwei2@ualberta.ca

Diamonds from Archean rocks: insights on early Earth geodynamics

A Pezzera[a], F Nestola[b], T Stachel[a], R Stern[a] & DG Pearson[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

[b] *Dipartimento di Geoscienze, Universita di Padova, Italy*

Diamonds hosted in rocks of Archean age provide unique information on the chemical and physical conditions of the early Earth mantle, allowing unique insights to the geodynamic processes acting at that time. Occurrences of this type of diamond deposit are very limited but have been found in several cratons worldwide. The five locations identified to date are: I) the Witwatersrand Basin, Kaapvaal Craton, South Africa; II) Olondo, southern Siberian Craton, Russia; III) Tree River, Slave Craton, Canada; IV) Wawa, southern Superior Craton; V) the recently reported Knee Lake area of the northwestern Superior Craton.

We investigated the Knee Lake diamonds and their inclusions using spectroscopic and spectrometric techniques to evaluate their paragenesis and the geothermal conditions at which they formed. We discovered crustal signals both in the inclusion geochemistry and in the isotopic composition of the diamonds, implying subduction-like processes to be active since at least 2730 Ma, the age of the Knee Lake diamonds host rock. The geochemical information agrees with the constrained geotherm of 38 mW/m^2, comparable to the coolest modern cratonic geotherms, in that such cool thermal conditions in the Archean can be reached only by the introduction of cold crustal components in the mantle, as demonstrated by thermal modeling.

The data for the Knee Lake diamonds agrees with and compliments observations from other Archean diamonds, such as the Tree River diamonds from the Slave Craton, pointing to an Archean geodynamic style that involves some type of subduction process. The main difference would reside in the higher thermal contrast between the Archean convecting mantle, hotter than modern, and the subducted material. In this regard, the constrained cool geothermal conditions should be considered transient, expressions of thermal disequilibrium existing during the building of the cratons rather than a stable cratonic geotherm. Because the thermal structure of cratons in their first 2 Ga of evolution is dominated by the thermal conditions inherited during their construction, these data, along with the evidence for recycled material, argue for an accretionary mode of cratons involving subduction of cool lithosphere.

Corresponding author: pezzera@ualberta.ca

Characterization of the sediment-hosted AurMac Au deposit in the Tombstone Gold Belt, Yukon, Canada

RK Parry[a], P Lecumberri-Sanchez[a], P Sack[b]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*
[b] *Yukon Geological Survey, YT, Canada*

Reduced intrusion-related gold systems (RIRGS) in the Tombstone Gold Belt of central Yukon and Alaska are characterized by their spatial and temporal relationship to the late-Early Cretaceous Mayo Suite intrusions (95-92 Ma), Au-Bi-Te-W elemental signatures, and array of mineralization styles including: sheeted Au-bearing quartz veins, disseminations, stockworks, replacements, breccias, and skarns. Deposits of economic significance, such as those that make up the Fort Knox Gold Mine (12.1 Moz Au) in Alaska and the Eagle Gold Mine (7.8 Moz Au) in central Yukon, consist of mineralized veins and shear zones hosted within their causative reduced intrusion.

The AurMac gold deposit (7.0 Moz Au), located in central Yukon, is interpreted to be a RIRGS but is hosted in metasediments along a potential thermal aureole of an undiscovered Mayo Suite intrusion. Similar to pluton-hosted RIRGS, mineralization of the AurMac deposit is both structurally and lithologically controlled consisting of sheeted veining and skarn-style carbonate replacement, and shares a Au-Bi-Te-W elemental signature. Because of the deposit's large gold endowment hosted solely in metasediments, our research is focussing on characterizing the AurMac deposit through defining property-scale geology, making geochemical comparisons to intrusion-hosted RIRGS and orogenic Au deposits, defining a mineralization paragenesis, determining absolute ages of mineralization, as well as employing graphite thermometry to define any thermal gradients that may be related to and vector towards undiscovered intrusions and sources of mineralization.

Detailed relogging of diamond drill core along a N-S section was completed in 2023 to define and sample the variety of mineralization styles, host rock lithologies, and graphite horizons. A preliminary mineral paragenesis provides evidence for two phases of Au mineralization consisting of an early Apy-Py-Au and later Pb-Bi-Sb-sulfosalt-Au stage. Graphite thermometry defines a northerly increasing thermal gradient across the section that corresponds to an observed andalusite isograd. Ongoing research and plans for the upcoming field season include completing trace element geochemical analyses on scheelite for discriminating mineralizing fluid sources, sampling for mineralization geochronology, and completing graphite thermometry on carbonaceous horizons across the property for integration into a property scale thermal model.

Corresponding author: rkparry@ualberta.ca

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

CR Graham[a], P Lecumberri-Sanchez[a], H Falck[b], and M Reynolds[b]

[a] Earth and Atmospheric Sciences, University of Alberta, AB, Canada
[b] Northwest Territories Geological Survey, NWT, Canada

As a demand for a greater transition to cleaner energy sources increases, Canada has turned its attention to increasing 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 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 varies 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 also helps place Easter-Duffy in context with other similar deposits in the East Arm Region.

Corresponding author: crgraham@ualberta.ca

Characterization of fluids related with alkalic porphyry deposits in British Columbia, Canada

MP Estrella[a], **P Lecumberri-Sanchez**[a]

[a]*Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

Alkalic porphyries are Cu-Au high-grade deposits also known to host important PGE resources. In contrast to calc-alkalic porphyries, alkalic porphyries are globally uncommon, predominantly occurring in British Columbia (B.C.) and eastern Australia. Alkalic deposits share some similarities with their calc-alkalic counterparts but also some differences in terms of metal budget, vein and alteration mineralogy, and associated lithologies.

This project aims to (1) identify the probable source of the mineralizing fluids and (2) characterize the physicochemical properties of these fluids as a function of their distance to likely sources.

Mount Polley and Galore Creek are two large alkalic porphyries in B.C. In the Mount Polley deposit, diopside phenocrysts host crystallized melt inclusions consisting of sulfate, carbonate, silicate phases, and CO_2. Additional K, Na and Cl single grain enrichment within the melt inclusions was identified using a Focused Ion Beam set up coupled with Scanning Electron Microscopy and Energy Dispersive Spectroscopy (FIB/SEM-EDS). Fluid inclusions at Mount Polley are mainly preserved in apatite crystals as secondary assemblages and consist dominantly of vapor-rich, liquid-rich, and polyphase fluid inclusion types. Preliminary observations at Galore Creek indicate similar fluid inclusion types and future work will focus on determining whether there is systematic spatial distribution of these fluid inclusion types.

Corresponding author: mestrell@ualberta.ca

Investigating the geothermal energy potential in Nunavut with magnetotelluric data

AR Williamson[a], **MJ Unsworth**[a, b], **ZE Vestrum**[a]

[a] *Department of Physics, University of Alberta, AB, Canada*
[b] *Department of Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

To reduce reliance on fossil fuels, Canada is investigating the development of alternative energy systems that have lower carbon emissions than those currently in use. This is particularly important for communities in the Canadian Arctic, where the vast majority of electricity and heating is currently generated from burning fossil fuels. Geothermal energy systems have the potential to provide an alternate source of heat in this region, and their feasibility is being investigated in remote Northern settlements.

Knowledge of subsurface rock type and groundwater conditions is an essential part of all geothermal energy projects. In summer 2023, a group from the University of Alberta collected magnetotelluric (MT) data at two communities in Nunavut to investigate the subsurface conditions. The magnetotelluric method can determine the subsurface electrical resistivity. Resistivity is a parameter that is sensitive to the temperature of the ground as well as the quantity and salinity of groundwater. At Cambridge Bay, 29 stations were recorded in July 2023 across a 17 x 8 km array. At Resolute Bay, 33 stations were recorded in August across an 8 x 5 km area. The time series data were processed to give frequency domain data between 500 and 0.001 Hz. The data were then used to generate models of subsurface resistivity using a combination of 1-D and 3-D methods. The resistivity was interpreted using knowledge of subsurface temperatures and experiments on frozen / unfrozen sedimentary rocks which contained saline ground water.

At Cambridge Bay, the resistivity model was characterized by two layers: (1) a 100 m thick surficial layer that has a low resistivity due to the presence of limestone saturated with partially frozen saline pore water and (2) a deeper high resistivity layer interpreted as limestone containing low salinity pore water. Knowledge of the geothermal gradient suggests that the upper part of this layer was frozen, and the lower part was not. At Resolute Bay, the model was characterized by three layers: (1) high resistivity limestone layer containing partially frozen saline pore water, (2) a low resistivity layer containing unfrozen saline pore fluids, and (3) a deeper high resistivity layer containing low salinity pore water.

The implications of these models for future geothermal energy development in Nunavut will be discussed.

Corresponding author: arw1@ualberta.ca

Magnetotelluric exploration at the Tres Virgenes geothermal field, Mexico: Evaluating the subsurface resolution

J Gonzalez[a], MJ Unsworth[a], J Antayhua-Vera[b], and O Campos-Enríquez[b]

[a] Earth and Atmospheric Sciences, University of Alberta, AB, Canada
b Instituto de Geofísica, Universidad Nacional Autónoma de México, D.F., Mexico

The Tres Virgenes geothermal field (TVGF) is located in Baja California Sur, Mexico, hosting an active volcanic geothermal field with a 10 MW_e installed capacity, and has been the subject of multiple geological and geophysical studies. Some of these studies indicate the presence of a shallow conductive cap seal, as well as the possibility of two deep conductors associated with magmatic activity. However, there is still uncertainty about the extent and location of the hydrothermal and magmatic systems.

MT exploration is a powerful technique for imaging the magmatic and hydrothermal systems beneath volcanoes and geothermal fields. An MT dataset from the Mexican Comisión Federal de Electricidad, includes 76 stations collected between 1992-1994 and covered an area 20 x 24 km. Previous analysis of these data primarily used 1-D and 2-D approaches to inversion. A fully 3-D inversion approach has significant advantages over 1-D and 2-D methods. To further investigate the deeper structure, a detailed 3D MT inversion was performed. This included the topography and bathymetry within the nearby Gulf of California. The analysis revealed an extensive, flat conductor at a depth of 0-500 metres above sea level, likely indicating a smectite-rich cap seal over the deeper geothermal reservoir. The deeper conductors suggested in previous studies were not resolved due to strong signal attenuation from the combined effect of the cap seal and the ocean. To enhance the interpretation reliability, a novel sensitivity analysis was introduced to quantify the influence of individual data points over the model parameters. This approach enhances model accuracy and allows for the implementation of a transparency mask to exclude poorly-constrained regions. Furthermore, a series of synthetic experiments were conducted to estimate the necessary conditions to detect deep-seated conductors, proving that the current dataset is not sensitive to features below the cap seal.

The results from this study have improved and refined the delineation of the hydrothermal system at TVGF and showed that the deeper conductive anomalies inferred from previous studies may be the result of inversion artifacts unrelated to the magmatic system and not supported by the existing MT data. Moreover, the results from the synthetic experiments will guide future magnetotelluric data collection efforts about the conditions required to detect and image the deeper parts of a magmatic system.

Corresponding author: jagonza1@ualberta.ca

Using frequency domain airborne electromagnetic data to map permafrost along the central Mackenzie Valley, NWT, Canada

K Moshtaghian[a], M J Unsworth[a,b], D G Froese[b] and A Chiasson[b]

[a] *Department of Physics, University of Alberta, Edmonton, AB, Canada*
[b] *Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB, Canada*

Permafrost in many areas of Northern Canada is thawing rapidly in response to ongoing climate change. The central Mackenzie Valley is undergoing significant changes due to the permafrost nearing its thawing threshold, where studies have shown that since 1984, the ground temperature has increased by +0.1°C per decade. This changing landscape presents challenges for communities, land users, and engineers. Traditional ground-based geophysical methods (e.g., ERT) for mapping permafrost have limitations in extent and detail, making it difficult to fully understand the spatial distribution of permafrost. These changes are important for the environment, especially for infrastructure development such as road construction or essential infrastructures.

This study introduces a novel approach that uses airborne electromagnetic (AEM) surveys to map the current distribution of permafrost over large areas of the Canadian North. Utilizing the advanced capabilities of the frequency-domain AEM method, our research employed the Resolve-6 AEM system to gather comprehensive geophysical data across the central Mackenzie Valley. The primary goal was to obtain detailed resistivity profiles to determine the spatial extent, depth, and condition (frozen or thawed) of permafrost. Using an open-source Python package, SimPEG, we carried out the inversion to create a resistivity model of the subsurface that shows the spatial distribution and heterogeneity of permafrost over a large territory.

Preliminary results reveal distinct resistivity patterns that are consistent with existing knowledge of permafrost in the area. These patterns are supported by comparison with ground-based observations and borehole data, enhancing our confidence in the interpretation of the resistivity and in the accuracy of the AEM method. Notably, delineating taliks (locally thawed areas within permafrost), their continuity with surface water features, and identifying regions susceptible to thaw offers a new way to view the permafrost landscape. This research helps us to understand permafrost, forest fires, surface water, and groundwater systems, providing essential insights for predicting permafrost changes, which are important for further environmental plans.

Corresponding author: keytash@ualberta.ca

Evaluation of Nickeline (NiAs) as a Re-Os Chronometer: A Case Study of Five-Metal Association veins in the Northwest Territories, Canada

E Dorais[a], **RA Creaser**[a]

[a] *Department of Earth and Atmospheric Sciences University of Alberta, Edmonton, AB, Canada*

Five-metal association (FMA) veins represent a major source of Ag, Bi, Ni, Co, and As. They are understudied compared to most deposit types, with a critical knowledge gap being the absence of direct age data to support a genetic model. Several FMA systems occur in the Northwest Territories, including the Great Bear Magmatic Zone (Eldorado mine) and the East Arm basin of Great Slave Lake (Blanchett Island, Copper Pass, and Caribou Lake). Existing age constraints, relying on cross-cutting relationships with intrusions, are tenuous due to the complex telescoping and overprinting structure of the veins.

FMA veins are characterized by a paragenetic co-occurrence of native Ag and Ni-Co arsenides. Though U mineralization occurs as an early-stage mineral in some FMA systems, it is currently unclear whether there is any genetic relationship with the FMA veins. There is a notable absence of any U mineralization in the East Arm basin and evidence of a 1453 Ma U-Pb resetting event at Eldorado Mine, making the sulfarsenide Re-Os system particularly suited to addressing this question. Nickeline is one of few FMA arsenides that exhibits large, centimeter-scale zoning, rendering it ideal for use in Re-Os geochronology.

8 Nickeline samples were analyzed for their Re content and underwent Re-Os geochronological analysis. Repeated sample runs produce T_{MA} model ages ranging from 440-1800 Ma for the East Arm basin and do not yield valid isochrons. One Eldorado Nickeline displayed a large Gersdorffite-Cobaltite and Bismuth rim; model ages for this rim varied between 1560-2260 Ma, with a cluster of model ages between 1650-1700 Ma. Our work suggests that Nickeline may not be suitable as a Re-Os chronometer due to its typically low Re content (0.2-2 ppb) and inability to yield isochrons, indicating a high degree of heterogeneity or a higher susceptibility to Os removal and Re-Os resetting. FMA Nickelines exhibit a tendency to include rims and inclusions of phases with a higher affinity for Re, namely Gersdorffite-Cobaltite (50-70 ppb Re).

The high scatter in model ages observed in the Nickeline and Gersdorffite-Cobaltite samples raises intriguing questions about the geological processes influencing these variations. The wide age spectrum suggests a complex history, possibly involving multiple mineralization, alteration, or Re-Os resetting events. This could indicate that FMA vein formation is a continuous or multi-stage process, rather than a single synchronous event. The lack of perceived co-genetic relationship between the Eldorado veins and the East Arm Basin veins further supports the idea that FMA vein formation may be intricately linked to a complex geological history involving multiple episodes or continuous processes.

Corresponding author: edorais@ualberta.ca

Magnesium Doping for Enhanced Stability of Lithium Manganese Oxide Ion-sieves for Lithium Recovery from Flowback and Produced Water

F Wu[a], KR Shivakumar[a], Y Li[a], KO Konhauser[a], and DS Alessi[a]

[a] *Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, T6G 2E3, Canada*

The rapid growth in demand for lithium (Li), driven by the use of Li-ion batteries (LIBs) in electric vehicles (VEs), poses a crisis in the future supply of Li. To meet demand, the exploration of alternative Li sources is imperative. Flowback and produced water (FPW), a byproduct of oil and gas production, is a potential resource that often contains tens to hundreds of parts-per-million Li. Among the various direct Li extraction (DLE) approaches applicable to FPW, the use of spinel lithium manganese oxide (LMO) ion-sieves stand out as one of the most promising materials due to their high Li uptakes and rapid adsorption kinetics. However, LMO experiences mass loss due to the reductive dissolution of manganese (Mn) caused by organics present in FPW, which impairs its recyclability. In this study, we doped a pristine LMO ($Li_{1.6}Mn_{1.6}O_4$) with 4 different concentrations of magnesium (Mg) to synthesize Mg-doped lithium manganese oxides, $Li_{1.6}Mg_xMn_{1.6-x}O_4$ or LMMO-x (where x = 0.1, 0.2, 0.3, 0.4). Li recovery tests conducted using FPW produced from the Duvernay Formation in Alberta demonstrate that both Li uptake and Mn dissolution decrease with increasing Mg doping amounts. Specifically, Li uptake decreased by 53% for LMMO-0.4, while the average Mn dissolution during subsequent acid desorption was reduced by 80% compared to pristine LMO. Cycling tests show that LMMOs retain 95% of their initial Li uptake after the 5th cycle of use, compared to only 90% for LMO, demonstrating LMMOs exhibit better recyclability due to Mg doping. Extended X-ray absorption fine structure (EXAFS) analyses further confirm the improved stability of LMMOs, as irreversible structural contraction only occurred in LMO after 5 cycles of extraction. This study demonstrates that Mg doping enhances the stability of LMMOs, making them promising candidates for Li recovery from FPW.

Corresponding author: fangshua@ualberta.ca

Undergraduate student posters

Sustainability Paradigms: Indigenous Voices and the Confrontation of Imperialist, Colonialist, and Capitalist Systems

LQ Busari[a]

[a] *Department of Earth and Atmospheric Sciences University of Alberta, Edmonton, Alberta, T6G 2E3, Canada*

The United Nation's acknowledgment of the essential role of Indigenous knowledge in combating the climate crisis stands in contrast to the marginalization of Indigenous perspectives within its sustainability framework. This project explores the oversight of capitalism and colonialism within existing sustainability paradigms and addresses the United Nations' failure to actively mitigate the harms perpetuated by capitalist systems in its sustainable development goals. Using a literature review approach, this project examines contributions by Indigenous and racialized scholars globally. The examination of these scholarly works reveals how environmental degradation today is a direct result of profit-driven systems influenced by capitalism and underpinned by colonial and imperialist ideologies.

Urgent action is needed to counter the climate crisis, and that demands a radical shift in perspective. Centring rather than incorporating Indigenous voices, confronting the legacies of imperialism and colonialism, and challenging the capitalist systems that prioritize profit over the environment are essential steps toward meaningful change. The United Nations must reassess its strategies and give greater priority to a solution to the climate crisis that is more inclusive, equitable, and environmentally sound as a leading organization in global sustainability efforts. I encourage others to critically assess the shortcomings of the United Nations. Only by addressing these fundamental issues can we hope to create a truly sustainable and equitable future for everyone.

Corresponding author: latifat@ualberta.ca

Palaeoecological Reconstruction of latest Pleistocene steppe-tundra from relict permafrost at Mint Gulch, central Yukon

E Francis[a], **S Cocker**[a], **D Tirlea**[b], **and D Froese**[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*
[b] *Quaternary Environments, Royal Alberta Museum, AB, Canada*

The Klondike Region of central Yukon is near the eastern limit of Beringia, the unglaciated region spanning from eastern Siberia to Yukon, connected by the Bering Land Bridge during Pleistocene cold stages. Relict permafrost in this region has led to the exceptional preservation of plant, insect, rodent, and megafauna fossils. As well, relict permafrost preserves meteoric waters in pore ice and ancient biomolecules including ancient environmental DNA. These factors make Klondike sediments optimal for multi-proxy reconstruction of Pleistocene palaeoenvironments. In this study, we develop a multi-proxy reconstruction of past environments from the Mint Gulch site 25 kilometres southeast of Dawson City. The site preserves a rich record of past environments dating from ca. 16,000 to 11,000 years BP, including the Pleistocene-Holocene transition.

The Mint Gulch site consists of seven metres of grey loess with at least two Arctic ground squirrel (AGS) nests and three weakly developed paleosols (regosols). Plant and insect macrofossils from these materials were identified using collections at the University of Alberta and Royal Alberta Museum. The uppermost soil layer represents the Pleistocene-Holocene transition as it is better developed, indicating a slowdown of loess deposition, with ice- and organic-rich sediments above. This soil layer preserves mammoth-steppe tundra indicator taxa including the beetles *Connatichela artemisiae*, *Lepidophorus lineaticollis*, and *Morychus* spp. An intact AGS nest, including a seed cache, was recovered 80 centimetres below this soil layer, presumed to be associated with the soil layer surface. This nest dates to ca. 13,760-13,695 cal yr BP, making it the youngest dated AGS nest recovered from the Klondike. Water isotopes from ice within the nest have values of –21.9‰ $\delta^{18}O$ indicating it follows the transition from cold-stage to warm-stage conditions (–32.5‰ to –25‰ $\delta^{18}O$), marking the reorganization of hydroclimate in eastern Beringia during the latest Pleistocene. This nest contains at least 22 plant and animal taxa, including seeds and/or fruit from *Elymus* sp., *Artemisia* spp., *Potentilla* sp., and *Carex* spp., and beetles *Lepidophorus lineaticollis* and *Aphodius* spp., representing plant and animal assemblages indicative of a mammoth-steppe tundra ecosystem. These data indicate that steppe-tundra persisted near the Pleistocene-Holocene transition, despite changing hydroclimate. Further investigation of the Holocene materials above this soil layer will aim to determine when more mesic shrub-tundra replaced steppe-tundra, and this timing will be compared to the collapse of an end-Pleistocene steppe-tundra ecosystem described by Monteath et al. (2023) at a site 25 kilometres south known as Lucky Lady.

Corresponding author: egfranci@ualberta.ca

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Apatite Grain-Size: A Novel Approach to Tephra Characterization and Source Identification

T R Gmeinweser[a], **B J L Jensen**[a], **S Buryak**[a], **and S Johnston**[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

Volcanic ash, or tephra, predominantly consists of glass, alongside free minerals and lithic fragments. Bulk grain-size determinations and geochemical analyses of the glass component are critical for identification of the source vent. However, devitrification, the transformation of glass to clay and other secondary minerals, hinders these analyses. This study investigates the potential of apatite grain size distributions as a proxy for traditional grain-size analysis to aid in source identification in devitrified tephra sequences. Grain-size analyses were conducted on bulk tephra and apatite grains from two well-studied Holocene eruptions: Mount St. Helens (MSH) May 18th 1980 and White River Ash East (WRAe; Mount Churchill). Four samples were selected from each eruption site representing proximal, medial, and distal locations relative to the source vent. Established techniques were used for grain size measurements including laser diffraction (Malvern Mastersizer 3000) for bulk tephra and scanning electron microscopy (SEM) with image analysis (ImageJ) for apatite grains. To validate our bulk grain-size analyses, we compared them to established literature. We subsequently investigated the impact of mineral separation procedures, specifically sieving, on the grain-size distribution. Initial findings from MSH are inconclusive and potentially influenced by the co-blast deposit. While WRAe generally exhibits a decrease in apatite grain size with increasing eruptive distance, this reduction is less pronounced when compared to the bulk grain size. Notably, the median grain sizes converge in the most distal sample. Our initial findings suggest the potential utility of this novel approach for interpreting volcanic eruptions, specifically in scenarios where traditional methods are ineffective. Further experimentation is ongoing to refine methodologies, expand the dataset, test reproducibility, and strengthen the validity and applicability of this approach. Future research also aims to carry out geochemical analyses on the apatite to determine their potential utility for geochemical correlation in the absence of glass.

Corresponding author: gmeinwes@ualberta.ca

Paleoenvironmental and Paleoclimate Controls on Ground Ice Content Over the Last 50,000 Years in Central Yukon

RK Hann[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

The Klondike area of central Yukon is located at the far eastern extent of Beringia, the unglaciated region of Yukon, Alaska and Siberia that was connected via the Bering Land Bridge during Pleistocene cold stages. As a result of remaining unglaciated, the Pleistocene-Holocene transition has been recorded in exceptional resolution in central Yukon permafrost. This study investigates the controls on ground ice abundance in yedoma deposits over the 50,000 years in samples collected from the Klondike area. Yedoma, derived from the Russian literature, refers to the syngenetic (aggrading) permafrost deposits associated with widespread loess accumulation that characterizes surficial materials across Beringia.

In this study, I describe characteristics of these ice-rich yedoma deposits, including cryostructures, volumetric ice content, organic content, water isotopes, pH, conductivity, aggradation rate, paleoenvironment during deposition, and frozen bulk density. More than 300 cuboid subsamples (frozen volume ~ 3 cm^3) were cut from permafrost core samples and processed using established methods to produce a dataset covering the last ca. 50,000 years. Ground ice abundance correlates strongly with climate and vegetation with the highest ice contents associated with expansion of shrubs in the Late Pleistocene and through the early Holocene, when water isotope ratios ($\delta^{18}O$ and $\delta^{2}H$) are most enriched, while ground ice content is at its lowest near the last glacial maximum (18 000 – 22 000 cal yrs BP) when water isotope ratios are at a minima. The ground ice minima is also associated with sparse vegetation cover (steppe-tundra vegetation). These data provide new insights into the drivers of ground ice over Late Pleistocene timescales and provide additional information on the role of soil moisture in the functioning of Beringian ecosystems.

Corresponding Author: rkhann@ualberta.ca

Water quality in the (unmixed) Yukon River

CM Lamb[a], **CA Cooke**[a,b], **AV Reyes**[a], **and KJ Staniszewska**[a]

[a]*Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB, Canada*
[b]*Environment and Protected Areas, Government of Alberta, Edmonton, AB, Canada*

The Yukon River drains Yukon Territory and Alaska and has the second highest sediment flux of the circumpolar rivers, of which a significant portion is contributed by glacierized tributaries. We found sediment concentrations along cross-sectional transects of the Yukon River mainstem do not homogenize for ~250 km downstream of its second largest glacierized tributary, the White River. Due to this lateral heterogeneity, left and right bank samples respectively overestimated and underestimated sediment flux, while center-channel samples were variably above or below the mean of cross-section samples. In contrast, solute concentrations homogenized within ~50 km. The sum of upstream tributaries overestimated sediment and underestimated solute flux, suggesting that some sediment may dissolve and/or deposit along the mainstem. We found that ~99% of suspended sediment flux along this reach derived from the glacierized White River, while solute fluxes derived from multiple boreal forest tributaries. These findings allow for improved sediment and solute flux estimates and water quality monitoring at fixed-gauge stations along this reach. Mixing dynamics should be investigated downstream of other high-sediment-flux tributaries, such as the Yukon River's largest glacierized tributary, the Tanana River in Alaska. Sediment deposition/erosion budgets, and estimates of solute contributions from groundwater, may be inaccurate if the mainstem sample(s) are not representative.

Corresponding author: clamb1@ualberta.ca

The significance of encrusting taxa and boring ichnotaxa on marinebivalves in the Miocene, shallow marine Calvert and Choptank Formations, Calvert Cliffs, Maryland

T McKenzie[a], SM Kidwell[b], JP Zonneveld[a]

[a] *Department of Earth and Atmospheric Sciences, University of Alberta*
[b] *Department of Geophysical Sciences, University of Chicago*

Fossil molluscs are common in the Miocene marine strata of coastal Maryland. Molluscs are particularly diverse and abundant in four densely-packed shell beds referred to as Shattuck zones (SZ) 10 and 14 (Calvert Formation) and in SZ 17 and 19 (Choptank Formation), each previously interpreted as the stratigraphically condensed record of a marine transgression. Although the taxonomy of the molluscan fauna is well-established, the occurrence of borers and encrusters has been minimally documented. The species composition, life habits and relative abundances of these foulers provides valuable evidence about the dynamics of sediment accumulation. This study compares and contrasts the encrusters and boring ichnofauna of SZ 14 and 17 at thefamous Parker Creek locality.

SZ 14 is dominated by abundant, commonly articulated scallops, whose shells support sparse traces and rare barnacle basal attachment plates. SZ 17 contrasts markedly, preserving a more diverse array of bivalve and gastropod taxa which are characterized by diverse and abundant encrusting taxa and boring ichnotaxa. Barnacles are numerous and diverse (6 species). Bryozoans and juvenile ostreid valves occur attached to both the inner and outer surfaces ofmany shells. The boring ichnofauna in SZ 17 includes traces emplaced by polychaetes, sponges, bivalves, octopods, gastropods, marine fungi and cyanobacteria. Many of these traces occur on both the inner and outer surfaces of the shells, implying that some traces were postmortem and that shells resided near the sediment-water interface (SWI) long enough to permit colonization, maturation, and in some instances perhaps, ecological succession. This set of foulers includes traces of both marine predators and encrusters that colonized the shell both before the basibiont died as well as after the shells became empty and disarticulated.

Differences in the diversity of the basibionts and in the proportion and abundance of foulers between the two horizons implies strong differences in paleoecological conditions and sediment dynamics during condensation. We interpret that, at Parker Creek, SZ 14 was deposited under deeper water conditions, with more frequent and persistent deposition of mud and rare post mortem exhumation/exposure of shells at the SWI, thus leaving insufficient time for encrusting and boring organisms to colonize the shells. The dynamics of sedimentation during this interval thus likely entailed only brief and/or infrequent exposure of shells at the SWI, with some short- term depositional events entombing still-articulated scallops. In contrast, the greater diversityand frequency of foulers on mollusks from SZ 17, as well as their occurrence on both internaland external shell surfaces, suggest more shell-gravel-like conditions at the sediment-waterinterface, or at the least more frequent burial-exhumation cycles of shells, consistent with slow sediment accumulation in shallower waters.

Corresponding author: thmckenz@ualberta.ca

UreC Diversity and the Potential for Microbially Induced Calcite Precipitate in Permafrost

J McLeay[A], C. Nesbø[A], S Cocker[B], B Lanoil[A], D Forese[B]

[A] Department of Biological Science, University of Alberta, AB, Canada
[B] Department of Earth and Atmospheric Science, University of Alberta, AB, Canada

Permafrost, covering ~25% of the northern hemisphere land area, is the only component of the cryosphere that people live upon. As ground temperatures warm, much of this area is compromised by the loss of ground ice and the associated integrity of the soil. Thawing permafrost thus has the potential to impact critical infrastructure along with northern ecosystems. There are few options to mediate these changes outside of costly engineering interventions. This project aims to investigate the potential for microbially induced calcite precipitation (MICP), a mitigation approach used to improve soil strength and increase soil stability, though not yet investigated in permafrost areas. In MICP, microbial activity raises the pH within the soil, which, along with an injection of calcium salts, leads to the precipitation of calcite ($CaCO_3$), stabilizing the soil and increasing its shear strength. There are several challenges to applying MICP to existing microsystems *in situ,* including stimulating microbial processes that raise pH, such as urea hydrolysis by the urease enzyme encoded by the ureC gene. As a first step toward evaluating the potential for MICP for use in permafrost environments, we explored ureC biodiversity in permafrost metagenomes in public databases, comparing these to metagenomes from non-permafrost regions. This analysis suggests that ureC biodiversity and composition from permafrost and non-permafrost areas are similar, indicating methods to enrich urease-degrading bacteria in thawed permafrost may be similar for different biomes. Using ureC primers, we amplified ureC genes from permafrost samples taken at several depths in our focus region of central Yukon. We will sequence these genes and add them to our metagenomic tree to examine the diversity of ureC genes from this region. Future research will also involve tracking ureC gene enrichment under other MICP conditions, correlating microbial communities to soil stabilization, and optimizing MICP treatments of thawed permafrost soils.

Corresponding author: jmcleay@ualberta.ca

Sediment sources in the Upper Devonian Duvernay formation from immobile trace element data

G Nicolas[a] and N Harris[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

Sources of clastic sediment in the Upper Devonian Duvernay Formation, Alberta Basin, have never been clearly established. Provenance may vary stratigraphically and geographically, thus the sediments are evaluated using geochemical datasets from 5 different wells across the province, observing changes in provenance based on immobile element ratios. The transition from the Duvernay to the overlying IretonFormation displays a dramatic change in immobile element ratios, suggesting that the two formations are of different provenances. We also see generally an upward decrease in the TiO_2/Zi immobile element ratios, hinting at a change in provenance during eposition of the formation. These results demonstratethat immobile element ratios in multi-well geochemical datasets can be used to interpret provenance changes geographically and stratigraphically in organic-rich shales.

Corresponding author: gsmeenk@ualberta.ca

Cretaceous Cordilleran Volcanism

HA Sicotte[a] **and ST Johnston**[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

The Cordilleran Orogen of westernmost Canada is bound to the east by the Western Canadian Sedimentary Basin (WCSB). It is commonly assumed that orogenic events within the orogen are recorded within the stratigraphic succession of the WCSB (Porter et al., 1982). However, relating specific tectonic and magmatic events in the Cordillera to distinct stratigraphic units and sequences within the WCSB has proved difficult (Ross et al., 2005). My aim is to use volcanic sequences of the Cordillera to better constrain the relationship between Cordilleran tectonism and WCSB stratigraphic sequences. The assumption is that effusive volcanism within the Cordillera may be recorded in the WCSB as tuff and bentonite layers. By compiling available geochronological, geochemical and stratigraphic data from Jurassic and Cretaceous volcanic sequences within the Cordillera, I hope to provide a database that can be used to test for correlations with known WCSB volcanic ash horizons, and in doing so better constrain the relationship between WCSB sedimentary sequences with Cordilleran tectono-magmatic events.

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Corresponding author: hsicotte@ualberta.ca

Brucite and Portlandite Synthesis, Carbonation and Phase Transitions: Implications for Carbon Capture and Mineralization

KN Woldemedehn[a], AS Patel[a] and S Wilson[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

Carbon mineralization is a process that sequesters atmospheric CO_2 by transforming Mg- and Ca-bearing hydroxide and silicate minerals into carbonate minerals, mitigating the effects of anthropogenic climate change. In particular, Mg- and Ca-bearing hydroxides like brucite [$Mg(OH)_2$] and portlandite [$Ca(OH)_2$] are excellent CO_2 sinks that are rare in nature. This study focuses on synthesizing brucite and portlandite for aqueous carbonation with dissolved CO_2 and documenting any solid solution or phase transitions that may influence the efficiency of CO_2 removal and the energy needed to recycle the synthesis products.

Brucite and portlandite were synthesized in different abundances using stock solutions of 0.75M $CaCl_2{\bullet}2H_2O$ and $MgCl_2{\bullet}6H_2O$ and 1.5M NaOH. Seven solution compositions with variable Ca to Mg molar ratios were used to synthesize hydroxide phases. Then, each synthesis product was suspended in ultrapure water and carbonated with ambient laboratory air (~420 ppm CO_2) and pressurized 10% CO_2 in N_2 for 24 hours. Quantitative X-ray diffraction was used to determine the mineralogy and phase abundances obtained before and after carbonation experiments, and scanning electron microscopy was used to observe the habit and microstructure of each phase.

Portlandite carbonated to calcite and aragonite (both $CaCO_3$) under reaction with air and 10% CO_2, while brucite only carbonated to a decomposing, structurally disordered nesquehonite-like ($MgCO_3{\bullet}3H_2O$) phase under 10% CO_2. No solid solutions were observed in either case. The calcium carbonates were more stable and formed much faster than the nesquehonite-like phase, implying that portlandite has a greater affinity for carbonation than brucite. Both the air and 10% CO_2 experiments yielded over 75% carbonate relative to input material within 24 hours, indicating that a high concentration of CO_2 is not required to sequester carbon efficiently in hydroxide group minerals. Further understanding of the nesquehonite-like phase is required to assess the difference in carbon capture potential between brucite and portlandite.

Corresponding author: kwoldeme@ualberta.ca