Atlantic Geoscience Society

ABSTRACTS

50th Colloquium & Annual General Meeting 2024

Moncton, New Brunswick

The Atlantic Geoscience Society held its 50th annual meeting in Moncton, New Brunswick, at the Crowne Plaza Hotel on February 2–3, 2024. A total of 87 presentations were made (60 oral and 27 poster), of which 48 were student presentations. AGS continues to be a great venue for students to present and is at the leading edge of geoscience in Atlantic Canada. On behalf of the society, we thank Colloquium organizers Denise Brushett, Aaron Bustard, Lynn Dafoe, Susan Johnson, Olivia King, David Lentz, Mike Parkhill, Rob Raeside, Steven Rossiter, Deanne van Rooyen, Jim Walker, and Chris White, as well as the numerous session chairs and judges, for facilitating an excellent meeting with about 185 registrants. AGS acknowledges support from the corporate sponsors and partners for the meeting: New Brunswick Department of Natural Resources and Energy Development, Engineers and Geoscientists New Brunswick, Terrane Geoscience, Dillon Consulting, Nova Scotia Department of Natural Resources and Renewables, and Geoscientists Nova Scotia.

In the following pages, we are pleased to publish the abstracts of oral and poster presentations from the meeting representing a wide variety of topics. Best undergraduate and graduate student presentations are recognized and indicated by an asterisk in the authorship. The meeting included seven special sessions: (1) From ocean crust to mountain peaks — a celebration of the career of Sandra Barr; (2) Gold in the northern Appalachians; (3) Sedimentary successions through time; (4) Igneous-hydrothermal systems and critical metals in the northeast; (5) Educational outreach, EdGEO, and outreach opportunities; (6) Environmental geoscience and sustainability; and (7) The energy transition and achieving carbon neutrality. The remaining talks were organized into one general session: Geoscience research developments.

Also included with the conference was a half-day short course on "Geochemical Data Collection, Preparation, Analysis, and Presentation" delivered by Cliff Stanley (Acadia University). The traditional Saturday evening Awards Banquet and Social was highlighted by a talk from Brian Hebert on "Citizen science in geology: past, present and future" and the announcement of the society awards, as well as student prizes for best poster and oral presentations. The student award winners are noted at the end of the appropriate abstract.

Although the abstracts have been edited as necessary for clarity and to conform to Atlantic Geoscience format and standards, the journal editors do not take responsibility for their content or quality.

THE EDITORS

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The first tetrapod ichnofaunal assemblage from the Boss Point Formation at Cape Enrage, New Brunswick, Canada

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A recently discovered fossil site situated along the coastline of Chignecto Bay at Cape Enrage, southeastern New Brunswick, has yielded a mosaic of tetrapod footprints from the Early Pennsylvanian (Yeadonian) Boss Point Formation. The cliffs of Cape Enrage are part of the Ward Point Member of the Boss Point Formation and are locally known for an abundance of allochthonous macrofloral remains of *Calamites*, lycopsids, pteridosperms, and cordaitaleans. Furthermore, a concurrent study has identified a plethora of invertebrate ichnofossils that are being described separately. Although vertebrate trace fossils have been noted from the Boss Point Formation at Joggins and River Phillip in Nova Scotia, no footprints have previously been described from the Boss Point Formation in New Brunswick. We herein report a moderately high diversity tetrapod ichnoassemblage consisting of *Batrachichnus*, *Hylopus*, *Matthewichnus*, *Charachichnos*, *cf. Notalacerta*, *Matthewichnus*, and *Pseudobradypus*. The tetrapod footprints from Cape Enrage are age-equivalent to tetrapod tracks discovered at Port Hood, Cape Breton Island, and are among the oldest evidence of tetrapod footprints in the Pennsylvanian of Atlantic Canada. The footprints are interpreted to have been made by temnospondyls, anthracosaurs, microsaurs, and possibly amniotes that would have traversed a floodplain paleoenvironment inhabited by *Calamites*, pteridosperm, and lycopod plants. The tetrapod footprints at Cape Enrage are typical of the Early Pennsylvanian and record the transition of reptiliomorph-dominated ecosystems of the Late Mississippian to more terrestrially diverse ecosystems at the dawn of the 'Coal Age'.

Joggins Fossil Cliffs, an UNESCO World Heritage Site: celebrating 200 years of research

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The Joggins Fossil Cliffs are an UNESCO World Heritage Site situated on the coast of the Bay of Fundy. The site encompasses almost fifteen kilometres of fossiliferous cliffs along the shoreline and is world renowned for preserving the most complete record of life from the late Carboniferous paleoenvironment in which they lived. The Joggins Fossil Cliffs have long been a field trip and research site, as well as a famous tourist destination. In the nearly 200 years since the first western researchers found tetrapod fossils in fossilized lycopsid stumps, new discoveries have not stopped, nor have they slowed. Each new tidal cycle, season, and year reveals new stumps in the cliffs, and new discoveries on the beach. In 2023, the Joggins Fossil Cliffs celebrated its fifteenth anniversary as an UNESCO World Heritage Site. This important milestone is a reflection on almost 200 years of scientific study and will generate new avenues of research at this historically important site.

Late Holocene changes in the Labrador Coastal Current and export primary production offshore Nain, Nunatsiavut, Canada

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Anthropogenic warming severely impacts (sub) arctic marine ecosystems with implications for coastal communities. Nain (Nunatsiavut) is the northernmost and largest Inuit community of the Labrador Coast, and its population maintains a close connection to marine resources for subsistence and cultural practices. The objective of this study is to provide insights into climate-driven changes in ocean conditions and primary production offshore Nain during the Late Holocene to better understand the system's natural variability and connectivity to larger-scale circulation patterns. This study presents a high-resolution record of changes in sea-surface and near-bottom conditions in the Labrador Coastal Current (LCC) that flows south on the Labrador shelf. The project looked at biogenic (dinoflagellate cysts, total organic carbon, Ca/Ti) and sedimentary (mean sortable silt, magnetic susceptibility, Zr/Rb) proxies preserved in the first 2 m of the sediment core retrieved offshore Nain. The data reveal an overall decrease in the LCC vigor during the last ca. 3000 years, superimposed by multi-centennial fluctuations. Most notably, at 2100 years BP, a decline in both the LCC strength and marine primary production coincided with a shift to a positive North Atlantic Oscillation phase, suggesting strong ocean-atmospheric coupling. As well, a decrease in the LCC vigor at 880 years BP was associated with a relative increase in marine primary production. Ultimately, the data provided by this study may be used to validate and improve regional climate models that help better anticipate the effects of climate change on northern communities.

The source of uranium for the Lac Cinquante uranium deposit, Nunavut, Canada

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The Lac Cinquante uranium deposit is hosted in an Archean greenstone belt below the Paleoproterozoic Baker Lake Basin, Nunavut, and is currently characterized as a vein-type uranium deposit. Vein-type uranium deposits consist of uranium mineralization concentrated in fractures, shear zones, and stockworks. The source of uranium in the Lac Cinquante deposit is unknown and will be determined in this study through petrographic work, trace element analysis, and geochronology of uranium minerals. We hypothesize that the uranium was sourced in one of two ways: either uranium was leached from apatite, zircon, or monazite from nearby c. 1.84 Ga Hudsonian granite or the uranium was sourced from glass of the potassic volcanic rocks (Christopher Island Formation) of the Paleoproterozoic Baker Lake Group. Petrographic work including micro-XRF mapping scanning electron microscopy confirm the complete paragenesis for the deposit is: (i) primary minerals of the host rock including plagioclase and quartz; (ii) albitization of plagioclase; (iii) disseminations of hematite, pyrite, chalcopyrite within host rock; (iv) formation of uraninite, brannerite, and uranophane in carbonate (calcite to dolomite) veins; and (v) hematite, carbonate, and chlorite alteration. Laser ablation inductively coupled plasma mass spectrometry will be carried out on uranium minerals to date discrete mineralization events and identify sources of uranium. Preliminary data from uraninite shows flat (i.e., none) to positive Eu anomalies with otherwise flat lying chondrite-normalized REE patterns, distinct from typical vein-type uraninite associated with granitoid rocks. The REE patterns together with the presence of brannerite ($(U, Ca, Ce)(Ti, Fe)_2O_6$) may indicate a mafic source for REE and Ti, potentially the local albitized host volcanic rocks. High contents of Ba, Zr, and U may be sourced from alkaline rocks such as the Baker Lake Group volcanic rocks.

Rare earth element- and yttrium-bearing mineral identification using μXRF and SEM: a case study of highly evolved granite-related Mount Pleasant W-Mo-Bi and Sn-Zn-In-Cu deposits, New Brunswick, Canada

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The Late Devonian Mount Pleasant deposits in southwestern New Brunswick are associated with three episodes of highly evolved A-type granites (Gr), resulting in the formation of three distinct mineralized zones: the Fire Tower Zone (FTZ) hosting W-Mo-Bi ore linked to Gr-I, the North Zone (NZ) containing Sn-Zn-Cu-In ore connected to Gr-II, and the lesser explored W-Sn-Zn-In occurrence in the Saddle Zone (SZ). μXRF-EDS mapping indicates that rare earth element- and yttrium (collectively referred to as REY)-bearing minerals are widespread in the breccia matrix and fluorite veins containing W-Mo-Bi in the FTZ, as well as in areas where the second stage of mineralization overprinted the initial stage. Utilizing SEM-BSE and EDS images, fluocerite, fluorite, bastnäsite, parisite, monazite, thorite, xenotime, and zircon have been

identified as the primary carriers of REY in the mineralized system. These mineral assemblages, some reported for the first time, are predominantly linked to the W-Mo-Bi mineralization of the initial magmatic episode. In regions where Sn-base metal mineralization replaced W-Mo-Bi ore zones, characterized by high REY content; coarse-grained bastnäsite, fluocerite, and parisite rim the voids of host rocks and fill the fractures, indicative of dissolution-reprecipitation processes. Fluocerite, which has been rarely reported in nature, represents the earliest REY mineral to crystallize in the Mount Pleasant deposits and undergoes extensive replacement by bastnäsite and locally parisite. A reduction in temperature might have resulted in a decrease in aF^- and an increase in aCO_3^{2-}, favoring the formation of fluorocarbonates. Secondary bastnäsite and parisite exhibit elevated light rare-earth-element (LREE) content relative to primary ones, implying an inheritance of LREE contents from fluocerite. Xenotime mostly rims zircon; however, it also appears either as discrete euhedral crystals or as intergrowths with fluocerite, monazite, and primary bastnäsite. Thorite primarily presents as fine-grained inclusions within xenotime, monazite, and fluocerite, providing additional evidence for dissolution-reprecipitation process. In brief, the FTZ exhibits significantly elevated REY enrichments featuring an unusual REY mineral assemblage.

Preliminary U–Pb zircon dating results from Avalonia and Ganderia in southern New Brunswick, Canada — corroborations and surprises

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Published chemical abrasion-isotope dilution-thermal ionization-mass spectrometry (TIMS) ages suggest that volcanic and related granitic plutons in the Avalonian Caledonia terrane of southern New Brunswick crystallized at ~551.5 Ma and were overlain by younger basalt and rhyolite at ~549 Ma. New dates obtained by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) from two rhyolite samples and Baxters Mountain granite yielded dates of 548 ± 4 Ma, 551 ± 4 Ma, and 550 ± 3 Ma, respectively. These dates are consistent with the TIMS results but not adequately precise to distinguish between the ~551.5 Ma and ~549 Ma magmatic events. All three samples contain evidence for inherited grains with ages of ~570 Ma, ages common in other parts of Avalonia but not in the Caledonia terrane. Samples analyzed by LA-ICP-MS to improve absolute age constraints in younger Cambrian units provide a maximum depositional age (MDA) of ~509 Ma for phosphatic quartz arenite in the basal part of the Hanford Brook Formation but quartz arenite in the younger Silver Falls Formation contained no zircon grains younger than 595 Ma.

In the Ganderian New River belt, LA-ICP-MS dates of 538 ± 3 Ma, 548 ± 2 Ma, and 522 ± 3 Ma were obtained from previously undated Goose Lake granite and Little New River granodiorite and granite, respectively, a wider spread in Ediacaran–Cambrian ages than previously reported. New TIMS work has provided a more precise age of ca. 516 Ma for rhyolite in the Mosquito Lake Road Formation, corroborating results from older work. Detrital zircon from hornfels in the underlying Matthews Lake Formation gave a MDA of ~561 Ma; however, an overlying conglomerate yielded an unexpectedly young MDA of ~420 Ma. Instead of the anticipated Devonian ages, coarse-grained monzonite from Wallace Ledge and granite from White Ledge, both in the Bay of Fundy south of Grand Manan Island, yielded LA-ICP-MS dates of 620 ± 1 Ma and 554 ± 2 Ma, respectively.

Deformation history of the Appalachian orogen in Gros Morne National Park, western Newfoundland, Canada

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The northern Appalachian orogen was built during several orogenic episodes involving obduction of ophiolites and accretion of terranes to Laurentia's eastern margin. During the Ordovician Taconian orogeny, allochthons, comprising structural stacks of slope/rise sedimentary rocks, mélange, and ophiolitic rocks, were emplaced onto the Laurentian margin. Although thin-skinned contractional structures do-

minate the deformation style in the allochthons, basement-reaching, thick-skinned normal faults formed on the lower, subducting plate. Post-Taconian orogenesis generated overprinting folds and Acadian thick-skinned thrust faults which transport basement and previously autochthonous rocks above allochthonous units.

Gros Morne National Park, western Newfoundland, boasts spectacular geology as the main tourist highlight of the park. However, the current resources and maps provided for education and geotourism are based on outdated regional government maps. Previous detailed work on coastal exposures in the park largely focused on the stratigraphy, leaving the structural geology poorly constrained. To better constrain the geologic history in the park we use a combination of geologic mapping, structural analysis, geochronology, and biostratigraphy. Detailed mapping and structural analysis of faults within allochthonous rocks demonstrates a complicated structural history of extension, followed by multiple contractional episodes. A regional transect suggests that Gros Morne peak resides in the hanging wall of a major, deep-seated basement thrust fault. Carbonate U–Pb dating of calcite slickenfibres will be undertaken to determine the absolute timing of deformation.

This project will provide new maps and updated resources for outreach in Gros Morne National Park. An improved understanding of the structural history of this well exposed part of the Appalachian orogen will help us reevaluate the orogen where similar features are present and the post-Taconian structural history is poorly understood.

Intrusion-related origins for gold mineralization at the Elmtree Deposit, northeastern New Brunswick, Canada

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Lower- to Middle-Devonian gold and polymetallic mineralization of the Elmtree deposit straddles the Melanson Brook Fault that locally marks the boundary between the Elmtree Inlier (Fournier Supergroup) and the Nigadoo River Syncline (Quinn Point Group). Gold mineralization is associated with wall-rock replacement processes with arsenopyrite, pyrite, and pyrrhotite and quartz-carbonate veining. Gold mineralization at the Elmtree Deposit has been previously dated at between ca. 398 and 386 Ma ($^{40}Ar/^{39}Ar$ sericite), which is coeval with ilmenite-bearing porphyry dykes (390.0 ± 4.8 Ma; U–Pb zircon) that intruded the Melanson Brook Fault approximately 2.5 km to the west. These dykes may have contributed to mineralizing fluids, as deuteric alteration and miarolitic cavities in the dykes indicate fluid saturation and exsolution. The Melanson Brook Fault was likely quite active and served as a permeability conduit for these mineralizing fluids.

To assess sulphur sources, Laser Ablation - Inductively Coupled Plasma-Triple-Quadrupole-Mass Spectrometry was used to collect in situ sulphur isotope data for pyrite (n = 25, average $\delta^{34}S$ range -5.8 to 7.4‰) and pyrrhotite grains (n = 15; average $\delta^{34}S$ range -4.6 to 6.4‰) from the Elmtree deposit. Though the isotopic composition of pyrite and pyrrhotite are similar, the distribution of individual $\delta^{34}S$ measurements (n-pyrite = 149, n-pyrrhotite = 89) suggests the mixing of two sulphur sources. $\delta^{34}S$ values lower than -1‰ probably represent sulphur sourced from the abundant black shale units in the region. Values greater than -1‰ overlap the range of $\delta^{34}S$ of volcanogenic massive sulphide (VMS) deposits in the California Lake Group (average $\delta^{34}S$ = 7.2‰, range = 1.1 to 14), which structurally underlies the Elmtree Inlier. Sulphur and gold from California Lake Group rocks, which structurally underlie the Elmtree Inlier, may have been assimilated by magmas prior to emplacement of the Ellis Brook dykes. Variations in relative fluid flux from magmatic versus metamorphic sources over time and mixing during transport accounts for the isotopic signatures observed.

The Carboniferous-Permian tetrapod fossil record of Prince Edward Island reaches global significance

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For decades if not centuries, the fossil record of tetrapods on Prince Edward Island was thought to be sparsely preserved in the rock record. For over a century, the sole tetrapod fossil known was the famous mandible of the dimetrodontid *Bathygnathus borealis* discovered by Donald McLeod

while digging his well in 1845. Discoveries, especially of tetrapod traces (footprints and trackways), are now being routinely discovered across the island, especially due to the work of Patrick Brunet. The past year, post-Hurricane Fiona, has been particularly productive. The growing record of tetrapod traces on Prince Edward Island is now as diverse as the famous localities of southwestern USA and Tambach, Germany, and together with the fossil record of Brule, Nova Scotia, provides records of first appearances of key taxa. Precision in dating the Carboniferous–Permian boundary in the terrestrial realm is a vexed pursuit, but the growing weight of paleontological data seems to confirm the strata of Prince Edward Island cross this boundary, with most of the tetrapod trace record being earliest Permian (Cisuralian). This terrestrial fossil record is undocumented elsewhere in Canada. In the current absence of a natural history museum in the province of Prince Edward Island, Parks Canada has provided research and collection space at their Greenwich Interpretive facility, as well as field staff, and Prince Edward Island's Museum and Heritage Foundation is providing the required numbering protocols in accessioning this globally significant collection.

Evaluation of CO_2 storage potential of Carboniferous sandstones in the Maritime Provinces of Canada

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The suitability of Carboniferous sandstones in three areas in the Canadian Maritime Provinces for geologic carbon storage was evaluated: (1) the Windsor Sub-Basin (Horton Bluff Formation); (2) the Cumberland-Sackville Sub-Basin (Lower Cumberland Group); and (3) Prince Edward Island (Pennsylvanian sandstones). The properties of potential reservoirs and characteristics of vertical seals and barriers to lateral migration were evaluated using previously collected well logs, sample descriptions, core analyses, and seismic interpretations. In all three areas, at least one key reservoir parameter (porosity, permeability, or thickness) was below thresholds used for selection of some offshore storage sites but may achieve less stringent thresholds for onshore sites. Sandstones in the upper Hurd Creek Member of the Horton Bluff Formation locally have porosities up to 15% and permeabilities up to 25 mD at depths suitable for supercritical CO_2 injection. Their aggregate thickness may be suitable for storage, but individual sandstones are thin and likely of limited lateral extent. The lower Cumberland Group contains sand-dominated successions up to 1 km thick with low porosity (5–7%) where drilled in the subsurface. Correlation of the lower Cumberland Group sandstones to the Joggins section is uncertain. Although lithologically similar to the Boss Point Formation, palynology data suggests some of the section is age equivalent to the Joggins and Springhill Mines formations. Sandstone bodies in the Bradelle, Green Gables, and Cable Head formations beneath Prince Edward Island exceed tens of metres in thickness with porosities averaging up to 10–12% and permeabilities up to 10 mD. Evaporites in the overlying Windsor Group would provide a suitable seal for the Horton Bluff Formation; in other areas the top seal would be provided by mud-prone heterolithic intervals. The evaluated areas may provide opportunities for small onshore storage projects. Further work is warranted to delineate reservoir trends and verify the integrity of potential top seals and traps.

Petrology, tectonic setting, and mineralization potential of late Devonian plutons in the central Cape Breton Highlands, Nova Scotia, Canada

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The West Branch North River (WBNR), Bothan Brook (BB), Centre Road (CR), and Peter Brook (PB) plutons are in the eastern Aspy terrane of central Cape Breton Island, part of Ganderia in the northern Appalachian orogen. Petrographic examination of cut rock slabs and thin sections from about 50 samples shows a wide range in rock types. Samples from the WBNR, BB, and PB plutons range from medium- to coarse-grained equigranular biotite granodiorite to monzogranite and syenogranite, whereas the Centre Road pluton consists of hornblende-biotite monzodiorite and hornblende-biotite quartz monzodiorite to monzonite. The plutons are undeformed and intruded after regional (Acadian) deformation and metamorphism in their host rocks. Their distinctive elongate shapes are the result of mainly post-shear emplacement in major shear zones related to juxtaposition of the Bras d'Or and Aspy terranes and hence their ages constrain timing of shear zone movement. Monzogranite from the WBNR pluton yielded a U–Pb zircon age 373 ± 2 Ma, the same within error as the published age of 376 ± 3 Ma for the BB pluton, whereas the Centre Road monzodiorite yielded a younger age of 361 ± 3 Ma. Chemical analyses of about 40 samples show a range in SiO_2 from about 51% to 77% with lowest contents in the CR pluton and highest in the BB pluton. High K_2O in most samples suggests that they have shoshonitic affinity. Total REE content and light REE enrichment are highest in the CR pluton and lowest in the BB pluton. The plutons generally display I-type chemical characteristics, and trace element compositions indicate that the magmas formed in a

post-collisional slab-failure tectonic setting. Although no mineralization has been observed yet, the presence of pegmatite in the CR pluton and highly evolved compositions in the BB pluton suggest some potential for Li or other critical elements.

Whole-rock and biotite critical metal concentration maps of the South Mountain Batholith, Nova Scotia, Canada

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The South Mountain Batholith (SMB) in southwestern Nova Scotia, Canada, is the largest granitic body emplaced within the Appalachian orogen. The SMB is comprised of multiple plutons that were emplaced in two phases: the earlier Stage 1 (379–375 Ma) comprised of granodiorites to monzogranites, and the later Stage 2 (375–372 Ma) comprised of monzogranites to leucogranites.

This project focused on using existing SMB geochemical data collected by the Nova Scotia Department of Natural Resources and Renewables and by Dalhousie University students, covering >500 samples, to map the distribution of whole-rock and biotite concentrations of various critical metals across the SMB. Concentration maps were produced using the ArcGIS Pro software to interpolate critical metal concentrations across the whole SMB from existing data points. These interpolations are then symbolized to produce a contour map of concentrations. As the data are derived from unmineralized samples, the resulting maps are representative of background concentrations, and therefore could highlight areas of unusual geochemistry.

The produced maps show that several elements of interest, including Sn, Li, Rb, Nb, Ta, and F, are correlated with areas of high SiO_2 concentration, consistent with enrichment following protracted magma crystallization. The spatial distribution of concentrations in biotite mimics the whole-rock data. Additionally, biotite Fe#/Ti ratios, a metric for magma fO_2, show differences across the SMB, with more reduced regions correlating with critical metal enrichments. Maps also highlight areas with a Nb/Ta ratio <5, which has been suggested to represent samples affected by magmatic-hydrothermal processes.

Overall, areas enriched in critical metals tend to be within Stage 2 plutons, particularly the Davis Lake and New Ross plutons, both known to host polymetallic mineral deposits. However, some areas outside these known deposits show elevated background concentrations and are therefore of potential interest for more detailed characterization.

Granite-related critical mineral potential of the Gander and western Avalon zones, southern Newfoundland, Canada

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The Gander zone and western part of the Avalon zone in southern Newfoundland are host to several known critical mineral deposits and prospects associated with granitic rocks. They include lithium–cesium–tantalum (LCT) pegmatites in the Burgeo area, where two zones of LCT pegmatites were first discovered in 2021 (Kraken pegmatite field and Hydra pegmatite). Other significant known deposits and prospects include vein-hosted W deposits (e.g., Grey River Deposit), porphyry Mo–Cu deposits (Moly Brook Deposit), Sn-greisen (Moulting Pond Prospect), and fluorite deposits (St. Lawrence fluorite). In addition, the potential of these lithotectonic zones to host other deposits is highlighted by numerous smaller Li, W, Mo, Sn, Bi and Be occurrences, as well as abundant peraluminous granites intruded into greenschist- to amphibolite-facies metasedimentary and metavolcanic rocks.

Despite the high prospectivity of this region, a number of fundamental geological questions and research avenues remain. They include the mineralogy, age, origin, tectonic setting, and economic potential of intrusive rocks in southern Newfoundland, the relative importance of crustal anataxis and crustal structures in the localization of mineralization, and regional correlations with similar deposits in peri-Gondwanan terranes across the Appalachian and Caledonian orogens. Ongoing multidisciplinary research between government, academic, and industry partners aims to fill these knowledge gaps by combining field data with petrography, geochemistry, mineral chemistry, and geochronology to improve our understanding of the tectonic history of southern Newfoundland, and the geological processes that resulted in formation of granite-related critical mineral deposits. In addition, mineralogy and mineral chemistry will be compared between mineralized bodies to help define advanced exploration vectors and aid in future mineral exploration.

Mineralogy of manganiferous metasedimentary rocks of the Goldenville Group, Nova Scotia, Canada

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Metasedimentary rocks of the uppermost unit of the Cambrian-Ordovician Goldenville Group are known to have high concentrations of manganese (up to 15 wt% MnO). However, many unanswered questions remain regarding the depositional environment, sedimentary provenance, Mn concentration processes, and potential for Mn deposits. The Goldenville Group is part of the Meguma terrane, which is interpreted to have originated as a lower Paleozoic continental margin on Gondwana, although its original position and underlying basement are not known. It may have developed adjacent to the West African craton during the Cambrian, but other workers included the Meguma terrane as part of Avalonia or interpreted it to have formed as a continental margin succession on Avalonia. Previous workers interpreted these strata, which in the lower parts of the stratigraphy consist primarily of massive or laminated sandstones, to be turbiditic continental slope and fan deposits. In contrast, Mn-rich facies in the upper Goldenville Group are typically finer-grained and characterized by brown-purple nodules and laminations or, at higher metamorphic grades, pink coticule beds and lenses. Mineral chemistry and SEM-MLA imaging demonstrates that the Mn occurs in several mineral phases, primarily carbonates (rhodochrosite, rhodochrosite-calcite, and manganiferous calcite) and spessartine garnet, but also chlorite, Mn-ilmenite, and pyrolusite. Whole-rock data indicate that the Mn-rich strata are also associated with elevated concentrations of iron, copper, cobalt, lead, zinc, nickel, gold, and arsenic. These metals occur in association with the manganiferous nodules and laminae as chalcopyrite, sphalerite, cobaltite, magnetite, pyrite, ilmenite, gersdorffite, and galena. This mineralogy suggests that the deep-marine environment in which strata of the upper Goldenville Group were deposited was impacted by hydrothermal circulation and volcanic vent systems that concentrated these metals into manganiferous crusts and nodules.

Sedimentological and ichnological characteristics of Holocene bottom current and internal tide deposits in Logan Canyon head, offshore Nova Scotia, Canada

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Hydrodynamic processes operating in submarine canyons often include turbidity currents; however, bottom currents, such as internal tides, can play a major role in sedimentation. At the head of Logan Canyon, offshore Nova Scotia, Holocene highstand conditions have enabled sediment accumulation within the canyon. At this locality we combined autonomous underwater vehicle acoustic survey data (swath bathymetry, sub-bottom profiler), high-resolution analyses of two sediment cores (grain size, X-ray imagery, thin sections), moored current measurements, and seabed video to document hydrodynamic and sedimentary processes. Bottom current activity is indicated in the acoustic data through the formation and maintenance of gullies and an axial channel and is further supported by sedimentological and ichnological observations of sediment cores. Holocene deposits comprise olive grey sandy mud that includes mud aggregates, silt, and fine-grained sand. A consistent mean sortable silt value throughout the cores confirms a lack of turbidity current influence. Three facies are recognized: laminated, partially laminated, and bioturbated sandy mud. Sedimentary structures include rhythmic sand and mud aggregate couplets, planar to low-angle parallel laminations, wavy laminations, current ripple cross-laminations, and fining-upward successions all attributed to sedimentation from bottom currents induced by internal tides. Partially laminated facies show alternations between laminated and mottled units or remnant lamination with a mottled fabric. Cores are primarily composed of the bioturbated facies with a tiered biogenic fabric, including discrete biogenic structures, local cross-cutting, and background mottling. The ichnological assemblage is consistent with a distal expression of the *Cruziana* Ichnofacies, typical of slope settings. Seabed video shows current ripple formation in opposing directions linked to internal tides, but the infaunal and epifaunal community rapidly re-establishes itself. Accordingly, preservation potential of internal tide deposits appears to be associated with enhanced sedimentation rates during storms that outpace biogenic reworking. These results support future study of modern and ancient internal tide deposits.

Nova Scotia offshore wind energy potential to assist in reaching net zero goals

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In order to reach the goal of net-zero CO_2 emissions in Nova Scotia by 2050, the province is exploring the possibility of establishing offshore windfarms as a source of green energy. Assessments have been done by Net-Zero Atlantic to determine the viability of such projects through exploring wind speeds, bathymetry, surface geology, and other environmental factors that will have an affect on the success of a project following the United Nations Framework Classification (UNFC). In-digenous peoples had early involvement to ensure their rights are maintained. Five locations were determined to be suitable to support an offshore windfarm and, comparing the Levelized Cost of Energy (LCoE) to other similar projects already established, are economi-cally viable. Although the average maximum wind speed remain where safe energy generation can occur, difficulties with consistency of power generation need to be solved to ensure that energy is available during times of low wind. Options of overcoming this problem include green hydrogen generation and compressed air storage to preserve electricity for when it is needed. However, little time remains to meet necessary dead-lines and work needs to be done quickly if the offshore wind project is to be done in time.

Using small-scale maps to interpret large-scale geological structures in the Windsor Group, Windsor-Kennetcook subbasin, Nova Scotia, Canada

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Using small-scale features as an indicator of large-scale structures is a common practice in geological mapping. It is especially useful when mapping in areas of sparse outcrop, such as within the Windsor Group of the Maritimes Basin. The Maritimes Basin contains a complex assemblage of upper Paleozoic strata that covers a large area of onshore and offshore eastern Canada. Within the Maritimes Basin, variably interconnected and isolated depocenters or subbasins are recognized to have different deformational histories. In the Windsor area of Nova Scotia, the Windsor–Kennetcook subbasin represents one such depocentre that includes highly deformed carbonate and evaporite-rich rocks of the Visean Windsor Group. Reginald Moore mapped much of the Windsor Group in detail at the Wentworth and Miller Creek quarries between 1970 and 1990. These hand-drawn and computer-generated maps provide insight to the stratigraphy, structure, and quarry evolution through multiple decades. For example, these maps show significant ductile structures, including recumbent, isoclinal, and sheath folds. However, these detailed maps were neither digitized, nor published, and the geological style is significantly different from the 2000 1:50 000 provincial geological map. These maps have now been georeferenced using QGIS and are used as a base for remapping of the Windsor Group within the Windsor-Kennetcook subbasin. This research will more accurately portray salt-related geological structures and the geological framework of the subbasin by combining data from historical maps, new field mapping in exposed areas of the quarries, and by producing a 3-D model, which will enhance our understanding of the role of evaporites in the structural evolution of the Maritimes Basin.

Tectonic and structural controls on granite pluton emplacement in the eastern Meguma terrane, Nova Scotia, Canada

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The tectonic environment of a region can directly influence the mechanisms through which granitic plutons and pegmatites are emplaced into Earth's crust. Favourably oriented faults and fractures can act as conduits that transport magmas to shallower depths where they are emplaced. Prolonged movement along a major east-west trending fault zone called the Cobequid–Chedabucto Fault Zone (CCFZ) in mainland Nova Scotia played a fundamental role in the emplacement of many coeval granitic plutons and pegmatites. A close spatial juxtaposition of plutons and structures in the eastern Meguma terrane offers an ideal area in which to study the nature and timing of movement of the CCFZ and its potential influence on pluton and pegmatite emplacement and deformation, including patterns like potential Riedel shear planes. Published U–Pb monazite ages indicate pluton emplacement between ca. 373–370 Ma and published $^{40}Ar/^{39}Ar$ muscovite data shows two generations of muscovite. Larger muscovite is primary and records pluton cooling between ca. 370–360 Ma. Later reheating and deformation along the CCFZ resulted in the growth of a second, finer-grained generation of muscovite between ca. 350–335 Ma. Evidence for ductile deformation is preserved as foliations, folds, and boudins, whereas brittle deformation is indicated by faults and tension gashes. Most shear sense indicators (e.g., asymmetric porphyroclasts, mica fish) indicate east-west dextral movement. This orientation is like the predominantly east-west regional

trend of the CCFZ. Locally, proto-mylonitic granite records evidence for intense ductile deformation. New $^{40}Ar/^{39}Ar$ data will allow for age comparison between deformed and undeformed samples to constrain the timing of pluton and pegmatite emplacement, cooling, and deformation.

Connecting teachers to geoscience through EdGeo workshops

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EdGeo workshops have the potential for significant, practical learning opportunities for teachers. Geoscience is becoming more important with respect to the effects of climate change, increased awareness of geohazards, the need for resources, and the importance of earth science literacy. The combination of people from local universities, Nova Scotia Department of Natural Resources and Renewables, Geological Survey of Canada (Atlantic), Nova Scotia Museum, and teachers from local regional education centres is a major resource that offers expertise in geoscience, pedagogical insights, and teaching experience. In the past, the day and a half long workshops offered time for instructional talks about rocks and minerals, geological problems and hazards, the 'world of geoscience,' and a field trip. The field trips explore local geology and landforms and have included walks in local cemeteries, the examination of building stones in communities, and looking at the boulders of rip rap along the coast. The lesson learned from past EdGeo Workshops is to highlight non-complex, local examples instead of using the 'classic-style geological field trip.' Teachers will often combine a writing exercise in language arts with a geology lesson. This has been developed further in some workshops. Teachers are given time to reflect on what they are learning and what it means to them, mimicking what they may ask their students to do. It is recommended that future EdGeo Workshops focus less on lecturing and more on active learning activities in small groups. The cooperative learning with others in an active learning setting gives participants a 'hands-on' basis in learning. The ideal EdGeo Workshop offers enough hands-on activities, examples of pedagogical insights, and examples of resources so that teachers feel comfortable returning to the classroom to help engage their students to learn more about geoscience.

Teaching environmental geoscience for non-scientists

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Environmental geoscience is an essential part of the fabric of science in this century. We are concerned about the many problems that affect society such as hazardous earth processes, enough potable water, water pollution, strategic mineral resources, and the intervention of government. At Saint Mary's University we teach GEOL 1208 (Environmental Geology) to a variety of students in Arts, Commerce, and Science. Acadia University, Cape Breton University, Dalhousie University, and Saint Francis Xavier University have similar courses. This course is organized in four parts based on the textbook by Edward Keller (UC Santa Barbara): (1) Foundations of Environmental Geology; (2) Earth Processes and Natural Hazards; (3) Resources and Pollution; and (4) Environmental Management, Global Perspective, and Society. Part 1 brings all students to the same level in their understanding about many topics such as earth materials, seismicity, and plate tectonics. Parts 2 and 3 deal with geological processes and geohazards and resources (energy, minerals, water, land, soil, and waste). Part 4 brings attention to society's concern about the influence of geological processes, health and pollution, changes in geological processes due to climate change, politics and science, corruption and graft, and population growth in the physical world. Students are involved in small-group, cooperative learning exercises. One of the most important aspects of class activity is understanding how a geoscientist builds a geological story to get at the 'truth' about a potential geohazard or geological process. These discussions bring together information that challenges students to consider the role of geoscientists in risk assessment, earth science literacy, use of citizen science, and the role of various levels of government in decision making, bylaws, and legislation. These students may learn a theoretical list of geohazards, resource problems, and/or societal implications, but they also work on 'real problems' as if they were hired to do so.

Constraint of Pliocene regolith thickness from ice sheet modelling and present-day sediment

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It is currently unknown how much regolith blanketed North America prior to the intensification of Northern Hemispheric Glaciation during the Pleistocene. Yet this is a key quantity for understanding how the North American landscape has evolved during the late Cenozoic—a landscape shaped by large dynamic ice sheets. While bounds on this regolith thickness are largely non-existent, drawing together multiple lines of evidence from available proxy data, Quaternary sediment record, and the relevant physics may help. What limits on regolith thickness in North America can be inferred from our understanding of Earth-surface processes and the present-day sediment distribution? How does pre-glacial sediment thickness influence the evolution of Pleistocene glacial cycles? These questions can be answered with an ensemble of whole-Pleistocene fully coupled ice sheet-climate-sediment simulations with high-variance parametrizations and range of pre-glacial regolith thickness.

The 3-D Glacial Systems Model is used which incorporates the relevant glacial processes: 3-D thermomechanically coupled hybrid ice physics, fully coupled sediment production and transport, subglacial hydrology, isostatic adjustment from dynamic loading and erosion, and climate from a 2-D non-linear energy balance model and glacial index. This fully coupled system is driven only by atmospheric CO_2 and insolation. The model captures the Pleistocene evolution of North American glaciation: 41 to 100 kyr glacial cycle shift, similar latitudinal extent in the early and late Pleistocene, Last Glacial Maximum ice volume, deglacial ice margin chronology, Pleistocene sea level change and the broad present-day sediment distribution within the parametric and observational uncertainty. Constrained by large scale reconstructions of present-day surface sediment distribution and regional bedrock erosion estimates, these results suggest regolith thickness influenced the size of Pleistocene ice sheets and that this regolith was most likely much thinner than previous studies have concluded.

Kimberlite emplacement conditions as told by experimentally produced reaction coronae on ilmenite macrocrysts

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Kimberlites, the primary host of diamond deposits, are enigmatic rocks emplaced into ancient cratons as pipe-shaped structures. The origin, formation, and emplacement of kimberlite are poorly constrained. Our research aims to place better constraints on the emplacement of various kimberlite lithologies using a novel method. Kimberlites entrain diamonds and other mantle minerals (e.g., ilmenite, chromite, and garnet) and transport them from the mantle to the surface where they react with the kimberlite melt producing: (i) dissolution surface features, (ii) compositional zoning, and (iii) a rim composed of secondary mineral phases (reaction coronae). Our novel method involves analysing reaction products on ilmenite from natural samples and reproducing these in controlled experiments to determine their crystallisation conditions. Natural samples from Orapa kimberlites (Botswana) showed ubiquitous presence of reaction coronae on ilmenite and mineral composition of these coronae, especially Ti-bearing phases (perovskite, titanite, or anatase), varies between different kimberlite lithologies. We examined the stability of ilmenite and the formation of reaction coronae using natural ilmenite grains and synthetic kimberlite melts (with a range of SiO_2/CaO) in piston-cylinder apparatus at 1100–1200°C, 0.5–2.5 GPa. All experiments with kimberlitic compositions produced only perovskite. Titanite appeared in ilmenite corona only in the runs testing assimilation of crustal rocks (granodiorite) by kimberlite melt with at least 6 wt. % of added granodiorite. We found that perovskite is more stable at lower pressure and titanite stable at higher pressure. We see that the stability of perovskite and titanite extends to higher temperatures when the starting composition contains a lower water content. We plan to apply the results from this study to various kimberlite localities and integrate our data from ilmenite with data on chromite and diamonds to better understand the crystallisation and emplacement of kimberlites and their diamond preservation.

Geometry of dissolution trigons on diamonds: implications for the composition of kimberlitic fluid and magma emplacement

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Volatiles, especially H_2O and CO_2, play an important role in kimberlite magmatism. They facilitate kimberlite production in the mantle, drive the fast ascent of kimberlites, fuel their explosive eruptions, and affect preservation of diamonds in kimberlite magma. However, the volatile contents and variations between different kimberlite localities are poorly constrained. We use a novel way to address this problem by utilizing etch pits on diamonds developed during the interaction with kimberlite magma.

We use precise measurements of the size and dimensions of trigonal etch pits (trigons) to compare crystallization conditions in seven kimberlites from the Northwest Territories, Canada. Parameters of 260 trigons on 39 natural diamonds are compared to the parameters of trigons developed in diamonds dissolution experiments to assess X_{CO2} = [CO_2/(CO_2+H_2O)], mol% in kimberlitic fluid, level of volatile saturation in the melt, and crystallization temperature of kimberlites. We integrate our results with H_2O and CO_2 solubilities in kimberlite melts to discuss their effect on kimberlite eruption processes. Diamonds from resedimented pyroclastic kimberlite units show predominantly pointed-bottomed trigons suggesting fluid with X_{CO2} >0.7 and shallow exsolution of volatiles. Diamonds from primary pyroclastic kimberlite units display mostly flat-bottomed trigons indicating fluid with X_{CO2} <0.5 and greater depths of volatile exsolution with possible partial fluid escape. Finally, extrusive and hypabyssal kimberlite units host diamonds with very complex trigons of flat-bottomed shape possibly indicating H_2O-rich magma and exsolution of the fluid at even greater depths with fluid loss during the ascent. The trigons' diameter allowed us to estimate kimberlite crystallization temperature at 1150°C to 1250°C, which agrees well with previous estimates. Our results confirm the important role of H_2O and CO_2 content of kimberlite magma in controlling the depth of fluid exsolution, reaching the magma fragmentation threshold, the style of magma eruption, and lithological infill of kimberlite pipes.

Extreme fractionation and magmatic–hydrothermal transition in the formation of Um Naggat rare-metal granite, Central Eastern Desert, Egypt

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The late Neoproterozoic Um Naggat Granite suite, in the central Eastern Desert of Egypt, is a rare metal-bearing post-collisional, A-type granite associated with Ta-Sn mineralization. It is petrographically discriminated into syenogranite that gradationally changes to alkali-feldspar granite, and a sheet-like cupola of albitic granite. The rare-metal mineralization is restricted to the albitic granite, and is represented by disseminated tantalite, cassiterite, and columbite. Field observations, and geochemical attributes suggest a comagmatic origin for these three granite phases. The continuous variations in most major and trace elements in addition to the temperature and pressure calculations are consistent with the evolution of the least-evolved syenogranite and the moderately-evolved alkali-feldspar granite through extensive fractional crystallization, which produced a residual high-silica melt and a late-stage, high-F magmatic volatile phase. Such a highly evolved melt was parental to the mineralized extremely fractionated albitic granite that formed within the apex to the alkali-feldspar granite. The transitional to mantle A-type signatures of the albite granite is indicated by the low Al/Ga and high Zr+Nb+Y+Ce. Moreover, the robust Zr/Ti fractionation index correlates well with SiO_2, Rb/Sr, high field strength elements (HFSE), and large ion lithophile elements (LILE). The parental magma was derived by partial melting of a lower granulitic crustal source possibly with mantle contribution. The volatile fluxes in these magmas lowered the crystallization temperature of the accessory minerals, extending the duration of quartz and feldspar crystallization, and allowing HFSE elements (including REE, Y, U, Th, Sn, Ta, and Nb) to behave incompatibly. The rare-metal enrichment was further promoted by volatile complexing, i.e., hydroxide and fluoride complexes. Extensive differentiation leads to the volatile exsolution enriched in HFSE elements. Intense fluid-rock interaction occurred at the most advanced stage of magmatic evolution, leading to greisenization, albitization, chloritization forming with the quartz veins, causing mineralization within the albitic granite.

Gold metallogeny of southwestern New Brunswick, Canada

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The New Brunswick segment of the Canadian Appalachian orogen exhibits diverse gold deposit types, associated with different phases of the Appalachian orogenic cycle and subsequent erosional processes. In the southern part of New Brunswick, orogenic-type gold deposits are predominantly found in the Annidale, New River, and Caledonia belts. Conversely, the St. Croix and Mascarene belts are focal points for intrusion-related gold mineralization in the region. Numerous occurrences in this area consist of gold-bearing quartz veins concentrated along fault-related structural features that also locally control dyke emplacement as well. The fundamental controls on mineralization are focusing fluid flow into these structures that were active mainly in the Neoacadian orogeny. The brittle-ductile transition typically has focused host-rock alteration and sulfidation features forming with sulfide-bearing quartz veins (intrusion-related)

and quartz-carbonate veins (orogenic); these veining events reflect fluid overpressures and are coincident with higher gold grades. A significant portion of the recognized gold resources in the area lies within either orogenic or intrusion-related systems, capturing the primary focus of ongoing gold exploration efforts. Gold was mined from the orogenic-type deposit located at Cape Spencer in southern New Brunswick. Recent exploration activities, which involve expanding known gold deposits and discovering new gold zones in the Clarence Stream gold district, in particular southwestern New Brunswick, have notably enlarged the gold inventory. Consequently, this has heightened the potential for future development of these intrusion-related auriferous deposits. In addition, the observed sodic-potassic alteration in the Pocologan Harbour granitoid belt suggests that the IOCG-related mineralization may possibly extend beyond Nova Scotia's Cobequid Highlands. It implies that the magmatic-hydrothermal system might have commenced as early as the Early Devonian period. Also, several gold occurrences are present within the Fundy Shear Zone, which encompasses multiple deep-rooted faults, revealing panels of sedimentary, volcanic, and granitoid rocks, along with mylonite.

Energy decisions today affect future generations

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Geoscientists are not usually nuclear physicists. However, most are concerned citizens of the world and respect those yet to be born. One alternative to fossil fuel use that has been presented as a "clean" energy source is nuclear power. In using nuclear fission reactions, lethal by-products are produced that require thousands of years of guardianship including protection from natural disasters, terrorists, rogue presidents/leaders, dictators, and societal collapse. Climate change will not directly kill those yet to be born. Uncontrolled radioactivity will. There is concern that nuclear power is being promoted as the best alternative to fossil fuels. The by-products of nuclear energy are not clean and require a long legacy of careful management to ensure safety. The information from the nuclear industries that it is the solution to eliminating fossil fuels is perhaps misleading, as the industry has not highlighted the information about the long legacy of nuclear waste management required for millennia. Nuclear power generation including Small Modular Reactors (SMRs) is three to four times more expensive to build and operate as compared to renewable energy sources. There is an opportunity now to do something for those yet to be born. Making energy decisions now that the descendants' descendants will appreciate and deserve has never been more timely.

Toward reconstructing the relative sea-level history of Chedabucto Bay, Nova Scotia, Canada

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Approximately 2.75 billion people globally live near a coastline and in Nova Scotia a substantial 70% of the population resides in coastal communities. The global rise in sea level due to anthropogenic climate warming has been amplified in Nova Scotia by local glacio-isostatic crustal subsidence, resulting in a rate twice as fast as the global average. In order to understand how coastlines in Atlantic Canada will evolve in response to future sea-level rise, it is imperative to understand how they responded to past relative sea-level (RSL) changes of a similar magnitude following the last glaciation. Coastlines in Nova Scotia are paraglacial, meaning that the geomorphology and morphodynamics of the coasts are largely controlled by glacigenic deposits from the latest glaciation. Across Nova Scotia, RSL has generally risen during the Holocene, but at different rates due to the influence of glacio-isostatic adjustments. In eastern Nova Scotia, Chedabucto Bay is known to contain uniquely preserved drowned sand and gravel barrier beach deposits which record step-wise coastal retreat following an early Holocene lowstand. This site lies between two established relative sea-level curves in Halifax Harbour and the Bras d'Or Lakes, Cape Breton Island, and presents an opportunity to reconstruct past paleogeographic changes over millennia of sea-level rise while also facilitating refinement of the post-glacial RSL curve for the region. The study will build on decades of previously collected data and interpretations combined with recently collected sediment cores, geophysical data, and anticipated multibeam bathymetric mapping efforts. The results of this work will help inform how coastlines in Atlantic Canada are expected to respond to sea-level rise, guide science and policy on managing shoreline retreat and coastal flooding, and provide new RSL constraints to improve glacio-isostatic adjustment models for North America.

Demonstrating the importance of using glaciotectonics as a glacial erosion process

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Ice sheets have contributed a first-order degree of high-latitude erosion, mainly through quarrying and abrasion processes. However, while evidence of glaciotectonism has been observed globally, it has never been evaluated as a similarly efficient glacial erosion process. Glaciotectonics are the result of immense stress on the upper hectametres of Earth's surface from the ice sheet dynamics. Large rafts of bedrock and sediments interpreted to be displaced by several metres to kilometres in distance can be decametres thick over hectares. In Canada, large glaciotectonic rafts often occur in clusters and have been identified on the Atlantic shelf and across the southern prairies. Other features interpreted to be ice-shoved hills similarly suggest the subglacial transport of larger masses with various degrees of brittle and ductile deformation. These features are widespread, occurring through many parts of North America and other continents. A map being compiled of North American glaciotectonic features (global distribution in the future) will help constrain the subglacial conditions and stresses required for their occurrence. For instance, it has been widely observed that evidence of glaciotectonism is associated with unconsolidated sediments or sedimentary/metasedimentary bedrock. These substrates tend to be relatively mechanically weak, leading to the possibility of more efficient subglacial entrainment. Correlating these features by geographic location will help to establish how glaciotectonism acts as an erosive process and the range of rates that may be expected.

Evaluation of suitable subsurface repositories for nuclear waste requires constraints on glacial erosion efficacy over timescales of millions of years. Although glaciotectonics can remove decametre-thick rock in one event, it is not clear how frequent during a single glaciation the process may repeat. Owing to the concealment of most glaciotectonic deposits underground or underwater, the extent of the process is also not known. Addressing these questions will better inform nuclear waste management strategies and help improve the knowledge of landscape evolution of million-year timescales in glaciated regions.

Evaluation of Li-(Rb-Cs) mineral host domains at the East Kemptville Sn-(Cu-Zn-Ag) deposit, Nova Scotia, Canada

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The ~385–368 Ma South Mountain Batholith comprises 11 plutonic centers, including the Davis Lake Pluton that hosts the East Kemptville Sn-Cu-Zn-Ag deposit (mined 1985–1992). In addition to Sn, other strategic elements of interest (e.g., group I alkali metals Li, Rb, and Cs) are the focus of recent exploration. Bulk rock Li (up to ~3000 ppm) is controlled by mica abundance, highest in metasedimentary country rocks in the leucogranite contact zone, and comparable to low grade Li stockpiles globally. High bulk rock Sn concentrations (up to ~1 wt % Sn) are always associated with low Li concentrations (<1500 ppm). Bulk rock Li-Rb-Cs correlate strongly and two trends are noted: (i) for the leucogranite, fractional crystallization led to increasing Li (up to ~1000 ppm), whereas (ii) in the metasedimentary rocks/contact zone, Li concentrations do not follow normal fractionation trends. In the leucogranite, zinnwaldite-annite-phlogopite solid solution ("zap-ss") is the main Li-Rb-Cs carrier (up to~9500 ppm Rb and 1.4 wt.% Li; >70% of bulk rock Li) in contrast metasedimentary rocks in the contact zone where muscovite-trilithionite solid solution ("mt-ss"; up to ~9500 ppm Rb, and 1.4 wt.% Li) hosts >90% of Li-Rb-Cs. Li-bearing micas in the contact zone likely grew during contact metamorphism during infiltration of early granite-derived fluids. Mineralogical hosts for Li-Rb-Cs can only be differentiated reliably using Raman and IR spectroscopy, offering inexpensive means to quickly screen samples for their Li content without assay. Notably, diagnostic absorption and Raman shift features are insensitive to orientation/grain size, applicable to drill core samples without additional sample preparation.

Perspectives on transformational energy geoscience: the evolution in western Canada

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The Western Canada Sedimentary Basin is considered a "global supergiant" in terms of absolute volumes of hydrocarbons both in place and cumulatively produced. As of January 2024, total global population is estimated to be 8.1 billion people, an increasing proportion of which are leading more energy-intensive lifestyles. Concerns are mounting regarding anthropogenic climate change, not least of which is attributed to the modern standard of living.Over the last decade, there has been a strong research interest by academic institutions, industry, geological surveys, and other government organizations in examining alternative types of energy geoscience. In 2022, members of the Canadian Society of Petroleum Geologists (CSPG) voted to rebrand to the Canadian Energy Geoscience Association (CEGA) to more accurately reflect the diverse needs of its membership. CEGA members are involved in a wide variety of projects and companies focused on alternative energy production, energy and carbon storage, and lowering emis-

sions, including: (1) Eavor Technologies Inc., which has developed a closed-loop geothermal system to provide baseload power, and is currently being deployed in Germany; (2) Entropy Inc.'s Glacier facility, a commercial carbon capture and storage project in west-central Alberta; (3) E3 Lithium, which has developed a proprietary extraction technology that concentrates lithium ions from saline formation waters, for use in Li-ion batteries; and (4) Atlas 2027, a joint initiative among CEGA, the Geological Survey of Canada, provincial and territorial surveys, academia, and industry to update the 1994 Geological Atlas of the Western Canadian Sedimentary Basin with additional chapters on critical minerals and pore-space resources. This talk summarizes some of the recent and ongoing work supporting the energy transformation in western Canada and demonstrates that energy geoscience is both thriving and continuing to evolve.

Characterization of calcite amygdules in Devonian basalts in the McArras Brook Formation, Nova Scotia, Canada

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Vesicular basalts in the McArras Brook Formation, Nova Scotia, Canada are host to calcite amygdules and veins. These basalts are interbedded with well characterized Devonian rocks but have not been directly dated. Through U–Pb dating elsewhere, calcite amygdules have been shown to form shortly after the eruption of the host basaltic lava. Secondary processes lead to the formation of overgrowths on existing calcite amygdules and low-T veins. These features may form during tectonic emplacement and thus, multiple generations of calcite can also be found in the same suite of basaltic rocks. Before the U–Pb ages of both volcanism (amygdule formation) and later tectonic activity (secondary calcite) can be accurately measured and used as a proxy for the age of the basalt flows, the growth history of the calcite amygdules and veins must be carefully characterized. In this study we have used basic textural relationships and UV fluorescence to examine calcite growth history, both in the field and in collected samples. In-situ UV-fluorescence shows the growth of several generations of calcite amygdules and veins in the basalts from McArras Brook. We will use the UV characterization to help target analysis of different generations of calcite using a scanning electron microscope (SEM), and laser-ablation-induced-coupled-plasma-mass-spectrometer (LA-ICP-MS) for both major- and trace-element compositions. The results are expected to identify activator elements in the calcite which correspond to the differences in fluorescence colour, and correlate element compositions to the growth history. This process will allow targeting of the best areas for subsequent U–Pb dating of calcite to determine the absolute (volcanic) ages of these basalts, and the ages of secondary processes.

Kinematics of the Middleton Fault: implications for the fault history and regional tectonics in south-central New Brunswick, Canada

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A new correlation of surface outcrops and industry borehole data has led to a significant refinement of fault kinematics in the Central Norton to Jordan Mountain areas of south-central New Brunswick. The newly defined Middleton Fault is between the regional northeast-trending Belleisle and Kennebecasis faults. In the Central Norton and Millstream areas, the sedimentary units are grey-green fine-grained sandstone, shale, and coaly horizons that fall within the informal Zone 2–3 palynology age (middle Tournaisian) of Dolby's classification system. At Central Norton, a similar grey-green unit is deformed and truncate to the northwest against Silurian basement rocks at the footwall of the Middleton Fault. Approximately 24 km to the northeast at Millstream, this unit is deformed and truncated to the southeast at the hanging wall of the Middleton Fault, against red beds that are interpreted to be part of the upper Tournaisian Sussex Group. These relations imply approximately 24 km of dextral displacement of the grey-green unit. From new palynology results near Norton, the revised geologic map shows the Kennebecasis Fault cutting the Middleton Fault near Perry Point in Kennebecasis Bay. As a result of this modification, coupled with seismic interpretation, the Middleton Fault is now believed to extend, relatively uninterrupted, about 120 km northeast from Perry Point before being truncated by the Belleisle Fault northwest of Moncton. On seismic profiles, the Middleton Fault cuts Sussex Group strata but does not appear to cut Visean Windsor Group strata, which therefore implies that the 24 km of dextral movement on the Middleton Fault is constrained to the late Tournaisian. This new interpretation has profound implications for the extent of the dextral displacement on the Kennebecasis Fault, and the fault kinematics and nomenclature of the Carboniferous subbasins to the northwest.

The reassembled Barnes Fossil Collection that went to Paris

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William Henry Barnes (1835–1870?) was a mining engineer who worked at Nova Scotia gold sites in the 1860s. In the summer of 1866 William Barnes was commissioned to establish a collection of fossil plants representative of Cape Breton Island. These fossils were organized and curated by Rev. David Honeyman, who was overseeing the Nova Scotia exhibits for the 1867 International Exposition in Paris. This exhibit was viewed by three million people over the span of 7 months, between April 1st and November 3rd. The Barnes Collection included over 80 paleobotanical and other fossil specimens.

Portions of the Barnes Collection were then given scientific attention, particularly the wing of a giant insect *Haplophlebium barnesii*, and the large pectoral fin spine *Gyracanthus magnificus*. Photographs of the specimens were provided to J.W. Dawson by Honeyman as drawing references for publication. This appears to be the source of some confusion when Dawson cited that the fossil wing was found in Baddeck by "James Barnes, of Halifax". James Barnes (1834–1883) was born in England and immigrated to Halifax. Honeyman was not known to have taken photographs; however, James Barnes was a publisher, and might have provided photographs of the fossil specimens, his name perhaps attributed along the photograph's edge. The Barnes Collection became part of the founding collections of the 'Provincial Museum', now the Nova Scotia Museum, when it formed in 1868. Over the past 150 years the collection has been separated in taxonomic and stratigraphic storage; however, this past summer the Barnes Collection was the focus of new curation and research, documenting and bringing the fossils together again for the first time. The new research provides insights into the history and culture of geology in Nova Scotia, and specifically Cape Breton Island, at the time of the dawning of Confederation.

Hummocky-like stratification and links to faulting on the passive Laurentian margin

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The Cambrian-Ordovician Cow Head Group of Western Newfoundland consists of allochthonous strata that provide a record of submarine carbonate sedimentation on the Laurentian margin. The most striking facies are catastrophic boulder limestone megaconglomerate (chaotic boulder conglomerate with large blocks up to >5 m) of the Upper Cambrian Downes Point and terminal Cambrian to Lower Ordovician Stearing Island members of the Shallow Bay Formation. While most authors agree that seismicity was involved in the initiation of megaconglomerate transport, the cause of slope failure and sedimentation has also been linked to eustatic regression. To detail the potential effects of faulting on sedimentary processes and elucidate tectonic versus eustatic control, facies analyses was undertaken from the Late Cambrian and Early Ordovician sections of the Shallow Bay Formation. Most facies are consistent with submarine sedimentation below storm wave base, suggesting a slope setting. However, the discovery of hummocky cross-stratification (HCS) and oscillatory ripples occupying the Tc interval of Bouma sequences suggests a significant influence from waves, and perhaps a much shallower sedimentary environment. Nevertheless, paleobathymetric constraints can be used to contextualize and understand these wave-formed features. For example, the megaconglomerates are generally clast-supported with extrabasinal white algal boulders and blocks surrounded by intrabasinal lime mudstone to grainstone clasts and lack a cohesive matrix, indicating sedimentation as slumps with short transport distances. Paleoflow directions are dominantly toward the south, and the coarsest clasts occur in the northern sections of the allochthon, suggesting the presence of a steep slope oriented 90° to the paleomargin. Moreover, isotopic data suggest progressive basin confinement from the late Cambrian onward. In this context, the genesis of HCS and oscillatory ripples are explained by the reflection of turbidity currents against fault scarps in a confined basin, resulting in the development of an internal shear boundary and propagation of oscillating currents to the bed during deceleration of turbidity flows.

Dynamic geocellular modeling of geological carbon storage in Jurassic-Cretaceous deep saline aquifers on the Scotian Shelf, Canada

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Numerous quantitative carbon storage assessments and atlases have been published in the 21st century with five editions of the USA–Canada atlas from 2007 to 2015. However, world-class storage resources in contiguous, deep saline aquifers offshore New England and Nova Scotia were not quantified publicly until 2019 in the USA and

2022 in Canada: P10-50-90 range of 150–479–1136 Gt (US DOE); low-medium-high of 7–151–1280 Gt (Dalhousie University and the Nova Scotia Department of Natural Resources and Renewables). These wide ranges reflect uncertainty in effective pore-volume, storage efficiency, and the density of supercritical CO_2 below 800 m. Pore-volume ranges can be estimated via geocellular models with sufficient structural and porosity-permeability data or using elementary calculations based on area and average aquifer parameters (gross thickness, net-to-gross ratio, effective porosity, 1-irreducible water saturation). Storage efficiency factors are more complex, typically in the 1–3–5+% range in atlases based on laboratory measurements and numerical modeling. But there is growing recognition that this range should be more limited (0.5–1.0%) in restricted systems when the risk of pressure build-up and topseal failure is minimised. At Dalhousie, the regional static modeling (in Schlumberger Petrel) has continued into geoscience-engineering undergraduate projects dynamically modeling (in Schlumberger Eclipse) a core area of the Kimmeridgian-Cenomanian Sable Island Delta updip of hydrocarbon fields near Sable Island. In this area, sparsely faulted, hydrostatic, Mesozoic aquifers ascend landwards, onlapping pre-rift basement, and - approaching the coast - subcrop near seabed glacial deposits beyond the termination of the regional Cenozoic topseal wedge. This study looks at migrating CO_2 plumes relative to potential topseal failure and the risk of seabed leakage (deep saline aquifers rely initially on residual/capillary trapping and do not require structural-stratigraphic traps). Variable injection rates, pressures, duration (typically 10s years injection, 100s–1000s equilibration), stratigraphic architecture, and connectivity to the ocean and atmosphere via the seabed are used.

Temporal variations in rare-earth-element distributions in the Cenozoic succession and modern sediments of the Cayman Islands

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The rare earth elements (REE) in limestones/dolostones that develop on isolated oceanic islands like the Cayman Islands were acquired from the seawater in which they formed and various diagenetic processes that led to their lithification and, in some cases, dolomitization. Modern sediments from North Sound, Grand Cayman, contain up to 30.93 ppm ∑REE and 45.23 ppm ∑REE + Y, whereas modern corals contain up to 2.30 ppm ∑REE and 3.65 ppm ∑REE + Y. The limestones/dolostones in the Brac Formation (upper Oligocene), Cayman Formation (Miocene), and Ironshore Formation (Pleistocene) generally contain <7 ppm ∑REE and <10 ppm ∑REE + Y. In contrast, the Pedro Castle Formation (Pliocene) contains up to 14.18 ppm ∑REE and 20.81 ppm ∑REE + Y. Distribution coefficients for the REE from the modern Cayman corals are similar to those determined for corals elsewhere in the world. In the modern sediments from North Sound there is a high correlation between the ∑REE + Y and Fe and Al but a low correlation with Na and Mn. In contrast, the correlation between the ∑REE + Y and other elements in the Ironshore Formation limestones and Brac and Cayman formations dolostones/limestones are low. The light REE are >Limit of Quantification (LoQ) in most samples, whereas the medium REE and heavy REE are commonly <LoQ. There is no recognizable pattern to the presence/absence of the light, medium, and heavy REE. Collectively, these data show that: (1) REE in the limestone/ dolostone succession on Grand Cayman are similar to those from Cayman Brac; (2) dolomitization does not seem to have modified REE of the original limestones; and (3) REE content in limestone and dolostone of the Pedro Castle Formation is higher than REE contents in the Brac and Cayman formations. This difference may indicate that the concentration of REE in the seawater during the Pliocene highstand was higher than when the original sediments of the Brac and Cayman formations were deposited.

Porphyry-low sulfidation epithermal systems of the Woodstock area, western New Brunswick, Canada: mineral systems approach and random forest-based mineral prospectivity mapping

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The Woodstock area, located between the Woodstock and Meductic faults, comprises Cambrian-Ordovician rocks of the Miramichi terrane. The large granitic intrusions of the Ordovician-aged Benton, Gibson, and other felsic intrusive units with smaller outcrops (such as Connell and Sharps mountains) within the Miramichi terrane caused proximal to distal Cu, Mo, Au, Ag, Bi, ± W, ± Zn mineralization related to porphyry- style and related low sulfidation epithermal-style systems. Thirty-five mineral occurrences and deposits with these characteristics, including the important Connell Mountain porphyry Cu-Au deposit, are recorded within this area. Herein, the mineral systems approach is used

to connect conceptual models of mineralizing systems and accessible exploration data with the goal of mineral prospectivity mapping (MPM). According to available data and the proposed model, we developed a suite of spatial vectors describing the main ore-forming processes. Cu, Mo, Au, Ag, As, Sb, Zn, and Co vectors of till geochemistry; K, eU, eTh, eTh/K, eU/eTh, and eU/K vectors of radiometric data; reduction-to-pole, analytic signal, and first-vertical-derivative vectors of aeromagnetic data; intrusive units, faults, and lithological contact vectors were utilized for mineral prospectivity mapping in the Woodstock area. The primary focus lies on translating the critical processes involved in the mineralization into a series of spatial vectors. Competent vectors, which strongly correlate with known mineral occurrences in the Woodstock area, were distinguished from those with minimal association with mineral deposits. Receiver Operating Characteristic (ROC) curves are employed as a measure for this spatial assessment. The area under the curve (AUC) and its standard deviation, Z-AUC, measures of aggregated classification performance in machine learning, are applied to measure the performance of spatial vectors. Considering occurrences and deposits in the Woodstock area, we developed a random forest (RF)-based prospectivity model for porphyry-epithermal prospectivity mapping.

Auriferous fluid evolution and the role of carbonaceous matter in a saddle-reef Au deposit: Dufferin deposit, Meguma terrane, Nova Scotia, Canada

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The metaflysch-hosted ~380 Ma Dufferin Au deposit in the Meguma terrane of Nova Scotia, Canada, is a typical metasedimentary rock-hosted orogenic gold deposit with mineralized saddle reef-type quartz veins localized between metasandstone and black slate in a tightly folded anticline. Ubiquitous to the veins is carbonaceous material (CM), occurring as immature organic matter (i.e., pyrobitumen), lining cavities and along grain boundaries proximal to vein contacts or wallrock fragments. The occurrence of native Au inclusions (≤1 μm; 88–92% Au; balance Ag) in CM-filled cavities indicates that gold mineralization is genetically related to CM. Through a combination of micro-analytical methods, we show that Au precipitated through the coupled fO_2 reduction and pH increase of aqueous-carbonic fluid (H_2O-NaCl-CO_2, N_2, CH_4) that was Au-undersaturated (0.045 ± 0.024 ppm Au; 1σ; n = 58). Importantly, Au-bearing fluids were always petrographically late, occurring exclusively as secondary inclusion assemblages in recrystallized quartz domains. The proposed mineralization mechanism is supported by: (i) a decrease in Au and redox-sensitive semimetals (As, Sb), and an increase in the concentration of elements inherited from metasedimentary wall rocks (i.e., Mg, K, Ca, Sr, Fe) in saddle-hosted fluid inclusions with time; (ii) a corresponding decrease in the X_{CO2} from Au-bearing to Au-depleted fluids, consistent with CO_2 removal via reduction/respeciation and late carbonate precipitation; and (iii) gold embedding in or on the surface of CM inside mineralized cavities and fractures.

Despite mineralizing fluids only transporting low concentrations of Au, far from saturation ($[Au]_{calc.}$ ≈ 0.1–2 ppm), they produced Meguma-type (metasedimentary rock-hosted) deposits indicating that the efficiency of Au precipitation from these fluids was high, a process promoted by the presence of CM. This work illustrates the role played by CM during gold mineralization in the Meguma terrane and re-emphasizes CM as a potential prerequisite for efficient gold precipitation within similar orogenic metasedimentary settings globally.

Updated Northwest Atlantic bomb-^{14}C reference chronology to the year 2022 from deep-water gorgonian corals

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Radiocarbon (^{14}C) analysis is an important tool in chemical oceanography. Nuclear bomb testing in the middle 20th century added artificial ^{14}C to the surface ocean, which is useful for tracking the movement and mixing of water masses. However, ^{14}C data for the Northwest Atlantic are significantly lacking, so proxy records of seawater ^{14}C are needed. A more complete record of past ^{14}C variability could better constrain the changing influence of water masses off eastern Canada, one of the fastest warming regions globally. Bomb-^{14}C reference chronologies are also critically important for dating materials such as fish otoliths, clams, corals, and sediments. However, the few available bomb-^{14}C chronologies for the Northwest Atlantic do not extend into the early 21st century or are limited by other factors. In this study, a combined time-resolved ^{14}C data from the gorgonin fraction of deep-water gorgon-

ian corals collected from the Northeast Channel, Laurentian Channel, and Gulf of Maine create an updated bomb-^{14}C reference chronology for the Northwest Atlantic. Gorgonian corals are ideal bio-archives of seawater ^{14}C since they are long-lived and secrete annual growth rings composed, in part, of organic gorgonin. The gorgonin fraction encodes the ^{14}C signatures of freshly exported organic matter from the marine mixed layer. Preliminary ^{14}C time histories from the organic fraction of the corals spanning the late 1950s to 2022 track the known pulse and subsequent decrease in mixed layer bomb-^{14}C activities. Specifically, the ^{14}C values align with in situ surface water ^{14}C data measured in the years 1997, 2003, 2012, and 2022. This updated chronology will be useful for a wide range of applications for which precise dating of natural marine materials over the last several decades is needed.

Portable X-ray fluorescence (pXRF) as a screening tool for characterizing historical tailings from the Lake George antimony mine, New Brunswick, Canada

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The Lake George antimony mine in New Brunswick operated intermittently from 1876 to 1996 and was once North America's largest primary antimony (Sb) producer. The mine shut down in 1997 because of mechanical issues and falling Sb prices. Mine tailings are currently stored in a tailings pond that represents an ongoing risk to the local environment. In this study, a portable X-ray fluorescence spectrometer (pXRF, Olympus Vanta™) was used as a preliminary assessment tool to analyze a suite of elements, including Sb, As, Fe, Pb, Ba, Rb, and U, in 29 tailing samples from part of the tailings pond. The calibrated pXRF data (120 s integration at each of three energy levels in soil mode) were analyzed using Cluster diagrams (dendrograms), Pearson Correlation Coefficients, and Principal Component Analysis (PCA) to understand the correlations among elements. Based on these methods, close correlations are evident between Sb and Fe, Pb, Ba, Rb, Y, V, K, Co, Cr, and W, as well as positive correlations between S, U, and Ca. Preliminary results indicate that the high correlation between Sb, Fe, and Pb can be attributed to the presence of insoluble secondary minerals, like bindheimite ($Pb_2Sb_2O_7$) and iron antimonates such as tripuhyite ($FeSbO_4$) and schafarzikite ($FeSb_2O_4$). Mean concentrations of Sb and As exceeded the Canadian Soil Quality Guidelines by more than 100 and 300 times, respectively. Antimony is commonly associated with As in tailings; however, our pXRF results suggest that As and Sb exhibit different geochemical behaviour in the weathering environment. The results of this study show that pXRF is a valuable tool for quick and easy assessment of tailings compositions and metalloid distributions. These analyses help to guide further subsampling and selection of samples for more quantitative chemical and mineralogical characterization using conventional and newly developed analytical techniques.

Anthropogenic scour of muddy seabed: assessing magnitude of sediment disturbance by fishing and shipping activities

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Distribution, density, and other metrics of seabed scour by past and present anthropogenic activity is assessed from Autonomous Underwater Vehicle (AUV) deployments in Emerald Basin, Scotian Shelf, and Halifax Harbour. Curvilinear otter board trawl marks in soft mud at up to 250 m water depth in Emerald Basin reflect groundfishing impact. High resolution (35 cm) acoustic bathymetric and backscatter data show dense, intersecting cuts on the seabed, 2–3 m wide and 10–20 cm deep, and a near-ubiquitous otter board skipping behaviour. Cut depth matches a modern mixing interpretation of C^{14} and Pb^{210} sediment core analyses from previous studies. Mud disturbance volume is semi-quantified to 38.0×10^3 m^3/km^2 at one site and 42.4×10^3 m^3/km^2 at another. Trawling disturbance is similar despite sites lying in high versus medium zones of trawling based on Vessel Monitoring System reporting by fishers (2014–2018). One interpretation is that long-term cumulative trawl disturbance involves more than 100% of the seabed, spanning the entire basin. Neither habitat effect nor carbon sequestering or release is addressed rigorously but the sediment is chemically characterized from existing literature, showing low total organic carbon (1.0 ± 0.7%) and moderate $CaCO^3$ amounts (7.7 ± 4.5%). The Bedford Basin survey also shows scour, many with a plumose plan view, characteristic of anchor and chain impression and drag across a large expanse of mud seabed at 75 m depth and shallower. Largest cuts exceed 65 cm and 30 cm cuts are common. Extensive wartime ship mooring is likely responsible but repeat surveys prove it is on-going. Cores also confirm the turbation by anchor scour. Our findings demonstrate the role that direct seabed observation of anthropogenic impact contributes and emphasize the responsible but repeat surveys prove it is ongoing. Cores also

confirm the turbation by anchor scour. Our findings demonstrate the role that direct seabed observation of anthropogenic impact contributes and emphasize the knowledge gaps on the effect of trawling on benthic habitats and quantification of potential release of sequestered carbon on continental shelves.

Palynological biostratigraphy of the Tournaisian Horton Bluff Formation of Nova Scotia and its implications in New Brunswick, Canada

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The Upper Devonian to Tournaisian Horton Bluff Formation is part of the widespread Horton Group in the Maritimes Basin of Atlantic Canada. The Blue Beach–Horton Bluff type area in Nova Scotia has been known for its early, terrestrial tetrapod fauna since the pioneering work of Logan and Dawson. It is one of the few places in the world from which tetrapod remains are known within "Romer's Gap", and possibly the oldest. The age of the Horton Bluff Formation is primarily constrained by macrofloras and palynology (miospores). Questions about the existing palynological biostratigraphic zonation in this area and its correlation to local (New Brunswick) and European (e.g., Scotland) locations arose when evaluating historical work. Whereas a small number of samples have been analysed from high in the section, a systematic palynological study of the entire tetrapod-bearing interval has not been published. New samples were taken from Horton Bluff coastline in Nova Scotia, commonly referred to as Blue Beach, and from tetrapod-bearing strata of the Albert Formation near Norton, New Brunswick. These strata should preserve subdivisions within the *Vallatisporites vallatus* miospore biozone: the *Claytonispora distincta* and *Spelaeotriletes cabotii* subzones (informally "spore zones 2 and 3"), but the exact position of the subzone boundary cannot be confidently identified from pre-existing data. Preliminary results and taxonomy of samples across the *Claytonispora distincta* and *Speleaotriletes cabotii* subzones in both areas suggest that significant modifications to the existing zonation scheme will be required. The study will also allow relative correlation between the Blue Beach, Nova Scotia and Norton, New Brunswick, localities, providing a greater understanding of how these Maritimes Basin sites relate, and refines the correlation of both areas to the global biozonation.

Tidal energy resources and development in Nova Scotia, Canada

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As Nova Scotia looks to shift its energy production from hydrocarbon-reliant to more sustainable sources, the risks of these projects must be considered not just in terms of environmental impact, but the impact that humans will face without this transition. Tidal energy may just be the energy source that is needed. It is widely available in the Maritimes –with Nova Scotia having the worlds largest tidal range– consistent in its production with minimal impacts on sediment transport (hydro dams). When looking at a new energy resource a classification is completed to determine its viability for the free market. This falls under the United Nations Framework Classification or UNFC. The UNFC considers three categories, the first being the project's economic, social, and environmental viability–community support, or short-term impacts on the environment, and likelihood of project continuation based on these criteria. The next category looked at is technical feasibility–the likelihood that construction and production will occur from this project. The last category for a UNFC is degree of confidence in the project. Looking at product quantity that will be manufactured by a project while considering all potential uncertainties and applying a level of confidence. Within this UNFC the focus will be on economic, social, and environmental viability of the recently cancelled Minas Passage Tidal plant proposed by Sustainable Marine Energy in congruence with the Fundy Ocean Research Center for Energy (FORCE). Particularly surrounding species and ecosystems that would be affected and potential mitigation. The need for an energy transition is imminent. Government and academia should be looking at ways to help push this transition forward through alteration of environmental legislation to consider negative impacts to human populations if proposed projects are not passed and to develop infrastructure with fewer environmental impacts.

A dualistic model for rare-metal mineralization in the Beauvoir Granite, France: insights and relevance for other mineralized settings

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The Beauvoir Granite (BG, Massif Central, France) lies in the European Variscan belt of rare-metal (RM) - rich peraluminous granites. This highly evolved lepidolite-two feldspar-topaz-amblygonite granite is mined for high-quality kaolinite in its exposed roof, but is known, based on historical (GPF1 hole of 1980s) and recent (Imerys, France) drilling to contain a substantial resource of Li(-Sn-W-Ta-Nb; planned production from 2028 onwards of 34kt/annum of LiOH with accessory RMs). Previous work on the BG was possible due to the ca. 900 m deep drill hole (GPF1) that has been intensely studied. This work highlights the presence of three mineralized granitic units (B1, B2, B3) having continuously elevated grades of Sn (200–1400 ppm) and Ta (20-400 ppm) reflecting magmatic cassiterite and columbite/tantalite phases (CTP). Here we report our recent findings based on observations in the open pit supplemented with core (GPF1, recent drilling) and the detailed study (petrographic, SEM-EDS, optical CL) of 150 archived polished thin sections through the GPF1. Despite appearing fresh with apparent igneous textures (idiomorphic to hypidiomorphic, equigranular to seriate), our studies suggest pervasive coupled dissolution and precipitation (CDP) of >60% of the BG based on feldspars being extensively pitted and inundated with fluid inclusions (FI), perthitic textures defined by FI trails, fractured and pitted plagioclase (Ab_{100}) lined by secondary apatite-illite, and amblygonite pseudomorphed by Na-Ca-Al-P-F phases. That euhedral to subhedral RM phases occur in feldspars and mica is consistent with a magmatic origin, but oscillatory zoned CTPs are often displaced by complexly zoned areas with variable Ta/Nb, secondary microlite, and pitted textures suggesting fluid-mediated CDP. Primary, near critical-type FI near topaz margins indicates onset of fluid saturation in the BG before hitting its solidus. Thus, we suggest a dualistic magmatic-hydrothermal model to accommodate our observations, which likely applies to many other RM mineralized felsic settings, including RM pegmatites.

Mafic sills in the Meguma terrane, southwestern Nova Scotia, Canada: petrology, tectonic setting, and ages

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In the western part of the Meguma terrane from Wolfville to Yarmouth the Cambrian to Devonian Goldenville, Halifax, and Rockville Notch groups are intruded by mafic sills. The sills are divided into Type I and Type II based on field relations, textures, and alteration. Type I sills are likely contemporaneous with their host rocks and display vesicular or peperitic textures near convolute top margins, making them ideal way-up indicators for the host sedimentary rocks. They are generally 1–5 m wide and are folded with their host rocks. The Type II sills are generally much thicker (up to 100 m) and have sharp contacts on top and bottom margins, and no differences in textures in any part of the sills. They also have more extensive carbonate, silicic, and epidote alteration than the Type I sills. The two types of sills have similar geochemical signatures, and all were formed in a within-plate environment with compositions that are mainly alkalic. Chemical analyses of about 120 samples show a range in SiO_2 from about 35% to 51% with $Fe_2O_3^T$ from 9% to16%, MgO from 3% to 11%, and CaO from 2% to 11% (CaO > MgO for all samples). Alteration is variable as shown by LOI values ranging from 1% to 15% and Sr values of 250–1300 ppm which suggest extensive fluid migration and alteration, complicating the use of chemical data in these sills. Additional chemical analyses with more trace-element data, including rare-earth-elements, may reveal subtle differences between sill types. Laser ablation ICP-MS U–Pb isotopic analysis will use zircon to determine crystallization ages for both types and apatite to determine cooling ages for the sills. These ages will determine if Type I and Type II sills formed from a singular intrusive event or multiple over time.

Implications of Nova Scotian geostorage opportunities: geocellular models for carbon sequestration in the Scotian Shelf

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Growing global attention towards geological storage (or geostorage) for the purpose of carbon dioxide capture and sequestration (CCS), sets Nova Scotia in a position to benefit and contribute significantly to global climate targets. The Intergovernmental Panel on Climate Change (IPCC) recognises the Scotian Shelf 's contiguous saline aquifers as an ideal location for large scale CO2 injection projects. A realistic CCS project on the Scotian Shelf requires detailed quantitative analysis; industry and government investment;

regulatory adjustments and negotiations; as well a robust plume monitoring strategy. This poster presents these critical considerations with regards to ongoing work at Dalhousie University to produce quantitative geocellular formation models for CO_2 injection simulations. The details of the modeling work are being presented separately; however key takeaways of that research will be included in this poster. Novel CO_2 plume monitoring strategies, economics, environmental, and development plans will be presented within the context of existing dynamic models which are built on a foundation of seismic and bore-hole geophysical measurements. Concurrent development of off-shore green initiatives such as wind, and hydrogen parallel to geostorage is also proposed to realise CCS and net zero targets. The objective is to facilitate discussion on the importance of utilizing quantitative data and implementing CCS opportunities in the Maritimes.

The inception, evolution, and terrane-scale significance of a Late Ediacaran foreland basin in the eastern Avalon Zone of Newfoundland, Canada

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The Ediacaran to Cambrian (ca. 590–510 Ma) arc-platform transition in Avalonia is widely attributed to ridge-trench subduction based on constraints from Avalonian terranes in the Maritimes and the western Avalon Zone in Newfoundland, where arc activity was followed by rifting. However, coeval successions from the eastern Avalon Zone contain evidence of post-arc compression, ascribed to the Avalonian orogeny, which has been used as evidence to support an alternative model of oblique terrane collision leading to arc shutdown. To attempt to resolve these conflicting tectonic regimes and understand the role of compression during the arc-platform transition, we summarize sedimentologic and provenance results from the upper Conception Group to the Signal Hill Group (ca. 565–550 Ma) on the eastern Avalon Peninsula of Newfoundland. The ca. 566–564 Ma Mistaken Point Formation records basin reorganization, with back-stepping, rerouting, and confinement of submarine fans, a change from volcaniclastic to siliciclastic sedimentation, and changes in provenance. The overlying St. Johnâ€™s Group (ca. 564–557 Ma) records a change in sediment routing with an increase in sedimentation rates, retreat of sub-marine fans, slumping, and deltaic progradation. The overlying Signal Hill Group (ca. 557–540 Ma) records deltaic to fluvial progradation, with evidence of forced regression, blind thrusting, and hinterland exhumation at ca. 556 Ma. The fluvial Flatrock Cove Formation (ca. 551–549 Ma) records growth strata development during fold limb rotation, followed by the emergence of a thrust with 3.5 km of vertical throw, and renewed hinterland exhuma-tion. Commonly cited as a strike-slip basin, the ca. 565–550 Ma stratal record in the eastern Avalon Zone is more consistent with a foreland basin. It probably represents a retro-arc basin, formed either on a coherent West Avalon-ian terrane during the subduction of a spreading ridge, or on a subsidiary West Avalonian terrane prior to collision.

Tales from a frozen island? Finding ways to tell the 'Ice Age' history of Cape Breton Island, Nova Scotia, Canada

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Since its inception in 2004, the Cape Breton Fossil Centre has focused almost exclusively on Pennsylvanian paleobotanical material. Due to their abundance, quality, and connection with local industry, this focus on 'Coal Age' fossils is reasonable, but it has also eclipsed other geological and paleontological narratives. As it enters its third decade, the Fossil Centre is in a period of reimagining, with an effort to be more geologically and culturally inclusive, and to leverage its collections to communicate general scientific concepts relevant to the public interest. Cape Breton Island's dynamic Quaternary history, well-represented in both macrofossils and geomorphology, but absent at present in the museum's displays, provides an obvious opportunity for narrative expansion—while also allowing the linkage of two eras of geological history through the shared themes of climate change and ecological response. This interactive poster session will provide several examples of Cape Breton Island's 'Ice Age' history that might be showcased and invite participants to share their own ideas for objects, localities, or stories that could support new exhibits, outreach, or regional geotourism opportunities.

Repeated soft-sediment deformation structures in the Pomquet Formation (Mabou Group) of Cape Breton Island, Nova Scotia, Canada: are they seismites?*

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The Mabou Group is a widely correlated succession of fine- to coarse-grained, red sandstone, green sandstone, limestone, pedogenic siltstone and shale found across the Maritimes Basin. Near Creignish, Cape Breton Island, the Pomquet Formation of the Mabou Group contains abundant soft-sediment deformation structures (SSDS). The purpose of this study is to characterize the sedimentologic and stratigraphic attributes of these distinctive SSDS and to critically evaluate their potential generative mechanisms. Detailed descriptive logging and photography of the SSDS in the context of pre-existing stratigraphic logs for the site are coupled with sample collection. At least 12 beds, ranging from 0.15 to 1.8 m thick within the 130 m succession, are pervasively deformed, indicating pronounced and repeated liquefaction and/or fluidization of large volumes of sediment. Numerous faults complicate the identification of the exact number of unique beds containing SSDS. The most common SSDS found are thick beds of bulbous sandstone masses ("pseudonodules") in a convoluted shale matrix (ball-and-pillow structure) with fining-upward pseudonodule grading. The absence of overlying sandstone beds that might have been the source for load deformation in some, coupled with the variable matrix amount, suggests complete liquefaction of a package of heterolithic strata after deposition. The second type contains dish structures and both upward and downward injection of clastic material from thin sandstones in otherwise shaley packages. The third contains convolute bedding with extensive folding, interbedded with horizontally bedded and lithologically identical rippled siltstone and shale, suggesting the rotation of liquefied material at discrete points during the continuous deposition of a single lithology bed. Based on these observations we consider the possibility that these unique SSDS are seismites, sedimentary beds that are deformed due to local or regional seismic activity.

**Winner: AGS Rupert MacNeill Award for best undergraduate student oral presentation*

Vertical muon paleotopometry: quantifying crustal thickening and erosion history using terrestrial cosmogenic nuclides at great depths

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The cosmic ray-produced muon flux is monitored worldwide by particle physics laboratories including Canada's 2 km deep SNOLAB. The penetrative muons interact with atoms in minerals to produce terrestrial cosmogenic nuclides (e.g., ^{10}Be, ^{26}Al, and ^{36}Cl) hundreds of metres below the Earth's surface. Recent advances in accelerator mass spectrometry, sample preparation, and muon interaction systematics enable the measurement of these muogenic nuclides (MN). Muon paleotopometry is a novel method employing the pattern of MN concentrations along vertical and horizontal sampling transects to resolve topographic evolution and erosion history. The vertical approach compares measured with computed MN concentrations at various muon-dominated depths (3.7–300 m in rock). The discrepancy between MN concentrations that accumulate in rock over millions of years and those computed using modern sample depths by physics-informed codes (MUTE and GEANT4) reveals changes in shielding, i.e., crustal erosion or addition. A proof of concept is underway in Sudbury, Ontario, Canada, where we hypothesize that: (1) the computed MN will underestimate concentrations due to the reduction in shielding by fluvial and glacial erosion over timescales controlled by the nuclide decay rate; and (2) the mean erosion rate determined by ^{26}Al for the glacially influenced past ~4 Myr will be faster than the ~8 Myr erosion rate recorded by ^{10}Be. The relative comparison among samples in a >1 km depth profile will allow for the examination of MN production rate uncertainty at those depths and the evaluation of the significance of non-cosmogenic (i.e., radiogenic and nucleogenic) pathways that may produce low concentrations of MN. Literature review, required software adaptations, and sensitivity analyses have been completed. AMS target chemistry preparation for ^{10}Be and ^{26}Al is now underway on the first quartz-rich subsurface samples from the Sudbury region, and analysis of ^{36}Cl on feldspar is planned for later this year.

Provenance and paleoenvironmental reconstruction of manganese-rich metasedimentary rocks of the Goldenville Group, Nova Scotia, Canada

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The Meguma terrane in Nova Scotia is characterized by a thick Cambrian-Ordovician metasedimentary succession, subdivided into the Goldenville and Halifax groups. The underlying Goldenville Group is dominated by metasandstone and ranges in thickness from ~4800–8500 m, representing an estimated 20–50 million years of deposition. The Goldenville Group is overlain by sulphidic slate and metasiltstone of the Halifax Group. The Meguma terrane is interpreted to have originated as a lower Paleozoic continental margin on Gondwana, although its original position and underlying basement remain uncertain. It may have developed adjacent to the West African craton during the Cambrian, but other workers include the Meguma

terrane as part of Avalonia or interpreted it to have formed as a continental margin succession on Avalonia. Both the Goldenville and Halifax groups are generally interpreted as turbiditic continental slope deposits; however, they are lithologically and geochemically distinct. Additionally, the uppermost unit of the Goldenville Group (Beaverbank formation) is anomalously fine-grained and manganiferous, with abundant manganese nodules and laminations (up to 14 wt % MnO). At higher metamorphic grades, the nodules and laminations form thin (up to 10 cm wide), pink coticule beds and lenses due to the metamorphic growth of spessartine garnet. In this study, a ~120 m-thick outcrop section through the upper Goldenville and lower Halifax groups was stratigraphically logged in cm-scale detail and sampled for bulk rock geochemistry at a sampling interval of 2-10 m. Major, minor, and trace elements were measured with ICP-ES to generate paleoproxy data and model changes in provenance, tectonic setting, weathering, and redox conditions throughout the manganiferous Beaverbank formation and across the Goldenville-Halifax contact. These data provide insights into the tectonic history of the Meguma terrane, the evolution of the basin in which these sedimentary rocks were deposited, and the origin and mineralogy of the manganese-rich interval.

Integration geology and 3-D inversion of aeromagnetic data for deep mineral exploration of McIntyre Brook and Moose Brook gold mineralization in northern New Brunswick, Canada

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The Canadian Appalachian orogen in New Brunswick exhibits diverse types of gold mineralization that originated at different times during the Appalachian orogenic cycle. The prominent Acadian dextral transcurrent faults in northern New Brunswick, such as the Restigouche, Rocky Brook-Millstream, McCormack-Ramsay Brook, McKenzie Gulch, and Moose Lake faults, played a crucial role in shaping the geological features and mineral deposits of the region. The McIntyre Brook occurrence, situated about 50 km east of Saint-Quentin, lies along the McIntyre Brook Fault, a subsidiary of the Rocky Brook-Millstream Fault. The region is underlain by Early Devonian bimodal volcanic and sedimentary rocks of the Wapske Formation (Tobique Group), which are underlain by red clastic sedimentary rocks of the Greys Gulch Formation to the south. Gold mineralization is associated with hematite- and sulfide-bearing quartz-carbonate veins within potassically altered feldspar-phyric rhyolite along an east-northeast striking shear zone. In this study, we investigate the effectiveness historic aeromagnetic data (circa 1997 and 300m line spacing) for outlining geological features and identification of various intrusive and extrusive units. We applied a range of edge enhancement filters to the dataset, and then proceeded with a 3-D inversion using the power spectrum method. The resulting 3-D model derived in part from magnetic susceptibility measurements was used to deduce the positions and shapes of felsic or mafic intrusions on the basis of their magnetic responses. The result of the 3-D inversion is combined with airborne geophysics vertical and horizontal cross-section and is confirmed through the drill core logging. Furthermore, the correlation between magnetic anomalies and the mineralogy of the rocks is established using microscopic studies and analyses conducted through micro-XRF-EDS spectrometry. The integration of these two- and three-dimensional models aids in recognizing various geological features, in particular the intrusive bodies that may have associated gold mineralization.

The geoscience of wine: the influence of surficial geology on viticulture in the Gaspereau Valley - Grand Pré region, Nova Scotia, Canada*

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Terroir encompasses the distinctive characteristics of a specific location that contributes a unique taste to wines. Nova Scotia is an emergent cool climate wine grape growing province and one of Canada's fastest growing wine regions. This study in the Gaspereau Valley–Grand Pré region of Nova Scotia investigates the association between different surficial landscape features that host vineyards and the geochemistry of strata in these landforms that is necessary for *Vitis vinifera* and hybrid varietal growth and vigor. *Vitas vinifera* requires specific metals (Ca, K, Mg, Cu, Fe, Mn, Zn, Mo) to regulate growth and vigor, these metals also impart specific aesthetic qualities to wine and contribute to a wines sense of place and the regions terroir.

The Gaspereau Valley was subject to multiple ice advances during the Wisconsinan glaciation which produced distinct tills and a variety of glacial and glaciofluvial landforms. LiDAR and ground investigation were used in landscape classification mapping in which eleven distinct geomorphic

landforms were recognized. Multiple stepped glaciofluvial terraces on the south side of the Gaspereau Valley are occupied by vineyards, as are most of the classified landforms. In the Grand Pré region vineyards were found to occupy palimpsest drumlins.

Soil samples were collected from the B and C soil horizons to a minimum depth of 0.6 m in four vineyards occurring on different landforms. Preliminary results of soil sample analyses indicate that the classified landforms have unique sedimentology and elemental concentrations. In particular, Cu is most prevalent in the glaciofluvial terraces and K is elevated in streamlined subglacial traction tills. This study contributes to an understanding of the relationship between glacial landforms that exhibit specific and desirable terroir characteristics and the geochemical benefits that each landform may provide, guidance which will aid in identifying viable grape growing areas in glaciated terrains.

**Winner: AGS Graham Williams Award for best graduate student poster presentation*

Using hyperspectral imaging of drill core to classify the mineralogy of the Walton barite deposit, Nova Scotia, Canada*

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The historic Walton mine, operational from 1941 to 1978, saw extensive exploration and production of commodities such as barite, copper, zinc, lead, and silver. Located in the Windsor-Kennetcook subbasin of the structurally and stratigraphically complex Maritimes Basin, the Walton deposit is part of the Visean Windsor Group. This deposit features a barite orebody with an underlying mineralized sulphide deposit. Traditionally, drill core analysis around this deposit has been a manual, visual process conducted by private and provincial geologists. This method, while traditional, is complex, time-consuming, and subject to subjective errors. Hyperspectral drill core imaging offers a non-destructive, objective approach to characterize rock compositions through spectral signatures, greatly enhancing accuracy and efficiency. Approximately 3000 m of Walton mine drill core, housed at the Stellarton core facility, were studied for this project. Specifically, around 300 m of cores, both near and far from the main deposit, were digitized using Scient Analytics' LithoScan mobile platform. This platform provides high-resolution RGB and hyperspectral scanning, capturing reflectance spectroscopic images of cores in the ultraviolet to shortwave infrared range (400 nm–2500 nm). This range covers the optical absorptions of various rocks and minerals, including barite (600 nm), siderite (1200 nm, 1950 nm, and 2350 nm), dolomite (2320 nm), and gypsum (1450 nm, 1760 nm, 1950 nm, and 2220 nm). Mapping the location, depth, and shape of spectral absorption features in hyperspectral imaging provides a robust tool for objective and efficient core logging. The false-colour images generated from these scans make it easier to identify and log minerals. Comparative hyperspectral scans of cores from areas proximal and distal to the Walton orebody, but at similar stratigraphic levels, reveal notable differences in barite volume and alteration levels. This underscores hyperspectral imaging's utility in delineating mineralized zones and guiding targeted exploration.

**Winner: AGS Rob Raeside Award for best undergraduate student poster presentation*

Lithium-cesium-tantalum pegmatites: concepts and exploration techniques

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Lithium-cesium-tantalum (LCT) pegmatites are highly fractionated igneous rocks with very large crystals and exotic mineralogy and are the main source of hard rock lithium. The more significant pegmatite lithium ore minerals are spodumene, petalite, and lepidolite; cesium ore consists of pollucite, and tantalum ore consists largely of minerals of the columbite-tantalite group. This type of deposit can concentrate large amounts of lithium, cesium, and tantalum but also other incompatible rare elements, a number of which are considered critical and can be found on the critical elements lists of Canada, USA, and the European Union. Lithium is particularly in high demand due to the interest in decarbonisation of our economy and the fossil fuel transition. Global estimates by the United States Geological Survey (USGS) for end-use markets suggests that 80% of lithium production is used in batteries. However, lithium has important physical and chemical properties that are also uniquely suited to a wide range of applications including pharmaceuticals, glass and ceramics, and aerospace technologies. Currently, LCT pegmatites account for the majority of the world's lithium production according to data from the USGS. Demand for lithium is driving considerable interest in LCT pegmatites, spurring academic research and driving multiple exploration efforts globally and in Canada. LCT pegmatites are economically important hard rock lithium deposits, in part because they are more evenly distributed around the globe, particularly in comparison to brine deposits. This makes lithium production from LCT pegmatites less dependant on

political changes and consequently less prone to disruptions of global supply chains. Exploring for LCT pegmatites has seen enormous uptake with multiple novel techniques being developed and continuing to be tested. Nevertheless, 'traditional' geochemical methods still play the main role in exploring for LCT pegmatites.

A fjord-head record of deglaciation and proglacial lake formation: implications for sediment transport and marine geohazards, northeastern Baffin Island, Canada

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Deglacial dynamics control sediment supply to fjords and consequently impact coastal geohazard susceptibility in cryospheric systems. The marine sediment record was studied in Gibbs fjord, northeastern Baffin Island, to examine the effects of glacier retreat and the growth of large proglacial lake systems associated with the Barnes Ice Cap on sediment transport and stability in a fjord head delta system. Bathymetric mapping of the fjord head revealed a deeply incised channel that hosts characteristic bedforms indicative of past turbidity currents. To investigate the variability of sediment flux and deposition in this environment relative to glacier retreat, a sediment core was collected from the channel levee and analysed. The lower part of the core (6000–5500 cal kyr) is dominated by thinly laminated and frequent turbidite deposits suggesting a period of high sediment supply and rapid accumulation, when glacier ice was proximal, directly feeding the fjord head delta. The record transitions to an upper unit (5500 cal kyr – present) of hemipelagic sediments with very low sedimentation rates, reflecting a significant cutoff to sediment supply, likely caused by the retreat of glaciers inland and the formation of large proglacial lakes, which act as sediment sinks within the watershed. This transition suggests that the extant Barnes Ice Cap proglacial lakes formed ~5.5k cal BP, which is supported by new mapping of ice marginal landforms within the catchment area and chronologies correlated with published radiocarbon ages from proximal fjord systems. The uppermost late-Holocene unit is punctuated by coarser mass transport deposits, interpreted as potential glacial lake outburst flooding, representing periods of catastrophic discharge from the watershed. Ultimately, this study demonstrates that deglaciation and the development of large proglacial lake systems in the watershed effectively shifted the dominant geohazard mode in the fjord head environment from low-magnitude, high-recurrence turbidity currents to high-magnitude, low-recurrence events.

Geoelectric imaging of flood embankments in a tidal environment: studying the Shepody dykelands near Riverside Albert, New Brunswick, Canada

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Coastal defense structures have long provided critical protection to low-lying agricultural areas and infrastructure in the Upper Bay of Fundy region. As these structures age, their risk of failure increases, exacerbated by escalating sea level rise and storm intensity due to climate change, prompting a recognized need to assess and improve the sustainability of these barriers. Geophysical methods, including electrical resistivity imaging (ERI) and electromagnetic induction apparent conductivity mapping (EMI), are increasingly being used to monitor flood barriers because they are non-destructive alternatives to drilling. The preliminary results of their application to the Shepody dykes near Riverside Albert, New Brunswick will be presented. The objectives of this study are: (i) to develop a rapid screening approach capable of imaging internal weak zones in dykes; (ii) to assess the viability of mapping the distribution of surficial materials most suitable for dyke raising; and (iii) to evaluate the effectiveness of geoelectrical methods in differentiating between geotechnically weak and strong foundation materials. Preliminary EMI mapping on fields behind the dykes shows significant lateral variation in the resistivity of surficial sediments suggestive of sedimentary facies changes (although there is a lack of a depositional model to interpret them). On the dykes themselves, a 550 m long ERI transect exhibits two localized (~20 m wide) resistivity lows within the dyke, and a highly conductive foundation layer that rises steadily from ~18 m to 2 m depth along the transect. Efforts are underway to interpret these features with reference to geotechnical borehole logs though the paucity of borehole data currently leaves uncertainty over the role of clay content vs groundwater salinity in controlling resistivity. Future research will include a 3-D time-lapse of inversion ERI data during a tidal cycle, field sampling of near-surface water salinities, and laboratory analysis of embankment foundation materials to refine the conceptual model.

Late Neoproterozoic glaciation and coeval extensional magmatism of the Musgravetown Group on the Bonavista Peninsula, Avalon Zone, Newfoundland, Canada

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The Musgravetown Group is the central unit within a tripartite subdivision of the Neoproterozoic strata underlying the Bonavista Peninsula of the Avalon Zone in northeastern Newfoundland. On the western Bonavista Peninsula, deep marine strata of the Connecting Point Group are separated from the terrestrial to shallow marine volcano-sedimentary Musgravetown Group to the east by the Indian Arm fault (IAF). On the eastern Bonavista Peninsula, the Spillars Cove fault separates the Musgravetown Group from mainly fine-grained clastic rocks of the easternmost Bonavista Peninsula, correlative to mainly younger clastic units characteristic of the Avalon Peninsula. Although the Connecting Point–Musgravetown contact is mainly faulted along the length of the IAF, the original angular unconformity is preserved at one location. Here, ca. 600 Ma calc-alkaline basalts of the basal Musgravetown Group overlie this unconformity. Younger, ca. 592 Ma volcanic units cropping out east of the IAF include continental tholeiites and alkaline rhyolites of the Plate Cove volcanic belt. Coarse clastic rocks overlie the volcanic belt to the east and are overlain by the lithologically distinct shallow glaciomarine Trinity diamictite, locally dated at ca. 580 Ma. Rocks below the Trinity diamictite have recently been interpreted as deposits of glacial advance and retreat cycles, and significantly increase the thickness and areal extent of glacial products correlative to the Ediacaran Gaskiers glaciation in Newfoundland. Alkaline basalts occur below and above the Trinity diamictite on northeastern and southwestern Bonavista, respectively. The spatial and temporal association of glacial deposits and alkaline basalts indicate that glaciation was coeval with extensional magmatism, the latter likely related to the Late Neoproterozoic breakup of Rodinia.

A mantle source for water in appinite complexes: implications for genesis of granitoid batholiths and crustal growth

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Appinites are ultramafic to felsic in composition, characterized by *idiomorphic hornblende* and by *spectacularly diverse textures*, such as multiple comb layers and mafic pegmatites, suggesting that they are anomalously water-rich mafic magmas. They commonly occur as small (~2 km) plutons adjacent to deep crustal faults along the periphery of arc granitoid plutons.

The ca. 607 Ma Greendale Complex, Nova Scotia, is typical of appinite complexes. Stable isotopic data from hornblendes (δD from -61 to -72 ‰; $\delta^{18}O$ from 3.7 to 7.0 ‰) indicate the water in the appinite magma has a strong mantle component. Hornblende geochemistry indicates crystallization over a range of pressure (3–6 kbar), temperature (750–1050°C) and H_2O content (4–10 wt. %). Collectively, these data imply appinites (i) represent aliquots of hydrous mantle-derived magma derived from mafic underplates emplaced along the base of the crust during protracted subduction and (ii) crystallized and differentiated as they ascended to middle-upper crustal levels. Transfer of heat and fluids triggered coeval (615–604 Ma) granitoid magmas by partial melting in the overlying MASH zone. These granitoids were emplaced when transient stresses activated favourably oriented structures. The ascent of late mafic magmas was impeded by rheological barriers created by overlying granitoid magma bodies. Greendale Complex magmas evaded barriers by exploiting the Hollow Fault which bounded the plutonic system. More generally, the most mafic components of appinite complexes may provide a window into the composition of the mafic underplate and insights into processes that generate granitoid batholiths and crustal growth in arc systems.

Canadian Federation of Earth Sciences: initiatives transforming Canada's geoscience perception

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Originally founded as the Canadian Geoscience Council in 1972, the Canadian Federation of Earth Sciences (CFES) are champions of the shared interests, and challenges of the member Canadian geoscience societies, associations, and organizations. One common challenge is the current negative public perception of Earth Sciences in Canada and across our planet. CFES and its member organizations have worked to raise awareness of the importance of geosciences to humanity. Specifically, CFES's Education Division led by the Canadian Geoscience Education Network (CGEN) collaboratively organized a number of initiatives and strategies to incentivize and support Earth Science literacy and engagement (e.g., EdGeo teacher workshops). Recent initiatives include: (i) the 'Careers Website', which provides updated information about geoscience careers to youth, their families, high-school educators and counselors; (ii) the Geoscientists in Residence program (GIR; 2022 and 2023) partnership with Parks Canada that funded a GIR in Pukaskwa National to work with the Park's staff to identify and interpret the geological resources and provide geology-oriented tours to the visitors of the Park; (iii) the National Geoscience Research Plan which is the first strategic plan for geoscience academics in Canada, with an education-outreach pathway; and (iv) Canada's bid to host the International Geoscience Congress (IGC) 2028 will have a significant focus on education and outreach including a proposed "Young Geoscientists" Keynote Theme Day. If successful with the IGC 2028 bid, the plan is to coordinate two Years of National Geosciences for 2027/28, which could include competitions for elementary to high school students with winners funded to attend IGC 2028. These initiatives are successful due to the greatly appreciated collaboration among CFES, CGEN, and members organizations that promote Canadian Geoscience in a global and rapidly changing world.

Application of mineral chemistry in LCT pegmatite exploration within the Yellowknife Pegmatite Province, Northwest Territories, Canada: insights from preliminary muscovite and K-feldspar analysis

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Li-Cs-Ta-Sn (LCT) granitic pegmatites of the Yellowknife Pegmatite Province are important sources of critical minerals (e.g., lithium, tantalum, and tin). These pegmatites occur as dykes, commonly in clusters and are mainly hosted within metasedimentary and granitic rocks. The mineralogical characteristics of these pegmatites vary significantly, with both mineralized and barren pegmatite commonly occurring together in the same cluster. This variability poses challenges for the regional assessment of these critical mineral resources. High concentrations of incompatible alkali elements (Li, Rb, and Cs) in primary muscovite and K-feldspar are commonly used as fertility indicators in Li-bearing systems, so are employed in this study for both pegmatite and granitic plutons.

Laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) was used to determine the concentration of alkali (including Li, Rb, Cs) and high-field-strength elements for primary muscovite and K-feldspar in 29 samples collected during reconnaissance field visits. Over 120 spots were analyzed in each mineral. Preliminary analysis revealed the highest concentrations of Li, K, Cs, and Rb in muscovite were 577 ppm, 92 421 ppm, 2324 ppm, and 21 460 ppm respectively. Notable results for K-feldspar include concentrations of up to 2004.0 ppm Li, 3730.7 ppm Rb, and 199.4 ppm Cs. These results were used to compute K/Rb and K/Cs ratios for both phases. The K/Rb ratios in muscovite ranges from ~4 to 75 and K/Cs from 35 to 6800; the K/Rb ratios in K-feldspar ranges from ~40 to 2500, and ~539 to 66 272 for K/Cs. Of the analyzed muscovite grains, over 75% had K/Rb ratios <40, indicating a high degree of fractionation and high rare-metals mineralization potential. This is further supported by high Li content (>200 ppm) for K/Rb ratios less than 40. K-feldspar grains generally exhibit low K/Rb ratios. These findings affirm the effectiveness of utilizing muscovite and K-felspar chemistry in LCT pegmatite assessment.

Improved resistivity monitoring of embankment dam leakage near abutments by modelling non-conventional electrode layouts

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Time-lapse electrical resistivity imaging (ERI) has recently shown great potential as a tool for non-invasive monitoring of seepage/leakage conditions within embankment dams. The approach relies on the fact that parts of a dam's core experiencing leakage are expected to exhibit seasonal variations in electrical resistivity that follow those observed in the reservoir or headpond with a relatively short lag time. Interfaces between embankment dams and concrete structures (such as spillways or abutments) are known to be regions of elevated risk for the development of concentrated seepage. However, these regions pose a special imaging challenge as the presence

of rebar, steel mesh and other infrastructure precludes the 'conventional' deployment of electrodes parallel to the dam crest onto the concrete structure. An alternative 3-D imaging method that has proven to be more practical involves running multiple lines of electrodes up the back of an embankment and across its crest adjacent to the abutment. This arrangement is able to image the dam core and abutment region beneath the crest, but with two limitations related to the fact that the core lies below the edge of the electrode array: (i) reduced depth of exploration; and (ii) susceptibility to imaging artefacts associated with changes in resistivity of the adjoining headpond. Synthetic numerical modelling has been done to assess ways to improve imaging in the dam. Some of the models include electrodes in boreholes drilled into the upstream part of the dam, or using electrodes laid underwater on the upstream face of the dam. So far, the optimal results have come from using submerged electrodes on the upstream face. The modelling is informing approaches that will be adopted to improve ERI monitoring on the embankment dam at the Mactaquac Hydroelectric Generating Station located on the Saint John River, 20 km upstream of Fredericton, New Brunswick.

Evidence for seismicity, landslides, and mass-transport deposits in a Mississippian (Tournaisian) lacustrine succession: the Albert Formation, New Brunswick, Canada

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The lower Carboniferous (Tournaisian) Albert Formation in southeastern New Brunswick consists of a thick succession of lacustrine sedimentary rocks sub-divided into a middle shale-dominated Frederick Brook Member (deeper water facies), and upper and lower sand-dominated units, the Hiram Brook and Dawson Settlement members respectively, representing deltaic incursions into the 'Albert Lake'. Slump-structures and debris flow deposits (mass-transport deposits or MTDs) are found throughout the succession but are especially common in the Frederick Brook Member. Three types of MTDs are recognized in the Albert Formation: (1) classic debris flows containing intra- and extra-basinal debris that may be transitional to turbidites; (2) slumped horizons with a well-defined base and top – typically an erosion surface; and (3) slumped horizons with a well-defined base, but no clear top. Types 2 and 3 are associated with features produced by seismicity, with Type 3 associated with instability of delta deposits, and involving failure of sedimentary sections from 10s to 100s metres in thickness. This last feature represents landslides into the lacustrine basin.

The shales of the Frederick Brook Member were intrinsically mechanically weak, with low plasticity and liquidity indexes contingent on high water content, high organic content, and the presence of swelling clays. Over-loading of this substrate by prograding sand-dominated deltaic structures enhanced this intrinsic instability, with individual landslides either representing spontaneous failure, or earthquake-induced collapse. Such sub-aqueous lacustrine landslides create environmental consequences such as tsunamis, the rapid inundation of delta-top ecosystems, and disruption of stratified water columns, mixing toxic anoxic deep water with biologically productive near-surface water. The spectacular preservation of large, 3-D tree fossils, burial of fossil forests, preservation of mass-kill events involving fish, are all documented. The nearby basin-bounding Belleisle Fault with a documented minimal displacement of 120 km during the Tournaisian interval is the best candidate for a source of this seismic activity.

The formation processes of chromian minerals and talc veins during retrograde metamorphism and exhumation, Cycladic Blueschist Unit, Greece

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Unusual minerals were formed during the so-called 'retrograde metamorphism' of high-pressure low temperature metamorphic rocks in the Ochi Unit in southern Evia, part of the Cenozoic Cycladic Blueschist Unit of southern Greece. Paleogene prograde metamorphism of calcareous sandstone resulted in albite-quartz-calcite-phengite-titanite metasandstones, whereas prograde metamorphism of mafic rocks formed blueschists with glaucophane, phengite and calcite. Late Oligocene top-to-west shearing produced inhomogeneous strain that flattened many prograde minerals, with chlorite, biotite and anthophyllite partially replacing prograde minerals. Subsequent Miocene exhumation produced

decompression fractures filled with a variety of hydrothermal minerals. More specifically, the metasandstones contain common 10–200 mm wide veins of talc rimmed by Cr-chlorite, with up to 0.6 apfu Cr. In the same samples, phengite with <0.08 apfu Cr and biotite with <0.3 apfu Cr are present. The talc veins occupy fractures in quartz, albite and calcite grains. The style of deformation is suggestive of hydraulic fracturing by overpressured fluid, a process that is inferred to create episodic tremor and slow slip (ETS) in active subduction zones, over a wide range of depths (15–35 km). The fluids were derived from dehydration at >0.8 GPa of subducted Fe-Cr-rich serpentinite elsewhere in the Ochi unit. Oligocene shearing is represented by disrupted foliation in the talc–Cr-chlorite veins, locally with kinked S-folds; least deformation is seen where thin talc veins are enclosed in strain-resistant masses of albite or calcite. The Miocene cross-cutting hydrothermal veins nucleated the precipitation of allanite (some with <0.4 apfu Cr and >0.8 apfu REE), apatite, titanite and zircon, reflecting the availability of halogen-rich fluids. Published zircon geochronology of ~15 Ma from the Ochi Unit, synchronous with the nearby adakitic volcanism at Oxylithos, may have dated similar veins. The retrograde metamorphic minerals were thus dominated by the effects of pervasive Cr-rich fluid metasomatism of changing composition through time.

Classic Paleozoic Nova Scotian shaly sedimentological localities revisited: Horton Bluff and the Ovens

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Classic 20th century sedimentological sites deserve updating in the light of new concepts and observations elsewhere. Horton Bluff is a Tournaisian lacustrine-estuarine succession that represents peak synrift subsidence. Sedimentation cycles are on a timescale and magnitude suggesting Milankovitch rather than tectonic control. Geochemical paleoweathering indicators show longer term variability in sediment supply, correlated with the transition from glacial to interglacial conditions in Gondwana in the middle-Tournaisian. Given the imprecision of palynological zoning and the lack of paleomagnetic reversals, paleoclimatic proxies provide an alternative means of regional correlation. Many previous workers have studied the small syn-sedimentary deformation structures, which in an actively subsiding rift basin are most reasonably attributed to seismicity, but we have also discovered larger slides and spreads, partly obscured by later tectonic deformation. Deposited during variable and sometimes cool climates of the Late Paleozoic Ice Age, Horton Bluff shales provide intriguing new perspectives on the early Mississippian history of the Maritimes Basin.

The Ovens exposes the Cunard and Feltzen formations of the Halifax Group, generally interpreted as prodeltaic turbidites based on their stratigraphic position. The prodeltaic model can be refined using abundant well preserved sedimentary structures. The common top-cutout Bouma sequences at this locality have become an important component of fine-grained turbidite facies models, yet their significance is uncertain. Erosion surfaces are unusually common in the Ovens section, yet evidence for prodeltaic channels is lacking. The slope seaward of the Eel River off northern California seems to be a good modern analogue. Wave-supported, muddy density flows transport sediment across the shelf. We infer that some of these flows dissipate and deposit on the slope, whereas others accelerate and bypass or erode the slope. Top-cut-out Bouma sequences are common in such settings but are much rarer in channel levee systems and in distal basin plain turbidites.

Metasomatic iron alkali calcic alteration of the Bass River deposit and the economic potential of the Cobequid-Chedabucto Fault Zone, Nova Scotia, Canada

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The Bass River deposit is a magnetite-pyrite-biotite breccia with cobalt-rich pyrite located on a splay of the Cobequid-Chedabucto Fault Zone (CCFZ) in northern Nova Scotia. We are currently examining the deposit using petrography, micro-X-ray fluorescence (XRF) element mapping, scanning electron microscopy, and geochronology to determine the nature of the deposit and whether it may be part of a larger Metasomatic Iron Alkali Calcic (MIAC) system. These systems are prospective for base and critical element deposits like Iron Oxide-Copper-Gold (IOCG) and Iron Oxide-Apatite-REE (IOA) deposits.

The Bass River deposit is a polymictic, multiphase breccia showing strong iron and potassic metasomatism (magnetite-biotite) replacing porphyritic and laminated volcanoclastic rocks of uncertain origin, possibly of the nearby late Neoproterozoic Jeffers Group volcanic rocks. Early sodic alteration (albitization + scapolite) replaced primary feldspar phenocrysts, whereas all phases are cross-cut by late calcite veining. Biotite geochronology (Rb-Sr)

is in progress to fit the timing of metasomatism into the structural history of CCFZ. Petrographically, we discovered trace REE, U, and Cu mineralization spatially associated with the iron-potassic metasomatism consisting of xenotime (YPO_4), fluorapatite ($(Ca, REE)_5(PO_4)_3F$), parasite ($Ca(Ce, La)_2(CO_3)F_2$), chalcopyrite inclusions in cobaltian pyrite, polycrase Y $(Y, Ca, Ce, U)Ti_2O_6$ in ilmenite, and possibly bastnäsite $(Ce, Y, REE)(CO_3)F$.

Based on the intensity of iron metasomatism, the magnetite-biotite-calcite-scapolite-REE mineralogy, and its position along a secondary splay near deep-seated structures (the CCFZ), it seems likely that the Bass River magnetite-cobalt deposit lies within a MIAC system. A similar analog could be the Ernest Henry magnetite-IOCG deposit in Queensland Australia; a shear zone bounded magnetite breccia pipe with early albite-magnetite-titanite-scapolite overprinted by K + Fe metasomatism resulting in biotite-magnetite-Kspar (+Cu) mineral assemblage. This work will continue to evaluate the potential of an MIAC system along the CCFZ, with the hope of aiding exploration for base and critical metals in Nova Scotia.

Experimental determination of partition coefficients for high field strength elements between ilmenite and felsic melts at low temperatures with applications to the enrichment of Nb and Ta in peraluminous granitoid rocks

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Ore deposits of several economically important metals (Li, Cs, Ta, Sn, W, etc.) are associated with peraluminous granitoid systems and their derivative pegmatites. Most peraluminous systems exhibit a trend of decreasing Nb/Ta concomitant with an increase in total concentrations of both Nb and Ta as crystallization progresses. Thus, the enrichment of incompatible Ta to economic concentrations requires extensive crystallization of phase assemblages with bulk partition coefficients in which DNb > DTa with both DNb and DTa <1. Few mineral assemblages can achieve this balance, with most authors attributing this geochemical evolution to assemblages with substantial (10%+) biotite fractions. Other minerals, like ilmenite, generally exhibit DTa > DNb. However, plotting literature data on ilmenite partitioning behaviour in log(D) vs 1/T space suggests that the fractionation trend for ilmenite will reverse at low temperatures, resulting in DNb > DTa. Given that ilmenite-melt partition coefficients for Nb and Ta are 1–2 orders of magnitude higher than biotite, it is possible that even trace ilmenite can be a critical contributor to decreasing Nb/Ta as crystallization progresses in peraluminous systems. We present preliminary experimental results as part of a study on the role of ilmenite in the fractionation and/or enrichment of HFSE in felsic systems. Samples are contained in a graphite inner capsule, inserted into a Pt outer capsule, then sealed. Experimental charges consist of peraluminous Macusanite glass doped with additional FeO and TiO_2 to force ilmenite crystallization, and distilled water is added to ensure H_2O saturation. Using a piston-cylinder apparatus samples are pressurized to 0.8 GPa, heated to 1300°C for 1 hour, cooled isobarically to 950°C, held for 72 hours, then quenched. Planned experiments at lower final temperatures will determine the temperature dependence of ilmenite-melt partitioning. These results are complemented by geochemical modelling and ilmenite textural analysis of samples from the South Mountain Batholith.

Quantitative assessments of subsurface energy transition opportunities in Nova Scotia, Canada

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The consequences of global warming are well-known and mitigating subsurface technologies have been developed for decades by our strategic neighbours within Canada, the USA, and Europe. In these regions, research has progressed systematically from conceptual and qualitative studies (prospective resources), through quantitative resource and economic assessments (contingent resources), to pilot- and regional/continental-scale projects (commercial/stored resources). In Nova Scotia we have: (1) an outstanding geoscience and engineering legacy from the salt, coal, and hydrocarbon industries expertly marshalled by government, academic, and global consulting organisations; (2) clear opportunities onshore and offshore, identified in ~25 years of publications - but a tendency to remain at the qualitative/prospective stage (notwithstanding three, recent, full-cycle, EAGE student competitions); (3) no operational subsurface facilities or plans (beyond shallow, district heating/cooling); and (4) two unsuccessful projects – the 2014 CCS1 well (ineffective porosity-permeability) and Alton salt cavern methane storage (community objections). The Scotia Department of Natural Resources and Renewables and Dalhousie University have undertaken quantitative studies from 2019 to 2023, focussing on static and dynamic geo-

cellular modeling, quantitative resource and rock quality assessments, and economic screening that might foster fiscal and regulatory policy with consummation in commercial projects. The high-level challenges are low-moderate heat flow, insufficient porosity-permeability, and moderate fracturing in the Carboniferous-Triassic Maritimes Basin and costs in Jurassic-Cretaceous aquifers on the Scotian Shelf. Key opportunities include: (1) geological carbon storage (GCS) in world-class deep saline aquifers on the shelf (10s to 100s Gt); (2) modest GCS in depleted fields at the shelf-margins (~100 Mt); (3) geothermal power potential in Cumberland County (~5–10 MW scale closed-loop projects, possible open-loop with fracturing); (4) massive, expensive, open-loop geothermal potential on the shelf (cost-sharing with GCS and mega-wind?); and (5) compressed air and hydrogen storage in salt caverns with MW-GW scale, load-balancing abundant wind power onshore (Carboniferous Windsor Group salt) and similarly offshore in the Mesozoic Argo Formation near Sable Island.

Occurrence of rare earth elements in kimberlite and recovery of rare earth elements from kimberlite tailings: a case study from Snap Lake diamond mine, Northwest Territories, Canada

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Rare earth elements (REEs) are crucial for the global transition to a green economy. However, their economic occurrences are rare and production is concentrated geographically. Consequently, they are classified as critical minerals in many jurisdictions, and alternative sources are required to proactively safeguard the supply chain. Kimberlites are mantle-derived igneous rocks and are primary diamond sources. However, some kimberlites contain significant concentration of REEs comparable to some primary REE deposits. Tailings of such kimberlites are potential secondary sources of REEs and would transition the diamond industry to a circular economy. However, the deportment of REEs in kimberlites is poorly understood. Hence, core and tailing samples from the Snap Lake (SL) diamond mine (Canada) were studied. The results from eighteen thin sections from the SL hypabyssal kimberlite are presented here. The samples were studied with petrographic and scanning electron microscopes (SEM), electron microprobe analyses (EMPA), and micro-Raman spectroscopy. Monazite is the principal host of REEs (50 wt%), followed by anatase (up to 7000 ppm) and apatite. Four types of monazite, four types of anatase (Types A-D), and two types of apatite were identified based on texture and composition. Anatase and monazite occur as intergrowths with cubic shape, suggesting that they are pseudomorphs of perovskite, although perovskite was not observed. The rims of Type A anatase are enriched in heavy REEs, probably due to hydrothermal alteration. The paragenetic evolution of the SL kimberlite probably involved primary perovskite that sequestered most of the REEs from the magma, and during subsequent deuteric alteration by CO_2-rich fluids, perovskite was completely replaced by the monazite-anatase intergrowths, with a higher concentration of REEs in monazite. The de-portment of REEs into monazite, without being in the original perovskite, enhances its concentration by twice and favors REE extraction. The study into the fate of REE-bearing minerals in the tailings is underway.

Models for a potential volcanosedimentary-hosted critical metal resource in southwestern New Brunswick, Canada

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A recently obtained lithium in till geochemical dispersal pattern and cesium in till geochemical anomalies in southwestern New Brunswick have prompted a re-examination of the geological setting of the volcanic and sedimentary rocks on the New Brunswick Platform of the Maritimes Basin. Although this area has previously been explored for uranium and hydrocarbon resources, the notion of exploration for lithium, cesium, and related elements in this area is completely new. Thus, there is currently a paucity of geochemical data at hand, which presents a potentially fruitful opportunity for new studies and resource exploration.

At surface, the southwestern portion of the New Brunswick Platform is flanked by hills of Late Devonian Harvey and Piskahegan Group strata, both of which contain highly fractionated felsic volcanic rocks and associated volcano-sedimentary deposits. The intervening molasse basin experienced rapid subsidence during the Mississippian, which has preserved a succession of intermontane fluvial and lacustrine strata and rift-related volcanic rocks, deposited in a warm, arid paleoclimate within the continental interior of Pangea. The geological setting of these and contemporaneous strata in the Maritimes Basin have previously been compared to the Basin and Range physiographic province of the southwestern United States, which

is a region currently experiencing a surge of exploration, research, and development for lithium clay and related evaporite deposits.

In this presentation, the geological setting of the study area is compared and contrasted with Basin and Range province geology, and volcanosedimentary lithium deposit models are discussed. In addition, cesium and boron are related commodities in this geological setting, and hence the potential for these resources is also examined. Preliminary results of this investigation include new geochemical and palynological data, outcrop discoveries, and observations from re-logging archived drillcore.

Preliminary results from the Tappy, Eagle, and F.D. no.5 pegmatites, Cat Lake-Winnipeg River pegmatite field, southeastern Manitoba. Canada

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This study investigates the geological features and petrogenesis of three lithium-bearing pegmatites in the Cat Lake-Winnipeg River pegmatite field, located in southeastern Manitoba. Fieldwork over the summer of 2023 focused on the Tappy, Eagle, and F.D. no.5 pegmatites. Observations and sample collection aimed to provide preliminary insights into the dykes. More recently, thin sections of the sampled pegmatites have been prepared, followed by detailed petrography to establish mineral assemblage and paragenesis. Further petrography, complemented by analytical work on specific mineral phases, will follow.

These pegmatites are Li-bearing rare element pegmatites broadly ascribed to the Li-Cs-Ta (LCT) class. The Tappy pegmatite is a dyke 50 m long by 3 m wide, hosted within the Winnipeg River pegmatite field. The Eagle and F.D. no.5 dykes are spatially related and located in the Cat Lake pegmatite field. The Eagle pegmatite outcrops over multiple exposures trending from east to west, whereas the F.D. no.5 dyke outcrops on one main hill to the northwest of the Eagle pegmatite.

Petrographic findings from polished thin sections indicate that all three of the dykes have undergone at least minor dynamic recrystallization. Bulging recrystallization of quartz as well as veins of sericitic alteration are common and point toward a dynamic recrystallization history for these pegmatites. The main mineralogy is quartz, plagioclase, spodumene, and alkali feldspar along with minor columbite, muscovite, garnet, and apatite. These minerals will be used in geochronological studies. The findings of this study will contribute to a better understanding of the origin of the pegmatites, enhancing geological and mineralogical knowledge in the region and aiding future exploration efforts.

Redox-sensitive element partitioning among apatite, biotite, and glass in natural igneous rocks*

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Apatite and biotite, ubiquitous minerals in a multitude of natural rocks, can host a variety of trace elements, including those whose valence state, and hence ionic radius and charge, can vary over the fO_2 of natural magmatic systems. In this study, we determine partition coefficients (D values) among apatite (ap), biotite (bt), and glass (gl) in 5 suites of natural, mostly silicic rocks, comprising metaluminous to peraluminous compositions, and reduced to oxidized conditions (FMQ-3.1 to +4.3). Elements considered include alkalis (Li, Rb, Cs), alkaline earths (Ba, Sr), REEs+Y, transition metals (Sc, V, Mn, Co, Ni, Cu, Zn, Mo), metalloids (Ge, Ge, Cd, In, Sn, Pb, Bi) and HFSE (Zr, Nb, Hf, Ta, W), of which Eu, V, Sn, and W are expected to be heterovalent over the fO_2 range considered.

Results show that most of the heterovalent element partitioning relationships exhibit redox sensitivity. With increasing oxidation, Dbt/gl for V decreases from ~500 to ~50 whereas D ap/gl increases from ~0.001 to ~0.06. Similarly, Sn becomes more compatible with both minerals as fO_2 increases (DSn = ~0.2 to ~1.0 for bt/gl and ~0.01 to ~0.4 for ap/gl). The ap/gl D for Eu increases with fO_2 (D = ~20 to 100) whereas values for bt/gl decrease (DEu = ~0.7 to 0.2). Bt/gl D values for W become progressively smaller with increasing fO_2 (DW=~0.1 to 0.02), whereas values for apatite remain at ~0.2–0.3.

Overall, the D for ap/bt partitioning of V varies from ~0.002 to ~0.5, in a positive correlation with the fO_2, suggesting a potential new oxybarometer. Application of the observed DV- fO_2 relations to V partitioning systematics in the peraluminous South Mountain batholith, Nova Scotia, and Palabora carbonatite, South Africa, yield relatively low fO_2 in the former (~FMQ-1) and high fO_2 in the latter (>FMQ).

**Winner: AGS Sandra Barr Award for best graduate student oral presentation*

New developments in education at Stonehammer UNESCO Global Geopark, Saint John, New Brunswick, Canada

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As one of the key pillars behind Stonehammer UNESCO Global Geopark, education is central to everything Stonehammer does. Over the past 3 years, work has involved renewing, refining, and reinvigorating the programming. To better serve the target audiences, efforts are divided between three key demographics: youth, tourists, and the general public. The main difference determined when defining these demographics is the educational goal behind program delivery. New programming geared towards these different audiences has been developed to meet those goals. Many of these new educational products are presently being launched, including new interactive programs geared towards 4th and 7th grade students, a new field trip, new digital interpretation products, a children's book that explores geologic time, a new public interpretation model for summer 2024, and several new tourism products. This session presents these new programs and discusses the goals and successes behind recent and upcoming programming initiatives.

Lithium-cesium-tantalum (LCT) pegmatite dykes in southern Newfoundland and Labrador, Canada

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Canada's efforts to develop low-carbon technologies has increased the demand for critical minerals, including those bearing lithium, which is driving current global exploration for difficult-to-locate lithium pegmatite dykes. Southern Newfoundland and Labrador is identified as a region displaying favourable geological conditions for lithium pegmatite dykes, particularly in the aureoles of voluminous, geochemically evolved plutonic rocks. The present research is focussed on the Killick prospect, a swarm of lithium-cesium-tantalum (LCT) pegmatite dykes discovered in 2021 in southern Newfoundland. This work is still in its early stages. Preliminary fieldwork focussed on mapping and sampling multiple spodumene-bearing pegmatite dykes. The dykes may be related to voluminous, geochemically evolved two-mica granites (Peter Snout and Rose Blanche plutons). Both the pegmatite dykes and granitic plutons intruded metasedimentary rocks of the Bay du Nord Group. The mineralogy of the dykes is spodumene, quartz, K-feldspar, muscovite, biotite, and garnet, with minor apatite, tantalite, white beryl, and schorl tourmaline. Some of the spodumene dykes exhibit discernible internal zoning patterns, characterized by layered aplite in the footwall, a lower intermediate pegmatite zone, a core zone that contains the coarsest spodumene, and a hanging wall zone with abundant tourmaline. However, some of the dykes are unzoned. This research aims to provide comprehensive insights into the age and mineralogy of the Killick LCT pegmatite prospect, thereby contributing to an enhanced understanding of lithium-bearing pegmatite dykes in southern Newfoundland and Labrador and the broader Ganderia in the northern Appalachian orogen.

The impact of precipitation phase on changing groundwater recharge in mountain regions of Canada and the United States

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Groundwater in alpine regions plays an essential role in downstream water supply. As the climate warms, mountain water resources are under threat with reduced snowpack and glacier recession negatively impacting summer streamflow. However, the extent to which such global changes can impact the mechanisms that contribute to groundwater recharge remains poorly understood. This project aims to address the limited spatial and temporal extents of observational studies surrounding the groundwater in mountainous regions, moreover, enhancing the understanding of long-term trends across geographical boundaries. The primary question for this research is: does snowmelt or rainfall precipitation dominate mountain groundwater recharge across mountain regions of Canada and the US? The secondary research question is: will a shift towards less snow and more rain impact this groundwater recharge, due to climate change? The research question will be addressed by analysing a dataset of 171 observation wells from mountain regions across Canada and the US. First, to build on previous work by categorizing each well as rainfall or snowmelt dominated. A step-wise multiple linear regression will be used on each group (snow/rain dominated) of wells to identify which watershed attributes (climate, geology, etc.) are associated with positive/

negative trends. Then, a compilation of new data from nearby weather stations which includes precipitation phase (rain/snow) will be done. Approximately 10 wells will be selected for detailed correlation analysis between the well hydraulic head data with the precipitation volume/phase to quantify the groundwater recharge sources and infer how future climate change will impact groundwater recharge.

Phylogeny of some Aeronian (early Silurian) monograptid graptolites

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The Hirnantian extinction event in the Late Ordovician saw the extinction of many graptolite faunas but also the radiation of some groups, most notably the monograptids. Previous work has been done on the phylogeny of monograptids in the Rhuddanian (early Llandovery, earliest Silurian) to understand the lineages and relationships among the different genera. However, less work has been done on later Silurian monograptids. This study used a selection of 41 monograptids species from Arctic Canada and Anticosti Island, as well as some species described in previous papers, to conduct a cladistic analysis to determine the relationship among these species within the Aeronian (middle Llandovery). The study used a previously developed, unpublished morphologic coding scheme created specifically for cladistic analysis of monograptids by one of us (MJM) and his colleagues. The species selected represent the range of genera and morphotypes that dominate Aeronian monograptid faunas and builds from the results of a previously conducted, unpublished master's thesis study. The results of the analysis were compared to a previous hypothesis on the origins and relationships of the genera to determine if the previous conclusions are supported by our results. The results show both resolved and unresolved clades, and they have agreement with some of the previous hypothesis. However, there is also disagreement in some key aspects, but more work on later Aeronian and younger monograptids is required. In addition, the poor resolution of some of the clades suggests that considerable refinement of the coding scheme is needed. Within the Silurian, several extinction events occurred, and one well-documented example, known as the *sedgwickii* event, occurred in the late Aeronian. The results of the cladistic analysis suggest that at least one of the major clades that dominated the faunas of the Rhuddanian to middle-Aeronian became extinct within this event.

Can the energy transition be inclusive?

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The energy transition is complex, concurrently impacting economic, societal, and environmental systems. Increasing levels of greenhouse gases (GHGs) are affecting our environmental systems, promoting temperature changes, intensifying weather events, increasing sea level changes, etc. These changes can also affect food and water security, human health, and geopolitical stability. An inclusive approach to climate change mitigation and the energy transition is required to manage the complex systems interactions. This approach considers system-level compromises, interactions, and dependencies, seeking solutions from diverse perspectives that also prioritize sustainable, resilient, and equitable development. This type of energy transition requires effective guidance to policymakers from these systems to ensure resulting policies are effective and balanced. A large part of the energy transition is focussed on decarbonization strategies; however, other non-CO_2 GHGs also impact the climate and require proportionate attention through a more inclusive plan that would integrate with CO_2 strategies. As efforts are made to reduce dependence on the fossil fuel market, there is an increase in dependence on the critical mineral market. The geopolitical importance of this change centres on resource distribution and consumption. Technology and infrastructure are geographically variable and can become barriers to decarbonization and transition; many renewable energies are limited based on physical limitations of the Earth or materials, and their (generally) intermittent nature cause challenges in consistent and reliable supply. In regions that are financially constrained, the high costs associated with transition can intensify economic inequalities, so processes that enable reasonable funding, collaboration, competition, and sharing of technologies at a global scale are critical to sustainable change. Policies that are built in collaboration with the public and with the above considerations in their approach are more likely to be stable, transparent, and foster public and industry support, overall leading to a more inclusive and sustainable transition.

Stratigraphic relations, age, and tectonic implications of the Gamble Brook and Folly River formations, Cobequid Highlands, Nova Scotia, Canada

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The Cobequid Highlands in northern mainland Nova Scotia are interpreted to be part of Avalonia, an exotic microcontinent of uncertain provenance now dispersed through the northern Appalachian orogen. Precambrian rocks of the Cobequid Highlands occur in three fault-bounded blocks with uncertain relationships: Jeffers, Bass River, and Mount Ephraim. Precambrian stratified rocks in the Bass River block are divided into the Gamble Brook (GBF) and Folly River (FRF) formations. These rocks have a long history of geologic work with differing interpretations of stratigraphic relations and age. The GBF consists of interlayered quartzite, metasiltstone, and metawacke, and minor ironstone, marble, and calc-silicate rocks. The FRF consists mainly of basaltic flows and autobreccia, texturally varied tuffaceous rocks, epiclastic rocks, and ironstone. In places, quartzite and metawacke are present in volcanic rocks of the FRF and vice versa, suggesting that the formations are similar in age. The FRF is intruded by abundant mafic sills and dykes. Quartzite and metawacke, both in the GBF and interlayered in the FRF, yielded mainly Mesoproterozoic U–Pb detrital zircon ages and a maximum depositional age of about 915 Ma. The detrital patterns are most consist with Baltica as the source. A mafic lithic tuff in the FRF yielded an age of ~760 Ma, interpreted as the age of magmatism in the FRF and of deposition of the GBF. The sample contains a large inherited population at ~890 Ma. The basaltic samples and some of the sills and dykes have mid-ocean ridge chemical characteristics. The FRF and GBF are interpreted to have been formed in a back-arc basin, for which ca. 760–730 volcanic arc rocks in the Mount Ephraim block may represent the arc.

A 400-year paleolimnological record of anthropogenic activity and environmental change from Oak Island, Nova Scotia, Canada

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Oak Island is the site of the worlds longest running treasure hunt (~1795–present) and has been the site of significant landscape disturbance and modification bo th before and during that time. Information on anthropogenic activity on Oak Island prior to 1795 has been primarily provided by archaeological investigation and historical records. Paleolimnological records from a small, presently freshwater back-barrier marsh ("The Swamp") and an open-water site (locally called "The Eye") in the Swamp record anthropogenic activity that provide insight into activity at the site. Gravity and percussion cores from The Eye were obtained between 2019–2021 and were split lengthwise to provide stratigraphic context. Carbon dating and total lead concentrations provided temporal control. Stratified clay and silt layers at the base of the core that contain axe-cut wood fragments were likely deposited during initial disturbance and use of the site. Wood in overlying disturbed and stratified sediment produced a 1500–1600 cal AD date. Some nearby large boulders overlie swamp sediment likely indicating that they were moved to create the feature. A carbon date of ~1500–1630 cal AD was obtained from the outside of a stump of a large tree on the perimeter of the feature. XRF data from percussion core records indicate that local industrial activity may have taken place coincident with the construction and use of the feature at The Eye. The Eye may represent a water source created prior to ~1750 AD. It was likely that the site was only used for a short time before being abandoned. Considerable landscape disturbance by treasure hunters in the early 19th century and onwards is well recorded in the cores. Collectively these inferences along with a robust archaeological record suggest significant, short-lived but unrecorded activity on Oak Island prior to 1800 AD likely not related to either fishing or farming.

The discovery and interpretation of the oldest known tetrapod burrows from Visean strata at Lepreau Falls and Visean-Serpukhovian strata from Midland, New Brunswick, Canada

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Despite the field of vertebrate ichnology originating in the 19th century, the ichnology of Paleozoic vertebrate burrows remains in its infancy. Tetrapod burrows are abundantly known from the Permian and Triassic periods through to the present, but prior to this study only a single lower Carboniferous tetrapod burrow has been described in the literature, and it is from upper Serpukhovian strata in the Mauch Chunk Formation of Pennsylvania. We describe the first occurrences of tetrapod burrows in the Maritimes Basin; in the upper Visean Windsor Group at Lepreau Falls, and from lower Serpukhovian strata of the newly defined Millstream Subbasin near Midland, New Brunswick. A Visean tetrapod burrow from Lepreau Falls is the oldest known tetrapod burrow in the fossil record. Two new morphologies are described, and both are preserved within red, non-marine fluvial clastic strata on the flanks of upper Visean channels, deposited during the transgression of the normal marine 'Windsor Sea' into the Maritimes Basin. One burrow consists of a subhorizontal bifurcating tunnel, whereas the second comprises a shallow entry shaft, entry chamber, subhorizontal tunnel system and a terminal chamber. Both burrows exhibit parallel scratch impressions on the burrow walls. The burrows are interpreted to have been excavated by tetrapods under semi-arid to arid conditions. In addition to protection, nesting, hibernation, food hoarding, and/or rearing young, burrows are classically interpreted to be the behavioural response of vertebrate life to unfavorable environmental conditions such as seasonal drought or climate change. This suggests that shortly after the diversification of tetrapods during the interval of time known as 'Romer's Gap', tetrapods sought refuge in the subsurface when environmental conditions shifted. These behavioural trends have been repeated in several vertebrate groups throughout geological time and are still employed by several tetrapod groups today.

Not the Neoacadian orogeny

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The term Neo-Acadian was introduced by Robinson in 1998 for Late Devonian – early Mississippian shortening in New England. The earlier Acadian orogeny is bracketed between emplacement of the ~422 Ma Pocomoonshine pluton in Maine and the end of westward foreland basin migration around 385 Ma; it has been associated with the accretion of Avalonia to composite Laurentia. The subsequent Neo-Acadian orogeny continued from 370 to ~350 Ma. The term has continued to be used in New England with this meaning, but was deprecated by Robinson, who favoured instead the Indigenous-derived name Quaboagian.

The term, now "Neoacadian", was further confused from 2005 by association with Meguma terrane accretion, even though published dates for deformation there fall either before or after the Neo-Acadian/Quaboagian as previously defined by Robinson. Folding at ~400 Ma during the Acadian interval possibly occurred in a tectonic environment different from the main Acadian event. The 370–350 Ma interval in Nova Scotia saw oblique extension, when the Horton Group was deposited in a basin-and-range setting, unconformably on older rocks, including subduction-related(?) plutons, mainly 379–372 Ma. Although the transtensional basins were probably connected with Quaboagian shortening in New England via dextral strike-slip, the tectonic environment in Atlantic Canada was clearly anorogenic. Subsequent basin inversion after 330 Ma was associated with dextral transpression on the Minas fault zone.

The (mis-)use of "Neo-Acadian" for accretion of the Meguma terrane has led to misconceptions about both the timing of accretion and about the Late Devonian tectonic regime. We recommend that this term be abandoned in favour of Quaboagian, and restricted to 370–350 Ma convergence in New England (synchronous with extension, not orogeny, in Atlantic Canada). Earlier deformation in the Meguma terrane, falling within the Acadian time-window but potentially unrelated to the rest of the Acadian orogen, may require a new name.

Silurian sequences in northern Maine, USA, and their tectonic evolution during the Salinic and post-Salinic orogenies

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Recent mapping reveals that Silurian strata in northern Maine (north of Houlton) can be grouped into several stratigraphic sequences in two major lithotectonic belts. The Aroostook-Matapedia Basin/Belt (AMB) contains two distinctive sequences: the dominant *Carys Mills sequence* of a conformable succession, including the Chandler Ridge (sandstone and slate), Carys Mills ("ribbon limestone"), and Spragueville (argillaceous micrite and calcareous silty mudstone) formations, and the *Perham Group sequence* consisting of the conformable and transgressive Frenchville (conglomerate, sandstone, and slate), Jemtland (sandstone and slate with minor arc-related felsic tuff), and New Sweden (limestone and slate with Fe-Mn deposits) formations. The latter lies unconformably on the Ordovician Winterville, York Ridge, and Castle Hill inliers and is interpreted to be originally the western part of the AMB. Both sequences were intensely folded and foliated during the Acadian orogeny, but later juxtaposed by a major Neoacadian (?) northeast-striking thrust fault with significant horizontal displacement.

The Number Nine Mountain terrane is a recently discovered composite Taconic-Salinic orogen formerly considered to be part of the Weeksboro-Lunksoos Lake belt (WLLB) and is separated from the AMB to the southeast by major southwest-striking thrust faults and from the WLLB to the southwest by northwest-striking high-angle faults. The base of its Silurian *Number Nine Mountain sequence* is the Nine Lake mélange, the first subduction-related Salinic mélange recognized in Maine and New Brunswick. The mélange rests unconformably on Middle Ordovician arc-related volcanic rocks (newly named "Morehouse Brook Formation") and Cambrian (?) Laurentia-sourced conglomerate/sandstone (newly named "Three Brooks Formation"), and is overlain unconformably by the *Maple Mountain subsequence*, comprising the internally conformable Spruce Top (basalt), Dunn Brook (pyroclastics), and Maple Mountain (slate hosting the Maple-Hovey Fe-Mn deposit) formations, and capped unconformably by the Burnt Brook Formation (phyllite). The unconformities within the sequence are attributed to early and middle phases of the Salinic orogeny.

Historical air photo analysis of old stone walls at Herring Cove, Nova Scotia, Canada, as vanishing cultural landscape elements

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Stone walls can outlast other more ephemeral elements of cultural and archaeological landscapes for a long time. Recent studies in Europe and the United States involved remote sensing to detect physical properties and spatial controls of old stone walls. Although there is physical evidence of them, as well as sporadic literature reference, little is known about historic stone walls as cultural landscape elements in Canada; relicts tend to be obscured by vegetation. They deserve further study as vestiges of past human activity and local land use dynamics. This study examines a variety of geospatial records with the goal to reveal location, function, and extent of old stone walls at Herring Cove, a historic fishing village at the entrance to Halifax Harbour in Nova Scotia. Forensic image analysis involves old air photos, ground-based photography, artistic portrayals, the study of cadastral and geological information, as well as recent satellite imagery and airborne LiDAR records. A surprising number of stone walls can be identified on aerial photographs dating back to 1931 and 1955; they also capture settlement and land use patterns at the time. Measurements related to stone walls reveal an average length of 100 metres per hectare. In addition to the air photo analysis, the study presents a hybrid map of stone wall locations and archival cadastral information. The latter is a critical component to verify the function of old stone walls in delineating property boundaries. Air photo analysis of contextual land use features indicates other stone wall functions; they include field enclosures, livestock holding pens, or roadway demarcations. The initial work pertaining to geospatial information on old stone walls at Herring Cove raises questions for further archaeological and historical research to confirm age, structure, and function of the remaining stone walls and to determine their heritage value.

Zircon as a tracer of mantle processes and kimberlite magmatism

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Zircon is a silicate mineral ($ZrSiO_4$) most frequently used for dating rocks. It incapsulates a variety of elemental and isotopic tracers of geological processes. Zircon is an extremely stable and a widespread accessory mineral in silica-rich crustal rocks. Its occurrence in kimberlites, representing the deepest mantle-derived magmas, and in ultramafic and mafic rocks provides evidence for stability of zircon in the mantle. However, its origin in the mantle is insufficiently explored. The key hypothesis to be tested is that formation of zircon is not limited to felsic crustal systems but can happen in the mantle. Further investigation

of zircon is important because it serves as a crucial marker of geological processes, enabling the study of processes in the mantle.

To determine the conditions of zircon formation and to use it as a geochemical tracer in mantle-derived magmas, we studied zircon saturation and stability in mantle melts through the experimental research. The study involved several mafic compositions, including synthetic kimberlite and natural mid-ocean ridge basalt (MORB) and disks cut from natural zircon crystals from the Mud Tank kimberlite deposit in Australia. The experiments were conducted in piston-cylinder apparatus at temperatures ranging from 1300 to 1350°C and pressure of 1 GPa. The results of the experiments showed that zircon can be stable under these conditions in short experiments lasting for 1 hour. This data differs from the results describing solubility of this mineral in the asthenosphere. It indicates that zircon is more stable under higher pressures, which occur in the mantle. The data obtained will be utilized to develop a new thermodynamic model describing the stability of zircon in mantle melts depending on temperature, pressure, and composition of mantle fluids and melts.

Developing mineralogical and geochemical discrimination methods to classify Li-barren and Li-prospective pegmatites in southwestern Nova Scotia, Canada

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The parental magma composition that produces a plutonic rock is what gives the lithium bearing pegmatite its distinct elemental composition. These magmas have very high concentrations of specific incompatible trace elements that distinguish them from other types of pegmatitic magma. A sought-after incompatible element, lithium, is challenging to detect through most routine analytical techniques. It occurs in abundance most commonly bonded within aluminosilicate minerals; for example, as the lithium aluminium silicate mineral spodumene ($LiAlSi_2O_6$). The current research is focusing on the detection of this element in prospective terranes aided by geological and geochemical data. The practical goal of the study is to be able to predict the occurrence of lithium-rich pegmatites that may not contain spodumene at a site of pegmatite dyke exposure but that contain hidden spodumene inventory. In other words, the goal is to find a "fingerprint" that can indicate the presence of geologically lithium-rich minerals. The main objective is to investigate if the chemical composition and mineralogy of chemically developed rocks can be used to differentiate between economic and sub-economic lithium rocks in the absence of spodumene. The first step is to follow pre-existing classification systems. Granitic pegmatites can be classified into three different sections, into which the samples are grouped by doing thin section analysis to determine the main and accessory minerals, using the SEM to confirm some of the data. The second step is discrimination; running a principal component analysis using the data acquired to further find out where lithium is occurring. The third step is to look at the larger picture and run soil analyses. This research is intended to find a way to facilitate lithium detection and to more reliably recognize lithium- prospective deposits.

Marginal conditions: the paleoenvironmental and stratigraphic setting for Manitoba's Ordovician William Lake Lagerstätte

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The William Lake Lagerstätte in the Grand Rapids Uplands of Manitoba preserves remarkable remains of soft-bodied or lightly sclerotized animals, many of which are unknown, or little known elsewhere in the Ordovician fossil record. These include arthropods (eurypterids, xiphosurids [horseshoe crabs], pycnogonids [sea spiders], and others), gelatinous zooplankton including cnidarian medusae (jellyfish), and other groups, representing organisms that lived along the margin of the tropical Williston Basin during the Late Ordovician (Katian). The fossils occur in an approximately 2.5 m interval within the Gunton and Williams members of the Stony Mountain Formation. Careful bed-by-bed collecting over a period of a decade has provided the Manitoba Museum with a collection of well over 1000 fossiliferous slabs from this interval. Ongoing documentation of these slabs, along with field assessment of sedimentary structures and bedding features, allows us to develop an understanding of the environmental setting of the William Lake biota. The data demonstrate an intimate tracking of organisms and facies during a regressive interval, from muddy, subtidal shallow marine facies, through various peritidal and lagoonal conditions, to restricted hypersaline intertidal to supratidal mud flat. The peak development of the lagerstätte biota is observed within

the lower 80 cm of the Williams Member. Dolomudstone in that interval exhibits channels, ripples, trough cross-lamination, horizontal lamination, microbial mat textures, and dewatering structures. These structures are consistent with peritidal and/or lagoonal conditions. Lingulide brachiopods, gastropods, and arthropod sclerites are concentrated in particular horizons, whereas cnidarian medusae, articulated chelicerate arthropods, and large phosphatic tubes occur within homogeneous mud bodies. In some places, lingulides and/or cnidarian medusae are abundant in channel fills but nearly absent in the adjacent dolomudstones. Some taxa, such as eurypterids and xiphosurids, occur throughout this interval, whereas others, such as pycnogonids, occur in just one or two horizons.

Is the genesis of porphyry Cu-related adakitic rocks in New Brunswick, Canada, a result of slab failure?

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Adakitic geochemistry signifies partial melting in subduction zone settings. Adakite commonly has SiO_2 ≥56 wt.%, Al_2O_3 ≥15 wt.%, Y ≤18 ppm, Yb ≤1.9 ppm, K_2O/Na_2O ≥1, MgO <3 wt.%., high Sr/Y (≥10), and La/Yb (>10). Devonian I-type adakitic granitoid rocks in New Brunswick are geochemically consistent with adakite elsewhere, i.e., SiO_2 ≥66.46 wt.%, Al_2O_3 >15.47 wt.%, Y ≤22 ppm, Yb ≤2 ppm, K_2O/Na_2O = 0.42 to 0.90, MgO <3 wt.%, Sr/Y ≥33 to 50, and La/Yb >10. Several of these adakitic intrusions have associated Cu mineralization, and include Blue Mountain Granodiorite Suite, Nicholas Denys, Sugar Loaf, Squaw Cap, North Dungarvan River, Magaguadavic Granite, Hampstead Granite, Tower Hill, Watson Brook Granodiorite, Rivière-Verte Porphyry, Eagle Lake Granite, Evandale Granodiorite, North Pole Stream Suite, and the McKenzie Gulch porphyry dykes. They are comparable to the Cu porphyry intrusions at Mines Gaspé, Québec, in that they are enriched in large-ion lithophile elements (Cs, Rb, and Ba) and depleted in high-field-strength elements (Nb, Ta, P, and Ti) and heavy REE.

Adakite formation related to slab failure and its influence on the generation of fertile porphyry Cu systems are supported by trace element systematics of the adakitic intrusions considered in this study, specifically: Sr/Y ≥33 to 50, Nb/Y >0.4, Ta/Yb >0.3, La/Yb >10, Ta/Yb >0.3, Sm/Yb >2.5, Gd/Yb >2.0, Nb+Y <60 ppm, and Ta+Yb <6 ppm. These characteristics indicate slab failure genesis, a process that generates post-collisional granitoid magmatism at destructive plate margins in terminal subduction systems. During subduction, a segment of the subducted oceanic plate undergoes fracture and separation. Upwelling asthenosphere, in response to slab sinking, results in elevated temperatures and partial melting of the descending oceanic slab. These silica-rich adakitic magmas ascend through thickened mantle lithosphere, without asthenospheric involvement. Transpression and transtension are crucial for the ascent and emplacement of adakitic magmas in subduction zones.

