Atlantic Geoscience
Journal of the Atlantic Geoscience Society

Geological Association of Canada, Newfoundland and Labrador Section Abstracts: 2025 Technical Meeting, February 27 and 28, 2025

Volume 61, 2025

URI: https://id.erudit.org/iderudit/1117640ar
DOI: https://doi.org/10.4138/atlgeo.2025.007

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Publisher(s)

Atlantic Geoscience Society

ISSN

2564-2987 (digital)

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Cite this document

(2025). Geological Association of Canada, Newfoundland and Labrador Section Abstracts: 2025 Technical Meeting, February 27 and 28, 2025. *Atlantic Geoscience*, *61*, 195–205. https://doi.org/10.4138/atlgeo.2025.007

Geological Association of Canada, Newfoundland and Labrador Section

ABSTRACTS

2025 Technical Meeting

St. John's, Newfoundland

The Geological Association of Canada Newfoundland and Labrador Section (GAC-NL) 2025 Annual Technical Meeting was held in-person at the Department of Earth Sciences, Memorial University, on February 27 and 28. However, oral presentations were also available to be viewed virtually.

This year the meeting kicked off on Thursday morning with introductory remarks from the GAC-NL President, Roderick Smith. The rest of the conference was taken up by presentations on a wide range of geoscience topics. In the following pages, we are pleased to publish the abstracts from the oral presentations.

The three best student presentations are recognized and receive the "Outstanding Student Presentation Award" which consists of $250, $150, and $100 cash prizes. The three award winners are indicated by an asterisk after the title and noted at the end of the appropriate abstract.

As always, this meeting was brought to participants by volunteer efforts and would not have been possible without the time and energy of the executive and other members of the section such as Roderick Smith, Sarah Hashmi, Zsuzanna Magyarosi, Zachary Adams, James Conliffe, Gabriel Santos, Nic Lachance, Eric Thiessen, Heidi George, Jonathan Remedios, and Anastasia Parrell. GAC-NL is also indebted to the partners in this venture, particularly the Geological Survey of Newfoundland and Labrador, Geological Association of Canada, Department of Earth Sciences-Memorial University, Alexander Murray Geological Club, Newfound Gold Corp., Altius Minerals Corp., Imdex, Atha Energy Corp., Landmark Surveys and Engineering Limited, Hatch, Krinor Resources, Canstar Resources Inc., Northern Shield Resources, and Wooden Walls Distilling. GAC-NL is pleased to see the abstracts published in "Atlantic Geoscience".

THE EDITORS

ATLANTIC GEOSCIENCE 61, 195-205 (2025) doi: 10.4138/atlgeo.2025.007

ISSN: 2564-2987.

Role of late transverse faults in gold mineralization in the Superior Province: a case study from the Michipicoten Greenstone Belt, Ontario, Canada

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Orogenic gold deposits in the Superior Province are characteristically hosted in Archean greenstone belts and are fundamentally controlled by their structural environment. Many of these deposits are recognized as syntectonic with the formation of the Superior Province between ca. 2.8–2.6 Ga and are strongly influenced by east–west-striking shear zones. Gold deposits associated with transverse faults that are at a high angle to these major shear zones have been observed but overlooked in past exploration frameworks; hence, the genesis, timing, and prospectivity of these deposits are poorly understood.

The Maskinonge Lake fault, a late northwest-trending brittle–ductile structure in the Michipicoten greenstone belt, is one of these transverse structures and is populated with zones of high-grade mineralization along its strike. The historic Pine-Breccia gold showing along this fault encompasses ca. 2750–2700 Ma metavolcanic rocks that have undergone pervasive silica alteration and gold mineralization, suggesting that the Maskinonge Lake fault was a potential conduit for gold-bearing hydrothermal fluids. Results of detailed outcrop-scale mapping and structural analyses have led to the recognition of three distinct stages of deformation along a steeply dipping fault plane in a dominantly strike-slip regime. Dextral motion is identified by the rotation and ductile drag of regional east-west shear zones and parallel felsic dykes, whereas sinistral movement is documented primarily by the substantial displacement of stratigraphy and vein array analysis. The coincidence of fluid infiltration with these events coupled with constraints on mineralization provide more insights into the significance of these structures on a local scale, and the results of this study may be used to aid future exploration around similar structures that are at a high angle to major east–west shear zones in the Superior Province.

Comparison of digestion methods applied to lake sediments in eastern Labrador, Newfoundland and Labrador, Canada

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This presentation examines the relationship between analytical results following different digestions and challenges some assumptions of equivalency. A dataset comprising 1809 analyses, performed at different times using three different digestions, and as total-sample analyses by neutron activation, is available for lake sediments from eastern Labrador. This unique dataset allows the comparison of at least one, and commonly more than one, pair of analytical methods for nearly 40 elements. The samples were initially collected in the 1970s and 1980s under the auspices of the National Geochemical Reconnaissance program of the Geological Survey of Canada.

Overall ratios of the most recent (modified aqua regia) analyses to stronger (multiacid) or total (INAA) analyses range from close to unity for most REE and some chalcophile and siderophile elements, to greater than x10 for the lithophile elements Zr, Na, K, and Hf. Ratios between results that would be expected to be similar, viz. multiacid/INAA and Lefort/modified aqua regia are closer to unity but not universally so.

When relationships between analytical methods are examined over the entire concentration range, they vary considerably. However, the variations fall into a limited number of classes, some of which are observed commonly whereas others are rather rare. Relationships that remain constant over the entire concentration range are extremely rare.

In conclusion, the measured analysis of almost any element in a lake-sediment sample depends on whether the sample is subjected to digestion prior to measurement, or to total-element measurement, and the nature of the digestion. Assumptions about the equivalence of analytical methods, or constancy of the relationship between them over the entire concentration range, are typically not valid. Overall, these results provide important information for any exploration program implementing lake-sediment sampling for geochemical analysis and are probably also applicable to some extent to other sample media.

Avalonia in the Maritime Provinces of Canada – 2025 update

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Avalonia in the northern Appalachian orogen extends from southeastern New England through the Maritime Provinces to eastern Newfoundland. It may continue through Wales and southern England into Belgium and central Europe, where it has been termed East Avalonia, but this connection remains controversial. Although eastern Newfoundland is recognized as the type area for Avalonia, on-going field work, petrological studies, and especially geochronology in the components in New Brunswick and Nova Scotia have resulted in increased understanding of terranes within Avalonia in those areas. The results demonstrate that the record is fragmentary and no single part of Avalonian preserves the entire story. Avalonia is a collage of diverse Neoproterozoic terranes with complex and apparently divergent tectonic settings and histories, isotopic compositions, and temporal evolutions. The oldest rocks known in Avalonia are preserved in the Cobequid Highlands of northern mainland Nova Scotia, where arc and backarc volcanic rocks have ages of ca. 780–730 Ma, with inherited zircon evidence for older arc rocks at ca. 890 Ma. Arc magmatism at ca. 700–670 Ma is preserved in volcanic and plutonic rocks in the Caledonia terrane of southern New Brunswick and in the Mira terrane of southeastern Cape Breton Island. The so-called "main phase" of arc magmatism in Avalonia is represented by volcanic and plutonic rocks with ages of ca. 625–615 Ma in the Caledonia terrane, ca. 630–600 Ma in the Cobequid Highlands, ca. 618–602 Ma in the Antigonish Highlands, and ca. 640–620 Ma in the Mira terrane. The late Ediacaran magmatic and sedimentary history differs markedly among these terranes and includes arc magmatism at ca. 575 Ma only in the Mira terrane and voluminous bimodal magmatism at ca. 550 Ma only in the Caledonia terrane. Non-marine Cambrian redbed sequences with maximum depositional ages of ca. 534 Ma overlie the Ediacaran rocks in all these areas except the Cobequid Highlands. These diverse histories need to be considered in studies of the less(?) fragmentary rock record in Avalonian Newfoundland.

Geochemistry and petrogenesis of granitoid rocks from southwest Bundelkhand Craton, central India: elemental and isotopic constraints

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Bundelkhand craton of central India is predominantly composed of abundant high-K granites formed at the Archaean-Proterozoic boundary, along with several enclosed rafts of TTG (tonalite-trondhjemite-granodiorite) dating back to ca. 3.5–2.5 Ga. Heterogeneity in these granitoid rocks can be observed in their textural feature, colour, and mafic mineral content, classifying them as Grey, Rapakivi and Pink granites. Mineral chemistry studies further reveal the 'Grey Granites' as the product of more than one pulse of magmatism containing plagioclase feldspar of low ($An_{1–19}$) and high ($An_{27–32}$) Ca content. Significant mafic content and andesine plagioclase suggests that these granites are granodioritic in composition. In pink granite and rapakivi granite, two types of K-feldspar are observed: perthitic and non-perthitic. The mesoperthitic nature of the K-feldspars suggest their high temperature origin.

The U–Pb zircon ages show overlapping ages between ca. 2.57 and 2.53 Ga, which is coincident with the late-Archaean alkaline magmatism. The present study therefore concludes that the crustal evolution and stabilization of Bundelkhand Craton began around the Palaeoarchaean (ca. 3.3 Ga) and by the Neoarchaean the cration was steadily reworked (ca. 2.57–2.54 Ga). Crust-mantle interactions resulted in the formation of Closepet-type granites whereas the Rapakivi granites and monzogranites were the result of dominant crustal melting. This thus makes Bundelkhand a crucial site for investigating Archaean crustal growth and the development of multi-source granitoid batholiths, which contributed to the stabilization of a supercontinent around 2.5 Ga.

Problematic post-*Paradoxides davidis* Biozone trilobites from Walsh's Road, Conception Bay South, Avalon Peninsula Newfoundland, Canada

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Incomplete, articulated ptychopariid trilobite material has been recovered from fragile black shales of probable Elliott Cove Formation (Harcourt Group), exposed along the eastern side of Walsh's Road (Conception Bay South),), near its intersection with Red Bridge Road. The newly discovered locality is of unknown stratigraphic distance above the *Paradoxides davidis* Biozone strata of the underlying

Manuels River Formation (Harcourt Group) of the adjacent Red Bridge Road Quarry (formerly known as 'The Kelligrews Quarry'), which are correlative with the late Maiolingian Series (Drumian Stage). The specimens are tentatively identified as *Leptoplastus* spp. A correlation with the Leptoplastus Superzone of Avalonia and Scandinavia would therefore be indicated, placing the locality within the Late Cambrian Furongian Series (Jiangshanian Stage).

Assessing heavy liquid separation and automated scanning methods to detect critical and precious minerals in the fine fraction of till associated with intrusions, gold bearing veins and LCT-type pegmatites: examples from northeast and southwest Newfoundland, Canada

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The increasing importance of critical minerals has necessitated a rethinking of exploration methods to optimize their detection in glacially dispersed material (i.e., till). Traditional optical mineral counts have been used to detect indicator minerals in the coarse visible fraction (>0.1 mm fraction) of till near known mineralized prospects. However, many of the economic minerals hosted in pegmatites, granites, ultramafic intrusive rocks and hydrothermal veins are smaller than 250 μm, hindering their optical identification. In addition, many optically identified indicator minerals are not unique to specific source units and are scarce in the coarse fraction of dispersed till, impeding exploration efforts.

For this study, nine samples collected from multiple till units overlying gold and pegmatite-related mineral prospects, and from three sites of unknown mineral potential were sent for analysis to assess the utility of detecting indicator minerals in the fine fraction (<250 μm) of till proximal and distal to mineralization employing fluidized separation, two-density heavy mineral separation, automated detection, and mineral characterization using a scanning electron microscope (SEM).

Economic minerals associated with granites and pegmatites (e.g., tantalum-, niobium-, tin- and tungsten-rich minerals), ultramafic intrusive rocks (e.g., osmium, ruthenium, rutheniridosmine, platinum, sperrylite and stibiopalladinite), as well as gold grains, were detected in abundance in the fine fraction of tills. Unique indicator minerals such as the Mn-garnet spessartine, associated with the Kraken prospect, and kaersutite, associated with the Budgell's Harbour and Dildo Pond dykes, were identified in single till units of sections with multiple tills. The results of this study indicate that automatic scanning is successful in detecting economic minerals in the fine fraction of till relating to up-ice and underlying mineral prospects, and in identifying unique mineral species that can help identify specific up-ice sources for further mineral exploration targeting.

Geology of the Valentine gold mine, central Newfoundland, Newfoundland and Labrador, Canada

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The Valentine Gold Mine is a series of orogenic, structurally controlled gold deposits found along the Valentine Lake Shear Zone (VLSZ) in central Newfoundland. The gold is hosted by quartz-tourmaline-pyrite-gold veins within the Valentine Lake Intrusive Complex (VLIC), a series of granitic to gabbroic, Precambrian intrusions. The VLIC lies in contact with the Silurian Rogerson Lake Conglomerate (RLC) to the southeast, along the VLSZ, and the brittle-ductile competency contrast between these two units allows for deposition of hydrothermal fluids in the more fractured, brittle, VLIC. Mineralization discovered to date has been concentrated along this VLSZ, but recent geophysical surveys and general geological setting indicate potential for additional mineralization in lithologies more distal from the main shear zone. A general project update, as well as future academic and exploration objectives, is provided in this session.

Silurian extensional collapse: evidence from mafic magmatism, western Newfoundland, Newfoundland and Labrador, Canada

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The Taylor Brook Gabbro Suite (TBGS) is a compositionally heterogeneous, cumulate mafic suite that intruded along the faulted margin of the Long Range Inlier of western Newfoundland. U–Pb zircon SHRIMP ages indicate that the TBGS formed at 431.0 ± 2.7/4.2 Ma, with subsequent minor silicic magmatism occurring at 419.7 ± 3.0/4.5 Ma (external error after slash). The geochemical data suggest that the TBGS is primarily tholeiitic, with characteristics transitioning towards calc-alkaline compositions. The TBGS was derived from an enriched mid-ocean ridge basalt (E-MORB) primitive magma and the primary differentiation mechanism

was fractional crystallization. The isotopic signatures for the TBGS are predominantly juvenile with $\varepsilon Nd_{(430\ Ma)}$ ranging from -1.1 to +6.4 and $^{87}Sr/^{86}Sr_{(i)}$ values ranging from 0.70337 to 0.71647; with one sample having an $\varepsilon Nd_{(430\ Ma)}$ of -8.6. The TBGS formed during a post-Salinic extensional/transtensional collapse of the eastern Humber margin. Magma ascended along pre-existing fault systems that represent long-lived, subparallel, deep-seated zones of lithospheric weakness. This post-Salinic extensional collapse appears to be widespread in western and central Newfoundland.

Potential for CO_2 storage in the Whale and South Whale basins, southern Grand Banks, Newfoundland and Labrador, Canada*

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Carbon capture and storage (CCS) is becoming a more common method of mitigating climate change. An effective method of storage is to inject CO_2 into a porous reservoir rock unit overlain by an impermeable caprock unit. CCS is particularly relevant to Newfoundland considering hydrocarbon exploration offshore, which produces significant quantities of CO_2. The Whale and South Whale basins, located in the southern Grand Banks, have been proposed as potential storage sites for CO_2. Their potential for storage is mainly being assessed through seismic interpretation, in which seismic data are being used to analyze the potential trapping structures and migration pathways for CO_2. The interpretation also involves calculating potential storage volumes. Core samples of relevant rock units from this region are currently being acquired for physical rock analysis, which includes measurements of velocity, density, porosity, and permeability. Currently, results show that there are multiple potential reservoir units with appropriate physical properties, and multiple areas whose structural properties are suitable for CO_2 trapping. Most of the identified trapping structures are related to the diapirs that are common in this region. The final results from these methods will later be combined to quantify the overall potential for CO_2 storage in these basins, which will take into account the physical properties of the potential reservoirs and caprocks, as well as the extent, structural complexity, and location of the promising rock units.

**Winner (2nd place): GAC-NL Section Award for best student oral presentation*

Geochronology and geochemistry of West African mafic dykes define a trans-supercontinental mafic magmatic province preceding Gondwana breakup

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The use of mafic dyke swarms in establishing geological correlations across continental-scale distances is well-established, with examples spanning Earth history, and they commonly preserve magmatic records of continental break-up. In this study, samples of mafic dykes from the San Pedro and Soubré dyke swarms in Côte d'Ivoire are dated using high-precision U–Pb geochronology of baddeleyite by ID-TIMS and are analyzed for their lithogeochemistry and isotope geochemistry. An age of 183 Ma was obtained for these dykes, indicating an affiliation with the Karoo-Ferrar LIP, which occurs in southern Africa through Antarctica to Australia in a Gondwana configuration. This genetic connection between the Côte d'Ivoire dykes and previously established Karoo-Ferrar LIP rocks suggests that the magmatism defined a linear belt that spanned the entire width of Gondwana. The length of this belt from Australia to the dykes in western Africa extended approximately 14 000 km. This connection is also supported by the geochemical signatures of the dykes. Analysis of Sm–Nd and Rb–Sr isotope systematics will provide further insights on the mechanisms causing the magmatism and related break-up, in concert with geophysical models of large linear occurrences of mantle melting

Stratigraphy and petrochemical evolution of volcanic rocks from the Long Harbour Group and Rencontre Formation, Avalon Zone, Newfoundland and Labrador, Canada

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Bimodal volcanic and volcano-sedimentary rocks of the Long Harbour Group and Rencontre Formation, northern Fortune Bay, are among the youngest Precambrian rocks of the Avalon Zone in Newfoundland, spanning ca. 570–550 Ma. The lowermost Belle Bay Formation is overlain by the Anderson's Cove and Mooring Cove formations, respectively, each of which is locally unconformably overlain by the Rencontre Formation. Flow-banded rhyolite, upper Belle Bay Formation, is rare-earth-element (REE)-enriched, A-type,

alkali rhyolite. Mafic volcanic flows, bombs, and breccias interbedded in the overlying Mooring Cove and Rencontre formations comprise four petrochemical suites. The stratigraphically lowest, suite 1, has plagioclase phenocrysts with honeycomb-textured cores and sieve-textured rims, reflecting repeated magmatic replenishment. These rocks have low Mg#'s, Ni, Co and V, and relatively high SiO_2 and Zr contents, negatively sloped multi-element patterns and prominent negative Nb anomalies. They are similar to volcanic-arc basalt but more heavy-REE-enriched and lack Zr and Hf troughs. Suites 2 and 3 exhibit iron-enrichment trends and flatter multi-element patterns relative to suite 1. Suite 2 rocks contain primary clinopyroxene and are chemically primitive, with higher Mg#, Ni, Cr, V and Co and lower SiO_2, Zr and Th than suite 3 rocks. Suite 3 basalts have variable Th and Nb and originated from a more E-MORB-like source relative to suite 2. Suite 4 basalts have smooth negatively sloped multi-element patterns and high TiO_2 and P_2O_5. They are alkali, OIB-like, low-degree partial melts of a deeper source than the other basalts.

The basalts show a progression from calc-alkaline, through transitional basaltic compositions (continental tholeiites) ranging from volcanic arc-like, through N-MORB-like and E-MORB-like, to alkali basalt. This temporal change reflects progressive deepening of the magmatic source, resulting from late Ediacaran extension of an inherited lower Ediacaran volcanic arc. Subsequent extension continued episodically, possibly culminating in rifting by Terreneuvian to Miaolingian time.

Age, petrogenesis, and tectonic significance of the Top Pond pluton, southern Newfoundland, Canada

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The eastern edge of the Appalachian-Caledonian orogenic belt is characterized by the peri-Gondwanan domains Ganderia and Avalonia and the Meguma terrane. These areas accreted to composite Laurentia during the closure of the Iapetus and Rheic oceans from the Ordovician to the Carboniferous and were subsequently intruded by voluminous orogenic to post-orogenic Palaeozoic plutons. The Top Pond pluton intruded along the Bay d'Est Fault Zone (BDFZ) and is surrounded by Silurian metasedimentary and metavolcanic rocks of the Dolman Cove formation, which is part of the Hermitage Flexure terrane in Ganderia. The tonalite intrusion is medium-grained, equigranular, and comprised of major minerals plagioclase, quartz, biotite, hornblende, and epidote. Minor minerals in the tonalite are orthoclase, titanite, muscovite, and apatite and accessory minerals include allanite, zircon, ilmenite, titanomagnetite, and magnetite. Epidote occurs throughout the pluton as euhedral crystals with common zoning, indicative of magmatic origin. Two new precise U–Pb zircon dates for the Top Pond pluton are 540.870 ± 0.072 Ma and 540.997 ± 0.068 Ma, indicating that the intrusion is older than the surrounding Dolman Cove formation (ca. 419 Ma). This age represents the oldest intrusive age recorded in the Hermitage Flexure north of the Bay d'Est fault and suggests that the Top Pond pluton represents Ganderian basement rocks correlated with plutons of similar age in the Bras d'Or terrane of Cape Breton Island. New lithogeochemical data show the pluton to have an average SiO_2 of about 63% and overall composition typical of a calc-alkaline I-type tonalite. The lithogeochemical data, and mineral chemistry of the Top Pond pluton will help to compare the pluton with magmatic and tectonic events elsewhere in Ganderia and to test the connection between southern Newfoundland and coeval plutons in Ganderian Cape Breton Island, Nova Scotia.

Mapping and modelling a boreal forest soil organic carbon predictor in glacial tills, Newfoundland, Canada*

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Boreal forest soils store 30% of global forest soil carbon, making them a major component of the carbon cycle. Increasing temperature and extreme weather are raising concerns about the stability of boreal soil organic carbon (SOC) stocks. The magnitude and distribution of current and future boreal SOC reservoirs under various climate scenarios are poorly constrained, introducing uncertainty in models relying upon such estimates. There is evidence that mineral soil properties may be used to model SOC boreal forest soils to a high degree of accuracy. While the surface slope, depth of enriched horizon, and climate characteristics are important parameters that are readily obtained to estimate SOC, aluminum (Al) availability is a crucial predictor that is not generally available. Available Al refers to weatherable aluminum, which can react form stable, carbon rich organometal complexes in mineral soils. To address this gap, I accessed the Geological Survey of Newfoundland and Labrador till geochemistry dataset to model and map Al availability in glacial till across the island of Newfoundland using geological and climatic predictors. The Random Forest algorithm was used to construct two high resolution geospatial models to map Al availability across the island: one relying exclusively on geological and climatic covariates, and

and a second that additionally leveraged the spatial relationships between sample points. Model validation suggested that the first model performed well ($R^2 = 0.60$), but that the inclusion of spatial information improved predictions ($R^2 = 0.71$). Results indicated that bedrock type and proximity of samples to bedrock units are the strongest controls on Al availability. Environmental covariates and surficial deposit types have less influence. This work demonstrates the value of empirical geospatial modelling for till geochemistry mapping, and provides critical Al availability predictions for deriving SOC storage estimates across the island of Newfoundland.

**Winner(1st place): GAC-NL Section Award for best student oral presentation*

Intrusion-related mineralization in the northern Mount Peyton Intrusive Suite, central Newfoundland, Canada: magmatic-hydrothermal potassic alteration and polymetallic mineralization in metaluminous biotite-hornblende-magnetite diorite and monzogranite

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Exploration in the northern Mount Peyton intrusive suite (MPIS), central Newfoundland has outlined a 17.9 km-long, NNW-trending corridor, the Mount Peyton trend, that is anomalous in many metals (e.g., Au-Ag-As-Sb). The trend's south end contains the Au-Ag-Sb mineralization of the Yellow Fox zone. Four kilometres north, drill-tested Au-Ag mineralization (6.3 g/t Au over 2m and 7.5 over 1m) occurs at the Salmon River zones and grab samples yielded elevated Au-Sb-As at Shirley Lake. In the Neyles Brook quarry in the north (Slip showing), Au-Ag-Sb mineralization occurs in monzogranitic dykes containing pyrite–muscovite–calcite–chalcopyrite ± galena ± arsenopyrite-filled miarolites with Au-As-Sb-Cu-Ag mineralization. The mineralized monzogranite at the Slip is a 418.0 ± 1.6 Ma metal-bearing, deuteric fluid-enriched residual magma that intruded a slightly older diorite (422.3 ± 1.2 Ma). At Yellow Fox, fractured, muscovite-pyrite-rutile-altered, granophyric-textured monzogranite generally lacking quartz veining, forms a 3000 m^2 zone that contains anomalous Au-Ag-Sb. Altered monzogranite yielded a U–Pb zircon crystallization age of 422.3 ± 1.3 Ma, overlapping in age with two $^{40}Ar/^{39}Ar$ incremental-heating ages for alteration muscovite of 422.4 ± 0.2 Ma and 422.9 ± 0.6 Ma, indicating that alteration, mineralization and crystallization were synchronous. Salmon River mineralization in fractured fine-grained quartz diorite consists of narrow (typically <10 cm), sulphide-poor quartz veins that have broad (cm- to m-scale), pyrite–arsenopyrite–muscovite–siderite–silica alteration envelopes. The alteration zones and veins are northeast-trending, moderately southeast dipping; veins at surface correlate with one set of conjugate regional joint surfaces. Mineralization at Salmon River yields elevated As-Au-Sb-Ag. The synchroneity of crystallization and mineralization of the MPIS rocks at both the Slip and Yellow Fox zones indicates that the vein/alteration systems and metal endowments along the length of the Mount Peyton trend are, at least in part, a result of contributions from 'intrusion-related' magmatic-hydrothermal fluids at ca. 422–418 Ma.

Ultra-trace aqueous pathfinder elements detect upstream Li-Cs-Ta (LCT) pegmatites in southern Newfoundland, Canada

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Granite-related Li-Cs-Ta (LCT) pegmatite dykes, with both Li-rich and Cs-rich varieties, in southern and central Newfoundland reveal potential for further discovery. However, exploration of these deposits is challenging due to their small geological footprint and limited capacity for geophysical detection. Aqueous geochemical exploration strategies hold promises to expand the window of detection and identify new focus areas for geological prospecting; however, clean chemistry methodology is needed to resolve subtle (low- to sub-ng/g) dissolved element variations in weathering-limited boreal environments and maximize the usable proxies capable of deciphering the context of watershed hydrochemical dynamics. A streamwater aqueous geochemical approach to detect LCT pegmatite mineralization is tested in southern Newfoundland with ICP-MS analyses from commercial and academic analytical facilities. Inter-laboratory comparisons show that commercial facility data identifies the main water signatures, but refined catchment resolution and use of other proxy elements requires academic clean laboratory protocols. Major-ion chemistry indicates dominant compositional controls from both atmospheric inputs and granitic bedrock weathering (e.g., LREE-enriched dissolved REE+Y patterns) in the boreal watershed, with local element enrichment proximal to till deposits. Nevertheless, aerosol-corrected and Na-normalized geochemical signatures of mobile 'pathfinder elements'- Li, Cs

Rb - are enriched above regional background levels downstream of known LCT pegmatites mineralization, which are gradually diluted further downstream. Spatial analysis reveals that even small-footprint dykes and their host-rock alteration haloes impart a detectable stream-water signature. Intercatchment Li/Na and Cs/Na variations suggest a dominant role of deposit-specific mineralogy, whereas soil and vegetation controls on pathfinder elements are also explored by their association with dissolved organic carbon (DOC) flux in streams. Rivers away from known mineralization with elevated Li/Na and Cs/Na ratios indicate potential for future refined aqueous geochemical exploration.

Volcanic-facies mapping and new U–Pb age constraints within the Buchans mining district, central Newfoundland, Canada: implications for exploration potential

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The polymetallic volcanogenic massive sulphide (VMS) deposits in the Buchans mining district, central Newfoundland, rank within the top 10% worldwide with respect to grade. Historic production yielded 16.2 Mt of ore at an average grade of 14.5% Zn, 7.6% Pb, 1.3% Cu, 1.37 g/t Au and 126 g/t Ag. Buchans stands out among VMS districts globally not only because of the unusually high metal content, but also because a little more than half the ore produced came from lenses of clastic transported ores, shed from in situ massive sulphide mounds. These deposits are hosted by the Middle Ordovician Buchans Group, a bimodal tholeiitic to calc-alkaline continental arc sequence that formed on the Laurentian margin and was affected by folding and thrust faulting during the closure of the Iapetus Ocean. Integration and recognition of fold-thrust belt style tectonics was largely adapted near the end of mining operations. Consequently, unravelling the structural architecture and the host stratigraphy offers potential for the discovery of new blind deposits on repetitions of the ore horizons within the various thrust panels. The application of volcanic-facies mapping utilizing detailed graphic logging of diamond-drill core represents a new approach to subdividing the Buchans Group stratigraphy, and when combined with whole-rock lithogeochemistry, provides an effective means of outlining several ore horizons developed within the immediate Buchans area. The ore-bearing stratigraphic interval is interpreted to comprise a series of four submarine rhyolite lava dome-cryptodome eruption packages, rather than a caldera filled with pyroclastic debris as was interpreted by previous workers. New TIMS U–Pb zircon ages constrain the ore-bearing stratigraphic interval to 472.3–467.1 Ma. The massive sulphide ores and ore-clast breccia units at Buchans formed in response to hydrothermal, volcanic and tectonic events during the emplacement of the rhyolite dome-cryptodome volcanoes. Two camp-wide and three additional local ore horizons are distinguished, which provide a foundation for future studies in the region and will allow for comparison with other volcanic sequences beyond the limits of the immediate Buchans area.

Petrology and thermodynamic modeling of Taconic eclogites in the Baie Verte margin, Newfoundland Appalachian orogen, Canada: implications for exhumation mechanisms

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The Appalachians represent a complex orogenic system resulting from the sequential closures of the Iapetus and Rheic oceans between the Cambrian and Permian. Newfoundland provides a well-preserved cross-section of the northern Appalachians, where evidence of the Ordovician Taconic orogeny—the earliest accretionary phase of the Appalachian orogen in the Laurentian realm—is recorded in the Baie Verte Peninsula. During this orogenic event, the Early Paleozoic Baie Verte Margin experienced subduction, collision, and subsequent exhumation, leading to the formation and exceptional preservation of eclogite, which is rarely preserved elsewhere in the Appalachians.

The geological record of the Taconic orogeny in this region is further complicated by pervasive tectono-metamorphic overprinting associated with the subsequent Salinic and Acadian orogenic events. To discern the Taconic structural and metamorphic signature from the widespread but spatially heterogeneous overprint, extensive regional mapping and multiscale structural analysis were conducted, leading to the identification of five deformation stages linked to both Taconic and post-Taconic tectonism.

This study has documented exceptionally well-preserved eclogites, including examples that retain structures associated with exhumation and retrograde metamorphic assemblages. Microstructural and mineralogical investigations indicate that the high-pressure eclogite-facies assemblage was

overprinted by four distinct retrogressive phases characterized by successive amphibole growth. Phase equilibria modeling was employed to generate isothermal P-M(H_2O) pseudosections, evaluating the role of fluid infiltration in facilitating metamorphic reactions leading to amphibole crystallization during retrogression. Additionally, garnet isopleth modeling provided constraints on the metamorphic peak as well as portions of the prograde and retrograde P–T evolution. Reconstructing the P–T trajectories of these eclogites is critical for elucidating the tectonic mechanisms governing their subduction and exhumation.

The processes responsible for the exhumation of these eclogites will be examined by comparing their P–T–t evolution with other high-pressure terranes and numerical models.

Deciphering polyphase metamorphism in the northern Rae craton (Baffin Island, Arctic Canada) using phase equilibria modeling, monazite petrochronology, and trace element mapping

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Integrated field mapping, phase equilibria modelling, and in situ U-Pb monazite geochronology from the northern margin of the Rae craton on Baffin Island (Qimivvik area) document three metamorphic events. High-grade metamorphism at ca. 2.56–2.50 Ga supports a footprint for late Neoarchean metamorphism over a distance of 600 km along the northwestern Rae margin from southern Boothia Peninsula to northern Baffin Island. Thermal peak mineral assemblages equilibrated at ca. 1.9 Ga at conditions of ~710–790°C and 4.3–5.5 kbar. Peak metamorphism and associated deformation, including the Qimivvik thrust that structurally juxtaposed Neoarchean tonalitic gneiss over Neoarchean metasedimentary rocks, are interpreted as a manifestation of the Ellesmere-Inglefield belt of Ellesmere Island and West Greenland, which links with the ca. 1.9 Ga Thelon orogen of western Canada. Partial melting also occurred at ca. 1.8 Ga, possibly resulting from decompression of the Churchill domain following collisional-accretionary events related to the late stages of amalgamation of Laurentia. Quantitative trace element maps (LA-ICP-MS) of monazite reveal distinct trace element signatures associated with each of the three growth stages. Circa 2.5 Ga monazite exhibits complex intragrain compositional zoning, elevated Y and heavy rare earth elements (HREE) relative to ca. 1.9 Ga monazite, and higher Th/U than both ca. 1.9 Ga and ca. 1.8 Ga monazite. These signatures suggest that ca. 2.5 Ga monazite growth was concomitant with partial melting and preceded the majority of garnet growth. Circa 1.9 Ga monazite has lower Y + HREE contents than both ca. 2.5 Ga and 1.8 Ga monazite, consistent with it forming after most garnet. Elevated Y + HREE in ca. 1.8 Ga monazite implies that it formed after retrograde resorption of garnet rims. Our results highlight the importance of integrating field and petrological data with high-spatial resolution geochronological and geochemical analyses of monazite to untangle the complex history of poly-metamorphosed rocks.

Assessing geologic uncertainty of CO_2 sequestration targets in the Jeanne d'Arc Basin, offshore Newfoundland and Labrador, Canada

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The Jeanne d'Arc Basin, within the Grand Banks of offshore Newfoundland and Labrador, Canada, holds prolific oil and gas fields and is currently being assessed for its CO_2 sequestration potential. Several factors, including the presence of existing infrastructure from conventional energy production, volume of available datasets, and favourable geologic conditions for storage, make the Jeanne d'Arc Basin and sequestration target areas in the basin attractive as CO_2 injection sites. We are assessing subsurface geologic conditions in areas of interest for CO_2 sequestration to determine the geologic risks and benefits of a variety of targets.

The target strata for CO_2 sequestration in this assessment are predominantly in post-rift sequences, sedimentary units that have not experienced complex extensional stress regimes and that mostly lack delineated vertical fluid flow pathways. However, a major consideration for targeting potential sequestration formations is understanding how sequestered fluids will behave and identifying possible migration pathways within and between the reservoir units. Understanding how the subsurface changes on a fine scale may become important for ongoing assessments, target ranking, and injection strategies. However, well data constraints are not distributed uniformly across the basin and seismic data are often too coarse to capture the fine details of the subsurface or are non-unique.

This presentation documents factors that we are considering for geologic assessment of the CO_2 storage potential in the Jeanne d'Arc Basin, such as changes in depositional regimes,

fluid migration pathways (both vertical and horizontal), stress regimes and data quality/coverage. We also discuss the uncertainties and potential risk mitigation for storage targets.

Planned launch of the Passive Array for Critical Minerals (PACMIN) on the Island of Newfoundland, Canada

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The objective of the PACMIN project is to install a network of 20 broadband seismograph stations across the island of Newfoundland to record local, regional and global earthquakes as well as ambient ground vibrations for a period of 2 years. The resulting seismograms will be analyzed using multiple methods, to probe the structure of the crust and upper mantle beneath the region. Information on lithospheric structure is key to understanding how the region was shaped by Appalachian mountain-building processes, and how this complex tectonic history controls the distribution of key mineral deposits such as gold and critical minerals.

This experiment will provide the first ever detailed 3-D crustal structure models of the entire island of Newfoundland from multiple types of seismic analysis. From these, we can extract maps of crustal thickness variations and can identify crustal regions with anomalous seismic wave speeds that may be linked to prospective mineral systems. We will also, for the first time, be able to obtain high-resolution views of upper-mantle structure beneath the island of Newfoundland and surrounding regions to allow mapping of lithospheric structural variations. Similar work in Australia has shown a direct spatial correlation between such deep lithospheric structural variations and prolific ore deposits such as Olympic Dam, which hosts some of the world's most significant deposits of gold, copper, and uranium.

The seismograph station coverage will also significantly improve our understanding of seismicity in the Newfoundland region. Although most earthquakes onshore Newfoundland are small, even microseismicity can have implications for mining exploration/exploitation hazards. In addition, more precise detection and location of small earthquakes will allow mapping of fault networks in the shallow crust and at depth, which represent potential pathways for fluids in the crust that may carry critical minerals.

A machine-learning approach to sourcing methane from the Tablelands, Gros Morne National Park, Newfoundland and Labrador, Canada*

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Determining the source of natural methane (CH_4) using stable isotope analysis alone has proven to be challenging in previous studies. Traditional methods rely on empirically derived fields of $\delta^{13}C_{CH4}$ and δD_{CH4} data to distinguish between thermogenic, abiogenic, or microbial CH_4 (i.e., origins arising through the breakdown of organic matter, by secondary serpentinization reactions, or production from methanogenic Archaea, respectively). However, these data fields often overlap, leading to ambiguity in source identification for CH_4 data points that fall within these overlapping regions (e.g., dissolved CH_4 found in ultrabasic springs at the Tablelands, NL). Alternatively, clumped isotope analysis offers another approach by estimating the formation temperature of CH_4. This method also presents challenges when looking at CH_4 from the Tablelands, where the inferred formation temperature could be consistent with any of the source pathways.

To address these limitations, we have compiled a database of $\delta^{13}C_{CH4}$ and δD_{CH4} values with known and unknown origins and applied a modified version of SciKit Learn's Density-Based Spatial Clustering of Applications with Noise (DBSCAN) algorithm using Python. This semi-supervised clustering approach classified CH_4 data from the Tablelands into the thermogenic group. This result is supported by the detection of dissolved ethane (C_2H_6; 1.4 μM ± 0.2 μM), propane (C_3H_8; 1.1 μM ± 0.09 μM), butane (C_4H_{10}; 0.33 μM ± 0.2 μM), pentane (C_5H_{12}; 0.15 μM ± 0.01 μM), and hexane (C_6H_{14}; 0.13 μM ± 0.04 μM). These findings suggest that the CH_4 likely results from the thermal cracking of these hydrocarbons under the heat and pressure conditions present at the base of the ultramafic body at the Tablelands.

Our study demonstrates the potential of combining stable isotope analysis with machine-learning techniques to improve CH_4 source attribution, offering a more robust and quantitative approach to resolving CH_4 source ambiguities.

**Winner (3rd place): GAC-NL Section Award for best student oral presentation*

Orogenic high-T granitoid rocks of the central Grenville Province, Quebec, Canada: characteristics and geodynamic implications

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Increasing interest in magmatic-related critical minerals (e.g., LREE-rich pegmatites) hosted in the Grenville Province highlights the importance of examining the magmatic patterns associated with the Grenvillian Orogeny. Conventional models of collisional orogens predict S-type granitoid emplacement during the orogenic climax, whereas high-T (A-type) granitoids, commonly associated with mantle-derived magmas, are expected to form by late-orogenic extensional collapse. However, in the Grenville Province, syn-orogenic S-granites are scarce, whereas high-T granitoid bodies were emplaced in its hinterland throughout the Grenvillian Orogeny. These rocks are particularly abundant in central Grenville, where they intrude Mesoproterozoic Quebecia crust, in the granulite-facies mid and low-P segments of the orogenic hinterland and are spatially associated with ca. 1.16–1.13 Ga anorthosites.

A review of a literature database shows that the high-T granitoids of central Grenville were emplaced intermittently between ca. 1086–1007 Ma (with an apparent gap ca. 1042–1032 Ma) and are dominantly ferroan, metaluminous to weakly peraluminous, alkali-calcic, with strong negative HFSE anomalies. In addition, a petrological and geochemical investigation of samples from four granitoid bodies suggests crystallisation conditions at ~5–6 kbar and ~800–1000°C and variable oxidising conditions. Arc-like geochemistry transitional to within-plate, oxidising fO_2 values, and relatively evolved whole-rock εNd and zircon εHf with Paleo- to Mesoproterozoic depleted-mantle extraction ages suggest significant inheritance from the Quebecia arc crust. The granitoids may have originated from the anhydrous melting of intermediate, granulitic middle- to lower crust.

Irrespective of the magma sources, this protracted orogenic high-T magmatism and its association with the ca. 1.16–1.13 Ga anorthosite reflects substantial mantle heat flux for over 160 My. The high concentration of both types of magmatism in Quebecia suggests that they have been influenced by lithospheric structures inherited from the evolution of Quebecia in the pre-Grenvillian Mesoproterozoic Laurentian margin.