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ABSTRACTS

2023 Technical Meeting

St. John's , Newfoundland and Labrador

After some unforeseen circumstances with the availability of meeting facilities at Memorial University of Newfoundland, the Annual Technical Meeting was rescheduled and held in person on April 25 and 26, 2023. However, oral presentations were also available to be viewed virtually.

This year the meeting kicked off on Tuesday morning with introductory remarks from the GAC-NL President, Zsuzsanna Magyarosi. 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 and poster presentations. The best student presentations are recognized and receive the "Outstanding Student Presentation Award" which consists of $100 and a certificate. The two award winners are indicated by an asterisk after the title.

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 Zsuzsanna Magyarosi, Jared Butler, James Conliffe, Shawn Duquet, Nic Capps, Sarah Hashmi, Annie Parrell, Roderick Smith, Eric Thiessen, and Nic Lachance. GAC-NL is also indebted to the partners in this venture, particularly the Geological Survey of Newfoundland and Labrador, Marathon Gold Corp., Matador Mining Ltd., Altius Minerals Corp., Labrador Uranium Inc., Geological Association of Canada, and Department of Earth Sciences, Memorial University. GAC-NL is equally pleased to see the abstracts published in Atlantic Geoscience.

Although the abstracts are modified and 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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Geophysical and geomorphological monitoring of three sites prone to coastal erosion, Bay Bulls area, Newfoundland and Labrador, Canada

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The primary aim of this study is to determine the subsurface structure of coastal roads in three key areas prone to erosion in the town of Bay Bulls, Newfoundland and Labrador. Information about the subsurface can facilitate the development of long-term strategies to reduce coastal exposure to the effects of climate change. Three sites of potential concern for coastal erosion are on roads built on steep slopes. On the north side of the bay, at the Bread and Cheese site, the road faces the risk of being undercut by waves, whereas the Cliff site road has a wooden retaining wall which is starting to slump sideways. At the Quays, located on the south side of Bay Bulls, the road runs very close to narrow inlets within steep cliffs.

Three geophysical techniques—ground-penetrating radar (GPR), direct current resistivity (DCR), and real-time kinematic (RTK) analysis — were utilized for this purpose, along with geological and coastal geomorphological observations. The GPR survey operates by sending a radar pulse down and recording reflections. The method revealed the extent of the fractured region at Bread and Cheese, the bedrock and rock structure interfaces on Quays road, and the location of bedrock and support beams at the Cliff site. DCR surveys measure the resistivity of the ground by sending an electric current into the ground. DCR identified the general structure of the ground, in terms of higher and lower resistivity blocks, which were then correlated with layers of stronger and weaker bedrock. In general, the Bay Bulls area is fortunate to be located in strong bedrock that is relatively resistant to wave action. Areas where the rock is fractured, or roads lie on Quaternary cover are most vulnerable to degradation.

Reality capture: a new and innovative technology for the mining industry

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Reality capture technologies have been increasingly adopted in the mining industry to improve efficiency, safety, and productivity. Reality capture refers to the process of capturing and creating digital replicas of real-world environments, including mine sites, using various technologies such as LiDAR, photogrammetry, and laser scanning. These technologies are used to create highly accurate 3D models and maps of producing and abandoned mines, which can be used for a variety of applications. For instance, with reality capture technologies, mining companies can identify potential safety hazards and improve their operational efficiency. Additionally, the use of reality capture can improve the accuracy of resource estimation and the predictability of mining operations, resulting in increased profitability. As reality capture technology continues to advance and become more accessible, it is expected to play an increasingly important role in the mining industry. With abandoned mines, the technology can be used to define potential hazards such as crown pillar collapse, tailings ponds, and piles.

College of the North Atlantic's Office of Applied Research and Innovation (OARI) has been making significant investments in state-of-the-art reality capture technologies for the mining industry over the past three years. The office has acquired a vast array of equipment, including autonomous LiDAR mapping unmanned aerial vehicles (UAVs), bathymetric and hyperspectral UAVs, and handheld systems. These tools have greatly enhanced the OARI's ability to create highly accurate 3D models and maps of mining sites for use in a variety of applications, including geological mapping, mine planning and design, equipment and infrastructure management, and safety training.

Fluids and ore forming processes in orogenic gold deposits in Newfoundland, eastern Canada: evidence from fluid inclusion and stable isotope studies

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Newfoundland is a major emerging gold district containing numerous gold occurrences associated with Paleozoic crustal-scale fault systems. These occurrences have charact-

eristics typical of orogenic gold deposits, such as an association with crustal-scale faults, syntectonic rock sequences, and lower greenschist- to amphibolite-facies metamorphism. However, there are significant variations in mineralization styles and settings between individual gold occurrences, including host lithologies, metal associations and sources, and inferred mineralization depths. This study investigates variations in mineralizing fluids and ore-forming processes in central Newfoundland, based on fluid inclusion and preliminary sulphur isotope data from several gold occurrences representing a diverse range of geological settings.

Fluid inclusion studies indicate that mineralizing fluids were typically aqueous carbonic fluids with moderate to high temperature (250 to 350°C) and low salinity (<10 wt.% eq. NaCl), typical of orogenic gold deposits. However, there are significant inter-deposit variations (e.g., XCO_2, CO_2, CH_4) that are likely related to fluid unmixing and the geochemical influence of the host lithologies. Isochoric modeling suggests different depths of mineralization for gold occurrences across central Newfoundland, ranging from relatively shallow, epizonal mineralization in northeast (e.g., Queensway, Moosehead, and Kingsway) to deeper, mesozonal mineralization in deposits to the southwest (e.g., Valentine Lake and Wilding Lake).

In-situ sulphur isotope analyses of pyrite associated with gold mineralization provide insights into ore deposition processes as well as the source of sulphur in orogenic gold deposits. Preliminary data from along the central Newfoundland orogenic gold district show significant inter-deposit variability. Future research will include more fluid inclusion studies along with in-situ sulfur isotope and trace element analyses, which will provide better constraints on ore fluids, sulphur and metal sources, and gold precipitation mechanisms.

Timing and origin of hematite in red beds of the upper Huronian Supergroup in Ontario and Quebec, Canada*

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The 2.45–2.22 Ga Huronian Supergroup (HSG) is a mainly clastic sedimentary succession that records the Great Oxidation Event (GOE), the first global-scale rise of oxygen in Earth's atmosphere. Red beds first appear in the glacio-marine and fluvial strata of the Gowganda and Lorrain formations of the upper HSG. These red beds occur in coincidence with oxidized paleosols and stratigraphically above reduced detrital mineral-bearing sequences of the lower HSG, such that their appearance is taken as geological evidence of the GOE. The Gowganda–Lorrain transition is also marked by a climatic shift from glacial to temperate, and potentially even tropical, conditions. Despite the association of the red beds with the GOE, direct evidence for syn- or early post-depositional oxidation is rare, such that direct links between hematite mineralization and environmental oxygenation are poorly understood. Establishing these links requires careful evaluation of the paragenetic timing of hematite formation and developing an association of hematite with primary steps of the sedimentary cycle, such as extent of chemical weathering, hydrodynamic sorting effects, possible local provenance, and establishing the effects of overprinting by post-depositional fluid alteration.

This work investigates hematite in the Lorrain and Gowganda formations via petrography and whole-rock major element and Fe^{2+}/Fe^{3+} measurements, with focus on siltstones and sandstones from different HSG exposures in Ontario and Québec. Textural and mineralogical associations indicate varied paragenetic timing of hematite formation for different strata/rock types, with some indicating unambiguously early (pre-lithification) timing, and others ambiguous in relative timing. Whole-rock data are used to assess mineralogy, grain size, and other mineral-chemical features developed from source weathering to deposition. Ultimately, this work provides new information on the depositional systems of the upper HSG and builds our broader knowledge of Precambrian red beds and their relationship with early atmospheric oxygenation.

**Winner: Outstanding Student Presentation Award.*

Geophysical study of the historical landfill at Wishingwell Park, St. John's, Newfoundland and Labrador, Canada

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The City of St. John's had to endure its own share of problems while addressing the aftermath of so-called

modernization/globalization. This trend had brought forth numerous constraints to already limited facilities. One prominent facility, put at stake, was land-fill area to cater the need of growing demands of the time and far future. Until the inception of municipal council in 1888, stretches along many riverbanks were dump sites, including most of the areas in the vicinity of the city limits without any agency in charge of the issue. The Wishingwell landfill was the first modern facility started based on the idea of sanitary fill (trench fill) with the motive to address the waste problem scientifically and environmentally consciously.

Though the landfill was extensively used for a few decades, it failed to bring expected harmony to the nearby expanding communities. It became a communal nuisance over time due to land, air, and water pollution originating from the facility, leading to its untimely closure in 1963 upon incessant complaints from the public. The city council promised to construct City Hall on the closure of the landfill; however, the area was later developed into modern day Wishingwell Park with the aggregated waste of nearly four decades buried in one principal trench trending roughly east to west. At this time, Kelly's Brook, part of which ran through the area, was confined to a buried pipe.

No information on the makeup of the landfill or of any remediation done at the site, following its closure, is traceable from the records. This is one of the issues which could have discouraged efforts of "daylighting" the whole stretch of Kelly's Brook, despite several efforts made to this end. Renewed attention from the relevant stakeholders to improve understanding of the properties of the historical landfill have motivated a geophysical study.

Satellite multispectral data in Newfoundland and Labrador, Canada: potential applications and limitations

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Satellite multispectral data from sensors like ASTER, MSI, and WorldView-3 have the potential to inform surface media composition by measuring characteristic absorption features of exposed material. This property has been developed into a robust research tool in geological mapping and exploration. Applications have proven most successful in arid regions with good bedrock exposure, including the Canadian arctic. Vegetation, soil, and glacial till covers much of the landmass of Newfoundland and Labrador, rendering the region a less than ideal target area for satellite multispectral analysis of bedrock. However, a recent proof-of-concept study using satellite multispectral data of the Long Harbour Group along the south coast of Newfoundland, and processing of data for several sites across the province, highlight the potential of both free and commercially available satellite multispectral data in well-exposed areas of the province.

Despite the challenges posed by vegetation, soil and till cover, non-ideal sun angles, and clouds, processing of satellite multispectral data for several test sites in the province yielded promising results. The sites include an expanded area of the Long Harbour Group, the south coast between Burgeo and Port-aux-Basques, and the Bay of Islands Ophiolite Complex in Newfoundland, as well as the coastal part of the Makkovik Province and the Harp Lake Intrusive Suite in Labrador. In all cases, lithological variations are evident from satellite data, with remotely predicted contacts providing priority areas for bedrock mapping efforts to ground truth. Mapping areas of hydrothermal alteration features yielded positive results, but also included false positives from exposed clay-rich soil and till. The lessons learned from early challenges will be used to improve a catalogue of satellite multispectral coverage of the province.

Thermal regime of the South Caspian Basin in eastern Azerbaijan, western Turkmenistan, and northern Iran

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The South Caspian Sea, with a large amount of sedimentary cover, and the Black Sea, are two areas with an extraordinarily high sedimentation rate. This high sedimentation rate violates the steady state thermal regime assumption and causes a colder sedimentary area. Present temperature and heat flow distribution are essential in oil and gas exploration because the rate of chemical reactions is primarily controlled by the temperature at which the reactions occur; temperature data are necessary to constrain the basin model; the depth of the oil window is controlled with temperature distribution; and they are required for paleo heat flow studies and oil maturation analysis. The present-day thermal state of the basin is also critical from the financial point of view since a 20°C variation could result in a 600 m deeper or shallower oil window.

In this study, potential field data, including gravity, geoid, and topography, were used, as well as surface heat flow data, to reconstruct the lithospheric structure of the area, including Lithospheric–Asthenospheric Boundary (LAB), Oceanic crust, Moho, and basement depth; and regional

steady-state thermal regime. Furthermore, using near-surface sonic, gamma, density, temperature, etc. well logs, I have applied the temperature and heat flow correction to steady state condition of the sedimentary area. Based on large-scale modeling and steady-state conditions, the average surface heat flow is about 40–41 mW/m^2. Applying heat flow corrections decreased the surface heat flow to about 20–21 mW/m^2, which is compatible with the observed surface heat flow and the measured well temperature data.

Enhancing mineral exploration discovery rates: a machine learning approach to predict copper and uranium in Labrador's Central Mineral Belt, Newfoundland and Labrador, Canada

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Mineral exploration faces considerable challenges due to low economic discovery rates and the complexities of the geological processes that led to their emplacement. The large amount of data collected over several iterations of exploration also makes it difficult to objectively process and interpret. We address these challenges by applying machine learning, specifically random forest regression, to predict the distance to new, yet undiscovered copper and uranium deposits. Our study area is the Central Mineral Belt in Labrador, a region with significant potential for mineral deposits. To enhance the effectiveness of our predictive model, we employed a mineral systems approach, integrating various data types at different scales and resolutions, including geophysical data (magnetics and gravity), structural data, and geology. These data were utilized in several phases, based on resolution and availability. By grounding our data-driven model in sound conceptual ideas, we ensured that the method was both objective and scientifically robust.

In extracting information from raw data, we considered shear zone uranium and iron oxide copper-gold (IOCG) mineral associations to inform our inferences. Applying random forest regression, we successfully identified potential mineralization hotspots throughout the Central Mineral Belt. To interrogate the results and assess the effectiveness of various features in predicting mineralization distances, we employed multiple interpretation methods, emphasizing geological validity.

Our research demonstrates the potential of machine learning techniques, such as random forest regression, in addressing the difficulties in predicting mineralization and reducing the search area. By combining a mineral systems approach with objective data-driven models, we can improve our ability to predict and potentially locate valuable mineral resources. This study represents a significant step towards enhancing the success rates of mineral exploration activities and ensuring the sustainable development of mineral resources in Labrador and beyond.

The evolution of western Newfoundland, Canada: a story of allochthons, ophiolites, and obduction

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Western Newfoundland preserved a Laurentian passive margin until the base of the Middle Ordovician (ca. 470 Ma) when tectonic loading due to allochthon emplacement was marked by the St. George unconformity that formed on a migrating peripheral bulge. Prior to the obduction of the allochthons, the Laurentia margin was stable; however, outboard elements of the Laurentian realm were deformed and metamorphosed earlier. Plutons of the Notre Dame arc (part of the Notre Dame Subzone) had stitched ophiolitic and deformed Laurentia-derived metasedimentary rocks of the Dashwoods terrane as early as ca. 488 Ma (possibly by ca. 495 Ma). This timing suggests that early Taconic deformation was accommodated by a southeast-dipping subduction zone that involved an arc-continent collision of an offshore microcontinent (Dashwoods block). The sliver of the Iapetus Ocean separating the Laurentian margin from the Dashwoods block is referred to as the Taconic Seaway. Following the initial early Taconic arc-continent collision, convergence continued along this south-(southeast?) dipping subduction zone progressively destroying the Taconic Seaway. Tremadocian juvenile ophiolites were formed in this seaway above a subduction zone and obducted onto the margin of Laurentia, including the Coastal Complex and the Bay of Island Ophiolite Complex (BOIC) in a fore-arc setting. Recent models propose that the spreading centre that formed the BOIC rifted an older Coastal Complex (ca. 508 Ma) ophiolitic fore-arc terrane and formed a welded composite fore-arc terrane with disparate ages. This model suggests that

ophiolite formation and hot subcretion of sole rocks to the BOIC were simultaneous as spreading proceeded and that the sole began to immediately cool in an oceanic realm. Continued subduction of oceanic crust adjacent to the stable Laurentian margin eventually resulted in ophiolite and a cooled sole obduction, near the ocean–continent transition to complete the igneous portion of allochthon. This process was followed by the complete assembly and final emplacement of the Humber Arm Allochthon during the Taconic orogeny.

Geological overview of the Dog Bay Line–Appleton Fault Zone gold corridor, northeast-central Newfoundland, Canada

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The Dog Bay Line and Appleton Fault Zone in the eastern Dunnage Zone of northeast-central Newfoundland are adjacent structural zones of focused deformation that host significant orogenic gold mineralization. Targeted exploration along the Dog Bay Line–Appleton Fault Zone gold corridor is uncovering well-preserved orogenic gold systems with high potential for continued discoveries.

Auriferous host rocks along the Dog Bay Line–Appleton Fault Zone gold corridor include structurally imbricated, clastic sedimentary rock slices with numerous mafic and silicic intrusions. The sedimentary rocks consist of sandstone, siltstone, shale, and locally conglomeratic sequences of the Ordovician Davidsville Group and stratigraphically overlying Indian Islands Group and Ten Mile Lake Formation. Regionally, these sedimentary rocks are variably deformed, but retain a penetrative, steeply southeast-dipping, tightly spaced cleavage that likely coincides with thrust imbrication during the Acadian orogenic cycle. The mafic intrusions consist of Ordovician to Devonian, variably textured, tholeiitic to calc-alkaline gabbros and hypabyssal dykes that occur proximal to the trace of the Dog Bay Line. Small sills of syenogranite also occur locally. Within the gold-mineralized deformation zones, the sedimentary host rocks are typically shale-rich, with local mélange, and the mafic intrusions are commonly strongly altered to low-grade, sulphide-bearing, secondary mineral assemblages. Orogenic gold mineralization is characterized by numerous structurally controlled, gold-bearing quartz vein-filled fracture networks that cut both the sedimentary and igneous host rocks. Gold mineralization is at least post-Ordovician and may be as young, or younger than, Late Devonian, with multiple gold-mineralizing events possible.

Future research along the Dog Bay Line–Appleton Fault Zone gold corridor will include systematic analysis and synthesis of structural, geophysical, lithogeochemical, and mineralogical data. Furthermore, integration of geochronological and petrological datasets with structural information will aid in the development of a comprehensive tectonic model for orogenic gold mineralization along the corridor.

Mineralogy and genesis of critical-metal bearing mineralization in the Betts Cove and Tilt Cove volcanogenic massive sulfide (VMS) deposits, Baie Verte, Newfoundland Appalachians, Canada

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Critical metals (e.g., Cu, Co, Ni, and Zn) will be essential for the electrification of the global economy needed for the evolution to a lower carbon society. Volcanogenic massive sulfide (VMS) deposits have been important contributors of some of these elements in the past and will continue to be into the future. Despite this fact, little is known about the distribution of some critical metals (e.g., Ni, Co) in VMS deposits and a better understanding of their setting and distribution is required. The Betts Cove and Tilt Cove deposits are two Cu-Zn-Ni-Co-bearing VMS deposits hosted within the Betts Cove ophiolite complex, Baie Verte Peninsula, Newfoundland Appalachians, but the nature and styles of mineralization, critical metal distributions and controls, and metal interrelationships in these deposits is poorly understood. This project will study the mineralogy, paragenesis, and major- and trace-element chemistry of the various sulfide mineral phases within the sulfide mineralization in these deposits, with the goal of providing a better understanding of the metal distribution and residence, and controls on deposit formation and critical metal enrichment. This work will also provide insight into the distribution and genetic controls on critical and other metals in ophiolite-hosted VMS deposits worldwide.

Core logging and standard petrography reveal that the main sulfide minerals within the Betts Cove and Tilt Cove deposits are pyrite, chalcopyrite, sphalerite, and pyrrhotite; in Tilt Cove, magnetite is also common. The mineralization is dominantly stringers/veins containing these minerals. Statistical evaluation of company assay/ICP data reveal key element groupings, including: (1) Zn, Cd, Cu, S, Au, and Ag reflecting mineralization; (2) Ca, K, Na, Fe, Mg, and S associated with carbonate, sericite, albite, chlorite, talc, and sulfide alteration; and (3) Ni, Cr, Mg, and Ti, which reflect and can be used to delineate stratigraphic units. Future work will include scanning electron microscopy, electron probe microanalysis (EPMA), laser ablation inductively coupled plasma mass spectro-metry (LA-ICP-MS), and secondary ion mass spectro-metry (SIMS) work to determine nanoscale textures, element residence, and sources of S in the Betts Cove and Tilt Cove deposits.

Seismic fault detection using encoder-decoder Convolutional Neural Network*

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Fault detection is a crucial step in seismic interpretation, often requiring considerable manual work and time, even for highly skilled experts. The convolutional neural network (CNN) is state-of-the-art deep learning technology that can perform even better than humans at image recognition. The aim of this study is to perform automated fault detection on 2D seismic reflection sections using a deep neural network, specifically a U-Net (Mobile-Net variation) encoder-decoder CNN.

The inputs to the algorithm are interpreted data from block WA-484-P in the North Carnarvon Basin in northwestern Australia (downloaded from Geoscience Australia) on which the faults are labelled manually. Traditionally, approaches for fault detection have used parts of a single seismic line to train and validate their fault picks. In contrast, we use several different 2D seismic lines for training and testing, allowing for our approach to predict faults along unseen seismic lines with reasonable accuracy. This approach will be more applicable in the industry for frontier basins with only sparse 2D seismic coverage.

We treat the fault detection process as a segmentation task and use the U-Net to perform a pixel-by-pixel prediction on the seismic section to determine whether each pixel is a fault or non-fault. Using this type of CNN in the experiments, we obtain good prediction results on our real data. In further steps, we plan to extract fault dip and population statistics from the predicted fault images automatically.

**Winner: Outstanding Student Presentation Award*

Variations of depositional redox conditions across the Cambrian–Ordovician boundary (GSSP, Green Point Formation) in western Newfoundland, Canada: implications from Mo-, U-, and S-isotope signatures and I/Ca ratios

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The Green Point Formation of the Cow Head Group in western Newfoundland includes the Global Boundary Stratotype Section and Point (GSSP) for the Cambrian–Ordovician (Ꞓ–O) boundary on Laurentia. This formation is dominated by slope deposits of alternating lime mudstones and shale interbeds. Here, we employ isotopic/elemental data (e.g., Mo, U, pyrite S, and I/Ca ratios) of these sediments to better understand the local depositional environments and the marine redox state at the Ꞓ–O transition. The wide ranges of the shale authigenic $\delta^{98}Mo_{auth}$ (-0.40 to +3.16‰) and the limestone $\delta^{98}Mo_{carb}$ (-0.30 to +2.34‰), along with the relatively low shale $[Mo]_{auth}$ (3.97 ± 10.26 μg/g, 2σ) and limestone $[Mo]_{carb}$ (0.25 ± 0.80 μg/g, 2σ), suggest that both shales and limestones of this interval were deposited under dysoxic to anoxic conditions. This interpretation agrees with the substantial low limestone I/Ca ratios (0.02 to 0.33 μmol/mol), which are well below the Proterozoic Eon background I/Ca values of ~0.5 to 1 μmol/mol, suggesting shallow marine oxyclines along the regional continental slope. An inverse correlation between the shale $\delta^{98}Mo_{auth}$ and $\delta^{238}U_{auth}$ values, analogous to those observed from modern semi-restricted basins, indicates that the local basin was probably partially isolated from the open ocean. Consistent with this inference, significant inverse relationships between the shale pyrite δ^{34}Spy signals and the contents of terrigenous elements (Al, Th, and ΣREE) imply that the terrestrial input could have played an important role in regulating the sulfate availability of the local water body. Despite the evidence for basin isolation, the shallow basin water δ^{238}U signals (-0.70 ± 0.24‰, 1σ), inferred from the limestone $\delta^{238}U_{carb}$, were probably close to coeval open oceans. With this presumption, the three-sink U-isotope mass balance model predicts that the Ꞓ–O transition was a time of expanded marine anoxia with anoxic/euxinic water covering 1.0 to 21.1% of the seafloor.

Hyperspectral imaging as a research and mineral exploration technique in a Newfoundland and Labrador drill core digitization initiative – first data release in support of new geoscience

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Hyperspectral imaging is a spectroscopic technique that allows rapid mineral identification in a variety of samples (e.g., drill core, rock slabs, thin section offcuts, drill cuttings) without the need for sample preparation, and high-resolution (<1 mm/pixel) data can be acquired directly on entire drill core boxes in a matter of seconds. An ongoing public geoscience initiative at the College of the North Atlantic is acquiring hyperspectral imaging data for over 200 000 metres of drill core stored in Newfoundland and Labrador's Department of Industry, Energy and Technology Core Storage Libraries using of a full range of hyperspectral instruments, ranging the Visible-Near Infrared (VNIR, 400–1000 nm), Shortwave Infrared (SWIR, 1000–2800 nm), Midwave Infrared (2800–5400 nm) to the Longwave Infrared (LWIR, 7500–13000 nm). Interpreted high-resolution mineralogical data are to be released in an online public geoscience database, which will facilitate geoscience research and mineral exploration in the province. The first data release covers over 25 000 m of drill core from 248 drill holes stored in the Pasadena core storage library. The instrumental setup, data examples, and highlights of key drill hole intervals in a variety of deposit types will be presented, and potential applications in both research and mineral exploration will be reviewed.

A geophysical investigation of coastal erosion near Manuels, Conception Bay South, Newfoundland and Labrador, Canada

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The coast of Conception Bay South (CBS), near the community of Manuels, is characterized by bluffs of Quaternary glaciofluvial sediment, and steep gravel and sand beaches and barachoix. As CBS is subject to winter storms which eat away at these materials, and the region has experienced a rapid growth in coastal development in recent years, coastal erosion is a concern. An open field bordered by a bluff (5 to 8 m high and 120 m long) at the end of Flats Road, Manuels, was chosen for geophysical surveys to determine the nature of the subsurface. The three geophysical techniques used were ground penetrating radar (GPR), direct-current resistivity (DCR) and real-time kinetics GPS (RTK). DCR measures resistance to the flow of electrical current. High values are associated with bedrock or dry overburden, low values with damp overburden, and very low values with saline water. Air photographs from 2005 and 2021 were compared to assess the rates of erosion along the bluff.

The GPR imaged the subsurface parallel to the bluff to a depth of 4 m and showed sediments with heterogeneous amounts of cobbles and boulders. A faint linear reflection at ~2 m depth correlated with a change in texture of the scarp face, visible from the beach. DCR profiles were taken both parallel and perpendicular to the bluff, imaging the subsurface to a depth of up to 21 m (13 m below sea level). They showed no sign of bedrock, but rather incursion of sea water into the sediments below sea level. Above sea level, a slab-like region of high resistivity, about 50 m × 50 m, corresponded to locations where the coastal erosion was slowest and the elevation was highest. This indicates that DCR may be a useful tool for assessing susceptibility to erosion in this environment.

An updated genetic model for fluorite mineralization in the St. Lawrence area, southern Burin Peninsula, Newfoundland, Canada: implications for exploration

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The St. Lawrence Granite (SLG) is a peralkaline to metaluminous granite, best known for its association with extensive, and economically significant, fluorite deposits. Genetic models for the fluorite mineralization have been proposed, but major gaps and misconceptions still remain, such as the

lack of fluorite in the country rocks, the source of Ca to form fluorite and the locally abundant calcite in the fluorite veins and the granite. This study reveals new details on the late-magmatic processes in the granite that played a significant role in fluorite mineralization.

The SLG intruded at shallow levels and comprises several phases. Most of the fluorite deposits are associa-ted with the East lobe, which is the only peralkaline and one of the most intensely altered phases. Alteration and fluorite mineralization are the results of devolatilization of the granite. The volatiles included F, Cl, CO_2, and water. Early exsolution of a F-rich vapour, followed by a F-rich acidic fluid led to the fluorite mineralization. In the later stages, a F-poor and CO_2-rich fluid was left and was unable to leave the granite, migrated along the upper contact of the granite and accumulated in the cupolas resulting in late carbonatization and extensive autometasomatism.

Exsolution of a F-rich vapour, coupled with the shallow depth of intrusion of the SLG, allowed the F to leave the granite leading to fluorite mineralization in the country rocks, as demonstrated by the AGS fluorite deposit, which is partially hosted in sedimentary rocks overlying the granite; this encourages further exploration in the surrounding rocks. The source of the Ca is the alteration of primary Ca-bearing feldspar and amphiboles in the granite, implying the lack of spatial correlation between fluorite mineralization and Ca-containing country rocks. This observation is significant for pursuing further exploration for fluorite in the St. Lawrence area, and elsewhere.

Extreme precipitation event timing can determine boreal forest soil carbon response to climate change

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Boreal regions store ~30% of the global forest soil organic carbon (SOC) stock and are expected to experience enhanced summer drying and extreme autumn precipitation events. Dissolved organic matter (DOM) facilitates weathering to form Al organo-metal complexes (OMCs) which stabilize mineral horizon SOC. Parent material and climate influence Al_{OMC} formation by controlling metal availability, hydrology, and DOM (C source). Extreme precipitation should limit Al_{OMC} precipitation. Yet, the impact of pre-event soil moisture on SOC response is unclear and could indicate event timing importance (i.e., different response to dry late summer events versus wetter autumn).

We investigate SOC response to short-term climate change by experimentally measuring DOC uptake into or loss from mineral soils at high water flux with varying antecedent soil moisture. Soils were collected across a mesic boreal forest climate transect with parent material of varying Al in Newfoundland, Canada. We find C saturation of Al_{OMC} (C:Al_{OMC}) and moisture control DOC change regardless of climate and parent material. This suggests surficial DOC exchange with extant Al_{OMC} is a dominant mechanism at high water-flux. As C:Al_{OMC} decreases with depth, shallow saturated soils exhibited DOC loss while significant uptake occurred in deeper soils indicating SOC storage potential. Deep soils are likely limited by a DOC source; however, increased infiltration could enhance subsoil SOC accrual.

Dry soils exhibited greater DOC loss and reduced the C:Al_{OMC} threshold for DOC loss. We present a simple model predicting extreme event SOC response which demonstrates the increasing depth of SOC vulnerability with drying. This indicates that event timing is key, as extreme precipitation on dry late summer soils should promote greater DOC loss relative to wetter soils later in autumn. These results suggest SOC reductions with climate change in shallow boreal mineral soils, while the impact on infiltration depth controls the fate of deep SOC.

Structural characterization and tectonic evolution of the 1.3 Ga REE-bearing Fox Harbour volcanic belt, southeast Labrador, Canada

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The eastern Grenville Province preserves a complex geological record of Paleoproterozoic to Mesoproterozoic orogenic phases punctuated by extensional periods between ca. 1.8 and 0.9 Ga. These various events are preserved in terranes, which are fault-bounded crustal blocks that present unique timing and style of crust formation, deformation, and metamorphism. The 1.3 Ga Fox Harbour bimodal volcanic belt (FHVB) in southeastern Labrador is at the confluence of three major terranes and consists of peralkaline rhyolites that host rare earth element (REE) mineralization. The rhyolites were strongly deformed and metamorphosed during later, ca. 1.0 Ga, Grenvillian orogenesis.

High-strain zones separate the FHVB from the Pinware terrane to the south and the Lake Melville terrane to the north; however, the FHVB itself has been interpreted to belong to the Lake Melville terrane and the Mealy Mountains terrane to the west. Additionally, previously inter-

preted 1.6 Ga pervasive ductile amphibolite- to granulite-facies deformation is challenged herein due to the highly deformed, amphibolite-facies 1.3 Ga FHVB, which indicates high-grade deformation younger than 1.3 Ga. Furthermore, prior regional-scale work employed relatively sparse sample and observation density and whole-grain zircon geochronology, which together leaves considerable uncertainty in the polycyclic pressure-temperature-time-deformation history of the FHVB.

This work (in progress) utilizes detailed local field observations coupled with modern in-situ dating methods that can target complex mineral growth that commonly occurs in multiply deformed regions. Field observations, structural analysis and petrography will aid in providing information about the structural style and kinematics of the FHVB as well as the temperature of deformation, geochronology of zircon (Chemical Ablation–Laser Ablation–Inductively Coupled Plasma–Mass Spectrometry) will be used to determine the age of key rock units and fabrics to place the REE mineralizing system into a structural framework that reconciles local and regional deformation patterns, metamorphic expressions, and stress regimes.

Mineral-melt reactions in a mafic crystal mush: examples from the ophiolitic Liuyuan Complex, China

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Mineral-melt reactions are a major process that influences the composition of minerals in the oceanic crust and may play a significant role in the chemical differentiation of basalts in oceanic spreading centers. The ophiolitic Liuyuan Complex in NW China contains a mapped continuous section of oceanic crust, providing an ideal setting to study these processes.

The composition of both olivine and clinopyroxene in troctolite and olivine gabbro in the Liuyuan Complex shows evidence of mineral-melt reactions. Olivine forsterite content deviates to lower values at a given NiO content than predicted by a simple fractional crystallization model, a behavior consistent with the interaction of primocryst and a more evolved pore melt. Clinopyroxene shows large variations in incompatible trace elements (TiO_2 and Na_2O) at constant Mg#, suggesting late refertilization of early formed clinopyroxene by reaction with evolved trapped residual melts. Refertilization, however, did not affect the concentrations of Cr_2O_3 or REE in clinopyroxene.

Two generations of amphibole are present in the Liuyuan Complex. Pargasite, typically showing well-developed magmatic zoning, is present as an interstitial mineral in melatroctolite. These grains show Fe/Mg values in equilibrium with the surrounding olivine and clinopyroxene primocrysts, with high Cr_2O_3 contents. In contrast, magnesio-hornblende in hornblende gabbro contains skeletal clinopyroxene and shows more evolved Fe/Mg than coexisting clinopyroxene primocrysts. Combined with their lower Cr_2O_3 contents, their texture and chemistry suggest that they formed via a reaction between interstitial clinopyroxene and a more fractionated trapped melt.

The texture and chemistry of olivine, clinopyroxene, and amphibole from the Liuyuan Complex illustrates the difficulties and complexities in untangling the effects of mineral accumulation and fractional crystallization from mineral-melt reactions in gabbroic rocks from the lower oceanic crust.

New tools in the packsack: from drones to drills, novel tools for geological field work

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There have been many technological advancements in the development of "field tools" that can be applied to everyday geological field work over the last 20 years. This presentation will highlight some practical applications for these new technologies, which include drones, portable rock drills and handheld shortwave infrared spectrometers for alteration mapping. Real-world examples will be used to highlight the application of these instruments to everyday field mapping and drill core logging to illustrate how they can aid data acquisition in the field.

Detailed stratigraphy of the Keats Zone: New Found Gold Corp's Queensway Project, Central Newfoundland, Canada

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Recent high-definition re-logging of 27 diamond drill holes (9237 m) in the Keats Zone of New Found Gold Corp's Queensway project provides new insight into the area's local stratigraphy. Correlation of defined lithofacies of the Ordovician turbidite sequence in the Davidsville Group was supported by ME-ICP61 data (ALS Global) to validate observably different lithological units. Due to the lateral continuity of a chemically distinct (Ni-Cr enriched), coarse-grained unit in the footwall of the Appleton Fault Zone, this "Cr-Wacke" was deemed a marker horizon in the Keats Zone stratigraphy warranting further investigation.

Lithological stacking patterns and sequence stratigraphic interpretations suggest that the Cr-Wacke represents part of a large submarine fan complex that experienced progradation/retrogradation during relative sea-level change. The Cr-Wacke is defined by two distinct lithological units, referred to as the outer levee and interior package. The outer levee comprises a thickly bedded, well-sorted greywacke commonly interbedded with siltstones to the east. The interior package, bound on either side by the outer levee, is characterized by a thickly bedded immature greywacke with common conglomeratic lags and the presence of diagnostic fuchsite grains. The narrow, and discontinuous distribution of conglomeratic lags suggests they represent the braided channels of a mid-submarine fan, with the outer levee representing the transition from mid to lower fan deposition. General eastward stacking patterns of the steeply NW-dipping stratigraphy reflects the transition from regressive to transgressive facies deposition during the late falling stage through to the early transgressive systems tracts of a relative sea-level curve.

A brief review of fine-grained clastic sediment geochemistry: methods, examples, and future applications

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Terrigenous clastic sediment/sedimentary rocks archive important information about provenance and processes operating during sediment source and transport weathering, physical sorting, and, in the case of rocks, diagenesis after deposition. Fine-grained sediment/sedimentary rocks (silt, mud and their rock equivalents) tend to be the focus of extracting this information due to: (1) their high abundance in the stratigraphic record; (2) their capacity to preserve source lithology signatures through the abundances and ratios of their insoluble element budget (e.g., Al, Ti, Zr, Cr, Th); and, (3) their capacity to preserve chemical weathering history via soluble element loss relative to insoluble elements (e.g., changes in Ca+Na+K relative Al via the chemical index of alteration).

Despite decades of research into the fine-grained sedimentary rock record, numerous points remain in the clastic sedimentary continuum from source to sink where direct constraints on how some elements cycle from their source minerals to their clastic sediment hosts (such as a lattice-bound or adsorbed component) are sparse. This is especially true for elements with a solubility that shifts drastically with changes in environmental pH and Eh atop of the chemical resistance of their starting mineralogical host. This element-specific information can be better constrained by studying first-cycle fluvial sediment generated in small catchments with known source-rock geology. However, this strategy requires the ability to physically isolate the fine-grained fraction (silt and clay) for study while retaining the geochemical integrity of the sample throughout the separation process.

This presentation will include: (1) common methods employed to extract the fine-grained component of unconsolidated sediment (some also applied to sedimentary rocks); (2) selected case studies where the isolation of the fine-grained fraction was critical to understanding sedimentary processes; and (3) an outline of future work planned for better constraining trace element cycling in two small catchment sites with endmember lithology in Newfoundland.