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Atlantic Universities Geoscience Conference 2023

ABSTRACTS

October 19–21, 2023

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ALEXANDER MURRAY GEOLOGY CLUB, MEMORIAL UNIVERSITY OF NEWFOUNDLAND

ST. JOHN'S, NEWFOUNDLAND AND LABRADOR

Abstracts from the Atlantic Universities Geoscience Conference (AUGC) are published annually in Atlantic Geoscience. Such publication provides a permanent record of the abstracts, and also focuses attention on the excellent quality of the oral presentations and posters at the conference and the interesting and varied geoscience topics that they cover. Although abstracts are modified and edited as necessary for clarity and to conform to Atlantic Geoscience format, the journal editors do not take responsibility for their content or quality.

THE EDITORS

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Determination of the source of uranium for the Lac Cinquante uranium deposit, western Churchill Province, Nunavut, Canada

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The Lac Cinquante uranium deposit located in the western Churchill Province of Nunavut is currently characterized as a vein-type uranium deposit consisting of uranium mineralization concentrated in fractures, shear zones, and stockworks. The deposit is hosted by Archean basement rocks overlain by Proterozoic sedimentary and volcanic strata of the Baker Lake Group. The source of uranium in the Lac Cinquante deposit is unknown. We hypothesize that the uranium was either (1) leached and transported in hydrothermal basinal fluids through faults and fractures in the underlying Hudson and/or Nueltin Granitic Suite where it became deposited in the Baker Lake Basin, or (2) sourced from the host Baker Lake Group and the granitoid rocks provided the heat to drive the hydrothermal system that leached and precipitated uranium. Preliminary results after XRF analysis and petrographic study show zirconium to be associated with uranium mineralization, which may indicate high field strength element mobility in the hydrothermal fluids that circulated throughout the system. Furthermore, the XRF data shows evidence of two distinct mineralization events, one hosted in a calcite matrix, and the second disseminated in an albitic plagioclase matrix. These findings suggest that the deposit is characterized by hydrothermal uranium as well as vein-type mineralization. Future work will aim to resolve the timing of discrete mineralization events by U–Pb dating to produce a paragenetic sequence. Trace element analysis will be used to deduce the source of uranium for this deposit. [*Poster presentation*]

A regional survey of clinopyroxene compositions in upper mantle xenoliths of the West Eifel Volcanic Field, Germany

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Lithospheric mantle xenoliths are common in the volcanic rocks of the West Eifel Volcanic Field, Germany. The model for evolution of the sub-Eifel mantle is: (1) depletion by partial melting at ~ 3 Ga, (2) a Cretaceous metasomatic event, and finally (3) a Quaternary metasomatic event related to the erupted lavas. Major element composition of clinopyroxene (cpx) in xenoliths from Gees are interpreted in two ways: in one interpretation the cpx formed during metasomatism by a carbonatite magma whereas the same results have also been linked to silicate magma metasomatism. We examine the trace element content of cpx to test these two contrasting hypotheses. Xenoliths range from harzburgite to wehrlite. Cpx in the wehrlites has lower χMg and higher CaO than the harzburgite/lherzolite xenoliths. The data show three distinct groupings of trace element signatures. The wehrlites (Cpx-1) have strong enrichment in LREE and positive to negative Zr, Hf, and Ti anomalies, whereas lherzolites/harzburgite show two groups: both are LREE-enriched and have negative Zr and Hf and variable Ti anomalies. The two groups (Cpx-2 and -3) are distinguished based on their total REE content. Cpx-1, related to veins of clinopyroxene and phlogopite, is interpreted to result from interaction of peridotite and silica-undersaturated mafic magma. Cpx-2 is suggested to be related to carbonatite metasomatism, and the origin of Cpx-3 is not yet clear. Future work will examine the textural relationship of the three cpx types to develop a relative time frame for enrichment events. [*Oral presentation*]

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

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The West Branch North River (WBNR), Bothan Brook (BB), Centre Road (CR), and Peter Brook (PB) plutons are in the Aspy terrane of central Cape Breton Island, part of Ganderia in the northern Appalachian orogen. The plutons are elongate parallel to regional trends but are undeformed and appear to have been emplaced after Acadian deformation in the area. U–Pb zircon dating has confirmed previously assumed late Devonian ages of ca. 370–360 Ma. No petrological studies have been done on these plutons since the 1980s, and their mineralization potential and tectonic setting have not been investigated. Preliminary petrographic examination of cut slabs and thin sections from about 40 samples collected as part of regional mapping projects that included these plutons show a wide range in rock types from monzodiorite to syenogranite. Samples from WBNR, BB, and PB plutons consist mostly of medium-to coarse-grained equigranular biotite monzogranite, whereas the CR pluton includes both hornblende-biotite monzodiorite and quartz monzonite. Chemical analyses of 33 samples range in SiO_2 content from about 53% to 77%, with lowest contents in samples from the CR pluton and the highest in the BB pluton. Most samples have high K_2O contents suggesting that

they are of shoshonitic affinity. Trace element compositions indicate that they formed in a subduction-related environment, perhaps from magmas generated in a post-collisional slab-failure tectonic setting. Although no mineralization has been observed, the highly evolved compositions in the BB pluton suggest some potential for Li or other critical elements. *[Poster presentation]*

Dynamics of porewater ions across two Scotian Slope cold seeps, offshore Nova Scotia, Canada

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The Scotian Slope is a deep ocean, passive margin environment off the coast of Nova Scotia. Recently, several active cold seep sites have been discovered. We hypothesize that biogeochemical cycles that naturally extend into surface sediments on the ocean floor will be altered by the upward migration of reduced hydrocarbon-rich fluids from these cold seeps. In this study we will reconstruct down-core profiles of carbonate, fluoride, nitrate, nitrite, phosphate, ammonia, iron, manganese, and sulfate porewater ions from frozen push core sediment samples. These samples were collected during a 2021 research cruise by a remotely operated vehicle (ROV). The push cores are from a transect between two newly discovered cold seep sites named 2A-1 and 2A-2 that reside between 2680–2740 m below the sea surface. Porewaters will be measured using a Dionex Aquion Ion Chromatography System and Hanna Instruments photometer. With this data set, we will construct a subsurface ion concentration heat map across the transect to examine the extent of the cold seep fluid migration. We will calculate diffusion fluxes to better constrain the microbially mediated sulfate methane transition zone (SMTZ), which in turn will help better characterize the range and effects of the cold seep fluid migration into the surrounding area. Upon completion of this study, we plan to provide a better understanding of the shallow sediment architecture of these two cold seep sites on the Scotian Slope. [*Poster presentation*]

Building the foundation for a 3D offshore model for Newfoundland, Canada*

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Offshore Newfoundland has a rich geological history in terms of energy production. The Continuously Evolving Newfoundland Offshore Model (CENOM) will comprise all geophysical data sets available, including seismic, potential field, and well logs, reconstructed over geological time. The goal is to create an interactive, evolving visual of offshore Newfoundland. CENOM will be continuously updated and improved as more data are released. My work has been focused on establishing the foundation for this project using various software packages such as QGIS, Petrel, GPlates, and Excel. To aid in future development of CENOM, "The Pantry" database was created in Excel, containing information from all the well logs available on the Grand Banks and on the Northeast Newfoundland Shelf Area. CENOM will involve synthesizing all existing models and databases and will continue to grow along with our knowledge of the area. [*Poster presentation*]

***Canadian Energy Geoscience Association Award for the best petroleum geology-related paper.**

Timing and structural controls on mineralization in the Prairie Creek zinc-lead-silver deposit, Northwest Territories, Canada*

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The Prairie Creek Zn-Pb-Ag deposit is located in the Mackenzie Mountains of the Canadian Cordillera. It is hosted within a thick marine succession of fine-grained dolomitic rocks deposited in the Late Ordovician to Middle Devonian in a N-S-oriented paleo-depression along Laurentia's western margin. The deposit involves two main styles of mineralization: stratabound massive sulphides, which formed by the replacement of host rocks, and quartz-carbonate-sulphide veins. Regional showings of vein-style mineralization parallel large-scale structural trends, including the S-striking Prairie Creek fault and the N-S-trending Prairie Creek anticline, indicating that structure is a key control on this mineralization style. This study aims to understand the timing of formation of major structures to provide the first absolute dates for Zn-Pb mineralization and to characterize the relationship between deformation and mineralization. Preliminary observations from core indicate that vein-style mineralization contains two generations of sulphides, including an early assemblage of quartz-sphalerite (ZnS)-galena (PbS) and later calcite-galena. The orientation of these veins and other other structures were measured from oriented core samples to determine their relationship with regional structures. Petrographic analyses

of thin sections will be used to further characterize the relative timing relationships of ore mineral assemblages and to identify targets for in situ Rb–Sr dating of sphalerite and U–Pb dating of gangue minerals (e.g., carbonate). Slickenfibres from the Prairie Creek fault will also be dated using the U–Pb radiogenic system. By combining geochronological and orientation data we hope to provide timing constraints for both mineralization and structures that control it. [*Oral presentation*]

***Winner of the Frank S. Shea Memorial Award for best economic or applied geology-related presentation**

Natural or anthropogenic: determining drivers of ecomorphodynamic change in the Avon River. Nova Scotia, Canada

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The Avon River is a hypertidal, muddy estuary in the upper Bay of Fundy. The substantial tidal range results in significant volumes of water and sediment moving in and out of the estuary with each tidal cycle. The system has been in dynamic equilibrium since construction of the causeway in 1970, but recent construction activities and changes in flood gate management have caused an observable shift to disequilibrium. To assess the environmental consequences of these activities, we will determine the influence of natural and anthropogenic drivers of ecomorphodynamic change within the Avon River, downstream of the Highway 101 causeway, by comparing data from 2019–2023 to baseline conditions, 2007–2019. Ecomorphodynamics is the study of how coastal morphologies are impacted by interactions among sediments, dynamic processes, morphology, and vegetation. In our research, changes in morphology will be represented by channel cross-sections, vegetated areas, and sediment budgets, while dynamic processes will be represented by tidal prisms, and sediments by changes in grain size distributions. Potential drivers of ecomorphodynamic change are flood-gate manipulations, construction activities, tidal cycles, and precipitation records. We aim to understand the relative influence of these drivers on the system. Correlations between ecomorphodynamic changes and anomalous conditions will be evaluated by aligning a timeline of the drivers with satellite images (Sentinel-2), orthophotos, cross-sections, and collected sediment samples. Preliminary results indicate coarser sediments with less variation across the sandflat compared to baseline conditions. Visual observations from satellite images indicate erosion in the north and accretion in the south of our study area. [*Poster presentation*].

A study of ankle breakers: measuring sinkholes at Irishmans Road Recreation Site, Nova Scotia., Canada

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Irishmans Road Recreation Site, in Hants County, Nova Scotia, is a publicly accessible park with hundreds of naturally occurring sinkholes. These karstic geomorphological features form as a result of deformation, dissolution, and erosion of Carboniferous evaporite-bearing rocks that exist near the surface. Despite their acknowledged risk factor by the local municipality, no systematic sinkhole mapping has been done in this area. LiDAR (Light Detection and Ranging) data at two different resolutions complement the field-acquired data to map these sinkholes: (1) provincial 1 m resolution collected between 2018 and 2020, and (2) private 25 cm resolution collected in 2022. An in-house automated sinkhole delineation program, COLDS, located over 2000 sinkholes within the Irishmans Road property. However, field data acquired in 2023 suggest inaccuracies in COLDS' results. In areas of lower concentration, COLDS accurately located and defined the shape of large sinkholes. In areas of higher concentration, COLDS struggled to delineate small sinkholes, resulting in sinkholes being combined or missed. For example, in a 1200 m^2 area in the northern area, 101 sinkholes were located, measured, and mapped, compared to the 57 sinkholes identified using COLDS. Precise mapping of these sinkholes is important because despite being aware of these sinkholes as a possible threat and health risk within the park and wider area, the county continues to allow unrestricted access to Irishmans Road Recreation Site. The sinkholes can be deep and the lack of clear communication of risks may result in bodily harm to site visitors. *[Oral presentation]*

A detailed petrographic study of the mineralized and structurally confined gold- bearing rocks from part of the Valentine Lake Shear Zone: Marathon Gold Property, central Newfoundland, Canada*

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The Valentine Lake Shear Zone (VLSZ) is in the central region of the island of Newfoundland, approximately 80 km southwest of the nearest town, Millertown. Marathon Gold

has conducted prospecting programs both east and west of the five main centralized gold deposits, located along the VLSZ and currently under construction to be mined. The prospecting team has been able to successfully extend the VLSZ from 20 km to 32 km, nearing the margins of the property boundaries both east and west of these deposits. The purpose of this study is to determine the importance of the newly mapped region of the Northeast Arm by comparing samples to those of gold-bearing host rocks from the main Marathon deposit localities, as well as to those from the western margins of the property. Igneous rocks in the area include a wide range of granitoid rocks, including trondhjemite, tonalite, granite, granodiorite, and gabbro. Samples collected will undergo petrographic analysis using microscopy on polished thin sections, and will be classified and named based on composition, mineral assemblage, textures and interpretation of igneous/fluid alteration processes. Petrographic descriptions of samples will enable comparison among samples from different localities, and a U–Pb age determination will give insight into the petrogenesis of the rocks. [*Oral presentation*]

***Winner of the Science Atlantic Presentation and Communication Award for best overall presentation**

Reconstructing changes in the northwest Atlantic Ocean ^{14}C depth gradient using deep water bamboo corals*

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Radiocarbon (^{14}C) analysis is an important tool in chemical oceanography. Nuclear bomb testing between 1945 and 1963 added artificial ^{14}C to the surface ocean, which is useful for tracking the move-ment and mixing of water masses. However, ^{14}C data for the North Atlantic Ocean are significantly lacking, so proxy records of seawater ^{14}C are needed. A more complete record of past ^{14}C variability could better constrain the changing influence of water masses off eastern Canada, one of the fastest warming regions globally. This region is home to a wide range of geologically and oceanographically diverse environments and hosts Canada's only known cold-water coral reef. Bamboo corals have been put forward as proxies for for sea-water ^{14}C since they are long-lived, have annual growth rings, and have a two-part skeleton of "gorgonin" and calcite. This two-part skeleton allows for the differentiation of ^{14}C variability insurface and deep waters. The proteinaceous gorgonin fraction is derived from sinking particulate organic matter (POM) from surface waters while the calcite fraction is derived from dissolved inorganic carbon (DIC) at the 300–1500 m depths where the corals live. In this study, we measure time-resolved ^{14}C in both skeletal fractions of recently collected corals and compared to in situ data from 1997, 2003, 2012, and 2022 to determine if bamboo corals resolve accurate ^{14}C depth gradients over the last few decades. If our measurements align with the in situ data, then bamboo corals could be used to fill an important gap in ^{14}C time histories in the ocean. [*Oral presentation*]

***Winner of the Atlantic Geoscience Society Environmental Geoscience Award for the best Environmental Science-related presentation**

Petrography, contact metamorphism, and geochronology of mafic sills in the Wolfville area, Nova Scotia, Canada

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In the Wolfville and Bear River areas pre-Carboniferous rocks of the Goldenville, Halifax, and Rockville Notch groups are intruded by mafic sills (Type I and Type II) that have similar chemistry but different textures, alteration, and mineralogy. Type I sills appear to be penecontemporaneous with the country rock deposition based on field relations but there are no conclusive geochronological data for the sills. The relationship between Type I and Type II sills is not clearly understood and their respective effects on the country rock have not been investigated. Field mapping of sills in the Wolfville area shows that sills range from 1 to 65 m in thickness and are concordant with bedding. All the sills have sharp bottom contacts with the country rock but only larger sills have sharp top contacts. The larger sills are generally homogeneous from bottom to top and show poorly developed cleavage along their bottom contacts with the country rocks. Some of the smaller sills have vesicular textures and convolute margins along their top contacts. Contact aureoles at the margins of the sills are variable in thickness and some appear to be silicified. Further field mapping and petrographic work will focus on mineralogical changes from bottom to top in the sills and comparisons among different sills, as well as the extent and mineralogy of the contact aureoles in contrast to the country rock unaffected by the sills. Laser Ablation ICP-MS U–Pb analysis will be used to determine the zircon crystallization and apatite cooling ages for the sills. [*Poster presentation*]

Regional marine trends following cessation of CO_2 emissions: what will be the future of coral reefs?

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In 2020, the Zero Emissions Commitment Model Intercomparison Project (ZECMIP) explored what will happen to global climate after net-zero carbon emissions are reached. The globally averaged value of the Zero Emissions Commitment (ZEC) was found to be approximately zero, but with strong regional variations. Moreover, ZECMIP projects that atmospheric CO_2 levels are to decrease, but that leaves unanswered questions about levels of CO_2 being sequestered in the ocean. The ocean is commonly referred to as a carbon sink, and dissolving the projected high levels of CO_2 into it will result in ocean acidification. The ZECMIP datasets are used here to examine marine trends such as ocean surface temperature and aragonite saturation state in the locations of modern major coral reefs. The aragonite saturation state implicitly considers ocean pH and will act as an indicator of healthy coral conditions. Given the current global trajectory, major coral reefs are expected to undergo mass bleaching events resulting in widespread coral mortality. After the turning point of coral mortality is surpassed, the question left to be answered is whether the oceans will be able to support coral ecosystems in the future. Through examining these regions with ZECMIP, it was found that while the data is largely inconclusive to date due to a lack of model availability, the ocean is very unlikely to return to a viable state to support coral ecosystems within 100 years after CO_2 emissions cease. [*Poster presentation*]

Shooting science into rocks: hyperspectral imaging of historic core from the Walton barite mine, Nova Scotia, Canada

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The historic Walton mine was operational from 1941 to 1978 and saw extensive mineral exploration and production of valuable commodities such as barite, copper, zinc, lead, and silver. This mine is located within the Windsor–Kennetcook subbasin of the Maritimes Basin, a vast, structurally and stratigraphically complex sedimentary basin extending from the Gulf of Maine to the Grand Banks of Newfoundland. The Walton deposit is hosted in the Visean Windsor Group and is characterized by a barite orebody with a mineralized sulphide halo. Drill core from this deposit was logged manually by geologists from the provincial government and private companies. Visual analysis of core is a complex, time-consuming process that can be subjective and prone to error. Hyperspectral imaging is a non-destructive tool that can be used to characterize the composition of rocks based on their spectral signature. Approximately 3000 m of Walton mine drill cores are preserved at the Stellarton core facility. For this project, ca. 300 m of drill cores were digitized using Scient Analytics' LithoScan mobile platform for high-resolution RGB and hyperspectral scanning. The scanners give reflectance spectroscopic images of core in the ultraviolet to shortwave infrared range which encompasses the optical absorptions of rocks and minerals including clay, mica, carbonate, and many sulfates. This talk will include description of the methodology of hyperspectral imaging and discussion of how this tool can be effectively used to characterize the mineralogical variability of the Walton deposit and the surrounding area. [*Oral presentation*]

MeHg and THg concentrations of Hawaiian invertebrates and surface soils: potential volcanogenic influence*

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Mercury (Hg) is a highly toxic element with organic forms (e.g., methyl mercury - MeHg) which can bioaccum-ulate and biomagnify in food webs. The island of Hawai'i has extensive volcanic activity which has been shown to release elemental and oxidized forms of mercury. Once this Hg is deposited it can be converted into MeHg which enters the base of the food web. Aquatic invertebrates have increasingly been used as biomonitors of MeHg in ecosystems; however, much fewer data are available on terrestrial invertebrates. This project used a combination of soil T(total) Hg and invertebrate MeHg samples from 15 locations to examine mercury distribution on the island of Hawai'i. Surface mineral soils (A horizon) were dried, sieved to a silt/clay fraction and analyzed for THg and LOI using thermal pyrolysis AAS. Invertebrates were dried and analyzed for MeHg using ethylation gas chromatography - atomic fluorescence spectroscopy (Brooks-Rand MERX). Soil samples were grouped based on their proximity to the

most active volcano, Kileaua and the dominant wind direction. Invertebrates were identified to their taxonomic family, and MeHg data grouped by functional feeding group (i.e., herbivores, omnivores, or carnivores). The carnivore group is significantly higher in MeHg than both the omnivore and herbivore groups ($p<0.05$). THg in soils is significantly higher in the Kilaeua slope group. More sampling is required to better quantify the spatial distribution of THg in soils and factors affecting bioaccumulation in terrestrial invertebrates. [*Poster presentation*]

***Winner of the Imperial Oil Best Poster Award for best overall poster presentation**

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

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Groundwater in alpine regions plays an essential role in downstream water supply. As the climate warms, mountain water resources are under threat with reduced snowpack and glacier recession negatively impacting summer streamflow. However, the extent to which such global changes can impact the mechanisms that contribute to groundwater recharge remains poorly understood. This project aims to address the limited spatial and temporal extents of observational studies surrounding the groundwater in mountainous regions, and will enhance our understanding of long-term trends across geographical boundaries. The primary research question is: Does snowmelt or rainfall precipitation dominate mountain groundwater recharge across mountain regions of Canada and the USA? The secondary research question is: will a shift towards less snow and more rain impact this groundwater recharge, due to climate change? The research question will be addressed by analysing a dataset of 171 observation well from mountain regions across Canada and the US. First, we will build on previous work by categorizing each well as rainfall or snowmelt dominated. We will use stepwise multiple linear regression on each group (snow/rain dominated) of wells to identify which watershed attrib-utes (climate, geology, etc.) are associated with positive/negative trends. Then, we will compile new data from nearby weather stations which includes precipitation phase (rain/snow). We will select ~10 wells for detailed correlation analysis between the well hydraulic head data with the precipitation volume/phase to quantify the groundwater recharge sources and infer how future climate change will impact groundwater recharge. [*Poster presentation*]

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

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The parental magma composition that produces a plutonic rock is what gives the lithium-bearing pegmatite its distinct elemental composition. These magmas have very high concentrations of specific incompatible trace elements that distinguish them from other types of pegmatitic magma. A sought-after incompatible element, lithium, is challenging to detect through most routine analytical techniques. It occurs in abundance, most commonly, bonded within aluminosilicate minerals; for example, as the lithium aluminium silicate mineral spodumene ($LiAlSi_2O_6$). The practical goal of the study is to be able to predict the occurrence of lithium-rich pegmatites that may not contain the spodumene at a site of pegmatite dyke exposure but that contain hidden spodumene inventory. In other words, the goal is to find a "fingerprint" that can indicate the presence of geologically lithium-rich minerals. The main objective is to investigate if we can use the chemical composition and mineralogy of chemically developed rocks can be used to differentiate between economic and sub-economic lithium rocks in the absence of spodumene. This research is meant to find a way to facilitate lithium detection and to discover lithium prospective deposits more reliably. [*Poster presentation*]