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See table of contents

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Atlantic Universities Geoscience Conference 2017

ABSTRACTS

October 26-28, 2017

67TH ANNUAL CONFERENCE HOSTED BY:
ALEXANDER MURRAY CLUB, MEMORIAL UNIVERSITY,
ST. JOHN'S, NEWFOUNDLAND AND LABRADOR

Abstracts from the Atlantic Universities Geoscience Conference (AUGC) are published annually in Atlantic Geology. 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.

THE EDITORS

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Effects of annealing and HF etching on U-Pb geochronology and Lu-Hf radiogenic isotopes in Sri Lankan zircon crystals

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The aim of this thesis is to study the effects of annealing and HF acid etching on the U-Pb geochronology and Lu-Hf radiogenic isotopes in Sri Lankan zircon crystals. The purpose is to improve our understanding of how zircon crystals that have accumulated significant amounts of radiation damage respond to these treatments. The main objective of this study is to determine if the annealing and HF acid will reduce the amount of discordance and dispersion in the U-Pb age and if the Lu-Hf isotopic systematics will be disturbed. The hypothesis to be tested is that areas of the zircon crystal extensively damaged (i.e., the breakdown of zircon to amorphous SiO_2 and crystalline baddeleyite [ZrO_2]) during the decay of U and Th to Pb will recrystallize during the annealing process forming newly crystallized zircon nanocrystals. By placing the annealed zircon in concentrated HF, the nanocrystals, and any pre-existing radiation damaged zircon, will dissolve leaving behind only the undamaged regions of the original zircon crystals. We postulate that the annealing process will not affect the age or Lu-Hf of the zircon in the non-radiation damaged regions of the crystals; the HF etching of the zircon will dissolve these newly formed zircon crystals leaving behind only undamaged regions. When plotted on a Concordia diagram this zircon should give a more precise and accurate age of crystallization with less dispersion and discordance in the data.

Assessment of methods for measuring glacier mass balance of the Taku and Lemon Creek glaciers, southeast Alaska

Max Bond, Benjamin Getraer, Btyn Huxley-Reicher, Gavin McNamara, Theodore Reinhardt-ertman, Joe Silverwood, Kara Vogler, Chris McNeil, Christian Kienholz, and Matt Beedle

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The Juneau Icefield Research Program (JIRP) has collected annual glaciological mass balances for the Lemon Creek Glacier (10 km^2) since 1953 and Taku Glacier (730 km^2) since 1946. End-of-season glacier-wide mass balances are derived annually from mid-summer snow depth measurements in pits and short-duration mass balance modeling. We continued this glaciological record during the 2017 JIRP season by compiling snow thickness and density measurements from more than 30 snow pits. Deploying a high frequency ground penetrating radar (GPR), we measured the variability of the snow depth around selected pits. We use these data to assess whether individual field sites are representative of the entire glacier. To evaluate the glaciers' health, we compare the 2017 mass balance both at pit sites and glacier-wide to corresponding measurements from previous years. We further compare the glacier-wide mass balances of the Taku and Lemon Creek glaciers (period 2004–2015) to mass changes detected by the Gravity Recovery and Climate Experiment (GRACE) satellites (mascons 1352 and 1353). The goal is to investigate whether regional GRACE-detected mass changes reflect the mass changes of the two glaciers. Lemon Creek Glacier is a challenging candidate for this comparison because it is small compared to the ~12 100 km^2 GRACE mascon solutions. Taku Glacier is equally challenging because its mass balance is stable compared to the negative balances dominating its neighboring glaciers. Challenges notwithstanding, a high correlation between the glaciological and GRACE-derived balances for Lemon Creek and Taku glaciers would encourage future use of GRACE data to estimate glacier-specific mass balance. [Poster]

Initial field and petrographic investigations of the geology, paragenesis, and gold deportment at the Hopper Prospect, Yukon

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The Hopper prospect covers an area of 7400 hectares and is owned wholly by Strategic Metals Limited. The prospect is located east of Aishihik Lake, in the Kluane Plateau of southwestern Yukon. Underlying the Hopper prospect is the 5 by 7 km Late Cretaceous Hopper pluton. The Hopper pluton is part of a larger plutonic suite termed the "Casino Suite". The Casino Suite is comprised of Late Cretaceous intrusive rocks which form a belt in Yukon extending from the Dawson Range to the northeast of Haines Junction. The Casino Suite represents a suite of rocks with metallogenic significance. The Casino Suite hosts the Casino porphyry deposit and several MINFILE occurrences of porphyry- and epithermal-style mineralization. Geological mapping and sampling of the Hopper prospect was performed in August 2017. Twenty-four polished thin sections are currently being reviewed to determine a paragenetic sequence for skarn mineralization observed at the Hopper prospect. Specific ore and gangue mineralogy will be determined through the use of the Scanning Electron Microscope. Factors controlling the gold deportment observed in gold-rich intervals of drill core from the Hopper prospect are of particular interest. These controls (if observed) will be compared to gold-enriched skarn samples from the past-producing Arctic Chief mine of the Whitehorse Copper Belt, which has a protolith composition similar to that of the Hopper prospect. [Poster]

The bountiful coprolites of the Joggins Formation, Nova Scotia

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The fossil cliffs at Joggins (Nova Scotia) hold a wealth of fossils, both terrestrial and aquatic, from the Late Carboniferous Period. Fossils from the aquatic realm have historically been understudied and the ecosystem that they represent is poorly understood. This research broadens our understanding of the aquatic ecosystem, specifically the food web, by examining fish coprolites that are abundant in limestone of the Joggins Formation. Coprolites preserve undigested material that give us a window into the diets of these fish and a better idea of species interactions within the ecosystem. The coprolites have been studied in thin section and hand sample, as well as cathodoluminescence and computed tomography to determine the contents. We found that specimens could be divided into six categories based on size and shape: cigar/cylindrical shaped; cone shaped; small/equant; spiral; irregular; and massive (samples greater than 5 cm in length). Small coprolites are the most abundant and massive coprolites are the rarest. They range in size from <1 cm to >10 cm and are 2–3 cm on average. The mineralogy of the coprolites is high-calcium phosphate, similar to the composition of bone. This composition suggests that the fish producing these coprolites were carnivorous and that there is a lack of herbivores present, supporting earlier faunal study findings. Bone fragments have been found in almost all samples; however, specific species identification has thus far not been possible. This research provides both a foundation for further studies on coprolites and similar fossils and a deeper understanding of aquatic ecosystems as fish diversified further into fresh water in the Palaeozoic.

Winner of the Canadian Society of Petroleum Geologists Award for the best petroleum geology-related presentation

Investigating the metamorphism of low-pressure metapelite in the Escoumins Supracrustal Belt, southern central Grenville Province, Quebec

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It has been proposed that the Grenville Province formed in a hot long-duration orogeny which took place in the late Mesoproterozoic to early Neoproterozoic from ca. 1090–980 Ma. Complex continental collision between Laurentia and possibly Amazonia included multiple thrusting events and was later modified by extension. The two primary tectonic zones which make up the Grenville Province are referred to as the Parautochthonous belt and the Hinterland. The Parautochthonous belt shows Barrovian sequence metamorphism from mid- to high-pressure (P) conditions, whereas the Hinterland consists of various belts which underwent different grades of Ottawan (1090–1020 Ma) and Rigolet (1000–980 Ma) metamorphism. The allochthonous High Pressure (aHP) belt and the Mid Pressure (aMP) belt experienced high-pressure granulite to eclogite and mid-P granulite-facies conditions, respectively. In contrast, the allochthonous Low-Pressure (aLP) belt experienced amphibolite-facies conditions, and the orogenic lid has avoided Ottawan metamorphism altogether. This project focuses on metapelite of the Escoumins Supracrustal Belt (ESB), which is part of the aLP belt in the southern central Grenville Province, Quebec. Nine samples of metapelite from four different areas in the ESB were collected mainly during 8 days of field work completed this summer. Methods such as petrography aided by SEM-MLA maps, imaging, and microprobe analyses have been used to determine the mineralogy and composition of these samples. In the near future, phase equilibria modelling will be done to determine the depth and temperature of metamorphism. In addition, if time permits, monazite compositional maps in select samples will be produced by electron microprobe, and specific zones will be dated using LA-ICP-MS, in order to constrain the age of metamorphism. The final results of this honours thesis will illustrate the overall relationship among the low-P metapelites in the ESB.

Spatiotemporal assessment of metal concentrations of pre-effluent estuarine sediments in a freshwater kraft pulp mill taillings pond in Pictou County, Nova Scotia, using paleolimnological methods

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Paleolimnological research at a former estuary in Pictou County, Nova Scotia, that has been contaminated by effluent from a kraft pulp mill and other inputs over the past 50 years has focussed on understanding the spatiotemporal distribution of metals in pre- and post-disturbance sediments. The site was dammed in 1967, effectively converting it into a shallow freshwater lake (140 ha, 4 m max. depth). The lake bottom sediments in Boat Harbour reflect both estuarine and fresh water environments, and can be broadly characterised as grey marine clay (~ 50% water content) which is overlain by black, organic-rich sediment (~ 90% water content). The contact between these two units is sharp and is present through the basin. To inform post-remediation management decisions the marine sediment was analysed for the spatiotemporal distribution of As, Cd,

Cr, Cu, Pb, Ti, Zn, Mo, and Ni, which were identified as uniquely representative of impact at the site. The samples were collected using a gravity corer, were analysed for metal concentrations using a portable X-ray Fluorescence (pXRF) analyzer and ICP-MS techniques and distribution was modelled using QGIS. Preliminary results indicate that As, Cr, Cu, Zn, and Pb concentrations at reference sites meet or exceed interim sediment quality guidelines. Metal loads in the grey marine clay at the impacted site are similar to or higher than those at the reference sites. Metals in the marine sediment at the impacted site and the reference sites show little stratigraphic variability, indicating that overprinting of contaminants from the overlying organic sediment at the impacted site is not likely. Spatial distribution maps of metals are being completed; preliminary results indicate substantial variability in metal concentrations spatially. These data must be taken into consideration in both the remediation and compliance stages of environmental assessment at the site.

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

Epithermal-style gold mineralization in the eastern Cobequid Highlands, Nova Scotia: towards a first model

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In the northeastern Cobequid Highlands, Nova Scotia, recent bedrock mapping, bulk rock geochemistry, and prospecting has identified a potential low-sulphidation epithermal Au system in Late Devonian to Early Carboniferous bimodal volcanic rocks. In this area of the Highlands, two distinct volcanic units are present, the Byers Brook Formation consisting of felsic and volcaniclastic rocks and the overlying Diamond Brook Formation comprised of vesicular basalts with minor felsic volcaniclastic rocks. To the southwest these formations overly the Hart Lake-Byers Lake granite, and to the north are unconformably overlain by Late Carboniferous sedimentary rocks of the Cumberland Basin. These magmatic events are synchronous with the onset of siliciclastic sedimentation in the Maritimes Basin and combined with the bimodal, within-plate characteristics of the volcanic package suggest emplacement in a continental-rift-type environment. Continental-rift, bimodal volcanic environments are known to host epithermal gold systems (e.g., Great Basin, Nevada) and the Warwick Mountain area located in the northwestern part of the Diamond Brook Formation shows the most potential for gold mineralization. Here two zones of intensely silicified and sulphidized basalt are present with the mineral assemblage of quartz + sericite + carbonate + pyrite ± chlorite ± epidote. Assays from the first narrower zone returned anomalous Au concentrations, up to ~660 ppb. Anomalous concentrations of As, Sb, Cd, and W were also detected. These trace elements are typical of the bimodal volcanic-hosted low-sulphidation deposits in Nevada. To date, there has been no detailed study conducted on this potential low-sulphidation Au system leaving many questions unanswered. This preliminary study aims to answer two questions: (1) What is the mineralogy and paragenesis of alteration and mineralization and (2) With what generation of pyrite (i.e., early vs. late) is gold mineralization associated? In order to address the above questions, petrographic microscopy and SEM-EDS will be conducted to determine the alteration and ore mineralogy and paragenesis, thereby aiding in determining the relative age of Au precipitation. This research will contribute new data to a poorly studied area and will help put constraints on the mineralization history and economic potential. [Poster]

Investigating the relationship between the Bras d'Or and Aspy terranes in Cape Breton Island, Nova Scotia: insights from Devonian plutonic rocks

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Located on the eastern margin of North America, Cape Breton Island, Nova Scotia, records a complex geological history that formed during Palaeozoic Appalachian orogenic events. The Appalachian orogen records the accretion of a series of peri-Gondwanan terranes to the composite Laurentian margin. The four major terranes in Cape Breton Island are the peri-Laurentian Blair River Inlier, and the peri-Gondwanan Aspy, Bras d'Or, and Mira terranes. The Bras d'Or terrane is comprised of Neoproterozoic gneissic and metasedimentary units with associated metavolcanic rocks. The Aspy terrane is dominated by younger Silurian–Devonian back arc sedimentary and volcanic rocks that were intruded by post-depositional plutonic rocks. The boundary between the Aspy and Bras d'Or terranes is defined as a regional, east over west, sinistral shear zone named the Eastern Highlands Shear Zone (EHSZ). Devonian plutons of the Black Brook Granite Suite (BBGS) that intruded into the EHSZ form the focus of this study. The BBGS is a peraluminous, muscovite and biotite granitoid suite which was interpreted to have formed from partial melting of metasedimentary rocks. The purpose of this study is to characterize the petrogenesis of the BBGS and other spatially associated "stitching" granitoid plutons such as Park Spur that are also located along the EHSZ. The study will further constrain the timing of the emplacement of the BBGS: preliminary zircon U-Pb data yielded an age of ca. 375 Ma. Geochemical and zircon hafnium isotopic

signatures will be analyzed to determine whether the protolith can be linked to either the Bras d'or terrane or the Aspy terrane as well as to better understand the tectonic setting at the time of pluton emplacement. Results will be used to correlate Devonian magmatism in the peri-Gondwanan terranes of northeastern Cape Breton Island that are associated with the EHSZ with coeval magmatic rocks in Newfoundland and New Brunswick that have similar ages, lithologies, and geological histories. [Poster]

A high resolution record of sediment deposition in the Gulf of Aqaba, Red Sea, during the last ~1000 years

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The Gulf of Aqaba is a narrow and deep basin at the northeastern tip of the Red Sea. Sedimentation is dominated by biogenic and eolian material, as well as by material delivered by the Wadi Mubarak. Here we present paleoenvironmental proxy records from a 108 cm gravity core, recovered at 720 m water depth at the northern end of the Gulf. These records are compared to sediment flux directly sampled by co-located sediment traps deployed since 2014, which show that sedimentation is dominated by sporadic, short-lived flux events on the order of days. An event deposit in the sediment core at 96–87 cm, with coarse sediment at the bottom and a fining upward sequence is tentatively, and in analogy to previous studies, ascribed to a turbidite triggered by the historical earthquake at 1068 AD. This age assignment implies overall sedimentation rates on the order of 1 mm/yr at the sampling site, in general agreement with bulk flux estimates from the sediment traps as well as previously published sediment core records from the Gulf of Aqaba. Records of basic sediment geochemistry, foraminiferal abundances, and nitrogen isotopes will be discussed in the context of regional climate, hydrographic variability, and nitrogen cycling during the last 1000 years.

Winner of the Science Atlantic Best Paper Award for best overall presentation

The hydrothermal system of the Miocene volcanic rocks of western Lesbos, Greece

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The Sigri Pyroclastic Formation in the western side of the island of Lesbos consists primarily of pumice flows, mudflows, and stream conglomerate. Most of the pyroclastic rocks appear to be derived from a caldera near Vatoussa and shows extensive alteration and mineralization. The purpose of this study is to understand the hydrothermal fluid(s) altering the volcanic rocks and to determine a model for the hydrothermal system. Samples were collected from the Jithra ignimbrite, layered fine-grained sediments underlying the ignimbrite, a zoned nodule at a fault zone, and a wood sample from the Sigri Petrified Forest. Rock mineralogy and chemistry were investigated using a petrographic microscope, scanning electron microscope, electron microprobe, and Laser Raman spectroscopy. Hydrothermal alteration minerals and assemblages identified from the altered ignimbrite are: (1) K-feldspar +silica +illite +minor apatite, zircon, TiO_2 minerals; (2) Jarosite +hematite +amorphous silica; and (3) Mn-oxides. Three different horizons from the underlying sediments shows identical mineral assemblage of smectite +silica +TiO_2 minerals ±monazite±hematite. The presence of hydrothermal quartz, K-feldspar, kaolinite and smectite are closely similar to the alteration assemblages in the epithermal system of the Taupo volcanic zone which were formed by different types of circulating groundwater. Hydrothermal veins and the zoned nodule are predominantly made up silica-iron-manganese mineralization. The availability of manganese may be related to the decay of organic matter as the study area used to be forested with multiple tree horizons, although the amorphous silica-iron mineralization is mineralogically and chemically comparable to jaspers found in exhalative marine systems. This observation is intriguing because there is no evidence for a nearby marine condition in western Lesbos. [Poster]

Changes in primary production and sedimentation in the North Water polynya between Greenland and Ellesmere Island during the past ca. 3500 years

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Polynyas are areas of open water located in a region that is otherwise covered by sea ice in the polar sections of the globe. Because light is not limiting and the mechanisms involved in their formation can enhance the nutrient supply to the surface waters, polynyas are regions of high primary production that sustain large and diverse food webs. The North Water (NOW) polynya is located off the coast of northwestern Greenland and Ellesmere Island, Canada. It is the largest polynya in the polar Arctic region. The purpose of this project is to investigate changes in the sedimentary tracers from a long sediment core collected from this region to better understand the response of the system to the climatic variability of the last ca. 3500 years. We further would like to understand how and why the polynya formed. Here, we will present preliminary results on changes in the

microfossil assemblages (e.g., dinoflagellate cysts) from a core drilled off the coast of Northwestern Greenland. The core was collected at 77°17.097'N–74° 23.214'W at a depth of 700 m. Variations in the dinocyst abundance and species composition will be used to infer temporal changes in the sea-surface properties such as temperature, salinity, etc. By understanding how climate has changed in the past, it allows us to better understand how it may evolve in the future. During a time where anthropogenic factors are contributing to a changing climate, it is necessary to understand and study areas with a major impact on ocean circulation. This study aims to better understand these factors and help predict the impacts of future climate fluctuations on the productivity and oceanic circulation of the NOW polynya.

Depositional environment and provenance of sedimentary rocks at MacIsaacs Point, Nova Scotia

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The Appalachian-Caledonide orogen was formed by the accretion of peri-Gondwanan terranes to Laurentia-Baltica at various times during the Ordovician–Devonian, followed by collision with Gondwana and the formation of Pangea in the Carboniferous–Permian. The t wo m ost outboard peri-Gondwanan terranes in Atlantic Canada are the Neoproterozoic Avalon terrane and the Cambrian-Early Devonian Meguma terrane. As the Rheic Ocean closed and Gondwana collided with the Laurussian, Avalon, and Meguma terranes, a large system of strike-slip faults developed. These regional-scale strike-slip faults resulted in the formation of syn-collisional basins, and as a result, their sedimentary rocks preserve a record of the orogenic events that marked the formation of the supercontinent Pangea. One such basin, the Antigonish Basin, contains late Devonian marine, coastal, and lacustrine sedimentary rocks such as sandstone, conglomerate, limestone, and shale. These rocks are well-exposed at MacIsaacs Point approximately 17 km north of Antigonish. This project aims to better understand the relationship of the basin evolution to the regional tectonic development during the formation of Pangea. Previous work mapped this area as the 'Undivided Devonian-Carboniferous rocks', consisting of mainly conglomerate and sandstone. To better constrain the relationship between these sedimentary rocks and the regional tectonics: (1) a detailed stratigraphic succession was created, (2) a detailed geologic map and cross section were made, and (3) detrital zircon data were collected from the section and from granite clasts from the major conglomerate bed. The detailed stratigraphic log allows for depositional environment analysis and preliminary results indicate this area was likely a braided stream system. The sandstone units were further subdivided by sedimentary features such as plant fossils, cross bedding, and grain size changes, and indicated a lacustrine depositional environment. The conglomerate layers were distinguished based on clast compositions and clast sizes and are interpreted as the remnants of stream channels. Furthermore, the ability to subdivide this area based on the sedimentary rocks observed will increase the overall geologic understanding of the Antigonish Basin. [Poster]

Mid-to Late Holocene changes in the hydrographic conditions of the Baltic Sea, as inferred from dinoflagellate cyst assemblages

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Dinoflagellate cyst assemblages from marine sediments in the south-central Baltic Sea provide a record of major changes in the Baltic Sea hydrographic system. Beginning just before 8000 BP, dinocyst assemblages show a sharp increase in salinity and decrease in dinocyst abundance and diversity associated with a growing reconnection with the Atlantic Ocean via the Kattegat north of Denmark. The appearance of marine dinoflagellate cysts, cross-referenced with C^{14} dates for the sediment core, indicates the times of transgression. Morphological characteristics such as increased process length for *Lingulodinium machaeorophorum* as well as relative abundances of the dinocyst assemblage correlate with the increase in salinity. This transgression continued the trend of increasing salinity and temperature for at least 1000 years, before dinocyst diversity and abundance declined. Recent brackish water conditions in the last 4000 years are lower in both diversity and abundance than pre-transgression, with assemblages dominated by *Operculodinium centrocarpum*.

Characteristics of epithermal-style gold occurrences at the Goldy and Irene showings, Dawson Range, Yukon Territory, Canada: towards a first model

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The objective of this study is to characterize and compare epithermal quartz-Au-sulphide vein mineralization that occurs on Triumph Gold Corporation's Goldy and Irene showings in the Dawson Range, Yukon Territory. Specific goals of the study will be to (1) determine if the two showings constitute part of a single hydrothermal system that had several mineralizing centers along common structures or in relation to a common heat source, (2) determine the fluid characteristics and crustal depth of the gold mineralizing

process(es), and (3) characterize the mineralogy expressed at the showings leading to a classification of the P-T regime of the mineralization. Both mineral showings contain economically significant concentrations of gold in quartz-sulphide veins that are focused along fault-modified contacts between the metamorphic rocks of the Yukon Tanana Terrane and the intrusive bodies that are Jurassic to Cretaceous in age. The Goldy showing comprises a roughly 160 × 160 m elliptical area of dense quartz-stockwork veining at a contact between biotite schist/gneiss and Jurassic syenite. The Irene showing, located 9.5 km NW of Goldy, comprises a greater than 3 m thick quartz-sulphide vein exposed over 150 m strike-length at a contact between biotite schist/gneiss and biotite-hornblende granodiorite to granite of probable mid- to late-Cretaceous age. At both showings, roughly fault/contact-parallel quartz-feldspar-porphyry dykes are present, and are interpreted to occur along segments or splays associated with the regionally important Big Creek Fault. Using petrographic microscopy, a paragenetic investigation of the mineralization (ore and accessory minerals) and associated alteration assemblages will be conducted to better characterize these two showings. This will be complemented by stable isotope (O and S) and fluid inclusion analyses (petrography and microthermometry) of the vein-hosted minerals, in order to constrain fluid composition and origin, as well as the crustal depth and temperature of the mineralizing event(s). The value of this study will be to ultimately establish robust geochemical criteria to aid in mineral exploration within this under-characterized region. [Poster]

A paleolimnological approach to understanding metal retention and mobility associated with salt-water inundation at Laytons Lake, Nova Scotia

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Sediments in constructed wetlands and lakes have the potential to retain metals mobilized by natural and anthropogenic disturbance. The Cumberland Marsh Region on the Nova Scotia - New Brunswick border is an important waterfowl refuge where arsenic (As) and lead (Pb) that exceed sediment quality guidelines (SQG) are widespread. The role of variable water column chemistry and nutrient load on metal retention and mobility in wetland sediments is not well understood. Laytons Lake, in the Amherst Marsh, Nova Scotia, was documented in the 1970s as becoming a density stratified, incompletely mixed (meromictic) lake by a sudden marine inundation which resulted in a saline bottom layer and a fresh top layer. New water column chemistry data indicate that the lake is no longer saline and has since mixed. A detailed paleolimnological assessment has been undertaken to investigate how these water column chemistry changes have influenced metal retention. Limnology and geochemical analysis of lake sediments using a portable X-ray Fluorescence (pXRF) analyzer, total C, total N and stable isotopes ($\delta^{15}N$, and $\delta^{13}C$) will be used to determine how salinity changes influence nutrient availability and the retention of As and Pb in aquatic sediments. Preliminary results indicate Laytons Lake is now dimictic with the former dense saline layer no longer present and average conductivity of 503 µs/cm at the surface and 1012 µs/cm at 11 m. When the lake was meromictic the average conductivity was 538 µs/cm at the surface and 26,000 µs/cm at 11 m. It is nutrient rich (high TP) averaging 0.09 mg/L at the surface and 0.42 mg/L at 10 m depth. A depth-time profile of 100 years was established for the core based on the Pb curve. The Pb curve indicates atmospheric deposition is considerable and correlates with lead curves from other lakes in the region. Arsenic indicates a slight increase associated with the salt-water inundation. Distinct sediment stratigraphy compares with chemical changes seen in the pXRF data.

Shortening of southern Tibet

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Geological studies of the Himalayan orogen have been focusing on three aspects: the initial collision in Early Eocene, Miocene tectonics, and recent seismotectonics. However little is known about first half of the Himalayan orogeny, during the Eocene and Oligocene. The Tethyan Himalaya, located between the crest of the Himalaya and the India-Eurasia suture (the Indus-Tsangpo suture Zone) in the southern Tibet, are a fold-and-thrust belt that developed during this period. This project has two principal objectives. The first one is to determine the geometry of the basal detachment of the Tethyan Himalaya. The current hypothesis is that the basalt detachment of this fold-and-thrust belt was a south-vergent thrust which was reactivated as a low-angle normal fault geometry shear zone. This structure crops out in the northern Himalaya as the South Tibetan Detachment. The second aim is to calculate the shortening amounts of the Tethyan Himalaya as only one such study was performed until now. The objectives of this project will be implemented through construction of a series of balanced, retrodeformable cross sections using MOVE ® software. The cross sections will be constructed based on published geological maps and field observations. This study is part of a larger project aimed to constrain the structure of southern Tibet and the Himalaya. [Poster]

A geophysical characterization of a Bog in Gullbridge, Newfoundland

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Characterization of a bog near Gullbridge in west-central Newfoundland was performed with the use of a ground penetrating radar (GPR) and coring. X and Y lines were taken of the bog on snowmobile in two different trips in February 2017 using the Earth Science Department's Sensors and Software GPR with 100 and 250 MHz antennas. The antennas were set up in a sled towed by a snowmobile, with one person in the back operating the GPR and a second person operating the snowmobile. The soft and deep snow was troublesome but gave interesting information. Different snowfalls are noted as layering and could possibly be detected in GPR profiles. Processing of the GPR data was done using EKKO Project software by applying many different techniques by observing the Nyquist frequency and applying appropriate filters (highpass, lowpass, and bandpass) where applicable. Processing was done in terms of the GPS locations and gain to create the best possible cross-sectional view of the area. The aims are to map snow thickness and bog bathymetry and if possible to image structures in both layers. Bog core samples for analysis with the multi-scanner core logger (MSCL). The data from the MSCL will be analyzed and also compared to data collected with the GPR. A bog corer has been borrowed from the geography department. It is planned to test this corer on local bogs, and if the tests are successful, to take core samples of the bog in a final field trip to Gullbridge in November.

Winner of the Canadian Society of Exploration Geophysics Award for best presentation of a geophysics-related paper

Structural evolution and tectonic history of the Glenelg area, Nova Scotia, and relationship to correlative rocks of the South Portuguese Zone, Spain

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The peri-Gondwanan Meguma terrane is the most outboard terrane of the Canadian Appalachian orogen and encompasses an area of 200 000 km^2 extending from the Gulf of Maine to the Grand Banks of Newfoundland. The terrane consists of mainly greenschist to amphibolite facies turbiditic metapelitic sequences that were intruded by Devonian plutonic rocks during the Neoacadian orogeny, a tectonic event that stitched the Meguma terrane to the Avalon Terrane (ca. 380–370 Ma). Surface exposure of the Meguma terrane is believed to be restricted to Nova Scotia. However, U-Pb detrital zircon and isotopic data indicate that the South Portuguese Zone (Iberian Peninsula) may be underlain by Meguma basement. This interpretation is consistent with paleogeographic reconstructions that place Maritime Canada adjacent to autochthonous Iberia in the Late Paleozoic. In Iberia, the oldest exposed rocks are relatively weakly deformed Late Devonian phyllite and quarzite; however, the recent discovery of exposed polydeformed alternating beds of phyllite and quartzite could represent an older sequence. These rocks were intruded by felsic-intermediate plutonic rocks and are discomformably overlain by Carboniferous (ca. 343 Ma) volcanic rocks of the Iberian pyrite belt. To test potential linkages between Iberia and Meguma, a sequence of folded and metamorphosed quartz-rich metasandstone and siltstones, in the northeastern Meguma terrane near Glenelg, Nova Scotia, was studied. The region is of economic interest as it hosts an anomalous galena deposit, and outcrops along strike of the Cochrane Hill gold occurrence. Preliminary field and petrographic studies in the Meguma terrane indicate a NE-SW trending fold system and amphibolite-facies metamorphism. Results show that metamorphic grade increases towards the center of the fold and has resulted in large staurolite and garnet porphyroblasts. U-Pb detrital zircon geochronology from both localities will test possible genetic linkages between the Meguma terrane and South Portuguese Zone. Sample assays were also taken to target and assess economic mineralization potential.

Corestone-saprolite interfaces as tracers of the Paleoproterozoic surface environment

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The ca. 1.85 Ga Flin Flon paleosol that developed on dolerite intrusions situated along the Manitoba-Saskatchewan border is one of the earliest explicit evidence for subaerial weathering under oxic conditions, which postdates the ca. 2.45 Ga Great Oxidation Event (GOE). Inferences from marine deposits around 1.85 Ga imply a decline in atmospheric oxygen levels. On the contrary, constraints from continental deposits, such as paleosols, remain sparse. This study aims to analyze corestone-saprolite interfaces, which are small-scale chemical weathering fronts, to study the changes occurring in the dolerite intrusions during early weathering reactions. Initial work using both petrographic analysis and scanning electron microscope and mineral liberation analyzer (SEM-MLA) has revealed albite-dominated cores surrounded by rinds primarily composed of clinochlore, chamosite, and illite. Hematite and magnetite are preferentially preserved in the

cores, whereas muscovite progressively increased outwards from the cores. Solution-based geochemistry using a quadrupole inductively coupled plasma mass spectrometer (Q ICP-MS) will be used to obtain high precision major to ultra-trace element data across the corestone-saprolite interface. Once completed, this study will provide a full elemental and mineralogical data set that can provide new insights into the poorly understood surficial conditions of the Paleoproterozoic. By combining the different data obtained from corestone-saprolite interfaces, the study will attempt to shed light on the processes that occurred during the incipient stages of oxidative weathering, which reflect the composition of the ancient atmosphere and have further implications for seawater composition and metal cycling in the Paleoproterozoic.

Ni-Cu-PGE potential of gabbro sills in the Labrador Trough

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The purpose of this project is to evaluate the Ni-Cu-PGE potential of gabbro sills in the Labrador Trough. The mineral potential of the Labrador Trough was first recognized in the 1930's when exploration programs were focused on its base and precious metals; however, it was not until recent exploration in Quebec by Northern Shield that mineralized gabbro sills were identified as potential targets for Ni-Cu-PGE mineralization. This project will examine the gabbro sills of the Howse Lake area and compare the results with the Northern Shield prospect 100 km north along strike in Quebec. Fieldwork for this project consisted of grab sampling from known occurrences and prospecting the areas in the immediate vicinity. It was conducted during the summer of 2017 through a student position with the Geologic Survey of Newfoundland and Labrador (GSNL). This project will attempt to determine the sulphur source in the mineralized gabbro, classify the deposit type(s), and generate a genetic model for exploration. Bulk rock geochemistry was conducted at the GSNL's laboratory in St. John's, with PGE and Au assays conducted at external commercial facilities. Petrographic analysis of the polished thin sections will be done to determine a paragenetic sequence for the sulphide mineralization, and selected samples will be chosen for SEM-MLA analysis to determine detailed petrographic relationships and host minerals for PGE mineralization. The sulphur isotopes of pyrrhotite and chalcopyrite from the mineralized gabbro will be analyzed in situ using secondary ion mass spectrometry (SIMS) to determine the source of the reduced sulphur within the melt, and to relate the different types of mineralization. These will be compared to results obtained from sulphide rich shales in contact with the gabbro sills. Whole-rock geochemistry from both mineralized and non-mineralized gabbro samples will be used to determine regional geochemical trends within the intrusions, and to identify which factors contributed to the localized mineralization. [Poster]

Determining the early incision history of the Colorado Plateau using an innovative dating method

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The early incision history of the Colorado Plateau remains highly debated. Multiple stages of uplift and erosion appear to exist and attempts to constrain these events have resulted in conflicting conceptual models. Over a century of thermochronologic, geodynamic, stratigraphic, and geomorphologic studies have not resolved the timing, mechanisms, and history of the plateau's incision, including the Grand Canyon. A new approach is necessary to help reconcile their differences. High-energy cosmic ray particles produce secondary particles when they interact with nuclei of atoms in the atmosphere or exposed minerals. Secondary muons are 209 times the mass of an electron, and because of their small mass they interact weakly with matter. Thus, muons can penetrate deeply into the subsurface, and cause further interactions to produce rare terrestrial cosmogenic nuclides (TCN). The TCN techniques have previously been limited to depths of 130 m below the valley bottom along a mine stope that runs laterally across the valley. The concentration of muogenic ^{10}Be produced from oxygen and silicon in the quartz, will be proportionate to the flux of cosmic radiation received over the past 8 Ma. The spatial pattern of the concentrations will reflect the cosmic ray shielding by the overlying crust. If the incision occurred recently, the ^{10}Be concentrations will be greatest under the deepest portion of the valley. Older or slower incision histories will generate other spatial distributions. Currently eight ^{10}BeO targets are being prepared at Dalhousie University and will be tested at Lawrence Livermore National Laboratory. With this project, we hope to first and foremost determine the viability of detecting muogenic isotopes for future applications of the dating method, and to accurately determine the incision history of the Colorado Plateau.

Polygonal ridges in the Medusae Fossae on Mars and analogous features on Earth

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Polygonal ridges found on Mars are morphologically similar to desiccation cracks found in periglacial and other ephemeral sedimentary environments on Earth. Such ridges, with up to 50 m of relief, have been observed in areas of the Medusae Fossae nearest the Tharsis region, the largest volcanic region on mars. These ridges have been interpreted to have formed as a result of lava extruding into pre-existing cracks in surficial rock. However, the origin of the cracks themselves is thought to be related to thermal stress, much like the thermal stress that creates the "patterned ground" common in polar regions on Earth. This paper comprises a selective review of literature that will form the basis of a team project by junior undergraduate students. [Poster]

Thallium isotopic analysis of microcline by laser ablation-inductively mass spectrometry with application to granite pegmatite petrogenesis

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Rare element granitic pegmatites are divided into two groups: Lithium, Cesium, Tantalum (LCT) type and Niobium, Yttrium, Fluorine (NYF) type based on their enrichment in these elements. In general, NYF pegmatites are related to anorogenic magmatism where as LCT pegmatites are related to peraluminous granites in orogenic settings. Previously, trace element geochemistry of various minerals has been used to identify LCT and NYF pegmatites, however the source of the magma is still uncertain. In an attempt to characterize the specific sources of these pegmatite types the thallium isotopic ratios of primary microcline from fourteen major pegmatites located around the world were determined by laser ablation inductively coupled mass spectrometry. Thallium was selected to be analyzed for because it is very enriched in highly fractionated granites and because its isotopic signature in crustal rocks show a small, but measurable, range which has been attributed to specific sources in the mantle or crust. The structural state of all microcline samples was determined by powder X-ray diffraction and the major as well as trace element content was measured by electron microprobe analysis and laser ablation inductively coupled mass spectrometry, respectively. The relative abundance of Ga, Rb and Pb found in the microcline clearly separates LCT and NYF type pegmatites as previous work has suggested. The $^{205}Tl/^{203}Tl$ ratios of microcline samples, which contain between 20 and 300 ppm Tl, was measured for the first time by Laser Ablation Inductively Coupled Mass Spectrometry. All the $^{205}Tl/^{203}Tl$ ratios were around 2.395 except for a rare alkali-enriched microcline from the core of the Tanco pegmatite. In conclusion, the $^{205}Tl/^{203}Tl$ ratios obtained by laser ablation inductively coupled mass spectrometry do not discriminate the different sources for NYF and LCT pegmatites, however, the results do indicate significant fractionation of thallium isotopes within the highly evolved Tanco pegmatite in Manitoba.

Discriminating multiple mineralization events of the diatreme-associated Cu-Mo-W-Au occurrences at the Revenue Deposit, Dawson Range, Yukon Territory

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The west-central area of the Tintina Gold Belt, Yukon Territory, Canada, is a perspective area for gold as it hosts large, high-grade deposits such as the Coffee Creek and Casino deposits. The Freegold Mountain Project located in the Dawson Range of the Tintina Gold Belt hosts multiple gold showings, including the Revenue Deposit: a poorly characterized diatreme-associated Cu-Mo-W-Au occurrence. This thesis project will characterize alteration and ore mineral assemblages at Revenue, and investigate the composition (major, minor, and trace element), and sulphur isotope signatures of ore minerals in order to discriminate different mineralizing events, fingerprint their chemical signatures, and elucidate the processes that led to their formation. Recent field work and sampling of exploratory drill-core confirmed at least two distinct styles of mineralization: early, vein-hosted and disseminated chalcopyrite-pyrite-pyrrhotite associated with potassic alteration in the Revenue Granite, and later breccia-hosted molybdenite-scheelite-pyrite-chalcopyrite with phyllic alteration likely associated with the emplacement of the pyroclastic diatreme and quartz-feldspar-porphyry dykes. Detailed petrographic work using optical microscopy and scanning electron microscopy, in conjunction with short-wave infrared spectroscopy (Terraspec), will (1) identify and characterize ore minerals and associated alteration, (2) examine microscopic textures, and (3) quantify the major and minor element composition of the mineral phases. By characterizing the mineral assemblages, we aim to classify the mineralization styles using existing models to be applicable in an exploratory setting. In situ laser ablation inductively-coupled plasma mass spectrometry will be used to determine the trace element compositions of ore minerals, in order to identify unique chemical signatures. Using secondary-ion-mass-spectrometry the

sulphur isotope composition of sulphides from different assemblages will be determined. Together with trace element data, this information will provide constraints on the source of sulphur (i.e., mantle or sedimentary derived) and allow for the discrimination of different mineralizing fluids. The results of this study will be used to assign the different mineralization styles at Revenue to existing ore deposit models to benefit exploration programs (e.g., intrusion-related, skarn) in the region. [Poster}

Winner of the Imperial Oil Award for the best poster presentation

An experimental study of the effect of water on chromite saturation in komatiites

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Chromite is an oxide mineral and the only chromium ore. Economically important deposits of chromite (massive chromitite) are associated with ancient ultramafic magmas known as komatiites. One such deposit has recently been discovered in the Ring of Fire area of the James Bay Lowlands, Ontario. Despite their economic value, the conditions of formation of massive chromitite are poorly constrained. The purpose of this investigation is to characterize the impact of magmatic water on the mineral phase relationships in komatiitic magmas. Orthopyroxene, an important constituent in komatiites, readily incorporates chromium into its crystal lattice. The early crystallization of orthopyroxene, therefore, inhibits the precipitation of chromite by depleting chromium in the melt. Studies of more felsic systems have shown that magmatic water significantly decreases the crystallization temperature of most silicate phases, but that it has a relatively lesser effect on oxides. Phase equilibrium experiments allow us to test the hypothesis that, by depressing the liquidus of orthopyroxene relative to that of chromite, magmatic water can facilitate the early crystallization and subsequent accumulation of chromite in a komatiitic melt. To accommodate water, experimental charges are sealed in graphite-lined platinum capsules and pressurized to 1 GPa in a piston-cylinder apparatus. This results in fixed pressure and redox state, allowing phase equilibria to be determined as functions of temperature and composition. Preliminary data from this study suggest that water does affect the chromite liquidus, and that olivine may be a heretofore overlooked competitor for chromium. In addition to phase characterization by electron microprobe analysis, we will analyse for chromium and trace element partitioning between mineral phases and melt using laser-ablation inductively coupled plasma mass spectrometry. If trace element partitioning is sensitive to water content, and water content affects the chromite formation capacity of a melt, then such a fingerprint may have applications in characterization of natural komatiites. Komatiites are some of the oldest lavas and best-preserved relics of the Archean Earth. Expanding our understanding of komatiites and their crystallization behaviour could provide important constraints on early Earth processes, including those associated with highly valued ores.

Winner of the Frank S. Shea Memorial Award for best economic geology presentation

Characterization of properties of the eutectic mixture of zirconium tetrafluoride and potassium fluoride for a molten salt nuclear reactor

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Transitioning to a non-carbon emitting energy source is one of the major challenges that the world currently faces as the impacts of a changing climate becomes more imminent. One of the main suggested sources during our transition to a new energy future will come from nuclear energy. In past decades, the use of uranium fuel rods have been used to generate heat to drive a turbine but in modern society, safer alternatives that have higher efficiency and electrical output are being proposed. Terrestrial Energy is a company based out of Ontario that is developing a pilot plan that uses a eutectic ZrF_4-KF mixture to be used in a molten salt nuclear reactor. The physical-chemical properties of a eutectic mix of potassium fluoride and zirconium tetrafluoride have been previously untested in a laboratory, but will be the integral mix that will be used in the cooling system in the second loop of the proposed molten salt nuclear reactor. The predictable behavior of the eutectic mix is crucial for the stability and efficiency of such a proposed project. As such, the homogeneity of the mixture, as well as the viscosity, melting and boiling point, solubility, purity, trace impurities of transition metals, and water moisture content within the crystal lattice will be measured. This will be accomplished by examination through laser ablation ionically coupled plasma mass spectrometry (LA ICP-MS), X-ray Fluorescence (XRF), and a scanning electron microscope (SEM). The data that will be collected will be submitted to the Nuclear Energy Board of Canada for future projects that will involve these compounds.