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Atlantic Universities Geoscience Conference 2021

ABSTRACTS

November 6–7, 2021

71ST ANNUAL CONFERENCE HOSTED BY:
D. HOPE SIMPSON GEOLOGICAL SOCIETY, SAINT MARY'S UNIVERSITY
HALIFAX, NOVA SCOTIA

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. Due to the COVID-19 pandemic and related travel restrictions the conference included both virtual and in-person presentations. The conference concluded with a field trip to the gypsum quarries in Hants County on Sunday afternoon.

Although abstracts are modified and edited as necessary for clarity and to conform to Atlantic Geology format, the journal editors do not take responsibility for their content or quality.

THE EDITORS

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Trace element geochemistry of biotite and apatite from the Scrag Lake pluton of the South Mountain Batholith, Nova Scotia, Canada*

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Currently, the trace element geochemical variability of biotite and apatite from the Scrag Lake pluton (SGP), part of the South Mountain Batholith (SMB), Nova Scotia, is under investigation. Previous research has shown that samples from phase 2 plutons of the SMB show significant geochemical variability within these minerals, but geochemical data are lacking from phase 1 plutons, particularly from their most evolved parts. The SGP is a phase 1 pluton and samples from it cover a range of rock types from biotite granodiorite to muscovite leucomonzogranite. Both biotite and apatite are common in these rocks and are being investigated to better understand the geochemical evolution of the SMB, and to potentially gain a better understanding of ore-forming processes in felsic intrusive rocks. An electron microprobe and laser ablation ICP-MS have been used to collect geochemical data from a suite of samples from the SGP, covering the least to most evolved parts of the pluton, ranging from 65.04–74.54 wt. % SiO_2. Laser ablation ICP-MS data have also been used to produce trace element maps of selected biotite grains using the Iolite (v.4) program, with a current focus on Nb, Ta, Sn, and W data. Preliminary results suggest that trace element variation is present in the more evolved samples from the SGP. However, these variations are small-scale in phase 1 samples, with concentrations changing by 10s –100s of ppm over one mineral grain. For comparison, phase 2 samples can show concentrations changing by 1000s of ppm over one mineral grain. Future research will focus on gathering more trace element data to create more maps of samples from a phase 2 pluton, the New Ross pluton (NRP). The trace element maps from SPG and NRP will then be compared to see how trace element geochemistry varies across the SMB, and what might be the driving factors causing these differences. As well, the geochemical data will be compared to crystallization models to better understand the geochemical evolution of the SMB. [Oral presentation]

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

The first discovery of vertebrate and invertebrate ichnofossils in the Stellarton Basin (Westphalian C), Nova Scotia, Canada

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Newly discovered tetrapod and invertebrate ichnofossils from the Pennsylvanian (Westphalian C) Stellarton Formation represent the first ichnofossil assemblage to be described in the Stellarton Basin of Nova Scotia. The Stellarton Basin is well known for its economic deposits of coal, yet very little paleontological work has been documented in the literature prior to this study. The tetrapod trackway bearing Plymouth Member is exposed in an aggregate quarry near the town of Stellarton and is composed of fluvial sandstones that locally preserve tetrapod footprints. This unit is interpreted to conformably overlie the lacustrine deposits of the Westville Member that crop out just east of the quarry along the East River of Pictou, where outcrops of the Westville Member preserve invertebrate trace fossils. The well-preserved, plantigrade tetrapod tracks are identified as *Batrachichnus salamandroides* and *Matthewichnus cf. M. velox*, ichnotaxa that are often attributed to temnospondyl or microsaurian trackmakers. Of greater abundance and diversity is the invertebrate trace fossil assemblage, which consists of *Cruziana isp*., *Monomorphichnus isp*., *Lockeia isp*. and various morphologies of *Rusophycus* tentatively assigned to various ichnospecies. They have been attributed to freshwater crustacean and molluscan tracemakers. In addition, a previously undescribed cubichnia morphotype is here assigned to a new ichnotaxon (*Pickerillichnus westvillei*) and is interpreted to have been produced by an isopod-like invertebrate. The marginal lacustrine depositional setting at this site encompasses a diverse invertebrate ichnoassemblage within the *Mermia* Ichnofacies and a low diversity vertebrate ichnoassemblage of the *Batrachichnus* Ichnofacies. [Oral presentation]

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

Geothermal potential in New Brunswick, Canada: updated maps and databases*

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Geothermal energy utilizes the flow of heat through the Earth to produce clean electricity with minimized surface environmental footprint. This is achieved either by using hydrothermal resources naturally present in deep subsurface fractures and pores, or by injecting water into hot, dry rock at depth and using the newly heated water for turbine-powered electricity generation. To be economically viable, sufficient heat must be available at shallow subsurface depths to minimize the expensive drilling and pumping costs associated with geothermal production, meaning steep geothermal gradients are required. As New Brunswick is not a tectonically or volcanically active region, any geothermal potential lies in (1) decay heat from radiogenic intrusive rocks, or in (2) elevated heat flow through moderate-temperature sedimentary basins coupled with low thermal conductivity rocks acting as insulators in the basin fill. Where geothermal gradients in sedimentary basins are promising, thermal conductivity and effusivity must be assessed to create heat flow models and reconstruct the thermal history in the basin. Previous maps of geothermal gradients in New Brunswick have not drawn from very extensive datasets, with some papers making assertions on the province's geothermal potential based on information taken from as few as five drilling reports. The updated maps and databases pull critically assessed information from over 790 well and drilling reports primarily covering the southeastern half of the province. The resulting subsurface thermal contour maps demonstrate general agreement with previously published maps: most data points in the study area have average geothermal gradients between ~10°C/km -30°C/km. These values are not prospective for geothermal energy with current technologies. However, the greater level of survey detail has revealed a few anomalous locations associated with New Brunswick's salt deposits, where average gradients appear greater than 30°C/km. For comparison with existing thermal conductivity ranges of particular rock types, the study also tabulated measured thermal conductivities of nine rock types taken from core in selected boreholes across southeast New Brunswick: Carboniferous–Triassic sandstone, mudstone, conglomerate, anhydrite, limestone, halite, and potash; Devonian granite, and Triassic basalt. Results from the sedimentary rocks are in general agreement with previously published work, whereas the measured basalt thermal conductivity averages 2.30 W/mK (30% higher than the highest published average found), and the granite 2.51 W/mK (19% lower than the lowest published average found). All cores were tested air-saturated, and some were reassessed while water saturated resulting in a much narrower range of measured thermal conductivities. [Oral presentation]

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

Textures, mineralogy, and geochemistry of intrusive phases of the hypabyssal granophile mineralized Kedron Stream Granite, southwestern New Brunswick, Canada

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The Kedron Stream Granite (KSG), situated in the Late Devonian (ca. 362 Ma $^{40}Ar/^{39}Ar$) Pomeroy intrusive series in southwestern New Brunswick, represents a highly fractionated mineralized magmatic hydrothermal system that shares numerous petrogeochemical characteristics with the surrounding granites. Other hypabyssal to subvolcanic intrusions in the area, such as the Mount Pleasant W-Mo-Bi and Sn-Zn-In deposits, True Hill Granite, Pleasant Ridge Granite, Sorrell Ridge Granite, and others, share geochronological, mineralogical, and geochemical characteristics with the KSG; they were emplaced at a high level into Ordovician to Silurian metasedimentary rocks which host various styles of hydrothermal stockwork granophile mineralization. The architecture of KSG is that of a collapsed cupola system with tuffisitic zones occurring at the boundaries of the intrusion. Earlier geochemical analysis of various samples taken from the endo-and exo-granitic mineralization around the Kedron Stock show this mineralized system is very high in Sn, Zn, In, Ag, Cu, Bi, and Li, and locally W and Mo. Various phases of this granite were analysed further and are characterized by high fractionation evident from low Zr (~30 ppm), high Zr/Ti (0.32–0.67), low Zr/Hf (11.20–22.33), low Nb/Ta (1.95–4.37), high Rb, Cs, and Li (and F), and high heat production (U above 10 ppm in all samples). Lithium and F (fluxes), which are in high abundance in the KSG, serve to suppress the temperature of crystallization by lowering the solidus and liquidus of the melt, and thus helping to drive extreme fractionation to higher degrees of specialization. The KSG features an assemblage of alkali feldspar, plagioclase, quartz, and biotite in phenocrysts and groundmass with accessory zircon and monazite. Textures range from pegmatitic to aplitic and alternate rhythmically with granophyric textures present in aplitic sections of the granite; these textures were also examined by micro-XRF-EDS mapping. The granophyric texture is evidence of widespread pressure quenching from rapid depressurization of the melt, probably linked to volatile saturation-exsolution. Extensive sericitization and local chloritization altered the assemblage to dark brown, although quartz is somewhat less altered. Many crystals retain some of their characteristic features (pseudomorphic replacement); Carlsbad twinning is evident in many alkali feldspar crystals and albite twinning is preserved in plagioclase phenocrysts. Zircon and monazite-xenotime SEM-BSE images will guide laser ablation-inductively coupled plasma-mass spectrometry for U–Pb geochronology and trace analysis of those two phases. [Oral presentation]

Survey of porewater geochemistry within deep marine hydrocarbon seep sediments of the Scotian Slope, Canada*

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The ocean floor surface sediments of the Scotian Slope, Nova Scotia, are host to a complex network of microbially mediated reactions that knit together the carbon, sulfur, and nitrogen biogeochemical cycles. Limited diffusion between the upper water column and ocean floor muds pore space, coupled with competitive microbial ecological niche partitioning, leads to the formation of biogeochemically controlled redox gradients. The energetics of such gradients are further governed by microbial heterotrophy with the deposition of detrital organic matter that is primarily sourced from terrestrial runoff and upper water column productivity. However, these microbial biogeochemical zones will likely change if surface sediments are impregnated by hydrocarbon seepage that migrates up from deeper within the basin. We hypothesize that the anions in the porewater, such as sulfate, carbonate, nitrate, nitrite, extracted from frozen marine sediment cores located in prospective hydrocarbon seep sites, can be used to reconstruct biogeochemical stratification depth profiles that can provide additional evidence for active seepage events. These profiles define microbial metabolic processes within the sediment subsurface. To test this hypothesis, a total of 28 samples across 7 sediment cores were collected, separated, centrifugated and analyzed using ion chromatography. Systematic stratigraphic trend of anions was observed in the sampled cores. For example, carbonate concentrations in porewater increase with sediment burial depth. Sulfate concentrations, however, systematically decrease with depth. Additionally, seep locations will be examined as this study progresses. When complete, it is expected that the results will help constrain the depth and extent to which biogeochemical cycles change within the Scotian Slope surface sediments. [Poster presentation]

Winner of the Nova Scotia Department of Lands and Forestry, Geoscience and Mines Branch Award for the best poster presentation and winner of the Canadian Society of Petroleum Geologists Award for the best petroleum geology-related presentation

Can a sediment core collected from the northern Nares Strait tell us about the long-term history of a natural ice arch?

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The Nares Strait is a narrow marine corridor between Ellesmere Island and Greenland, connecting the Arctic Ocean to the North Atlantic. Ice arches (naturally forming sea ice structures bridging across the strait) tend to form each winter, limiting the export of Arctic Ocean sea ice. The stability of modern-day ice arches has decreased in recent years due to climate change, making this an area of interest for climate reconstructions. The objective of this study is to determine if a sediment core collected from the northern Nares Strait (AMD19-6.4, collected in July 2019) can be used to understand long-term changes in the ice arch and local climate conditions. 6 subsamples along the length of the core are being examined for microfossil proxies with a focus on counting and identifying dinoflagellate cysts (dinocysts). Foraminiferal linings, pollen grains, halodinium, radiosperma, and other ciliate cysts are also being counted. Microfossil assemblages from temporal subsamples will be compared to determine if changes in local conditions can be inferred. Dinocysts are sparse but present in the upper 0.5 cm of the core, whereas foraminiferal linings are abundant. [Poster presentation]

Resolution of the hydrocarbon molecular matrix by two-dimensional gas chromatography as evidence of hydrocarbon sources of the Scotian Margin, offshore Nova Scotia, Canada

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Shallow deep marine surface sediments commonly contain hydrocarbons that do not have a well-constrained point of origin. Over the course of three cruises (2015, 2016, and 2018 subsurface sediment samples of piston and gravity cores were collected over prospective hydrocarbon seep sites. These cores have been classified based on petroleum geochemistry as being either positive or negative for containing hydrocarbon that have migrated up from deeper within the Scotian Basin. We hypothesize that the extractable hydrocarbon matrix of the shallow sediments

may represent a mix of organic matter having different origins. In this study, we are examining the hydrocarbon matrix of 8 sediment cores (n = 35). Hydrocarbon extraction involved isolation of organic matter (OM) from the sediment by means of sonication and separation of a polar and polar fractions in organic solvents. Comprehensive two-dimensional gas chromatography, coupled with high-resolution mass spectral data, will be used to resolve these hydrocarbon matrices. The produced two-dimensional chromatograms will be used to map down core variations in the absolute abundance of compounds in the hydrocarbon matrix. A background hydrocarbon fingerprint will be formulated from an average chromatographic trace that will further be subtracted from individual sample chromatograms. The resulting mean difference chromatograms will be used to identify downcore matrix attenuation and evaluate point sources from the multimolecular composition in the sediment strata. Bulk extract data, including total lipid extracts, a polar, and polar fractions, along with sediment TOC and their associated multi-molecular difference chromatograms will further the support downcore mapping. Through this methodology, the project aims to provide evidence for sources of hydrocarbon production by differentiating native and migrated hydrocarbons. [Poster presentation]

Petrology and tectonic setting of the Park Spur pluton, Aspy terrane, Cape Breton Highlands, Nova Scotia, Canada*

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The Park Spur pluton (PSP) is located near the eastern margin of the Aspy terrane in the central Cape Breton Highlands, near its tectonic contact with the adjacent Bras d'Or terrane. New logging roads have provided additional outcrops of this otherwise poorly exposed granitic pluton that has not previously been the focus of a petrological study. This study was undertaken to determine the petrological characteristics of the pluton, including its potential for critical element mineralization, and to compare the PSP to the Black Brook Granitic Suite (BBGS) to the northeast and the West Branch North River Granite (WBNRG) to the south. Based on previously published U–Pb zircon ages, all three plutons have similar mid-to late Devonian ages of about 373Ma, but their relationship to one another and their tectonic setting are not well understood. The BBGS has been previously interpreted as an S-type granite whereas the WBNRG has been interpreted as an A-type granite. Thirty-seven PSP samples was collected for petrographic study and a subset of twenty samples were submitted for whole-rock chemical analysis, including critical elements. As a result of the field work and petrographic study, the mapped extent of the pluton has been modified compared to published maps, and the pluton has been subdivided into three units. Most widespread is medium-grained muscovite-biotite monzogranite with ~35% quartz, ~35% plagioclase, 25% microcline, 4% biotite, and 1% muscovite. Myrmekitic texture is common in plagioclase. Pegmatite and aplite dykes occur in this unit. The northwestern tip of the pluton consists of finer-grained garnet-bearing muscovite monzogranite which lacks the significant amounts of biotite characteristic to rest of the pluton. An area of protomylonitic granite occurs along the southwestern margin of the of the PSP, near its contact with metamorphic rocks of uncertain age. Deformed granitic dykes occur in metamorphic units adjacent to the southeastern margin of the pluton. Both the dykes and deformed pluton margin are characterized by large K-feldspar grains with anastomosing texture of the surrounding quartz and plagioclase grains. Myrmekitic texture in the plagioclase has been preserved. Preliminary comparison of published geochemical data from the BBGS and WBNRG to analyses of six samples from the PSP obtained in previous work suggests that all three plutons are peraluminous with similar S-type chemical characteristics consistent with those of volcanic-arc to syn-collision granites, formed in association with slab breakoff. [Oral presentation]

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

A preliminary assessment of physical characteristics of a jasper pebble conglomerate deposited during the Great Oxidation Event

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A jasper pebble conglomerate, colloquially referred to as "puddingstone", of the Lorrain Formation of the ca. 2.45–2.22 Ga Huronian Supergroup, Ontario and Québec, is composed of a white, coarse, quartz-rich matrix and varicoloured, angular to rounded, poorly-sorted pebbles of red jasper, other chert varieties, vein quartz, and finer-grained siliciclastic rock fragments, all typically around 2 to 3 cm in length. The Lorrain Formation has geological significance as the oldest sequence on Earth hosting continental (fluvial) red beds (clastic deposits reddened by

the presence of hematite), widely regarded as evidence for the development of newly oxidative surface weathering/ diagenesis conditions during Earth's Great Oxidation Event (GOE). While studies have analyzed the sedi-mentological framework of this conglomerate's fluvial depositional environment, as well as stratigraphic changes in clast types and proportions at several localities near Bruce Mines (Ontario), questions have recently been raised regarding initial interpretations of the provenance of the clasts. In particular, jasper, jaspillite, and banded chert clasts have long been hypothesized to be derived from Archean iron formations (IF). However, several characteristics of the clasts, including their angularity, lack of magnetite (a common mineral in Archean IF), and other unusual granular (possibly oolitic) textures were noted to be unlike the documented Archean sources relatively distal to the conglomerate. It is thus a possibility that the clasts were sourced from locally reworked Paleoproterozoic deposits, which, if substantiated, indicates that individual clasts could reveal new insights into the surface environment and sedimentary processes during the GOE. A more detailed clast-specific analysis of the "puddingstone" with modern mineralogical and geochemical tools is needed to address unknown aspects of the clast sources and surface depositional environment. This study will describe different populations of the conglomerate clasts, identify clasts and matrix for more detailed petrographic and microscopic analysis (e.g., to undertake modal mineralogy, accessory mineral identification, and examine micro-scale textures such as grain overgrowths and recrystallization), and physically extract a subset of clasts for lithogeochemical analysis. This specific contribution will focus on preliminary observations of clast types, textures, and selected aspects of the matrix and clast accessory mineralogy. Future aspects of the study will more closely examine clast geochemistry with the aim to link clast physical and compositional characteristics and compare signatures to published data from possible source rocks (i.e., nearby Archean IF and other siliciclastic rocks from the Huronian Supergroup). [Poster presentation]

