The Atlantic Geoscience Society (AGS)
La Société Géoscientifique de l'Atlantique

47th Colloquium and Annual Meeting

Special Sessions:

- Sedimentological and Paleontological Investigations from the Onshore and Offshore Realms
- Defining the controls on onshore and offshore Pliocene-Quaternary processes
- Developments in Geoscience Education
- Developments in Mineral Resources research in the northern Appalachians
- Karst Research in Atlantic Canada

General Sessions:
Current Research in the Atlantic Provinces

5-6 February, 2021
Online

PROGRAM WITH ABSTRACTS

We gratefully acknowledge sponsorship from the following companies and organizations:

Department of Energy and Resource Development

Department of Energy and Mines:
Geological Survey Division
Petroleum Resources Branch

We are pleased you are able to attend the 47th Colloquium and Annual Meeting of the Atlantic Geoscience Society. The AGS community has risen to the challenge to mount an excellent conference like no other in these unprecedented times (how many more clichés can I squeeze in there?)

We will be hosting online up to three simultaneous sessions, with topics all across the geoscience spectrum. We thank all who have submitted posters and papers as well as the session organizers and the organizers of the three short course and workshop events associated with the Colloquium. On Saturday the Society will conduct its annual general meeting and elect its new council. True to form, the 22 volunteers have stepped up to constitute the council for the upcoming year. AGS never seems to want for eager contributors, whether it be scientific or service. In this volume you will find reports of the activity of the Society over the past year.

Participants probably noticed that registration for this year's meeting is much reduced, because we are not able to meet in person in a regional hotel. Our benefit is, however, a loss to our usual hosting facilities, so why not commit to enjoying their hospitality as soon as it is safe to do so.

We hope you will be able to use the weekend to renew old acquaintances, make new ones, and further the aims of your Atlantic Geoscience Society.

The organizers: Donnelly Archibald, Rob Raeside, Chris White

ATLANTIC GEOSCIENCE SOCIETY
47th COLLOQUIUM AND ANNUAL GENERAL MEETING
5-6 February, 2021, online

PROGRAM SUMMARY

Monday, 1st February 2021
3.00 – 4.30 p.m. AGS Council meeting (MS-Teams)

Friday, 5th February 2021
9.00 – 4.00 p.m. Short Course: Applications of GIS (Geographical Information Systems) to Earth Science" - Robin Adair, P.Geo.
1.00 – 5.00 p.m. Workshop: Looking to the Future; Equity, Diversity, and Inclusion as a way of being in our discipline - Anne-Marie Ryan (Dalhousie University) and Deanne van Rooyen (Cape Breton University)
7.00 – 9.00 p.m. Developments in Mineral Resource Research in the Northern Appalachians, Pitcher Room
7.20 – 8.40 p.m. Karst Research in Atlantic Canada, Mayflower Room
8.40 – 10.00 p.m. Poster Session

Saturday, 6th February, 2021
8.00 – 10.20 a.m. General Session: Mineralogy, Petrology and Structural Geology, Violet Room
8.20 – 10.20 a.m. Sedimentological and Paleontological Investigations from the Onshore and Offshore Realms, Mayflower Room
9.00 – 10.20 a.m. Developments in Mineral Resource research in the northern Appalachians, Pitcher Room
10.20 – 10.40 a.m. Refreshment break
10.40 – 12.00 noon Developments in Geoscience Education, Mayflower Room
10.40 – 12.00 noon Defining the Controls on Onshore and Offshore Pliocene-Quaternary Processes, Violet Room
11.00 – 12.00 noon Developments in Mineral Resource Research in the Northern Appalachians, Pitcher Room

12.30 p.m. – 1.30 p.m. Annual General Meeting, Pitcher Room

2.00 – 3.40 p.m. Defining the Controls on Onshore and Offshore Pliocene-Quaternary Processes, Violet Room
2.00 – 4.00 p.m. General Session: Geophysics and Environmental Geoscience, Mayflower Room
2.20 – 4.00 p.m. Developments in Mineral Resource research in the northern Appalachians, Pitcher Room
4.00 – 5.00 p.m. Judges' convention, Violet Room

7.00 p.m. Awards banquet – Dress up your table, find a great geo-background for your Zoom link, and beam in for the announcements of the winners of the student poster and paper awards, the Nelly Koziel Award, the Laing Ferguson Distinguished Service Award, and the Gesner Medal.

Saturday, 13th February 2021
9.00 – 5.00 p.m. Short course: QAQC Methods in Geochemical Research and Mineral Exploration, with a Focus on Gold Assay Quality Control" – Cliff Stanley, Ph.D., P.Geo. FCG.

PROGRAM AT A GLANCE

	Pitcher Room	Mayflower Room	Violet Room
Friday 7 – 10 p.m.	Developments in Mineral Resource research in the northern Appalachians *Kevin Neyedley, Mitch Kerr, Aaron Bustard* (5 papers)	Karst Research in Atlantic Canada *Mo Snyder, Amy Tizzard, Tim Fedak* (5 papers)	Poster presentations (8.40 – 10.00 p.m.)
Saturday 8.00 – 10.20 a.m.	Developments in Mineral Resource research in the northern Appalachians *Kevin Neyedley, Mitch Kerr, Aaron Bustard* (4 papers)	Sedimentological and Paleontological Investigations from the Onshore and Offshore Realms *Nikole Bingham-Koslowski, Lynn Dafoe* (6 papers)	General Session: Mineralogy, Igneous and Metamorphic Geology, Structural Geology (5 papers)
Saturday 10.40 – 12.00 noon	Developments in Mineral Resource research in the northern Appalachians *Kevin Neyedley, Mitch Kerr, Aaron Bustard* (3 papers)	Developments in Geoscience Education *Tracy Webb* (4 papers)	Defining the controls on onshore and offshore Pliocene-Quaternary processes *John Gosse, David Piper, Ned King* (4 papers)
Saturday 12.30 – 1.30 p.m.	Atlantic Geoscience Society Annual General Meeting		
Saturday 2.00 – 3.40 p.m.	Developments in Mineral Resource research in the northern Appalachians *Kevin Neyedley, Mitch Kerr, Aaron Bustard* (5 papers)	General session: Environmental Science and Geophysics (6 papers)	Defining the controls on onshore and offshore Pliocene-Quaternary processes *John Gosse, David Piper, Ned King* (5 papers)
Saturday 7.00 p.m.	**Awards Banquet**		

TECHNICAL PROGRAM

Posters

Sessions: Friday, 7th February, 8.40 – 10.00 p.m.; others by individual arrangement

Posters presenters should be prepared to enter a break-out group in the Violet Room during scheduled hours.

Student presentations (all student presenters are eligible for a best poster award. The Graham Williams Award for Best Student Poster will be awarded to the best poster by a graduate student, the Rob Raeside Award for the best poster by an undergraduate student.)

* = graduate student; ** = undergraduate student

Sedimentological and Paleontological Investigations form the Onshore and Offshore Realms

***Narges Ahangarian, J. Bentley, A MacDonald, M Fowler, C Campbell, C Hubert, GT Ventura** Lipidomic environmental ocean sediment baseline survey of Scotian Slope

***Anirban Chowdhury, E Lalk, S Ono, MJ Kerr, J Bentley, A MacDonald, MG Fowler, C Hubert, GT Ventura** Is methane clumped isotopologue the future offshore exploration tool?

***John Dooma, K Azmy, A Chowdhury, GT Ventura** Hydrocarbon fingerprinting of Cambrian-Ordovician sedimentary rocks in eastern Laurentia (western Newfoundland, Canada): organic geochemical approach to palaeo-environmental investigation

Developments in Mineral Resources Research in the Northern Appalachians

***Alan Cardenas, D Lentz, C McFarlane, K Thorne** Gold mineralization at the Cape Spencer area, New Brunswick – Project update

Ayalew L Gebru The geological setting and Pb- and S-isotopic signature of the base metal mineralization at the Lumsden polymetallic deposit, southeastern New Brunswick

****Moya MacDonald, D Lentz, A Cardenas, K Thorne** Epithermal gold mineralization and associated alteration at the Golden Ridge Deposit, Poplar Mountain Volcanic Complex, southwestern New Brunswick: analysis of the role of pyrite and arsenopyrite during mineralization

****Jessica Patterson, D Gregory, Bernd Milkereit** Solving the structural puzzle: A 3D model of the Nash Creek deposit, New Brunswick

General Session

****Nikita Lakhanpal, E Redshaw, J Dooma, JN Bentley, M Pasterski, F Kenig, GT Ventura** Survey of potential syngenetic occurrences of archaeal lipid biphytanes in lower greenschist, Late Archean (2.65 Ga) metamorphosed argillites of the Abitibi Subprovince, Timmins, Ontario, Canada

***Gamra Oueslati** Organic geochemical water column survey of the Labrador Sea

****Margaret Scott, AJ Anderson, MA Wise** Conditions of pocket formation in Zapot pegmatite, Gillis Range, Nevada

Oral Presentations:

All undergraduate student presenters are eligible for the Rupert MacNeill Award for the best undergraduate student oral presentation and graduate students for the Sandra Barr Award for the best graduate student oral presentation. **Undergraduate Student Presenter; *Graduate Student Presenter.

Friday evening, 7.00 – 9.40 p.m., Pitcher Room

Developments in Mineral Resource Research in the Northern Appalachians

Host: Kevin Neyedley

7.00-7.40 Keynote Address: John F. Slack Potential for critical mineral deposits in Maine with applications to the Maritimes

7.40-8.00 Alan J Anderson, Tanja Knoll and Ralf Schuster The temporal relationship between two LCT pegmatites and the Streaked Mountain pegmatitic granite, Oxford County, Maine

8.00-8.20 *Luke Bickerton, Daniel J Kontak, Iain M Samson, J Brendan Murphy, Dawn Kellett, Greg Dunning and Richard Stern Constraints on the emplacement of the South Mountain Batholith using zircon petrochronology and implications for Sn-W metallogeny in the northern Appalachians

8.20-8.40 Jacob Hanley, Travis Kendall and Brandon Boucher Characterizing the mineral domains of Li-(Rb-Cs) enrichment at the East Kemptville Sn-(Cu-Zn-Ag) deposit, Nova Scotia, Canada

8.40-9.00 *Bryan Maciag, James M Brenan and Jacob Hanley Variation in the major and trace element geochemistry of biotite and apatite from the South Mountain Batholith, Nova Scotia

Friday evening, 7.20 – 8.40 p.m., Mayflower Room

Karst research in Atlantic Canada

Host: Mo Snyder

7.20-7.40 Fred Baechler and Lynn Baechler Karst hydrogeology of the basal Windsor limestone at Glen Morrison Cape Breton: preliminary findings

7.40-8.00 Ronnie Van Dommelen, Mitchell MacInnis, Derek Inglis and Gareth Hoar A Global Navigation Satellite System (GNSS) system for monitoring ground movement

8.00-8.20 Amy Tizzard and Peter Horne The Disappearance of Slade Lake, Cumberland County, Nova Scotia

8.20-8.40 Tim Fedak Reviewing 200 years of Nova Scotia geology: gypsum caves and mastodon sinkholes

Saturday morning, 8.00 a.m. – 12.00 noon, Pitcher Room

Developments in Mineral Resource Research in the Northern Appalachians

Host: Mitch Kerr

9.00-9.20 Aaron L Bustard, David R Lentz and James A Walker Geochemical evaluation of mineralization and igneous activity in the vicinity of the Elmtree deposit, northeastern New Brunswick

9.20-9.40 Dustin RL Dahn, Aaron L Bustard, Anna Terekhova and Jacob Hanley Structural, petrographic, and lithogeochemical analysis of the vein-hosted Williams Brook South gold occurrence, north-central New Brunswick

9.40-10.00 *Hassan Heidarian, David R. Lentz, Christopher RM McFarland and Kathleen Thorne U-Pb geochronologic and mineral-chemical results from apatite and titanite in the Clarence Stream gold-antimony deposit, southwestern New Brunswick, Canada

10.00-10.20 *A Furlan, H Ugalde, A Ondercova and B Milkereit 3D modelling & synthesis of geophysical data in Nash Creek, New Brunswick, Canada

---break---

11.00-11.20 Stephen J Piercey, Stephanie Brueckner, David Copeland, Graham D Layne, Maciej Pawlukeiwicz, Jean-Luc Pilote and Samuel Ybarra Contrasting gold-bearing volcanogenic massive sulfide (VMS) and orogenic gold deposits in the Baie Verte Peninsula, NL Appalachians

11.20-11.40 **Marie Flanagan and Alison Leitch Finding fault in a shear zone

11.40-12.00 Fergus Tweedale, Charles Banks and Ian Scanlon Field and petrographic reports on mineral exploration at Castle Frederick

Saturday morning, 8.20 – 10.20 a.m., Mayflower Room

Sedimentological and Paleontological Investigations from the Onshore and Offshore Realms

Host: Nikole Bingham-Koslowski

8.20-8.40 David Lowe, RWC Arnott, Edward DeSantis and James Conliffe Groundwater silcrete in the Potsdam Group, Ottawa Graben: A case example of shallow fault-controlled silicification and desilicification in a tectonically active basin**.**

8.40-9.00 Nikole Bingham-Koslowski, Melissa Grey, James M Ehrman and Peir Pufahl Investigating the relationship between the elemental composition of coprolites and trophic level: a brief digest of Late Carboniferous coprolites from the Joggins Formation

9.00-9.20 Ricardo L Silva, Micha Ruhl, Cillian Barry, Matías Reolid, Wolfgang Ruebsam Pacing of Late Pliensbachian and Early Toarcian carbon cycle perturbations and environmental change in the westernmost Tethys (Betic Cordillera, Spain)

9.20-9.40 Ricardo L Silva, Grant Wach, Steven P Hesselbo, Micha Ruhl, Darragh O'Connor Integrating coastal environments into our understanding of Early Cretaceous carbon cycle perturbations and oceanic anoxic events (OAEs)

9.40-10.00 Lynn T Dafoe and Graham L Williams An integrated paleoenvironmental study of Lower Cretaceous to lower Cenozoic strata of the Labrador margin, offshore eastern Canada

10.00-10.20 *Kenneth T Martins-Yellowe, Grant D Wach, Frank W Richards and Neil Watson Crestal faulting: a source of trap integrity loss and gas migration in the Migrant Structure, Sable Delta, Offshore Nova Scotia

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Saturday morning, 10.40 – 12.00 noon, Mayflower Room

Developments in Geoscience Education

Host: Jason Loxton

10.40-11.00 Howard Donohoe, Regan Maloney and Danielle Serratos Empowering citizen science and earth science literacy

11.00-11.20 Mike Finn, Chau Huynh, Jeff Calvert and Devita Naidu The CSEG Foundation Outreach Programs: another approach to enhancing effective learning

11.20-11.40 Rilea Kynock Public opportunities to discover geoscience in industry from historic and modern mining practices through the partnership of Atlantic Gold and the Moose River Gold Mines Museum in Middle Musquodoboit, Nova Scotia

11.40-12.00 Jason Loxton Digital specimens as a substitute for the real thing in an introductory geology lab: a real world trial

Saturday morning, 8.00 – 10.20 a.m., Violet Room

General Session: Mineralogy, Petrology and Structural Geology

Host: Robin Adair

8.00-8.20 **Bailey Milos and Yana Fedortchuk Experimental study of the formation conditions of trigonal etch pits on diamonds

8.20-8.40 *Robin Adair, David R Lentz and Christopher RM McFarlane Insights into complex titanian andradite crystal growth using micrometre GIS and 3D GIS applied to EPMA, µXRF, and petrography

8.40-9.00 *Natashia Drage and James Brenan An experimental study of the effect of pressure on the formation of chromite deposits

9.00-9.20 **Jessica Danielle Albert and Alexandra Arnott Study of silica-under saturated dykes of the Bermuda basement

9.20-9.40 *Caleb J Grant, Sandra M Barr, Donnelly B Archibald and Deanne van Rooyen Petrological and U-Pb zircon age constraints for metamorphic rocks of the northeastern Cape Breton Highlands, Nova Scotia: New insights into the geological history of the Aspy terrane

9.40-10.00 Adrian F Park, Steven J Hinds and Susan C Johnson The Belleisle Fault at Beaver Harbour, New Brunswick: where is it, what is it and when (and how) did it move?

10.00-10.20 John WF Waldron, Sandra M Barr, Phil JA McCausland, David I Schofield, L Wu, D Reusch Kinematic models for the northern Appalachians and Caledonides

---break---

Saturday morning, 10.40 – 12.00 noon, Violet Room

Defining the Controls on Onshore and Offshore Pliocene-Quaternary processes

Host: John Gosse

10.40-11.00 Gordon DM Cameron and Edward L King Seabed evidence for a paleo-ice shelf along the Newfoundland and Labrador continental margins

11.00-11.20 David Piper Relating thick proglacial mud successions to processes at ice-stream margins: a tool for dating ice advances

11.20-11.40 David C Mosher and Gonzalos Yanez-Carrizo The elusive Continental Rise: Insights from residual bathymetry analysis of the Northwest Atlantic Margin

11.40-12.00 Edward L King and Sydney Stashin Large scale Late Cenozoic to post-glacial growth faulting in the northern sector of the Banks-Beaufort Basin, western Canadian Arctic

----- AGM in Pitcher Room 12.30 – 1.30 p.m.-----

Saturday afternoon, 2.00 p.m. – 3.40 noon, Pitcher Room

Developments in Mineral Resource Research in the Northern Appalachians

Host: Aaron Bustard

2.00-2.20 **Joshua Jackman, N. Welt, E Adlakha, J Hanley, M Kerr, N Kennedy and G Baldwin Quartz-hosted fluid inclusions associated with polymetallic mineralization (Fe-Co-Ni-Cu-As-Ag-Sb-Au-Pb), of the Nictaux Falls Dam, Lansdowne, and Cape Saint Mary's occurrences in the Meguma Terrane, Nova Scotia

2.20-2.40 *Naomi Welt, Joshua Jackman, Erin Adlakha, Natalie McNeil, Jacob Hanley, Mitchell Kerr and Geoff Baldwin Characterization of polymetallic vein-type Meguma Au deposits: Meguma's lesser known Au deposit type

2.40-3.00 *Marko Szmihelsky, Stephen Piercey, David Copeland and Tanya Tettelaar Wallrock alteration and gold-bearing vein paragenesis of a Meguma-hosted gold deposit: Goldboro, Nova Scotia

3.00-3.20 Mitchell Kerr, Jacob Hanley and Daniel Kontak Application of bulk fluid volatile chemistry to exploration for metasedimentary rock-hosted orogenic gold deposits: An example from the Meguma terrane, Nova Scotia, Canada

3.20-3.40 Daniel J Kontak Microscopic insight into a Meguma gold deposit setting: Nature of arsenopyrite beds at The Ovens

Saturday afternoon, 2.00 – 3.40 p.m., Mayflower Room
General Session: Geophysics and Environmental Geoscience
Host: Rob Raeside

2.00-2.20 **Sarah Green and Alison Leitch One city's trash is a geophysics student's treasure

2.20-2.40 Alison Leitch, Jiangguang Chen, Elliott Burden and Haranur Rashid A Tale of Two Ponds

2.40-3.00 *Tayfun Turanli and Alison Leitch Analysis of Vertical Electrical Sounding (VES) data over a prospective geothermal area in Turkey

3.00-3.20 **Madison Matthews and Anne Marie Ryan The relationship between selected metal content of Nova Scotia soils and the underlying geology: Possible implications for public Health

3.20-3.40 **Anna Ryan and Markus Kienast Constraining the effect of a weakening Atlantic Meridional Overturning Circulation on ocean temperatures in the Gulf of St. Lawrence over the past 150 years

Saturday afternoon, 2.00 – 3.40 p.m., Violet Room
Defining the Controls on Onshore and Offshore Pliocene-Quaternary processes
Host: John Gosse

2.00-2.20 *Philip Sedore, Alexandre Normandeau and Vittorio Maselli Investigating the controls of submarine landslides and associated hazards in Pangnirtung Fiord, Eastern Baffin Island (Nunavut)

2.20-2.40 ** Michael J Kishchuk, Panya S Lipovsky, Jeffrey D Bond and John C Gosse Investigation of geological controls on radon concentration in surficial sediment in Whitehorse, Yukon

2.40-3.00 *Cody Paige, John Gosse, Lukas Wacker, Eric Kirby, Eric McDonald, Annina Margreth, and Nathaniel Lifton Combined soils and in situ ^{14}C approach to evaluate erosion of non-lithified landforms

3.00-3.20 Sophie L Norris, Matthew C Drew, Julia Fast and John C Gosse Quaternary glacial erosion: a global review of process, measurement and rate

3.20-3.40 John C Gosse, Sydney Stashin and Neil Davies Advances in the chronostratigraphy of the Beaufort Formation, Arctic Canada

ABSTRACTS

† a poster presentation * a graduate student paper **an undergraduate student paper

Insights into complex titanian andradite crystal growth using micrometre GIS and 3D GIS applied to EPMA, µXRF, and petrography

*ROBIN ADAIR, DAVID R. LENTZ, AND CHRIS R.M. MCFARLANE
Department of Earth Sciences, University of New Brunswick, Fredericton, NB E3B 5A3, Canada
<Robin.adair@unb.ca>

Crystal growth mechanisms are investigated using EPMA, µXRF, and petrology on a euhedral andradite crystal from the Crowsnest Formation in southwestern Alberta. A micrometre scale, non-earth geographical reference system is used to combine these datasets. In two dimensions, this approach enhances interpretation of chemical, physical, and crystallostratigraphic relationships that are demonstrated by crystal growth patterns and that define growth domains of unique character. Using an idealized three-dimensional model of a euhedral garnet exhibiting {110} faces, a 3D-GIS analysis can also be performed to investigate these various characteristics in 3D space within the crystal. A basal section created in the plane of two crystallographic axes was cut in a sample garnet measuring 0.44 centimetres across. This plane cuts at or near the nucleation point of the crystal. Datasets from the above analyses that include graphic as well as numerical point data were combined to map the growth history of the garnet.

Three domains of crystal growth are defined. An initially formed core crystal, a first regrowth rim (RR1) and a second regrowth rim (RR2) with a coupled dissolution-reprecipitation (CDRP) boundary between RR1 and RR2. The core and the second regrowth domains exhibit rhythmic zonation in Ti, Fe, V, Al, Mn, and Zr. All three domains can be defined on mean weight percent TiO_2 as follows: 1) core – 4.58%, 2) RR1 – 3.31%, and 3) RR2 – 4.10%. The core garnet exhibits marked titanium enrichment towards its original rim, culminating in a symmetrical spike high in the 6.6 weight percent TiO_2 range. Initial multivariant analyses demonstrates positive correlation between MgO and TiO_2 and negative correlation between TiO_2 and SiO_2 in all domains. Calculated garnet compositions (mol%) from EPMA are andradite (mean = 68.1%), morimotoite (mean = 16.6%), grossular (mean = 5.6%), and schorlomite-*Al* (mean = 5.15%). Titanium content can be shown to dictate the relative andradite versus morimotoite/schorlomite-*Al* compositions with negative and positive correlations, respectively. This suggests a proxy for silica saturation.

Demonstrated is that a euhedral garnet was initially formed with sharply increased TiO_2 content towards its rim and it did not undergo resorption. Regrowth followed by a somewhat TiO_2 depleted magma that was interrupted by a period of resorption (CDRP). Continued regrowth followed to form the final euhedral crystal shape. The later period of regrowth on the original garnet occurred in a crystallographic orientation that was both tilted and rotated, each at roughly 45°, from the original, and initially formed, core crystal.

† *Environmental lipidomic baseline survey of the Scotian Margin

NARGES AHANGARIAN[1], JEREMY N. BENTLEY[1], ADAM MACDONALD[2], MARTIN FOWLER[3], CALVIN CAMPBELL[4], CASEY HUBERT[5] AND G. TODD VENTURA[1]

1. Department of Applied Science, Faculty of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada <Narges.Ahangarian@smu.ca> 2. Nova Scotia Department of Energy and Mines, 1690 Hollis St., Halifax, Nova Scotia B3J 3J9, Canada. 3. Applied Petroleum Technology Ltd., Calgary, Suite 400 119 - 14th Street NW, Calgary, Alberta T2N 1Z6, Canada. 4. Geological Survey of Canada-

Atlantic, Lands and Minerals Sector, Natural Resources Canada, Dartmouth, NS B2Y 4A.2 5. Department of Biological Sciences, University of Calgary, Calgary, AB, T2N 1N4, Canada

The natural microbial community composition of ocean floor sediments for the Scotian Margin has yet to be fully resolved. Such an environmental baseline study can be conducted by genomic and lipidomic surveys of sediments collected from the ocean floor. For this investigation, we are applying lipidomic techniques to resolve the microbial cellular membranes of bacteria and archaea that are hosted in the upper 10 m of ocean floor sediments across the Scotian Margin. The Scotian Margin off the coast of Nova Scotia is ~500 km in length and descends down to 4,000 m water depth. It is dominated by a series of anastomosing sub-basins that are themselves stratigraphically disrupted by salt tectonic features. Some of the basin sedimentation has resulted in active petroleum systems, which are expressed at the ocean seafloor as active hydrocarbon seeps. These seeps may host unique microbial communities that will be offset from the background microbiological ecology. We are extracting the intact polar lipids and core lipids using high resolution, ultra-high performance liquid chromatography-quadrupole time of flight mass spectrometry (UHPLC-qToF-MS). It is hypothesized that seep associated microbes may be dependent on the natural occurrence of hydrocarbon thus having a distinct lipid diversity. We therefore aim to use this environmental baseline survey to help differentiate the microbial community composition of ambient sediments from those that have been impacted by hydrocarbon seepage. Thus far, we have processed ~50 samples from various gravity and piston core samples that were collected across the Scotian Margin. Ultimately, the results of this study will provide a lipid diversity map of Scotian Margin, which contains information about the geochemical environmental conditions of the subsurface sediments, taxonomy and metabolism of microorganisms, and improves the resolution of their activities.

**Study of silica-undersaturated dykes of the Bermuda basement

JESSICA DANIELLE ALBERT[1] AND ALEXANDRA ARNOTT[2]
1. Department of Earth and Environmental Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada <Jessica.D.Albert@gmail.com> 2. Department of Earth and Environmental Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada

The Bermuda Islands are comprised of 181 carbonate islands on volcanic basement rocks of the Bermuda Rise. Two deep drill cores extracted from the islands show the islands are capped with thick limestone concealing the igneous basement rocks. The Bermuda Rise is significantly above sea-level indicating smaller rates of subsidence in comparison to other Atlantic seamounts, due to further magmatic activity after its original formation. It has been determined from the drill cores that the basement consists of two distinct igneous rock types that are chemically and texturally distinct. The volcanic flows (100 Ma) show classic mid-ocean ridge (MOR) basalt textures and mineralogy of pyroxene, plagioclase and altered olivine and have been determined to have erupted at the MOR. The plutonic rocks observed in the two cores are silica-undersaturated ultramafic sheeted dykes (30 Ma) and are metasomatized. The intrusions are characterized by phenocrysts of olivine altered to hydrous iron-magnesium silicates, chemically and optically zoned clinopyroxene with smaller phenocrysts of melilite, phlogopite, and secondary minerals. The groundmass consists of clinopyroxene, biotite, melilite, oxides, and apatite. The groundmass is more altered than the phenocrysts. The preliminary petrography and mineral chemistry suggest that the intrusions are ultramafic lamprophyres. The clinopyroxenes found in the ultramafic lamprophyres have chemical zoning with areas of high Mg, Al, and Ti concentrations. Therefore, analyzing the pyroxene chemistry will allow an understanding of the emplacement and origin of melt.

The temporal relationship between two LCT pegmatites and the Streaked Mountain pegmatitic granite, Oxford County, Maine.

ALAN J. ANDERSON[1], TANJA KNOLL[2] AND RALF SCHUSTER[2]
1. Department of Earth Sciences, St. Francis Xavier University, Antigonish, Nova Scotia B2G 2W5,Canada <aanderso@stfx.ca> 2. Department of Geology, Geologische Bundesanstalt / Geological Survey of Austria, Neulinggasse 38, 1030 Vienna, Austria

Precise age constraints on magmatic and regional tectono-thermal events are essential for elucidating the petrogenesis of mineralized granitic pegmatites. Geochronological studies of granitic rocks in southwestern Maine, report ages of 267.6 ± 7.9 Ma and 270.4 ± 8.1 Ma (U-Pb apatite) for the Mount Mica and Emmons pegmatites, respectively, 283 ± 32 Ma (U-Pb zircon) for the Streak Mountain pegmatitic granite, and 293 ± 2 Ma (U-Pb monazite) for the Sebago granite pluton. Previous workers have suggested that lithium-cesium-tantalum (LCT) type pegmatites in the region were derived from spatially associated pegmatitic leucogranite stocks, such as the beryl-bearing Streaked Mountain granite. However, large uncertainty in the U-rich zircon age of the Streaked Mountain granite does not provide unambiguous support for this hypothesis.

In order to better constrain the temporal relationship between the Streak Mountain pegmatitic granite and the spatially associated LCT pegmatites, we determined the age of the granite by the Sm-Nd isochron method using garnet and tourmaline separates. Our new Sm-Nd age of 287.9 ± 5.5 Ma indicates that crystallization occurred between 10 and 20 Ma before emplacement of the Mount Mica and Emmons pegmatites. It is therefore improbable that the Mount Mica pegmatite is the product a residual liquid derived from the Streaked Mountain stock. This result demonstrates the need for more widespread Sm-Nd dating of simple and geochemically evolved granites and pegmatites in the region in order to understand the derivation and evolution of LCT pegmatite groups.

Karst hydrogeology of the basal Windsor limestone at Glen Morrison Cape Breton: preliminary findings

FRED BAECHLER[1] AND LYNN BAECHLER
1. EXP Services Inc., 301 Alexandra Street, Sydney, Nova Scotia B1P 6R7, Canada <fred.baechler@exp.com>

Quarrying of the basal Windsor limestone 18 km southwest of Sydney, Cape Breton has been on-going since 1993, exposing 10 hectares along 750 m of strike. This basal limestone has been referred to as either the Glen Morrison or Maccumber Brook Formation. It dips to the northeast at 5 to 10 degrees with an apparent thickness up to 15 m. It is underlain by conglomerates of the Grantmire Formation of the Horton Group and overlain by shales of the Sydney River Formation of the Windsor group. Geological assessments, visual observations and environmental monitoring over 27 years of operation have identified a wide variety of micro and macro karst features exposed over 250 m of subcrop width, in up to 20 m high quarry walls. These include paleo epikarst features over the top 1 to 5 meters of the subcrop surface, including a variety of, as well as rapid transition between, karren features including pit and tunnel, clint-and-grike, splitkarren, rundkarren, dolines, and possible Carboniferous paleokarst. At depth features include schlottenkarren chimneys, solution walls following vertical jointing, solution along sub-horizontal exfoliation planes, and horizontal caves along the contact with the Horton conglomerate. However, these have been rendered essentially hydraulically inactive, having been infilled with glacial till, which forms an up to 8 m thick cap over the subcrop. This suggests well developed karst prior to Wisconsinan glaciation and perhaps earlier. Glacial overburden becomes thin and discontinuous along strike to both the east and west of the quarry. The resultant exposed karst pavement exhibits boulder fields, hydraulically active runnels, clint and grike, and nine springs ranging in Meinzer flow categories

from 4 to 8. Also present are three 5 to 8 m deep trenches carved into the limestone outcrop, trending northeast-southwest at right angles to strike. Ground surface water interaction within the trenches create influent streams, periodically dry river beds, a blind valley and swallet. The swallet can accept flows up to at least 3400 USgpm. Dye testing noted groundwater flow did not follow northeast trend of the trenches but instead was directed north along the master joint set, down both structural dip and topographic gradient. Velocities of 120 m per hour were recorded during a 40 mm rainfall event.

*Constraints on the emplacement of the South Mountain Batholith using zircon petrochronology and implications for Sn-W metallogeny in the northern Appalachians

LUKE BICKERTON[1], DANIEL J. KONTAK[1], IAIN M. SAMSON[2,1], J. BRENDAN MURPHY[3], DAWN KELLETT[4], GREG DUNNING[5], AND RICHARD STERN[6]

1. Harquail School of Earth Sciences, Laurentian University, Sudbury, Ontario P3E 2C6, Canada <lbickerton@laurentian.ca> 2. School of the Environment, University of Windsor, Windsor, Ontario N9B 3P4, Canada. 3. Department of Earth Sciences, St. Francis Xavier University, Antigonish, Nova Scotia B2G 2W5, Canada. 4. Geological Survey of Canada, 1 Challenger Drive, Dartmouth, Nova Scotia B2Y 4A2. 5. Department of Earth Sciences, Memorial University, St. John's, Newfoundland A1B 3X5, Canada. 6. Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2R3, Canada

A variety of sources have been proposed for the causative magmas related to Sn-W deposits, including deep metasomatized mantle and enriched supracrustal sequences, the latter relating to anatexis or contamination. Such magmas typically form multi-stage intrusive complexes and the associated Sn deposits form in multiples. Here we explore aspects of Sn metallogeny in the northern Appalachians through a study of the South Mountain Batholith (SMB, Nova Scotia). This multi-phase batholith hosts numerous polymetallic (Sn, W, Mo, Cu, Ta, Nb, Zn) occurrences; however, the only significant Sn(-Zn-Cu-Ag-In) deposit is at East Kemptville (EK) in the Davis Lake pluton (DLP). Timing of emplacement and the nature of magma sources is assessed via U-Pb dating, REE chemistry and isotopic (Lu-Hf, $\delta^{18}O$) characterisation of zircon samples from across the SMB.

CA-TIMS zircon dates indicate a transition from less-evolved granodiorite (378.7 ± 1.2 to 375.4 ± 0.8 Ma) to more evolved leucogranite (375.4 to 370.8 ± 0.8 Ma), reflecting ~10-15 m.y. of magmatic activity. In situ SHRIMP, LA-MC-ICP-MS, and SIMS analyses of distinct CL-defined zircon domains reveal: 1) autocrysts with ages coincident with the CA-TIMS results and $\delta^{18}O$ between +7.3 and +9.1 ‰ (V-SMOW), but the DLP is distinctly younger (365.3 ± 2.3 to 362.2 ± 3.4 Ma); 2) the $\delta^{18}O$ for antecrystic domains (+7.1 and +8.9 ‰) are similar to autocrystic rims, but generally record crystallization ages 3–15 Ma older than the autocrysts; 3) abundant xenocrystic cores of varied ages (~420 Ma to 2.2 Ga) with distinct chemical and isotopic signatures; 4) zircon REE patterns and derived fO_2 values are similar across the SMB; and (5) the εHf signature in zircon autocrysts from the EK host pluton is higher (+1.74 to +4.38) than from the rest of the SMB (-2.99 to +1.68).

These new data suggest the following in regards to the SMB: 1) its construction occurred over a protracted interval spanning 15-20 m.y.; 2) variation in its zircon $\delta^{18}O$ and εHf values suggests that a mantle source with elevated $\delta^{18}O$ and εHf values influenced its original melt; 3) contamination of the melt via assimilation of the Meguma Supergroup country rocks was widespread; and 4) the DLP represents a separate magmatic phase distinct petrogenetically from the rest of the SMB. These data strongly suggest that Sn in the DLP and thus the EK deposit was likely introduced during a magmatic process distinct from that which formed the rest of the SMB.

Investigating the relationship between the elemental composition of coprolites and trophic level: a brief digest of Late Carboniferous coprolites from the Joggins Formation

NIKOLE BINGHAM-KOSLOWSKI[1], MELISSA GREY[2], JAMES M. EHRMAN[3] AND PEIR PUFAHL[4]
1. Geological Survey of Canada (Central), Ottawa, Ontario K1A 0E8, Canada <nikole.bingham-koslowski@canada.ca 2. Department of Biology, Mount Allison University, Sackville, New Brunswick E4L 1G7 Canada 3. Digital Microscopy Facility, Mount Allison University, Sackville, New Brunswick E4L 1G7, Canada 4. Department of Geological Sciences and Geological Engineering, Queen's University, Kingston, Ontario K7L 3N6, Canada

Coprolites offer insights into the diets of the animals that produced them, and thereby also provide a unique perspective of the paleoenvironments and paleoecosystems that existed during their deposition. Late Carboniferous fish coprolites are abundant in the Joggins Formation at the Joggins Fossil Cliffs UNESCO World Heritage Site (Joggins, Nova Scotia, Canada) and offer an opportunity to study the lesser-understood aquatic realm. The research presented here builds on a previous study that used hand samples and thin sections to classify coprolites into six morphotypes (conical, cylindrical, irregular, large, small, and spiral). Collectively, these morphotypes were interpreted to represent four trophic levels, and used to create a theoretical trophic pyramid for the Late Carboniferous aquatic realm at Joggins. This study hypothesizes that coprolites of differing trophic levels should show discrepancies in elemental composition due to dissimilar dietary requirements. If this hypothesis proves correct, chemical analyses of coprolites and the substrates in which they are found could provide valuable paleoenvironmental information and assist with the reconstruction of paleoecosystems and food webs throughout geological history.

Scanning electron microscopy – energy dispersive x-ray spectroscopy (SEM–EDS) was conducted on 42 coprolites, with representatives of each morphotype, to test whether elemental variation occurs between morphotypes reflecting variations in dietary requirements of the different trophic levels. SEM–EDS analysis detected the presence of three main compounds in both the coprolites and the surrounding substrate: FeS_2, $BaSO_4$, and ZnS. Of these, FeS_2 and $BaSO_4$ were detected more frequently than ZnS, and the sulphates/sulphides are not mutually exclusive of one another, with the rare sample containing all three and some samples being barren of any of these compounds. The sulphates/sulphides occur commonly (but not exclusively) near the boundaries of the coprolites, which could suggest a possible sulphur-based diagenetic crust. Furthermore, rare occurrences of zircon (substrate) and TiO_2 (substrate and coprolite) were identified in some samples during the analysis.

Initial examination of the results has produced no obvious relationship between the presence of FeS_2, $BaSO_4$, and ZnS and morphotype/trophic level. Additional analyses (e.g., x-ray diffraction, carbon isotope analysis, ICPMS etc.) are needed to further delineate the elemental composition of coprolites, determine the origin of the various compounds detected, to establish the significance of the compounds, and to investigate how they are related, if at all, to morphotype and, by extension, trophic level.

Geochemical evaluation of mineralization and igneous activity in the vicinity of the Elmtree deposit, northeastern New Brunswick

AARON L. BUSTARD[1,2], DAVID R. LENTZ[2], AND JAMES A. WALKER[1]
1. Geological Surveys Branch, New Brunswick Department of Natural Resources and Energy Development, 2574 Route 180, South Tetagouche, New Brunswick E2A 7B8, Canada <aaron.bustard@gnb.ca> 2. Department of Earth Sciences, University of New Brunswick, P.O. Box 4400, Fredericton, New Brunswick E3B 5A3, Canada

The Elmtree deposit is situated approximately 5 kilometres to the west of Petit Rocher and hosts a resource of over 300,000 ounces of gold and subordinate polymetallic (Ag, Zn, Pb, Sb) mineralization in

three zones: the West Gabbro, South Gold, and Discovery zones. Ongoing work aims to identify controls on mineralization and the potential for additional deposits in the region.

Lithogeochemical data was collected for several intrusive units: felsic and mafic dykes from the South Gold Zone, the Nigadoo porphyry (located 6 km to the south-southeast), and dykes from the Nigadoo Gold property (approximately 5 kilometres to the west). Mafic dykes at the South Gold Zone are locally mineralized, fine to medium grained, and locally feldspar phyric. The mafic dykes have Zr/Y (4.4-5.4, n = 3) and Ti/V (38.4-41.3) ratios consistent with within plate basalts, with some similarities to volcanic arc basalts, and are more geochemically similar to basalts of the Dickie Cove, Dalhousie, and Tobique groups than to the Quinn Point Group. Felsic dykes at the South Gold Zone are aphanitic, feldspar to quartz phyric, post-date gold mineralization, and have crustal A-type compositions unlike those of the major intrusions in the area (e.g., Antinouri Lake Granite, Nicholas Denys Granodiorite) and known felsic volcanic units (e.g., Benjamin and Madisco Brook formations). To the west, at the Nigadoo Gold property, unmineralized, unfoliated dacitic porphyry dykes that intrude the Melanson Brook Fault/Ordovician-Silurian angular unconformity have chemistry comparable to the Nicholas Denys Granodiorite. These observations indicate that the Melanson Brook Fault was the site of multiple episodes of magmatic activity. Geochronological work is ongoing to identify the temporal, and possibly genetic, relationship between magmatism and gold mineralization.

Comparison of mineralized and least-altered pairs of sedimentary and mafic dyke host rocks from the South Gold and Discovery zones, and gabbro from the West Gabbro Zone reveal several systematic lithogeochemical variations. Specifically, enrichments of Au, As, W, S, Sb, Rb, and K_2O are recognized in mineralized intervals across all host rock types, whereas depletions of Na_2O in mineralized zones are observed in all but the medium- to coarse-grained gabbro. These trends are consistent with observed pervasive sericite alteration and are compatible with fluids derived from either a metamorphic or magmatic source. Although the South Gold and Discovery zones are also host to base-metal mineralization, the lack of base-metal enrichment with gold mineralization provides further evidence that polymetallic mineralization was emplaced during a separate, later event.

Seabed evidence for a paleo-ice shelf along the Newfoundland and Labrador continental margins

GORDON D.M. CAMERON AND EDWARD L. KING
Natural Resources Canada, Geological Survey of Canada – Atlantic, 1 Challenger Drive, Dartmouth, Nova Scotia B2Y 4A2, Canada <gordon.cameron@canada.ca>

A regionally coherent suite of erosional lineations along the outer Newfoundland and Labrador continental shelves is imaged with Olex bathymetric rendering, supplemented locally with higher resolution multibeam bathymetric and 3-D seismic-generated seabed imagery and seismic profile data. They reveal a primarily erosive character of expansive lineations and broad planar ramps, cutting into both till and Cretaceous-Cenozoic strata, found shallower than ~450 m water depth. Lineation fields cover at least 25,000km^2, in each area across NE Grand Bank, Flemish Cap and Makkovik Bank. These lineations are flat-bottomed or V-shaped and range from ~5 to ~60 km long, up to 8km wide, with a max depth of 28m. Orientations are strongly coherent, trend N-S, both parallel and across bathymetric trends. Deep cuts on west Flemish Cap occur on a north-tilted erosional plane developed across the Cenozoic strata. Branching and asymmetric pin-wheel-like eroded bedrock lineations are found in the eastern and southern areas of Flemish Cap. These sometimes sinuous and irregular features shallow northeast to southwest, are up to 40 kms long, 13 m high and are found between 230-330 m water depth. These lineations developed when glacial ice differentially eroding up-dipping Cretaceous-Cenozoic beds that rap around Flemish Cap, creating the pin-wheel appearance. These lineations have a different orientation than the MSGLs where they intersect and may be from an earlier glaciation. A moraine identified for the first time on Flemish Cap is found at the terminal end of bedrock and till gouging MSGLs, forming a moraine up to 40 m high, 7.5 km wide and nearly 50 km long. We submit that an expansive ice shelf

generated the lineations, erosion ramps and moraine. It skirted the entire Labrador Shelf, sourced strongly from Hudson Strait and recently recognized pathways across NE Newfoundland Shelf, splayed eastward as it rode 150km across a strongly buttressing Grand Bank, overriding much of Flemish Cap which also provided crucial pinning. We cannot yet develop strong arguments for the timing or duration of such an ice shelf, but published works favor both a penultimate or younger glaciation. Multiple-age feature inheritance is possible. Many of the morphologic details require further explanation in an ice shelf context, including the role of sub-ice water and deforming sediment. The implications for a fundamental shift in understanding ice shelf integrity, extent, flow pattern, dampened ocean calving, and deep ocean sediment proxies like Heinrich events are strong, warranting further discussion and investigation.

† *Gold mineralization at the Cape Spencer area, New Brunswick – Project update

ALAN CARDENAS[1] , DAVID LENTZ[1] , CHRIS MCFARLANE[1] AND KATHLEEN THORNE[2]
1. University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <alan.cardenas@unb.ca> 2. Geological Surveys Branch, New Brunswick Department of Energy and Resource Development, Fredericton, New Brunswick E3B 5H1, Canada

The Cape Spencer area is located 15 km southeast of Saint John in southern New Brunswick. Gold mineralization has been identified in illitized (illite-carbonate ± quartz ± pyrite ± chlorite ± specularite), pyrite-rich rocks of the Millican Lake Granite and the Cape Spencer Formation, along thrust faults and folds, and in quartz ± carbonate veins with sulphides (pyrite ± chalcopyrite ± galena ± arsenopyrite ± sphalerite). These styles of gold deposition related to major accretion-related faults and/or reactivation of faults are consistent with the orogenic class of gold deposits; the gold system is associated with the accretion of the Meguma terrane to southern New Brunswick.

Gold occurs in both the intensely illitized host rocks and the associated quartz-carbonate veins, mainly parallel to the S_2 cleavage. It is closely related with pyrite grains, present for the most part as particles along fractures in grains or along grain margins, and to a lesser extent in particles within quartz and carbonate in the vicinity of gold-bearing pyrite that commonly contains inclusions of chalcopyrite, galena and arsenopyrite. These features were identified by detailed µXRF-EDS mapping and reflected light microscopy of pyrite grains, following a paragenetic evaluation that resulted in the selection of different pyrite-bearing assemblages with high Au grades, according to previous assays from drill core. The presence of inclusions from host rocks in pyrite grains as well as the development of "pressure shadows" point to pyrite growing contemporaneously with the alteration and strain.

Through the geochronological assessment of various parts of the area, including both the host rock system and the mineralization system, a better understanding of the distribution of gold mineralization in the region will be obtained, by constraining the source of the metals and chronologic information related to ore deposition. The project goals are to identify the local to regional controls on mineralization, source of fluids and gold, and determine its relative timing with respect to the tectonic evolution of the region. Therefore U-Pb (zircon, apatite, rutile) and $^{40}Ar/^{39}Ar$ (illite) geochronology of the different fabric elements and vein systems have been applied to constrain the timing of the mineralizing events. Both µXRF-EDS mapping of thin sections and XRD have been used to help identify phases for *in situ* dating. Additionally, LA-ICP-MS analysis on pyrites will ascertain the presence of refractory gold, and sulphur and lead isotope geochemistry studies will assist in the characterization of the mineralizing fluids.

† *Is methane clumped isotopologue the future offshore exploration tool?

ANIRBAN CHOWDHURY[1], ELLEN LALK[2], SHUHEI ONO[2], MITCHELL J. KERR[1], JEREMY N. BENTLEY[1], A. MACDONALD[3], MARTIN G. FOWLER[4], CASEY R.J. HUBERT[5] AND G. TODD VENTURA[1]
1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H C3C, Canada <anirban.chowdhury@smu.ca> 2. Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge MA 02139, USA 3. Nova Scotia Department of Energy and Mines, 1690 Hollis St., Halifax, Nova Scotia B3J 3J9, Canada 4. Applied Petroleum Technology Ltd., Calgary, Suite 400, 119 - 14th Street NW, Calgary, Alberta T2N 1Z6, Canada 5. Department of Biological Sciences, University of Calgary, Calgary, Alberta T2N 1N4, Canada

In sedimentary basins, methane is produced by thermogenic cracking of deeply buried organic-rich source rocks and through the reduction of CO_2 or H_2 and acetate by microbial methanogenesis. Comparative gas speciation and stable isotopic compositional ($\delta^{13}C$ and δD) analyses are traditionally used to distinguish the origin and formation mechanism of methane gas. Recent advances in the measurement of 'clumped' isotopologues of methane ($\Delta^{13}CH_3D$ and $\Delta^{12}CH_2D_2$) enables the determination of the thermodynamic isotopic equilibrium of the gas from various sedimentary environments. We therefore hypothesize a 'clumped' isotopologues study of the methane collected from the Scotian Margin sediments and a reference sample from an abandoned gas well. These can be used to determine the burial depths of methane producing source rock intervals. To do this, we are analyzing headspace-gas samples obtained from piston and gravity core sediments collected on the Scotian Margin for cruises conducted from 2015–2018. We have also analyzed a gas sample from the ExxonMobil Alma 4, an abandoned well operated off Sable Island located on the Scotian Shelf. The extracted hydrocarbon gas from the 15 cores (n=83 samples) all contain methane and in 3 cores ethane and propane (n=18 samples), which is consistent with previous published reports studying gas collected from the bottom core rounds. The methane concentration of 7 cores collected in 2015 and 2016 cruises have an average of 0.05 ppm (n=26 samples), while 8 cores sampled in 2018 is average to 0.003 ppm (n=57 samples). Methane core profiling shows a putative concentration dip at 3.5–4.5 meters below sea floor, which may relate to the presence of a sulfate-methane transition zone (SMTZ) at this depth. This study is expected to provide a better understanding of the depth of gas formation, and therefore better constrain the maturity of underlying source rocks across the margin. It may also further test the efficacy of using this isotope technique as a tool for offshore gas exploration activities.

An integrated paleoenvironmental study of Lower Cretaceous to lower Cenozoic strata of the Labrador margin, offshore eastern Canada

LYNN T. DAFOE[1] and GRAHAM L. WILLIAMS[1]
1. Geological Survey of Canada, Bedford Institute of Oceanography, 1 Challenger Drive, Dartmouth, Nova Scotia B2Y 4A2, Canada <lynn.dafoe@canada.ca>

Rifting and opening of the Labrador Sea began in the Early Cretaceous and ceased in the latest Eocene as the Greenland plate separated from the paleo-North American plate. A record of this tectonism is preserved in the stratigraphic successions of the Hopedale and Saglek basins, respectively to the south and north along the Labrador margin. Previous paleoenvironmental studies of these strata have primarily focused on a single methodology using cuttings samples, typically microfossils or sedimentological observations, to define paleoenvironments. In this study, we use conventional core intervals to combine macroscopic observations of the sedimentology and ichnology with quantitative microscopic palynological analyses of bisaccates, other miospores, dinoflagellate cysts (dinocysts), acritarchs, and other palynomorphs to provide robust paleoenvironmental interpretations. The results are reported for 23 core intervals from 14 wells representing key intervals from the Early Cretaceous to basal Ypresian, with

palynological counts from a total of 64 samples. The sedimentological and ichnological observations generally provide well defined interpretations of the paleoenvironment, while the palynomorph ratios indicate an approximate distance from the shoreline. Lower Cretaceous mudstones are typically devoid of dinocysts and acritarchs but contain bisaccates and other miospores: the palynological assemblages combined with low diversity and low abundance trace fossil suites indicate a restricted (brackish) marine embayment. Upper Cretaceous mudstones deposited in slope-equivalent and shelfal-equivalent water depths show high proportions of dinocysts and acritarchs relative to miospores, as expected. The slope strata are devoid of trace fossil suggesting reduced oxygenation, but fully marine *Cruziana* Ichnofacies characterize bioturbated shelfal strata. The Upper Cretaceous, and Selandian–basal Ypresian deposits are mostly deltaic, reflecting various depositional conditions. Storm- or wave-influenced deposits are characterized by low dinocyst and acritarch abundances and weakly stressed expressions of the *Cruziana* Ichnofacies. River-influenced deltaic strata mostly contain limited dinocyst and acritarch abundances with sedimentary structures prevalent and highly stressed expressions of the *Cruziana* Ichnofacies are present. River-dominated and tide-dominated (channel) strata lack marine palynomorph indicators, with sedimentary structures predominating. Dinocyst and acritarch results tend to parallel trace fossil diversity and abundance, but can be misleading in highly brackish settings where these marine indicators may not be present. Palynomorph counts can, however, help to refine paleoenvironments from strata that contain non-ubiquitous sedimentary features and can provide evidence of mixing of shallow and deeper water settings, such as progradation of a delta into deeper water. Overall, integration of the two methodologies, operating at very different scales, provides more robust paleoenvironmental interpretations.

Structural, petrographic, and lithogeochemical analysis of the vein-hosted Williams Brook South gold occurrence, north-central New Brunswick

DUSTIN R.L. DAHN[1], AARON L. BUSTARD[1], ANNA TEREKHOVA[2], AND JACOB HANLEY[2]
1. Geological Surveys Branch, New Brunswick Department of Natural Resources and Energy Development, 2574 Route 180, South Tetagouche, NB, E2A 7B8 <dustin.dahn@gnb.ca>; 2. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada

The Williams Brook South occurrence is situated approximately ninety kilometres west of Bathurst in north-central New Brunswick. The occurrence consists of a series of gold bearing quartz veins cutting rhyolite host rocks exposed semi-continuously for approximately 150 metres. Current work takes advantage of bed rock exposure created during recent mineral exploration in order to elucidate the structural controls on mineralization and other characteristics to assist with exploration in the region.

Mineralized quartz veins at Williams Brook South are hosted predominantly in porphyritic to locally fragmental rhyolite and to a lesser extent in adjacent siltstone and tuff which are all assigned to the Wapske Formation (Tobique Group). Veins occur in several apparently cogenetic sets. Quartz veins are up to two metres wide, typically vuggy, locally contain millimetre to centimetre scale fragments of brecciated wall-rock, and contain minor syn-quartz sphalerite, chalcopyrite, and galena. Lithogeochemical data from rhyolite samples indicate that host rocks are post-orogenic (A-type), compositionally homogenous, and similar to rhyolite host-rocks at the Williams Brook Au occurrence located five kilometres to the north-northwest. Preliminary analysis of primary aqueous-carbonic fluid inclusions in quartz indicates the minimum temperatures of formation are between 300 and 314°C, pressures of at least 400-900 bar (2000-3500 metres depth; lithostatic P), and salinities between 4.2-5.6 wt% NaCl equivalent.

Structural analysis of the vein and fracture sets at Williams Brook South indicate that all of these structural elements can be explained by a single deformational event characterized by sub-horizontal, northwest-southeast directed shortening. This deformation manifests itself as ductile deformation in the enclosing sedimentary units and as brittle deformation in the rhyolite. Veins within the rhyolite generally correspond with extensional or shear planes, whereas fractures are related to compressional or shear planes. The tectonic forces responsible for the generation of these features are attributed to regional

dextral transpression resulting from collision between the Gander and Avalon terranes during the Acadian Orogeny. Mineralized veins also appear to be most common near the northern siltstone-rhyolite contact indicating that contrast in host rock competencies may be an important for focusing strain and/or fluid flow. These results indicate that host rock rheology is an important factor in the formation of gold mineralization in the region, and that rhyolite units near regional structures (e.g., Rocky Brook-Millstream, McCormack Brook, and Ramsay Brook faults) are prospective for gold mineralization.

Empowering citizen science and earth science literacy

HOWARD DONOHOE[1], REGAN MALONEY[2] AND DANIELLE SERRATOS[2]
1. Department of Geology, Saint Mary's University, 923 Robie Street, Halifax, NS, B3H 3C3 <howard.donohoe@smu.ca> 2. Fundy Geological Museum, 162 Two Islands Road, Parrsboro, NS, B0M 1S0

Citizen science and earth science literacy are important for the welfare of humankind due to the increasing stresses resulting from the global climate crisis and rapid population growth. Citizen science has a long and well-established history in the earth sciences. A meteorologist, Alfred Wegener, consolidated the evidence for continental drift and publicized his thoughts. His insightful view of the world was not accepted until a revolution in earth science thought occurred in the 1960s. Although trained in scientific principles, Wegener applied this ability outside his field of knowledge and specialization. Mary Anning was considered "the greatest fossilist the world ever knew" and yet she was an avocational paleontologist with no formal training. She was the foremost expert on Jurassic marine reptile anatomy during her lifetime and is responsible for countless specimens that have shaped the field of paleontology. A local earth science enthusiast, Eldon George, became a self-taught citizen scientist. His work has added to our knowledge of the Paleozoic and Mesozoic flora and fauna in the Parrsboro, NS region. These three people from entirely different backgrounds are just a few examples of citizen scientists who developed their own sense of earth science literacy We continue the work of earth science literacy through geology courses in university, AGS's EdGeo Program, Geology 12 in NS public schools, and in the numerous outreach initiatives that promote an understanding of earth science like those found in science museums all over Nova Scotia. For over twenty-five years, the former NS Department of Natural Resources encouraged geoscientists to lead walks in provincial parks to interpret, explain, and connect geological processes with modern human activity. Likewise, the Fundy Geological Museum in its 28 years of operation have encouraged people to be more aware of geological processes and their effect on humans. All these outreach activities have a common thread of developing earth science literacy to be relevant for current audiences. As the world becomes more populous, we need more people to become aware of geological processes and potential hazards as well as resources. This literacy may well encourage an increased number of citizen scientists who may then help with hazard and resource identification and development and enforcement of public policies that benefit the planet and its inhabitants for generations to come.

† *Hydrocarbon fingerprinting of Cambrian-Ordovician sedimentary rocks in eastern Laurentia (western Newfoundland, Canada): organic geochemical approach to palaeo-environmental investigation

JOHN DOOMA[1], KAREM AZMY[2], ANIRBAN CHOWDHURY[1] AND G. TODD VENTURA[1]
1. Organic Geochemistry Lab, Saint Mary's University, 923 Robie St. Halifax, NS, B3H 3C3 <John.Mishael.Dooma@smu.ca>; 2. Memorial University of Newfoundland, 9 Arctic Avenue, St. John's, Newfoundland and Labrador A1B 3X5, Canada

This study investigates marine carbonates and shales deposited as rhythmites from the lower Shallow Bay Formation and upper Green Point Formation of the Cow Head Group, which marks a type locality for the Cambrian-Ordovician boundary. Due to the lack of molecular evidence to characterize the ancient geochemical environment of western Newfoundland, 24 samples were collected and processed for their hydrocarbon biological markers. However, carbonate samples from the Lower and Upper Cambrian contained relatively high extract yields that were not in accordance to the very low total organic carbon values (n=8; 0.04–0.54 wt. %). These organic-lean samples were most likely contaminated by secondary addition of organic matter and/or sample storage. Hydrocarbon biomarkers were measured for the remaining 16 samples Lower to Upper Cambrian carbonates and the Cambrian-Ordovician shales. The sample location further records the SPICE, post-SPICE, and HERB global carbon isotope excursions that are strongly linked to eustatic sea-level fluctuations. The Ph/*n*-C_{18} and Pr/*n*-C_{17} ratios indicate the organic matter (OM) for most of the samples was derived from mixed Type II/Type III kerogens common to marginal marine settings. C_{27}, C_{28}, C_{29} αββ- and αα-steranes were dominated by C_{29} stigmastanes implying the sedimentary organic matter was deposited in an open marine setting consistent with sediment lithology and expected basin palaeo-geography. Pr/Ph ratios mostly record dysoxic conditions with low gammacerane index values (avg. 2.0) suggesting minimal levels water column stratification. However, a carbonate sample from the Lower Cambrian, global $\delta^{13}C$ excursion SPICE event recorded an exceptionally high value suggesting at least one temporal interval where oceanographic conditions markedly changed. Periodic intervals of anoxia may have existed at the end of the HERB event, during the transition into the Ordovician, and across a discrete interval of the Early Ordovician as evidenced by low Pr/Ph values (<3). These events also record distinctive steranes/hopanes and Pr/Ph ratios displaying a pronounced inverse relationship that implies systematic changes in organic matter input and redox conditions that are similarly linked to oxygen drawdown from increased productivity in the water column. V/Ni and V/Cr trace metal palaeo-redox and the Ni/Co palaeo-productivity parameter support these findings. There is a narrow interval of anoxia in the Early Ordovician accompanied with increased microbially-induced methane and sulfate oxidation shown by 3β-MHI and BNH/(30αβ + BNH). These changes are likely the result of tectonic configuration of the Early Ordovician Taconic orogeny, which allowed the full opening of the basin to the ocean.

*An experimental study of the effect of pressure on the formation of chromite deposits

NATASHIA DRAGE AND JAMES BRENAN
Department of Earth and Environmental Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada, <Natashia.drage@dal.ca>

Despite extensive research on the Bushveld Complex chromite deposits, the mechanism(s) that form such anomalous chromite segregations remains uncertain. A recent study using the MELTS thermodynamic model proposed that reduction of pressure upon magma ascent shifts the silicate-in temperature to lower values, with the chromite-in temperature remaining unchanged, resulting in chromite-alone crystallization and the formation of massive chromitites. This project aims to evaluate this

hypothesis through laboratory phase equilibrium experiments conducted at 0.1 MPa and 1 GPa employing two bulk compositions. Composition 1 (C1) corresponds to the widely accepted parental magma of the Bushveld chromitites, termed B1, and composition 2 (C2) is the same used in the recent MELTS modeling study, which contrasts with C1 most significantly in Al_2O_3 (17.4 wt.% vs 11.8 wt.% in C1) and MgO (6.7 wt.% vs 11.9 wt.% in C1) contents. Starting materials are synthesized from reagent grade oxides and carbonates which were fused into a homogeneous glass, and contain ~970 and ~700 ppm Cr, for C1 and C2, respectively. Thus far, experiments have been done at 0.1 MPa over the temperature interval of 1170-1340°C and at the FMQ buffer. Samples were mounted on Fe-pre-saturated Ir wire loops and equilibrated in a vertical tube, gas-mixing furnace for run durations of 24-48 hours. Results show that the Cr# (Cr/(Cr+Al) in the C1 experimental chromite (0.7-0.75) is within the range of the most primitive chromitites (~0.65-0.76) located in the Lower Critical Zone of the Bushveld. However, Cr# of experimental chromite in C2 (0.6-0.63) is more consistent with the chromitites located in the Upper Critical Zone (~0.59-0.76). The Fe# (Fe/(Fe+Mg) for experimental chromite in C1 (0.39-0.41) and C2 (0.44-0.48) are on the lower end of natural Bushveld chromitites (0.45-0.75) but slightly higher than MELTS predictions (0.39-0.42). Experiments show that C1 agrees with the crystallization sequence observed in the Lower Critical Zone with chromite + orthopyroxene on the liquidus at 1280°C. Composition C2 crystallizes chromite-alone at 1280°C, followed by plagioclase + chromite at 1200°C and plagioclase + chromite + orthopyroxene at 1170°C. Again, this composition is more reflective of the Upper Critical Zone which is dominantly noritic. This sequence is also in agreement with the MELTS modelling study, with the exception that chromite-alone crystallization in experiments begins at a higher temperature (1280°C) than predicted (1230°C). Further experiments at high pressure will allow a more complete evaluation of the pressure reduction model and the effect of pressure on chromite crystallization.

Reviewing 200 years of Nova Scotia geology: gypsum caves and mastodon sinkholes

TIM FEDAK
Nova Scotia Museum, Halifax, Nova Scotia B3H 3A6, Canada. <tim.fedak@novascotia.ca>

Solomon Thayer, from Lubec, Maine, wrote to Professor Cleaveland at Bowdoin College in October 1819, noting that around the Windsor gypsum quarries there were holes in the earth like tunnels or an amphitheatre and these were formed by dissolution of the gypsum by water. As part of the first detailed survey of Nova Scotia geology in 1833, Jackson and Alger noted that gypsum in the vicinity of Windsor, abounds in conical or inverted funnel-shaped cavities. They also mention human remains had been found associated with indigenous points in one of the local gypsum caves. The skeleton and artefacts were likely later lost during the fire at King's College. When Charles Lyell visited in 1842, he drew attention to the fossil shells from the Windsor limestones along the Avon River, and much later, the International Geological Congress fieldtrip to Atlantic Canada in 1913 provided important research contributions from Jennison, Bell, and others, on the Windsor area gypsum and limestones. In the late 1950's, William Take, the Curator of Geology at the Nova Scotia Museum excavated beaver chewed wood and beaver bones from a sinkhole structure in the gypsum fields at Milford. In the late 1980's workers at the Bailey Quarry near Windsor discovered a Mastodon tusk, but the largest discovery of Mastodons was made by Bob Grantham in the early 1990s back at the Milford quarry. In 1992 and 1993, as Curator of Geology at the Nova Scotia Museum, Grantham oversaw field work to collect the skull and large portions of the postcranial skeletons of an adult and portions of a juvenile Mastodon, along with fossil turtles, insects, wood and dung. Most recently, other Mastodon bones have been recovered from gypsum sinkhole deposits from Little Narrows, Cape Breton, and Falcon-Lang and others have described Cretaceous aged fill in the Windsor area gypsum that included the oldest pine fossils in the world. By providing an overview of the history of geology research involving karst and sinkholes in Nova Scotia, this report

highlights the key topics of interest for engaging public and allowing discussion of fossils and evidence of risk that demonstrates millions of years of karst terrain in Nova Scotia.

The CSEG Foundation Outreach Programs: another approach to enhancing effective learning

MIKE FINN[1], P.GEOL., CHAU HUYNH[2], JEFF CALVERT[3] AND DEVITA NAIDU[4]
1. Denali Energy Solutions Inc., Calgary, Alberta T3B3L9, Canada. 2. Frontera Energy Corporation, Calgary, Alberta T2R 1A7, Canada, 3. Repsol Oil and Gas, Calgary, Alberta T3G 3Y7, Canada. 4. Hampson-Russel/CGG, Calgary, Alberta T2P 3C5, Canada

On April 30, 1949 eleven geophysicists met for an "informal" lunch in Calgary. From this the Canadian Society of Exploration Geophysicists was born, formed to “increase (the) skill, knowledge and experience in the field of exploration geophysics. In 1956 the CSEG Foundation established a scholarship program, joined the Calgary Technical Library Advisory Committee and contributed financial resources to the cause. In 1973 the Society’s University Liaison Committee, became active, marking the start of a long history of outreach. In 2009 the CSEG established the Mentorship Program as part of its University Student Outreach initiative. In 2014 the Emerging Professionals Program was established to help young professionals transition into the industry by creating community, and opportunity for technical and soft skill development.

Wikipedia defines Mentorship as “a relationship in which a more experienced or more knowledgeable person helps to guide a less experienced or less knowledgeable person.” Traditionally, Oil and Gas entities employed professionals that ranged in levels of experience from new graduates to 30+ years. As the industry evolved to a larger number of small entities, aggravated by business cycle downturns and resulting in staff reductions, the number of senior staff in many organizations has decreased dramatically. Training budget constraints have reduced or eliminated another source of knowledge for young professionals to access. Professional and industry bodies have developed both Continuous Professional Development requirements and mentorship programs to ensure all members have professional growth opportunities.

While not perhaps considered to be teaching/learning in the classical or classroom sense, the CSEG mentorship program nevertheless provides additional learning resources to its participants. Coupled with the Emerging Professionals program, they represent a unique extension of the learning experience. This session will outline the goals and approaches used by the CSEG to expand the total skills package of those who avail themselves of the mentor programs.

**Finding fault in a shear zone

MARIE FLANAGAN AND ALISON LEITCH
1. Department of Earth Sciences, Memorial University of Newfoundland, St. John’s, Newfoundland and Labrador, A1B 3X5, Canada <mflanagan@mun.ca>

Marathon Gold Corporation's Valentine Gold Property is located in west central Newfoundland. The property has four known gold deposits in early exploration stages along 20 kilometres of northeast to southwest trend. It is a future site for an open-pit gold mine, and upon completion, will be the largest gold mine in Atlantic Canada. The Valentine Lake property contains orogenic-type quartz-tourmaline-pyrite veins which are gold-bearing. These veins are structurally controlled, occurring along or proximal to the Valentine Lake Shear Zone. The mineralization is found only on one side of the shear zone in intrusive rocks, and is rare in the conglomerate on the other side. The area has considerable basaltic dykes, which show up well when conducting a magnetic survey due to their proportions of magnetite. Though their relationship to the mineralogy is uncertain, these dykes can help indicate structure. To further constrain

the location of the shear zone (and hence the mineralized region), a detailed magnetics survey was conducted over a 200m x 300m section of a larger-scale magnetics study completed in 2014 using a GPS enabled Overhauser magnetometer. Sixteen lines were traversed all together through a heavily wooded area with thick soil and moss cover. The survey area also contained two roads and several anthropogenic objects such as trucks, fuel tanks, and culverts. Magnetic susceptibility measurements of surrounding rock types were taken to supplement data provided by Marathon Gold. With the collected data, total magnetic intensity maps were created and further processed using pole reduction and first vertical derivative computation. This helped identity a zone where the pattern of linear magnetic highs was offset, with lesser magnetic intensity near the offset. This zone has been identified as a fault offset to the shear zone, as the loss in magnetic intensity could be due to alteration or thinning of the basaltic dykes at the fault boundary.

*3D modelling & synthesis of geophysical data in Nash Creek, New Brunswick, Canada

A. FURLAN[1], H. UGALDE[1], A. ONDERCOVA[2], B. MILKEREIT[2]
1. Department of Earth Sciences, Brock University, St Catharines, Ontario L2S 3A1, Canada <afurlan@brocku.ca> 2. Department of Earth Sciences, University of Toronto, Toronto, Ontario M5S 3B1

Since the development of the Bathurst Mining Camp (BMC) in the 1950's, New Brunswick has been characterized by its volcanogenic massive sulphide deposits. Early electromagnetic surveys had success detecting 'hotspot' anomalies that lead to the development of mines such as Brunswick No. 6. While there are 45 known deposits with the BMC, only 4 have been discovered since 1989. The decrease in exploration can be attributed to several factors: fewer easy-to-detect geophysical targets, changing prices of base metals, less economic incentive, and most importantly, lack of subsurface knowledge. As exploration efforts expand and geophysical methods improve, regions such as Nash Creek show potential to revitalize the mining industry of New Brunswick. Located within the Chaleur Bay Synclinorium, Nash Creek plays host to Zn-Pb-Ag deposits. Like Bathurst, a plethora of airborne and ground-based geophysical surveys have been conducted. Some 3D modeling has been completed but lacks geologic control and was restricted in the number of datasets used. A true synthesis of all available geophysical data has yet to be conducted. Thus, the purpose of this study is to construct a 3D geological model of the Nash Creek exploration area using a multidisciplinary approach that can provide new exploration insights. New software and more powerful computers make the construction of multiparameter 3D models highly accessible, however, adding proper geological constraints to mitigate non-uniqueness is a problem that cannot be solved by the many semi-automatic tools that have become popular over the past few years. In this study we used borehole logs, petrophysical data and the limited mapping information available in the area. By integrating all the data, we generated an initial geological model, which was then optimized to fit the available geophysical information (EM, IP, magnetics, Lidar).

† The geological setting and Pb- and S-isotopic signature of the base metal mineralization at the Lumsden polymetallic deposit, southeastern New Brunswick

AYALEW L. GEBRU
New Brunswick Department of Natural Resources and Energy Development, Geological Surveys Branch, PO Box 6000, Fredericton, NB E3B 5H <ayalew.gebru@gnb.ca>

The Lumsden Zn-Cu-Pb deposit, situated within the eastern Caledonia Highlands of the Avalon Zone in southeastern New Brunswick, is hosted by the highly deformed Crooked Creek Formation of the Neoproterozoic Broad River Group. Major- and trace-element geochemical signatures of this volcano-

sedimentary sequence is consistent with an island arc convergent plate margin, which have been intruded by several plutons ranging in age from ca. 693 to 564 Ma.

The epigenetic polymetallic mineralization is structurally-bound and most likely controlled by Devonian to post-Devonian fault systems. Mineralization is hosted by impure dolomite and chloritized felsic rocks, and predominantly consists of pyrite and sphalerite with lesser galena and chalcopyrite. Field relations and petrographic observations suggest two main stages of mineralization: (1) sphalerite and iron sulphide precipitated in the wall rocks during an early brittle-ductile shearing event, and (2) emplacement of dolomite veins followed by subsequent fracturing and precipitation of pyrite, sphalerite, chalcopyrite and galena.

Dolomitic rocks in the mineralized zone are enriched in Mg (7.55-13.5%), Ca (13.5- 18.5%) and Ba (7-1220 ppm) and have relatively low abundances of Si (1.58-7.23%), Al (0.08-0.475%), Fe (1.45-4.97%), Mn (1.4-5.99 %), Ti (<0.01%),Na (< 0.01%), K (<0.01%), and P (0.01-0.03%). The Zn-Cu-Pb mineralization is associated with anomalous Ag, As, Bi, Cd, In, Mo, Se, Sn, Sb, and Te. Galena mineralization controls the amount of Bi and Ag mobilized in the system, whereas sphalerite controls that of Cd and to a lesser extent In. There is a strong correlation between Zn and Cu indicating that the two elements may have mobilized together in the system. Alteration of the felsic host rocks is characterized by strong leaching of Na and K.

Secondary Ion Mass Spectrometry analysis of galena yielded lead isotope ratios of 17.495-17.972 $^{206}Pb/^{204}Pb$, 15.431-15.625 $^{207}Pb/^{204}Pb$, and 37.215-37.887 $^{208}Pb/^{204}Pb$. Galena from dolomitic rocks yielded Pb-Pb model ages of 518 and 471 Ma. Sulphur isotope analysis of pyrite and galena yielded mean values of $^{34}S_{V\text{-}CDT}$ 23.2.and 25.8‰, respectively thus suggesting crustal sources for the sulphur. The mineralization style, structural control, and sulphur isotope signature indicate that the sulphur source for the mineralization may have been largely mobilized from the Carboniferous-aged Windsor Group evaporites. Lead isotope signatures indicate the recycling of Pb into the mineralizing systems from an older orogenic belt, most likely mafic volcanic rocks of the Broad River or Coldbrook Group. This newly recognized polymetallic system has genetic similarities to Mississippi Valley-type mineralization.

Advances in the chronostratigraphy of the Beaufort Formation, Arctic Canada

JOHN C. GOSSE[1], SYDNEY STASHIN[1] AND NEIL DAVIES[2]

1. Department of Earth and Environmental Sciences, Dalhousie University, 1355 Oxford Street, Halifax, B3H 4R2, Nova Scotia, Canada <john.gosse@dal.ca> [2]Department of Earth Sciences, University of Cambridge, Cambridge CB2 3EQ,United Kingdom

The late Miocene and Pliocene Beaufort Formation and equivalent units throughout the Canadian Arctic Archipelago captured a rich record of landscape evolution, Arctic paleoclimatology, and paleo-ecosystem changes caused by a polar-amplification of global climate change and the opening of the Northwest Passage. We provide new insights into the age, sedimentology, erosion rates, and range of depositional environments through the Archipelago, with emphasis on new and previously investigated sites with key paleoclimate and sedimentology data. Interpretation of previous and new cosmogenic nuclide measurements in combination with previous lithospheric flexure modeling we are able to estimate the paleo-erosion history throughout the region and suggest that the modern limited distribution of the Beaufort Formation to the western archipelago is not only some 200 m thinner than it was, but that equivalent age sediments once covered much of the entire Canadian Arctic region before it was an archipelago.

***Petrological and U-Pb zircon age constraints for metamorphic rocks of the northeastern Cape Breton Highlands, Nova Scotia: New insights into the geological history of the Aspy terrane**

CALEB J. GRANT[1], SANDRA M. BARR[1], DONNELLY B. ARCHIBALD[2] AND DEANNE VAN ROOYEN[3]
1. Department of Earth and Environmental Science, Acadia University, 15 University Ave, Wolfville, Nova Scotia B4P 2R6, Canada <152352g@acadiau.ca> 2. Department of Earth Sciences, St. Francis Xavier University, 5009 Chapel Square, Antigonish, Nova Scotia B2G 2W5, Canada 3. Department of Mathematics, Physics, and Geology, Cape Breton University, Sydney, NS, B1P 6L2, Canada.

Geological mapping, petrological studies, and U-Pb (zircon) dating were done to better characterize metasedimentary and metaigneous rock units in the northeastern Aspy terrane, Cape Breton Highlands, Nova Scotia. Foliated biotite monzogranite of the newly recognized South Aspy River pluton has a Silurian age (440.3 ± 2.1 Ma or 421.6 ± 4.0 Ma). An early Devonian age for the Glasgow Brook granodiorite pluton was confirmed at 415.7 ± 2.7 Ma, consistent with a previously reported age of 416.0 ± 1.9 Ma. U-Pb (zircon) ages from the Cheticamp Lake Gneiss of 416.9 ± 1.3 Ma and 415.9 ± 1.9 Ma, combined with mineralogical and textural similarities, suggest that the Cheticamp Lake orthogneiss and Glasgow Brook pluton may be related. Both the South Aspy River pluton and Glasgow Brook pluton were emplaced in a volcanic-arc tectonic setting and combined with ages of volcanic and plutonic rocks from other parts of the Aspy terrane indicate an extended history of arc magmatism from the early Silurian through the early Devonian. The plutonic units intruded metasedimentary rocks previously assigned to the Money Point Group but now named the Little Southwest Brook formation. The youngest detrital zircon population in a semi-pelitic schist sample provides a maximum depositional age of 441.2 ± 2.5 Ma. Mineral assemblages, lack of evidence for melting, and thermobarometry constrain peak prograde metamorphic conditions to <650 °C at 5.5 – 7 kbar. Based on similar lithologies, including characteristic pelitic rocks interlayered with amphibolite and marble as well as similar detrital zircon signatures, the Little Southwest Brook formation is interpreted to be part of the Cape North Group and correlative with high-grade metamorphic rocks elsewhere in the northern, western, and central Aspy terrane. The igneous, metamorphic, and deformational history of the area records the Salinic and Acadian orogenies and the Silurian-Devonian collision between the Aspy and Bras d'Or terranes within Ganderia.

****One city's trash is a geophysics student's treasure**

SARAH GREENE AND ALISON LEITCH
Department of Earth Sciences, Memorial University, St. John's, Newfoundland and Labrador A1B 3X5, Canada <segreene@mun.ca>

The Robin Hood Bay landfill is located in the north-east part of St. John's, Newfoundland island. It is the solid waste management facility for the City of St. John's and the greater Avalon region. It has been in use since the 1940s, first by the American military before it was turned over to the City of St. John's in 1963. In the past, there have been concerns of leachate penetrating groundwater at the site and draining into the ocean and adjacent streams. In 2009, the landfill underwent a large-scale renovation. This included adding a geosynthetic cover, creating regulations to residential dumping and adding gas and groundwater monitoring wells to the site to counteract leachate seepage. The south-east corner of the landfill, an area that has not been infilled with new waste since the 2009 renovations has been chosen as a site for geophysics surveys. This is the first geophysical study that has been performed over the landfill, despite being common practice in other landfills. It is the first step in the process of monitoring long-term changes to the subsurface of Robin Hood Bay. The area studied is flat and grassy with an underlying layer of cobblestone. Magnetics and DCR surveys were performed among other techniques. These are non-invasive geophysical studies that provide a method in which to interpret the subsurface environment for ground structure, water flow patterns and environmentally concerning anomalies. These include past

improper disposal of large metal objects and iron debris. The magnetics surveys used a GEMGSM-19GW Overhauser Magnetometer in a grid formation to identify localized magnetic materials. The DCR surveys were conducted with both a Schlumberger Vertical Electrical Sounding and Wenner Constant Separation Transverse array in a south-west to north-east colinear manner in the study area.

Characterizing the mineral domains of Li-(Rb-Cs) enrichment at the East Kemptville Sn-(Cu-Zn-Ag) deposit, Nova Scotia, Canada

JACOB HANLEY[1], TRAVIS KENDALL[1], AND BRANDON BOUCHER[2]
1.Department of Geology, Saint Mary's University, Halifax, B3H3C3, Canada <jacob.hanley@smu.ca>
2.Department of Earth Sciences, University of New Brunswick, Fredericton, E3B 5A3, New Brunswick

The 385-368 Ma South Mountain Batholith comprises 11 plutonic centers, including the Davis Lake Pluton that hosts the East Kemptville Sn-Cu-Zn-Ag deposit (mined 1985-1992). In addition to Sn, other strategic elements of interest (e.g., group I alkali metals Li, Rb and Cs) have been the focus of recent exploration. This study of the mineralized topaz-muscovite leucogranite intrusion and locally, and its host metasedimentary rocks, describes the mineralogy and chemistry of Li-Rb-Cs characterized by optical and scanning electron microscopy, IR and Raman spectroscopy, and laser ablation ICP-MS.

Bulk rock Li (up to ~3000 ppm) is controlled by mica abundance, highest in the metasedimentary country rocks in the contact zone near the leucogranite, and comparable to low grade Li stock piles in producing deposits in Canada (NA Lithium), Germany (Banacora), and the Czech Republic (Cinovac). High bulk rock Sn concentrations (up to ~1 wt% Sn) are always associated with low Li concentrations (< 1500 ppm). Bulk rock Li-Rb-Cs correlate strongly and two trends are noted: (i) for the leucogranite fractional crystallization led to increasing Li (up to ~1000 ppm), whereas (ii) in the metasediments/contact zone, Li concentrations do not follow normal fractionation trends. In the leucogranite, zinnwaldite-annite-phlogopite solid solution ("zap-ss") is the main Li-Rb-Cs carrier (up to ~9500 ppm Rb and 1.4 wt.% Li; >70% of bulk rock Li) in contrast metasediments in the contact zone where muscovite-trilithionite solid solution ("mt-ss"; up to ~9500 ppm Rb, and 1.4 wt.% Li) hosts >90% of Li-Rb-Cs. The mt-ss replaces earlier zap-ss in the contact zone. Li-bearing micas in the contact zone likely grew during contact metamorphism, augmented by the infiltration of early granite-derived fluids, and later by fluids released during the chloritization of earlier zap-ss in the leucogranite.

Ternary Rb-Sn-Li and Nb-Li-Ta diagrams discriminate different Li domains by assay, clearly separating metasediment, contact zone metasediment, and leucogranite/greisen. However, mineralogical hosts for Li-Rb-Cs can only be differentiated using spectroscopy. In particular, IR spectroscopy may offer cheap and portable technique to quickly screen samples for their Li content without assay. Elevated mt-ss abundance is recognized through key absorption features near 1411 cm^{-1} (O-H bending) and 2200 cm^{-1} (Al-OH vibration) that shift to higher wavenumbers due to replacement of octahedral Al by Li. Notably, the wavenumbers of diagnostic absorption features are insensitive to orientation/grain size, suggesting that the method can be applied to drill core samples and does not require preconcentration/grain orientation before analysis.

***U-Pb geochronologic and mineral-chemical results from apatite and titanite in the Clarence Stream gold-antimony deposit, southwestern New Brunswick, Canada**

HASSAN HEIDARIAN[1], DAVID R. LENTZ[1], CHRISTOPHER R.M. MCFARLANE[1] AND KATHLEEN THORNE[2]
1. Department of Earth Sciences, University of New Brunswick, 2 Bailey Drive, Fredericton, New Brunswick E3B 5A3, Canada <Ha.heidarian@unb.ca> 2. Geological Surveys Branch, New Brunswick Department of Energy and Resource Development, Fredericton, New Brunswick E3B 5H1, Canada

The Clarence Stream deposit in southwestern New Brunswick, consists of several antimony-bearing gold mineralized zones hosted within large-scale structures in metasedimentary and metavolcanic sequences of the Cookson and Mascarene groups, as well as several younger magmatic intrusive rocks, consisting of gabbroic and intermediate dykes, and granitic pegmatite-aplite dykes. Mineral chemistry and U-Pb geochronology of apatite and titanite in the South, George Murphy, Richard, and Jubilee zones reveals details about the mineralizing fluids and timing of mineralization. Hydrothermal apatite and titanite hosted in mineralized quartz veins were analyzed by *in situ* methods including microX-Ray Fluorescence Spectrometry (µXRF) followed by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS).

The apatite chondrite-normalized REE plots illustrate $LREE_N$ and $HREE_N$ enrichment (0.95, 2.08) and depletion (0.61, 1.94) patterns, pronounced negative ($(Eu/Eu^*)_N$, <0.80) and positive Eu anomalies ($(Eu/Eu^*)_N$, >0.82), in the South (CS332-264.5), Richard (BL12-117.5), and one of the Jubilee zone samples (BL43-74.2). These different REE patterns show that the apatite formed during two different stages from hydrothermal fluids under reducing to oxidizing environments. Apatite within the George Murphy Zone sample (CL33-247.25) shows $(LREE/HREE)_N$ of 0.33 with negative Eu anomalies ($(Eu/Eu^*)_N$, <0.65), corresponding to crystallization in a reduced environment. The second sample from the Jubilee Zone (BL19-44-303) shows $(LREE/HREE)_N$ of 0.73 with a positive Eu anomaly ($(Eu/Eu^*)_N$,>0.98), which formed in an oxidized environment. As the George Murphy, Richard, and Jubilee zones are hosted within the same structure, their combined U-Pb age is 374±24 Ma.

Two mafic intrusive rocks from the West (CS13-329-14.8) and South (CS17-353-127) subzones of the South Zone contain hydrothermal titanite. The chondrite-normalized REE plots in CS13-329-14.8 illustrate $LREE_N$-depletion ($(LREE/HREE)_N$, 0.18) with positive Eu anomalies ($(Eu/Eu^*)_N$, >1.29) reflecting crystallization from a low oxygen fugacity fluid. However, CS17-353-127 shows $LREE_N$-enrichment ($(LREE/HREE)_N$, 1.24) with positive to negative Eu anomalies ($(Eu/Eu^*)_N$, 2.40-0.61). These positive to negative Eu anomalies could be representative of fluctuations from low to high oxygen fugacity of the mineralizing fluid; combined U-Pb geochronology results from these two samples yielded an age of 396.9 ±2.5 Ma.

Based on previous studies, the age of gold mineralization associated with the late phase of the Magaguadavic Granite is 396.0 ± 0.5 Ma at the South Zone, which is confirmed by U-Pb geochronologic data from hydrothermal titanite. The maximum age from apatite shows that the gold mineralization at the George Murphy, Richard, and Jubilee zones is no older than the mineralization at the South Zone.

**Quartz-hosted fluid inclusions associated with polymetallic mineralization (Fe-Co-Ni-Cu-As-Ag-Sb-Au-Pb), of the Nictaux Falls Dam, Lansdowne, and Cape Saint Mary's occurrences in the Meguma Terrane, Nova Scotia

J. JACKMAN[1], N. WELT[1], E. ADLAKHA[1], J. HANLEY[1], M. KERR[1], N. KENNEDY[1], G. BALDWIN[2],
1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada <joshmarpa@gmail.com>; 2. Nova Scotia Department of Energy and Mines, Halifax, Nova Scotia B3J 2T9, Canada

This study is on quartz-hosted fluid inclusions (FI) from three metasediment-hosted polymetallic vein occurrences [Nictaux Falls (Co-Ni-As-Au-Bi), Lansdowne (Zn-As-Ag-Sb-Au-Pb) and Cape Saint Mary's (Co-Ni-Cu-Zn-Ag-Sb-Au-Pb-Bi)] in the SW Meguma Terrane, NS. Similarities in host rock-type, alteration, and metal association suggest a possible genetic link between these occurrences. This work aims to establish the P-T-X of fluids associated with all three sites to confirm their genesis.

Nictaux Falls FI are classified into three types: *type-1* are liquid-rich, two-phase ($L_{H2O-NaCl}+V_{H2O\pm CH4}$), *type-2* are liquid-rich, three-phase ($L_{H2O-CaCl2-NaCl}+V_{H2O\pm CH4}+S_{halite}$), and *type-3* are single-phase ($L_{H2O-CaCl2-NaCl}$) inclusions. Textural observations indicate that *types-1* and *-2* inclusions are primary or pseudo-secondary in origin, while *type-3* inclusions are secondary. Most inclusions (all types) did not freeze at/before -180°C, suggesting high divalent cation contents (likely Ca^{2+}). Final ice melting temperatures (T_m^{ice}) were -47.1°C (n = 1), -49.8°C (n = 1) and -40.1 to -51.1°C (n = 3), for the three respective fluid types, suggesting minimum salinities of 43.2 wt% $CaCl_{2equiv}$. Heating experiments yielded homogenization temperatures (T_h; to liquid) of 127-213°C (n = 6) and 194-202°C (n = 3) for *types-1* and *2* fluids. Calculated isochore data for *type*-1 inclusion assemblages combined with chlorite thermometry (~280°C) indicate a very low entrapment pressure (~110 bar).

Lansdowne FI are classified into four types: *type-1* inclusions are single-phase ($L_{H2O-CaCl2-NaCl\pm CH4}$) inclusions, *type-2a* are liquid-rich, two- or three-phase ($L_{H2O-NaCl}+V_{CH4\pm CO2}$ or $L_{H2O-NaCl}+L_{CO2}+V_{CH4}$), *type-2b* are two phase ($L_{H2O-NaCl}+V_{CH4\pm CO2}$) vapour-rich inclusions, and *type-2c* inclusions are one-phase ($V_{CH4\pm CO2\pm H2O}$). *Type-2* inclusions may occur in single assemblages. Crosscutting relationships show FI are primary or pseudosecondary in secondary quartz coeval with mineralization. *Type-1* inclusions show T_m^{ice} between -44.0°C and -20.4°C (n = 26), suggesting salinities of 23.4 – 47.1 wt% $CaCl_{2equiv}$. Many *type*-1 inclusions did not freeze, suggesting high Ca^{2+}. *Type-2a* inclusions show T_m^{ice} between -8.3 and -3.9°C (n = 54), suggesting moderate to low-salinity (6 to 12 wt% $NaCl_{equiv}$). Only CH_4-poor, *type-2a* inclusions homogenized before decrepitation between 148-173°C (n = 7). *Type-3* inclusions homogenized to vapour between -110 and -92°C (n=10), indicating a very low entrapment pressure of ~150 bar.

The results of this study show that ore fluids at both Lansdowne and Nictaux Falls were variably Ca-rich and highly saline in a near surface epigenetic environment. The co-entrapment of low salinity brines and CH_4 is unique to Lansdowne, where mingling between the two fluids is preserved in *type-2* assemblages showing variable brine-hydrocarbon phase ratios. The characterization of Cape Saint Mary's samples is under way.

Application of bulk fluid volatile chemistry to exploration for metasedimentary rock-hosted orogenic gold deposits: An example from the Meguma terrane, Nova Scotia, Canada

MITCHELL KERR[1,2], JACOB HANLEY[1] AND DANIEL KONTAK[2]
1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada <mitchell.kerr@smu.ca>; 2. Harquail School of Earth Science, Laurentian University, Sudbury, Ontario P3E 2C6, Canada

Disseminated Au deposits hosted in metasedimentary rocks present unique exploration challenges because the Au is generally very fine-grained or refractory, and not vein-hosted. Exploration programs in

such settings rely on extensive lithogeochemical surveys, lesser structural analysis, and little emphasis on ore-fluid geochemistry. The Moose River anticline (MRA) in the Lower Paleozoic Meguma terrane (Nova Scotia, Canada) hosts several high-tonnage (~10-20 Mt), low-grade (≤1 – 4 g/t Au) Au deposits comprised of disseminated ± quartz vein-hosted mineralization in metamudstones. Here, the Touquoy deposit is used to evaluate a new approach to geochemical exploration by examining if the volatile chemistry of host rocks preserves a signature related to Au mineralization, using a gas chromatographic (GC) technique that analyzes bulk volatiles released from crushed rock. Since GC is a bulk analytical technique, the volatile compositions of fluid inclusions were also investigated using laser Raman microspectroscopy to reconcile bulk analyses with the composition and abundance of different inclusion types. Inclusions in quartz pressure shadows associated with porphyroblasts host N_2±CH_4-dominant vapor phases and represent wall rock-equilibrated fluids. In comparison, fluid inclusion vapor phases in quartz veinlets crosscutting the metamudstones are more complex in composition and show a continuum between CO_2-dominant and N_2±CH_4-dominant compositions; the former is interpreted as the fluid responsible for Au mineralization in the Meguma terrane (e.g., H_2O-CO_2±CH_4±N_2 fluids). GC shows statistically significant differences between the bulk volatiles released from crushed metamudstones from the Touquoy deposit (n = 21) and barren (n = 24) settings. Whereas the former commonly contain detectable CO_2 (50% of samples), only ~4% of metamudstones from barren settings along the MRA contain CO_2, yielding a t-test p-value of 0.0103 between the two sample populations. Additionally, anomalous differences in abundances of released C3 (t-test p-value = 0.043) and C4 (t-test p-value = 0.03) hydrocarbons (HC) are recognized between the two populations, with Touquoy metamudstones having higher $\Sigma(C3)/CH_4$ and $\Sigma(C4)/CH_4$ ratios compared to barren equivalents. The compositional differences suggest that more aqueous-carbonic fluids infiltrated metamudstone units where locally favourable physical and/or chemical conditions are present, resulting in increased Au endowment. The relative increase in fluid flux, and thus Au grade, resulted in more trapped CO_2 and modification to hydrocarbon signatures through homologation and/or degradation reactions.

Tentatively, the results suggest that bulk analysis of volatiles released from fluid inclusions in metamudstones may be a useful vectoring tool for disseminated Au mineralization in Meguma-type gold systems and similar environments (e.g., Carlin-type).

Large scale late Cenozoic to post-glacial growth faulting in the northern sector of the Banks-Beaufort- Basin, western Canadian Arctic

EDWARD L. KING[1] AND SYDNEY STASHIN[2]

1. Natural Resources Canada, Geological Survey of Canada-Atlantic, Dartmouth, Nova Scotia B2Y 4A2, Canada <edward.king@canada.ca> 2. Department of Earth and Environmental Sciences, Dalhousie University, B3H 4R2, Nova Scotia, Canada

The Cenozoic Banks-Beaufort Basin spans >1000 km from the Beaufort Shelf (SW) to M'Clure Strait (NE). Offshore seismic and exploratory hydrocarbon wells are numerous within the analogous Mackenzie Basin, beneath Beaufort Shelf, in the southwest, yet no offshore well control exists in the north. A recently accessed industry multichannel seismic grid enables focus on the Neogene-Quaternary stratigraphy for the Banks-Beaufort Basin. Strong faulting persists along the Banks Island shelf-break between Amundsen Gulf and M'Clure Strait. Assessing the nature and timing of faulting is necessary to mitigate geohazard risk.

A series of deep-seated (>4 km) listric growth faults demonstrate periodic reactivation through differential offsets upward through the undated strata. A limited chronology was establishing though seismic ties to wells on Banks Island and correlation from the Mackenzie Basin. We subdivided the Plio-Pleistocene section of Banks Island Shelf into six seaward thickening, aggradational units bounded by planar, conformable horizons. The lowermost unit overlies a basin-wide unconformity previously assigned late-Miocene to early Pliocene age buried over 1km at the shelf break. Two additional

uppermost units are erosion bound and attributed to a glacial origin. The two glacial units (<200 m thick) attest to shelf-crossing glaciations on Banks Island Shelf. They are Shallow Bay Seq. equivalents as defined on the Beaufort Shelf, apparently stratigraphically equivalent to the earliest and latest of multiple glacial sequences preserved in nearby Amundsen Gulf.

Most faults dip steeply seaward, flattening at depth, with synthetic and antithetic components. They number over 20; the most prominent are correlated across >75 km. Offset measurements on 15 seismic transects across 12 traced horizons reveal >30% exceed 50 m while 60% exceed 25 m. The most recent fault activity is closest to the shelf break where the aggradational wedge is thickest; the more landward fault occurrences de-activated in the mid Pliocene. Maximum horizon offset through time decreases from >200 m near the Miocene-Pliocene unconformity to >75m at the seabed, reflecting periodic re-activation. The older glacial deposits are slightly more commonly offset than the younger deposits. This contrasts the Beaufort Shelf where no faults are observed to cut even the oldest glaciated surfaces. Bathymetric multibeam and ultra-high resolution sub-bottom profiler transects express >10 m throw across otherwise extremely planar glacial erosion surfaces, a late glacial age canyon, and seabed iceberg scours. All are attributed to the last glaciation. Seabed mud volcanoes and a ridge diaper, both with undiscernible sediment cover, suggest recent fluids flux. These observations all point to an active fault system.

**Investigation of geological controls on radon concentration in surficial sediment in Whitehorse, Yukon

MICHAEL J. KISHCHUK[1], PANYA S. LIPOVSKY[2], JEFFREY D. BOND[2] AND JOHN C. GOSSE[1]

1. Department of Earth and Environmental Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada <mc723665@dal.ca> 2. Yukon Geological Survey, P.O. Box 2703, Whitehorse, Yukon Y1A 1B5, Canada

Indoor concentrations of radon gas in excess of Health Canada guidelines have been reported throughout the Whitehorse area, yet only cursory measurements have been made to determine the concentration of radon in undisturbed near-surface settings. Radon-222 is a carcinogenic gas formed by the decay of uranium in rock and sediment and is the second-leading cause of lung cancer in Canada. Information about its occurrence is important for public health policy such as building codes. Prolonged inhalation of radon-222 leads to radioactive daughter nuclides and heavy metals in lung tissue. While bedrock is often considered the source of radon, the combination of uranium-poor bedrock and thick sediment cover suggests that surficial sediment may be a primary source of radon around Whitehorse.

To evaluate radon sources and activity, we sampled 30 sites over summer 2020 representing a range of bedrock and surficial sediment types. The underlying bedrock types are granodiorite, limestone, clastic sedimentary, and basalt. The surficial sediment we classified genetically as till, glaciofluvial sand and gravel, glaciolacustrine sediment (fine sand and silt), fluvial sand and gravel, and eolian sand. To determine controlling factors we then compared mean radon concentration at each site to bedrock lithology, thickness of surficial sediment, surficial sediment type, surficial sediment grain size distribution, sediment maturity, and soil moisture.

We observed correlation between grain size distribution and radon concentration, with sediments containing more silt and clay in their matrix displaying higher radon concentration. We also observed that radon concentration is generally higher in less mature sediments (e.g. till) compared to more mature sediments (e.g. fluvial and eolian sand). We observed no significant correlation between radon concentration and bedrock lithology nor depth to bedrock. Our findings suggest that sediment maturity and grain size are first order controlling factors of radon concentration in surficial sediment, and that bedrock is neither the only nor the most important source of radon in the study area. We also observed pronounced interseasonal variation at three long-term monitoring sites, but little intraseasonal variation over the summer.

Microscopic insight into a Meguma gold deposit setting: Nature of arsenopyrite beds at The Ovens

DANIEL J. KONTAK
Harquail School of Earth Sciences, Laurentian University, Sudbury, ON, P3E 2C6, Canada <dkontak@laurentian.ca>

The Meguma terrane of southern Nova Scotia is well-known and studied for its slate-belt type orogenic quartz-vein gold deposits (i.e., Meguma deposits). Of the numerous studies of these deposits, the majority have focused at the macro-scale with emphasis on the host lithologies, structure, alteration and vein types with supporting fluid inclusion, isotopic and age dating studies which together suggest a hybrid metamorphic-magmatic model. In contrast, lesser attention has been given to micro-scale mineralogical features which has, in recent years, become the focus of attention for such settings globally due to the advent of LA-ICP-MS and related elemental mapping of sulfides. At the Ovens deposit, auriferous quartz veins are localized to the hinge of a tight fold closure and cut metasiltstone and mudstone rocks which are locally inundated with arsenopyrite (aspy) and best referred to as aspy beds. Previous work (i.e., Re-Os aspy, $^{40}Ar/^{39}Ar$ whole rock, muscovite) constrains formation of the auriferous veins to ca. 405 Ma with a later overprinting event at ca. 375 Ma. To better understand the nature and relevance of the aspy to the Au event, a detailed SEM-EDS study was undertaken of these aspy-rich beds. Results indicate a complex paragenesis in a general sequence of: 1) an early framboid-like porous pyrite (py1) locally recrystallized to As-pyrite (py2) with cavities lined by zoned carbonate hosting Cu-Fe-Pb sulfides and monazite; 2) an early matrix muscovite-Fe carbonate-rutile-apatite-gal assemblage (EA) overgrown by later pyrite (py3) with inclusions of euhedral aspy (aspy1); 3) euhedral aspy (aspy2) overgrows and replaces py3, hosts tourmaline, Fe(Ca-Mg-Mn) carbonates and overgrowths the EA noted before; 4) the host rock contains resorbed detrital quartz with sub- to euhedral overgrowths that coexisting with abundant neomorphic muscovite which together define a variable developed fabric; and 5) Fe-rich chlorite replaces the latter muscovite. Disseminated in the matrix and sulfides are hydrothermal monazite and xenotime. These observations reveal a complex paragenesis for these aspy beds which commenced with early diagenetic py (py1) followed by subsequent periods of fluid ingress and new mineral growth (py2, py3, aspy1, aspy2) accompanied by modification of earlier assembles. How this relates to the geotectonic evolution of the setting, previous age dating and the implications for the Meguma Au event will also be addressed.

Public opportunities to discover geoscience in industry from historic and modern mining practices through the partnership of Atlantic Gold and the Moose River Gold Mines Museum in Middle Musquodoboit, Nova Scotia

RILEA KYNOCK
Atlantic Mining NS Inc., a wholly owned subsidiary of St. Barbara Limited, 409 Billybell Way, Mooseland, Middle Musquodoboit, Nova Scotia B0N 1X0, Canada <rilea.kynock@atlanticgold.ca>

The best opportunities for learning geoscience and geoheritage are centred around “seeing and doing”, often though field excursions that can cause barriers for people limited by travel and mobility. On the site of Atlantic Gold’s Touquoy mine, there is accessible public infrastructure encouraging visitors to not only closely park and behold the natural and engineered features of the pit but discover the history of mining in the area and the community built around it. The Touquoy mine is a 1-2-hour drive from most mainland cities. From the public viewing point, visitors can view the deep, benched walls showing pristine examples of sedimentary layering, folds, faults and mineralized veins exposed in the hinge of the Moose River Anticline. These features easily make visualizing geologic processes tangible to even novice geology enthusiasts, available freely without cost or appointment. From Mooseland Road, there is also visibility of the ore and waste stockpiles, tailings management facility, and processing plant exhibiting the vast amount of geological and environmental engineering efforts involved in modern mining.

Neighbouring the mine, is the Moose River Gold Mines Museum that was established in 1986 in the village's historic one-room schoolhouse. While it holds the histories of early gold mining on the Eastern Shore and the community of Moose River Gold Mines, its largest collection is centred on the Cave-in of 1936, which trapped three men, and the rescue effort that ensued. The event was the first for on the spot news coverage in history and gained millions of listeners around the world. The museum is open for the months of July and August, seven days a week from 10am till 4pm. In the off season it will open for tours by appointment. The preserved history is a critical reminder for the safety perspective of mining. The adits of those underground tunnels that trapped the three men for ten days are visible from the public observation point, along with the geotechnical structures contributing to the collapse. The same geotechnical predisposition affects the current pit and modern safety mechanisms are situated close to the collapse site. The viewing point and Moose River Gold Mines Museum will remain accessible after the inevitable closure of Touquoy, but visitors are encouraged to timely observe the mine in operation and see the contrast of modern mining methods, technology, and safety from the ways of history.

† **Survey of potential syngenetic occurrences of archaeal lipid biphytanes in lower greenschist, Late Archean (2.65 Ga) metamorphosed argillites of the Abitibi Subprovince, Timmins, Ontario, Canada

NIKITA LAKHANPAL[1], ELISH REDSHAW[1], JOHN, M. DOOMA[1], JEREMY, N. BENTLEY[1], MICHAEL PASTERSKI[2], FABIEN KENIG[2], G. TODD VENTURA[1]

1. Saint Mary's University, 923 Robie St, Halifax, Nova Scotia B3N 3C3, Canada <nikitalakhanpal30@gmail.com> 2. University of Illinois at Chicago, Chicago, IL USA.

Molecular fossils (i.e. biomarkers) from ancient rocks are not expected to preserve if subsurface temperatures reach above 200°C over extended periods of time. This makes reconstruction of the microbial diversity of life using biomarkers highly problematic for rocks older than the Paleoproterozoic Era (i.e. 2.5 Ga) where to date all known rocks have undergone at least some degree of metamorphism. Nonetheless, biphytanes, which are archaeal lipid biomarker, were detected in lower greenschist metamorphosed argillites (200–300 °C between 2,669 and 2,665 Ma) from the Abitibi province, Timmins, ON, Canada. This work is highly controversial with many researchers favoring alternative sources for the reported lipids that are significantly younger in age than their host rock. We hypothesize that by using different extraction techniques, the sources of organic matter contamination can be more clearly defined and an evaluation of biphytane host-rock syngeneity better evaluated. For this study, all equipment was carefully solvent washed, combusted, or acid treated to remove laboratory sources of contamination. Initial results have shown that different core or hand samples may have different susceptibilities to secondary inputs of organic matter. Near surface collected hand samples were fissile along their foliation planes and absorb water readily through foliation planes. These samples are therefore removed from further study. For the drill core samples, which did not adsorb water, drill mud contamination was evaluated and screened from the samples by an initial solvent wash that was followed next, by grinding away ~1cm of the exterior layer of the core sample. The powder was then collected and extracted for hydrocarbon biomarkers. These series of steps were then repeated until the core sample was completely ground to powder. This technique has been performed on two core samples. The first did not recover any biphytanes, but did display bacterial hopane and eukaryotic sterane biomarkers. A second sample is still to be completed. It is hoped that these improved extraction methods can significantly reduce potential sources of contamination in the resulting extracts to further help to constrain the age and origin of the biphytane biomarkers.

A Tale of Two Ponds

ALISON LEITCH, JIANGGUANG CHEN, ELLIOTT BURDEN, HARANUR RASHID
Department of Earth Sciences, Memorial University of Newfoundland, St John's, Newfoundland and Labrador A1B 3X5, Canada

Bathymetry surveys of two small lakes in Newfoundland, in very different environments and separated by hundreds of kilometres, were carried out using two different survey methods – ground penetrating radar (GPR) and sonar. Tippings Pond, on the outskirts of the town of Cornerbrook in western Newfoundland, is a popular recreation area. Grassy Pond, several kilometers inland from the Trans Canada Highway in eastern Newfoundland, is within an undeveloped area accessible by skidoo in the winter. Tippings Pond, roughly square with an area of 1.6 km^2, is slightly salty, making it largely impenetrable by radar. Sonar surveys revealed it to be bowl shaped and more than 26 m deep in the centre. Grassy Pond, with an elongated shape 1.2 km^2 in area, is very fresh, and GPR was able to image structure in the soft sediment as well as the bedrock interface. The sediment interface is undulating and shallow (up to 2.8 m deep) while the bedrock features sub-basins up to 8.3 m deep. Apart from revealing the different structure of these two disparate ponds, the study outlined the strengths and limitations of the two survey methods.

Groundwater silcrete in the Potsdam Group, Ottawa Graben: A case example of shallow fault-controlled silicification and desilicification in a tectonically active basin

DAVID LOWE[1], RWC ARNOTT[2], EDWARD DESANTIS[3] AND JAMES CONLIFFE[4]
1. Department of Earth Sciences, Memorial University, St. John's, Newfoundland and Labrador A1B 3X5, Canada <dlowe@mun.ca> 2. Department of Earth and Environmental Sciences, Ottawa, Ontario K1N 6N5, Canada 3. Fisheries and Oceans Canada, Ottawa, Ontario K1A 0E6, Canada 4. Geologic Survey Division, Newfoundland and Labrador Department of Industry, Energy and Technology, St. John's, Newfoundland and Labrador A1B 4J6, Canada

Silcrete forms by silicification of sediment or bedrock at the Earth's surface due to soil-forming processes (pedogenic silcrete), or in the shallow subsurface (< 100 m) along the water table (groundwater silcrete). Unlike pedogenic silcretes, the origin of groundwater silcretes are poorly understood with existing case studies highlighting near-surface silica flux, whereas extrabasinal sources and/or migration of silica-bearing fluids along faults have not been demonstrated. Based on spatial and textural characteristics of a groundwater silcrete from the Cambrian-Ordovician Potsdam Group in the Ottawa Graben, however, a close association between the migration of silica-rich fluids and multiple northeast-trending faults is suggested. This ≤ 150 cm thick silcrete horizon underlies an unconformity that caps a succession of fluvial quartz arenite along the flanks of fault-bounded ridges of Grenville basement. The silcrete horizon thickens toward these faults and shows a systematic change in morphology from nodular to massive to brecciated. Cathodoluminescence reveals an early luminescent zoned cement (C1) associated with silcrete formation, and a later massive non-luminescent cement (C2) that occurs as overgrows filling remaining porosity in these and adjacent Potsdam strata. Fracturing and autoclastic brecciation of silcrete occurs within tens of meters of faults and is characterized by jigsaw and collapse breccia made up of silcrete clasts in a massive sand, kaolinite, and Fe-oxide matrix. Here it is speculated that silica-rich fluids moved along faults and advected into adjacent Potsdam sediment where the effects of pH change and evaporation promoted C1 precipitation. Later fracturing and migration of high pH fluids near faults led to local C1 dissolution and autoclastic brecciation. Finally, C2 cements formed throughout Potsdam strata following burial and pressure solution of non-silcretized arenite. Although the source of silica and fluid reservoirs for C1 remains uncertain, the scarcity of remnant detrital feldspar or unstable silicates in Potsdam strata suggests that the Grenville basement was the most likely source.

Ongoing fluid inclusion analyses of C1 cements aims to resolve fluid temperature and salinity conditions, and a meteoric versus hydrothermal origin.

Student acceptance of digital specimens as a substitute for the real thing in an introductory geology lab

JASON LOXTON
Department of Mathematics, Physics, and Geology, Cape Breton University, Sydney, Nova Scotia B1P 6L2, Canada <jason.loxton@gmail.com>

Over the past decade, there has been a dramatic expansion in the availability of digitized versions of materials typically used in teaching geology labs (e.g., rock and mineral samples, sediment, and thin sections). The shift to online delivery of courses and labs during the 2020 fall semester presented an opportunity to test the effectiveness of these materials for instruction. While some schools opted to deliver rock and mineral kits by mail, instructors at Cape Breton University shifted entirely to digital resources to support introductory geology labs (GEOL 2101: Engineering Geology), while leaving the overall content and structure of labs largely unchanged. Enrolled students were given an anonymous end of term survey about their experience with three technologies: virtual microscopes, 3D digital models of hand samples, and 360-degree panoramic photos of localities. 38 students responded (64% response rate). Feedback on all three technologies was very positive, with 86-90% at least somewhat agreeing—and 44-55% "strongly agreeing"—that these devices helped their learning. Additionally, 47-52% strongly agreed that these technologies "replicated the experience of interacting with physical specimens or environments," and only 6-8% disagreeing. Written comments were overall positive, with emphasis on their realism, variety, and interactivity, but several respondents noted missing the tactile aspect of physical specimens, limitations of digital quality (resolution, lighting or contrast), or issues getting the models to load. This latter problem was likely exacerbated by the fact that 31% of students were accessing the course on a mobile device or tablet and/or had only low-speed Internet. While students, overall endorsed these technologies, they were split on whether they would have preferred to have access to mailed sample kits if given the option, with a moderate preference for mailed kits (42% mailed/34% digital/24% neutral). Taken together, these data suggest that digital specimens provide an acceptable alternative for delivering traditional introductory geology labs.

† **Epithermal gold mineralization and associated alteration at the Golden Ridge Deposit, Poplar Mountain Volcanic Complex, southwestern New Brunswick: analysis of the role of pyrite and arsenopyrite during mineralization

MOYA MACDONALD[1], DAVID R. LENTZ[2], ALAN CARDENAS[2], AND KATHLEEN G. THORNE[3]
1. Department of Earth Sciences, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <mmacdo24@unb.ca> 2. University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada 3. Geological Surveys Branch, New Brunswick Department of Energy and Resource Development, Fredericton, New Brunswick E3B 5H1, Canada

The Middle Ordovician Poplar Mountain Volcanic Complex, southwestern New Brunswick, consists of three main volcanic phases: porphyritic rhyodacite, rhyodacitic volcaniclastic rocks, and basaltic volcanic rocks; previous U-Pb zircon dating indicates that these volcanic rocks formed at 459.0 ± 3.0 Ma. Gold mineralization is associated with veining and associated illitic alteration that was dated using $^{40}Ar/^{39}Ar$ methods to be 411.0 ± 3.7 Ma, thus suggesting it to be considerably younger than the volcanic sequence and possibly related to the Pokiok Batholith to the south. Based on gold assay data from

archived assessment file reports and relogging available drill core, gold mineralized stockwork-like veining is mainly constrained to the porphyritic rhyodacite. The presence of gold appears to be restricted to areas containing arsenopyrite, and to a lesser extent pyrite, as well as in areas of multiple quartz-carbonate vein stockworks and areas of hydrothermal brecciation. Selected samples were analysed using Instrumental Neutron Activation Analysis and Inductively Coupled Plasma-Optical Emission Spectrometry and -Mass Spectrometry. Paragenetic examination of the complex veining helped select various pyrite- and arsenopyrite-bearing assemblages for microX-Ray Fluorescence (µXRF) – Energy Dispersive Spectrometry mapping; certain pyrites were chosen based on their size and textures, as well as the Au grades of the corresponding samples. Using µXRF, two electrum grains were found within a sample containing 10.2 g/t Au. There is also evidence of some arsenic zoning in pyrite within a few samples, as well as S-As zoning in arsenopyrite overprinting some earlier pyrite that occurs as disseminations. The purpose of this research is to determine if gold is refractory within pyrite and arsenopyrite or if it is present as free gold or electrum. If gold was saturating during pyrite and/or arsenopyrite formation, there should be a geochemical association between As, S, and Au, which is evident in the bulk geochemical analyses. Laser Ablation Inductively Coupled Plasma – Mass Spectrometry (LA-ICP-MS) analysis has been conducted on pyrites within six of the samples, as well as elemental mapping of the six samples. From pyrite LA-ICP-MS analysis, samples contained values of up to 210 ppm Au in association with As substitution; a geometallurgical balancing is still needed to ascertain the relative forms of gold in this system. Future work includes Ar-Ar dating of illite from the NE zone discovered in 2011. Rare hydrothermal apatite has been identified in several stockwork veins, which may be dated by *in situ* LA-ICP-MS U-Pb methods to confirm the ages of mineralization.

*Variation in the major and trace element geochemistry of biotite and apatite from the South Mountain Batholith, Nova Scotia

BRYAN J. MACIAG[1], JAMES M. BRENAN[1], JACOB HANLEY[2]
1. Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada <bmaciag@dal.ca> 2. Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada

The South Mountain Batholith (SMB) is a 7300 km^2, peraluminous, felsic intrusion that consists of 13 plutons that were emplaced in two different phases between ~385 and ~368 Ma. Despite its large size, only one significant mineral deposit (East Kemptville) was mined. To aid in assessing magma metal fertility this study is characterizing biotite and apatite compositions with goals to (i) establish a geochemical "baseline" for these minerals; and (ii) determine if these minerals can highlight geochemical anomalies related to mineral deposits. We have analyzed 24 samples representing seven of the major plutons. Major elements (including F and Cl) were measured by electron microprobe and trace elements by LA-ICPMS. The trace element suite includes transition metals, semi metals, high field strength elements and large ion lithophile elements. Key results are:

i) Biotite is close to the siderophyllite end-member with a composition of $K_{1.8\text{-}2.0}(Fe_{2.2\text{-}4.2}Mg_{0.20\text{-}1.8}Al_{0.58\text{-}2.2})(Si_{5.3\text{-}6.0}Al_{2.0\text{-}2.7}O_{20})(OH_{2.5\text{-}3.8}Cl_{0.00\text{-}0.06}F_{0.15\text{-}1.4})$.
ii) Both biotite and apatite are F-rich with F# (=F/[F+Cl]; wt.% elements) ranging from 0.75 to 1.0 in biotite, and from 0.93 to 1.0. in apatite.
iii) The biotite F# shows a weak, positive correlation with Fe# (=Fe/[Fe+Mg]; wt.% elements), which ranges from 0.77 to 0.98. The F# and Fe# along with the Al content of biotite can be used to discriminate which pluton the sample originated from, although there is overlap between some plutons. Thus, biotite is a good reflection of individual pluton geochemistry and may reflect differences in pluton parental melts.
iv) The biotite Fe# also correlates with the whole rock SiO_2 content (66 to 75 wt.%), indicating that Fe# of biotite can be used as a measure of SMB differentiation.

v) Cobalt, Cr, and Ni concentrations in biotite decrease from 40 to 5.9 μg/g, 155 to 1.7 μg/g, and 43 to 0.45 μg/g, respectively, as the Fe# increases. The biotite V concentration decreases linearly from 280 to 82 μg/g over the range of Fe# of 0.77 to 0.94 before dropping to 0.71 μg/g at an Fe# of 0.98. The whole rock V concentration (2 to 64 μg/g) is lower than that of biotite but mimics the slope of the biotite V content from Fe# 0.77 to 0.84 and 0.86 to 0.94. These similar slopes suggest that biotite is exerting some control on the abundance of V.
vi) Lithium (230 to 5800 μg/g) and Sn (10.0 to 120 μg/g) both correlate positively with the biotite Fe#, reflecting their incompatible behaviour during SMB differentiation.

*Crestal faulting: a source of trap integrity loss and gas migration in the Migrant Structure, Sable Delta, Offshore Nova Scotia

KENNETH T. MARTYNS-YELLOWE[1], GRANT D. WACH[1], FRANK.W. RICHARDS[1] & NEIL WATSON[1]
[1] *Dalhousie University, Basin and Reservoir Lab, Department of Earth Sciences, Life Sciences Centre, 1355 Oxford Street, Halifax, Nova Scotia B3H 4R2, Canada <Ken.Martyns-Yellowe@dal.ca>*

On the Scotian Shelf, rollover anticlines host most of the significant and commercial hydrocarbons. The size and commerciality of hydrocarbons trapped in their reservoirs may depend on the apparent crestal faulting of these structures. This study analyzes the Upper Jurassic to Lower Cretaceous age reservoirs contained in rollover targeted by the Migrant N-20 exploration well. The well was drilled on closure at the Missisauga Formation level based on sparsely intersecting 2D seismic data. However, a crestal fault below 2D seismic resolution that is visible in modern 3D seismic data is visible in the structure.

With commercial hydrocarbons produced from the Thebaud rollover structure faulted at its crest located downdip of Migrant, audited structural maps show that successful trapping was due to a combination of change in isochron thicknesses and favorable juxtaposition of strata on either side of key faults. Given that some rollover structures in the Sable Subbasin are commercially unsuccessful, this study integrates well data and 3D Sable MegaMerge seismic data to demonstrate the relationship between lithological variations and fault displacement (along a crestal fault). A combination of pressure and petrophysical analysis, and 3D geocellular models, populated with petrophysical parameters were incorporated to demonstrate the mechanism and processes responsible for the failure of the Migrant Structure as a commercial trap.

Results indicate a low sand/shale ratio deep in the Migrant Structure with localized trapping of hydrocarbons. Furthermore, a corresponding increase in pressure deep in the structure coincides with zones containing hydrocarbons. The shallow and intermediate sections of the structure is characterized by increased crestal fault displacement with increased lithological juxtaposition. At this level, petrophysical analyses reveal sporadic gas shows suggesting some degree of hydrocarbon migration in that part of the system.

A fault plane profile of the crestal fault using 3D seismic data highlights the creation of juxtaposed leak points in the Migrant Structure from the fault displacement and variable lithological relationships that pose significant implications on the size, distribution, and estimates of hydrocarbon accumulations in these types of structures. The closure and fault relationship in deeper reservoirs in the Migrant Structure observed in this study indicates that most of the zones in the shallow and intermediate intervals at Migrant would likely have been filled to the structural saddle point in the absence of the crestal fault. These insights may be useful for predicting the trapping potential of untested rollover structures in the Sable Subbasin.

****The relationship between selected metal content of Nova Scotia soils and the underlying geology: possible implications for public health (As, Cd, Cr, Cu, Hg, Pb, U, Zn)**

MADISON MATTHEWS AND ANNE MARIE RYAN
Department of Earth Science, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada
<md499783@dal.ca>

Toxic metals in soils can pose a threat to human and environmental health when elevated above health guidelines. The North American Soil Geochemical Landscapes Project (NASGLP) conducted in 2007-2010 provided soil geochemical data of the different horizons from 72 sites around the province. These data have yet to be thoroughly analyzed. All samples were taken from sites with no known direct anthropogenic sources. This study aims to examine the relationship between the geochemistry and underlying geology with a focus on the toxic metal concentrations. Coordinates of the soil sample sites and field data descriptions were used to identify the bedrock and glacial geology underlying each soil sample. In order to assess both the relationship between soil and underlying material and to assess any potential public health concerns, I studied geochemical data from the C horizon and public health layer (0-5 cm) of the following metals: As, Cu, Cd, Cr, Hg, Pb, U, Zn. The preliminary results show some consistency within different bedrock lithologies and toxic metal content that is more evident in the C horizon than in the public health layer. Most metal data for the public health layer are within guidelines, although soil overlying Meguma Group and, less commonly, Horton Group bedrock, do show arsenic above guidelines locally. This initial exploration of the currently available soil data will allow further research on the geochemistry of Nova Scotia soils and their relationship to the province's complex geology, as well as provide important information related to the presence or absence of elevated toxic metals within the soils.

****Experimental study of the formation conditions of trigonal etch pits on diamonds**

BAILEY MILOS[1] AND YANA FEDORTCHUK[2]
Department of Earth Science, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada
<baileymilos@hotmail.com>

Diamonds are a key material for providing information on our Earth's interior due to their ability to reflect and preserve chemical information. Diamonds form at high temperatures and pressure conditions and are brought to the surface by kimberlite magmas. Kimberlites originate from deep regions in the mantle and their composition can vary greatly due to a number of chemical and geological factors, making them difficult to understand. Diamonds often show dissolution (resorption) features on their surfaces, such as etch pits, that reflect the conditions of kimberlite magmas and can provide researchers with a stronger understanding of the deep regions of the mantle. Previous studies have shown that high temperature (T) and oxygen fugacity (fO2) and low pressure promote diamond resorption. However, the limiting values of these parameters for the onset of diamond resorption are not well known. This experimental study determines minimal T and fO_2 for diamond etching at 0.1 MPa. Experiments were conducted with eight natural octahedra diamonds etched in a Na,Ca-carbonate melt in a gas-mixing furnace and in air using box furnace at 630 – 850 ºC for a duration of 60 minutes. *F*O2 was controlled with mix of CO_2 and CO gases in gas-mixing furnace and using iron-wustite (IW), nickel-nickel oxide (NNO), and magnetite-hematite (MH), oxygen fugacity buffers in the box furnace were conducted using a silver capsule containing a layer of quartz between the diamond and buffer. Presence or absence of resorption was confirmed by imaging selected areas of diamond surface before and after experiments with Atomic Force Microscope (AFM) at resolution done to ~1 micron (horizontally) and ~20 nm (vertically). Experiments established minimal T required for diamond etching between 850ºC and 800ºC in IW buffer, between 800ºC and 700ºC in NNO buffer and in pure CO2 gas, and below 630ºC in air. The temperature

and fO_2 levels can provide further information on the conditions in a kimberlite magma (such as CO2, CO and H2O levels).

The elusive Continental Rise: Insights from residual bathymetry analysis of the Northwest Atlantic Margin

DAVID COLE MOSHER[1] AND GONZALOS YANEZ-CARRIZO[2]

1. Geological Survey of Canada – Atlantic, Bedford Institute of Oceanography, Dartmouth, Nova Scotia B2Y 4A2, Canada <david.mosher@canada.ca> 2. Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860 Macul, Santiago, RM, 782-0436, Chile

The concept of the continental rise is engrained in our text books and consequently our perception of the 'Atlantic' passive margin morphology. But is it real? Heezen *et al*. (1959), who were the first to identify the continental rise, derived the concept from bathymetric profiles off the eastern U.S. continental margin. These profiles crossed Chesapeake Drift and the Hatteras Outer Ridge; two massive submarine contourite drift deposits. Morphologies of continental margins are highly variable, as recognized even by Heezen *et al*. and they suggested that identification of the continental rise off Nova Scotia is difficult. Hydrogeologists have recognized for many decades that equilibrium stream dynamics result in a graded, concave-shaped profile along axis of the stream. This same graded shape has been recognized as an equilibrium condition in hydrocarbon exploration models. It is proposed in this study that a graded slope is the equilibrium condition for a margin that represents from long-term balance in processes of sediment input, transport, deposition, erosion and output as a result of particle diffusion processes. The presence of a rise as identified by Heezen *et al*. is, therefore, anomalous. This study further proposes that the graded shape of a margin is mathematically predictable as an exponential decay curve with a constant exponent. To test this hypothesis, a graded surface model slope that extends from the shelf break to the abyssal plain was produced for the northwest Atlantic margin (NWAM). Subtraction of this model from measured bathymetry results in residual anomalies that highlight above grade and below grade segments of the margin. The majority of the margin is graded, i.e., in balance, but the margin is complex. Above grade segments are related to contourite deposition (e.g., Chesapeake Drift and Hatteras Outer Ridge) and submarine fan deposition (e.g. Laurentian Fan). Below grade segments are related to erosion (e.g. Blake Escarpment) or non-deposition (e.g. Flemish Cap). The complexity of the margin, highlighted by this residual bathymetry technique, emphasises the inadequacy of dividing a margin into long established components of slope, rise and abyssal plain. Classification of a passive margin based on grade is more informative in terms of understanding its geomorphology and its sedimentary history.

Quaternary glacial erosion: a global review of process, measurement and rate

SOPHIE L. NORRIS[1], MATTHEW C. DREW, JULIA FAST[1] AND JOHN C. GOSSE[1]

1. Department of Earth and Environmental Sciences, Dalhousie University, 1355 Oxford Street, Halifax, B3H 4R2, Nova Scotia, Canada. <sophie.norris@dal.ca> 2. Department of Physics and Physical Oceanography, Memorial University, St John's, A1B 3X7, Newfoundland, Canada.

Glacial erosion exerts a dominant control on the earth's terrestrial landscape. Through the excavation of material, glacial erosion plays a fundamental role in mountain range exhumation, isostatic processes, and biogeochemical fluxes. Yet, the factors that control the rate and spatial distribution of glacial erosion remain poorly understood. To address this problem, we present the first steps in a project that aims to synthesize and review glacial erosion by using a new global compilation of published Quaternary erosion rates (n= 955). We collate erosion rates from five different measurement techniques integrated over 10^{-1} to 10^{6} years: (i) instrumental measurements beneath active glaciers, (ii) sediment fluxes derived from

streams or ice-marginal deposits, (iii) differential topographic incision of chronologically constrained surfaces, (iv) terrestrial cosmogenic nuclide (TCN), and (v) thermochronology dating. Collated erosion rates range over five orders of magnitude, between 10^{-5} and 10 mm yr^{-1}. This variability in rate supports the interpretation of glacial erosion as both episodic and nonuniform, a fact frequently explained by controls that modulate the efficiency of glacial processes at a variety of spatial and temporal scales. The most widely recognized controlling variables are ice velocity, mean annual temperature, precipitation, subglacial topography, lithology, geological structure, and glaciation duration. This glacial erosion compilation provides the foundation for the next step of the project. We will assess the dominant controls on these erosion rates and present (i) contemporary and (ii) long-term relationships between environmental and physical conditions.

*Organic Geochemical Water Column Survey of the Labrador Sea

GAMRA OUESLATI[1], STEPHEN SNOOK[2], JEREMY, N. BENTLEY[1] AND G TODD VENTURA[1]
1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H C3C, Canada <Gamra.Oueslati@smu.ca> 2. Biological & Physical Oceanography Section, Environmental Sciences Division, Science Branch, Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre, 80 East White Hills Road, P.O. Box 5667, St. John's, Newfoundland and Labrador, Canada

The Labrador Sea has vital importance in the global ocean circulation system. However, it is characterized by difficult environmental conditions, which have led to limited understanding of the marine ecosystem and biogeochemical cycles. My project aims to survey a very specific area of the Newfoundland Labrador Shelf where the warm water masses of the Gulf Stream and the cold-water masses of the Labrador current mix via three transects that cross the Laurentian Channel, Flemish Cap, and Grand Banks This study aims to investigate nutrients variation and thermal water column stratification effects on particulate organic matter, microbial abundance, and community compositions. Microbial group identification is based on the quantification of intact polar lipids (IPLs) that represent the main building blocks of cellular membranes and an important biomarker in marine environments. IPLs have the potential to help delineate the taxonomic diversity and metabolic activity of organisms and can be used to resolve an organism's response to varying environmental conditions. This environmental lipidomic study focuses on the analysis of IPLs and their fossil counterparts, core lipids, which have lost their polar headgroups. Water column filtrate samples marking a series of transects extending out across the shelf margin of the Labrador Sea around Newfoundland were collected at different depths from 52 m to 1818 m. IPLs are being extracted using the Modified Bligh and Dyer technique and will then be analyzed by ultra-high-performance liquid chromatography-mass spectrometry (UHPLC-MS). Lipids analyses will further involve the collection of structural information across various compound classes to identify the respective source organisms and their location of habitability within the water column. The molecular diversities of lipids give quantitative evidence of the living microbial community and their metabolic activity. This project will help to improve our understanding of the sources of input of organic matter that enters into the Newfoundland Labrador Shelf and the productivity of upper water columns.

***Combined soils and in situ ^{14}C approach to evaluate erosion of non-lithified landforms**

CODY PAIGE[1], JOHN GOSSE[2], LUKAS WACKER[3], ERIC KIRBY[4], ERIC MCDONALD[5], ANNINA MARGRETH[6], AND NATHANIEL LIFTON[7]

1. Department of Earth Science, Dalhousie University, Halifax, Nova Scotia B3H4R2, Canada, <cody.a.paige@dal.ca> 2. Department of Earth Science, Dalhousie University, Halifax, Nova Scotia B3H4R2, Canada 3. Department of Earth Science, ETH Zurich, Zürich 8093 Switzerland 4. Department of Geological Sciences, University of North Carolina at Chapel Hill, Chapel Hill, NC 27514, USA 5. Desert Research Institute, Reno Campus, Reno, Nevada 89512, USA 6. Geological Survey of Norway, Trondheim N-7491, Norway 7. Department of Earth, Atmospheric and Planetary Sciences, Purdue University, West Lafayette, IN 47907, USA

Reliable chronology of sediment landforms is required to establish rates of a wide range of pedogenic and geologic processes. Cosmogenic nuclide depth profile exposure dating provides a useful means of estimating the age of the upper meters of sediment by reducing uncertainty related to inheritance. However, surface erosion remains a largely unconstrained variable that together with other variables can contribute a significant uncertainty in the exposure ages. We use a novel approach to estimate erosion rates on five late Pleistocene landform surfaces in Panamint Valley, California, by measuring ^{14}C saturation concentrations in quartz sand from amalgamated sediment samples collected just below the soil mixing zone. The selection of specific sample locations was guided by optimal soils and geomorphic conditions. Erosion rate uncertainty improved by up to 50%, compared to soils geomorphology-based estimates, and previously computed ^{36}Cl and ^{10}Be depth profiles were recalculated. The ages re-calculated with the ^{14}C calculated erosion rates provided confirmation of previously calculated ages (for ^{10}Be profile data), with up to 50% improvement on uncertainty, as well as providing a corrected age (for ^{36}Cl data). While the approach improves uncertainty in the erosion rate, it is now apparent that previous field-based estimates of erosion rates may have significantly underestimated uncertainties.

The Belleisle Fault at Beaver Harbour, New Brunswick: where is it, what is it and when (and how) did it move?

ADRIAN F. PARK[1], STEVEN J. HINDS[1] AND SUSAN C. JOHNSON[2]

1. Geological Surveys Branch, Department of Natural Resources and Energy Development, PO Box 6000, Fredericton, New Brunswick, E3B 5H1, Canada <Adrian.Park@gnb.ca>; 2. Geological Surveys Branch, Department of Natural Resources and Energy Development, PO Box 5040, Sussex, New Brunswick, E4E 5L2, Canada

Three Appalachian tectonostratigraphic terranes converge in the Beaver Harbour area of southern New Brunswick, overlain by two upper Paleozoic sedimentary sequences. The Ediacaran to Cambrian New River and Brookville terranes are separated by the Silurian Kingston terrane, and the cover sequences consists of the late Devonian red beds of the Perry Formation, and the Lighthouse Cove, Cripps Stream and Beaver Harbour formations of more ambiguous affinity, but most probably Carboniferous age. Separating the New River terrane from the Kingston terrane is the Belleisle Fault, a major regional structure that moved as a right-lateral strike-slip fault during the late Devonian and Mississippian interval. Defining which of several faults between Letang Harbour and Beaver Harbour is the 'Belleisle Fault' is not straight-forward, nor is the continuation of the fault in Maine where the Lubec Fault is considered the best candidate. Fieldwork during summer 2020 examined critical relationships between the rocks of the upper Paleozoic cover sequences, the Cambrian rocks and two igneous bodies, the Blacks Harbour granodiorite and Beaver Harbour porphyry and the various candidates for the Belleisle Fault itself. A major tectonic mélange at Beaver Harbour itself north of what has been thought of as 'the Belleisle Fault', and of Perry Formation beneath an angular unconformity below the Beaver

Harbour Formation (and south of what was termed the 'Belleisle Fault') suggests this boundary has a more complex history and form. Instead of a single faulted boundary the fault appears to be a broader zone between Kingston terrane and New River terrane with enclaves of various sequences incorporated, including Blacks Harbour granodiorite, Cambrian Saint John Group and Devonian Perry Formation.

† **Solving the structural puzzle: A 3D model of the Nash Creek Deposit, New Brunswick

JESSICA PATTERSON[1], DANIEL GREGORY[1] AND BERND MILKEREIT[1]
1. Earth Sciences Department, University of Toronto, Toronto, Ontario, Canada
<JessicaTaylor.Patterson@mail.utoronto.ca>

The Nash Creek Deposit (NCD) is a zinc, lead, and silver deposit located within the northernmost segment of the Appalachians. This deposit is a Volcanogenic Massive Sulphide (VMS) that is contained within the Early Devonian rocks of the Jacquet River Syncline. The mineralization is bounded by the Nash Creek Graben, which was active at the time of deposition While the formations that host mineralization have been established, how, or if at all, the mineralization is structurally controlled is not yet well understood. The NCD has great economic potential, but has not yet been modelled using modern software. Therefore, the development of an in-depth three-dimensional (3D) model could improve our understanding of the deposit. This study aims to make a 3D model of the NCD, which could help to better constrain the structural geology, and its interaction with late mafic intrusions. Such a model can be used to better understand the late mafic intrusions, and could also provide insight as to areas in the NCD that have not been drilled and may potentially host an undiscovered deposit or mineralized extension to the known deposit.

Contrasting gold-bearing volcanogenic massive sulfide (VMS) and orogenic gold deposits in the Baie Verte Peninsula, NL Appalachians

STEPHEN J. PIERCEY[1], STEFANIE BRUECKNER[2], DAVID COPELAND[3], GRAHAM D. LAYNE[1], MACIEJ PAWLUKIEWICZ[4], JEAN-LUC PILOTE[5], AND SAMUEL YBARRA[6]
1. Department of Earth Sciences, Memorial University of Newfoundland, St. John's Newfoundland and Labrador, A1B 3X5 <spiercey@mun.ca>; 2. Department of Geological Sciences, University of Manitoba, 125 Dysart Road, Winnipeg, Manitoba R3T 2NT; 3. Anaconda Mining Inc., 55 Elizabeth Avenue, St. John's, Newfoundland and Labrador A1A 1W9; 4. Nord Gold SE, 4th Floor, 27 Dover Street, Mayfair, London, W1S 4LZ, UK; 5. Geological Survey of Canada, 490 rue de la Couronne, Québec City, Quebec, G1K 9A9; 6. Bronco Creek Exploration Inc, 1815 E Winsett Street, Tucson, Arizona 85719, USA

The Baie Verte Peninsula has a history of Au (and Cu) mining (>100 years) and is one of the key gold producing regions in the Canadian Appalachians. Gold mineralization was (and is) mined from both volcanogenic massive sulfide (VMS) deposits and orogenic Au deposits. Gold-enriched volcanogenic massive sulfides are associated with ophiolitic rocks in the peninsula, with most mineralization produced from bimodal mafic sequences in deposits hosted by Cambro-Ordovician (~488-485 Ma) felsic volcanic and volcaniclastic rocks of the Rambler Rhyolite formation (e.g., Ming, Rambler). The mineralization is associated with typical VMS-related sericite-(chlorite-quartz) alteration and consists of (semi-)massive sulphide with epithermal suite element associations (Au, Ag, As, Hg, Sb, Bi, Te) and a complex mineral assemblage consisting of ~40 different sulfide, sulfosalt and oxide minerals associated with Au mineralization. While deformed and metamorphosed, Au mineralization in the VMS deposits is syngenetic and related to Cambro-Ordovician seafloor hydrothermal and magmatic-hydrothermal activity. Orogenic Au deposits are

spatially associated with the Baie Verte Line, but hosted in subsidiary faults off of this regional structure (e.g., Scrape thrust). Producing and past-producing orogenic deposits (e.g., Pine Cove, Nugget Pond, Stog'er Tight) are structurally controlled within the hanging walls of the thrust faults and predominantly restricted to chemically reactive units (e.g., Fe-Ti-rich mafic intrusive rocks, and iron formation) within the Ordovician Snooks Arm Group cover sequence that overlies the Cambro-Ordovician ophiolitic rocks. Mineralization occurs as quartz vein arrays and/or as wall-rock hosted mineralization in chemical reactive units and has alteration assemblages typical of orogenic Au-mineralization (e.g., carbonate-chlorite-muscovite-albite-(hematite-rutile)). Further, the ore mineral assemblages are simple, with Au associated with disseminated pyrite in wall rock with few other sulfides; mineralization is not associated with massive sulfide. Stratigraphic and structural relationships coupled with U-Pb/Re-Os geochronology suggest that mineralization is likely Silurian (to Devonian) in age (~420 Ma and younger). Over 10 years of research on these deposits demonstrates there are two clear episodes of gold mineralization that represent two distinct pulses of mineralization that while spatially associated but genetically distinct.

Relating thick proglacial mud successions to processes at ice-stream margins: a tool for dating ice advances

DAVID J.W. PIPER[1]

1. Natural Resources Canada, Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, P.O. Box 1006,Dartmouth, Nova Scotia B2Y 4A2, Canada <david.piper@canada.ca>

Thick red mud successions many metres thick of late Pleistocene age on Laurentian Fan have attracted attention since the 1950s. Recent studies have shown that they represent periods of high sediment supply on a centennial to millennial time scale, separated by intervals of hemipelagic sedimentation on a similar time scale. Comparison with independent evidence for ice margin positions suggests that the distinctive red muds with silt laminae are not restricted to times when ice reached the top of the continental slope, but may also be deposited after retreat of the ice stream within Laurentian Channel. Most red mud successions are not accompanied by major plunging hyperpycnal flows of sand and gravel.

Seaward of Trinity Trough, muddy glacigenic debris flows (GDFs) are preserved on the low-gradient trough-mouth fan, providing evidence for the muddy composition of the basal deforming layer beneath the Trinity Trough ice stream. The GDFs are cut by three erosional horizons corresponding to plunging sand and gravel flows. Such observations suggest that some of the thick mud successions on Laurentian Fan are the result of breakup on the steep upper slope of GDFs derived from the basal deforming layer of the ice stream, involving rapid entrainment of ambient seawater.

Within Halibut Channel, a young erosional surface provides evidence for powerful meltwater flow seaward of the Younger Dryas ice margin and corresponding proximal turbidites in Halibut Canyon demonstrate that meltwater flow was sufficiently prolonged to deposit multiple turbidites. Sand transported by glacial meltwater was not restricted to a single catastrophic breaching event, but rather was a repetitive ice-margin process. "Normal" meltwater flows with low salinity, driven by a hydraulic head of water in the ice sheet, apparently filled the transverse trough and transported sediment to the shelf edge, where they probably evolved in a manner similar to that monitored in the Squamish Delta. Such a process provides an explanation for the youngest thick red mud successions on Laurentian Fan deposited after the ice stream had retreated from the shelf edge.

Seaward of the Hudson Strait ice stream, cores suggest that thick mud successions and GDFs accumulated at the time of Heinrich layer H3 and probably H4, whereas in H1 and H2 little sediment was supplied to deep water. Concepts developed at mid latitudes may be less applicable, because the outer transverse trough is bounded by deeper water on either side, and there is less evidence for abundant meltwater.

Constraining the effect of a weakening Atlantic Meridional Overturning Circulation on ocean temperatures in the Gulf of St. Lawrence over the past 150 years

**ANNA RYAN[1] AND MARKUS KIENAST[2]
1. Department of Earth and Environmental Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada <anna.c.ryan@dal.ca> 2. Department of Oceanography, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada

Ocean circulation is essential for transporting heat, dissolved CO_2, and nutrients all around the globe. The strength of the ocean circulation, therefore, has a major influence on climate and vice versa. Over time, ocean currents can change causing climate to vary on local, regional, and indeed global scales; in turn, changing climate can affect the strength and location of ocean currents. Recent studies suggest that freshwater addition to the western North Atlantic from melting Arctic and Greenland ice is causing the Atlantic Meridional Overturning Circulation (AMOC), which encompasses the northward flow of warm saline water of the Gulf Stream and the return flow of colder deep water of the Labrador Current, to weaken. This results in surface ocean temperatures offshore of Atlantic Canada to rise faster than in the rest of the global ocean. Ocean warming, in turn, is detrimental to a wide variety of marine species, thus impacting both the environment and the local economy. The objective of this study is to assess past changes in ocean currents in the western North Atlantic, based on sea surface temperature (SST) reconstructions from alkenones preserved in sediments on the Scotian Shelf. Alkenones are long-chain carbon molecules uniquely synthesized by a certain group of phytoplankton that change in composition depending on surface water temperatures. To improve the spatial and temporal resolution of previous studies investigating past SST variability in the open NW Atlantic, we analyzed a high-resolution sediment core from the central Gulf of the St. Lawrence that contains a detailed record of the last 150 years. From 1850 to present, our alkenone-derived SST estimates fluctuate between 6.5 – 7°C with a local error of estimation of 1.4°C. This absence of any significant trend in SST in the central Gulf of the St. Lawrence over the last 150 years implies that factors other than open ocean warming affect our study site. We will discuss how the hydrography of the St. Lawrence River itself, or variable admixture of colder waters from the Labrador Current could mask or offset any SST warming expected from the weakening AMOC. From such analyses, we can gain a better understanding of the changes we are seeing now and more reliably predict what is to come.

† **Conditions of pocket formation in the Zapot pegmatite, Gillis Range, Nevada

MARGARET SCOTT[1], ALAN J. ANDERSON[1] AND MICHAEL A. WISE[2]
1. Department of Earth Sciences, St. Francis Xavier University, Antigonish, Nova Scotia B2G 2W5, Canada, <aanderso@stfx.ca> 2. Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, U.S.A.

We investigated the pressure and temperature conditions of pocket formation in the Zapot pegmatite, Gillis range, Nevada, using Raman spectroscopic and microthermometric data obtained from pseudo-secondary fluid inclusions in smoky quartz crystals. Thin sections of four quartz crystals reveal partially dissolved smoky quartz cores overgrown by colourless quartz. Randomly oriented planar arrays of negative crystal-shaped fluid inclusions cross-cut the smoky quartz core but do not extend into the colourless quartz rim. At room temperature, the fluid inclusions typically contain one or more solid phases, an aqueous fluid, and a vapour bubble. Raman spectroscopic analysis of solid phases show that topaz, sassolite (H_3BO_3) and stibioclaudetite ($AsSbO_3$) are common daughter minerals. The average homogenization temperature (T_h LV→L) for fluid inclusion assemblages (FIAs) varies between 122°C and 337 °C, and the average fluid salinity ranges between 2.51 and 3.71 wt.% (NaCl equivalent). The presence of sassolite daughter minerals indicate that orthoboric acid is a dominant solute in the fluid

involved in pocket formation. Orthoboric acid concentrations for different FIAs, as determined by the dissolution temperature of sassolite, varies between 4.5 and 7.5 wt.% H_3BO_3. We estimated the pressure and temperature of fluid inclusion trapping by extrapolating isochores in the system H_3BO_3-H_2O to the water-saturated solidus of a F-rich granite. Assuming near solidus crystallization temperatures, the different fluid inclusion assemblages reveal large changes in fluid pressure (375 to 800 MPa) during pocket formation. Such high internal pressure during crystallization accounts for pocket rupture, which is evident in many gem-bearing miarolitic pegmatites.

*Investigating the controls of submarine landslides and associated hazards in Pangnirtung Fiord, Eastern Baffin Island (Nunavut)

PHILIP SEDORE[1], ALEXANDRE NORMANDEAU[2], VITTORIO MASELLI[1]

1. Department of Earth and Environmental Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada <sedore.p@dal.ca> 2. Geological Survey of Canada, Bedford Institute of Oceanography, Dartmouth, Nova Scotia B2Y 4A2, Canada

High-latitude fiords are susceptible to hazardous subaerial and submarine slope failures. Recent investigations have shown that past slope failures in fiords of Greenland and Alaska have generated devastating landslide induced tsunamis. Since coastal communities inhabit these high-latitude fiords, it is critical to understand the slope failure recurrence time, their distribution, potential triggers, and ability to generate tsunamis. In this study, we identified > 50 near-surface submarine landslides in Pangnirtung Fiord, eastern Baffin Island, Nunavut, using multibeam bathymetric and sub-bottom profiler data, along with sediment gravity-cores collected in 2019. Morphometric and morphological analyses, along with sedimentological analyses, were carried out on submarine landslide deposits to quantify their spatial and temporal distribution throughout the fiord and to evaluate the factors that may have triggered the slope failures.

Combining bathymetric with topographic data from unmanned aerial vehicle imagery, we found that most of these landslide deposits are relatively small (~ 0.08 km^2) and are associated with outwash fans and steep fiord sidewalls. However, since most slope failure head scarps lie between the intertidal zone and ~30 m water depth, they could not be mapped, which makes it challenging to determine the triggers of the submarine slope failures. Radiocarbon dating reveals that most of these surficial landslide deposits are younger than 500 years old and that they were most likely triggered at different times. This finding highlights a high recurrence rate of slope failures within the fiord, suggesting that localised triggers are responsible for slope failures within the fiord, as opposed to widespread, seismically induced triggers which do not occur as frequently in the study area. In addition, the elongated morphology of the landslide deposits and the varying degrees of landslide deposit surface roughness supports localised point-source triggers. Since most landslides are associated with subaerial outwash fans and deltas, we suggest that triggers of these relatively frequent submarine landslides within Pangnirtung Fiord include rapid floodwater input, subaerial debris flows, and sea-ice loading during low tide.

This research shows that slope failures in an Arctic fiord are affected by the interaction of numerous subaerial and submarine processes, leading us to speculate that a potential increase in the frequency of subaerial debris flows and river floods due to climate change may increase the recurrence of submarine landslides.

Pacing of Late Pliensbachian and Early Toarcian carbon cycle perturbations and environmental change in the westernmost Tethys (Betic Cordillera, Spain).

RICARDO L. SILVA[1,2,3], MICHA RUHL[1,2,3], CILLIAN BARRY[1], MATÍAS REOLID[4], WOLFGANG RUEBSAM[5]
1. Department of Geology, Trinity College Dublin, The University of Dublin, Dublin 2 Ireland <ricardo.silva@tcd.ie> 2. Irish Centre for Research in Applied Geosciences (iCRAG), Trinity College Dublin, The University of Dublin, Dublin 2 Ireland. 3. Earth Surface Research Laboratory, Trinity College Dublin, The University of Dublin, Dublin 2 Ireland. 4. Departamento de Geología, Universidad de Jaén, Jaén Spain. 5. Department of Organic and Isotope Geochemistry, Institute of Geoscience, University of Kiel, Kiel, Germany.

Significant perturbations to the global carbon cycle from the Rhaetian (Triassic) to Toarcian (early Jurassic) time interval are recorded by short- and long-term, and smaller and larger amplitude positive and negative shifts in $\delta^{13}C$ from marine and terrestrial sedimentary archives. Two abrupt carbon cycle perturbations, reflected by negative carbon-isotope excursions (CIEs), occurred at the Triassic–Jurassic boundary (at ~201.5 Ma) and during the early Toarcian Oceanic Anoxic Event (T-OAE; at ~183 Ma).

The successions of positive and negative shifts in global $\delta^{13}C$ recorded in upper Pliensbachian and lower Toarcian sedimentary rocks worldwide are interpreted to reflect changes in the flux and source of carbon into the ocean-atmosphere system and sequestration of organic carbon into marine and continental sedimentary successions. These carbon cycling changes, directly affecting atmospheric pCO_2, are thought to have modulated contemporaneous climates and global temperatures. Despite the global nature of the late Pliensbachian and early Toarcian environmental changes, and the clear expression of these in marine and continental basins from both hemispheres, the interplay between global and local processes varies between sites, resulting in spatially different depositional conditions and, consequently, sedimentary records.

The low–mid latitude Jurassic basins of southern Iberia and the nearby northern Gondwana (e.g. Middle Atlas Basin) palaeomargins are thought to have been well connected to the western Tethys Ocean. Their palaeogeographical location and connection to the Tethys Ocean resulted in markedly different depositional conditions (organic-poor and without evidence of anoxia/euxinia) compared with the restricted to semi-restricted (generally organic-rich) northern European basins.

For this presentation, we use high-resolution elemental and isotopic geochemical datasets collected from marl–limestone alternations cropping out at La Cerradura (Subbetic domain, Betic Cordillera, Spain) to address the nature, and timing and pacing of (1) paleo-ocean chemistry and climate change and (2) global carbon cycle perturbations during the late Pliensbachian–early Toarcian on the south Iberian palaeomargin. We also compare and correlate the La Cerradura section with the reference Mochras borehole (Cardigan Bay Basin, UK).

Integrating coastal environments into our understanding of Early Cretaceous carbon cycle perturbations and oceanic anoxic events (OAEs)

RICARDO L. SILVA[1,2,3,4], GRANT WACH[4], STEPHEN P. HESSELBO[5], MICHA RUHL[1,2,3], DARRAGH O'CONNOR[4]
1. Department of Geology, Trinity College Dublin, The University of Dublin, Dublin 2 Ireland <ricardo.silva@tcd.ie> 2. Irish Centre for Research in Applied Geosciences (iCRAG), Trinity College Dublin, The University of Dublin, Dublin 2 Ireland. 3. Earth Surface Research Laboratory, Trinity College Dublin, The University of Dublin, Dublin 2 Ireland. 3. Basin and Reservoir Lab, Department of Earth and Environmental Sciences, Dalhousie University, Nova Scotia Canada 4. Camborne School of Mines and Environment and Sustainability Institute, University of Exeter, Penryn, Cornwall TR10 9FE UK

The late Aptian–early Albian oceanic anoxic event (OAE) 1b cluster is characterized by several carbon cycle perturbations and deposition of high TOC sediments in many locations worldwide. This OAE cluster was a significant event in the marine realm, associated with drastic changes in ecosystems and ocean chemistry. However, there is a wide gap in knowledge concerning the response of terrestrial and coastal areas to the environmental drivers of the OAE 1b cluster and the impact of changes in the flux of carbon in-and-out of these depositional environments on the global carbon cycle.

The Upper Aptian–Lower Albian in the Isle of Wight (Wessex Basin, United Kingdom) comprises a thick sedimentary succession of sands and mudstones (the Ferruginous Sands, Sandrock, and Monk's Bay Sandstone formations of the Lower Greensand Group) deposited in estuarine and shallow marine shelf environments. This study investigated the Upper Aptian–Lower Albian successions cropping out along the southwestern Isle of Wight, analyzed for total organic carbon (TOC), organic matter programmed pyrolysis, and $\delta^{13}C_{TOC}$.

In this presentation, we discuss potential implications of coastal environments on global organic matter storage and atmospheric carbon feedback during the OAE 1b cluster. We will draw some parallels with the Scotian sedimentary successions. The integration of our findings from the Early Cretaceous coastal palaeoenvironments in both sides of the Atlantic margins with current modelling efforts will help to clarify the impact of estuaries and wetlands on climate change, carbon cycle perturbations, and OAEs and help elucidate the factors contributing to present-day issues of coastal anoxia expansion and tidal wetland loss.

Potential for critical mineral deposits in Maine with applications to the Maritimes

JOHN F. SLACK
Retired, 138 Court Street, Farmington, Maine 04938, USA <jfslack7@gmail.com>

The increasing global emphasis on green technologies demands the mining of known critical mineral deposits and the exploration for undiscovered resources of these commodities. In Maine, known critical mineral deposits of significant size and/or grade are limited to the sediment-hosted Mn-Fe deposits of Silurian age in Aroostook County in the northeast part of the state (largest known Mn resource in the US), and the pegmatite-hosted Li deposit of Permian(?) age at Plumbago Mountain in the southwest. Small deposits and occurrences of other critical minerals in Maine, long documented, include those of Cr, Co, Mo, Sb, W, and U. Importantly, however, potential exists for the discovery of larger—and potentially economic—resources of these critical minerals, including (1) Cr (and PGE) in the Ordovician Boil Mountain ophiolite, (2) Co in magmatic sulphide deposits associated with Devonian mafic intrusions (e.g., Moxie pluton), (3) Sb in tectonically controlled vein deposits within Silurian metasedimentary rocks (Bangor area), (4) W in skarns related to Devonian granites (western Maine), and (5) U (and Th) associated with two-mica granites of Carboniferous age in southwestern Maine; these granites, and other small alkaline to peralkaline plutons in southern Maine, also have potential for deposits of Sn, REE, Nb, and/or Ta. A potential for V may exist in some Ordovician black shales such as those of the Penobscot Formation near the coast; volcanic-hosted Be deposits might occur in Devonian rhyolitic tuffs along the coast. Successful exploration programs for these critical minerals, and others, should carefully integrate geological, geochemical, and geophysical data with those for known deposits, prospects, and mineral occurrences—the last including even those of interest mainly to specimen collectors. Very important are relevant descriptive and genetic models for giant deposits occurring in analogous geologic settings, regardless of location; e.g., the largest Sb orebody in the world is a tectonically controlled vein deposit in South China, for which detailed information in the western literature has only been published recently.

Metallogenic implications for Maine derived from the Maritimes include those of significant deposits in western New Brunswick such as Battery Hill Mn-Fe, Lake George Sb-Au-W-Mo, and Mount Pleasant W-Mo-Bi-Sn. In turn, the metallogeny of Maine offers insights into potential for these and other critical

minerals in the Maritimes. Selected applications will be presented for diverse deposit types with a focus on those containing generally under-emphasized critical minerals including Be, Sb, and V.

*Wallrock alteration and gold-bearing vein paragenesis of a Meguma-hosted gold deposit: Goldboro, Nova Scotia

MARKO SZMIHELSKY[1], STEPHEN PIERCEY[1], DAVID COPELAND[2], TANYA TETTELAAR[2]
1. Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador A1B 3X7, Canada <mszmihelsky@mun.ca>; 2. Anaconda Mining Inc., 915-20 Adelaide St. East, Toronto, Ontario M5C 2T6, Canada

Sediment-hosted orogenic Au deposits are some of the largest orogenic Au systems in the Phanerozoic (e.g., Victorian Gold Belt, Sukhoi Log). Despite their importance, the understanding of the lithogeochemical and mineralogical footprint of such hydrothermal systems is not well understood, particularly so for Meguma-type Au deposits. Here, we present results from an ongoing lithogeochemical study of the Goldboro Deposit in Nova Scotia.

At Goldboro, mineralization is associated with quartz veins in the crests and limbs of upright anticlinal domes, along greywacke-mudstone contacts of the Upper Seal Harbour anticline. Hydrothermal alteration of the vein-proximal mudstones includes biotite, chlorite, albite, muscovite arsenopyrite, and trace carbonates and mass change calculations illustrate that the wall rocks exhibit enrichments in K_2O, Fe_2O_3, Na_2O, and As proximal to mineralization. Additionally, unlike other Meguma-type deposits, there are four distinct quartz vein generations at Goldboro: two syn-deformational, reef-type veins, and two younger vein stages that infill cleavage fractures and crosscut pre-existing veins. The two younger veins consist of an initial stage of stringer-type veinlets of ankerite, pyrite, and quartz, and fracture-filling chlorite, biotite, K-feldspar, albite, ilmenite, tourmaline, and gold. Thus, the relative timing of these veins raises questions regarding the source(s) of K, Na, REE, Ti, and Au, and perhaps provides evidence for gold deposition late in the paragenetic history of gold mineralization in Goldboro, as has been suggested by previous workers in the Meguma zone.

The disappearance of Slade Lake, Cumberland County, Nova Scotia

AMY TIZZARD & PETER HORNE
Geological Survey Division, Nova Scotia Department of Energy and Mines, Halifax, Nova Scotia B3J 2T9, Canada <Amy.tizzard@novascotia.ca>

Slade Lake is a 1.5 kilometre long, 200 metre wide body of water situated adjacent to the TransCanada Highway 104 between exits 5 and 6 in Cumberland County, Nova Scotia. The lake resides within a well-defined belt of Windsor Group karst topography that extends approximately 5 kilometers southwest from the Town of Oxford. In early May 2020, it was reported that the water level within Slade Lake had dropped significantly. The area was subsequently surveyed in late May using a DJI Phantom 4 RTK Remotely Piloted Aerial System (RPAS), more commonly known as a drone. The RPAS survey data was used to produce a 0.25 metre contour surface of the recently exposed lakebed. This new surface model was compared to a provincial LiDAR-derived digital elevation model that correlated to a time when maximum water levels were observed in the fall of 2019. A volumetric analysis was then completed using the two surfaces with a resultant total draw down of 783,280 m^3 of water between October 10, 2019 and May 27, 2020. Water levels continued to drop for the remainder of 2020 exposing a number of karst features such as sinkholes and vertical solution pipes that likely served as natural drainage outlets for Slade Lake. A review of Landsat imagery dating back to 1984 indicates the lake is subject to periodic fluctuations of water levels. Future monitoring of the karst belt will be used to examine the frequency of change, physical characteristics and associated risk of karst activity to the surrounding area.

*Analysis of Vertical Electrical Sounding (VES) Data over a prospective geothermal area in Turkey

TURANLI, F.T AND LEITCH, A.M.
Department of Earth Sciences, Memorial University of Newfoundland, 300 Prince Philip Drive, St John's Newfoundland and Labrador, A1B 3X5, Canada <ftturanli@mun.ca>

Geophysical methods are one of the important disciplines to delineate geothermal resources. Among the geophysical methods, geophysical electrical methods play a vital role by determining the resistivity, which depends on temperature and fluid content and is therefore a key variable in geothermal systems. In this study, data from 384 Vertical Electrical Soundings (VES) were analysed, to determine heat sources and structure of the geothermal area in the Afyon-Sandikli graben, Turkey.

This study applied 1D and 2D inversion techniques in an effort to generate resistivity models of geothermal system. Prior to inversion, the raw resistivity data was characterized in terms of elevation changes in the study area, smoothness of the resistivity sounding curves, consistency between neighbouring sounding curves and their nearness to faults. Considering all these criteria, 1D resistivity models were obtained. Many of the soundings were arranged at even intervals along lines. Such linear arrangements of soundings were used for 2D inversion. The resulting models are compared and discussed in terms of resistivity distribution in the geothermal system.

Field and petrographic reports on mineral exploration at Castle Frederick

FERGUS TWEEDALE[1], CHARLES BANKS[2] AND IAN SCANLON[3]
1. Mineral Exploration and Ore Fluids Laboratory, Department of Geology, Saint Mary's University, 923 Robie Street, Halifax, Nova Scotia B3H 3C3, Canada <Fergus.Tweedale@smu.ca>; 2. Atlantic Mineral Exploration, 70 Country Club Lane, Falmouth, Nova Scotia B0P 1L0, Canada; 3. Blue Innovation, 1824 Robie Street, Halifax, Nova Scotia B3H 3G3, Canada

Mineralization in the South Mountain Batholith (SMB) occurs near an unconformable contact with overlying Horton Group sediments. Government reconnaissance (2006) discovered sulphide mineralization filling linear fractures in SMB monzogranite which is exposed in a quarry situated a few kilometres from Castle Frederick Road, near Windsor Junction. The Castle Frederick (CF) prospect is centred on the quarry. Vein orientation is dominantly flat-lying or vertical, and displacement is not easily measured. The average (n = 30) vein width is about two centimetres. Ground cover obscures the lateral extent of vertical veins and flat-lying veins extend a minimum of 10 metres. In order of decreasing abundance, vein minerals include pyrite, quartz, galena and barite. Mineral textures at CF range between unaltered hypidiomorphic granular to megacrystic (feldspar) porphyry. Vein quartz and primary SMB quartz in contact with vein selvages host fluid inclusions (FI). In the oral presentation, mineral textures and FI solute chemistry will be discussed. To characterize the CF geological setting, the granitoid facies exposed in the quarry headwall will be petrographically compared to a SMB-Meguma contact facies. Modal biotite in the porphyry significantly exceeds the compositional range of peraluminous felsic intrusions (e.g., SMB). Feldspar alteration ranges from minimal to extreme and is clarified by examining polished sections. Results from core sample analysis will be presented. The objective of future exploration work is to grid survey the CF prospect and surrounding claim area using advanced geomagnetic techniques.

A Global Navigation Satellite System (GNSS) system for monitoring ground movement

RONNIE VAN DOMMELEN[1], MITCHELL MACINNIS[1], DEREK INGLIS[1] AND GARETH HOAR[1]
Reftek Systems Inc.,36 Topple Dr., Dartmouth, Nova Scotia, B3B 1L6 <mitch@reftek.com>

Global Navigation Satellite System (GNSS) receivers that monitor multiple satellite constellations (GPS, Glonass, Galileo) have become nearly ubiquitous in mobile applications such as phones and cars and in surveying applications. This mass market has resulted in the availability of small, low power, and low-cost receivers. Real-time kinematic (RTK) positioning is a commonly used method to improve the positioning accuracy of GNSS receivers from what would normally be a few meters, down to centimeters. In applications where the receiver is stationary or normally moving slowly, then multiple readings can be averaged on a daily timescale to achieve millimeter-level accuracy. Such a system is ideally suited for applications such as slope and dam monitoring, landmass deformation due to oil and gas extraction, or monitoring for sinkholes in karst topography. In the past such systems have required expensive solar panels and associated cabling to run each of the receiver nodes. We are developing a new ultra-low power node that can run from a single battery for a duration of several months. The system consists of a single base station that communicates with the outside world via satellite or internet and multiple, unwired nodes or monitoring stations. The nodes can be positioned up to 2 kilometres from the base, allowing a large area to be monitored.

Kinematic models for the northern Appalachians and Caledonides

JOHN W.F. WALDRON[1], SANDRA M. BARR[2], PHIL J.A. MCCAUSLAND[3], DAVID I SCHOFIELD[4], LEI WU[5], DOUG REUSCH[6]

1. Department of Earth & Atmospheric Sciences, University of Alberta, Edmonton AB T6G 2E3 Canada <john.waldron@ualberta.ca> 2. Department of Earth and Environmental Science, Acadia University, Wolfville NS Canada. 3.Western Paleomagnetic & Petrophysical Laboratory, Western University, London ON Canada. 4. British Geological Survey. 5. McGill University, Department of Earth and Planetary Sciences, Montreal QC, Canada. 6. University of Maine at Farmington, ME, USA.

Appalachian-Caledonide orogen development has been traditionally illustrated using cross-sections showing terrane accretion and collision over time. This approach is valuable but leads to implicit assumptions: subduction was initiated at passive continental margins; convergence was mainly orthogonal; terranes and zones had ribbon-like geometry parallel to continental margins; and present-day orogen geometry is a valid "end point" for reconstructions. Post-Pangea tectonic evolution provides little support for these assumptions. We will use GPlates software to display alternative, more actualistic kinematic models.

We will include in this analysis several previously under-utilized data sets: (1) Estimates of late Paleozoic and Mesozoic plate motions, to restore a valid mid-Devonian geometry from which to build back in time; (2) Reviews of legacy biostratigraphic data using calibrated time scales to place sedimentary units accurately relative to isotopically dated igneous units; (3) A review of paleomagnetic information including both declinations and inclinations, so as to evaluate systematic vertical-axis rotations as well as latitude changes; (4) A compilation of detrital zircon data using newly developed display techniques to show proximity of terranes to major continental blocks that are the best candidates for sedimentary provenance.

Preliminary results suggest that terranes attributed to Ganderia and associated Gondwana-derived arcs crossed the Iapetus in several pieces, arriving at the Laurentian margin at different times from Ordovician to Devonian. Portions of "Ganderian" and "Avalonian" continental crust may have been juxtaposed during Penobscottian convergence on the margin of Gondwana. The Taconian Orogeny is explained as

the result of a diachronous arc-continent collision that involved both Laurentia-derived and Gondwana-derived units. It was followed by subduction-polarity reversal at the Laurentian margin. Salinian deformation resulted from subduction-accretion of terranes at this margin, over a period of time lasting from the Late Ordovician nearly the end of the Silurian Period. Acadian deformation resulted from sinistral and convergent motions at an Early Devonian along-margin boundary that may have varied from transpressional in New England to ideal strike slip in Britain and Ireland.

*Characterization of polymetallic vein-type Meguma Au deposits: Meguma's lesser-known Au deposit type

NAOMI WELT[1], JOSHUA JACKMAN[1], ERIN ADLAKHA[1], NATALIE MCNEIL[1], JACOB HANLEY[1], MITCHELL KERR[1] AND GEOFF BALDWIN[2]

1. Department of Geology, Saint Mary's University, 923 Robie St., Halifax, Nova Scotia, B3H 3C3, Canada <naomi.welt@smu.ca>; 2. Nova Scotia Department of Energy and Mines, 1701 Hollis St, Halifax, Nova Scotia, B3J 2T9, Canada

This study focuses on three Au-bearing, polymetallic (Sb-Pb-Zn-Co-Ni-Cu-Bi-Ag-Au) vein occurrences in the western Meguma Terrane with a suspected, but unproven, genetic link. The aim is to understand how the occurrences formed, including their timing, sources of metals, and relationship to other Meguma Au deposits and metasedimentary-hosted polymetallic vein deposits globally (e.g., Sb-Au deposits of the Bohemian Massif, Variscan Orogen, Europe).

At the Lansdowne and Cape Saint Mary's (CSM) occurrences in Digby County, Bear River Formation metapelites are intruded by gabbro (~440 Ma; apatite U-Pb) and crosscut by quartz±carbonate veins, some of which host multi-stage, sulfide-sulfosalt mineralization. At Lansdowne, mineralization crosscuts the early quartz veins and consists of an early Fe-As stage (pyrite-arsenopyrite-pyrrhotite), a Zn-Cu stage [(Cd-rich) sphalerite-chalcopyrite], and a later Pb-Sb stage (boulangerite-jamesonite-galena) with multiple generations of quartz-calcite-chlorite gangue. Arsenopyrite thermometry indicates temperatures of 425-450˚C, while chlorite of the Zn-Cu stage provides a lower temperature of 350-390˚C. The latest chlorite provides a temperature of 120-160˚C. Isocon diagrams generated using least- and most-altered samples from the mafic intrusions and metapelites indicate variable depletion in the above metals (except Sb, which was gained), potentially indicating these rocks as metal sources.

At the CSM Stibnite Occurrence, siderite infilled-breccia hosts mineralization and crosscuts earlier, brittle-ductile deformed quartz veins in Bear River Formation metapelite. Mineralization consists of an early As±Co-Ni stage [arsenopyrite-(Co-rich) gersdorffite], followed by a Cu-Sb-Ag stage [tetrahedrite-(Ag-rich) freibergite], a Cu-Sb-Bi stage (chalcopyrite, Bi-Sb alloy) and late REE-P alteration (florencite-pyrite). At the Mavillette Beach Occurrence, Pb-Sb mineralization (boulangerite-jamesonite-galena) is observed in quartz-pyrite veins.

At the Nictaux Falls Dam Occurrence (NFDO), variably mineralized quartz veins and quartz-infilled breccia cut Kentville Formation metapelites, near their contact with the South Mountain Batholith (370 Ma), diabase dykes and a gabbro intrusion (~380 Ma; apatite U-Pb). Mineralization consists of early pyrite, a zoned Fe-Co-Ni-As stage (arsenopyrite-cobaltite-gersdorffite) with chlorite (~280˚C) and rutile, and late-stage electrum.

The mineralogy, paragenesis, metal associations, and ore textures are distinct from typical Meguma Au deposits. The occurrence of mineralization in breccias and mineral thermometry suggest their formation in relatively shallow crustal environments at moderate to high temperature. Striking similarities between Lansdowne and CSM with the West Gore Sb-Au deposit (Hants Country, N.S.) in terms of mineralogy and paragenesis are noted. Future work includes Re-Os dating of arsenopyrite and trace element work on ore minerals to compare with similar deposit types.

2020-2021 ANNUAL GENERAL MEETING OF THE ATLANTIC GEOSCIENCE SOCIETY

Saturday, 6 February, 2021, 12.30 noon – 1.30 p.m.

online – Pitcher Room

AGENDA

1) Approval of Agenda

2) Approval of minutes of 8 February, 2020, Truro, NS (p. 52)

3) Matters arising from the Minutes

4) Presentation of the Financial Report (P Batson)

5) Appointment of Financial Reviewers for 2021

6) Annual Reports of the 2019 Executive and Committees

- Report from the President (D Lentz)
- Report from the Education Committee (T Webb) (p. 54)
  - Revision of LBY (R Fensome, G Williams) (p. 55)
- Report from the Nova Scotia EdGeo Workshop Committee (J Bates)
- Report from New Brunswick Teachers Workshop Group (A Timmermans)
- Report from the Video Committee (G Williams) (p. 55)
- Report from the Products Committee (R Raeside) (p. 56)
- Report from the Membership Secretary (A Miller) (p. 56)
- Report from the Awards Committee (AM Ryan) (p. 57)
- Report from the Publications Committee (S Barr) (p. 58)
- Report from the Atlantic Geology editors (S Barr) (p. 58)
- Report from the Webmaster (J MacIntosh) (p. 60)
- Report from Website Renewal Committee (L Dafoe, D Dunnington) (p. 61)
- Report from the AGS–Science Atlantic Speaker tour (D van Rooyen)
- Report from the Travelling Speaker Series coordinator (S Watters) (p. 61)
- Report from CFES representative (C White) (p. 62)
- Report from Halifax 2022 LOC / 50th anniversary liaison (S Barr / I Spooner) (p. 63)
- Report from the Science Atlantic Earth Science Committee (A Arnott)
- Report from AUGC 2020 (G Fisher, H Sharpe) (p. 64)
- Report from Social Media group (A Calder) (p. 65)
- Report from Geoheritage Committee (J Calder) (p. 67)

7) Election of Incoming Executive & Councillors (M Grantham) (see slate appended p. 68)

8) Other Business Arising from Meeting

9) Adjournment

2019-2020 ANNUAL GENERAL MEETING OF THE ATLANTIC GEOSCIENCE SOCIETY

Saturday, 8 February 2020, 12.00 noon – 1.45 p.m.
Holiday Inn, Truro, Nova Scotia

MINUTES OF MEETING

President Martha Grantham called the meeting to order at 12.35 p.m. with over 70 members present.

1) **Approval of Agenda** – G Wach moved, J Calder seconded, that the agenda be accepted. Carried.

2) **Approval of minutes of Annual General Meeting, 9 February 2019, Fredericton, NB** – H Donohoe moved, G Pe-Piper seconded, that the minutes be approved as distributed. Carried.

3) **Matters Arising from the Minutes** – no matters arising.

4) **Presentation of the Financial Report**
N Bingham-Koslowski presented the status of the finances of the Society and its Education, Video, EdGeo and *Atlantic Geology* committees as a whole and moved that the reports be accepted as distributed. Seconded by C White. Thanks were extended to J Gosse and I Spooner for their service as reviewers. The motion was carried.

5) **Appointment of Financial Reviewers for 2020**
C White nominated Ian Spooner (Wolfville) and N Bingham-Koslowski nominated John Gosse (Halifax) to conduct the review of the 2020 finances. Carried.

6) **Annual Reports of the 2020 Executive and Committees**

Report from the President (M Grantham) – circulated in program
Report from the Education Committee (T Webb) – circulated in program
Report from the Nova Scotia EdGeo Workshop Committee (N Bingham-Koslowski) – circulated in program
Report from New Brunswick Teachers Workshop Group – R Raeside reported on behalf of A Timmermans on the December workshop held at the Quartermain Earth Science Centre in Fredericton on the recently developed New Brunswick middle school science curriculum.
Report from the Video Committee (R Grantham for G Williams) – circulated in program
Report from the Products Committee (R Raeside) – circulated in program
Report from the Awards Committee (D Lentz) – circulated in program
Report from the Membership Committee (R Raeside for A Miller) – circulated in program. As of the 6 February, renewed memberships for 2020 are 102 professional members and 81 student members.
Report from the Publications Committee (S Barr) – circulated in program
Report from the Atlantic Geology editors (S Barr) – circulated in program
Report from the Webmaster (M Grantham for J MacIntosh) – circulated in program
Report from the AGS-Science Atlantic speaker tour coordinator (D van Rooyen) – circulated in program
Report from the Travelling Speaker series coordinator (S Watters) – circulated in program
Social Media report – T Fedak reported on tweets prepared about *Atlantic Geology* articles as they become open access and on Facebook advertising for the colloquium and talks.

Report from CFES representative (C White) – circulated in program. Attention was drawn to the prominence of AGS members in CFES activities and awards.

Report from Halifax 2022 LOC (S Barr and I Spooner) – circulated in program

Report from the Science Atlantic Earth Science Committee – J Loxton reported on the AUGC in October 2019 at St. Francis Xavier University, which drew 83 participants.

7) Bylaws changes

No bylaws changes were proposed, but for information of membership, the following procedural changes were recorded:

a) For the Nelly Koziel Award, a valid nomination shall include a statement between 200 and 500 words that succinctly explains how the candidate meets the selection criteria

b) For the Laing Ferguson Distinguished Service Award, the former requirement of a curriculum vitae is being made optional

c) Regulations concerning travel claims on AGS business have been substantially rewritten

d) The criteria for the award for best poster / presentation on undergraduate / graduate research presented at the AGS colloquium was adjusted to include the clarification that it must be in progress or have been completed within the six months prior to the colloquium.

8) Election of Incoming Executive & Councillors

Past President L Dafoe expressed appreciation to out-going council members: student council members Alison Barkhouse and Lauren Macquarrie (St. F.X.) and Sydney Stashin (Dalhousie), sabbatical replacement Greg Dunning (MUN), and Catrina Russell.

Councillors being nominated for 2020-2021 are Donnelly Archibald, Lexie Arnott, Denise Brushett, John Calder, Alison Leitch, Tim Fedak, Bob Grantham, Ann Miller, Ann Timmermans, Deanne van Rooyen, Grant Wach, Jim Walker, Sheila Watters, Chris White.

Student councillors being appointed are Hannah Sharpe and Grace Jackson (to hold one vote, undergraduate students, UNB), and graduate student Dewey Dunnington (Dalhousie).

New executive comprises Past President Martha Grantham, President David Lentz, Vice-President Anne-Marie Ryan, Secretary Rob Raeside, Treasurers Nikole Bingham-Koslowski and Mike Lewis.

The president called for further nominations; no further nominations were forthcoming. Approval of the slate was moved by L Dafoe, seconded by D Piper. Carried.

9) Other Business Arising from Meeting

M Grantham expressed thanks to the judges of student talks and posters, drew attention to the release of the book *Geology of New Brunswick and Prince Edward Island*, and requested assistance for staffing the AGS booth at the Nova Scotia Gem and Mineral Show on 14-16 August.

10) Adjournment

J Walker moved adjournment at 1.35 p.m.

ATLANTIC GEOSCIENCE SOCIETY EDUCATION COMMITTEE
REPORT FOR 2020-2021

Despite the complications of dealing with the Covid pandemic, the Committee has continued our work on supporting earth sciences and education. Necessity being the mother of invention, we have successfully transitioned into virtual meetings, solving one of our challenges of past years. Perhaps because of this, the Committee has welcomed in several new members, and we look forward to the expanding collaboration of ideas, interests and expertise.

Key highlights to share:

- After much discussion, members explored ideas of updating the Vision and Mission statement of the Education Committee, and reviewed the by-laws and goals of the AGS. Bob Grantham drew up the Terms of Reference for the Education Committee, which was accepted and approved by the committee on January 22, 2021 for submission to AGS Council.
- We are exploring various aspects of social media to determine how we can best encourage and facilitate more interest in the earth sciences, and the work of AGS and the various groups/membership. Aside from the AGS FB page, there are other numerous FB groups posting photos and questions about rocks in NS (and elsewhere likely) so there is definitely an audience. Tracking metrics and assessing the outreach will help define our social media platform(s).
- The AGS Education Website is under active construction, as we are identifying strategic resources and clarifying what may best serve the public/education sector/specific interest groups. If anyone has resources that may be useful for this, please share (Lynn Dafoe) – appropriate credits given!
- Tim Fedak summarized his project in Windsor, based on the past research of Dr. Harding, and the connections with Lyell and Dawson. The historical aspects are fascinating and in conjunction with Haliburton House, plans are being discussed for guided walking trail down to the Avon, along with possible interpretation panels explaining Karst and sinkholes around the Windsor area. (part of the Karst project with Amy Tizzard and Mo Snyder)
- Rob Fensome provided a written report on the LBY-2 at the last Council meeting, with an update provided for the Colloquium report. With updated, modified and some new chapters, new illustrations and graphics, it is still on track to be ready for GAC-MAC 2022 in Halifax.
- Outreach for Halifax 2022: Louise Leslie - ongoing discussions and ideas; considering guest speakers, field trips, venues; encourage more participation of education groups (teachers, students)
- AGS Colloquium Session - "Developments in Geoscience Education" We have four wonderful presentations as part of the Education Outreach session, open to everyone to Zoom in.
- Brochures – we are still considering a "Gem and Mineral" brochure, modeled after the highly successful NS Pebbles brochure…stay tuned!
- Kevin Gallant shared some information about his Living Shoreline Workshop, held on Jan. 27th, 2021 which considers how to reduce the impacts during coastal erosion and flooding.
- Finally, plans are underway for celebrating the 50th Anniversary of AGS – we have a list of ideas to consider, and look forward to sharing with the "Head Coordinator" Ian Spooner…

Tracy Webb, Chair AGS Education Committee *Submitted January 22, 2021*

REPORT ON PROGRESS ON REVISION OF THE BOOK *THE LAST BILLION YEARS* (JANUARY 2021)

Work on the second edition of *The Last Billion Years* is progressing well, although as it represents an extensive revision of both text and illustrations, the task is time-consuming. The edition will include eleven chapters and eleven boxes, with layout similar to the original. Eight of the nine chapters are revised; the original Chapter 8 has been split into two chapters one on resources and one on societal issues (hazards and environmental topics). Some of the boxes are revisions of originals, but we plan new boxes on remote sensing, rivers, evolution, evaporites and building stones. The book will have a new cover design and perhaps a different page size to give it an overall fresh look.

The review process has begun, with chapters 1 and 2 and boxes 1 and 2 sent out to reviewers. All other chapters and boxes are in advanced stages and should be out for review within the next two months. The reviewers include interested non-geologists, an educator, and a geoscientist with an interest in outreach. The revision is being guided by a committee consisting of Sandra Barr, Jennifer Bates, Rob Fensome, Graham Williams and Reg Wilson, with Graham and Rob as co-editors. As with the first edition, *The Last Billion Years* will be a co-publication of the Atlantic Geoscience Society and Nimbus Publishing. The book committee is currently working on a contractual agreement with Nimbus for consideration by the AGS President and Council. Funding support has been impressive with the book committee being awarded a grant from the Canadian Geological Foundation, as well as funding from APEGNB and APGNS. We intend to continue to raise sufficient funds to keep the retail sale price attractive and hence spread the word about Maritimes geology widely.

Highlight of the revisions will include the latest ideas on the Paleozoic tectonic evolution of the Maritimes (including a new suite of paleogeographic maps), a new understanding of events across the Triassic/Jurassic boundary as exposed in the Fundy Basin, and major new input on fossils and evolution. We also have a wide range of new photographs to draw upon (though it's not too late if you have suggestions of neat geological imagery). And we have some attractive new graphics.

We'd like to thank all those who have so kindly contributed to the text and graphics of the second edition so far and look forward to seeing it published in 2022.

ATLANTIC GEOSCIENCE SOCIETY VIDEO COMMITTEE ANNUAL REPORT FOR 2020-2021

A major disruption to meetings and productivity of the AGS Video Committee in 2020 was the Covid-19 pandemic. This brought to a halt all filming on location. But some progress was made, thanks to the dedication of Dave Frobel. Despite the difficulties, he managed to complete the final version of the vignette, which outlines the geology and history of York Redoubt National Historic Site. The leading actors of this vignette are Patrick Potter, the narrator, and his talking dog Dusty, who was an ideal sidekick but who sadly passed away after completion of the filming. Dave shot all the footage and edited the production.

In the video, Patrick and Dusty take the viewer on a tour of York Redoubt in an informative but entertaining manner; they introduce the geology and some of the history of this important site. Dusty, who dogged Patrick's footsteps, played a leading role in questioning the meaning of any geological terms, so the script is not too difficult to follow. The sub-committee which guided this endeavour was Patrick Potter, Dave Frobel, Jennifer Bates and Graham Williams. Our goal is to make the vignette available on YouTube.

Some of the Video Committee members are now working on a second vignette highlighting the geology and history of the Arisaig section. The stars of this production are Martha and Bob Grantham,

the video expert and editor is Dave Frobel and the still photographer is Rob Fensome. Editing of the vignette is nearing completion, although progress has been slowed because of the inability to hold meetings at Bedford Institute. The final product is enhanced by some superb video shots of the Arisaig area and cliffs taken by a drone operated by professionals. The sub-committee — chaired by Bob Grantham — comprises Dave Frobel, Martha Grantham, Brendan Murphy, Rob Fensome and Graham Williams.

The Video Committee did not manage to get any drone footage during the year, again because of the pandemic. However, the hope is to complete the Joggins vignette this year. The sub-committee is Melissa Grey, Dave Frobel (video expert and editor), Jennifer Bates, Nikole Bingham-Koslowski and Rob Fensome.

Over the 37 years of its existence, the success of the AGS Video Committee has been a credit to its members who now include Jennifer Bates, Gordon Fader, Tim Fedak, Rob Fensome, Dave Frobel, Bob Grantham, Martha Grantham, Melissa Grey, Patrick Potter, Anne-Marie Ryan and Phil Spencer. We lost one very active member, our treasurer Nikole Bingham-Koslowski who moved to Ottawa. I would like to thank her for all her contributions over the years. And as chair of the Committee, I would like to thank all the above for their continuing commitment and dedication.

Graham Williams

AGS PRODUCTS COMMITTEE - 2020-2021

The **Products Committee** evaluates proposals for grant or loan-based funding from the Publications, Video, Education, and EdGeo Committees, and from those outside the AGS, by vetting the proposals and making recommendations to AGS Council regarding the value of such proposals, whether they should be funded, and how much should be awarded for the project proposed; AGS Council then approves or rejects these funding recommendations.

Grants awarded in 2020:

Return of Gensel Collection of Devonian plants to New Brunswick Museum	February 2020	$2500
Gary Blundell Art Show, Saint John	March 2020 (deferred)	$1500
AGS Social Media communications coordinator	September 2020	$ 750
AUGC – UNB	November 2020	$1000

2020 AGS Membership Report

At year end, AGS had 272 members, 190 professionals and 82 students, up from 253 members in 2019. 207 members (132 professional + 75 students) attended the Colloquium in Truro, and paid dues via registration fees. 46 (41 + 5) joined by making an online payment through PayPal, and 7 (7 + 0) submitted dues via Canada Post. 7 (5 + 2) had pre-paid dues (or paid twice in one year) prior to the current year. In additional there are 2 Life-Time members and 2 complimentary memberships. Professional members are from academia (44), government (or government agencies) (49), industry (50), or are retired/hobbyists (46, including Lifetime and complimentary). 12 Canadian universities (7 from Atlantic Canada) are represented, plus 2 from the USA and 1 international school. Students are from 2 high schools, 9 Canadian universities (8 in Atlantic Canada), and 2 international schools. New memberships were received throughout the spring and summer, possibly due to the publicity generated by the webinars. 13 members have pre-paid 2021 dues, and not including conference registration, 4 renewals or new memberships have been received.

Ann Miller, Membership Secretary

Atlantic Geoscience Society
2021 Annual General Meeting
Report of the AGS Awards Committee

There were six members of the AGS Awards Committee for 2020-21, with 5 voting members and the Chair of the Committee (VP of the Society) as a non-voting member.

Submissions were invited in the late fall, and the committee reviewed submissions with the mandate to select a recipient for the following three awards:

AGS Distinguished Scientist Award (Gesner Medal)
AGS Distinguished Service Award (Liang Ferguson Award)
AGS Nelly Koziel Award

In early December 2020, nominations were solicited from AGS members. Nominations, seconder letters and letters of support were received up to January 9th 2021. The nominators and seconders were vetted for up-to-date membership in the AGS as required by the rules for submission of a candidate.

Two nominations were received for the AGS Distinguished Scientist Award (Gesner Medal).
Two nominations were received for the AGS Distinguished Service Award (Laing Ferguson Award).
One nomination was received for the AGS Nelly Koziel Award.

Evaluations from the 5 judges were completed and results tallied by early February 2021. The successful recipients of the Awards will be announced at the banquet at the AGS Colloquium.

Respectfully submitted,
Anne Marie Ryan
Vice President and Chair of the AGS Awards Committee
Feb 5, 2021

AGS Publications Committee
Report to AGM – 2021

Responsibility for AGS publication sales is largely focused in the Department of Earth and Environmental Science at Acadia University, managed by the departmental Administrative Assistant, Lynn Graves. Lynn's report is inserted below. Understandably, the number of publications sold and distributed this year is lower than usual, in large part due to closure of provincial visitors' information centres and the cancellation of the Parrsboro Gem and Mineral show.

AGS Publication Distribution - 2020

Pub#	# Distributed	
	1	Geology of NS
	2	Geology of NB/PEI
	1	Joggins Fossil Cliffs
	1	Island at Centre of World
	6	Colouring Books
	1	Postcard Set: Fundy Basin.
#1	7	Highway Map
#6	1	A Guide to the Geology...NS
#8 #11	1	The Appalachian Story
#9 #12	1	Offshore Oil and Natural Gas Video & Guide
#10 #13	1	The Recent Ice Age Video & Guide
#14	1	Discovering Rocks, Minerals and Fossils....
#15	11	LBY
#39	87	NS Rocks (3 boxes@300)
#50	84	NS Pebbles Brochure (+3 boxes@700)
#51	11	Geology of Green Cove

*Note from Lynn: VICs were not open due to Covid-19. In a normal year at least 10 more boxes of rocks and pebbles would have been distributed.

The NB Department of Energy and Resource Development and the NS Department of Energy and Mines continuing to collaborate on the production of new geological highway maps of both New Brunswick plus PEI and Nova Scotia. Goal is completion by 2022, as a contribution to the celebration of the 50th anniversary of AGS.

Responsibility for the preparation of the second edition of the best-selling book "The Last Billion Years" is in the hands of an editorial committee set up by the AGS Education Committee. The editorial committee has contributed a separate report to this meeting. Like the first edition, the book will be co-published with Nimbus, and a contract between Nimbus and AGS is in preparation. The goal is to have the new book available by March 2022, in time for the Halifax 2022 GAC-MAC meeting – another fitting contribution to the celebration of the 50th anniversary of AGS.

Submitted by Sandra Barr (Publications Committee Chair)
February 1, 2021

Publications Committee members: Sandra Barr, Rob Fensome, Dave Frobel, Rob Raeside, Chris White, Graham Williams, Reg Wilson

Atlantic Geology **Editors' Report to AGS (2020-2021)**

Volume 56 (2020) of *Atlantic Geology* was concluded in December, with nine papers and three sets of abstracts (2020 AGS colloquium, annual meeting of the Newfoundland and Labrador Section of GAC, and AUGC). The volume is available to subscribers and subscribing institutions on the website (http://journals.hil.unb.ca/index.php/AG). The page count for Volume 56 is 290, down from 399 in v. 55 when

eleven papers were published, as well as the three sets of abstracts. The total number of individual and institutional subscriptions to the journal has increased to about 260 (compared to about 230 in 2019). The number of subscribers who request printed copies of the volume continues to decline (down to fewer than 10). However, to meet that need we still printed about fifteen copies in black and white through Gaspereau Press (Kentville, NS). Hence, a few extra paper copies are available if anyone wishes to purchase one ($15 plus postage).

Volume 57 (2021) has been initiated on the website, with the first four papers of the "Circum-Arctic Palynological Event Stratigraphy (CAPE)" series now available. We thank *Atlantic Geology* editor Rob Fensome for looking after these manuscripts; another six papers anticipated during 2021. A financial contribution was made by NRCan to contribute to publication cost and making the papers "open access" immediately on publication. Regular manuscripts will also be published in this volume, as they become ready. We currently have only one additional manuscript in the system, with two others promised soon. We would welcome additional submissions at this time (or any time!).

Journal Production Manager Chris White prepared the annual financial report (including in the AGS Treasurer's Report) as well as the subscription report. Those reports are presented to the annual *Atlantic Geology* editorial board meeting, held this year on February 4th. As usual, the current and incoming AGS presidents are invited to attend this meeting. The financial picture for the journal continues to be excellent, with total assets as of December 31st, 2020, of $111,930 (compared to $99,878 at the end of 2019). Our subscription number have also increased (to 261 compared to 233), in large part due to our participation in Le Consortium Érudit, a Montreal-based journal aggregating organization. We have a contract agreement with them for managing subscriptions which seems to work very well and is low-cost for the journal. We also benefit from significant royalties, especially from AAPG DataPages.

We thank the staff at the Centre for Digital Scholarship @ UNB Libraries, notably James Kerr and Rob Glencross, who continue to help in our on-going struggles with the rather mysterious journal website. We are also grateful to Chris White for his exceptional work as Production and Financial Manager. We also thank the associate editors and other reviewers of manuscripts for their help, without which we would not have a high-quality journal. Reviewers' names are acknowledged annually on the website unless anonymity was requested. Our layout staff (Leann Grosvold and Eugene MacDonald) do excellent work for the journal. And, of course, we thank the authors who submitted manuscripts to the journal for publication.

Submitted by:
Sandra Barr, Denise Brushett, Rob Fensome, and David West
Co-editors, Atlantic Geology
February 1, 2021

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Abstracts

ATLANTIC GEOSCIENCE SOCIETY WEBMASTER REPORT 2020-2021

Google Analytics (GA) is used to track the Atlantic Geoscience Society website usage. GA has changed their reporting dashboard and now focus is more on Google Searches than actual visits.

Between January 18, 2020 and January 17, 2021, there had been 2,500 visits to the AGS website by 1,800 individual users. A breakdown of the visitors by country of origin is: Canada (82%), USA (13%), China, United Kingdom, Iran and others (1.2% each). The average time spent on the site homepage is 1 – 2 minutes which reflects the fact that the AGS home page is the jump in point to our society's information and it also has links to outside websites, such as those set up for this Colloquium. The website is mainly accessed using Google Chrome 60%, Safari 18%, Firefox 11% and Edge 5% as browsers. The site is still primarily accessed from desktop computers 76% (Windows 54% and Macintosh 22%) but now usage includes mobile devices 23% and tablets 1%.

Over the past year the website has not undergone any major changes. Routine updates to the information presented on the AGS website are conducted as requested by the Executive. The AGS Webmaster is not responsible for any information found or presented on the "Atlantic Geoscience Society" Facebook page.

The website committee is continuing to create a mobile accessible website. The committee report should bring us more insight on that project.

Please report any link errors, information errors or omissions to the webmaster or AGS executive, so corrections can be made.

Joe MacIntosh

Website Renewal Committee 2020-2021

With a rise in mobile device use and a need for the AGS website to be compatible with such devices, Council approved the development of a mobile-friendly AGS website, which is temporarily viewable at http://ags.fishandwhistle.net/ while it is under construction. Content from the current AGS website is being copied into the WordPress format, with a focus on the following:

- Ensuring mobile-friendly viewing of all pages
- Restructuring the menu and nested pages
- Stream-lining content, where applicable
- Adding imagery, where applicable
- Updating content, where applicable

We reached out to Dalhousie IT services at Joe MacIntosh's suggestion to see if continuing to host the site with the new framework is an option. The software on the server would need to be updated for this to happen. If this is not possible, the cost for a commercial host would be $3-5 per month.

We hope to launch the new mobile-friendly version in late February or early March after the Colloquium. For the launch, we are putting priority on key pages such as membership information, Council contacts, publications, speaker tours, etc. However, all content will eventually be moved to the mobile-friendly site. Once the launch occurs, the existing AGS webpage will no longer be accessible and updates and posts should be forwarded to Lynn Dafoe and Dewey Dunnington for incorporation into the new website platform.

Lynn Dafoe and Dewey Dunnington

Travelling Speaker Series

submitted by Sheila Watters – Jan 30th 2021

The AGS committee (Sheila Watters, Lynn Dafoe, Catrina Russell and Matt Stimson) is pleased to report on the 2020 activities of the Travelling Speaker Series. Activities in 2020 were subject to postponements and rescheduling issues due to the Covid-19 pandemic but eventually a single talk was delivered via Zoom to interested parties from all 4 provinces.

Three in-person presentations had been scheduled for spring 2020 but had to be postponed due to the pandemic restrictions. John Calder was to present "Big Footprint: Humanity's Role in Global Environmental & Climate Change." He initially felt that it was best presented in-person so we anticipated new in-person presentation dates in the fall. Significant Covid restrictions continued and Nature clubs and the Nova Scotian Institute of Science were contacted to determine if they would consider proceeding with their programming via online talks. With uncertainty how they would proceed, the committee decided to organize its own AGS Zoom talk.

In the fall John suggested a change in topic for his presentation based on the recent announcement of two more UNESCO Global Geoparks for Atlantic Canada. John is currently Chair of the Canadian Geoparks Network and Atlantic Canada now has three of Canada's 5 Geoparks. He suggested a talk comparing and contrasting the Geoparks.

The committee thanks John for presenting "Explore Atlantic Canada's UNESCO Global Geoparks", an educational and entertaining talk that was attended by about 60 Zoom participants. Thanks to Dave Lentz for providing Zoom connection, to Catrina Russell for advertising, to Lynn Dafoe for preparing digital poster and hosting the event, Matt Stimpson for introduction and moderating questions. Additional thanks to our inhouse advertising team, Tim Fedak and Joe MacIntosh, and to Rob Raeside for his ongoing support. The recorded TSS talk has been posted on You Tube by Zeinab Azadbakht.

Expenses for the 2020 Zoom talk totaled about $260, well under the previously approved budget of $2210 for the Series (Feb 2014).

Committee meetings to define the 2021 Series will also begin early in the New Year. Input and ideas for the Travelling Speaker Series are welcomed by the committee!

Report from Canadian Federation of Earth Sciences (CFES) 2020

CFES is an umbrella organization that represents 13 Earth Science societies and associations and has 6 Observer societies across Canada and hence represents as many as 15 000 Earth scientists. The federation aims to provide a coordinated voice for Canada's Earth Science community to try to ensure that decision makers and the public understand the contributions of Earth Science to Canadian society and the economy.

The Atlantic Geoscience Society (AGS) is one of thirteen member organizations of CFES. Each member organization has a representative on the CFES Council, which annually elects a Board of Directors to manage the day-to-day activities of CFES. As the AGS representative my role is keep the AGS Executive and members-at-large informed of CFES activities, and also to take any concerns from AGS back to CFES. The CFES fiscal year runs from April 1 to March 31st, and they hold their annual meeting in April each year, at which the Board and Officers are elected and the budget approved for the coming year.

I attended the CFES Council Meeting and Annual General Meeting in Ottawa (April 17th and 18th 2020) and was involved with several e-mail and virtual discussions and votes during the year. Below are some of the highlights of the past year:

(1) We finalized the CFES Operational Plan for 2020 to 2023 outlining Strategic Initiatives and Tactical Actions including timelines for each year. (see website for details).

(2) We established a video Newsletters (U-Tube) to present updates from the CFES Board of Directors and the Member Organizations. If we (AGS) have any interesting news updates we can forwarded to the President Elect for inclusion in these video newsletters

(3) Climate change committee has received input from all the membership. I thank those AGS members who had supplied input in the draft copy, especially John Calder's work on the original draft. A close-to-complete version will be presented in February, with view to a final version up for approval at the AGM in April. - document in preparation (with input from John Calder)

(4) Professor Dominique Weis of the University of British Columbia is the winner of the 2020 CFES Mentorship Medal. Nominations for 2021 closed on January 15th. Nominations currently being reviewed.

CFES website: https://www.cfes-fcst.ca

Submitted by AGS Representative Chris White (February 01, 2021)

Report to AGS Annual General Meeting – 2021
Halifax 2022 Organizing Committee

Planning continues for "Halifax 2022", the joint annual meeting of the Geological Association of Canada (GAC®), Mineralogical Association of Canada (MAC), Canadian Society of Petroleum Geologists (CSPG), and the International Association of Hydrogeologists – Canadian National Committee (IAH-CNC). AGS is the host society for the meeting, which will be part of the 50th anniversary celebrations of AGS. The meeting dates are May 15-18, 2022, at the Halifax Convention Centre (HCC). The conference website has been established at http://ags.earthsciences.dal.ca/Halifax2022/.

A core group of volunteers has stepped forward to fill the committee chair positions on the local organizing committee (LOC; see list accompanying this report). Additional volunteers from AGS will be needed on most of these committees and we will also be relying on AGS members to propose and organize sessions, short courses, workshops, field trips and all the other events associated with this large and topically diverse scientific meeting. Three meetings of the LOC were held during 2020: in person on Feb. 7th in Truro during the AGS colloquium and virtually via TEAMS on May 20th and October 13th. The 9th LOC meeting will be held (virtually) on February 11th, 2021.

At this point in time the LOC is still hoping that Halifax 2022 can be mainly in person but given the current global situation, it seems likely that the meeting will also have a virtual component. On the other hand, if travel is again safe and viable, we anticipate that geoscientists will be very ready and willing to come to Halifax in May 2022!

Planning is going ahead for the conference program, field trips, short courses, business meetings, and of course social events, especially those in celebration of the 50th anniversary of AGS. A call was made in January for field trip proposals to be submitted to Amy Tizzard by February 11.

A new initiative for the meeting is an Equality and Inclusion component, spearheaded by Dawn Kellett, Ricardo Silva, and current GAC President Deanne van Rooyen. We anticipate enhanced information about topics such as expected behaviour at meetings, genderless bathrooms, and a code of conduct, including in online settings, in keeping with enhanced awareness of these aspects in society in general.

Submitted by
Sandra Barr and Rob Raeside, Co-chairs
Halifax 2022 Organizing Committee

Halifax 2022 Committee	Chair
General Chair	Sandra Barr
MAC Vice/Co-Chair	Rob Raeside
CSPG Vice chair	Carla Skinner
General Secretary	Lynn Dafoe
Finance	Nikole Bingham-Koslowski
Accommodations/Transportation	Erin Adlakha
Exhibits	Jacob Hanley
Field Trips	Amy Tizzard
Fundraising	David Lowe
Outreach	Louise Leslie
Publications	Denise Brushett
Publicity/website	Donnelly Archibald
Registration	Dawn Kellett
Short Courses	Deanne van Rooyen
Special Events/Social Events	Lexie Arnott
Technical Program	Chris White
Technical Services	John Gosse
Early Career Events	Ricardo Silva
AGS Liaison	Ian Spooner
IAH-CNC representatives	Gavin Kennedy, Barret Kurylyk
CCUEN representative	Peter Mushkat

AUGC 2020 Report from UNB committee

The virtual AUGC 2020 conference concluded the 21st of November with 58 official registrants (37 undergraduate students, 4 graduate students, 13 faculty, 4 other) and 8 volunteers. The conference included:

- 8 oral presentations (3 UNB, 2 MUN, 2 Dal, 1 SMU)
- 8 poster presentations (2 UNB, 5 MUN, 1 SMU)

Financial report:

Income:

- Registration: $20 each x 58 registrants = $1,160.00
- General Sponsorships = $3,850.00
- Award Sponsorships = $2,950.00
  Total = $7,960.00

Costs:

- Awards = $2,950.00
- Virtual platforms = $2,604.57
- Thank you gifts = $450.00
- T-shirts = $1,945.10
- Bank fees = $12.50
  Total = $7,962.17

Income - Costs = $7,960.00 - $7,962.17 = - $2.17 covered by the Science Atlantic Float

All remaining money has been sent to Science Atlantic and the bank account is now closed.

AUGC 2021:
AUGC 2021 will be hosted by SMU in 2021. We have been in contact with Josh Jackman and Aidan Buyers, who will be organizing the conference. We have provided detailed advice regarding the various aspects of conference planning in the Science Atlantic Conference in a Box. Our main advice is to start early, as it can take a while to get replies and it will be less stressful. Our advice also included staying organized as being in contact with so many people can get confusing.

Grace Jackson & Hannah Sharpe

AGS Colloquium 2021 Social Media Report

After surveying AGS members in the summer of 2020 with regards to their social media habits, the intent was to get an idea of how various individuals spend their time on these platforms. Including which social media sites members use, as well as the time of day they spend the most time using social media.

Since the survey was conducted there have been a number of 'zoom series' and traveling speaker series presentations that have been promoted on both the AGS Facebook and Twitter Accounts. I also started regularly posting content on both Facebook and Twitter, photos from years past in a series called 'Throwback Thursday' (#tbt).

Here are the analytics from social media posts over the past few months:

Facebook: Likes 915, Followers 992 (February 4, 2021)

Definitions:
- Reach: times people saw this post on Facebook. This includes those who do and do not follow the AGS Facebook account
- Post clicks: times people clicked on the post to read/view it
- Reactions; including 'likes', comments and shares: times people directly engage with a post

#tbt Series Analytics (5 posts):
Reach: 1156 (231 average)
Post clicks: 24 (4.8 average)
Reactions: 70 (14 average)

Zoom Seminars & Speaker Series Analytics (9 posts)
Reach: 1775 (197 average)
Post clicks: 65 (7.2 average)
Reactions: 81 (9 average)

Twitter: Following 97, Followers 181 (February 4, 2021)
Definitions:
- Impressions: times people saw this Tweet on Twitter. This includes those who do and do not follow the AGS Twitter account
- Total engagements: times people interacted with this Tweet

- Media engagements: number of clicks on your media counted across videos and images
- Likes: times people liked this Tweet
- Retweets: times people retweeted this Tweet
- Detail expands: times people viewed the details about this Tweet
- Profile clicks: number of clicks on your name, @handle, or profile photo

#tbt Series Analytics (7 photos):
Impressions: 1686 (241 average)
Total engagements: 109 (15.6 average)
Media engagements: 67 (9.6 average)
Likes: 16 (2.3 average)
Retweets: 4 (0.57 average)
Details expanded: 18 (2.6 average)
Profile clicks: 7 (1 average)

Zoom Seminars & Speaker Series (8 Posts):
Impressions: 3811 (476 average)
Total engagements: 102 (13 average)
Media engagements: 37 (4.6 average)
Likes: 21 (2.6 average)
Retweets: 8 (1 average)
Details expanded: 30 (3.8 average)
Profile clicks: 5 (0.63 average)

(Throwback Thursday) #tbt Facebook & Twitter Summary: What is not surprising is that posts with higher quality imagery and human faces tend to get more overall engagements from users on Twitter and Facebook. There have only been eight #tbt posts to date, and seven were analyzed for this report. The first posts in this series have come at different times of day on Thursday. It's difficult to say if time of day is a factor at this point, but it will continue to be monitored as more posts are made in the coming months. Based on the survey from Summer 2020 AGS tend to monitor their social media accounts throughout the day. The goal for the next three months will be to increase overall impressions on Twitter. Retweeting more content from other accounts is something I'm heavily considering as a way to boost online interactions.

Zoom Seminars & Speaker Series, Facebook & Twitter Summary: Most of the Zoom webinar series posts tend to have the similar, lower numbers when it comes to overall impressions and interactions. They definitely would benefit from an added image to their posts so that they catch readers eyes. In the future I will look at including imagery to the specific Zoom webinars in the future. Tim Fedak's presentation on "200 Years of Mineralogy and Contributions to Nova Scotia Geology" and John Calder's presentations on "Exploring Atlantic Canada's UNESCO Global Geopark" tended to yield more responses and overall interactions on Twitter than the webinar series. Again these posts benefited from imagery and an embedded video link to Tim Fedak's talk on YouTube.
Overall Conclusion: The main goal **i**n the coming months is to address the points I have previously mentioned. I would like to also add a series focusing on rocks, something along the lines of "Mineral Monday', where I would regularly upload photos to social media of interesting fossils, minerals and rocks from across Atlantic Canada and beyond!

AGS Geoheritage Committee

Bringing public attention to the rich geoheritage of the Atlantic Provinces is in keeping with the central tenets of the AGS. The Geoheritage Committee of the society was born during the past year 2020, and like many other initiatives of that year, has been slow to take flight but is steadily growing. Presently, the Committee comprises Rob Fensome, Jason Loxton, Jeff Poole and John Calder. The committee seeks representation from New Brunswick and from Newfoundland and Labrador. Jeff Poole brings knowledge of the construction and maintenance of Nova Scotia's Geoheritage list and database, which will be helpful to the AGS and to other jurisdictions interested in compiling geoheritage sites.

John Calder

NOMINATION OF OFFICERS AND COUNCILLORS – February 2021

The following individuals have agreed to be nominated as new members or agreed to continue to serve on council subject to ratification by the AGS membership.
* new member on Council

President	Anne-Marie Ryan, Dalhousie University	1
Past President	Dave Lentz, University of New Brunswick	2
Vice-President	Deanne van Rooyen, Cape Breton University	3
Treasurer	Paul Batson, Timberlea, NS	4
Secretary	Rob Raeside, Acadia University	5
Councillor	Donnelly Archibald, St. Francis Xavier University	6
Councillor	Lexie Arnott, Dalhousie University	7
Councillor	Denise Brushett, NS Department of Energy and Mines	8
Councillor	John Calder, St. Mary's University	9
Councillor	*Dewey Dunnington, Dept. of Fisheries & Oceans, BIO	10
Councillor	Tim Fedak, Nova Scotia Museum	11
Councillor	Martha Grantham, Stewiacke, NS	12
Councillor	Alison Leitch, Memorial University	13
Councillor	Ann Miller, Wolfville, NS	14
Councillor	Catrina Russell, New Brunswick Museum	15
Councillor	Ann Timmermans, University of New Brunswick	16
Councillor	Grant Wach, Dalhousie University	17
Councillor	Jim Walker, NB Dept. of Energy and Resource Development	18
Councillor	Sheila Watters – GeoExplorations Inc.	19
Councillor	Chris White, Nova Scotia Department of Energy and Mines	20
Student Councillor	*Alan Fernando Cardenas Vera, UNB (graduate student)	21
Student Councillor	*Josh Jackman & Aidan Buyers, SMU (undergraduate students)	22

Completion of term:
Bob Grantham
Dewey Dunnington completion of term as Grad student rep – continuing as Councillor
Hannah Sharp (UNB) & Grace Jackson (UNB)