The 72nd Annual

Atlantic Universities Geoscience Conference

AUGC

Acadia University 2022

October 27 – 29, 2022

Acadia University

Wolfville, Nova Scotia

We acknowledge that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People. This territory is covered by the "Treaties of Peace and Friendship" which Mi'kmaq and Wolastoqiyik (Maliseet) People first signed with the British Crown in 1725. The treaties did not deal with surrender of lands and resources but in fact recognized Mi'kmaq and Wolastoqiyik (Maliseet) title and established the rules for what was to be an ongoing relationship between nations.

AUGC 2022
would like to thank our sponsors:

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Letter from the Head of Earth and Environmental Science

Acadia University
Department of Earth & Environmental Science
Acadia University, Wolfville, Nova Scotia,
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Welcome to the 2022 Atlantic Universities Geoscience Conference at Acadia University. The Earth and Environmental Science Department is pleased to be hosting one of the oldest geoscience conferences in Canada, especially one focused on undergraduate research and networking and that brings together students from across Atlantic Canada. I would like to congratulate the organizing committee for putting together a great collection of field trips (which are a highlight of AUGC), interesting speakers and some fun activities. I am especially keen to attend the student talks which are always of a very high caliber and a great opportunity to take in current research in Atlantic Canada.

Make sure you take the opportunity to mingle with and meet other students as well as professionals and professors that are at the conference; AUGC is a great opportunity to establish some new contacts and chat about graduate opportunities and employment prospects. Above all else enjoy your stay in Wolfville and at Acadia. See you at the conference!

Ian Spooner.
Head and Professor, Earth and Environmental Science
Acadia University, Wolfville, NS.

Letter from the AUGC Organizing Committee Chair

Acadia University
Department of Earth & Environmental Science
Acadia University, Wolfville, Nova Scotia,
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Telephone: (902) 790-1088
Fax: (902) 585-1816

Dear Conference Attendees:

We are very excited to welcome you all to 72nd Atlantic Universities Geoscience Conference!

The Acadia Earth and Environmental Science student body and the Fletcher Geology Club are very proud to be hosting this year's event. We hope that your time at the conference is full of great experiences, learning opportunities, and memories. We invite everyone to experience all that Acadia and the beautiful Annapolis Valley have to offer by taking part in the activities we have available and taking some free time to explore the Acadia campus and the surrounding area.

This year we have chosen three wonderful field trips that showcase both the Valley and other geology-rich parts of Nova Scotia.

We would like to thank all our industry sponsors, earth science professors, and especially our department administrator Lynn Graves, as well as the Acadia student volunteers. All of them were necessary to make this conference possible.

Sincerely,

Cameron Greaves

Chair
AUGC Organizing Committee

Conference Schedule

Thursday October 27th, 2022

4:00 pm – 7:00 pm	Arrive at Old Orchard Inn
7:00 pm – 11:00 pm	Registration and mixer at the University Club, 6 Park Street

Friday October 28th, 2022

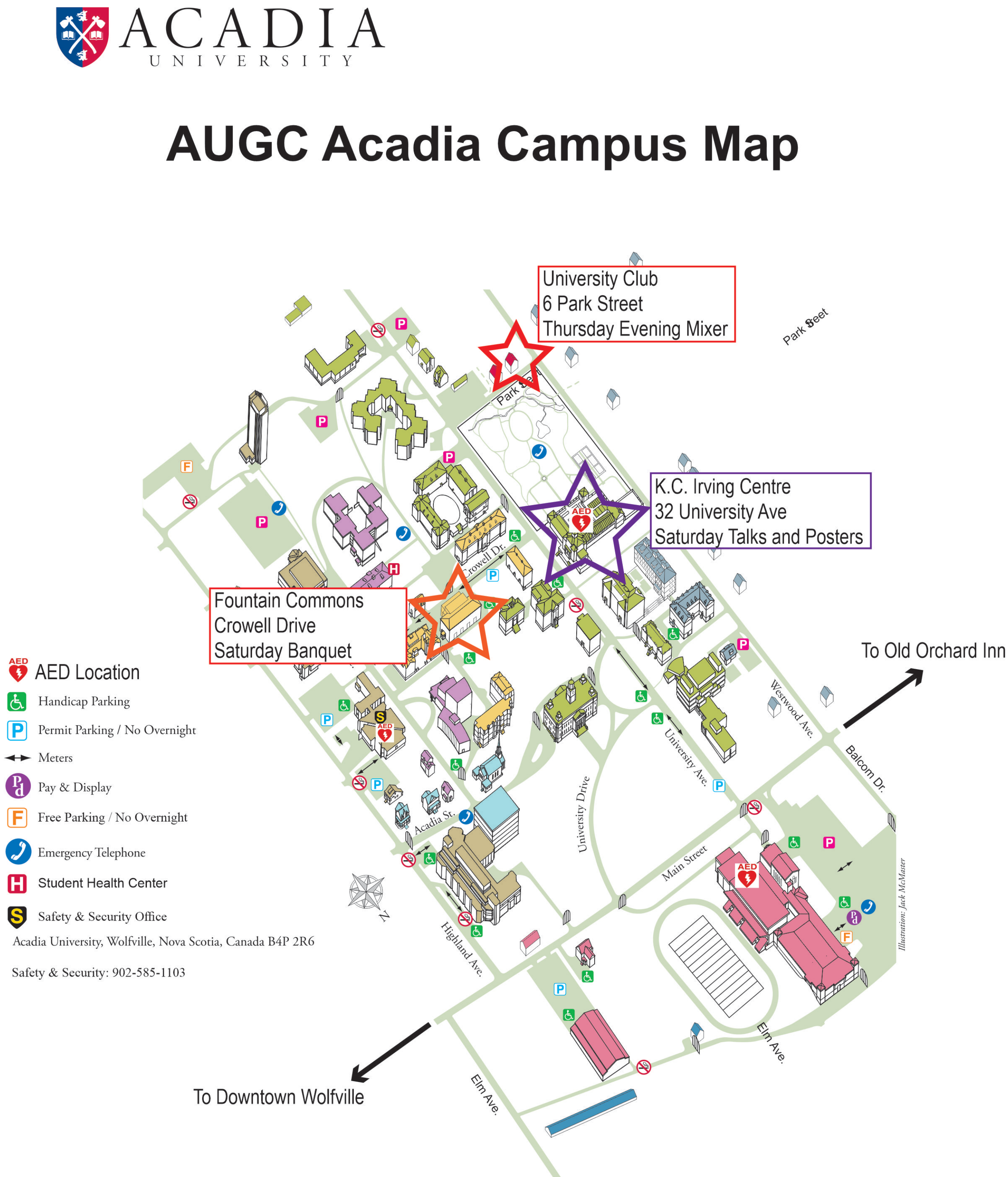
8:00 am – 9:00 am	Registration & assembly for field trips at the Old Orchard Inn
9:00 am – 4:00 pm	Field Trip #1: The Story Beneath the Scenery - Going Back in Time in the Wolfville Area
8:30 am – 5:00 pm	Field Trip #2: Geology of the South Shore of Nova Scotia
9:00 am – 3:00 pm	Field Trip #3: Surficial features and geohazards around the Annapolis Valley
7:00 pm – 7:30 pm	Club Executive Meeting
7:00 pm – 11:00 pm	CSEG Trivia Challenge Bowl at the Wolfville Lion's Club

Saturday October 29th, 2022

Conference located on the Acadia University Campus, K.C. Irving Centre, lower lobby

8:30 am – 9:00 am	Registration and Poster Set-up
9:00 am – 10:20 am	Oral presentations: Session #1
10:20 am – 10:40 am	Poster session and refreshment break
10:40 am – 12:00 pm	Oral presentations: Session #2
12:00 pm – 12:20 pm	Guest Speaker: Carla Skinner (IDEA for early career)
12:20 pm – 1:40 pm	Poster session and lunch break
1:40 pm – 3:00 pm	Oral presentations: Session #3
3:00 pm – 3:20 pm	Poster session and refreshment break
3:20 pm – 5:00 pm	Oral presentations: Session #4
5:00 pm – 6:30 pm	Judges deliberation for conference awards
5:00 pm – 6:00 pm	Science Atlantic Representatives Meeting, Huggins Science Hall 336
6:30 pm – 10:30 pm	Banquet, award presentations, and guest speakers, Fountain Commons

Campus Map


ACADIA
UNIVERSITY
AUGC Acadia Campus Map
University Club
6 Park Street
Thursday Evening Mixer
K.C. Irving Centre
32 University Ave
Saturday Talks and Posters
Fountain Commons
Crowell Drive
Saturday Banquet
AED Location
Handicap Parking
Permit Parking / No Overnight
Meters
Pay & Display
Free Parking / No Overnight
Emergency Telephone
Student Health Center
Safety & Security Office
Acadia University, Wolfville, Nova Scotia, Canada B4P 2R6
Safety & Security: 902-585-1103
To Old Orchard Inn
To Downtown Wolfville
Westwood Ave.
Balcom Dr.
University Ave.
University Drive
Main Street
Acadia St.
Highland Ave.
Elm Ave.
Elm Ave.
Crowell Dr.
Illustration: Jack McMaster

AUGC 2022 Organizing Committee

Cameron Greaves	Conference Chair
Dr. Sandra Barr	Faculty Advisor
Dr. Mo Snyder	Faculty Advisor
Jesse Demaries-Smith	Treasurer and Fundraising Coordinator
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Mitch Maracle	Events Coordinator
Sully Harnum	Volunteer Coordinator and Webmaster
Yuzhe Gan	Webmaster
Parker Ingham	Communications and Outreach
Leah Mymin	Presentation Session Chair

Special Thanks

Dr. Sandra Barr

Dr. Mo Snyder

Dr. John Waldron

Dr. Aaron Taylor

Lynn Graves

Judges and sponsor representatives

Andy Williams, P. Geo.
Director – Solutions Provider
Convex Rolling Energy Inc.
(CSEG representative)

Mike Power, P.Geo.
Director, Business Development and Senior Geologist,
Mercator Geologist Services Limited.
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Vice President, Mining Association of Nova Scotia.
(Geoscientists Nova Scotia representative)

Kevin Neyedley
Mineral Deposits Geologist
Nova Scotia Department of Natural Resources and Renewables
(PDAC representative)

Mick O'Neill
Liaison Geologist
Nova Scotia Department of Natural Resources and Renewables
(NSDNRR representative)

Poster judges (AGS representatives)

Donnelly Archibald, PhD
Instructor, Department of Earth Sciences
St. Francis Xavier University

David Keighley, PhD
Professor and Assistant Dean of Science
Department of Earth Sciences, UNB

Guest Speakers

Carla Skinner

Carla Skinner (she/her) is a geologist from Dartmouth, Nova Scotia. She has a BSc in Biology because she thought she wanted to go into medicine but realized near the end it wasn't the right path, so she took an Intro to Geology class and found her calling. She decided to stay at Dalhousie University and completed a BSc Honours and MSc Earth Science. She then moved to Calgary to work for Shell Canada Ltd as an Operations Geologist for 4 years before returning to Nova Scotia. She started her PhD at Dalhousie in 2020, focusing on geothermal energy and is also working at the Geological Survey of Canada, focusing on carbon capture and storage. As an Indigenous geologist, Carla is an advocate for IDEA in the geoscience community and enjoys learning how she can do more to actively support others.

Sydney Lancaster

Sydney Lancaster is a Prairie-born artist and writer from Amiskwacîwâskahikan, also known as Edmonton. Sydney has presented work across Canada, and held residencies in Alberta, Nova Scotia, and Newfoundland. Recent exhibitions include Macromareal (a rising tide lifts all boats) at Society of Northern Alberta Printmakers Gallery (2020), Boundary|Time|Surface at the Art Gallery of St. Albert (2019), and Macromareal (redux) at ~Diffuser Gallery, Emily Carr University (2019). An artist book, Boundary|Time|Surface: a record of change was published in 2019. Sydney's practice considers place, memory, knowledge, and time, and includes site-specific installation & sculpture, video and audio works, printmaking, and photography.

John Waldron

Sydney's partner John Waldron grew up in the UK, and completed his doctorate at Edinburgh University, working on the Antalya Complex of SW Turkey. After a short post-doctoral fellowship at Memorial University of Newfoundland he taught at Saint Mary's University from 1981 to 2000, while carrying out research projects on deformed sedimentary rocks in the Appalachians of Atlantic Canada. Subsequently he moved to the University of Alberta but continued work on the Paleozoic rocks of Atlantic Canada and their continuation in the UK, receiving the Gesner Medal of the Atlantic Geoscience Society in 2009. Outside the Appalachians, he has worked on projects in the Slave Province of the Northwest Territories, and in the Nepal Himalaya.

Presentation Schedule

9:00 am to 9:20 am	Dylan McKeen, Saint Mary's University
9:20 am to 9:40 am	Colin Clancey, Memorial University
9:40 am to 10:00 am	Jesse Demaires-Smith, Acadia University
10:00 am to 10:20 am	Abby Kelly, University of New Brunswick
10:20 am to 10:40 am	**Refreshment break and poster viewing**
10:40 am to 11:00 am	Rowan Norrad, Acadia University
11:00 am to 11:20 am	Parker Ingham, Acadia University
11:20 am to 11:40 am	Claire Gullison, University of New Brunswick
11:40 am to 12:00 pm	Yuzhe Gan, Acadia University
12:00 pm to 12:20 pm	**Guest speaker Carla Skinner (IDEAs for Early Careers)**
12:20 pm to 1:40 pm	**Lunch and poster session (viewing and judging)**
1:40 pm to 2:00 pm	Hayley Fitzgerald, Memorial University
2:00 pm to 2:20 pm	Julianna Whelan, Memorial University
2:20 pm to 2:40 pm	Juvani Bryce, Memorial University
2:40 pm to 3:00 pm	Catherine Brenan, Dalhousie University
3:00 pm to 3:20 pm	**Refreshment break and poster viewing**
3:20 pm to 3:40 pm	Brayden Harker, University of New Brunswick
3:40 pm to 4:00 pm	Taylor Mugford, Memorial University
4:00 pm to 4:20 pm	Michael LeBlanc, St. Francis Xavier University
4:20 pm to 4:40 pm	Arthur Hilliard, Dalhousie University
4:40 pm to 5:00 pm	Cameron Greaves, Acadia University

Student Abstract Index

Oral Presentations

Poster Presentations

Groove Casts? More Like Whose Cast? What made these anomalous structures?

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The Meguma terrane is home to the metasandstone rich Goldenville Group. This Cambrian unit contains many sedimentary structures including but not limited to flute casts, wave and current ripples, sand volcanoes, and large enigmatic groove casts. The origin of these large groove casts is currently unknown, but given the consistency and size of the grooves, it is speculated that they may have been formed from biogenic source such as a large organism being dragged across the sediment surface. Analysis of the structures is made more complex because the rocks within the Goldenville Group have been deformed causing the structures within these rocks to be strained. Reversing strain is an important step in determining the possible origin of the large groove casts. One method to reverse strain is to examine sedimentary structures, such as equant sand volcanoes and circular and meandering trace fossils, and determine an overall strain ratio and then apply an inverse strain value to the groove casts. A 3-D model of the groove casts created using photogrammetry software will then be compared to various large objects or organisms that were present in the Cambrian to find a potential match for the groove casts. The results of this investigation have implications including the size and abundance of animals from the Cambrian in Nova Scotia.

Where's the Carbon? Spatially mapping carbon on the seafloor

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Coastal sediments contain the largest stocks of organic carbon and play a vital role in influencing the carbon cycle. Protecting organic carbon hotspots is essential to mitigating climate change since development and bottom trawling can disturb the seafloor, driving the remineralization of organic carbon into carbon dioxide. Terrestrial carbon stocks are well studied and mapped, but our knowledge of standing stocks of marine sedimentary carbon and the role that it can play in minimizing the effects of climate change are poorly understood. One of the challenges in mapping the seafloor environment is the issue of characterizing spatial heterogeneity of different substrata, which is critical in estimating organic carbon standing stocks in the marine environment. In this study, we use high-resolution multibeam echosounder (MBES) data from the Eastern Shore Islands off Nova Scotia to predict the distribution of percent organic carbon in surface sediments. We applied benthic habitat mapping approaches, utilizing high-resolution continuous coverage environmental variables (bathymetry, backscatter, current velocity, bottom salinity, bottom temperature, ruggedness, slope, Euclidean distance) combined with subsea video and ground truthing to generate thematic maps of sediment types for the area. We then compared that to the measurements of organic carbon from the samples, which were spatially modelled using different methodologies to estimate organic carbon standing stocks in the area by substrate type. These high-resolution sedimentary organic carbon maps can help determine the best approach for using MBES surveys to map carbon and identify carbon hotspots, which are essential for seabed management and climate mitigation strategies.

Pebble provenance across a syn-tectonic braided fluvial to alluvial fan transition, Flatrock Cove Formation, Flatrock, Newfoundland

JUVANI BRYCE[1], DAVE LOWE[1]
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The Ediacaran Flatrock Cove Formation in the Avalon Zone, Eastern Newfoundland, is composed of the Knobby Hill member conformably overlain by the Piccos Brook Member. These units record syn-tectonic sedimentation and a change from a braided fluvial to alluvial fan environments during progressive folding and thrusting along the proximal margin of the Signal Hill Basin, coinciding with the Avalonian Orogeny (ca. 600-545 Ma). This project aims to constrain the provenance of clasts in conglomerates of the Knobby Hill and Piccos Brook members to identify changes in sources and sediment routing coinciding with Avalonian deformation in sediment hinterlands. Point counting of clasts in the field from the middle of the Knobby Hill Member upward through to the Piccos Brook Member reveals significant changes in clast compositions. In Knobby Hill, there is an upward change in igneous clast populations from angular black rhyolite, andesite, and granite, to a mainly subrounded to rounded weathered granite. Clasts in the Piccos Brook Member are dominated by sandstone, mudstone, and siltstone. Based on this data, significant changes in clast hinterlands occurred throughout the Flatrock Cove Formation sedimentation, from mainly volcanic, to plutonic, to sedimentary. Fourteen representative igneous clasts were also selected for bulk major and trace element geochemistry, with a focus on high field strength elements (HFSE), rare earth elements (REE), and Y, which will be used to discriminate the petrogenesis of igneous source areas and provide more detail of the sequence of hinterland uplift and exhumation coinciding with Flatrock Cove Formation sedimentation.

Chemical characterization of melt inclusions in Blake River Volcanics of the Swayze area, Abitibi Greenstone Belt, Ontario

AIDAN BUYERS[1], JACOB HANLEY[1], KEVIN NEYEDLEY[1], THOMAS GEMMELL[2]
[1]*Mineral Exploration and Ore Fluids Laboratory, Department of Geology, Saint Mary's University, Halifax, NS B3H 3C3,* [2]*Earth Resources and Geoscience Mapping Section, Ontario Geological Survey, Mines and Minerals Division, Ministry of Mines, Sudbury, ON, P3E 6B5*
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Volcanogenic massive sulphide (VMS) deposits are important sources of economic concentrations of copper, zinc, lead, gold, silver and other strategic minerals. The Neoarchean Abitibi Greenstone Belt (AGB) is a world class mining district straddling the Ontario and Quebec border and is host to numerous world-class VMS deposits. In terms of total metal endowment, the Blake River Group (BRG; 2704-2695 Ma) is the most enriched group within the Abitibi. The megacaldera complex has 31 known VMS deposits, most of which are concentrated around the Noranda and Doyon-Bousquet-LaRonde (DBL) mining camps. However, in the Swayze area of the AGB, no economic VMS deposits are known, despite considerable volumes of BRG rocks present in the area. This raises the question as to what factors control the occurrence of BRG-hosted economic VMS deposits in the AGB. This study will investigate whether the Swayze BRG rocks had the same initial melt compositions as the BRG rocks in the prolific DBL camp, specifically ore metals available to be concentrated by magmatic-

hydrothermal systems. To achieve this, the study aims to chemically characterize the BRG rocks in the Swayze area, including a sub-economic VMS occurrence, through lithogeochemical melt inclusion chemical analysis. Integrated with detailed petrography, these geochemical data will be compared to data from temporally and lithologically similar rocks of the DBL mining camp. The use of laser ablation inductively-coupled plasma mass spectrometry on zircon-hosted melt inclusions will enable the base and precious metal fertility of the melts associated with the sub-economic VMS occurrence to be determined.

Geochronology of the Loki's Castle hydrothermal vent field

Colin Clancey[1], John Jamieson[1]

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Loki's Castle is an active high-temperature hydrothermal vent field located on the northern end of the Mohns Ridge, where it transitions into the Knipovich Ridge. The Mohns Ridge is part of the slow spreading ridge system that extends northward from Iceland to Gakkel Ridge in the Arctic Ocean. At 2400 m depth, Loki's Castle consists of black smoker chimney clusters located atop two coalesced hydrothermal mounds that are up to 30 m high and 200 m across.In 2017 and 2019, rock samples were collected from Loki's Castle using a remotely-operated vehicle operated from the Norwegian research vessel G.O. Sars. These samples were collected from hydrothermal mounds, and include an active and an inactive barite chimney, an active chimney flange, and an exposed fault surface. In our study, we will use the 226Ra/Ba isotopic system to date hydrothermal barite from a subset of ten samples from the vent field. Chronological analysis will be completed using gamma spectroscopy combined with bulk geochemical analyses. Sample ages will be used to determine how long this system has been forming. These results will be combined with deposit volume estimates determined from analysis of high-resolution bathymetry, to calculate the rate of deposit formation. The barite ages will be compared to previously determined 230Th/234U ages of pyrite from the same samples to evaluate the accuracy and reproducibility of both methods. Along with this geochronological analysis, a petrographic examination of the samples will be conducted to determine mineral paragenesis as it is related to barite and pyrite.

You had me at "Reflector": Interpretations of seismic data for the earliest formations in the Scotian Basin

Jesse Demaries-Smith[1], Mo Snyder[1], Shawna White[2]

[1]Department of Earth and Environmental Science, Acadia University, Wolfville, NS B4P2R6,
[2]Department of Geology, Saint Mary's University, Halifax, NS B3H 3C3
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The Scotian Basin is a rifted continental margin that began forming in the late Triassic during the breakup of Pangea as the North American and African plates began to separate. Rifting created horsts and grabens which formed a series depocenters, into which sediment could accumulate, bounded by intervening platforms. The first formation deposited was dominantly sandstone, shale, and siltstone of the Eurydice Formation. Directly overlying the Eurydice Formation is the Argo Formation, which is dominated by halite units and lesser anhydrite evaporite units. These formations represent an underexplored potential reservoir for petroleum systems in the petroleum rich Scotian Basin. The purpose of this project is to investigate these earliest Mesozoic (Eurydice and Argo formations) as potential reservoirs in terms of depocenter connectivity early in the basin history using interpretations of 2-D seismic data, and through that gain a better understanding of initial basin architecture from which basin petroleum system elements evolved. The ultimate objective for this project is to produce a 3-D model of basin geometry and connectivity between the Mohican Graben Complex and the Shelburne sub-basin.

Aspects of morphology, taphonomy and growth orientation of Charnia sp. from Sword Point, Conception Bay, Little Catalina and Catalina

HAYLEY FITZGERALD[1], DUNCAN MCILROY[1]
[1]*Department of Earth Sciences, Memorial University of Newfoundland, St. John's, NL A1B 3X7*

Animal-like lifeforms from the Ediacaran period (635-541Ma) have been preserved as impressions in sedimentary rocks from the Avalon and Bonavista peninsulas of Newfoundland. These lifeforms are better known as the Ediacaran macrobiota and are some of the earliest multicellular life preserved on Earth. Charnia is a well known Ediacaran macrofossil which is a member of the extinct clade, Rangeomorpha: a group of sessile, epibenthic organisms that occupied deep marine environments in the Ediacaran period. The purpose of this study is to describe Charnia fossils in their sedimentological context as well as focusing on morphometrically quantifying and explaining asymmetric, tousled, and disrupted specimens. A number of Charnia specimens were photographed at several localities to digitally measure length, width and orientation, using the program imageJ. Sedimentary structures indicating a paleocurrent were observed and noted where possible to analyze fossil orientation with respect to current direction, and several casts were made from well preserved specimens to observe morphological aspects and further understand taphonomy. Further investigation into the morphology, taphonomy and growth orientation of Charnia will help reveal an accurate depiction of this early animal-like lifeform, which can help us further understand animal evolution.

Composition and origin of xenocrysts in the Eastern Shore lamprophyre dykes, Nova Scotia

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The Eastern Shore dykes are a swarm lamprophyric dykes in the Sheet Harbour area of eastern Nova Scotia. Two of the dykes, Pleasant Harbour-Borgles Island and Popes Harbour, contain a huge number of exotic xenoliths and xenocrysts that are presumed to have been derived from the deep crust, and hence they may represent deeper crust of the Meguma terrane. Although the xenoliths have been studied previously, no studies have been reported on the xenocrysts, and hence this study was undertaken to determine the petrological characteristics of the xenocrysts, including possible connection to the orogenic gold deposits of the Meguma terrane. Twenty-three samples from the dykes collected by previous workers were examined for xenocrysts, from which one sample each from the Borgles Island and Pleasant Harbour dykes was selected for detailed study, based on the abundance and variety of xenocrysts seen in hand specimen. About twenty thin section-sized chips were cut from those samples, and 14 chips with abundant xenocrysts were made into polished sections and used for major and trace element analysis by electron microprobe and LA-ICP-MS. Based on the petrographic evidence, the xenocrysts are subdivided into three groups: (1) small silicate xenocrysts, including quartz, K-feldspar, garnet, and kyanite, all with reaction rims; (2) large silicate xenocrysts; and (3) sulphide xenocrysts. The sulphide xenocrysts are pyrite, with small inclusions of chalcopyrite. The silicate xenocrysts may have been derived from disaggregated xenoliths in which similar minerals have been reported. However, the origin of the large silicate and sulphide xenocrysts remains uncertain.

Late Quaternary geochronology and stratigraphy of St. Anns Basin, offshore Nova Scotia

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St. Anns Basin is a Quaternary offshore intrashelf basin located SE of Cape Breton Island, Nova Scotia. The eastern Scotian Shelf remains a poorly understood area due to its complex physiography and late glacial history. St. Anns Basin has a high frequency of widely distributed mass-failures, yet a complete chronology for the deglacial sediment record has not been developed to date these deposits. Here, we present preliminary results that utilize an archival sediment core of a glaciomarine sediment package on the eastern margin of the basin to revise the St. Anns Basin sediment chronology using radiocarbon dating of benthic foraminifera and shell fragments. The sediment core contains suspected brick red mud layers associated with major deglacial ice-calving events that have been precisely dated in the nearby Laurentian Channel. An updated lithostratigraphic section alongside existing biostratigraphic interpretations will be used to provide a framework for the deglacial chronology of the basin. Additionally, the updated chronology enhances the understanding of the seismostratigraphic framework of the St. Anns Basin. This data will collectively be used to interpret if mass failures found throughout the basin are contemporaneous, possibly constituting a seismically induced event and constraining an assessment of modern geohazard risk in the basin. The revision of the chronology of sediments in St. Anns Basin could also further constrain the timing of shelf-ice cover on the eastern Scotian Shelf.

Microplastic in beach sediment from Mary's Point, Shepody National Wildlife Area, Southeast New Brunswick

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The Shepody National Wildlife Area (NWA) hosts 50-95% of the world's Semipalmated Sandpiper population during their > 3,000 km migration south. The sandpipers rest and feed on a variety of biota, including mud shrimp, other crustacea, molluscs, worms, biofilms, etc., that live on and in the NWA's inter-tidal mudflats backed by sand and gravel beaches. Plastic waste is now widely documented as polluting these environments, where it often breaks down into particles of < 1 mm size (microplastic), becoming difficult to collect and remove, while

becoming more available for ingestion by biota in the sediment and eventually accumulating progressively up the food chain, potentially in humans or sandpipers. Previous studies investigating the microplastic fraction have focused on the readily visible, surficial sediment (< 5 cm depth), disregarding the processes active in sediment that may mix the vertical sediment column, distributing the plastic to a greater depth. This initial study aims to investigate microplastic distribution across and vertically within a sandy beach section at Mary's Point, using a sediment corer. Samples are analyzed in 4 cm depth increments, with microplastics separated and compositionally classified for each increment via a novel procedure using low-cost, non-toxic chemicals: four density separations, involving solutions with increasing densities (fresh water, saline water, and low and high concentration $NaH2PO4$ solutions), followed by an oleophilic separation. Separated microplastics were then further analyzed by microscopy to determine size, shape, colour, and degradation; compositions were validated using Raman Spectroscopy. Preliminary results indicate clear and blue fibres (from fishing gear, potentially) dominate.

Long-term changes in the Nain landfast sea-ice edge

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Since 1971, the Arctic has warmed three times faster than the rest of the world. This warming has led to drastic changes in land and sea-ice environments that are particularly challenging for northern sub-Arctic coastal communities. Sea ice loss due to accelerated Arctic warming is jeopardizing important habitats for ice-dwelling life, as well as areas that have been used for fishing, hunting, and gathering for millennia by the Dorset, Thule and Inuit cultures. Changing sea-ice conditions also impact the abundance and diversity of algal communities that form the basis of the marine food web. Many algae, such as dinoflagellates, produce robust resting cysts that are preserved in marine sediments. By analyzing these and other palynomorphs alongside other biogenic proxy indicators and geochemical signals preserved in marine sediment cores, past trends in primary production and sea-ice conditions can be inferred. Understanding past responses to climate fluctuations can provide critical insights into understanding current trends and predicting future changes to primary production and the local environment. Using standard palynological methods this project aims to analyze two gravity cores (7cm diameter) collected in the Nain area (Nunatsiavut), one located within and the other outside of the present day landfast sea-ice edge. Each core is approximately 60cm long, allowing for a comparison of the observed changes in each respective environment. The resulting data from this project will contribute to a larger research program, combining other zooarchaeological and collective knowledge to better understand climate-induced changes in the coastal ecosystem of Nain.

Pyrite paragenesis and relation to gold-bearing fluid phases in the Lone Star deposit, YT

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The Klondike region of the Yukon Territory, Canada, is famous for extensive placer deposits, recovering over 20 million oz since discovery, but lacks any major defined bedrock resources. As a result of a surge in exploration activity, recent drilling efforts have delineated several new bedrock targets, including the Lone Star deposit near Dawson City, Yukon. The Lone Star deposit is hosted by a suite of Late Permian plutonic, volcanic and sedimentary units known as the Klondike Assemblage. This assemblage formed as a result of subduction-related arc-magmatism, followed by Late Permian-Early Triassic regional greenschist-amphibolite facies metamorphism during accretion onto Laurentia as part of the Yukon-Tanana Terrane. Gold deposition is thought to be mid-late Jurassic, mainly occurring within discordant quartz veins with common pyrite mineralization but overall low sulfidation (galena, sphalerite, chalcopyrite, etc. only trace). This study will add to the overall understanding of the Lone Star deposit by establishing relations between pyrite paragenesis and gold mineralization. This will be done through detailed examination of a suite of ten samples, selected based on differences in pyrite occurrence. Textural relations will be determined using reflected light microscopy and SEM on polished mounts. Following this, samples will be analyzed for major and minor elements by electron microprobe and LA-ICPMS will be used to measure the 2-d distribution of trace chalcophile elements. Correlations between texture type and element distributions will be used to determine if there were discrete pyrite-forming events, and whether these can be related to the influx of gold-bearing fluids.

How to measure changes in topography without eroding an undergraduate research budget

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Quick, efficient, and affordable monitoring of coastal surface erosion is an ongoing challenge for scientists and stakeholders. The current standard, aerial LiDAR surveying, can yield precise surface elevations, even through dense foliage. However, LiDAR surveying is expensive and inaccessible to researchers on a tight budget. Additionally, LiDAR surveying does not collect data on complex steep intertidal and subtidal surfaces with caves or indentations that significantly change through time. In contrast, ground-based technicians can collect photographs from multiple angles to create nuanced, coloured photogrammetry clouds with high temporal frequency. However, stakeholders are unable to pin their photogrammetry clouds to accurate coordinates on a map because consumer GPS accuracy is relatively low. This project provides an opportunity for consumer products and open-source software to be tested with the ultimate goal of decreasing the barrier of entry. Merging GeoNova's open coastal elevation LiDAR point cloud to drone or action camera photo-clouds combines the strength of both techniques described above. This work necessitates an evaluation of point cloud similarity which can be done with the open-source software, Cloud Compare. The methodology of creating photogrammetry point

clouds, merging point-clouds with LiDAR data, and overcoming challenges is here described. The area of study is at Kingsport Beach, an area of relatively constant topographic change in short amounts of time.

Sustainable gold mining: Replacing gold mining with novel ionic thiourea ligands for gold extraction

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Cyanidation has been the most widely applied gold extraction method world-wide for over a century. Unfortunately, there have been many accidental releases of toxic cyanide, which have resulted in extensive damage to the environment and surrounding communities. Due to this, various alternatives are being explored in efforts to replace cyanidation but have yet to be implemented due to the high material costs and infrastructure changes that would be needed. The current project is working to develop an alternative to cyanidation using novel ionic thiourea derivatives, which can selectively extract gold and silver. Two imidazolium salts have been functionalized with a thiourea group and a dodecyl sulfate [DS]- anion. Up to 98% extraction of gold(III) from a model leachate solution has been achieved reproducibly to date and future efforts are being made to develop a method of extraction from raw gold-containing ore.

Petrology and metamorphism of the 'Bright-eyed' Gneiss, Grand Teton, Grand Teton National Park

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The Archean southern Teton range, Wyoming, hosts a unique 'bright-eyed gneiss' unit exposed in Death Canyon, Grand Teton National Park. These rocks are biotite orthogneisses with magnetite (Fe3+2Fe2+O4) porphyroclasts surrounded by lenticular quartzofeldspathic pods. The major minerals are biotite, alkali feldspar, plagioclase, quartz, magnetite, ilmenite and titanite. The accessory minerals are apatite, allanite, some sulfides, and small zircon grains. Evidence suggests that these rocks underwent low-degrees of partial melting at amphibolite-facies conditions as recorded by melt pseudomorph microtextures. A variety of analytical techniques were applied to eleven hand samples. These include uXRF mapping, SEM backscattered imagery, optical microscopy, and X-ray CT to obtain central cuts through the magnetite grains. Hypotheses to be tested are whether the rocks formed in an open system involving water-fluxed biotite dehydration melting. Another key step in this experiment is to determine the role of original oxidation of possible protoliths for these gneisses including tonalite-granodiorite. EPMA chemical analyses and laser ablation will also be used in tandem to examine mineral zoning and develop a reaction model to help explain how these rocks formed. The significance of this project is to determine the relative ages of the rock, whether it was metamorphic or magmatic in origin. Therefore, this project will be crucial to understanding the Archean rocks in the Grand Teton, and most importantly, the formation of the 'magnetite eyes.

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

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The ocean floor surface sediments of the Scotian Slope, Nova Scotia are host to a complex network of microbially mediated reactions that knit together the various biogeochemical cycles. Limited diffusion between the upper water column and ocean floor mud pore spaces, coupled with competitive microbial ecological niche partitioning, leads to the formation of biogeochemically controlled redox gradients. These microbial biogeochemical zones change if surface sediments are impregnated by hydrocarbon seepage that migrates up from deeper within the basin. Porewater profiles of F−, NO2-, NO3-, CO32- and SO42- were used to reconstruct biogeochemical stratification depth profiles that can provide comparative evidence for anion behaviour in active cold seep sites. A comparative study between two methods of data analysis was applied to the samples. The method of standard addition proved to be a better method than the external calibration curve method to measure porewater anion concentrations of natural samples with complex matrices and a varying range of concentrations. For this reason, porewater anion concentrations were compared using the standard addition method. Sulfate concentration decreases dramatically in both ambient and hydrocarbon impacted marine benthic sediments although, in hydrocarbon impacted sites, it appears to occur at a much shallower depth suggesting that the redox gradient is much more pronounced and as much sulfate reduction has not yet transpired with the ambient sediments at the same depth. Nitrate and NO2- trends also show similar pronounced reduction patterns occurring at shallower depths for hydrocarbon impacted sediments suggesting widespread increased microbial and bacterial activity in these regions.

Zircon petrochronology of the West Barneys River Plutonic Suite: Insights into the origin of a potential critical element (REE and Zn) deposit in Nova Scotia

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The transition to a green-energy future requires a significant increase in the supply of critical elements. Therefore, it is essential that we advance our knowledge of the processes that concentrate these elements. Of the 31 elements that Canada has deemed to be critical, many of them can be concentrated by igneous rock-forming processes. For example, rare earth elements (REEs) are known to be concentrated by magmatic processes associated with the emplacement of alkaline to peralkaline igneous rocks. This research focuses on the West Barneys River Plutonic Suite (WBRPS) in Nova Scotia, which has elevated concentrations of both REEs and Zn. The WBRPS is a complex, heterogeneous mix of coeval lithologies ranging in composition from mafic to felsic plutonic rocks. Published U-Pb data indicates a range of crystallization ages between ca. 495 and 460 Ma, however, there remain many knowledge gaps related to the origin of these rocks and the associated REE and Zn mineralization. Ten representative samples were collected from the WBRPS that range in composition from gabbro to quartz syenite. Of those, seven samples yielded dateable zircon, with preliminary interpretations of LA-ICP-MS U-Pb data yielding a crystallization age range between ca. 465 and 430Ma. Zircon trace element and hafnium isotope data were also collected and will be analyzed to determine the magmatic processes and magma source(s) involved in the generation of the plutonic suite. These new petrochronological data and interpretations will help to better understand the petrogenesis of the WBRPS and the processes that concentrated the REEs and Zn.

Machine-learning focal mechanism inversion for hydraulic fracking-induced earthquake

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Hydraulic fracking has contributed to an increase in induced seismicity in recent years in Fox Creek, Alberta. Earthquake focal mechanisms, relying on polarities of earthquake first motions, provide insight into the state of stresses in a region. Traditional methods for manually determining the polarities of first motions are not suitable for microearthquakes due to the large volume of data, and owing to their low signal-noise ratio. Machine learning provides a reliable and efficient way for polarity classification. Using data obtained from the Tony Creek Dual Microseismic Experiment, this study aims to show that machine learning can reliably solve for polarities of earthquake first motions, and characterize the focal mechanisms of hydraulic fracking-induced earthquakes. The project will provide greater insights into the state of stresses and geologic structures (such as faults) in the study area and will improve our understanding of earthquake-triggering mechanisms during hydraulic fracking. In this presentation, we are going to introduce the seismic data, proposed methods, and preliminary results.

Coastal Erosion Study on the Flats Rd Property in Conception Bay South, NL

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This report focuses on the sensitivity of the Newfoundland coastline to erosion, specifically surrounding the beach located at the end of Flats Rd in Conception Bay South, Newfoundland.In this study, I use many different Geophysical Instruments available to me from the equipment pool to locate the bedrock or any other subsurface features that will affect the erosion rate in the area. Thus far, I have conducted a ground-penetrating radar (GPR) survey, a real-time kinematic positioning survey (RTK) and a direct current resistivity survey (DCR).My research aims to locate the bedrock or subsurface properties that will affect the rate of erosion happening on the land located at the end of Flats Rd in Conception Bay South, Newfoundland. This information is directly proportional to the effects of climate change on the province of Newfoundland. Currently, the average coastal erosion rate for the region is approximately 20cm/yr. This number will increase with the rise of climate change and sea levels, as the volume of water increases in

the oceans, the speed and strength of coastal erosion grows. Post glacial rebound in Newfoundland varies from coast to coast. The west coast is rising and the east coast, while no precise numbers are known, is generally sinking slowly with respect to the earths center. Newly found high winds, hurricanes and storm surges are all factors of the shrinking coastline. This project is going to research the rate of erosion and how the changing climate affects it.

Dating fault motion at the northern Appalachian structural front, western Newfoundland

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The Appalachians formed during Cambrian through Devonian orogenesis, as a result of multiple microcontinent and terrane accretions which occurred as the Iapetus Ocean episodically closed. In west Newfoundland folds and faults that formed during the Taconian and Acadian orogenies are preserved. The limit of deformation, or Appalachian structural front, extends along Newfoundland's west coast. This front is defined by a structural triangle zone, the upper detachment of which is marked by the Tea Cove Thrust, a back-thrust that only outcrops in one location on the Port au Port Peninsula, our study area. Timing of motion along the structural front is constrained as Devonian through Visain using structural and stratigraphic relationships largely observed in seismic. However, previous work suggests earlier Ordovician (Taconian) movement is likely. Observations and data collected during fieldwork suggests significant structures associated with the structural front, outcropping along the Port au Port Peninsula, have been reactivated. Faults parallel to the Tea Cove Thrust preserve two generations of motion; NW-directed and SE-directed. Later, cross-cutting NW-directed faults with an orientation consistent with post-Taconian basement faults are present too. These cross-cutting and kinematic relationships, combined with data we aim to collect using in-situ dating of calcite slickenfibres and mica using U/Pb and Rb/Sr by LA-ICP-MS respectively, will allow us to determine an absolute age of generation and reactivation of faults defining the structural front. New data will also provide information to petroleum models for active exploration in the region, whereby structures at the structural front are demonstrated petroleum traps.

Mineralogy and corundum trace element composition at the Hopedale "ruby" occurrence, Labrador: Comparison to till-hosted pink corundum.

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In the Hopedale Block, Labrador, pink to reddish-purple corundum occurs in gneiss and has also been found as pink detrital grains (0.25-0.50 mm) in till. The till-hosted corundum grains occur 28 km west of the hard rock occurrence; however, the ice flow direction is to the east. This indicates that at least two reddish corundum ("ruby") localities occur in this region, and are separated by a vast distance, making the region attractive to ruby exploration. The hard-rock

corundum occurrence consists of a weakly foliated corundum-biotite-plagioclase gneiss containing accessory rutile, pyrrhotite, pentlandite, and zircon as well as trace galena, titanite,Bi-Ag telluride, and thortveitite (a rare Sc silicate). Corundum occurs as ~10mm to ~70mm porphyroblasts with cross-hatched twining within a finer-grained matrix of corundum, biotite, and plagioclase (An50). Both corundum from the outcrop and the till show minor amounts of diaspore retrograde alteration along fractures. This study will compare the mineral associations and corundum trace element composition in the till-hosted grains with that at the gneiss-hosted occurrence to determine whether they come from geologically similar sources.

The impacts of historical gold mining on chironomid assemblages in Lake Thomas, Nova Scotia

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Gold mining operations were one of the predominant economic activities in Nova Scotia between the late 19th and early 20th centuries. The Waverley gold mine district was active from 1862 to 1940 and mine tailings produced were transported into the local environment that contributed to the pollution of the Shubenacadie Canal drainage basin. In this study, we used paleolimnological approaches to understand the long-term ecological effects of historical gold mining operations on Lake Thomas. Concentrations of mining-related contaminants (arsenic and mercury) were measured from a dated sediment core to track pollution history and subfossil chironomid remains were analyzed to examine biological effects. Sedimentary arsenic and mercury levels were low prior to gold mining activities, however, during the mining era concentrations of both elements increased. Sedimentary arsenic and mercury levels reached concentrations of 980 ppm (dry weight) and 31,400 ppb (dry weight), respectively. Arsenic and Mercury levels have decreased in the most recent sediments but continue to be higher than national sediment quality guidelines, Arsenic levels are 58x and Mercury 65x higher than national guidelines. Notable declines in the number of chironomid head capsules per gram of dry sediments during the mining era suggest biological impacts. Although the Waverley gold mine was closed eight decades ago, elevated contaminant levels may still be affecting aquatic biota. This research contributes to the growing number of environmental assessments that are aiming to understand the long-term ecological consequences of past gold mining operations on aquatic ecosystems.

Mineralogy of the Boundary Volcanogenic Massive Sulfide (VMS) deposit of the Tally Pond Group, Victoria Lake Supergroup, Newfoundland Appalachians

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The Cambrian Boundary volcanogenic massive sulfide (VMS) deposit is located in the Victoria Lake Supergroup in the Newfoundland Appalachians, Canada. The deposit is hosted within chlorite-sericite-quartz–altered rhyolite lapilli tuff and tuffs and represents one of the best

preserved subseafloor-replacement-style VMS deposits globally. The purpose of this study is to provide insights into the mineralogical evolution of the replacement style mineralization in the North Zone of the Boundary using mineral textures, paragenesis, and reflected light microscopy, scanning electron microscopy (SEM), and electron probe microanalysis (EPMA). Initial textural results show that the Boundary deposit is dominated by an assemblage of pyrite, sphalerite, chalcopyrite, galena, and pyrrhotite. Pyrite is the dominate sulfide, displaying many textures disseminated, the latter occurring as sulfide stringers. Pyrrhotite is present as small inclusions in pyrite intergrown with chalcopyrite. Sphalerite is present in majority of the mineral facies, but its abundance varies from disseminated, massive, and sulfide stringers; sphalerite also locally exhibits chalcopyrite disease. Galena occurs as irregular grains commonly intergrown with sphalerite and pyrite. SEM and EPMA work are ongoing.

On the discovery of fossil land snails (*Dendropupa* sp*)* from the Minto Formation of central New Brunswick, Canada

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The Pennsylvanian-aged (late Bashkirian–early Moscovian) Minto Formation of central New Brunswick was previously studied for its diverse paleofloral, rare invertebrate fauna (*trigonotarbid*) and rare disarticulated vertebrate fauna. The Minto Formation has been interpreted as a peat-forming wetland that experienced occasional euryhaline influence within back-barrier or delta front depositional settings. A recently discovered fossil locality situated along the southern shoreline of Grand Lake, yields a diverse array of plant fossils, tetrapod and invertebrate footprints and invertebrate body fossils from the Sunbury Creek Member of the middle to upper Minto Formation. Recent work has described a new Carboniferous stem dragonfly (*Brunellopteron norradi*) and a new specimen of the tetrapod footprints Batrachichnus the latter with new tracemaker interpretations. Here we describe two new terrestrial gastropod (pupa) shells (NBMG 21521) that broadly conform to the Carboniferous land snail *Dendropupa*, with a similar apex and post-apical whorls. However, the Minto Formation pupa differ from *Dendropupa* by possessing axial (longitudinal) sculpture on the shell. Dendropupa exhibits an axial lirae along its shell that is not preserved in the Minto Formation specimens. Both Minto Formation specimens exhibit the same morphology but differ in size, suggesting one is an adult and one a juvenile. The diminutive size of the shells suggests that they may represent the smallest known Carboniferous land snails in the fossil record. The two shells are associated with invertebrate ichnofossils (*Gordia*, *Helminthoidichnites*, and *cf. Helminthopsis*) that are of similar

width, implying a trace and trace-maker relationship, and broadening the tracemaker interpretations for those ichnogenera.

Documenting recent human influences using remote sensing techniques on the Tekes River alluvial fan, Xinjiang, China

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The Tekes River alluvial fan is located in Xinjiang Province which has an arid to semi-arid climate as well as a historically unpredictable precipitation rate. Further, increasing population and urbanization means that all water resources must be used efficiently. The Tekes River alluvial fan has had a vast amount of human influence in recent decades in the form of dam construction, irrigation and agriculture expansion. Although development on and surrounding the Tekes River alluvial fan is apparent, there is a lack of research on how these human impacts have affected the fan. The primary objective of this project is to use remotely sensed image analysis to document the human influence that has occurred to the Tekes River alluvial fan. A 31-year time series (1990-2021) was created using Landsat imagery from 1990 – 2021. The results have found that four dams have been constructed upstream from the fan, irrigation canal length had increased by approximately 400 km, and agricultural fields had increased by approximately 250 km2. Average seasonal NDVI values were calculated on agricultural fields and compared to natural vegetation in the area for seven dates in 2021. The results do not show great observable differences between agricultural field and natural vegetation cover. However, these results are limited temporally and spatially. Further research should continue to document and test NDVI as well as consider measuring groundwater levels to build upon this research and provide a greater understanding of the anthropogenic impacts on the fan.

Methane flux, source, and lipid biomarkers of serpentinite-hosted groundwater springs at contrasting sites of terrestrial serpentinization

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Serpentinization sites are a point of recent scientific interest because of their implications toward primitive microbial metabolisms and astrobiological exploration. Serpentinization occurs when circulating groundwater hydrates ultramafic rocks, a reaction that is common in submarine environments and on land at ophiolite complexes. Three sites of terrestrial serpentinization were studied through their groundwater springs, which act as windows into the subsurface with respect to geochemistry and microbial activity. Serpentinization causes groundwater springs with unique parameters including ultra-basic pH levels (>10), low redox values, and methane and hydrogen gas enrichment. The Tablelands (NL, CAN), The Cedars (CA, USA), and Aqua de Ney (CA, USA), produce groundwater springs which act as endmembers, displaying a range of values with respect to the above properties. These sites have been extensively studied in the past and changes have been observed over the last decade, proving it imperative to characterize these changes and

interpret the temporal variations in these systems, made possible through the present comparison. Through past research it has been determined that the source of methane gas is different at each of the sites, but the flux of methane gas had not been quantified. This study intends to relate the methane flux to their source, aqueous geochemistry, and lipid biosignatures. Through gas chromatography and mass spectrometry, this study contributes to the knowledge around what microbial life consumes, what it produces, and how these things are preserved in terrestrial serpentinization systems.

Atlantic Universities Geoscience Conference (AUGC) – Awards

Judging

Oral and poster presentations at AUGC are evaluated by a panel of at least 3 qualified judges with diverse geoscience expertise. In consultation with the award sponsors (as described below), the AUGC student organizers are responsible for assembling the panel of judges. At least four weeks before the date of the conference, the student organizers should contact the Science Atlantic Earth Science Committee and ask that they suggest at least one appropriate and available judge. Similarly, the student organizers should contact Imperial Oil, CSPG, CSEG, and the Mining Society of Nova Scotia to invite them to send representatives to the conference. If such representatives are present at the conference, they may take the lead in judging the awards of those organizations. Professors at the host university can also be asked by the student organizers for advice in assembling the judging panel. Normally the awards are presented by representatives of the award sponsors at the closing banquet of the conference.

In all cases where plaques are awarded, the winner's department is responsible for ensuring that the plaque is suitably engraved and that it is returned to the AUGC in the subsequent year so that it is available to be given to the next recipient.

Science Atlantic Best Paper Award

The Science Atlantic Presentation and Communication Award is given for the best overall student paper on any geoscience topic presented orally at the annual AUGC (Atlantic Universities Geoscience Conference).

Judging:
The award is judged primarily on the basis of the scientific quality of the topic, the amount of original work done by the student, and his/her understanding of the subject. Evaluation criteria include: Abstract – Clear statement of problem, objectives, principal findings; Presentation – Clarity, visual aids, organization; Scientific merit – Experimental design, innovative approach, and interpretation of data; Understanding - Overall knowledge and response to questions.

The award will be judged by a panel of at least 3 qualified judges with diverse geoscience expertise as described under judging above.

The Award:
The award consists of a monetary prize ($500 in 2015) and letter of commendation for the presenter, as well as a plaque which resides at the winner's university for one year, after which the winner's university is responsible for bringing the plaque to the next annual conference. The award is usually presented by a representative of the Science Atlantic Earth Science Committee at the annual banquet of the AUGC.

Sponsor Information:
This award (previously known from 2004-2012 as the APICS-NSERC Award) is the AUGC version of the Science Atlantic Undergraduate Research Award and Communication Award offered at all Science Atlantic-sponsored conferences. The Communication part of the award is sponsored by Canadian Science Publishing. A separate Communication Award is not offered at AUGC.

Imperial Oil Best Poster Award

The Imperial Oil Best Poster Award is given to the student presenting the best overall student poster on any topic at the annual AUGC.

Judging:
The award is judged primarily on the basis of the scientific quality of the topic, the amount of original work done by the student, and his/her understanding of the subject. Evaluation criteria include: Abstract – Clear statement of problem, objectives, principal findings; Poster design – Clarity, organization, visual appeal; Scientific merit – Experimental design, innovative approach, and interpretation of data; Understanding - Overall knowledge and response to questions.

The award will be judged by a panel of at least 3 qualified judges with diverse geoscience expertise as described under judging above. When a representative of Imperial Oil is present, he/she will take the lead in judging this award.

The Award:
The award consists of a monetary prize for the student presenter.

Sponsor Information:
This award has been sponsored by Imperial Oil since 2007. Imperial Oil recognizes that business success depends on the economic, social and environmental health of the communities where they operate and views community investment not simply as a responsibility but as an essential component in building a strong society. Imperial Oil gives back to local communities through financial contributions, in-kind donations and volunteer efforts and supports scientific research with a number of awards and sponsorship.

Canadian Society of Petroleum Geologists (CSPG) Award

The Canadian Society of Petroleum Geologists Award is given annually for the best presentation of a petroleum geology-related paper at the AUGC. If the winner of the Science Atlantic Best Paper Award gave a petroleum geology-based presentation, then the CSPG award will go to the petroleum geology-based paper judged to be next best.

Judging:
The award will be judged by a panel of at least 3 qualified judges with diverse geoscience

expertise as described under judging above. When a CSPG representative is present, he/she will take the lead in judging for the award.

A plaque is presented to the winner at the AUGC banquet as well as a monetary prize ($500 in 2015), preferably by a CSPG member or representative. The plaque will reside at the winner's university until the next AUGC, when the winner's university is responsible for bringing the plaque to the next conference.

Sponsor Information:
This award is sponsored by the Canadian Society of Petroleum Geologists. Founded in 1927, the mission of the Society is to advance the professions of the energy geosciences – as it applies to geology; foster the scientific, technical learning and professional development of its members; and promote the awareness of the profession to industry and the public.

Canadian Society of Exploration Geophysicists (CSEG) Award

Canadian Society of Exploration Geophysicists (CSEG) Award was established in 2008. The award is given to the student who presents the best overall geophysics paper at the AUGC conference (typically awarded for an oral presentation; however, poster presentations are also eligible). Geophysics is a diverse discipline with many different areas of study, and this award could be awarded to any student whose work falls under this broad category.

Judging:
Students will be evaluated on the scientific merit of their work, their general understanding of the material covered and their ability to effectively communicate this to the judges. This award will be judged by the panel of judges chosen by the conference organizers. Ideally one of these judges should have a geophysics background. The CSEG will typically send representatives to attend the conference so if a geophysics judge cannot be found locally then one of these representatives may be asked to judge. The award may not be presented if the judges and the CSEG representatives determine that no presentation fulfills the spirt of the award.

The Award:
The award consists of a monetary prize ($500 in 2015) for the student presenter, as well as a plaque which resides at the winner's university for one year, after which the winner's university is responsible for bringing the plaque to the next annual conference. The award is usually presented by a CSEG representative at the annual banquet of the AUGC. The monetary prize of $500 comes from the funds ($4,500 in 2015) that the CSEG commits to the conference. It is a responsibility of the school that hosts the conference to prepare and distribute a cheque for the winning presenter.

Sponsor Information:
The Canadian Society of Exploration Geophysicists began in 1949 at around the time of the petroleum production boom of the Leduc and Redwater discoveries. As a result of these 4 significant discoveries, there was a need for increased knowledge, skill and professional attributes in the field of geophysics. Today, the CSEG is a thriving organization. CSEG's

mandate is to promote the science of geophysics among its members, especially as it applies to exploration, and to promote fellowship and co-operation among those persons interested in geophysical prospecting.

Frank S. Shea Memorial Award in Economic or Applied Geology

The Frank S. Shea Memorial Award honours the student making the best presentation regarding an aspect of or with implications for economic or applied geology. If the winner of the Science Atlantic Best Paper Award gives an economic or applied geology presentation, then the Shea Award will go to the economic or applied geology presentation judged to be next best.

The award was established by the Mining Society of Nova Scotia at its annual meeting in June 1981 to honour Frank Shea, a long-time member and former president.

About Frank Shea:
During some 27 years, Frank Shea was engaged in mineral resources exploration and development activities in the Atlantic region. For more than 10 years he served as Chief Geologist and division director of the Mineral Resources and Geological Services Division in the former Nova Scotia Department of Mines. Frank graduated from St. Francis Xavier University in 1954 with a BSc in geology. He continued his studies at Dalhousie University, receiving his Master's degree in 1958. Frank had a great love for his native province and promoted its welfare by assisting mineral exploration and research projects whenever and wherever he could. He was a strong supporter of educational programs in geology such as the geology field school at Crystal Cliffs near Antigonish and prospector training.

Judging:
Student papers are reviewed and judged for content in economic or applied geology or implications for economic/applied geology by a panel of practicing geologists. For practical purposes, this will be done the same panel of judges as evaluates the other awards. If there are no papers on economic or applied geology deemed worthy during the annual AUGC, the award may not be given.

The Award:
The award consists of a cheque ($500 in 2015) for the winning student and a $100 cheque for the geoscience club that the student represents.

Sponsor Information:
The Frank Shea Memorial Award is sponsored by the Mining Society of Nova Scotia. Organized in the 1890s to promote the mineral industry, to share technical knowledge and to encourage fellowship, this Society was one of the founding members of the Canadian Institute of Mining and Metallurgy (CIM), the premier mining organization in Canada. The Society is pleased to support this award honouring a student, the contributions of Frank Shea, and the economic impact of geology on the Canadian economy.

Atlantic Geoscience Society (AGS) Environmental Geoscience Award

The Atlantic Geoscience Society Award was established in 2015 by the Atlantic Geoscience Society to recognize the best project (talk or poster) at the annual AUGC involving a significant component of environmental geoscience.

Judging:
Student papers are reviewed and judged for content in environmental geoscience or implications for environmental geoscience by the same panel of judges as evaluates the other awards.

The Award:
The award consists of a monetary prize ($100 in 2015) to the winning student and a plaque that will reside at that student's university until the next AUGC.

Sponsor Information:
The Atlantic Geoscience Society exists to promote a better and wider understanding of the geology of Atlantic Canada, both to its members and to the public. An entirely volunteer association, the AGS brings together earth scientists from universities, government institutions, the environmental, mining, and petroleum industries, and consultants in the Atlantic provinces.

Field Trip Guides

Field Trip #1
The Story Beneath the Scenery – the Geology of the Wolfville area

Leaders: Sandra Barr and Chris White
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Stop 1: ROSS CREEK (basalt, chert, zeolite minerals, agate, and amethyst?)
(UTM Zone 20T 385712E 5011233N)
North Mountain Basalt formed from fissure eruptions in the latest Triassic (about 201 million years ago) as Africa and North America began to break apart. The basalt is well exposed along the Bay of Fundy shoreline. In synclinal bays, sedimentary rocks of the overlying Scots Bay Formation are also preserved. The calcareous sedimentary rocks of the Scots Bay Formation were deposited in lakes and hot springs on top of the basalt. The formation has a thickness of several kilometres under the Bay of Fundy.

North Mountain Basalt is composed of up to 18 basaltic flows, ranging in thickness from a couple of metres to 60 m, with a total thickness of about 250 m. At Ross Creek, we will look at the uppermost flow of the sequence. As you walk from Ross Creek to the southwest along the shore you are seeing a section through this flow from near the bottom to the top. Because of this, you will notice an obvious change in texture. The lower part of the flow displays columnar joints and is cut by veins containing chalcedony (agate) and zeolite minerals. Most veins are parallel to the axis of the Bay of Fundy, consistent with on-going extension after the basalt cooled and crystallized. Toward the top, the flow becomes highly amygdaloidal, and the amygdales contain the same minerals (and more!) as the veins. How many different zeolite minerals can you spot?? You can walk through the top of the flow into the overlying Scots Bay Formation.

The Scots Bay Formation is mainly well bedded limestone but contains abundant large **chert** nodules (which may represent algal structures or silicified tree remains or just dissolved cavities in the limestone filled by silica?). Cavities in the chert nodules commonly contain well developed quartz crystals, in places with purple colour (amethyst). The chert was popular with and widely traded by indigenous people in the area who used it to make arrow heads and other stone tools.

Stop 2: THE LOOK-OFF - more than just scenery!
(UTM Zone 20T 389423E 5006106N)
The view from the Look-off shows how bedrock geology controls topography and land use in the Wolfville area. The North Mountain Basalt "caps" North Mountain between Cape Blomidon and Brier Island, a distance of about 200 km, and forms a protective barrier from the cold north winds of the Bay of Fundy. The basalt is underlain by the Blomidon and Wolfville formations, which are less resistant to erosion and underlie the Annapolis Valley. The sandstone and mudstone of the Blomidon and Wolfville formations erode to form the fertile red soils of the valley, and the red mud of Minas Basin. On the south side, the valley is protected by South

Mountain, underlain by resistant metamorphic and plutonic rocks that we will see later today. These rocks are unconformably overlain by the Wolfville Formation. Carboniferous sedimentary rocks underlie the Avon River area to the east - if it is a clear day, you may be able to see outcrops of these rocks around the lighthouse at Horton Bluff and on the Cheverie shoreline on the northeastern side of the Minas Basin.

On top of the bedrock, varied effects of glacial and post-glacial erosion and deposition and post-glacial erosion and deposition have produced the detailed topography of river valleys, gentle rolling hills, and the Minas Basin itself.

Stop 3: BLOMIDON FORMATION, HOUSTONS BEACH
(UTM Zone 20T 392776E 5007695N)
A walk along Houstons Beach brings us to outcrops of the Blomidon Formation, composed of shale and siltstone deposited in a mainly lacustrine (playa lake) environment. What evidence can you find in these rocks for the type of climate in this area back in the Triassic?

The bedrock is overlain by thick glacial outwash sediments. Together, the two are eroding to produce a great beach (when the tide is high!).

Stop 4: WOLFVILLE FORMATION, KINGSPORT
(UTM Zone 20T 393191E 5001563N)
Along the beach at Kingsport, we can see the effects of coastal erosion, and what landowners are doing to try to stop it. We can also see very well the rocks which form the Wolfville Formation, easily eroded fluvial sandstone and conglomerate deposited about 220 million years ago. The rate of erosion here is as much as 1 m/year – so one hundred years ago, the rocky bluffs were 100 m farther out in the basin. "The Canada", one of the largest sailing ships ever built in Canada, was constructed here at the wharf in Kingsport more than 125 years ago. Try to imagine what this place must have looked like then (1891), back in the “days of sail”.

Scenery to notice: CORNWALLIS RIVER
(UTM Zone 20T 389372E 4994374N)
The Cornwallis River, clearly viewed from the bridge in Port Williams, is part of a tide-dominated estuarine system. If the tide is low enough, it may be possible to see large current dunes developed on the river floor, an indication that the current has sufficient strength to both transport and deposit appreciable amounts of sand. Similar deposits to these are prolific oil producers in western Canada. Dykes protect these farmlands from flooding – their maintenance is an on-going topic of debate.

LUNCH AT IRVING GAS STATION IN GREENWICH

Stop 5: TUPPER LAKE BROOK FORMATION (Goldenville Group)
(UTM Zone 20T 374528E 4987367N)
The Tupper Lake Brook Formation consists of banded maroon and green, thin- to medium-bedded metasiltstone to slate. Some of the thin metasiltstone beds display small-scale cross-lamination. Thin (<10 cm thick) metasandstone layers are rare and are typically very fine grained and poorly to moderately sorted. The composition of the metasandstone is dominantly

feldspathic wacke. These sediments may have been deposited from dilute silty to muddy turbidity currents. Towards the southern part of the quarry these rocks are more interlayered with thicker metasandstone beds that marks the transition into the underlying Church Point Formation of the Goldenville Group.

In a quarry to the east, which we were not able to obtain permission to enter, the Tupper Lake Brook Formation locally contains 5 to 20 mm wide, ptygmatically folded, Mn-rich brown carbonate laminations and lenses, and proximal fractures are stained with steel-blue manganese. Within the contact metamorphic aureole of the South Mountain Batholith, these laminations and lenses are pink (converted to coticules) due to the presence of spessartine garnet.

Stop 6: SOUTH MOUNTAIN BATHOLITH at Gaspereau Lake
(UTM Zone 20T 379454E 4981980N)

South Mountain Batholith underlies much of southern Nova Scotia and forms a topographic feature known as South Mountain (maximum elevation ca. 250 m). The South Mountain Batholith consists of ca. 375 Ma granodiorite and granite which have been divided into many mappable units based on in most cases subtle differences in texture and mineralogy. All units of the South Mountain Batholith are peraluminous, meaning that they contain high Al_2O_3 relative to CaO, Na_2O, and K_2O. This chemical characteristic is reflected in the mineralogy, which is dominated by quartz, plagioclase, K-feldspar, and biotite, with accessory aluminum-rich minerals such as muscovite, cordierite, and andalusite. No hornblende is present.

Pegmatite and other highly evolved rocks associated with the South Mountain Batholith and other plutons of similar throughout the Meguma terrane of southern Nova Scotia are currently a target for rare metal exploration, including REE and lithium.

When the water level in Gaspereau Lake is relatively low, it provides a wonderful opportunity to see what the terrain underlain by the batholith would look like without vegetation or water. The biotite granodiorite here contains large phenocrysts ("megacrysts") that are mostly K-feldspar. It also contains metasedimentary xenoliths – do they look like their assimilation may have affected the composition of the granite magma?

Stop 7: WHITE ROCK FORMATION (ROCKVILLE NOTCH GROUP)
UTM Zone 20T 389885E 4986982N

The Silurian White Rock Formation in the Wolfville area consists mainly of quartzite. The original quartz sands were likely deposited on a beach. The quartzite weathers light grey (hence the name of the small community after which the formation is named) but shows a lot of iron oxide staining as a result of groundwater movement along joints and fractures.

The quartzite is a popular building stone in the Wolfville area, and was used, for example, in the construction of the gymnasium/arena complex at Acadia University and The Church brew pub.

From this stop one can also see the highly incised upper part of the Gaspereau River. This incision is about 70 m deep and could not be formed by the river in its present condition. The incision was almost certainly formed by subglacial meltwater erosion during the waning stages of deglaciation.

Stop 8: ELDERKIN BROOK FORMATION (HALIFAX GROUP)
(UTM Zone 20T 385617E 4990522N)
At this location the rocks of the Elderkin Brook Formation occupy the core of a regional southwest-plunging anticline. The formation consists of light to dark grey laminated slate and fine-grained metasiltstone which locally contain numerous trace fossils. Compared to trace fossils in the overlying Hellgate Falls Formation, the trace fossils in this formation display a less diverse assemblage and display 'simple' grazing trails and burrows. Acritarchs recovered from this formation are early Ordovician (latest Tremodocian) (White et al. 2012).

Stop 9: LUMSDEN DAM FORMATION (HALIFAX GROUP)
UTM Zone 20T 389885E 4986982N
[Note - This description refers to the spillway. If water is too high or rocks too slippery, we will see similar rocks in a nearby roadside outcrop.]
When the water level above the dam is low and the spillway clear of water this spectacular expanse of outcrop is considered to be the type area/section for the lower part of the Lumsden Dam Formation. Here the formation consists of grey thickly to thinly bedded and well laminated metasandstone to metasiltstone. Sedimentary structures are common and include cross laminations and graded-bedding, groove, tool, and load marks, ripples, and small-scale slump features. Towards the northern end of the outcrop rare graptolite specimens are preserved.

The contact with the underlying North Alton Formation is not exposed, however, when water levels are low in Lumsden Lake to the south the exposed outcrops are sulphide-rich slates and metasandstone typical of the North Alton Formation.

Bedding is almost vertical in this outcrop. Axial planar slaty cleavage (formed during regional greenschist-facies metamorphism associated with the Neoacadian/Kejimkujik orogeny at ca. 400 - 380 Ma) is approximately parallel to bedding. Some beds contain cross-laminations which you can use to interpret younging direction - are younger beds to the north or to the south? Those with sharp eyes for fossils may find well preserved graptolites on some bedding planes. They have been identified as *Rhabdinopora flabelliformis Flabelliformis*, an Early Ordovician species.

The outcrop is intruded by a large gabbro sheet with chilled margins. Would you call this intrusion a sill or a dyke?

Stop 10: NORTH ALTON FORMATION (HALIFAX GROUP)
UTM Zone 20T 391298E 4986994N
The North Alton Formation is stratigraphically equivalent to the Acacia Brook Formation in the southwestern Nova Scotia and the Cunard Formation in southeastern and eastern Nova Scotia. The rocks in this quarry are typical of the formation and consist of black to rust-brown slate with thin beds and lenses of minor black cleaved metasiltstone interbedded with cross-laminated, fine-grained, pyritiferous metasandstone. The slate contains abundant pyrite, arsenopyrite, and pyrrhotite that form beds and nodules up to 5 cm thick and may be a source of potential acid rock drainage issues, as they are ay many locations in the Meguma terrane. Several

late Cambrian (Furongian) acritarchs were identified in samples from this quarry (White et al. 2012). The North Alton Formation is about 1000 m thick, although in areas of abundant folds it appears much thicker.

Stop 11: NORTH ALTON FORMATION (contact aureole, South Mountain Batholith) (UTM Zone 20T 391322E 4981695N)

This outcrop of the North Alton Formation is about 200 m from the contact with the South Mountain Batholith and contact metamorphism has been superimposed on regional metamorphism. In this outcrop, the bedding is approximately vertical. Cross-bedding in beds with silty protoliths indicates younging to the north. This younging direction appears to contradict the overall stratigraphy but at this location we are in an area of multiple folds and this stop is on the southern limb of one of these minor synclinal folds. Interlayered pelitic beds contain large crystals of andalusite up to 1 cm in length, as result of contact metamorphism. The cleavage in these rocks has been annealed as a result of the later contact metamorphism.

Stop 12: SOUTH MOUNTAIN BATHOLITH AT BLACK RIVER LAKE (UTM Zone 20T 391667E 4979977N)

At this location near Black River Lake, we are in biotite monzogranite, a major unit that forms much of the northern part of the batholith according to MacDonald et al. (2001). Large phenocrysts of K-feldspar show some alignment due to flow during magma emplacement. Xenoliths of metasedimentary rocks indicate that stoping may have played a major role in magma emplacement in this part of the batholith.

The rocky, uneven topography produced by weathering of the granite demonstrates why most areas of Nova Scotia underlain by South Mountain Batholith are sparsely populated!

End of Trip and Return to Old Orchard Inn

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MacDonald, M.A. 2001. Geology of the South Mountain Batholith, southwestern Nova Scotia. Nova Scotia Department of Natural Resources, Open File Report ME2001-2, 320 p.

White, C.E. 2019. Bedrock geology map of the central Annapolis Valley area, Nova Scotia. Nova Scotia Department of Energy and Mines, Geoscience and Mines Branch, Open File Map ME 2019-006, scale 1:50 000.

White, C.E., and Barr, S.M. 2012. The new Meguma: stratigraphy, metamorphism, paleontology, and provenance. Field Trip Guidebook B5, prepared for St. John's 2012 GAC-MAC Joint Annual Meeting, 68 p.

White, C.E., Palacios, T., Jensen, S, and Barr, S.M. 2012. Cambrian–Ordovician acritarchs in the Meguma terrane, Nova Scotia, Canada: resolution of Early Paleozoic stratigraphy and implications for paleogeography. Geological Society of America Bulletin. 124: 1773–1792.

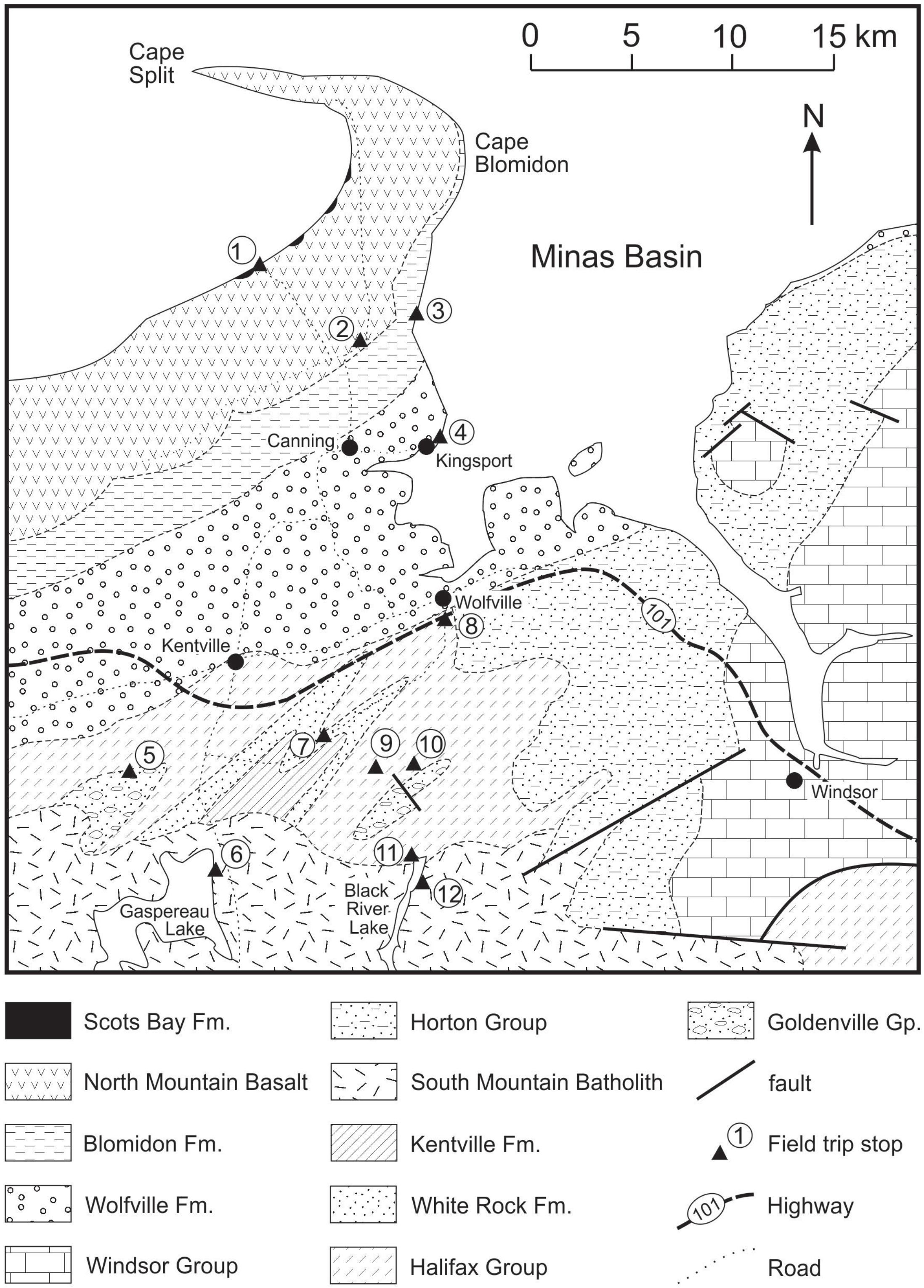

Fig. 1 Geological sketch map of the Wolfville area showing the location of stops for the field trip. More detailed geology in the Goldenville and Halifax groups is shown in Figure 2.

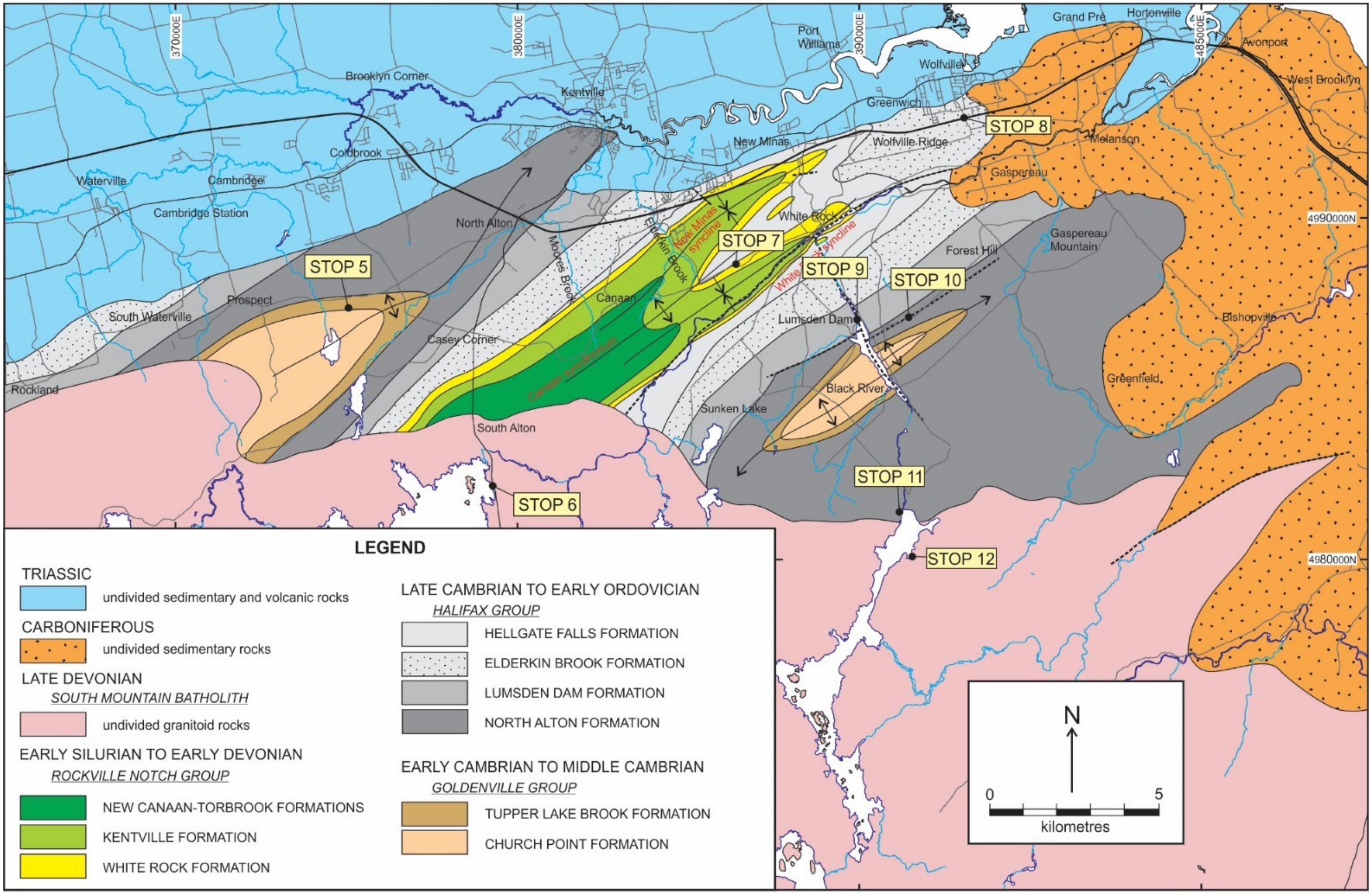

Fig. 2. Geological map of the area south and west of Wolfville showing more detail in the area of stops 5 to 12. Map is modified from White and Barr (2012) and White (2019). Dashed lines are faults.

Field Trip #2

Sedimentary, structural and metamorphic geology on the South Shore of Nova Scotia

Leader: John Waldron, Acadia University and University of Alberta
This document is based on a previous version by Rob Raeside, Acadia University.

The Meguma terrane is the farthest outboard (SE) terrane of the Appalachian Orogen. Much of the terrane is made up of Cambro-Ordovician rocks of the Meguma Supergroup, which comprises two units: the Goldenville and Halifax groups. On this trip, we will visit several of the formations that make up these groups, we will see the evidence for their deformation, and trace them into the contact metamorphic aureole of the South Mountain Batholith.

The South Shore of Nova Scotia is largely underlain by rocks of the Meguma Supergroup, a thick succession of Cambro-Ordovician siliciclastic sedimentary rocks that were deformed during the Devonian into a series of upright large-scale folds. They were subsequently intruded by granite of the Devonian South Mountain Batholith, the heat from which resulted in a contact metamorphic overprint up to 2 km from the pluton. Mineralization (gold, arsenopyrite) accompanied or post-dated the folding and metamorphism, and is focused in saddle-reef structures and a variety of bedding-parallel and cross-cutting veins. Excellent outcrops of the contact aureole, the effects of the folding, and the mineralization can be found around the shores of the LaHave Islands, Mahone Bay, and at Blandford on the Aspotogan Peninsula (Fig. 1).

The field trip will focus on the stratigraphy of the Halifax group, and the contact with the underlying Goldenville Group (Fig. 2). The overall thickness of the two groups is in excess of 11,000 m. Much of that is placed in the Goldenville Group (about 8000 m), dominated by thickly bedded metasandstone, with rare interbedded slate, the Green Harbour Formation. Higher, finer-grained units of the Meguma Supergroup are particularly well exposed in the Lunenburg – Mahone Bay area, where a regional plunge depression takes the deeper units into the subsurface. Uppermost parts of the Goldenville Group (Government Point Formation) contain more slate and less metasandstone. The overlying Moshers Island Formation is dominantly green laminated mudstone and contains elevated concentrations of manganese, leading to the development of fine-grained garnet (spessartine) at low metamorphic grades (greenschist facies). Garnet is typically not visible in hand sample, but contributes to a silty appearance. The overlying Cunard Formation is generally considered most typical of the Halifax Group, consisting of conspicuously black slate, siltstone and fine sandstone that weather orange because of the presence of abundant sulphides, including pyrite, pyrrhotite and locally arsenopyrite. The upper part of the Halifax Group in the Mahone Bay area consists of grey slate and siltstone assigned to the Feltzen Formation, This trip will visit the top of the metasandstone and outcrops of the fine grained Moshers Island, Cunard and Feltzen formation. Initial stops will examine the effect of contact metamorphism on rocks of the Cunard Formation as a result of intrusion by the South Mountain Batholith.

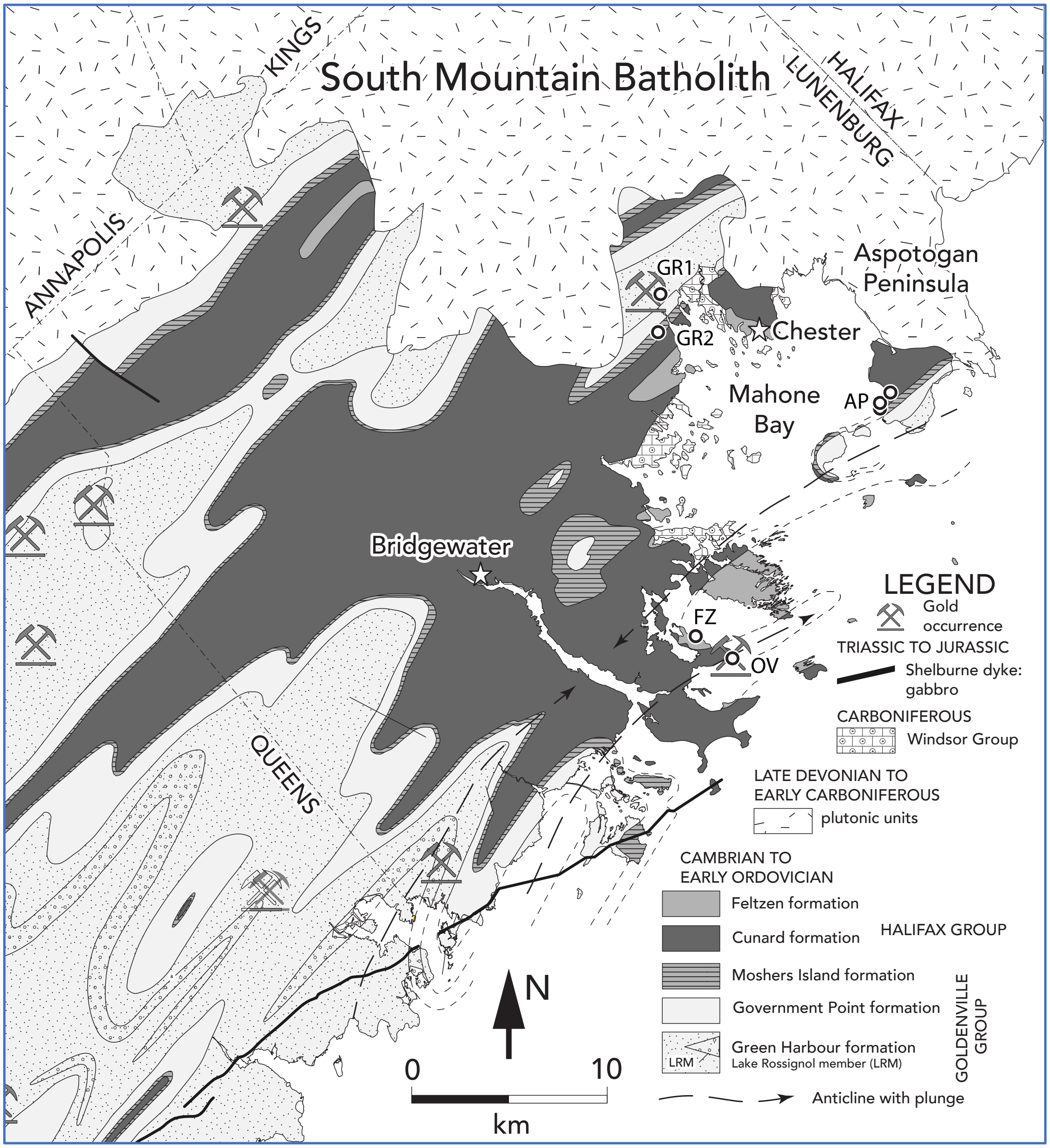

Figure 1 Simplified geological map of Lahave – Mahone Bay area showing field stops, after White & Barr (2012).

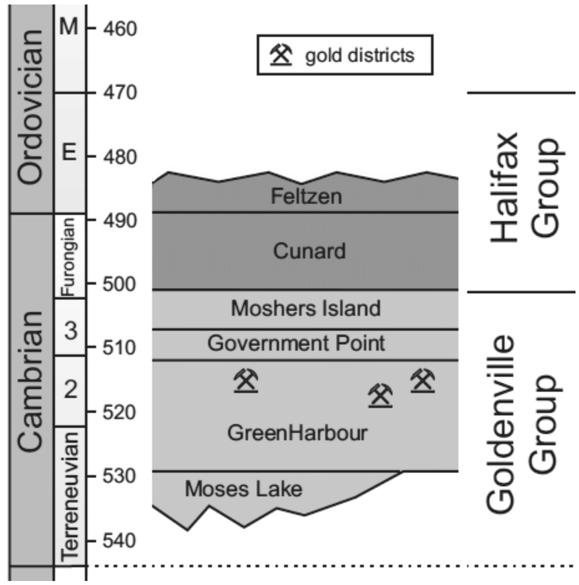

Figure 2 Stratigraphy of the Goldenville and Halifax groups (after White, 2010).

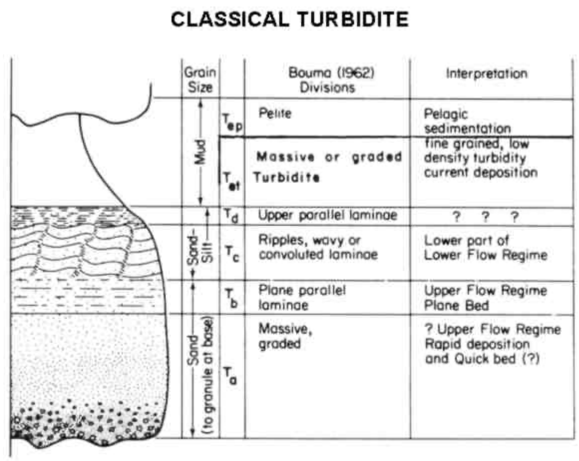

Figure 3 Classical Bouma sequence in a turbidite deposit (Bouma 1962).

STOP AP1. UPPER BLANDFORD: contact aureole of the South Mountain Batholith.

20T 410730 4930000. 200 m north from the junction of Highway 329 in Upper Blandford (opposite house #42)

The South Mountain Batholith intruded chlorite-zone black slate and metawacke of the Cunard Formation (Halifax Group). Here, on glacially polished outcrop showing excellent glacial striae, bedding (shallow dip) and cleavage (steep dip) are well preserved. The silty layers are folded and locally appear offset along the cleavage, possibly due to pressure solution. However, the rocks lack the extreme fissility characteristic of slate, suggesting that the slaty cleavage has been at least partially annealed. The most obvious evidence of contact metamorphism here is the presence of small (1–10 mm) andalusite (variety chiastolite) porphyroblasts. These clearly postdate the cleavage, although they tend to be concentrated along cleavage planes, but also along certain sedimentary layers, presumably those with higher aluminum content. In thin section, chiastolite is seen to be completely replaced by sericite, chlorite and quartz. Small, ovoid, inclusion-choked cordierite spots can be seen in thin section although they are very difficult to see in outcrop. Chlorite is stable and biotite is absent.

STOP AP2: UPPER BLANDFORD

North along the road 700 m is a pull-off at a small pier at house #198. 20T 410940 4930701: walk N to 410930 4930880

The outcrops north of the pier consist of black, very hard hornfels. The slaty cleavage has almost disappeared although its effects can still be seen where silty layers are offset against the pelite (resembles “ripples”). The mineral assemblage consists of andalusite + cordierite + biotite + plagioclase + quartz + muscovite. Biotite typically rims cordierite and muscovite is relatively fine-grained and largely confined to the matrix. In comparison to the previous outcrop, the overall grain size has increased, although andalusite (chiastolite cross not as well developed) and cordierite (much larger with fewer inclusions) still form distinct porphyroblasts. The matrix has partly recrystallized, but relicts of the slaty cleavage in the matrix, and straight inclusion trails in cordierite porphyroblasts can be seen in thin section.

STOP AP3. DEEP COVE: hornfels cut by granite

412558 4930741 and 412505 4930656

On route 329 is a large rusty-weathering cliff at Deep Cove (3.7 km north of the Upper Blandford intersection). A second, smaller but more accessible outcrop has been created as a result of construction on Deep Cove Road. The outcrop is the west end of the 150 m high Aspotogan Mountain, which owes its existence to the hardness of the hornfels that composes it. The rubble here is loose, and not for climbing on! The actual contact is not exposed, but granite outcrops at the top of the hill, and granite veins cut the hornfels part way up the rock face. The matrix is considerably coarser than at the last stop. Cordierite is the dominant porphyroblast phase and is rimmed by biotite and muscovite. Andalusite, now lacking the chiastolite texture, takes on a very spongy appearance and is mainly interstitial to the cordierite. Fibrolite is present, although not visible in hand specimen. The sulphide responsible for the iron staining here is pyrrhotite. The abundance of secondary muscovite suggests that some K-feldspar may once have been present in the matrix. The granite veins here contain andalusite, probably of igneous or hydrothermal origin, since it forms euhedral, zoned crystals unlike those seen in the hornfels.

STOP GR1: HIGHWAY 103 OFF-RAMP AT EXIT 9, NE OF GOLD RIVER: Green Harbour Fm. turbidites.

396120 4936886

Caution: park at the east end of the offramp where the shoulder is wider. Beware of traffic. Beware of falling rocks.

This outcrop is typical metasandstone of the Goldenville Group, near the top of the Green Harbour Formation. The sandstone is relatively quartzose, but poorly sorted, and has variously been termed "quartzite" (in the metamorphic sense) or "quartz wacke". There are thinner, recessive interbeds of grey-green to black slate. Most beds are relatively structureless, but show grading in their top few centimetres. The upper portions of the beds may show parallel lamination and/or cross-lamination. At other locations, lower parts of beds may show larger-scale scour and fill structures that represent incipient cross-bedding. The sandstone beds are interpreted as deposits of high-concentration turbidity currents, in which the dense concentration of interacting sand particles inhibited the development of Bouma sequence structures, except in the thin, graded, top few centimetres of each bed. One bed at this location shows a conspicuous development of ripple marks.

STOP GR2: HIGHWAY 103 SHOULDER, SW OF GOLD RIVER. Mosher's Island Formation Mn-rich mudstone.

During highway construction there is a wide shoulder. Beware of traffic. This outcrop is probably temporary. 20T 394917 4933036

This long, temporary outcrop displays typical Moshers Island Formation, consisting of blocky, well indurated siltstone. The upper part of the Goldenville Group is enriched in manganese, probably concentrated in the overlying water as conditions changed from oxidized to reduced conditions. Fresh outcrops are not particularly conducive to the observation of structures in these very fine-grained, low-energy sediments, but coastal outcrops of the same unit display small rounded concretions of Mn-rich carbonate. Manganese stabilizes garnet (spessartine) at much lower temperatures than other forms of garnet, and garnet is commonly observed in thin section. However, spessartine-rich garnets are characteristically very small, and are unrecognizable in hand sample, except that they impart a silty, blocky appearance to the rocks, and a characteristic 'dark chocolate' weathering colour of hydrous manganese oxides.

At the far S of the outcrop, the transition to the overlying Cunard Formation can be detected in a colour change of near-outcrop float from grey to the characteristic black and orange of Cunard Formation slate.

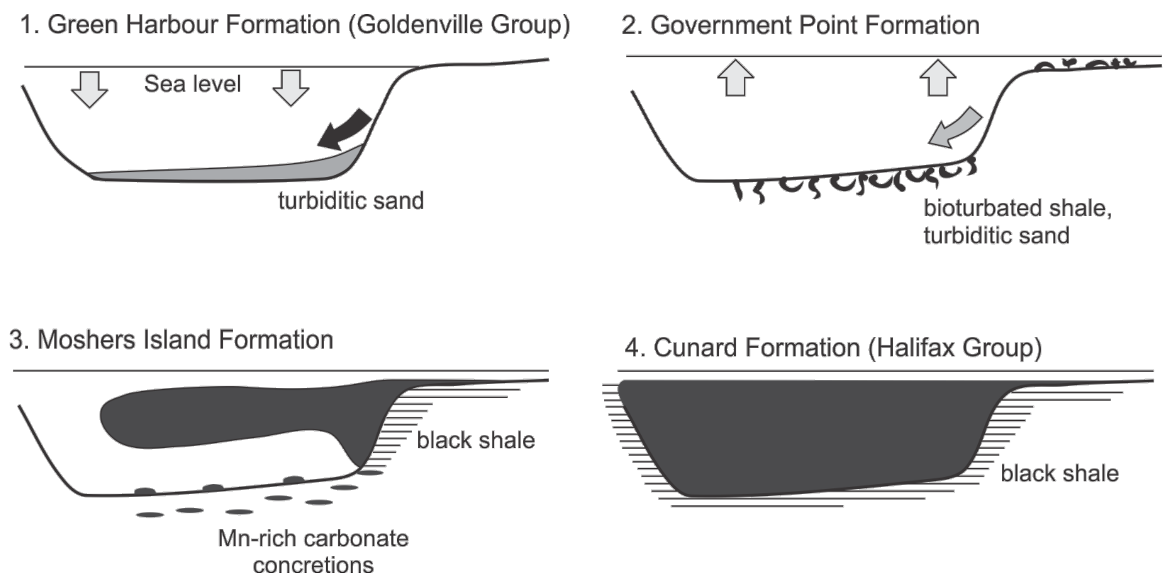

Figure 4 Evolution of the ocean basin from the deposition of the Green Harbour Formation to the black shale of the basal Halifax Group (after Waldron, 1987).

STOP FZ: FELTZEN SOUTH: Folds and strained burrows.

Proceed along the mowed trail to the outcrop below the graveyard 396764 4909825

The outcrop here is a glacially eroded "roche moutonnée", with numerous glacial striations and a prominent glacial furrow. The down-ice side is much rougher, having been subjected to glacial plucking. If you look carefully on the smooth surfaces of the outcrop you will find interesting carvings made in the 19th century by ship owners. Some of these are good subjects for taking rubbings.

The Feltzen Formation occurs only in the cores of synforms and its top is not seen. It is light grey to blue-grey slate, rhythmically interlayered with laminated fine-grained metasandstone.

The rocks here are complexly deformed interbedded slate and metasandstone. On the main humpback, find the layer of white banded metaturbidite – follow it around until you return to where you started. You should have walked around a complex "mushroom shape", the result of folding in two directions and erosion through the fold structure. Where the outcrop is less smooth, you can also observe the plunge of the bedding-cleavage intersection lineation (the pattern on the cleavage surface formed by the sedimentary beds). It varies across the outcrop. Both these observations suggest that more than one generation of folds formed during deformation. However, in most of the Meguma Supergroup there is a single dominant generation of folds. One possible explanation is that these rocks underwent soft-sediment deformation in a slope environment, and this may explain the locally highly discontinuous bedding. Comparable strata on Halifax peninsula contain a thick mass-transport deposit.

To the east of the humpback outcrop is a small outcrop with finely bedded slate, exposed over the hinge of an anticline. As a result, bedding and cleavage are at a high angle, and many vertical burrows are visible. Some are U-shaped. Viewed from above, these burrows are distinctly elliptical, the result of deformation. These burrows have been ascribed to the ichnogenus *Arenicolites*, common in the littoral zone, and might indicate that the Feltzen Formation was deposited in alternating deep and shallow water environments.

STOP OV: The Ovens Park

Drive to the Ovens Park (privately operated park). 20T 399774 4908199.

Park in the designated parking area and descend to the beach

The Ovens Park at Cunard Cove is located in the Cunard Formation of the Halifax Group. Before gold was discovered in 1861 CE, the beach was apparently sandy. During the first Nova Scotian gold rush in the 1860s, the founder of the famous steamship line, took out a number of mining claims, and the entire beach was removed and sent to Halifax and England to be processed for gold, yielding about 2500 ounces in 2 years. For a short time, the site was a substantial town of over 600 people. The beach has only partially returned, but with patience, it's still possible to pan specks of gold from the beach sand.

The rocks here are black, organic-rich slate interbedded with very thin to medium-bedded rusty-weathering, sulphide-bearing metasiltstone and very fine sandstone. The courser beds show normal grading, cross-lamination and parallel lamination, forming partial (locally complete) Bouma sequences. Comparable beds at the same position in the stratigraphy have yielded acritarchs of Furongian (Cambrian Epoch 4) age.

The rocks are cleaved, and a regional fold, the Ovens Anticline, passes through the cliffs and foreshore to the N of the park entrance. The fold is upright and is marked by strong axial planar cleavage. The cleavage was dated at 395 ± 3 Ma by Hicks et al. 1999.

The Ovens Anticline folds not only bedding, but also the conspicuous quartz veins that cut the Cunard Formation. Veins and their host rocks contain both pyrite (cubic) and arsenopyrite (orthorhombic) crystals, which are concentrated in the region around the fold hinge, together with local gold. Several generations of veins are recognized, and the earliest, the bed-parallel, buckle folded "barrel quartz" of the gold miners, locally had the reputation of being the most productive. Although field relations clearly indicate that these veins pre-date the folding and associated cleavage, for many years the best dates available on the gold veins were Ar/Ar dates around 370 Ma that were paradoxically younger (Kontak & Archibald 2002 and references therein). However, more recent dating of sulphide minerals within the bed-parallel veins has yielded dates of ~407±4 Ma (Morelli et al. Econ.Geol. 2005), consistent with the field relations that indicate vein formation prior to or during development of the ~395 Ma cleavage axial planar cleavage. A second phase of mineralization affected the Meguma Terrane between 380 and 370 Ma during emplacement of the South Mountain Batholith and other intrusions, remobilizing gold and resetting the Ar/Ar chronometers. This was associated with tightening of the folds by flexural slip, that has locally caused metamorphic porphyroblasts to be offset by bed-parallel microfaults.

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Field Trip #3
Surficial Features and Geohazards around the Annapolis Valley

Leaders: Mo Snyder, Aaron Taylor, and Wesley Weatherbee
Department of Earth and Environmental Science, Acadia University

Stop 1: Submerged Shorelines at Oak Point
(UTM 20T 392,712.33E 5,001,192.72N)
Park at Kingsport Wharf and walk along the shore to Oak Point. Rubber boots required. No washroom.

Oak point is an archaeological site located on the northeastern edge of Kingsport marsh. Currently, the site is represented largely by a scatter of lithic tools and flakes redeposited in the swash zone of a recent beach deposit. The area was briefly dyked in the 1890's; remnants of which can still be observed partly constraining the southwestward elongation of the beach. Historic air photos indicate the sand and fine gravel beach deposit has only recently established itself atop of a salt marsh in the past six or seven decades with sands that were formerly from Kingsport Beach prior to the 1970's. The installation of armour stone in front of Kingsport has increased the longshore energy in the coastal system and reduced available sediment supply responsible for nourishing Kingsport Beach. This change in the coastal system forced the sand and gravels to overtop the salt marsh and establish the beach platform where artifacts are turning up.
Below the beach-topped salt marsh is sandflats that rapidly change to mudflats moving to the southeast towards the Minas Basin. The mudflats hold an ancient drowned forest apparently preserved in part by the rapid tidal range expansion in the Minas Basin approximately 3400 years ago (Shaw et al. 2010). The drowned forest is an area of anthropogenic disturbance on the mudflats caused by annual digging of bloodworms for fishing bait.
Stylistically, the artifact assemblage at Oak Point suggests that the occupation at the site could have existed here during, or directly after, the expansion of the tidal range. The lack of water polishing present on the artifacts suggests the archaeological deposit is close to the beach. Future sediment cores on the mud flats intend to locate the archaeological deposit acting as a feeder source for the artifacts being redeposited on the beach at Oak Point.

Stop 2: Raised Shorelines at Medford
(UTM 20T 391,838.89E 5,004,810.55N m)
Park to the side of gravel road bordering the orchard then walk through a field. No bathroom.

A fluted projectile point located in the 1920's on a cattle pasture in Medford and reported in the 1960's stylistically fits the time range between 13000 and 11600 years ago (Deal 1991). At this time, the landscape of the Minas Basin was much different; retreat of the ice sheets during the Scotian Ice Divide had only just revealed the area we now call Medford up to one millennium prior to this. It is suggested that a large glacial lake or paramarine basin filled the area (Rivard et al. 2012; Stea 2011). Paleolandscape modelling suggests that the shorelines of this lake are close in elevation to the reported location of the fluted projectile point (Weatherbee 2021).
Over the past year, the area of the fluted projectile point find has been cleared of old apple trees and is likely awaiting the planting of new trees. This allows for a clear view of multiple erosion scarps that likely represent former shorelines. Future shovel test excavations intend to further define the stratigraphy of the area and refine the shoreline of this water body during the end of the Pleistocene

Stop 3: The Look-off
(UTM Zone 20T 389423E 5006106N)
This beautiful landscape shows the interaction of topography and geology (Fig. 1). On the south side of the valley the resistant South Mountain metamorphic and plutonic rocks. These rocks are overlain by less resistant Carboniferous to Triassic rocks in the centre of the valley. On the north end (where we are) is the North Mountain Basalt, another strong unit that acts as a barrier against northern winds blowing off the Bay. During the last glacial period we can see a variety of glacial and post-glacial features that make up the present-day topography of the Annapolis Valley.

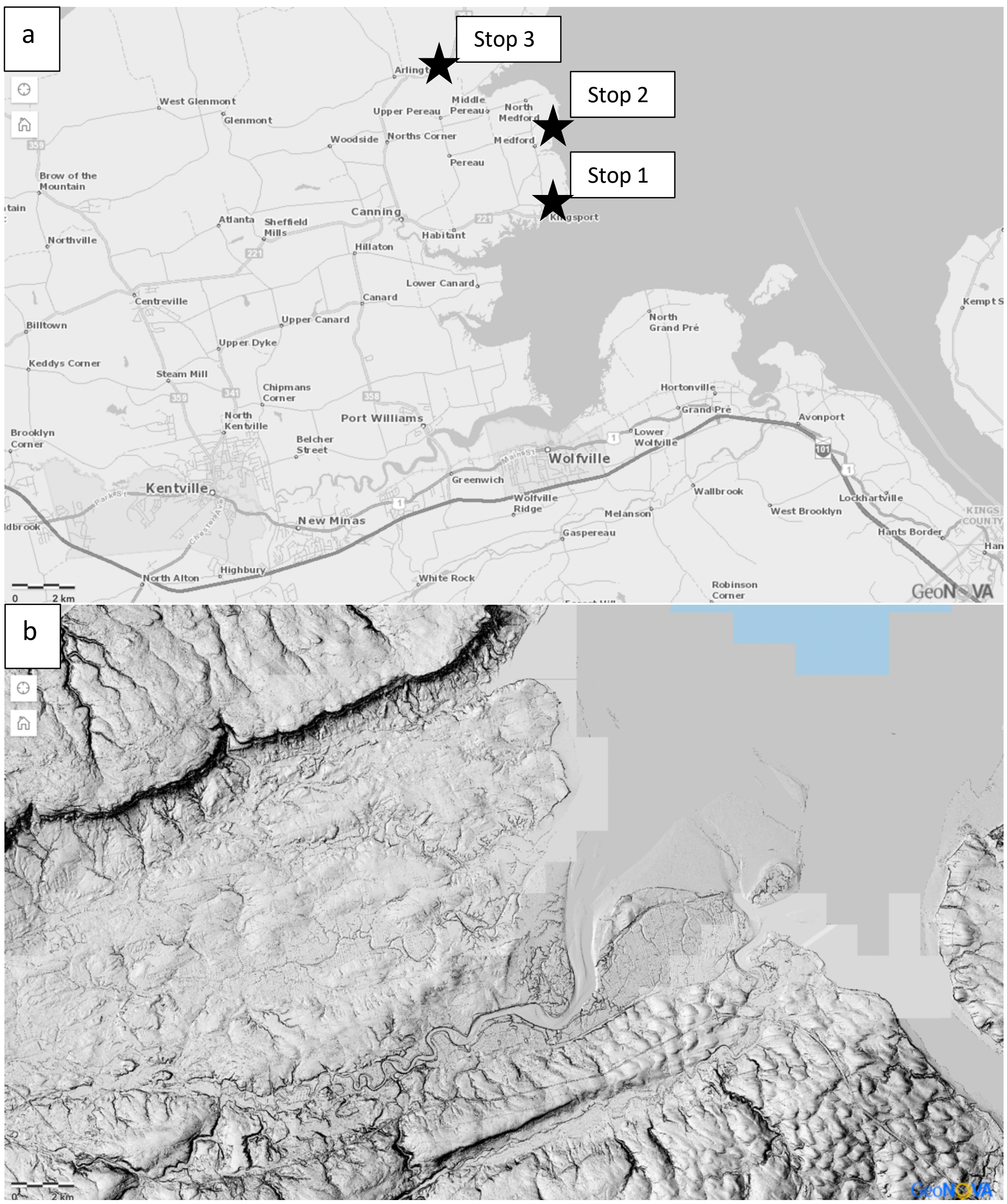

Fig. 1 Stops 1–3 shown on a (a) road map and (b) hillshaded LiDAR.

After lunch we will be looking at surficial features and geohazards associated with evaporites around Windsor, NS. Evaporites are unique when compared to other rocks as they have low shear strength, low resistance to flow, high thermal conductivity, and high ductility (Warren 2016). Because of these properties, evaporite deposition and later deformation strongly influence the overlying topography. Atlantic Canada is home to an evaporite giant, hosted within the Visean (ca. 335 Ma) Windsor Group of the late Paleozoic Maritimes Basin. Places where evaporites are at-or-near the present-day surface are often places of amazing landforms including doline karst, pinnacle karst, and collapse sinkholes.

Stop 4: Wentworth Quarry
(UTM Zone 20T 4146434 982101)
Note: quarry is in 'care and maintenance'. Safety vests and hard hats are required. Do not enter tunnels, caves, unstable ground. Bathroom available at quarry office.

At this location, we see bedded white gypsum and blueish anhydrite of the White Quarry Formation of the Windsor Group. Above is middle Windsor Group (Miller Creek Formation) consisting of rubbly gysum and thin limestone beds. This is an interesting structural site as it includes evidence of autochthonous (untransported) evaporites below and allochthonous (transported) evaporites above. However, this contact is difficult to observe as the zone itself has been modified by rehydration of anhydrite to gypsum.

Stop 5: Miller Creek Quarry
(UTM Zone 20T 417413 4983846)
Note: quarry is in 'care and maintenance'. Safety vests and hard hats are required. Do not enter tunnels, caves, or unstable ground. No bathrooms.

This location is a site where significant evaporite movement has taken place. Unpublished maps by R.G. Moore (previous Acadia University professor) and Acadia University students made in the late 20th century mapped numerous mappable limestone beds through the quarry and associated drill holes. They mapped highly convoluted structures including overturned folds and sheath folds.

Stop 6: Irishmans Road Recreation Site
(UTM Zone 20T 416200 4980300)
Park at the Irishmans Road Recreation Site parking lot. Bathroom available.

This is a 'gee whiz' stop and a chance to stretch your legs. This location showcases incredible doline karst. We will take a ~1.5 km walk on the main trail. Everywhere you look there are sinkholes. If you look carefully, you will see gypsum cropping out.

Stop 7: Thumb Mill Creek
(UTM Zone 20T 419052 4979837)
Park along Rocks Rd. No bathroom available.

The final stop of the day takes us to one of the highlights of the drive along Highway 101. Along the north side of the highway, amazing surficial features including drumlins and Roche moutonnee. At the stop along Rock Road, you will see gypsum cliffs along Thumb Mill Creek, an offshoot of the Avon River. You can also check out the salt marsh immediately adjacent to the gypsum cliffs.

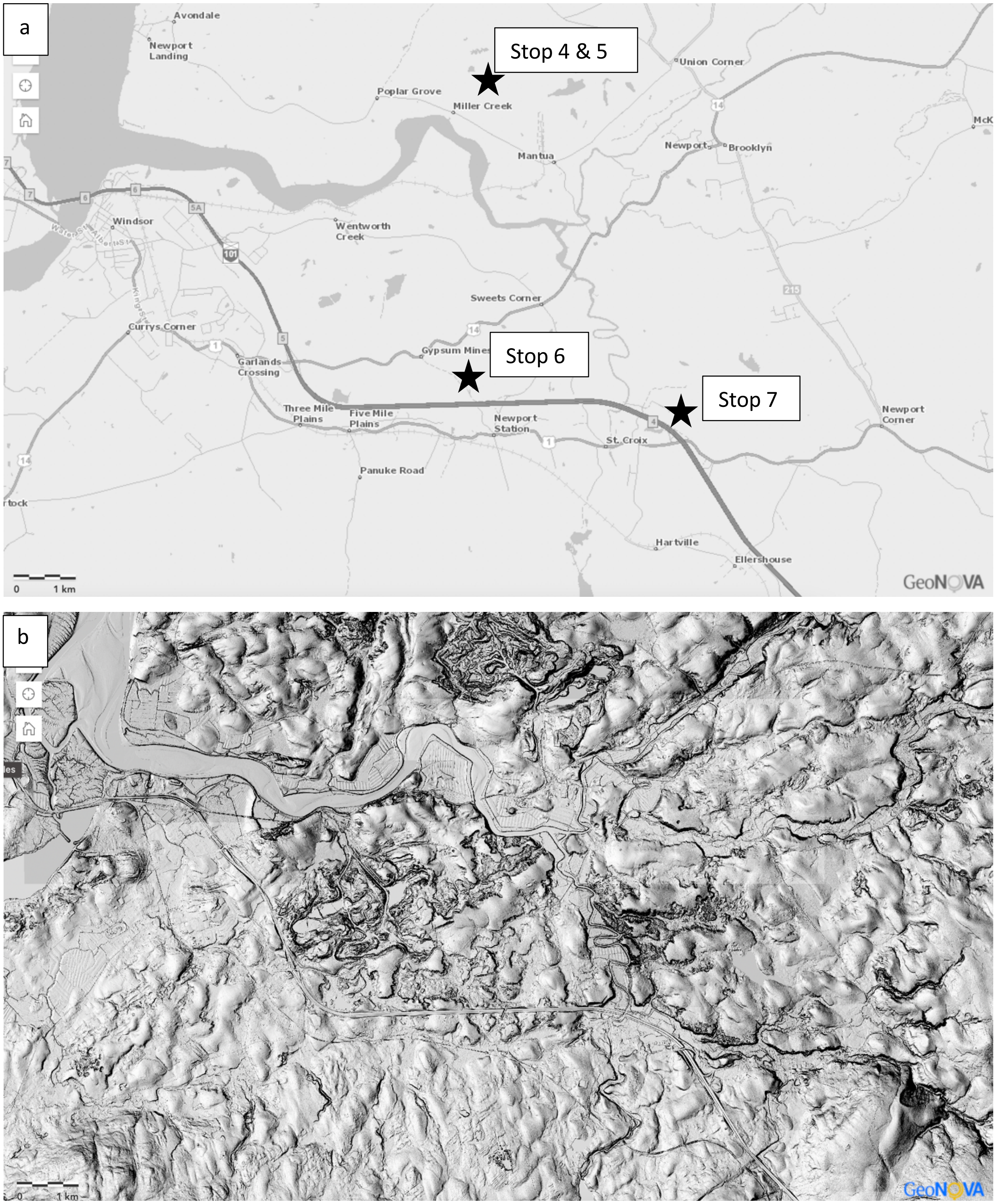

Fig. 1. Stops 4 – 7 shown on a (a) road map and (b) hillshaded LiDAR.

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