AUGC

StFX

Saint Francis Xavier University

October 24-26th, 2013

Antigonish, Nova Scotia

Welcome Package & Schedule of Events

October 21, 2013

Welcome to the Science Atlantic AUGC (Atlantic Universities Geoscience Conference) which is proudly hosted by the Fairbault Geological Society of StFX. Science Atlantic supports and promotes this series of conferences as it provides tremendous opportunities for students and other researchers to present the results of their research in a setting that promotes excellence and openness in Atlantic Canada. For many this is the first step in their future towards becoming researchers, professionals or community citizens.

Please enjoy this wonderful learning opportunity. Take time to network and to get to know your colleagues from the other Atlantic Universities. Sharing ideas is a critical component of any conference. I wish you all a successful and productive weekend.

Dr. Robert van den Hoogen

Dean of Science

ST. FRANCIS XAVIER
UNIVERSITY

October 21, 2013

Dear AUGC Participants,

On behalf of the Department of Earth Sciences, I am please to welcome you to St. Francis Xavier University for the Atlantic Universities Geological Conference.

The AUGC has a long tradition of excellence in terms of presentation of high-calibre research conducted by students of the region. The combination of technical sessions, field trips and workshops, and social events provides great opportunities for both learning and networking – both essential aspects of career development.

We are grateful for the financial support and ecouragement of all of the sponsors and university participants in this event. The AUGC would not be possible without this support.

Best wishes, and I hope that you enjoy and benefit from all aspects of the 2013 AUGC.

Mike Melchin
Chair, Department of Earth Sciences

Dear Students, Faculty and Guests,

We would like to take this opportunity to welcome you all the this years Atlantic Universities Geoscience Conference on behalf of the Faribault Geological Society.

We would like to thank everyone that helped in the organizing of this event, especially all our sponsors. Without their generous support this conference would not be possible. We would also like to thank our guest speaker, student presenters and judges who are donating their fee time to support this conference.

We hope you enjoy the weekend in Antigonish and St. Francis Xavier University and that you take advantage of everything that the area has to offer while you are here. We wish the best of luck to all the presenters on Saturday.

Sincerely,

Emilie Oicle & Jenna Romano

Co-Chairs of AUGC 2013 Committee

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AUGC 2013 Organizing Committee

Co-Chairs - *Jenna Romano and Emilie Oicle*

Venue and Accommodations Coordinator - *Drew Berg*

Finance - *Hilary MacDonald*

Food Coordinator - *Johnny MacFarlane*

Judging and Awards Coordinator - *Peter West*

T-shirt design - *Erin Higgins*

Thanks to: Brendan Murphy, Cindy Murphy, Mike Melchin, Susan Grant, Lois Whitehead, Tatum Haglund, Rebecca MacDonald and everyone else who had a hand in planning

Guest Speaker - Dr. Fraser Keppie

Dr. Keppie's initial research and mapping in Nova Scotia is focused on compiling and extending tectonic models for the assembly and breakup of Pangea, with an emphasis on understanding the mechanisms of formation and evolution of the Devono-Carboniferous Maritimes Basin and its hydrocarbon potential.

Prior to 2010, Fraser completed undergraduate degrees in geology and computer science at St. FX and Acadia Universities, respectively, a doctoral degree in tectonics at McGill University, and a post-doctoral appointment at Caltech in geodynamics. Previous research directions have included understanding forearc removal processes at subduction zones, and evaluating tectonic models for the opening of the Gulf of Mexico and the origin of the Caribbean Plate.

Judges

Deanne van Rooyen- Cape Breton University
Greg Godec- Exxon Mobil Canada

Field Trips 2013

Ordovician-Silurian Arisaig Group, Dr. Mike Melchin

This field trip will examine the Late Ordovician to Silurian stratigraphy and paleontology of the Arisaig Group, well exposed along the shore of Northumberland Strait. This unit represents an almost continuous succession through the Silurian, with predominantly fossiliferous, shallow marine sediments, and some deeper marine and terrestrial intervals. The trip will focus on paleoecology and the interaction between facies and sea level change. We will also briefly visit the volcanic strata that underlie the Arisaig Group.

Stable Isotope Primer Workshop, Dr. Dave Risk

Broad introduction to the principles and utility of the stable isotopes in the earth sciences, with an emphasis on hands on learning using instrumentation at St.FX.

Mineral occurrences in southern Cape Breton, Sid Taylor, Travis McCarron, Evan Gladney

This field trip will focus on different styles of mineralization in southeastern Cape Breton Island, Nova Scotia. Stops will include the Yava sandstone lead deposit, a look at stratiform Sr-Ba mineralization near Lake Enon and the Stirling Zn-Pb-Cu-Ag deposit, a volcanoclastic-hosted massive sulphide deposit.

Day by Day Schedule- AUGC 2013

Thursday October 24th

4:00 pm - 6:00 - Registration
Check in, Physical Science Complex Foyer
7:00 pm - Meet & Greet
Desmond Oval in the West Cody Building, Room 110
Light snacks and refreshments provided

Friday October 25th

8:30 am - 4:00 pm Field Trips
Meeting in front of the Keating Millennium Center
Buses leave at **9:00**
Lunch is provided
8:00 pm - Evening at the Split Crow

Saturday October 26th

9:00 am - 3:30 pm - Presentations and Posters
*Poster presenters please show up at 8:30 with your posters
*Students giving talks please show up at the beginning of your section
Schwartz Auditorium Room 110
- There will be a morning coffee break, lunch and afternoon coffee break
4:00 - Executives Meeting
Location TBA

6:00 pm - Awards Banquet
Desmond Oval in the Cody Building, Room 110
Bar open at 6pm, Dinner will be served at 7:00 pm

StFX CAMPUS MAP

1. Xavier Hall
2. Schwartz School (north entrance)
3. Schwartz School
4. St. Ninian's Cathedral
5. St. Ninian Place
6. Angus L. Macdonald Library
7. Mount Saint Bernard
   A) Immaculata Hall B) Camden Hall
   C) Marguerite Hall D) Gilmora Hall
8. Nicholson Hall (classroom section)
9. Nicholson Tower
10. Annex
11. Lane Hall
12. J. Bruce Brown Hall
13. Bloomfield Centre
14. MacIsaac Hall
15. MacDonald Hall
16. MacNeil Hall
17. Alumni Aquatic Centre
18. Oland Centre
19. Charles V. Keating Centre
20. Governors Hall
21. Coady International House
22. Somers Hall
23. Power Hall
24. 42 West Street Building
25. West Street Apartments
26. Bishops Hall
    A) Plessis House B) Fraser House
    C) Burke House
27. University Chapel
28. MacKinnon Hall
    A) Business Office B) Chisholm House
    C) Gillis House D) MacNeil House
29. Bauer Theatre
30. Physical Sciences Centre
31. Recruitment and Admissions Office
32. Morrison Hall
33. Cameron Hall
    A) MacPherson House B) Thompson House
    C) Tompkins House D) MacDonald House
34. Mockler Hall
35. Aberlard House
36. Coady International Institute East
37. Coady International Institute West
38. Fine Arts Building

ST. FRANCIS XAVIER UNIVERSITY

Town of Antigonish Map: Amenities

Restaurants:

1) Dairy Queen/ Boston Pizza

1) Justamere Cafe

3) Kenny's Pizza

5) Subway/McDonald's/A&W/Tim Horton's/Snow Queen

6) The Wheel Pizza & Sub

7) Little Christo's Pizza/ Pizza Delight/ Tall N' Small Eatery / X-Burger

8) Prissy Pig's Cafe and Deli

Groceries/Miscellaneous/Convenience:

1) Sobey's / NSLC

5) Need's Convenience

9) Walmart / Superstore

10) Shopper's Drugmart

Accommodations:

1) The Claymore Inn

Nightlife:

2) Split Crow Pub

3) Piper's Pub

4) Golden X Inn (student campus bar in SUB)

Time	Presenters
9:00 AM	Detrital Zircon U-Pb Evidence for Possible Meguma Terrane in Cornwall, SW England, UK **Rebecca MacDonald- St. Francis Xavier**
9:20 AM	Seismic Stratigraphy and Attribute Analysis of the Mesozoic and Cenozoic of the Penobscot Area, Offshore Nova Scotia **Taylor Campbell- Dalhousie**
9:40 AM	A Hydrogeological Investigation at the Crane Mountain Landfill, Saint John, New Brunswick **Michelle Jacobs- University of New Brunswick**
10:00 AM	Substrate (CO and CO2) Utilization in Chemolithotrophic Microorganisms at a Site of Serpentinization: Tablelands Ophiolite, Newfoundland **Sarah Miles- Memorial**
10:20 AM	**Coffee Break**
10:40 AM	Provenance of Pre- and Post-Contact Copper Artifacts Used by Aboriginal People in Atlantic Canada: Implications For Understanding Historical Metal Trades and Usage **Jess Whattam- Saint Mary's**
11:00 AM	Examination of surface features on kimberlitic Iron-Titanium oxide minerals **Rachel Milligan- Dalhousie**
11:20 AM	Petrological comparison of sills and dykes in metasedimentary rocks of the Meguma terrane, Nova Scotia, and the Harlech Dome, Wales **Lisa Mundry- Acadia**
11:40 AM	Sedimentology and Paleoenvironment of a Jurassic Dinosaur Bone Bed, Parrsboro, Nova Scotia **Leigh van Drecht- Dalhousie**
12:00 PM	**Lunch**

Time	Presenters
1:00 PM	The Early Devonian, Evandale Porphyry Cu-Mo-(Au) deposit, Southern New Brunswick: Petrologic, Geochemical, Geothermobarometric, and Geochronologic Characterization of the Host Rocks and its Origin **Travis White- University of New Brunswick**
1:20 PM	Permeability and Porosity of Collapsed Cone Structures Associated with Ophiomorpha Trace Fossils in Offshore Newfoundland Cores **Daniel Niquet- Memorial**
1:40 PM	Correlating PGE enrichment to alteration assemblages at the Afton-Ajax Cu-Au-Pd porphyry System, Kamloops British Columbia **Mark Garagan- Saint Mary's**
2:00 PM	The possible role of the petroleum system in ore genesis in Nova Scotia: spatial coincidence or active involvement? **Ian Borg- Dalhousie**
2:20 PM	**Coffee Break**
2:40 PM	Gold in the Cantung W-skarn deposit, Northwest Territories: distribution, mineralogy, and petrogenesis **Emily Palmer- University of New Brunswick**
3:00 PM	Reservoir Characterization and Forest Density of the Joggins Formation, Joggins, Nova Scotia **Carlos Wong- Dalhousie**

Detrital Zircon U-Pb Evidence for Possible Meguma Terrane in Cornwall, SW England, UK

Rebecca MacDonald
St. Francis Xavier University

In southeast Cornwall, the Late Devonian Meneage Formation consists of sedimentary mélange deposits that are part of the Gramscatho Group flysch deposited in the footwall of the basal thrust of Lizard ophiolite and adjacent to the Variscan suture zone. The age and composition of the Meneage clastic rocks constrain changing patterns of provenance as the Variscan orogen developed. The depositional age of the Meneage Formation is constrained by the ca. 275-295 Ma Cornubian Batholith, which intrudes it, and by the youngest cluster of detrital zircon ages, ~505 Ma. Sample LZ-10, the matrix of a conglomerate within the Cornish mélange, is dominated primarily (33 of 103 concordant grains) by a major peak at ~543-590 Ma with minor peaks occurring at ~504-518 Ma (3), ~605–693 Ma (14), ~2.05-2.08 Ga (6), ~2.11-2.19 Ga (9), ~2.15-2.19 Ga (4), ~2.51-2.58 Ga (6) and ~2.69-2.76 Ga (7). Samples LZ-7 and LZ-8 and are quartzite cobbles within the conglomerate. Sample LZ-7 displays two major peaks occurring at ~1.95-2.05 Ga (24 of 103 concordant grains) and ~2.05-2.25 Ga (30). Minor peaks occur at ~562-589 Ma (6), ~591-728 Ma (9), ~2.23-2.32 Ga (4), ~2.32-2.49 Ga (3), ~2.51-2.58 Ga (6), ~2.61-2.70 Ma (10) and ~2.70-2.75 Ga (4). LZ-8 shows major peaks at ~538-598 Ma (17 of 101 concordant grains) and ~2.06-2.09 Ga (16), with minor peaks occurring at ~522-532 Ma (3), ~600-692 Ma (6), ~736-763 Ma (3), ~774-790 Ma (3), ~1.91-2.05 Ga (11), ~2.10-2.19 Ga (12), ~2.43-2.57 Ga (3), ~2.61-2.69 Ga (6), ~2.70-2.78 (9), ~2.79-2.80 Ga (3) and ~2.81-2.91 Ga (3). The youngest cluster dated in the matrix of the mélange, Late Cambrian (~505 Ma), is considerably older than the known depositional age for the conglomerate.

A comparison of data from possible source areas constrains the provenance of the strata. All analyzed samples have populations dominated by ca. 500-700 Ma and/or 1.9-2.4 Ga, suggesting the cobbles and matrix were derived from similar sources. These data compare favorably with Strachan et al. (in press) who interpret the Meneage Formation to have been derived from erosion of the northern margin of the advancing Armorican microplate during collision with southern Avalonia during the final closure of the Rheic Ocean in the late Paleozoic. Regional considerations, however, suggest a more complex scenario. The Late Devonian rocks of the study area have long been correlated with coeval rocks of the South Portuguese Zone (SPZ) of southern Iberia. However, recent data from SPZ suggest it is underlain by Meguma terrane basement, permitting the possibility that the Meneage Formation rocks may have a similar origin. The geochronological data from the Meneage Formation shows striking similarities not only to autochthonous Armorica (Armorican Quartzite Formation), but also to the Meguma terrane of the Appalachian Orogen, which is exposed in Nova Scotia. Armorica and Meguma, however, have both formed part of West Africa and so their detrital zircon signatures are very similar. Distinction between the two terranes must therefore be made on other criteria.

Isotopic Sm-Nd data indicate that felsic magmas produced by crustal melting in the Meguma terrane are isotopically more juvenile than the rocks they intrude. Braid et al. have recently identified this relationship in the SPZ and available data proposes this distinction may be true for the Cornubian Batholith in southwest England. These isotopic analyses combined with detrital zircon suites of this study give strong implications that southwest England may indeed be floored by the Meguma terrane.

Seismic Stratigraphy and Attribute Analysis of the Mesozoic and Cenozoic of the Penobscot Area, Offshore Nova Scotia

Campbell, T.[1] and Wach, G.[1]

[1] *Basin and Reservoir Lab, Department of Earth Sciences, Dalhousie University, Halifax*

The Penobscot Area is on the Scotian Shelf, northwest of Sable Island within the Scotian Basin, offshore Nova Scotia. The Penobscot dataset comprises 3D seismic survey, covering 87 km^2, two well logs and cored intervals from both wells. Approximately 180 exploratory wells have been drilled in the Scotian Basin since 1980. Penobscot L-30 and Penobscot B-41 are two of these wells. The wells had hydrocarbon shows but did not test enough hydrocarbons to be economic. Geologic software (e.g Petrel) was used to interpret the seismic facies, structure, seismic sequence stratigraphy, and seismic attribute analysis, to interpret the petroleum system. The focus of the study is on seismic inversion that solves for acoustic and elastic properties from the 3D seismic data. Inverting the seismic data to a layer property provides a clearer understanding of the subsurface geology and the potential hydrocarbon reservoirs within the survey. Seismic inversion was also used to correlate the well logs across the seismic survey to define the reservoirs of interest. The cored intervals from both wells were studied, examining the characteristics of different lithofacies and their corresponding depositional environments. The lithofacies from the core were tied to the well logs to develop petrophysical facies, and then were tied to the seismic data to define the seismic facies. These new detailed analyses of the stratigraphy, seismic facies and attributes suggest missed opportunities.

A Hydrogeological Investigation at the Crane Mountain Landfill, Saint John, New Brunswick

M.P. Jacobs1, T.A. Al1, and K.T. MacQuarrie2
1. Department of Earth Sciences, University of New Brunswick, Fredericton, New Brunswick 2. Department of Civil Engineering, University of New Brunswick, Fredericton, New Brunswick

The Crane Mountain Landfill is located in southern New Brunswick and is operated by the Fundy Region Solid Waste Commission (FRSWC). Although there are 61 monitoring wells located on and around the site, they have mostly been used for water-quality sampling, and the groundwater flow system is not well understood. This study, sponsored by the Fundy Regional Solid Waste Commission, was designed to develop a better understanding of the hydrogeology of the site.

The landfill is an engineered system designed with clay and geomembrane barriers, and a leachate collection system. It is underlain by glacial till that may be up to 20 m thick, and the till overlies fractured tonalite with minor argillite bedrock. Outcrop is sparse, but from observations at ten locations the bedrock is moderately to highly fractured.

Continuous monitoring of hydraulic head at 24 well locations over a period of ten months indicates a variety of hydraulic responses to precipitation and snowmelt. They include: 1) rapid response indicating a shallow, unconfined aquifer condition; 2) no response indicating the monitoring well is isolated in unfractured bedrock; and 3) a time lag indicative of a confined aquifer condition. Pump tests were conducted at three water supply wells, while continuously recording head in surrounding monitoring wells, to investigate the connectivity of the fracture network and its influence on groundwater flow. The data collected from these tests will be used to construct a site conceptual model to visualize the influence of geologic features such as lithology, fracture network and distribution of glacial till on groundwater flow beneath and adjacent to the landfill.

Substrate (CO and CO_2) Utilization in Chemolithotrophic Microorganisms at a Site of Serpentinization: Tablelands Ophiolite, Newfoundland

Sarah Miles, Penny L. Morrill and Lukas Khol
Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador

Studying ultra-basic reducing springs discharging from serpentinites can inform us about how life can survive in these extreme (i.e. high pH, anoxic) environments. We need to better understand metabolic pathways in these locations where ultra-basic springs discharge at the surface because they give us a window into what is going on in the subsurface. By studying these springs, then we can extrapolate this data to biogeochemical reactions occurring underground. Biotic processes may take up carbon through CO or CO_2 from the system and use it for their metabolic processes. The Tablelands, located in Gros Morne National Park in western Newfoundland, Canada, is a prime example of an active site of ultra-basic serpentinization springs in North America.

To determine the potential for autotrophic metabolisms at the Tablelands site of serpentinization, water and sediments that were sampled from an ultra-basic spring at the site were incubated in sealed 100ml wheaton bottles, known as microcosms. Bicarbonate (HCO^{-3}) was adding to microcosm experiments that tested for a carbonate reduction metabolism, and $CO_{(g)}$ was added to microcosm experiments that tested for CO supported metabolisms.

The results of the CO enriched microcosms showed that CO was constantly utilized in the Live experiments but not the Killed. In the Live microcosms with $CO_{(g)}$ additions the CO became more enriched in ^{13}C, and had a decrease in the fraction of CO remaining in the headspace. Conversely, in the Killed microcosms with $CO_{(g)}$ additions minimal ^{13}C enrichment was observed in the residual CO. Rayleigh isotopic distillation fractionation factors calculated using the data from the Live CO experiments showed consistent fractionation in duplicate microcosms. This suggests that there was consistent microbial CO utilization in these experiments. ^{13}C labelled CO microcosm experiments corroborated the data from the non-labelled CO experiments.

The bicarbonate experiments showed very little to no methane production. Therefore, under the environmental conditions of this experiment, bicarbonate was not used as a substrate for microbial methanogenesis in these experiments. Therefore the results of this experiment suggest that the autotrophic metabolism in the ultra-basic spring may be fueled by CO and not dissolved CO_2.

Provenance of Pre- and Post-Contact Copper Artifacts Used by Aboriginal People in Atlantic Canada: Implications For Understanding Historical Metal Trades and Usage

Jessica Whattam
Department of Geology, Saint Mary's University

Native copper had in many cultural applications by both pre- and post-contact Mi'Kmaq peoples throughout the Maritimes, including the fabrication of tools, jewellery, gifts, and ceremonial wares. The central role of native copper in the Mi'Kmaq culture is better understood than the provenance of this metal, which this research seeks to address. Archaeological excavations within Nova Scotia have uncovered a large collection of native copper artifacts ranging from the Early Woodland Period (2500-2400BP) to the Protohistoric Period (450-350 BP) to Post-European Contact (1500+BP). Specifically, this innovative study will build upon past archaeology research by applying laser ablation inductively-coupled plasma mass spectrometry (LA-ICPMS) to characterize trace elemental compositional signatures that can identify different native copper compositions derived from natural occurrences of the metal and synthetic (refined) sources. The methodology used in this study, and the interpretation of results, improves on previous bulk analytical methods that suffer inherently from the presence of contaminating grains of other accessory minerals within the native copper, and most importantly, is a comparatively non-destructive technique.

Evaluation of LA-ICPMS data (i.e., trace element compositions) collected from 15 artifacts reveals four distinct native copper compositions. Each group is characterized by specific elemental enrichment/depletions, and for single artifacts, little compositional variation was observed (i.e., samples are homogeneous). Group 1 is distinguished by significant enrichment in Zn, Sn, Pb, and Au and is consistent with the composition of refined Cu originating from Europe. Group 2 (enrichment in Hg and depletion in Au), Group 3 (Mo-enrichment), and Group 4 (enrichment in Ag and Cd, and depletion in Hg) are suspected to be objects derived from native copper sources. Native copper from many known sources of the metal along the Bay of Fundy, Nova Scotia and New Brunswick, as well as other documented localities outside of the Maritimes will be analyzed in order to assign provenance to the three groups of suspect non-European-source artifacts. Variable trace element compositions within the collection of artifacts provides evidence that supports a multiple-provenance theory for the origin of native copper within the collection. The application of these results may have a great significance in our understanding Maritime cultural history.

Examination of surface features on kimberlitic Iron-Titanium oxide minerals

Rachel Milligan, Yana Fedortchouk, Richard Cox
Dalhousie University

Oxide minerals, including chromite and ilmenite, are found in abundance in kimberlite deposits, brought to the surface during the eruption of a kimberlitic magma from the upper mantle. Previous studies have shown that the dissolution of these oxide minerals reflects the magma chemistry and the fluids present, which also cause the dissolution of diamonds. The goal of this study is to establish a connection between surface features and reaction products occurring on kimberlite oxide minerals and the dissolution found on diamonds from the same kimberlite pipe. This study will also address the specific chemical and fluid interactions that result in the features seen on the examined grains.

Chromite and ilmenite grains from two kimberlites were examined for distinct dissolution features and imaged using a Scanning Electron Microscope. The chromite grains from both kimberlites displayed consistent regular polygonal, stepping, and triangular pitted features on the grain surface. The ilmenite grain surfaces were predominantly covered by reaction products, primarily perovskite and titanite, and in some cases by kimberlitic groundmass. Several grains were cleaned in hydrochloric acid in an attempt to reveal ilmenite grain surface beneath the carbonaceous groundmass. This yielded some unique surface features unlike those seen on the chromite grains, mainly, circular pitting. Following imaging, the chemistry and zonation of selected grains was analysed through wavelength dispersive spectroscopy and elemental x-ray mapping methods. Several ilmenite grains were found to show complex zonation, as well as the abundance of reaction products on the surface. The chromite grains, however, only display a very thin ring of zonation, as well as some minor pitting around the very edge of the grains. The eventual aim is for the possible prediction of preserved quality diamonds in a kimberlite through examination of the more abundant oxide minerals.

Petrological comparison of sills and dykes in metasedimentary rocks of the Meguma terrane, Nova Scotia, and the Harlech Dome, Wales

LISA MUNDRY
Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia

The Meguma terrane of southern Nova Scotia and the Harlech Dome of North Wales have similar Cambrian metasedimentary successions consisting of thick basal units of quartzose turbidite deposits, grading upward into early to middle Cambrian mud-rich and sand-rich units, containing manganese-rich layers, and overlain by turbidites deposited in anoxic environments and Tremadocian mudstone. Coarse clastic units low down in both successions contain similar detrital zircon age populations, and both areas are considered to have originated as peri-Gondwanan terranes. Their similarities have led to the suggestion that both areas were part of one palaeogeographical domain, for which the name Megumia has been proposed.

In addition to their stratigraphic similarities, both areas are characterized by abundant intrusive igneous rocks. The Harlech Dome hosts a large number of sills dykes, and plutons of mafic to intermediate composition, generally assumed to be related to the Ordovician Rhobell and Aran volcanic groups. The northwestern part of the Meguma terrane, northwest of the Chebogue Point Shear Zone, is also characterized by abundant intrusions, mainly mafic sills, some of which show syn-sedimentary relationships with their Cambrian host rocks and some of which are Silurian-Devonian. A comparison of petrographic and chemical characteristics of the intrusions has been undertaken to shed additional light on the possibility of a paleogeographic relationship between the Harlech Dome and the Meguma terrane, using a compilation of petrological data from previous studies as well as analyses of new samples collected in both areas for the present study. Samples from the Harlech Dome range from mafic to felsic whereas those from the Meguma terrane are mafic. Preliminary results show that the Harlech Dome samples are calc-alkalic and likely formed in a magmatic arc setting at a convergent plate margin. In contrast, the mafic sills in the Meguma terrane are tholeiitic transitional to alkalic and formed in a within-plate tectonic setting.

Sedimentology and Paleoenvironment of a Jurassic Dinosaur Bone Bed, Parrsboro, Nova Scotia

Leigh van Drecht
Department of Earth Sciences, Dalhousie University, Halifax, NS.

The Early Jurassic McCoy Brook formation at Wasson Bluff has been a site of dinosaur bone discoveries for over thirty years. The formation crops out on the north side of the Minas subbasin, deposited during the break up of Pangea and prior to the opening of the Atlantic Ocean. The first discovery of dinosaur bone was in 1976 with numerous excavations in 1998-2006 which yielded several articulated prosauropods within a confined bone bed. The prosauropod bone bed is of particular interest to the scientific community because it represents the richest prosauropod site in North America and the oldest dinosaur bones discovered in Canada. Recent field work took place in August 2013, lead by Dr. Tim Fedak, where 15 disarticulated bones and bone fragments were collected in an eastern extension of the bone bed. The dinosaur material has been well documented by multiple researchers and the detailed sedimentology of this particular bone-bearing bed is now of interest. Assessing the stratigraphy at Wasson bluff is complicated by syn-depositional faulting that occurred as the Fundy rift basin matured. Faults are present on a meter scale as well as a centimeter scale, as displayed by offsets of some bone.

During this study a comprehensive account was prepared of the bone bed strata and the strata immediately above, which has been described at a centimeter scale. Important features of the strata include interbedding of thin mudstones containing abundant micas with coarse to medium-grained sandstone; isolated boulders presumably eroded from a paleocliff and trough cross beds. Poorly sorted sands are also present, with some outsize, well rounded grains. These sediment characteristics can lead to the conclusion that the dinosaurs were preserved in a river channel with episodic flow and eolian additions to the river sediment. This detailed account, as well as grain size analysis, thin sections and paleoflow will be used to interpret the paleoenvironment in which the dinosaurs were buried.

The Early Devonian, Evandale Porphyry Cu-Mo-(Au) deposit, Southern New Brunswick: Petrologic, Geochemical, Geothermobarometric, and Geochronologic Characterization of the Host Rocks and its Origin

Travis White and David Lentz
Department of Earth Sciences, University of New Brunswick, Fredericton

Relatively little research has been dedicated to porphyry Cu-Mo-(Au) systems associated with the granitoid rocks in Eastern North American orogenic belts. The circular Middle Devonian, hornblende-biotite Evandale Granodiorite (U-Pb zircon, 391.2 ±3.2 Ma for the granite, and 390.2±1.6 Ma for the aplite) intrusion is a locally Cu-Mo-Au mineralized polyphase pluton intruding through deformed Silurian sedimentary and mafic volcanic rocks of the Mascarene Basin in southern New Brunswick. The two intrusive phases have been identified as magnesian, calc-alkalic to alkali-calcic, peraluminous I-type granite generated by decompressional melting of the lower crust caused by post collisional uplift. The Evandale Granodiorite consists of two textural, petrochemically related but distinct phases ranging from medium- to coarse-grained seriate to porphyritic and aplitic texture. INAA analyses of the aplitic and coarser granite phases found the highest concentration of Cu and Au (108 ppm Cu, and 33 ppb Au) and associated with pyrite, chalcopyrite, and arsenopyrite within the aplitic dykes sampled. Concentrations of up to 6 ppm Mo were detected within the c.g. granite, whereas only trace amounts of Mo were recognized within the aplite. Current models suggest that the transport of metals (particularly Cu and Au) are sourced from secondary two-phase fluids at shallow depths (approximately 1-2 kb), and is greatly affected by Cl fugacity of the magma. Analyses of biotite phenocrysts from both the aplite and granite contains an average of 0.21 wt% Cl, which is similar to other high grade Cu-Mo-(Au) porphyry deposits. The hornblende-plagioclase thermometry revealed the crystallization temperature of the granite to be 642°C and 600°C for the aplite (cooler than most deposits of the same type). Al in hornblende geobarometery indicates crystallization depths of approximately 2.1 kb for hornblende in the aplite and ~0.7 kb for the c.g. granite. The higher crystallization pressure of hornblende in the aplite phase indicates that it intruded to higher levels rapidly and pressure quenched (aplite to porphyritic texture) within the host granodiorite, which is consistent with volatile exsolution controlling emplacement and formation of porphyry Cu-Mo-(Au) mineralization at a shallower depth.

Permeability and Porosity of Collapsed Cone Structures Associated with *Ophiomorpha* Trace Fossils in Offshore Newfoundland Cores

Daniel Niquet
Memorial University of Newfoundland

Collapsed cones commonly associated with *Ophiomorpha* trace fossils are poorly documented structures and their effects on reservoir quality are seemingly underappreciated. As such, the focus of this honours dissertation is to investigate the characteristics of collapsed cone structures and the role they play in localized reservoir systems. To do so, four samples of varying morphology were selected from two cores originating in the Hibernia Formation of the Jeanne D'Arc Basin. Permeability data was collected with a gas probe permeameter and porosity was calculated from blue-dye epoxied thin-sections. Half-core faces were turned into semi-translucent thin-slabs to enhance sedimentological and structural features. Since the scale of the collapse structure is relatively modest in comparison to grain size, packing efficiency overrides grain sorting as the dominant characterisation factor. Preliminary results seem to indicate a thin zone of heightened communication between the surrounding sediment and the significantly decreased permeability and porosity zone of the collapsed cone structure. This research indicates that collapsed cone structures associated with trace fossils, such as *Ophiomorpha*, have the potential to dramatically alter reservoir estimations and should be incorporated into reservoir characterisation studies.

Correlating PGE enrichment to alteration assemblages at the Afton-Ajax Cu-Au-Pd porphyry System, Kamloops British Columbia

Mark Garagan
Department of Geology, Saint Mary's University

The Afton-Ajax porphyry system is located just outside of Kamloops in the Southern Cordillera of British Columbia. It is classified as an alkalinic copper-gold porphyry deposit, and has been noted to contain up to 3 ppm of palladium in multiple ore zones. The platinum group elements (PGE) in the deposit are found within (i) platinum group minerals (PGM), specifically Hg-Te-As-Sb-Pd phases, often associated with chalcopyrite, pyrite, bornite, electrum and hematite; and in (ii) pyrite (as dissolved constituent with Co and Ni). However, Cu and Au grades rarely correlate with PGE abundances, and therefore, the timing/conditions of Cu and Au precipitation is not the same as for the PGE. The exact mode of occurrence and alteration assemblage associated with the PGE enriched zones are unknown.

Variations in alteration assemblages may be useful to differentiate between PGE rich and PGE poor zones. Thus, petrographic analysis and infrared spectroscopy will be used to determine the alteration assemblages within the a suite of 44 samples. An attempt to correlate these specific alteration assemblages with enrichment in PGE will be made.

The styles of alteration at the Afton mine described in drill core logging are as follows: iron oxide, silicification, argillic, dolomite+sericite+quartz (D-S-Q), propylitic, potassic, phyllic, and k-feldspar+actinolite+chlorite (K-A-C). Within the suite of samples examined by transmitted light microscope, only silicification, argillic, potassic, phyllic, propylitic alteration, and iron oxide were found. Silicification occurs as a pervasive front in high sulfidation and vein rich samples, usually associated with strong phyllic or argillic alteration. Argillic alteration is only noted in a few samples in the form of a matrix of indistinguishable clay minerals. Argillic alteration is found primarily in samples with a Au:Pd ratios equal to or greater than two. There are two forms of potassic alteration found in these thin sections, first represented by large biotite hornfels ocassionally replaced by chlorite. Second, potassic alteration is found in the form of fine grained biotite, localized around veins and blebs of sulfide, uncommonly forming a net texture around the remaining igneous fabric. Phyllic alteration is strictly pervasive and characterized by sericite, muscovite and clays. Propylitic is always locally pervasive around quartz/carbonate veins and blebs or infilling fractures, and is identified by the presence of chlorite, actinolite and/or epidote. The iron oxide zone is a result of supergene oxidation, and represents the upper portions of the system. Gold and copper grades do not tend to deviate much from the supergene zone to the hypogene zones.

As these alteration minerals are very fine grained and tend to be difficult to identify in thin section. The Terraspec4 Hi-res mineral spectrometer (ASD Inc) will be used to conduct infrared spectroscopy with the aim of identifying the alteration minerals, specifically the clays and other phyllosilicates. The data collected from infrared spectroscopy will also be used to determine concentrational variations in clay minerals that may correlate with an increased abundance in PGE/PGM. This process, if applied in a field or lab setting, has the potential to assist in determining in which stages of alteration PGE were deposited. Alteration-PGE criteria may assist in creating exploration guidelines for the occurrence of PGE in other similar porphyry deposits within the Canadian Cordillera.

The possible role of the petroleum system in ore genesis in Nova Scotia: spatial coincidence or active involvement?

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Most economic metallic deposits (e.g. Pb, Zn, Cu, U, Au, W, Ba (barite), Sn) in Nova Scotia have some association with organic carbon in the form of coaly matter, liquid petroleum or solid bitumen, black shale, or carbonate of organic origin. It has been proposed that organic matter can be used as a guide to ore; some authors suggest that the association is more than just a spatial coincidence, that organic matter may have played a primary or secondary role in metallogenesis as a scavenger of metals, a participant in metal transport, an agent in precipitation as a chemical reductant, a substrate for the development of diagenetic sulphides, or a physical role in the preservation of porosity and as an agent during rock deformation. It is locally important environmentally in the preservation of sulphides from oxidation/destruction.

This review will highlight and summarize the current knowledge regarding this spatial association and provide a brief introduction to an honours project. The thesis will explore the relationship between organic carbon and gold in the Meguma Terrane of Nova Scotia, to determine if the carbon and the deposits are linked in more than just a cursory way. For instance, it is known that anticlines and domes host the richest Au deposits in Nova Scotian gold districts, and these structures may have represented ideal hydrocarbon reservoirs during the onset of the Devonian Acadian Orogeny. Was organic matter, or intimately associated diagenetic sulphides in black-shale, play a role as a source, or an agent in transporting or concentrating Au?

Gold in the Cantung W-skarn deposit, Northwest Territories: Distribution, mineralogy, and petrogenesis

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Cantung is a world-class W-Cu-(Au-Bi) skarn deposit located in the Northwest Territories close to the Yukon border. It is within the polymetallic W-Au Tintina Belt of the northern Canadian Cordillera and is currently operated by North American Tungsten Corporation Ltd. Despite multiple mine closures since its opening in 1962, Cantung had an estimated 6.21 Mt with an average recovered grade of 1.56% WO_3 extracted as of the end of 2009. The most recent estimate of the indicated mineral resources is 2.06 Mt grading 1.04% WO_3 with probable mineral reserves of 1.34 Mt grading 1.05% WO_3 as of October 2011. The deposit is located in both an underground mine, termed the "E Zone", and an Open Pit resource near the surface. Extensive magmatic systems formed the W skarns that were later altered by magmatic-hydrothermal events. Previous research indicates that the hydrothermal fluid was predominately of supercritical, hot magmatic brines with homogenization temperatures that ranged from 270 to 500°C. Mineralization at the Cantung mine comprises calc-silicate skarn replacements within the Ore Limestone, a clean limestone receptive to skarn development, and lower grade replacements in the Swiss Cheese Limestone, a calc-silicate/chert unit. Pyrrhotite is abundant in all skarn facies and is positively correlated to the W mineralization. Scheelite and chalcopyrite are dominant, although locally abundant sphalerite and anomalous Bi and Au concentrations were also significant. The purpose of this study is to characterize the distribution, mineralogy, and petrogenesis of Au found within this deposit. From the E Zone, five samples with bulk rock Au assay values greater than 0.5 ppm were examined petrographically. Using the bulk assay data (n = 48), Au correlates positively (Spearman's Rank, r') with Bi (0.76), Ag (0.70), Fe (64), Cu (0.64), and Mo (0.60). No free Au (electrum) has been identified optically or by SEM and FEG-SEM in analyses thus far. The hypothesis is that the Au is present as nano-inclusions within chalcopyrite or is lattice bound within Bi-minerals or related tellurides and selenides that occur in the interstices of calc-silicate minerals that have been identified. The liquid bismuth collector model is tested using LA-ICP-MS analysis to determine the extent of lattice bound Au. This model involves Au scavenging from magmatic hydrothermal fluid by complex liquid Bi-sulphide phases saturating during W-Cu mineralization.

Reservoir Characterization and Forest Density of the Joggins Formation, Joggins, Nova Scotia

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The Carboniferous Joggins Formation crops out along the shoreline of Chignecto Bay, Nova Scotia, within the Cumberland Basin. The Joggins Fossil Cliffs present a 2D and 3D exposure of the meanderbelt channel deposits and fossils of the Joggins Formation. These outcrops demonstrate the stratigraphy of the formation and the preserved flora in the Carboniferous. This study uses LiDAR as a survey technique with a spatially calibrated Diferential GPS (DGPS) to image the meanderbelt channel architecture and the fossils of the *Lycoipsids, Calamites, Lepidodendron, Alethopteris* and *Sigillaria* in the Joggins Formation. This high resolution imaging provides a 3D image of the cliff with details of the channels and the fossil tree trunks. The data collected can be used to identify the fossil tree density and architecture of the channels within the formation. Post-processing methods involve in a reconstruction of series of LiDAR images of the area that have been taken in past years. This reconstruction provides a time series of the cliff profile. These high resolution images will provide a record of the fauna and the architecture of the meander channels in the Carboniferous.

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