ATLANTIC GEOSCIENCE SOCIETY

37th COLLOQUIUM & ANNUAL GENERAL MEETING

February 11-12, 2011, The Fredericton Inn, Fredericton, New Brunswick

PROGRAM

Meetings, technical sessions, luncheon, and banquet are all at the **The Fredericton Inn,** Fredericton, New Brunswick (Phone 1-800-561-8777 or **http://www.frederictoninn.nb.ca** for reservations)**.** For Colloquium registration information contact Kay Thorne @ (506) 453-2206; email: **Kay.Thorne@gnb.ca** or check the AGS website **http://ags.earthsciences.dal.ca/ags.php.**

Friday, February 11, 2011

8:30-5:00pm	Workshop: Applications of Laser Ablation to Problems in Mineral Exploration and Ore Petrogenesis. (Quartermain Centre, Room 104, UNB Geology)
1:00-4:30pm	Tour: Potash Corporation of Saskatchewan mine and mill, Sussex, NB. (***Participants are responsible for their own transportation to and from Sussex***)
3:00-4:30pm	Tour: UNB's EM facilities (UNB Geology)
3:00-4:30pm	Tour: Research and Productivity Council of New Brunswick Mineral Process Development and Testing (921 College Hill Road, Fredericton)
3:30-10:00pm	Registration (**Foyer**)
4:00-5:30pm	Poster set-up (**Salon A**). Friday evening talk set-up (All Friday presenters should load their PowerPoint presentations at this time)
4:15-5:00pm	Atlantic Geology Editors Meeting (**Salon B**)
5:00-7.00 pm	AGS Council Meeting (**Salon B**)
5:30-7:00pm	Poster Session I (**Salon A**). Cash bar. *Sandwiches sponsored by Geodex Minerals*.
7:00-8:20pm	**Special Session:** *New Developments in the Appalachian Orogen: a Symposium in Honour of Hank Williams I* - **Royal Stewart Room**
7:00-8:20pm	**Special Session:** *Groundwater Vulnerability in Atlantic Canada: Climate Change, Sea Water Intrusion, Agriculture, and Other Stressors I* - **Bicentennial Room**
8:20-8:35pm	Refreshment and snack break - *Sponsored by SWN Resources Canada*
8:35-10:05pm	**Special Session:** *New Developments in the Appalachian Orogen: a Symposium in Honour of Hank Williams II* - **Royal Stewart Room**

8:35-10:05pm **Special Session:** *Groundwater Vulnerability in Atlantic Canada: Climate Change, Sea Water Intrusion, Agriculture, and Other Stressors II* - **Bicentennial Room**

10:05-Midnight Poster Session II (until 11:00pm), Social, and cash bar (**Salon A**). *Student beer ticket sponsored by Potash Corp.*

NOTE: Saturday am talk set-up (All Saturday am presenters should load their PowerPoint presentations between 10pm and 11pm)

Saturday, February 12, 2011

8:15-2:00pm Registration (**Foyer**)

8:15-9:55am **Special Session:** *New Developments in the Appalachian Orogen: a Symposium in Honour of Hank Williams III* - **Royal Stewart Room**

8:15-9:55am **Special Session:** *Surficial Materials and the Environment* - **Bicentennial Room**

8:15-9:55am **General Session:** *New Developments in Atlantic Geoscience I* - **Salon B**

9:55-10:20am Poster Session III (**Salon A**). *Coffee and snacks - sponsored by APEGNB*

NOTE: All Saturday pm presenters should load their PowerPoint presentations at this time

Saturday, February 12, 2011 con't

10:20–noon **Special Session:** *Ordovician Metallogeny in the Appalachian Orogen* - **Royal Stewart Room**

10:20–noon **Special Session:** *Carboniferous Basins: Toward a Better Understanding of their Resource Potential I* - **Bicentennial Room**

10:20–noon **General Session:** *New Developments in Atlantic Geoscience II*- **Salon B**

Noon-2:00pm LUNCHEON AND ANNUAL GENERAL MEETING (**Salon F**)

2:00-3:20pm **Special Session:** *Siluro-Devonian Metallogeny in the Appalachian Orogen I* - **Royal Stewart Room**

2:00-3:20pm **Special Session:** *Carboniferous Basins: Toward a Better Understanding of their Resource Potential II* - **Bicentennial Room**

2:00-3:20pm **General Session:** *New Developments in Atlantic Geoscience III* - **Salon B**

3:20-3:35pm *Coffee – sponsored by Corridor Resources; Snacks - sponsored by Apache Canada*

3:35-4:35pm **Special Session:** *Siluro-Devonian Metallogeny in the Appalachian Orogen II* - **Royal Stewart Room**

3:35-4:35pm **General Session:** *New Developments in Atlantic Geoscience IV* - **Bicentennial Room**

3:35-4:35pm **General Session:** *New Developments in Atlantic Geoscience V* - **Salon B**

4:45-5:45pm APICS Earth Science Committee - **Salon A**

5:00-7:00pm Inaugural Earth-ring Ceremony (APEGNB) - **Prince Edward Room**

6:30-12:00pm Cash Bar - **Royal Stewart-Bicentennial Rooms**

7:00-Midnight Awards Banquet & Social - **Royal Stewart-Bicentennial Rooms**

Guest Speaker: Jim Franklin - **Future Mineral Resources Discoveries: New Knowledge Needed for Discovery**.

Student-presenter subsidy: Potash Corp., SWN Resources Canada, APEGNB, Geodex Minerals, GSC-Atlantic, Apache Canada, and Corridor Resources

9:00-1:00am **AGS Ceilidh and Jam-Session** showcasing AGS members' instrumental and voice talents. The musically-inclined are invited to bring their instruments and entertain the rest of the audience. All instruments and styles welcome.

NOTES

1) Posters will be displayed on 6'x 6' velcro friendly boards, Velcro provided. Posters will be assigned to a designated board. Please set up posters as soon as possible after arrival, preferably before 5:00pm on Friday to be ready for the first poster session at 5:30pm and so that the judges of student posters may get started before the evening sessions begin. The Graham Williams student poster award will be presented at the Banquet. Posters must be taken down by 3:35pm on Saturday. Presenters should be at their posters during the dedicated poster session times.

2) Speakers will have 20 minutes including time for loading the presentation and for questions. The sessions will be kept on schedule by the Chairs, to allow for judging of the high number of student presentations. The Rupert MacNeill (undergraduate) and Sandra Barr (graduate) student awards will be presented at the Banquet.

3) Speakers will have one LCD projector with a dedicated laptop, and a laser pointer available. Deliver your CD or memory stick to the technical assistant well in advance of your scheduled talk (see times in program); if possible have it loaded on the session computers on Friday February 11th, before 7pm.

4) The Fredericton Inn requires notice for the number of meal attendees. Accordingly, buy your Luncheon and Banquet tickets before February 10th. Special accommodation rates at the Fredericton Inn ends, Friday, February 4th.

5) There is no speaker-ready room. Presenters should bring a laptop if they wish to practice their talks.

2011 AGS COLLOQUIUM WORKSHOP

"Laser Ablation ICP-MS: Theory and Practice Applied to Mineral Exploration and Ore Petrogenesis"

Friday, February 11th, 9-5pm, Room 104, University of New Brunswick Geology

This one-day workshop will present the theory and application of laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) to the earth sciences. The workshop is organized by Dr. Chris McFarlane (UNB). The focus will be on applications of laser ablation to problems in mineral exploration and ore petrogenesis.

8:00	**Arrival, name tags, coffee, distribution of workshop materials**
8:30-8:45	**Introductions and opening remarks** (McFarlane)
8:45-9:15	**Laser ablation fundamentals** (Jacob Hanley, with live demos via VNC connection) a) Excimer laser pulse generation (e.g., pre-mix, thyratron, excited dimers) b) Beam delivery and imaging systems and laser optics c) Ablation cells, carrier gases, cell 'washout' d) Sample preparation strategies
9:15-9:45	**ICP-MS fundamentals** (Paul Sylvester, with live demos via VNC connection and visualizations) e) ICP-MS torch, plasma, and interface region f) ICP-MS ion lenses and reaction/collision cells g) ICP-MS quadrupole filter vs. magnetic sector h) ICP-MS detectors, pulse vs. analog counting, dynamic range
9:45-10:30	*Coffee break and lab tours (in groups)* This will involve rotation of 3-4 groups rotating between: 1) the PASSC FEG-SEM to look at ablation craters; 2) AxioImager Polarizing microscope to look at light imaging techniques; and 3) visit to the lab to walk through the instrumentation
10:30-11:00	**Laser-target interactions, ablation modes, and workflow** (Chris McFarlane, with live demos) a) Ablation modes, plasma plumes, and ablation products (particle size) b) Ablation thresholds and ablation yields in glasses, silicates, sulphides c) Monitoring and minimizing Laser-Induced Elemental Fractionation (LIEF)
11:00-11:30	**Standardization, data reduction, QA/QC** (Chris McFarlane and Paul Bedard) d) Matrix-matched standards; GEOREM, NIST, USGS, GSC, CGS, sulphides, oxides e) Calibration procedures and internal standards f) Offline data reduction software, Quality Assurance and Quality Control
11:30-12:00	Q&A session
12:00-12:40	Lunch (provided) and lab open house
12:40-13:40	PAUL SYLVESTER, (Memorial University) - **U-Pb geochronology by laser ablation (MC)-ICP-MS (Q vs. SF?)**
13:40-14:40	PAUL BEDARD (University of Quebec at Chicoutimi) - **Trace element analyses of oxides and sulphides**
14:40-15:00	Afternoon coffee break group (arrange cabs and rides for folks heading up to the start of AGS Friday evening sessions)

15:00-16:00 JACOB HANLEY (Saint Mary's University) - **Analysis and interpretation of fluid and melt inclusions by LA-ICP-MS**

16:00-17:00 CHRIS MCFARLANE (University of New Brunswick) - **Elemental mapping and TRA data reduction using Iolite software**

17:00-on Lab open house and commencement AGS sessions at Fredericton Inn.

ATLANTIC GEOSCIENCE SOCIETY ANNUAL COLLOQUIUM PROGRAM

CONCURRENT TECHNICAL SESSIONS - FRIDAY EVENING

* **Undergraduate Student Presentation** ** **Graduate Student Presentation**

AGS POSTER SESSION – Salon A Friday 5:30pm–7:00pm and 10:00pm-11:00pm

Special Session: *New Developments in the Appalachian Orogen: a Symposium in Honour of Hank Williams I* - Royal Stewart

Chairs: Brendan Murphy and Sandra Barr

7:00 – J. BRENDAN MURPHY, BRIAN L. COUSENS, JAMES A. BRAID, ROB A. STRACHAN, JAROSLAV DOSTAL, J. DUNCAN KEPPIE, and R. DAMIAN NANCE - **Highly depleted oceanic lithosphere in the Rheic Ocean: implications for Paleozoic plate reconstructions**

7:20 – ALANA M. HINCHEY and IAN KNIGHT - T**he southern Long Range Inlier, Newfoundland: evidence for early Appalachian thrusting of Paleozoic metasedimentary rocks within a Proterozoic basement massif**

7:40 – D.N. REUSCH and C.R. VAN STAAL - **The Dog Bay-Liberty Line and its significance for Silurian tectonics of the northern Appalachian orogen**

8:00 – LESLIE R. FYFFE, SUSAN C. JOHNSON, and CEES R. VAN STAAL - **Proterozoic to Early Paleozoic lithotectonic terranes in New Brunswick, Canada**

Special Session: *Groundwater Vulnerability in Atlantic Canada: Climate Change, Sea Water Intrusion, Agriculture, and Other Stressors I* - Bicentennial Room

Chairs: Karl Butler, Grant Ferguson, and George Somers

7:00 **–** *DAVID TERRY, IAN SPOONER, and CHRIS E. WHITE - **Assessing the vulnerability of shallow lakes to water level fluctuations: an example from southwestern Nova Scotia**

7:20 – **CALVIN BEEBE, GRANT FERGUSON, and GAVIN KENNEDY - **Hydrologic and geochemical investigation of saltwater intrusion at two sites in Nova Scotia**

7:40 – **B. HANSEN, G. FERGUSON, Y. JIANG, and D. JARDINE - **Identifying and mapping the saltwater transition zone in Summerside, Prince Edward Island**

8:00 – **N.R. GREEN, E.B. MOTT, K.T.B. MACQUARRIE, and K.E. BUTLER - **Preliminary hydrogeological data and numerical modeling for a seawater intrusion study at Richibucto, New Brunswick**

8:20 – *Refreshment and snack break - Sponsored by SWN Resources Canada*

Special Session: *New Developments in the Appalachian Orogen: a Symposium in Honour of Hank Williams II* - Royal Stewart

Chairs: Brendan Murphy and Sandra Barr

8:35 – REGINALD A. WILSON and SANDRA L. KAMO - **The Salinic Orogeny in northern New Brunswick: geochronological constraints and implications for Silurian stratigraphic nomenclature**

8:55 – **J.-L. PILOTE, S.M. BARR, and R.A. WILSON - **Petrology, petrogenesis, economic potential, and tectonic implications of the Landry Brook, Dickie Brook, and Charlo plutons, northern New Brunswick**

9:15 – C.E. WHITE, T. PALACIOS, S. JENSEN, and S.M. BARR - **The Meguma terrane of southern Nova Scotia: insights on its pre-Carboniferous stratigraphy**

9:35 – **KEYNOTE SPEAKER**: JAMES HIBBARD - **An orogen-wide perspective on the Appalachians**

CONCURRENT TECHNICAL SESSIONS - FRIDAY EVENING

Special Session: *Groundwater Vulnerability in Atlantic Canada: Climate Change, Sea Water Intrusion, Agriculture, and Other Stressors II* - Bicentennial Room

Chairs: Karl Butler, Grant Ferguson, and George Somers

8:35 – **E.B. MOTT, N. GREEN, K.E. BUTLER, and K.T. MACQUARRIE - **Preliminary interpretation of electrical resistivity tomography (ERT) surveys investigating seawater intrusion at Richibucto, eastern New Brunswick**

8:55 – GIL VIOLETTE - **Sustaining consistent well production despite a changing near-well environment**

9:15 – **R. PANNU, N.O' DRISCOLL, S. SICILIANO, J. DALZIEL, and A. RENCZ - **A laboratory method for the quantification of mercury and GHG volatilization from soils**

10:00pm-Midnight Poster Session and Cash Bar – **Salon A** *Student beer ticket sponsored by Potash Corp.*

CONCURRENT TECHNICAL SESSIONS SATURDAY MORNING

AGS POSTER SESSION – Salon A Saturday 9:55–10:20am and 3:20-3:35pm

Special Session: *New Developments in the Appalachian Orogen: a Symposium in Honour of Hank Williams III*- Royal Stewart

Chairs: Georgia Pe-Piper and Angeliki Papoutsa

8:15 – GEORGIA PE-PIPER and DAVID J.W. PIPER - **Denudation of the Appalachians in the Cretaceous: tracking fluvial dispersion with mineral geochronology and chemistry**

8:35 – JOHN W.F. WALDRON, R.A. JAMIESON, and C.E. WHITE - **Significance of a Meguma mass transport deposit in Halifax, Nova Scotia**

8:55 – **R.L. TREAT, S.M. BARR, A.F. PARK, C.E. WHITE, and P.H. REYNOLDS - **Structure and petrology of the Partridge Island block and adjacent areas, Saint John area, southern New Brunswick**

9:15 – **S.D. CRAGGS - **Controlling mechanisms for dyke emplacement and fluid flow around strike-slip faults in the Campbellton region, northern New Brunswick.**

9:35 – ****ANGELIKI D. PAPOUTSA and GEORGIA PE-PIPER - The REE and rare metal accessory minerals of the A-type granite of the Late Paleozoic Wentworth pluton, Cobequid Highlands, Nova Scotia

Special Session: *Surficial Materials and the Environment* - Bicentennial Room

Chairs: Michele Coleman and Toon Pronk

8:15 – **S.A. DABBOUS, J. GRIFFITHS, and D.B. SCOTT - **Reconstruction of pollution history in two Atlantic Canada estuaries impacted with two pollution kinds: industrial (Sydney Harbour) vs. domestic (Halifax Harbour) using benthonic foraminiferal proxies**

8:35 – ****M. NASR, P.A. ARP, and A. RENCZ - **Geospatial analysis of mercury in stream and lake sediments across Canada**

8:55 – **J. OGILVIE, M. CASTONGUAY, and P.A. ARP - **Modelling and mapping hydrological risks related to flooding and slopes, inland to coastal**

9:15 – R.T. BOWSER, and C.A. SMALL - Rehabilitation of an acid generating gold tailings area in northern Ontario

9:35 – A.G. PRONK, JING CHEN, MICHAEL A. PARKHILL, REX BOLDON, and MARC DESROSIERS - **Radon surveys as part of the North American Soil Geochemical Landscape Project and a Health Canada sponsored radon/thoron survey in the urban environment**

CONCURRENT TECHNICAL SESSIONS SATURDAY MORNING

General Session: *New Developments in Atlantic Geoscience I* - Salon B

Chairs: David Piper

8:55 – A.C. OKWESE, G. PE-PIPER, and D.J.W. PIPER - **Controls on regional variability in sea-floor diagenesis in Upper Jurassic–Lower Cretaceous pro-deltaic sandstone and shales, Scotian Basin, eastern Canada**

9:15 – K.M. GOULD, D.J.W. PIPER, and G. PE-PIPER - **Facies interpretations and lateral variability based on correlation of conventional core in the Logan Canyon and Missisauga formations of the Scotian Basin**.

9:35 – DAVID J.W. PIPER, SARAH J. BOWMAN, GEORGIA PE-PIPER, and R. ANDREW MACRAE - **The ups and downs of Guysborough County – the mid Cretaceous Naskapi Member in the Scotian Basin: eustacy or tectonics ?**

9:55 – *Coffee and snacks - sponsored by APEGNB*

Special Session: *Ordovician Metallogeny in the Appalachian Orogen* - Royal Stewart Room

Chairs: Jim Walker and Sean McClenaghan

10:20 – N. ROGERS, H. UGALDE, W.A. MORRIS, and C.R. VAN STAAL - **Determining the 3D structure of the Bathurst Mining Camp: results from the TGI 3 Appalachians Project**

10:40 – STEVEN R. MCCUTCHEON - **"Durchbewegung" texture: what is it and does it occur in massive sulphide deposits of the Bathurst Mining Camp?**

11:00 – J.A. WALKER and S.R. MCCUTCHEON - **Stratigraphic setting of the Halfmile Lake South deep zone, part of the Halfmile Lake VMS deposit, Bathurst Mining Camp**

11:20 – *A.M. SHINKLE, D.R. LENTZ, and R.M. TOOLE - **Precious-metal mineralization in the Boomerang and Domino Volcanogenic massive sulphide deposits of the Tulks Belt, central Newfoundland: multi-element ICP-ES and laser ablation ICP-MS results**

11:40 – **JOSEPH D.S. ZULU, CHRISTOPHER R.M. MCFARLANE, and DAVID R. LENTZ - **Paleozoic tectono-thermal evolution of the Key Anacon Zn-Pb-Cu-Ag deposit, Bathurst Mining Camp, Canada, from pyrite microfabric and thermodynamic modeling of garnet**

Special Session: *Carboniferous Basins: Toward a Better Understanding of their Resource Potential I* - Bicentennial Room

Chairs: David Keighley and Steve Hinds

10:20 – JOHN W.F. WALDRON, SANDRA M. BARR, C.E. WHITE, and JIM HIBBARD - **Strike-slip faults and the mid-Paleozoic reconfiguration of the Appalachians in Atlantic Canada**

10:40 – ADRIAN F. PARK - **Unstable at any scale: slumps, debris flows, and landslides during the deposition of the Albert Formation, Tournaisian, southern New Brunswick.**

11:00 – N.S. DAVIES and M.R. GIBLING - **Pennsylvanian emergence of anabranching fluvial deposits: the parallel rise of arborescent vegetation and fixed-channel floodplains**

11:20 – BRIAN ROULSTON - **Getting at the potash: geological and hydrogeological considerations in shaft sinking**

11:40 – K.E. BUTLER and J. EVANGELATOS - **Delineation of the Cocagne Subbasin, eastern New Brunswick, based on new ground gravity data**

CONCURRENT TECHNICAL SESSIONS SATURDAY MORNING

General Session: *New Developments in Atlantic Geoscience II* - Salon B

Chairs: Catherine O'Connell-Cooper and Kim Klausen

10:20 – **C.D. O'CONNELL-COOPER and J.G. SPRAY - **Differentiation processes within the Manicouagan impact melt sheet, Quebec**

10:40 – **MARC B. BIREN and JOHN G. SPRAY - **Shock veins in the central uplift of the Manicouagan impact structure**

11:00 – **KIM B. KLAUSEN and CLIFF S.J. SHAW - **A comparison of the behaviour of SiO_2 and Al_2O_3 during dissolution of quartz and sapphire in a CaO-Al_2O_3-SiO_2 melt at 1600 ^{o}C and 1.5 GPa**

11:20 – CLIFF S.J. SHAW - **First steps in the development of a predictive model for xenolith assimilation rates: the link between melt structure, viscosity, and mineral dissolution rates**

11:40 – D. FRASER KEPPIE - **The Caribbean controversy: thinking outside of the plate**

12:00 - 2:00 *LUNCHEON and AGS ANNUAL GENERAL MEETING – **Salon F***

CONCURRENT TECHNICAL SESSIONS SATURDAY AFTERNOON

Special Session: *Siluro-Devonian Metallogeny in the Appalachian Orogen I* - Royal Stewart Room

Chairs: Dave Lentz and Kay Thorne

2:00 – ANDREW KERR - **An overview of proven and probable Devonian mineralization in the Newfoundland Appalachians**

2:20 – T.G. MACHATTIE - **Nature and setting of Late Devonian-Early Carboniferous rare earth element mineralization in the northeastern Cobequid Highlands**

2:40 – DANIEL J. KONTAK - **The East Kemptville Sn deposit, southwest Nova Scotia: a product of focusing saline, F-rich magmatic fluids into an active fault zone**

3:00 – DAVID R. LENTZ - **Petrochemical evidence for autometasomatic alteration associated with fluidized emplacement of dykes in subvolcanic rhyolitic pyroclastic systems: implications for dissecting W-Mo-Bi and Sn-Zn-Cu-In ore-forming environments like Mount Pleasant (NB)**

Special Session: *Carboniferous Basins: Toward a Better Understanding of their Resource Potential II* - Bicentennial Room

Chairs: David Keighley and Steve Hinds

2:00 – N.J. ATKINSON, J.C. POL, and A.O. SLAUGHTER - **Resource potential of the Maritimes Basin, New Brunswick, Canada**

2:20 – PAULA MARNER - **Constructing a 3D geological model of the McCully Gas Field, southern New Brunswick**

2:40 – K.J. O'SHEA - **A conceptual review of water extraction requirements associated with shale gas activities in New Brunswick**

3:00 – STEVEN J. HINDS - Stratigraphic and structural relationships of the Elgin area, southeastern New Brunswick: preliminary results from 2010 field mapping

CONCURRENT TECHNICAL SESSIONS SATURDAY AFTERNOON

General Session: *New Developments in Atlantic Geoscience III* - Salon B

Chairs: Grant Wach and Matthew Vaughan

2:00 – *M.J. VAUGHAN and G.D. WACH - **High resolution radar stratigraphy (GPR) of braided channel complexes in the Triassic Wolfville Formation: controls on reservoir heterogeneity**

2:20 – **L. HILCHIE, Z. ZHANG, and Y. FEDORTCHOUK - **A temporal link between mantle metasomatism and kimberlite magmatism: evidence from olivine Mg-Fe diffusion profiles in metasomatized peridotite xenoliths, Jericho kimberlite, Northwest Territories**

2:40 – *J. WILSON, R. BORIC, J. DIAZ, and M. ZENTILLI - **Geochemistry of the igneous rocks associated with the MMH porphyry copper deposit, Chuquicamata District, Chile**

3:00 – J. GREGORY MCHONE - **Triassic stratigraphy and topography at Grand Manan, New Brunswick**

3:20 – *Coffee – sponsored by Corridor Resources; Snacks - sponsored by Apache Canada*

Special Session: *Siluro-Devonian Metallogeny in the Appalachian Orogen II* - Royal Stewart Room

Chairs: Dave Lentz and Kay Thorne

3:35 – ****DAVID A. SHINKLE, DAVID R. LENTZ, and STEVEN MCCUTCHEON - **The Early to Late Devonian North Pole Stream granitic suite: a strongly peraluminous granitic complex hosting a intragranitic vein-type uranium deposit, New Brunswick**

3:55 – **W. ZHANG, D.R. LENTZ, K. G. THORNE, and C.R.M. MCFARLANE - **Mineralogical, petrological, and petrogenetic analysis of felsic intrusive rocks at the Sisson Brook W-Mo-Cu deposit, west-central New Brunswick**

4:15 – H.A. SANDEMAN - **Mesoproterozoic (?) monzodiorite-syenite hosted Au-Ag-Te mineralization at the Aucoin prospect (NTS 13N/6) Hopedale Block, Labrador**

General Session: *New Developments in Atlantic Geoscience IV* - Bicentennial Room

Chairs: Deborah Skilliter and Melissa Grey

3:35 – MELISSA GREY, PEIR K. PUFAHL, and ANNAS ABDUL AZIZ - **Marine influence at the Joggins Fossil Cliffs UNESCO World Heritage Site and its implications**

3:55 – L.T. DAFOE, M. STIMSON, and M.R. GIBLING - **One more piece to the puzzle: new developments in the trace fossil record from the Pennsylvanian Joggins Formation**

4:15 – DAVE KEIGHLEY and NICOLA HARCOURT - **A preliminary outcrop chemostratigraphic profile of the upper Green River Formation (Mahogany Oil Shale Zone — Uinta Fm. boundary) in the Uinta Basin, Utah, USA**

General Session: *New Developments in Atlantic Geoscience V* - Salon B

Chairs: Michael Parkhill and Bruce Broster

3:35 – B.E. BROSTER and K.B.S. BURKE - **Site-specific factors influencing earthquake hazard assessment: examples from New Brunswick**

3:55 – ALAN RUFFMAN - **Thank God for plagiarism: newspapers as the seismometers of the 18th and 19th centuries**

4:15 – BILL MERCER - **Health and safety in mineral exploration: the role of the Prospectors and Developers Association**

7:00 – Awards Banquet & Social - Bicentennial-Royal Stewart Rooms

Guest Speaker: JIM FRANKLIN: **Future Mineral Resources Discoveries: New Knowledge Needed for Discovery.**

Student-presenter subsidy: Potash Corp., SWN Resources Canada, APEGNB, Geodex Minerals, GSC-Atlantic, Apache Canada, and Corridor Resources

AGS POSTER SESSION:

***Salon A* Friday 5:30pm – 7:00pm and 10:00pm-11:00pm; Saturday 9:55-10:20am and 3:20–3:35pm**

* **Undergraduate Student Presentation** ** **Graduate Student Presentation**

SPECIAL SESSION: *Groundwater Vulnerability in Atlantic Canada: Climate Change, Sea Water Intrusion, Agriculture, and Other Stressors*

TRINA ADAMS - **Examining potential sea-water intrusion in past and current public water supply wells, southwest Newfoundland**

A.J. DESROCHES, K.E. BUTLER, S. PELKEY, and V. BANKS - **Application of fractured aquifer characterization techniques in the development of a wellfield protection plan, Springdale, south central New Brunswick

HILARY WHITE and IAN SPOONER - **How wet was it? A 5000 year wetland sediment record of changing moisture regimes in Nova Scotia**

SPECIAL SESSION: *Surficial Materials and the Environment*

SERGE ALLARD - **New surficial mapping initiative in New Brunswick**

ALAN J. HIDY, JOHN C. GOSSE, and DUANE G. FROESE - **Burial dating of Klondike and Upper White Channel gravels confirms a Pliocene age for the earliest advance of the Cordilleran Ice Sheet

C.L. LEGERE, B.B. BROSTER, and J.E. HUGHES CLARKE - **Surficial sediments and Quaternary stratigraphy of Maces Bay, Bay of Fundy

A. MARGRETH, J.C. GOSSE, and A.S. DYKE - **Testing the concept of altitudinal weathering zones on Cumberland Peninsula, Baffin Island, using terrestrial cosmogenic nuclide (TCN) exposure dating

A.A. SEAMAN - **The Northumberland Phase: the Illinoian glaciation of the Canadian Maritime Provinces**

D.J. UTTING - **Erosion Susceptibility Prediction (ESP) for Yarmouth, Nova Scotia**

SPECIAL SESSION: *Carboniferous Basins: Toward a Better Understanding of their Resource Potential*

NAZRUL ISLAM and DAVID KEIGHLEY - **Preliminary chemostratigraphy of the Mabou Group in the Penobsquis area, Sussex, New Brunswick

G.S. STRATHDEE, DAVID J.W. PIPER, and GEORGIA PE-PIPER - **Geographic and stratigraphic variation in shales of the Scotian Basin and their impact on basin evolution

SPECIAL SESSION: *New Developments in the Appalachian Orogen: a Symposium in Honour of Hank Williams*

*J.L. HANSEN and D.N. REUSCH - **Imbricated Seboomook Group, Bald Mountain, west-central Maine: tectonic, slump, or mixed origin?**

H.M. STEENKAMP, J.P. BUTLER, and R.A. JAMIESON - **Tectonic assembly of basement and supracrustal nappes in the ultra-high pressure Western Gneiss Region of Norway

SPECIAL SESSION: *Siluro-Devonian Metallogeny in the Appalachian Orogen*

E.P. LYNCH, D. SELBY, V. MCNICOLL, M. FEELY, D.H.C. WILTON, and A. KERR - **Geochronology of the Moly Brook Mo-Cu deposit, southern Newfoundland: implications for local and regional granite-related metallogeny**

AGS POSTER SESSION:

GENERAL SESSION: *New Developments in Atlantic Geoscience*

D.B. ARCHIBALD, S.M. BARR, C.E. WHITE, J.B. MURPHY, and E.A. ESCARRAGA - **Field relations, petrology, and tectonic setting of the Ordovician West Barneys River Plutonic Suite, southern Antigonish Highlands, Nova Scotia**

*A.C. BELANGER, D. CORRIGAN, and R.A. JAMIESON - **Origin of tourmaline in a potential SEDEX-type deposit, Penrhyn Group, Melville Peninsula, NU**

BINIAM BISRAT, CLIFF STANLEY, and JOHN MURIMBOH - **Partial digestion geochemistry of Nova Scotia soil samples: monitoring digestion conditions to understand how samples leach

L.J. CALHOUN, J.C. WHITE, D. MACISAAC, C.W. JEFFERSON, and J.G. PATTERSON - **Basement-cover relationships in the Paleoproterozoic Amer Group, Nunavut

*GLENN G. CHAPMAN and REBECCA A. JAMIESON - **Contact metamorphism of calcareous concretions in the Bluestone formation, Halifax Group, Halifax, Nova Scotia**

*LEAH M. CHISTE, CLIFF STANLEY, and BRIAN TOWNLEY - **Geochemistry of pediment over the Toki Cluster porphyry copper deposits, Atacama Desert, Chile**

*J.M. GATES and S.M. BARR - **Petrology and tectonic implications of mafic to intermediate dykes in the Kellys Mountain area, Cape Breton Island, Nova Scotia**

*I.J. JACQUES and L.J. PLUG - **Trail degradation on the Nine Mile Trail system: a study on the effects of users on trail compaction and rutting**

R.A. JAMIESON, JOHN W.F. WALDRON, and C.E. WHITE - **Bluestone formation of the Halifax Group: metamorphosed slope and mass-transport deposits, Halifax Peninsula, Nova Scotia**

P.G. LELIÈVRE, C.G. FARQUHARSON, and C.A. HURICH - **Creating 3-D Earth models that unify geological and geophysical information**

*D.A. MACISAAC, J.C. WHITE, L. J. CALHOUN, and C. JEFFERSON - **Paleoproterozoic supercrustal deformation, Amer Lake, Nunavut**

SHAWN MEREDYK - **Environmental characterization of the Hudson Strait Coral Hotspot: current state of knowledge

*N.A.M. RADZI and S.M. BARR - **Petrography of stratigraphic units in the subsurface in the Phetchabun basin, Thailand**

*CHRISTIAN RAFUSE and GRANT WACH - **Stratal-geometry architecture of meanderbelt systems and vegetation density in the Carboniferous: using LiDAR imagery**

L. ROBICHAUD, J. LAFONTAINE, and J.C. WHITE - **Structural analysis of the Matoush uranium deposit, Quebec

*CYNTHIA SAWATZKY and GEORGIA PE-PIPER - **A protocol for determining provenance of quartz grains in sandstones using the hot-cathode cathodoluminscence (CL) microscope**

DEBORAH M. SKILLITER and MELISSA GREY - **Collections management at the Joggins Fossil Cliffs UNESCO World Heritage Site: a new model?**

*COOPER D. STACEY and DAVID J.W. PIPER - **Origin of slope gullies in Flemish Pass: evidence for an ice cap on Flemish Cap**

J.C. WHITE - **Micro-mechanical processes from the San Andreas Fault Observatory at Depth (SAFOD) Phase 3 cores**

*KHALHELA ZOELLER - **IODP site 1256: petrological and textural variations down-core**

ABSTRACTS

Examining potential sea-water intrusion in past and current public water supply wells, southwest Newfoundland

TRINA ADAMS
Water Resources Management Division, Department of Environment and Conservation,
P.O. Box 8700, Confederation Building, West Block, 4th Floor, St. John's, Newfoundland and Labrador A1B 4J6, Canada
<trinaadams@gov.nl.ca>

Due to the growing concern of climate change and its current and future impact on coastal communities, adaptation is essential to carry on in a changing climate. The Atlantic Canada Adaptation Solutions (ACAS) Project is a partnership by the Atlantic Provinces in Canada and Natural Resources Canada (NRCan) to work alongside local communities, organizations, and professionals to investigate the susceptibility and influence of climate change and to offer a basis for community acclimatization decisions. While the Newfoundland and Labrador, Department of Environment and Conservation has taken the lead for inland land use and vulnerability studies, extra efforts are in progress to investigate the impact of sea level rise on groundwater reservoirs. These efforts will serve to identify municipal groundwater supplies thought to be at risk of salt water intrusion due to sea level rise.

Based on the International Panel for Climate Change, predictions of local sea level rise have been made for four zones in Newfoundland and Labrador. The southwest portion of the island falls within zone 2 where sea water for the region is expected to rise less than 2 mm per year. This equates to a projected sea level rise of 40 cm by the year 2049 and greater than 100 cm by the year 2099. The highest risk communities within zone 2 have hydrogeologic units consisting primarily of glaciofluvial sand and gravel deposits with varying thicknesses of 1.5 to 50 m; Carboniferous sedimentary bedrock, or a combination of the two units. Both units have the highest yield for the southwest region and the highest potential for sea water contamination caused by groundwater recharge.

A recent field excursion to communities along the Port au Port Peninsula and St. Georges Bay area helped identify towns that have abandoned or soon to be abandoned wells. During the spring of 2011, parameters such as conductivity, temperature, and static water level will be measured on selected wells and grab samples will be collected and further analyzed in a lab for chloride and sodium. The results, available well construction data, and community cooperation will be deciding factors for which wells will be selected for long term observation.

New surficial mapping initiative in New Brunswick

SERGE ALLARD
Geological Surveys Branch, New Brunswick Department of Natural Resources,
P.O. Box 6000, Fredericton, New Brunswick E3B 0B6, Canada <serge.allard@gnb.ca>

A comprehensive understanding of surficial geology is essential to the socio-economic fabric of New Brunswick. It is the responsibility of the New Brunswick Department of Natural Resources (NBDNR), Geological Surveys Branch (GSB) to delineate, describe, and analyze surficial materials in order to generate client-oriented products that: (1) help to locate construction aggregate resources (i.e. sand, gravel, clay, etc.); (2) are relevant to the mineral exploration community; (3) provide useful baseline geological information to agencies involved with land-use planning, groundwater resources, forestry, and agriculture, and; (4) help to identify landforms and sediment characteristics that present hazards to public health and safety.

In 2009, the Geological Surveys Branch initiated a mapping program with the aim of improving the quality and availability of surficial geology maps for southern New Brunswick. Although various types of surficial geology data have been systematically collected over the past three decades, only modest effort had gone into synthesizing surficial geology maps. Current datasets could be considered under-utilized. Older maps are available for some areas, but these maps don't share a common mapping approach, scale, or legend. In some cases they are inadequate or difficult for clients to access. Throughout the past decade, the GSB has put a lot of emphasis on the compilation and publication of standardized digital bedrock geology maps. Likewise, the current initiative to compile 1:50 000 scale surficial geology maps for southern New Brunswick should be viewed as the first step towards a standardized set of surficial geology maps for New Brunswick.

Through consultation with staff form NBDNR, other government agencies, and industry, a new mapping methodology and unit classification system was developed. The new mapping approach relies equally on the acquisition of field data and aerial photo/satellite radar/LIDAR imagery interpretation. Field mapping and the compilation of existing data was initiated in 2009 and to date, 1:50 000 maps have been compiled for the St. George (NTS 21 G/2), McDougall Lake (NTS 21 G/7), and Fredericton Jct. (NTS 21 G/10) map areas. A complete set of maps for southwestern New Brunswick (NTS 21G) will be made available to NBDNR clients and the general public within 5 years.

Field relations, petrology, and tectonic setting of the Ordovician West Barneys River Plutonic Suite, southern Antigonish Highlands, Nova Scotia

D.B. ARCHIBALD[1], S.M. BARR[1], C.E. WHITE[2], J.B. MURPHY[3], AND E.A.ESCARRAGA[1]

1. Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada <103795a@acadiau.ca>

2. Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, Canada

3. Department of Earth Sciences, St. Francis Xavier University, Antigonish, Nova Scotia B2G 2W5, Canada

The Antigonish Highlands in northern mainland Nova Scotia are part of Avalonia. Plutonic rocks occur throughout the highlands and recent studies have shown that they are of predominantly two ages: ca. 610 Ma (Late Neoproterozoic) and ca. 470-460 Ma (mid-Ordovician). The older suites are mafic through felsic rocks with typical calc-alkalic "I-type" characteristics. In contrast, the Ordovician plutons, which occur mainly in the southern highlands, are of gabbroic to syenitic and granitic compositions. Mapping in the summer of 2010 showed that the Ordovician intrusions are widespread, covering an area of approximately 100 km^2 and they have been named the West Barneys River Plutonic Suite. Gabbroic rocks comprise approximately 40% of the area whereas granitic and syenitic rocks represent about 55%. The remaining 5% of the area consists of metasedimentary and volcanic rocks which occur as xenoliths and roof pendants in the plutonic suite. The plutonic suite intruded Neoproterozoic sedimentary and volcanic rocks of the Georgeville Group, which is the probable source of the xenolithic and roof pendant material. The West Barneys River Plutonic Suite displays magma mixing and mingling textures indicative of a co-genetic relationship between the felsic and mafic lithologies. Younger mafic dykes cross-cut all lithologies. This study focuses on the petrography and geochemistry of the gabbroic rocks in the suite. Earlier studies had shown that the granitic and syenitic rocks contain aegirine, riebeckite, and in some samples fayalite, indicative of peralkaline compositions. Petrological indicators suggest that they formed in a within-plate extensional setting. Preliminary petrographic study of the gabbroic rocks shows that they consist mainly of plagioclase, clinopyroxene, amphibole, and rarely olivine or quartz, together with apatite, biotite, and a number of opaque phases including ilmenite, magnetite, and pyrite. Many samples are extensively chloritized, sericitized, and/or saussuritized. Textures are ophitic to sub-ophitic with some samples showing porphyritic textures. Preliminary chemical data indicate that the gabbroic rocks have compositions characteristic of continental within-plate tholeiite.

Resource potential of the Maritimes Basin, New Brunswick, Canada

N. J. ATKINSON, J. C. POL, AND A. O. SLAUGHTER

Southwestern Energy, 2350 N. Sam Houston Pkwy E., Houston, Texas 77302, USA

The Maritimes Basin is a Carboniferous-age basin in Eastern Canada. Although much of the basin lies offshore in the Gulf of St. Lawrence, the largest onshore extent of the basin lies in New Brunswick and Nova Scotia. The Maritimes Basin formed as a series of pull-apart basins related to strike-slip movement along major fault systems similar to the modern-day San Andreas fault system of California. This event post-dates the continental accretion resulting from the closing of the Early Paleozoic ocean basin and predates a final accretion event in the Permian. This final event resulted in compression and creation of folds and faults in the Maritimes Basins.

Existing oil and gas production from the Moncton Subbasin and numerous oil and gas shows across the region indicate the existence of a viable hydrocarbon system. Depth-to-basement interpretations made from magnetic data have identified a series of previously unknown sub-basins covering more than two million acres in central New Brunswick. Additional magnetics, airborne gravity, geochemical, and seismic surveys will be conducted to confirm the presence and extent of these subbasins.

The known source rock in the area is the Carboniferous Frederick Brook shale member of the Albert Formation. This rich oil-prone source rock was deposited in a lacustrine setting and can be up to 1000 feet thick and contain up to 20% total organic carbon. Although elevated maturity levels suggest natural gas will predominate at depth, liquids may be preserved on the shallower margins of the basin. Secondary targets are the Hiram Brook member sandstone beds. These sandstones may develop into conventional, structurally and/or stratigraphically trapped reservoirs. Evaporite beds of the Windsor Group form regional seals to the Hiram Brook sandstone, although uplift during the Permian caused the erosion or non-deposition of these beds in local areas.

Hydrologic and geochemical investigation of saltwater intrusion at two sites in Nova Scotia

CALVIN BEEBE[1], GRANT FERGUSON[1], AND GAVIN KENNEDY[2]

1. Department of Earth Sciences, St. Francis Xavier University, Antigonish, Nova Scotia B2G 2W5, Canada <CBeebe@stfx.ca>

2. Nova Scotia Department of Natural Resources, Groundwater Program, Halifax, Nova Scotia, Canada

The risk of saltwater intrusion and subsequent impact to fresh groundwater supplies is expected to increase in coastal regions around the world over the next century due primarily to sea level rise. Many of Nova Scotia's coastal communities rely on groundwater for their water supply and are therefore vulnerable to sea level rise impacts. As part of a regional initiative to investigate the vulnerability of the province's coastal aquifers (Atlantic Climate Adaptation Solutions project), the Village of Pugwash and the Town of Wolfville, Nova Scotia were selected for a focused investigation of salt water intrusion. The investigation is using a combination of methods; geochemistry, physical hydrologic investigation, and numerical modeling to present a comprehensive analysis of the risk of saltwater intrusion at each site. Here, results of geochemical analyses, including

[Cl]:[Na], [Br]:[Cl], and [SO4]:[Cl] ratios, indicate that seawater intrusion at the two locations is not occurring at either of the field locations at present. However, the investigation did highlight some concerns with respect to groundwater contamination from the application/storage of road salt. The results will be used to assist in defining factors that may be associated with increased risk of saltwater intrusion at other locations in the province. This will help to assist in selection of "high vulnerability" sites for investigation on a narrow regional scope or on a site-by-site basis.

Origin of tourmaline in a potential SEDEX-type deposit, Penrhyn Group, Melville Peninsula, NU

A.C. BELANGER[1], D. CORRIGAN[2], AND R.A. JAMIESON[1]

1. Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada <ABelanger@dal.ca>

2. Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada

A suite of metamorphosed and hydrothermally altered sedimentary and chemogenic rocks were sampled from an area on the northern flank of Barrow River, Melville Peninsula (N 67º24'08.44", W 82º35'43.23"), Nunavut. The study area is in the Proterozoic Penryhn Group which lies within the Foxe Fold Belt of the Trans-Hudson orogen. On a regional scale, the Penryhn Group consists of interlayered pelitic and psammitic gneisses, amphibolites, marbles, and calc-silicates, all intruded by continental arc and syn-collisional plutons and pegmatites.

In order to identify the nature and extent of superimposed hydrothermal and metamorphic processes, samples were collected from 19 outcrops spanning an area of about 400x100 m. Sampled lithologies include amphibolites, granites, tourmalinites, greywackes, and sulphide-rich rocks, typically with abundant fine-grained, euhedral tourmaline crystals. The presence of fibrolitic sillimanite within tourmaline cores suggests upper amphibolite facies metamorphism. Sulphide-rich layers contain pyrrhotite, pyrite, sphalerite, and chalcopyrite; however their abundance is highly variable throughout sampling area.

The study area has been the focus of several mineral exploration projects, including those by Aquataine (1970), Borealis Exploration Limited (BEL; 1985-87), and BEL-BHP (1994-1996). Assays indicated concentrations of 2000-7000 ppb Au, with Zn concentrations locally over 9%. The area was classified as a "black shale" environment.

This study focuses on the petrography, composition, and origin of tourmaline in these rocks. At least two generations of tourmaline have been documented from petrographic and electron microprobe work; early tourmaline may be detrital while later grains and outer rims are interpreted as hydrothermal or metamorphic. Tourmalines range in colour from clear to light brown, locally with darker cores that may have been inherited from originally detrital grains. Distinctive diamond-shaped aggregates, possibly psuedomorphs after tremolite, consist of medium-grained muscovite + tourmaline ± sillimanite cores with finer-grained albite + tourmaline rims. Tourmaline compositions are Mg-rich (dravite) with variable Ti and Mg/(Mg+Fe) contents. Dravitic tourmalines are commonly associated with submarine fumarole and massive sulphide exhalative deposits, where boron is derived from exhalative hydrothermal fluids. In the study area, late-stage tourmaline may have been derived from boron that was remobilized during metamorphism from boron-bearing minerals deposited within the original sedimentary host rocks.

Shock veins in the central uplift of the Manicouagan impact structure

MARC B. BIREN AND JOHN G. SPRAY

Planetary and Space Science Centre, Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <marc.biren@unb.ca>

Shock veins that developed and penetrate the anorthositic central uplift of the Manicouagan impact structure, Quebec, occur as thin (<2.5 mm wide), linear micro-fault systems that can be traced for several metres in length. They predominantly trend radially from the point of impact. The shock veins are distinguished by the development of maskelynite along vein margins and stishovite in vein matrices. These phases define a shock excursion of up to 30 GPa, in contrast to bulk shock effects of ≤12 GPa defined by development of shatter cones, planar fractures, and planar deformation features in various minerals.

The shock veins at Manicouagan share many similarities with vein systems developed in meteorites. They also provide an in situ context with which to better understand meteoroid source and lofting conditions. In addition to containing high pressure phases, the shock veins exhibit evidence for high-temperature partial melting of host silicate clasts, with the generation of flow-textured fragments and glasses. Temperature excursions in the veins are constrained by plagioclase melting (~An60 @ >1400 °C), partial melting of augite (>1400 to <1500 °C), and partial melting of garnets (>1650 °C). Plagioclase geothermometry indicates that some melt injections crystallized at ~1350 °C (~An_{74}). Geochemical analysis of the melts indicates they are in situ (i.e., native to their host rock) and are not derived from an external source. The formation of microcrystallites and dendrites from some melts indicates rapid cooling.

A two-stage generation mechanism is proposed comprising an initial high-pressure shock excursion (estimated to last <0.5 s based on projectile size considerations) followed by a longer high-temperature pulse of a few seconds duration. The shock excursion is initiated by target heterogeneities that cause distortions in the hemispherically propagating shock front. This results in radially oriented tearing and vein formation. High-speed displacement along the veins is driven by stress release on rarefaction, which results in frictional melting via adiabatic heating. Future study of these and similar shock veins in other terrestrial craters should provide further insight into the possible launch locations of meteorites on other planetary bodies.

Partial digestion geochemistry of Nova Scotia soil samples: monitoring digestion conditions to understand how samples leach

BINIAM BISRAT, CLIFF STANLEY, AND JOHN MURIMBOH
Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada <94728b@acadiau.ca>

Partial digestions have been used in exploration geochemistry over the past 15 years to detect surface anomalies associated with buried mineralization. Vertical migration of elements from a primary mineralized source at depth to the surface is necessary to create these anomalies. Within the anomalous soils, elements transported from depth by groundwater typically reside in loosely bound sites on the surfaces of minerals. Partial digestions are designed to only leach such elements from the surfaces of these minerals, as they do not dissolve the minerals themselves, and thus do not liberate any elements contained within those minerals. As a result, partial digestions tend to suppress geochemical background and increase geochemical contrast, features that should make partial digestion results more interpretable and visually compelling than total digestion results.

To investigate what happens during partial digestion geochemistry, B-horizon samples from study areas in Nova Scotia were leached using deionized water (probably the weakest partial digestion possible) and analyzed by ICP-MS. The partial digestions were analyzed for a suite of metals every 30 seconds for at least the first 30 minutes of leaching, and compared with results obtained over 2 hour batch digestions. During these temporal studies, the pH and pE of the solutions were also measured every 30 seconds to monitor digestion conditions. These results have also been compared with the results of analogous partial digestions obtained using an argon atmosphere to avoid any oxidation effects resulting from exposure to ambient air.

The results of these experiments have provided significant improvements in the understanding of how partial digestion conditions change over time, and how these changes can result in un-intended, and sometimes, completely disastrous results. Essentially, the results conclusively demonstrate how the matrices of soil samples simultaneously buffer both the pH and pE conditions of the digestions, precisely because these buffers overwhelm the chemical controls exerted by these weak partial digestions. As a result, samples with different matrices will commonly undergo leaching under vastly different chemical conditions, undermining interpretation because the consequent results can't be rigorously compared. Interestingly, the results also demonstrate that partial digestion concentrations obtained with less than 5 minutes of leaching are typically less impacted by these matrix effects, and thus provide more accurate exploration results and better geochemical contrast than conventional (longer) leach times.

Rehabilitation of an acid generating gold tailings area in northern Ontario

R.T. BOWSER AND C.A. SMALL
AMEC Earth and Environmental, Fredericton, New Brunswick E3A 6V9, Canada <travis.bowser@amec.com>

The Hollinger Mine is a gold mine in Timmins, Ontario, that operated from 1910 through 1968. Tailings were deposited into a lake, referred to as the Hollinger Tailings Management Area (HTMA). In addition to tailings, 400,000 cubic metres of off-spec (high sulphide) concentrate were also stored in the HTMA. The site is 256 ha in area with the majority of the site covered in acid generating tailings that had spread over the area after a containment dam failed in the 1960s. The site is located within the Timmins city limits and has been a major health and safety concern to the local residents. The acidic tailings also damaged a stream and rendered it barren of fish.

Goldcorp Canada Ltd. is now the owner of this site and in 2005 PGM retained AMEC's services to prepare and implement the closure plan for the site as part of their commitment to protecting the environment. AMEC carried out tailings characterization; ground water and surface water investigations; developed groundwater, hydrotechnical, and contaminant loadings models; and prepared a detailed closure design for the regulatory agencies. The overall objective of the closure design is to improve the surface waters sufficiently to support aquatic life, improve the overall aesthetics of the site, and create a self sustaining/low maintenance landscape. This involved relocating acid generating tailings to the pond within the tailings area, stream restoration, ditch construction, and revegetation. The closure activities started in the fall of 2008 and are expected to be complete by the fall of 2011. This presentation will describe the site, some of the history, the investigations that were undertaken, and the measures (implemented and planned) required to achieve closure.

Site-specific factors influencing earthquake hazard assessment: examples from New Brunswick

B.E. BROSTER AND K.B.S. BURKE
Department of Geology, Quaternary and Environmental Studies Group, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <broster@unb.ca>

Seismic hazard studies by Earthquakes Canada places most of New Brunswick in the moderate part of the hazard range. Seven earthquakes with estimated magnitudes in the range of 4.5 to 6 have occurred in the last 200 years. In addition, seven larger regional earthquakes in Quebec, New Hampshire, and on the Grand Banks have had notable effects within the province. Interpretations of intensities associated with these 14 events range between Modified Mercalli (MM) values of II to VII. The higher intensity values have mostly occurred where local geology and site specific factors play a dominant role. Many of the communities in New Brunswick were settled along river valleys and coastal areas, which are underlain by thick deposits of glacial and alluvial sediments. Historical documentation and paleoseismic studies that identify seismic-generated disturbances are reviewed in this presentation. Both moderate local and larger regional earthquakes have caused significant

effects at some locations, particularly those sites adjacent to steep slopes or sites underlain by thick surficial deposits, which amplify ground motion. Amplification of ground motion would be expected at sites overlying low shear wave velocity zones, such as alluvial sediments, and may explain the larger shaking effects experienced in the downtown area of Fredericton from distant earthquakes. Minor alteration of springs, rivers, and groundwater supplies has happened as a result of earthquakes, although few effects remain permanent. Earthquake-induced rock falls occurred along some rock slopes during moderate earthquakes in 1855 and 1937. This study has identified the need for future paleoseismic research and microzonation studies for the major communities within the province.

Delineation of the Cocagne Subbasin, eastern New Brunswick based on new ground gravity data

K.E. BUTLER AND J. EVANGELATOS

Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <kbutler@unb.ca>

A regional gravity survey was undertaken in the fall of 2009 over a portion of the late Paleozoic Maritimes Basin in eastern New Brunswick that includes the eastern end of the Late Devonian to Early Carboniferous Cocagne Subbasin and adjacent areas of the New Brunswick Platform to the north. The survey area measures approximately 54 km along the Northumberland coast between Shediac and Richibucto, and extended 11 to 23 km inland. A total of 708 gravity stations with a nominal (though non-uniform) spacing of approximately 1 km were acquired using a modern gravimeter and the rapid-static GPS method for positioning.

The Cocagne Subbasin, thought to be a graben-like structure, produces a well-defined 10-15 mGal gravity low in the southern part of the survey area. The gravity low is bounded to the south by a relatively broad gravity high associated with uplifted Lower Carboniferous sedimentary rocks and crystalline basement rocks of the Indian Mountain Deformed Zone. In contrast, the northern boundary of the gravity low is well defined by abrupt changes in both gravity and vertical gravity gradient, suggesting that the basin is asymmetric in cross-section. It is proposed that this linear northeast trending anomaly marks the position of the Belleisle Fault and the northern boundary of the Cocagne Subbasin beneath Upper Carboniferous cover. The Belleisle Fault was previously extrapolated through this area along a pronounced magnetic anomaly that is now recognized to bisect the Cocagne Subbasin gravity low and to be co-linear with the trajectory of a subtle anomaly in the vertical gravity gradient. The inferred fault along that trajectory is renamed the Cormierville Fault, thus allowing the Belleisle Fault to retain its originally defined significance as the southern margin of the New Brunswick Platform. Simple 2D forward modeling of two gravity profiles suggests that the Cocagne Subbasin within the survey area is 3 to 4 km deep north of the Cormierville Fault, and 2 to 3 km deep south of it, though these estimates were made without the benefit of either borehole control or seismic reflection data. The subbasin appears to deepen towards the southwest and thin towards the northeast, which may explain why previous investigators did not identify the subbasin or its bounding faults in marine seismic reflection data from the Northumberland Strait.

Basement-cover relationships in the Paleoproterozoic Amer Group, Nunavut

L.J. CALHOUN[1], J.C. WHITE[1], D. MACISAAC[1], C.W. JEFFERSON[2], AND J.G. PATTERSON[3]

1. Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <lydia.c@gmx.com>

2. Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada

3. Department of Geography, Planning and Environment, Concordia University, Montreal, Quebec H3G 1M8, Canada

The Paleoproterozoic Amer Group, central Nunavut, comprises four sequences (Ps1 through Ps4) unconformably overlying Archean basement of the Rae sub-province. Basement of the study area around South Amer Lake is quartzo-feldspathic gneiss with subordinate metabasalt, intruded by diorite. Ps1 in the Amer Group is the Ayagaq quartzite formed as a stable fluvial to marine platform. Ps2 is a transgressive sequence of Resort Lake siltstone shallowing up to Aluminium River dolomite and intercalated Five Mile Lake basalt. Ps3 comprises three units recording an overall coarsening- then shallowing-upward sequence, involving siltstone to feldspathic arenite; the Three Lakes, Oora Lake, and Showing Lake formations. Above a profound post-D1 unconformity, Ps4 Itza Lake arkose is preserved in a small area of outcrop in the study area.

The structural history of the Amer basin is spatially and temporally variable. The regional map pattern is defined by shallowly doubly plunging synclinoria (D2) affected by later open D3 folds. Field mapping has documented at least three preceding deformation generations, grouped as D1. The basement-cover contact varies throughout the study area; the nature of this boundary is central to elucidating the structural history of the area. The basal unconformity of the Ayagaq quartzite is commonly marked by a distinctive polymictic conglomerate with a schistose matrix. In some places this contact is just a schistose layer, or a sharp discontinuity.

Immediately adjacent to the basement-cover contact, D1 deformation in the quartzite includes bedding parallel displacements and meso- to macroscopic isoclinal folds; hence, the layered quartzite sequence lying on the basement is defined by fold limbs. Proximal Archean gneiss foliations are sub-parallel to axial planes of the quartzite isoclines. Gneiss and quartzite were first folded together during latest D1 consistent with a significant decoupling of basement and cover during much of the pre-D2 deformation. Folding of the basin during D2 created steep axial planar cleavage. The two-stage development of the tectonic architecture is seen in the post-fabric folding of the basal schist, a presumed detachment, with the basement during D2. A primary conclusion is that large tracts of Paleoproterozoic units may be allochthonous with respect to the underlying Archean basement.

Contact metamorphism of calcareous concretions in the Bluestone formation, Halifax Group, Halifax, Nova Scotia

GLENN G. CHAPMAN AND REBECCA A. JAMIESON

Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada <gchapman@dal.ca>

The Bluestone formation represents the uppermost unit of the Halifax Group in the Halifax area. It is an early Ordovician turbidite sequence, interpreted to have been deposited on the continental margin of Gondwana. The formation comprises a coarsening-up sequence of interbedded grey-blue slate, silt, and fine sandstone. A characteristic feature is the presence of abundant calcareous concretions concentrated within sandstone and siltstone layers. In outcrop the concretions generally form regularly spaced, discrete, oblate bodies from ~5 mm to 1 m across, and from 50 mm to several metres long. They locally form thin, continuous horizons, distinguishable by their distinctive green to buff colour and recessive weathering. Concentric colour banding in some concretions reflects systematic changes from Ca-rich cores to Ca-poor margins adjacent to the host rock. Compositional banding overprints cross-bedding and sedimentary laminations, and the concretions were deformed with their host rocks, indicating that they formed after deposition but before regional deformation, probably during diagenesis.

Samples for this study were collected throughout the Bluestone formation including Point Pleasant Park, Bluestone Quarry, and the Williams Lake area. The concretions and their host rocks lie within the contact aureole of the South Mountain Batholith, with metamorphic grade increasing from east to west toward the intrusive contact. Mineral assemblages vary from calcite + grossular + anorthite + augite in low-grade (distal) examples, to white mica + (Ca and Mn) garnet + biotite, to clinopyroxene + (Ca and Mn) garnet in high-grade (proximal) outcrops. The transition between concretion rims and host rocks is marked by radiating sprays of chlorite intergrown with minor biotite. The groundmass in this zone is dominated by detrital quartz with intergranular Ca-rich plagioclase. Detrital quartz and feldspar, ubiquitous in distal concretions and their host rocks, are virtually absent in concretions proximal to the contact. Systematic variations in mineralogy, texture, and composition will be used to constrain P-T-X_{fluid} conditions in the contact aureole of the South Mountain Batholith.

Geochemistry of pediment over the Toki Cluster porphyry copper deposits, Atacama Desert, Chile

LEAH M. CHISTE[1], CLIFF STANLEY[1], AND BRIAN TOWNLEY[2]

1. Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada

2. Departemento de Geologio, Universidad de Chile, Casilla 13518, Correo 21, Santiago, Chile

Most porphyry copper deposits (PCD's) in Chile have been found because they are/were exposed at the surface. The absence of vegetation in Chile has allowed the use of satellite imagery to successfully locate gossans associated with such deposits, and thus most exposed deposits have already been found. The remaining PCD's are mostly covered by pediments and ignimbrites, making them difficult to discover. Over the past 15 years, exploration techniques have been developed to more easily locate these buried deposits; one of these techniques involves the use of partial digestion geochemistry. These partial digestions extract only the metals that are loosely bound to the surfaces of soil particles (metals most likely transported from below by circulating groundwaters), and thus produce anomalies with geochemical contrasts that are higher than those obtained using total digestions.

In this presentation, the results of total digestion geochemical methods applied to fine-grained vertical trench profile samples collected from pediment over and adjacent to the Quetena PCD near Calama, Chile are presented. An aqua regia digestion (with ICP-MS finish) was used because it is virtually total for the chalcophile pathfinder elements associated with porphyry copper deposits (*e.g.*, Cu, Pb, and Zn). Results illustrate a distinct contamination zone at the surface for many elements, probably due to wind-blown dust from the nearby Chuquicamata PCD and mine. This contamination generally swamps out any anomalies that might exist at depth related to the underlying Quetena PCD. If contaminated samples (those from less than 50 cm depth) are removed from consideration, subtle geochemical anomalies become evident. Partial digestion geochemical methods involving simple deionized water extractions are expected to produce anomalies with much higher geochemical contrast. These results will be reported in future communications.

Controlling mechanisms for dyke emplacement and fluid flow around strike-slip faults in the Campbellton region, northern New Brunswick

S.D. CRAGGS

Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <simon.craggs@unb.ca>

In a strike-slip regime, the bulk compressive stresses are near horizontal, and as such there has been much debate about the space generating mechanism required for magma emplacement. In the Campbellton region of New Brunswick numerous intermediate, fine- to medium-grained sheets intrude Late Ordovician to Late Silurian, sedimentary rocks and Early Devonian, subvolcanic to subaerial igneous rocks. Intrusions are most prevalent proximal to regional-scale, strike-slip faults where cross-cutting relationships indicate coeval magma emplacement and fault displacement. In sedimentary rocks, intrusions are typically oriented along a pre-existing fabric (bedding) along which abundant bedding-parallel slip has occurred.

Analysis of fault orientation and movement history allows for an approximation of the far-field stress directions, with σ^1 oriented WNW-ESE. Traditional theories on magma emplacement in strike-slip regimes suggest that magma should orient itself perpendicular to the maximum tensile stress. However, in the study area, this is uniformly not apparent with all intrusions oriented oblique to, or parallel with far-field σ^3.

It is very difficult for a dyke to intrude a pre-existing fracture that is misaligned with σ^3 unless the resolved shear stress on the plane is small relative to excess magma pressure, or the effective dyke-normal stress is small relative to the rock tensile strength. Without these conditions the magma will propagate into a self-generated crack perpendicular to σ^3. During mode I-II fracture propagation, maximum tensile stress occurs at the dyke tip and parallel to the dyke; thus, if the tensile stress exceeds the tensile strength of the rock, the dyke cannot propagate into the pre-existing plane. However, for mode I-III fractures effective tension at a dyke tip is significantly lower and may allow propagation along the pre-existing front. The Campbellton region experienced a transpressive stress regime during dyke emplacement and thus fracture propagation was dominantly mode I-III. In addition, during major fault development, subsidiary fracture propagation can significantly alter stress trajectories around the parent fault and introduce local dilatant zones that are misaligned with far-field σ^3. As such, the combination of a far-field transpressive stress regime and local stress perturbations are considered feasible mechanisms for controlling dyke orientation around major displacement surfaces.

Reconstruction of pollution history in two Atlantic Canada estuaries impacted with two pollution kinds: industrial (Sydney Harbour) vs. domestic (Halifax Harbour) using benthonic foraminiferal proxies

S. A. DABBOUS, J. GRIFFITHS, AND D.B. SCOTT

Department of Earth Sciences and Centre for Environmental and Marine Geology, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada <saaddabbous@dal.ca>

The extensive analyses of foraminiferal assemblages were conducted on seven sediment cores from two impacted environments, Halifax Harbour (domestic) and Sydney Harbour (industrial) in Maritime Canada, to reconstruct an extensive history of pre- and post-impact environmental conditions of both areas. Presently, and without any baseline (target environment) studies, both areas underwent a remediation program at a cost of $400 million, after long, intensive, and untreated pollution.

The characteristics of the foraminiferal assemblage (e.g. diversity, abundance, deformities, and inner linings) provided very strong evidence on pollution type, rate, and duration in both harbours. In Halifax Harbour, the major species were agglutinated since the high organic content caused low pH in the sediments that precluded preservation of calcareous tests. However, in Sydney Harbour many calcareous species were found, among them *Ammonia beccarii*, which had not been observed sub-tidally in high West Atlantic latitudes previously. The high diversity, dominant calcareous record, and presence of other fossil groups (e.g. Ostracods, Pelecypods, etc) within the cores of Sydney Harbour reflect the type (i.e. industrial), rate (i.e. low), and duration (i.e. short) of pollution in this area when compared to Halifax Harbour. In addition, ratios and types of deformities in foraminiferal shells showed a remarkable relation to pollution type and rate in both harbours.

The present study provides a pollution record as well as a target environment for current remediation program and/or any future long term monitoring programs in both environments. Additionally, it is the first work to be done on benthonic foraminifera in Sydney Harbour. Furthermore, it documents the use of benthonic foraminifera as an accurate and cost effective tool for environmental studies.

One more piece to the puzzle: new developments in the trace fossil record from the Pennsylvanian Joggins Formation

L.T. DAFOE[1], M. STIMSON[2], AND M.R. GIBLING[3]

1. Department of Mathematics, Physics, and Geology, Cape Breton University, Sydney, Nova Scotia B1P 6L2, Canada <Lynn_Dafoe@cbu.ca>

2. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada

3. Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada

Since the mid 1800s, research conducted on the Joggins Formation has primarily focused on sedimentological, stratigraphic, and paleontological perplexities of the exposed cliffs. Despite this rich history of research, detailed studies of the less-preserved (generally soft-bodied) fauna that leave their mark as trace fossils is incomplete. Accordingly, this study incorporates a systematic ichnofossil record from the Joggins cliffs, as well as core from the River Hebert area, which adds another piece to the puzzle pertaining to faunal diversity, organism behaviours, and prevailing environmental conditions (water energy, food supply, and salinity).

Along the Joggins cliffs at Chignecto Bay, well-drained floodplain deposits reflecting a seasonally dry alluvial plain cut by channels are characterized by trackways (*Diplichnites* and *Kouphichnium*), locomotion trails (*Cochlichnus*), and unnamed burrow networks. This assemblage is typical of the *Scoyenia* Ichnofacies, which reflects fluctuations between periods of subaerial exposure and intermittent inundation by freshwater. During Joggins deposition, alluvial plains also reflected wetland conditions within poorly-drained floodplain units containing: trackways (*Diplichnites* and tetrapod trackways), locomotion trails (*Cochlichnus*), resting traces (*Limulicubichnus*), unnamed burrow networks, deposit-feeding structures (*Planolites*), and rare vertical dwellings (*Skolithos*). The presence of trackways again suggests an assemblage characteristic of the *Scoyenia* Ichnofacies; however one that is more diverse and abundant. Periodic flooding of these alluvial plain deposits is marked by limestones with faunal concentrates and associated open-water deposits characterized by locomotion or grazing traces (*Cochlichnus*, *Gordia*, and *Haplotichnus*), resting traces (*Limulicubichnus*), mobile deposit-feeding structures (*Taenidium*), horizontal dwellings (*Paleophycus*), unnamed burrow networks, and trackways (*Kouphichnium*). This diverse assemblage contains more abundant grazing structures and is best described by a transitional *Scoyenia-Mermia* Ichnofacies suggesting semi-permanent water bodies during deposition.

Surprisingly, a more fully marine ichnofossil signature was identified within core. Interbedded with fossiliferous shales that mark the onset of flooding, black silty shales contain a very low diversity suite of marine trace fossils (*Phycosiphon* and *Chondrites*) in low abundances. This suite of traces reflects a highly stressed *Cruziana* Ichnofacies, which supports previous work suggesting periods of brackish water deposition. These early results indicate that traces will be pivotal to further understanding the complex shift in Joggins coastal marine and alluvial settings.

Pennsylvanian emergence of anabranching fluvial deposits: the parallel rise of arborescent vegetation and fixed-channel floodplains

N.S. DAVIES AND M.R. GIBLING

Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada <neil.s.davies@dal.ca>

Anabranching (anastomosing) rivers are low-energy fluvial systems consisting of multiple channels separated by stable islands which evolve over time through avulsion. Such river systems host a variety of terrestrial sub-environments and habitats that have been relatively common during the Mesozoic and Cenozoic and into the present day. Anabranching requires bank stability, usually provided by vegetation or cohesive floodplain muds, both of which were prominent in the fluvial realm by the Siluro-Devonian. However, based on a literature review of 144 Cambrian-Devonian and 188 Carboniferous fluvial successions, facies interpreted as anabranching river deposits do not appear in abundance until the Pennsylvanian (Bashkirian).

Original field data from Carboniferous fluvial strata in Atlantic Canada and the SW USA support the assertion that a distinct suite of fluvial facies and sandbody geometries, still apparent in recent anabranching fluvial deposits, makes its first appearance at about this time. The channel deposits are narrow (width: thickness typically <15) with steep margins and aggradational fills, with little evidence for lateral accretion, and encased in floodplain muds with paleosols. Although it is rarely possible to demonstrate that the parent channels formed 3D networks, it is probable that some suites were anabranching. Although a few small, narrow channel bodies are known from Devonian and Mississippian formations, this "fixed-channel" style is conspicuously absent from older fluvial formations but is widespread from the Pennsylvanian onwards.

It is argued that the seemingly delayed appearance of this fluvial style in part reflects the infrequency of repeated short-term triggers for avulsion prior to a threshold-crossing increase in arborescent floodplain vegetation. The increase in arborescent vegetation through the Carboniferous would have resulted in an increase in the size, abundance, and distribution of large woody debris in fluvial channels. Such debris would have provided, for the first time, one of the most common triggers for river avulsion; as demonstrated by the fact that large log-jam deposits also first appear in the rock record during the Bashkirian.

Application of fractured aquifer characterization techniques in the development of a wellfield protection plan, Springdale, south central New Brunswick

A.J. DESROCHES[1], K.E. BUTLER[1], S. PELKEY[2], AND V. BANKS[2]

1. Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <aaron.desroches@unb.ca>

2. GEMTEC Ltd. 191 Doak Road, Fredericton, New Brunswick E3C 2E6, Canada

An integrated hydrogeological and borehole geophysical study was completed on the fractured sandstone and mudstone aquifer underlying the Springdale wellfield, located 18 km east of Sussex, New Brunswick. The objective was to characterize the bedrock fracture network responsible for the complex anisotropic conditions observed at the Springdale wellfield, and to determine the magnitude of the resulting drawdown around the primary and secondary production wells for purposes of developing a wellfield protection plan. Groundwater flow is primarily controlled by the distribution, and orientation of fractures dispersed throughout the aquifer.

Bedrock fractures were assessed by borehole logging methods within five vertical boreholes ranging from 36 to 91 metres in depth. Detailed inspection of the borehole images revealed 179 high-angle fractures and 84 bedding parallel fracture planes. Statistical analysis of the orientation of high-angle fractures indicates that they can be grouped into three discrete sets with mean strikes of roughly 005°-185°, 063°-243°, and 144°-324°. Mean perpendicular spacing's between fractures of the same orientation were calculated to be 0.3 to 0.6 metres, depending on the fracture set. Low-angle fractures associated with openings along bedding planes display a mean spacing of 1.2 metres. Considering that high-angle fractures comprise 68 percent of the identified fracture network, and that 13 percent of these fractures possess apparent apertures greater than 10 mm, they are expected to be a dominant influence on groundwater flow. This contrasts with earlier studies of Carboniferous aquifers in the area that attributed most flow to sub-horizontal bedding plane fractures.

Anisotropic groundwater flow conditions were confirmed using a network of 8 monitoring wells during a 24-hour pump test with a variable pumping rate ranging from 4.9 to 7.7 L/sec (64 to 102 igpm). Drawdown of 1.31 m was recorded in the pumping well, with a resulting drawdown of 1.23 m recorded 592 m away in a southeast orientation, consistent with one of the high-angle fracture set orientations. Observation wells situated to the northeast and southwest show minimal drawdown during the test. This borehole-geophysical approach combined with other hydrogeological analysis lead to an improved understanding of the anisotropic conditions influencing the groundwater flow system, and has further aided the development of a hydrogeological model.

Proterozoic to early Paleozoic lithotectonic terranes in New Brunswick, Canada

LESLIE R. FYFFE[1], SUSAN C. JOHNSON[2], AND CEES R. VAN STAAL[3]
1. Geological Surveys Branch, New Brunswick Department of Natural Resources, P.O. Box 6000, Fredericton, New Brunswick E3B 5H1, Canada <les.fyffe@gnb.ca>
2. Geological Surveys Branch, New Brunswick Department of Natural Resources, P.O. Box 5040, Sussex, New Brunswick E4E 5L2, Canada
3. Geological Survey of Canada (Pacific), Vancouver, British Columbia V6B 5J3, Canada

A significant advance was made to the understanding of the geodynamics of the Appalachian orogen with the introduction of four lithotectonic zones defined on the island of Newfoundland by Hank Williams in the early 1960s. The plate tectonic evolution of these zones was interpreted in terms of a simple, orthogonal Wilson Cycle. In such a model, the Humber Zone in the west and Gander Zone in the east represented opposing Laurentian and Gondwanan continental margins of the Paleozoic Iapetus Ocean. Vestiges of Iapetan island arcs and oceanic crust were preserved in the intervening highly deformed Dunnage Zone. The clastic sedimentary rocks characterizing the Gander Zone were thought to represent the continental rise prism deposited along the margin of Gondwana represented by the Neoproterozoic basement rocks of the Avalon Zone. The application of suspect terrane concepts in the early 1980s led to the recognition that the tectonic evolution of the Appalachians was far more complex than previously envisioned. The Gander and Avalon zones came to be viewed as separate ribbon microcontinents that were rifted at different times from different parts of the Gondwanan margin - Ganderia from the Amazonian craton and Avalonia from a position between the West African and Amazonian cratons. These microcontinents and fringing volcanic arc systems were subsequently accreted to the Laurentian continental margin during various episodes of Paleozoic orogenesis associated with oblique subduction of Iapetan ocean crust and closure of backarc basins.

Eight pre-Silurian lithotectonic terranes are presently recognized along the peri-Gondwanan margin of Iapetus in New Brunswick. The Caledonia terrane, which forms part of Avalonia, comprises Neoproterozoic continental volcanic arc rocks and comagmatic plutons. The remaining terranes are associated with Ganderia and include: Brookville terrane - Mesoproterozoic to Neoproterozoic platformal carbonates and Neoproterozoic to Early Cambrian plutonic rocks; New River terrane - Neoproterozoic volcanic and comagmatic plutons unconformably overlain by Early to Middle Cambrian rifted arc volcanic rocks; Annidale terrane - Late Cambrian to Early Ordovician arc-backarc volcanic rocks unconformably overlain by late Early Ordovician volcanic rocks; St. Croix terrane - Cambrian to Late Ordovician sedimentary rocks deposited along the continental margin of Ganderia; Miramichi terrane - Cambrian to Early Ordovician sedimentary rocks unconformably overlain by Early to Late Ordovician, ensialic, arc- backarc volcanic rocks; Elmtree terrane - Middle to Late Ordovician, backarc ophiolitic and sedimentary rocks; and Popelogan terrane - Middle to Late Ordovician volcanic arc and sedimentary rocks. The accretion of these terranes to the Laurentian margin is attributed to four major tectonic events: Early Ordovician Penobscot Orogeny; Late Ordovician Taconic Orogeny; Late Ordovician to Late Silurian Salinic Orogeny; and Late Silurian to Early Devonian Acadian Orogeny.

Petrology and tectonic implications of mafic to intermediate dykes in the Kellys Mountain area, Cape Breton Island, Nova Scotia

J.M. GATES AND S.M. BARR
Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada <075353g@acadiau.ca>

The Kellys Mountain area is located in east-central Cape Breton Island in the Bras d'Or terrane. The area is underlain by Proterozoic metamorphic rocks (Bras d'Or Gneiss and George River Metamorphic Suite), and Late Proterozoic and Late Cambrian dioritic and granitic plutons, all intruded by abundant mafic to intermediate dykes. Carboniferous sedimentary rocks of the Horton and Windsor groups unconformably overlie all of these units, constraining the age of emplacement of the dykes to between Late Cambrian and Late Devonian.

Petrographic examination of samples from 40 dykes from the area indicates that they are of five main types: clinopyroxene-bearing gabbroic dykes, amphibole-bearing dioritic dykes, gabbroic dykes containing both clinopyroxene and amphibole, plagioclase-rich gabbroic to dioritic dykes, and rare lamprophyric dykes with phlogopite phenocrysts. All of the dykes contain abundant secondary minerals such as chlorite, epidote, calcite, quartz, sericite, actinolite, serpentine, and prehnite. Pseudomorphs of olivine are evident in the lamprophyric dykes and some of the dykes containing clinopyroxene. Most of the dykes are fine-grained and a few are amygdaloidal, indicative of shallow emplacement. Mineral analyses by electron microprobe show that clinopyroxene compositions vary from augite to diopside. Amphibole in the dioritic dykes is magnesiohornblende, but in other dykes it tends to be secondary actinolitic hornblende. Plagioclase compositions in the dykes show a wide range from calcic (bytownite) to sodic (albite). Whole-rock chemical analyses of 21 samples show loss-on-ignition values up to 11.5% but mainly between 2 and 7%. Silica contents, recalculated volatile-free, range from 46% to 62%. Oxides TiO_2, $Fe_2O_3^t$, MgO, MnO, and CaO show negative correlation with SiO_2, whereas Na_2O, Al_2O_3, and K_2O show scatter but generally positive correlation with SiO_2. Trace element data also show wide scatter, although some show weak correlation trends with SiO_2. The dykes classified as gabbroic on the basis of mineralogy generally have volatile-free SiO_2 contents less than 52% and are mainly tholeiitic, transitional to alkalic, with the relatively immobile high-field strength elements indicating that they formed in a within-plate tectonic setting. In contrast, the dioritic dykes have higher SiO_2 and chemical characteristics suggesting that they are calc-alkalic and formed in a volcanic-arc setting. The lamprophyric dykes have compositions indicating that they are genetically unrelated to the other dykes.

Facies interpretations and lateral variability based on correlation of conventional core in the Logan Canyon and Missisauga formations of the Scotian Basin

K.M. GOULD[1], D.J.W. PIPER[2], AND G. PE-PIPER[1]

1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada <kathleen.gould@smu.ca>

2. Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada

The interpretation of sediment facies in the Lower Cretaceous of the Scotian Basin has been based almost entirely on vertical successions of rock recovered in conventional core or logged with wireline logs. Previous work by others in the Glenelg field has demonstrated that lateral correlation and interpretations of reservoir extent and connectivity require an understanding of the lateral extent and variability of sediment facies. In this study, two other areas of the Scotian Basin with several adjacent wells and overlapping cored intervals in the Aptian to Cenomanian Logan Canyon and Tithonian to Barremian Missisauga formations were investigated. The Panuke-Cohasset area included five wells sampling the Upper Member of the Missisauga Formation through to the basal Cree Member of the Logan Canyon Formation. The West Venture-Venture area includes five wells in the Lower Member of the Missisauga Formation.

A regional correlation in each area was completed using gamma ray well logs. Sixty-seven cores were described, using lithology, sedimentary, and biogenic structures to determine lithofacies. Using the regional correlation, packets of equivalent core were correlated and compared.

Within the Panuke-Cohasset area, the middle Cree Member in the Cohasset A-52 well shows tidal inlet facies, whereas 3 km away in the Balmoral M-32 well it shows trangressive offshore facies. The base of the Cree Member in the Cohasset well has a blocky gamma character, with estuarine channel and river mouth facies not seen in the gamma ray logs at Panuke B-90. Sand packages near the top of the Upper Missisauga Member are tidal flat to tidal estuary in Panuke, shoreface and river-mouth turbidites in Cohasset, and reworked sands and thick turbidites in Lawrence D-14. Down section, in the Upper Member of the Missisauga Formation, the Panuke well has muddy tidal deposits, whereas the Lawrence well remains sandy and less clearly tidal. Overall, facies become more distal to the NE. River mouth sand complexes have lateral dimensions of 15 km.

In the West Venture-Venture area, a key surface at the top of industry sandstone 7 and an underlying thick sandstone package give confident correlation across the area. This interval at the West Olympia O-51 well is slumped, and may represent a delta front. In West Venture C-62 and Venture B-52, delta-front turbidites in industry sandstone 6 are overlain by estuarine-tidal flat facies, but in West Venture N-91 and Venture H-22 are overlain by more distal prodelta sands and muds, suggesting delta lobe switching.

The recognition of facies associations and distinctive vertical successions of parasequences was effective for comparing and correlating across several wells. Individual trangressive surfaces and coal beds proved vital for reliable correlation between wells. Tidal parasequences can be quite local and therefore are more difficult to correlate than regional sandstone packages. Some sandstone packages are laterally continuous, even if depositional environment changes. Gamma logs are most effective for regional correlation, but since lithology and sedimentary facies change laterally on a scale of 10 km, gamma can only correlate major lithological changes related to sand input or transgressions.

Preliminary hydrogeological data and numerical modeling for a seawater intrusion study at Richibucto, New Brunswick

N.R. GREEN[1], E.B. MOTT[2], K.T.B. MACQUARRIE[1], AND K.E. BUTLER[2]

1. Department of Civil Engineering, University of New Brunswick, P.O. Box 4400,Fredericton, New Brunswick E3B 5A3, Canada <nathan.green@unb.ca>

2. Department of Geology, University of New Brunswick, P.O. Box 4400, Fredericton, New Brunswick E3B 5A3, Canada

Hydrogeological data collected from the area of Richibucto, New Brunswick, suggests the potential for seawater intrusion. In historic data from local supply wells, strong correlations exist between specific conductance and chloride content, as well as between chloride levels and pumping rates. Recent observations of specific conductance (and thus chloride content) in a monitoring well in a new portion of the pumping field are well correlated with water levels. Fluctuations in specific conductance during pumping suggest chloride concentration changes of about 10 mg/L, although concentrations remain well below the drinking water guideline of 250 mg/L. However, in a monitoring well located closer to the coast, the correlation between pumping and specific conductance is absent. This may indicate complex intrusion paths, perhaps vertically from lower in the aquifer (upconing), rather than horizontal encroachment.

Existing hydrogeological data from the study area have been assembled into a borehole database, and this has facilitated the construction of a preliminary two-dimensional numerical model in SEAWAT. Units included in the variable density groundwater flow model include a peat bog, surficial sediments, and a sandstone aquifer with discontinuous layers of siltstone resulting in semi-confined conditions. Initial simulations of pseudo-steady-state conditions, with no groundwater pumping, indicate that the Richibucto River and harbor would be a groundwater discharge zone and thus would not contribute to intrusion. However, a prominent saltwater wedge is developed deeper in the sandstone aquifer due to a hydraulic connection under the Northumberland Strait.

Future work will include the generation of a three-dimensional numerical model that will be used to simulate the effects of climate change and increased groundwater pumping on seawater intrusion. On the east coast of New Brunswick, sea levels are predicted to rise by as much as 0.74±0.28 m, mean annual air temperatures are forecast to increase by 3.7 °C, while

changes in precipitation are expected to be negligible through 2080. Results of such simulations could be used to provide recommendations that will assist the operation of water supply wells in coastal communities.

Marine influence at the Joggins Fossil Cliffs UNESCO World Heritage Site and its implications

MELISSA GREY[1,2], PEIR K. PUFAHL[2], AND ANNAS ABDUL AZIZ[2]

1. Joggins Fossil Institute, 100 Main Street, Joggins, Nova Scotia B0L 1A0, Canada <curator@jogginsfossilcliffs.net>

2. Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada

The Joggins Fossil Cliffs coastal section was selected as a UNESCO World Heritage Site for representing the Late Carboniferous Period, while the Joggins Formation is considered the best example of Pennsylvanian coal swamps in the world. Despite an abundance of research over the past 150 years, significant questions remain regarding the paleoenvironments of deposition, including the degree of marine influence. Accumulation of cyclothems occurred in the Cumberland Basin, a sub-basin of the Maritimes Basin complex of southeast Laurasia. Previous work suggests that brackish water lithofacies are associated with rising sea-level, indicating that the Cumberland Basin was only weakly connected to the open ocean. Lowstand conditions are interpreted to have caused complete restriction, producing an intracontinental basin.

New sedimentological and paleontological data from interbedded limestone beds indicate that Joggins was closer to the ocean than previously surmised. Open marine lithofacies characterize the base of the section and gradually change upward into fluvial dominated deposits. Limestone beds are 15 to 100 cm thick and contain ostracods, bivalves, and echinoderm fragments. They occur primarily at the base of cyclothems interbedded with coal and flood plain deposits. The presence of echinoderm fragments and framboidal pyrite infilling ostracods in older limestone beds, antithetic abundances between ostracods and freshwater bivalves, and an overall upwards coarsening into fluvial lithofacies provide independent lines of evidence for diminishing marine influence with time. These data indicate that the Cumberland Basin was well connected to the open ocean and thus much closer to the margin of Laurasia than previously thought. Such results also suggest that early *Cordaites* trees from the Joggins section are the oldest known examples of mangroves.

Identifying and mapping the saltwater transition zone in Summerside, Prince Edward Island

B. HANSEN[1], G. FERGUSON[1], Y. JIANG[2], AND D. JARDINE[3]

1. Department of Earth Sciences, St. Francis Xavier University, Antigonish, Nova Scotia B2G 2W5, Canada <bhansen@stfx.ca>

2. Environment, Energy, and Forestry, Charlottetown, Prince Edward Island C1A 7N8, Canada

3. DE JARDINE CONSULTING, Winsloe South, Prince Edward Island C1E 1Z3, Canada

The salinization of groundwater in coastal aquifers is a global phenomenon with the potential for severe consequences in water resources in localized settings. It is therefore, imperative to understand the interaction between fresh groundwater and sea water intrusion to best manage the available resources for the future. Summerside, Prince Edward Island (PEI) is the second largest city in the province and is located on an isthmus in the narrowest part of the island. The combination of intensive groundwater withdrawals and the close proximity to the coast makes this area highly susceptible to saltwater intrusion and intensive groundwater withdrawals have in the past lead to an encroachment of saline water into freshwater wells in the Summerside area. This study incorporates a detailed geological, geophysical, and hydrochemical analysis coupled with prior research, to provide an in-depth understanding of the underlying mechanisms which govern the location and extent of saltwater in the Summerside area aquifer. Six wells were drilled to varying depths in a rough transect, perpendicular to the coast. A down-hole camera was used in conjunction with electrical resistivity profiling to aid in the identification and correlation of geological units between wells. Water samples from varying depths along the transect were analyzed for major ions and stable isotopes to determine mixing relationships. With the beginning of the saltwater transition zone identified and mapped, preliminary variable-density modeling scenarios simulate the extent of this mixing zone, the response to parameter variability, groundwater extractions, and the effect of sea level rise on the position and extent of salt water intrusion for Summerside, PEI.

Imbricated Seboomook Group, Bald Mountain, west-central Maine: Tectonic, slump, or mixed origin?

J.L. HANSEN AND D.N. REUSCH

Department of Geology, University of Maine at Farmington, Farmington, Maine 04938, USA <jacob.hansen@maine.edu>

Bald Mountain is composed of pelite-rich turbidites correlated with the Devonian Seboomook Group, which have been metamorphosed to sillimanite grade related to late, regional-scale plutonism. This site hosts several prime examples of imbricated, boudinaged, and isoclinally folded beds, D_1, overprinted by regional F_2 folds. Four distinct marker beds recognizable by "barcodes" of sand and pelite layers, as well as a quartz vein-decorated fault, were mapped utilizing a high precision global positioning system (<0.5 m). Due to the degree of structural overprinting, the nature of the fault system was cryptic; recognition of these marker beds was necessary for the recognition of imbrications. Along the imbricated base of the hanging wall, bedding orientations follow an asymmetrical pattern of alternating subhorizontal, upright limbs and steeply dipping, southeast-topping limbs on subhorizontal, northeast-trending F_2 hinges. In the footwall to the northwest, the orientation of the bedding is similar, but the beds here are much thinner and more sand-rich. Higher in the hanging wall to the southeast, exist several thick beds that dip moderately (32-40^o) and top to the southeast. S_2 schistosity dips 80^o towards 293^o, while S_1 schistosity, present in one of the refolded isoclines, dips 78^o towards 330^o, showing two distinct cleavages.

It is still unclear whether this deformation was gravity driven or of tectonic origin, and whether the sediment was lithified or not. Imbrications are indicative of shortening, while boudins indicate lengthening; both can be found at the toe of a sediment slump. Mass wasting, triggered by liquefaction of bedding, is implied by the ductile nature of refolded F_1 isoclines. However, the earlier of two distinct cleavage surfaces located within the isoclines is suggestive of at least partially indurated beds during D_1 deformation. Since this terrane displays signs of both slump and tectonic features, it is most likely of mixed origin: a syn-sedimentary fault, resulting either from down-slope movement in the foreland basin or thrusting/slumping at the Acadian deformation front.

An orogen-wide perspective on the Appalachians

JAMES HIBBARD
Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, North Carolina 27695, USA <jim_hibbard@ncsu.edu>

Early, far-sighted Appalachian syntheses by Hank Williams provide the springboard for modern analyses that encompass the evolution of the entire orogen. At present, sufficient data have been accrued to allow for a more integrated and meaningful, orogen-wide perspective of Appalachian architecture and evolution. These data reveal that some first-order concepts derived from one portion of the orogen are applicable to other segments, implying periods of evolutionary convergence along the orogen. For example, recognition of a Dashwoods microcontinent in Newfoundland and documentation of mid-Paleozoic dextral translation of the Virginia promontory both have bearing on the interpretation of the entire orogen.

First-order contrasts between the northern and southern Appalachians are also recognized; some signify evolutionary divergence between these segments. The limited northerly distribution of Avalonia strongly supports the idea that the Acadian Orogeny is strictly a northern Appalachian event. The significance of other first-order contrasts in the orogen is more ambiguous; e.g. Grenville basement in the southern Appalachians contains a significant component of exotic Mesoproterozoic rock, whereas northern Appalachian basement is native Laurentian Mesoproterozoic rock; does this contrast contribute to differences between the northern and southern orogen? The contrast in Carboniferous tectonic styles between the northern and southern segments is also poorly understood. Likewise, the concentration of Devonian magmatism in the north and significant Carboniferous magmatism in the south is not fully understood; however, this pattern may well place constraints on the extent of strike-slip modification to the orogen.

Considering Appalachian evolution from an orogen-wide perspective raises broader questions that provide challenges to be addressed in the future. Upper crustal growth of the Appalachian orogen is clearly a progressive, outward accretion of crustal elements; however, is there any evidence of this growth pattern in the lower crust and lithospheric mantle? If not, what pattern is preserved? Also, Appalachian promontories persistently preserve the Iapetan ridge-transform geometry of the continental margin; what are the rheological implications of these long-lived features? And if the Appalachian Moho and mantle were rejuvenated in the late Paleozoic-Mesozoic, is the memory of this ridge-transform template preserved only in the crust?

Burial dating of Klondike and Upper White Channel gravels confirms a Pliocene age for the earliest advance of the Cordilleran Ice Sheet

ALAN J. HIDY[1], JOHN C. GOSSE[1], AND DUANE G. FROESE[2]
1. Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada <alanhidy@dal.ca>
2. Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3, Canada

The most extensive Cordilleran Ice Sheet (CIS) in northwestern Canada is also thought to be the earliest. Outwash gravel associated with this advance is magnetically normal, and predates the Mosquito Gulch tephra (ca. 1.4 Ma) in the Klondike area, suggesting either a Pleistocene (1.77-1.95 Ma; Olduvai) or Pliocene (2.58-3.58 Ma; Gauss) age. In the lower Klondike valley, this outwash (Klondike gravel) is interbedded with Upper White Channel (UWC) gravel, which is elsewhere associated with tephra beds dating to ca. 3 Ma on the basis of glass fission-track ages.

Here, in situ-produced cosmogenic ^{26}Al and ^{10}Be, is used to test the age model for earliest CIS advancement by burial dating sediment at the top of the UWC, and at the base of the Klondike gravel at Australia Hill near Dawson City, Yukon Territory. Based on recent estimates for post-depositional deep muon production, a mean burial age of 2.8±0.3 Ma (1σ) is calculated for the Klondike gravel. This result assumes a depositional ^{26}Al/^{10}Be ratio equal to 6.75 (spallogenic production ratio). Depositional ratios can differ substantially from this value due to: (1) temporary burial of sediment during transport (sediment storage or ice cover); (2) deep-seated mass wasting of material whose production ratio is controlled by muons; and (3) long-term (>1 Ma) stability followed by rapid erosion of surfaces contributing sediment to the deposit. However, reconciling these results and the paleomagnetic record with a Pleistocene age requires unrealistic exposure and erosion scenarios for the catchments sourcing the UWC. Furthermore, the ^{26}Al/^{10}Be ratios measured in the UWC and Klondike gravels are identical, suggesting an insensitivity of their depositional ratios to the widely different sediment sources, glacial histories, and transport mechanisms responsible for the two deposits. These results confirm a Pliocene age for the earliest advance of the CIS, and imply that large ice volumes in the northern Cordillera predate extensive Laurentide glaciation.

A temporal link between mantle metasomatism and kimberlite magmatism: evidence from olivine Mg-Fe diffusion profiles in metasomatized peridotite xenoliths, Jericho kimberlite, Northwest Territories

L. HILCHIE, Z. ZHANG, AND Y. FEDORTCHOUK

Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada <lhilchie@dal.ca>

Kimberlites are volcanic rocks formed from small-volume magma-crystal mixtures that are thought to form by interaction between subcontinental mantle peridotites and infiltrating metasomatic magmas or fluids (proto-kimberlite model). There is a temporal link between the emplacement of the Jericho kimberlite (Northwest Territories) and aqueous metasomatism affecting two xenoliths carried therein. The harzburgite xenoliths contain a primary assemblage of olivine, orthopyroxene, and garnet with accessory clinopyroxene, chromite, and phlogopite. The garnets feature reaction rims of phlogopite and spinel, and in the less altered sample orthopyroxene exhibits reaction rims of diopside and K-richterite (?). Phlogopite lines the grain boundaries throughout much of the less altered xenolith. In both samples, olivine contains overgrowth rims of more fayalitic olivine that are spatially associated with the secondary minerals. The growth of phlogopite and amphibole clearly represents a metasomatic influx of water and alkalis; by association the olivine rims represent the same event. Zoning profiles through the olivines show weakly diffuse contacts between cores and rims. Mg-Fe diffusion models were used to constrain the timescales between metasomatism and kimberlite eruption (quenching). At temperatures similar to those determined or expected for kimberlite magmas (1400-1000 °C), the models show that the metasomatic olivine rims were annealed for durations ranging on the order of one to 300 days. Even if it is assumed that annealing during magmatism had no effect on Mg-Fe diffusion (which is physically impossible), and that the crystals resided in relatively cold temperatures of 800 °C, only ~15 years diffusion time is permitted. Considering that kimberlites attain temperatures of ~1050-1170 °C at relatively late stages, these results indicate that hydrothermal metasomatism occurred within days of kimberlite magmatism at Jericho. These findings support the proto-kimberlite model, and indicate a water-rich proto-kimberlite fluid. Further studies of samples such as these may provide firm source-to-surface average magma ascent rates, and better constrain the composition of the proto-kimberlite fluids.

The southern Long Range inlier, Newfoundland:
evidence for early Appalachian thrusting of Paleozoic metasedimentary rocks within a Proterozoic basement massif

ALANA M. HINCHEY AND IAN KNIGHT

Geological Surveys Branch, Newfoundland and Labrador Department of Natural Resources,
P.O. Box 8700, St. John's, Newfoundland and Labrador A1B 4J6, Canada <alanahinchey@gov.nl.ca>

The Long Range Mountains of western Newfoundland contain one of the largest exposures of Proterozoic crystalline basement rocks within the Appalachian orogen, the Long Range Inlier. Recent regional bedrock mapping in the Silver Mountain and Bonne Bay areas suggests that it is not a simple stratigraphic inlier, but rather represents a massif reactivated during early Appalachian deformation. The basement rocks of the inlier comprise the largest portion of the external Humber Zone, considered to be the foreland belt of the Appalachian orogen. The inlier forms a structural culmination that is bounded to the west, north, south, and locally to the east, by Proterozoic to Paleozoic volcano-sedimentary cover rocks.

The southern part of the Long Range Inlier is broadly divisible into the following tectonic divisions: (a) high-grade Long Range gneiss complex; (b) foliated plutonic rocks, dominantly Grenvillian in age; (c) mafic dykes (Long Range dyke swarm); (d) thin remnants of a latest Neoproterozoic to Early Paleozoic cover sequence (previously interpreted as Grenvillian in age); and (e) Early Silurian gabbroic intrusions (ca. 430 Ma Taylor Brook gabbro) and minor felsic dykes, sills, and porphyries.

The latest Neoproterozoic to Early Paleozoic cover sequence is a quartzite-marble-dolomite sequence that is restricted peculiarly to the flanks of the Taylor Brook gabbro near Silver Mountain. These strongly recrystallized rocks compare to polydeformed Paleozoic metasedimentary rocks that lie below, and are carried unconformably upon, thrusted Proterozoic basement near Bonne Bay Big Pond at the southwest of the inlier. This indicates that the inlier may be thrust above the cover sequence along its southern edge. In the Silver Mountain area, the metasedimentary units flank the Taylor Brook gabbro and could either be thrust onto the Long Range Inlier, the structure later utilized during emplacement of multiple magmatic pulses of the gabbro, or form part of the footwall to the Long Range overthrust that was elevated during emplacement of the intrusion. The early Silurian age of the Taylor Brook gabbro however suggests that the timing of these structural relationships and emplacement of the massif is early Appalachian (Taconic or Salinic) and is likely to have significant implications on the timing of emplacement of the Taconic allochthons in the western Newfoundland Humber Zone.

Stratigraphic and structural relationships of the Elgin area, southeastern New Brunswick:
preliminary results from 2010 field mapping

STEVEN J. HINDS

New Brunswick Department of Natural Resources, Geological Surveys Branch,
P.O. Box 6000, Fredericton, New Brunswick E3B 5H1, Canada <steven.hinds@gnb.ca>

The Early Carboniferous age rocks of southern New Brunswick have been subjected to many phases of extension and inversion, approximately 320 to 353 million years ago. These events have resulted in multiple overlapping fault structures that pose a challenge to the subsurface correlation of the Albert Formation, and to determining the kinematics of each tectonic event. Further, the lacustrine facies of the Albert Formation change over short lateral distances. For example, the

Irving/Chevron Lee Brook and the Corridor/Columbia Will DeMille boreholes near Elgin have Albert aged facies that vary significantly despite being only a kilometre apart.

Recent field mapping in the Elgin area and a new generalized measured section of the Mapleton area have refined stratigraphic correlations and the location of fault structures within Tournaisian aged rocks along the southern margin of the Moncton Subbasin. As a result, the stratigraphy at surface can be successfully correlated to the Lee Brook well. From seismic and field interpretations, a steeply dipping fault structure has been identified between the two wells and provides the reason for the stratigraphic differences observed. This fault can be laterally traced to the surface south of Goshen and further work will be done to determine the fault movement style and the timing of the different tectonic events.

Preliminary chemostratigraphy of the Mabou Group in the Penobsquis area, Sussex, New Brunswick

NAZRUL ISLAM AND DAVID KEIGHLEY

Department of Geology, University of New Brunswick, Fredericton New Brunswick E3B 5A3, Canada <z1x61@unb.ca>

Lithostratigraphic subdivision for the Mabou Group in New Brunswick has previously met with little success due to limited outcrop, the absence of significant marker beds, and poor biostratigraphic control. The present study considers the post-Windsor Group section from drill core PCS-02-05 in the Penobsquis area to help subdivide the Group. Here, Mabou Group sedimentary rock consists of a variety of sandstone facies, gravel facies, and fine-grained facies. Most are brown, greyish-brown or reddish-brown coloured, poor to moderately sorted, moderately compacted, ferruginous or calcareous, and mainly horizontally laminated or cross-stratified. Broadly, sandstone, siltstone, and mudstone at the base of the section gradually coarsens up into conglomerate, and considered the result of active alluvial fan progradation However, horizontally laminated to cross-stratified bluish grey sandstone containing carbonaceous plant fragments and siltstone rip-up clasts occur between ~666-686 metres depth.

Bulk geochemical analysis (ICP-MS, XRD) of 59 samples from PCS-02-05 indicates anomalously high concentrations of Sr between 615-655 metres, whereas the Si/Na and Cs/Rb ratios increase and Ga/Rb ratio decreases above 655 metres. Coinciding with these trends, petrographic analyses indicate localized concentration of anhydrite concretions at this depth interval. The preliminary interpretation is that an unconformity, identified by the rip-up clasts, is also manifest in the overlying succession by changing detrital mineralogy and diagenetic phases. Ongoing studies of adjacent drill cores will attempt to confirm these trends and the validity of an unconformity-based subdivision of the post-Windsor red-beds, first postulated by Gussow nearly 60 years ago.

Trail degradation on the Nine Mile Trail system: a study on the effects of users on trail compaction and rutting

I.J. JACQUES AND L.J. PLUG

Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada <is654744@dal.ca>

Trail deterioration is a major issue to consider for trail builders and managers. Trail deterioration can be caused by: overuse, use of the trail for an unintended purpose, mismanagement, improper construction techniques, and failure to ensure proper upkeep. In order for trail management to adequately maintain a trail system, an understanding of the physical properties of soils and the underlying geomorphology, as well as the impacts that various types of uses will have on the trail is essential. The impacts can vary depending on the geological properties at the trail site. This study will attempt to provide trail managers with essential data regarding the influence that both the underlying geology and users can have on a trail track.

On a section of the new Nine Mile Trail system, just north of Elmsdale Nova Scotia, soil data and the slope of the trail section and its position in the overall topography of the area was noted. A total of 50 mountain biking and 50 hiking test runs, were completed to record the impact of these activities on trail compaction and roughness. The findings of this study show an average compaction of a trail cross-section of 2.2 mm, with a greater impact on areas of the trail that had higher than average soil moisture, as well as on areas with a steeper slope. The differing effects of hiking and mountain biking in this study were apparent. Both showed a similar amount of compaction after the runs, but the mountain biking showed a much greater tendency for rutting with roughness ratios of ~1.07, while hiking actually tended to have an overall flattening effect, a roughness ratio of ~1.02. These results indicate that a large number of factors can influence trail degradation. While these findings are specific to this trail, the methods used for determining both the natural effects and the user-influenced trail degradation can be applied to any trail location.

Bluestone formation of the Halifax Group: metamorphosed slope and mass-transport deposits, Halifax Peninsula, Nova Scotia

R.A. JAMIESON[1], JOHN W.F. WALDRON[2], AND C.E. WHITE[3]

1. Department of Earth Sciences, Dalhousie University, Halifax Nova Scotia B3H 4J1, Canada <beckyj@dal.ca>

2. Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3, Canada

3. Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, Canada

Fine-grained metasedimentary rocks of the Halifax Group in southern mainland Nova Scotia can be subdivided into mappable units. In Halifax Peninsula, pyrite-rich hornfels, black slate, metasiltstone, and metasandstone of the Cunard formation are overlain by grey metasedimentary rocks with abundant cross-laminations and local carbonate and calc-silicate concretions, assigned to the Bluestone formation, the highest part of the succession exposed in Halifax Regional Municipality. The most suitable type section lies along a railway cutting and adjacent roads into Point Pleasant Park. No fossils are known

from the Bluestone formation but lithological correlatives elsewhere contain graptolites and acritarchs indicating Tremadocian age.

Contact metamorphism produced cordierite + biotite + muscovite + albite + ilmenite + pyrrhotite in pelitic horizons throughout Point Pleasant Park. The cordierite-in isograd marks the outer limit of the contact aureole north of a conspicuous grain elevator; the biotite-in isograd is predicted to lie ~200 m to the south. Andalusite±K-feldspar appear west of Northwest Arm; the andalusite-in isograd is interpreted to run under the Arm, curving inland towards Williams Lake. The distribution of andalusite contrasts markedly with the underlying Cunard formation, where chiastolite appears before biotite in graphitic slates in the outer aureole.

Despite visits to the formation by generations of geology students, no stratigraphic subdivisions have previously been mapped. The formation is here divided into four members. The lowest (Point Pleasant member) contains thin parallel-laminated and cross-laminated metasandstone beds with Bouma Tbcde and Tcde structures, and thicker beds with Bouma 'a' divisions. The overlying Black Rock Beach member lacks the thicker massive beds and is dominated by rippled and cross-laminated metasedimentary rocks. The Chain Rock member, an erosion-resistant ridge-forming unit, shows bedding disrupted by folds, boudinage, and localized shear zones, interpreted as synsedimentary. The overlying Quarry Pond member consists of thinly bedded coherent metasedimentary rock that generally resembles the Black Rock Beach member.

Although there are indications of upward shallowing in equivalent successions elsewhere in the Halifax Group, the presence of a major mass transport deposit in the Bluestone formation shows that this part of the Halifax Group was deposited on a generally NE-facing submarine paleoslope.

A preliminary outcrop chemostratigraphic profile of the upper Green River Formation (Mahogany Oil Shale Zone - Uinta Formation boundary) in the Uinta Basin, Utah, USA

DAVE KEIGHLEY AND NICOLA HARCOURT

Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <keig@unb.ca>

In the Uinta Basin of eastern Utah, the base of the Mahogany Oil Shale Zone (MOSZ) marks the start of the mudstone-dominated upper Green River Formation (GRF). The thickness of the upper GRF increases from east to west due to the subsequent interfingering and progradation of the sandstone-bearing Uinta Formation; in the east of the basin at Buck Canyon, the upper GRF is ~175 m thick. Although variably grey to brown to black, variably shaley, variably organic rich (oil shale) to dolomitic to very finely arenaceous and tuffaceous, the mudstone of the upper GRF is not easily subdivided, and correlation exercises are complicated by the thickness variation and interfingering of the different types of mudstone. In such thick successions of mudstone and shale, where biostratigraphic control is lacking, an emerging method for subdivision is chemostratigraphy. This ICP-MS-based technique has the potential to subdivide section based on the identification of beds with unique elemental anomalies, gradual or stepped trends of increasing/decreasing elemental ratios in particular intervals of the succession, or changing dispersion about the mean of elemental ratios at particular horizons.

Samples were taken in the upper GRF at two adjacent sections near Buck Canyon. Regular, but different sampling intervals were chosen at the two sections, and additional samples were taken at other distinct beds. Statistically significant differences in the ratio of many pairs of elements between a lower and upper interval in the upper GRF were identified in one set of data, but not replicated in the other. A subtle decrease in the Ga:Rb and Fe:Ti ratios for shale samples are the only potential changes common to both sets of data. Recognition of elemental anomalies associated with particular beds shows much more promise. To date, work has concentrated on phosphorus anomalies associated with oil shales. One oil shale in both sets of data shows a P-enrichment of well over an order of magnitude, approaching 7% abundance. Additionally, the normalized abundance of REEs shows a distinct and unique increase in relative abundance progressively from the lightest to heaviest REE.

The Caribbean controversy: thinking outside of the plate

D. FRASER KEPPIE[1,2]

1. Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, Canada

2. Seismolab, Caltech, California, USA <keppiedf@gov.ns.ca>

There is a long-standing controversy regarding the tectonic evolution of the Caribbean Plate. Previous research has considered two end-member possibilities. During the Cretaceous, the Caribbean Plate may have formed in the eastern Pacific relative to North and South America and migrated relatively eastwards into its current position, or it may have formed roughly in situ. The Pacific model requires shear zone connections between the northern and southern Caribbean Plate boundaries and the Middle America Trench. However, interpretations of data indicate these boundaries may curve into North and South America, respectively, prior to reaching the Middle America Trench. The in situ model requires that sinistral and dextral displacements at the northern and southern Caribbean Plate boundaries, respectively, be balanced by west-east sense extension in the western Caribbean Plate. However, interpretations of data indicate >1100 km of total displacement versus <200 km of total extension for these parameters since the Cretaceous. Thus, neither the Pacific nor in situ models appear compatible with all of the data.

What if there is a third possibility? It turns out that the constraints of conservation of mass and triple junction stability permit another model for the tectonic evolution of the Caribbean Plate. Lithosphere from southern North America and northern South America may have rotated into the western Caribbean Plate region about counter-clockwise and clockwise poles of rotation, respectively. This model, dubbed the pirate model, involves assembling western Caribbean Plate lithosphere from

material originally located outside of the modern Caribbean Plate boundaries. At the northwest Caribbean Plate corner, operation of the pirate mode since the late Cretaceous links microplate escape with opening of the Gulf of Mexico. This is compatible with recent studies showing late Cretaceous and Cenozoic extension in the northwest Gulf of Mexico, but is incompatible with classic interpretations restricting opening of the Gulf of Mexico to the Jurassic. At the southwest Caribbean Plate corner, operation of the pirate mode helps to explain the clockwise relative rotation of the South American Plate into the western Caribbean region since ca. 55.9 Ma.

An overview of proven and probable Devonian mineralization in the Newfoundland Appalachians

ANDREW KERR

Geological Surveys Branch, Newfoundland and Labrador Department of Natural Resources, P.O. Box 8700, St. John's, Newfoundland and Labrador A1B 4J6, Canada <andykerr@gov.nl.ca>

From a metallogenic perspective, the Newfoundland Appalachians are best known for volcanogenic massive sulphide deposits formed during the Cambrian and Ordovician, in Iapetan island arcs and related marginal basins. Mesothermal ("orogenic") gold deposits are also widespread; direct and indirect evidence suggests that many of these are Silurian. This presentation reviews diverse mineralization of proven or probable Devonian age in the region, which is not as well-known as its older counterparts.

The best examples of Devonian mineral deposits are granite-related deposits in southern and south-central Newfoundland. These include the St. Lawrence fluorite deposits, two potential bulk-tonnage Mo±Cu deposits at Moly Brook and Granite Lake, and vein-style tungsten mineralization near Grey River. U-Pb ages and Re-Os (molybdenite) determinations from host rocks and mineralization suggest a Middle Devonian (Frasnian; 380 to 374 Ma) age for these systems. Vein-style base-metal, silver, and barite mineralization in the region around Placentia Bay is probably related to a large granitoid body of similar age concealed beneath coastal waters. Absolute age constraints are lacking for these minor deposits and the present knowledge of the age pattern of late magmatism remains incomplete. In central and northern Newfoundland, some mesothermal gold mineralization must also be Devonian or younger, based on dates from igneous host rocks. Many other such occurrences hosted by Cambrian-Ordovician sequences are not constrained by geochronology, and could also be post-Silurian. Epithermal-style gold mineralization is also locally present in east-central Newfoundland, and some of these veins and stockworks are hosted by late Silurian sedimentary rocks. This near-paleosurface style of mineralization may also be of Devonian age, and perhaps related to magmatic activity that is not manifested at the present erosion level. The vein-style antimony deposit at the Beaver Brook mine, which has not yet been dated, may also belong to this group of deposits.

A comparison of the behaviour of SiO_2 and Al_2O_3 during dissolution of quartz and sapphire in a CaO-Al_2O_3-SiO_2 melt at 1600 ^oC and 1.5 GPa

KIM B. KLAUSEN AND CLIFF S.J. SHAW

Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <r187a@unb.ca>

Since silicon and aluminium are considered to be network forming cations in silicate melts, their addition should result in increased melt polymerization and therefore higher viscosity. The behaviour of quartz and sapphire dissolving in a melt was examined in the CAS system (CaO=32.50, Al_2O_3=17.50, and SiO_2=50.00 weight percent). Experiments, two with quartz and two with sapphire, were carried out for 300 and 1800 seconds at 1600 ^oC and 1.5 GPa. The rate constants, determined by mass balance, are 2.2 $\mu m/s^{0.5}$ and 0.73 $\mu m/s^{0.5}$ for quartz and sapphire respectively.

Quartz dissolution results in a smooth diffusion profile for SiO_2 and CaO. However, Al_2O_3 shows unusual behaviour as there is a distinct peak in Al_2O_3 values, i.e. ~0.5% enrichment over the composition of the solvent which is not expected given that the dissolving phase is silica. For sapphire dissolution all profiles are as expected, i.e. Al_2O_3 decreases outward while SiO_2 and CaO increase outward.

Calculations of the variation in viscosity give an indication of the effect of the added components on melt structure. As expected, addition of SiO_2 leads to significant increase in the viscosity of the interface melt compared to the solvent i.e. 50-60 Pa s at the interface compared to ~1 Pa s in the solvent. Previous studies indicate that as the CaO/(CaO+Al_2O_3) ratio (Ca#) of melt decreases, there is a marked increase in viscosity. The data indicates that contrary to expectations, viscosity decreases by two orders of magnitude as the Ca# decreases inward. These experiments cover a different range of composition than those in the literature - (Ca# 60-77, compared to 40-62 in the literature). Preliminary data suggest that Al_2O_3 may have a different structural role in the melts produced in these experiments (acting as network modifiers rather than network formers).

The East Kemptville Sn deposit, southwest Nova Scotia: a product of focusing saline, F-rich magmatic fluids into an active fault zone

DANIEL J. KONTAK

Department of Earth Sciences, Laurentian University, Sudbury, Ontario P3E 2C6, Canada <dkontak@laurentian.ca>

The East Kemptville Sn-(Cu-Zn-Ag) deposit (ca. 56 Mt, 0.18% Sn) occurs in a medium-grained topaz-muscovite leucogranite. The leucogranite formed due to extreme fractionation of the chemically zoned, F-rich Davis Lake Pluton (DLP) which occurs at the western end of the 380 Ma South Mountain Batholith, southern Nova Scotia. Significantly, the leucogranite outcrops as an elongate body localized to the northeast-trending contact between the DLP and competent metasandstone rocks of the Meguma Supergroup. At the top of the intrusion, which is chilled against the adjacent metasedimentary rocks, occur zoned pegmatites, layered aplite-pegmatites, UST textures, aphanitic dyke, and miarolitic

cavities, which indicate pressure cycling and periodic fluid saturation during the terminal stages of crystallization that is constrained to P=3.5 kbars, T=≤500-600 °C. Mineralization occurs as structurally controlled, subvertical dipping and northeast-trending, cm- to metre-scale, zoned topaz-sulphide-cassiterite greisens and related, but paragenetically later, quartz-sulphide veins. The mineralization formed due to infiltration of F- and Sn-rich, saline (30-40 wt. % equiv. NaCl) fluids of magmatic origin, as indicated from isotopic data ($\delta^{34}S_{H2S}$ = +5±0.5‰, $\delta^{18}O_{H2O}$ = +8±1‰); fluid inclusion data integrated with mineral and isotope geothermometry constrain greisen and vein formation to ≤ 400-450 °C. The maximum concentration of greisens and, consequently, the widest ore zones, coincide with northeast-trending, brittle-ductile structures which traverse the deposit. Contouring of the Sn contents from blast-hole data also define the same structural features. In addition, the presence of quartz-sulphide-albite fibre veins coating faults, quartz-sulphide shear veins and mylonite zones suggest the mineralizing fluids infiltrated an active shear zone environment, the same structure which earlier localized the leucogranite. These data indicate that the East Kemptville deposit is an unusual type of granite-hosted Sn deposit in that it formed in a mesothermal setting (i.e., 10-12 km depth) rather than in a high-level, brittle environment which is more typical of vein and greisen Sn-W deposits. It is suggested that the unusual setting related to the localization of the DLP proximal to an active fault zone resulted in the breaching of an evolved, fluid-saturated melt causing the release of F- and metal (Sn-Cu-Zn) – rich fluids, which were subsequently focused into the structurally prepared host leucogranite.

Surficial sediments and Quaternary stratigraphy of Maces Bay, Bay of Fundy

C.L. LEGERE[1], B.B. BROSTER[1], AND J.E. HUGHES CLARKE[2]

1. Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <christine.legere@unb.ca>

2. Department of Geodesy and Geomatics Engineering, Ocean Mapping Group, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada

Maces Bay is a large triangular-shaped bay on the northwestern coast of the Bay of Fundy. Surrounding the bay onshore are extensive meltwater complexes deposited along coastal areas of New Brunswick during the Late Wisconsinan deglaciation (~14-12 ka B.P.). The Pennfield-Pocologan delta complex occurs along the coast in the Maces Bay area and grades eastward into a series of unnamed kame moraines and the Sheldon Point moraine at Saint John.

In the spring of 2008 the Ocean Mapping Group launch, CSL Heron, collected high-resolution geophysical data for Maces Bay. Sub-bottom profiler and multibeam bathymetry data were collected simultaneously to provide 28 km^2 area of Maces Bay seafloor at depths ranging from 4 to 70 metres. The offshore study area data consists of 371 km of seismic data, totaling 66 sub-bottom lines east-west and north-south orientation, providing information on the character and thickness of the subglacial features and overlying sediments on the sea floor.

Results are presented here for the surficial and subsurface Quaternary geology of Maces Bay using 3.5 kHz seismic sub-bottom, backscatter, and multibeam bathymetry. High-resolution seismic profiles provide information on both glaciation and deglaciation and its effect on the offshore geology. These results demonstrate that the Wisconsinan glaciofluvial deposits extend offshore into Maces Bay. There are two major depositional sequences characterized by the seismic data; glacial and glacial marine sequence and Holocene sequence. Within these units there are at least 5 distinct seismic facies. The glacial and glacial marine facies are till, sand and gravel, and glacial marine sediments. The glacial marine sediments were likely deposited by a proximal glacier, as they contain ice-rafted debris and incised channels. These were deposited by a melting glacier after retreating inland to the position of the Pocologan delta complex. Evidence of the low-stand of sea level, glacial fed channels, an esker, and other glacial landforms occur along the bottom and subsurface of Maces Bay underlying Holocene marine muds.

Creating 3-D Earth models that unify geological and geophysical information

P.G. LELIÈVRE, C.G. FARQUHARSON, AND C.A. HURICH

Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador A1B 3X5, Canada <plelievre@mun.ca>

Earth models used for mineral exploration or other subsurface investigations should be consistent with all available geological and geophysical information. Geophysical inversion provides the means to integrate geological information, geophysical survey data, and physical property measurements taken on rock samples. Inversion is a computational process that recovers models of the subsurface that could have given rise to measured geophysical data while maintaining consistency with the geological knowledge available.

Throughout the development of a mineral exploration site, subsurface models are developed based on available data and subsequent interpretations. Geological contacts are often known at points from drill-hole intersections and/or outcrop observations. The contacts can be interpolated or extrapolated throughout the subsurface volume of interest. Such 3-D geological models are typically created on unstructured wireframe meshes, which are sufficiently flexible to allow the representation of arbitrarily complicated subsurface structures. However, geophysical forward modelling and inversion algorithms typically work with regular rectilinear meshes when parameterizing the subsurface because this simplifies the development of numerical methods.

3-D rectilinear meshes are comprised of regular brick-shaped cells, tightly fitted together in three dimensions. The relevant rock type or physical properties are assumed to be uniform within each cell but possibly different from one cell to the next, creating pixelated models. Such meshes will always be incompatible with wireframe geological models, regardless of

how fine a discretization is used. To address this incompatibility unstructured tetrahedral meshes are used in the geophysical forward modelling and inversion techniques. On these meshes arbitrarily complicated features can be represented and it is therefore possible to have geological and geophysical models that are, in essence, the same Earth model. Geophysical modelling software is being developed using unstructured tetrahedral meshes for seismic travel-time, gravity, and electromagnetic data. A suite of tools necessary for creating a volumetric tetrahedral discretization of geological models containing triangulated surfaces is also being developed, and these techniques allow for the incorporation of a large amount of geological information.

Petrochemical evidence for autometasomatic alteration associated with fluidized emplacement of dykes in subvolcanic rhyolitic pyroclastic systems: implications for dissecting W-Mo-Bi and Sn-Zn-Cu-In ore-forming environments like Mount Pleasant, New Brunswick

DAVID R. LENTZ

Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <dlentz@unb.ca>

In intrusion-related environments, the emplacement of dykes can often be overlooked as part of an analysis of the ore-forming system. Although typically cryptic, fluidization is commonly the dominant process controlling the emplacement, via hydrofracturing, of these felsic dykes, based on rheologic arguments and empirical field and petrographic evidence, i.e., tuffisites. It is well known that that expansion of exsolved volatiles increases the ΔV of the system, thus enhancing the energy associated with an eruption.

The decrease in geostatic pressure to sub-hydrostatic conditions within the subvolcanic magma chamber and conduit further pressure quenches these evolved low-T magmas inhibiting flow as a melt. The rhythmic textural features, various types of quench textures (i.e., skeletal growth), crystal fragmentation, autobrecciation, and conduit scaling all point to the important role of magmatic volatiles, i.e., gas-glass.

Rheomorphic like features associated with continual emplacement of the tuffisite may be developed. However, subsolidus recrystallization processes, governed by the degree of undercooling below the solidus (ΔT), may obscure these primary textures. The vapour associated with pyroclastic emplacement can also alter and mineralize the quenched glass entrained within it, but also along the conduit walls, by devitrification-alteration processes; this mineralization process has implications for metal vapour transport.

These deuteric alteration effects resultant from F/R>>1 can obscure those same textural features that might otherwise indicate the emplacement mechanism. In addition, ore-element abundances and sulfur can be enhanced within these autometasomatically altered dykes indirectly revealing the ore-forming potential of the magmatic systems from which they were derived.

Geochronology of the Moly Brook Mo-Cu deposit, southern Newfoundland: implications for local and regional granite-related metallogeny

E.P. LYNCH[1], D. SELBY[2], V. MCNICOLL[3], M. FEELY[1], D.H.C. WILTON[4], AND A. KERR[5]

1. Earth and Ocean Sciences, School of Natural Sciences, National University of Ireland, Galway, Ireland <e.lynch9@nuigalway.ie>

2. Department of Earth Sciences, Durham University, Durham DH1 3LE, UK

3. Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada

4. Department of Earth Sciences, Memorial University of Newfoundland St. John's, Newfoundland and Labrador A1B 3X5, Canada

5. Geological Surveys Branch, Newfoundland and Labrador Department of Natural Resources, St. John's, Newfoundland and Labrador A1B 4J6, Canada

The Moly Brook deposit, located near Grey River on the south coast of Newfoundland, is hosted within deformed granitoid rocks of the Siluro-Devonian Burgeo Intrusive Suite. The deposit consists of a broadly linear zone of N-S-trending, steeply-dipping, sheeted to locally stockwork-style hydrothermal veinlets. Molybdenite and other sulphides occur as disseminated and stringer mineralization within quartz veins and adjacent wall rocks. Undeformed granitic and aplitic dykes and veins appear both spatially and temporally coincident with the mineralization. The results of Re-Os molybdenite and U-Pb (SHRIMP) zircon geochronology constrain the age of the host rock, sulphide mineralization, and cogenetic felsic magmatism. The data also suggest a link between the Mo-Cu mineralization and nearby tungsten deposits.

Re-Os molybdenite ages from four molybdenite-bearing quartz veins at Moly Brook yield a weighted mean model age of 380.9±0.8 Ma, or an ^{187}Re-^{187}Os isochron age of 381.2±1.8 Ma. Two samples from the Grey River deposit, in which molybdenite is paragenetically associated with lode tungsten mineralization, yield a weighted mean Re-Os model age of 381.4±1.2 Ma. Both ages are identical within uncertainty and are within the range of previously determined K-Ar ages on hydrothermal muscovite (~370-390 Ma). U-Pb (SHRIMP) zircon data from a molybdenite-bearing granite dyke at Moly Brook yields a $^{206}Pb/^{238}U$ weighted average zircon age of 378±3 Ma. The foliated granitoid host rock to the mineralization yields a $^{206}Pb/^{238}U$ weighted average zircon age of 411±3 Ma, which agrees with an earlier Rb-Sr whole-rock date of 412±5 Ma.

The Re-Os and U-Pb data show that Mo-Cu mineralization at Moly Brook was contemporaneous with the formation of W-bearing quartz veins at Grey River and suggest that both are cogenetic with a phase of evolved granitoid magmatism at ca. 380 Ma. The age of the granite dyke is identical to the age of the nearby François Granite (378±2 Ma), while the timing of mineral deposition in the Moly Brook area agrees with Re-Os ages determined for granophile mineralization within the Ackley

Granite (380±2 Ma), some 140 km to the east. These results add to evidence for a regionally significant and geologically concentrated episode of Upper Devonian granitic magmatism and related mineralization in this part of the northern Appalachians.

Nature and setting of Late Devonian-Early Carboniferous rare earth element mineralization in the northeastern Cobequid Highlands

T.G. MACHATTIE

Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, Canada <machattg@gov.ns.ca>

The most prominent geological feature of northern mainland Nova Scotia is the Cobequid Highlands, a ~150 km long and up to ~20 km wide crustal block consisting predominantly of Late Neoproterozoic and Late-Devonian-Early Carboniferous volcanic and plutonic rocks. The crustal-scale, Cobequid-Chedabucto Fault Zone defines the southern boundary of the highlands and its northern margin is unconformably overlain by Late Carboniferous sedimentary rocks of the Cumberland Basin. Bimodal Late Devonian to Early Carboniferous mafic and felsic plutonic and volcanic rocks dominate the geology of the central and northeastern highlands. From southwest to northeast these rocks constitute four distinctive lithological units: the Folly Lake Pluton (mafic), Hart Lake-Byers Lake Pluton (felsic), Byers Brook Formation (felsic), and Diamond Brook Formation (mafic).

Significant rare earth element (REE) and associated Y, Zr, Nb, and Th mineralization has recently been discovered in the Debert Lake area along the contact zone between granitic rocks of the Hart Lake-Byers Lake Pluton and overlying cogenetic felsic volcanic and volcaniclastic rocks of the Byers Brook Formation. REE mineralization is represented by fine- to coarse-grained magmatic/hydrothermal granitic dykes that range in thickness from <1 to >50 cm. The dykes often display well-developed mineralogical banding and sinuous intrusive contacts with their hosts, which include overlying felsic volcanic rocks, earlier granite phases of the Hart Lake pluton, and late diabase dykes. Chemically, the mineralized dykes are characterized by elevated SiO_2 (up to 75 wt.%), Fe_2O_3T (~7-13 wt.%), F (0.06-1.4 wt.%), exceptional heavy rare earth (HREE) and high-field-strength (HFSE) element enrichments (e.g. Y >6000 ppm, Yb >1000 ppm, Zr >10000, Nb >1000 ppm), and anomalous Sn (200-800 ppm), W (20-200 ppm), Sb (2-8 ppm), and Zn (200-800 ppm).

The origin of the dykes is interpreted, in part, to be related to differentiation of a high-level, unusually HFSE-rich, (Na-Fe)-amphibole-bearing alkali-feldspar granite phase of the Hart Lake pluton. The mechanism of differentiation is still not full understood but requires up to a ~100-fold increase in HFSE in the mineralized dykes compared to the HFSE-enriched granite. A prominent role for REE-partitioning into Na-Fe-F-rich hydrothermal fluids of magmatic origin is suspected. Support for this interpretation is found in the correlation between REE, Na, and Fe that occurs within intensely Na-altered rhyolites of the Byers Brook Formation immediately overlying the Hart Lake granite in the Debert Lake area.

Paleoproterozoic supercrustal deformation, Amer Lake, Nunavut

D.A. MACISAAC[1], J.C. WHITE[1], L. J. CALHOUN[1], AND C. JEFFERSON[2]

1. Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <dmacisaac.geology@gmail.com>

2. Geological Survey of Canada, Earth Science Sector, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada

The Amer basin comprises a sequence of Paleoprotorozoic units centered on Amer Lake, Nunavut (65°26'24"N, 96°46'44"W) approximately 150 km north of Baker Lake. There has been long standing interest in this area because of both its known uranium potential and its implications to the overlying uraniferous Thelon basin. The Amer Group supercrustals are divided into eight formations (from youngest to oldest); (1) Ayagaaq Lake, (2) Resort Lake, (3) Aluminium River, (4) Five Mile Lake, (5) Three Lakes, (6) Oora Lake, (7) Showing Lake, and (8) Itza Lake. These formations record four transitions, from a shallow marine environment to deep marine and back to shallow marine. Lithologies are characterized by orthoquartzite, quartzarenite, pelite, and dolomite with one episode of basalt volcanism in the lower part of the section. The Paleoproterozoic units in the study area structurally overlie mainly Archean granitoid gneisses with variable amounts of amphibolites.

The current disposition of units is as NE and SW doubly plunging synclinoria (D2) that define the regional structure. Despite the apparent simplicity of the latter, most of the internal deformation of units takes place prior to D2 as locally variable generations of D1 structures. This study examines the relationship between D1 and D2 structures in a critical area of the larger Amer basin structure. The study area consists of a well-defined D2 antiformal structure containing the Ayagaaq Lake through to the Oora Lake formations. The Aluminium River Formation dolomite exhibits extreme pre-D2 transposition, components of which are observed in the other units. In particular, mixed sandstone and phyllite units of the lower Resort Lake Formation contain multiple foliations and lineations. The complexity of deformation in this area is addressed by integrating detailed field mapping, high resolution geophysics, and microstructural analysis.

Testing the concept of altitudinal weathering zones on Cumberland Peninsula, Baffin Island, using terrestrial cosmogenic nuclide (TCN) exposure dating

A. MARGRETH[1], J.C. GOSSE[1], AND A.S. DYKE[2]

1. Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada <annina.margreth@dal.ca>

2. Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada

Fieldwork on Cumberland Peninsula has bolstered the concept of altitudinal weathering zones nowadays documented in many glaciated landscapes. Presently, the interpretation of altitudinal weathering zones is hotly debated and associated with a controversy over the maximum extent of both the Laurentide Ice Sheet (LIS) and local alpine glaciers during the Last Glacial Maximum. In particular, the question whether inter-fiord uplands remained ice-free during the last glacial cycle and thus served as biological refugia is significant. In this study, a new 1:100 000-scale map of the glacial deposits and ice flow stratigraphy of Cumberland Peninsula is constrained with TCN exposure ages throughout the peninsula and additional radiocarbon ages on mollusc shells from raised marine deposits along the coast. The TCN data reveal a significant inherited concentration of ^{10}Be and ^{26}Al, indicating glacial erosion was insufficient to remove previously exposed regolith. This supports previous notions of cold-based glaciation on Cumberland Peninsula, particularly in thin-covered highlands. Using the youngest ages at each sample site confirms that valleys and fiords were filled with glacial ice until around 12.5±1.2 - 12.1±1.1 ka (all errors 1□) with subsequent retreat to the interior until 8.8±0.8 - 8.3±0.7 ka. Separation of the LIS and local fiord ice occurred at about the same time (12.7±1.1 - 8.6±0.8 ka) based on a sequence of moraines damming a lake, whose shoreline sediments have been dated using a ^{10}Be depth profile. Significantly reduced ^{26}Al/^{10}Be ratios measured on inter-fiord uplands reveal a complex exposure history indicating one or more burial events likely due to protective cold-based ice cover. However, the timing of the last ice coverage cannot be estimated leaving the question of biological refugia during the last glacial cycle unanswered. A novel approach for estimating the timing of the last glacial plucking of exhumed pre-Quaternary tors combined with exposure dating with in situ ^{14}C to circumvent the problem of inheritance will be applied to test the diverse interpretation of altitudinal weathering zones and address the enigma of biological refugia on uplands.

Constructing a 3D geological model of the McCully Gas Field, southern New Brunswick

PAULA MARNER

Corridor Resources Inc. #301-5475 Spring Garden Road, Halifax, Nova Scotia B3J 3T2, Canada <pmarner@corridor.ca>

The McCully Gas Field in southern New Brunswick is a northeast-trending anticlinal structure, discovered in September 2000. McCully gas came on-stream in April 2003. In June 2007, first gas was delivered to the northeast American market via the Maritimes and Northeastern Pipeline. Production is from the upper part of the Albert Formation (Horton Group) Hiram Brook Member sandstones at approximately 2.5 km depth. The field is structurally and stratigraphically complex and compartmentalized by faults. Production is from 30 wells over 7 reservoir packages.

In order to understand this geological complexity, a 3D model has been constructed of the McCully field using multiple 3D seismic volumes, in combination with an extensive wellbore database. The objective of model construction is to understand the structure, fault compartmentalization, correlations, reservoir characteristics and gas-in-place volumes in greater detail. By developing a more consistent and integrated analysis in 3D space, the model can be utilized to plan complex wellbores with greater accuracy and to optimize gas extraction into the future.

"Durchbewegung" texture: what is it and does it occur in massive sulphide deposits of the Bathurst Mining Camp?

STEVEN R. MCCUTCHEON

McCutcheon Geo-Consulting, 1935 Palmer Drive, Bathurst, New Brunswick E2A 4X7, Canada <steve.mccutch@gmail.com>

The German words "durch bewegung" literally mean 'by movement/motion' in English, and the term "durchbewegung" texture (or structure/fabric) has been applied to mixtures of silicate and competent sulphide clasts (commonly rounded) in a matrix of less competent sulphides (typically pyrrhotite and chalcopyrite). Rock exhibiting this texture, "durchbewegt", has been interpreted to have formed by tectonic processes "involving disruption, separation, kneading, milling, and rotational movement" ever since this terminology was introduced in the 1960s. In effect, durchbewegt is a type of tectonic mélange that occurs in a shear zone within (or bounding) massive sulphides.

Mixtures of silicate clasts (typically chloritite) and sulphides (including pyrrhotite) are common in many deposits in the Bathurst Mining Camp (BMC), including Brunswick 12, Heath Steele, and Halfmile Lake. These mixtures either conformably underlie or are sub-parallel to the main sulphide mass, and have been interpreted as "transposed stringer zones", implying large-scale rotational movements and the presence of durchbewegung textures. However, such mixtures can also be formed by non-tectonic (depositional/replacement) processes and then deformed without significant rotational movement, as shown by examples from other deposits in and outside the BMC.

One way to distinguish tectonically produced durchbewegt from non-tectonic silicate-sulphide-clast mixtures is to look at the bounding surfaces (margins) of these bodies. The margins of durchbewegt will show the least disruption of original texture, analogous to "broken formation" in tectonic mélange, progressing inward to clast separation, milling, and rotational movement at the center of the body. Conversely, the margins of bodies produced by depositional/replacement processes will exhibit similar deformation effects as their centers, i.e. deformation will be more or less homogeneous across the body because there is no strain-focusing shear zone. Most of the macroscopic sulphide-silicate-clast mixtures in the BMC do not appear to be durchbewegt.

Triassic stratigraphy and topography at Grand Manan, New Brunswick

J. GREGORY MCHONE

9 Dexters Lane, Grand Manan, New Brunswick E5G 3A6, Canada <greg@earth2geologists.net>

The island of Grand Manan in the southwestern Bay of Fundy contains the only exposed strata of the Grand Manan Basin, a poorly known Early Mesozoic rift basin roughly 20 km wide by 65 km long. The Red Point Fault on Grand Manan is

its eastern border fault, so the western 2/3 of the island are within the basin and mostly covered by c.120 m of Grand Manan Basalt (equivalent to the North Mountain Basalt of Nova Scotia). Unlike in most rift basins of eastern North America, border fault movements have left Grand Manan Basin strata close to horizontal.

Exposed beneath the basalt along the western shoreline are up to 12 m of gray to maroon playa-type mudstone and fine sandstone, informally named the Dwellys Cove Formation and correlated with the Blomidon Formation of Nova Scotia. Coarse red sandstone with breccia exposed in a section a few metres thick at Miller Pond Road is apparently equivalent to the Wolfville Formation, and likewise it is the lowest stratigraphic unit in the Grand Manan Basin. Thicknesses of correlated sub-basalt formations in the Chinampas N-39 exploration well in the Fundy Basin north of Grand Manan are 1718+ m and 1157 m, respectively. These Late Triassic formations are estimated to span ages of c.230 to 201 Ma (Carnian to Rhaetian), and the 201.27 Ma basalt is also now latest Triassic (no longer earliest Jurassic) and a likely contributor to the end-Tr mass extinction.

Exposures of the Dwellys Cove mudstone are near the top of the Triassic sedimentary section, but the Miller Pond Road sandstone rests directly upon and mixes with the highly fractured upper surface of the Ingalls Head Formation, which is Late Neoproterozoic meta-volcanic/ meta-sediment correlated with the New River and Mascarene terranes of southern New Brunswick. The bedrock surface topography beneath the Miller Pond Road sandstone and across eastern Grand Manan is remarkably flat and level, suggesting that the present landscape is a relict Late Triassic peneplain that was beneath the Mesozoic basin and only recently exposed. The offset indicated for the Red Point basin border fault is therefore around 3000 metres.

Health and safety in mineral exploration - the role of the Prospectors and Developers Association

BILL MERCER

Avalon Rare Metals Inc., Suite 1901, 130 Adelaide St West, Toronto, Ontario M5H 3P5, Canada
<bmercer@avalonraremetals.com>

Mineral exploration has unique health and safety issues because working conditions are complex and often in remote regions subject to extremes of weather and terrain. The industry is increasingly dominated by junior companies and small contractors, which lack the internal health and safety resources of major companies. With the recent expansion in mineral exploration there has been a significant increase in accidents and fatalities in Canada. Due to difficult access to advanced medical care while working in remote sites, minor accidents have the potential to become major issues.

The Prospectors and Developers Association recognizes that health and safety are integral parts of responsible mineral exploration (corporate social responsibility) and in 2005 formed a committee to assist industry achieve zero fatalities and to decrease accidents. For five years the PDAC committee has assessed exploration safety performance through an annual Canadian national exploration accident survey by partnering with the Association for Mineral Exploration in British Columbia (AME BC). Companies are encouraged to submit their safety records for the year, and the data is combined to create a statistical analysis of accident causes. Since the inception of the survey, the proportion of responding companies has increased rapidly resulting in improved understanding of the causes of accidents. An overview of the results of these surveys will be presented, with recommendations to improve field safety.

In addition to the survey, the PDAC has commissioned the most comprehensive 800 page global manual for exploration health and safety. The purpose, contents, and use of this manual will be briefly reviewed. Finally, the association is in the process of developing a pocket sized variant of the comprehensive manual.

The presentation is part of PDAC's attempt to improve field safety through researching incidents, publishing procedure manuals, and publicizing incident causes. The whole health and safety initiative is an integral part of PDAC's E3 Plus principles for responsible exploration, which comprises comprehensive material in the areas of community relations, environmental practice in the field, and health and safety.

Environmental characterization of the Hudson Strait Coral Hotspot: current state of knowledge

SHAWN MEREDYK

Department of Environmental Science, Memorial University of Newfoundland,
St.John's, Newfoundland and Labrador A1C 5S7, Canada <smeredyk@mun.ca>

The Hudson Strait Coral Hotspot (HSCH) is one of many areas in the northwest Atlantic that were identified as hotspots of coral biodiversity by the Canadian Department of Fisheries and Oceans (DFO) and Memorial University, in 2007. Previous DFO-Memorial University research has shown an elevated large weight (>500 kg) of cold-water sponges and broad diversity of cold-water corals are being caught as a result of commercial bottom fisheries within the Northwest Atlantic Fisheries Organization (NAFO) regions 0B and 2G. Known and predicted cold-water coral and sponge habitats in the HSCH and Baffin Bay areas are presented as a series of maps. Qualitative predictive habitats, were generated using an interdisciplinary methodology; through an interaction analysis of oceanographic, geological (including sub-surface seismic profiles), biological, and ecological data relative to the fisheries (northern shrimp and demersal fish) spatial harvesting effort/"footprint". The proposed placements of Vulnerable Marine Ecosystems (VMEs) using an Ecosystem-based Management (EBM) approach are delineated and presented alongside knowledge gaps in habitat conservation for the HSCH. Efforts to sample naturally occurring petroleum seeps and coral and sponge habitat in the HSCH are scheduled for the summer of 2011.

Preliminary interpretation of electrical resistivity tomography (ERT) surveys investigating seawater intrusion at Richibucto, eastern New Brunswick

E.B. MOTT[1], N. GREEN[2], K.E. BUTLER[1], AND K.T. MACQUARRIE[2]

1. Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <eric.mott@unb.ca>

2. Department of Civil Engineering, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada

The coastal community of Richibucto, New Brunswick, situated 65 km north of the city of Moncton, has a municipal wellfield producing from a fractured sandstone aquifer, with wells located approximately 1 km from the coast and within 500 m of a tidally influenced brook. In recent years some wells have experienced elevated levels of groundwater salinity, an issue that was addressed by expanding the wellfield farther inland with the commissioning of a new pumping well in the summer of 2010. In light of this history, the Richibucto area was selected as the focus for a study of how climate change and sea level rise are expected to affect seawater intrusion along New Brunswick's predominantly low-lying eastern coast. One of the study objectives is to assess the current groundwater salinity distribution using noninvasive geophysical techniques.

In late July 2010, electrical resistivity tomography (ERT) surveys were carried out along seven profiles, each 400-800 m in length, in an effort to identify the current extent of saline water intrusion. ERT data were acquired, in both dipole-dipole and Wenner array configurations, using a 72-electrode Syscal Pro resistivity system with electrodes spaced 6-10 m apart. A two-dimensional inversion algorithm (RES2DINV) was used to generate resistivity sections for each profile to depths of approximately 60 to 100 m. Line 1, located along a narrow peninsula-like point of land, revealed relatively low resistivities of 30-60 ohm-m below 35-40 m depth, suggesting the presence of saltwater-freshwater mixing beneath a freshwater lens. Lines oriented perpendicular to the coast, and extending into the wellfield showed no compelling evidence of significant lateral saline intrusion from the coast. However, anomalously low resistivities were found at depths below 25-45 m in the vicinity of the main pumping well (PW1). Preliminary modelling of the effects of steel well casings on nearby measurements of earth resistivity indicates that the anomaly is far too strong to be explained as such an artifact. The low resistivities below the well may instead be indicative of saline water being drawn up from depth by pumping; a process known as upconing.

Highly depleted oceanic lithosphere in the Rheic Ocean: implications for Paleozoic plate reconstructions

J. BRENDAN MURPHY[1], BRIAN L. COUSENS[2], JAMES A. BRAID[1], ROB A. STRACHAN[3], JAROSLAV DOSTAL[4], J. DUNCAN KEPPIE[5], AND R. DAMIAN NANCE[6]

1. Department of Earth Sciences, St. Francis Xavier University, Antigonish, Nova Scotia B2G 2W5, Canada <bmurphy@stfx.ca>

2. Department of Earth Sciences, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario K1S 5B6, Canada

3. School of Earth and Planetary Sciences, University of Portsmouth, Burnaby Road, P.O. Box 1, Portsmouth 3QL, UK

4. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada

5. Instituta de Geologia, Universidad Nacional Autonoma de Mexico, 04510 Mexico D.F., Mexico

6. Department of Geological Sciences, Ohio University, Athens, Ohio 45701, USA

The Rheic Ocean formed at ca. 500 Ma when some peri-Gondwanan terranes (e.g. Avalonia, Carolinia) drifted from the northern margin of Gondwana, and was consumed during the Late Carboniferous collision between Laurussia and Gondwana, a key event in the formation of Pangea. Several mafic complexes ranging from ca. 400-330 Ma preserve many of the lithotectonic and/or chemical characteristics of ophiolites. They are characterized by anomalously high εNd values that are typically either between or above the widely accepted model depleted mantle curves. These data indicate derivation from a highly depleted (HD) mantle and imply that (i) the mantle source of these complexes displays time-integrated depletion in Nd relative to Sm, and (ii) depletion is the result of an earlier melting event in the mantle from which basalt was extracted.

The extent of mantle depletion indicates that this melting event occurred in the Neoproterozoic, possibly up to 500 million years before the Rheic Ocean formed. If so, the mantle lithosphere that gave rise to the Rheic Ocean mafic complexes must have been captured from an adjacent, older oceanic tract. The transfer of this captured lithosphere to the upper plate enabled it to become preferentially preserved. Possible Mesozoic- Cenozoic analogues include the capture of the Caribbean plate or the Scotia plate from the Pacific to the Atlantic oceanic realm. This model implies that virtually all of the oceanic lithosphere generated during the opening phase of the Rheic Ocean was consumed by subduction during Laurentia-Gondwana convergence.

Geospatial analysis of mercury in stream and lake sediments across Canada

M. NASR[1], P.A. ARP[1], AND A. RENCZ[2]

1. Faculty of Forestry and Environmental Management, University of New Brunswick, Fredericton, New Brunswick E3B 6C2, Canada <mnasr@unb.ca>

2. Mineral Resources Division, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada

The Geological Survey of Canada's (GSC) sediment historical surveys provide data for total mercury concentrations (THg) and other elements of stream and lake sediments across Canada. This study developed a GIS-based framework for investigating these data by wet-area coverage per basin above each sampling location, using digital elevation models (DEMs). Average THg were found to be higher on upland than lowland terrains (p-value <0.0001), with the highest values from areas affected by high geo-genic sources, metal exploration sites, and mining activities. Lakes had higher THg than streams. Lake and stream THg were correlated with AES-modelled atmospheric mercury deposition (p-value <0.0001; R^2=0.74), except for alpine and arctic locations where sediment THg was relatively low. The THg data within Selwyn basin in Yukon Territory, the

area north-east of the Great Bear Lake in North West Territory, Nova Scotia, and in northern New Brunswick were further investigated using multiple regression analysis, and were found to be positively related to total Cd, Cu, Zn, and Ag and loss of ignition, and negatively related to the wet-area coverage per basin (overall model R^2=0.65). The importance of the wet-area coverage per basin became strongly accentuated when grouping the stream sampling locations by $\log_{10}$THg classes from low to high, and by determining the mean wet-area coverage per basin for each by logTHg class (R^2=0.76 and 0.90, respectively).

Differentiation processes within the Manicouagan impact melt sheet, Quebec

C.D. O'CONNELL-COOPER AND J.G. SPRAY

Planetary and Space Science Centre, Department of Geology, University of New Brunswick, 2 Bailey Drive, Fredericton, New Brunswick E3B 5A3, Canada <r52bm@unb.ca>

The impact crater site at Manicouagan, Quebec (51° 23° N, 68° 42° W) is the 2nd largest of Canada's 30 confirmed impact structures. The Manicouagan impact structure (215.56±0.05 Ma), is a complex impact structure (D=90 km), formed within predominantly crystalline metamorphic and igneous rocks of the Grenville Province of the Canadian Shield. Previous studies (based on observable melt) describe a geochemically homogeneous melt sheet, with a post-erosion thickness of the melt sheet estimated at 230 m (with a further 50 metres lost to erosion), and a preserved melt volume of around 1000 km^3. As with all other terrestrial impact melts (excluding Sudbury, Ontario), differentiation was not recognized at Manicouagan.

This study examines >3100 m of melt sheet from 9 drill holes located across the impact melt sheet and confirms a (local) depth of c.1400 m (including clast-laden melt), and a macroscopic clast-free impact melt of c.1000 metres. On the basis of whole-rock geochemistry (major, trace, and REE element analysis) and degree of internal differentiation, the clast-free impact melt sheet at Manicouagan is divided into two distinct units - undifferentiated (U-IMS) and differentiated (D-IMS). The U-IMS is composed of a homogeneous quartz monzodiorite, showing little variation in terms of major, trace, or REE element chemistry with respect to depth.

The D-IMS shows considerably more variation, and can be subdivided into three clast-free to clast-poor melt units (total 1045 m), underlain by a clast-laden melt unit (450 m). The D-IMS progresses from a monzodiorite (Lower Zone) through quartz monzodiorite (Middle Zone and Upper Zone) to rare quartz monzonite. The compositional difference within the D-IMS is also reflected in trace and REE abundances.

Isotope analysis (Rb, Sr, and Pb) has shown the melt sheet to have a homogeneous isotopic signature, suggesting that footwall assimilation or contamination does not play a significant role in the differentiation of the D-IMS. It is speculated that the large volume of melted material in the D-IMS facilitated fractional crystallization processes, not seen in other shallower parts of the melt sheet.

Modelling and mapping hydrological risks related to flooding and slopes, inland to coastal

J. OGILVIE, M. CASTONGUAY, AND P.A. ARP

Faculty of Forestry and Environmental Management, University of New Brunswick, Fredericton, New Brunswick E3B 6C2, Canada <jae.ogilvie@unb.ca>

Potential hydrological risks (flooding and slope instabilities) can be modelled and mapped (mainland, coastlands, and islands) using; (i) province- to state-wide digital elevation data and images, and (ii) local LiDAR-derived digital elevation models (DEMs). This modelling and mapping applies conventional algorithms used for deriving slope, flow direction and accumulation from DEMs into map features displaying (i) flow channels, (ii) flood plains, (iii) the cartographic depth-to-water next to all flow channels, shorelines, and wetland borders, and (iv) the extent to which coastal lands are subject to sea-level rise. Additional algorithms are used to automatically (i) locate road and stream of flow-channel crossings, (ii) draw catchment borders based on catchment order or stream order, and (iii) display and classify the recharge-discharge zonation across the land. The maps provide a high-resolution platform for planning land and water resources, from state-, municipal, industrial, and private perspectives, with geological and ecological considerations included. The illustrations show how this modelling process works, with examples for New Brunswick and Nova Scotia. This process can used to anticipate and determine the extent of inland and coastal flooding and related damage to local infrastructure.

Controls on regional variability in sea-floor diagenesis in Upper Jurassic-Lower Cretaceous pro-deltaic sandstone and shales, Scotian Basin, eastern Canada

A.C. OKWESE[1], G, PE-PIPER[1], AND D.J.W. PIPER[2]

1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada

2. Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada

Diagenesis in the uppermost Jurassic to Lower Cretaceous sandstones and shales of the Scotian Basin is an important control on reservoir quality. These rocks are deltaic, up to 3 km thick, with progradational parasequences with high sedimentation rates capped by transgressive units with much lower sedimentation rates. Mineral phases in the sea-floor diagenetic system are commonly preserved where there was abrupt change in sedimentation rates, and also in coated grains found in transgressive units. This study assesses the role of sea-floor diagenesis in the overall diagenetic system by studying the sedimentology, mineralogy, and geochemistry of the transgressive unit and underlying sediments from conventional cores in the Peskowesk A-99 and Thebaud C-74 wells.

Coated grains preserve a record of whether sea-floor diagenesis was dominated by suboxic or sulphate reduction processes. Type A grains result from suboxic reduction of Fe to give Fe-silicates and siderite, favoured by low organic carbon availability and/or by brackish water. Where reworked into high-productivity outer shelf areas, they alter to type C coated grains with an outer cortex of Mg carbonate, covering replacive pyrite, Fe-calcite, and ankerite. Where buried by rapidly deposited organic-rich sediments, they alter to type B coated grains with Fe-calcite, pyrite, and in some cases kaolinite. Facies that are directly supplied by riverine sediments have a lower Fe:Ti ratio than do fully marine facies 1, 2, and 3 as a result of input of detrital ilmenite and its alteration products. Suboxic diagenesis is common in low sedimentation rate transgressive sediments with low carbon content, and in delta-front turbidites and river-mouth sandstones, generally with little interbedded mudstone and hence low carbon content. Where large changes in sedimentation rate occurred at transgressive surfaces, the underlying progradational sediments have a higher total Fe content to a depth of as much as 10 m. The suboxic diagenesis forms Fe-silicates that are precursors of chlorite rims on framework grains. The distribution of suboxic diagenesis is thus a predictor of the distribution of high porosity preserved by chlorite rims.

A conceptual review of water extraction requirements associated with shale gas activities in New Brunswick

K.J. O'SHEA

Dillon Consulting Limited, Cambridge, Ontario N3H 4R7, Canada <KOShea@dillon.ca>

The development of shale gas resources throughout North America has been referred to as an economic game changer by economists and the media. Recently developed techniques to fracture low permeability host rocks to extract significant volumes of natural gas are reshaping the global energy supply chain. As shale gas exploration activities expand reserves, an exciting variety of economically viable opportunities are emerging for increased use of natural gas as a "clean" fuel for generation of energy.

However, there has been a collision between the needs of the industry to access large volumes of water to fracture the host rock and public perception. People have expressed concerns that potential environmental impacts associated with the industry's use of water are excessive. Further complicating the matter, shale gas related activities commonly occur in areas where, historically, there has not been a strong oil and gas industry presence. In the absence of an established relationship with the industry representatives, people in the local communities are turning to some information sources that may not be subjected to the appropriate level of scientific rigour. Developers are concerned that the fear and emotion being generated in the public sphere can sway regulators to place moratoriums, or outright bans on shale gas. Accordingly, the shale gas industry needs to proactively respond to these concerns by collecting and distributing the scientific data required to help enable the public, politicians, and policy makers to formulate educated decisions regarding future of this valuable resource.

As a starting point, the industry can collect the data required to benchmark water usage associated with the shale gas activities against other activities that are familiar to the public. A preliminary attempt at compiling publically available data to benchmark shale gas developments in New Brunswick has been completed. The data has been reviewed to determine the relative potential impact that shale gas development could have on the regional water resources assuming a peak of 200 wells are being fracced each year.

A laboratory method for the quantification of mercury and GHG volatilization from soils

R. PANNU[1], N.O' DRISCOLL[2], S. SICILIANO[1], J. DALZIEL[3], AND A. RENCZ[4]

1. Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan S7N 5A8, Canada <r.pannu@usask.ca>

2. Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada

3. Environment Canada, Dartmouth, Nova Scotia B2Y 2N6, Canada

4. Natural Resources Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada

Elemental mercury is a volatile metal at standard temperatures which can be transformed into several species in ecosystems some of which are persistent, bio-accumulative and highly toxic. Mercury emitted from natural sources is eventually deposited to ecosystems, thus re-entering terrestrial and aquatic systems. Natural emissions and re-emissions of mercury from soils have been identified as a major contributor to the global mercury budget and conservative estimates of global mercury fluxes suggest a total of 700 to 1000 ta^{-1} volatilized from soils. The growth of research in soil Hg emissions has brought attention to a large number of uncertainties associated with the estimation of the overall contribution of soil Hg emissions to the atmospheric Hg pool and the effects on global Hg cycling. An accurate assessment of mercury emissions from soils is crucial in order to quantify and predict the movements of natural and re-emitted mercury from anthropogenic sources. Soils can store and release large quantities of carbon through natural processes including litter deposition, decomposition, and root respiration. The main processes producing CO_2, N_2O, and CH_4 are microbial related and are strongly influenced by soil moisture content. The exchange of green house gases (CO_2, CH_4, and N_2O) between soils and the atmosphere is an important contributing factor to global climate change.

Two simple, accurate and reproducible laboratory methodologies for simultaneous quantification of mercury and green house gas volatilization from different soils were compared using two types of flux chambers: the Li-Cor flux chamber and the O'Driscoll et al. (2005) Hg flux chamber design. The Li-Cor chamber is an automated unit while the O'Driscoll et al. (2005) Hg flux chamber is a simple quartz chamber. Preliminary data of the mercury and green house green emission from soil samples as affected by increasing moisture will be presented. Analysis of mercury flux using the Licor flux chamber and the O'Driscoll et al. (2005) Hg flux chamber was found to be above the method detection limits and reproducible (mean RSD of triplicates <5-10%) for a series of soil samples with varying carbon and total mercury contents. Short term mercury flux from

these soils, determined by both the Li-Cor and O'Driscoll et al. (2005) Hg flux chambers was significantly and linearly related as tested by principle axis slope. The green house gas degassing was found to be increasing with increasing (up to 60%) water filled pore space moisture contents.

The REE and rare metal accessory minerals of the A-type granite of the Late Paleozoic Wentworth pluton, Cobequid Highlands, Nova Scotia

ANGELIKI D. PAPOUTSA AND GEORGIA PE-PIPER

Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada

The Wentworth pluton comprises an early granite emplaced about 362 Ma, intruded by a major gabbro (~354 Ma) that remelted large parts of the original A-type granite. The mineralogy and geochemistry of these rocks have been investigated by petrographic microscope, electron microprobe, and whole-rock geochemical analyses in order to determine the genetic links between the petrogenesis of the granite and the rare earth and rare metal element mineralization in the pluton.

The accessory mineral phases in the granites include magmatic phases like allanite, chevkinite, hingganite, and zircon and post-magmatic mineral phases like samarskite, aeschynite, yttrocrasite-Y, Th-rich zircons, rutile, thorite, and bastnaesite. The early fractionation of magmatic allanite in the early granite and of chevkinite in syn and post-gabbro granites indicates that magma was close to REE saturation. Presence of these minerals in the granite is significant, not only for establishing the magmatic origin of the mineralization, but for revealing several stages of REE and rare metal – mineral formation related to the magmatic evolution of the Wentworth pluton.

The early granites contain 200-600 ppm fluorine. The presence of F in the granitic magma resulted in the REE phosphates remaining in solution, so that monazite-xenotime saturation was never achieved, which would otherwise have removed LREE from the magma. When the early granites were emplaced, allanite crystallized. After the gabbro intrusion and granite melting, chevkinite crystallized. These minerals are major sinks for LREE, resulting in the granitic magma becoming enriched in middle and heavy REEs forming hingganite during late magmatic stages. Partial melting of the early Wentworth granite from the younger gabbro resulted in the release of F and Li in volatile phases. Fluorine started to circulate through late magmatic fluids, along with the REEs and rare metals like Nb, Y, Th, and U. Changes in fluorine activity led to the precipitation of Y and HREEs in samarskite, yttrocrasite, and in the fluid enrichment in LREEs. The enriched fluids leached yttrocrasite and altered samarskite to aeschynite. Geochemical changes in the fluids resulted in the reduction of Zr mobility. This led to the precipitation of Th, forming Th-rich zircon overgrowths and thorite inclusions in magmatic zircons. The formation of the fluorine-bearing carbonate bastnaesite could be related to the 320-315 Ma hydrothermal circulation along the Cobequid-Chedabucto fault which is related to carbonate and sulphide-rich fluids.

It appears that parameters like the high temperatures from the coeval mafic magma, hydrothermal activity and the presence of fluorine both in the granitic magma and in late magmatic fluids were significant factors for the formation of the magmatic and post-magmatic minerals that appear to be significant hosts for REEs and rare metals. The identification of these factors could have significant applications in establishing magmatic models for REE enrichment for further investigation of prospective areas for the mining industry.

Unstable at any scale: slumps, debris flows, and landslides during the deposition of the Albert Formation, Tournaisian, southern New Brunswick

ADRIAN F. PARK[1], PAUL WILSON[2], AND DAVID G. KEIGHLEY[1]

1. Department of Geology, University of New Brunswick, P.O. Box 4400, Fredericton, New Brunswick E3B 5A3, Canada
<apark@unb.ca>

2. School of Earth, Atmospheric, and Environmental Science, University of Manchester, Williamson Building, Oxford Road, Manchester M13 9PL, UK

The early Carboniferous (Tournaisian) Albert Formation in southeastern New Brunswick consists of a thick succession of lacustrine sedimentary rocks, sub-divided into a middle shale-dominated Frederick Brook Member between upper and lower sand-dominated units, the Hiram Brook and Dawson Settlement members, respectively. Slump-structures and debris flow deposits are found throughout the succession, but are especially common in the Frederick Brook member. Of the slump folds there has been considerable debate as to whether they are all soft-sediment structures. Some of them involve tens of metres of section and contain cleavages, and a consistent feature of many of these structures is the integrity of layering: features more characteristic of 'tectonic' structures.

Slumped intervals range in scale from a few centimetres to thicknesses in excess of 50-100 m, the maximum scale seen in outcrop. Seismic profiles suggest listric slumps on a larger scale - possibly involving more than half a kilometre of section. Road cuts along Highway 2 near Norton have been analyzed to determine the thickness of slumped intervals and their frequency, between the centimetre scale and 50-100 m. The size-frequency of slumped intervals between the centimetre scale and 50-100 m show a log-linear relationship with a distinctive fractal dimension, larger scale features follow a distinctly different log-linear relationship. This implies two distinct mechanical responses producing slumping in the Fredericton Brook Member. Below the 50-100 m scale, slumping is related to the high water content and high organic matter content of the sediments, which would have had a very low angle of repose and low plasticity limit. Repeated collapse of the sediment pile down a very shallow gradient would have been the norm. Collapse at scales larger than 50-100 m seems to be consistently associated with listric structures that root into the lower part of the Albert Formation and do not extend up section higher than the upper Hiram Brook Member. These features involve substantial thicknesses of Albert Formation (the largest may involve

the entire thickness), and represent collapse of more coherent bodies of sediment by rotational slumping. The sediment pile involved in these collapse events may have been substantially dewatered, with loading of the Frederick Brook Member by the overlying Hiram Brook Member sands being the driving mechanism.

Denudation of the Appalachians in the Cretaceous:
tracking fluvial dispersion with mineral geochronology and chemistry

GEORGIA PE-PIPER[1] AND DAVID J.W. PIPER[2]
1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada <gpiper@smu.ca>
2. Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography,
P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada

In the Early Cretaceous of the passive margin Scotian Basin, more than 45 million years after the onset of sea-floor spreading, sandy deltas prograded tens of kilometres seawards. Sand supply was 3-4 times higher than in the early history of the passive margin. Multiple sedimentary petrology methods show that the dominant source of the sand was from the local Appalachians, supplied by at least three different rivers.

Geochronology of detrital muscovite, monazite, and zircon provides a first-order assessment of the source of detrital sediment. Almost all detrital muscovite grains are Late Paleozoic in age. Mass-balance calculations require a few hundreds of metres of exhumation of the inner continental shelf during the Early Cretaceous. The paucity of older ages results from abrasion during transport from more inboard Appalachian terranes.

Most detrital monazite grains are Devonian, but Lower Paleozoic, latest Neoproterozoic, Mesoproterozoic, and Paleoproterozoic grains each make up about 10% of the total assemblage. Although monazite survives mechanical abrasion, it is readily broken down chemically under acid conditions. There is no systematic variation of monazite morphology with age, except that euhedral grains are over-represented in middle Paleozoic ages, characteristic of the outboard Appalachians, and involving short transport distances. This variation indicates that most monazite is of first cycle origin.

Most detrital zircon grains are of Precambrian age, with peaks at 1.0 Ga and 1.7 Ga that are characteristic of reworked zircons in inboard Appalachian rocks of Laurentian provenance. A few samples show peaks at 0.6 and 2.0 Ga, characteristic of outboard Appalachian rocks of Gondwanan provenance. All samples have a few 300-550 Ma zircons, representing Appalachian crystalline basement. Comparing abundance of dated monazite and zircon grains in the same sample provides estimates of the importance of polycyclic reworking. Samples with similar distribution of monazite and zircon ages suggest that most zircons are first cycle, and only a few zircons are rounded or broken. Samples with many zircons older than the monazites have many rounded and broken zircon grains. In such samples, bulk chemical analyses show a good correlation of Zr and Cr. These elements are principally in zircon and chromite, derived from quite different rock types, but resistant minerals concentrated by polycyclic reworking. In contrast, Zr correlates with Ti only at low concentrations, above which the abundance of Ti is largely constant as Zr abundance increases. Ti is transported principally in ilmenite, an abundant first-cycle mineral in proximal fluvial sediments, but very susceptible to chemical weathering. Ce, which is principally present in monazite, shows no correlation with Zr but correlates well with Ti, suggesting that mostly first cycle monazite and ilmenite are concentrated together by sedimentary sorting.

Petrology, petrogenesis, economic potential, and tectonic implications of the
Landry Brook, Dickie Brook, and Charlo plutons, northern New Brunswick

J.-L. PILOTE[1], S.M. BARR[1], AND R.A. WILSON[2]
1. Department of Earth and Environmental Science, Acadia University,
Wolfville, Nova Scotia B4P 2R6, Canada <096594p@acadiau.ca>
2. Geological Surveys Branch, New Brunswick Department of Natural Resources,
P.O. Box 50, Bathurst, New Brunswick E2A 3Z1, Canada

The Late Silurian calc-alkaline, Landry Brook, Dickie Brook, and Charlo plutons cover a combined area of approximately 80 km^2 in the northeastern part of the Silurian-Devonian Tobique-Chaleur tectonostratigraphic belt in northern New Brunswick. The Landry Brook plutonic suite consists of four units: gabbro, granodiorite, quartz monzodiorite to monzogranite, and a later, mainly monzogranite unit. A significant geochemical separation (i.e. a gap) exists between the mafic and felsic rocks. A quartz monzodiorite sample from Landry Brook pluton yielded a U-Pb (zircon) crystallization age of 419.63±0.23 Ma. The bimodal Dickie Brook plutonic suite consists of four units: contemporaneous (comingled) gabbro and clinopyroxene-bearing diorite to quartz diorite, meso- to melanocratic hedenbergite-quartz monzodiorite to monzogranite, and aphanitic to porphyritic felsic dykes, all cut by later basaltic dykes. REE-bearing fluoroapatite-Fe-diopside-magnetite porphyry in the eastern part of the pluton is most likely related to the late basaltic dykes. Electron microprobe analyses measured cerium (Ce), lanthanum (La), and yttrium (Y) maximum concentrations of 8891 ppm, 4406 ppm, and 3473 ppm, respectively, in apatite from the porphyry. These rocks were likely formed in a post-collisional setting based on discrimination diagrams. A medium-grained granophyric monzogranite sample yielded a U-Pb (zircon) crystallization age of 418±1 Ma, the same age as the Landry Brook quartz monzodiorite. The so-called "Charlo stocks" form a group of dykes and plutons west of the Dickie Brook and Landry Brook plutons and consist mainly of high-level, fine- to medium-grained, granophyric quartz monzodiorite to monzogranite with miarolitic cavities and less abundant plagioclase-amphibole dacite porphyries. Geochemical data show similarities with the Dickie Brook pluton on variation diagrams for both major and trace elements but higher Fe and lower Ca. Collectively, the lithology, whole-rock chemical data, and age are very similar, and given their spatial proximity, all of these

plutons are likely to be petrogenetically related. However, they show a wide range in abundances of REE, Zr, Y, and Nb, and a correspondingly wide variation in apparent tectonic settings on discrimination diagrams from volcanic-arc to within plate or post-collisional fields. On a larger scale, slab break-off after closure of the Tetagouche-Exploits basin is most likely to be the mechanism responsible for magma formation.

The ups and downs of Guysborough County - the mid Cretaceous Naskapi Member in the Scotian Basin: eustacy or tectonics?

DAVID J.W. PIPER[1], SARAH J. BOWMAN[2], GEORGIA PE-PIPER[2], AND R. ANDREW MACRAE[2]

1. Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada <dpiper@nrcan.gc.ca>

2. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada

The Naskapi Member is a distinctive shale unit of Aptian age in the Scotian Basin, underlain by the sandy deltas of the Missisauga Formation and overlain by sandy deltas of the Cree Member. It has been generally regarded as resulting from the eustatic early Aptian transgression, creating a classic highstand systems tract (HST). It has a fully marine biota, contrasting with marginal marine biota in under- and overlying units.

The authors question this classic interpretation. The Naskapi Member thins and onlaps onto a regional unconformity on the Banquereau Platform and in Orpheus graben. The presence of remnants of basalt flows at the Hesper wells, derived from Scatarie Ridge, implies erosion of an emergent Banquereau Platform in the mid Aptian. Only in the Cree Member did significant sediment accumulation resume. Regional seismic reflection profiles suggest Barremian tectonic uplift of the Banquereau Platform, with tilting of the Missisauga Formation and cutting of the regional unconformity. Thus deposition of the Naskapi Member was not controlled solely by eustacy.

The four unconformity-bound units of the Chaswood Formation in the Elmsvale Basin provide a record of related tectonism. The lowest Unit 1 includes ash correlated with the Hauterivian volcanism of the SW Grand Banks. Unit 2 accumulated following uplift of Unit 1 and has low kaolinite, characteristic of the arid Barremian, and is overlain by a pronounced unconformity analogous to the top Missisauga unconformity offshore. Unit 3 includes ash correlated with Aptian volcanism in the Orpheus graben.

Offshore wells show an important change in sediment source in the late Hauterivian to Barremian, with greater input of sediment from the Meguma terrane indicated by more negative ε_{Nd} and more metamorphic lithic clasts. In the Scotian Basin, published work on Glenelg and Panuke has shown that the late Hauterivian to Barremian Upper Member of the Missisauga Formation has an overall transgressive character, with maximum regression near the base of the Member. The onset of tilting is interpreted to have occurred in the late Hauterivian, resulting in increased sediment supply from landward of the hinge zone and increased accommodation seaward.

Throughout the Missisauga Formation and Cree Member, two rivers entering the basin through Cabot Strait supplied vast amounts of sand. What stopped this sand supply and allowed fully marine conditions to flourish during deposition of the Naskapi Member? It is suggested that the Barremian tilting of the Banquereau Platform culminated in the river pathway being blocked along the Chedabucto–SW Grand Banks fault, so that the only sand supply to the basin was from small local rivers from the Meguma terrane. Whether the blocked rivers found a new route through the Strait of Belle Isle or along the Cobequid fault system and out through the Bay of Fundy is uncertain. The abrupt influx of sand at the base of the Cree Member includes a high proportion of volcanic clasts, implying that the rivers eroded through the Aptian volcanic edifices at that time, restoring the former drainage systems through Cabot Strait.

Radon surveys as part of the North American Soil Geochemical Landscape Project and a Health Canada sponsored radon/thoron survey in the urban environment

A.G. PRONK[1], JING CHEN[2], MICHAEL A. PARKHILL[3], REX BOLDON[1], AND MARC DESROSIERS[3]

1. Geological Surveys Branch, New Brunswick Department of Natural Resources, P.O. Box 6000, Fredericton, New Brunswick E3B 5H1, Canada <toon.pronk@gnb.ca>

2. Radiation Protection Bureau, Health Canada, 775 Brookfield Road, Ottawa, Ontario K1A 1C1, Canada

3. Geological Surveys Branch, New Brunswick Department of Natural Resources, P.O. Box 50, Bathurst, New Brunswick E2A 3Z1 Canada

Naturally occurring isotopes of radon, Rn-222 (radon gas), and Rn 220 (thoron gas), are present in rocks, soil, and in the atmosphere and find their way into our homes. The Health Canada indoor radon guideline was lowered to 200 Bq/m3 in 2007 (down from the 1988 guideline of 800 Bq/m3). Radon is the second largest contributing factor to lung cancer after smoking. The gas typically finds its way from the rock and soil, through cracks, conduit entries, and porous basement wall and floor materials, into our homes. The Environmental Protection Agency has radon potential maps for each state and the Maine data can be extrapolated into New Brunswick and the Maritime Provinces. As a component of the North American Soil Geochemical Landscape Project, soil radon measurements were made at each site, complimented by radiometric measurements within the soil pit. This data will aide in the compilation of a radon potential map for Canada. With a little over 100 sites randomly selected and covering all of New Brunswick the radon distribution closely (and as expected) reflects the province's bedrock geology.

A simultaneous radon-in-soil and indoor radon survey was carried out in the larger Fredericton area during the fall of 2007. Results show regional consistency, but for individual homes there is no correlation between soil and indoor radon. Type

of construction, overburden thickness and texture, and water table depth are some of the variables that influence local radon migration and levels. During the winter/spring of 2010 a radon/thoron survey was carried out in the Fredericton area to determine the contribution of thoron to the overall indoor radiation budget. Radon measurements between the different surveys with different survey methodologies in the same residences correlate quite well.

One of Health Canada's recommendations is that every home should have a radon test carried out to assess the overall radiation risk. The significant potential for above-guideline radon levels is relatively easy to counteract with minor measures and costs. Minimizing porosity, sealing cracks and conduits, and increasing air movement are some of the simple less expensive ways to "keep radon out".

Petrography of stratigraphic units in the subsurface in the Phetchabun basin, Thailand

N.A.M. RADZI AND S.M. BARR

Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada <091014m@acadiau.ca>

The Phetchabun basin is one of at least 30 Cenozoic intermontane basins in Thailand formed by regional crustal extension localized by strike-slip faults. Most oil production in Southeast Asia is from these basins, and they are primary targets for hydrocarbon exploration. The basins contain thick lacustrine strata, in places including coal, lignite, and oil shale. This study focuses on the Wichian Buri subbasin, one of five grabens that comprise the Phetchabun basin in central Thailand. This subbasin is unusual due to the presence of fractured igneous intrusions that form hydrocarbon reservoirs. The stratigraphic units of the Phetchabun basin have been defined by earlier workers and include an upper unit of Pliocene-Pleistocene sediments, underlain by the Miocene Chaliang Lab Formation and Wichian Buri Group, and Oligocene "basal Tertiary", which unconformably overlies Mesozoic volcanic and granitoid rocks. The Chaliang Lab Formation consists of claystone with minor sandstone and lignite. The Wichian Buri Group is divided into 4 units. Unit 1 has been described previously as reworked basaltic tuff interbedded with coarsening-upward sandstone. Underlying units 2, 3, and 4 contain basaltic flows and gabbroic sills interlayered with or intruded into claystone, sandstone, and siltstone. The basal Tertiary has been described as claystone with minor interbedded sandstone and altered fine-grained basaltic flows or sills. A petrographic study of thin sections made from 150 cuttings samples from units 1 through 4 of the Wichian Buri Group from 15 drill holes in the Wichian Buri subbasin is being done to provide additional information about these units. Preliminary observations indicate that the samples are dominated by 7 different type of grains: (1) interlayered lithic (quartz, feldspar and other grains) sandstone and siltstone with bitumen and high porosity; (2) lithic sandstone composed of quartz, feldspar, and other grains with bitumen and high porosity; (3) dark grains of lithic arenite and siltstone with high organic content that might represent a hydrocarbon source; (4) igneous fragments including basalt and gabbro; (5) siltstone with bitumen and moderate to low porosity; (6) spotted hornfels formed by contact metamorphism of siltstone and sandstone clasts; and (7) bitumen grains. These observations are being correlated with location in the stratigraphic column to provide information about how the Wichian Buri Group varies across the area.

Stratal-geometry architecture of meanderbelt systems and vegetation density in the Carboniferous: using LiDAR imagery

CHRISTIAN RAFUSE AND GRANT WACH

Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada <ch564064@dal.ca>

This project was designed with two objectives; (1) to define the stratal geometry and architecture of meanderbelt fluvial depositional systems, and (2) model Carboniferous vegetation density, using the excellent outcrop exposures found at Joggins, along Chignecto Bay, Nova Scotia. The primary methodology utilized for this project is that of LiDAR based reconstruction and interpretation. Operating in the ultraviolet, visible, and near infrared spectrum, LiDAR capture allows the creation of extremely accurate representations of these cliff sections. What makes this method superior to traditional digital photography captures is the spatial aspect of the LiDAR data; the captured returns of the laser pulses contain XYZ coordinates giving the image spatial representation, as well as signal return strength.

With proper georeferencing and proof of concept, this project can become the framework for future 3D model construction of Carboniferous vegetation density at Joggins. As the cliffs naturally erode, new fossil trees are exposed. Using differential GPS and LiDAR, successive erosional events can be digitally measured and captured, on an annual schedule; eventually a model of a standing forest can be created. The same data set will also be used to develop 3D models of the architecture and geometry of the meanderbelt fluvial systems that developed in the Carboniferous, in response to the gradient of the coastal plain and increased vegetation.

Preliminary investigations also indicate the intensity of the return values of the LiDAR data represent a contrast in lithology with unique, distinguishable return signatures. This is being explored as a potential avenue for lithology identification using LiDAR.

The Dog Bay-Liberty Line and its significance for Silurian tectonics of the northern Appalachian orogen

D.N. REUSCH[1] AND C.R. VAN STAAL[2]

1. Department of Geology, University of Maine at Farmington, Farmington, Maine 04938, USA <reusch@maine.edu>

2. Geological Survey of Canada, 625 Robson Street, Vancouver, British Columbia V6B 5J3, Canada

The Dog Bay Line, a Silurian suture key to deciphering Appalachian accretionary history, was first recognized in Newfoundland. It marks where the Ordovician Tetagouche-Exploits ensimatic back-arc basin (TEB), which opened within the

leading peri-Gondwanan Gander terrane, finally closed. This suture can be extrapolated into New England, placing it between the Liberty-Orrington-Miramichi inliers (LOM) and the Merrimack-Fredericton trough (MFT). Southeastward, marine strata of the MFT overlie the TEB passive margin, exposed in the Ganderian St.Croix block, and display southeast-vergent structures transected by Acadian cleavage. They structurally underlie southeast-vergent thrusts at the base of the LOM. Northwestward, the LOM, Central Maine-Matapedia trough (CMMT), and Lower Silurian igneous rocks record elements of the upper plate trench-arc system, respectively a subduction complex, forearc basin, and arc. The CMMT forearc received detritus both from the northwesterly arc region, and also from the Early Silurian-exhumed subduction complex. Minimal contrast in Silurian turbidites near the line may be due to sediment bypassing the subduction complex, and/or a common provenance when the complex emerged above sea level. Salinic unconformities in the upper plate (arc-trench) reflect episodes of shortening, within an overall extensional setting that resulted in thinned, weakened lithosphere, and final uplift accompanying latest Silurian slab breakoff. Silurian strata of the Coastal Volcanic Belt document a separate arc system built on Ganderia's trailing edge, where northwest-directed subduction of a narrow seaway led to latest Silurian collision with buoyant, strong lithosphere of Avalonia's passive margin, and the onset of kinematically distinct dextral-oblique, northwest-vergent, Acadian deformation.

Structural analysis of the Matoush uranium deposit, Quebec

L. ROBICHAUD[1], J. LAFONTAINE[2], AND J.C. WHITE[1]

1. Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <lise.robichaud@unb.ca>

2. Ressources Strateco Inc., Boucherville, Québec J4B 7K1, Canada

The Matoush deposit is situated 260 km north east of Chibougamau in the Otish basin, north of the Grenville front in the Superior Province. The deposit is hosted in the Proterozoic Indicator Formation, which comprises conglomerates, conglomeratic sandstones, and subarkosic sandstones. The deposit is structurally controlled by the Matoush fault, which strikes 007° and dips 85°E. Mineralization is primarily uraninite lenses pitching 45°S on the fault surface.

Tourmaline and eskolaite are the phases most commonly associated with the uranium mineralization. In areas of intense mineralization, the tourmaline contains varying levels of Cr (15-39 wt% oxides), Fe (up to 8.82 wt% oxides), V (up to 1.75 wt% oxides), and Mn (up to 0.43 wt% oxides) whereas the tourmaline in unmineralized areas contains Fe (with only up to 5 wt% oxides). The uranium is also strongly associated with eskolaite as well as other Cr-oxides and hydroxides which are usually intergrown with the uranium phase. This is indicative of a strong chromium association with the uranium mineralization. Three-dimensional distribution of the mineral phases shows a strong zonation centered on the uranium mineralization.

Measurements were collected for sets of structural elements in order to establish in detail the relationship of mineralization to deformation features, and to extend these mesoscopic observations to the macroscopic scale. Fracture, fault, slickenside, and vein orientations were measured. Several kinds of fractures were observed, the most predominant being argillaceous, bleached, silicified, and pyritized. The fracture orientations indicate that the Matoush fault is the dominant control on fracture orientation. Similarly, veins show a clear correlation with the Matoush fault. The mineral zonation is nevertheless strongly linked to overall fracture density.

Fault-fluid interaction has affected element transport and concentration. Cr concentration is a positive indicator of uranium mineralization. However, spatial distribution and localization of uranium mineralization as of this time defies characterization by simple geometric relationships. This is exemplified by the lack of obvious intersections of structural elements or clear development of dilatational zones that correspond with deposit orientations. However, the observation of rare U-bearing microscopic fault oversteps and linkages are suggestive of similar fault-scale structures for which exploration is ongoing.

Determining the 3D structure of the Bathurst Mining Camp: results from the TGI 3 Appalachians Project

N. ROGERS[1], H. UGALDE[2], W.A. MORRIS[2], AND C.R. VAN STAAL[3]

1. Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A OE8, Canada <nrogers@nrcan.gc.ca>

2. School of Geography and Earth Sciences, McMaster University, 1280 Main Street West, Hamilton, Ontario L8S 4K1, Canada

3. Geological Survey of Canada, 605 Robson Street, Vancouver, British Columbia V6B 5J3, Canada

The Geological Survey of Canada's 2005-10 TGI 3 program was devised to help sustain base metals reserves in existing mining communities. For the Bathurst Mining Camp (BMC) the primary aim was to reduce the inherent risk in exploration by improving the understanding of the 3D geological structure to provide a framework to vector in on mineralization.

The BMC is host to numerous known base metal deposits, the great majority of which occur at or very near the surface. As with many mature mining camps, the likelihood is that if there are significant deposits awaiting discovery, then they will be hidden or deeply buried. Although the distribution of units at the surface of the BMC is reasonably well established, prior to this study, the trace of these units to depth has been highly speculative. The prevalence of steeply dipping fabrics and poly-phase deformation of the BMC hampers structural interpretation and precludes accurate projections of deeply buried mineralized horizons. Integration of multiple geophysical sources with geologic data has constrained inversions to provide a realistic 3D model for the region.

The data used for the modelling are the 1994 EXTECH II airborne geophysical survey for total field magnetic field, resistivity and gamma spectrometry, TGI 3 2006/2008 ground gravity surveys, and the Government of New Brunswick's digital elevation model. These data are reprocessed and combined to produce a series of transects across major structural and/or economically significant parts of the BMC.

Significant implications from the 3D geological model include that: (i) the Flat Landing Brook Formation extends to below 10 km in the central portion of the BMC, and the Nine Mile Synform amplitude in excess of 5 km; (ii) a hidden ophiolite underlies the southeast portion of the BMC with the Tomogonops Formation its cover, and these units are thrust beneath the Tetagouche and Sheephouse Brook groups; and (iii) the Miramichi Group is tectonically emplaced as a thin sheet over the younger Sheephouse Brook felsic volcanic rocks and associated Chester ore horizon, effectively increasing the area of high mineral prospectivity by approximately 35%.

Getting at the potash: geological and hydrogeological considerations in shaft sinking

BRIAN ROULSTON

Potash Corporation of Saskatchewan, New Brunswick Division, P.O. Box 5039, Sussex, New Brunswick E4E 5L2, Canada <Brian.Roulston@potashcorp.com>

Deep underground mining typically requires two shafts from surface to the orebody, for hoisting of ore, services, and mine ventilation. Currently two 5.5 m diameter concrete lined shafts are being constructed to a depth of almost 1 km at the Picadilly potash property, east of Sussex. These shafts, capable of hoisting 7 MM t of potash ore and 1 MM t of rock salt per year, were located relatively close to the existing Penobsquis mine so that existing mill facilities could be incorporated economically into the new development.

Geologically, the rock units through which the shafts are being sunk are comprised of a thick sequence of Mabou Group siltstones and sandstones, divided into two units: (1) an upper, fractured, water-bearing unit; and (2) a lower, non-water-bearing, generally finer grained unit in which fractures are gypsum-filled. The unconformable (?) contact between these units represents a regional, seismically distinctive, horizon and is known from drilling to be a water-bearing vuggy siltstone and poorly consolidated sandstone. This contact represents a significant challenge to shaft sinking, as the final concrete lined shaft must be essentially dry before it enters the evaporites below.

When sinking through the Windsor Group evaporites, the geomechanical properties of various geological members are the most important consideration. Closure rates of the salts vary, depending on geology, and the presence of hydroscopic salts adds further challenges to the construction of these shafts that must be designed and built to maintain their liner integrity for the life of the mine.

Thank God for plagiarism: newspapers as the seismometers of the 18th and 19th centuries

ALAN RUFFMAN

Geomarine Associates Ltd., P.O. Box 41, Station M, Halifax, Nova Scotia B3J 2L4, Canada <aruffman@dal.ca>

In today's world of Wikipedia, Google, tweets and turnitin.com, professors and journal editors are hard pressed to impress upon students and article writers the need for careful and religious referencing, and a bibliography. But there was once a kinder, gentler time that not only permitted plagiarism, but saw it as an essential medium to get the news out and to communicate knowledge. Prior to the start of the 20th century, newspapers are one of the best sources by which one can discover and document historic earthquakes. Indeed, well into the 1930s newspapers can serve to define felt seismic events that are not in national catalogues, or not in the early instrumental record.

One such event appeared in a March 8, 1774 Halifax newspaper, and cited an October 16, 1773 unidentified London newspaper that had arrived on a sailing vessel from Britain. The article reported an apparently tsunamigenic earthquake in the southern Algarve Province of Portugal and in the vicinity of the Guadiana River that forms the border of southwestern Spain and Portugal. The July 27-28, 1773 event is not found in the modern seismic catalogues of Portugal or Spain.

Was it a mis-cited report of some other earlier known offshore event such as one on April 12, 1773, or even a hoax? Even though the article was brief, the descriptions of the apparent tsunami and of the seismic effects were consistent with observations that one might expect in the area, and the geographic locations reporting the events were quite real, though locations were occasionally somewhat misspelled in the English-speaking press.

Initial enquiries with Portuguese contacts yielded no confirmation of the event. Five years later a visit to the National Library of Portugal in Lisbon frustrated the writer with a seeming absence of any Portuguese newspapers from the year 1773. The data dam broke in The British Library's newspaper collection with the discovery of the probable Oct. 16, 1773 newspaper that found its way across the Atlantic where a Halifax editor reprinted a precis of the seismic and tsunami events in 1774. There were three very similar London reports that in turn came from the *Amsterdam Gazette*. These gave more details: "... a religious house belonging to the Dominican Friars was thrown down, as were several houses, the falling of which killed many people." and "The vessels in the bay, ... were thrown on shore, a great number of fishing boats were thrown on the land, and several men perished."

European colleagues have been skeptical that a brief account in a Nova Scotia newspaper some 7.5 months after the event could lead to a suggestion of a new "historical" 1773 tsunamigenic event in the Golfo de Cadiz and now to its confirmation 237 years after a Lagos resident in the southern Algarve wrote a letter to a merchant in Rotterdam, but that reality now appears to be the case. It has also lead to the discovery of England's second oldest apparent tragic tornado at 09:00, Sunday, Oct. 3, 1773 near York with a possible second event at 14:00 at the Trent Bridge in Nottingham.

Mesoproterozoic (?) monzodiorite-syenite hosted Au-Ag-Te mineralization at the Aucoin Prospect (NTS 13N/6) Hopedale Block, Labrador

H.A. SANDEMAN

Mineral Deposits Section, Geological Survey of Newfoundland and Labrador, Department of Natural Resources, St. John's, Newfoundland and Labrador A1B 4J6, Canada <hamishsandeman@gov.nl.ca>

The Aucoin gold prospect is located 70 km west of Hopedale in the Archean Hopedale Block of Labrador (NTS 13N/6). Remarkably, it represents one of only two examples of gold mineralization in Labrador that have been tested by drilling. It was discovered in 1995 via ground prospecting in the vicinity of a single gold-in-lake sediment geochemistry anomaly, obtained from a regional government survey. Trenching and grab sampling have yielded assays of up to 478 g/t Au with >100 g/t Ag and, diamond drilling has yielded intercepts of up to 12.4 g/t Au with 14g/t Ag over 1.05 m.

The mineralization occurs within an array of anastamosing, discontinuous, NE- and NW-trending white quartz veins (typically <20 cm wide) that are associated with a NW-SE-trending, strongly chlorite-ankerite-epidote-talc±sericite altered and sheared curviplanar contact zone between massive to weakly foliated syenite and cogenetic monzodiorite. The weak foliation is interpreted as primary magmatic layering. High gold assays correlate with elevated silver and tellurium, reflected by the presence of argentiferous electrum and Ag-Au telluride (Petzite?) occurring as inclusions in pyrite, chalcopyrite, and in association with rutile replacing ilmenite. Rare wire gold has been reported at the margins of the veins.

The Aucoin mineralization was previously inferred to be hosted by Archean granitoid gneisses. These are cut by 2235 Ma, vertical diabase dykes with chill margins that were inferred to correlate with the regionally extensive Kikkertavak dyke swarm. Based on the presence of mineralized *"diabase dykes"* the mineralization was inferred to be younger than the Kikkertavak dykes but likely Paleoproterozoic in age. The fresh igneous nature of the unaltered syenite and monzodiorite host rocks to the mineralized quartz veins, along with their alkaline character, however, suggests an alternate interpretation. The alkaline host rocks are herein inferred to correlate with either the ca. 1500-1420 Ma, intermediate rocks of the Harp Lake Complex or, alternatively, those of the 1350-1290 Ma Nain Plutonic Suite. If this inference is correct, then precious metal mineralization at Aucoin is likely Mesoproterozoic or younger in age and may have a direct magmatic connection with the alkaline plutonic host rocks. Further geoscientific data acquisition, including U-Pb geochronology of the syenite and ^{40}Ar-^{39}Ar thermochronological investigations of alteration are currently underway.

A protocol for determining provenance of quartz grains in sandstones using the hot-cathode cathodoluminscence (CL) microscope

CYNTHIA SAWATZKY AND GEORGIA PE-PIPER

Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada

Determining the source of sedimentary detritus to the Lower Cretaceous deltas of the Scotian Basin is important for understanding the distribution of reservoir sandstones and their subsequent diagenesis. It thus contributes to both exploration models and to understanding reservoir quality. Quartz is the principal mineral in reservoir sandstones, but most quartz grains have few characteristics that are diagnostic of provenance. The technique of hot-cathode cathodoluminescence (CL) provides a method of identifying quartz from different sorts of igneous, hydrothermal, and metamorphic rocks.

Quartz of different origins shows different colours after the first few seconds of exposure to the CL beam and after the color shift has completed. Representative bedrock samples of possible source rocks from the Appalachians were collected and the CL characteristics of quartz of known origin were determined. CL criteria were established for the following six types of quartz: plutonic, volcanic, undivided igneous, vein, medium-high grade metamorphic, and low grade metamorphic quartz.

Once a grain has been irradiated, the CL properties cannot be reproduced. A protocol has been developed that ensures that each part of a thin section is only irradiated once. Colours are captured by digital photography at 3 and 12 seconds after irradiation commences. The origin of individual detrital quartz grains is then interpreted from the CL photomicrographs, and petrographic features.

A test sample of 890 quartz grains from the Logan Canyon Formation in the Peskowesk A-99 well contained 32.6% plutonic, 31.7% low grade metamorphic, 25.4% vein, 4.27% volcanic, 3.20% medium-high grade metamorphic, and 2.90% undivided igneous quartz. Sand-sized lithic clasts from the same sample, determined by standard petrographic microscope, comprise 17.7% polycrystalline quartz of igneous origin, 12.7% polycrystalline quartz of metamorphic origin, 16.5% deformed (metamorphic) polycrystalline quartz from mylonite, 45.6% igneous rocks (both plutonic and volcanic), and 2.50% metamorphic rocks. No vein quartz was recorded, as sand-sized vein quartz would normally be indistinguishable from monocrystalline quartz of other origins. The lithic clast data thus tends to overestimate the overall supply from igneous rocks, probably because igneous quartz tends to be coarser grained than metamorphic quartz. The proportion of volcanic quartz by CL is reasonably consistent with the proportion estimated from detrital zircon geochronology: 11% of dated zircons are volcanic, but there was probably a bias towards dating nice-looking euhedral volcanic zircon grains. The developed protocol has since been employed to determine provenance or quartz grains in sandstones from various depths in wells Alma K-85, Venture B-13, and Thebaud I93. Results so far thus suggest that hot-cathode CL imaging is a powerful method for determining the provenance of quartz grains in Scotian Basin sandstones.

The Northumberland Phase: the Illinoian glaciation of the Canadian Maritime Provinces

A.A. SEAMAN

New Brunswick Department of Natural Resources, Geological Surveys Branch,
P.O. Box 6000, Fredericton, New Brunswick E3B 5H1, Canada <Allen.Seaman@gnb.ca>

Evidence for an early east-trending glaciation has long been known from New Brunswick, Nova Scotia, and Prince Edward Island. In New Brunswick this was initially inferred from erosional stratigraphy, i.e., cross-cutting relationships between subglacial erosion marks. Subsequently it was identified in stratigraphic section, with till with a west-east fabric or evidence for eastward dispersal identified beneath younger till(s). In several sections, the deposits overlying these older tills contained organic materials. Bulk radiocarbon dates for organic materials from the Half Moon Pit and McGregor Brook sites in New Brunswick returned non-finite ages of >36 and >35 ka, respectively. Therefore the organics were interpreted to represent Mid-Wisconsinan depositional environments, and deposition of the underlying till was assigned to the Early Wisconsinan. The main Early Wisconsinan ice flow was the southeast flow of the Caledonia Phase. Therefore, the earlier eastward flow was informally attributed to the "early Caledonia Phase" in New Brunswick, or "Caledonia Phase 1a" in Nova Scotia.

Based on recent investigations at the Half Moon Pit and McGregor Brook sites, including new AMS ^{14}C dates for charcoal fragments, the organic materials are now interpreted to be of Sangamonian Interglacial age. The underlying till must therefore belong to an entirely separate glacial phase that is of at least Illinoian age. This phase has been named the "Northumberland Phase", to honour the concept of an eastward flowing "Northumberland glacier" originally proposed by Robert Chalmers in 1895.

The geologic record for the Northumberland Phase begins with eastward flow that subsequently transitioned to east-southeastward flow. This is observed in both the erosional and the depositional stratigraphy. At Flume Ridge in southwestern New Brunswick large east-trending grooves with rat-tails are cross-cut by east-southeast trending striae (plus later Wisconsinan striae). In west-central New Brunswick, at a site within the east-southeast trending Carlisle dispersal train, the change in pebble lithology of the till from bottom to top indicates a transition from eastward flow to east-southeastward flow.

The Carlisle dispersal train comprises reddish till, grading to brown near the margins, extending approximately 15 km east-southeast from the reddish clastic sedimentary rocks of the Carboniferous Carlisle Formation. Glacially streamlined bedrock landforms of parallel trend lie within its limits. The relative age of the dispersal train is indicated by the observation of 'pebbles' of brown till reworked into the regional Wisconsinan yellowish brown till at a site several kilometres farther to the east. Till fabric measurements at several sites within the dispersal train indicate that the upper 1 to 2 m is a hybrid till, with a Wisconsinan fabric but otherwise Northumberland characteristics. At depth the till exhibits an east to east-southeast fabric. The presence of hybrid Northumberland till at the surface in this area indicates the relative inefficiency of subsequent Wisconsinan glacial processes.

First steps in the development of a predictive model for xenolith assimilation rates: the link between melt structure, viscosity, and mineral dissolution rates

CLIFF S.J. SHAW

Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <cshaw@unb.ca>

Assimilation has significant effects on the trace element and isotopic composition of igneous rocks. Current models deal with the geochemical and thermal evolution of such systems but ignore a fundamental variable: is enough time available for assimilation of the solid into the magma before it solidifies? Incorporation of cations from a dissolving mineral will, unless mineral and melt have the same composition, lead to a change in the structure of the melt adjacent to the crystal and to the development of chemical potential gradients in the melt. If network forming cations such as silica or alumina are added, the interface melt should become more viscous than the solvent. If the proportion of network modifying cations added is greater than that of network formers then the interface melt should become less viscous. In both cases, melt viscosity can be used as a proxy for the degree of polymerization. The difference in the degree of polymerization from interface to far field, measures the degree of change needed to equilibrate the solvent with the interface melt. Since the network forming cations are generally considered to be the slowest diffusing by virtue of their strong bonds with oxygen it is expected that dissolution rates of minerals should be related to the degree of resistance to change in the network structure of the melt. Tests of this hypothesis using literature data show that there is a direct correlation between the dissolution rate constant measured in experiments and the difference in viscosity, and therefore melt structure, between the solvent melt and the melt at the dissolving crystal interface. For dissolution of olivine in andesite and quartz in synthetic melts in the CMAS system, the dissolution rate constant increases as the viscosity difference between interface and solvent melt decreases. The data indicate that there is a maximum possible dissolution rate when the viscosity difference is zero and no structural rearrangement is required. This should correspond to the rate of interface reaction. The observed relationships suggest that it may be possible, given knowledge of the viscosity of the melts and experimentally determined rate constants, to compute assimilation rates as a function of temperature.

Precious-metal mineralization in the Boomerang and Domino volcanogenic massive sulphide deposits of the Tulks Belt, central Newfoundland: multi-element ICP-ES and laser ablation ICP-MS results

A.M. SHINKLE, D.R. LENTZ, AND R.M. TOOLE
Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada
<angela.shinkle@gmail.com>

The Boomerang and Domino volcanogenic massive sulphide (VMS) deposits can be found hosted within felsic pyroclastic rocks of the Victoria Lake Supergroup located in central Newfoundland's late Cambrian to middle Ordovician Tulks Belt. The rock assemblage of the Tulks Belt is that of a bimodal volcanic arc and back-arc setting and hosts numerous prospective mineral deposits including Boomerang, Domino, Tulks Hill, Tulks East, Bobby's Pond, Daniel's Pond, Jack's Pond, and Curve Pond. Boomerang's indicated resources are calculated as 1.36 million tonnes grading 7.1% Zn, 3.0% Pb, 0.5 % Cu, 110 g/t Ag, and 1.7 g/t Au with a cut-off grade of 1%, with similar inferred grades calculated for the Domino deposit and other deposits in the belt.

Massive sulphides in the Boomerang and Domino deposits are hosted within a mixture of sandy dacitic ash tuff, and locally lapilli tuff, with laminated graphitic argillite in the deposit hanging wall. In hand sample, the massive sulphides are comprised of varying amounts of interbedded-laminated, fine-grained sphalerite, galena, and tetrahedrite with pyrite porphyroclasts; sphalerite, galena, tetrahedrite, pyrite, and rare chalcopyrite porphyroblasts that are irregular in shape and form pressure shadows up to 5 cm in size; and/or as brecciated pyrite and angular to sub-angular, arsenopyrite porphyroblasts intergrown with a siliceous groundmass. Argentiferous tetrahedrite (up to 16.9 wt% Ag compared to only 0.3 wt% Ag in galena) is found as interlocking grains, or as inclusions in sphalerite.

Multi-element ICP-ES analysis of precious metal-enriched massive sulphides (n=156) from the Boomerang deposit illustrate positive Spearman Rank correlations between Au and Ag with As, Cd, Cu, Fe, Hg, Pb, Sb, and Zn; Au and Ag are also strongly correlated (r`=0.86). Laser ablation ICP-MS (n_{Py} =36, n_{Asp} =52) brings to light the elemental abundance variations from core to rim, between early pyrite mineralization and later arsenopyrite mineralization; Au (averaging 13 ppm) <Ag (averaging 382 ppm) in cores of pyrite, whereas Au (averaging 228 ppm) >Ag (averaging 25 ppm) is found concentrated in rims of arsenopyrite. Porphyroblastic pyrite and arsenopyrite along with local occurrences of pressure-shadows in the Boomerang and Domino VMS deposits indicate shear stress post-dating original sulphide formation and suggests possible metasomatic recrystallization and Au remobilization.

The Early to Late Devonian North Pole Stream granitic suite:
a strongly peraluminous granitic complex hosting a intragranitc vein-type uranium deposit, New Brunswick

DAVID A. SHINKLE[1], DAVID R. LENTZ[1], AND STEVEN MCCUTCHEON[2]
1. University of New Brunswick, Department of Geology, P.O. Box 4400, Fredericton, New Brunswick E3B 5A3, Canada
<david.shinkle@unb.ca>
2. McCutcheon Geo-Consulting, 1935 Palmer Drive, Bathurst, New Brunswick E2A 4X7, Canada

The Early to Late Devonian North Pole Stream granitic suite (NPSG) underlies an area of about 500 km^2 in north-central New Brunswick. AFC processes produced four probable comagmatic differentiates namely: biotite granite (n=6, oldest phase), biotite-muscovite granite (n=10), muscovite leucogranite (n=10), and quartz-feldspar porphyry (QFP) granitic dykes (n=2) that crosscut all other phases of the pluton.

Existing petrochemical data for the NPSG suggest that the young muscovite leucogranite has S-type, syn-collisional characteristics; it is the most highly evolved phase in that it has A/CNK=1.3-1.4, a P/Ca of 0.45, has low average ∑REE (11.78 ppm), Zr/Hf (18.84), Nb/Ta (6.10), and Th/U (0.18), has a high Zr/TiO2 (467.76) and is also enriched in Rb (489 ppm), Sn (28 ppm), Nb (44 ppm), Ta (7.8 ppm), and U (28 ppm). The fractional crystallization of monazite, xenotime, zircon, and apatite produced extreme depletions in HFSE's and the REE's, and a chondrite-normalized REE pattern with a pronounced tetrad effect ($TE_{1,3}$=1.28). Average zircon and monazite saturation temperatures for the muscovite leucogranite are 650 °C and 630 °C, respectively.

Past research has yielded a U-Pb monazite age of 417±1 Ma from a sample of biotite granite, which has been interpreted as the emplacement age of the NPSG. Recent CHIME dating of monazite grains in a sample of muscovite leucogranite has yielded a age date of 399±16 Ma; however, quartz-hosted monazite inclusions have yielded an age date of 421±6 Ma, implying they are inherited from either the source material of the NPSG, or an earlier phase in the crystallization history. Ar-Ar dating of a grain of coarse-grained plutonic muscovite resulted in an age of 406.1±1.9 Ma and is believed to be the age of emplacement for the muscovite leucogranite.

The muscovite leucogranite of the NPSG is abnormally enriched in the radioactive elements U (28 ppm), K (4.26 K_2O wt.%), and to a lesser degree, Th (5 ppm) and therefore it can be considered a high-heat producing granite. Post-crystallization of the NPSG, hydrothermal convection cells driven by radiogenic heat circulated oxidized meteoric fluids along late wrench faults crosscutting the NPSG, which leached uranium from the surrounding granites via the oxidation of uraninite. The dissolved uranium was transported in these circulating meteoric fluids and was deposited as pitchblende and uraninite after being reduced by sulphides formed along these late wrench faults.

Collections management at the Joggins Fossil Cliffs UNESCO World Heritage Site: a new model?

DEBORAH M. SKILLITER[1] AND MELISSA GREY[2]

1. Nova Scotia Museum, 1747 Summer Street, Halifax, Nova Scotia B3H 3A6, Canada <skillidm@gov.ns.ca>

2. Joggins Fossil Institute, 100 Main Street, Joggins, Nova Scotia B0L 1A0, Canada

A unique museum collections management model is presented wherein two institutions, one, a non-profit charitable organization (Joggins Fossil Institute-JFI) and the other, a governmental institution (Nova Scotia Museum-NSM), collaborate within the limits and framework of provincial legislation to curate a collection of geological and paleontological specimens. All fossils in Nova Scotia are protected under provincial legislation through the Special Places Protection Act (SPPA). The SPPA is administered by the Heritage Division of the Department of Communities, Culture, and Heritage, whose mandate is to protect important archaeological, historical, and paleontological sites and remains, including those underwater. The SPPA effectively means that the Joggins Fossil Institute cannot legally own and develop a modern collection of fossils (i.e. any fossils collected after 1980) from the Joggins Fossil Cliffs. The NSM and the JFI have entered into a collaborative model of curating a portion of the Nova Scotia Provincial Paleontological Collection, specifically specimens from the Joggins Fossil Cliffs. The collaborative curation model was established within the framework of the SPPA, the Nova Scotia Museum Act, and the NSM Collection Management Policy. This collaborative approach to museum collections management is successful because those involved work towards the mutually agreeable goals of housing a growing collection of specimens from the Joggins Fossil Cliffs adjacent to the World Heritage Site, having the collection curated with the highest possible standards, and having the collection readily available for research and display. This collaborative curation model has allowed for the pooling of skills and resources, while easing the strain on the provincial collection space and staff resources.

Origin of slope gullies in Flemish Pass: evidence for an ice cap on Flemish Cap

COOPER D. STACEY[1] AND DAVID J.W. PIPER[2]

1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada <cooper.stacey@smu.ca>

2. Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, Dartmouth, Nova Scotia B2Y 4A2, Canada

New seafloor multibeam bathymetry data in water depths of 600 to 2000 m has been collected by the Spanish research vessel *Miguel Oliver* from Flemish Pass and Flemish Cap. This study compares the style and distribution of slope gullies on the Grand Banks flank (GBf) and Flemish Cap flank (FCf) of Flemish Pass and relates them to the Quaternary geological history of the area revealed by previously acquired piston cores and seismic-reflection profiles.

Most gullies head at ~600 m water depth and terminate at the floor of Flemish Pass at roughly 1100 m. The GBf has a slope of 7.6% in the south, gradually decreasing towards the north and a density of 0.4 gullies/km. Main types are: (1) asymmetric, U-shaped, linear gullies with headscarps; (2) gullies that terminate in a depositional lobe; and (3) regularly spaced, infilled, linear gullies with little relief and no headscarps, found only in the north. On FCf, most gullies are on a slope of 4.5-8.2%, with a density of 1.7 gullies/km. Types are: (1) parallel to sub-parallel linear, with two or more gullies merging where gully densities are high. A few gullies have headscarps; (2) in places, several gullies lead into a channel on a low slopes that cuts through a field of sediment waves; and (3) many smaller closely spaced gullies on ~13% slope in an amphitheatre-like depression.

The upslope limit of gullies at ~600 m on GBf corresponds to the previously recognized limit of glacial till from marine isotope stage (MIS) 6. Gullies of this region resemble ice margin gullies observed elsewhere. Similar gullies on FCf and Beothuk Knoll suggest glacial ice was grounded in these areas. Sparker reflection profiles show apparent till that pinches out at about 600 m, passing seawards into stratified sediment that is different seismically from iceberg-turbated marine sediment. A core on SE Flemish Cap shows that these till deposits date from MIS 6. Gullies on the GBf overlie buried gullies that date from MIS 6 and have been modified by southward Labrador Current flow resulting in asymmetry and by retrogressive sediment failure, in some cases resulting in depositional lobes. Sediment waves at the end of some gullies on FCf imply turbidity current flow. Amphitheatre-like depressions result from sediment failure.

The presence of MIS 6 ice on both Flemish Cap and Beothuk Knoll is unexpected, given that their least depths at present are at 126 m and 487 m respectively. Glacially lowered sea-level exposed enough of Flemish Cap for an ice dome to develop, which eventually merged with ice that crossed the Grand Banks, grounding on Beothuk Knoll and creating an ice shelf across Flemish Pass. This may be the cause of the large differences in paleoceanographic circulation previously recognized in the Labrador Sea between MIS 2 and MIS 6.

Tectonic assembly of basement and supracrustal nappes in the ultra-high pressure Western Gneiss Region of Norway

H.M. STEENKAMP, J.P. BUTLER, AND R.A. JAMIESON

Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada <hollys@dal.ca>

The Western Gneiss Region (WGR) of Norway is famous for its ultra-high pressure (UHP) metamorphic rocks that indicate burial to and exhumation of continental crust from depths of ~120 km during Caledonian collision. While subduction provides a plausible burial mechanism, how these rocks were rapidly exhumed from such depths remains enigmatic. To address this problem, contrasting the pressure-temperature-time-deformation (PTtd) histories of tectonostratigraphic units assembled during subduction and exhumation is essential. Preliminary findings are presented from complementary M.Sc. and Ph.D. theses designed to constrain the PTtd histories of orthogneisses and adjacent supracrustal units on the island of Harøy, in the northwestern WGR.

The island can be divided into two moderately NW-dipping lithotectonic domains based on 1:5000 mapping. The northern domain is a supracrustal sequence comprising (from SE to NW) coarse-grained garnet-amphibolites, minor medium-grained impure marbles, and migmatitic pelitic gneisses with kyanite. In contrast, the southern domain exposes a series of belts of amphibolite-facies granitic to dioritic, migmatitic orthogneisses with abundant fresh eclogite boudins, minor augen gneisses, and metagabbros that locally preserve eclogite-facies mineralogy. Tentatively the supracrustal sequence and orthogneisses can be correlated with the regional-scale Blåhø nappe (derived from the outboard Baltican margin), and Baltican basement, respectively.

Early deformation, characterized by NW-plunging folds and tops-to-the-NW mylonites, is restricted to the southern domain and the contacts between the orthogneisses and supracrustal units, which are interpreted as normal-sense shear zones. A second deformation phase evident in both domains is characterized by subhorizontal isoclinal folds and pervasive sinistral fabrics, consistent with widely-documented sinistral, transtensional deformation in the WGR.

Preliminary findings suggest pervasive UHP metamorphism was restricted to the southern domain, and that the two domains were juxtaposed during crustal exhumation, possibly by tops-to-the-NW normal-sense shearing. However, several important questions remain. What were the conditions and timing of peak metamorphism in these domains? At what point during exhumation were the two domains juxtaposed? Was partial melting in the two domains synchronous and did it assist the exhumation process by weakening the crust? By addressing these questions, this research will provide valuable new insight into the tectonics of UHP rock exhumation in the WGR.

Geographic and stratigraphic variation in shales of the Scotian Basin and their impact on basin evolution

G.S. STRATHDEE[1], DAVID J.W. PIPER[2], AND GEORGIA PE-PIPER[1]

1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada <gstrathd@nrcan.gc.ca>

2. Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada

The Mesozoic shales of the Scotian Basin are a primary source of oil and gas. Compaction of these shales influenced the composition of the basinal fluids that affected diagenesis of sandstones. The composition of these shales and its impact on the evolution of basinal fluids is poorly understood. The composition of clays deposited in the basin depends on detrital supply, mostly through rivers, from reworking of older shales and from weathered products in soil. It is thus dependant on the drainage basins and on climate. Clays may also undergo diagenetic alteration during shallow burial beneath the sea floor, and during deeper burial and compaction.

Samples from conventional core and cuttings have been analyzed by X-ray diffraction (XRD) analysis. Previous analyses using side-pack mounts and a zincite standard have been re-picked and the consistency of the data has been analyzed and found to be generally acceptable. Previous XRD analyses that were run at different times have been compared to evaluate the consistency of the previous analytical data. This data was normalized to the zincite standard that was used and the sum of mineral peak area versus the zincite peak area and versus depth were plotted. This shows that variations in zincite peak area are a consequence of detector sensitivity and quality of packing that affect zincite and the clay minerals equally, but a decline in detector sensitivity over time led to overestimation of the peak areas of small peaks.

The newly picked data has been used to test the distribution of different clay minerals interpreted in a previous study using a smaller data set. Fe-chlorite is not only abundant in the Missisauga Formation, as previously recognized, but also in the Logan Canyon Formation. The new data also suggest that Mg-chlorite is characteristic of intervals with higher sediment supply from the Meguma terrane, such as in the Alma field and in the Logan Canyon Formation at Thebaud. No evidence was found for significant changes in crystallinity with depth in the Cretaceous interval.

The data have also been used to evaluate the hypothesis that more arid climates in the Barremian resulted in a lower kaolinite to illite ratio compared with the preceding and following time intervals. 72 analyses from a total of 7 wells show a distinct lowering of kaolinite abundance in the Barremian. Overall the data is rather noisy, perhaps because of variable effects of early diagenetic kaolinite authigenesis in sediments deposited in the coastal zone.

Assessing the vulnerability of shallow lakes to water level fluctuations: an example from southwestern Nova Scotia

DAVID TERRY[1], IAN SPOONER[1], AND CHRIS E. WHITE[2]

1. Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada <ian.spooner@acadiau.ca>

2. Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia, B3J 2T9, Canada

Lakes are of particular importance in groundwater vulnerability studies since they act as catchment basins for close to 40% of the landscape, supply drinking water, generate electricity, are used to irrigate fields, and serve as recreational areas. To develop effective lake management strategies and assess risk associated with development or changing climate it is necessary to understand contemporary processes operating ~~in lakes~~ and catchments ~~areas~~. Most lakes in Atlantic Canada are small (<50 ha.) and shallow (<3 m avg. depth). This study focuses on assessing the vulnerability of a shallow organic lake to small variations in water depth. Tupper Lake is a 45 ha lake with an average depth of 1.3 m and is located on the South Mountain Uplands in Kings County, Nova Scotia. The lake has recently been the focus of water quality and environmental change studies both prompted by an awareness of the potential impacts of shoreline development. Recently, much controversy has centered on short term, anthropogenically driven water level changes that have been a consequence of development pressure at

Formatted: Font: Times New Roman, 10 pt, Small caps

Formatted: Font: Times New Roman, 10 pt, Small caps

Formatted: Font: Times New Roman, 10 pt, Small caps

Formatted: Font: Times New Roman, 10 pt, Italic, Not Superscript/ Subscript

Formatted: Font: Times New Roman, 10 pt, Italic

Formatted: Font: Times New Roman, 10 pt, Italic

Formatted: Font: Times New Roman, 10 pt, Italic

Formatted: Font: Times New Roman, 10 pt, Italic, Not Superscript/ Subscript

Formatted: Font: Times New Roman, 10 pt, Italic

Formatted: Font: Times New Roman, 10 pt, Italic

the lake. This study focuses on determining if relatively small fluctuations in water level have the potential to affect water quality.

In the summer and fall of 2010, a variety of autochthonous physical and chemical data was collected. A historical perspective was provided by long term residents of the lake and climatological data was gathered from regional sources. Interviews indicate that metre-scale water level change occurred in the early 1900s associated with hydroelectric development. Sonar, sub-bottom, and penetrometer data indicate that strong storms have the potential to create sufficient bottom shear to re-suspend lake bottom sediment. Gravity core stratigraphy indicates significant anthropogenic influence during the past 100 years including the addition of substantial amounts of saw mill waste. Chemical data from lake sediment cores demonstrate that though the limiting nutrient P decreases up core, the concentrations of many metals including Cu, Zn, As, and Ni increase substantially towards the top of the core.

The results of this study indicate that Tupper Lake, and likely many other lakes in Atlantic Canada, may experience substantial water quality change in response to small, decimetre-scale reductions in lake level. Lake management strategies are required to address the risk associated with drawdown.

Structure and petrology of the Partridge Island block and adjacent areas, Saint John area, southern New Brunswick

R.L. TREAT[1], S.M. BARR[1], A.F. PARK[2], C.E. WHITE[3], AND P.H. REYNOLDS[4]

1. Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada <098865t@acadiau.ca>

2. Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada

3. Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, Canada

4. Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada

The Partridge Island block consists of three areas of highly deformed metasedimentary and metaplutonic rocks, informally named the Tiner Point formation and Seaview plutonic suite, which are located in and near the city of Saint John in southern New Brunswick. During the summer of 2010, detailed geological and structural mapping was conducted in and around the Partridge Island block in order to better elucidate its relationship to adjacent Carboniferous, Cambrian, and Neoproterozoic units, as well as to characterize the rocks of the Partridge Island block itself. On Partridge Island and east of Saint John in the Red Head area, these rocks are diorite to quartz-diorite gneiss and plagiogranite. The gneiss contains variably altered plagioclase, K-feldspar, and hornblende porphyroclasts in a matrix of quartz, chlorite, sericite, and opaque minerals; the plagiogranite consists of quartz and plagioclase porphyroclasts in a matrix of quartz, plagioclase, and muscovite. In some areas, quartz-chlorite-muscovite schist is also present, likely the product of local retrograde metamorphic conditions. East of Saint John, around Red Head, these rocks occupy the core of a syncline as a fault-bounded block, thrust on top of a Carboniferous sedimentary sequence. Some of these Carboniferous units were deformed during overthrusting, and later deformation involved northwest-directed folding around the more competent material. The gneiss and plagiogranite are structurally overlain by variably deformed basalt and red and grey siltstone of the Taylors Island Formation and yielded a $^{40}Ar/^{39}Ar$ muscovite cooling age of 332±3 Ma. This suggests mylonitization during the Neoacadian orogeny, followed by exhumation and subsequent deposition of the Taylors Island Formation in the Carboniferous. West of Saint John, in the Lorneville area, the Partridge Island block consists of variably deformed alkali-feldspar granite and plagiogranite, both of which contain tectonic inclusions of thinly laminated quartzite and quartz-chlorite-muscovite schist. The alkali-feldspar granite consists of porphyroclasts of K-feldspar and aegerine in a matrix of K-feldspar, quartz, and opaque minerals, and displays a metamorphic texture ranging from protomylonitic along the coast to ultramylonitic and phyllonitic approaching the steeply faulted contact with the Taylors Island Formation. The rocks in this area are also extensively mineralized by numerous hematite and quartz-siderite veins, with previously unreported IOGC-type mineralization present in some places.

Erosion Susceptibility Prediction (ESP) for Yarmouth, Nova Scotia

D.J. UTTING

Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, Canada <uttingdj@gov.ns.ca>

Planners and other decision makers require information about rates of erosion in order to take the measures necessary to protect public safety, including creating setbacks for locating infrastructure and housing. Interest in the rates of erosion is increasing because of sea-level rise and the potential for increased coastal storms. Generally, the approach is to measure past rates of erosion from aerial photography, and extrapolate this rate into the future. This is not an ideal method; for example, rapid rates of erosion of a drumlin in the past might reduce the potential for future erosion, or at least make it more likely that the erosion would occur at a lower rate. Erosion along the coast has been found to occur during major storms, which might not be reflected during the period of aerial photography, and some rates of erosion are difficult to calculate because of varying qualities of aerial photography. Because of these issues, an alternative approach similar to calculation of regional coastal sensitivity and vulnerability indexes (where variables contributing to coastal erosion and flooding are combined to determine an index) is proposed for a test for the Yarmouth, Nova Scotia area. Combining new surficial geology maps, including coastal deposits and backshore materials (e.g. dunes, beach ridges, drumlins, or bedrock), with new bedrock mapping, as well as slope from LiDAR, distance to the backshore, fetch, tidal range and wave climate, an index of erosion susceptibility can be calculated. In general, steep slopes of unconsolidated material have a higher erosion potential than steep slopes of durable bedrock. Similarly, steep slopes of the same material have different erosion potential with different exposures to wave attack. This Erosion Susceptibility Prediction (ESP) tool will be adapted with planners to provide a simplified, yet scientifically

backed decision-making dataset for assigning setbacks in coastal areas. This would be applied coupled with flood modeling based on LiDAR DEMs. Future work will attempt to test this model in other areas of Nova Scotia.

High resolution radar stratigraphy (GPR) of braided channel complexes in the Triassic Wolfville Formation: controls on reservoir heterogeneity

M.J. VAUGHAN AND G.D. WACH

Department of Earth Sciences, Dalhousie University,Halifax, Nova Scotia B3H 4J1,Canada <mattvaughan@dal.ca>

The Triassic Wolfville Formation crops out along the shoreline of the Minas Basin of the Bay of Fundy, Nova Scotia. Cambridge Cove contains an exceptionally well preserved outcrop which presents 2D and 3D exposures of the braided channel depositional environment of the Wolfville Formation. These outcrops demonstrate the stratigraphic complexities associated with the depositional environment.

This study aims to: (1) use Ground Penetrating Radar survey techniques spatial calibrated with DGPS to image braided channel depositional architecture in the subsurface for correlation to outcrop LiDAR data; (2) provide 3D, hi-resolution stratigraphic and structural information about braided channel deposits and their effectiveness as petroleum reservoirs; and (3) understand gas and fluid connectivity within braided channel complexes and the influence of these factors on petroleum production and geological sequestration of CO_2.

Sustaining consistent well production despite a changing near-well environment

GIL VIOLETTE

Stantec Consulting Limited, 845 Prospect Street, Fredericton, New Brunswick E3B 2T7, Canada <Gil.Violette@stantec.com>

Maintaining a wellfield at full capacity requires knowledge of the well's mechanical conditions and knowledge of near-well conditions of the aquifer. A sustained well production will fulfill scheduled user demand over the lifespan of a well. Wellfield operators routinely face challenges in sustaining well production because of aging infrastructure and also face declining production due to the aquifer plugging and related transmissivity changes of the host geological deposits. A pro-active approach to well maintenance by the City of Fredericton has resulted in sustainable production of potable water from the existing wells, which would not have been possible otherwise.

The sustained production of a wellfield can be achieved by monitoring well and aquifer hydraulics on a regular basis. The information will allow an evaluation of well performance and provide information to forecast the production of a well and schedule maintenance when required. In addition, key indicators such as well water chemistry and microbiology can assist in determining maintenance requirements. Methods of monitoring, analysis, forecasting, and well regeneration will be presented as they apply to a case study of the Fredericton Aquifer, a large glaciofluvial sand and gravel aquifer that produces 25 ML per day from 11 wells.

Strike-slip faults and the mid-Paleozoic reconfiguration of the Appalachians in Atlantic Canada

JOHN W.F. WALDRON[1], SANDRA M. BARR[2], C.E. WHITE[3], AND JIM HIBBARD[4]

1. Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3, Canada <john.waldron@ualberta.ca>

2. Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P2R6, Canada

3. Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, Canada

4. Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, North Carolina 27695, USA

Dextral NE-SW, roughly orogen-parallel strike-slip faults were active in the Late Devonian and Carboniferous, in both the northern and southern Appalachians. In the southern Appalachians, these faults cut through, and offset, structures related to promontories and reentrants in the Laurentian margin. In the Canadian Appalachians, however, the St. Lawrence promontory was not truncated, but instead formed a right-handed stepover, around which dextral strike-slip faults frame the deepest parts of the Maritimes Basin. This enormous sedimentary basin contains over 12 km of sediment, and accounts for nearly one third of the thickness of the crust beneath parts of the Gulf of St. Lawrence. Two main orientations of strike-slip faults are present: NE-SW orogen-parallel faults with major activity early in basin history, and E-W faults including the Cobequid-Chedabucto Fault Zone of Nova Scotia, which experienced major activity in the mid-Carboniferous.

Restoration of plausible amounts of movement on these strike-slip faults is possible using offset basin margins and extreme contrasts in facies. Using conservative estimates of offset, the Belleisle, Kennebecasis, Caledonia, Rockland Brook, Canso, Cabot, and other faults may be restored to possible mid-Devonian configurations. The resulting geometry places ~1 Ga rocks of the Blair River Complex in NW Cape Breton Island close to rocks of equivalent age in the Indian Head Range of Newfoundland, and rearranges contrasting components of Avalonia into two coherent belts. Widely separated, but similar, components of Ganderia in New England and New Brunswick are also juxtaposed in the reconstruction.

Despite the uncertainties inherent in the restoration, it is clear that offset in the Laurentian margin between the Québec reentrant and the St. Lawrence promontory played a major role in Appalachian tectonism throughout the Paleozoic, and that late Paleozoic strike-slip faults rearranged the configuration of Appalachian terranes produced by the Acadian orogeny. Restoration of the early Paleozoic assembly of the orogen should take these late Paleozoic movements into account. Misleading results may be obtained by attempting to restore early Paleozoic plate configurations based on present-day cross-sections.

Significance of a Meguma mass transport deposit in Halifax, Nova Scotia

JOHN W.F. WALDRON[1], R.A. JAMIESON[2], AND C.E. WHITE[3]

1. Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3, Canada <john.waldron@ualberta.ca>

2. Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada

3. Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, Canada

Portions of the Meguma Supergroup in Nova Scotia have been interpreted as originating in slope, rift, and shelf environments; indications of paleoslope have important implications for tectonic environment. The Bluestone formation represents the upper part of the Halifax Group in the Halifax Peninsula and adjacent mainland. Despite the overprint of regional deformation and contact metamorphism, most outcrops display well-bedded metasedimentary rocks with Bouma sequence structures. Cleavage and an intersection lineation are related to the WSW-plunging Point Pleasant syncline.

In contrast, at Chain Rock, quartzose and calc-silicate hornfels representing originally coarser metasedimentary rocks occurs as isolated blocks containing rootless folds with curved axial traces. Along strike at the Martello Tower, folds display curved hinges that plunge both WSW and ENE. At Fort Ogilvie, ovoid metasandstone blocks occur in an originally fine-grained matrix. The unit, distinguished as the Chain Rock member, is 50 to 100 m thick and forms a ridge that was exploited for 19th century fortifications. On the hinge of the Point Pleasant syncline, upper and lower contacts are exposed. Folds, indicated by curved intersection lineations, are cross-cut by cleavage. On the north limb, the unit can be traced beneath Saint Mary's University to Northwest Arm. Traced west from Chain Rock to Bluestone Quarry, it is offset with sinistral separation by an inferred fault beneath Northwest Arm.

The style of deformation suggests localized extreme competence contrasts. Deformation post-dated cementation of concretions, but pre-dated regional metamorphism. The unit is interpreted as a mass-transport deposit produced by downslope mass-movement of weakly consolidated sediment. Shear zones at the base climb up-section along strike towards the ENE, shortening strata, with folds that face generally NE. This implies N or NE-directed movement, consistent with regional paleocurrents and a proposed location for the Meguma terrane on a rifted margin of Gondwana. The most likely location of deposition is at the toe of a submarine slope; farther up-slope, extensional structures would be predicted. Not all the structures within the member are purely synsedimentary; outcrop-scale folds near the top may result from tectonic strains that have amplified heterogeneities initially produced by synsedimentary deformation.

Stratigraphic setting of the Halfmile Lake South Deep zone, part of the Halfmile Lake VMS deposit, Bathurst Mining Camp

J.A. WALKER[1] AND S.R. MCCUTCHEON[2]

1. New Brunswick Department of Natural Resources, Geological Surveys Branch, P.O. Box 50, Bathurst, New Brunswick E2A 3Z1, Canada <jim.walker@gnb.ca>

2. McCutcheon GeoConsulting, 1935 Palmer Drive, Bathurst, New Brunswick E2A 4X7, Canada

The Halfmile Lake South Deep zone (HLSDz) was discovered in 1999 by Noranda Exploration Ltd. during drilling of a 3-D seismic anomaly; it was intersected at a vertical depth of approximately 1200 m. This zone is interpreted to be the down-dip extension of the known South and North zones. Collectively, these zones constitute a continuous sheet with a strike length of >950 m, and a thickness ranging between 2 and 75 m. The sheet dips northerly between 50 ^{o} and 80^{o} and extends to a vertical depth of at least 1300 m. Kria Resources Ltd. is presently developing the deposit and has published a NI 43-101 compliant inferred resource of 6.26 Mt grading 6.37% Zn, 1.6% Pb, 0.15% Cu, and 17.04 g/t Ag for the HLSD zone.

The HLSDz discovery hole (HN-99-119), which was collared approximately 1500 m north of the surface exposure of the South Zone (Upper AB part), passes through the axis of a southeasterly overturned, east-west striking anticline. In the upright limb, 80 m of rhyolite and tuff of the Flat Landing Brook Formation conformably overlie 540 m of quartz-feldspar phyric rocks of the Nepisiguit Falls Formation. The latter formation, comprising five eruptive units ranging in thickness from 26 to 218 m, conformably and gradationally overlies green to grey siltstone, shale, and minor sandstone of the Miramichi Group that continues down hole for 600 m in the core of the anticline.

In the overturned limb, the Miramichi Group is in apparent conformable contact with a narrow interval (~20 m), of sericite-chlorite altered, fine-grained volcaniclastic rocks (Nepisiguit Falls Formation), which give way down hole to exhalative massive sulphides (≤40 m). Stockwork stringer mineralization that is ubiquitous in other parts of the Halfmile Lake deposit is only weakly developed, whereas oxide facies iron formation, which is unknown in the other parts of the Halfmile Lake system, was intersected in two other drill cores from the HLSD zone.

The Meguma terrane of southern Nova Scotia: insights on its pre-Carboniferous stratigraphy

C.E. WHITE[1], T. PALACIOS[2], S. JENSEN[2], AND S.M. BARR[3]

1. Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, Canada <whitece@gov.ns.ca>

2. Area de Paleontologia, Facultad de Ciencias, Universidad de Extremadura, Avenida de Elvas s/n, 06006 Badajoz, Spain

3. Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada

The Meguma terrane of southern Nova Scotia includes the Neoproterozoic-Ordovician Goldenville and Halifax groups and the younger Silurian to early Devonian Rockville Notch Group, intruded by mainly Devonian plutons and overlain by Carboniferous and younger rocks. The Goldenville Group consists of metasandstone with minor interbeds of metasiltstone

and slate (Moses Lake, Church Point, Green Harbour, Tangier, and Taylor Head formations), and locally grades upwards into thinly bedded metasandstone, metasiltstone, and silty slate (Government Point formation). The uppermost unit, which includes the laterally equivalent Moshers Island, Bloomfield, Beaverbank, and Tupper Lake Brook formations, is characterized by numerous Mn-rich laminations and concretions. The Church Point formation contains a distinctive metasiltstone unit (High Head Member) that contains a deep-water Lower Cambrian trace fossil assemblage, including the ichnofossil *Oldhamia*. The upper part of the Government Point formation has yielded early Middle Cambrian Acado-Baltic trilobite fossils and the overlying Tupper Lake Brook formation yielded an acritarch species consistent with middle Cambrian age.

Units in the overlying slate-rich Halifax Group include the basal pyritiferous units (laterally equivalent Acacia Brook and Cunard formations), overlain by non-pyritiferous units, the laterally equivalent Bear River, Feltzen, Bluestone, Glen Brook, and Lumsden Dam formations. Two new formations are recognized above the Lumsden Dam formation in the Wolfville area, the trace fossil-rich Elderkin Brook and overlying Hellgate Falls formations. The upper part of the Cunard formation yielded a late Cambrian assemblage of acritarch species. The Bear River, Feltzen, and Lumsden Dam formations locally contain the Early Ordovician graptolite *Rhabdinopora flabelliformis*. Samples collected up-section from the graptolite occurrence in the Lumsden Dam formation yielded acritarch species that are indicative of the later Tremadocian. Slightly post-Tremadocian (Floian) acritarchs have been recovered from the Hellgate Falls formation.

The younger Silurian to Devonian units include volcanic and sedimentary rocks of the lower White Rock Formation, overlain by siltstone and slate of the Kentville Formation. The uppermost unit (New Canaan and Torbrook formations) consists of marine sedimentary and volcanic rocks. These formations are included in a newly defined Rockville Notch Group. The gap in age between the Halifax Group and the overlying Rockville Notch Group confirms that a major unconformity exists between the two groups.

How wet was it? A 5000 year wetland sediment record of changing moisture regimes in Nova Scotia

HILARY WHITE AND IAN SPOONER

Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia B4P 2R6, Canada <ian.spooner@acadiau.ca>

Nova Scotia has one of the densest archives in Canada of regional paleoenvironmental data owing to the excellent preservation of Late Glacial and Early Holocene climate change records in lake sediments. Wetlands have received far less attention, though recent studies indicate that they have the potential to preserve long (9000+yr) and continuous records of past hydrogeological and moisture regimes. At the Pleasant River Fen (southwestern Nova Scotia) and Baltzer Bog (Annapolis Valley, Nova Scotia) excavated sections, gravity cores, and vibracores were used to expose sediment for stratigraphic analyses. Ages were obtained by conventional and AMS radiocarbon dating of terrestrial wood. Core samples were analyzed for lithostratigraphic proxies including loss on ignition (LOI) and magnetic susceptibility (MS).

At Pleasant River Fen a transition in lithostratigraphic (MS and LOI) properties at 126 cm depth (~3000 ^{14}C yr BP) is a result of a rising water table and is coincident with a regime shift to moister and slightly cooler conditions as recorded in regional palynological records. Baltzer Bog is located in an elevated, closed basin located on an extensive glacial outwash deposit. Excavation and trenching exposed a ~2 m high continuous section of alternating wood and sphagnum dominated sediment. The base of the section is composed of glacial outwash sand that is directly overlain by coarse woody material which, in turn is overlain by a wetland assemblage. A conventional ^{14}C date obtained on an upright stump at the initial woodland-wetland contact indicates an increase in local water table occurred shortly after 3070±50 yr BP. Another woodland - wetland transition was dated at 1730±40 yr BP. A minimum of 4 transitions are evident, demonstrating that the water table at the site fluctuated substantially during the Late Holocene. Historical records show that over the past 200 + years the site has been in transition from wetland to woodland, an indication of a declining water table.

Taken together these data indicate that rapid and substantial regional fluctuations in water table elevation occurred during the late Holocene. The rapid environmental change accompanying these fluctuations may have had a significant impact on several rare, disjunct species particular to wetlands, most notably the Blanding's Turtle, the survival of which may be dependent on the stability of these environments.

Micro-mechanical processes from the San Andreas Fault Observatory at Depth (SAFOD) Phase 3 cores

J.C. WHITE

Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <clancy@unb.ca>

Microstructural development in core retrieved from SAFOD Phase 3 drilling has been examined in three locations utilizing light, scanning electron (SEM), and transmission electron microscopy (TEM): (1) within the Salinian terrane near its contact with the presumed Great Valley sequence (Hole E-Run 1-Section 4 and 6); (2) proximal to the Southwest Deformation Zone (SDZ) with which are associated casing deformation and seismic aftershocks indicative of active faulting (Hole G-Run-1-Section 2 and Hole G-Run 2-Section 3); and (3) within the Central Deformation Zone (CDZ) in the centre of the damage zone identified in Phase 2 drilling (Hole G-Run 4-Section 2). The sampling locations translate to an across-strike distance from outside the damage zone to its centre of approximately 125 m, and a change in current measured depth from 2610 m to 2685 m. Common to all cores are: (1) a significant fractional volume (<1 um) of very fine-grained material, both primary grains and tectonized particles; (2) evidence of extensive fluid flux in the form of stress-induced dissolution seams (pressure solution), grain precipitation, and veining; and (3) complex, non-systematically varying phyllosilicate intergrowths (illite, muscovite, phengite, and chlorite).

The Salinian terrane material (E14 and E16) comprises coarse-grained quartz and perthitic feldspar clasts that locally form slightly foliated cataclasite. The matrix is commonly chloritic with very fine-grained aggregates and zones of quartz and/or feldspar. Microbrecciation is ubiquitous. There are both fluid-corroded clasts, particularly of quartz, and globular infillings of calcite with sutured contacts. Quartz and feldspar grains are coated by chlorite. Amorphous silica and secondary Ti-Fe oxides occur within cataclasite. Foliated siltstone-shale cataclasites (G12 and G23) at the edge of the damage zone close to the SDZ exhibit brecciation and cataclasis at different scales. Deformation is episodic as there are distinct overprinting relationships. The fine-grained matrix exhibits a strong SPO of phyllosilicates and cryptocrystalline quartz (<5 mm). The quartz is introduced as fine stringer veins that are progressively incorporated into the overall fabric. Similar thin calcite veins form parallel to the cataclastic foliation, suggestive of fault parallel hydraulic fracture. Coarser grained phyllosilicate zones develop C-S type fabrics with dextral displacement sense. Deformation bands can exhibit well-rounded clasts separated by thin foliae of a pressure solution foliation. Sheared siltstone/sandstone (G42) from within the central portion of the damage zone, approximately 7 m across strike from the CDZ, exhibit extensive evidence of fluid-rock interaction. Grains commonly have overgrowths, and there are well-developed pressure solution foliae. Quartz grains commonly 'float' in a calcite matrix. The fine-grained matrix itself has a strong foliation. The most unique feature is the occurrence of calcite veins at a high angle to the tectonic foliation. Collectively, microstructures indicate repeated cycles of cataclasis, with rapid strength recovery (interseismic?) by fluid-enhanced healing with significant aseismic strain accumulation.

Geochemistry of the igneous rocks associated with the MMH porphyry copper deposit, Chuquicamata District, Chile

J. WILSON[1], R. BORIC[2], J. DIAZ[2], AND M. ZENTILLI[1]

1. Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada <jessica.wilson@dal.ca>

2. Codelco Norte, Calle 11 Norte 1291, Calama, II Región, Chile

Whole rock and trace element geochemistry, petrographic and microprobe analyses of representative samples from drill core are used to characterize, compare, and correlate various igneous bodies within the Mina Ministro Hales (MMH) deposit. MMH is a large (1,310 Mt) Cu-Mo porphyry type deposit of Eocene-Oligocene age, located 7 km south of the Chuquicamata mine. The two deposits are on opposite sides of the West Fault (aka Falla Oeste), a regional strike-slip system that truncates the Chuquicamata ore deposit in the west, and has an estimated 35 km of sinistral displacement. The host rock at MMH is a Triassic granodiorite (MM Granodiorite), intruded by the Eocene MM Porphyry (39 Ma) and MM Quartz Porphyry (36 Ma). At depth MMH contains Cu-(Mo) porphyry type mineralization and potassic alteration, with K-feldspar, green-gray sericite, and anhydrite, but at higher levels there is an overprinting by younger hydrothermal breccia bodies containing high-grade Cu-(Ag-As) ore with abundant alunite, and advanced argillic alteration (silica, alunite, pyrophyllite, sericite, and dickite). The ores are hosted by granodiorite and the various porphyries, but the genetic relationships between the high sulphidation hydrothermal breccias and the younger intrusive phases remain uncertain. Although the porphyry stage MMH is older than Chuquicamata, the high sulphidation ores may be coeval with the equivalent at Chuquicamata. MMH is being prepared for open pit mining to begin in 2013 and subsequent underground mining.

Trace element geochemistry reveals that some mineralized lithologies given different names during ca. 20 years of core logging are in fact the same rock body with different textures and degrees of alteration. Locally, K-feldspar phenocrysts formed by potassic alteration of the host mineralized granodiorite may have led to its designation as porphyry. Microprobe study suggests that part of these K-feldspar phenocrysts are of magmatic origin and grew further during potassic alteration. The MMH porphyries have age and geochemical similarities with the Fortuna Igneous Complex which is across the West Fault from Chuquicamata (same side as MMH) and also with the El Abra Porphyry Complex located east of the fault more than 35 km to the north, giving credence to the postulated left lateral displacement.

The Salinic Orogeny in northern New Brunswick:
geochronological constraints and implications for Silurian stratigraphic nomenclature

REGINALD A. WILSON[1] AND SANDRA L. KAMO[2]

1. New Brunswick Department of Natural Resources, Geological Surveys Branch,
P.O. Box 50, Bathurst, New Brunswick E2A 3Z1, Canada <reg.wilson@gnb.ca>

2. Jack Satterly Geochronology Laboratory, Department of Geology, University of Toronto,
22 Russell Street, Toronto, Ontario M5S 3B1, Canada

Late Ordovician to Lower Silurian rocks of the Matapedia Cover Sequence in northern New Brunswick contain widespread evidence of Middle Silurian tectonism, variously expressed as a disconformity, angular unconformity, or by steeply plunging Acadian folds and fold interference patterns indicating Acadian overprinting of earlier structures. Silurian deformation is attributed to the Salinic Orogeny, which has been poorly documented until the relatively recent past, largely because of the absence of an easily identifiable "footprint" (Salinic folds typically lack axial planar cleavage), poor age control on some key units, and the lack of evidence of Salinic tectonism in some areas. However, U-Pb (zircon) radioisotopic dating of rhyolite near the base of the Bryant Point Formation (Chaleurs Group), just above the Salinic unconformity, has yielded an age of 422.3±0.3 Ma; in contrast, fossiliferous rocks just below the unconformity are no younger than early Wenlock, indicating a *ca.* 5 Ma Silurian hiatus in northern New Brunswick. This hiatus is not present in the Silurian section of southern Gaspé Peninsula, the type area of the Chaleurs Group. Although all Silurian rocks in northeastern New Brunswick have historically been included in the Chaleurs Group, the presence of a significant unconformity, as well as important lithological differences (especially the comparative abundance of volcanic rocks) argue in favor of revised higher-rank nomenclature in New

Brunswick. Hence, the Quinn Point Group is introduced to encompass Lower Silurian rocks, the Petit Rocher Group to include Upper Silurian sedimentary rocks in the Nigadoo River Syncline, and the Dickie Cove Group for Upper Silurian subaerial volcanic/volcaniclastic rocks in the Charlo-Jacquet River area. Upper Silurian rocks west of Campbellton that are contiguous with the Chaleurs Group in southern Québec, will remain in the Chaleurs Group. No revision or redefinition of constituent formations is proposed.

Mineralogical, petrological, and petrogenetic analysis of felsic intrusive rocks at the Sisson Brook W-Mo-Cu deposit, west-central New Brunswick

W. ZHANG[1], D. R. LENTZ[1], K. G. THORNE[2], AND C.R.M. MCFARLANE[1]

1. Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <wei.z@unb.ca>

2. Geological Surveys Branch, New Brunswick Department of Natural Resources, Fredericton, New Brunswick E3B 5H1, Canada

The Sisson Brook W-Mo-Cu deposit, situated in west-central New Brunswick, is hosted by Cambro-Ordovician volcanic and sedimentary rocks of the Miramichi and Tetagouche groups. These have been intruded by the Early Devonian Howard Peak diorite-gabbro, Nashwaak Granite, a felsic dyke swarm spatially associated with mineralization, and a distinctive younger porphyritic dyke. This study focuses on classifying and petrogenetically characterizing the felsic units, based on their petrology and major- and trace-element geochemistry.

Petrophysical and lithogeochemical research has identified three types of felsic units in the vicinity of the deposit. The Nashwaak Granite is light pinkish grey, medium- to coarse-grained, and locally slightly foliated. Biotite is abundant (20%) in these samples with accessory zircon, apatite, monazite, magnetite, and ilmenite. This group has low Zr/TiO_2 (0.04 to 0.07), high K_2O (4.24 to 6.58 wt.%), A/CNK (>1.1), molar K_2O/Na_2O ratio (>1), Zr/Y (>3), $(La/Yb)_N$ (2.35 to 31.9), and a high Fe/(Fe+Mg) (0.68 to 0.78).

The second felsic unit is a cross-cutting granitic dyke swarm ranges from a few centimetres up to 12 m wide. These unfoliated dykes are light greenish grey, medium- to coarse-grained, and typically have sharp boundaries that are locally irregular. Biotite (5%) coexists with apatite, pyrrhotite, and titanite. They are broadly characterized by high Zr/TiO_2 (0.06 to 0.19), low A/CNK (<1.1), molar K_2O/Na_2O (<1), Zr/Y (<4), and $(La/Yb)_N$ (<7). They are ferroan with Fe/(Fe+Mg) up to 0.9.

The granite porphyry dyke is the third felsic unit, and yielded a concordant U-Pb zircon age of 364±1.3 Ma from drill hole SSN-26. Phenocrysts consist of approximately 23% plagioclase (up to 1 cm), 10% quartz (up to 7 mm), 8% biotite (up to 0.03 mm), and 7% K-feldspar (0.2 to 1.0 cm). This porphyry dyke has low Zr/TiO_2 (0.03), A/CNK (0.99 to 1.05), molar K_2O/Na_2O (<1), medium Zr/Y (6.62), and medium $(La/Yb)_N$ (8.91). Overall, the biotite compositions found within the three felsic groups are similar with slightly elevated Al contents and moderate Fe numbers. Plagioclase crystals are predominantly albitic with minor orthoclase, whereas the K-feldspars have a minor anorthite component.

All these granites were formed in a volcanic arc environment (evolved I-type) and probably originated from infracrustal rocks contaminated by upper crust. These magmas have oxidized characteristics (fO_2 between 10^{-13} and 10^{-16}), were emplaced at low pressures (An-Ab-Or diagram, <2.5 kbar) and low temperatures (T_{Zr} <800 ºC), and contain at least 6% wt. water (Holtz's P-T diagram). The fHF/fHCl ratio of the fluids, calculated from biotite EPMA analyses, are higher than typical porphyry Cu deposits, similar to W-related porphyry systems, and lower than porphyry Mo deposits. The formation of these granites is related to tectono-magmatic activities in the Canadian Appalachians, in Early to Late Devonian time.

IODP site 1256: petrological and textural variations down-core

KHALHELA ZOELLER

Department of Earth Sciences and Oceanography, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada <KH573513@dal.ca>

An intact core from IODP (Integrated Ocean Drilling Program) site 1256, located in the eastern equatorial pacific (Cocos Plate), was collected on three different legs (legs 206, 309, and 312). This is the fourth deepest hole that IODP has drilled since 1968, and is the first hole to reach the uppermost portion of in situ gabbroic oceanic layer 3. The purpose of this study is to examine down-hole petrological and textural trends, including variations in hydrothermal alteration products.

Fifty thin sections were cut at specific depths down-core and point counts of primary and secondary minerals were done on all samples. Some systematic trends can be inferred from the modal analyses concerning the dominant minerals and alteration products. Trends include a change from possible smectites to chlorite at 1050 mbsf, concentrations of quartz at varying depths, and changes in opaque oxides at 1230 mbsf. Preliminary electron microprobe analysis was done on six representative thin sections to identify some unknown minerals, including amphiboles, opaque oxides, and possible clay minerals, suggested by previous work that showed clays to be present in the upper part of the core. Back-scattered electron images were also collected in order to determine the mineralogy and texture of the fine-grained groundmass present in most of the upper core. Results to date have shown the presence of minimal sulphides, orthopyroxene and olivine, an abundance of clays, and the amphiboles were determined to be hornblende and actinolite.

Point-counts and electron microprobe analyses from a core collected from the Kane Fracture Zone on the Mid-Atlantic Ridge will be used to supplement data obtained from the site 1256 core, in particular whether the observed variations in textural and alteration minerals are unusual. Results from both cores will assist in understanding spatial variations in igneous and hydrothermal processes at mid-ocean ridges.

Paleozoic tectono-thermal evolution of the Key Anacon Zn-Pb-Cu-Ag deposit, Bathurst Mining Camp, Canada, from pyrite microfabric and thermodynamic modeling of garnet.

JOSEPH D.S. ZULU, CHRISTOPHER R.M. MCFARLANE, AND DAVID R. LENTZ

Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <d4Ln8@unb.ca>

Pyrite in the upper-greenschist to amphibolite Ordovician metavolcanic and metapelitic rocks hosting the Key Anacon Zn-Pb-Cu massive sulphide deposits, records brittle-ductile deformation microtextures. These are preserved as pulled-apart boudins aligned parallel to S_1 fabric assemblages of M_1 that is associated with F_1, and as fine-grained inclusions in garnet, cordierite, and andalusite. Isoclinal to tight F_1 and F_2 microfolds in pyrite layers relate to the ductile deformation stage during progressive regional metamorphism. Deformation reflects marked structural thickening that produced garnet-bearing metapelites followed by exhumation via ductile shearing. Garnet in the metapelites display compositional zoning, and records a series of growth and resorption stages, with an early formed core and the first annulus preserving S_1, whereas the other annuluses through to the rim are synchronous with S_2 development during M_2.

Pressure-temperature estimates using sphalerite-arsenopyrite geothermobarometry on the sulphides suggest an average pressure of 4.1 kbar and temperature of 400 °C. The garnet-bearing metapelites record an average temperature of 536±11 °C at 2.5 kbar (THEMOCALC v.3.21), whereas garnet-biotite Fe-Mg exchange thermometers suggests metamorphic temperatures of 530 °C. The P-T conditions of growth of the garnet core were derived from isochemical P-T diagrams generated using THERIAK-DOMINO using XRF-derived bulk compositional data. Isopleths intersections for the garnet core give a temperature estimate of 437 °C and pressure of 0.57 kbar. Successive P-T estimates from the first garnet annulus through to the rim were calculated to infer a P-T path followed by the rock during its tectono-thermal history. Peak metamorphic conditions of the garnet rim are 570 °C and 2.5 kbar and during this stage, pyrite recrystallization and plastic deformation predominated. The P-T path suggests burial of the rocks during D_2 regional metamorphism with attainment of peak pressure (4.1 kbar) at a temperature of 524 °C, whereas peak temperature conditions occurred during the exhumation stage. Contact metamorphism associated with the intrusion of the Devonian Pabineau Granite is the third metamorphic event (M_3) that overprints earlier regional metamorphic assemblages associated with S_1, S_2, and S_3 fabric elements. This is characterized by recovery textures in pyrite, quartz, cordierite, andalusite, and random growth of biotite. Annealing of pyrite suggest that conditions during this episode were predominated by thermal metamorphism that followed exhumation of the rocks.

The temperature estimates of the massive sulphides are lower as compared to the garnet-bearing metapelites, since sulphide assemblages re-equilibrate early during regional metamorphism. However, the calculated pressure from the sphalerite geobarometer is consistent with peak pressure estimates from the forward modeling of garnet using THERIAK-DOMINO. The close correlation of results in the different bulk rock compositions of metapelites suggest that the estimates are realistic and have a geological significance.