# 2015

February 20-22

Schedule and Abstracts

# [CORDILLERAN TECTONICS WORKSHOP 2015]

HOSTED AT THE UNIVERSITY OF CALGARY

# Cordilleran Tectonics Workshop

# February 20-22, 2015

# Sponsored by Department of Geoscience, University of Calgary

Welcome to the 2015 Cordilleran Tectonics Workshop!

The meeting this year marks the 40th anniversary of the 1st CTW, which was held at Queens University on January 16, 1975.

In honour of that event, we reproduce on the next couple of pages the schedule from the first CTW in 1975 (courtesy of Ray Price). The first two presenters from that event (Ray Price and Phil Simony) will be here this year and Ray will again be giving the opening talk!

We hope the 2015 Cordilleran Tectonics Workshop will be as stimulating and convivial as the first!

2015 CTW Committee:

Dr. Dave Pattison, Dr. Bernard Guest, Shantal Goldsmith, Will Matthews, Julia Pickering, Paul Starr, Ewan Webster

AGENDA

Workshop on Tectonics of the Southeastern Canadian Cordillera

Department of Geological Sciences

Queen's University

Thursday, January 16th

Seminar Room, Miller Hall

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| 10.00 a.m. | Introduction, coffee and review of agenda. |
| 10.30 - 12.00 | R. A. Price - review of Queen's University Program on Tectonic Analysis of the southeastern Canadian Cordillera. |
| 12.00 - 1.30 | Luncheon - McLaughlin Room, Students' Union Building. |
| 1.30 - 3.00 | P. S. Simony - review of University of Calgary Program. |
| 3.00 - 3.30 | Coffee Break |
| 3.30 - 5.00 | R. L. Brown - review of Carleton University Program. |
| 5.00 - 7.30 | Dinner |
| 7.30 - | Informal Discussions - Department Lounge - Bruce Wing. |

Friday, January 17th

Seminar Room - Miller Hall

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| 9.00 - 10.00 | E. W. Mountjoy - review of McGill University Program. |
| 10.00 - 10.30 | Coffee Break |
| 10.30 - 11.00 | M. G. Lis (Queen's Ph.D. Project) Tectonic Evolution of the Kootenay Arc, Crawford Bay Area, B. C. |
| 11.00 - 11.20 | J. K. Glover (Queen's Ph.D. Project) Structural Analyses of Proterozoic rocks, southern Kootenay Arc, B. C. |
| 11.20 - 11.40 | G. L. Benvenuto (Queen's Ph.D. Project) Structural Evolution of the Hosmer Nappe. |
| 11.40 - 12.00 | P. R. Fermor (Queen's M.Sc. Project) Structural Analysis of the Lewis Thrust Fault Around the Cate Creek and Haig Brook Windows |
| 12.00 - 1.40 | Luncheon - McLaughlin Room, Students' Union Building. |

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|---|---|
| 1.40 - 2.00 | J. van der Linden (Carleton Ph.D. Project) Late State Refolding in the Selkirk Mountains |
| 2.00 - 2.20 | C. Tippitt (Carleton M.Sc. Project) The Sir Sanford Structure. |
| 2.20 - 2.40 | D. Shaw (Carleton M.Sc. Project) Tectonic Relationships in the Adamant Pluton. |
| 2.40 - 3.00 | Coffee Break |
| 3.00 - 3.20 | M. Perkins (Carleton M.Sc. Project) Correlation of Mt. Trident Structures and Stratigraphy Northwestward. |
| 3.20 - 3.40 | R. Leatherbarrow (Carleton M.Sc. Project) P-T Relationships During Deformation in the Northern Selkirk Mountains. |
| 3.40 - 4.00 | D. G. Gardner (Queen's Ph.D. Project) Metamorphism and Mechanics of Deformation in the Chancellor Formation of the Porcupine Creek Anticlinorium, Blackberry River Area, B. C. |
| 4.00 - 5.00 | General discussions. |

**Recent Cordilleran Tectonics Workshops**

| Year | Organizer | Location |
|---|---|---|
| 2015 | U Calgary | Calgary |
| 2014 | UBC-Okanagan | Kelowna |
| 2013 | Queen"s U | Kingston |
| 2012 | BCGS | Victoria |
| 2011 | YGS | Whitehorse |
| 2010 | Carleton U | Ottawa |
| 2009 | U Calgary | Calgary |
| 2008 | UBC | Vancouver |
| 2007 | U Alberta | Edmonton |
| 2006 | SFU | Vancouver |
| 2005 | YGS | Whitehorse |
| 2004 | U Calgary | Calgary |

# Schedule – 2015 Cordilleran Tectonics Workshop

## Friday Feb 20

17:00 - Informal Meet and Greet

Last Defense Lounge (2nd Floor MacEwan Hall)

## Saturday Feb 21 (MacEwan Hall Ballroom)

8:00 - Breakfast/Registration

9:00 - Talk Session

10:30 - Coffee Break

11:00 - Talk Session

12:30 - Lunch

13:30 - Talk Session

15:30 - Drinks and Poster Session

18:00 - Supper (Jamesons Irish Pub)

## Sunday Feb 22 (MacEwan Hall Ballroom)

8:00 - Breakfast

9:00 - Talk Session

10:30 - Coffee Break

11:00 - Talk Session

12:30 - Lunch/End of Workshop

# Technical Program – CTW 2015

## Saturday Feb 21 (MacEwan Hall Ballroom)

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**8:00** **Breakfast**

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**9:00** **Welcome and Announcements**

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**9:05** **Conceptual Models and the Role of Gravity in Tectonics**

Raymond A. Price

*Dept. of Geological Sciences and Geological Engineering, Queen's University, Kingston, Ontario*

**9:25** **Did Westward Subduction Cause Cretaceous-Tertiary Orogeny in the North American Cordillera? Probably Not**

William A. Matthews[1], Bernard Guest [1]

[1]*University of Calgary, AB*

**9:45** **Plateau uplift in western Canada caused by lithospheric delamination along a craton edge**

Bernard Guest[1], Xuewei Bao[1], David W S Eaton[1]

[1]*University of Calgary, AB*

**10:05** **Discussion**

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**10:30** **Coffee**

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**11:00** **Pressure-temperature evolution of zoisite eclogites from Faro Area, Yukon**

Edward Ghent[1], Robert Marr[1], and Allison Klincker[1]

[1]*Department of Geoscience, University of Calgary, Calgary, AB T2N 1N4*

**11:20** **A model for diachronous ductile deformation, metamorphism and exhumation in the metamorphic hinterland of the northern Canadian Cordillera**

Reid D. Staples[1], Dan Gibson[1], Maurice Colpron[2], Jim J. Ryan[3], Rob G. Berman[4]

*[1]Simon Fraser University, BC, [2]Yukon Geological Survey, YT, [3]Geological Survey of Canada, BC, [4]Geological Survey of Canada, ON*

**11:40** **Insights from $^{40}Ar/^{39}Ar$ thermochronology on the exhumation history and juxtaposition of different tectonic domains within the northern Priest River Complex and Kootenay Arc, southeastern British Columbia.**

Ewan R Webster[1], David R.M. Pattison[1], Douglas Archibald[2]

*[1]University of Calgary, AB, [2]Queens University, ON*

**12:00** **Discussion**

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**12:30** **Lunch**

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**13:30** **New U-Pb geochronology and fossil age control, Earn Group near Anvil Lake, central Yukon.**

Rosie Cobbett[1] and Jim Crowley[2]

*[1]Yukon Geological Survey, YT, [2]Boise State University, ID*

**13:50** **Birth of the northern Cordilleran orogen, as recorded by detrital zircons in Jurassic synorogenic strata and regional exhumation in Yukon**

Maurice Colpron

*Yukon Geological Survey, YT*

**14:10** **Interplay between antecedent Cambrian features and Cordilleran structures in the eastern Mackenzie Mountains and Franklin Mountains, NWT.**

Karen M. Fallas

*Geological Survey of Canada, Calgary*

**14:30** **Burial and Exhumation History of the Mackenzie Mountains and Plain, NWT, through the Integration of Low-Temperature Thermochronometers**

Jeremy W. Powell[1], Dale R. Issler[2], David A. Schneider[1] and Daniel F. Stockli[3]

[1]*University of Ottawa,* [2]*Geological Survey of Canada,* [3]*Jackson School of Geosciences, TX*

**14:50** **Discussion**

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**15:30** **Posters**

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**18:00** **Supper (Jamesons Irish Pub)**

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## Sunday Feb 22 (MacEwan Hall Ballroom)

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**8:00** **Breakfast**

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**9:00** **Announcements**

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**9:05** **The Ruddock Creek Zn-Pb deposit: Constraining the timing of deposition of the metalliferous Windermere Supergroup, Northern Monashee Mountains, Southern British Columbia**

Lucia Theny[1], Dan Gibson[1], James Crowley[2], Jim Miller-Tait[3]

*[1]Simon Fraser University, BC, [2]Boise State University, ID, [3]Imperial Metals Corporation, BC*

**9:25** **The Chinook compilation map series: GSC open files 7475, 7476, and 7477**

Glen S. Stockmal[1], Karen M. Fallas[1], and Margot E. McMechan[1]

*[1] Geological Survey of Canada – Calgary*

**9:45** **Effects of Large Scale Anisotropy on Thrust Fronts**

Malcolm Lamb

*Shale Petroleum, Calgary*

**10:05** **Discussion**

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**10:30** **Coffee**

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**11:00** **Thrust Linkage and Lateral Ramps insight into the thrust kinematics of the Southern Canadian Front Ranges and Foothills**

Paul A. MacKay

*Shale Petroleum Ltd.*

**11:20** **Is the Monashee Cover Sequence a portion of the Windermere High? (Constraints from palinspastically restored maps of the southeastern Canadian Cordillera.)**

Kevin Root

*Glencore E&P Canada*

**11:40** **Discussion**

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**12:30** **Lunch**

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## List of Posters (alphabetical order by last name of first author):

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**Building a Structural Framework for the northern Interior Plateau of British Columbia from Aeromagnetic Data**

Joel J. Angen[1], Craig J.R. Hart[1], Elizabeth Westberg[2], Rachel Kim[1], Chelsea Raley[3]

*[1]Mineral Deposit Research Unit, The University of British Columbia, BC, [2]Consulting Geologist, Calgary, AB [3]Consulting Geologist, Vancouver, BC*

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**Secular evolution and metallogeny of sedimentary basins in Yukon: project outline and preliminary results**

Luke P. Beranek

*Department of Earth Sciences, Memorial University of Newfoundland, St. John's, NL*

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**Title of Presentation: SIMS zircon U-Pb geochronology and REE geochemistry of the Late Jurassic Saint Elias intrusive suite, northern Coast Plutonic Complex, Yukon**

Luke P. Beranek[1], William C. McClelland[2], Cees van Staal[3], and Steve Israel[4]

*[1]Department of Earth Sciences, Memorial University of Newfoundland, St. John's, NL, [2]Department of Earth and Environmental Sciences, University of Iowa, Iowa City, Iowa, [3]Geological Survey of Canada, Vancouver, BC, [4]Yukon Geological Survey, Whitehorse, Yukon*

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**New U-Pb geochronology and fossil age control highlighting the extent of the Earn Group near Anvil Lake, central Yukon**

Rosie Cobbett[1] and Jim Crowley[2]

*[1]Yukon Geological Survey, YT, [2]Boise State University, ID*

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**Mineralogy, petrography and geochemistry of calc-silicates and implications for regional metamorphism in the Central Kootenay Arc, BC**

Annie Cyr-Parent[1], Rajeev Nair[1], Brett Hamilton[1]

*[1]University of Calgary, AB*

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**Geochronology of the Late Triassic Stuhini arc in northwestern British Columbia**

Nancy Joyce[1], Alex Zagorevski[1], Mitch Mihalynuk[2], and Richard Friedman[3]

*[1]Geological Survey of Canada, Ottawa, ON, [2]Geological Survey and Resource Development Branch, BC Ministry of Energy and Mines, Victoria, BC, [3]Pacific Centre for Isotopic and Geochemical Research, Department of Earth and Ocean Sciences, University of British Columbia, Vancouver, BC*

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**Characterization and Stratigraphic Framework for Late Cretaceous Kasalka Group volcanics, northern Interior Plateau, central British Columbia**

Rachel Kim[1], Craig J.R. Hart[1], Joel Angen[1], Elizabeth Westberg[2]

*[1]Mineral Deposit Research Unit, The University of British Columbia, Vancouver, BC, [2]Consulting Geologist, Calgary, AB*

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**Comparative Fracture Characterization of the Upper Cretaceous Second White Specks Formation, Southwestern Alberta**

Bram A. Komaromi[1] and Per K. Pedersen[1]

*[1]Department of Geoscience, University of Calgary, Canada*

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**Paleogeography and tectonic evolution of Paleozoic and Triassic pericratonic strata in the northern Kootenay Arc, British Columbia**

Jamie Kraft[1], Bob Thompson[2] and Philippe Erdmer[3]

*[1]University of Alberta (presently at Teck Resources Limited, Vancouver, BC), [2]Geological Survey of Canada, emeritus (presently at RIT Minerals Corp., North Saanich, BC), [3]University of Alberta, emeritus*

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**Digital mapping in southern Quesnellia: A PhD Thesis.**

Gerri McEwen[1], Mitchall Mihalynuk[2], Larry Diakow[2], Martha Henderson[1], Stephen T. Johnston[1]

*[1]University of Victoria, BC, [2]British Columbia Ministry of Energy and Mines, Geological Survey Branch*

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**Nature and Tectonic Significance of Aptian-Albian Blairmore Strata, Stanford Range, Western Rocky Mountains, SE BC**

Margot McMechan[1], Lisel Currie[1], Arthur Sweet[1] and Julito Reyes[1]

[1]*Geological Survey of Canada – Calgary, Calgary, AB*

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**Detrital zircon geochronology of Mesozoic successions of the Liard Basin**

Margot McMechan[1], Lisel Currie[1], William Matthews[2] and Bernard Guest[2]

[1]*Geological Survey of Canada – Calgary, Calgary, AB,* [2]*Department of Geoscience, University of Calgary*

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**Stratigraphic ties between the Windermere Supergroup and Hyland Group in the Rackla belt of east-central Yukon: implications for the age of Selwyn basin**

David Moynihan[1], Justin V. Strauss[2], Maurice Colpron[1], Steve Israe1[2] and Grant Abbott[1]

[1]*Yukon Geological Survey, YT,* [2]*Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA*

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**Low temperature Paleogene thermal evolution of the British Mountains using apatite U-Th/He dating, Northern Yukon, Canada**

Julia Pickering[1], Bernard Guest[1], William Matthews[1], David Schnieder[2], Larry Lane[3]

[1]*University of Calgary, Department of Geoscience, Canada,* [2]*University of Ottawa, Department of Earth Science, Canada,* [3]*Geological Survey of Canada, Calgary, Canada*

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**Greenschist-amphibolite facies metamorphism of the volcanic rocks of the Rossland Group, southeastern British Columbia**

Matthew Polivchuk[1], Paul G. Starr[1], David R.M. Pattison[1]

[1]*University of Calgary, AB*

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**Detailed cross-sections and a reinterpretation of tectonic cover-basement interleaving in southern Valhalla**

Philip Simony[1] and Sharon Carr[2]

*[1]University of Calgary, Calgary, AB, [2]Carleton University, Ottawa, ON*

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**Mineralogy and Geothermometry of the mid-Jurassic Trail Pluton, Southeastern British Columbia**

Kris Thesen[1], Jennifer Cuthbertson[1], Edward Ghent[1]

*[1]University of Calgary, AB*

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## List of Attendees:

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# Oral Presentations

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# Abstracts

## Conceptual Models and the Role of Gravity in Tectonics

Raymond A. Price

*Dept. of Geological Sciences and Geological Engineering*

*Queen's University, Kingston, Ontario*

Our thinking in tectonics is done with models. We use conceptual models, analog models, and mathematical models to describe processes and products of displacement and distortion of rock. Our models must „fit‟ the scale of time and the scale of size (length) that is involved. Gravity dominates when the size (length) is large and/or the time is long (S.W. Carey, 1962).

As illustrated by „the mechanical paradox of large overthrusts‟, precise mathematical models that use faulty conceptual models are deceptive.

„Planet Earth‟ is a gravity-drive heat engine. The preeminent conceptual model in tectonics (Harry Hess, 1960) posits that oceanic lithosphere is continuously generated by gravity driven, buoyant, symmetrically divergent, upward flow of hot mantle, and is continuously consumed as colder, gravity driven, negatively buoyant slabs of oceanic lithosphere sink asymmetrically into the mantle in subduction zones.

Regional rock uplift above subduction zones induces lateral gravitational spreading from regions of higher to lower elevation (W.H. Bucher, 1956). This involves adjacent domains of extending flow (e.g. boudinage) and compressing flow (e.g. thrusting and folding). The popular „simple shear‟ conceptual model for tectonic flow (no elongation in the direction of flow) is a rare special case. Diachronous „polyphase‟ deformation occurs as rock passes from one domain into the other. „Channel flow‟ occurs in both extending flow and compressing flow domains. Tectonic wedging occurs in compressing flow domains at all scales from microscopic to lithospheric. Isostatic subsidence in „foreland basins‟ records shifting compressing-flow surface loads.

Other conceptual models that have influenced me in the southern Canadian Cordillera are: balanced 3d reconstructions require compatible geologic maps of opposite sides of major faults; and a small change in plate motion explains the abrupt transition from Paleocene dextral transpression with foreland thrust faulting and folding to Eocene dextral transtension with hinterland plateau collapse and crustal scale boudinage.

## Did Westward Subduction Cause Cretaceous-Tertiary Orogeny in the North American Cordillera? Probably Not

William A. Matthews[1], Bernard Guest [1]

[1]*University of Calgary, AB*

The Cordilleran orogen of western North America has long been thought to result from Jurassic to Cretaceous terrane accretion and back-arc shortening above an east-dipping subduction zone. This model is founded on observations from regional and detailed geological mapping, the correlation of stratigraphic units within the Cordillera to those on cratonic North America and lithospheric scale seismic studies. Two alternative models involving microcontinent collisions with North America above a west dipping subduction zone have been proposed (Johnston 2008, Hildebrand 2009). These models require a cryptic continental suture within the eastern portion of the orogen between rocks of North American affinity in the east and “exotic”, potentially far travelled rocks to the west. We use detrital zircon geochronology of latest Neoproterozoic and Cambrian clastic units to test, at the scale of the continent, the location of the suture proposed by Hildebrande (2009, 2013). In the south some significant east-west variations in detrital zircon populations are found. Specifically, zircons derived from the Grenville orogen (1-1.25 Ga) are abundant in western locations and rare to absent in the east. We argue that these differences are not evidence for the “exotic” nature of the western locations. Instead we interpret western detrital zircon populations to have been derived from a combination of erosion of the Laurentian craton and recycling from local sedimentary sources rich in Grenville detritus. In the north no significant variation in detrital zircon populations are found.

## Plateau uplift in western Canada caused by lithospheric delamination along a craton edge

Bernard Guest[1], Xuewei Bao[1] and David W S Eaton[1],

[1]*University of Calgary, AB*

The interior of the Canadian Cordillera is part of an exhumed fossil plateau located in a back-arc tectonic setting. Using data compiled from western Canada and USArray, we integrate new analysis of teleseismic Rayleigh-wave tomography with thermochronology data to investigate lithospheric structure and exhumation history in this region. The edge of the North American craton is marked by a remarkably abrupt change in lithospheric thickness, from > 200 km to < 50 km, coincident with a significant step in surface heat flow. This sharp plate edge delineates the eastern limit of a fossil orogenic plateau that experienced rapid uplift and exhumation (10 to 15 km) during the mid to late Eocene. Our tomographic images show evidence for a high-velocity block in the sub-Cordilleran mantle, at depths greater than 165 km, which we interpret as foundering lithospheric mantle; we propose that delamination of this block was triggered by edge-driven convection and led to rapid uplift, voluminous magmatism and transition from compressional to extensional regime. Similar processes may have resulted in removal of the lithospheric keel beneath the North China craton and regional uplift of the Altiplano.

## Pressure-temperature evolution of zoisite eclogites from Faro Area, Yukon

Edward Ghent[1], Robert Marr[1], and Allison Klincker[1]

[1]*University of Calgary, AB*

Eclogite occurs as metre-sized lenses within metasedimentary schists and gneisses near Faro, Yukon Territory, Canada (Lat. 62.2°N,Long. 133.3°W). The common mineral assemblage in eclogite is quartz-garnet-zoisite-Ca-amphibole-clinopyroxene-rutile-phengite. Secondary minerals include epidote-titanite-chlorite-glaucophane-calcite-K-feldspar and albite. Eclogites have undergone strong deformation, locally producing a mylonitic matrix. Garnet is relatively fresh but contains numerous fractures and veins of chlorite, calcite, and quartz. Estimates of pressure (P) and temperature (T) attending metamorphism have been made using $Fe^{2+}$-Mg fractionation between clinopyroxene and garnet and Ca-amphibole and garnet, Zr in rutile, clinopyroxene-garnet-phengite equilibria and isochemical phase diagram sections (also known as pseudosections). Peak P-T conditions are difficult to estimate. Using Zr in rutile the temperature ranges from 580 to 595°C at 20 kbar, with no difference between rutile included in garnet and rutile in the matrix. For $a_{H2O} = 1.0$, the lack of stable lawsonite suggests P<~18 kbar at T~600°C. The P-T path during unroofing and cooling is difficult to estimate but the occurrence of albite suggests that some of the P-T path was in the albite stability field. The host metasedimenary rocks contain zircon-quartz-rutile but suggest equilibration temperatures of about 545°C. Post-peak penetrative deformation promoted some retrogressive reactions but the coarser peak porphyroblasts survived this deformation and retrogression. This implies that $H_2O$-$CO_2$ fluids were not abundant during cooling and denudation.

# A model for diachronous ductile deformation, metamorphism and exhumation in the metamorphic hinterland of the northern Canadian Cordillera

Reid D. Staples[1], Dan Gibson[1], Maurice Colpron[2], Jim J. Ryan[3], Rob G. Berman[4]

**Note, Dan Gibson would be the presenting author

[1]*Simon Fraser University, BC*

[2]*Yukon Geological Survey, YT*

[3]*Geological Survey of Canada, BC*

[4]*Geological Survey of Canada, ON*

Development of amphibolite facies transposition fabrics found throughout the northern Canadian Cordilleran hinterland occurred diachronously in Permo-Triassic, Early Jurassic, Middle to Late Jurassic and Early to mid-Cetaceous time. Rocks tectonized in the Permo-Triassic and Early Jurassic were exhumed in the Early Jurassic, while rocks immediately to the northeast (toward the foreland) were not buried and heated until the Middle Jurassic to mid-Cretaceous. Early Jurassic to mid-Cretaceous obduction of Yukon-Tanana terrane over the North American continental margin, together with the imbrication of parautochthonous rocks, formed a foreland-propagating orogenic wedge. Cooler rocks in front of the wedge were progressively buried and metamorphosed to amphibolite facies from the Jurassic to Early Cretaceous as they were underthrust into a ductile shear zone near the base of the overriding wedge. Rocks previously incorporated into this zone were displaced upward and exhumed through the combined effects of renewed underplating at depth and compensating extensional and erosional denudation above to maintain a critically tapered wedge. The mid-Cretaceous metamorphic hinterland changed from orogen-perpendicular wedge dynamics in operation since the Early Jurassic to orogen-parallel extension. Rocks incorporated into the mid-crustal shear zone in the Middle Jurassic to Early Cretaceous were exhumed in the mid-Cretaceous along southeast-directed (orogen-parallel) extensional faults from beneath a supracrustal „lid" tectonized in the Permo-Triassic and Early Jurassic. Like the Himalayan orogen and eastern Alps, orogen-parallel extension developed in an orthogonal plate convergent setting, simultaneous with, and bounded by, orogen-parallel strike-slip faulting that facilitated northwestward lateral extrusion of rocks normal to the direction of convergence.

**Insights from $^{40}Ar/^{39}Ar$ thermochronology on the exhumation history and juxtaposition of different tectonic domains within the northern Priest River Complex and Kootenay Arc, southeastern British Columbia.**

Ewan R Webster[1], David R.M. Pattison[1], Douglas Archibald[2]

[1]*University of Calgary, AB*

[2]*Queens University, ON*

The Priest River Metamorphic Core Complex (PRC) is situated on the eastern flank of the Shuswap complex and extends from northern Idaho to southeastern British Columbia. North of the 49$^{th}$ parallel the PRC interfaces with the southern Kootenay Arc and western flank of the Purcell Anticlinorium in the area between Creston, Salmo and Nelson. This area has undergone multiple phases of metamorphism and deformation, and is characterized by a north-south trending belt of regional amphibolite facies metamorphism.

Here we present new results from $^{40}Ar/^{39}Ar$ hornblende, muscovite, and biotite analysis. Contouring of the new $^{40}Ar/^{39}Ar$ data, in conjunction with previously published dates reveal three separate domains with distinct thermal histories. These domains provide evidence of a complex tectonic history with different structural levels now juxtaposed adjacent to one another. These reflect three Mesozoic to Eocene orogenic events that are preserved in this region of the southeastern Canadian Cordillera: 1) Early-Middle Jurassic, 2) Early Cretaceous and 3) Late Cretaceous to Eocene. These different domains are bound by a series of N-S trending Eocene detachment faults that are in part responsible for the exhumation of the metamorphic infrastructure.

## New U-Pb geochronology and fossil age control, Earn Group near Anvil Lake, central Yukon.

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New geological mapping near Anvil Lake in the west central part of the Tay River map sheet, south-central Yukon, has highlighted unrecognized stratigraphy within, and re-defined the extent of, Devono-Mississippian formations. Previously mapped Cambro-Ordovician rocks have been newly assigned to the Earn Group based on micro- and macro-fossil data and U-Pb geochronology. The lowermost part of the Earn Group in this area is made up of black chert and recessive shale with rare fossiliferous lenses that yield late early to early Middle Devonian macro-fossils. Sitting conformably above these rocks are coarse sandstone and conglomerate interlayered with siltstone and shale and intermediate volcanic rocks. The latter are andesite flows and crystal tuffs both of which have U-Pb ID-TIMS ages that range from 363-365 Ma. The uppermost part of the Earn Group in this area comprises a succession dominated by fine grained, quartz-rich clastic rocks with lesser limestone that contain Upper Devonian to Lower Mississippian conodonts and radiolarians. Our new detailed mapping and age constraints are improving the stratigraphic knowledge of Devono-Mississippian successions and providing the basis for regional correlation and paleogeographic analysis.

## Birth of the northern Cordilleran orogen, as recorded by detrital zircons in Jurassic synorogenic strata and regional exhumation in Yukon

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Whitehorse trough (Laberge Group) is an Early to Middle Jurassic marine sedimentary basin that overlaps the Intermontane terranes in the northern Cordillera. Detrital zircons from Laberge Group sandstones all show similar age distributions with the majority of grains in the 220-180 Ma range, and minor mid-Paleozoic ages that correspond exactly with known igneous ages from areas surrounding Whitehorse trough. In addition, source terrains for these zircon populations are generally characterized by Early Jurassic mica cooling ages (ca. 200-180 Ma) and the petrology of metamorphic rocks and Early Jurassic granitoid plutons flanking Whitehorse trough suggests rapid exhumation during emplacement. Together, these data suggest that foundering of the Whitehorse trough and coarse clastic sedimentation occurred concurrently with rapid exhumation of the basin"s shoulders. Isolated occurrences of similar sandstone and conglomerate units with identical detrital zircon signatures are also documented west and east of Whitehorse trough, as well as overlapping the Cache Creek terrane. These occurrences either indicate that Whitehorse trough was once more extensive or that these other occurrences developed as isolated smaller basins tapping similar sources. Development of these sedimentary basins and accompanying rapid exhumation in the northern Cordillera are coeval with documented onset of orogenic activity in the hinterland of the southern Canadian Cordillera and with onset of subsidence in the western Canada sedimentary basin. The Intermontane basins are interpreted as piggyback and foreland basins developed atop the nascent orogen and their sediment record witnessed the birth of the Cordilleran orogen. Late Jurassic fluvial deposits overlapping Whitehorse trough have detrital zircons that are mainly derived from recycling of Laberge Group but also contain exotic zircons interpreted to reflect wind-blown detritus from Late Jurassic-Early Cretaceous arc developed atop the approaching Insular terranes to the west.

## Interplay between antecedent Cambrian features and Cordilleran structures in the eastern Mackenzie Mountains and Franklin Mountains, NWT.

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Cambrian extension in the eastern Mackenzie Mountains and Franklin Mountains, accompanied by the development of the Mackenzie Trough depocentre, influenced the development of Cordilleran structures in three ways. First, inversion of Cambrian normal faults can be documented in the eastern Mackenzie Mountains and the Franklin Mountains. Second, anticlinal structures with associated thrust faults have developed within the Mackenzie Plain at discontinuities associated with normal faults in the Cambrian strata. This is expressed as faulted anticlines positioned above Cambrian normal faults. Third, the concentration of Cambrian salt deposition within, and adjacent to, the Mackenzie Trough has created favourable conditions for the development of a basal decollement within the evaporitic strata under the Mackenzie Plain and parts of the Franklin Mountains. This decollement surface within the salt is interpreted to be an important element in the development of thrust faults in these regions. The resulting variations in structural style from the eastern Mackenzie Mountains, across the Mackenzie Plain, and through the Franklin Mountains can therefore be linked in part to the presence or absence of Cambrian evaporitic strata, and the involvement or non-involvement of Cambrian normal faults in the development of Cordilleran structures. Each of these three structural styles will be illustrated with recently published map relationships, previously published structural cross-sections, and/or seismic line interpretations.

# Burial and Exhumation History of the Mackenzie Mountains and Plain, NWT, through the Integration of Low-Temperature Thermochronometers

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The Mackenzie Mountains and the adjacent Mackenzie Plain have experienced a dynamic geologic history from the Neoproterozoic through to the present. While the modern fold-and-thrust belt and its corresponding foreland basin are a product of Cordilleran tectonism, the unconformities throughout the Neoproterozoic to Paleogene sedimentary succession indicate that episodic burial and exhumation are a common theme through deep time. Understanding the duration and magnitude of these events is especially critical in the hydrocarbon bearing foreland basin, where the timing of maturation for the Devonian source rock is a major uncertainty for oil and gas exploration.

To better understand the tectonic and thermal evolution of the study area, samples of sedimentary sequences were collected for apatite and zircon (U-Th)/He and apatite fission track thermochronometry. Strategic sampling followed a transect from the hanging wall of the Plateau Fault in the southwest of the Mackenzie Mountains through to the Mackenzie Plain in the northeast. Additionally, samples were collected along strike of the deformation front. Within the higher topography, sampling targeted the siliciclastic units in the Neoproterozoic cores of the anticlines and in the Cambrian, Devonian and Cretaceous strata in the basin.

Variations in the morphology and provenance of detrital apatite and zircon populations can result in disparate cooling ages within a single sample. However, advances in our understanding of the roles of grain size, radiation damage and chemistry on diffusion kinetics allows us to resolve formerly inexplicable intra-sample age scatter and quantify the thermal evolution of sedimentary samples with complex geologic histories. As a result, this study provides a comprehensive assessment of 1) the probable geologic history across a Devonian to Cretaceous unconformity and its implication for the timing of hydrocarbon generation, and 2) the spatial-temporal growth of the Mackenzie Mountains in the Late Cretaceous through Paleogene.

# The Ruddock Creek Zn-Pb deposit: Constraining the timing of deposition of the metalliferous Windermere Supergroup, Northern Monashee Mountains, Southern British Columbia

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The Ruddock Creek stratabound Pb-Zn deposit is in the parautochthonous Kootenay terrane of the southern Omineca Belt, within mainly clastic and carbonate rocks. The terrane includes Neoproterozoic Windermere Supergroup and craton margin strata that were deposited in the early stages of rifting related to the breakup of Laurentia and were involved in polyphase deformation that complexly folded the rocks in during Cordilleran orogenesis.

Constraint on the maximum age of deposition of the mineralized horizon was determined from U-Pb dates of detrital zircon in adjacent metasediments. Four samples contain Neoproterozoic detritus. Other samples show typical Laurentian signatures with ages between 1 and 3 Ga. In addition, common lead isotopic ratios from four massive sulphide samples from different zones of the mineralized horizon interpreted via the shale curve are consistent with a model age of ~ 525 Ma. The close corroboration of the youngest detrital zircon ages and the age determined from the lead isotope ratios indicate that the deposit formed ca. 600 - 525 Ma. Preliminary data from igneous zircon from variably deformed and undeformed granitoids suggest crystallization at 116, 103 and 63 Ma

The southern Canadian Cordillera hosts a number of stratabound lead-zinc deposits that may be related to the Ruddock Creek deposit. Ages of these deposits are poorly constrained. Determining the age of the host stratigraphy at Ruddock Creek will be the first step toward resolving if these deposits are related and help place them in the context of other deposits along the Cordillera. A major break in the lithostratigraphic ages between the underlying Monashee complex and the Ruddock Creek area would corroborate the interpretation that the two are separated by a major crustal shear zone, the Monashee décollement, which has been recently brought into question farther to the south.

# The Chinook compilation map series: GSC open files 7475, 7476, and 7477

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The Chinook GIS compilation map series, compiled at a nominal scale of 1:100,000 on 1:50,000-scale topographic bases, comprises three GSC open files that encompass twenty-six 1:50,000-scale map sheets in the Rocky Mountains and Foothills of southwestern Alberta and southeastern British Columbia. Source maps and other data used in compilation include GSC and provincial survey maps and reports, published page figures, unpublished thesis maps, unpublished GSC field notes, aerial photos, and field maps, as well as new spot field checking. Revision and reinterpretation during compilation also involved extensive use of Google Earth™ and traditional aerial photograph imagery.

The most intensive revisions or reinterpretations of source maps and other data were made to the following areas or features, listed approximately from foreland to hinterland:

- Fault and fold linkages in the Foothills encompassed by GSC NATMAP open files.
- In the hanging walls of the Livingstone Thrust and Station Creek Fault.
- In the footwall of the Lewis Thrust, including the Oyster Syncline, the Etherington Creek Fault, and the Carbondale River–Goat Creek structure.
- The Howell Creek and Squaw Creek structures.
- Structures bounding, within, and north of the Fernie Basin adjacent to Wisukitsak Range and Erickson Ridge, where the Fernie Formation hosts the Fernie Basin Detachment.
- The Bourgeau Thrust – inferred to terminate at the town of Elkford, B.C.
- The Hosmer Thrust sheet – reinterpreted as two or possibly three distinct fault slices, where the underlying thrusts merge upward with the Fernie Basin Detachment.
- The Gypsum Fault – reinterpreted as a folded, east-dipping, and east-directed detachment.
- The structure from Mount Broadwood northward to Mount Hosmer – reinterpreted as a blind thrust stack between the Fernie Basin Detachment above and two overlapping detachments below: beneath the Middle Aldridge Formation in the south and the Gypsum Fault in the north.
- Structures along Inverted Ridge, including the Hefty and Macdonald faults.

## Effects of Large Scale Anisotropy on Thrust Fronts

Malcolm Lamb

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Under compression, isotropic rock has the possibility of failing along two conjugate planes at equal angle from a central plane perpendicular to the maximum and minimum stresses with opposite senses of shear. Most rock, however, is not isotropic. In sedimentary rock in particular, the bedding layers create a strong anisotropy. When the stresses are perpendicular or parallel to the anisotropy, the rock behaves as it would if it were isotropic. If the anisotropy is at angles to these stresses, then only one sense of shear can occur.

This relationship of anisotropy to shear sense is demonstrated on a large scale in the Southern Canadian Rocky Mountains. The bedding anisotropy is mainly west dipping and the thrust faults are dominated by foreland (eastward) verging thrusts. The exception to this is along the eastern margin of the thrust belt. Along the eastern margin, the foreland verging faults remain at depth but at surface the sense of vergence changes to hinterland (westward) verging thrusts. The transition is coincident with the change vertically from west dipping strata at depth to east dipping strata. Further east, across the basin axis where the upper strata is again west dipping, the faults are again verging to the east.

The relationship of anisotropy to rock failure then has implications in the evolution and extents of thrust belts.

## Thrust Linkage and Lateral Ramps insight into the thrust kinematics of the Southern Canadian Front Ranges and Foothills

Paul A. MacKay

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Structural shortening of the southern Canadian Cordillera is accommodated by displacement on several different thrust faults. In Foothills and Front Ranges the thrust faults link along strike in a series of hard and soft links that root out of a common basal decollement. The thrust faults that carry Paleozoic strata typically have steep, south-facing lateral ramps that cut up section from the Devonian into the overlying basal Mesozoic detachment within the Jurassic Fernie shale section. The Lewis Thrust is a large displacement thrust fault with up to 100 kilometres of displacement at the Canadian/US border. The Lewis thrust loses displacement along strike to the north till it tips out to near zero displacement at Mount Kidd in the Kananaskis Valley. The motion is taken up by a series of minor thrusts that feed displacement onto the McConnell-Livingstone Thrust System, such that the total displacement along strike in the thrust belt remains consistent.

Fault geometry, fold style and ramp to bedding angles indicate that thrust propagation begins as detachment folding that evolves into thrust failure. Displacement at the Paleozoic level is balanced to the foreland with displacement at the Mesozoic level such that at any given geographical position the Mesozoic section is shorten and then subsequently carried to the foreland on deeper younger thrust that displaces the Paleozoic section. In this manner the Mesozoic section undergoes co-axial polyphased deformation.

At some point the thrust within the Paleozoic section climbs to surface, possibly to maintain critical taper and offset the effects of erosion. This stage of the thrust is out-of-sequence and represents the youngest stage of the thrust shortening. The along strike linkage tends to cluster along aeromagnetic lineaments suggesting that basement topography may play a role in the thrust development.

## Is the Monashee Cover Sequence a portion of the Windermere High? (Constraints from palinspastically restored maps of the southeastern Canadian Cordillera.)

Kevin Root

*Glencore E&P Canada*

The Monashee cover sequence comprises approximately 2 km of metasediments that overlie Paleoproterozoic crystalline basement. This succession underlies the Monashee Decollement at the Frenchman Cap and Thor Odin domes. Up to 9 km of Windermere strata (ca. 730 – 550 Ma) are present above the decollement; in contrast, the cover sequence below the decollement includes at most a few hundred metres of Windermere, and includes a lower, probably pre-Windermere, succession deposited between 780 and 725 Ma and an upper succession that contains Cambrian and Devonian strata (e.g., Crowley et al., 2014). Previous investigators have concluded that the cover sequence may have been deposited near the Windermere basin margin or on a paleo-high within the basin.

There are striking similarities between the Monashee cover sequence and the stratigraphic succession that was deposited on the Windermere High, which is now located within the Purcell Mountains, approximately 100 - 150 km to the SE of the Monashee Complex. The lower Monashee succession may be correlative with the Mount Nelson Formation in the Purcell Mountains, which has traditionally been considered to be part of the Mesoproterozoic Purcell Supergroup but is likely only slightly older than the Windermere Supergroup because it locally contains Windermere-like diamictite. Strata above the Mount Nelson Formation may be similar to the upper Monashee succession, and include tens to hundreds of metres of Windermere strata, zero to hundreds of metres of lower Paleozoic strata, and hundreds of metres of Devonian strata.

Palinspastically restored maps of the Rocky Mountain Thrust Belt are used to test the viability of the hypothesis that the Monashee cover sequence may have been deposited on a northern portion of the Windermere High, and to explore the related implications for some of the big-picture aspects of structural geometries and timing of deformation within the southeastern Canadian Cordillera.

*References:* Crowley, J.L., Gibson, D., Scammell, R., 2014, New constraints on deposition age and provenance of the Monashee Cover Sequence, southern Canadian Cordillera (Abstract); 2014 Cordilleran Tectonics Workshop.

# Poster Presentations

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# Abstracts

# Building a Structural Framework for the northern Interior Plateau of British Columbia from Aeromagnetic Data

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The Interior Plateau of British Columbia is a region of high mineral exploration potential, as highlighted by the recent discovery of the 9.5 Moz Blackwater epithermal gold deposit, and is the focus of the GeoscienceBC TREK project. However, the underlying geology is poorly understood and contributes to high exploration risk due to significant Neogene flood basalt and Quaternary glacial till cover. Analysis of newly acquired, high-quality airborne magnetic data, reprocessed gravity data and targeted regional mapping results in significant improvements to the geological map of the TREK area and advances understanding of the regional geological framework.

In particular, two previously unmapped tectonic domain bounding faults are identified. The Bobtail Lake shear zone is a newly-recognized, north-striking zone of ductile deformation that locally defines the boundary between the Stikine and Cache Creek terranes. It is represented by a poorly-exposed zone of mylonite with subhorizontal stretching lineations and a linear trend of low magnetic response. The Tatuk Lake structural zone is a cryptic northwest-striking feature defining a pre-Late Cretaceous boundary between predominantly plutonic and high grade metamorphic rocks to the north and predominantly supracrustal rocks to the south. It is represented by a linear trend of high magnetic response suggesting that this structure likely localized the emplacement of younger mafic volcanics. The significance of these features in contributing to the greater understanding of the regional geological framework, and their timing constraints, is not yet certain and will be the focus of subsequent mapping.

## Secular evolution and metallogeny of sedimentary basins in Yukon: project outline and preliminary results

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Abstract Text: Paleozoic basins of Yukon are endowed in sediment- and volcanic-hosted mineral deposits and mineral occurrences. Long-standing issues that must be resolved to advance our understanding of these systems include the precise timing of host rock deposition, nature of plate tectonic processes that drove mineralization, and crustal- to lithospheric-scale controls on metal fertility. To address these and other issues, the first phase of a multi-year project has begun to constrain the secular evolution and metallogeny of sedimentary basins in Yukon. Current studies are focused on: (1) the chemostratigraphy of Cambrian, Ordovician, and Silurian black shale and mafic-intermediate volcanic successions that form the crustal substrate to base- and precious-metal deposits in the Pelly Mountains area of the Cassiar terrane; (2) Devonian black shale deposition and syngenetic Ni-Mo mineralization in the Wernecke Mountains; and (3) precisely when, how, and why volcanic-hosted deposits related to Devonian-Mississippian alkaline magmatism formed in the Pelly Mountains. The results of these and future projects are expected to modernize the knowledge of Yukon sedimentary basins and provide new ideas on Cordilleran tectonics and metallogeny.

**Title of Presentation: SIMS zircon U-Pb geochronology and REE geochemistry of the Late Jurassic Saint Elias intrusive suite, northern Coast Plutonic Complex, Yukon**

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The Coast Plutonic Complex (CPC) is a 1900 km-long belt of Jurassic to Eocene intrusive rocks that from north to south underlies the Saint Elias Mountains of SW Yukon and NW British Columbia, the Coast Mountains of SE Alaska and coastal British Columbia, and the Cascade Mountains of northern Washington. The oldest CPC rocks in SW Yukon were emplaced into the Alexander terrane and comprise diorite to granodiorite batholiths and discrete plutons of the Saint Elias intrusive suite that have previously yielded K-Ar biotite and hornblende ages of 130-160 Ma. To further investigate the timing and petrogenesis of CPC magmatism in SW Yukon, we conducted reconnaissance field studies in the Saint Elias Mountains and analyzed seven rock samples of the Saint Elias intrusive suite for zircon U-Pb geochronology and rare earth element (REE) geochemistry using ion-microprobe (SIMS) methods. Intrusive rocks of the Mt. Maxwell, Alsek, Snowshoe (2 samples), Lowell Glacier (2 samples), and Ham plutons yield 207-corrected, weighted mean $^{206}Pb/^{238}U$ ages of 147 ± 2 Ma, 149 ± 2 Ma, 151 ± 2 Ma and 152 ± 3 Ma, 150 ± 2 Ma and 155 ± 2 Ma, and 154 ± 2 Ma, respectively. A few of the rock samples show evidence of 155-161 Ma inheritance. Zircon REE geochemical signatures are broadly consistent with oxidized magma conditions in a suprasubduction zone environment. In combination with published constraints, the new results support a plate tectonic model that involves: (1) the formation of a Late Jurassic arc along the Cordilleran margin after the accretion of the Alexander terrane; and (2) the subsequent Late Jurassic-Early Cretaceous cessation of arc magmatism because of changing plate motions and sinistral transpression along the Coast Belt. The new U-Pb ages further imply that the Saint Elias intrusive suite was a source region for c. 150 Ma detrital zircons in adjacent Jurassic-Cretaceous sedimentary successions of Alaska and NW Canada.

## Mineralogy, petrography and geochemistry of calc-silicates and implications for regional metamorphism in the Central Kootenay Arc, BC

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Kootenay arc, lying to the west of Purcell Anticlinorium in the Canadian Cordillera, is a polydeformed zone that was metamorphosed and deformed during Middle Jurassic to the Eocene. A previous study within the Kootenay arc, focusing on metapelitic rocks around Kootenay Lake area (Moynihan and Pattison, 2013) revealed a typical Barrovian series (biotite/chlorite to K-feldspar + sillimanite zones), metamorphosed from greenschist to amphibolite facies. Marbles and Calc-silicate rocks are common in this area interlayared with the metapelites. The objectives of this study are to map the isograds within calc-silicate rocks in the area surrounding the Kootenay Lake, study their P-T conditions of metamorphism and to document the metamorphic reactions in calc-silicates. The calc-silicates occur in layers cm‟s to 10 m‟s thick within the Milford Group and Lardeau Group. Twenty calc-silicate samples were collected near Ainsworth, Riondel, and Pilot Bay that transect mapped isograds in metapelites. Petrographic study delineate three isograds separating four mapable metamorphic mineral assemblage zones: quartz+dolomite, tremolite, diopside+quartz, and forsterite. Comparison with published petrogenetic grids suggest that the tremolite-in and diopside-in isograds correspond to with the model reactions: dol+qtz=cal+trem, and trem+cal+qtz=diop. Calcite-dolomite thermometry, isochemical phase diagram section calculations, and whole-rock geochemical studies are being undertaken to ascertain the conditions of metamorphism and to understand the evolution of mineral assemblages in calc-silicates.

# Geochronology of the Late Triassic Stuhini arc in northwestern British Columbia

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The Late Triassic Stuhini-Lewes River arc was founded on a composite basement comprising the Paleozoic Stikine assemblage, Yukon-Tanana terrane and Boswell assemblage. The present configuration of these rocks, comprising arc terranes enclosing exotic Cache Creek terrane, has been largely attributed to an orocline. The Late Triassic Stikinia characteristically comprises augite to feldspar porphyritic lavas and volcaniclastic rocks of shoshonitic to calc-alkaline affinities and lesser alkaline rocks. Basaltic to andesitic rocks are the dominant volcanic rocks; minor picritic and rhyodacitic rocks occur sporadically. The consanguineous plutonic rocks of the Stikine Plutonic Suite range from gabbro to monzogranite with minor troctolite, clinopyroxenite and hornblendite associated with larger plutons. Identification of polarity of subduction under Triassic Stuhini arc has been, in part, unsuccessful due to overall poor geochronological coverage and lack of a regional variation in the composition of the arc magmatic rocks. This study focuses on the along- and across-arc geochronological characteristics of the Late Triassic Stuhini Arc to constrain timing and character of magmatism. Volcanic, epiclastic and sedimentary rocks were analysed using U-Pb SHRIMP, $^{40}Ar/^{39}Ar$ (GSC) and U-Pb CA-ID-TIMS (UBC) techniques. Plutonic rocks of the Hickman batholith, Nightout pluton, Willison Bay Pluton and Star property quartz diorite yielded ca. 217 to 230 Ma U-Pb crystallization ages and ca. 220 Ma $^{40}Ar/^{39}Ar$ cooling ages. Gnat Lakes hornblendite yielded a ca. 222 Ma $^{40}Ar/^{39}Ar$ cooling age. Volcanic rocks in the Andrei ice field yielded ca. 218 to 223 Ma U-Pb crystallization ages. Epiclastic rocks near Schaft Creek yielded a ca. 220 Ma U-Pb zircon depositional age. These ages supplement the existing geochronology database for the Triassic of northwestern British Columbia and aid in stratigraphic correlations and tectonic reconstructions for the region.

# Characterization and Stratigraphic Framework for Late Cretaceous Kasalka Group volcanics, northern Interior Plateau, central British Columbia

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The Interior Plateau in central British Columbia is a highly prospective region as it hosts several epithermal Au-Ag deposits and prospects, notably the 9.5 Moz Blackwater epithermal gold-silver deposit. The Blackwater and similar epithermal deposits are hosted in rhyolitic and andesitic volcanic rocks assigned to the Late Cretaceous Kasalka Group. Poor exposure due to Neogene flood basalts and Quaternary glacial till has hindered the understanding of these important host rocks and diminished the success of exploration targeting initiatives in this region. Preliminary characterization and a stratigraphic framework are presented for the Late Cretaceous volcanic stratigraphy from data collected in 2014 as a component of Geoscience BC‟s TREK project. An important local stratigraphic succession of the Kasalka Group was evaluated along the Tchesinkut Lake-Yellowhead Highway traverse. This traverse has a basal red polymictic pebble conglomerate which is overlain by a transitioning sequence of andesitic to rhyolitic flows and minor fragmented packages. The andesites are dark green- to maroon-weathering with distinct plagioclase and/or hornblende phenocrysts and typically occur as competent flows with sections dominated by autobrecciated andesite. The rhyolitic volcanic rocks are dominantly crystal-lithic lapillistone with pink and green-altered lithic pumice fragments. A preliminary interpretation of whole rock geochemical data indicate that Kasalka Group andesites and rhyolites have a high-K calc-alkaline arc character.  This investigation will provide enhanced regional context for Late Cretaceous volcanic strata and aid in targeting future exploration efforts for associated epithermal Au-Ag mineralization in northern central British Columbia.

# Comparative Fracture Characterization of the Upper Cretaceous Second White Specks Formation, Southwestern Alberta

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Analysis of natural fracture network geometry is an important step in the characterization of unconventional tight reservoirs as fractures provide flow pathways for hydrocarbons and other fluids in the subsurface as well as influence hydraulically induced fracture development. Exposed outcrops of the Second White Specks Formation along the Highwood River in southwestern Alberta were divided into three major facies: 1) the Jumping Pound Sandstone; 2) finely laminated siltstones and mudstones; and 3) organic-rich mudstone. Natural fracture parameters were recorded from each facies using scanlines and the circular estimator method on the bedding plane of the Jumping Pound Sandstone. Results were used to compare the relative differences in fracture characteristics between sedimentary facies in the Second White Specks Formation. The Jumping Pound Sandstone contains conjugate shear fractures that occur at low intensity (2.56–4.7 fractures per meter) with tall heights (0.79–3.38 meters). The finely laminated siltstones and mudstones contain extensional fractures that occur at high intensity (29.2 fractures per meter) with short heights (0.18 meters), the latter being related to the finely interlaminated siltstone-mudstone fabric. The organic-rich mudstone contains fractures that are conjugate to the underlying thrust fault in addition to extensional fractures that both occur at low intensity (4.88–7.4 fractures per meter) with tall heights (1.18–1.25 meters). Elevated fluid pressures resulting from hydrocarbon generation within the two mudstone facies could have altered the stress field in such a way that promoted the formation of extensional fractures compared to the shear fractures that occur in the overlying Jumping Pound Sandstone. The results from this analysis suggest that sedimentary facies characteristics such as lithology, heterogeneity and mechanical bed thickness have a strong influence on fracture generation and propagation in the Second White Specks Formation outcrops along the Highwood River that are also likely to be present in the subsurface.

## Paleogeography and tectonic evolution of Paleozoic and Triassic pericratonic strata in the northern Kootenay Arc, British Columbia

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The northern Kootenay Arc in southeastern British Columbia hosts Cambrian to Permian strata that were deposited in overlapping marginal basins outboard of the Cordilleran miogeocline. Deep basinal strata of the Late Cambrian and younger Lardeau Group are gradationally overlain by a succession of Devonian and Early Mississippian phyllite, limestone and metavolcanic rocks that we call the Mount Sproat assemblage (MSA). Mafic metavolcanic strata in the MSA have geochemical signatures recording a transition from non-arc to arc-related volcanism. Calc-alkaline basalt in the upper MSA yielded prismatic zircon dated at 367.2 ± 2 Ma. Along with the Lardeau Group, lower levels of the Mount Sproat assemblage were deformed penetratively under brittle-ductile conditions prior to deposition of the unconformably overlying Late Mississippian Milford Group. We hypothesize that this pre-Milford deformation occurred in the hangingwall of the Lardeau shear zone during Early Mississippian shortening in a back-arc setting. The localized nature of evidence for this tectonism (within the southern Canadian Cordillera) suggests the event was not widespread, however probable time-equivalence with the Antler Orogeny in Nevada and Idaho offers a tempting potential connection.

Major detrital zircon populations in the intervals 2.8-2.6 Ga and 2.1-1.75 Ga link most of our Paleozoic samples to the Canadian Cordilleran miogeocline. Additional to those „typical" ages, abundant detrital zircon dates of 1.48-1.41 Ga, 1.38-1.32 Ga, and 1.30-0.95 Ga from Broadview Formation grits (upper Lardeau Group) are inferred to record Devonian(?) uplift of sialic North American crust that existed outboard of the Lardeau trough because such crust apparently did not shed detrital zircons into the miogeocline. In Late Devonian to Late Triassic time, detrital zircon grains with Neoproterozoic (700-550 Ma) and Silurian (ca. 420 Ma) dates appear in the dataset. Zircons of these ages are interpreted to originate from an exotic terrane that docked in mid-Devonian time.

## Digital mapping in southern Quesnellia: A PhD Thesis.

Gerri McEwen[1], Mitchall Mihalynuk[2], Larry Diakow[2], Martha Henderson[1], Stephen T. Johnston[1]

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In the summer of 2014, I was fortunate to be part of the BCGS crew mapping between Merritt and Princeton, BC, a region underlain by Mesozoic rocks of the Quesnel Terrane. The mapping region contains expansive fields of pyroxene-porphyry lavas, interbedded tuffites and epiclastic sediments of the late Triassic Nicola Group. These lavas are overlain by Jurassic-aged ferruginous plagioclase porphyry andesites and interbedded tuffites. Lavas have been cut by dioritic to granitic intrusions and overlain by Cretaceous and Cenozoic volcanic and sedimentary rocks.

At this early point in my PhD thesis I have identified two main areas of interest: the Osprey Lake pluton and a chert pebble conglomerate. The Osprey Lake pluton is a potassium feldspar megacrystic granite which has been cut by east-west trending plugs of quartz-eye feldspar porphyry, aphanitic andesite dykes, and mineralized quartz veins of presumed late Cretaceous to Eocene age. I plan to collect samples across the pluton and in the porphyry plugs and obtain εNd and $(^{87}Sr/^{86}Sr)_i$ ratios to quantify the involvement, or lack thereof, of cratonic material. Crosscutting relationships and structural analyses will serve to place constraints on the timing of emplacement and kinematics in this plutonic complex. The goal will be to devise a best-fit model describing the evolution of the Osprey Lake pluton.

The chert pebble conglomerate is preserved in grabens in a north-south trending linear belt indicating uplift and deposition of a chert-rich source was occurring in the late Mesozoic. There are two potential sources terranes for chert clasts: the Cache Creek Terrane to the west and the Chapperon Group to the east. I will attempt to identify the most-likely source terrane using faunal and isotopic analyses.

This poster will present the map created during the summer of 2014 and outline these and other goals for future research as I progress through my graduate degree.

# Nature and Tectonic Significance of Aptian-Albian Blairmore Strata, Stanford Range, Western Rocky Mountains, SE BC

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A second locality of Cretaceous Blairmore Group strata has been found in the Stanford Range. These strata consist primarily of soft siltstone, mudstone and very fine-grained sandstone that were briefly exposed in 2008 along the side of a logging road. Resistant bands of poorly sorted, somewhat stratified chert and quartz sandstone clast conglomerate occur in the lower part of the succession. Overall the succession appears similar to the Gladstone Formation found in the Foothills. At this new locality vitrinite reflectance values are low (0.47 - 0.67 %Ro) and rockeval data indicate the strata are in the oil window. Preliminary thermal modelling of AFT and vitrinite reflectance data indicates that these sedimentary rocks were heated relatively quickly shortly after deposition during the Albian, and then cooled from about 90$^{o}$ C to near surface conditions in the early Tertiary. The samples were never deeply buried by the Maastrichtian-Paleocene clastic wedge.

Strata at the new locality in the immediate hangingwall of the Redwall Fault, dip steeply eastward, as do Ordovician Beaverfoot Formation strata exposed immediately to their west. Although not exposed there is no evidence to suggest the contact is faulted. At the other Stanford Range locality, Aptian- Albian strata occur as fault slivers in a zone of faulting along the west side of the Redwall Fault and are faulted adjacent to Cambrian and Ordovician strata (Leech, 1967; GSC Paper 1A). Relationships at these localities suggest the Stanford Range west of the Redwall Fault experienced kilometres of uplift and erosion prior to the deposition of Aptian (~125 – 113 Ma) strata. The Redwall Fault links to the Lussier River Fault that is plugged by the 108 Ma Lussier River stock (Larsen et al. 2006; CJES v. 43). The Cretaceous localities in the Stanford Range suggest compressional motion occurred at least several millions of years earlier.

## Detrital zircon geochronology of Mesozoic successions of the Liard Basin

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The Liard Basin, a sub-basin of the Western Canada Sedimentary Basin, is characterized by anomalously thick Upper Paleozoic and mid-Cretaceous sections. The Basin occupies an important reentrant in the main Cordilleran deformation front near 59$^{o}$ N. Two fundamental unconformity bounded tectonostratigraphic units comprise the Mesozoic succession: the Triassic and the Cretaceous.

Triassic clastic and younger carbonate strata form a shallowing upward succession (>1.5 km thick) that records an episode of major subsidence. Recently these strata have been interpreted as deposits in the foreland of the late Permian Klondike Orogeny (Golding, 2014 unpub. Ph.D., UBC). New detrital zircon U-Pb age distributions for Triassic strata show no definitive evidence of a western source, even for the basal sandstone unit. In contrast Triassic strata exposed <100 km to the north have a significant component of zircons sourced from the west.

The Albian to Campanian shale-dominated Cordilleran foreland basin deposits (>2 km thick) overlie a major regional unconformity that downcuts progressively north and eastward such that no Jurassic or lower Cretaceous is preserved in the Liard area and only a little of the Triassic package remains along the northeastern edge of the basin. Detrital zircon U-Pb age distributions for all but the Campanian have been analysed. The basal sandstone (Chinkeh, formerly considered Aptian in age), locally contains Albian aged zircons, presumably from volcanic airfall, but no other zircons young enough to be first-cycle material from the west. The middle Albian sandstone unit (Scatter) contains about 20% first-cycle material from the west. The late Albian sandstone (Sikanni) contains little first-cycle material from the west, but the Cenomanian conglomerate-sandstone unit (Dunvegan) zircon population is overwhelmingly composed of first-cycle detrital zircons as well as a volcanic airfall component.

# Stratigraphic ties between the Windermere Supergroup and Hyland Group in the Rackla belt of east-central Yukon: implications for the age of Selwyn basin

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The Dawson thrust zone of central Yukon, Canada, separates Neoproterozoic-Cambrian slope and basinal rocks of the Hyland Group (Selwyn basin) from Proterozoic-Paleozoic shelf and slope rocks of the Ogilvie platform (Yukon block). As a result of this juxtaposition, stratigraphic relationships between Proterozoic-Cambrian successions on opposite sides of the fault zone have remained ambiguous. Here we provide the first documentation of stratigraphic relationships across the basin margin, in an area that is informally known as the Rackla belt. In this region, Proterozoic-Cambrian successions can be traced around the eastern tip of the Dawson thrust zone, demonstrating equivalence between the Hyland Group (Selwyn basin) and the upper part of the Windermere Supergroup (Yukon block).

The Neoproterozoic-early Cambrian Hyland Group, which comprises the oldest strata in Selwyn basin, includes three formations: the basal coarse-grained siliciclastic-dominated Yusezyu Formation, the overlying carbonate-dominated Algae Formation, and the uppermost fine-grained siliciclastic Narchilla Formation. The Yusezyu Formation is equivalent to at least three units in the Windermere succession – the Nadaleen, Gametrail and Blueflower formations. A late Ediacaran age (<~580 Ma) for these formations is indicated by the presence of Ediacaran body fossils in the Nadaleen formation, and by anomalous $\delta^{13}C_{carb}$ values in the Gametrail Formation. This unit, and its equivalent carbonate member in the Yusezyu Formation are each characterised by $\delta^{13}C_{carb}$ values up to -13‰ (VPDB). This $\delta^{13}C_{carb}$ excursion has been correlated with the Ediacaran Shuram/Wonoka Anomaly, which is documented globally in ~580–560 Ma strata. The latest Ediacaran Algae Formation is equivalent to the Risky Formation, whereas the Narchilla formation correlates with the Ingta, Backbone Ranges, Vampire and possibly parts of the Sekwi formations.

Although the base of the Hyland Group is not exposed elsewhere in Selwyn basin, these relationships indicate that most if not all of the Yusezyu Formation was deposited during the latter part of the Ediacaran. This in turn suggests a late Ediacaran age for the formation of Selwyn basin, possibly coincident with ~570 Ma rift-related volcanism in southern British Columbia.

## Low temperature Paleogene thermal evolution of the British Mountains using apatite U-Th/He dating, Northern Yukon, Canada

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The age and rate of exhumation of the British Mountains is tied to the timing of deformation in the Beaufort Sea, an active site for hydrocarbon exploration. This region contains a large portion of North America‟s oil and gas reserves. The British Mountains, the eastern extent of the Brooks Range in Alaska, include Paleogene structures that are the onshore portion of the Beaufort fold belt. In the Beaufort Sea, deformation is dominated by thin-skinned folding and thrusting of Paleocene to Oligocene sediments that is sourced from the British Mountains. Onshore, Paleogene deformation overprints multiple older structural events. The low temperature time history of the onshore Paleogene structures will be determined through U-Th/He dating of apatites (AHe) and zircon (ZHe). The results will contribute to better understanding of the timing of the maturation and migration of hydrocarbons in the Beaufort Sea. Previous work on the thermal history of northern Yukon and the North Slope of Alaska provides a regional framework for the region‟s low temperature-time history. These regional studies of the northern Yukon and Alaska yielded Paleocene to Eocene (60Ma – 40Ma) apatite fission track (AFT) cooling ages that progressively young to the north, consistent with geological evidence for northward propagating deformation.

This study aims to improve the understanding of the Paleogene tectonic activity of the British Mountains and the deformation history of the Beaufort fold belt. ZHe results show rapid cooling from 50-65 Ma. Future AHe data will better constrain the exhumation and deformation rates at low temperatures (~60-90°C). A sampled transect through the British mountains, along the Firth River valley, will provide good resolution on these rates of the deformation. The results will be used to relate the onshore time-temperature history with the development of offshore structures in the Arctic Canadian Cordillera.

# Greenschist-amphibolite facies metamorphism of the volcanic rocks of the Rossland Group, southeastern British Columbia

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The volcanic rocks of the Rossland Group in southeastern British Columbia have been variably metamorphosed from sub-greenschist to lower amphibolite facies (Powell & Ghent, 1996, CJES). Sub-greenschist to greenschist facies assemblages occur to the south of the Bonnington Pluton, whereas higher grade, hornblende-bearing rocks occur between the Bonnington and Nelson plutons. This study documents textural and mineral-compositional changes in metamorphosed basalts and flow breccias of the mid-Jurassic Elise Formation going through this transition.

Augite and hornblende phenocrysts in sub-greenschist samples located in the southern part of the map area remain relatively unaltered, while chlorite and sericite occur as metamorphic products within an albite-rich matrix. Rocks appear to grade into the greenschist facies within 1 km of the southern extent of the Bonnington Pluton and western margin of the Salmo Stock, containing abundant actinolite as a pseudomorphic replacement of augite phenocrysts, in addition to chlorite, biotite, albite, and epidote. North of Salmo, particularly in close proximity to the Nelson intrusive bodies, hornblende commonly rims and is intergrown with actinolite within both clinopyroxene pseudomorphs and the matrix, while plagioclase compositions become more anorthite-rich. Samples containing multiple amphiboles display a variety of intergrowth textures in pseudomorphs and the matrix, commonly displaying core-rim textures of actinolite and hornblende, respectively, as well as patchy-to-euhedral intergrowths with more distinct grain boundaries. Actinolite, epidote, and chlorite coexist with hornblende throughout the hornblende zone, suggesting that this suite of rocks was metamorphosed to pressure and temperature conditions representative of the greenschist-amphibolite transition zone.

The spatial pattern of mineral assemblages suggests that the dominant driver for metamorphism within the area was heat provided by the multiple intrusive bodies. This is evidenced by a broad zone of transitional greenschist-amphibolite assemblages between the Bonnington and Nelson intrusions, with metamorphic grade dropping off sharply to the south with increasing distance from the intrusions.

## Detailed cross-sections and a reinterpretation of tectonic cover-basement interleaving in southern Valhalla

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The southwest and south upper boundary of the Valhalla complex is exposed 8km north of Trail in southeastern B.C. The boundary is a surface that lies on the north side of, and dips southwest and south under, the Mid. Jurassic, tonalitic Trail pluton. It is the upper limit of injection of Paleocene-Eocene leucogranite sheets and of ductile shearing in the Eocene Valkyr shear zone. It obliquely transects tectonically interleaved sheets of a Devonian and older gneissic (basement) complex and of unconformably overlying cover of the Pennsylvanian Mt. Roberts formation.

In previously published interpretations, the upper basement sheet and the underlying sheet of Mount Roberts formation were shown as a recumbent fold pair that was not involved in the downward deflection (a south-facing ramp) at the north contact of the Trail pluton. Some remapping and the construction of detailed cross-sections show that it is only the upper (unconformity) contact of the upper basement sheet that continues southward undeflected. The lower part of the sheet and the underlying Mount Roberts formation are deflected to pass under the Trail pluton.

The upper basement sheet contains a trondhjemite body and related injections. The lower basement sheet has none. It is thus plausible that the two basement sheets come from separate parts of the basement and that, at the base of the upper basement sheet, there is a thrust that emplaced basement over cover. The thrust predates Mid. Jurassic intrusions.

# Mineralogy and Geothermometry of the mid-Jurassic Trail Pluton, Southeastern British Columbia

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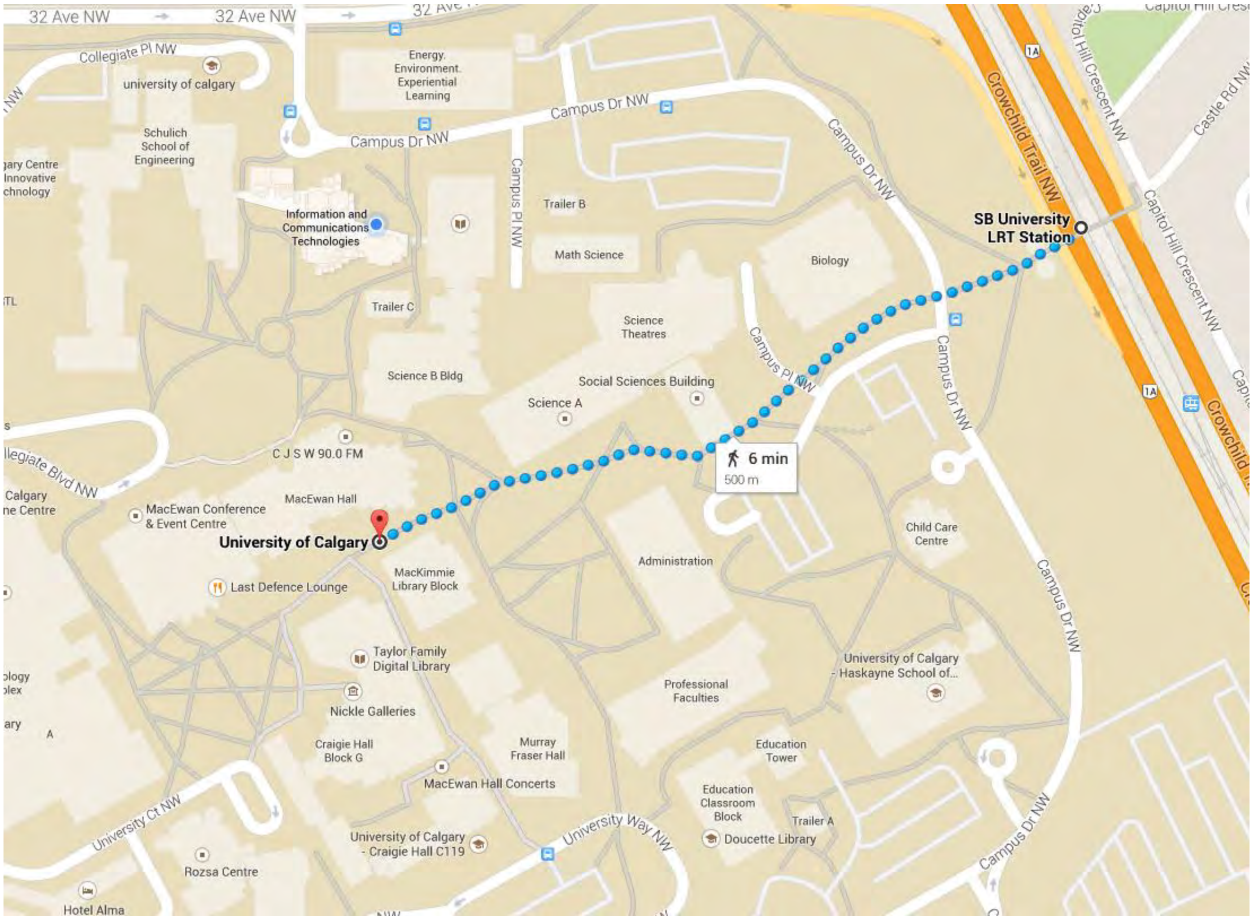
[1]*University of Calgary, AB*

The Trail pluton, located in southeastern British Columbia, is part of a suite of mid-Jurassic granitic rocks of probable continental arc affinity that were transported eastwards as a result of Cordilleran tectonics. Previous work on the nearby Nelson Batholith has suggested that magmatic rocks in this area were subjected to substantial post-equilibration rotation and tilting, possibly as a result of movement on listric faults. Twenty-five samples were collected from the Trail pluton for the purpose of mineralogical description and amphibole-plagioclase thermometry using the HB-PLAG program by Holland and Blundy (1994). The average modal mineralogy of the samples is: quartz 13%, plagioclase 33%, potassium feldspar 20% (late in the magmatic crystallization history), amphibole 14%, biotite 10%, titanite 1%, and a minor amount of alteration minerals such as chlorite and epidote. Many samples show evidence of localized strain, including comminution of grain size in quartz and feldspars and folding of biotite. Most plagioclase crystals fall within the composition range $An_{39}$ to $An_{31}$. The potassium feldspar is low in Na, suggesting a lower crystallization temperature. All amphiboles are calcic, ranging from magnesiohornblende to tschermakite to pargasite. Nearly all amphiboles have $Al^{vi} > 1.0$, giving them the prefix alumino. Preliminary thermometry calculations using the edenite-tremolite end-member system give an average result of 745°C for amphibole-plagioclase equilibration at P = 5 kbar. This result agrees well with calculations by Ghent et al. (1991) for both the Nelson Batholith and Bonnington pluton. Further work on this project will include barometric calculations as well as an examination of possible differential uplift and tilting of the Trail pluton.

**Directions from University LRT station to MacEwan Hall:**



**Map - MacEwan Hall (3rd Floor)**


**Directions:**

*MacEwan Hall Ballroom*: Use eastern set of stairs. Ballroom is straight ahead.

*Last Defence Lounge*: Use western set of stairs. Turn left at top of stairs.

**Directions from MacEwan Hall to Jamesons Irish Pub:**