48th Cordilleran Tectonics Workshop

View to east from Mount Yamnuska. The spur of rock comprises resistant Middle Cambrian carbonate of the Eldon Formation. In the late Paleocene to early Eocene these rocks were thrust (McConnell thrust) over Upper Cretaceous and lower Paleocene siliciclastic strata of the Foreland basin that underlie the low ground to the east. Post-Eocene erosion of these rocks of different competency accounts for the dramatic geomorphologic expression of these events. Photo: Dave Pattison.

March 1st - 3rd, 2024

University of Calgary

48th Cordilleran Tectonics Workshop

March 1-3, 2024

University of Calgary

Welcome to the 2024 Cordilleran Tectonics Workshop, the 48th running of this event!

The workshop itinerary, scientific program, and abstracts (listed alphabetically) can be found below.

All events will be held in the University of Calgary MacEwan Hall Ballroom, except for the workshop dinner which will be held at the The Banquet (3953 University Ave NW #220, Calgary, AB T3B 6K3). Please consult the map below for details. Announcements will also be made at the meeting.

Wi-Fi is available in the Mac Hall ballroom through eduroam or airuc-guest.

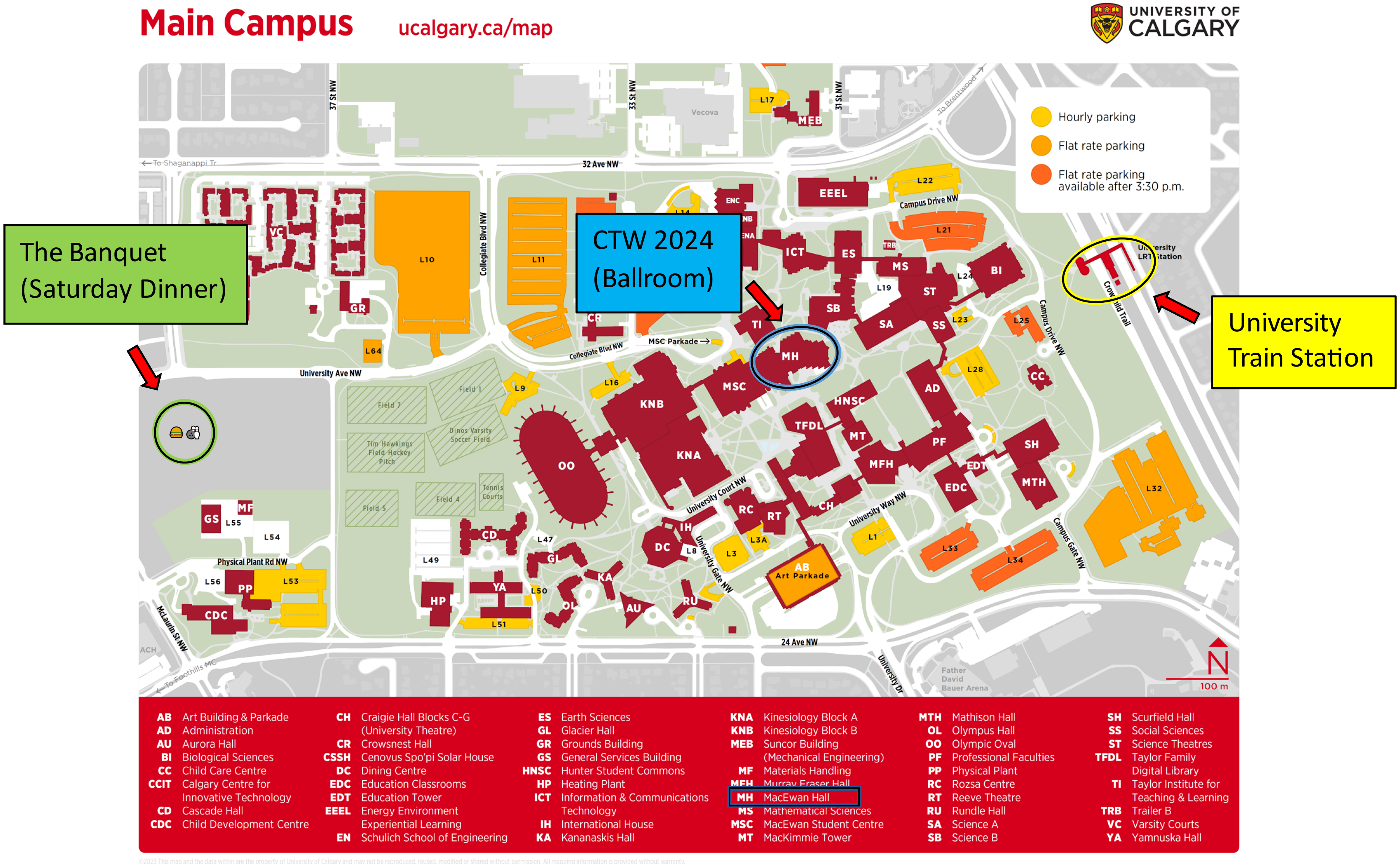
We hope that the 2024 running of this event will be as stimulating and convivial as the previous ones. Thank you for coming!

2024 CTW Committee:

Faculty organizers: Eva Enkelmann and Dave Pattison

Meeting coordinators: Birk Härtel, Akeek Maitra

Graduate and undergraduate student organizers in alphabetical order: Tais Fontes Pinto, Jessica Girard, Richard Hieber, Emily Johns-Buss, Collin Kehler, Douglas MacLeod, Joel Padgett, Baiansuluu Terbishalieva, Elisha Whelan


Main Campus
ucalgary.ca/map
UNIVERSITY OF CALGARY
Hourly parking
Flat rate parking
Flat rate parking available after 3:30 p.m.
The Banquet (Saturday Dinner)
CTW 2024 (Ballroom)
University Train Station
MH
32 Ave NW
University Ave NW
24 Ave NW
Campus Drive NW
Collegiate Blvd NW
MSC Parkade
University Court NW
University Way NW
Campus Gate NW
University Gate NW
Physical Plant Rd NW
McLaurin St NW
Crowchild Trail
37 St NW
33 St NW
31 St NW
Vecova
Art Parkade
Father David Bauer Arena
100 m
AB Art Building & Parkade
AD Administration
AU Aurora Hall
BI Biological Sciences
CC Child Care Centre
CCIT Calgary Centre for Innovative Technology
CD Cascade Hall
CDC Child Development Centre
CH Craigie Hall Blocks C-G (University Theatre)
CR Crowsnest Hall
CSSH Cenovus Spo'pi Solar House
DC Dining Centre
EDC Education Classrooms
EDT Education Tower
EEEL Energy Environment Experiential Learning
EN Schulich School of Engineering
ES Earth Sciences
GL Glacier Hall
GR Grounds Building
GS General Services Building
HNSC Hunter Student Commons
HP Heating Plant
ICT Information & Communications Technology
IH International House
KA Kananaskis Hall
KNA Kinesiology Block A
KNB Kinesiology Block B
MEB Suncor Building (Mechanical Engineering)
MF Materials Handling
MFH Murray Fraser Hall
MH MacEwan Hall
MS Mathematical Sciences
MSC MacEwan Student Centre
MT MacKimmie Tower
MTH Mathison Hall
OL Olympus Hall
OO Olympic Oval
PF Professional Faculties
PP Physical Plant
RC Rozsa Centre
RT Reeve Theatre
RU Rundle Hall
SA Science A
SB Science B
SH Scurfield Hall
SS Social Sciences
ST Science Theatres
TFDL Taylor Family Digital Library
TI Taylor Institute for Teaching & Learning
TRB Trailer B
VC Varsity Courts
YA Yamnuska Hall

https://cegageos.ca/

University of Calgary
Department for Earth, Energy and Environment

Calgary Geo-and Thermochronology Lab

Program

Friday, 1 March

5:00 – 8:00 PM *Icebreaker & Poster setup*
Pick up registration badge

Saturday, 2 March

8:00 AM *Breakfast*
Pick up registration badge

8:30 AM **Welcome**

8:40 AM **Oral – Session 1**

A modern (sediment) perspective on the ancestral Brooks Range, Arctic Alaska: tectonic insights from detrital geo- and thermochronology
Jared Gooley (U.S. Geological Survey, Anchorage, Alaska)

Paleozoic volcanic rocks in the northern Canadian Cordillera: Remnants of a rifted margin
Rosie Cobbett (Yukon Geological Survey)

Petrogenetics of intrusion-related gold systems in the Rogue and Olympus plutonic complexes, eastern Selwyn basin, Yukon Territory
NicolasPiette-Lauziere (University of British Columbia Okanagan)

10:00 AM *Coffee Break*

10:20 PM **Oral – Session 2**

Eclogite and garnet amphibolite in the Big Salmon Range, southern Yukon
David Moynihan (Yukon Geological Survey)

Magma source rocks in the western Mackenzie Mountains, northern Canadian Cordillera: implications for the basement
Kirsten Rasmussen (University of Alberta)

All aligned on the western front of North America? – Present-day deformation in the diffuse plate boundary zone of Alaska-Canadian Cordillera
Tobias Stephan (Lakehead University)

11:45 PM **2-minute Poster Pitches**

12:30 PM *Lunch & Posters*

1:40 PM **Oral – Session 3**

Upper plate response to transient changes in subducting plate geometry: An example from the central Andes
Joel Saylor (University of British Columbia)

The Rocky Mountain Trench – the surface expression of a Late Devonian lithospheric scale strike-slip zone?
Uwe Kroner (TU Bergakademie Freiberg, Germany)

	Magmatism in the southern Omineca belt: New insights from bulk rock and zircon trace element geochemistry *Robinson Cecil (California State University, Northridge)*
3:00 PM	**2-minute Poster Pitches**
3:30 PM	*Poster session with Coffee & Snacks*
6:00 PM	*Conference Dinner & Bowling*

Sunday, 3 March

8:00 AM	*Breakfast & Posters*
9:00 AM	**Oral – Session 4**
	Atlas 2027: Structural cross-sections through the entire Foreland Belt of the Canadian Cordillera *Karen Fallas (Geological Survey of Canada, Calgary)*
	Is the Bourgeau (MacDonald) Thrust a major fault in southeastern BC and northern Montana? *Kevin Root (Retired)*
	Sources of syndepositional zircons in the Alberta foreland basin *Sarah George (University of Oklahoma)*
10:20 AM	*Coffee Break*
10:40 PM	**Oral – Session 5**
	Tensions in Elastic Thermobarometry: Discussing Quartz-in-Garnet Barometry and its Application to the Nelson Batholith in southeastern British Columbia *Collin Kehler (University of Calgary)*
	Investigation of mica fish in deformed rocks using in situ Rb-Sr geochronology *Kyle Tollefson (University of British Columbia Okanagan)*
	Exhumation response of a continental margin to boundary tectonics: Low-temperature thermochronology study of southern Vancouver Island, Canada *Xin Qiao (University of Victoria)*
12:15 PM	**Closing remarks**
12:30 PM	*Lunch & Posters*
3:00 PM	Poster boards will be removed

Poster presentations in alphabetical order of the first author's last name

The use of lead-isotope ratios in unravelling carbonate-hosted Zn-Pb-Ag deposits in central Yukon
Tyler Ambrose (Yukon Geological Survey)

Dating discrete episodes of potassic/calc-potassic alteration in porphyry systems: Insights from the alkalic Burgundy prospect, British Columbia, Canada
Carl Beno (University of British Columbia Okanagan)

Time-integrated lithologic and structural geologic insights from ophiolites, shear zones, and Au-bearing quartz veins in the Yukon-Tanana upland, Alaska
Jonathan Caine (U.S. Geological Survey, Lakewood, Colorado)

Characterization of the Burgundy Prospect, Northwestern British Columbia, through LA-ICP-MS Trace Element Mapping, Sulphur Isotope Analyses and Rb-Sr Geochronology
Joanna Dlugosz (University of British Columbia Okanagan)

Fold- and Thrust belt development and erosion of foreland basin strata across southern Alberta
Eva Enkelmann (University of Calgary)

Influence of the Cordilleran evolution on the development of the geothermal anomaly in southwestern Northwest Territories – thermochronological constraints
Taís Fontes Pinto (University of Calgary)

Improved temporal constraints on the formation of the Alaska orocline inferred from forearc basin geometry and fault cross-cutting relations
Bob Gillis (Alaska Division of Geological & Geophysical Surveys)

Syn-rift volcanism (ca. 670 Ma) from the Irene Formation in the lower Windermere Supergroup, southern Canadian Cordillera
Thomas Hadlari (Geological Survey of Canada, Calgary)

Multi-method dating of sediment and sedimentary rocks
Birk Härtel (University of Calgary)

Barrovian- and contact-metamorphism north of the Valhalla Metamorphic Core Complex, southeast BC, Canada: Preliminary results from mapping and petrographic analysis
Richard Hieber (University of Calgary)

Late Paleozoic to Mesozoic bedrock exhumation in the Newfoundland Appalachians recorded by low-temperature thermochronology
Emily Johns-Buss (Memorial University)

Insights from geochronology and geochemistry of Cretaceous plutons and their influence on mineralization in the Yukon-Tanana upland, interior Alaska
Douglas Kreiner (U.S. Geological Survey, Anchorage, Alaska)

Time, temperature, and strain history of the Tombstone Strain Zone (Keno Hill silver district, Yukon)
Anya Kulchycki (University of British Columbia Okanagan)

Progressive Paleocene–middle Eocene exhumation of the Yukon-Tanana upland during intracontinental Tintina fault strike-slip and assembly of the Cordillera
Richard Lease (U.S. Geological Survey, Anchorage, Alaska)

Thermal history, exhumation, and landscape evolution of the Goodpaster district, eastern Alaska
Rob McDermott (U.S. Geological Survey, Anchorage, Alaska)

Age and emplacement depth of Jurassic to Paleocene intrusions in the southern Omineca belt, southeastern British Columbia
Douglas McLeod (University of Calgary)

Crustal thickness of the Quesnel terrane constrained by the petrology of the Late Triassic to Early Cretaceous Hogem batholith and its host rocks
Dejan Milidragovic (Geological Survey of Canada, Pacific)

Cenozoic faulting in southeastern Yukon constrained by low-temperature thermochronology
Joel Padgett (University of Calgary)

Contact Metamorphism and Emplacement Depth of the Wragge Creek Stock, Southeastern British Columbia
Asha Pianarosa (University of Calgary)

Cross structures, the Skeena arch and geologic domains of the Stikine Terrane
Thomas Richards (TR Prospecting Ltd.)

New constraints from the Challis-Kamloops Group on crustal evolution during Early Eocene extension in southeastern British Columbia and northeastern Washington
Eric Schmidtke (Simon Fraser University)

Upper Crustal Exhumation History of the Intermontane Belt in the Southern Canadian Cordillera
Baiansuluu Terbishalieva (University of Calgary)

Mineral and rock compositional constraints on the petrogenesis of Seventymile and Kanuti ophiolites, Alaska
Erin Todd (U.S. Geological Survey, Anchorage, Alaska)

Geologic mapping of the Yukon-Tanana Upland: Working towards an improved regional framework
Evan Twelker (Alaska Division of Geological & Geophysical Surveys)

Exhumation History of Hogem Batholith, Quesnel Terrane, North-Central British Columbia Constrained by Apatite Fission Track Analysis
Xi Wang (University of Victoria)

Glacial and fluvial controls on the landscape evolution of Southern Canadian Rocky Mountain fold and thrust belt.
Himani Yadav (University of Toronto)

The Olympic orocline, a mountain formation from orogen-parallel deformation
Wenbo Zhang (University of Alberta)

The use of lead-isotope ratios in unravelling carbonate-hosted Zn-Pb-Ag deposits in central Yukon

Tyler Ambrose, Patrick Sack

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The southern margin of the Ogilvie Platform of central Yukon, Canada, contains hundreds of carbonate-hosted Zn-Pb-Ag mineral occurrences. Host rocks range from Paleoproterozoic to Mississippian in age. However, the timing and drivers of mineralization are largely unconstrained. Most of the deposits are thought to be epigenetic and generally considered to be Mississippi Valley-type.
To constrain the timing of mineralization and source(s) of Pb (and other metals), we integrate geological mapping with new and previously published galena and whole-rock Pb-isotope data of samples collected from the Ogilvie Platform. Our data reveal 3 galena Pb-isotope populations when plotted on the Pb-isotope growth curve for the Canadian Cordillera: 1) A population, which includes the Blende deposit, has Pb-isotope ratios that fall along the Proterozoic part of the curve. Galena with this signature is hosted solely in Paleoproterozoic strata and appears to be associated with Mesoproterozoic magmatism; 2) A population, which includes the Goz Creek deposit, has Pb-isotope ratios that form mixing arrays that intersect the Paleozoic section of the curve. Galena with this signature occurs in Devonian and older strata. The relatively well studied Pine Point and Gayna River Mississippi Valley-type deposits, located to the east in the Northwest Territories, have a similar signature; 3) A population has a highly radiogenic Pb-isotope signature that falls beyond the young end of the curve. Galena with this "future" Pb-isotope signature occurs in Mississippian and older strata. These occurrences are spatially restricted and located along trend with Cretaceous–Paleocene intrusions in the adjacent Selwyn basin. This suggests that this highly radiogenic Pb-isotope signature, typically attributed to MVT-type mineralization, could be related to magmatism, though no intrusions of a similar age have been identified in the Ogilvie platform. Whole rock Pb-isotope compositions from different stratigraphic levels provide insight into the source of metals for these deposits.

Dating discrete episodes of potassic/calc-potassic alteration in porphyry systems: Insights from the alkalic Burgundy prospect, British Columbia, Canada

Carl J. Beno[1], Joanna Dlugosz[1], Kyle P. Larson[1], Brendan Dyck[1], Ali Wasiliew[2], Phoenix Karadimas[2], Mark Button[1], Sudip Shrestha[1]

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Porphyry deposits commonly have complicated petrogenetic histories. They are often characterized by multiple episodes of alteration associated with repeated emplacement of both barren and mineralized intrusions, hydrothermal activity, and multiple generations of brecciation. Analytical advances in LA-ICP-MS techniques now provide access to investigate alternative isotopic records of the timing of magmatic/hydrothermal processes that can buttress established radiometric dating methods commonly applied in mineral systems. Robust workflows for the generation of high-quality garnet U-Pb and biotite Rb-Sr datasets are particularly valuable in characterizing porphyry systems as both phases are common in alteration assemblages therein and can provide unique records of metasomatic processes associated with alteration and mineralization.

The Late Triassic Burgundy porphyry system in the Golden Triangle of northwest British Columbia, Canada comprises Cu-Au mineralization in multiple prospective centers emplaced into Upper Stikine to Lower Stuhini Group strata. The prospect contains a complex series of texturally and geochemically distinct silica-undersaturated alkalic porphyries that have been overprinted by multiple episodes of brecciation and alteration. Titanite U-Pb (212.8 [±2.6] to 208.6 [±1.9] Ma), apatite U-Pb (216.7 [±2.9] to 208.2 [±4.1] Ma), garnet U-Pb (215.1 [±1.3] to 211.4 [±0.95] Ma), and biotite Rb-Sr (218.9 [±5.4] to 200.5 [±0.5] Ma) dates provide insight into the timing and duration of hydrothermal alteration/re-equilibration experienced throughout the prospect. Considering associated textural and geochemical data, the dates provide a minimum emplacement age for the porphyry suite and define a protracted period (>>10 Myr) of localized syn-/post-emplacement hydrothermal alteration/re-equilibration. U-Pb chronometers (titanite, apatite, and garnet) record high-T post-emplacement and early hydrothermal calc-potassic alteration and discrete episodes of brecciation when hosted in hydrothermal breccia cements. Biotite also records post-emplacement and early hydrothermal episodes of potassic and calc-potassic alteration, but further records a texturally distinct period of late-hydrothermal alteration (204.7 [± 0.5] to 200.5 [±0.5] Ma). The new geochronologic data from Burgundy indicate that alkalic magmatism in the Golden Triangle began earlier than is currently recognized within the working regional framework model of Stikinia (i.e. 212–205 Ma) and that alkalic porphyry centers were conduits for protracted hydrothermal activity well after their emplacement. Long-lived hydrothermal activity in alkalic porphyry centers (i.e., Galore Creek, Burgundy) during this critical metallogenic epoch near the Triassic-Jurassic boundary possibly contributed to their unique critical mineral endowments.

Time-integrated lithologic and structural geologic insights from ophiolites, shear zones, and Au-bearing quartz veins in the Yukon-Tanana upland, Alaska

Jonathan Saul Caine[1], Douglas C. Kreiner[2], William M. Benzel[1], and Robert G. McDermott[2]

[1]*U.S. Geological Survey, Geology, Geochemistry, Geophysical Science Center, Denver, CO*
[2]*U.S. Geological Survey, Alaska Science Center, Anchorage, AK*
Contact: jscaine@usgs.gov

The bedrock geology of the Yukon-Tanana upland is lithologically complex with sparse exposures of polydeformed Paleozoic basement intruded by Mesozoic-Cenozoic granitoids. Distinct lithologic juxtapositions, metamorphic gradients, and rare exposures of plastic and brittle regime shear zones (SZ) provide new data to better understand relations between Jura-Cretaceous collisional tectonics and Au mineralization.

Small outcrops of contractional SZs at the base of ophiolite bodies are dispersed over ~25,000 km^2 and occur structurally above Pogo, an active underground gold mine. Ophiolite SZs consist of low-temperature carbonate alteration of peridotites hosting residual Cr-rich clays and quartz-vein networks whereas other SZs reflect higher temperature conditions characterized by anthophyllite/peridotite metamorphism. All are indicative of SZ-related fluid flow and may demarcate the minimum extent of a crystalline thrust-wedge.

SZ rocks from drill core and underground at the Pogo mine include carbonaceous materials (CM) with quartz, carbonate, sulfide, and illite composed of 1M (lower temperature) and 2M (higher temperature) polytypes. The discrete SZ CMs and clays are rheologically weak and are commonly juxtaposed proximal to Au-related quartz veins (AQV). SZ crosscutting kinematics show evidence for extensional reactivation of contractional fabrics. Graphitic schist host rocks may have initially localized SZs and provided a potential carbon source to the fluid flow system.

Controversy remains regarding the origins and timing of Pogo and of texturally and structurally diverse quartz and carbonate vein systems characteristic of the deposit. Variable mechanisms of vein formation are proposed for AQV types at Pogo including: quartz originating from metamorphic segregation, hydrothermal metamorphic and magmatic processes, hydraulic fracturing, and (or) shear ± opening mode veins. Some AQVs are large, 10s m thick, 100s m in strike length, with low angle orientations subparallel to SZs and host rock foliations, where others cut host and SZ fabrics. SZ textures show evidence for plastic and overprinting brittle deformation mechanisms, the latter co-genetic with sulfides and Au deposition. Paragenetically late bladed calcite and Cr-mica, carbonate-silica SZs associated with ophiolites additionally attest to coupled, shallow crustal processes, perhaps concurrent with exhumation.

New work will provide geochronological and paleotemperature data from SZ clays, CMs, and carbonates from surface to depth; documentation of deformation mechanisms/conditions tied to Au parageneses; and temporal correlation of kinematics to local/regional tectonics and mineralization. Documenting the diversity of geologic structures, P-T conditions of mineralization and associated timing of processes at Pogo will produce comprehensive models that integrate structural and tectonic context of mineralization locally and across the broader region.

Magmatism in the southern Omineca belt: New insights from bulk rock and zircon trace element geochemistry

Cecil, M. Robinson[1], Rebelo, F.[1], Gehrels, G.E.[2], George, S.W.M.[3]

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The Omineca belt is part of a series of roughly N-S trending batholiths and associated metamorphic rocks that is inboard from, but parallel to, continental arc systems at the North American plate margin. The southern Omineca belt, in southeastern BC, is the site of three distinct episodes of magmatism in the Jurassic (175 – 160 Ma), the mid-Cretaceous (120 – 100 Ma), and the Paleogene (65 – 45 Ma). Given the great distance from the modern plate boundary, the drivers of magmatism in the Omineca are not well understood and likely reflect complex and changing tectonism across the accretionary boundary of the Intermontane terrane with North America. New geochronology and trace element geochemistry is used to track temporal changes in the fractionation, depth of crystallization and crustal input of granitoid plutons of the southern Omineca belt. Jurassic intrusions are dioritic to granodioritic with a restricted SiO_2 range (62 – 67%), and are geochemically similar to plutons of the Coast Mountains batholith (CMB) to the west. Mid-Cretaceous intrusions are more felsic (66 – 74 % SiO_2) and have higher Ta, Nb, and Rb/Sr, and lower Ba and Eu anomalies than the Jurassic suite. Jurassic plutons plot with the CMB in the volcanic arc granitoid field in most tectonic discrimination diagrams, whereas most mid-Cretaceous plutons are restricted to syn-collisional and within-plate fields. The Jurassic and mid-Cretaceous Omineca plutons are not easily distinguished in the zircon trace element data, though Cretaceous zircons are more heterogeneous and trend toward higher U/Yb, Hf and REE+Y concentrations. Paleogene plutons are quartz monzonitic to granitic and are more alkalic than earlier intrusions. Zircons from Paleogene plutons record notably flatter HREE trends marked by higher Gd/Yb, and a greater proportion of grains with U/Th > 10 (8 %). As previously recognized, Jurassic plutons have many geochemical hallmarks of volcanic arcs and were likely produced via subduction during and following emplacement of Quesnellia onto North America. Mid-Cretaceous plutonism is markedly different, with geochemistry reflecting greater fractionation and crustal contamination, and shallow processing in equilibrium with plagioclase. Mid-Cretaceous plutons likely formed via crustal anatexis following crustal thickening, though the tectonic driver for this is uncertain, especially in light of paleogeographic models that place the Insular terrane at southern latitudes. Paleogene plutons record a strong garnet influence, indicating melting at depth in thickened crust prior to exhumation in the footwalls of local core complexes.

Paleozoic volcanic rocks in the northern Canadian Cordillera: Remnants of a rifted margin

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Lower and mid-Paleozoic volcanic rocks that occur in continental margin successions of northwestern Canada provide insights into the architecture of the western Laurentian or Cordilleran rifted margin system. Precise U-Pb CA-ID-TIMS studies of zircon collected from mafic volcanic rocks in the Sekwi Formation in western Northwest Territories and the Crow Formation at two locations in southeast Yukon yield late Cambrian dates (~493-486 Ma). Fossil age constrains from carbonate interbedded with mafic volcanic rocks of the Haywire Formation in western Northwest Territories are Middle Ordovician. These upper Cambrian and Middle Ordovician volcanic rocks are coincident with the inferred location of the platform (Mackenzie platform) to deep-water basin (Selwyn basin) boundary in the northern Cordillera. The locations of basin to platform transitions in western Northwest Territories and southeast Yukon changed through the early and mid-Paleozoic and the mafic volcanic rocks exposed in this area track these changes. The whole-rock geochemical compositions of the mafic rocks are consistent with partial melting in the garnet stability field (greater than ~75km) and the whole-rock Nd-Hf isotope signatures indicate subcontinental lithospheric mantle sources. Collectively, these features add detail to our understanding of the geometry of the Cordilleran rifted margin and allow inferences to be made about how western Laurentia evolved after lithospheric breakup. Westward-dipping normal faults that accommodated crustal extension during Paleozoic and older rifting are favorably oriented for reactivation as thrust faults during Mesozoic orogenesis. For example, north-south trending, east-vergent thrust faults in the Coal River area of southeast Yukon may have initiated as early to mid-Paleozoic normal faults that developed during and after rifting. Continental extension in this area resulted in late Cambrian magmatism and subsequent reactivation of these structures may be responsible for Early and Middle Ordovician volcanic occurrences in the Haywire Formation.

Characterization of the Burgundy Prospect, Northwestern British Columbia, through LA-ICP-MS Trace Element Mapping, Sulphur Isotope Analyses and Rb-Sr Geochronology

Joanna Dlugosz[1], Kyle P. Larson[1], Christopher J.M. Lawley[2], Carl J. Beno[1], Crystal Laflamme[3], Duane C. Petts[2], Guillaume Barré[3]

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The Burgundy prospect is a silica-undersaturated Cu-Au alkalic porphyry prospect located on the Enduro Metals' Newmont Lake property in the Golden Triangle of British Columbia. Chalcopyrite is the dominant sulphide mineral in the prospect, with pyrite, sphalerite, bornite and galena present as well. Mineralization occurs as disseminations, veins, and with biotite veins in breccia zones. *In situ* LA-ICP-MS trace element mapping and sulphur isotope analyses of pyrite and chalcopyrite provide a better understanding of the mineral paragenesis of mineralization at this poorly characterized prospect. Trace element mapping identified pyrite grains with Bi-, Te-, Co-, and Ni-rich pyrite rims relative to metal-poor pyrite cores. Further quantitative analyses of Co and Ni within pyrite rims show trends typical of pyrite generation in hydrothermal or volcanogenic deposits, rather than sedimentary environments. Trace element mapping further indicates that Au mineralization is petrogenetically late, occurring as solid solution and micro inclusions in pyrite rims, factures within pyrite grains, and within the surrounding rock matrix. In contrast, Ag mineralization is present in semicontinuous zones along chalcopyrite crystal boundaries. We interpret the trace element-rich pyrite rims and Au-Ag textures in sulphides to indicate that metal enrichment occurs late in the hydrothermal evolution of the system. Sulphur isotope analyses of pyrite and chalcopyrite yield predominantly negative $\delta^{34}S$ values. Pyrite grains yield depleted rims (i.e., -5.5 ± 5.8‰, n = 86) and slightly more enriched cores (i.e., -4.0 ± 4.3‰, n = 34), with inclusion-rich pyrite averaging -13.2 ± 9.8‰ (n = 7). Chalcopyrite yields more enriched $\delta^{34}S$ values (i.e., -4.2 ± 2.8‰, n = 163), with no clear rim and core zonation. Overall, the negative $\delta^{34}S$ values from pyrite and chalcopyrite are indicative of sulphide mineralization from oxidized fluids. Initial results from Rb-Sr geochronology of mica interpreted to be cogenetic with pyrite and chalcopyrite yield a single population, with isochron dates that range between 208.3 ± 1.8 and 200.9 ± 5.4 Ma. Initial 87Sr/86Sr values measured in cogenetic calcite in each sample was used as an anchor for the isochron. The presence of mica grains along and within metal-rich pyrite rims, rather than cores, is consistent with the dates being associated with the metal-rich rims. Combining the above results indicates that mineralization in the Burgundy prospect occurred as a result of infiltration of oxidized, late high-temperature hydrothermal-magmatic fluids between 210 to 200 Ma.

Fold- and Thrust belt development and erosion of foreland basin strata across southern Alberta

Eva Enkelmann[1], William Matthews[1], Joel Padgett[1]

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Most of Alberta comprises Late Cretaceous to Paleocene clastic strata deposited in the foreland basin during the eastward growth of the Canadian Cordillera. In the west, these strata were deformed within the front range and foothills of the Rocky Mountains, while in central and eastern Alberta they are undeformed. The youngest strata of the Paleocene Paskapoo Fm are found east of the Cordilleran deformation front and taper out towards the east. What is generally unknown is the burial and erosional history of the Alberta basin. When did thrusting in the foothills end? How much sediment was eroded during the Cenozoic and at what time?

To address these questions, we used low-temperature thermochronology to obtain new time and temperature constraints. We present new data from 23 samples collected along a 350 km long east–west transect across southern Alberta. We used apatite and zircon (U-Th)/He dating (AHe and ZHe) and apatite fission track (AFT) analysis to determine the timing of heating and cooling in the range of 200–50ºC. Combined with the stratigraphic age of the samples, these time-temperature constraints reveal sediment burial, maximum burial temperatures, and timing of accelerated cooling due to deformation and/or erosion.

Our preliminary data and thermal models show samples collected in the foothills underwent rapid cooling during the late Paleocene to early Eocene (60–50 Ma). Most of these samples were buried to temperatures >140 ºC resulting in reset AFT data and partially reset ZHe data. At the Moose Mountain culmination, temperatures exceeded 180ºC resulting in fully reset ZHe dates. We interpret these data to record the last stage of thrusting and this event is not seen in samples from east of the deformation front. A second phase of cooling during the Oligocene–early Miocene is recorded within the foothills and just east of the deformation front, which we interpret to record cooling due to erosion. The second phase of cooling coincides with the deposition of Oligocene-Miocene gravels further east in the plains and within the proposed Bell River catchment that transported material from the Rocky Mountains into the Saglek Basin.

Samples from southeastern Alberta record late Paleocene–early Eocene cooling like those in the foothills with maximum burial temperatures of >140ºC resulting in fully and partially reset AFT and partially reset ZHe data. These data suggest significant erosion at this time and implies that this region was not covered by the Paskapoo Fm.

Atlas 2027: Structural cross-sections through the entire Foreland Belt of the Canadian Cordillera

K.M. Fallas[1], M.A Cooper[2], P.R. Fermor[3], and M.J. Warren[4]

[1]Geological Survey of Canada, Calgary; Natural Resources Canada
[2]Sherwood GeoConsulting Inc., Calgary, and School of Geosciences, University of Aberdeen
[3]Devon Energy, retired
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A new effort to update the Geological Atlas of the Western Canada Sedimentary Basin, *Atlas 2027*, provides an opportunity to expand regional coverage into the Northwest Territories and Yukon, and employ modern digital mapping techniques and software for compilation and publication. Like the 1994 edition of the *Atlas*, the new version will include chapters addressing structural relationships and tectonics.

The 1994 Atlas included eight structural cross-sections through the Foreland Belt of British Columbia and Alberta that illustrated along-strike variations in structural style. Five of these had accompanying partial palinspastic restorations to address magnitude of shortening and paleogeographic reconstructions. *Atlas 2027* will include additional cross-sections, at regular intervals along the full length of the Foreland Belt to illustrate the range of structural styles. This work will incorporate published cross-sections, exploration well data, and reflection-seismic data provided by Pulse Seismic Inc. and Explor Geophysical Ltd. Where appropriate, existing cross-sections will be extended westward or revised to incorporate newer structural information or updated map relationships.

Work to this point has focused on literature searches identifying existing structural cross-sections, organizing relevant well data, and acquiring access to reflection-seismic data to support cross-section construction or revision. In addition, palinspastically restored well and outcrop locations from the 1994 Atlas are being converted to the *Atlas 2027* GIS base for the use of authors of the chapters on the stratigraphic systems. The intended publication date of 2027 for the new version of the Atlas sets a timeline for assembling the intended suite of cross-sections within the next two years. Forty to fifty cross-section locations are under consideration, between the Waterton area in the south and the Richardson Mountains in the north, to cover all the major structural domains of the Foreland Belt.

Influence of the Cordilleran evolution on the development of the geothermal anomaly in southwestern Northwest Territories – thermochronological constraints

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In the southwestern Northwest Territories (SW-NWT), geothermal gradients reach 50°C/km and are elevated compared to most other regions of Canada. The SW-NWT is part of the Western Canada Sedimentary Basin (WCSB), stretching from the U.S. border to the Arctic. The WCSB overlies the western portion of the Canadian Shield and is bounded in the west by the Canadian Cordillera. It is composed of Cambrian to Triassic passive margin strata that deposited after breakup of western Laurentia. Cordilleran development followed, resulting in the deposition of Jurassic to Cenozoic foreland basin strata. In this study, the WCSB comprises the undeformed Great Slave Plain in the east, and the Liard Basin in the west, where parts of it were incorporated into the Cordilleran fold-and-thrust belt. Basement structures and Cordilleran orogeny may have influenced the current geothermal gradients through associated exhumation processes. High gradients can result from isothermal imbalance caused by moving of hot rocks from greater depth towards the surface. To constrain tectonically-driven upper crustal processes such as burial and exhumation in the NWT, we use low-temperature thermochronology. Thermochronology allows to constraint of cooling of rocks between 55–200°C. In the Liard Basin, we dated 20 sedimentary rocks (Devonian, Carboniferous, Triassic, and Cretaceous strata), mostly within the fold-and-thrust belt. In the Great Slave Plain, we dated 9 samples from Cambrian strata and Precambrian basement.

In the Liard Basin, Carboniferous and Cretaceous strata show similar trends with westward decrease in dates, suggesting the experience of greater temperatures in the west. Preliminary modeling of Carboniferous samples shows that the westernmost sample experienced 240°C and the easternmost sample experienced 160°C, and samples in between experiencing 160-200°C. Modeling shows that samples experienced cooling at different times, ranging from Jurassic in the west to Cretaceous in the east. Triassic strata of the Liard Basin experienced temperatures >200°C and cooling during the Upper Cretaceous, being coeval with the formation of the Sub-Cretaceous unconformity. In the Great Slave Plain, most Cambrian strata experienced maximum burial between 80–160°C, possibly up to 200°C. Considering the data from the Liard Basin and Great Slave Plain together is consistent with the assumption that rocks experienced greater burial and heating towards the west. This is based on the thicker sedimentary pile in the west, particularly the Devonian–Carboniferous and Lower Cretaceous strata are thick. Next steps include thermal history modeling and reassessment of geothermal gradients in the area.

Sources of syndepositional zircons in the Alberta foreland basin

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Questions remain over the paleolatitude of the Intermontane and Insular terranes in the late Mesozoic. The Mesozoic Coast Mountains Batholith intrudes the Intermontane and Insular terranes; its volcanic counterparts would have served as a potentially mobile zircon factory during purported terrane displacement. Here, we test whether near syndepositional zircons derived from the Coast Mountains Batholith (and extrusive equivalents) contributed to the autochthonous Jurassic-Paleocene Alberta foreland basin through time. Syndepositional contributions from the Coast Mountains Batholith are unlikely in long-transport Baja-BC models. Detrital age spectra show inter-sample variability, but most spectra show prominent age modes at ca. 1.8-1.6 Ga, 1.3-1.0 Ga, 500-300 Ma, and 250-65 Ma. In many samples, the 250-65 Ma age modes include populations that overlap with biostratigraphic age constraints, suggesting the presence of roughly syndepositional zircons. We use Lu-Hf isotopes on the near syndepositional grains to determine their most likely source. Possible sources include magmatic centers in the Omineca belt, Coast Mountain Batholith, and southerly regions, including the Idaho and Boulder batholiths and associated volcanic centers. Near syndepositional zircons in one Albian sample (depositional age of ~103 Ma) exhibit negative εHf signatures (prominent cluster at -8 to +2 εHf units, with three more scattered grains between +6 and +13 εHf units), likely most consistent with sources in the Omineca belt. In contrast, near syndepositional zircons in Campanian-Paleocene strata (depositional ages of ~80-64 Ma) are characterized by juvenile εHf signatures (clusters from -3 to +15 εHf units), most consistent with a Coast Mountains source. Our results suggest significant volcanic contributions from the Coast Mountains since 80 Ma, but do not preclude earlier contributions.

Improved temporal constraints on the formation of the Alaska orocline inferred from forearc basin geometry and fault cross-cutting relations

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The Alaska continental margin is believed to be bent about a vertical axis centered in the Gulf of Alaska, but its timing of development is poorly constrained. In its western limb, a Jurassic−Paleogene forearc basin is bounded by three major fault systems: the Bruin Bay (BBFS), Castle Mountain (CMFS), and Border Ranges (BRFS). Recent work in the upper Cook Inlet (CI) and Talkeetna Mountains (TM) provides new insights for fault cross-cutting relations, forearc geometry, and their implications for oroclinal bending. In the CI segment of the forearc basin, the BBFS forms the boundary between the magmatic arc and basin. The CMFS cuts obliquely to the Jurassic arc-forearc basin, with dextral offset of 130 km. At its distal eastern end, the CMFS may tie into the dextral BRFS at the Matanuska Valley (MV) where the BRFS system makes a sharp ~60° degree bend in the hinge of the orocline. Whereas many of the Jurassic arc-forearc elements reappear in the TM north of the CMFS, the truncated BBFS and Paleogene forearc basin are not clearly recognized, leading most researchers to believe the basin axis follows the trace of the BRFS into the oroclinal hinge. New geologic mapping and structural studies in the TM reveal a 4.5 km wide deformation zone with an orientation, hangingwall-footwall relations, and sinistral-reverse slip kinematics that correlate it to the BBFS. New stratigraphic work on previously mapped, but unstudied conglomerates discontinuously distributed parallel to the trend of the Jurassic−Paleogene arcs and BBFS yield fluvial lithofacies associations and 55−53 Ma detrital zircon maximum depositional ages. The conglomerates and 60−54 Ma fluvial forearc strata (Arkose Ridge, Chickaloon, Wishbone Formations) are unconformably overlain by <48.6 Ma lavas. Thus, the CMFS cuts across the Paleogene and older forearc system, which continues through the TM rotated, but unbent in the western limb of the orocline. The age of syntectonic strata filling a pull-apart basin on the distal southwest end of the CMFS is well constrained at ≤47.0−38.1 Ma, marking the time at which the TM segment of the forearc basin became decoupled from the Neogene to modern CI segment and ceased to subside. We suggest the CMFS initiated or integrated with the BRFS as the orocline tightened and it became more efficient for some of the proposed >600 km of dextral slip on the BRFS to transfer across the forearc basin onto the CMFS as increasing curvature restricted movement of material through the oroclinal hinge.

A modern (sediment) perspective on the ancestral Brooks Range, Arctic Alaska: tectonic insights from detrital geo- and thermochronology

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The Brooks Range of Arctic Alaska and the Yukon is the northernmost orogenic belt of the North America Cordillera. While prior thermochronological studies have primarily focused on Cenozoic Brooks Range uplift, there are sparse absolute constraints of the ancestral orogen's Jurassic–Cretaceous evolution. Here, we use a multimineral approach to survey the thermal history of the orogen using detrital-zircon (DZ) and detrital-apatite (DA) U-Pb and fission track (FT) double-dating. Sands from 35 modern rivers were sampled along a contiguous >600 km west–east transect that encompases juxtaposed Mesozoic allochthonous and parautochthonous rocks and traverses west-east increasing gradients of topographic relief and historical siesmicity.

DZU-Pb ages in river sediments match published data from allochthonous and parautochthonous bedrock, with Cambrian–Devonian zircon prevalent in western catchments and Proterozoic zircon dominant in eastern catchments, respectively. DAU-Pb offers new perspectives on mid-crustal orogenic cooling (~375–570°C). Dominant DAU-Pb age components resolved by mixture modeling include, from southwest to northeast: 1) ubiquitous Paleozoic components that constitute 75–100% of ages from catchments within the allochthonous central Brooks Range; 2) Cretaceous components abundant in the northern salient of the orogen; and 3) Paleoproterozoic components throughout the northeasternmost Brooks Range. Notably, Cretaceous DAU-Pb ages from the northern salient may suggest significant burial and thermal overprinting of parautochthonous Paleozoic rocks prior to exhumation.

Brooks Range low-temperature cooling ages can be compared with the Colville Foreland Basin stratigraphic record to explore conceptual models of foreland basin filling. Older DZFT age components accord with relative timing of pre-Brookian and Late Jurassic–Early Cretaceous collisional events that culminated in basin subsidence and deposition of a thick foredeep-wedge. An absence of DZFT ages from ~110–75 Ma coincides with deposition of multiple early Brookian megasequence clinothems in the Colville Foreland Basin. DZU-Pb ages from the foredeep indicate limited Brooks Range-derived sediment entered the basin during this time relative to voluminous sediment derived from the Russian Chukotka terrane. The paucity of Late Cretaceous FT ages implies a post-tectonic period of slow exhumation, with Chukotka sediment-supply and eustasy as primary drivers of Brookian megasequence deposition. Post-75 Ma DZ and prevalent DAFT ages record the onset of Cenozoic orogenic rejuvenation that resulted in foredeep exhumation and coeval wedgetop basin development in the present-day northeast Brooks Range. Collectively, our modern river detrital dataset provides new absolute age constraints on Jurassic–Cretaceous evolution of the ancestral Brooks Range and onset of a second phase of Cenozoic uplift.

Syn-rift volcanism (ca. 670 Ma) from the Irene Formation in the lower Windermere Supergroup, southern Canadian Cordillera

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The southern Canadian Cordillera is considered the type area for the Windermere Supergroup, where it had long been assumed that the syn-rift basaltic lavas of the Irene Formation were co-genetic with the ca. 720 Ma Franklin LIP. Accordingly, the inferred age of the Irene volcanics is variously cited for either the breakup of Rodinia or for the base of Cryogenian strata in the southern Canadian Cordillera, and yet they have not been directly dated until now. Reported here are geochronological data from a volcanic sample of the Irene Formation yielding a U-Pb SHRIMP zircon age of 669.6 ±6.7 Ma, which is significantly younger than the presumptive age. The Irene Formation is overlain by basin floor turbidite facies that correlate with the Horsethief Creek Group, which represent some of the oldest post-rift deposits in the study area. The dated sample was collected from the upper portion of the Irene Formation and so the transition from syn-rift to post-rift is younger than ca. 670 Ma, which is estimated at approximately 660-650 Ma.

Multi-method dating of sediment and sedimentary rocks

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The advances of laser-ablation techniques in geosciences over the last two decades have boosted the development of new dating approaches in geo- and thermochronology. The large throughput of laser-ablation analyses together with the high spatial resolution enable combining several dating techniques on 100s of individual grains. This is ideal for dating sedimentary rocks, for which provenance, the cooling history in the source region, and burial and erosion after deposition are of interest to resolve complex geological histories.

Laser-ablation-based dating allows us to carry out geochronology (U-Pb dating) and thermochronology (fission track and (U-Th)/He dating) on the same grains to elucidate both, sediment provenance and basin thermal history. This makes it possible to: (1) trace the cooling history of particular source regions such as distinguishing between magmatic and exhumational cooling on a grain-by-grain basis, (2) evaluate maximum burial temperatures of basin strata and timing of basin inversion, and (3) use the relationship between the geo- and thermochronological ages as an internal consistency check. Besides, the use of laser ablation in (U-Th)/He dating enables us to increase the number of dated grains compared to whole-grain dating, making proper analysis of (U-Th)/He data in sediments and sedimentary rocks possible.

At the Geo-and Thermochronology Lab of the University of Calgary, we have developed procedures for several multi-method dating schemes and successfully applied them to a variety of settings. This contribution features a variety of geological applications we conducted using multi-method dating on detrital materials. This includes apatite U-Th/He and U-Pb dating on modern river sands from the Appalachians and combined zircon fission track and U-Pb dating on Cretaceous borehole strata from the Newfoundland Margin. The latest addition to our analytical toolkit is detrital zircon dating with the laser ablation U-Th/He and U-Pb methods. We present data from the northern Cordillera underpinning the potential of multi-method dating and giving an overview of the newest developments.

Barrovian- and contact-metamorphism north of the Valhalla Metamorphic Core Complex, southeast BC, Canada: Preliminary results from mapping and petrographic analysis

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Preliminary results from fieldwork in 2023 north of the Valhalla Complex uncovers a regional prograde Barrovian-style metamorphic sequence with a complex relationship to low pressure contact aureoles developed around Mesozoic igneous intrusions.
The Valhalla complex is a metamorphic core complex located between Nakusp and Trail in southeast British Columbia. It is bound by the ~60 Ma brittle-ductile Valkyr Shear Zone (VSZ) to the South, West, and North, to the East the VSZ is cut by the ~50 Ma brittle Slocan Lake Fault (SLF). Those two faults separate the complex from the structurally overlying, lesser metamorphosed country rock.
The studied area lies immediately north of the complex in the hanging wall of the VSZ. Metapelitic mineral assemblages reveal a Barrovian-style metamorphic sequence that increases in grade going from North to South toward the VSZ through the following zones: Chlorite + biotite, garnet, staurolite, kyanite, and sillimanite zones.
In this region various Mesozoic-aged intrusions are found that developed low pressure contact aureoles containing combinations of andalusite, cordierite, and sillimanite. Temporal relationships between regional metamorphism, intrusion emplacement and faults, however, remain unclear. East of the SLF the Mount Carpenter Stock aureole contains andalusite that overprints a regional foliation in low grade chlorite + biotite grade rocks. Emplacement of the Snowslide Creek Stock located west of the SLF, in contrast, appears to predate regional metamorphism based on contact metamorphic andalusite that is overprinted by regional sillimanite-zone metamorphism. A culmination of intrusions including the Wragge Creek Stock, South Wragge Creek Stock, East Caribou Stock, and Shannon Lake Stock are found East and West of the SLF and are here collectively called "Wragge Intrusions". Where intruded into regional low-grade chlorite + biotite zone rocks the prograde contact metamorphic sequence andalusite, ±cordierite, sillimanite overprints the regional metamorphic foliation. The observation that andalusite occurs on both sides of the SLF either implies that emplacement of the Wragge Intrusions post-dates the SLF or if movement on the fault was later or coeval with emplacement of the intrusion, displacement along the SLF was insignificant at this location.

Late Paleozoic to Mesozoic bedrock exhumation in the Newfoundland Appalachians recorded by low-temperature thermochronology

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The Newfoundland magma-poor rift margin is underlain by late Paleozoic and older rocks of the Appalachian orogen and was established as a result of the Mesozoic opening of the North Atlantic Ocean. Tectonic models for the Newfoundland margin predict discrete phases of lithospheric extension that resulted in several margin-parallel architectural domains. Specifically, the Newfoundland margin was generated sequentially by Late Triassic to Early Cretaceous lithospheric stretching in the proximal and necking domains, Early to mid-Cretaceous hyperextension and mantle exhumation in the distal domain, and mid-Cretaceous breakup and onset of seafloor spreading in the outer and oceanic domains. The progression of extensional deformation and the exhumation of basement rocks is correspondingly predicted to shift oceanward during rift-margin development. However, there has yet to be regional studies that quantify the spatial patterns and rates of rift-related exhumation in Newfoundland. We used low-temperature thermochronology to constrain the timing, rates, and spatial distribution of exhumation in the eastern Newfoundland Appalachians to evaluate how deformation was accommodated during Mesozoic rift evolution. Zircon and apatite fission-track and (U-Th)/He thermochronological systems were applied to rock units in eastern Newfoundland. Each sample was analysed with a combination of two to three thermochronological systems. Inverse thermal history modelling was used to characterize cooling rates and inferred exhumation rates from ~300°C to ~50°C. Inverse thermal modelling results show Late Devonian to Jurassic accelerated cooling phases (>2°C/myr) that are interpreted to reflect phases of enhanced exhumation. Late Devonian to early Permian accelerated cooling is consistent with exhumation in the northern Appalachian orogen during Neoacadian and Alleghanian transpression. Late Permian to Jurassic accelerated cooling phases require brittle deformation in Newfoundland during proximal domain development and supports the hypothesis that the earliest phases of lithospheric stretching affected a region 100's of kms wide. Slow cooling rates during the Early Cretaceous indicate that deformation propagated oceanward during the onset of necking and distal domain development as predicted by magma-poor rift models. The temporal and spatial distribution of Mesozoic accelerated cooling in the eastern Newfoundland Appalachians is consistent with the differential exhumation of distinct crustal blocks during extension. The highest rates of exhumation are observed along a mid-Paleozoic suture (Dover-Hermitage Bay fault) and suggests that inherited, lithosphere-scale structures accommodated some Mesozoic extension. Results from the Newfoundland margin reveal insights in the spatial distribution of exhumation during later phases of Appalachian orogenesis and inform predictions for rift-related exhumation on modern and ancient magma-poor rift margins globally.

Tensions in Elastic Thermobarometry: Discussing Quartz-in-Garnet Barometry and its Application to the Nelson Batholith in southeastern British Columbia.

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Quartz-in-Garnet thermobarometry (QuiG) is the most widely used method of "elastic thermobarometry", a technique based on the relative expansion or compression of mineral inclusions within a host. In contrast to classical thermobarometry which uses the chemical compositions of minerals to determine the pressure-temperature (P-T) conditions of metamorphism, QuiG uses the present-day pressures experienced by quartz inclusions in garnet to determine the P-T conditions of garnet growth. Due to its independence from chemical equilibrium, elastic thermobarometry has the potential to provide insights into the P-T paths of metamorphism and the interplay between equilibrium and kinetics in metamorphic recrystallization. QuiG has been applied mainly to collisional and subduction-related metamorphic sequences worldwide, however, has not been thoroughly tested in low-pressure settings (~5 kbar and lower). In these settings, quartz inclusions in garnet are predicted to preserve tensional rather than compressional stresses. Here, QuiG is applied to the contact metamorphic aureole of the Nelson batholith in southeastern British Columbia – a staurolite + andalusite bearing aureole which preserves pressures of metamorphism at ~3.5 kbar (~12-14 km depth). This talk will discuss the results of this study, which carry implications for the strengths, pitfalls, and nuances in the method and its application to metamorphic recrystallization.

Insights from geochronology and geochemistry of Cretaceous plutons and their influence on mineralization in the Yukon-Tanana upland, interior Alaska

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Middle- to Late Cretaceous magmatism is voluminous across the northern Cordillera of Alaska, but only generated a few significant mineral deposits (Pebble, Fort Knox). Plutons emplaced during this time have diverse characteristics indicative of varying source materials. We describe new U/Pb zircon geochronology and geochemistry from 138 samples across ~45,000 km^2 of Cretaceous magmatism that help constrain the metallogenic setting of the Yukon-Tanana upland. Magmatism was nearly continual between 114-87 Ma and from ca. 72-67 Ma, although compositionally diverse.
Plutons emplaced ca. 114-101 Ma are weakly to strongly peraluminous and have steep LREE and shallow MREE-HREE patterns with a negative Eu anomaly (Eu/Eu* 0.59-0.65). Chemistry is variable, but a broad spatial pattern is observed. Weakly peraluminous plutons prevalent in the southeast are characterized by ilmenite fractionation (uniform V/Sc with increasing Sc concentration). Whereas strongly peraluminous plutons to the northwest are characterized by magnetite(±ilmentite) fractionation (decreasing V/Sc with decreasing Sc concentration). This pattern correlates with Hf isotopic ratios; compositions are most juvenile to the southeast and increasingly crustal to the northwest.
From ca. 101-90 Ma, metaluminous bodies are restricted to the central upland with distinct garnet-bearing peraluminous intrusions to the north. Metaluminous plutons have shallower LREE and flat MREE-HREE slopes compared to peraluminous plutons, and both exhibit moderate negative Eu anomalies. Metaluminous intrusions are less alkaline and less differentiated with ilmenite fractionation. Strongly peraluminous plutons trend toward magnetite to magnetite+ilmentite fractionation. Younger middle-Cretaceous Hf isotope ratios are also more crustal to the northwest.
Late Cretaceous magmatism occurred between ca. 72-67 Ma and is sub-alkaline to alkaline and are metaluminous to weakly peraluminous. The suite has variable but moderate LREE and shallow to flat MREE-HREE slopes. These rocks show evidence for hornblende/clinopyroxene fractionation (increasing V/Sc with decreasing Sc) in contrast to older plutons. Late Cretaceous Hf isotope ratios overlap but average higher than middle Cretaceous and have similar patterns, becoming more crustal to the northwest.
The distinctive geochemical and isotopic parameters of the Cretaceous plutons suggest varying sources with gradationally increasing crustal contributions from southeast to northwest. This pattern correlates with magma oxidation states and associated metallogeny: W-Mo porphyries in the southeast and Au-Bi(-As) veins in the northwest. The most juvenile and oxidized are the Late Cretaceous associated with Cu-Mo-Au porphyry mineralization. These plutons reflect the poorly documented subduction environment bounding the southern Yukon-Tanana margin and have temporal and compositional links to suites in the Yukon separated by the Tintina fault system.

The Rocky Mountain Trench – the surface expression of a Late Devonian lithospheric scale strike-slip zone?

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The Rocky Mountain Trench is a first-order morphologic feature in the southern Canadian Cordillera. The NE-SW strike of the trench runs parallel to the strike of the Late Mesozoic fold and thrust belt and parallel to the margin of the North American craton. The adjacent NNW-SSE striking Tintina Fault to the north represents a crustal-scale sinistral transcurrent shear zone that was active during the formation of the Cordillera. Because the Rocky Mountain Trench did not experience tectonic processes like the Tintina Fault, its role during Cordilleran tectonics remains enigmatic. Using the spherical strain pattern preserved in the continental crust, here we present a plate kinematic model of the Late Devonian North American subplate and demonstrate that in such a scenario the strike of the Rocky Mountain Trench is parallel to a small circle segment of the Paleo-Tethys plate tectonic system, and thus, can be explained as the surface expression of a sinistral transform plate boundary originated during the late Devonian Antler orogeny. Through correlating timing, orientation, and kinematics of regional tectonic events, we propose a plate tectonic scenario as follows.

The formation of western Pangea resulted from prolonged convergent tectonics of Gondwana and Laurussia to the south and the north, respectively. Late Devonian opening of Paleotethys to the east caused continued convergence of Gondwana with Laurussia to the west. Collision of Gondwana with the Appalachian segment of North America resulted in decoupling of North American lithosphere from Laurussia. The northward motion of this lithospheric domain relative to Laurussia explains the tectonic events along its boundaries, namely the Ellesmerian and the Antler orogenies along the frontal and the Panthalassan margins, respectively. To the southeast, the formation of the Maritimes Basin reflects dextral transtension and associated strike-slip faulting parallel to the SE margin of Greenland. Dextral transpression during the reactivation of the Greenland – Scandinavian Caledonides culminated in Ellesmerian UHP metamorphism.

At the future Rocky Mountain Trench, Paleozoic, sinistral decoupling of the North American subplate and Panthalassa created a vertical, lithospheric-scale inheritance that can be reactivated during Cordilleran tectonics. Hence, the existence of such pre-existing anisotropies should be considered when evaluating the architecture of orogens and may be serve as an explanation for Late Cretaceous mantle delamination even in a region that is not affected by prominent shearing during Cordilleran tectonics.

Time, temperature, and strain history of the Tombstone Strain Zone (Keno Hill silver district, Yukon)

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The Keno Hill silver district, located within the Proterozoic to Paleozoic Selwyn Basin of the Canadian Cordillera, is known for its Late Cretaceous Ag-Pb-Zn mineralization. A mid-Cretaceous deformation event led to the formation of many convergent structures across the northern Cordillera, including the northeast-vergent Selwyn thrust and fold belt. The Keno Hill area sits within this belt and contains the Robert Service Thrust (RST) to the south, and the Tombstone Thrust (TT) to the north, below the RST. The TT is associated with a high-strain zone that extends from the TT into the hanging wall of the RST. Although previous studies have focussed on the stratigraphy and late brittle faults associated with mineralization in the area, understanding the structural evolution of the Keno Hill silver district is crucial for quantifying the regional kinematic framework and structural architecture prior to mineralization. Previous work has identified at least two folding events in the Keno Hill area, but their relationship with the timing of the RST remains debated. This study incorporates 1:25000 detailed structural field mapping, microstructural analyses, *in situ* $^{87}Rb/^{87}Sr$ geochronology, quartz c-axis crystallographic preferred orientations, and Raman spectroscopy of carbonaceous materials on fine-grained, weakly metamorphosed, clastic sedimentary rocks of the TSZ. Our results outline a regional foliation that dips moderately to the southwest, overturned (to-the-north) isoclinal folds, and subvertical open folds that strike southeast-northwest. Although the overall shear sense varies at both the macro- and microscale, it is predominantly top-to-the-northwest. The timing of movement of the RST is informed by a 116.3 +/- 13.8 Ma *in situ* $^{87}Rb/^{87}Sr$ date on cleavage-forming white mica in a sample from the hanging wall of the RST. Raman spectroscopy data define an average peak temperature in the study area of 466.3 +/- 37.1°C, and temperature show no evident spatial correlation with RST or TT. Relating the results of this study to data from the Selwyn Basin will inform our understanding of the structural evolution of its thrust and fold belt.

Progressive Paleocene–middle Eocene exhumation of the Yukon-Tanana upland during intracontinental Tintina fault strike-slip and assembly of the Cordillera

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Assembly of the North America Cordillera occurred through accretion and translation along terrane boundaries that drove intracontinental deformation and exhumation. The >2000-km-long, lithospheric-scale Tintina fault-Northern Rocky Mountain Trench marks the inboard extent of accreted terranes and forms the northern boundary of the Yukon-Tanana upland (YTU). Prior research indicates 430–490 km of ~65–42 Ma Tintina fault dextral offset at a ~20 km/Myr implied rate, but the fault's role in focusing regional exhumation is less well understood. We characterize YTU exhumation patterns with detrital thermochronology from 13 modern river catchments that drain >45,000 km^2 of eastern Alaska. We apply apatite fission-track (AFT) and U-Pb (AUPb) double-dating to constrain cooling through ~110°C and ~500°C, respectively, and resolve constituent detrital AFT age components with mixture modeling. Regionally widespread AFT age peaks record YTU exhumation during Paleocene–middle Eocene Tintina fault strike-slip (50% of age distributions), mid-Cretaceous extension and plutonism (30%), and Permian–Jurassic collisional orogenesis (10%). The AUPb ages highlight a spatial contrast in mid-crustal cooling, exemplified by a northwestward jump from Permian–Jurassic ages in rivers draining the Yukon-Tanana terrane (extensional upper plate) to mid-Cretaceous ages in rivers draining ancestral North America (lower plate). Across the variable mid-crustal substrate in this region, Paleocene–middle Eocene upper crustal cooling is ubiquitous and detrital AFT age peaks progressively young from ~65 to 45 Ma northwestward over a 370-km-long, Tintina fault-parallel transect, though spatial heterogeneity in exhumation magnitude is implied by the preservation of Late Cretaceous and Paleocene volcanic paleo-surfaces in some areas. Paleocene–middle Eocene YTU exhumation is coeval with rapid accumulation of 5 km of nonmarine strata in the Yukon Flats basin and broad upright folding of Paleozoic–Paleogene rocks in the YTU. Our data suggests ~20 km/Myr westward propagation of Paleocene–middle Eocene YTU exhumation, similar to the implied Tintina fault slip rate and consistent with deformation between the Denali and Tintina faults. Middle Eocene cessation of major Tintina fault slip and YTU exhumation coincided with a three-fold decrease in northward plate velocity during the demise of Kula–Pacific plate spreading. Major dextral slip subsequently migrated south onto the Denali and Fairweather faults, which bound a region where younger exhumation due to Oligocene–recent Yakutat flat-slab subduction is widespread. Overall, this study attests to the utility of detrital apatite thermochronology in mapping the evolving footprints of middle and upper crustal exhumation during successive tectonic regimes (i.e., collision, extension, strike-slip).

Thermal history, exhumation, and landscape evolution of the Goodpaster district, eastern Alaska

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The Goodpaster district in Alaska's Yukon-Tanana upland is host to numerous Au and critical mineral-bearing mineralized systems. Among these is the ~8 Moz Pogo Au deposit and several Au-Bi-Te(-As, Sb) prospects that define a ~50 km-long, east-west transect. Revised deposit models suggest mineralization at shallower paleodepths than previously inferred, motivating development of new constraints on probable geological and landscape evolution scenarios influencing exhumation and preservation of mineralization. We present new zircon and apatite (U-Th)/He (He) dates from 17 samples collected along the mineralization transect. Sample spatial distribution, date patterns, and apatite He date-effective uranium (eU) trends define two sample groups. Most samples (N=13; Group I) have mean zircon and apatite He dates of ~95-80 and ~65-55 Ma, respectively, and exhibit a well-defined, positive apatite He date-eU trend from ~35 Ma at ~5 ppm eU to ~65 Ma at ~125 ppm eU. Group II samples (N=4) lie within an ~10 km-wide swath centered on the Pogo mine, have mean zircon and apatite He dates of ~40 and ~60 Ma, and exhibit invariant apatite He dates from ~50 to >400 ppm eU.
Thermal history inversions of Group I samples are compatible with rapid cooling (≥10 °C/Myr) of the broader Goodpaster district from ~75-60 Ma to temperatures <60 °C, followed by slow cooling (≤1 °C/Myr) to the present day. Rapid cooling is coeval with regional deformation along NE-trending fault systems and magmatism. This cooling may reflect a combination of exhumation in response to documented upland-wide, ~east-west Late Cretaceous extension and post-magmatic cooling. Group II inversions suggest rapid cooling near Pogo at ~40 Ma, overlapping a date mode in regionally distributed apatite fission-track data. The origin of this thermal event is cryptic, but may reflect younger exhumation (possibly fault-related, given the sharp gradation between Group I and II samples) and(or) reheating during fluid flow.
Episodes of rapid cooling post-date ~104 Ma mineralization, but give insight to post-mineralization tectonic and geomorphic processes influencing present-day mineralization exposure. Assuming probable paleogeothermal gradients of 30-45 °C yields post-mineralization exhumation of ~3-5 km across the Goodpaster district, although these estimates are potentially confounded by nonmonotonic cooling. As an alternate approach, low-eU apatite grains delimit the thermal history down to ~40 °C, which we leverage with topographic swath profiles, paleosurface constraints from volcanics in nearby paleovalleys, and numerical models of topographically-influenced crustal thermal structure to infer ~0.5-1 km of exhumation and slow relative relief reduction over the Cenozoic.

Age and emplacement depth of Jurassic to Paleocene intrusions in the southern Omineca belt, southeastern British Columbia

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The tectonic history of the Omineca belt of the southeastern Canadian Cordillera is constrained by synorogenic intrusions emplaced between the Middle Jurassic and Eocene. These intrusions provide depth-time pins in the evolution of the crust during Cordilleran orogenesis. Despite their importance for understanding cordilleran geology, many of these have not been dated and their depth of emplacement not estimated. To address this, 17 new U-Pb in zircon LA-ICP-MS ages from 12 intrusions are presented from across the region. These new ages are combined with existing geochronology data from other intrusions to provide a new map detailing the relationship between magmatism and regional geology. These new data include a ~164 Ma age from the Jurassic Kuskanax batholith, lowering the maximum age of Jurassic plutonism to after the onset of Jurassic orogenesis. New ages from Cretaceous intrusions have elucidated two distinct phases of magmatism at ~100 and ~76 Ma. The Fry Creek batholith and adjacent Shoreline stock, previously considered to be emblematic of the Bayonne suite, have dates between ~60 and 65 Ma. They form part of a newly identified phase of Paleocene magmatism in the region. The compiled intrusion ages were then combined with estimates of emplacement depth determined from contact aureoles developed in pelitic host rocks. Jurassic intrusions mainly have staurolite + andalusite-bearing contact aureoles (3.3-4.0 kbar; ~12.5 - 15 km depth), whereas Cretaceous and Paleocene intrusions mainly have andalusite + cordierite-bearing contact aureoles (2.3 – 2.9 kbar; ~8.5 - 11 km depth). These data indicate systematic regional exhumation of 2-6 km during Middle Jurassic to mid-Cretaceous orogenesis.

Crustal thickness of the Quesnel terrane constrained by the petrology of the Late Triassic to Early Cretaceous Hogem batholith and its host rocks

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A better understanding of petrological controls on magmatic critical metal (e.g., Ni-Cu-PGE) and porphyry mineralization in convergent margin settings is intimately tied to a deeper understanding of the overall tectono-magmatic setting of the rocks that host the mineralization. Here we interrogate the tectono-magmatic evolution of the northern Hogem batholith, a multi-phase intrusive complex that was episodically emplaced into north-central Quesnellia over nearly 100 million years (Late Triassic-Early Cretaceous). The Hogem batholith comprises at least five distinct phases that intruded the Late Triassic Plughat Mountain succession (Nicola Group): 1) ca. 220 Ma ultramafic-mafic Abraham Creek complex; 2) ca. 207-194 Ma Thane Creek suite, comprising diorite to quartz monzodiorite and subordinate hornblendite; 3) ca. 182-174 Ma Duckling Creek suite comprising biotite hornblende clinopyroxenite and 2-feldspar syenite; 4) <160 Ma Osilinka suite leucogranite; and 5) ca. 135-127 Ma Mesilinka suite tonalite to leucogranite. Using whole-rock and amphibole geochemistry of both the host volcanic rocks and the ca. 220-125 Ma plutonic rocks we provide qualitative and semi-quantitative constraints on temporal changes in crustal thickness of the Quesnel terrane and the ensuing composite margin at the latitude of Hogem batholith. Our results suggest that the thickness of Late Triassic-Early Jurassic intra-oceanic Quesnel arc, during the time of most prolific magmatic and porphyry mineralization, was ≥35 km, consistent with the well-documented association between porphyry Cu deposits and thick volcanic arcs.

Eclogite and garnet amphibolite in the Big Salmon Range, southern Yukon

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Permian (Guadalupian-Lopingian) eclogite has been documented in a number of localities near the interface between Yukon-Tanana terrane and the ancestral continental margin in the Northern Cordillera. While there is considerable uncertainty over the geometry, extent and structural position of the Permian high pressure belt, eclogite facies metamorphism has generally been interpreted to record subduction associated with closure of the Slide Mountain ocean.

In Yukon, Permian eclogite has hitherto been documented in three regions — in the St. Cyr klippe, the Faro – Ross River area, and at a single isolated locality in the northern Big Salmon Range. The two former regions cooled rapidly after eclogite facies metamorphism and have not been subsequently reheated or penetratively deformed. In contrast, the Big Salmon eclogite, which has undergone extensive hydration, is located in a region that underwent further deformation and metamorphism during the Early Jurassic.

Recent bedrock mapping of part of the southern Big Salmon Range has led to identification of a narrow belt of highly deformed garnet-bearing rocks, including lenses of garnet amphibolite. Garnet contains abundant rutile inclusions, while rutile in the matrix is typically surrounded by rims of titanite. The matrix of the garnet amphibolite is otherwise composed of green amphibole, plagioclase, quartz, white mica and clinozoisite. Zircon was separated from three samples of garnet amphibolite for LA-ICP-MS and CA-TIMS U-Pb geochronology. In each case, metamorphic zircon yielded precise Guadalupian dates. Trace element concentrations in zircon substantiate the interpretation that Permian zircon growth accompanied formation of garnet and rutile-bearing assemblages. Pennsylvanian zircon in two of the samples also records the age of the protoliths, which have the geochemical characteristics of mid ocean ridge basalt. One of the samples experienced further zircon growth during the Middle Triassic; the age of this zircon is identical to that of an adjacent metagabbro and grew as a result of contact metamorphism.

Occurrences of eclogite and garnet amphibolite in the Big Salmon Range define a narrow belt, interpreted as a discrete thrust sheet, which can be traced for > 150 km along strike. It is separated from rocks of the Cassiar platform (ancestral North America) by a belt of greenschist facies, oceanic mafic rocks. The geochronology presented here supports the interpretation that the Big Salmon range hosts the root zone of an eclogite facies thrust sheet, which is exposed as a klippe in the St. Cyr Range to the northeast. The talk will consider the regional extent of this thrust sheet and implications for tectonic reconstructions of the northern Cordillera.

Cenozoic faulting in southeastern Yukon constrained by low-temperature thermochronology

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The Upper Hyland fault (UHF) in the Selwyn Fold Belt is one of a major network of Cretaceous N-NW-striking dextral faults in the Northern Canadian Cordillera. However, kinematic and temporal constraints on the evolution of this and other Cretaceous and younger structures in this region are lacking. Here we use low-temperature thermochronology and inverse thermal history modeling to quantify the timing and magnitude of exhumation in the Upper Hyland valley and to investigate the relationship between exhumation and faulting. We sampled mid-Cretaceous plutons that straddle the UHF, as well as the Shannon fault and the Hyland Valley fault (HVF). These faults are oblique to, and are inferred to connect with, the UHF.

We applied apatite and zircon (U-Th)/He and apatite fission-track thermochronology to 31 samples. We present 20 new apatite (U-Th)/He ages, 15 new apatite fission-track ages, and 18 new zircon (U-Th)/He ages. Apatite (U-Th)/He ages range 101–41 Ma, apatite fission-track ages range 86–45 Ma, and zircon (U-Th)/He ages range 97–51 Ma. Young sample ages were obtained from rocks southwest of the Shannon fault. Samples adjacent to the HVF are generally characterized by highly-dispersed single-grain apatite (U-Th)/He dates and inverted apatite (U-Th)/He and apatite fission-track ages. Inverse thermal history modeling is compatible with a pulse of rapid cooling (~13 °C/Myr) in the inferred hanging wall of the Shannon fault. A coeval rapid cooling pulse is modeled near the inferred branching of the UHF and HVF. Thermal history models for samples on both sides of the UHF show protracted Cenozoic cooling rates, suggesting that differential exhumation across the UHF has not occurred in the Cenozoic.

Our working model is that Cenozoic exhumation in the Upper Hyland valley was driven by renewed dextral motion on the UHF. This displacement also reactivated the Shannon fault as a reverse fault, resulting in 3–5 km of hanging wall exhumation. The timing of fault reactivation, ca. 60–50 Ma, is coeval with dextral displacement on the Tintina fault, which strikes roughly parallel to the UHF and is located ~150 km west of the Upper Hyland valley. We suggest that early Cenozoic development of the Tintina fault reactivated pre-existing structures in the Upper Hyland valley. Faulting in the Upper Hyland valley ceased in the early Eocene, possibly due to strain localization along the Tintina fault.

Contact Metamorphism and Emplacement Depth of the Wragge Creek Stock, Southeastern British Columbia

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The contact metamorphism around the Wragge Creek stock within southeastern British Columbia been explored. The Wragge stock, located 10km north of New Denver, is a Mesozoic quartz monzonite-diorite intrusion that is emplaced in regionally metamorphosed sedimentary strata just north of the Valhalla Core Complex. The intrusion extends across the Slocan Lake Fault to the east, but it is unclear if the fault cuts the intrusion or vice versa. Mineral assemblages of the Wragge Creek stock contact aureole previously have been minimally documented. Investigating the mineral assemblages of the contact aureole allows for interpretations to be made regarding some or all of its emplacement depths, the interplay between the contact and regional metamorphism of the area, and whether emplacement occurred before, during, or after the Slocan Lake Fault.

Field work was conducted over the summer of 2023. Of 68 samples collected of the contact aureole, 22 were chosen for more detailed investigation. On the western side of Slocan Lake, the mapped mineral assemblages reveal an andalusite±cordierite isograd north of the stock, whereas south of the stock, close to the Valkyr Shear Zone, the aureole is less distinct owing to the higher regional metamorphic grade. On the eastern side of Slocan Lake, rafts of country rock in the stock contain andalusite. The presence of andalusite in the aureole on both sides of the lake suggests either emplacement of the stock across (later than) the Slocan Lake Fault, or modest displacement on the fault if the fault is later or coeval with emplacement of the stock.

Petrogenetics of intrusion-related gold systems in the Rogue and Olympus plutonic complexes, eastern Selwyn basin, Yukon Territory

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The mid- to Late-Cretaceous Tombstone-Tungsten belt (TTB) is characterized by several magmatic suites emplaced inboard of the active western margin of the North American continent. In the Selwyn basin of Yukon Territory, the ca. 96-93 Ma Mayo plutonic suite hosts most of the known economic gold deposits related to the TTB. However, several mineral occurrences are inferred to be related to plutons of the ca. 92-90 Ma Tombstone plutonic suite. In this study, we evaluate the petrogenetic characteristics of 19 intrusions from the Rogue and Olympus plutonic complexes using whole rock major and trace elements geochemistry and U/Pb zircon geochronology. Our results indicate that a combination of mafic, intermediate, and felsic intrusive lithologies form two distinct fractionation paths herein named group A and B. Group A is characterized by diorite, granodiorite, and granite plutons and host the most prospective intrusion-related targets in this dataset. Group B is characterized by higher Na + K, Rb and La monzonite, syenite, and granite lithologies. While both magmatic suites have similar crystallization ages, the plutons that form group A are interpreted to be part of the Mayo plutonic suite, whereas the Group B plutons are interpreted as part of the Tombstone plutonic suite which indicates that the Rogue and Olympus plutonic complexes recorded a complex and co-temporal magmatic evolution.

Exhumation response of a continental margin to boundary tectonics: Low-temperature thermochronology study of southern Vancouver Island, Canada

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At ca. 50 Myr ago, Vancouver Island, within the Wrangellia Terrane, was located outboard the triple junction of Kula-Farallon-North America plates and experienced ridge subduction which triggered the formation, accretion and passage of oceanic plateaux. Sited at the oceanic-continental transition, Vancouver Island provides a natural laboratory to study the exhumation response of continental margins to terrane accretion and convergent boundary tectonics since the Eocene. We investigate the Cenozoic exhumation of Wrangellia on southern Vancouver Island using low-temperature thermochronology. We report Paleocene to Eocene (22.5 to 85.4 Ma) apatite fission track ages (AFT) and, for the first time, Oligocene to early Miocene (19.8 to 36.6 Ma) apatite (U-Th)/He ages (AHe) for 16 igneous bedrock samples. The thermal history modelling of these ages shows mainly fast cooling during the Eocene to Oligocene (>3.4°C/Myr) followed by very limited cooling since the early Miocene (<1.4°C/Myr). The fast-cooling stage from the Eocene to Oligocene is explained by oroclinal bending and the exhumation of southern Vancouver Island in response to accretion of Siletzia following ridge subduction. The development of Olympic orocline since the early Miocene has been accommodated mostly by the bending within the Olympic core and by faulting on the limbs, leading to less shortening deformation and deceleration of exhumation of southern Vancouver Island on the northern limb. Other proposed exhumation mechanisms for southern Vancouver Island as being driven by the passage of Yakutat terrane, slab window heating and near-trench magmatism do not provide a robust explanation for the AFT and AHe ages.

Magma source rocks in the western Mackenzie Mountains, northern Canadian Cordillera: implications for the basement

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The crustally derived mid-Cretaceous Tungsten Plutonic Suite (TPS) in the western Mackenzie Mountains of the northern Canadian Cordillera is responsible for several of the world's most important tungsten resources. While determining the melt and metal source of the TPS and associated mineralization has obvious implications for metallogenic models and regional exploration, it also provides tangible information on the age and affinity (i.e., infracrustal vs supracrustal) of basement rocks, which are not exposed in the region and are poorly understood as a result. Recent detrital zircon studies have improved our knowledge of exposed supracrustal packages, including those interpreted to underlie the western Mackenzie Mountains, and provide the background needed for a study of inherited zircon age distributions in the TPS.

Inherited zircon ages (n = 320) and corresponding Lu–Hf isotopic compositions (n = 204) for the TPS have a dominantly northwest Laurentian signature, with dominant age populations at 1750–2150 and 2500–2800 Ma, and small populations each comprising 5% or less of the data at 1000–1200, 1400–1700, 2200–2450, and 2900–3100 Ma. Cross-correlation statistical analysis, multidimensional scaling, and whole rock neodymium isotopic compositions indicate that mid-late Cambrian sedimentary rocks are the most likely melt source for the TPS magmas. These strata were likely derived from depositional mixing of reworked older material (previously deposited along the continental margin) and Cambrian volcanic detritus. Additional whole rock Sm–Nd isotopic work on mudrocks, and U–Pb and Lu–Hf analysis on zircons from sandstones for latest Proterozoic to Ordovician strata in the region is underway to test this interpretation.

The TPS forms a narrow ~200 km long belt roughly paralleling the interpreted ancient continental margin. The depth of the MOHO below this belt (35-40 km), and the estimated emplacement depths for the exposed TPS plutons (8-10 km) together imply that the crust was up to 50 km thick in the region during the mid-Cretaceous. A general lack of magmatic muscovite in the TPS plutons indicates anatexis was dominated by biotite-dehydration melting, requiring paleodepths of 25–30 km and placing the source rocks to these magmas within the middle crust. The mid- to late Cambrian melt source for the TPS is significantly younger than geophysical interpretations have suggested for the middle crust and, therefore, may necessitate modifications to our understanding of the crustal architecture below the western Mackenzie Mountains.

CROSS STRUCTURES, the SKEENA ARCH and GEOLOGIC DOMAINS OF THE STIKINE TERRANE

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Stikinia is the largest allochthous terrane in the British Columbia Cordillera. In the geologic literature, the Stikine Terrane has generally been treated as a homogeneous geologic terrane with respect to its position and role in the geologic evolution of the North American Cordillera. This presentation attempts to show that the varied geology of Stikinia may be divided into three distinct geologic domains, separated by two north-east trending cross-structures and a transverse zone, the Skeena Arch. Evidence for the cross structures are marked regional and local geologic contrasts between the three proposed domains.

Stikinia is defined by Middle Jurassic and older units: Middle and Lower Jurassic Hazelton Group, Upper Triassc Takla/Stuhinni Group and Mississipian to Permian Stikine Assemblage. These units are termed the Basement Assemblages. Stikinia as an allochthonous terrane terminated by collision with the craton in the late Middle Jurassic, initiating mainly eastern-sourced sediments to be deposited onto Stikinia, defining the Overlap Assemblages.

The Overlap Assemblage comprises Callovian to mid-Cretaceous units: Callovian to Oxfordian Ashman Formation and the Upper Jurassic to mid-Cretaceous Bowser Lake and Lower Cretaceous Skeena groups. During the mid-Cretaceous (Albian), the Rocky Ridge felsic volcanics of the Skeena Group foreshadow termination of the Overlap Assemblages. Post Overlap Assemblages include: the Upper Cretaceous Kaslka Group volcanics, Bulkley Intrusive Suite and sedimentary Sustut Group, followed after a hiatus, the Eocene felsic Ootsa Lake and mafic Endako groups and the Central Gneiss, Tatla and Vanderhoof metamorphic core complexes. The post-Overlap Assemblages are here referred to as the Laramide-age Assemblages (+/-100-40 Ma).

The three proposed domains or sub-terranes are roughly coincident with the northern, central and southern Stikinia and respectively referred to as Domains A, B and C. Domain A is underlain by Basement and Overlap Assemblages. Domain B is overlain by Basement, Overlap and Laramide-age assemblages and Domain C is overlain almost solely by Eocene phases of the Laramide-age Assemblages.

The Nass-Sustut cross structure separate domains A and B. The Blackwater cross structure separate domains B and C. The Skeena Arch transverse zone lies within the northern part of Domain B. The Arch was a hinge-zone for Lower Jurassic to Eocene geologic changes in Domain B. Laramide-age mineralization is highly restricted to Domain B, from the Nass-Sustut cross structure to the Blackwater cross structure.

Is the Bourgeau (MacDonald) Thrust a major fault in southeastern British Columbia and northern Montana?

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The Bourgeau Thrust is a major fault in the southern Canadian Rockies. It is clearly defined in outcrop over a distance of ca. 345 km between its northern termination at 52° 45’ N latitude near Maligne Lake in Jasper National Park and a location to the south near Elkford, BC, in the Elk River Valley at 50° 10’ N, where the fault loses stratigraphic displacement and juxtaposes Jurassic Fernie Formation against Fernie Formation. Although there is no compelling outcrop information that indicates a major fault is present to the south of Elkford, some geological compilation maps show the fault continuing to the south along the Elk River Valley and connecting with the MacDonald Thrust, which has been mapped as far north as 49° 22’ N. Other maps do not continue the fault to the south.

Interpretation of reflection seismic data located near Elko, British Columbia, near the northernmost mapped trace of the MacDonald Thrust, indicates that there is a significant amount of thrust displacement, potentially tens of kilometres, on the fault. This conclusion is unexpected, and is not obvious from outcrop information alone, as there is minimal stratigraphic separation across the fault at the surface. Large displacement thrusts typically have substantial lateral extents in map view and the favoured interpretation is that the MacDonald Thrust is the southern continuation of the Bourgeau Thrust.

One of the factors that complicates recognition of the Bourgeau (MacDonald) Thrust using outcrop information is that the hanging wall is interpreted to be wedged into a detachment within Jurassic Fernie Formation strata in a triangle zone (passive roof duplex), herein called the Elk River triangle zone, developed along the west flank of the Fernie Basin near the towns of Fernie and Sparwood. As a result of the triangle zone geometries, the Bourgeau (MacDonald) Thrust may be a blind thrust that is buried below imbricated Jurassic Fernie Formation strata, and not exposed at surface over significant distances.

Several structural scenarios have been investigated using the Elko seismic and additional seismic profiles to the south in southern British Columbia and northern Montana. The minimum interpreted displacement on the Bourgeau (MacDonald) Thrust in this region is 25 km; displacements of 80 km or more are possible. The displacement thus could be comparable with that of the Lewis Thrust, which has traditionally been considered to be the largest thrust in the southern Canadian Rockies.

Upper plate response to transient changes in subducting plate geometry: An example from the central Andes

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The central Andes hosts the largest plateau formed in a non-collisional setting and is taller, wider, and has thicker crust and higher magnitude shortening than any other location in the Andes. It has experienced widening and contraction of the magmatic arc along with deposition of some of the thickest Cenozoic stratigraphy in the Andes. Multiple hypotheses, including both upper and lower plate effects, have been advanced to explain these anomalous characteristics, yet a detailed plateau-scale basin history remains unavailable and therefore has not been integrated into the better known deformation and magmatic history. Here we synthesize new detrital zircon-based stratigraphic ages for non-marine strata from ~15°–16.5°S with existing records of sediment accumulation, deformation, and magmatism from ~14°–26°S to develop a model of the Eocene–early Miocene evolution of the plateau. Chronostratigraphy shows an unconformity/condensed section that becomes younger to the south at a rate of ~0.35°/Myr. The resumption of rapid sediment accumulation and age of introduction of Eastern Cordilleran detritus young to the south at a rate of ~0.35°/Myr, with rapid sediment accumulation resuming at 46–43 Ma at 15-16°S but as young as 36 Ma at 18°S and 19 Ma at ~23°S, and proceeds in lockstep with both the initiation of exhumation in the Eastern Cordillera and also a magmatic lull and widening of the magmatic arc followed by magmatic flare-up.
Because the upper plate configuration remained unchanged between the onset of orogenesis in the Late Cretaceous and this late Eocene–Oligocene flat slab episode, we attribute these major changes in the cordilleran margin to lower plate processes. We propose a model in which initial slab flattening was driven by late Paleocene–early Eocene subduction of buoyant oceanic crust: potentially a Manihiki Plateau Conjugate. Subsequent southward shallowing and resteepening of a late Eocene–early Miocene flat slab beneath the Altiplano-Puna Plateau, driven by subduction of an asperity on the Nazca Plate which we tentatively identify with the Juan Fernandez Ridge, resulted in the stratigraphic hiatus, along with magmatic migration and flare ups, orogenic widening, tectonic rotations, and high-magnitude shortening. All of these conditioned the crust for later surface uplift of the CAP. Similarities with the Cretaceous evolution of the North American Laramide province point to the transportable nature of this model.

New constraints from the Challis-Kamloops Group on crustal evolution during Early Eocene extension in southeastern British Columbia and northeastern Washington

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Southern British Columbia and northern Washington underwent profound post-orogenic extension, mid-crustal exhumation, basin formation and magmatism in the early Eocene. This is recorded in the volcanic and sedimentary rocks of the Challis-Kamloops Group. High-grade metamorphic exhumed core complex infrastructure has been studied in great depth, but much less so the associated supradetachment basins. Chronologic ties between core complex footwall and hanging wall, and the regional chronostratigraphy of the supradetachment basins have not been established with high precision. Vigorous debate continues over geodynamic drivers of post-orogenic extensional collapse.

To better understand geodynamic drivers of early Eocene lithospheric collapse, we are taking a three-pronged approach to providing new regional constraints on crustal evolution, which include utilizing CA-ID-TIMS U-Pb zircon geochronology to refine regional chronostratigraphy of the supra-detachment basins, geochemical estimation of crustal thickness, and new whole-rock geochemical constraints on the evolution of magmatism. Twelve new high-precision ages help to refine the regional chronostratigraphy, previously constrained using lithostratigraphy and low-precision K-Ar geochronology. Combining these three methods at the regional scale will help elucidate the spatial and temporal distribution of lithospheric extension, magmatism and sedimentation and the contribution of various geodynamic mechanisms throughout the extensional period.

Results to date indicate that crustal thickness reached a maximum of ~62 km and paleoelevation ~4.9 km prior to the onset of crustal collapse. Our new ages, when integrated with extant regional U-Pb geochronology, support extensional collapse in two (or more) distinct phases consistent with data from the footwall domain. The first and larger was between ~52.1 and ~50 Ma with total crustal thinning of ~18-20 km, associated with ductile-brittle detachments. A second brittle low-angle normal fault phase with 7-10 km of thinning occurred between ~49 Ma and ≤46.2 Ma. The basal "O'Brien Creek" or "Kettle River" tuff comprises at least three eruptive events over 360 kyr. In the hyperextended region, volcanism in the central Republic Graben appears to have preceded the westerly White Lake Basin or easterly Priest River Complex.

All aligned on the western front of North America? – Present-day deformation in the diffuse plate boundary zone of Alaska-Canadian Cordillera

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The tectonically active region of Alaska and the Canadian Cordillera is characterized by diffusively distributed seismicity across generally hot and thin lithosphere. These complex lateral variations in stress and strain are poorly understood. To understand the interplay of potential tectonic driving forces we compare the crustal stresses (World Stress Map data) and geodetic strain fields (GPS velocities) with stress fields generated by plate boundary forces, gravitation-induced body forces, and the upper mantle drag at the base of the lithosphere. First, we derive the fields of the potential driving forces by modeling the plate boundary forces using the relative motion across 7 plate boundaries, the mantle tractions from SKS-shear wave splitting, and the buoyancy forces from stress inversion of the gravitational potential energy field. We then transform the modeled and the observed stress fields into a coordinate reference frame of their first-order source—the plate boundary forces. This allows the stress orientations to be analyzed statistically and spatially without being affected by angular distortions.
We show that most of the stress field orientations in Alaska and the Canadian Cordillera are significantly aligned with the trajectories of plate boundary forces. The stresses particularly to the south and west of the Kaltag-Tintina Fault and the Rocky Mountain Trench are parallel to collisional and tractional forces emanating from the convergent and transform plate boundaries. Anomalies occur to the north and east of this fault system where crustal stresses parallel (i) gravity-induced stresses in the Brooks Range, and (ii) trajectories of the Arctic-Atlantic ridge-push in the Cordilleran foreland belt (e.g. Mackenzie Mountains and Rocky Mountains). A major anomaly in the area between the Cascadian subduction zone and the Rocky Mountains Trench is characterized by compressional stresses oblique to the convergence between the Juan de Fuca plate and North America. We show that the oblique Cascadian plate boundary causes strain partitioning into thrusting and sinistral strike-slip in the fore-arc and the back-arc regions, respectively. Moreover, the back-arc stresses are aligned with buoyancy forces and pre-existing lithospheric-scale structures.
Mantle drag trajectories are parallel to crustal stresses and geodetic shortening only in a narrow zone along the plate boundaries, indicating a minor contribution to the observed stress and strain field. We demonstrate that stress and strain patterns in a diffuse plate boundary zone are dominated by plate boundary forces that are locally modified by the plate boundary geometry and superimposed buoyancy stresses.

Upper Crustal Exhumation History of the Intermontane Belt in the Southern Canadian Cordillera

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The Canadian Cordillera, situated along the western edge of the ancestral North American craton, underwent significant tectonic changes marked by crustal thickening and subsequent extension. These processes began in the Early Jurassic, leading to considerable NE-SW horizontal shortening by the Cenozoic. The southern Canadian Cordillera experienced notable compression and crustal thickening, reaching an estimated total thickness of around 50-60 km. Major crustal thickening concluded by the late Paleocene (58 Ma), followed by post-orogenic extensional collapse. The extension of the crust involved normal faulting in the brittle upper crust and the ductile thinning of the mid- to lower crust. The Intermontane belt, one of five morphogeological belts of the Cordillera, is in central BC and comprises an amalgamation of smaller island arc terranes. This belt consists of low-relief plateaus and highlands positioned between two high-relief, rapidly exhumed mountainous belts known as the Coast belt to the west and the Omineca belt to the east. The geology of the Intermontane belt is dominated by sub-greenschist to greenschist facies late Paleozoic to Mesozoic volcanics and sedimentary rocks, overlain by Neogene to recent basalts.

In this study, we investigate an area spanning from the Coast Mountains to the Columbia Mountains, with a specific focus on the region between approximately 50° and 53°N. Our primary aim is to compile published low-temperature thermochronology data to observe a larger-scale transect crossing the Coast, Intermontane, and Omineca belts, as well as three regional transects in the Intermontane Belt. An extensive published literature review reveals that most of the data focuses on AFT and K-Ar dating in the study area and primarily targeted areas within the Coast and Omineca Belts. In contrast, there is limited data from the Intermontane Belt which primarily focuses on energy resources.

Our study aims to identify vertical movements in the upper crust and analyze the cooling ages of the rock by presenting newly acquired multi low-temperature thermochronology data. We use apatite (U-Th)/He (AHe), apatite fission track (AFT), and zircon (U-Th)/He (ZHe) thermochronometers to gain cooling information within 250–40 °C, representing the top 10–2 km of the crust. We dated 14 samples collected along three east-west transects within the southern Intermontane belt. We present 10 new AHe sample ages derived from 65 single-grain AHe dates, 12 new AFT ages, and 12 new ZHe sample ages from 30 single-grain dates.

Mineral and rock compositional constraints on the petrogenesis of Seventymile and Kanuti ophiolites, Alaska

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New bulk-rock and mineral chemistry and isotopic data provide key evidence of the styles and extent of melt depletion and melt-rock reaction history in ophiolitic rocks from interior and eastern Alaska, providing key constraints on tectonic evolution and terrane accretion. Two suites, the Seventymile and Kanuti mafic/ultramafic (M/UM) complexes, are thought to be dismembered ophiolite components thrust over ancestral North America. Both suites contain variably serpentinized ultramafic and low-grade meta-mafic rocks, and minor components of oceanic sedimentary rocks (argillite, chert, limestone and metasandstone). Ultramafic rocks dominate both localities, typically harzburgite with minor lherzolite to dunite. Pyroxenite is common in the Kanuti complex; but rare in the Seventymile complex. Mafic rocks from each suite include gabbro and diabase, typically as dikes, veinlets, or rare massive stocks intruding peridotite. Volcanic rocks present at both suites are typically greenschist altered but rarely seen in contact with underlying intrusive rocks, and the link between them is poorly understood.
Trace element and isotope systematics from mafic igneous rocks associated with the Seventymile and Kanuti complexes lack evidence for subduction-modified mantle, with a few exceptions. Both complexes contain a depleted upper mantle component that overlaps with Pacific MORB. Two Kanuti mafic samples define an array to slightly lower εNd (±εHf), indicating at least some enrichment of the Kanuti depleted source. Spinel compositions from lherzolite to harzburgite in both complexes resemble those from abyssal peridotite. Some high-Cr exceptions are usually symplectite rims on lower-Cr pristine cores or have textural and/or compositional evidence of complete melt- or fluid-rock reaction. Spinel compositions in both complexes indicate harzburgites are residues of partial melting (Seventymile ~16%, Kanuti ~14%). Clinopyroxene Cr and Mg compositions in lherzolite from both complexes, and in harzburgite from the Kanuti complex, resemble those in abyssal peridotite, but clinopyroxene in Seventymile harzburgite is more depleted, resembling suprasubduction types. Yet, clinopyroxene trace element trends in both complexes are consistent with mostly dry melting of abyssal peridotite. Chromitite and high-Cr dunite, common in the Kanuti but not Seventymile complex, are atypical of mid-oceanic ridge settings, but are found in forearc ophiolites, and their mineral compositions suggest they are likely reaction products (e.g. with silicic melts), rather than residues of extreme partial melts. In total, new mineral and bulk-rock data show that M/UM complexes bounding ancestral North America have compositional affinity with oceanic lithosphere formed at mid-oceanic ridges, but were possibly modified by suprasubduction processes, potentially in a forearc environment.

Investigation of mica fish in deformed rocks using *in situ* Rb-Sr geochronology

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Understanding the role temperature and/or deformation play in affecting the diffusion of radioisotopes out of mineral phases is vital for interpreting what spot dates collected by *in situ* geochronologic methods (i.e. U-Pb, Ar-Ar) record (i.e. crystallization, cooling, or deformation). To date, little study has focused on the distribution of beta-decay isotopic systems (e.g., Rb-Sr) within minerals relative to other chronometers. This dearth of information reflects historical dating methods for beta-decay chronometers require dissolution and subsequent column chemistry to overcome isobaric overlaps in parent and child isotopes, which destroys textural context. Recently developed methods using new multi-mass spectrometer systems with reaction cells, however, now allow *in situ* Rb-Sr dating of K-bearing phases at a high spatial resolution (i.e. ~50 microns). This advancement makes mica phases prime candidates to investigate the effects of deformation on radio-isotope systems as they are common rock-forming minerals that readily deform across a wide range of crustal conditions.

The purpose of this study is to determine the role deformation may play on the systematics of Rb-Sr in mica phases. To do this, biotite and white mica porphyroclasts in deformed specimens that reflect different deformational conditions were mapped by electron backscatter diffraction, electron microprobe, and LA-ICP-MS and dated via *in situ* Rb-Sr geochronology. Matrix mica in each specimen was also dated. Within the specimen that records the highest apparent deformation conditions (i.e. quartz grain-boundary migration), analyses of two biotite porphyroclasts define different isochrons, one at ca. 926 Ma and one at ca. 900 Ma. The younger isochron overlaps the date defined by matrix biotite (ca. 892 Ma). In two intermediate deformation condition specimens (i.e. quartz sub-grain rotation) both porphyroclasts and matrix mica define single Rb-Sr populations (ca. 403 Ma, ca. 250 Ma). Biotite and white mica fish and matrix grains in the lowest temperature deformation specimen (i.e., quartz sub-grain rotation to bulging) do not comprise single Rb-Sr populations. White mica Rb-Sr data spreads between ca. 70 and 135 Ma while biotite spreads between 25 and 63 Ma. Despite evidence of deformation and compositional differences within mica porphyroclasts, there are no defined correlations to trends in Rb-Sr dates across the specimens examined.

Geologic mapping of the Yukon-Tanana Upland: Working towards an improved regional framework

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As part of the U.S. Geological Survey's Earth Mapping Resources Initiative (Earth MRI), the Alaska Division of Geological & Geophysical Surveys (DGGS) is working to complete modern and detailed geologic, geophysical, geochemical, and geochronology datasets covering the mineral-rich Yukon-Tanana Upland (YTU). This region of eastern Interior Alaska lies between the Tintina and Denali faults and is underlain by structurally complex metamorphic rocks affiliated with both the allochthonous Yukon-Tanana Terrane and parautochthonous North America. These rocks experienced post-metamorphic magmatism spanning Permian through Cenozoic time, followed by block faulting and localized sedimentary basin development during the Late Cretaceous through Cenozoic. Mapping and understanding these geologic elements—especially those that impact the YTU's mostly Cretaceous economic mineral systems—is the focus of DGGS's research in the area.
Our understanding of the chronology, chemistry, and spatial distribution of post-metamorphic magmatism has progressively improved during the past 20 years as USGS and DGGS have added new zircon ages and whole-rock analyses to the YTU dataset. Consequently, we are working to define or refine (and ultimately formalize) named plutonic suites using specific age and compositional criteria. Developing this nomenclature is a key part of making more informative geologic maps, regional interpretations, and cross-border geologic reconciliations.
This poster presents an overview of our growing Yukon-Tanana Upland geological and geophysical datasets, along with proposed plutonic suite names and definitions, for the purpose of seeking feedback and discussion from workshop participants.

Exhumation History of Hogem Batholith, Quesnel Terrane, North-Central British Columbia Constrained by Apatite Fission Track Analysis

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The Hogem Batholith intrudes volcanic-arc rocks of the Quesnel terrane (Late Paleozoic and the Mesozoic) of the Canadian Cordillera, north-central British Columbia. This batholith comprises four intrusive suites characterized by compositional and chemical diversity, with emplacement ages ranging from 207 to 125 Ma. The distinctive petrology of this area is considered to be closely related to the tectono-thermal evolution of the Quesnel terrane since the Late Mesozoic.
We present apatite fission track (AFT) ages from six bedrock samples and track length distribution data from four bedrock samples from the four intrusive suites, aiming to reconstruct the post-emplacement evolution of the batholith. Thermal history modeling of the AFT data indicates that, following the initial cooling of the batholith, the samples resided in the AFT partial annealing zone or experienced reheating until the Eocene. Since the Early Eocene, the samples were slowly exhumed to the shallow level of the crust. The thermal and exhumation histories of the batholith reflect the deformation of the terrane when the Pacific Plate subducted beneath the North American continent. Lastly, no further major tectonic movement has occurred since the Early Eocene in the area, and the Hogem Batholith has undergone cooling to the present.

Glacial and fluvial controls on the landscape evolution of Southern Canadian Rocky Mountain fold and thrust belt

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The present-day landscape of Southern Canadian Rocky Mountains is a product of the interaction among tectonics, lithologic resistance, and surface processes including erosion by rivers and glaciers. Rivers have adjusted to the orogeny-associated structures, regional tectonic uplift and growing terrain slope, and post-orogenic, extensive glaciation by modifying their channel profile and planform geometry. Understanding the relationship between fluvial and glacial erosion is crucial, as not only does it reflect the landscape's sensitivity to the climate change, but also because it can indicate whether glacier-driven river system alterations can cause significant basin reorganization. The controls of glacial erosion, drainage divide evolution, and resulting stream capture, still form a significant research gap in landscape evolution studies. Due to an extensive glaciation history, the Canadian Rockies provide an excellent opportunity for understanding the progression of subglacial channel network geometry and related basin reorganization. This study aims to evaluate glacial headwall erosion processes in glaciated headwaters through progressive divide lowering, lateral migration, and stream capture. We remotely analyze topographic features, corroborating them in the field. We completed the morphometric investigation using the MATLAB based TopoToolbox, Topographic Analysis Kit, and a customized DivideMigration function. We observe two unique signatures of glacial divide migration in the Canadian Rockies: (1) breached drainage divides that suggest lateral erosion by glaciated headwaters directed along weak lithologies and (2) the presence of low relief, high elevation divides without headwall preservation, possibly indicating periods of paleo-drainage capture during glaciation. Our preliminary results have implications for the role of glacial erosion in reshaping the landscape with respect to the structure, lithology, and climate.

The Olympic orocline, a mountain formation from orogen-parallel deformation

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The highly arcuate and elevated geometry of the Olympic Mountains, surrounded by the Crescent/Siletzia terrane, define a concave-seaward horseshoe shape (the Olympic orocline) east of and in the hangingwall of the Cascadia subduction zone. The curvature has been explained as a product of orogen/trench-normal deformation due to accretion and underplating or as a product of trench-parallel shortening due to subduction obliquity. Siletzia continues south of the Olympic orocline, underlying much of the 'Oregon forearc block'. Regional GPS and paleomagnetic studies demonstrate that the limbs of the Olympic orocline record opposing rotations during overall northward motion relative to cratonic North America. Here we compile paleomagnetic and structural data to show that the Olympic orocline is a vertical axis fold. We palinspastically undo the fold and restore the Oregon forearc block, showing that it rotated and was displaced to the north during orocline formation. Palinspastic restoration of the Olympic orocline shows that it is a product of 200 km of northward displacement. Our suggested sequence of events includes: 1.clockwise rotation and northward translation of the Oregon forearc block; 2. Siletzia north of the Oregon forearc block accommodates the northward translation by folding, forming the Olympic orocline and 3. bending of the upper plate resulted in its landward retreat from the trench resulting in the passive upward warping of the downgoing Juan de Fuca oceanic lithosphere beneath the growing orocline, elevating the Olympic Mountains. Our model provides a deformation sequence that explains the Olympic Mountains as a result of margin-parallel translation of Cascadia forearc.