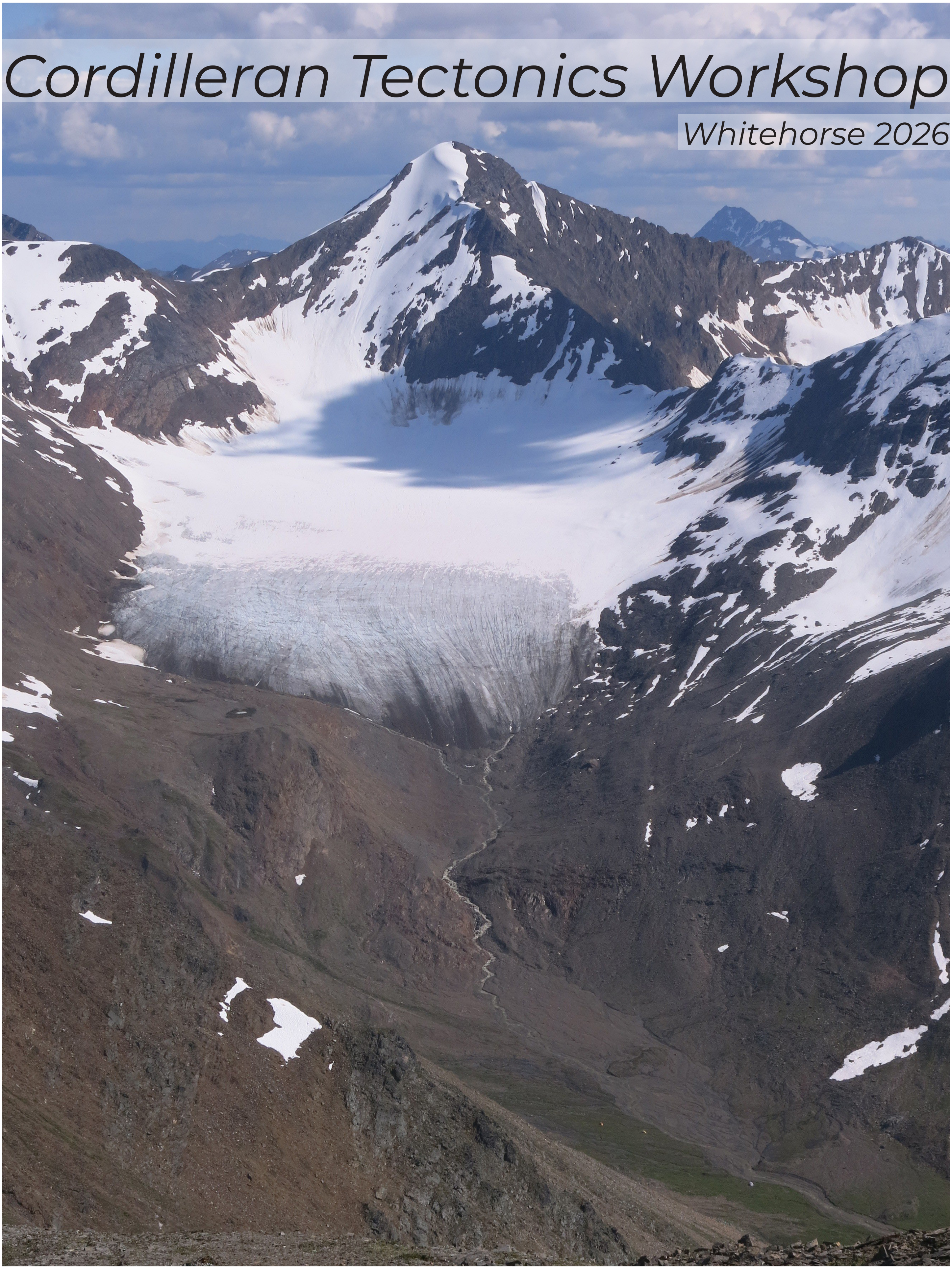
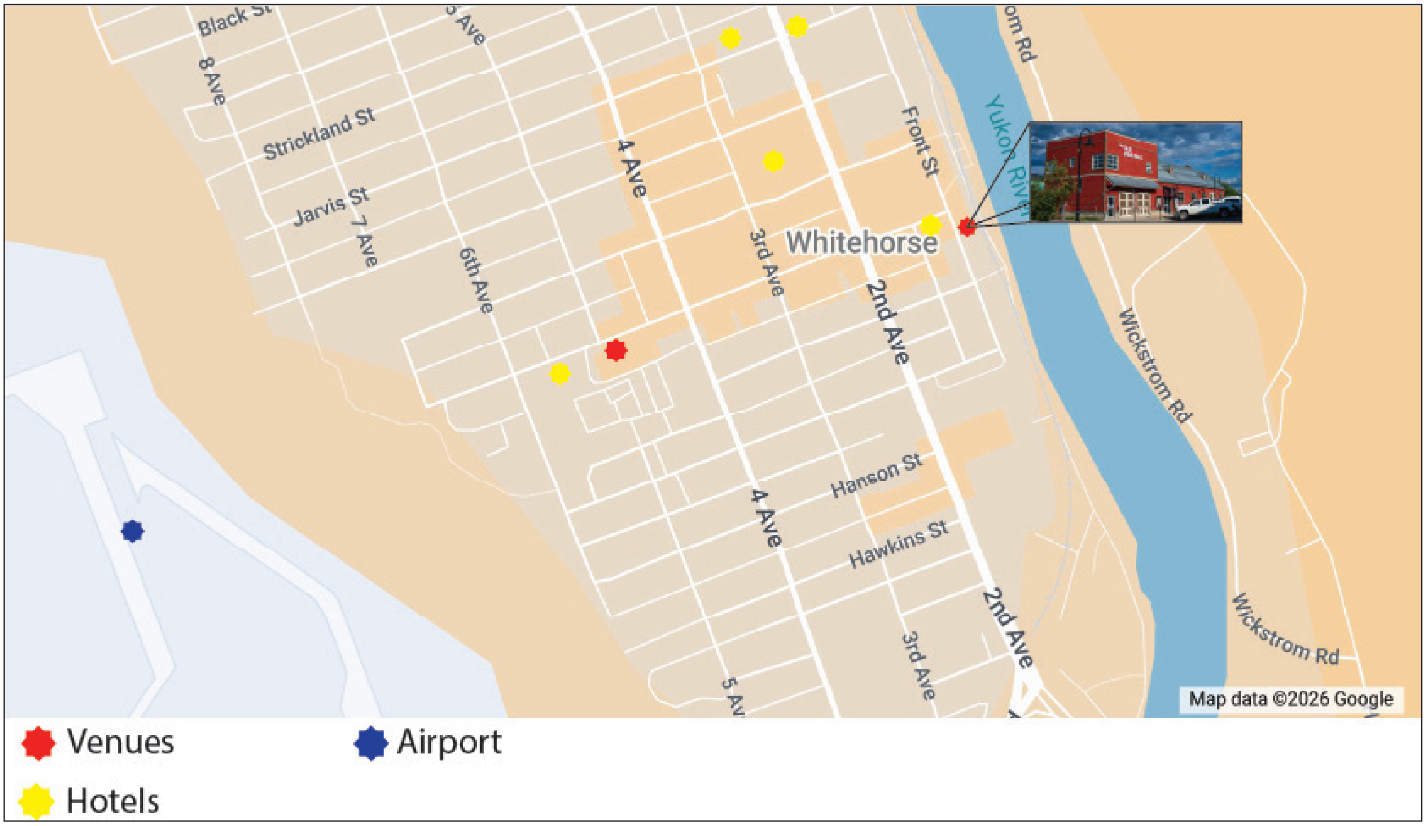
Cordilleran Tectonics Workshop

Whitehorse 2026





Getting around Whitehorse

CTW 2026 events will be held within walking distance of hotels in downtown Whitehorse, but should you wish to explore farther or if you need some help getting around town see below:

Taxi services

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Best Western Gold Rush Inn

Edgewater Hotel

Hyatt Place Whitehorse

Sternwheeler Hotel

Transit

Whitehorse's transit system runs seven days a week.

A map and schedule can be found on the city's website at:

www.whitehorse.ca/routes-schedules

Schedule

Friday February 27th

Registration and Icebreaker (17:00-20:00; Old Fire Hall)

Saturday February 28th

Breakfast and set-up (8:30-9:00)

Morning session 1 (9:00-10:40)

Presenter	Title	Page
George R. Geier IV	*Devonian arc magmatism and sedimentation in the Ulungarat Basin of Arctic Alaska*	*21*
Chris Connors	*Subsurface constraints on Paleozoic deformation in Arctic Alaska and the adjacent offshore region*	*16*
Richard Lease	*Mesozoic detrital zircon Hafnium data from the Kandik and Manley Basins discern Arctic island arc from Yukon-Tanana orogenic provenance during northern Cordillera assembly*	*26*
Justin Strauss	*Polyphase Cretaceous and Cenozoic deformation along the Porcupine Fault System of Yukon and Alaska*	*30*

Posters (10:40-11:40)

Morning session 2 (11:40-12:55)

Presenter	Title	Page
Sean Mulcahy	*Constraints on Mesozoic subduction polarity and terrane translation from the contemporaneous Franciscan complex and Easton metamorphic suite*	*28*
Erin Donaghy	*The outer forearc record for Eocene seamount collision during the early construction of the Olympic subduction complex, western Washington*	*17*
Rose N. Cobbett	*The link between faulting, Cenozoic magmatism, and mineral occurrences in southwest Yukon*	*12*

Posters and lunch (12:55-14:30)

Afternoon session (14:30-16:30)

Presenter	Title	Page
Andrew Schaeffer	*Current tectonics of the Richardson Mountains, northwestern Canada, from preliminary double-difference earthquake relocations*	*33*
Theron Finley	*Paleoseismology and Tectonic Geomorphology of the Rocky Mountain – Tintina Trench fault system*	*20*
Guy Salomon	*Cryptic late Quaternary surface ruptures in a recently deglaciated, forested landscape - the San Juan Fault, Vancouver Island, BC*	*32*
Himany Yadav	*Glory of the glaciers, lithology, and structure: controls of fluvial erosion in Southern Canadian Rocky Mountains*	*37*
Jan Dettmer	*December 6. 2025 M_w 7.0 earthquake in southwestern Yukon*	*35*

Posters and Beer (16:30-18:00)

Evening gathering (18:30-22:00; Gold Rush Inn Games Room, Main Street)

Sunday March 1st

Breakfast and set-up (8:30-9:00)

Morning session 1 (9:00-10:15)

Presenter	*Title*	*Page*
Maurice Colpron	*Late Triassic (Carnian) Gabbro Sills in Continental Margin Successions of the Northern Cordillera, Yukon and Alaska: Age, Geochemistry, Correlations and Tectonic Setting*	*13*
Merilie Reynolds	*Did anaerobic oxidation of methane play a key role in trapping metals in the Howard's Pass zinc-lead district?*	*31*
Aithne Lawrence	*Evaluating the role of volcanic massive sulphide deposits as a metal source for the Keno district, central Yukon: a case study on the bulk tonnage Ag-Pb-Zn Fox deposit*	*25*

Posters (10:15-11:15)

Morning session 2 (11:15-12:30)

Presenter	*Title*	*Page*
Tyler Ambrose	*The Paleoproterozoic to Tonian sedimentary record of northwestern Laurentia*	*8*
Doug MacLeod	*Paleocene to Miocene exhumation and fault reactivation on the western flank of the Purcell Mountains, southeastern British Columbia*	*27*
Tom Lamont	*Himalayan Style Late Cretaceous Channel Flow In Western Arizona: Implications For The Ancestral Evolution of Metamorphic Core Complexes*	*24*

Posters and lunch (12:30-13:30)

Afternoon session (13:30-14:45)

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Doug Kreiner	*Mapping mineral systems and critical resource prospectivity across the North American Cordillera*	*23*
Sarah Ellis	*Preliminary geology and metallogeny of Oligocene to Miocene magmatic rocks in southwest Yukon, NTS 115F15*	*18*
Maria Carter	*Structural and Geochronological Constraints on High-grade Gold and Silver Mineralization at Mount Hinton, Yukon*	*10*

Posters (14:45-16:00)

Posters

38– Preliminary thermochronologic observations from an orogen-normal transect in central Yukon

Presenter: Alex Brubacher

39– Field observations, mineralogy, microtextures, and preliminary Cr-mica $^{40}Ar/^{39}Ar$ geochronology of Seventymile listwanitized ophiolites reveal fault-related fluid flow during contractional and extensional tectonics in the Alaska Yukon Tanana upland

Presenter: Jonathan Saul Caine

41– Progressive underplating and Metamorphic Sole Formation in the Easton metamorphic suite of the North Cascades of Washington

Presenter: Jennifer E. Chan

42– Preliminary geology and metallogeny of Oligocene to Miocene magmatic rocks in southwest Yukon, NTS 115F15

Presenter: Sarah Ellis

44– Uranium-Lead Geochronology of Three Mesozoic Intrusions in Southeastern British Columbia

Presenter: Maren E. Glaser

45– Sediment Provenance of the Lower Cretaceous Colville Foreland Basin, Arctic Alaska, Exhibits Widespread but Cryptic Permian-Triassic Detrital Zircon U-Pb Ages

Presenter: Jared T. Gooley

46– Structural and metamorphic evolution on the northern flank of the Valhalla Metamorphic Core Complex, Southeast BC, Canada

Presenter: Richard Hieber

48– Investigating the tectonic significance and carbon capture potential of ultramafic rocks in the eastern Harrison Lake area, southwestern British Columbia

Presenter: Gabrielle Jones

51– Late Cretaceous Tectonothermal Development of the Northern Kootenay Arc and Western Selkirk Fan Recorded by U-Pb Monazite and Lu-Hf Garnet Geochronology

Presenter: Collin Kehler

52– Mineral Diversity at the Gun Occurrence, a Barium Silicate Skarn in Devonian Strata of the Selwyn Basin

Presenter: Mary G. Macquistan

53– Regional low-pressure, high-temperature (LP-HT) metamorphism of the Hyland River area, southeastern Yukon

Presenter: David Moynihan

54– Alkaline magmatism and volcanism in southeastern Yukon: What gives?

Presenter: Tiera V. Naber

56– Permian-Triassic Polyphase Deformation and High-Pressure Low-Temperature Metamorphism in the Vedder Complex, Southern British Columbia and Northwest Washington

Presenter: Sydney E. Rayburn

57– Numerical models of the opening of the Canada Basin and the lithospheric evolution of the northern Cordillera region

Presenter: Jonathan E. Rich

58– The relationship between Late Cretaceous calc-alkaline arc magmatism and Late Cretaceous mafic-potassic volcanism in Yukon

Presenter: Patrick Sack

59– Coeval deposition of transgressive and normal regressive strata in a structurally controlled area of the Viking Formation, central Alberta, Canada

Presenter: Sarah Schultz

60– Geochemical, isotopic, and geochronological constraints on the tectonic setting and obduction history of the Kanuti ophiolite, AK

Presenter: Erin Todd

62– Attendees


Abstracts

The Paleoproterozoic to Tonian sedimentary record of northwestern Laurentia

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Deposition of Paleoproterozoic to early Neoproterozoic (Tonian) strata in Yukon spans the interval from the breakup of Nuna to the assembly of Rodinia. However, a lack of geochronological constraints has impeded our ability to establish regional correlations and interpret tectono-sedimentary settings. To elucidate the sedimentary record of northwestern Laurentia, we combined geological mapping with U-Pb detrital zircon and Re-Os whole-rock geochronology of Proterozoic strata in the Wernecke inlier, southern Wernecke Mountains.

The oldest strata exposed in the northern Canadian Cordillera belong to the Wernecke Supergroup, which is inferred to rest directly on crystalline basement. The age of the Wernecke Supergroup was previously bracketed between 1649 ± 14 Ma (detrital zircon geochronology; Furlanetto et al., 2016) and 1599 ± 1 Ma (Wernecke Breccia; Furlanetto et al., 2013). Our detrital zircon dates provide an updated maximum depositional age of 1644 ± 3 Ma. In the northern Wernecke Mountains, carbonate and siliciclastic strata of the Pinguicula Group overlie the Wernecke Supergroup with angular unconformity. Detrital zircons from the Pinguicula Group fall into 3 populations. The oldest population consists of Archean and Paleoproterozoic grains that have a similar age distribution to, and were likely recycled from, the underlying Wernecke Supergroup. Another population consists of grains that are the same age and composition as zircon from intrusions of the underlying c. 1380 Ma Hart River suite. The youngest population consists of c. 1130 Ma grains, which is nearly 200 Myr younger than the previously reported maximum depositional age. The c. 1130 Ma grains were likely derived from the Grenville Province of eastern Laurentia and indicate that the Pinguicula Group was deposited during the assembly of Rodinia rather than rifting of Nuna, as previously interpreted (Medig et al., 2023). We suggest that the Pinguicula Group constitutes the base of the Mackenzie Mountains Supergroup (Sequence B) in the Northern Canadian Cordillera and correlates with parts of other late Mesoproterozoic successions across northern Laurentia, including parts of the Shaler Supergroup (Victoria Island/Brock Inlier/ Coppermine area), Fury & Hecla Group (Melville Peninsula/NW Baffin Island), and the Bylot Supergroup (NW Baffin Island).

A mixed siliciclastic-carbonate succession in the southern Wernecke Mountains previously assigned to the Wernecke Supergroup yields a Re-Os depositional age of 1494 ± 24 Ma, which falls between the Wernecke Supergroup and Pinguicula Group. This newly recognized unit, which we have named the Salutation Formation, correlates with unit PR1 in the Ogilvie Mountains and potentially part of the Belt-Purcell Supergroup in southern B.C. and northwest U.S. In northern Wernecke Mountains, the Pinguicula Group overlies the Wernecke Supergroup with pronounced angular unconformity, providing evidence for the c. 1600 Ma Racklan-Forward Orogeny. In contrast, bedding in the Pinguicula Group and underlying strata—previously thought to be the Wernecke Supergroup—in the southern Wernecke Mountains is sub-parallel. This relationship led geologists to infer that deformation associated with the Racklan-Forward was absent in the southern Wernecke Mountains. However, our work shows that the Pinguicula Group there instead overlies the Salutation Formation, which postdates the Racklan-Forward Orogeny. Consequently, the angular unconformity occurs lower in the stratigraphic section, at the base of the Salutation Formation.

Structural and Geochronological Constraints on High-grade Gold and Silver Mineralization at Mount Hinton, Yukon

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High-grade gold- and silver-bearing veins and breccias are widespread in the Mount Hinton property in central Yukon. The property is situated in northwestern Selwyn Basin and lies within the Tombstone Gold Belt, a ~800km long region of reduced intrusion-related gold system (RIRGS) deposits. These RIRGS are genetically and spatially associated with the mid-Cretaceous Tombstone and Mayo plutonic suites (Hart et al. 2002). While there are several intrusion-related deposits near Mount Hinton such as Dublin Gulch and Scheelite Dome, there is no apparent evidence of major plutonism on the property that would fit the RIRGS model. However, preliminary geochemical results on Mount Hinton and recent studies at the adjacent Keno Hill mine area suggests that the mineralization at both are related and in the distal zones of a RIRGS deposit model (Hantelmann 2013; Willms and Friend 2023). Located in the Tombstone Strain Zone between the Robert Service and Tombstone thrusts, Mount Hinton records a complex history of pervasive ductile and brittle deformation (Gordey and Anderson 1993, Mair et al. 2006, Murphy 1997). This regional deformation likely directed mineralizing fluid flow, as shown by structurally controlled veins (Stephens et al. 2004). Field and analytical techniques are utilized to characterize the relationships between mineralization and structures. U-Pb dating of igneous bodies provides bounds on the intervals of deformation, while direct Rb-Sr and Ar-Ar dating of select vein stages constrains the timing of emplacement. Anchored by these isotopic ages, vein paragenesis indicates an early mineralization stage of arsenopyrite + gold ± pyrite ± jamesonite followed by a silver-rich stage of sphalerite + galena + jamesonite ± remobilized gold ± tetrahedrite that crosscuts earlier veins. Initial Rb-Sr dates of calcite-arsenopyrite-muscovite veins suggest Late Cretaceous carbonation of Triassic sills. Preliminary graphite thermometry offers insight into the thermal evolution of the system. Results from this ongoing study will be used to refine the deposit model for Mount Hinton and reconcile it with the regional RIRGS framework.

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The link between faulting, Cenozoic magmatism, and mineral occurrences in southwest Yukon

Rose N. Cobbett[1] and Sarah Ellis[1,2]*

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Neogene Wrangell Formation volcanic rocks crop out near Mät'àtäna Män (Kathleen Lake) in southwest Yukon and form elongate bodies that parallel faults and are coincident with the location of known mineralization. In one area, the volcanic rocks overlie the fault they follow and may also be deformed by recent movement along the fault. The historic Johobo mine occurs along the fault near where the volcanic rocks erupted. The deposit was mined for copper and silver extracted from semi-massive sulphide bodies and veins comprised of bornite, chalcopyrite, pyrite, and pyrrhotite. The sulphide is hosted in basalt and/or andesite that is mapped as Triassic and/or Neogene. It is hypothesized that the faults formed pre-Neogene and are likely related to the Denali fault, a dextral strike-slip fault that is over 2000 km long and has ~400 km of movement (e.g. Caine and Benowitz, 2022). Two deposit styles are being considered for the Johobo occurrence. Metal-bearing fluids and heat sourced from Neogene magma utilized crustal breaks linked to the Denali fault to migrate to the surface. In this model, sulphide was deposited when the metalliferous fluids encountered favorable host rocks for sulphide precipitation. Alternatively, the Johobo deposit could be similar to the Kennecott copper mine in Alaska. In this model, oxidized fluids generated from low grade metamorphism of basalt scavenged copper and possibly sulphur from the basalt. Metalliferous fluids utilized faults to migrate to areas where there was a source of reduced sulphur for sulphide precipitation (i.e. carbonate rock; Price et al., 2014). The study area lies within Kluane National Park, but the geologic relationships observed here may apply along strike to areas outside the park where mineral exploration is active. For example, west of White River in southwest Yukon, active exploration programs are targeting both skarn and porphyry style mineralization associated with Cenozoic magmatism and Kennecott-style mineralization associated with Triassic Nikolai basalt.

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Late Triassic (Carnian) Gabbro Sills in Continental Margin Successions of the Northern Cordillera, Yukon and Alaska: Age, Geochemistry, Correlations and Tectonic Setting

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Occurrences of Late Triassic gabbro sills intruded into mid to late Paleozoic sedimentary rocks of the western Laurentian continental (passive) margin are enigmatic. The gabbro sills were first delineated over ~270 km in strike length during regional mapping in central Yukon, northeast of the Tintina fault (Galena suite; Fig. 1). Offset equivalents southwest of the Tintina fault were identified in the Livengood quadrangle of central Alaska, and a distinct belt of gabbro sills (Snag Creek suite) was mapped over 200 km from the eastern Alaska Range into western Yukon near the Denali fault (Fig. 1). Preliminary U-Pb ID-TIMS dating of multi-grains zircon and baddeleyite fractions from gabbro occurrences in Yukon and Alaska yielded interpreted ages of ca. 232 Ma (0.7–1.9% error) for the Galena suite (Mortensen and Thompson, 1990; Weber et al., 1992) and ca. 228–226 Ma (~0.4% error) for the Snag Creek suite (Dashevsky et al., 2003; Murphy et al., 2009), indicating Carnian to earliest Norian intrusive ages (Fig. 2). The paucity of geochemical data and apparent difference in age between the Galena and Snag Creek suites have however hindered interpretation of their tectonic setting and correlations between these two suites, and other Late Triassic magmatic events in the northern Cordillera.

This study focuses on gabbro of the Galena and Snag Creek suites in Yukon. New U-Pb zircon geochronology and whole rock lithogeochemical and isotope analyses provide better constraints for correlations with gabbro occurrences in Alaska and other terranes of the northern Cordillera, and interpretation of tectonic setting for these enigmatic intrusions. Gabbro of the Galena suite intruded strata of the upper part of the Earn Group (Upper Devonian) and the overlying Keno Hill Quartzite (Carboniferous). Single zircon crystals from two coarse-grained gabbro collected ~180 km apart yielded identical CA-TIMS dates of ca. 230.5 Ma (0.03% error; this study; Fig. 2) that suggest synchronous emplacement of the Galena suite in the Carnian along its entire strike-length in central Yukon. The Snag Creek suite intruded into lower Paleozoic–Triassic(?) metasedimentary rocks tentatively correlated with continental margin strata northeast of Tintina fault. A LA-ICPMS zircon date of ca. 230.4 Ma (0.7% error; Murphy et al., 2009) is comparable to Carnian CA-TIMS dates for the Galena suite. Single zircon CA-TIMS dates from two other gabbros are ca. 230.9 Ma and ca. 231.6 Ma (0.07–0.19% errors; this study) and may suggest that the Snag Creek suite is slightly older than Galena suite (Fig. 2). Both the Galena and Snag Creek suites have identical whole rock geochemical EMORB-type signatures with relatively juvenile Nd and Hf isotope composition (εNd_{230} +5.3 to +6.4; εHf_{230} +9.3 to + 12.4) that are consistent with derivation from similar enriched mantle sources. Available geochemical data for gabbro in Alaska show similar EMORB-type signatures as those of the Galena and Snag Creek suites of Yukon, supporting regional correlation of Late Triassic gabbro and host strata across the region.

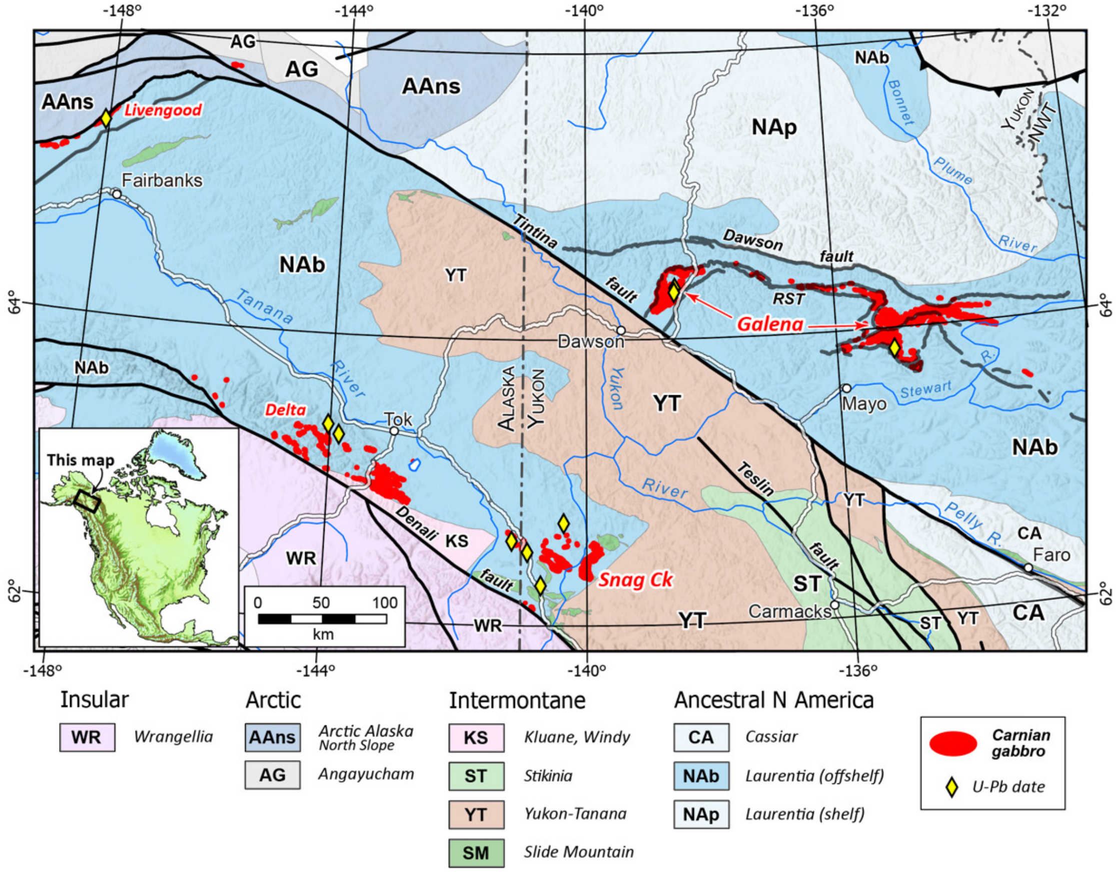

Figure 1. *Terrane map of part of Yukon and eastern Alaska showing the distribution of Late Triassic (Carnian) gabbro sill complexes intruded in continental margin strata (NAb). RST – Robert Service thrust.*

Carnian gabbro intrusions are also documented in Wrangellia where they are inferred feeders to flood basalts. Recent CA-TIMS U-Pb zircon dating of the Maple Creek gabbro in Wrangellia yielded an age of ca. 231 Ma (0.03% error; Grosswiler, 2022) similar to the Snag Creek suite (Fig. 2), but distinct geochemical signatures more consistent with island arc tholeiites. Although the geochemistry of the Galena and Snag Creek suites overlap with younger, high-Ti basalts of Wrangellia, there are considerable uncertainties as to the paleogeographic location of Wrangellia with respect to the continental margin of northwestern Laurentia in the Late Triassic, with fossils and paleomagnetic data indicating positions far to the south. It is therefore unlikely that intrusions of the Galena and Snag Creek suites are directly related to Wrangellia magmatism.

Another major magmatic and tectonic Carnian event is recorded in onset of widespread arc magmatism in Quesnellia and Stikinia (Fig. 2). Although the arc tholeiite to calc-alkaline geochemical signatures of Stikinia/Quesnellia preclude direct links with magmatism of the Galena and Snag Creek suites, paleogeographic models commonly show the arc terranes developed in proximity to the western Laurentian continental margin. Gabbro of the Galena and Snag Creek suites could therefore result from far-field back-arc extension in the continental margin following onset of arc magmatism in the Carnian.

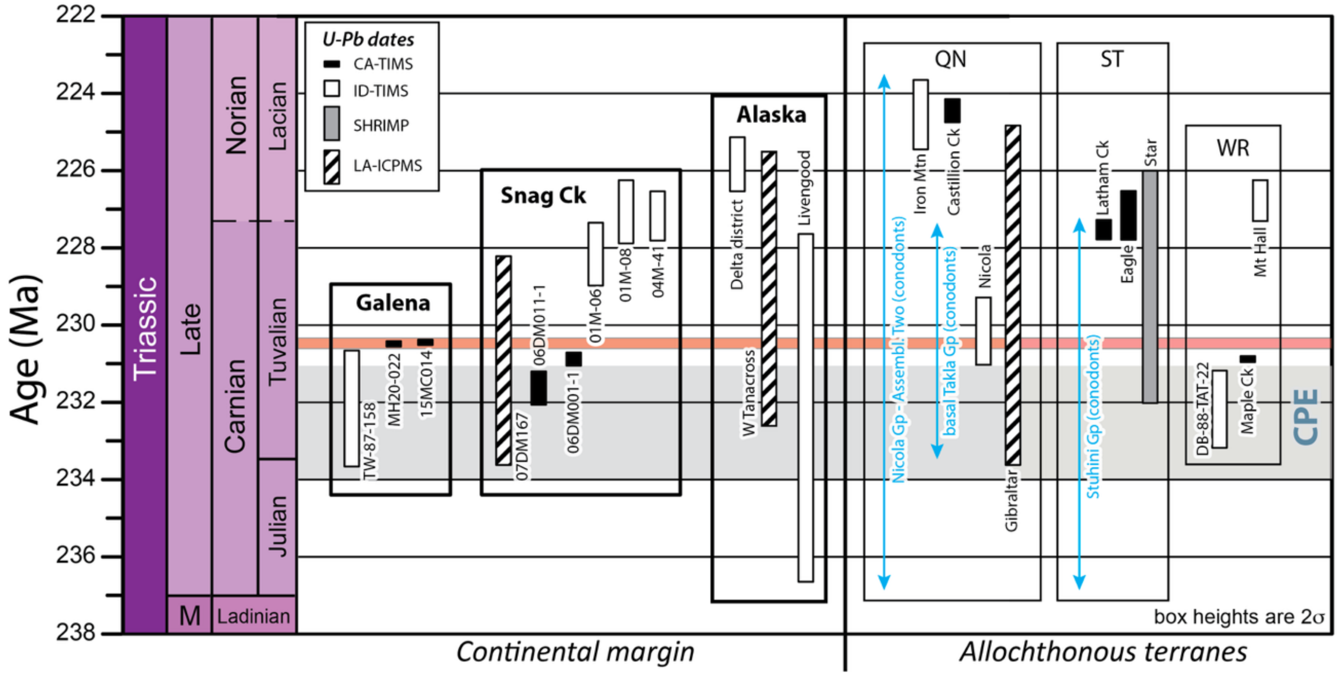

Figure 2. *Age constraints on timing of Late Triassic magmatism in the northern Cordillera. Blue arrows indicate range of fossil ages. CPE – Carnian Pluvial Event; QN – Quesnellia; ST – Stikinia; WR – Wrangellia.*

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Subsurface constraints on Paleozoic deformation in Arctic Alaska and the adjacent offshore region

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We present regional reflection seismic interpretation and multifaceted analyses from well cores and cuttings that provide new constraints on Paleozoic deformation in Arctic Alaska and the adjacent offshore region. Seismic interpretation shows that in Arctic Alaska and the Beaufort Sea shelf pre-Mississippian strata are imbricated in widespread east-west-trending fold-and-thrust belts. A belt of south-directed structures underlies the North Slope east of the Colville River, the western Beaufort Sea shelf, and nearshore Point Barrow (Nuvuk) area. West of the Colville River, in the central National Petroleum Reserve in Alaska (NPR-A), north-directed contractional structures predominate. A complex superposed zone marks the boundary between these different structural belts.

Detrital zircon (DZ) U/Pb LA-ICP-MS age spectra in pre-Mississippian strata from 20 wells on the North Slope and Beaufort shelf, along with associated petrography, define distinct domains that correspond with these different major structural transport directions. Quartz- and feldspar-rich sandstones with Proterozoic DZ ages are present in south-directed belts, whereas chert-rich sandstones dominated by Silurian–Devonian maximum depositional ages (MDAs) are present in the north-directed belts, suggesting differences in provenance. A third domain of potentially mixed signature corresponds to the boundary between the belts. CA-TIMS analysis on young zircon from selected wells shows the estimated MDA from carefully filtered LA-ICP-MS datasets are robust.

Though south-directed belts were active and deeply exhumed in the Devonian, constraints provided by seismic interpretation of growth strata and unconformities indicate that the north-directed belts were both active in the Devonian and reactivated in the Mississippian and probably Pennsylvanian. Farther north in NPR-A, this north-directed thrust belt impinged on older south-directed structures, likely in Pennsylvanian–Permian time. The north-directed belt in part overlaps spatially with an area of Mississippian–Permian zircon fission track central ages in older Paleozoic strata. Contrary to prior assumptions, late Paleozoic crustal extension on the North Slope is limited. This is in contrast to previously documented Mississippian extension in the Chukchi Sea shelf that reactivated pre-Mississippian east-directed thrusts.

The outer forearc record for Eocene seamount collision during the early construction of the Olympic subduction complex, western Washington

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The Eocene collision and accretion of the Siletzia oceanic plateau to the continental margin of the Pacific Northwest set the stage for the initiation of the early Cascade forearc region. However, new research suggests a previously unrecognized record of seamount collision immediately followed Siletzia's accretion and profoundly impacted initial forearc geometry. The key components of the outer forearc region at this time included metasedimentary and volcanic strata of the Olympic subduction complex and age-equivalent deep-marine (peripheral rock sequence) to nonmarine (Puget Group) sedimentary strata of the forearc basin. We present a new depositional and structural model for the Eocene–Oligocene units of the Olympic subduction complex (OSC), in which the middle Eocene Blue Mountain Unit (BMU) represents the oldest part of the OSC and is structurally juxtaposed between Siletzia basalts (Crescent Formation) and the formally defined oldest unit of the OSC, the Needles-Gray Wolf lithic assemblage. We interpret volcanic and sedimentary strata of the BMU to represent ocean plate and seamount stratigraphy that are characteristic of an ocean plate stratigraphy mélange based on detailed lithofacies mapping and U-Pb detrital zircon geochronology (N=5; n=1389). We compare these data to new stratigraphic and geochronologic data from the Needles-Gray Wolf (N=2; n=582) and Grand Valley (N=2; n=568) lithic assemblages in the OSC to better constrain the geologic record for and duration of seamount accretion during the Eocene. Preliminary lithofacies mapping of all units along the northern Olympic Peninsula indicates a distinct departure from seamount stratigraphy lithofacies (pillow basalts, pillow breccias, hyaloclastites, etc.) interbedded with and/or faulted against siliciclastic trench-turbidite lithofacies of the BMU to structurally juxtaposed sequences of massive metabasalt to metagabbro with shale and metasandstone in the Needles-Gray Wolf lithic assemblage. This is a marked difference from lithofacies mapped in the adjacent Grand Valley lithic assemblage near Grand Valley, which contains no volcanic lithofacies. Yet, detrital zircon age spectra from the Needles-Gray Wolf and Grand Valley lithic assemblages are nearly identical and also yield maximum depositional ages of ~36 Ma and ~33 Ma, respectively. These age spectra differ significantly to the trench-turbidite lithofacies of the middle Eocene (~45 Ma) BMU. We also compare detrital zircon age spectra from Eocene–Oligocene OSC units to sedimentary strata of the age-equivalent forearc basin to better understand sediment routing pathways in the outer forearc during the middle to late Eocene and across the Eocene–Oligocene boundary. Preliminary results from these data support a transition from a period of middle Eocene seamount collision and accretion to a sediment-dominated accretionary margin by the Late Eocene–Oligocene time.

Preliminary geology and metallogeny of Oligocene to Miocene magmatic rocks in southwest Yukon, NTS 115F15

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Cenozoic subduction along the western margin of North America has produced a broad, semi-continuous belt of forearc magmatism across the northern Cordillera stretching from western Alaska, through southwest Yukon, down the coastal regions of BC, Washington, and Oregon (Figure 1). Despite how extensive this belt is, large regions lack basic, first-principles understanding of geological relationships, geochronology, and geochemistry which limit the understanding of their tectonic and magmatic framework as well as their metallogenic significance. As a result, mineral occurrences within this belt are sparsely documented and poorly constrained.

Unique to this region of the northern Cordillera, specifically southern Alaska, southwest Yukon and northwestern BC, is the flat to shallow subduction of the Yakutat microplate, a rifted oceanic plateau fragment of the Pacific plate that was translated northward along the Queen Charlotte transform fault and began subducting around 30 million years ago. This study investigates Oligocene and Miocene magmatic rocks and associated porphyry system (porphyry, epithermal and skarn) mineral occurrences within the Insular terranes across southwest Yukon associated with this subduction environment.

Preliminary field mapping, geochemistry, petrography and drill core observations from the Mint Cu-Mo-Au porphyry occurrence within NTS map sheet 115F15 are presented here. Petrographic, geochronological, geochemical results and detailed mapping will be integrated into a surrounding 1:50,000 scale bedrock geology map. In addition, regional work on these magmatic rocks will place them in a broader tectonic and magmatic framework consistent with the rest of the northern Cordillera.

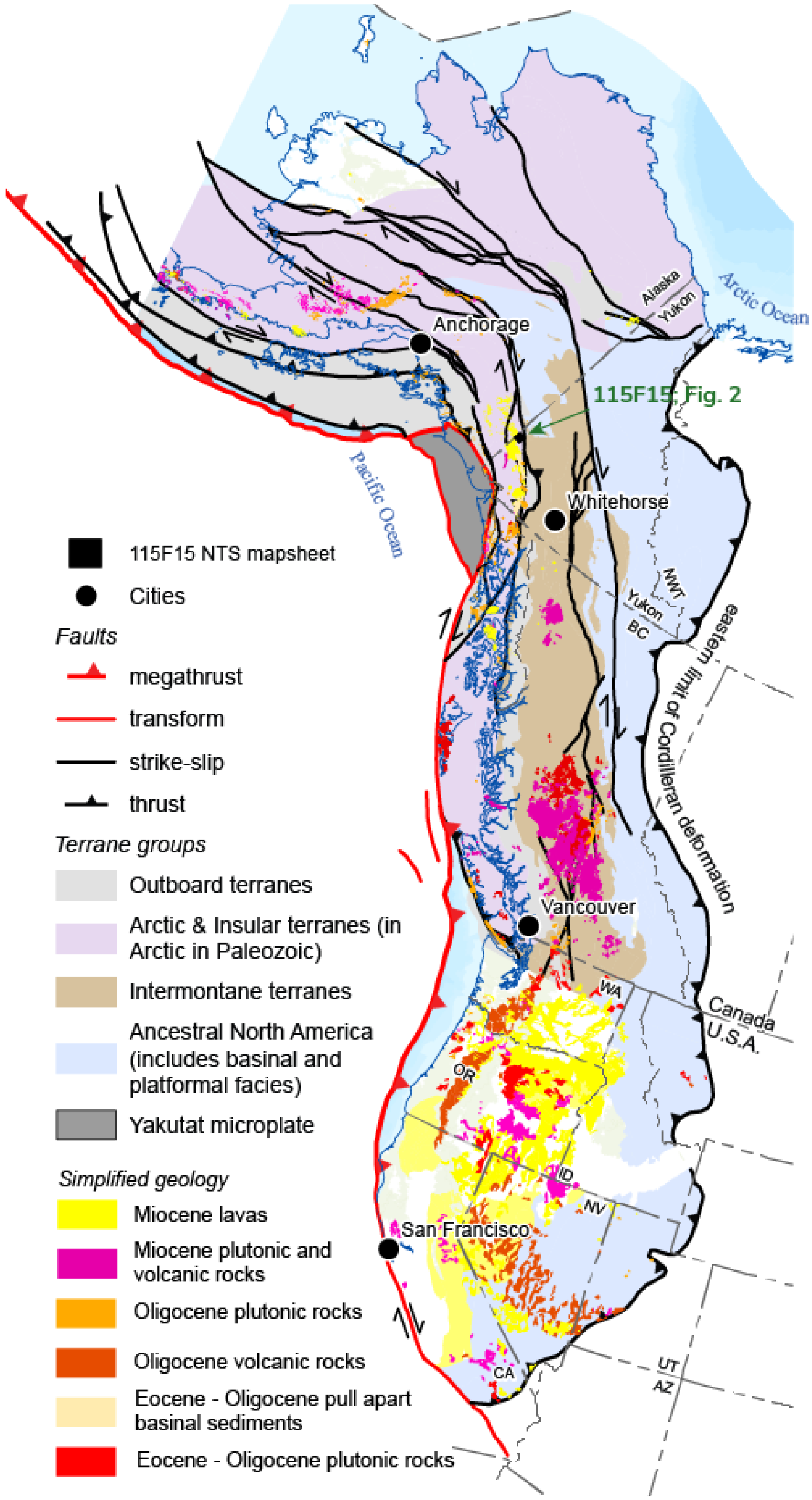

Figure 1. *Cordilleran terrane map with major faults and distribution of Eocene to Miocene magmatic rocks across Alaska, southwest Yukon, British Columbia and western United States. Yakutat microplate (part of the outboard terranes) is highlighted to show proximity to field study area.*

Paleoseismology and Tectonic Geomorphology of the Rocky Mountain – Tintina Trench fault system

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The Rocky Mountain – Tintina Trench (RMTT) is a conspicuous ~3500 km-long topographic lineament and fault system that extends along the entire length of the Canadian-Alaskan Cordillera. It is known to have hosted major dextral and normal displacements in the Late Cretaceous to Eocene. At present, instrumentally recorded seismicity and global navigation satellite system (GNSS) velocities indicate minor ongoing strain across the region. However, the neotectonic activity of the RMTT and potential for large surface-rupturing earthquakes has remained unclear, in large part due to recent glaciation and dense forests that obscure fault geomorphology. In this talk I will review and describe geomorphic evidence of Pleistocene and Holocene surface ruptures revealed by new high-resolution topographic datasets at multiple locations along the RMTT. Particular attention will be paid to two sites. The first is near Invermere in southeastern BC, where geomorphic mapping and geophysical surveys are used to characterize a short (~3.6 km) fault scarp cutting across a Holocene paraglacial fan. This scarp appears to have normal kinematics, pointing towards gravity-driven orogenic collapse as a primary driver. The second site is near Dawson City in west-central Yukon, where geomorphic mapping and paleoseismic trenching confirm the occurrence of multiple large strike-slip earthquakes throughout the Quaternary. Along the entire RMTT, expressions of faulting are especially pronounced beyond the boundaries of late Pleistocene ice cover, highlighting the preservation bias caused by glacial erosion and sedimentation. Collectively, our observations underscore the lingering seismic hazard on relict, mature fault systems in slowly deforming orogenic belts.

Devonian arc magmatism and sedimentation in the Ulungarat Basin of Arctic Alaska

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Middle Paleozoic strata of the Arctic Alaska terrane record tectonic events that profoundly shaped the northwestern margin of North America. This record is uniquely preserved in rocks exposed in the northeastern Brooks Range of Alaska, including the Middle–Upper(?) Devonian Ulungarat Formation, the Upper Devonian–Mississippian Endicott Group, and a previously unnamed succession of Middle–Upper Devonian sedimentary, volcanic, and volcaniclastic rocks that we define as the Double Mountain Formation. The Ulungarat Formation was originally interpreted as a syn-rift deposit, reflecting an abrupt Middle Devonian transition from regional contraction to extension in the Arctic Alaska terrane (Anderson et al., 1994; Anderson and Meisling, 2021). The rift interpretation of the Ulungarat Formation served as a key constraint on the introduction of the Early Devonian "Romanzof orogeny," a deformational event in Arctic Alaska distinct from the Middle Devonian–Early Carboniferous Ellesmerian orogeny of the Canadian Arctic Islands (Lane, 2007).

To explore the purported discrepancy between the orogenic history of Arctic Alaska and the adjacent Laurentian margin, we conducted detailed geologic mapping of the continental divide region of the northeastern Brooks Range. Within a revised stratigraphic and structural framework, we integrated biostratigraphy, major and trace element geochemistry, and zircon U-Pb geochronology and Hf isotope geochemistry to determine the age, provenance, and tectonic setting of these Middle Devonian–Carboniferous rocks. Critically, volcanic rocks in the Double Mountain Formation have zircon U-Pb ages of ca. 375–373 Ma and arc geochemical signatures. Additionally, a brachiopod species originally described in the Ulungarat Formation (Popov et al., 1994) was also found to occur in the Double Mountain Formation, demonstrating a biostratigraphic link between these units, which are located on adjacent Mesozoic–Cenozoic thrust sheets. Together with detrital zircon and mudstone geochemical data, these results provide compelling evidence for Middle–Late Devonian arc volcanism and sedimentation recorded by the Ulungarat and Double Mountain Formations, suggesting that previous post-collisional rift interpretations of these units are untenable. Instead, the Arctic Alaska terrane records multiphase tectonic convergence throughout the Devonian, indicating that "Romanzof" deformation is best considered as a phase within the broader Ellesmerian orogeny. This more closely matches the timing of middle Paleozoic orogenesis recorded in the Canadian Arctic Islands and is therefore more consistent with other regional geological relationships preserved along North America's northern margin.

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Mapping mineral systems and critical resource prospectivity across the North American Cordillera

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Mineral systems are a wholistic geologic framework that relates coeval and cogenetic mineral deposits to the geotectonic environments in which they form. A single mineral system may generate multiple deposit types, and a single deposit type may form in multiple mineral systems – demonstrating the many to many relationships intrinsically associated with ore deposits and systems. For instance, a porphyry-epithermal mineral system can form bulk-tonnage porphyry deposits, Fe- and Cu-rich skarns, and(or) replacement deposits. However, Fe and Cu skarns and replacement deposits may also be found in iron oxide-copper-gold mineral systems, among others. The utility of mineral systems is that they represent geologic frameworks, with regional-scale footprints in contrast to the relatively small footprints of local, individual deposits. Mineral systems also relate precious and base metals – the main commodities that drive mineral exploration – to critical minerals more commonly found as co- or by-products.

One common schema for mineral systems describes the tectonic setting in which they form, such as convergent, divergent, and passive settings. Each tectonic setting may have multiple geotectonic stages (e.g. subduction, orogenesis, post-orogenic collapse) and settings (continental arc, island arc, orogen). Mineral systems can be broken down into various constituent components that include: 1) a trigger, 2) a driver, 3) a source, 4) transport, 5) trap, 6) and preservation. Each of the components can be mapped using defined geologic criteria and may represent different scales and temporal parts of the overall system.

Developing mappable criteria forms the linkage between the theoretical system and the application to resource assessments and mineral exploration. Mappable criteria involve identification of what the important geologic feature(s) is(are) for each component of the system, how it can be mapped, and what datasets can be used to map the system. The U.S. Geological Survey is currently developing mappable criteria for 24 mineral systems prioritized by their importance as domestic sources of critical mineral resources. Geoscience Australia is similarly developing criteria for systems that are relevant and important for resource development in Australia. Given that mineral systems and the geotectonic systems that host them commonly occur at the plate scale, developing a consistent set of mappable criteria and mineral systems maps for the resource-rich Cordillera spanning the western United States and Canada would provide a desirable and useful framework for integrating and interpreting geologic mapping and other relevant datasets in the region.

Himalayan Style Late Cretaceous Channel Flow In Western Arizona: Implications For The Ancestral Evolution of Metamorphic Core Complexes

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The origin of ancestral 'extensional' ductile shear fabrics preserved within the footwall of many metamorphic core complexes (MCC's) remains a fundamental unknown in our understanding of continental tectonics. In many cases, peak metamorphism and 'extensional' ductile shearing occurred 10's of Myrs before MCC formation and final exhumation due to normal faulting, and therefore such features are related to earlier phases of exhumation. Here we show that in the Harcuvar, Harquahala and Granite Wash mountains MCCs in West Arizona, Late–Cretaceous kyanite and sillimanite gneisses and migmatites were partially exhumed due to Himalayan style mid-crustal 'channel flow' between ca. 73–70 Ma, approximately ca. 40 Myrs before the MCCs were finally exhumed due to Miocene extension. The channel comprises high-grade metamorphic rock and leucogranites that reached pressure and temperature (P-T) conditions of ~8 kbar and 750°C, dated by U-Th-Pb monazite at ca. 73–60 Ma. These rocks are affected by top-NE 'extensional' shear fabrics that define the channel roof associated with a right way up metamorphic field gradient. Whereas the base of the channel is defined by the top-SW Hercules and Harquahala Thrusts and is associated with an inverted metamorphic field gradient. Late Cretaceous McCoy sediments in the footwall of these thrusts were metamorphosed at lower greenschist facies conditions, whereas a mylonite on the Hercules Thrust reached P-T conditions of ~4 kbar and 500°C. In-situ Rb-Sr geochronology of recrystallized white mica from this mylonite suggest top-SW shearing occurred at ca. 72 Ma, whereas leucogranite veins that cross-cut the Harquahala Thrust yield U-Pb zircon dates of ca. 70 Ma. The timing of metamorphism above and below the Hercules and Harquahala Thrust therefore overlaps, and top-SW thrust related shearing was coeval with top-NE extensional shearing at higher structural levels. This requires that the high-grade metamorphic rocks in the hanging wall of the Harcuvar and Harquahala thrusts were extruded on top of rocks that didn't reach as high of pressures or temperatures, similar to the Greater Himalayan Series (GHS). This syn-orogenic extrusion mechanism may have occurred in response to underthrusting the low angle Farallon plate beneath Western Arizona, and inducing water fluxed melting of the lower crust from slab derived volatiles. This can also explain why the Pelona-Orocopia-Rand Schists record similar pressures (~8–10 kbar) at ca. 70–65 Ma, as the lower crustal rocks once at such depths were exhumed to shallower crustal levels. We therefore speculate that the ancestral 'extensional' shear fabrics observed within many MCCs represent the roof of an extruding mid-crustal channel in an overall contractional setting and is captured or overprinted by a later phase of extensional tectonism.

Evaluating the role of volcanic massive sulphide deposits as a metal source for the Keno district, central Yukon: A case study on the bulk tonnage Ag-Pb-Zn Fox deposit

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The Keno Hill district in central Yukon is unusually endowed with mineral deposits. The district includes: one of Canada's largest silver producers in the form of Cretaceous high-grade Ag-Zn-Pb veins (>350 Moz Ag at >1300 g/t Ag), Cretaceous reduced intrusion-related gold (RIRG) deposits (~15Moz Au across the district) and the Paleozoic polymetallic volcanogenic massive sulphide (VMS) Marg deposit (14 Mt @ 1.1% Cu, 1.5% Pb, 2.9% Zn, 38 g/t Ag and 0.6 g/t Au). Though they occur in the same region, a genetic link between these mineralisation styles has not been made. The Fox deposit is a recently defined, relatively low-grade, bulk tonnage Ag-Pb-Zn deposit that may represent an example of mineralisation intermediate between Paleozoic VMS and Cretaceous high-grade Ag-Zn-Pb veins. Here, we investigate VMS mineralisation as a potential metal source for high-grade Ag-Zn-Pb veins in the Keno region. We do this through comparative analysis of diamond drill core from the Marg (Azarga Metals Corp.), Fox (Metallic Minerals Corp.) and Birmingham (Hecla Mining Co.) deposits, aiming to identify the source and geochemical characteristics of ore-bearing fluids at each deposit. Initial analysis comparing the Fox and Marg deposits shows that Marg (relative to Fox) is (1) preserved in a different stratigraphic horizon, (2) undergone more intense deformation closer to the brittle ductile transition, and (3) showcases different metal ratios and trends. Ongoing work will further investigate this interpretation by comparing petrographic and geochemical characteristics of Fox to both Birmingham (Keno-style) and Marg (VMS) deposits, evaluating the VMS metal contribution to the region.

Mesozoic detrital zircon Hafnium data from the Kandik and Manley Basins discern Arctic island arc from Yukon-Tanana orogenic provenance during northern Cordillera assembly

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The Kandik and Manley basins of east-central Alaska lie near the intersection of Arctic, North American, and Intermontane terranes and are filled by sediments that may record evolving tectonic configurations during the assembly of the northern Cordillera. Detrital zircon U-Pb (DZ) data from Neocomian (145-130 Ma) quartzites and arenites in the Kandik basin are dominated by ~2.7 Ga and 2.0-0.9 Ga Laurentian grains that suggest derivation from cratonic provenance areas. In contrast, the Aptian-Albian (125-100 Ma) Kathul Greywacke in the Kandik basin contains volcaniclastic deepwater deposits with an influx of 230-150 Ma DZ grains that signify a major change in provenance. To the west and across the Tintina fault, the Manley basin exhibits a similar upsection shift to 230-150 Ma DZ grains that occurs during the transition from early Cretaceous quartzites to the Albian Wilber Creek unit, which includes volcaniclastic graywacke.

The 230-150 Ma DZ grains have two potential source areas based solely on age. The grains may be derived from widespread syncollisional magmatism to the southeast that records Triassic–Jurassic accretion of the Yukon-Tanana terrane with the North American margin, followed by Cretaceous extension. Alternatively, the grains may be derived from a hypothesized Triassic-Jurassic oceanic island arc to the northwest that collided with the Arctic margin during the Jurassic-Cretaceous Brookian Orogeny. Published zircon Hafnium isotope data suggest that the Arctic island arc source is juvenile (εHf of +11 to +16) based on igneous clasts and DZ data in the eastern Yukon-Koyukuk basin, whereas the Yukon-Tanana collisional orogenic source is more evolved (εHf of -22 to +6) based on igneous bedrock data.

New εHf data from Kathul Greywacke 230-150 Ma DZ grains in the Kandik basin are dominated by juvenile εHf (+10 to +17) that provides compelling evidence for an island arc source. In contrast, εHf from Wilber Creek 230-150 Ma DZ grains in the Manley Basin vary spatially from predominantly juvenile (εHf of +9 to +17) in the western basin, to more evolved (εHf of -15 to +5) in the eastern basin, suggesting a west-east transition from island arc to collisional orogen sources. Notably, map restoration based on alignment of the juvenile island arc εHf provenance in the western Manley basin and western Kandik basin suggests >400 km of dextral strike-slip offset along the Cenozoic Tintina-Victoria Creek fault system, comparable to several independent strike-slip estimates of ~430-490 km.

Paleocene to Miocene exhumation and fault reactivation on the western flank of the Purcell Mountains, southeastern British Columbia

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Much of the presently exposed Omineca belt within the southeastern Canadian Cordillera was exhumed to 8.5–14 km depths by the middle-Cretaceous or Paleocene, followed by a transition to regional extension. The timing and spatial pattern of this last phase of extension and exhumation remains enigmatic, however recent work has shown that parts of the region have been active as recently as the Miocene. The Purcell Mountains, located within the southeastern Omineca belt, are bounded on their western flank by the west-dipping Gallagher Fault zone and the east-dipping Purcell Trench fault, two extensional structures previously assumed to be of Paleocene–Eocene age. This study examines the timing of Paleocene and younger exhumation across these two structures by using low-temperature thermochronology data (closure temperatures of ~200–60°C). Samples for zircon (U-Th)/He (~200–160°C) and apatite (U-Th-Sm)/He (~80–40°C) were collected from four elevation profiles located in the hanging wall and footwall of both the Gallagher fault zone and Purcell Trench fault. New and compiled ZHe mean ages from profiles near the Gallagher fault zone range from ~54 to ~29 Ma and new AHe mean ages range from ~36 to ~10 Ma. New and compiled ZHe mean ages from profiles near the Purcell Trench fault range from ~44 to 32 Ma and new AHe mean ages range from ~41 to ~18 Ma. These data, when combined with existing mica $^{40}Ar/^{39}Ar$ data and intrusion emplacement depths, indicate 10–13 km of exhumation in the footwall of the GFZ since 66 Ma, with 3–5 km of that exhumation occurring after 30 Ma. In contrast, rocks from the footwall of the Purcell Trench fault experienced 18–23 km of exhumation since 66 Ma, with 8–10 km of that exhumation occurring from 48–33 Ma and ~2 km between 33 Ma and the present. These data, paired with Oligocene and younger cooling ages from the hanging walls of both the Gallagher fault zone and Purcell Trench fault, indicate post-Eocene differential exhumation across the structures, building upon a growing dataset supporting widespread reactivation of the normal faults of the region.

Constraints on Mesozoic subduction polarity and terrane translation from the contemporaneous Franciscan complex and Easton metamorphic suite

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Tectonic models for the North American Cordillera differ in the absolute age, duration, and polarity of Mesozoic subduction zones. Andean-style models propose long-lived, continuous, east-dipping subduction throughout the Jurassic and Cretaceous. In contrast, alternative models invoke early west-dipping intra-oceanic subduction zones followed by younger east-dipping subduction. These Mesozoic tectonic models are further complicated by the role of terrane collision and translation, particularly in the Late Cretaceous.

The metamorphic and structural record of Jurassic–Cretaceous subduction accretion complexes are critical to resolve conflicting interpretations for convergence history of the Cordillera. Of these, the Franciscan complex of California and the Easton metamorphic suite of Washington provide contemporary records of subduction and accretion at different locations within the western United States. Published work from the Franciscan complex provides strong evidence for long-lived east dipping subduction from the Jurassic to the Neogene. The metamorphic ages of high-grade blocks in mélange and coherent units record continuous subduction metamorphism from 176 Ma to 100 Ma and the detrital zircon ages extend the subduction accretion record to <40 Ma. East-dipping subduction throughout that time is supported by the position of the Franciscan complex seaward of the Coast Range ophiolite, Great Valley forearc, and Sierra Nevada batholith, as well as metamorphic ages and temperatures that young structurally downward and to the west.

The Easton metamorphic suite in the Northwest Cascades similarly records Early Jurassic subduction initiation and continuous east-dipping subduction into the Early Cretaceous. High-grade (650-700° C) garnet amphibolite at the structurally highest position of the Easton records a garnet Lu-Hf peak metamorphic age of 183 Ma. This same unit contains blocks of 203 Ma garnet-clinopyroxene amphibolite that we interpret as eroded from the hanging wall of the subduction zone. The amphibolite is structurally underlain by high-grade (500–540° C) blueschist with a peak metamorphic garnet age of 173 Ma and the two units were juxtaposed by approximately 167 Ma. These early formed high-grade blueschists were then underplated by lower-grade (<400° C) regional blueschist units between

150 and 135 Ma. Further west within the San Juan Islands, correlative blueschist facies metagraywacke units have detrital zircon and fossil ages that constrain subduction zone metamorphism to younger than 112 Ma. Similar to the Franciscan, east-dipping subduction is supported by the decreasing metamorphic grade and age structurally downward to the west. The record of Easton subduction, however, is truncated by the Late Cretaceous faults of San Juan islands – northwest Cascades thrust system that placed the Easton metamorphic suite and other nappe sequences over Wrangellia circa 93 Ma to <87 Ma. Unlike the Franciscan, it is difficult to link the Easton to a specific forearc or arc because of post-metamorphic translation. However, minimum fault offset models, terrane characteristics, and Triassic age garnet blocks are consistent with an origin near the Klamath mountains.

A comparison of the Franciscan complex and Easton metamorphic suite records reveals that both complexes underwent synchronous initiation of east-dipping subduction between ca. 183 and 176 Ma. The age and vergence of subduction initiation in both areas is inconsistent with Cretaceous subduction initiation models. The Franciscan complex preserves a prolonged record of subduction into the Cenozoic that supports traditional Andean-style models and appears incompatible with the Late Cretaceous collision of the Insular terrane at southern paleolatitudes. In contrast, the subduction record in the Easton metamorphic suite is truncated by Late Cretaceous faulting and northward translation. This truncated record, combined with evidence of exotic Triassic amphibolite blocks, suggests that the subduction record of the Easton metamorphic suite is permissive with models involving a Late Cretaceous collision of the Insular terrane near the Klamath region. Together, these records provide essential constraints for reconciling competing interpretations of the structural configuration and convergence history of the Cordilleran margin.

Polyphase Cretaceous and Cenozoic deformation along the Porcupine Fault System of Yukon and Alaska

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The Porcupine Fault System (PFS) of northern Yukon and Alaska is a major craton-bounding fault zone that accommodated Paleozoic terrane translation of Arctic Alaska along the northern margin of Laurentia. The Mesozoic–Cenozoic history of the PFS remains poorly understood due to a lack of coupled structural and geo- thermochronological datasets required for new kinematic and paleogeographic models for the circum-Arctic, northern Pacific, and northern Cordillera. We couple regional low-temperature thermochronology, Raman spectroscopy of carbonaceous material (RSCM), and fault rock thermochronology to understand faulting and exhumation patterns along the PFS. Faults within the PFS exhibit normal, thrust, and strike-slip kinematics and are commonly coated by hematite, epidote, and/or calcite which are amenable to (U-Th)/He and U-Pb thermochronology. Field and microstructural observations support synkinematic growth and deformation of these minerals, allowing us to target them to date deformation. RSCM analyses show similar peak temperatures of ~325 °C across the various structural blocks in the PFS, supporting lateral juxtaposition of para-autochthonous and allochthonous rocks against autochthonous strata of the Laurentian margin. Zircon (U-Th)/He (He) dates across the PFS are ~115–75 Ma and apatite He dates are dominantly between ~80–50 Ma. Inverse thermal history modeling coupled with RSCM temperatures indicate periods of cooling in the Cretaceous and Paleogene. The Cretaceous cooling is coeval with calcite U-Pb ages from fault related veins and fault surfaces at ~120 Ma and 100–95 Ma, recording deformation during Early Cretaceous opening of the Canada Basin and in the Late Cretaceous. A thin tuff interbedded within nonmarine strata cut by PFS faults yielded an eruption age of ~61 Ma, overlapping with Paleogene cooling and highlighting the presence of previously unrecognized early Cenozoic synorogenic deposits in potential pull-apart basins. Hematite He yielded dates from ~8.5–0.7 Ma, and microstructural observations support that dates record hematite precipitation and deformation along brittle faults in the shallow crust. Our field observations and structural data integrated with regional and fault rock geo- and thermochronology support reactivation of the PFS during the Cretaceous and Paleogene with deformation as young as the Pleistocene, suggesting the PFS played a role in the opening of the Arctic Ocean and widespread Cenozoic strike-slip faulting in the northern Cordillera. Our new results show that the PFS was active through the Late Cretaceous and Cenozoic, requiring new models for the Arctic and Northern Cordillera in Alaska and northern Canada.

Did anaerobic oxidation of methane play a key role in trapping metals in the Howard's Pass zinc-lead district?

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Howard's Pass is a world-class district of clastic-dominated zinc-lead deposits located in the Selwyn mountain range of the Canadian Cordillera and spanning the Northwest Territories-Yukon border. Mineralization is hosted in variably siliceous and calcareous organic-rich mudstone of the Ordovician–Silurian Duo Lake Formation, which also contains abundant calcareous concretions that can exceed a metre in diameter. Previous work has shown that anaerobic oxidation of methane – a microbial process in which methane (CH_4) and sulfate (SO_4^{2-}) react to produce bicarbonate (HCO^{3-}) and reduced sulfur (HS^-) – was active during diagenesis of the host strata at Howard's Pass. The process contributed to the formation of carbonate in the Duo Lake Formation and was likely a source of at least some reduced sulfur in the Zn-Pb deposits. To better understand the factors controlling methane production and distribution within the host sediment, we systematically sampled concretions and limestone beds in a section of the Duo Lake Formation and analyzed for C and O isotopic composition of carbonate. Preliminary results for concretions occurring stratigraphically above the zinc-lead-mineralized interval show an average isotopic composition of -7.29 ± 2.86‰ $\delta^{13}C$ and -9.54 ± 1.13‰ $\delta^{18}O$. The absence of extremely negative $\delta^{13}C$ values (i.e., ≤ -50 ‰) indicates that methane was delivered to pore waters via diffusion from underlying sediments rather than by advective flow along synsedimentary faults. In contrast, bedded limestones from within the mineralized interval have an average isotopic composition of -3.42 ± 0.51‰ $\delta^{13}C$ and -10.85 ± 1.90‰ $\delta^{18}O$. The less negative $\delta^{13}C$ values may reflect a smaller contribution of methane-derived carbonate while the more negative $\delta^{18}O$ values may indicate higher temperatures at the time of carbonate precipitation, driven by hydrothermal fluid activity. Results from concretions in the mineralized interval are pending, but will be used to evaluate the role methane played in generating a trap for base metal mineralization forming the deposit and inform future exploration strategies.

Cryptic late Quaternary surface ruptures in a recently deglaciated, forested landscape - the San Juan Fault, Vancouver Island, BC

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Forearc crustal faults pose significant risks within the Cascadia subduction zone, and a wealth of new lidar data allow for their identification and characterization. In the northern Cascadia forearc, the E–W-striking, terrane-bounding, San Juan fault (SJF) displays topographic lineaments that are more conspicuous in lidar imagery than those along other known active faults in the region, but it remains unresolved whether the fault has ruptured in large prehistoric earthquakes and poses a risk to the ~600,000 people living on southern Vancouver Island. Initially a collisional suture between the Wrangellia and Pacific Rim terranes, the SJF is last known to have accommodated left-lateral slip during the Eocene driven by accretion of the outboard Crescent-Siletz terrane. As locking of the Cascadia megathrust may mask smaller geodetic signals from crustal faults, and without clear concentrations in crustal seismicity, a multi-faceted approach is required to ascertain whether the SJF is active. We map a relatively continuous and linear set of 2–150 m high, north-facing scarps along the fault trace, but find limited evidence of clear offset of Quaternary sediment that would be diagnostic of neotectonic activity. An alternative hypothesis is that the scarp formed due to differential glacial erosion of the distinct bedrock units juxtaposed by the fault. We disprove this hypothesis using Schmidt hammer measurements, which reveal harder rocks on the lowered (north) side of the scarp than on the raised (south) side, suggesting that south-side-up motion is tectonically driven. In combination with the vertical scarps, curved channel offsets are consistent with dextral-reverse slip, which would invert the sinistral offsets accrued by the fault in its early history. We also use electrical resistivity tomography to investigate one prominent, uphill-facing scarp. Disruption beneath the scarp to otherwise continuous subsurface structure is further evidence of late Quaternary rupture. Though somewhat equivocal, these results strongly motivate future paleoseismic investigations along the SJF.

Current tectonics of the Richardson Mountains, northwestern Canada, from preliminary double-difference earthquake relocations

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The Richardson Mountains (RM) of northwestern Canada form a tectonically active boundary between the northern Canadian Cordillera and stable North American craton. Although host to abundant seismicity, the RM modern geometry and kinematics remain poorly resolved. To better delineate active structures, we apply double-difference (DD) earthquake relocation to all seismicity in the Canadian National Earthquake Database (NEDB) between 2015 and 2021 (775 events). We jointly invert catalog P and S-wave picks and waveform cross-correlation measurements with the *scrtdd* implementation of *HypoDD*.

The resulting 594-event catalogue reveals two zones. Along the eastern front of the central RM, DD relocations collapse into a sharply defined west-dipping plane extending from the surface to 35 km. Its approximate 75° dip and surface intersection with the Knorr fault suggest that contemporary deformation is reactivating a Paleozoic normal fault. In contrast, seismicity remains broadly distributed across the White Mountains and Barn uplifts, reflecting deformation partitioned among several interacting inherited structures within a complex deformation zone. A reduction in seismicity between these regions (in both original and relocated catalogues) may indicate structural segmentation or a locked segment with implications for seismic hazard.

These results demonstrate the effectiveness of DD relocation for resolving active tectonic structures in remote northern regions and provide a refined framework for future investigations. Continued incorporation of new data from the Western Arctic Regional Network of Seismographs (WARNS) will support improved assessments of crustal deformation and seismic hazard in Canada's North.

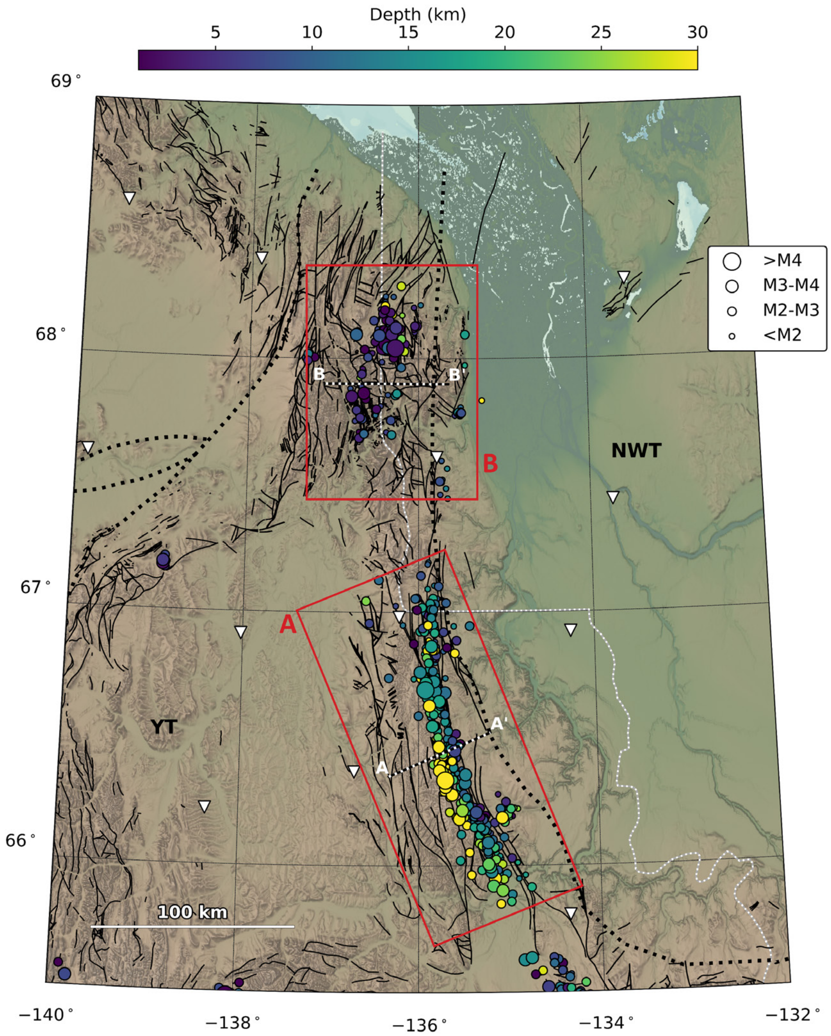

Figure 1. *Map view of relocated catalog of 594 earthquakes across the Richardson Mountains study region. Earthquake depths are denoted by the colour of the circle, and magnitudes by the size of the circle. Major faults are plotted as dotted lines and 'defined' faults as solid lines, from the Yukon Geological Survey and Northwest Territories Geological Survey online repositories. Regions A and B are indicated by red boxes.*

December 6. 2025 M_w 7.0 earthquake in southwestern Yukon

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The December 6, 2025 moment magnitude (M_w) 7.0 earthquake in southwestern Yukon was the largest onshore earthquake in Canada in more than 75 years. The earthquake occurred in a remote, glaciated area with sparse seismicity over the last several decades. The area lies in the gap between the right-lateral Totschunda and Fairweather transform faults and has been hypothesized to host the "Connector Fault" to accommodate right-lateral shear inboard of the plate boundary. The Connector Fault appears to be illuminated by the M_w 7.0 earthquake. We present preliminary results based on interpretation of aftershock relocations and invite discussion about the tectonic implications of this event.

Geologic framework of the Goodpaster and Richardson mining districts

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Alaska Division of Geologic & Geophysical Surveys (DGGS)

Withdrawn From Schedule

The Goodpaster and Richardson mining districts of Interior Alaska are well-endowed with gold and accessory critical minerals. Despite the district's discoveries, and almost two decades of production at the Pogo mine, much remains to be understood about the genesis and district-scale spatial controls of this mineral system. Drawing on our recent geologic mapping and analytical work conducted through the Earth Mapping Resources Initiative (Earth MRI), we examine the broader geologic framework of the district and place mineralization into this context.

Recent DGGS mapping divides the host metamorphic rocks into three assemblages, groups of rocks with shared geologic histories, which apparently represent three structural panels during Jurassic orogenic and mid-Cretaceous extensional events. The Lake George assemblage is dominated by paragneiss, granite to quartz diorite orthogneiss, amphibolite, and batholith-scale bodies of augen orthogneiss. The Fairbanks-Chena assemblage, in contrast, includes a wider range of lithologies including garnet-bearing schist, siliceous paragneiss, marble, calc-silicate gneiss, graphitic schist, granitic orthogneiss, amphibolite, and lesser augen orthogneiss. The greenschist facies Butte assemblage is the structurally highest assemblage, locally preserving Triassic argon cooling ages, which indicate ties to the allochthonous Yukon Tanana Terrane.

Garnet-biotite geothermobarometry indicates that Lake George and Fairbanks-Chena assemblages follow separate, but parallel, P-T paths, suggesting that the two assemblages are separated by a regional extensional detachment fault. Both assemblages experienced decompression and heating, with the Lake George P-T path crossing the muscovite + quartz → sillimanite + K-feldspar + liquid reaction boundary. The result is a regional fluid release event, which includes local flux melting of metasedimentary rocks, recrystallization, and zircon overgrowths dated ca. 117–110 Ma. Voluminous granitic magmatism, ca. 112–108 Ma, marks the tail end of this extensional event and is concentrated overwhelmingly in the footwall of the main detachment structure separating the allochthonous and parautochthonous assemblages. Both melt generation and pluton emplacement may be extensionally facilitated.

The most significant deposits of the district, including the Pogo mine and the SAM (Naosi) and LMS resources, are hosted in low angle shear vein systems near the boundary between the Lake George and Fairbanks-Chena assemblages, which we infer to be a regional detachment. The mineralization is difficult to date, but age determinations for the district range from 113 to 93 Ma. Our interpretation is that this ~20 Ma span reflects a long-lived mineral system, and that vein formation and mineralization at a range of pressures is responsible for the range of ductile to brittle textures observed. In our view, the mineral system is driven by extension, including decompression-related melt generation (adding heat ± fluids ± metal to the upper crust), metamorphic fluid generation via muscovite to sillimanite phase transition, and structural control along or near second-order extensional detachment faults.

Glory of the glaciers, lithology, and structure: controls of fluvial erosion in Southern Canadian Rocky Mountains

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The southern Canadian Rockies represent a late-stage tectonic landscape, with its evolution complicated by fluvial erosion, glacial processes, and contrasts in lithologic erodibility. To understand the importance of these factors on landscape evolution, we apply statistical modelling to a new set (N=22) of ^{36}Cl catchment averaged erosion rates. This constitutes the first reported cosmogenic catchment averaged erosion rates from the Canadian Rockies. For each catchment, we extract summary statistics (e.g., 10th, 25th, 50th percentiles) of factors that may influence erosion rates, including climate factors (mean annual temperature [MAT], mean annual precipitation [MAP], and normalised difference vegetation index [NDVI]) and topographic factors (relief, gradient, and channel steepness [k_{sn}]). Additionally, to capture the stepped nature of the topography in the Rockies resulting from spatially variable lithologic strength and glacial modification, we compute the standard deviations in k_{sn}, terrain ruggedness index (TRI) and topographic curvature for each catchment. Finally, constraining lithologic erodibility is especially challenged by the high complexity in depositional architecture of mixed carbonate-siliciclastic rocks and facies structure of carbonate rocks in passive margins. Therefore, we measure and employ direct intact rock strength measurements (6629 individual measurements at 96 distinct locations) for each geologic unit in sampled catchments using a Schmidt hammer. The impact of fault-related damage zones on lithologic erodibility is partially accounted for by calculating fault density derived from mapped structures. Additionally, we employ a new method to assess landscape stability based on the TOBIA index, which accounts for the relationship between the bedding orientation (primary plane of weakness) and hillslope angle. For transitional landscapes (those affected by both fluvial and glacial erosive processes), we find that the standard deviations in k_{sn} and topographic curvature are much more important regressors with erosion rates than their corresponding mean values. Interestingly, we find that climatic factors (MAP and NDVI) have significant influence on fluvial erosion despite being uniform across the region. Although fully accounting for lithologic erodibility remains challenging, our TOBIA index-based method is a significant step in constraining litho-structural controls on landscape evolution.

Preliminary thermochronologic observations from an orogen-normal transect in central Yukon

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A transect across the Intermontane Terranes in central Yukon is being investigated using a subset of the large low temperature thermochronology dataset collected as part of the Geological Survey of Canada's GEM-GeoNorth Program. The cooling history of the Dawson Range has implications for understanding the exhumation history of the region and preservation potential of porphyry systems. Preliminary observations are presented from zircon U-Th/He, apatite U-Th/He, and apatite fission track data from 27 plutonic samples in an approximately orogen-normal transect in central Yukon from the Denali fault in the west to the Tintina fault in the east. Broad-scale spatial variations in single crystal ages and mean ages are presented for discussion. Inverse models created using the HeFTy software (Ketcham, 2025) are used to examine potential differences in the cooling history of mid-Cretaceous Whitehorse suite intrusive rocks in the western half of the transect.

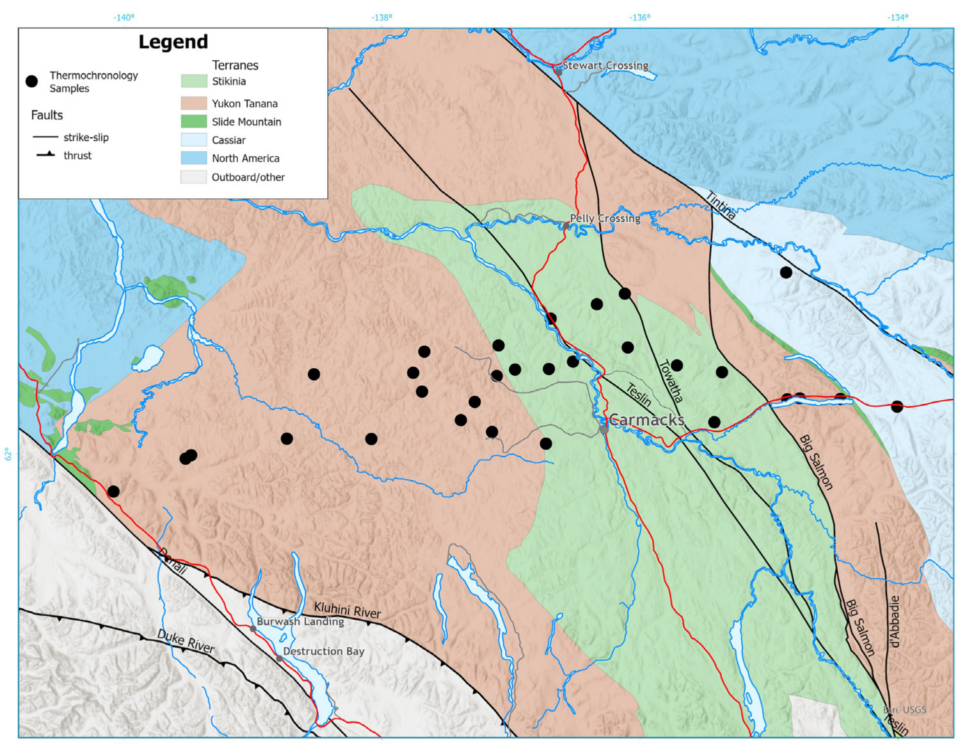

Figure. *Map of transect area with simplified geologic Terranes, major faults, and sample locations. Rivers, roads, and towns overlain.*

Field observations, mineralogy, microtextures, and preliminary Cr-mica $^{40}Ar/^{39}Ar$ geochronology of Seventymile listwanitized ophiolites reveal fault-related fluid flow during contractional and extensional tectonics in the Alaska Yukon Tanana upland

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Ultramafic (UM) and mafic (M) ophiolitic klippen of the Seventymile terrane are exposed throughout the Alaska-Yukon Tanana upland (YTu). These largely greenschist facies klippen have been obducted onto, and locally imbricated with, parauthochthonous amphibolite facies supracrustal Devonian-Mississippian basement assemblages of the composite Alaska-Yukon Tanana terrane (AK-YTT). The present outcrop distribution of the UM/M rocks in the YTu indicates that the klippen may have been dismembered by post-contractional extension. Yet the degree of tectonic, structural, and magmatic continuity among the UM/M rocks from regional to outcrop scales presents uncertainty regarding their evolution, kinematics and age of emplacement.

UM/M rocks associated with YTu ophiolites are exposed over a region ~125 km N-S by ~190 km E-W. We present data from two study areas including one to the northwest, Salcha, and one ~70 km to the southeast, Healy. At Salcha, we observed a discrete ophiolite basal shear zone (BSZ) containing listwanite, a product of Mg-rich peridotite altered by CO_2-rich waters. At Healy, basal shear zones are marked by talc-rich rocks in sharp contact with megacrystic garnetiferous amphibolite metamorphic sole and basement gneiss. Shear zone and other kinematic indicators show evidence for overall north-directed contraction *and* (possibly) later complex southerly-directed extension perhaps reflecting the existence of a previously hypothesized metamorphic core complex. However, the timing of these events is poorly documented by direct, kinematically constrained shear zone/fault rock textures and geochronology.

Listwanitized zones are found along exposures of the Salcha ophiolite BSZ and as discrete, tabular fracture zones (TFZs) internal to several ophiolite klippen NE of Salcha, at Healy, and at smaller occurrences in the broader study area. Mineral assemblages of the listwanites from whole rock X-ray diffraction analyses (n=11) include, in order of abundance, magnesite, dolomite, quartz, ankerite, Cr-illite, chlorite, and small concentrations of talc. Cobalt, Cr, Ni, and Mn are present at ~0.2 wt%; S and Au are present at low-ppm and ppb levels, respectively. Field observations and microstructural characteristics of all listwanites show near complete transformation of Mg silicates to Mg carbonates. Study area listwanites show textural evidence of multiple generations of Mg carbonate precipitation and microbrecciation of veins and massive domains. Potassium bearing Cr-illite occurs as clots, stringers, and disrupted microveins with textural evidence of multiple Cr-illite growth events. The entire assemblage is cut by complexly oriented, paragenetically late milky white quartz and chalcedony veins. At Healy an exposure of listwanite shows microstructures suggestive of mylonitic, synkinematic Cr-mica growth.

We used $^{40}Ar/^{39}Ar$ step-heating experiments on six samples of listwanite Cr-illites to characterize the timing of ophiolite emplacement and fault/fracture related fluid flow. Three samples are from west, central, and east localities along the Salcha BSZ; two are from TFZs northeast of Salcha-proper; and one is from a TFZ with mylonite at Healy. $^{40}Ar/^{39}Ar$ dates for 59 steps show a dominantly bimodal population: an older group from ca. 145–108 Ma (median ca. 119 Ma), and a younger group from ca. 93–49 Ma (median ca. 69 Ma). A small cluster of 4 additional dates from ca. 220–185 Ma stands apart from the other 59 dates. Of the 59 dates in the bimodal population, 31 are dominated by radiogenic (RD) ^{40}Ar (i.e., $^{40}Ar^* > 50\%$), and 28 are dominated by atmospheric/trapped (AD) ^{40}Ar (i.e., $^{40}Ar^* < 50\%$). The older group has 16 RD and 4 AD analyses, while the younger group has 15 RD and 24 AD analyses.

Although preliminary, the date clusters, isotopic compositions, listwanite textures, and overall geotectonic framework can be interpreted as reflecting multiple periods of hydrothermal fluid flow. The oldest cluster of 220–185 Ma dates may be related to ophiolite contractional emplacement and regional metamorphism. The 145–112 Ma dates may reflect hydrothermal activity during the transition from contraction to extension, and the 96-49 Ma dates indicate ongoing hydrothermal activity well into the extensional regime. Possible thermal overprinting and resetting of the Cr-illites has not yet been evaluated. The dominance of the RD $^{40}Ar^*$ component associated with older dates is possibly due to an early period of thickened crust with limited circulation of fluids derived from the near surface. In contrast, the AD ^{40}Ar dates centered around ca. 63 Ma may reflect shallower fluid-flow events localized in relatively high permeability shear/fracture zones in crustal conditions associated with regional extension and related exhumation. This interpretation is consistent with observations of late quartz and chalcedony veins cutting listwanite, as well as regionally distributed ca. 55 Ma volcanic and hypabyssal rocks that require near-surface conditions in the Cenozoic.

Progressive underplating and Metamorphic Sole Formation in the Easton metamorphic suite of the North Cascades of Washington

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Metamorphic soles provide critical snapshots of the thermal and structural evolution of nascent subduction zones. In the Easton metamorphic suite (northwest Washington), an inverted metamorphic sequence preserves a record of Jurassic-Cretaceous (183–136 Ma) subduction initiation and subsequent accretion. This suite comprises the high-temperature (630–700 °C) Gee Point Amphibolite structurally overlying lower-temperature (500–550 °C) High-Grade Blueschists and regional low-grade units (Shuksan greenschist). We test competing models of sole formation—conductive heating versus progressive tectonic underplating—integrating garnet 76Lu-76Hf geochronology, RSCM thermometry, and microstructural analysis.

Results of our new Lu-Hf garnet ages resolve a temporal gap between the initiation of subduction at ~183 Ma and the previously determined High-Grade Blueschist titanite age of ~167 Ma, indicating High-Grade Blueschist underplating between 173–167 Ma. Structural mapping reveals a subhorizontal WNW-trending regional synform that preserves dismembered Gee Point Amphibolite in fold hinges, while microstructural data identifies a high-strain contact between the sole units and the underlying Shuksan Greenschist. This contact records the final assembly of the regional low-grade units and their underplating beneath the metamorphic sole between 140–136 Ma, characterized by a prominent S3 foliation in the High-Grade Blueschist and greenschist-facies overprinting of the blueschist assemblage in the contact zone with Shuksan Greenschist.

The constrained ~10 My duration between peak amphibolite metamorphism and blueschist underplating suggests a rapidly evolving thermal regime. These relationships indicate that the Easton metamorphic sole was constructed via the progressive accretion of discrete tectonic slices rather than steady-state conductive heating. This conclusion refines existing models of convergent margin evolution and underscores the dominance of tectonic stacking during the early stages of subduction.

Preliminary geology and metallogeny of Oligocene to Miocene magmatic rocks in southwest Yukon, NTS 115F15

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Cenozoic subduction along the western margin of North America has produced a broad, semi-continuous belt of forearc magmatism across the northern Cordillera stretching from western Alaska, through southwest Yukon, down the coastal regions of BC, Washington, and Oregon (Figure 1). Despite how extensive this belt is, large regions lack basic, first-principles understanding of geological relationships, geochronology, and geochemistry which limit the understanding of their tectonic and magmatic framework as well as their metallogenic significance. As a result, mineral occurrences within this belt are sparsely documented and poorly constrained.

Unique to this region of the northern Cordillera, specifically southern Alaska, southwest Yukon and northwestern BC, is the flat to shallow subduction of the Yakutat microplate, a rifted oceanic plateau fragment of the Pacific plate that was translated northward along the Queen Charlotte transform fault and began subducting around 30 million years ago. This study investigates Oligocene and Miocene magmatic rocks and associated porphyry system (porphyry, epithermal and skarn) mineral occurrences within the Insular terranes across southwest Yukon associated with this subduction environment.

Preliminary field mapping, geochemistry, petrography and drill core observations from the Mint Cu-Mo-Au porphyry occurrence within NTS map sheet 115F15 are presented here. Petrographic, geochronological, geochemical results and detailed mapping will be integrated into a surrounding 1:50,000 scale bedrock geology map. In addition, regional work on these magmatic rocks will place them in a broader tectonic and magmatic framework consistent with the rest of the northern Cordillera.

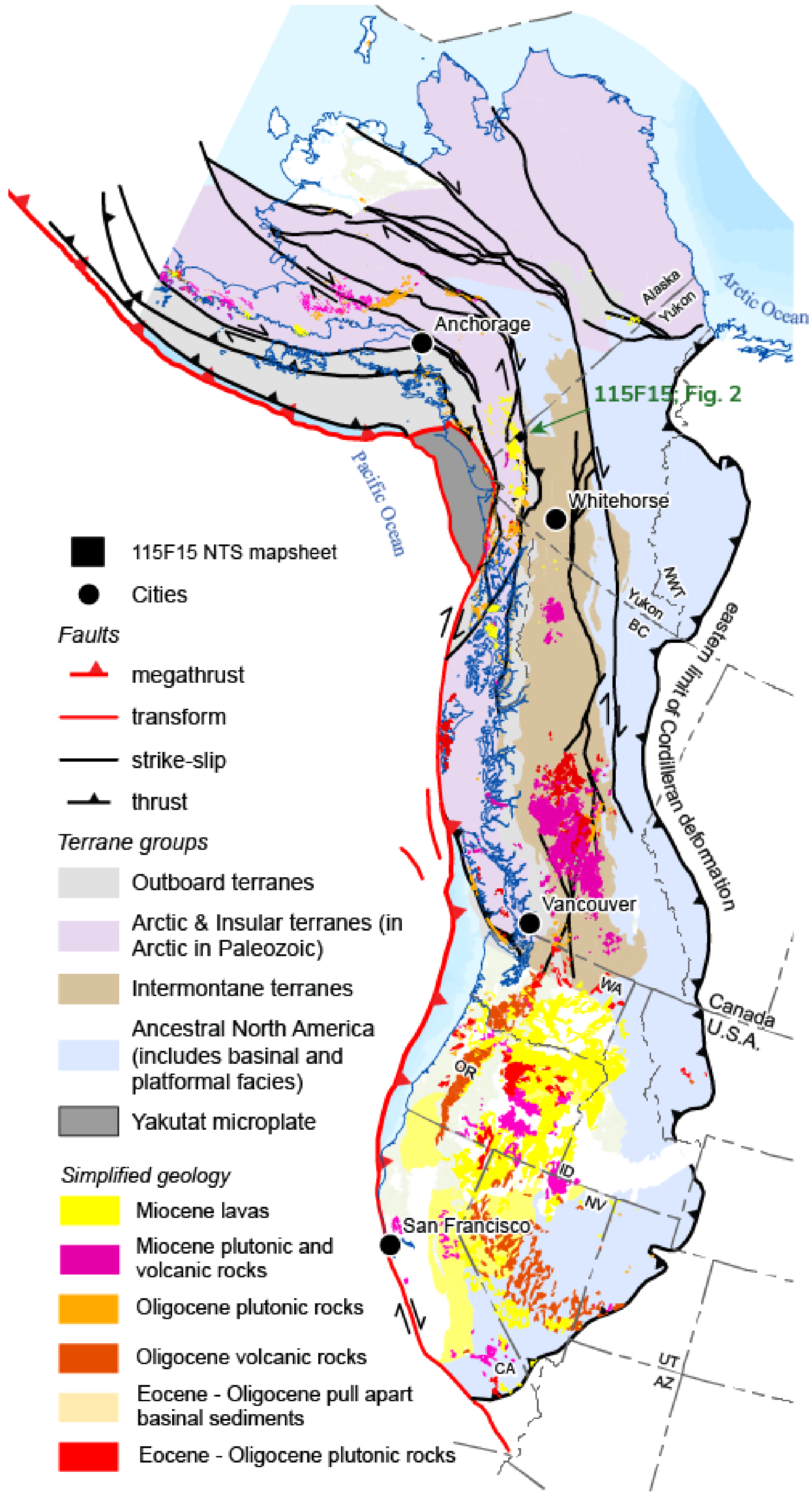

Figure 1. *Cordilleran terrane map with major faults and distribution of Eocene to Miocene magmatic rocks across Alaska, southwest Yukon, British Columbia and western United States. Yakutat microplate (part of the outboard terranes) is highlighted to show proximity to field study area.*

Uranium-Lead Geochronology of Three Mesozoic Intrusions in Southeastern British Columbia

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This study presents preliminary results on the emplacement ages and geologic context of the South Wragge Creek, Snowslide Creek, and Mount Carpenter stocks using uranium–lead (U–Pb) zircon geochronology supported by petrographic observations. These igneous intrusions are located south of Nakusp and geologically north of the Valhalla Complex in southeastern British Columbia. Results of this study are supported by previously suggested Jurassic ages for the South Wragge Creek and Mount Carpenter stocks, while the Snowslide Creek stock was interpreted to have been emplaced in the Cretaceous. Constraining the timing of these intrusions will help define relationships between magmatism and the timing of regional deformation in the area.

Zircon grains recovered from each intrusion were imaged using cathodoluminescence (CL) to identify inherited cores and magmatic rims, the latter showing oscillatory zoning. U–Pb dates were obtained by LA-ICP-MS and are reported as weighted mean $^{206}Pb/^{238}U$ ages. Crystallization ages from spots on the rims were used to estimate emplacement ages. Reported ages are calculated from datasets that excluded discordant grains and statistical outliers (Chauvenet criterion). The Snowslide Creek stock, a biotite monzogranite, returned an age of 81.32 ± 0.40 Ma (n = 11). The South Wragge Creek stock, a weakly foliated epidote hornblende granodiorite, recorded a Jurassic age of 170.47 ± 0.65 Ma (n = 20). The Mount Carpenter stock, a biotite hornblende quartz monzonite, returned what are interpreted to represent two age populations with absolute ages of 168.4 ± 1.0 Ma (n = 7) and 231.8 ± 1.6 Ma (n = 6), indicating emplacement in the Jurassic and Triassic, respectively. These results are consistent with Jurassic and Cretaceous emplacement ages previously inferred from regional geologic relationships. The results provide timing constraints on magmatism that can be compared with the timing of regional deformation.

Sediment Provenance of the Lower Cretaceous Colville Foreland Basin, Arctic Alaska, Exhibits Widespread but Cryptic Permian-Triassic Detrital Zircon U-Pb Ages

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The Colville Foreland Basin is a product of the collision of the Jurassic Koyukuk arc and the Arctic Alaska continental margin (AACM) during the assembly of the northern Cordillera of North America. We synthesize published and new detrital zircon U-Pb (DZ) data from Lower Cretaceous strata of the Alaska North Slope and eastern Brooks Range to interpret sediment sources and transport pathways during initial filling stages of the Colville Basin. Results show that Neocomian strata autochthonous to the AACM are dominated by Paleozoic–Neoproterozoic DZ and are interpreted to have been shed southward from the rifted AACM. To the south, the allochthonous Neocomian Okpikruak Formation (Fm.) flysch and mélange record initial syntectonic sediment that was shed northward off the ancestral Brooks Range orogen. Moore et al. (2015) studied the Okpikruak Fm. in the western foothills and inferred that Jurassic DZ ages in higher allochthons were sourced from Angayucham terrane and more common Permian–Triassic DZ ages were recycled from Triassic clastic strata from Russian Chukotka because there are no known sources of these ages in Arctic Alaska. New data from the Okpikruak Fm. and correlative units along the central and eastern Brooks Range show that these age populations persist eastward for another ~700 km, with Permian–Triassic ages most widespread. A Chukotka source of Permian–Triassic DZ to the northeast Brooks Range would require >1000 km of longitudinal sediment transport, plus intermingling with proximal petrofacies, clasts, and olistoliths transversely-derived from the Brooks Range allochthons. Alternatively, more proximal but cryptic Permian-Triassic DZ sources may be required. Possible sources include Chukotka-equivalent Triassic clastic strata that may have extended to the northern Angayucham ocean, or hypothesized Permian–Triassic arcs that were accreted in the Jurassic to Early Cretaceous and fully exhumed during mid-Cretaceous extension of the orogen. Subsequently, wedgetop facies of the Aptian–Albian Fortress Mountain Fm. prograded northward into the early Colville Basin. DZ U-Pb results from the Fortress Mountain Fm. show DZ age distributions that are interpreted to be recycled from the Okpikruak Fm. Finally, the syntectonic and wedgetop DZ pattern can be contrasted with DZ ages from the overlying Albian–Cenomanian Nanushuk and Torok Fm. that was deposited during the late stages of the ancestral orogen and rapidly filled the relict foreland basin. The southern and most proximal to the Brooks Range (~70–90 km) Nanushuk and Torok Fms. are dominated by Paleozoic and older DZ that suggest central Brooks Range sediment was sequestered in the proximal foredeep and not broadly distributed to the north. Stratigraphic transects through these formations show an eastward and upsection increase in sediment recycled out of Paleozoic strata that culminates in Nanushuk Fm. non-marine strata. This spatiotemporal transition delineates the northeastward propagation of the foredeep axis during mid-Cretaceous filling of the basin.

Structural and metamorphic evolution on the northern flank of the Valhalla Metamorphic Core Complex, Southeast BC, Canada

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Results from fieldwork and literature compilation north of the Valhalla Complex uncovers a complex relationship between Mesozoic deformational events, regional prograde metamorphism, contact metamorphic aureoles developed around Jurassic and Cretaceous intrusions, and Eocene extension. The studied area lies immediately north of the Valhalla Complex between the northern end of Slocan Lake and the town Nakusp in Southeast British Columbia. This area straddles the northern termination of the ~54–45 Ma Slocan Lake Fault (SLF), an extensional brittle-ductile normal fault that is linked to exhumation of the Valhalla Complex.

Here strata of the Triassic Slocan and Jurassic Rossland Groups of Quesnellia were deformed and metamorphosed during the Mesozoic. Field observations and descriptions from the literature suggest at least two regional deformational events (Hyndman, 1968; Read and Wheeler, 1976; Parrish, 1981). Whether these phases are two separate episodes or part of one prolonged event, however, is unclear. The first phase (D1) is reported to have produced NW to W trending isoclinal folds which developed an axial planar cleavage. This fabric is expressed as a slaty to schistose foliation that is mostly parallel to bedding. A later phase (D2) deformed bedding and S1 fabric into large scale upright to inclined folds that also trend NW to W. Stereonet analyses of what has been mapped as two different fabrics, however, plot within error of each other and are therefore not distinguishable when plotted.

Metapelitic mineral assemblages reveal a prograde Barrovian-style metamorphic sequence observed in the studied area. Metamorphic grade increases going from North to South through the following zones: Chlorite + biotite, garnet, staurolite + kyanite, and sillimanite zones. Timing of metamorphism and its relationship to regional deformation mentioned above is uncertain. This metamorphic sequence is situated west of the Slocan Lake fault in its footwall. In contrast, regional metamorphic grade in the hanging wall to the east is consistently low at chlorite + biotite grade. The observation of this rapid increase of metamorphic grade only in the footwall of the SLF implies that displacement along the fault increases significantly over a short distance.

Seven recently dated Jurassic and Cretaceous intrusions developed contact metamorphic aureoles containing cordierite ± andalusite or staurolite ± andalusite bearing assemblages (Pianarosa, 2024, Colman, 2025; Glaser et al., 2026). All of these aureoles overprint the regional deformation. The Middle Jurassic Mount Carpenter Stock east of the SLF developed a cordierite + andalusite bearing contact aureole. The Late Jurassic Shannon Lake Stock west of the SLF developed a prograde contact metamorphic sequence containing staurolite, ± andalusite, sillimanite. The Late Cretaceous Wragge Creek Stock is located on both sides of the SLF ca. 15 km south of its northern termination. Where intruded into regional low-grade chlorite + biotite and garnet zone rocks a prograde contact metamorphic sequence cordierite, ± andalusite, sillimanite formed. Considering that the contact metamorphic minerals consistently overprint the regional foliation in the low-grade rocks, formation of this fabric is likely earlier or coeval with emplacement of the mid-Jurassic Mount Carpenter Stock.

In contrast, the relationship between regional high-grade metamorphism and emplacement of the mid-Cretaceous Snowslide Creek Stock west of the SLF is enigmatic. This intrusion is located in regional sillimanite-grade rocks where contact metamorphic andalusite is replaced by sillimanite. Whether this pseudomorphing sillimanite is of regional- or contact-metamorphic origin requires further analyses, owing to its implication for the timing of regional metamorphism.

The timing and number of deformational events and how they relate to regional metamorphism therefore remain unclear.

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Investigating the tectonic significance and carbon capture potential of ultramafic rocks in the eastern Harrison Lake area, southwestern British Columbia

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Hydrated ultramafic rocks (i.e., serpentinites) have the potential to rapidly and permanently capture carbon via carbonate mineralization (e.g., Kelemen and Matter, 2008) and are major hosts to Ni-Cu-PGE minerals that are essential in the transition to a green economy (e.g., Nagasingha et al., 2004). Therefore, ultramafic rocks are critical targets to reduce atmospheric carbon dioxide and mitigate climate change. In addition, ultramafic rocks are generated and emplaced in a range of geodynamic settings and thus have significant impacts on tectonic interpretations of lithological packages. Within accretionary orogens, ultramafic rocks may derive from oceanic lithosphere of the lower plate (e.g., abyssal peridotite or mid-ocean ridge ophiolites) or upper plate (e.g., supra-subduction zone ophiolites) of a subduction system (e.g., Bodinier and Godard, 2014; Wakabayashi, 2017), or as mantle-sourced ultramafic-mafic intrusions emplaced in the crust (e.g., Alaskan-type intrusions; e.g., Voormeji and Simandl, 2004). Multi-disciplinary studies that utilize bedrock mapping, whole-rock and mineral geochemistry, and geochronology of ultramafic bodies and surrounding country rock are necessary to elucidate the petrogenesis and tectonic significance of these ultramafic rocks.

Large volumes of ultramafic rocks occur within the Bridge River terrane in southwestern British Columbia; however, the petrogenetic and tectonic interpretations of these rocks have been hindered by obscuring effects of polyphase deformation and metamorphism, and the prolonged history of magmatism associated with the Coast Plutonic Complex. Compounding the problem is a paucity of modern geochemical and geochronological data throughout the area. The eastern Harrison Lake area in southwestern British Columbia (BC) is underlain by three structurally imbricated rock packages that are loosely correlated to the Bridge River terrane, Nooksack-Harrison terrane, and Tyaughton-Methow basin. Each of the eastern Harrison Lake rock packages is partly separated by ultramafic rocks bodies that are interpreted to delineate faults (Monger, 1986; Monger and Journeay, 1994). These field relationships have led previous studies to suggest the three rock packages represent individual terranes separated, in part, by dismembered ophiolitic rocks (Monger, 1986; Monger and Journeay, 1994; Brown et al., 2000).

Fieldwork undertaken in 2025 focused on targeted bedrock mapping and rock sampling of the ultramafic bodies and surrounding country rock to better understand the extent, emplacement, mineralogy, and alteration of the ultramafic rocks. The ultramafic bodies primarily comprise relatively fresh (up to 50% serpentinized), medium- to coarse-grained dunite with local Cr-spinel schlieren. Contacts between the dunite and country rock (including meta-volcanic rock, chlorite schist, gabbro, chert, and pelite) are generally under cover, recessively weathered, and spatially associated with increased serpentinization in dunite that agrees with previous interpretations that these contacts are faulted (Gabites, 1985; Brown et al., 2000). Preliminary whole-rock chemistry results, which yield high Mg-numbers (89.7-91.7) and low anhydrous Al_2O_3 (0.21–1.8 wt. %) and CaO (0.10–2.4 wt. %) values, are consistent with olivine-predominant mineralogy and overlap compositions of peridotites from the Izu-Bonin-Mariana forearc (Ishii et al., 1992; Parkinson and Pearce, 1998) and Cache Creek terrane (Milidragovic and Grundy, 2019; Steinthorsdottir, 2021).

Future work for the eastern Harrison Lake area includes additional targeted mapping to constrain the emplacement mechanism(s) of the ultramafic bodies relative to the country rock. Further whole-rock and mineral chemistry analyses will be undertaken to better understand the petrogenesis and geodynamic setting of the ultramafic rocks and surrounding country rock. Igneous and detrital zircon from units surrounding the ultramafic bodies will be dated to better constrain the ages and protoliths of the country rock and the relative timing of emplacement of the ultramafic rocks. This work will provide a better understanding of the petrology, mineralogy, and physical properties of ultramafic rocks in southwestern BC, which may be used to assess their potential to sequester carbon and host critical minerals. Additionally, this new data will improve our understanding of the petrogenesis and tectonic history of the Bridge River terrane and surrounding terranes of southwestern BC.

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Late Cretaceous Tectonothermal Development of the Northern Kootenay Arc and Western Selkirk Fan Recorded by U-Pb Monazite and Lu-Hf Garnet Geochronology

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The transition from the western Selkirk Fan into the Kootenay Arc occurs approximately 30 km southeast of Revelstoke in southeastern British Columbia. Recent mapping, structural and petrographic analysis, and geochronology at this interface and southward into the northern Kootenay Arc has uncovered a phase of Late Cretaceous mid-crustal tectonothermal development. Two dominant phases of deformation are recognized in this area; the earlier preserved as km-scale upright F1 folds with an axial-planar phyllitic to schistose S1 fabric, and a later phase of recumbent F2 folds with associated crenulations of S1 and axial-planar schistose S2 fabrics. The area has experienced a widespread chlorite to garnet zone metamorphic event (M1) which is overprinted by successive garnet, staurolite-kyanite, and sillimanite zones along the eastern shores of Upper Arrow Lake (M2). M1 garnet is commonly wrapped by S1, while M2 garnet and staurolite overprints early stages of S2 development and is weakly to moderately wrapped by S2. In-situ LA-ICP-MS U-Pb monazite dating in two garnet-staurolite bearing metapelites record single spot ages between 151-71 Ma, with the majority of analyses between 88 and 71 Ma. Monazite inclusions within staurolite range from ~85-82 Ma while inclusions in garnet rims range from ~151-82 Ma. In-situ LA-ICP-MS Lu-Hf garnet dating produced ages comparable to that recorded in monazite, with inverse isochron ages defined by garnet cores at 161 ± 5, 140 ± 7, and 84 ± 4 Ma. Analysis of garnet rims on the ca. 140 Ma garnet produced an age of 80 ± 12 Ma, compatible with 89-82 Ma monazites included in the rim of this garnet. Textural relationships between garnet, staurolite, and S2 indicates that S2 and potentially F2 development was ongoing during, and outlasted ca. 82 Ma and younger garnet and staurolite growth.

Mineral Diversity at the Gun Occurrence, a Barium Silicate Skarn in Devonian Strata of the Selwyn Basin

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The Gun occurrence is a barium-rich skarn that hosts at least 28 barium minerals, making it the most diverse barium mineral locality identified on Earth. It is a type locality for eight barium minerals, of which five are only known to be found at the Gun occurrence. This locality acts as an excellent natural laboratory to understand barium silicate mineral relationships. Textures in hand sample and thin section can be used to infer the relative order of formation for these rare minerals. Eight texturally and mineralogically distinct assemblages have been identified based on hand sample observations. A paragenetic sequence has been constructed based on mineral relationships in thin section which imply that during metamorphism, rocks at the Gun occurrence first formed a suite of anhydrous barium silicate minerals, followed by the formation of carbonate and chlorine-bearing barium silicates, sulfide minerals, and lastly hydrous barium silicate minerals. The hydrous barium silicate minerals are commonly observed to be alteration products of the earlier formed anhydrous barium silicates [for example: in the gillespite skarn unit, bright pink grains of gillespite ($BaFe^{2+}Si_4O_{10}$) are rimmed by dark blue cerchiaraite-(Fe) ($Ba_4Fe^{3+}{}_4O_3(OH)_3(Si_4O_{12})[Si_2O_3(OH)_4]Cl$)].

The striking colours of these minerals in hand sample and under the microscope makes this locality an excellent teaching example when introducing members of the public to paragenetic sequences and mineral relationships. This image-centered poster invites viewers to interpret the mineral textures presented and discuss the degree to which these textures support hypotheses for the environment of formation of these complex rocks.

Regional low-pressure, high-temperature (LP-HT) metamorphism of the Hyland River area, southeastern Yukon

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The Hyland River schist-gneiss belt is an elongate region (approximately 85 * 30 km) that includes a migmatitic core flanked by schist and phyllite. Unfaulted flanks are characterised by high metamorphic field gradients and the area hosts numerous large mid-Cretaceous intrusions. Regional metamorphic grade increases progressively from the Chl zone on the flanks to the Crd+ Kfs zone in the migmatised core over a structural thickness of approximately 4 km. We interpret the metamorphic zones as the products of three superimposed phases of metamorphism, based on the mineralogical and textural characteristics of metapelitic rocks in the area. An early stage of regional metamorphism (M2) took place after the formation of high-amplitude recumbent fold nappes. This was followed by low-pressure, high-temperature (LP-HT) regional metamorphism (M3), and subsequent contact metamorphism. We document the timescales involved in the transition from regional LP-HT to contact metamorphism by integrating mineralogical and microstructural observations with high resolution U-Pb TIMS geochronological data from variably deformed intrusions. Felsic-intermediate magmatism within the schist-gneiss belt extended over a period of ≥7 My. Low pressure-high temperature regional metamorphism (M3) overlapped with early syntectonic leucogranite and pegmatite intrusions (~112-106.9 Ma), but took place prior to the emplacement of large, late- to post-kinematic batholiths of granite and granodiorite (106.2-105.1 Ma). Regional (M2+M3) isograds were overprinted by upright folds during the short interval of time between peak M3 metamorphism and formation of the batholiths (≤0.7 my). These folds produced km-scale structural relief, with the result that post-kinematic contact aureoles were emplaced across steep regional metamorphic gradients. The minimal time gap between regional LP-HT and contact metamorphism attests to a common cause and illustrates the short timescales over which overprinting relationships can develop in such settings. LP-HT regional metamorphism records the presence of a thermal anomaly, which we attribute to a cross-strike basement structure that focused magmatism over a 15 my interval. High mantle heat flux suggested by the LP-HT regional metamorphism may have been facilitated by thin lithosphere in the back-arc region of the northern Canadian Cordillera.

Alkaline magmatism and volcanism in southeastern Yukon: What gives?

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The Canadian Cordillera hosts 18 alkaline complexes, all of which are hosted in the miogeoclinal strata in the Foreland and Omineca belts (Pell 1994; Woolley & Kjarsgaard 2008). Most (14) also have associated carbonatites. Three episodes of alkaline and carbonatite magmatic activity have been recognised in British Columbia—in the Neoproterozoic (~800–700 Ma), Late Cambrian (~500 Ma), and Upper Devonian to Lower Carboniferous (~360–340 Ma). These have been attributed to multiple rifting and extensional events along the western margin of ancestral North America (e.g., Cecile et al., 1997; Millonig et al., 2012; Millonig & Groat., 2013).

Carbonatites have not been recognised in Yukon, but the southeastern part of the territory (NTS 095C and NTS 095D) hosts two alkaline magmatic suites. These are spatially overlapping but temporally and mineralogically distinct. The ~ 650 Ma Pool Creek nepheline syenite is cut by ~ 52.0 Ma Eocene biotite syenite that is part of the Ting suite (Pigage & Mortensen, 2004; Naber 2023). Another exposure of the Ting suite, called the Ting Creek alkaline complex, is a composite complex of syenites and volcanic ring dikes (Harrison, 1982; Culligan, 2011) located 12 km north of the Pool Creek nepheline syenite. The petrography, geochemistry, and rare-earth element (REE) and high field strength element (HFSE) mineralogy have been described for most of the intrusions in these alkaline suites (i.e., Harrison, 1982; Pigage & Mortensen, 2004; Culligan, 2011; Naber, 2023). Notably, a 600 Ma gap exists between these two superimposed alkaline suites, and such spatial coincidence has not been recorded elsewhere in the Canadian Cordillera, begging the question: What is focusing mechanism of this alkaline magmatism in southeastern Yukon? Previous workers have suggested a link to cross-strike basement structures (Pigage & Mortensen, 2004) but the influence of these structures on petrogenesis is unclear.

This poster summarizes the geochemical, mineralogical, and geochronological work completed to date on alkaline magmatism in southeastern Yukon, and discusses implications for regional tectonics, REE and HFSE metallogeny and mineral potential in the region.

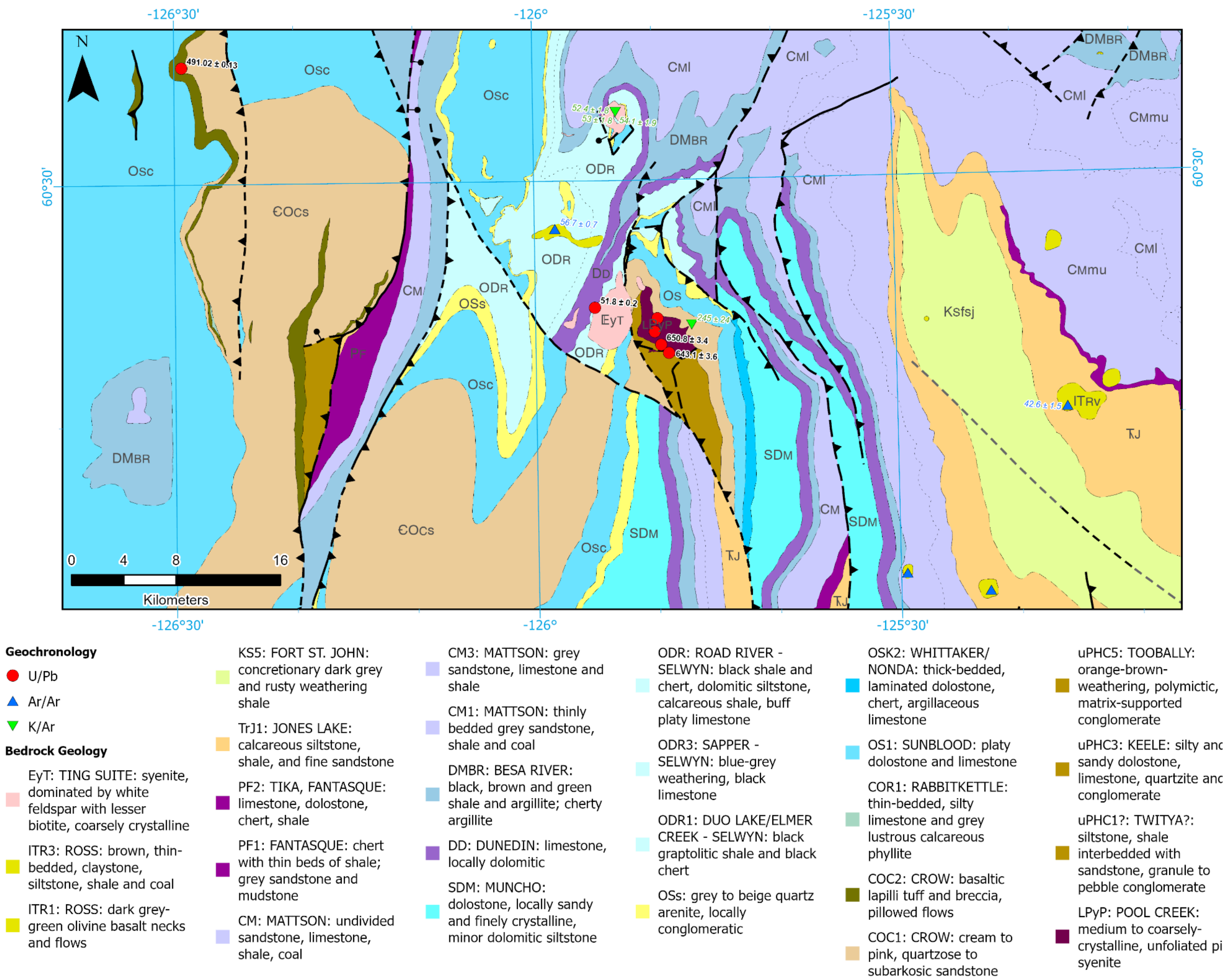

Figure. *Location of Eocene and Neoproterozoic alkaline magmatism in southeastern Yukon.*

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Permian-Triassic Polyphase Deformation and High-Pressure Low-Temperature Metamorphism in the Vedder Complex, Southern British Columbia and Northwest Washington

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High-pressure/low-temperature (HP/LT) rocks along the western margin of North America record subduction and metamorphism from the Paleozoic through the Cretaceous. Much is known about Jurassic-Cretaceous subduction complexes (e.g., the Franciscan), but older Permian-Triassic rocks lack comparatively detailed geochronologic, structural, and metamorphic studies. The Vedder complex of southern British Columbia and northwest Washington preserves Permian to Triassic HP/LT metamorphic rocks as blocks within the Bell Pass Mélange of the Northwest Cascades – San Juan Island Thrust System. Existing K-Ar and Rb-Sr ages for the Vedder complex range from 286 to198 Ma but have large analytical uncertainties (greater than ±15 million years) and are not linked to structural fabrics or metamorphic assemblages.

At Vedder Mountain, the Vedder complex consists of garnet-epidote amphibolite, actinolite schist, and graphitic garnet schist. These metamorphic units are structurally juxtaposed against the Jurassic Kent formation and a metagabbro of uncertain age. The amphibolite unit is medium to coarse grained, and compositionally banded with alternating plagioclase, quartz, and epidote + amphibole rich layers. Two amphibole generations are present: a primary brown-green amphibole (interpreted as calcic) overprinted by blue-green amphibole (interpreted as sodic), indicating early amphibolite facies metamorphism followed by a blueschist facies overprint. Graphitic garnet schists are foliated and include quartz, plagioclase, amphibole, muscovite, chlorite, and stilpnomelane. Raman thermometry on graphitic garnet schists suggests amphibolite facies metamorphism occurred at temperatures of 480 to 500°C. The amphibolite records polyphase deformation and preserves two foliations, two-fold generations, and a late brittle overprint. The first foliation (S1) is preserved as intrafolial folded quartz veins and as aligned quartz and epidote inclusions within garnet porphyroblasts. The dominant foliation (S2) is defined by compositional banding. The S1 quartz veins are folded by S-plunging folds (F2) with axial planes parallel to S2. The F2 fold axes and S2 foliation are folded by SE-plunging folds (F3) at the outcrop scale. The metagabbro preserves an igneous texture away from the contact but is foliated adjacent to the metamorphic units, indicating a tectonic contact.

A preliminary $^{40}Ar/^{39}Ar$ integrated age of syn- to post-S2 white mica in the amphibolite suggests that HP/LT amphibolite facies metamorphism, and S1-S2 deformation occurred prior to 287 Ma. Ongoing work includes garnet Lu-Hf, in-situ titanite U-Pb, and $^{40}Ar/^{39}Ar$ geochronology to better constrain the timing of metamorphism and deformation in the Vedder complex units.

Numerical models of the opening of the Canada Basin and the lithospheric evolution of the northern Cordillera region

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The Mesozoic breakup of northernmost Pangea led to the formation of the Canada Basin, via the rifting of the Arctic Alaska-Chukotka microplate from the northern Laurentian margin. Previous work has highlighted two different opening styles in which Arctic Alaska-Chukotka is either rotated counterclockwise from the Laurentian margin or translated along a massive continental transform system, both of which are still debated within the current literature. Furthermore, there has been limited research into the mechanism for such rift initiation. Given that earlier plate tectonic processes can influence continental breakup, the pre-rift architecture of Arctic Pangea may offer insight into the opening of the Canada Basin and the kinematic evolution of the Arctic Alaska-Chukotka terrane.

Here, we hypothesize that inherited structures from the Paleozoic assemblage of Arctic Pangea and late Proterozoic large igneous provinces may play a fundamental role in the subsequent opening of the Canada Basin. We test this hypothesis using lithospheric 3D numerical models by applying a range of plausible inherited structures to the pre-rift conditions of the Arctic region under two extensional regimes like that of rotation and translation. We then critically compare the different rifting styles produced from our suite of models against the latest geological and geophysical data available to determine a best-fit opening model.

Given this first attempt at using numerical experiments to investigate the evolution of the Canda Basin and North American Cordillera region, we invite discussion on linking numerical results back to geologic and geophysical data collected in the region. Based on our results, we discuss selected locations around the North American Cordillera which could identify supporting evidence of deformation related to the either opening of the Canada Basin (e.g., rotational or translational).

The relationship between Late Cretaceous calc-alkaline arc magmatism and Late Cretaceous mafic-potassic volcanism in Yukon

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A belt of Late Cretaceous (ca. 83 Ma to 68 Ma) volcanic and shallow level plutonic rocks is primarily found within the Intermontane terranes from northwestern British Columbia, through Yukon and into eastern Alaska. In the Yukon, Late Cretaceous volcanic rocks are often lumped together as the "Carmacks group" with a conglomerate/breccia lower unit, an andesitic middle unit and a basaltic upper unit. In the literature an emphasis is put on the uppermost basalt portion of the stratigraphy where the high-MgO and high K_2O (shoshonitic) character of some of the basalts have been interpreted to indicate the melting of mantle above a hot spot; it is unclear how much of this interpretation applies to the lower stratigraphy.

A review of original bedrock mapping, historic and new whole-rock geochemistry and new geochronology shows that relatively mafic shoshonitic rocks are restricted to an orogen-oblique (E–W) trend immediately north of the village of Carmacks. Geochronology of the shoshonitic rocks is imprecise but the best age estimates suggest short-lived and voluminous volcanic activity between ca. 70 and 69 Ma without discernible variation across the trend. The shoshonitic rocks are not associated with significant mineral deposits. In contrast, intermediate to felsic Late Cretaceous intrusive and volcanic are mostly restricted to an orogen-parallel (NW–SE) trend. These rocks are calc-alkaline and have whole-rock and isotope chemistry characteristics consistent with a continental magmatic arc origin. The ages of these arc rocks are well-constrained and show a consistent progression of volcanic, plutonic, and mineralization ages from ca. 83 Ma in the SE to 68 Ma in the NW. These rocks are associated with significant porphyry, epithermal and skarn deposits.

We will outline the evidence for a change in magmatism near Carmacks and explore geophysical and geochemical explanations for what we see in the bedrock geology. We attempt to reconcile the Late Cretaceous juvenile volcanism with slightly older to coeval, arc magmatism and provide a framework for magmatic-hydrothermal mineralization along the arc.

Coeval deposition of transgressive and normal regressive strata in a structurally controlled area of the Viking Formation, central Alberta, Canada

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The Viking Formation in central Alberta is a sequence stratigraphically complex unit owing to the variability in accommodation and sedimentation rates within the foreland basin. This variability generates significant deviations in the along-strike stratal stacking patterns of systems tracts. Allogenic controls on systems tracts can lead to the coeval development of units that juxtapose transgressive (retrogradational stacking) and regressive (progradational stacking) deposits over a relatively short distance. In these cases, it is challenging to accurately map the 3D variability of these systems tracts and place them into a sequence stratigraphic framework. In this study, the syn-depositional reactivation of Precambrian basement structures along the Snowbird Tectonic Zone created significant variability in accommodation across the Western Canada Sedimentary Basin during the late Albian. Tectonic reactivation of these basement faults influenced sedimentation patterns and created anomalous zones of accommodation in localized areas within the Snowbird Tectonic Zone. Across fault boundaries and within the anomalously thick strata, both progradational and retrogradational stacking patterns occur, complicating the correlation of stratigraphic units. While the coeval deposition of transgressive and regressive units has been documented in a number of modern marine analogues, the concept has only been applied rarely to ancient successions. By identifying along-strike variability in shoreline trajectories and incorporating the autogenic and allogenic controls that were active during deposition, a more accurate sequence stratigraphic framework can be proposed for the Viking Formation.

Geochemical, isotopic, and geochronological constraints on the tectonic setting and obduction history of the Kanuti ophiolite, AK

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The Kanuti ophiolite of the Angayucham terrane occurs as NE-trending nappe-like structures within a 115 km long by ~5-8 km wide contractional belt along the southern Yukon-Koyokuk basin (YKB) margin, extending from Caribou Mountain to the northern Ray Mountains. The Kanuti ophiolite is correlative with the Brooks Range ophiolite to the north of the YKB. New field, compositional and geochronological data are presented to understand its original tectonic setting, obduction/emplacement history, and implications for mineral resource potential.

Kanuti rocks consist of at least six discrete ultramafic complexes ranging from ~5 to 170 km^2 in exposure area at the surface. Together, these complexes are interpreted to represent a gently NW-dipping thrust fault system locally separated from the underlying Paleozoic Arctic Ruby terrane by at least one other thrust sheet. One of the intercalated thrust sheets is comprised of a mélange of mafic igneous and metamorphic rocks. Evidence for the coupling of deformation and fluid interactions are manifested by locally increased degrees of serpentinization of ultramafic rocks near inferred fault boundaries. The ultramafic rocks overlie garnet- and scapolite-bearing amphibolite mylonites, and eclogite from at least one locality. In aggregate, these are interpreted as the metamorphic sole to the ophiolite.

Kanuti lithostratigraphic groups are dominantly ultramafic and include lherzolite, harzburgite, and dunite. Most Kanuti ultramafic rocks are only partly serpentinized (generally 10%-50%) with original mineral assemblages commonly identifiable. Ultramafic rocks host local domains of pyroxenite, chromite-rich dunite and chromitite ranging in from sub-cm tabular selvages and veins to layered and massive domains ≥100 meters in length scale. Disseminated, podiform, and massive high-Cr chromitite bodies, observed in at least a dozen occurrences along the entire length of the Kanuti ophiolite, have been the subject of mineral exploration for chromium, nickel, asbestos, and platinum group elements (PGE). Preliminary beneficiation tests on placer deposits from drainages at each end of the ophiolite yielded metallurgical grade chromite concentrates. Minor domains of intrusive mafic rocks, mostly gabbro and diabase, are also present but represent <10% of the exposed Kanuti assemblage.

Kanuti is a partial ophiolite, lacking shallow components of classic ophiolite stratigraphy. Initial characterization of the Kanuti system had grouped a structurally underlying package of volcanic rocks and pelagic/hemi-pelagic sediment with the broader Kanuti suite, contributing to its classification as an ophiolite. But more recent mapping, geochemistry, and geochronology demonstrated that these volcanic and sedimentary rocks are likely not coeval with mafic/ultramafic intrusive rocks of the Kanuti system.

Lherzolite, harzburgite, and most dunites have olivine forsterite (Fo) contents ~90.5±1.0, typical of equilibrium (residual) mantle composition. In some cases, dunite Fo is lower (~87), suggesting magmatic/cumulate origin. In chromite-rich dunite and chromitite, olivine Fo content is higher (93–96), outside the range of normal mid-ocean ridge systems. Fo content is lower (77–87) in mingled zones of pyroxenite. In rocks with mantle-like olivine composition, clinopyroxenes have high Mg# (90–100) and variable TiO_2 (0.05–0.3 wt.%), transitional between depleted abyssal and suprasubduction types. Spinels in mantle-like ultramafic rocks have broadly variable and negatively correlated Mg# and Cr# (77 to 47, 13 to 71, respectively), reflecting a broad range of mantle depletion. The apparent degree of melt depletion suggested by spinel composition correlates with rock type (i.e., increases from lherzolite to dunite). But spinels in chromite-rich dunite and chromitite are distinctly chromian (Cr# 60 to 80), have negatively correlated Mg# and Cr#, and define an array towards spinel in boninite from the western Pacific.

Spinel in most pyroxene cumulates are displaced to lower Mg# at the same range of Cr#, indicating variable clinopyroxene/plagioclase saturation in melt. Clinopyroxene compositions in Kanuti gabbro (TiO_2 ~0.8 wt.%, Mg# ~80) resemble those found in mid-ocean ridge cumulates. Kanuti gabbros are subalkaline, with small Th over Nb enrichment and Ti/V < 20, compatible with weak crustal/subduction modification of mantle melt sources. Mafic Kanuti rocks have εNd $^{(+)}$9±1 and $^{(+)}$15±1 εHf, resembling N-MORB from the Eastern Pacific Rise (EPR).

Residual Kanuti dunite is unlikely to represent complete pyroxene removal due to the extreme degree of melt depletion required (>40%), and dunite Mg# and Fo contents are generally consistent with enclosing harzburgite. Instead, dunitic zones may represent discrete conduits of melt flow within mantle peridotite, similar to dunite pipes observed in Oman ophiolite. The contrasts in observed dunite types may indicate that residual Kanuti mantle rock reflects multiple stages of melt–rock reaction with contrasting melt types; one similar to MORB, another similar to boninite. Thus, the compositions of melt and residual mantle rock of the Kanuti ophiolite are consistent with an immature forearc setting.

Preliminary high-precision whole rock PGE abundance patterns correlate with rock type. Peridotite, including chromite-poor dunite, has flat primitive mantle-normalized patterns, ranging to slight (up to 5x) Pt-Pd enrichment. Chromitites have steep Os-Ir-Ru enrichment up to 40x relative to host peridotite. Among few analyzed pyroxenites, PGE patterns are generally flat and depleted relative to primitive mantle, but with variable Pt±Pd. Two distinctly high MgO (>37 wt.%) pyroxenites have Pt 10x over baseline, and one lower-MgO (23 wt.%) pyroxenite has negative Pt-Pd anomalies. Platinum group minerals, including PGE alloys and sulfides, were positively identified as free anhedral grains in both chromitite and (high-MgO) pyroxenite, suggesting the same melt-rock reactions that produce dunite and pyroxenite preferentially concentrate PGEs relative to ambient mantle.

Mafic rocks in the mélange facies underlying Kanuti thrust sheets are compositionally and isotopically distinct from overlying Kanuti gabbros. These rocks have Ti/V >20 and range to higher Nb/[Y, Yb] contents, similar to E-MORB, with volcanic rocks displaying slight Th vs. Nb enrichment relative to intrusive rocks. The mafic mélange facies are more isotopically heterogeneous, extending from EPR-like to more enriched Nd along the mantle array (up to $^{(+)}$5.5 εNd). Chemical and isotopic traits of mafic rocks in the lower mélange sequence strongly resemble early Triassic gabbro of the Rampart Group to the east.

New U-Pb geochronology from mafic Kanuti rocks provide constraints on timing of crystallization and ophiolite obduction. In-situ U-Pb ages from primary zircon and titanite in Kanuti gabbro are ca. 165–160 Ma. U-Pb ages from titanite and apatite in mafic rocks near the metamorphic sole are more variable. The oldest primary ages from mafic rocks in the mélange (ca. 230–210 Ma) resemble newly acquired U-Pb zircon ages in Rampart gabbro (ca. 235–224 Ma). But both magmatic Kanuti rocks and mélange mafic rocks near the metamorphic sole have U-Pb intercept ages ca. 150–140 Ma, in close agreement with legacy K-Ar cooling ages nearby, and are inferred to record local metamorphism associated with ophiolite obduction. These age and compositional constraints suggest that the Kanuti ophiolite was obducted in the Late Jurassic within 10–20 My of primary crystallization, onto Rampart gabbros capping the Arctic margin of continental Laurentia.

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