CTG Virtual Workshop, Fall 2025

November 27th, 2:00 – 5:00 EST

Logistical Information

Date: Thursday, November 27th
Time: 2:00 to 5:00 EST
Location: Zoom – link: CTG Workshop Fall 2025
Meeting ID: 850 0405 8248
Passcode: 728018
Oral Presentations: 15 minutes for talk with 5 minutes for questions. * Indicates presenter.
Full Abstracts: at end of this document.

Talk Schedule

2:00 – 2:20 pm

Catherine Mottram[1*], Isabelle Coutand[2], Glenn Chapman[1], ***Constraining the timing of extensional and transtensional deformation in the North Aegean using U-Pb carbonate geochronology***

2:20 – 2:40 pm

Willem Langenberg[1*], Kyle Larson[2], Stephen Johnston[1], ***Dating thrust movements in Canada, Switzerland and Spain***

2:40 – 3:00 pm

Joel Padgett[1*], Eva Enkelmann[1], Dawn Kellett[2], ***Cretaceous–Cenozoic Exhumation in the Northern Canadian Cordillera***

3:00 – 3:10 pm

Break 1 of 2

Talk Schedule Continued

3:10 – 3:30 pm

Sarah Bowie[1]*, Catherine Mottram[1], Maria Shtereva[1], Dawn A. Kellett[2], Monica Barrington[3], Hugo Moreira[1], Rosie Martin[1,4], Joseph Dunlop[1], ***Mid-Cretaceous and Paleocene magmatism and porphyry mineralization in the Llewellyn fault corridor, NW British Columbia***

3:30 – 3:50 pm

Dave Klepacki[1*], ***Constructing a balanced structure section across the Kootenay Arc to better understand mineral deposits***

3:50 – 4:00 pm

Break 2 of 2

4:00 – 4:20 pm

Taís Fontes Pinto[1*], Eva Enkelmann[1], Viktor Terlaky[2], Talha Qadri[2], ***Influence of basement structures on the burial and exhumation histories of the Western Canada Sedimentary Basin and Canadian Shield, Northwest Territories***

4:20 – 4:40 pm

[1*]Schwerdtner, W.M, Rivers, Toby[2], Waddington, D.H. [3] and Jarvis, Anjali[4], ***Multiscale relict S-Z structures in the Grenville Province of Ontario***

4:40 – 5:00 pm

Further Questions and Discussion

Abstracts

Pages 3 to 9.

Constraining the timing of extensional and transtensional deformation in the North Aegean using U-Pb carbonate geochronology

Catherine Mottram[1*], Isabelle Coutand[2], Glenn Chapman[1],
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The Aegean is one of Earth's most geodynamically active regions, shaped by major tectonic boundaries, including the Hellenic subduction zone to the south and the 1,200 km-long North Anatolian Fault Zone (NAFZ) in the north. The NAFZ is a seismically active dextral strike-slip boundary accommodating the south-westward extrusion of the Anatolian Plate. Understanding the spatial and temporal relationships between extensional and transtensional stress regimes in the North Aegean, and the NAFZ's role in this process, is essential for geodynamic reconstructions. Key knowledge gaps remain regarding (1) the causal, temporal, and spatial relationships between N-S extension and NW-SE transtension, and (2) the timing of NAFZ propagation—whether strain localized in the Miocene or as late as the Pleistocene (<1 Ma).

This study aims to provide absolute timing constraints for brittle extensional and strike-slip faulting in the Aegean. In-situ carbonate U-Pb geochronology is an established method for dating brittle faulting and has already provided timing constraints for NAFZ movement in Anatolia at ca. 11 Ma (Nuriel et al., 2019). In this study, U-Pb carbonate dating was used to investigate the timing and nature of brittle deformation and fluid flow in the North Aegean. Fault rocks were analysed from the Mt. Olympus fault and from the Sporades Islands of Skopelos and Alonnisos. Results reveal episodic extensional faulting and fluid flow during the Eocene and Miocene. Additional evidence of localised extensional and strike-slip faulting at ~5–4 Ma is observed at Mt. Olympus and from multiple sites in the Sporades.

These findings provide the first direct temporal constraints on coeval extensional and transtensional deformation in the North Aegean. Extension associated with Hellenic slab rollback likely facilitated the propagation of the NAF into the region. Strike-slip strain localization along NE-SW–oriented proto-NAF structures occurred significantly earlier than inferred from indirect methods, suggesting an active transtensional stress regime in the North Aegean since the Late Miocene.

Nuriel et al., (2019). Geology, 47, p.465.

Dating thrust movements in Canada, Switzerland and Spain

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Nine carbonate samples with slickensides were collected in the Canadian Cordillera. Only one sample with hanging wall up dip-slip slicken-fibres (from the Crowsnest Pass) gave a reliable U-Pb age of 32.4 +/- 0.6 Ma. This indicates that compression and possibly thrusting still played a role in the early Oligocene. Slicken-fibres along the Rocky Mountain Trench have not provided reliable U-Pb ages because of the low U content of the calcite in the Trench rocks.

Two samples were collected from the inverted limb of the Morcles Nappe on SW Switzerland, limestone with a stretched belemnite (Figure 1) and a limestone mylonite. The Morcles Nappe was formed during Miocene NW-SE shortening between 22 Ma and 4 Ma ago, but the underlying Morcles Thrust may still be active today. U-Pb dating of the calcite in the stretched belemnite may provide information on the timing of the formation of the Morcles Nappe. The core of the Morcles Nappe displays two phases of deformation. A sample from the core with a D_1 stretching lineation may provide information on the timing of the initiation of the Morcles Nappe.

A marble with a D_1 stretching lineation from the Mulhacen Complex in SE Spain does not contain sufficient U to attempt U-Pb dating. The main deformation in this complex is expected to have taken place in the Miocene from 22 Ma to 4 Ma. In situ $^{87}Rb/^{87}Sr$ dating will be attempted on micas of the highly deformed meta-granites and tourmaline gneisses of the Bedar Gneiss unit of the Mulhacen Complex.

Figure 1: Stretched Leytron belemnite

Cretaceous–Cenozoic Exhumation in the Northern Canadian Cordillera

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The Intermontane region of the Northern Canadian Cordillera assembled by terrane accretion in the Mesozoic, and was later displaced by major dextral structures during the latest Cretaceous–early Cenozoic. This displacement was accommodated along a wide network of NW-trending orogen-parallel faults that bound and transect the previously-accreted terranes. To constrain the timing and magnitude of exhumation in the Northern Canadian Cordillera and to investigate the response of plate interiors to changing plate boundary conditions, we present new low apatite and zircon (U-Th)/He (AHe & ZHe) and apatite fission-track (AFT) low-temperature thermochronology data from the Cassiar Mountains, which span southern Yukon and northern British Columbia. This region is bounded by two major orogen-parallel dextral faults: the Cretaceous Teslin fault to the west and the early Cenozoic, lithospheric-scale Tintina fault to the east. The Cassiar fault transects the Cassiar Mountains and is suggested to be mid- to Late Cretaceous in age.

New AHe data from 25 samples yielded ages that range 77–5 Ma, AFT data from 24 samples range 78–22 Ma, and ZHe data from 29 samples range 142–31 Ma. We find young ages (ca. 60–40 Ma) in multiple thermochronometers near the Teslin, Cassiar, and Tintina faults. Ages generally increase (ca. 100–70 Ma) with increasing distance from these structures.

To investigate orogen-scale cooling trends, we integrate our new data from the Cassiar Mountains with recently published data from the early Mesozoic Whitehorse Trough to the west of the Teslin fault and from mid-Cretaceous plutons in the Logan Mountains east of the Tintina fault. Single-grain ZHe dates from the Whitehorse Trough and Logan Mountains show dominant modes in the mid-Cretaceous, previously interpreted to reflect the onset of post-burial cooling facilitated locally by faulting and post-emplacement cooling, respectively. In the Cassiar Mountains, single-grain ZHe, AFT, and AHe dates show a dominant early Cenozoic mode that overlaps with early Cenozoic AFT and AHe modes in the Whitehorse Trough and Logan Mountains. These data suggest widespread cooling and exhumation in the early Cenozoic and that the magnitude of early Cenozoic cooling was greater in the Cassiar Mountains compared to adjacent regions. Our results suggest that the distribution of Cenozoic cooling and exhumation was influenced by older structures, such as the Teslin fault, that likely reactivated during the Paleocene.

Mid-Cretaceous and Paleocene magmatism and porphyry mineralization in the Llewellyn fault corridor, NW British Columbia

Sarah Bowie[1]*, Catherine Mottram[1], Maria Shtereva[1], Dawn A. Kellett[2], Monica Barrington[3], Hugo Moreira[1], Rosie Martin[1,4], Joseph Dunlop[1]

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Establishing the timing and duration of magmatism, mineralization, and deformation leading to the development of porphyry systems is key to identifying prospective regions within orogenic belts. The Blue Property in the Atlin Lake area in northwestern British Columbia is characterized by Mo-Cu porphyry, skarn and carbonate replacement mineralization ('Laverdiere', 'Sulphide City', and 'Jackie' occurrences). This ore deposit system is hosted in the polymetamorphic Florence Range and Boundary Ranges metamorphic suites and felsic intrusive rocks. In this contribution, we combine detailed field mapping and igneous petrography with U-Pb zircon and titanite petrochronology to elucidate the magmatic history of these mineralized systems. Results indicate two distinct periods of magmatic and mineralizing activity at ca. 103 Ma and ca. 58 Ma and reflect the potential longevity and overprinting nature of mineralization related to the Coast Plutonic Complex in this region. Trace element signatures from analyzed zircons are similar to those from porphyry indicator zircons in large Andean porphyry deposits. Magmatic events are linked to similar porphyry systems occurring in northwestern British Columbia and southern Yukon within the Dawson Range batholith, and Ruby Range and Sloko-Hyder intrusive suites. In this region, mid-Cretaceous and Paleocene-Eocene magmatic units may therefore be highly prospective for porphyry mineralization, and often hosted in polymetamorphic basement rocks.

Constructing a balanced structure section across the Kootenay Arc to better understand mineral deposits

Dave Klepacki[1]
[1]*Essential Earth Analysis*

The Kootenay Arc of southeastern British Columbia has been the focus of mining and geological study since the discovery of silver near Kootenay Lake in 1882. In the last two decades we realize much of the mineralization in the Kootenay Arc results from Early Eocene (Parrish et al 1988, Schmidtke et al 2024) extensional structures (Moynihan and Pattison 2008, 2011, Webster and Pattison). Understanding the metallogeny involves resolving the structural history and geometry of the host rock, the mineralizing fluid conduits and depositional chemistry of the ore. Unlike many deposit types, the heat source for ore-bearing fluids in extensional "core-complex" terrains is hot, mid-crustal footwall rocks exhumed to shallow levels along low-angle normals faults creating hydrothermal cells in hanging wall structures (Beaudoin et al 1992).

Today I review an initial part of my research: I use Halliburton's Lithotect software to construct a balanced cross section from the western flank of the Purcell Anticlinorium (Fyles, 1964) through the Goat Range northwest of Kaslo (Klepacki, 1985; Read, 1973) and Sandon areas (Cairnes,1934; Hedley, 1952) to the eastern flank of the Valhalla Metamorphic Complex (Carr et al 1987) crossing the Slocan Lake Normal Fault. Several geological insights arise from this exercise:

1) The large (4-8km) F1 nappes comprise at least 58kms of shortening (55%) and detach within the underlying Hamill group within the Marsh-Adams and at the top of the Mt Gainer quartzite. These nappes require an underlying "duplex nappe stack" of the remaining 1400m of Hamill Gp to accommodate that shortening as does the deeper Horsethief Ck group. I consider the F1 shortening to be Early Mississippian as assigned by Kraft et al 2013.

2) What happens to the shortening carrying Quesnellia Terrane onto North America in the Early Jurassic? The Stubbs Thrust is this fault (Klepacki et al 1985). In today's work I invoke a deformed triangle zone involving the Stubbs thrust as well as a deeper (Lardeau/Horsethief Creek?) "daylighting" the shortening along the enigmatic Shroeder/Spyglass fault and equivalent faults along the Kootenay Arc.

3) Mineralization in both the Lardeau and Slocan districts is hosted in the axial surface areas of large (2km) late (Cretaceous or Eocene) folds with shallowly west-dipping axial surfaces (Hedley, 1952; Klepacki, 1985; Kraft, 2013). These folds could be related to crustal-scale shear developed in the initial stages of extensional faulting (Harris, 2002).

Influence of basement structures on the burial and exhumation histories of the Western Canada Sedimentary Basin and Canadian Shield, Northwest Territories

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Inherited basement structures influence the evolution of overlying basins by controlling accommodation space and driving differential exhumation. In the Western Canada Sedimentary Basin, the role of underlying Canadian Shield structures on the basin's evolution remains poorly understood. However, such influence is expected given the complex Phanerozoic history of western North America, which includes rifting, passive margin establishment, development of an active margin, and Cordilleran orogeny and foreland basin evolution. To investigate how inherited structures controlled the basin response to this complex history, we combine stratigraphic cross-sections that identify fault reactivations with low-temperature thermochronology on basin strata and basement rocks from the eastern basin edge in the Northwest Territories. This approach allows us to constrain upper crustal processes such as burial, exhumation, and hydrothermal activity that thermally affected the basin and basement within a temperature range of 55–200°C.

Our thermal history models reveal that both basin and shield experienced Late Devonian–Mississippian peak burial to >120°C, which we attribute to a combination of sedimentary burial and elevated geothermal gradients. Subsequent exhumation phases differ based on position relative to the modern basin edge: the exposed Canadian Shield to the east record slow exhumation since the Mississippian, while strata and basement rocks to the west remained at high temperatures until Late Cretaceous–Cenozoic exhumation began. This contrasting pattern, despite sample proximity (<50 km), indicates structural control by basement structures such as the Wopmay fault zone and Great Slave shear zone. We propose that these structures were reactivated during the Phanerozoic, strongly influencing basin subsidence and differential exhumation.

The slow exhumation matches previously reported data from the shield, while the later exhumation to the west corresponds to unconformity development in the foreland basin related to Cordilleran orogeny. These findings reveal that Late Devonian heating was greater than previously recognized and that Cordilleran orogeny influenced the basin >400 km to the east of the ancient convergent margin. This demonstrates that inherited structures fundamentally controlled the basin's response to Phanerozoic tectonic events and highlights thermochronology's ability to reconstruct basin evolution.

Multiscale relict S-Z structures in the Grenville Province of Ontario

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Roadcuts, detailed geological maps and satellite photographs of poly-deformed high-grade gneiss terranes in the western Grenville Province (Ontario) provide many examples of remnants of multi-scale monoclinic folds that we have termed relict S-Z structures in recent publications. A relict S-Z structure consists mainly of the strained short limb of a former S- or Z-fold and is markedly asymmetric or approximately mirror-symmetric in three dimensions. In many examples, the short limb remains connected with the adjoining fold-hinge zones and pinched-out segments of the original long limbs. Depending on their size, relict S-Z structures have been variously misinterpreted as competent boudins, buoyancy-driven diapirs or other deformational structures. In this presentation, we highlight km-scale examples and place them in their regional geological setting.

Figure 1: Subvertical rock-cut showing an asymmetrical relict S-Z structure defined by an amphibolite layer in banded monzonitic orthogneiss; person at bottom right of photo for scale. The core of the S-shaped structure consists of the tightly buckled short limb of an original 10m-scale fold. In its left (northwestern) flank, the longer limb of the fold is reduced to a pinched-out remnant, whereas in its right (southeastern) flank a longer segment is preserved. Location: NW-bound lanes of Hwy. 400, near the bridge across the Moon River; subvertical rock cut faces approximately SW.