Geological Survey of Canada
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WHITEHORSE TROUGH RECORD OF LATE TRIASSIC-CRETACEOUS ACCRETIONARY OROGENIC CYCLE FROM DETRITAL MINERAL THERMOCHRONOMETRY, BRITISH COLUMBIA, NORTHWEST TERRITORIES, AND YUKON

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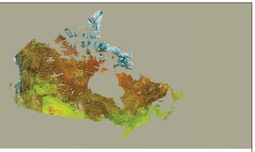
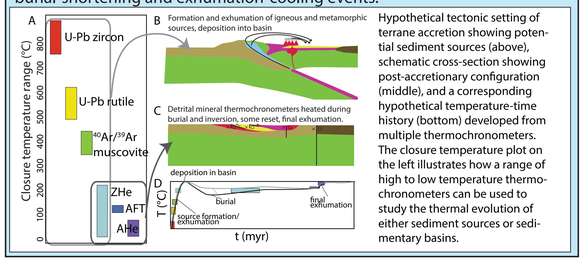


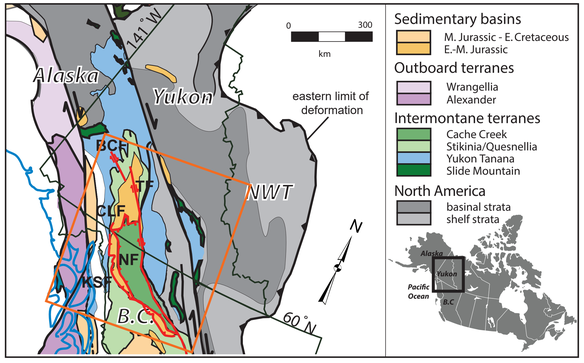
INTRODUCTION

The Late Triassic to Cretaceous sedimentary record of the Whitehorse trough captures Intermontane terranes assembly and accretion to Laurentia, including changes in depositional environment and basin extent, shifts in sediment types and provenance, and syn- to post-depositional basin structural evolution, all of which contribute to reconstructing this critical accretion period.

Thermochronological methods, including (U-Th)/He dating applied to detrital zircon and apatite (ZHe, AHe) and detrital apatite fission track dating (AFT) provide detailed temperature-time histories of rocks through the upper crust. New multi-thermochronological data from the Laberge Group (deposited into Whitehorse trough in Early to Middle Jurassic) and over- and underlying strata, constrain basin evolution from sedimentary deposition to burial-shortening and exhumation-cooling events.

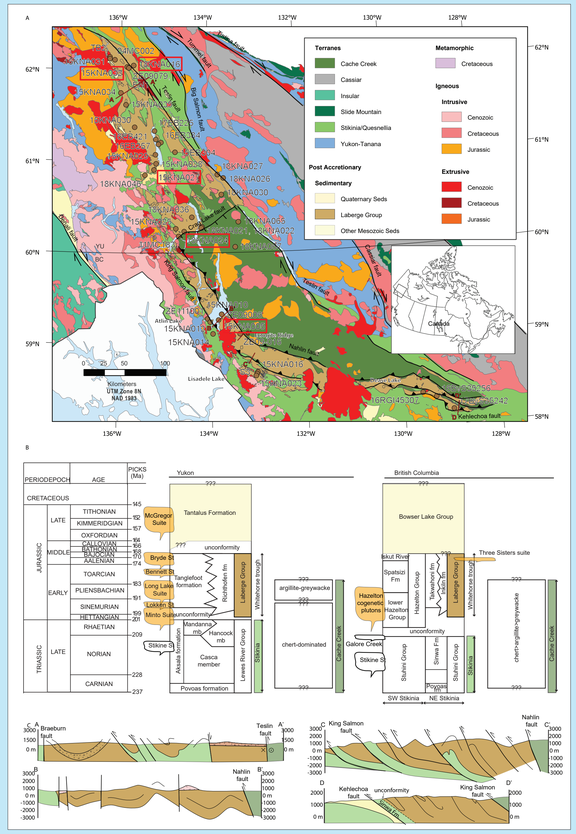


Hypothetical tectonic setting of terrane accretion showing potential sediment sources (above), schematic cross-section showing post-accretionary configuration (middle), and a corresponding hypothetical temperature-time history (bottom) developed from multiple thermochronometers. The closure temperature plot on the left illustrates how a range of high to low temperature thermochronometers can be used to study the thermal evolution of either sediment sources or sedimentary basins.



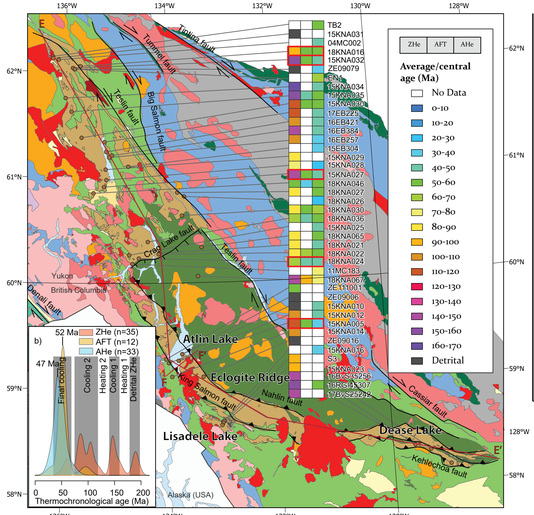
Modified terrane map of the northern Canadian Cordillera[1]. Faults: BCF - Big Creek fault; TF - Teslin fault; CLF - Crag Lake fault; NF - Nahlin fault; KSF - King Salmon fault. Orange box indicates the study area extent.

WHITEHORSE TROUGH LABERGE GROUP

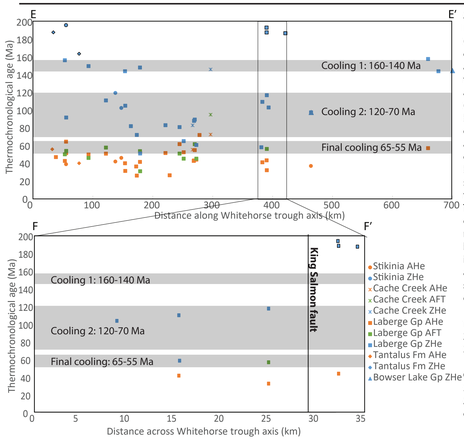


Geological map showing Intermontane terranes, Whitehorse trough and post-accretionary units, and all sample locations, modified from Cui et al. (2017) and Colpron et al. (2016). Red boxes identify samples modeled in BASIN THERMAL EVOLUTION section of poster. B: Late Triassic to early Cretaceous stratigraphic columns for Yukon and British Columbia. Yukon stratigraphy modified from Hutchison (2017). British Columbia stratigraphy modified from Souther (1972), Shirmohammad et al. (2011), Mihalynuk et al. (2018), Nelson et al. (2018), van Straaten and Bichlmaier (2018). Geological time scale from Walker et al. (2018). C: Cross-sections through Laberge Group. Section lines are shown in A. A-A' is redrawn from White et al. (2012). B-B' and C-C' are redrawn from English et al. (2005), and D-D' is redrawn from van Straaten and Bichlmaier (2018b).

MULTI-THERMOCHRONOMETRY and THERMAL MATURITY



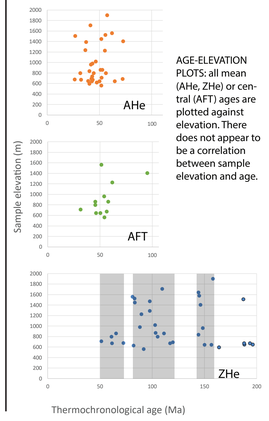
MULTI-THERMOCHRONOMETRY RESULTS: map to the left summarizes all ZHe, AFT and AHe results, binned into 10 myr increments. AFT and AHe ages are Cenozoic and broadly overlapping. ZHe ages are not reset (grey), or range Jurassic to Cretaceous. They indicate **3 cooling events**, shown as grey bars in the accompanying plots. Red boxes show samples modeled in BASIN THERMAL EVOLUTION.



AGE-DISTANCE PLOTS: mean (AHe, ZHe) or central (AFT) ages are plotted along (E-E') and across (F-F') the basin. There does not appear to be a correlation between sample elevation and age. The **3 cooling events are represented by ZHe cooling ages along the strike length of the basin**:

1. 160-140 Ma
2. 120-70 Ma
3. 65-55 Ma

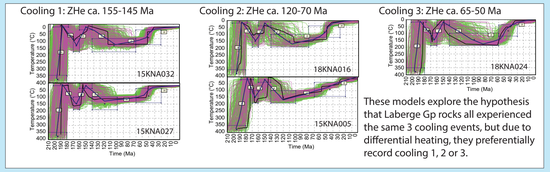
Cooling event 3 approaches AFT and AHE data.



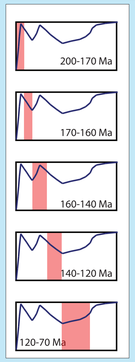
AGE-ELEVATION PLOTS: all mean (AHe, ZHe) or central (AFT) ages are plotted against elevation. There does not appear to be a correlation between sample elevation and age.

BASIN THERMAL EVOLUTION

Subset of samples representing the 3 cooling events were modeled using HeFTy thermal modeling software (v1.9.3, © 2017, Richard Ketcham). Pink paths are good fits and green paths are acceptable fits to the input thermochronological data, and boxes show the user-defined temperature-time constraints used to guide polyphase heating in the models.



These models explore the hypothesis that Laberge Gp rocks all experienced the same 3 cooling events, but due to differential heating, they preferentially record cooling 1, 2 or 3.



TECTONIC INTERPRETATION BASED ON BASIN THERMAL EVOLUTION

200-170 Ma: zircons form as arcs develop on proximal Stikinia/Quesnellia. Arc collapse and subduction zone closure delivers abundant volcanic, plutonic and rare metamorphic detritus to Whitehorse trough (WT).

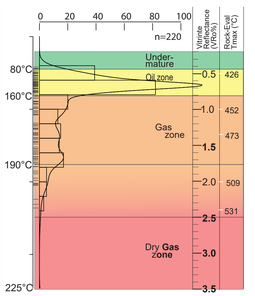
170-160 Ma: Sedimentary and structural burial as Intermontane terranes shortened. King Salmon, Kehlechoa and Nahlin faults form. Detrital ZHe ages reset in most deeply buried parts of WT. Pervasive resetting of AFT and AHe ages in detrital apatite.

160-140 Ma: Basin inversion during shortening leads to cooling and partial exhumation of Laberge Group. Bowser Lake Gp and Tantalus Fm successor strata deposited over unconformity.

140-120 Ma: Laberge Group and overlying strata buried together and heated again. Possible structural reactivation, e.g. along King Salmon fault. Detrital ZHe ages reset in some parts of WT, including in Bowser Lake Gp strata. Pervasive resetting of AFT and AHe ages in detrital apatite.

120-70 Ma: Slow and variable cooling/exhumation of Laberge Group before final cooling through ZHe, AFT and AHe systems in the Paleocene.

THERMAL MATURITY: according to available vitrinite reflectance and Rock-Eval data, most Laberge Gp. and under/overlying strata were heated to 80-190 °C, which falls into the oil and gas zones (White et al., 2012; Lowey et al., 2009). This suggest that most samples will be fully reset for AHe and AFT. ZHe can have a closure T >190 °C and therefore may be only locally reset.



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