New Detrital Zircon Age Constraints for the Darrington Phyllite East of the Straight Creek-Fraser River Fault

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Abstract

The Northern Cascades Strait Creek fault system creates a divide between the Coast Plutonic Complex and western North Cascade units with a 90km offset from the west side. Small amounts of the Easton suite can also be found on the east side of the fault, with its constituent Darrington phyllite (141-155 Ma) correlated across the fault due to rock similarity. However, there are uncertainties in the age and appearance of previously dated Darrington phyllite and a phyllite found between the Kaches and Cle Elum Lakes on the east side of Strait Creek Fault. Here we present the first detrital zircon age correlation of possible Darrington phyllite across the Strait Creek Fault. We found a primary peak of 145 Ma with a notable second peak of 133 Ma. A Precambrian zircon tail was notable in Concordia plots, which aligns with detrital zircons found in units nearby not correlated to Darrington phyllite. The 133 Ma peak can mean that this unit is younger than Darrington Phyllite and could be explained by a different younger oceanic basin that accreted similarly to Darrington Phyllite but was open for longer.

Introduction

- Northern Cascade Mountains are characterized by deformed island arc and oceanic basin accretions (Dungan et al., 1983)
- West side of Strait Creek-Fraser River fault system (N-S) has a minimum 90km offset apparent by some Easton suite found on the east side of the fault (Macdonald and Dragovich, 2015)
- Easton suite characterized by late Jurassic oceanic and trench deposits including relevant units such as Darrington phyllite and Shuksan blue-greenschist (Dungan et al., 1983)
- Darrington phyllite dates to around 141-155 Ma and is composed of Qtz+Ab+Mu+Gr+Ep+Chl, and Lawsonite in certain areas (Cordova et al., 2018)

Research Question

Is the Phyllite found between the Kaches and Cle Elum lakes part of the Darrington phyllite, as it has been interpreted to be, or should it be classified under a different unit due to possible differences in detrital zircon age?

Background

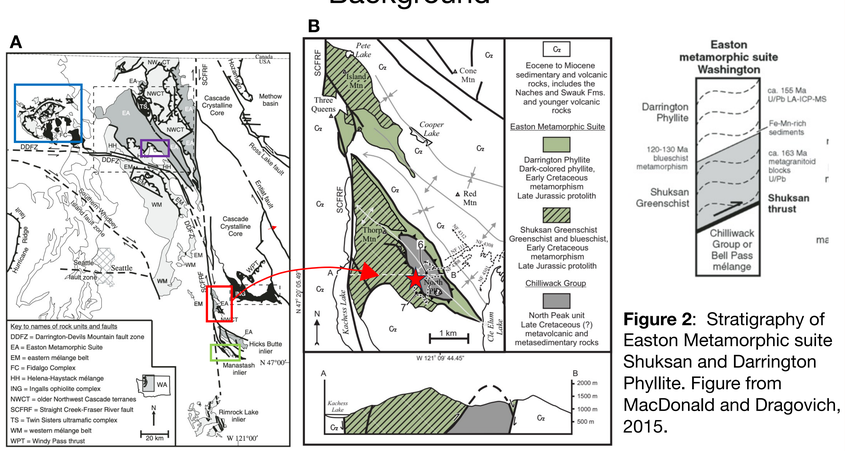

Figure 1: **A**. Geologic map displaying relevant units in the northern cascades including the Easton Suite. Figure from MacDonald and Dragovich, 2015. Red square designates Kaches Inlier where phyllite was collected. Green square designates the Manastash Inlier where Lookout Formation (figure 5A) comes from. Blue square outlines the San Juan Islands where Easton Suite was previously dated (figure 5B). Purple square outlines Darrington phyllite dated near Gee Point (figure 6). **B**. Simplified geologic map of the Kachess Lake inlier. Red star indicates phyllite sample collection area. Modified from Lofgren (1974), Ashleman (1979), and Tabor et al (2000), Macdonald et al (2022).

Figure 2: Stratigraphy of Easton Metamorphic suite Shuksan and Darrington Phyllite. Figure from MacDonald and Dragovich, 2015.

- Easton suite confirms volcanic arc accretion through the Hicks Butte Tonalite of about 153 Ma (Macdonald et al., 2022)
- Shuksan Schist stratigraphically beneath Darrington phyllite (figure 2)
- Mount Josephine Metagraywacke was correlated to Darrington Phyllite →two U-Pb ages of ca. 155 and ca. 238 Ma. (MacDonald and Dragovich, 2015)
- Original protolith likely intermediate and mafic provenance.
  - Matches to back-arc basin turbidities geochemistry which aligns with its detrital origin (MacDonald and Dragovich, 2015)

Methods

- University of Arizona LaserChron Center Laser Ablation ICP Mass Spectrometry
  - U-Th-Pb of detrital zircons (figure 3)
  - Ages sorted into accepted (283 zircon) and rejected (30 zircon) analyses
- Data processing through IsoplotR Online
  - Analyzed >600Ma and <600Ma ages separately
  - Age distribution and Concordia plots shown together
    - Data accepted if near Concordia curve

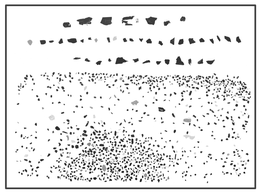

Figure 3: Detrital zircon analyzed from Phyllite. 315 zircons were picked from all collected for mass spectrometry. Known standard zircons lined up on top. Photo from Arizona LaserChron Center.

Results

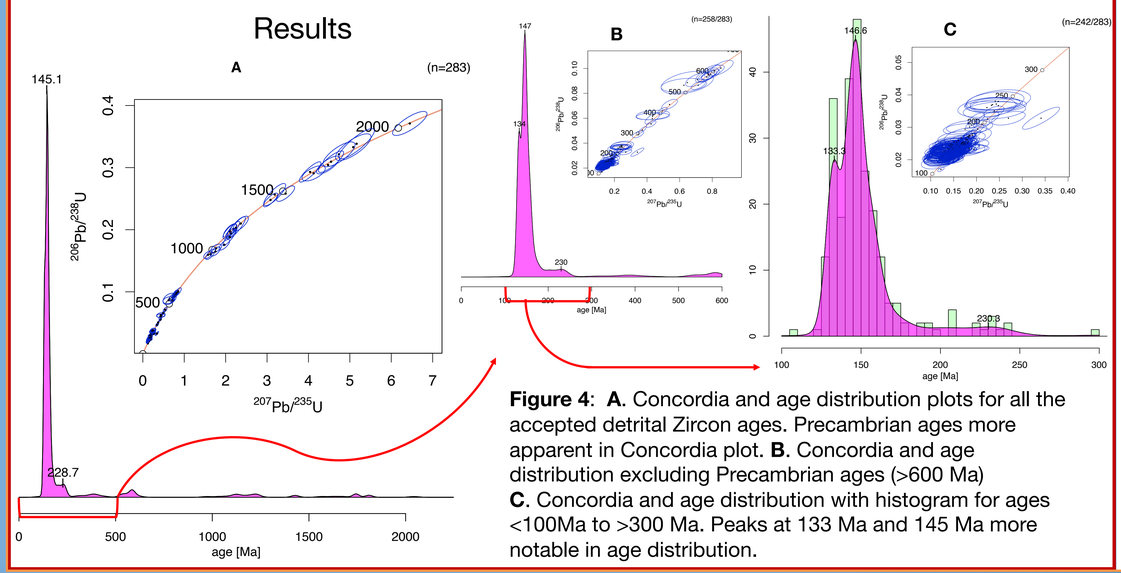

Figure 4: **A**. Concordia and age distribution plots for all the accepted detrital Zircon ages. Precambrian ages more apparent in Concordia plot. **B**. Concordia and age distribution excluding Precambrian ages (>600 Ma) **C**. Concordia and age distribution with histogram for ages <100Ma to >300 Ma. Peaks at 133 Ma and 145 Ma more notable in age distribution.

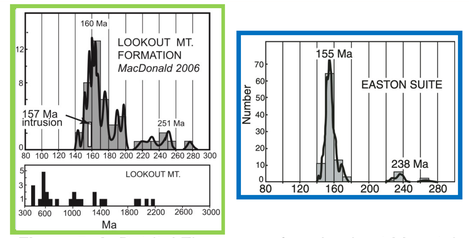

Figure 5: **A.** Detrital Zircon ages from Lookout Mountain formation **B.** Detrital Zircon ages of Easton Suite from the San Juan Island- Northern Cascades thrust system. Figures from Brown et al., 2007.

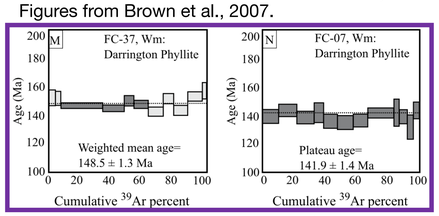

Figure 6: Age spectra collected from Ar/Ar from Mica in Darrington Phyllite, which yielded metamorphic ages from the youngest metamorphic fabric. Data from Cordova et al., 2018.

Discussion

- Prominent peaks at 133 Ma and 145 Ma → significant sediment accumulation during those times (figure 4C)
- Sharp drop in sediment input at about 125 Ma signifies the approximate age from when the basin closed (figure 4C)
  - The young peak at 133 Ma compared to metamorphic ages of 148.5±1.3 Ma and 141.9±1.4 Ma (figure 6) from Darrington Phyllite means that a different basin must have been open while Darrington phyllite was cooling its last metamorphic fabric.
- Precambrian zircon tail in our data (figure 4A) is not present in other Easton suite constituents West of the Straight Creek Fault (figure 5B), but can be found in the Lookout Mountain formation (figure 5A) located in the Manastash inlier South of our sample area (figure 2A)
  - The lack of this tail in Darrington means there was a different basin sediment input in our sample and surrounding rocks that does not align with Darrington.

Conclusion

- Differences in the age and accretion history of Darrington phyllite and the sample phyllite mean that the two rock units must have accreted in different arc-related basins that were subject to similar metamorphic conditions
  - The phyllite found between the Kaches and Cle Elum Lakes should not be considered Darrington phyllite
- Uncertainty in the movement of the Straight Creek fault brings up a question of where our sample basin was deposited before being offset by the fault

Acknowledgements

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